Appendix 1A
Published Advertisements

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The Mayor of Palm Bay presents his February 2024 message
Page 17

Indiafest: Celebrando la cultura y la comunidad en Melbourne

INDIA: Viene de la página 1

Iniciado en 1996 mediante los esfuerzos sinceros de la comunidad étnica india, Indiafest ha evolucionado hasta convertirse en un símbolo de enriquecimiento cultural, acogido con entusiasmo por los habitantes locales. Cada año, el festival presenta un tema único que destaca diversos aspectos de la cultura india. El tema de este año, "De Cero a Infinito", resalta las significativas contribuciones de la India a las matemáticas, la ciencia y la tecnología, desde la invención del cero hasta el sistema decimal y el reciente logro histórico de aterrizar en el Polo Sur de la Luna.

Un aspecto notable de Indiafest es su compromiso con devolver a la comunidad. Como organización cultural sin fines de lucro, Indiafest es conocida por sus esfuerzos caritativos, apoyando a organizaciones benéficas locales como Manav Mandir y ayudando en los esfuerzos de recuperación ante desastres tanto a nivel nacional como internacional. A lo largo de los años, la organización ha recaudado y donado más de $1.4 millones, reflejando la creencia de la comunidad en su misión de fomentar la armonía cultural y apoyar causas dignas. En 2022, Indiafest inició una beca de dotación de $100,000 con el Eastern Florida State College para ayudar a estudiantes merecedores, y este año, el festival ha elegido apoyar a Aging Matters of Brevard y al Children Hunger Project.

Indiafest ofrece algo para todos, incluidas actividades prácticas para jóvenes, juegos para niños, compras para adultos, demostraciones de yoga, entretenimiento durante todo el día y deliciosa comida india. El puesto Descubre India proporcionará información y exposiciones que muestran las contribuciones de la India a STEM, mientras que el escenario contará con actuaciones de artistas locales que exhibirán música tradicional folclórica, clásica y moderna de la India. El desfile de moda promete ser uno de los aspectos más destacados del evento, y los asistentes pueden participar en rifas para ganar emocionantes premios. Los entusiastas de la comida pueden visitar el puesto de cocina para probar recetas indias, mientras que el recinto del festival estará lleno de vendedores que ofrecen prendas étnicas, joyas y artesanías.

En el mundo interconectado de hoy, fomentar la apreciación por diferentes culturas es más importante que nunca. En Indiafest, los asistentes experimentarán la riqueza de la cultura india a través de artes, artesanías, comida, joyas, música, danza y ropa. El festival ofrece una oportunidad única para sumergirse en los aspectos tradicionales y vibrantes de la cultura india.

¡Únete a nosotros para el 27º Indiafest el sábado 9 de marzo y el domingo 10 de marzo en el parque Wickham de Melbourne! Los boletos cuestan $8 para adultos, $4 para niños menores de 12 años y son gratuitos para niños menores de 5 años. Evita las filas comprando tus boletos por adelantado en línea en indiafestbrevard.org. ¡Ven y celebra la cultura y la comunidad en Indiafest!

Photo: For AL DIA TODAY

¡Únete a nosotros para el 27º Indiafest el sábado 9 de marzo y el domingo 10 de marzo en el parque Wickham de Melbourne! Los boletos cuestan $8 para adultos, $4 para niños menores de 12 años y son gratuitos para niños menores de 5 años.

Photo: For AL DIA TODAY

Join us for the 27th Indiafest on Saturday, March 9th, and Sunday, March 10th, at Wickham Park in Melbourne. Tickets are $8 for adults, $4 for children under 12, and free for children under 5. Avoid the lines by purchasing tickets in advance online at indiafestbrevard.org.

Indiafest: Celebrating Culture and Community in Melbourne

INDIA: Jumps from page 1

This fun-filled family event brings the vibrant culture, rich history, and colorful traditions of India to the Space Coast.

Started in 1996 through the earnest efforts of the Indian ethnic community, Indiafest has evolved into a symbol of cultural enrichment, eagerly embraced by locals. Each year, the festival presents a unique theme showcasing various aspects of Indian culture. This year's theme, "Zero to Infinity," highlights India's significant contributions to mathematics, science, and technology, from the invention of zero to the decimal system and the recent landmark achievement of landing on the South Pole of the Moon.

One remarkable aspect of Indiafest is its commitment to giving back to the community. As a non-profit cultural organization, Indiafest is renowned for its charitable endeavors, supporting local charities like Manav Mandir and aiding in disaster recovery efforts both nationally and internationally. Over the years, the organization has raised and donated over $1.4 million, reflecting the community's belief in its mission of fostering cultural harmony while supporting worthy causes. In 2022, Indiafest initiated a $100,000 endowment scholarship with Eastern Florida State College to assist deserving students, and this year, the festival has chosen to support Aging Matters of Brevard and the Children Hunger Project.

Indiafest offers something for everyone, including hands-on activities for youth, games for children, shopping for adults, yoga demonstrations, all-day entertainment, and mouth-watering Indian cuisine. The Discover India booth will provide information and displays showcasing India's STEM contributions, while the stage will feature performances by local artists showcasing traditional folk, classical, and modern Indian music. The fashion show promises to be a highlight of the event, and attendees can participate in raffle drawings to win exciting prizes. Food enthusiasts can visit the cooking booth to sample Indian recipes, while the festival grounds will be bustling with vendors selling ethnic garments, jewelry, and arts and crafts.

In today's interconnected world, fostering appreciation for different cultures is more important than ever. At Indiafest, attendees will experience the richness of Indian culture through arts, crafts, food, jewelry, music, dance, and clothing. The festival offers a unique opportunity to immerse oneself in the traditional and vibrant aspects of Indian culture.

Join us for the 27th Indiafest on Saturday, March 9th, and Sunday, March 10th, at Wickham Park in Melbourne. Tickets are $8 for adults, $4 for children under 12, and free for children under 5. Avoid the lines by purchasing tickets in advance online at indiafestbrevard.org. Come and celebrate culture and community at Indiafest!

DSAB

Continued from Page 3A

babies born in the country have Down syndrome. This means that Down syndrome occurs in about one in every 700 babies.

Back in 2007, a group of Brevard moms "on the unexpected journey of Down syndrome" started the local group. The volunteers involved today share the founders' vision as well as the passion and love for someone with Down syndrome. Timberlake said DSAB is involved with 75 Brevard families on a regular basis. She's hoping the new facility will increase the organization's visibility and its community offerings.

"It gives our families a place to call home when they have questions," Timberlake said. "I was meeting with parents at Starbucks regarding their prebirth diagnosis and it will be much more comfortable having that conversation in our own space, on a comfy couch."

Timberlake has a daughter born in 2014 with Down syndrome, and understands it can be scary and overwhelming when soon-to-be parents get this news about their unborn child. "Often times they don't understand or know what Down syndrome is," Timberlake said. "A lot of us get a negative feeling, question 'Is it our fault? Why did this happen to us?' I take time to bring in current families, let them meet a baby, an adult and allow them to meet the family."

The new space has a small office, storage space and a recreational area that can accommodate about 20 people. The space is intended to serve as a one-stop shop for individuals with Down syndrome and their families where they can take classes, listen to guest speakers, participate in seminars or just gather with friends.

Executive Director Victoria Timberlake shows Jenna Rothenbush the photo of Jenna with her friends that hangs on the wall in the Down Syndrome Association of Brevard's new officce in Cocoa. MALCOLM DENEMARK/FLORIDA TODAY

That's what Jenna Rothenbush, 18, is most looking forward to. Rothenbush has been using services offered by DSAB for several years.

"I like art club," Rothenbush said, referring to the classes that were previously held once a month at a church.

A big canvas photo of Rothenbush posing with two friends hangs on the wall in the new facility. Rothenbush was even more excited by one of the other large photos hanging on the wall. "That's my best friend, Mya," Rothenbush said pointing to a photo near the front of the building, which is decorated with photos of locals who have benefitted from DSAB.

Down Syndrome Association of Brevard

4200 SR 524, Suite 101 Cocoa, FL 32926

321-576-3296

info@dsabrevard.org

Hours: Monday - Friday 9 am - 2 pm or by appointment

Candace Whiting, 38, walked around the new office space eager for what's to come. Whiting takes exercise classes held by DSAB, is co-captain of a Special Olympics cheerleading team and has taken trips to Washington D.C. to speak with politicians about her condition.

"I'm very excited for everyone involved," Whiting said. "It provides opportunity."

Eventually the goal is to offer vocational training and possibly even a school. Right now Timberlake is the only paid employee. A board, as well as other volunteers, help provide support. Eventually the organization hopes to get to a place where more employees are hired, possibly even individuals with Down syndrome.

Most of the organization support comes from two yearly fundraisers, a Buddy Walk in November and the Down for Derby Gala in May. "These people are important and they are capable of so much," Timberlake said. "We are bringing them to the forefront and showing what they are capable of, which is so many things."

Spitzer can be reached at Mspitzer@floridatoday.com.

Immigration

Continued from Page 3A

whether Florida had legal standing to challenge the immigration policies. Plaintiffs must show standing before judges have jurisdiction to decide cases.

While Tuesday's one-paragraph order remanding the case to Wetherell did not provide a detailed explanation, the U.S. Supreme Court decided in June that Texas and Louisiana did not have standing to challenge Biden administration immigration-enforcement policies. That opinion came after the federal government appealed Wetherell's rulings in the Florida case.

The Supreme Court opinion said the Texas and Louisiana case "implicates the executive branch's enforcement discretion and raises the distinct question of whether the federal judiciary may in effect order the executive branch to take enforcement actions."

"In short, this (Supreme) Court's precedents and longstanding historical practice establish that the states' suit here is not the kind redressable by a federal court," the Supreme Court decision said.

Gov. Ron DeSantis and state Attorney General Ashley Moody have made a high-profile issue of challenging federal immigration policies as migrants have streamed across the country's southwestern border.

The state filed a lawsuit in September 2021 alleging that the Biden administration violated laws through "catch-and-release" policies that led to people being released from detention after crossing the border. The state has contended that undocumented immigrants move to Florida and create costs for such things as the education, health-care and prison systems.

Wetherell, a former state appellate judge who was appointed to the federal bench by former President Donald Trump, issued rulings in March 2023 and May 2023 that said immigration policies known as "Parole Plus Alternatives to Detention" and "Parole with Conditions" violated federal law.

The Biden administration went to the Atlanta-based appeals court in May. After the Supreme Court ruling in the Texas and Louisiana case, U.S. Department of Justice attorneys filed a brief in July arguing the appeals court should reject the Florida case for similar reasons.

"In United States v. Texas, the Supreme Court held that two states lacked standing to challenge DHS's (the U.S. Department of Homeland Security's) immigration enforcement policies because they lacked 'a legally and judicially cognizable' injury where their alleged injury were costs associated with having more noncitizens in their states. Florida similarly fails to satisfy the 'bedrock constitutional requirement' of standing," the Justice Department brief said.

But on June 26, just three days after the Supreme Court opinion, state attorneys filed a brief that tried to differentiate the cases. As an example, they said the Texas and Louisiana case involved policies related to arresting and starting removal proceedings against migrants who crossed the U.S. border, while the Florida case involves "parole" policies that involve releasing people.

"Because the parole policies are not enforcement policies — because they both concern only detention and grant affirmative legal benefits — Florida has a judicially cognizable interest in remedying the sovereign and financial injuries they cause," the state's lawyers wrote.

A panel of the appeals court heard arguments in the case Jan. 26. In Tuesday's order, the appeals court directed Wetherell to make a determination on the jurisdiction issue and then return the court to the higher court for "further proceedings."

Melbourne to hold Black History Celebration

Enjoy speakers, artwork, culture at Eddie Lee Taylor, Sr. Community Center

By Chris Bonanno

For Hometown News

MELBOURNE — The City of Melbourne will hold its annual Black History Celebration on Friday, Feb. 23 from 4 to 6 p.m. at the Eddie Lee Taylor, Sr. Community Center, 3316 S. Monroe St., according to Gina Petereins, marketing and development administrator with Melbourne Parks and Recreation.

"It's a cultural history event," Petreins said. "There will be demonstrations, guest speakers, artwork and refreshments and we're doing this along with Club Esteem."

Petreins added that would be skits performed "in conjunction with Club Esteem," and there would be "games and prizes" at the event as well.

"The kids are going to be able to participate in this and there's going to be cultural art in the form of African masks," she said.

Petreins also indicated that there would be booths set up at the event featuring Black-owned businesses and from Historically Black Colleges and Universities.

Per the website, admission is free to what Petreins referred to as a "family event."

"We love events like this, because it gets the community involved and it's also a teaching experience. It allows people to see things hands-on and learn the cultural history, it's a lot of fun," she said.

Those interested in more information about the event may contact (321) 608-7450.

Did you feel the shaker?

4.0 earthquake centered east of Cape Canaveral

By Chris Bonanno

For Hometown News

An earthquake that measured a 4.0 on the Richter Scale was centered just over 100 miles east of Cape Canaveral on Wednesday night, Feb. 7, according to the United States Geological Survey.

The quake had a depth of 10 km, or just over 6.2 mi., the USGS added.

"That magnitude of earthquake, even if it had been an epicenter right over land, probably wouldn't have been very noticeable and probably would not have damaged any buildings," Bleakley said.

Shaking of a 2.5 magnitude on the Richter Scale may have been felt in northern beachside areas of Brevard, including at the Kennedy Space Center, according to an interactive map from the USGS.

Even if the earthquake was centered over land and had been stronger, many newer Brevard buildings would have had a leg up in terms of not sustaining damage if such an event were to ever occur, Bleakley indicated.

"The fact that we design here for wind loads due to a hurricane means that we have a lot of extra safety factors for loads we didn't expect … If I'm a beam or a girder inside of a building, if I'm designed to take a very large wind load then if a little earthquake comes along, basically,-' the beam is way stronger than what's needed," Bleakley said.

The Richter Scale, Bleakley noted, is designed to be an "indicator of the amount of energy that the earthquake has" with higher numbers indicating exponentially higher intensity.

Those interested in more information about this earthquake, others around the world and accessing past earthquake information should visit www.usgs.gov.

Catch of the Week

Bella Edwards, 9, of Rockledge caught this tiny fish in the Indian River at Riverway in Rockledge. She used shrimp as her bait to catch the 3-incher. You can tell by her big smile that she was having a great time fishing! Of course, they let this little baby go back to its fishy family. Kiss a fish for luck, Bella!

To submit your fish story, go to www.hometownnewstc.com, scroll to the bottom of the landing page; click on Submission Forms and choose Catch of the Week. Include your name, hometown city, age if under 18, species and size of fish, bait used and general area in which you caught the fish, and a phone number in case we need to contact you. Don't forget to attach a photo.

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Appendix 1B
Copy of Notice of Intent

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cannot guarantee that we will be able to do so.

Sheleen Dumas,

Department PRA Clearance Officer, Office of the Under Secretary for Economic Affairs, Commerce Department.

[FR Doc. 2024–03513 Filed 2–20–24; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF COMMERCE

Patent and Trademark Office

[Docket No. PTO–C–2023–0056]

National Medal of Technology and Innovation Nomination Evaluation Committee Charter Renewal

AGENCY: United States Patent and Trademark Office, Commerce.

ACTION: Notice.

SUMMARY: The Department of Commerce has renewed the charter for the National Medal of Technology and Innovation Nomination Evaluation Committee (NMTI Committee) for an additional two-year period, as it is a necessary committee that is in the public interest. The charter is renewed until February 8, 2026.

FOR FURTHER INFORMATION CONTACT: Linda Hosler, Program Manager, NMTI Program, United States Patent and Trademark Office, 600 Dulany Street, Alexandria, VA 22314; 571–272–8514; or *nmti@uspto.gov.* Information is also available at *www.uspto.gov/nmti.*

SUPPLEMENTARY INFORMATION: The NMTI Committee was established in accordance with 15 U.S.C. 1512 and the provisions of the Federal Advisory Committee Act, 5 U.S.C. 1001 *et seq.* The NMTI Committee members are distinguished experts from the private and public sectors, with experience in and an understanding of technology and technological innovation. The NMTI Committee provides recommendations of nominees for the NMTI. The duties of the NMTI Committee are solely advisory in nature. Nominations for the NMTI are solicited through an open, competitive, and nationwide call, and the NMTI Committee members are responsible for reviewing the nominations received. The NMTI Committee forwards its recommendations, through the Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office, to the President.

On December 22, 2023, the Secretary of Commerce approved the continuance of the NMTI Committee. On February 7, 2024, the Deputy Assistant Secretary for Administration, Performing the non-exclusive functions and duties of the Chief Financial Officer and Assistant Secretary for Administration, signed the charter for the NMTI Committee. This charter will terminate two years from the date of its filing with the standing committees of the United States Senate and the House of Representatives having legislative jurisdiction over the United States Patent and Trademark Office unless earlier terminated or renewed by proper authority. The charter was filed on February 8, 2024, and it expires on February 8, 2026.

Katherine K. Vidal,

Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office.

[FR Doc. 2024–03526 Filed 2–20–24; 8:45 am]

BILLING CODE 3510–16–P

DEPARTMENT OF DEFENSE

Department of the Air Force

Notice of Intent To Prepare an Environmental Impact Statement for SpaceX Starship-Super Heavy Operations at Cape Canaveral Space Force Station

AGENCY: Department of the Air Force, Department of Defense; Federal Aviation Administration; National Aeronautics and Space Administration; and United States Coast Guard.

ACTION: Notice of intent.

SUMMARY: The Department of the Air Force is the lead agency for this notice. The Federal Aviation Administration is a cooperating agency and the National Aeronautics and Space Administration and U.S. Coast Guard were invited to be cooperating agencies for this action. The Department of the Air Force (DAF) is issuing this Notice of Intent (NOI) to prepare an environmental impact statement (EIS) to evaluate the potential environmental impacts associated with (1) the execution of a real property agreement between the United States Space Force (USSF) and Space Exploration Technologies Corp. (SpaceX), which would enable SpaceX to develop a launch site to support Starship-Super Heavy operations, including launch and landing at Cape Canaveral Space Force Station (CCSFS), and (2) the Federal Aviation Administration's (FAA) issuance of a vehicle operator license at the selected launch site and approval of related airspace closures.

DATES: A public scoping period will take place starting from the date of this NOI publication in the **Federal Register** and will last for 30 days. Comments will be accepted at any time during the environmental impact analysis process; however, to ensure the DAF has sufficient time to consider public scoping comments during preparation of the Draft EIS, please submit comments within the 30-day scoping period.

The DAF invites the public, stakeholders, and other interested parties to attend one or more of the three in-person public scoping meetings or the virtual public scoping meeting. In-person meetings will be held March 5 at Catherine Schweinsberg Rood Central Library, 308 Forrest Ave., Cocoa, FL 32922; March 6 at Titusville Civic Center, 4220 S Hopkins Ave., Titusville, FL 32780; and March 7 at Radisson Resort At The Port, 8701 Astronaut Blvd., Cape Canaveral, FL 32920. Each in-person scoping meeting will take place from 4 to 7 p.m. A virtual meeting is scheduled for March 12 at 6 p.m. Information on how to attend the virtual meeting is available on the project website (*SpaceForceStarshipEIS.com*). The meetings will provide an opportunity for attendees to learn more about the Proposed Action and Alternatives and provide an early and open process to assist the DAF and its Cooperating Agencies in determining the scope of issues for analysis in the EIS, including identifying significant environmental issues and eliminating from further study non-significant issues. Scope consists of the range of actions, alternatives, and impacts to be considered in the EIS. Project team members will be available to answer questions and there will also be an opportunity to provide oral and written comments. Scoping meeting materials will be provided in English and Spanish.

The Notice of Availability (NOA) of the Draft EIS is anticipated in December 2024 and the NOA for the Final EIS is anticipated in September 2025. A decision could be made no earlier than 30 days after the Final EIS.

ADDRESSES: The project website (*SpaceForceStarshipEIS.com*) provides information related to the EIS, such as environmental documents, schedule, and project details, as well as a comment form. Comments may be submitted via the website comment form, emailed to *ContactUs@SpaceForceStarshipEIS.com,* or mailed to CCSFS Starship EIS c/o Jacobs, 5401 W Kennedy Blvd., Suite 300, Tampa, Florida 33609. Members of the public who want to receive future mailings informing them of the availability of the Draft EIS and Final EIS are encouraged to submit a comment that includes their name and email or postal mailing address. For other inquiries, please contact Ms. Molly Thrash, NEPA Project Manager at *ContactUs@SpaceForceStarshipEIS.com* or 1–813–954–5608.

SUPPLEMENTARY INFORMATION: The purpose for the DAF's Proposed Action is to advance U.S. space capabilities and provide launch and landing infrastructure in furtherance of U.S. policy to ensure capabilities necessary to launch and insert national security payloads into space (United States Code [U.S.C.] Title 10, Section 2273, ''Policy regarding assured access to space: national security payloads'').

The need for the DAF's Proposed Action is to ensure National Security Space Launch Assured Access to Space without compromising current launch capabilities and fulfill (in part) U.S. Congress's grant of authority to the Secretary of Defense, pursuant to 10 U.S.C. 2276(a), ''Commercial space launch cooperation,'' that the Secretary of Defense is permitted to take action to maximize the use of the capacity of the space transportation infrastructure of the Department of Defense (DOD) by the private sector in the U.S.; maximize the effectiveness and efficiency of the space transportation infrastructure of the DOD; reduce the cost of services provided by the DOD related to space transportation infrastructure at launch support facilities and space recovery support facilities; encourage commercial space activities by enabling investment by covered entities in the space transportation infrastructure of the DOD; and foster cooperation between DOD and covered entities.

The DAF has identified a Proposed Action alternative, one reasonable action alternative (Alternative 1), and the No Action Alternative to be carried forward for analysis in the EIS. Under the Proposed Action, SpaceX would modify, reuse, or demolish the existing Space Launch Complex (SLC)-37 infrastructure at CCSFS to support Starship-Super Heavy launch and landing operations. Under Alternative 1, leasing SLC–50 at CCSFS, SpaceX would construct infrastructure to support Starship-Super Heavy launch and landing operations on a site that is currently undeveloped. Under the No Action Alternative, USSF would not enter into a real property agreement with SpaceX, SpaceX would not develop a launch and landing site in support of Starship-Super Heavy launches, and SpaceX would not apply for an FAA vehicle operator license for Starship-Super Heavy launches at either of the alternative SLCs under consideration.

Potential impacts may include noise, air quality, and hazardous material effects associated with operations and construction, as well as effects on biological and cultural resources because of ground disturbance and operational noise and vibrations. Implementation of the Proposed Action would potentially impact wetlands and/or floodplains, therefore this NOI initiates early public review as required per Executive Order 11988 ''Floodplain Management.'' and Executive Order 11990 ''Protection of Wetlands.''

A Federal Coastal Zone Management Act determination will be conducted and coordinated with the Florida State Clearinghouse to determine consistency of the action with the Florida Coastal Management Program. SpaceX would be required to obtain an FAA Vehicle Operator License for the Starship-Super Heavy launch vehicle at CCSFS, which could include launch, reentry, or both. A Clean Air Act Title V operating permit may be required, as well as a Clean Water Act Section 404 permit and National Pollutant Discharge Elimination System permit.

Scoping and Agency Coordination: Consultation will include, but not necessarily be limited to, consultation under Section 7 of the Endangered Species Act and consultation under Section 106 of the NHPA, to include consultation with federally recognized Native American Tribes. Regulatory agencies with special expertise in wetlands and floodplains, such as the U.S. Army Corps of Engineers, will be contacted and asked to comment. The DAF and Cooperating Agencies will determine the scope of the analysis by soliciting comments from interested local, state, and federally elected officials and agencies, federally recognized Native American tribes, as well as interested members of the public. Comments are requested on identification of potential alternatives, information, and analyses relevant to the Proposed Action.

Tommy W. Lee,

Acting Air Force Federal Register Liaison Officer.

[FR Doc. 2024–03554 Filed 2–20–24; 8:45 am]

BILLING CODE 6001–FR–P

DEPARTMENT OF DEFENSE

Office of the Secretary

Meeting of Department of Defense Federal Advisory Committees—Defense Innovation Board

AGENCY: Office of the Under Secretary of Defense for Research and Engineering, Department of Defense (DoD).

ACTION: Meeting of Federal advisory committee.

SUMMARY: The DoD is publishing this notice to announce that the following Federal Advisory Committee meeting of the Defense Innovation Board (DIB) will take place.

DATES: Open to the public Tuesday, March 5, 2024, from 4:00 p.m. to 4:45 p.m.

ADDRESSES: The open meeting will take place virtually, via the Defense Visual Information Distribution Service (DVIDS).

FOR FURTHER INFORMATION CONTACT: Dr. Marina Theodotou, the Designated Federal Officer (DFO) at (571) 372–7344 (voice) or *osd.innovation@mail.mil.* Mailing address is Defense Innovation Board, 4800 Mark Center Drive, Suite 15D08, Alexandria, VA 22350–3600. Website: *https://innovation.defense.gov.* The most up-to-date changes to the meeting agenda and link to the virtual meeting can be found on the website.

SUPPLEMENTARY INFORMATION: Due to circumstances beyond the control of the Designated Federal Officer and the Department of Defense, the Defense Innovation Board was unable to provide public notification required by 41 CFR 102–3.150(a) concerning its March 5, 2024 meeting. Accordingly, the Advisory Committee Management Officer for the Department of Defense, pursuant to 41 CFR 102–3.150(b), waives the 15-calendar day notification requirement.

This meeting is being held under the provisions of chapter 10 of title 5, United States Code (U.S.C.) (commonly known as the ''Federal Advisory Committee Act'' or ''FACA'') and 41 Code of Federal Regulations (CFR) 102–3.140 and 102–3.150.

Purpose of Meeting: The mission of the DIB is to provide the Secretary of Defense, the Deputy Secretary of Defense, and the Under Secretary of Defense for Research and Engineering (USD(R&E)) independent advice and strategic insights on emerging and disruptive technologies and their impact on national security, adoption of commercial sector innovation best practices, and ways to leverage the U.S.

Appendix 1C
Tribal Letters

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DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

February 21, 2024

Subject: Environmental Impact Statement for SpaceX Starship-Super Heavy Operations at Cape Canaveral Space Force Station

The Department of the Air Force (DAF) is preparing an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts associated with (1) the execution of a real property agreement between the United States Space Force (USSF) and Space Exploration Technologies Corp. (SpaceX), which would enable SpaceX to develop a launch site to support Starship-Super Heavy operations, including launch and landing at Cape Canaveral Space Force Station (CCSFS), and (2) the Federal Aviation Administration's (FAA) issuance of a vehicle operator license at the selected launch site and approval of related airspace closures.

The DAF has identified a Proposed Action alternative, one reasonable action alternative (Alternative 1), and the No Action Alternative to be carried forward for analysis in the EIS. Under the Proposed Action, SpaceX would modify, reuse, or demolish the existing Space Launch Complex (SLC)-37 infrastructure at CCSFS to support Starship-Super Heavy launch and landing operations. Under Alternative 1, SpaceX would construct infrastructure to support Starship-Super Heavy launch and landing operations at SLC-50, which is currently undeveloped. Under the No Action Alternative, USSF would not enter into a real property agreement with SpaceX, SpaceX would not develop a launch and landing site in support of Starship-Super Heavy launches, and SpaceX would not apply for an FAA vehicle operator license for Starship-Super Heavy launches at either of the alternative SLCs under consideration.

Per Section 306108 of the National Historic Preservation Act (NHPA) and its implementing regulations at 36 Code of Federal Regulations (CFR) Part 800, the DAF is engaging early with tribal governments as the lead federal agency. In accordance with NHPA, DAF would like to initiate government-to-government consultation regarding the Proposed Action. The DAF is the lead federal agency and is preparing this EIS in accordance with the National Environmental Policy Act (NEPA), as amended (*United States Code* Title 42, Section 4321, et seq.); the Council on Environmental Quality's regulations for Implementing the Procedural Provisions of NEPA *Code of Federal Regulations* [CFR] Title 40, Parts 1500 through 1508); the U.S. Air Force's NEPA implementing regulations (32 CFR Part 989) and policy; and FAA Order 1050.1F Environmental Impacts: Policies and Procedures, and FAA Order 1050.1F Desk Reference. Because of their jurisdiction and special expertise related to the Proposed Action, the FAA, National Aeronautics and Space Administration (NASA), and U.S. Coast Guard are cooperating agencies in the development of the EIS.

As required by 32 CFR Part 989, DAF requests your input on the Proposed Action and assistance in identifying any potential areas of environmental impact to be assessed in this analysis. Additionally, please advise if this undertaking might adversely affect any historic properties of religious and cultural significance to your tribe. If you have any specific items of interest about this proposal, please contact

Ms. Molly Thrash via email at ContactUs@SpaceForceStarshipEIS.com by March 22, 2024. Thank you in advance for your assistance in the effort.

Sincerely

Michael Blaylock, NH-03, DAF
Chief, Environmental Conservation

Appendix 3.1A
Air Conformity Applicability Model (ACAM) Results

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AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

1. General Information: The Air Force's Air Conformity Applicability Model (ACAM) was used to perform a net change in emissions analysis to assess the potential air quality impact/s associated with the action. The analysis was performed in accordance with the Air Force Manual 32-7002, *Environmental Compliance and Pollution Prevention*; the *Environmental Impact Analysis Process* (EIAP, 32 CFR 989); the *General Conformity Rule* (GCR, 40 CFR 93 Subpart B); and the *USAF Air Quality Environmental Impact Analysis Process (EIAP) Guide*. This report provides a summary of the ACAM analysis.

Report generated with ACAM version: 5.0.24a

a. Action Location:
Base: CAPE CANAVERAL AFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

b. Action Title: SpaceX Starship-Super Heavy

c. Project Number/s (if applicable):

d. Projected Action Start Date: 1 / 2026

e. Action Description:

Proposed Action: SpaceX would modify, reuse, and/or demolish the existing SLC-37 infrastructure at CCSFS to support Starship-Super Heavy launch and landing operations. SLC 37, located at CCSFS, supports the Delta IV Heavy launch vehicle, but the SLC will be available likely by the end of 2024. In the Range of the Future Cape Canaveral Space Force Station District Plan (USSF 2022), USSF identifies a need to reallocate SLC-37 as a medium- or heavy-lift to a future launch provider after the completion of the remaining scheduled Delta IV Heavy launches.

Alternative 1: SpaceX would construct infrastructure to support Starship-Super Heavy launch and landing operations on a site that is currently undeveloped. SLC-50 would become a new SLC between SLC-40 and SLC-37. In the Range of the Future Cape Canaveral Space Force Station District Plan (USSF 2022), USSF identifies the need for a new medium- or heavy-lift launch site in this area. To support a super-heavy lift launch site at this location, USSF would re designate the area as SLC-50. Additionally, Phillips Parkway would be realigned to the east of the complex to avoid encompassing Titan Road in Starship-Super Heavy's blast danger area.

f. Point of Contact:
Name: Caitlin Santinelli
Title: Scientist
Organization: Jacobs
Email: caitlin.santinelli@jacobs.com
Phone Number:

2. Air Impact Analysis: Based on the attainment status at the action location, the requirements of the GCR are:

____ applicable
__X__ not applicable

Total reasonably foreseeable net direct and indirect emissions associated with the action were estimated through ACAM on a calendar-year basis for the start of the action through achieving "steady state" (cCba.e., no net gain/loss in emission stabilized and the action is fully implemented) emissions. The ACAM analysis uses the latest and most accurate emission estimation techniques available; all algorithms, emission factors, and methodologies used are described in detail in the *USAF Air Emissions Guide for Air Force Stationary Sources*, the *USAF Air Emissions Guide for Air Force Mobile Sources*, and the *USAF Air Emissions Guide for Air Force Transitory Sources*.

"Insignificance Indicators" were used in the analysis to provide an indication of the significance of the proposed Action's potential impacts to local air quality. The insignificance indicators are trivial (de minimis) rate thresholds that have been demonstrated to have little to no impact to air quality. These insignificance indicators are the 250 ton/yr Prevention of Significant Deterioration (PSD) major source threshold and 25 ton/yr for lead for actions occurring in areas that are "Attainment" (cCba.e., not exceeding any National Ambient Air Quality Standard (NAAQS)). These indicators do not define a significant impact; however, they do provide a threshold to identify actions that are insignificant. Any action with net emissions below the insignificance indicators for all criteria pollutants is considered so insignificant that the action will not cause or contribute to an exceedance on one or more NAAQS. For further detail on insignificance indicators, refer to *Level II, Air Quality Quantitative Assessment, Insignificance Indicators*.

The action's net emissions for every year through achieving steady state were compared against the Insignificance Indicators and are summarized below.

Analysis Summary:

2026

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	2.072	250	No
NOx	12.390	250	No
CO	12.842	250	No
SOx	0.027	250	No
PM 10	71.182	250	No
PM 2.5	0.470	250	No
Pb	0.000	25	No
NH3	0.040	250	No

2027 (Steady-State)

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.834	250	No
NOx	0.361	250	No
CO	10.997	250	No
SOx	0.008	250	No
PM 10	0.064	250	No
PM 2.5	0.021	250	No
Pb	0.000	25	No
NH3	0.116	250	No

None of the estimated annual net emissions associated with this action are above the insignificance indicators; therefore, the action will not cause or contribute to an exceedance of one or more NAAQSs and will have an insignificant impact on air quality. No further air assessment is needed.

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

Caitlin Santinelli, Scientist	Apr 24 2025
Name, Title	**Date**

AIR CONFORMITY APPLICABILITY MODEL REPORT
GREENHOUSE GAS (GHG) EMISSIONS

1. General Information: The Air Force's Air Conformity Applicability Model (ACAM) was used to perform a net change in emissions analysis to estimate GHG emissions associated with the action. The analysis was performed in accordance with the Air Force Manual 32-7002, *Environmental Compliance and Pollution Prevention*; the *Environmental Impact Analysis Process* (EIAP, 32 CFR 989); and the *USAF Air Quality Environmental Impact Analysis Process (EIAP) Guide*. This report provides a summary of the GHG emissions analysis.

Report generated with ACAM version: 5.0.24a

a. Action Location:
Base: CAPE CANAVERAL SFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

b. Action Title: SpaceX Starship-Super Heavy

c. Project Number/s (if applicable):

d. Projected Action Start Date: 1 / 2026

e. Action Description:

Proposed Action: SpaceX would modify, reuse, and/or demolish the existing SLC-37 infrastructure at CCSFS to support Starship-Super Heavy launch and landing operations. SLC 37, located at CCSFS, supports the Delta IV Heavy launch vehicle, but the SLC will be likely available by the end of 2024. In the Range of the Future Cape Canaveral Space Force Station District Plan (USSF 2022), USSF identifies a need to reallocate SLC-37 as a medium- or heavy-lift to a future launch provider after the completion of the remaining scheduled Delta IV Heavy launches.

f. Point of Contact:

Name: Caitlin Santinelli
Title: Scientist
Organization: Jacobs
Email: caitlin.santinelli@jacobs.com
Phone Number:

2. Analysis: Total combined direct and indirect GHG emissions associated with the action were estimated through ACAM on a calendar-year basis from the action's start through the action's "steady state" (SS, net gain/loss in emission stabilized and the action is fully implemented) of emissions.

GHG Emissions Analysis Summary:

GHGs produced by fossil-fuel combustion are primarily carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). These three GHGs represent more than 97 percent of all U.S. GHG emissions. Emissions of GHGs are typically quantified and regulated in units of CO2 equivalents (CO2e). The CO2e takes into account the global warming potential (GWP) of each GHG. The GWP is the measure of a particular GHG's ability to absorb solar radiation as well as its residence time within the atmosphere. The GWP allows comparison of global warming impacts between different gases; the higher the GWP, the more that gas contributes to climate change in comparison to CO2. All GHG emissions estimates were derived from various emission sources using the methods, algorithms, emission factors, and GWPs from the most current Air Emissions Guide for Air Force Stationary Sources, Air Emissions Guide for Air Force Mobile Sources, and/or Air Emissions Guide for Air Force Transitory Sources.

AIR CONFORMITY APPLICABILITY MODEL REPORT
GREENHOUSE GAS (GHG) EMISSIONS

The Air Force has adopted the Prevention of Significant Deterioration (PSD) threshold for GHG of 75,000 ton per year (ton/yr) of CO2e (or 68,039 metric ton per year, mton/yr) as an indicator or "threshold of insignificance" for NEPA air quality impacts in all areas. This indicator does not define a significant impact; however, it provides a threshold to identify actions that are insignificant (de minimis, too trivial or minor to merit consideration). Actions with a net change in GHG (CO2e) emissions below the insignificance indicator (threshold) are considered too insignificant on a global scale to warrant any further analysis. Note that actions with a net change in GHG (CO2e) emissions above the insignificance indicator (threshold) are only considered potentially significant and require further assessment to determine if the action poses a significant impact. For further detail on insignificance indicators see Level II, Air Quality Quantitative Assessment, Insignificance Indicators (April 2023).

The following table summarizes the action-related GHG emissions on a calendar-year basis through the projected steady state of the action.

Action-Related Annual GHG Emissions (mton/yr)						
YEAR	**CO2**	**CH4**	**N2O**	**CO2e**	**Threshold**	**Exceedance**
2026	2,484	0.09372127	0.05591145	2,502	68,039	No
2027 [SS Year]	903	0.03859882	0.01463173	908	68,039	No

The following U.S. and State's GHG emissions estimates (next two tables) are based on a five-year average (2016 through 2020) of individual state-reported GHG emissions (Reference: State Climate Summaries 2022, NOAA National Centers for Environmental Information, National Oceanic and Atmospheric Administration. https://statesummaries.ncics.org/downloads/).

State's Annual GHG Emissions (mton/yr)				
YEAR	**CO2**	**CH4**	**N2O**	**CO2e**
2026	227,404,647	552,428	58,049	258,255,572
2027 [SS Year]	227,404,647	552,428	58,049	258,255,572

U.S. Annual GHG Emissions (mton/yr)				
YEAR	**CO2**	**CH4**	**N2O**	**CO2e**
2026	5,136,454,179	25,626,912	1,500,708	6,251,695,230
2027 [SS Year]	5,136,454,179	25,626,912	1,500,708	6,251,695,230

GHG Relative Significance Assessment:

A Relative Significance Assessment uses the rule of reason and the concept of proportionality along with the consideration of the affected area (Rtba.e., global, national, and regional) and the degree (intensity) of the proposed action's effects. The Relative Significance Assessment provides real-world context and allows for a reasoned choice against alternatives through a relative comparison analysis. The analysis weighs each alternative's annual net change in GHG emissions proportionally against (or relative to) global, national, and regional emissions.

The action's surroundings, circumstances, environment, and background (context associated with an action) provide the setting for evaluating the GHG intensity (impact significance). From an air quality perspective, context of an action is the local area's ambient air quality relative to meeting the NAAQSs, expressed as attainment, nonattainment, or maintenance areas (this designation is considered the attainment status). GHGs are non-hazardous to health at normal ambient concentrations and, at a cumulative global scale, action-related GHG emissions can only potentially cause warming of the climatic system. Therefore, the action-related GHGs generally have an insignificant impact to local air quality.

However, the affected area (context) of GHG/climate change is global. Therefore, the intensity or degree of the proposed action's GHG/climate change effects are gauged through the quantity of GHG associated with the action as compared to a baseline of the state, U.S., and global GHG inventories. Each action (or alternative) has significance, based on their annual net change in GHG emissions, in relation to or proportionally to the global, national, and regional annual GHG emissions.

To provide real-world context to the GHG and climate change effects on a global scale, an action's net change in GHG emissions is compared relative to the state (where the action will occur) and U.S. annual emissions. The following table provides a relative comparison of an action's net change in GHG emissions vs. state and U.S. projected GHG emissions for the same time period.

Total GHG Relative Significance (mton)					
		CO2	**CH4**	**N2O**	**CO2e**
2026-2028	State Total	682,213,941	1,657,283	174,147	774,766,717
2026-2028	U.S. Total	15,409,362,537	76,880,735	4,502,123	18,755,085,689
2026-2028	Action	4,290	0.170919	0.085175	4,318
Percent of State Totals		0.00062890%	0.00001031%	0.00004891%	0.00055731%
Percent of U.S. Totals		0.00002784%	0.00000022%	0.00000189%	0.00002302%

From a global context, the action's total GHG percentage of total global GHG for the same time period is: 0.00000308%.*

* Global value based on the U.S. emitting 13.4% of all global GHG annual emissions (2018 Emissions Data, Center for Climate and Energy Solutions, accessed 7-6-2023, https://www.c2es.org/content/international-emissions).

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

1. General Information

- Action Location
Base: CAPE CANAVERAL SFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Action Title: SpaceX Starship-Super Heavy

- Project Number/s (if applicable):

- Projected Action Start Date: 1 / 2026

- Action Purpose and Need:
The purpose of the Action is to advance U.S. space capabilities and provide launch and landing infrastructure in furtherance of U.S. policy to ensure capabilities necessary to launch and insert necessary national security payloads into space (10 U.S.C. Section 2273, "Policy regarding assured access to space: national security payloads"). The need for the Action is to ensure National Security Space Launch Assured Access to Space without compromising current launch capabilities and fulfill (in part) the U.S. Congress's grant of authority to the Secretary of Defense, pursuant to 10 U.S.C. Section 2276(a), "Commercial space launch cooperation."

- Action Description:
Proposed Action: SpaceX would modify, reuse, and/or demolish the existing SLC-37 infrastructure at CCSFS to support Starship-Super Heavy launch and landing operations. SLC 37, located at CCSFS, supports the Delta IV Heavy launch vehicle, but the SLC will be available likely by the end of 2024. In the Range of the Future Cape Canaveral Space Force Station District Plan (USSF 2022), USSF identifies a need to reallocate SLC-37 as a medium- or heavy-lift to a future launch provider after the completion of the remaining scheduled Delta IV Heavy launches.

- Point of Contact
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Organization: Jacobs
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Phone Number:

Report generated with ACAM version: 5.0.24a

- Activity List:

	Activity Type	Activity Title
2.	Construction / Demolition	SLC-37 Footprint Grading - Phase 1
3.	Construction / Demolition	Phillips Pkwy Realignment - Phase 1
4.	Construction / Demolition	Construction of (2) Launch Pads
5.	Construction / Demolition	Construction of Launch Mounts (2)
6.	Construction / Demolition	Construction of Launch Integration Towers (2)
7.	Construction / Demolition	Construction of Launch Flame Trenches/Diverters
8.	Construction / Demolition	Construction of Landing Pads (2)
9.	Construction / Demolition	Construction of Landing Catch Towers/Test Stands (2)
10.	Construction / Demolition	Construction of Nat Gas Pretreatment System
11.	Construction / Demolition	Methane Liquifier
12.	Construction / Demolition	Air Separation Unit
13.	Construction / Demolition	GSE Fabrication Building
14.	Construction / Demolition	GSE Outdoor Storage Space

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

Activity Type		Activity Title
15.	Construction / Demolition	Office Building
16.	Construction / Demolition	Parking Lot
17.	Construction / Demolition	Propellant Commodity Storage
18.	Personnel	Personnel Commuting
19.	Construction / Demolition	Phillips Pkwy Realignment - Phase 2
20.	Construction / Demolition	Phillips Pkwy Realignment - Phase 3
21.	Construction / Demolition	SLC-37 Footpring Grading - Phase 2
22.	Construction / Demolition	SLC-37 Footprint Grading - Phase 3
23.	Construction / Demolition	SLC-37 Footpring Grading - Phase 2

Emission factors and air emission estimating methods come from the United States Air Force's Air Emissions Guide for Air Force Stationary Sources, Air Emissions Guide for Air Force Mobile Sources, and Air Emissions Guide for Air Force Transitory Sources.

2. Construction / Demolition

2.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: SLC-37 Footprint Grading - Phase 1

- Activity Description:
Grading of "fenceline" area

- Activity Start Date
Start Month: 1
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 4
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.154609
SO_x	0.002711
NO_x	1.236432
CO	1.219045

Pollutant	Total Emissions (TONs)
PM 10	14.894835
PM 2.5	0.047681
Pb	0.000000
NH_3	0.001869

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.010801
N_2O	0.002284

Pollutant	Total Emissions (TONs)
CO_2	266.359481
CO_2e	267.267274

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

2.1 Site Grading Phase

2.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

2.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 1492000
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Generator Sets Composite	50	8
Graders Composite	2	8
Other Construction Equipment Composite	2	8
Rollers Composite	1	8
Rubber Tired Dozers Composite	3	8
Scrapers Composite	6	8
Tractors/Loaders/Backhoes Composite	2	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

2.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19606	0.00488	1.74061	1.53912	0.06788	0.06245
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02381	0.00476	586.91372	588.92786
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Scrapers Composite [HP: 423] [LF: 0.48]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02145	0.00429	528.85412	530.66901
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

2.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)

VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

3. Construction / Demolition

3.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Phillips Pkwy Realignment - Phase 1

- Activity Description:
Widening of existing Parkway

- Activity Start Date
Start Month: 1
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 8
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.089781
SO_x	0.001596
NO_x	0.710228
CO	0.821969

Pollutant	Total Emissions (TONs)
PM 10	3.182381
PM 2.5	0.027971
Pb	0.000000
NH_3	0.000897

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.007041
N_2O	0.001843

Pollutant	Total Emissions (TONs)
CO_2	175.469968
CO_2e	176.155470

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

3.1 Site Grading Phase

3.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

3.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 158400
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Scrapers Composite	2	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

3.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.39317	0.00542	3.40690	4.22083	0.09860	0.09071
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.19606	0.00488	1.74061	1.53912	0.06788	0.06245
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	587.02896	589.04350
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02160	0.00432	532.54993	534.37751
Scrapers Composite [HP: 423] [LF: 0.48]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02145	0.00429	528.85412	530.66901
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020

LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

3.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase
$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

3.2 Paving Phase

3.2.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 7
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

3.2.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 237600

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Pavers Composite	1	8
Paving Equipment Composite	2	6
Rollers Composite	2	6

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

3.2.3 Paving Phase Emission Factor(s)

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- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	586.91372	588.92786

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

3.2.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)

HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
VOC_P = (2.62 * PA) / 43560 / 2000

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)
2000: Conversion Factor square pounds to TONs (2000 lb / TON)

4. Construction / Demolition

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

4.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction of (2) Launch Pads

- Activity Description:

- Activity Start Date
Start Month: 5
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.151400
SO_x	0.002060
NO_x	1.000561
CO	1.037973

Pollutant	Total Emissions (TONs)
PM 10	0.042234
PM 2.5	0.037535
Pb	0.000000
NH_3	0.003558

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.006726
N_2O	0.002087

Pollutant	Total Emissions (TONs)
CO_2	168.448683
CO_2e	169.189950

4.1 Paving Phase

4.1.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

4.1.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 320000

- Paving Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

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- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Cement and Mortar Mixers Composite	4	6
Generator Sets Composite	50	8
Pavers Composite	1	8
Paving Equipment Composite	2	6
Rollers Composite	2	6

- Vehicle Exhaust

Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

4.1.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.55280	0.00854	4.19778	3.25481	0.16332	0.15025
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02313	0.00463	570.16326	572.11992
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	N_2O	CO_2	CO_2e

Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	586.91372	588.92786

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

4.1.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_P = (2.62 * PA) / 43560 / 2000$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)
2000: Conversion Factor square pounds to TONs (2000 lb / TON)

5. Construction / Demolition

5.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction of Launch Mounts (2)

- Activity Description:

- Activity Start Date
Start Month: 7
Start Month: 2026

- Activity End Date
Indefinite: False

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End Month: 8
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.101207
SO_x	0.001523
NO_x	0.733831
CO	0.730607

Pollutant	Total Emissions (TONs)
PM 10	0.031301
PM 2.5	0.027266
Pb	0.000000
NH_3	0.002958

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.005031
N_2O	0.002774

Pollutant	Total Emissions (TONs)
CO_2	131.930889
CO_2e	132.806828

5.1 Building Construction Phase

5.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 7
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 15

5.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 7200
Height of Building (ft): 80
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Generator Sets Composite	50	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

5.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

5.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

6. Construction / Demolition

6.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction of Launch Integration Towers (2)

- Activity Description:

- Activity Start Date
Start Month: 8
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 9
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.116138
SO_x	0.002062
NO_x	1.058067
CO	0.943038

Pollutant	Total Emissions (TONs)
PM 10	0.054051
PM 2.5	0.038267
Pb	0.000000
NH_3	0.011249

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- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.007613
N_2O	0.023222

Pollutant	Total Emissions (TONs)
CO_2	292.156428
CO_2e	298.523217

6.1 Building Construction Phase

6.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 8
Start Quarter: 3
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 15

6.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 12800
Height of Building (ft): 600
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Generator Sets Composite	50	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

6.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

6.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase

VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)

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BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

7. Construction / Demolition

7.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction of Launch Flame Trenches/Diverters

- Activity Description:

- Activity Start Date
Start Month: 10
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 10
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.004865
SO_x	0.000077
NO_x	0.037502
CO	0.063568

Pollutant	Total Emissions (TONs)
PM 10	0.413055
PM 2.5	0.001077
Pb	0.000000
NH_3	0.000113

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.000343
N_2O	0.000076

Pollutant	Total Emissions (TONs)
CO_2	8.466227
CO_2e	8.496027

7.1 Trenching/Excavating Phase

7.1.1 Trenching / Excavating Phase Timeline Assumptions

- Phase Start Date

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Start Month: 10
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

7.1.2 Trenching / Excavating Phase Assumptions

- General Trenching/Excavating Information
Area of Site to be Trenched/Excavated (ft^2): 41400
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Trenching Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	2	8
Other General Industrial Equipmen Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

7.1.3 Trenching / Excavating Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.39317	0.00542	3.40690	4.22083	0.09860	0.09071
Other General Industrial Equipmen Composite [HP: 35] [LF: 0.34]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.45335	0.00542	3.58824	4.59368	0.11309	0.10404
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

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Excavators Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	587.02896	589.04350
Other General Industrial Equipmen Composite [HP: 35] [LF: 0.34]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02385	0.00477	587.87714	589.89459
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

7.1.4 Trenching / Excavating Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

8. Construction / Demolition

8.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction of Landing Pads (2)

- Activity Description:

- Activity Start Date
Start Month: 11
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.024734
SO_x	0.000369
NO_x	0.185680
CO	0.251837

Pollutant	Total Emissions (TONs)
PM 10	0.799681
PM 2.5	0.007730
Pb	0.000000
NH_3	0.000422

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.001589
N_2O	0.000471

Pollutant	Total Emissions (TONs)
CO_2	39.818045
CO_2e	39.987491

8.1 Site Grading Phase

8.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 11
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

8.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 79522
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	6
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	6
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

8.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02160	0.00432	532.54993	534.37751
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081

HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

8.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase
$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)

1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

8.2 Paving Phase

8.2.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 12
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

8.2.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 79522

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Paving Equipment Composite	2	6
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC

POVs	50.00	50.00	0	0	0	0	0

8.2.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.55280	0.00854	4.19778	3.25481	0.16332	0.15025
Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02313	0.00463	570.16326	572.11992
Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	586.91372	588.92786
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020

LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

8.2.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)

0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_P = (2.62 * PA) / 43560 / 2000$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)
2000: Conversion Factor square pounds to TONs (2000 lb / TON)

9. Construction / Demolition

9.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction of Landing Catch Towers/Test Stands (2)

- Activity Description:

- Activity Start Date
Start Month: 10
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 11
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.013694
SO_x	0.000391
NO_x	0.198519
CO	0.186145

Pollutant	Total Emissions (TONs)
PM 10	0.012189
PM 2.5	0.006968
Pb	0.000000
NH_3	0.003671

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.001812
N_2O	0.008791

Pollutant	Total Emissions (TONs)
CO_2	85.450312
CO_2e	87.830506

9.1 Building Construction Phase

9.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date

Start Month: 10
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 15

9.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 5000
Height of Building (ft): 600
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

9.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02138	0.00428	527.09717	528.90603
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

9.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

10. Construction / Demolition

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

10.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction of Nat Gas Pretreatment System

- Activity Description:

- Activity Start Date
Start Month: 9
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 9
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.004968
SO_x	0.000110
NO_x	0.041743
CO	0.064874

Pollutant	Total Emissions (TONs)
PM 10	0.001765
PM 2.5	0.001572
Pb	0.000000
NH_3	0.000127

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.000487
N_2O	0.000137

Pollutant	Total Emissions (TONs)
CO_2	12.163334
CO_2e	12.213391

10.1 Building Construction Phase

10.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 9
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

10.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 305
Height of Building (ft): 38
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes

Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips

Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

10.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

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- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

10.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

11. Construction / Demolition

11.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Methane Liquifier

- Activity Description:

- Activity Start Date
Start Month: 10
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 10

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End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.033160
SO_x	0.000492
NO_x	0.235688
CO	0.237078

Pollutant	Total Emissions (TONs)
PM 10	0.009857
PM 2.5	0.008780
Pb	0.000000
NH_3	0.000797

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.001608
N_2O	0.000469

Pollutant	Total Emissions (TONs)
CO_2	40.133485
CO_2e	40.302685

11.1 Building Construction Phase

11.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date

Start Month: 10
Start Quarter: 1
Start Year: 2026

- Phase Duration

Number of Month: 0
Number of Days: 15

11.1.2 Building Construction Phase Assumptions

- General Building Construction Information

Building Category: Office or Industrial
Area of Building (ft^2): 531
Height of Building (ft): 65
Number of Units: N/A

- Building Construction Default Settings

Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Generator Sets Composite	50	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust

Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

11.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

11.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

12. Construction / Demolition

12.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Air Separation Unit

- Activity Description:

- Activity Start Date
Start Month: 10
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 10
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.033541
SO_x	0.000506
NO_x	0.243971
CO	0.242505

Pollutant	Total Emissions (TONs)
PM 10	0.010438
PM 2.5	0.009061
Pb	0.000000
NH_3	0.001008

- Global Scale Activity Emissions of Greenhouse Gasses:

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Pollutant	Total Emissions (TONs)
CH_4	0.001674
N_2O	0.000991

Pollutant	Total Emissions (TONs)
CO_2	44.226747
CO_2e	44.536221

12.1 Building Construction Phase

12.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 10
Start Quarter: 3
Start Year: 2026

- Phase Duration
Number of Month: 0
Number of Days: 15

12.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 1800
Height of Building (ft): 120
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Generator Sets Composite	50	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

12.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

12.1.4 Building Construction Phase Formula(s)

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- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = BA * BH * (0.42 / 1000) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
VMT_{VT} = BA * BH * (0.38 / 1000) * HT

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)

BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

13. Construction / Demolition

13.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: GSE Fabrication Building

- Activity Description:
Part of the Staging, Storage, and Support Infrastructure

- Activity Start Date
Start Month: 11
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.416136
SO_x	0.002267
NO_x	1.082265
CO	1.114166

Pollutant	Total Emissions (TONs)
PM 10	0.044751
PM 2.5	0.039181
Pb	0.000000
NH_3	0.004034

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.007523
N_2O	0.003655

Pollutant	Total Emissions (TONs)
CO_2	194.954664
CO_2e	196.133822

13.1 Building Construction Phase

13.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 11

Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

13.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 23000
Height of Building (ft): 30
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	6
Forklifts Composite	2	6
Generator Sets Composite	50	8
Tractors/Loaders/Backhoes Composite	1	8
Welders Composite	3	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

13.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925

Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839
Welders Composite [HP: 46] [LF: 0.45]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.46472	0.00735	3.57020	4.49314	0.09550	0.08786

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468
Welders Composite [HP: 46] [LF: 0.45]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.29068	570.24091

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

13.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

13.2 Architectural Coatings Phase

13.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 12
Start Quarter: 2
Start Year: 2026

- Phase Duration
Number of Month: 0
Number of Days: 21

13.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 23000
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

13.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

13.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase
$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0$

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

14. Construction / Demolition

14.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: GSE Outdoor Storage Space

- Activity Description:
Part of the Staging, Storage, and Support Infrastructure

- Activity Start Date
Start Month: 11

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.022745
SO_x	0.000351
NO_x	0.178230
CO	0.238142

Pollutant	Total Emissions (TONs)
PM 10	0.406184
PM 2.5	0.007464
Pb	0.000000
NH_3	0.000367

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.001506
N_2O	0.000389

Pollutant	Total Emissions (TONs)
CO_2	37.458181
CO_2e	37.603396

14.1 Site Grading Phase

14.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 11
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

14.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 40000
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	6
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	6
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

14.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551

LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

14.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase
$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)

WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

14.2 Paving Phase

14.2.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 12
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

14.2.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 40000

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Paving Equipment Composite	1	8
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

14.2.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.55280	0.00854	4.19778	3.25481	0.16332	0.15025
Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02313	0.00463	570.16326	572.11992
Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02381	0.00476	586.91372	588.92786
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
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HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503

LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

14.2.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)

VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_P = (2.62 * PA) / 43560 / 2000$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)
2000: Conversion Factor square pounds to TONs (2000 lb / TON)

15. Construction / Demolition

15.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Office Building

- Activity Description:
Part of the Staging, Storage, and Support Infrastructure

- Activity Start Date
Start Month: 11
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.242728
SO_x	0.000249
NO_x	0.100685
CO	0.141015

Pollutant	Total Emissions (TONs)
PM 10	0.004736
PM 2.5	0.003727
Pb	0.000000
NH_3	0.000693

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.001111
N_2O	0.001360

Pollutant	Total Emissions (TONs)
CO_2	32.825568
CO_2e	33.216936

15.1 Building Construction Phase

15.1.1 Building Construction Phase Timeline Assumptions

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- Phase Start Date
Start Month: 11
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

15.1.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 20000
Height of Building (ft): 20
Number of Units: N/A

- Building Construction Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

15.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925

Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02138	0.00428	527.09717	528.90603
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

15.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

15.2 Architectural Coatings Phase

15.2.1 Architectural Coatings Phase Timeline Assumptions

- Phase Start Date
Start Month: 12
Start Quarter: 2
Start Year: 2026

- Phase Duration
Number of Month: 0
Number of Days: 21

15.2.2 Architectural Coatings Phase Assumptions

- General Architectural Coatings Information
Building Category: Non-Residential
Total Square Footage (ft^2): 20000
Number of Units: N/A

- Architectural Coatings Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

15.2.3 Architectural Coatings Phase Emission Factor(s)

- Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

15.2.4 Architectural Coatings Phase Formula(s)

- Worker Trips Emissions per Phase

$VMT_{WT} = (1 * WT * PA) / 800$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
1: Conversion Factor man days to trips (1 trip / 1 man * day)
WT: Average Worker Round Trip Commute (mile)
PA: Paint Area (ft^2)
800: Conversion Factor square feet to man days (1 ft^2 / 1 man * day)

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_{AC} = (AB * 2.0 * 0.0116) / 2000.0$

VOC_{AC}: Architectural Coating VOC Emissions (TONs)
BA: Area of Building (ft^2)
2.0: Conversion Factor total area to coated area (2.0 ft^2 coated area / total area)
0.0116: Emission Factor (lb/ft^2)
2000: Conversion Factor pounds to tons

16. Construction / Demolition

16.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Parking Lot

- Activity Description:
Part of the Staging, Storage, and Support Infrastructure

- Activity Start Date
Start Month: 12
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 12
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.012005
SO_x	0.000175
NO_x	0.088775
CO	0.118181

Pollutant	Total Emissions (TONs)
PM 10	0.220582
PM 2.5	0.003713
Pb	0.000000
NH_3	0.000198

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- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.000750
N_2O	0.000233

Pollutant	Total Emissions (TONs)
CO_2	18.839399
CO_2e	18.922041

16.1 Site Grading Phase

16.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 12
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 0
Number of Days: 15

16.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 44000
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	6
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	6
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

16.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02160	0.00432	532.54993	534.37751
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

16.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

16.2 Paving Phase

16.2.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 12
Start Quarter: 3
Start Year: 2026

- Phase Duration
Number of Month: 0
Number of Days: 15

16.2.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 44000

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cement and Mortar Mixers Composite	4	6
Pavers Composite	1	7
Paving Equipment Composite	1	8
Rollers Composite	1	7
Tractors/Loaders/Backhoes Composite	1	7

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

16.2.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.55280	0.00854	4.19778	3.25481	0.16332	0.15025
Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5

Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cement and Mortar Mixers Composite [HP: 10] [LF: 0.56]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02313	0.00463	570.16326	572.11992
Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	586.91372	588.92786
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

16.2.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

- Construction Exhaust Emissions per Phase

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$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_P = (2.62 * PA) / 43560 / 2000$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)

PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)
2000: Conversion Factor square pounds to TONs (2000 lb / TON)

17. Construction / Demolition

17.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Propellant Commodity Storage

- Activity Description:

- Activity Start Date
Start Month: 7
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 8
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.028264
SO_x	0.000555
NO_x	0.243395
CO	0.310477

Pollutant	Total Emissions (TONs)
PM 10	0.010086
PM 2.5	0.007918
Pb	0.000000
NH_3	0.001470

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.002212
N_2O	0.002917

Pollutant	Total Emissions (TONs)
CO_2	66.383455
CO_2e	67.218326

17.1 Building Construction Phase

17.1.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 7
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

17.1.2 Building Construction Phase Assumptions

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- General Building Construction Information

Building Category: Office or Industrial
Area of Building (ft^2): 29040
Height of Building (ft): 30
Number of Units: N/A

- Building Construction Default Settings

Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	6
Forklifts Composite	2	6
Generator Sets Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8
Welders Composite	3	8

- Vehicle Exhaust

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips

Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

17.1.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.19758	0.00487	1.83652	1.63713	0.07527	0.06925
Forklifts Composite [HP: 82] [LF: 0.2]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.24594	0.00487	2.34179	3.57902	0.11182	0.10287
Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**

Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839
Welders Composite [HP: 46] [LF: 0.45]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.46472	0.00735	3.57020	4.49314	0.09550	0.08786

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Cranes Composite [HP: 367] [LF: 0.29]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.46069	529.27080
Forklifts Composite [HP: 82] [LF: 0.2]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02138	0.00428	527.09717	528.90603
Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02305	0.00461	568.32694	570.27730
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468
Welders Composite [HP: 46] [LF: 0.45]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02305	0.00461	568.29068	570.24091

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

17.1.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)

0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)

2000: Conversion Factor pounds to tons

18. Personnel

18.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Personnel Commuting

- Activity Description:

- Activity Start Date
Start Month: 1
Start Year: 2027

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions of Criteria Pollutants:

Pollutant	Emissions Per Year (TONs)
VOC	0.834186
SO_x	0.008341
NO_x	0.361251
CO	10.996616

Pollutant	Emissions Per Year (TONs)
PM 10	0.063558
PM 2.5	0.021170
Pb	0.000000
NH_3	0.115844

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Emissions Per Year (TONs)
CH_4	0.042548
N_2O	0.016129

Pollutant	Emissions Per Year (TONs)
CO_2	995.425940
CO_2e	1000.890740

18.2 Personnel Assumptions

- Number of Personnel
Active Duty Personnel: 0
Civilian Personnel: 450
Support Contractor Personnel: 0
Air National Guard (ANG) Personnel: 0
Reserve Personnel: 0

- Default Settings Used: Yes

- Average Personnel Round Trip Commute (mile): 20 (default)

- Personnel Work Schedule
Active Duty Personnel: 5 Days Per Week (default)

Civilian Personnel: 5 Days Per Week (default)
Support Contractor Personnel: 5 Days Per Week (default)
Air National Guard (ANG) Personnel: 4 Days Per Week (default)
Reserve Personnel: 4 Days Per Month (default)

18.3 Personnel On Road Vehicle Mixture

- On Road Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	37.55	60.32	0	0.03	0.2	0	1.9
GOVs	54.49	37.73	4.67	0	0	3.11	0

18.4 Personnel Emission Factor(s)

- On Road Vehicle Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30250	0.00278	0.10216	4.37740	0.02381	0.00738	0.04984
LDGT	0.25584	0.00352	0.15087	3.96319	0.02489	0.00829	0.04170
HDGV	0.80268	0.00758	0.53554	9.42531	0.05206	0.02398	0.08830
LDDV	0.11600	0.00133	0.17757	7.08987	0.02608	0.00873	0.01694
LDDT	0.11871	0.00132	0.20883	3.52458	0.02453	0.00897	0.01663
HDDV	0.10536	0.00421	2.35450	1.64049	0.17368	0.08066	0.06684
MC	2.90332	0.00331	0.53638	11.52717	0.03290	0.02177	0.05245

- On Road Vehicle Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01413	0.00493	331.23691	332.93781
LDGT	0.01514	0.00719	419.65142	421.98105
HDGV	0.04771	0.02469	904.41092	912.28839
LDDV	0.04390	0.00074	393.54551	394.96998
LDDT	0.02222	0.00109	393.93490	394.84539
HDDV	0.02015	0.16469	1252.74971	1296.95643
MC	0.10508	0.00322	390.91110	394.70550

18.5 Personnel Formula(s)

- Personnel Vehicle Miles Travel for Work Days per Year
$VMT_P = NP * WD * AC$

VMT_P: Personnel Vehicle Miles Travel (miles/year)
NP: Number of Personnel
WD: Work Days per Year
AC: Average Commute (miles)

- Total Vehicle Miles Travel per Year
$VMT_{Total} = VMT_{AD} + VMT_C + VMT_{SC} + VMT_{ANG} + VMT_{AFRC}$

VMT_{Total}: Total Vehicle Miles Travel (miles)
VMT_{AD}: Active Duty Personnel Vehicle Miles Travel (miles)
VMT_C: Civilian Personnel Vehicle Miles Travel (miles)
VMT_{SC}: Support Contractor Personnel Vehicle Miles Travel (miles)
VMT_{ANG}: Air National Guard Personnel Vehicle Miles Travel (miles)
VMT_{AFRC}: Reserve Personnel Vehicle Miles Travel (miles)

- Vehicle Emissions per Year
$V_{POL} = (VMT_{Total} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{Total}: Total Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Personnel On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

19. Construction / Demolition

19.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Phillips Pkwy Realignment - Phase 2

- Activity Description:
Widening of existing Parkway

- Activity Start Date
Start Month: 3
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 10
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.089781
SO_x	0.001596
NO_x	0.710228
CO	0.821969

Pollutant	Total Emissions (TONs)
PM 10	3.182381
PM 2.5	0.027971
Pb	0.000000
NH_3	0.000897

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.007041
N_2O	0.001843

Pollutant	Total Emissions (TONs)
CO_2	175.469968
CO_2e	176.155470

19.1 Site Grading Phase

19.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 3
Start Quarter: 1
Start Year: 2026

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- Phase Duration
Number of Month: 2
Number of Days: 0

19.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 158400
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Scrapers Composite	2	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

19.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.39317	0.00542	3.40690	4.22083	0.09860	0.09071
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5

Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.19606	0.00488	1.74061	1.53912	0.06788	0.06245
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	587.02896	589.04350
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02160	0.00432	532.54993	534.37751
Scrapers Composite [HP: 423] [LF: 0.48]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02145	0.00429	528.85412	530.66901
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

19.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)

20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

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19.2 Paving Phase

19.2.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 9
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

19.2.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 237600

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Pavers Composite	1	8
Paving Equipment Composite	2	6
Rollers Composite	2	6

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

19.2.3 Paving Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Pavers Composite [HP: 81] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.23717	0.00486	2.53335	3.43109	0.12904	0.11872
Paving Equipment Composite [HP: 89] [LF: 0.36]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18995	0.00487	2.06537	3.40278	0.08031	0.07388
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5

Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Pavers Composite [HP: 81] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02133	0.00427	525.80405	527.60847
Paving Equipment Composite [HP: 89] [LF: 0.36]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02141	0.00428	527.70636	529.51732
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	586.91372	588.92786

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

19.2.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_P = (2.62 * PA) / 43560 / 2000$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre$)^2$ / acre)
2000: Conversion Factor square pounds to TONs (2000 lb / TON)

20. Construction / Demolition

20.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Phillips Pkwy Realignment - Phase 3

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- Activity Description:
Widening of existing Parkway

- Activity Start Date
Start Month: 5
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.069810
SO_x	0.001371
NO_x	0.603895
CO	0.652698

Pollutant	Total Emissions (TONs)
PM 10	3.177432
PM 2.5	0.023700
Pb	0.000000
NH_3	0.000453

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.006041
N_2O	0.001238

Pollutant	Total Emissions (TONs)
CO_2	148.950991
CO_2e	149.448313

20.1 Site Grading Phase

20.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 2
Number of Days: 0

20.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 158400
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8

Scrapers Composite	2	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

20.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.39317	0.00542	3.40690	4.22083	0.09860	0.09071
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19606	0.00488	1.74061	1.53912	0.06788	0.06245
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02381	0.00476	587.02896	589.04350
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Scrapers Composite [HP: 423] [LF: 0.48]				

	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02145	0.00429	528.85412	530.66901
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

20.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)

$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

21. Construction / Demolition

21.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: SLC-37 Footpring Grading - Phase 2

- Activity Description:
Grading of "fenceline" area

- Activity Start Date
Start Month: 2
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 2
End Month: 2026

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- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.153192
SO_x	0.002696
NO_x	1.226984
CO	1.208346

Pollutant	Total Emissions (TONs)
PM 10	14.894433
PM 2.5	0.047311
Pb	0.000000
NH_3	0.001869

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.010739
N_2O	0.002272

Pollutant	Total Emissions (TONs)
CO_2	264.825143
CO_2e	265.727895

21.1 Site Grading Phase

21.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 2
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

21.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 1492000
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Generator Sets Composite	50	8
Graders Composite	2	8
Other Construction Equipment Composite	2	8
Rollers Composite	1	0
Rubber Tired Dozers Composite	3	8
Scrapers Composite	6	8
Tractors/Loaders/Backhoes Composite	2	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

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- Worker Trips

Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

21.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19606	0.00488	1.74061	1.53912	0.06788	0.06245
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02381	0.00476	586.91372	588.92786
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Scrapers Composite [HP: 423] [LF: 0.48]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02145	0.00429	528.85412	530.66901
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e

Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

21.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

22. Construction / Demolition

22.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: SLC-37 Footprint Grading - Phase 3

- Activity Description:
Grading of "fenceline" area

- Activity Start Date
Start Month: 3
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 3
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.154609
SO_x	0.002711

Pollutant	Total Emissions (TONs)
PM 10	14.894835
PM 2.5	0.047681

NO_x	1.236432
CO	1.219045

Pb	0.000000
NH_3	0.001869

- Global Scale Activity Emissions of Greenhouse Gasses:

Pollutant	Total Emissions (TONs)
CH_4	0.010801
N_2O	0.002284

Pollutant	Total Emissions (TONs)
CO_2	266.359481
CO_2e	267.267274

22.1 Site Grading Phase

22.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 3
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

22.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 1492000
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Generator Sets Composite	50	8
Graders Composite	2	8
Other Construction Equipment Composite	2	8
Rollers Composite	1	8
Rubber Tired Dozers Composite	3	8
Scrapers Composite	6	8
Tractors/Loaders/Backhoes Composite	2	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

22.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19606	0.00488	1.74061	1.53912	0.06788	0.06245
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02381	0.00476	586.91372	588.92786
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Scrapers Composite [HP: 423] [LF: 0.48]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02145	0.00429	528.85412	530.66901
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3

LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688
LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

22.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

23. Construction / Demolition

23.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: SLC-37 Footpring Grading - Phase 2

- Activity Description:
Grading of "fenceline" area

- Activity Start Date
Start Month: 4
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 4
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.154609
SO_x	0.002711
NO_x	1.236432
CO	1.219045

Pollutant	Total Emissions (TONs)
PM 10	14.894835
PM 2.5	0.047681
Pb	0.000000
NH_3	0.001869

- Global Scale Activity Emissions of Greenhouse Gasses:

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

Pollutant	Total Emissions (TONs)
CH_4	0.010801
N_2O	0.002284

Pollutant	Total Emissions (TONs)
CO_2	266.359481
CO_2e	267.267274

23.1 Site Grading Phase

23.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 4
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 1
Number of Days: 0

23.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 1492000
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: No
Average Day(s) worked per week: 5

- Construction Exhaust

Equipment Name	Number Of Equipment	Hours Per Day
Generator Sets Composite	50	8
Graders Composite	2	8
Other Construction Equipment Composite	2	8
Rollers Composite	1	8
Rubber Tired Dozers Composite	3	8
Scrapers Composite	6	8
Tractors/Loaders/Backhoes Composite	2	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20
Average Hauling Truck Round Trip Commute (mile): 20

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

23.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.53947	0.00793	4.32399	2.85973	0.17412	0.16019
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.54202	0.00541	3.61396	4.09268	0.15387	0.14156
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19606	0.00488	1.74061	1.53912	0.06788	0.06245
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour)

Generator Sets Composite [HP: 14] [LF: 0.74]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02305	0.00461	568.32694	570.27730
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02381	0.00476	586.91372	588.92786
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.54993	534.37751
Scrapers Composite [HP: 423] [LF: 0.48]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02145	0.00429	528.85412	530.66901
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30919	0.00284	0.11347	4.53889	0.02452	0.00746	0.05155
LDGT	0.26441	0.00357	0.16673	4.15025	0.02544	0.00839	0.04331
HDGV	0.86518	0.00768	0.60380	10.32821	0.05358	0.02478	0.09044
LDDV	0.10849	0.00133	0.16923	6.81953	0.02585	0.00833	0.01688

LDDT	0.18226	0.00135	0.30624	4.58701	0.02597	0.00982	0.01664
HDDV	0.11915	0.00430	2.58738	1.69518	0.18154	0.08779	0.06616
MC	2.91656	0.00331	0.53768	11.64899	0.03308	0.02177	0.05214

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01488	0.00507	338.87521	340.63551
LDGT	0.01603	0.00741	426.31862	428.73081
HDGV	0.05162	0.02582	915.95668	924.24503
LDDV	0.04375	0.00074	395.37005	396.79020
LDDT	0.02250	0.00109	401.49415	402.41201
HDDV	0.02061	0.16317	1278.58677	1322.40331
MC	0.10643	0.00322	390.86633	394.69952

23.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)

2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

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Appendix 3.1B
Barge Emissions Modeling

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1.0 Data Used to Estimate Emissions from Barge Transport

Diesel Used Per Barge Day =	2800	gal/day [(1)]
Energy in Diesel =	0.137	MMBtu/gallon [(2)]
Roudtrip Distance =	2,712	miles [(4, 5)]
Vessel Speed =	11.51	mph [(6)]
Roundtrip duration =	9.82	days/trip
Vessel Roundtrips per Year =	6	trips/year

1.1 Actual Emissions From Proposed Action, Barge Transport - Criteria Pollutants

Pollutant	Emission Factor [(3)] (lb/MMBtu)	Daily Actual (lb/day)	Annual Actual (ton/yr)
NO_X	4.41	1,696	**50.0**
CO	0.95	365	**10.8**
SO_X	0.29	112	**3.29**
$PM_{2.5}$ [(7)]	0.31	119	**3.51**
PM_{10}	0.31	119	**3.51**
CO_2	164	63,085	**1,858**
VOC [(8)]	0.35	135	**3.97**

(1) Daily barge fuel usage provided by SpaceX

(2) U.S. Energy Information Administration (https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php)

(3) Emission Factors for Criteria Pollutants, from AP-42, Section 3.3 Table 3.3-1 (https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources)

(4) Roundtrip distance from Port of Brownsville, Texas to Cape Canaveral, Florida

(5) 1 nautical mile = 1.15 statute miles

(6) Gulf Symphony Specifications (https://mubarakmarine.com/wp-content/uploads/2023/01/Gulf_Symphony-V2.pdf)

(7) PM2.5 emission factor assumed to be equal to PM10 emission factor

(8) VOC approximated by using the TOC-Exhaust emission factor

1.2 Actual Emissions From Proposed Action, Barge Transport - Greenhouse Gases [(9)]

CH_4 GHG emission factor =	6.41	g/gal
N_2O GHG emission factor =	0.17	g/gal
CH_4 Global Warming Potential =	28	
N_2O Global Warming Potential =	265	
Conversion Factor =	1.1023E-06	tons/g
Conversion Factor =	0.907185	metric ton/ton

Greenhouse Gas	GHG (g/year)	GHG (tons/year)	CO_2e (metric tons/year)
CH_4	1,057,317	1.17	29.60
N_2O	28,041	0.03	7.43
CO_2		1,858	1,686
		TOTAL	**1,723**

(9) EPA 2024 GHG Emission Factors, Table 5 (https://www.epa.gov/climateleadership/ghg-emission-factors-hub)

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Appendix 3.1C
Raptor Engine Emissions Report

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ANALYSIS REPORT	NUMBER: 2024-001P_RevA DATE: 16 Sep 2024
SUBJECT: Exhaust Plume Calculations for SpaceX Raptor3 Booster Engine	PAGE 1 OF 14 NO. OF APPEN. 0
PREPARED FOR: Katy Groom, SpaceX	(W.O. 6017)
DISTRIBUTION: J. Tsohas, K. Tice	

1.0 SUMMARY

Calculations were performed to estimate the far-field exhaust constituents of the SpaceX Raptor3 liquid oxygen-liquid methane (LOX-LCH4) booster rocket engine firing under sea-level conditions. Although the exit-plane exhaust is fuel-rich and contains high concentrations of carbon monoxide (CO), subsequent entrainment of ambient air results in nearly complete conversion of the CO into carbon dioxide (CO2). A small amount of nitrous oxide (NO) formed in the combustion chamber as a result of N2 present in the propellants. A two-dimensional mixing model predicts the formation of thermal NOx downstream of the engine exit. The worst case CO and NOx emissions are predicted to be < 0.29 lbm/s and 9.19 lbm/s respectively, per engine, under nominal power (100%) operation. No soot is predicted to be generated by this engine cycle. The worst case emission rates for the 33 engine Super Heavy booster have been estimated to be <9.57 and 303.1 lbm/s for CO and NOx, respectively. Worst-case CO2 emissions from a single engine and a Super Heavy booster are 986.3 and 32,548 lbm/s, respectively. Starship landing emissions are estimated to be < 0.58 lb_m/s CO, 18.38 lb_m/s NOx and 1972.6 lb_m/s CO_2.

2.0 ENGINE DESCRIPTION

The subject engine is the latest upscaled booster engine for the SpaceX Super Heavy launch vehicle. The current uprate Super Heavy stage configuration includes 33 Raptor3 engines. The propellants are liquid oxygen (LOX) and liquid methane (LCH4). Similar to the previous Raptor2 analyses, these analyses include approximately 0.5% nitrogen in both the fuel and oxidizer to simulate real propellant characteristics. The subject engine uses a closed power cycle with a regeneratively-cooled thrust chamber nozzle.

The current analysis was performed for the 100% nominal engine operating condition, with results matched to performance data.

3.0 ANALYSIS APPROACH

A series of simulations were required to estimate the emissions from the Raptor3 engine. The PERCORP analysis model[1] was used to estimate the O/F mixture ratio variations that exist within the Raptor3 thrust chamber. The VIPER parabolized Navier-Stokes model[2] was used to kinetically expand the thrust chamber exhaust to the nozzle exit plane. The VIPER results were used to assess the validity of the PERCORP solution, correlating engine thrust, mass flow rate and specific impulse (ISP) to test results. PERCORP input parameters were adjusted until there was good agreement between the VIPER performance predictions and the test results. The legacy version of the plume flow field code SPF[3] was used to predict the flow structure of the free exhaust plume and the entrainment of ambient air. The VIPER solution was used as the inflow starting condition for the SPF. Though the legacy SPF code can handle detailed chemical kinetics within the evolving plume flow field, the strong barrel shock downstream of the nozzle exit produces numerical convergence problems with this legacy version of SPF. The present SPF simulations were performed without chemical kinetics. The SPF results were evaluated to extract air entrainment and gas temperature profiles. The SPF and VIPER results were used as inputs for one-dimensional kinetic modelling of the plume flow field. The kinetic model in the TDK code[4] was used to model chemical reactions within the evolving plume flow field.

TDK modelling of the plume flow field included chemical mechanism that address

a) the oxidation of CO to CO_2,

b) the complex oxidation of hydrocarbons to H_2O and CO_2, and

c) the thermal generation and destruction of NOx in a mixture of air and combustion products.

Table 1 includes the chemical reactions and rates used in the TDK simulation.

Unlike previous emission studies, an additional reacting chemistry plume flow field simulation was performed with the current release of the SPF code.[5] The basic System 2 species and chemical kinetics were augmented with the addition of species CH_4, HO_2, NO, NO_2, N_2O, Ar, and hydrogen, and NO_x reactions 46-64 which are reproduced in Table 2.[5] The reacting SPF results are different than generated using the historic approach,[6] in part due to differences in the chemical reactions considered. The results will be compared in Section 4.0.

Table 1: Kinetic Reactions Included in One Dimensional Chemistry Simulations*

	A	N	B
H + H + m = H2 + m†	6.4E17	1.0	0.0
H + OH + m = H2O + m	8.4E21	2.0	0.0
O + O + m = O2 + m	1.9E13	0.0	-1.79
CO + O + m = CO2 + m	1.0E14	0.0	0.0
O + H + m = OH + m	3.62E18	1.0	0.0
CH4 + m = CH3 + H + m	1.259E17	0	88.4
HCO + m = CO + H + m	5.012E14	0	19.0
C2H3 + m = C2H2 + H + m	7.943E14	0	31.5
N+NO = N2+O	2.700E13	0	0.355
N+O2 = NO+O	9.000E9	-1.0	6.5
N+OH = NO+H	3.360E13	0	0.385
HO2+NO = NO2+OH	2.110E12	0	-0.480
NO2+O = NO+O2	3.900E12	0	-0.240
NO2+H = NO+OH	1.320E14	0	0.360
O2 + H = O + OH	2.2E14	0.0	16.8
H2 + O = H + OH	1.8E10	-1.	8.9
H2 + OH = H2O + H	2.2E13	0.0	5.15
OH + OH = H2O + O	6.3E12	0.0	1.09
CO + OH = CO2 + H	1.5E7	-1.3	-.765
CO + O = CO2	2.5E6	0.0	3.18
CO2 + O = CO + O2	1.7E13	0.0	52.7
CH4+ OH = CH3 + H2O	3.162E13	0	6.0
H + CH4 = CH3 + H2	6.310E14	0	15.1
O + CH4 = CH3 + OH	3.981E14	0	14.0
CH3 + O = CH2O + H	1.259E14	0	2.0
CH3 + OH = CH2O + H2	3.981E12	0	0
C2H2 + OH = C2H + H2O	6.310E12	0	7.0
H + CH2O = HCO + H2	3.162E14	0	10.5
O + CH2O = HCO + OH	1.995E13	0	3.1

* TDK reaction format is k=AT**(-N)*EXP(-1000B/RT) [cc-Kcal-K-mole-s]

† m is any molecule for a third body reaction

Table 1: Kinetic Reactions Included in One Dimensional Chemistry Simulations (ctd)

	A	N	B
OH + CH2O = HCO + H2O	7.943E12	0	0.2
H + HCO = CO + H2	1.995E14	0	0
OH + HCO = CO + H2O	1.000E14	0	0
H + C2H2 = C2H + H2	1.995E14	0	19.0
O + C2H2 = CH2 + CO	5.012E13	0	3.7
C2H + O2 = HCO + CO	1.000E13	0	7.0
CH2 + O2 = HCO + OH	1.000E14	0	3.7
H + C2H4 = C2H3 + H2	1.000E14	0	8.5
C2H2 + H = C2H3	5.500E12	0	2.39
H + C3H6 = C2H4 + CH3	3.981E12	0	0

Table 2: Kinetic Reactions Included in Reacting SPF Plume Simulation‡

	A	N	B_{SPF}
OH+ O = H + O2	3.00E-11	0	-960
OH+ H = H2+ O	1.40E-14	-1	-7000
OH+ OH= H2O + O	1.00E-11	0	-1100
OH+ H2= H2O + H	3.50E-11	0	-5180
H + H + M = H2+ M	3.00E-30	1	0
H + O + M = OH+ M	1.00E-29	1	0
O + O + M = O2+ M	3.00E-34	0	1800
H + OH+ M = H2O + M	1.00E-25	2	0
OH+ CO= CO2 + H	2.80E-17	-1.3	660
CO+ O + M = CO2 + M	6.50E-33	0	-4360
H + O2+ M = HO2 + M	4.10E-33	0	1000
HO2 + H = OH+ OH	4.20E-10	0	-1900
HO2 + H = H2+ O2	4.20E-11	0	-700
HO2 + H2= H2O2+ H	1.20E-12	0	-18800
HO2 + HO2 = H2O2+ O2	3.30E-12	0	0
OH+ OH+ M = H2O2+ M	2.50E-33	0	5100
H2O2+ OH= H2O + HO2	1.70E-11	0	-1820
N + O2= NO+ O	1.10E-14	-1	-7300
O + N2= NO+ N	1.30E-10	0	-76000
N + OH= NO+ H	1.00E-10	0	-850
NO2 + H = NO+ OH	5.80E-10	0	-1470
NO2 + O = NO+ O2	1.70E-11	0	-600
NO+ NO= N2O + O	2.20E-12	0	-64200
N2O + H = N2+ OH	1.30E-10	0	-15200
HNO + H = H2+ NO	8.00E-12	0	0
HNO + OH= H2O + NO	6.00E-11	0	0
NO+ O + M = NO2 + M	1.80E-31	0.5	0
NO+ H + M = HNO + M	5.00E-32	0	600
NO2 + NO2 = NO+ NO+ O2	3.30E-12	0	-26900

‡ SPF reaction format is k=AT**(-N)*EXP(B_{SPF}/RT) [cc-Kcal-K-mole-s]

4.0 ANALYSIS RESULTS

The PERCORP modelling of the Raptor3 thrust chamber included film coolant. The PERCORP solution includes core mixing loss, yielding a characteristic velocity (C*) efficiency consistent with test data. The PERCORP results served as initial boundary conditions for the VIPER nozzle flow field simulation. The predicted thrust chamber nozzle exit species mass fractions from VIPER are listed in Table 3.

The SPF modelling stepped to 320 nozzle exit radii (Rexit = 25.718 inches, 2.143 ft). Since the propellants contain N2 for the current simulations, the air was modelled as a more complex N2-O2-Ar-CO2 mixture (0.7807/0.2095/0.00934/0.000412 moles fraction).[7] This approach allowed the Ar to serve as a marker for air entrainment. Predicted plume contours for temperature and mass fractions of argon (Ar), CO and NO are presented in Figure 1 through Figure 4. Since there plume entrainment and mixing field are simulated for chemically frozen flow, the Ar contours are representative of the air entrainment, while the CO and NO contour indicates a key product of incomplete combustion that were created by the engine.

Table 3: Thrust Chamber Nozzle Exit Species Mass Fraction from VIPER Simulation

Species	Mass Fraction
H2O	0.4198
CO2	0.3810
CO	0.1384
O2	0.0417
H2	0.0077
N2	0.0047
NO	0.0032
OH	0.0026
HO2	0.0006
O	0.0003
H	3.69E-05
CH4	2.26E-08

Figure 1: Air Entrainment Plume Temperature Contours (degrees K)
R/Rj and X/Rj are Normalized by the Nozzle Exit Radius Rj

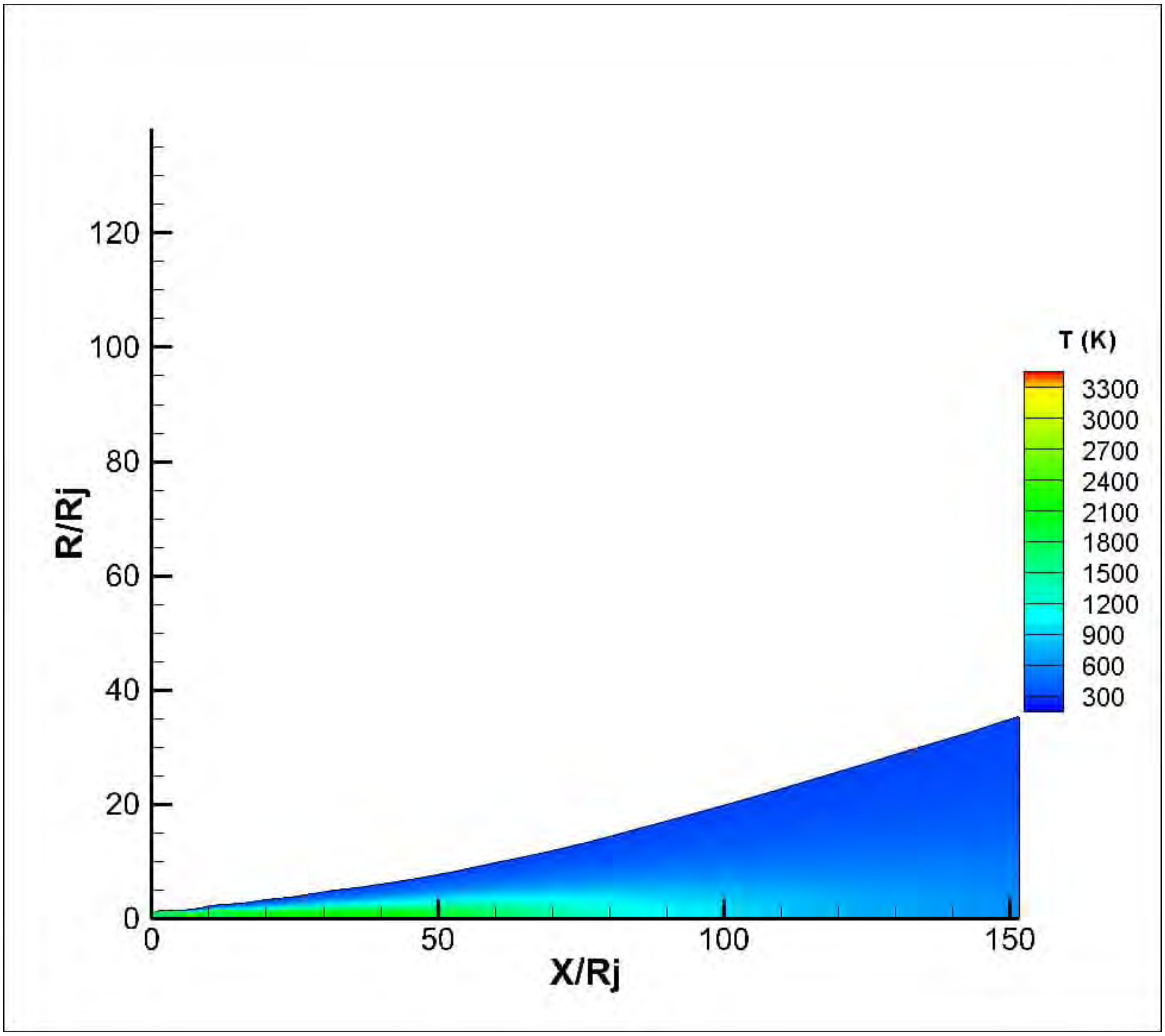


Figure 2: Plume Ar Mole Fraction Contours
R/Rj and X/Rj are Normalized by the Nozzle Exit Radius Rj

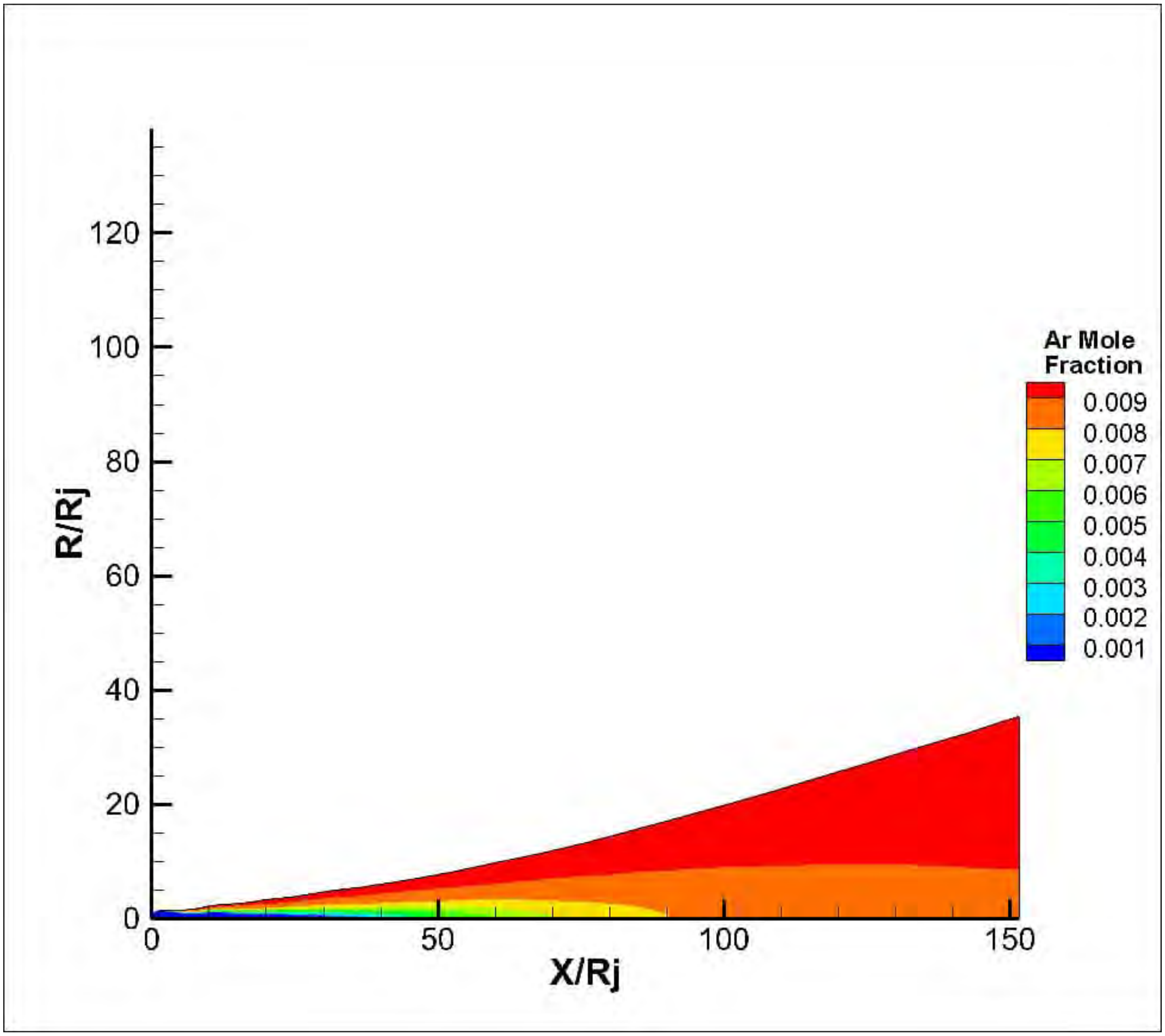


Figure 3: Non-Reacting Plume CO Mole Fraction
R/Rj and X/Rj are Normalized by the Nozzle Exit Radius Rj

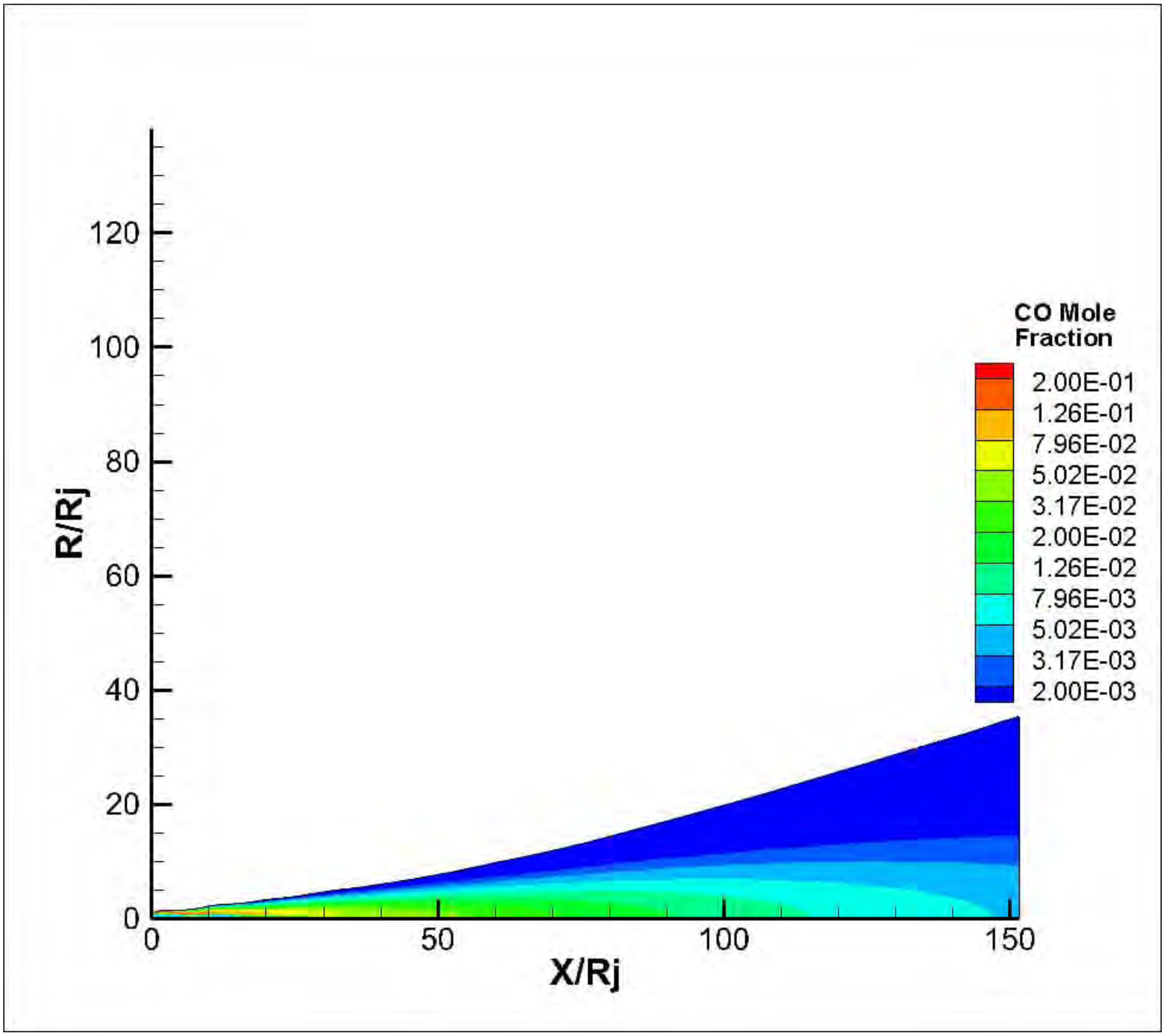
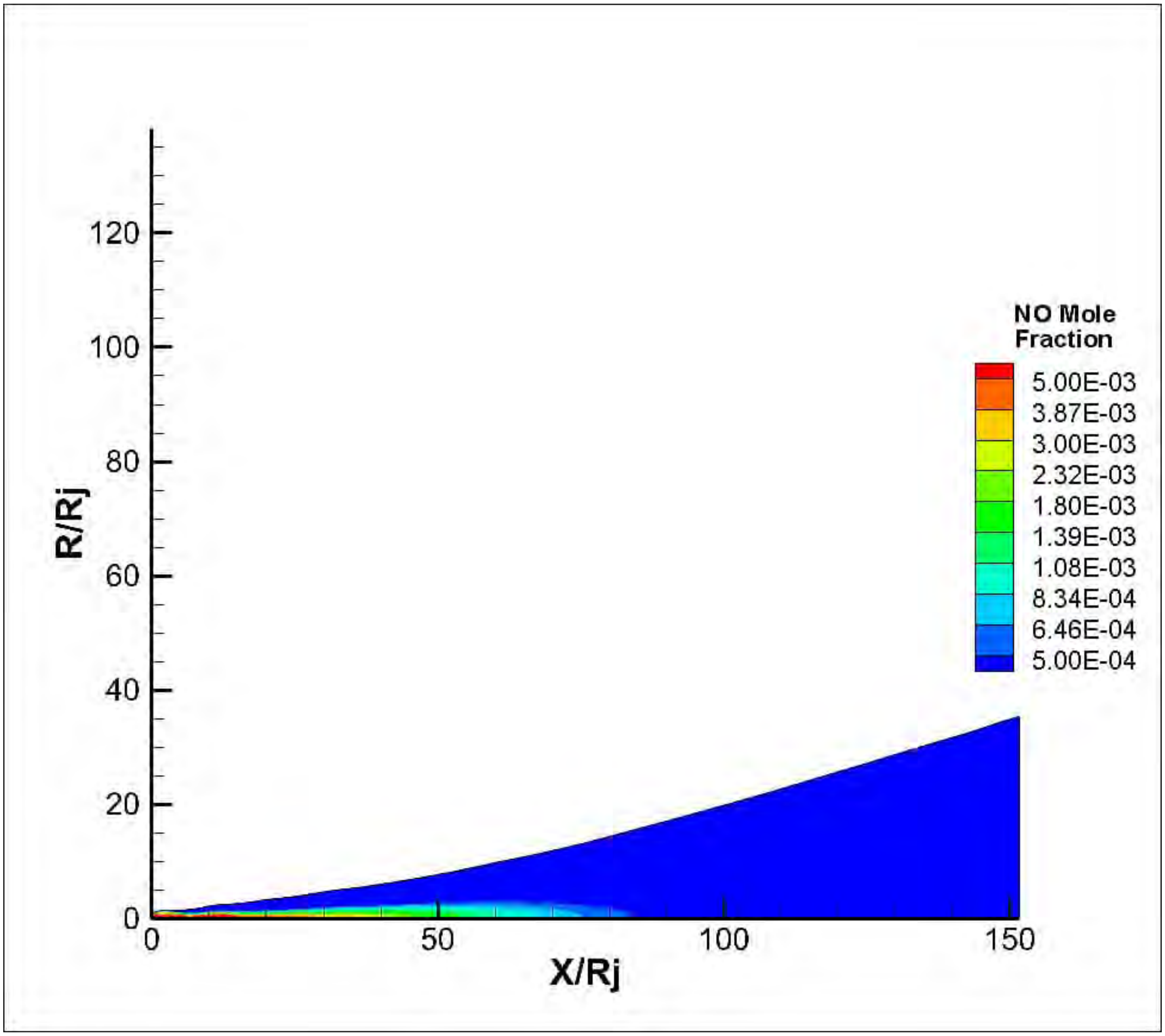


Figure 4: Non-Reacting Plume NO Mole Fraction
R/Rj and X/Rj are Normalized by the Nozzle Exit Radius Rj



Integration of the SPF data indicates that 289,473 lbm/s air is entrained by the core jet at the end of the simulation (Figure 5). It is estimated that the 690-foot simulation end point is reached 3.5 sec after the plume flow exits the nozzle.

The subsequent TDK simulation of the plume chemistry required an approximate fit of the air entrainment rate. The SPF air entrainment profile was fit to an "availability profile" for the TDK simulations, whereby ambient air is mixed into the plume flow. Figure 6 shows that the approximate TDK air addition agrees well with the entrainment rate predicted by SPF.

Figure 5: Axial Air Entrainment Estimates from Non-Reacting SPF.

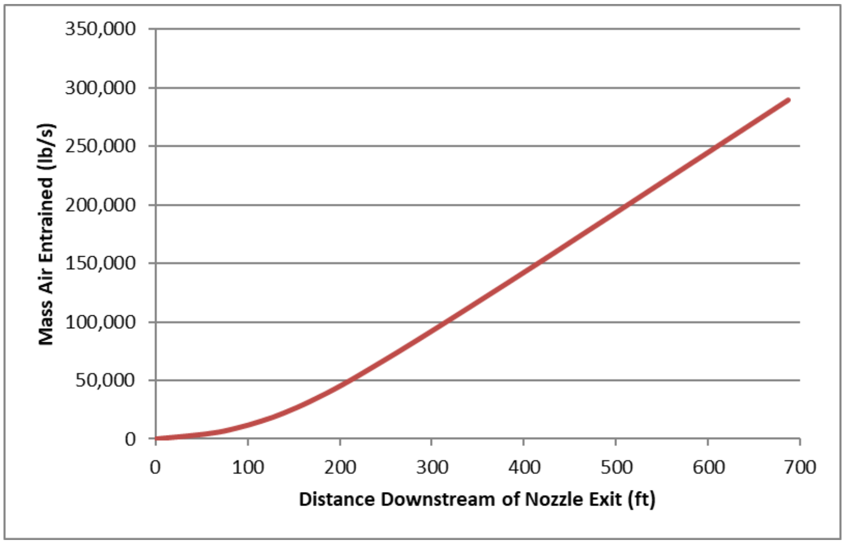
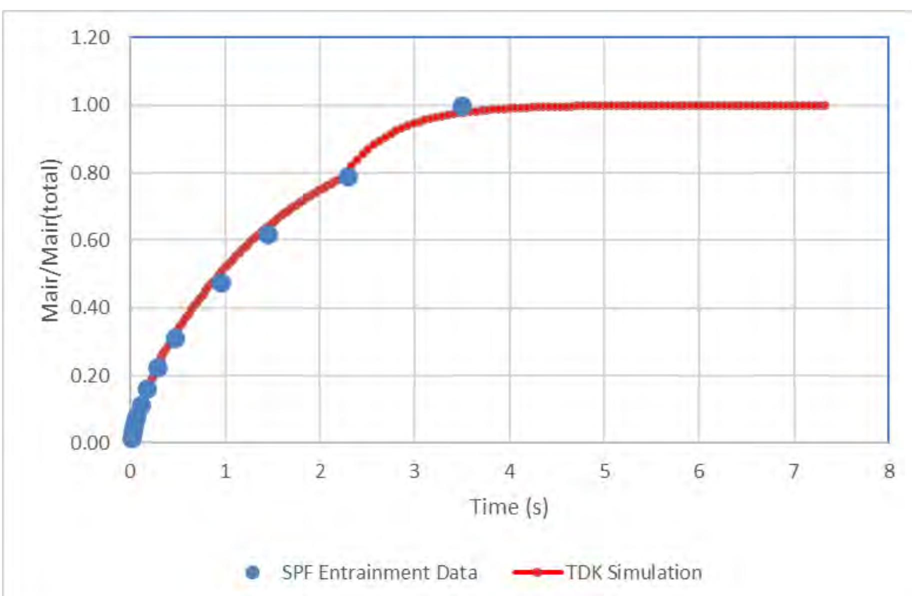
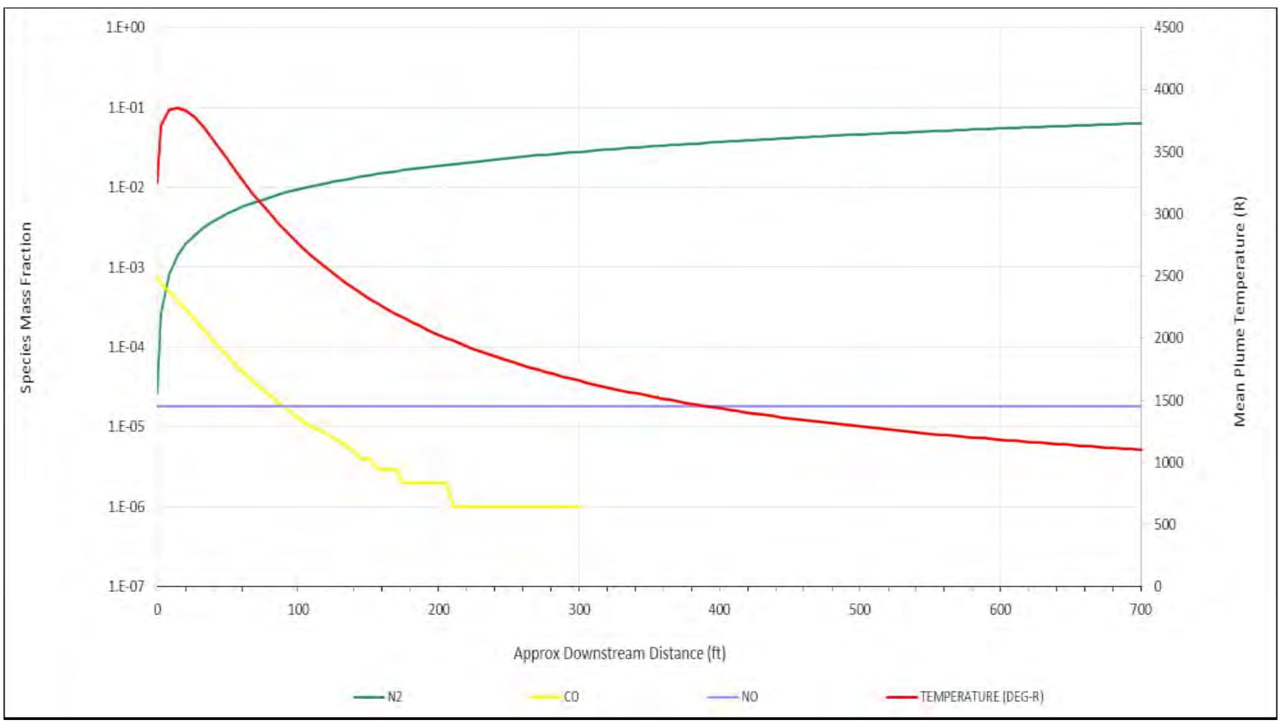


Figure 6: Approximate Air Entrainment Profile used in TDK Simulations



The one-dimensional kinetics modeling of the after-burning characteristics of the exhaust plume was performed assuming a piecemeal constant pressure (12.4-14.7 psia) and entrainment of ambient temperature air. The underexpanded nature of the Raptor3 nozzle exit flow induces rapid entrainment of ambient air into the plume, dropping the exhaust temperature and freezing kinetically controlled reactions. The small concentration of unburnt methane is rapidly oxidized, surviving less than 1 msec. The model predicted that complete CO oxidation occurs, with concentrations reduced to 1 ppm 200 ft downstream of the engine exit. For reference, the Raptor3 nozzle exit concentration is approximately 115,000 ppm (11.5%). There is no significant thermal NO formation predicted in the plume, but the presence of N2 in the propellants produces 2440 ppm NO in the main combustion chamber. The NO mole fraction at the end of the 690 ft long plume entrainment is 17 ppm. Given the total mixed plume mass flow rate of 291,127 lb/s, this corresponds to 5.24 lb_m/s for NO and <u>less than</u> 0.29 lbm/s CO.[§] Figure 7 shows the predicted temperature and pollutant species concentration profiles. The total CO_2 emission from the plume entrainment is 986.3 lb_m/s. The pollutant flow rates were calculated in terms of lb_m generated per second of steady engine operation.

Figure 7: Predicted Profile of Bulk Plume Temperature and Species Mass Fraction



§ TDK species mole fraction lower limit is 1E-6 and "0" is predicted

For comparison purposes, the results from the current version of SPF with chemical reaction predicts 8% lower air entrainment (265,165 lbm/s) at the end of the simulation. The predicted plume pollutant mass flows are 0.054 lbm/s CO (-81.4%), 9.14 lbm/s NO (+74.4%) and 961.1 lbm/s CO2 (-2.6%), where the percentages indicate change relative to the baseline values listed above. The reacting SPF simulation approach also predicts the emission of 0.045 lbm/s NO2, 0.00053 lbm/s N2O and 0.00001 lbm/s CH4. As noted above in Section 3.0 and Table 2, the SPF mechanism does not address the destruction of CH4 (contained in the Raptor3 exhaust). Because this approach includes two-dimensional mixing effects at the edge of the hot plume, the predicted NOx levels are likely more accurate than the historical approach.

5.0 VEHICLE EMISSION ESTIMATES

Due to the complexity of how the 33 engines are integrated into the base of the Super Heavy vehicle, there is not a simplified method to directly predict the air entrainment and exhaust burnout chemistry for the installed engines. An extensive computational fluid dynamics (CFD) analysis would likely be needed to fully address the entrainment process. However, engineering judgement can be used bound the problem. The outermost 20 engines will entrain air like the single engine for the outboard portion of their flow (about 50%), but the inboard portion of the flow will interact with the exhaust from the inner engines, delaying the time and distance before the plume flow field interacts with ambient air. The centermost 13 engines will likely entrain rocket exhaust plume for a significant amount of time before air entrainment begins. The effluent from the rocket nozzle exhaust primarily contains both CO and NO as unburned combustion products. The single engine analysis shows the rapid air entrainment cools the plume before significant thermal NO formation can occur. It is likely that the hot interior and CO and NO will oxidize as soon as air is available (entrained), though there may be a small time window when the exhaust is hot and there is air introduced, allowing formation of thermal NOx.

Video images from Starship launches show that the engine plumes merge to form a "superplume" that is characterized by this outer diameter.[8] The scaled single engine plume results relate to a location approximately 5233 ft downstream of the vehicle, well beyond the visible plume in Figure 8 (approx. 360 ft downstream). The estimated CO, NO and CO_2 emission for the Super Heavy should be 33 times the single engine level (less than 9.6, 303.1 and 32,548 lb_m/s for CO, NO and CO_2, respectively).

During the landing phase, Starship fires two Raptor3 engines. Though there will be ground effects as it nears final touchdown, the single engine emissions can be used to estimate the emissions from Starship as it approaches the landing pad. The two engines are spatially separated and to first order, can be treated as individual firing engines. As such, the emissions rate is just two time (2x) the single engine value. Starship landing emissions are estimated to be < 0.58 lb_m/s CO, 18.38 lb_m/s NOx and 1972.6 lb_m/s CO_2.

Figure 8: Screen Capture from Starship Flight 4 Video[8]

6.0 REFERENCES

[1] *Performance Correlation Program (PERCORP) Reference and User's Manual, Version 3.2.0,* Sierra Engineering & Software, Inc., Sacramento, CA, September 2022

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[5] Taylor, M.W. and Pergament, H.S., *Standardized Plume Flowfield Model (SPF-III), Version 5*, PST TR60-1 and TR60-2, Propulsion Science and Technology, Inc., Langhorne, PA, September 2005.

[6] Muss, J.A.; "Exhaust Plume Calculations for SpaceX Raptor Booster Engine", Report 2022-001P, Sierra Engineering & Software, Sacramento, CA, 31 May 2022

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[8] https://www.youtube.com/watch?v=wZligwZMODU, viewed 20 Jun 2024

Appendix 3.5A
Noise Report

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STARSHIP ROCKET NOISE ASSESSMENT FOR FLIGHT AND TEST OPERATIONS AT CAPE CANAVERAL SPACE FORCE STATION SPACE LAUNCH COMPLEX 37

TN 25-03

March 2025

Prepared for:

Jacobs Engineering Group, Inc.

KBR

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Cover Image By Space Exploration Technologies Corp. - SpaceX

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Executive Summary

Space Exploration Technologies Corporation (SpaceX) is proposing to conduct flight operations and testing of the Starship launch vehicle at Space Launch Complex 37 (SLC-37) at Cape Canaveral Space Force Station (CCSFS), Florida. Starship is a two-stage fully reusable super heavy-lift launch vehicle capable of carrying crew and cargo to Earth orbit, the Moon, Mars and beyond. The Starship launch vehicle, referred to as Starship, includes the first stage Super Heavy (or booster), and the second stage Starship spacecraft. To support environmental studies for Department of the Air Force (DAF) and cooperating agency actions, KBR, Inc. conducted this noise modeling study to estimate the single event and cumulative noise levels in the vicinity of SLC-37 from future Starship launches, Starship spacecraft and booster landings, and static fire tests of both vehicles. Starship operations at SLC-37 would consist of 76 annual operations of each of these types of flight and ground test events and this noise study assumed 50 percent of these operations would occur at nighttime. Rocket noise and sonic boom exposures were assessed for all proposed Starship operations at SLC-37 along with other related operational scenarios including the study Baseline (which describes the cumulative noise exposure from past rocket operations within the last 12 months prior to this analysis), the No Action Scenario (which describes the cumulative noise exposure from all approved future actions which have completed their environmental review), the Proposed Action (including the No Action operations plus the proposed Starship operations at SLC-37), and the Reasonably Foreseeable Future Actions scenario (which includes the Proposed Action for SLC-37 plus the proposed Starship operations at Launch Complex 39A [LC-39A] at Kennedy Space Center [KSC]). While the focus of this study is the Starship operations and noise exposures at SLC-37, a similar noise modeling study was conducted in parallel to evaluate the proposed Starship operations at LC-39A, as these results were needed to estimate noise exposure for the Reasonably Foreseeable Future Actions scenario.

The RNOISE model, which computes far field noise levels in the community, was used to estimate rocket noise from Starship flight and test operations at SLC-37 and noise from SpaceX's Falcon 9 and Falcon Heavy operations at CCSFS and KSC; all other launch operations at CCSFS and KSC were modeled in a separate study and combined with the Falcon 9 and Falcon Heavy operations to create the Baseline and No Action noise models for this study. SpaceX provided the operations data for all their vehicles required to conduct noise modeling of the individual flight and test events, including orbital launch and Starship spacecraft and booster landing trajectories, engine operating data, and static fire test parameters. The PCBoom model was used to compute single-event sonic boom contours of peak overpressure from the same Starship flight operations at SLC-37 and for the Falcon 9 and Falcon Heavy operations that are part of the Baseline and No Action scenarios.

The noise and sonic boom modeling included weather variations. SpaceX provided five weather data sets representing seasonal and daytime and nighttime profiles at Cape Canaveral. Noise results were obtained for all weather variations; Annual Mean results, typically used for environmental noise assessments, are presented in this report while the noise results representing the other four weather variations (Summer Day, Summer Night, Winter Day, and Winter Night) are included in an appendix to this report.

Starship orbital launch events are the loudest single rocket noise events of all the flight and test operations assessed in this modeling study. First, considering single event noise levels, the higher Maximum A-weighted Sound Level (L_{Amax}) contours (100 dB – 140 dB) are located within about 8 miles of SLC-37; the 100 dB contour is located entirely within the KSC property and CCSFS property. The L_{Amax} 90 dB contour extends west of the Indian River into Titusville. L_{Amax} levels are less than DAF's 108 dBA upper noise limit guideline for hearing conservation, at distances greater than approximately 5 miles from the launch pad. The 111 dB and 120 dB Maximum Unweighted Sound Level (L_{max}) contours, used to conservatively assess the potential for structural damage, are approximately 24 miles and 10 miles from the launch pad, respectively; the L_{max} 120 dB contour is within the KSC and CCSFS properties, except for limited exposure in north Cape Canaveral, whereas the L_{max} 111 dB contour extends beyond Titusville to the west and Cocoa Beach to the south (one damage claim is expected per 1,000 households exposed at 111 dB). Super Heavy static fire tests have a similar, unlikely probability of causing structural damage with the estimated L_{max} 111 dB contour also extending west of Titusville. The extent of the rocket noise exposures for all other Starship spacecraft and booster flight and test operations would be less than the noise exposure for launch. Cumulatively, these subsonic noise events would not cause significant impacts to residents in communities outside of CCSFS and KSC, as determined by the Day-Night Average Sound Level (DNL) 65 dB threshold for land use compatibility; although depending on their location, rocket noise from individual launch, landing, and static fire test events are expected to be heard by people in the nearby communities, including Merritt Island, Titusville, Port St. John, Allenhurst, and Cape Canaveral; and communities located farther away from SLC-37 when atmospheric conditions favor long-range sound propagation. However, due to the estimated levels and frequency of events, these individual noise events are not expected to cause general annoyance or pose health concerns, though noise complaints may occur.

Cumulative rocket noise levels were assessed for all Starship operations combined as well as for the four primary study scenarios: Baseline, No Action, Proposed Action, and Reasonably Foreseeable Future Actions. The estimated DNL 65 dB contours for all these scenarios are estimated to be entirely within the CCSFS and KSC properties. Similarly, DNL was also assessed at the twenty-four study points of interest, for each scenario, and there are no residential areas outside of CCSFS and KSC exposed to DNL above 65 dB.

Additional supplemental metrics were assessed at the study points of interest (POIs) to provide a better understanding of the potential impacts from rocket noise events, including Speech Interference, Classroom Learning Interference, Probability of Awakening, Potential for Hearing Loss, and the Potential for Structural Damage. Due to most residential areas and schools being located relatively far (5+ miles) away from SLC-37, and due to the infrequency of Starship operations (e.g., compared with operations at a military airfield), the assessment for most of the supplemental metrics indicates minor impact with the exception that probability of awakenings is close to or above 10 percent at most POIs for Starship launches, but decreases below 10 percent for all other Starship operations. The probability of awakenings is to be taken as a conservative, rough estimate since no current, standardized method of assessment exists and additional research needs to be done to evaluate sleep disturbance. To address the other supplemental metrics, the highest number of speech interfering events per daytime hour (0.035), that would potentially be experienced at 11 of the 24 POIs, is equal to 15.75 speech interfering events per month or almost 190 speech interfering events per year. The potential for classroom learning interference was screened by checking if any of the seven schools evaluated would be exposed to exterior Leq(8hr) levels greater than 60 dB; which equates to an interior noise level of 45 dB Leq(8hr) with windows open and represents the threshold at which studies have found classroom learning is affected. Since none of the schools would be exposed to exterior levels this high, no further analysis is warranted. Workers at KSC and CCSFS launch facilities would be exposed to noise levels capable of causing hearing damage; however, noise mitigation programs are implemented at these sites. The noise levels would be below the minimum level/time threshold in the communities adjacent to KSC and CCSFS.

Sonic boom exposures were assessed for the flight operations at SLC-37: Starship launches, Starship spacecraft reentry/landings and booster landings. The sonic boom from a Starship launch at SLC-37 would occur over the Atlantic Ocean after the vehicle pitches over during ascent, making it unlikely that people would be exposed to this noise event. The estimated sonic boom footprints for Starship spacecraft reentry/landing events at SLC-37 indicate overpressure contours from 1 psf to 1.7 psf shown along and to the side of the trajectory. Near the landing site there is an oval shaped boom footprint region (with a reported maximum overpressure level of 1.72 psf). The 1 psf contour is estimated to extend about 30 miles west of the landing site, west of Titusville. Booster landings would generate the greatest sonic boom exposure of the three flight operations: boom levels near the SLC-37 landing pad would be greater than 20 psf; boom levels on CCSFS and KSC properties would range from 4 to 10 psf in areas away from the landing pad; residents outside of the CCSFS and KSC properties would experience lower boom levels ranging from 1 to 4 psf (some residents in the northern part of the city of Cape Canaveral could experience boom levels above 4 psf). The highest boom levels offshore are between 10 and 20 psf just east of SLC-37. While exposure to sonic booms at these levels can annoy and startle people and may interfere with their sleep, these levels pose no realistic risk of causing hearing damage or any other health impairment.

Cumulative sonic boom levels were also estimated, using C-weighted Day-Night Average Sound Level (CDNL), for the projected annual landing operations at SLC-37. CDNL values from Starship spacecraft landing operations are all below the impulsive noise limit of 60 dBC for acceptable land uses. Super Heavy booster landings would result in CDNL values at most POIs that exceed the 60 dBC noise limit, primarily because of the number of nighttime landing operations. Thus, whereas cumulative noise impacts due to rocket noise (or subsonic noise) would not be significant in the communities around KSC and CCSFS, cumulative sonic boom impacts, primarily due to booster landings, would be considered significant in areas where the threshold for land use compatibility (CDNL 60 dBC) is exceeded; these include the communities of Cape Canaveral, Cocoa Beach, Cocoa, and parts of Titusville.

The noise results for proposed Starship operations at LC-39A are similar, except LC-39A is approximately 5 miles north of SLC-37 and would have 44 annual operations of each type (launch, landings and static fire tests of both vehicles) compared with 76 annual operations of each type at SLC-37.

Noise exposure results for the four operation scenarios analyzed (Baseline, No Action, Proposed Action, and Reasonably Foreseeable Future Actions), along with Starship operations at SLC-37 alone, are presented in the report and are summarized in the Noise Exposure Assessment Summary in Section 8.

1 INTRODUCTION

1.1 BACKGROUND

Space Exploration Technologies Corporation (SpaceX) proposes to conduct launch, reentry, and ground test operations of their Starship launch vehicle at Cape Canaveral Space Force Station (CCSFS) Space Launch Complex 37 (SLC-37). Under the supervision of the Department of the Air Force (DAF) and with the Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), United States Coast Guard (USCG), National Park Service (NPS) and the U.S. Fish and Wildlife Service (USFWS) participating as cooperating agencies, SpaceX is preparing an Environmental Impact Statement (EIS) to evaluate the potential environmental impacts of proposed infrastructure construction and Starship operations. To support the EIS, KBR, Inc. has estimated noise levels for the Starship operations at SLC-37. The Starship spacecraft, which is currently under development, has a length of seventy meters and a diameter of nine meters, will be attached to a Super Heavy booster rocket (length of eighty meters) to form the Starship launch vehicle intended to provide long-duration cargo- and passenger-carrying capability. Both vehicles have vertical take-off and landing (VTOL) capability and are fully reusable. The Starship spacecraft would use nine Raptor engines that each provide sea-level thrust of about 3.19 Meganewtons (MN) (or 6.45 million (MM) pound-force total) during flight operations and static fire tests. The Super Heavy, or booster, would use thirty-five Raptor engines that each provide sea-level thrust of about 2.94 MN (or 23.1 MM pound-force total) during launch and static fire tests.

This noise study was conducted to estimate single event and cumulative noise levels, including rocket noise and sonic boom exposure, from future Starship launches, Starship spacecraft and booster Return to Launch Site (RTLS) landings, and static fire tests of both vehicles at SLC-37. SpaceX provided the following operations data for noise modeling:

- Orbital launch trajectory for the Starship from liftoff to stage separation, including Raptor engine operating data and nominal ascent thrust profile.
- Starship spacecraft and booster RTLS (descent/landing) trajectories with descent thrust profiles.
- Static fire test parameters for the Starship spacecraft and booster.
- Projected annual daytime and nighttime launches, landings, and static fire tests of these vehicles at SLC-37 using a 50/50 daytime/nighttime split.
- Weather profile variations for Cape Canaveral, including seasonal and daytime/nighttime profiles.

Rocket noise levels were estimated for proposed Starship flight and static test operations of both vehicles at SLC-37 using the RNOISE[1,2] model. RNOISE is a far-field (distances beyond several hundred feet) community noise model for rocket noise assessment. Sonic boom exposures due to Starship operations at SLC-37 were estimated using the PCBoom model[3,4], which computes single-event sonic boom contours of peak overpressure and signatures from supersonic vehicles. This report presents the estimated results for Starship single event and cumulative noise exposures at SLC-37 along with cumulative noise estimates for other existing and future rocket operation scenarios at Cape Canaveral Space Force Station (CCSFS) and KSC. Comparison of the results from these study scenarios, described below, are used to assess the change in noise exposure due to proposed Starship operations at SLC-37.

1.2 Operational Scenarios Analyzed

1.2.1 Baseline Scenario

The Baseline (or Existing) operations scenario and cumulative rocket noise levels were developed by Blue Ridge Research and Consulting (BRRC) in a separate study and report titled "Cape Canaveral Space Force Station and Kennedy Space Center DNL Noise Contours"[5], dated 20 November 2024. The BRRC report describes the launch, landing, and static fire test operations that were conducted between 1 September 2023 and 31 August 2024 at all active CCSFS and KSC rocket facilities. Note that the Baseline operations, as defined in this report (described in Section 3.1 below) are based on all the non-SpaceX operations included in the BRRC report plus all the existing annual SpaceX Falcon 9 and Falcon Heavy operations which were modeled separately as part of the current effort; Day-Night Average Sound Level (DNL) contour results, described following, from both efforts were combined to produce the Baseline DNL contours for CCSFS and KSC reported herein. Additionally, Baseline cumulative sonic boom levels, associated with SpaceX's Falcon 9 and Falcon Heavy landing operations, were estimated as part of the current effort.

1.2.2 No Action Scenario

The No Action (Maximum) scenario was also developed in BRRC's study[5] and includes the planned future operations and cumulative rocket noise levels from all approved future actions that have completed their environmental review. Like the Baseline operations and noise exposure, the No Action operations and associated noise exposure, as defined in this report (described in Section 4.1 below), are based on all the non-SpaceX operations included in the BRRC report plus all the No Action annual SpaceX Falcon 9 and Falcon Heavy operations which were modeled separately as part of the current effort; Day-Night Average Sound Level (DNL) contour results from both efforts were combined to produce the No Action DNL contours for CCSFS and KSC reported herein. No Action cumulative sonic boom levels for SpaceX Falcon 9 and Falcon Heavy operations were also estimated as part of the current effort.

1.2.3 Proposed Action Scenario

The Proposed Action Scenario consists of the proposed Starship operations at SLC-37 plus the No Action operations. The Proposed Action noise results are compared with the No Action noise results (in Section 8) to assess the change in noise exposure that would result from implementing the proposed Starship operations at SLC-37. Proposed Starship annual operations are described in Section 5.1.

1.2.4 Reasonably Foreseeable Future Actions Scenario

For the purposes of this study, the Reasonably Foreseeable Future Actions Scenario is defined to include the Proposed Action Scenario plus the proposed Starship operations at KSC Launch Complex 39A (LC-39A). Proposed Starship operations at LC-39A and the cumulative noise exposures defining the Reasonably Foreseeable Future Actions Scenario are described in Section 7.

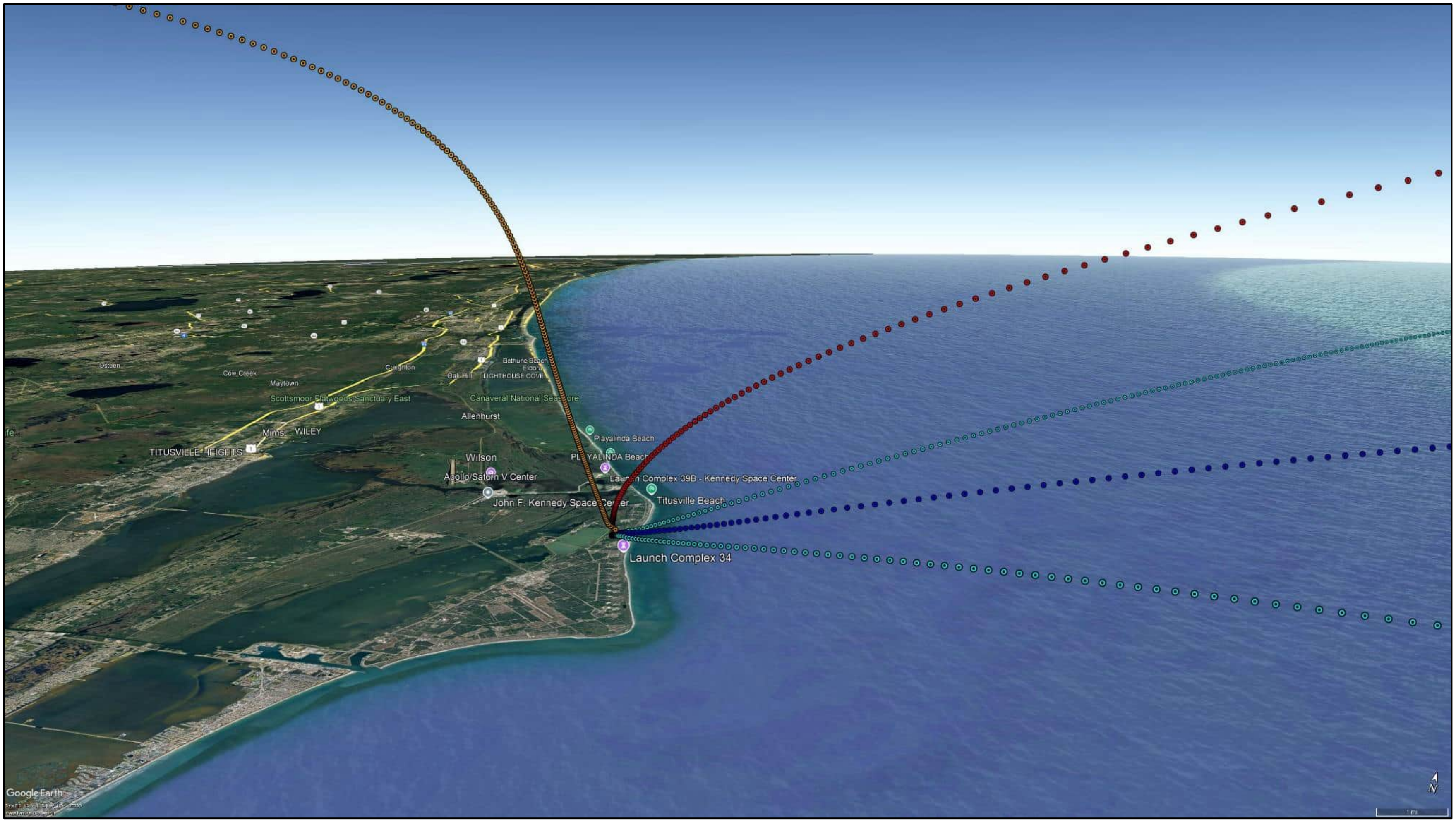
Cumulative noise levels are among the primary measures used when assessing noise impact from rocket operations. The FAA's metric for assessing cumulative subsonic (or rocket) noise is DNL (A-weighted) with a 65 dBA significance threshold; the FAA defines a "significant impact" due to noise as any noise sensitive area[6] exposed to noise greater than DNL 65 dBA following implementation of the federal action and experiencing a 1.5 dBA or greater increase in noise due to the federal action[7]. Similarly, the FAA's metric for assessing cumulative noise from supersonic operations (i.e., sonic boom exposure) is the C-weighted Day-Night Average Sound Level (CDNL) with a 60 dBC significance threshold. Both metrics are discussed further in this report, though they are mentioned here since they are the primary metrics used to compare the cumulative noise results estimated for each of the study scenarios analyzed.

1.3 Proposed Starship Operations at Cape Canaveral Space Force Station (SLC-37)

The Starship operations proposed to occur at SLC-37 include 76 annual operations, with a 50/50 daytime/nighttime split, of each type of operation including: Starship orbital launch, Starship spacecraft reentry/landing, Super Heavy descent/landing, and static tests of both vehicles. The 76 annual booster landings would utilize three different flight paths including a nominal heading 80 percent of the time (from an 80-degree heading), north bounding heading (from 40-degrees) 10 percent of the time, and a south bounding heading (from 115-degrees) 10 percent of the time. Figure 1 shows a representation of these trajectories at SLC-37 (scale bar at bottom right = 1 mile). Starship would launch to the east, Starship spacecraft landings would descend from west to east prior to landing at SLC-37, and booster landings would descend from east to west prior to landing at SLC-37.

1.3.1 Noise Events Associated with Starship Operations at SLC-37

Starship operations at SLC-37 and LC-39A would include the same types of flight and test operations. Static fire test operations would occur with either vehicle mounted vertically to a test stand with engines oriented towards the ground. A typical flight operations sequence, shown on Figure 2 (courtesy of SpaceX), illustrates the operational events comprising a Starship launch at SLC-37 and booster landing; in this diagram, the booster is shown returning to an offshore platform, however all landings assessed in this study are at SLC-37 (or LC-39A when including cumulative noise from LC-39A). It is useful to describe certain elements of this flight operations sequence, specifically the ones that generate noise events heard in the communities adjacent to KSC and CCSFS; event numbers 1 through 5 and their associated times shown in the diagram will be referred to. Starship launch (indicated as Booster Stage Launch) occurs at the start of the flight operations sequence (1), at T+0 seconds (s), when the highest rocket noise levels, from all Starship and booster engine operations, would be heard in the nearby communities (the highest levels would occur at different times during the liftoff and ascent, depending on the receiver location, but after the vehicle has gained some altitude). During the ascent phase, the two-stage vehicle would generate a sonic boom once it has reached supersonic speeds and is in the process of pitching over to target the intended orbit; the sonic boom generated during ascent will occur entirely over the Atlantic Ocean and will not be noticed by anyone inland.



Starship Launch	Super Heavy Landing (Nominal, From ~80-degree Heading)
Starship Spacecraft Landing	Super Heavy Landing (From 40-degree and 115-degree Headings)

Figure 1. Starship Launch and Starship Spacecraft and Super Heavy (Booster) Landing Flight Trajectories at SLC-37

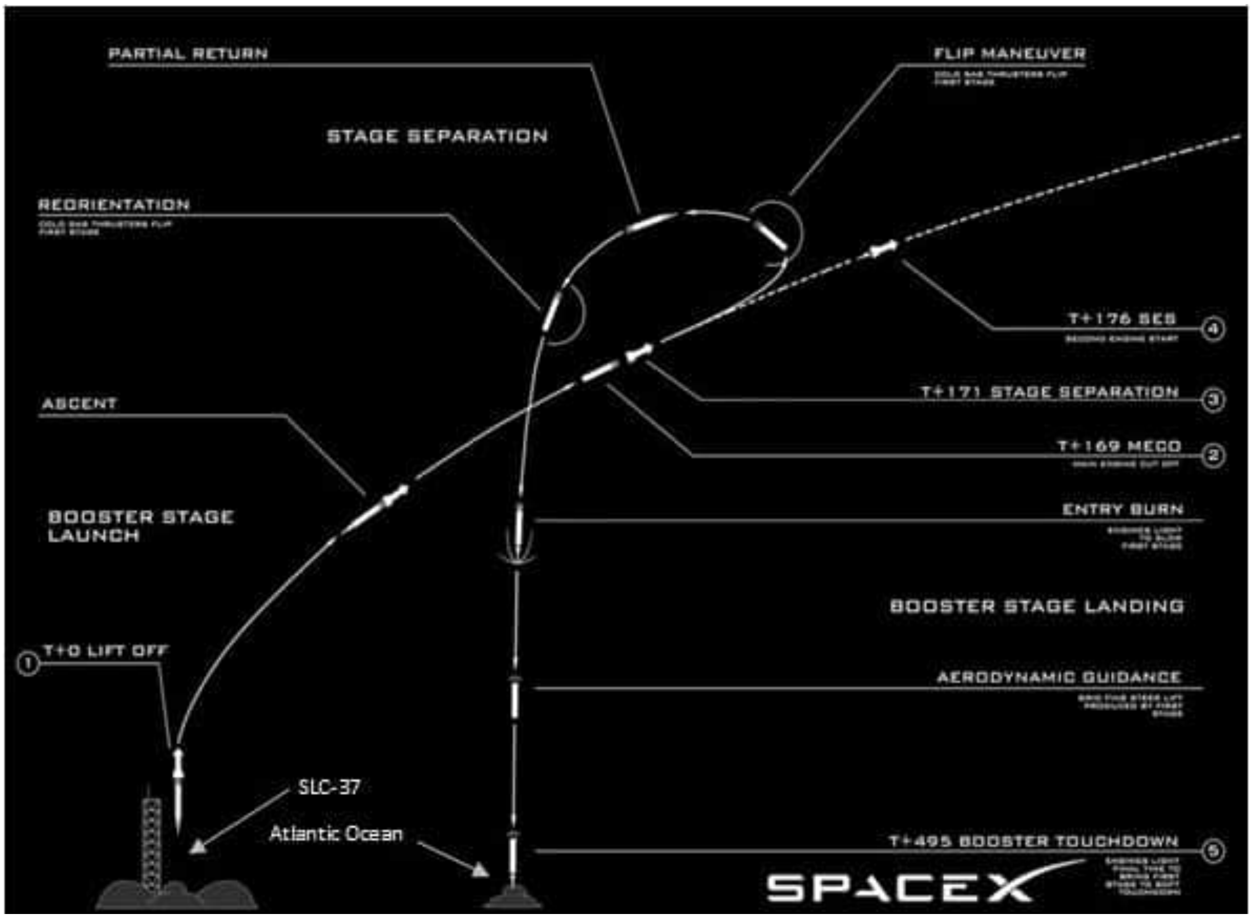


Figure 2. Flight Operations Sequence of Starship Orbital Launch and Landing Events

Main Engine Cutoff (2) occurs at T+169 s, followed soon by Stage separation (3) at T+171 s and Second Engine Start (4) at T+176 s as the second stage Starship spacecraft continues to orbit while the booster stage executes a reorientation and flip maneuver to change course for landing back at SLC-37. While events 2 through 4 do not generate noticeable noise events, the remaining noise events that would be heard in communities near KSC and CCSFS include rocket noise during the Booster Touchdown (5) at T+495 s [at SLC-37], rocket noise during the Starship spacecraft landing at SLC-37, and the sonic booms generated by both vehicles during the descent phases of their flights. The Starship spacecraft descent is along a west to east flight path like past Space Shuttle Landings though the Starship spacecraft performs its own reorientation maneuver to prepare for a vertical landing at SLC-37 like the booster. These are the proposed Starship operations and noise events that were analyzed at SLC-37 (and similarly at LC-39A for the Reasonably Foreseeable Future Actions Scenario). Note that SLC-37 is about 5 miles south of LC-39A.

1.4 DOCUMENT STRUCTURE

The remaining sections of this report starting with Section 2 provide a description of the rocket noise and sonic boom modeling studies conducted including the study design, modeling and assessment methodologies including the primary noise metrics and their assessment guidelines and the use of additional supplemental metrics. The Baseline operations at CCSFS and KSC and the associated cumulative rocket noise and sonic boom exposures are presented in Section 3. Section 4 presents the No Action operations at CCSFS and KSC and the associated cumulative rocket noise and sonic boom exposures. Proposed Starship operations at SLC-37 and the associated rocket noise and sonic boom exposure levels, including single event and cumulative levels, are presented in Section 5. The Proposed Action noise exposure levels are shown in Section 6 and the Reasonably Foreseeable Future Action noise exposure levels are presented in Section 7. A noise exposure assessment summary is provided in Section 8, comparing the results for all the operational scenarios studied. The study conclusions are presented in the Executive Summary and the references listed in Section 9.

2 NOISE MODELING AND ASSESSMENT

2.1 MODELING STUDY DESIGN

A modeling study was initially designed to permit assessment of various weather conditions and trajectory variations for the booster landings. At the phase of the project when modeling was to begin, SpaceX provided a fixed utilization schedule for three proposed booster landing trajectories, described previously as including a nominal heading (from 80-degrees) 80 percent of the time, north bounding heading (from 40-degrees) 10 percent of the time, and south bounding heading (from 115-degrees) 10 percent of the time. This fixed the number of booster landing trajectories to three and the precent utilizations were accounted for in the cumulative noise analyses. To further make the parameter variations reasonable in number, the five different flight and test operations (i.e., Starship orbital launch, Starship spacecraft reentry/landing, booster descent/landing, and static fire tests of both vehicles) were analyzed as a group for each of the weather variations examined.

SpaceX developed five weather variation data sets from Cape Canaveral historical weather data. These data sets represent seasonal and daytime and nighttime conditions at the Cape, referred to as: Annual Mean, Summer Day, Summer Night, Winter Day, and Winter Night. Upper air data sets were developed from balloon launch data including atmospheric pressure, temperature, relative humidity, wind speed and wind direction; balloon data generally do not go above 60,000 feet altitude, so an atmosphere extension, based on the U.S. Standard Atmosphere[8], was applied to these data sets. Mean surface wind (rose) data were also provided for these five representative weather periods. Table 1 shows an example of the upper air data for Annual Mean conditions and Figure 3 shows wind rose data for the same conditions.

The complete set of modeled Starship noise results generated for this study, including noise contour sets and noise levels at the study points of interest (POIs), includes the following Starship operational events and weather variations:

- Single event rocket noise contours and POI results at SLC-37, including multiple metrics, for each individual Starship operation (orbital launch, Starship spacecraft landing, booster landings with 3 trajectories, Starship spacecraft static fire test, and booster static fire test) and for all five weather conditions for each event. An example of the effects the different weather variations have on a select single event contour (level) is shown in Figure 4.

- Cumulative rocket noise contours and POI results at SLC-37, in terms of DNL, combining the noise results for each individual Starship operation, for each representative weather condition.
- Single event sonic boom contours and POI results at SLC-37, including multiple metrics, for each individual Starship operation and for all five weather conditions for each event.
- Cumulative sonic boom exposure contours and POI results at SLC-37, in terms of CDNL, combining the sonic boom exposure results for each individual Starship operation for all five representative weather conditions.
- All the above datasets were also generated for Starship operations at LC-39A (since the cumulative results at LC-39A are part of the Reasonably Foreseeable Future Actions scenario in this study).
- All results of the Baseline, No Action, Proposed Action, and Reasonably Foreseeable Future Actions Scenarios required for the noise assessment for SLC-37.

The modeled noise contours and POI results represent a sizeable database of noise results for proposed Starship operations at SLC-37. Since noise assessments are typically presented for local, annual mean weather conditions, this report focuses on the annual mean results generated from the modeling study and all noise exposure assessments are based on those results. All modeled noise results, including all the other weather variations analyzed, are presented in the Noise Appendix.

Table 1. Cape Canaveral Upper Air Historical Data: Annual Mean Conditions

Height (Feet)	Temperature (Kelvin)	Pressure (Millibar)	Relative Humidity (%)	Wind Speed (Knots)	Wind Direction (Degrees)
0	298.5	1000	72.5	11.5	244.6
2,000	293.0	950	77.0	7.2	160.3
3,500	290.4	900	72.5	7.0	181.5
5,000	288.0	850	66.1	7.1	208.5
6,000	287.0	825	62.4	6.9	204.5
6,500	284.7	800	53.2	10.1	243.4
7,500	284.5	775	52.5	8.1	232.0
8,500	283.4	750	49.2	7.8	230.7
10,000	276.3	700	31.2	16.6	267.7
11,500	261.3	650	8.1	10.6	127.7
13,500	259.1	600	7.9	14.8	321.8
16,000	260.1	550	7.7	31.4	265.9
18,000	254.1	500	1.5	27.8	299.0
21,000	253.0	450	2.5	42.5	268.5
23,500	245.6	400	2.6	35.6	287.9
26,500	240.6	350	3.3	28.5	303.9
30,000	235.5	300	4.2	31.8	300.3
34,500	225.3	250	22.4	44.6	265.1

Height (Feet)	Temperature (Kelvin)	Pressure (Millibar)	Relative Humidity (%)	Wind Speed (Knots)	Wind Direction (Degrees)
37,000	222.9	225	26.2	49.4	264.9
39,000	226.1	200	4.1	49.2	277.2
42,000	218.5	175	8.1	47.4	262.5
45,500	212.8	150	11.9	44.6	272.4
49,000	210.3	125	8.3	37.8	270.8
53,500	206.5	100	11.0	29.7	273.5

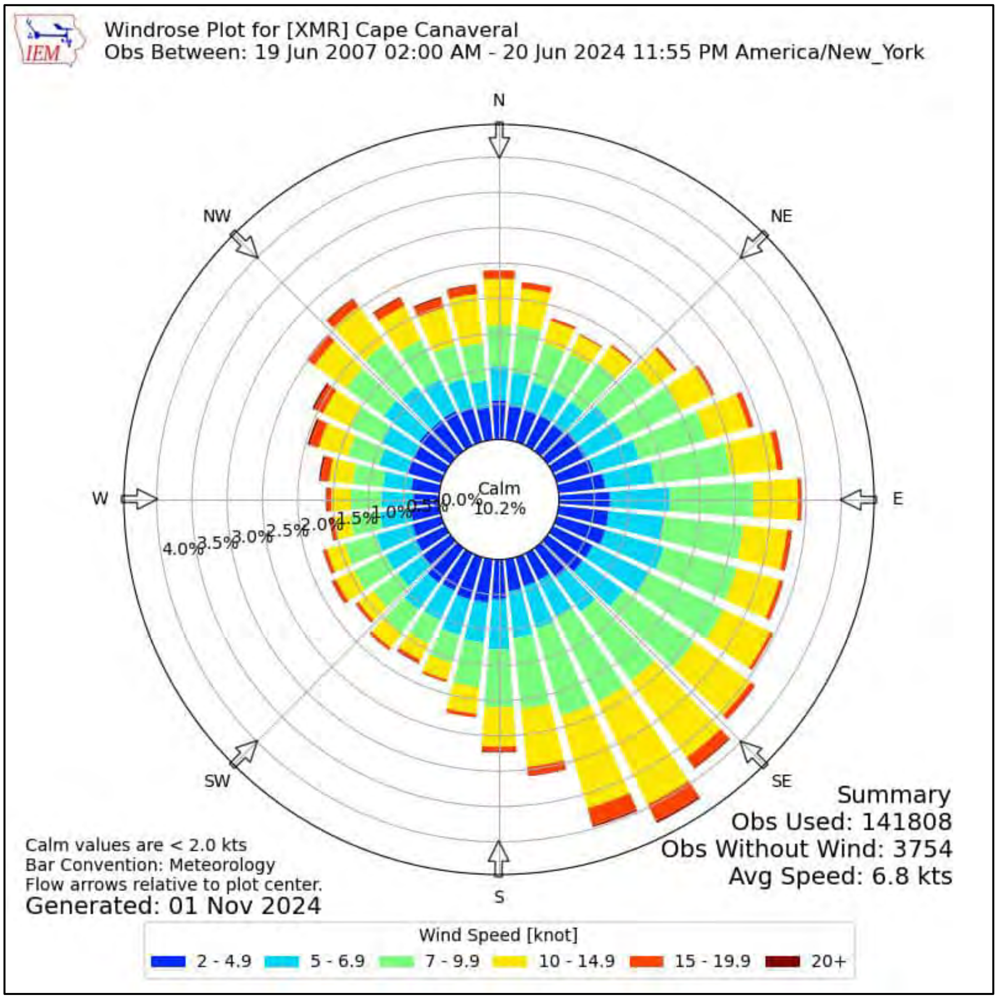


Figure 3. Cape Canaveral Wind (Rose) Historical Data: Annual Mean Conditions

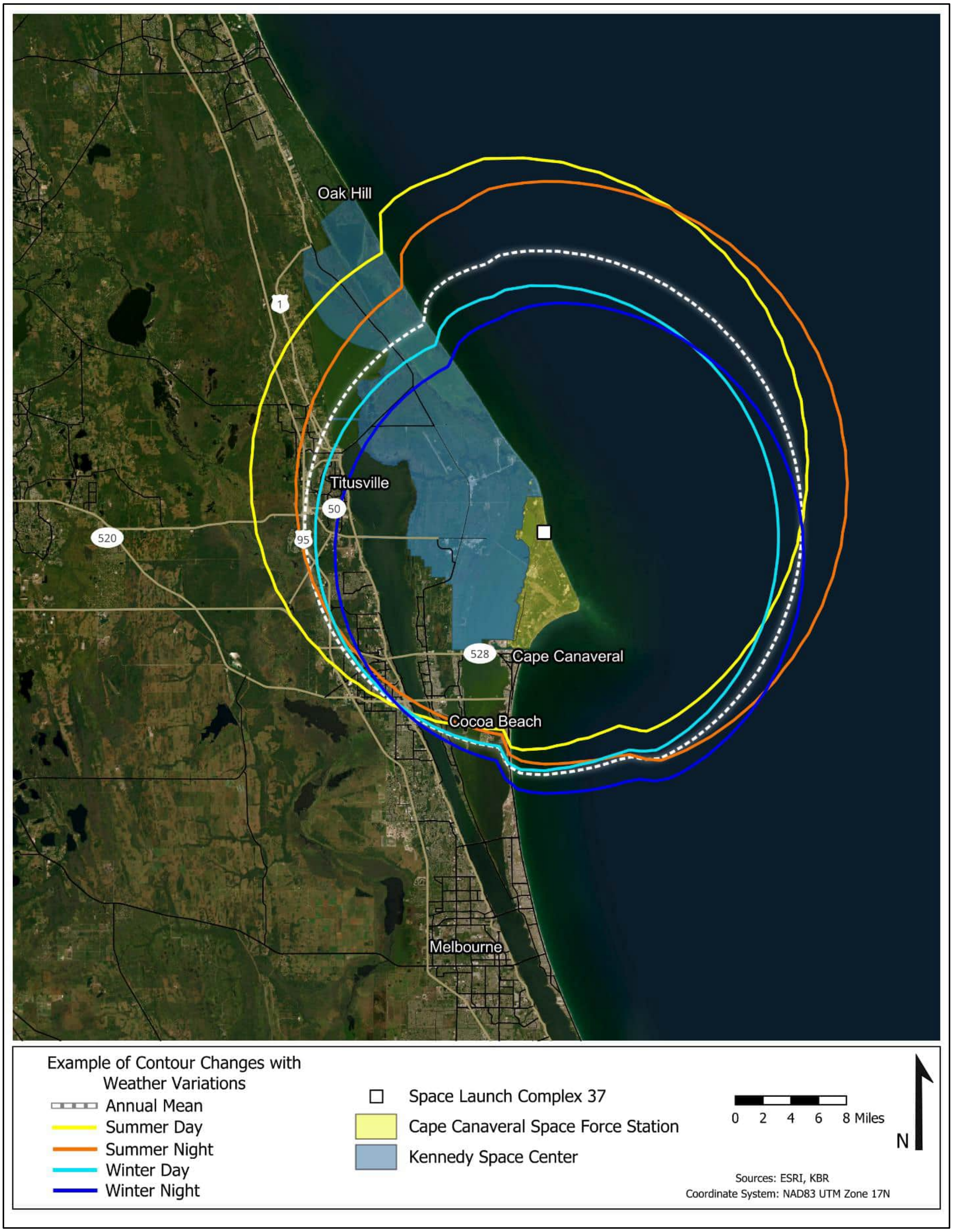


Figure 4. Example of Weather Variation Effects on Modeled Noise Contours At SLC-37

2.1 Rocket Noise Assessment Methodology

2.1.1 Rocket Noise Model

Rockets generate significant noise from the combustion process and turbulent mixing of the exhaust flow with the surrounding air. Figure 5 is a sketch of rocket noise. There is a supersonic potential core of exhaust flow, surrounded by a mixing region. Noise is generated in this directional flow with the highest noise levels at an angle of about 50 degrees, on average, from the direction of the exhaust flow. The fundamentals of predicting rocket noise were established by Wilhold et al.[9] for moving rockets and by Eldred et al.[10] for static firing. Sutherland[11] refined modeling of rocket source noise, improving its consistency relative to jet noise theory. Based on those fundamentals, Wyle has developed the PAD model for near field rocket noise[12] and the RNOISE model for far field noise in the community. RNOISE was used for the current analysis.

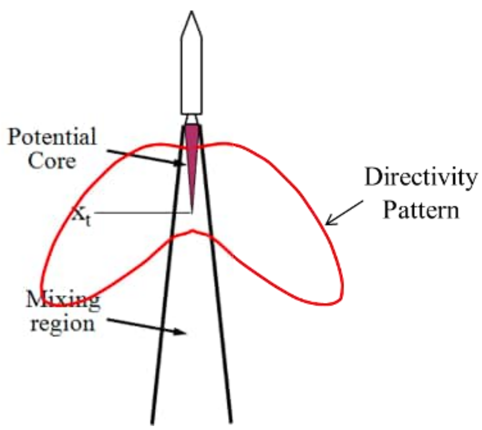


Figure 5. Rocket Noise Source

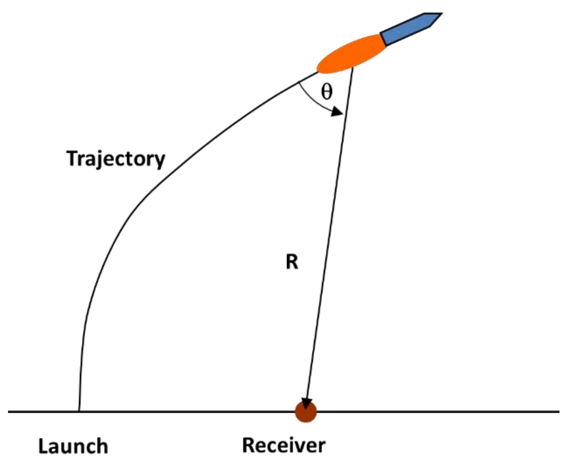


Figure 6. Modeling Rocket Noise at the Ground

Figure 6 is a sketch of far field rocket noise as treated by RNOISE. The vehicle's position and attitude are known from the trajectory. Rocket noise source characteristics are known from the engine properties, with thrust and exhaust velocity being the most important parameters. The emission angle and distance to the receiver are known from the flight path and receiver position. Noise at the ground is computed accounting for distance, ground impedance,[13] and atmospheric absorption of sound.[14] RNOISE propagates the full spectrum to the ground, accounting for Doppler shift from vehicle motion. It is a time simulation model, computing the noise at individual points or on a regular grid for every time point in the trajectory. Propagation time from the vehicle to the receiver is accounted for, yielding a spectral time history at the ground (including a range of frequencies from 1 Hz to 16 kHz). A variety of noise metrics can be computed from the calculated noise field and the metrics commonly used to assess rocket noise are described in the following section.

2.1.2 Primary Noise Metrics

FAA Order 1050.1F[7] specifies Day-Night Average Sound Level (DNL) as the standard metric for community noise impact analysis, but also specifies that other supplemental metrics may be used as appropriate for the circumstances. DNL is appropriate for continuous noise sources, such as airport noise and road traffic noise. The noise metrics used for rocket noise analysis are:

- DNL, as defined by FAA Order 1050.1F;
- SEL, the Sound Exposure Level, for individual events;
- L_{Amax}, the maximum A-weighted overall sound pressure level (OASPL), for individual events;
- L_{max}, the maximum unweighted OASPL, for individual events; and
- One third octave spectra at certain sensitive receptors.

As mentioned, DNL is necessary for policy. The next three metrics provide a measure of the impact of individual events; SEL and L_{Amax} are A-weighted and L_{max} is un-weighted. Loud individual events can pose a hearing damage hazard to people and can also cause adverse reactions by animals. Adverse animal reactions can include flight, nest abandonment, and interference with reproductive activities. L_{max} along with spectra, may be needed to assess potential damage to structures and adverse reaction of species whose hearing response is not like that of humans.

L_{Amax} is appropriate for community noise assessment of a single event, such as a rocket launch or static fire test. This metric represents the highest A-weighted integrated sound level for the event in which the sound level changes value with time. Slowly varying or steady sounds are generally integrated over a period of one second. L_{Amax} is important in judging the interference caused by a noise event with conversation, TV listening, sleep, or other common activities. Similarly, L_{max} is the highest unweighted integrated sound level for the event, used to assess the potential for structural damage. Although A-weighted maximum sound level provides some measure of the intrusiveness of the event, it does not completely describe the total event, because it does not include the duration that the sound is heard.

SEL is a composite metric that represents both the level of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period during which the event is heard. SEL provides a measure of the total acoustic energy transmitted to the listener during the event, but it does not directly represent the sound level heard at any given time. For example, during an aircraft flyover, SEL would include both the maximum noise level and the lower noise levels produced during onset and recess periods of the overflight. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For a rocket launch, SEL is expected to be greater than L_{Amax}.

2.1.3 Noise Assessment Guidelines

Land Use Compatibility Guidelines for Cumulative Noise Exposure

As previously mentioned, DNL represents the average sound level for annual average daily aircraft events which are used to assess cumulative noise exposure. FAA's published 14 Code of Federal Regulations (CFR)

Part 150 defines land use compatibility guidelines for aviation noise exposure that are also applicable to rocket noise exposure. These guidelines consider land use compatibility for different uses over a range of DNL noise exposure levels, including the adoption of DNL 65 dBA as the limit for residential land use compatibility.

Hearing Conservation

In this study, the highest noise levels from Starship flight and test operations are expected to occur in the vicinity of the launch and landing pads at SLC-37 (on CCSFS property) and at the adjacent KSC property. The Department of the Air Force Instruction (DAFI) 48-127, *Occupational Noise and Hearing Conservation Program,* provides suitable guidelines to protect human hearing from long-term, continuous exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). DAF's permissible daily noise exposure limits include a L_{Amax} of 108 dBA (slow response) for a duration of 2.4 minutes or less. This is the criteria used in this study to evaluate areas around launch, landing, and static fire test sites that would require implementing a hearing conservation program, i.e., areas within the L_{Amax} 108 dBA contour. This level was chosen as an indicator of when a hearing conservation program should be implemented since the received levels from most proposed flight and test operations, individually or together, are not expected to exceed this level for more than 2 minutes on any given day.

Structural Damage Potential

The potential for structural damage due to Starship rocket engine noise events is assessed using criteria developed from two separate studies. The first is based on a study of structural damage claims from rocket static firing tests which indicates that, based on Maximum Unweighted Sound Level (L_{max}), approximately one damage claim will result per 100 households exposed at 120 dB and one damage claim will result per 1,000 households exposed at 111 dB[16]. The second, less conservative criteria is based on conclusions from a recent study to ascertain whether range activities (i.e., test, evaluation, demilitarization, and training activities of items such as weapons systems, ordinance, and munitions) would cause structural damage. This study concluded that structural damage becomes improbable below 140 dB [Maximum Un-weighted or linear Sound Level (L_{max})]. No glass or plaster damage is expected below 140 dB and no damage is expected below 134 dB[17].

2.1.4 Supplemental Noise Metrics

As noted in Section 2.1.2, DNL is the standard metric for community noise impact analysis. And while DNL is a cumulative metric that is appropriate to estimate the overall noise environment at military airfields, civilian airports, and now space launch facilities, the Department of Defense (DoD) Noise Working Group (DNWG) provides guidance on the use of additional metrics to fully describe the noise impacts to noise sensitive locations. The DoD expands upon DNL with the following supplemental metrics described in the DNWG guidelines[18]; note that L_{Amax} and SEL, which are included in the guidelines, and are the basis for two of the supplemental metrics, Speech Interference and Residential Sleep Disturbance, were defined previously in Section 2.1.2:

- Number of Events at or above a specified threshold (NA) or Time Above a threshold (TA),

- Equivalent Sound Level (L_{eq}), a cumulative noise metric that represents the average sound level (on a logarithmic basis) over a specified period; the period specified for L_{eq} is typically provided and relates to a type of activity being assessed (e.g., L_{eq}(24) for 24 hours). An L_{eq}(8) is used in this study to represent a typical school day,
- Probability of Awakening (PA).

NA, L_{eq}, and TA use a specified period of time that can include an average 24-hour day, daytime (7 a.m. (0700) to 10 p.m. (2200)), nighttime (10 p.m. (2200) to 7 a.m. (0700)), school day (7 a.m. (0700) to 3 p.m. (1500)), or other time period appropriate for the analysis. The supplemental metrics used in this study are described in the following sections.

2.1.4.1 Potential for Hearing Loss

Considerable data on hearing loss have been collected and analyzed by the scientific/medical community, and it has been well established that continuous exposure to high noise levels will damage human hearing. People exposed to high noise environments may experience temporary or permanent hearing loss; those exposed over a long period of time are at an increased risk of experiencing permanent hearing loss. While various government organizations have defined noise thresholds, based on L_{eq}, to protect workers from noise exposure during their lifetime working period (40 hours per week over 40 years), the DoD uses a screening threshold for residences of DNL 80 dB to ensure a conservative approach to assessing the potential for hearing loss[19]. If residences are identified within the DNL 80 dB exposure area, then additional analysis should be carried out using L_{eq}.

2.1.4.2 Speech Interference

Interference with speech disturbs normal social activities and can be a leading contributor to annoyance. In residential areas, concern is about the effect that noise has on face-to-face conversations, telephone conversations, and watching television. Aircraft and spacecraft noise events can disrupt these types of activities when indoor L_{Amax} exceeds 50 dB because word intelligibility decreases at that level[20]. This study determines the number of potential speech interfering events per average daytime hour (from 7 a.m. until 10 p.m.) at all noise sensitive receptors selected for assessment, also referred to as points of interest (POIs). This speech interference assessment is targeted primarily at POIs other than schools, since schools are assessed separately using Classroom Learning Interference; however, each POI may be considered to include other types of noise sensitive receptors nearby (such as residences near a school).

2.1.4.3 Classroom Learning Interference

Noise in the classroom can adversely affect student's speech communication and interfere with learning. Various governmental organizations have developed criteria for classroom noise impacts using L_{eq} and the number of interfering events. DoD recommends an exterior Leq of 60 dB (equivalent to 45 dB interior Leq with windows open) as a screening criteria to determine schools at risk of classroom learning affects[18]. Schools that exceed an exterior L_{eq} of 60 dB are further analyzed by counting the number of events per hour above an interior L_{Amax} of 50 dB, which equates to the highest permissible classroom level for speech intelligibility. Interior sound levels are determined from exterior levels with a noise reduction applied for the building (15 dB for windows open and 25 dB for windows closed). The TA 50 dB has also been determined as a measure of the time that students are potentially impacted.

2.1.4.4 Residential Sleep Disturbance

Elevated noise levels above the background may cause sleep disturbance which can prevent people from falling asleep or wake them from sleep. A method formerly relied upon to estimate the percent awakenings (PA) is described in ANSI/Acoustical Society of America (ASA) S12.9-2008/Part 6[21] which was endorsed by the DNWG[22]. It should be noted that as of July 2018, the ANSI and ASA have withdrawn the 2008 standard noting that the 2008 Standard for calculating at least one behavioral awakening per night would lead to unreliable and difficult-to-interpret predictions of transportation noise-induced sleep disturbance (ANSI/ASA 2018)[23]. Also notable is that ANSI/ASA S12.9-2008/Part 6[21] is based on studies of airport noise environments and multiple nighttime noise events; Proposed Action Starship launches (and associated landings) during nighttime would include several noise events with the landings occurring several minutes after each launch, whereas Starship spacecraft and Super Heavy nighttime static fire tests would each normally occur as one noise event. Without a current, standard method to estimate PA, and with the limitations noted for Starship nighttime operations, this study estimates PA using the FICAN updated (1997) recommended dose-response curve[24], interpreted to be the "maximum precent of the exposed population expected to be behaviorally awakened" for a given residential population.

The FICAN 1997 relationship, Percent Awakenings = $0.0087 \times [SEL - 30]^{1.79}$, provides a method to estimate PA from at least one noise event per night. This relationship utilizes the estimated interior SEL resulting from proposed nighttime Starship operations to provide a conservative estimate (based on the most recent sleep disturbance studies at the time) of the percentage of the population that would be awakened at least once per night. Percent awakening results at the study points of interest are presented for Starship launches and both windows open and windows closed cases.

2.2 SONIC BOOM ASSESSMENT METHODOLOGY

2.2.1 Sonic Boom Model

A sonic boom is the wave field about a supersonic vehicle. As the vehicle moves, it pushes the air aside. Because flight speed is faster than the speed of sound, the pressure waves can't move away from the vehicle, as they would for subsonic flight, but stay together in a coherent wave pattern. The waves travel with the vehicle. Figure 7 is a classic sketch of sonic boom from an aircraft in level flight[25]. It shows a conical wave moving with the aircraft, much like the bow wave of a boat. While Figure 7 shows the wave as a simple cone, whose ground intercept extends indefinitely, temperature gradients in the atmosphere generally distort the wave from a perfect cone to one that refracts upward, so the ground intercept goes out to a finite distance on either side. A sonic boom is not a onetime event as the aircraft "breaks the sound barrier" but is often described as being swept out along a "carpet" across the width of the ground intercepts and the length of the flight track. Booms from steady or near-steady flight are referred to as carpet booms.

The waveform at the ground is generally an "N-wave" pressure signature, as sketched in the figure, where compression in the forward part of the vehicle and expansion and recompression at the rear coalesce into a bow shock and a tail shock, respectively, with a linear expansion between.

Figure 7 is drawn from the perspective of aircraft coordinates. The wave cone exists as shown at a particular time but is generated over a time period. Booms can also be viewed from the perspective of rays propagating relative to ground-fixed coordinates. Figure 8 shows both perspectives. The cone represents rays that are generated at a given time, and which reach the ground at later times. The intercept of a given ray cone with the ground is called an "isopemp." When computing sonic booms the ray perspective is appropriate, since one starts the analysis from the aircraft trajectory points and each isopemp is identified with flight conditions at a given time. As sketched in Figure 8, the isopemps are forward facing crescents.

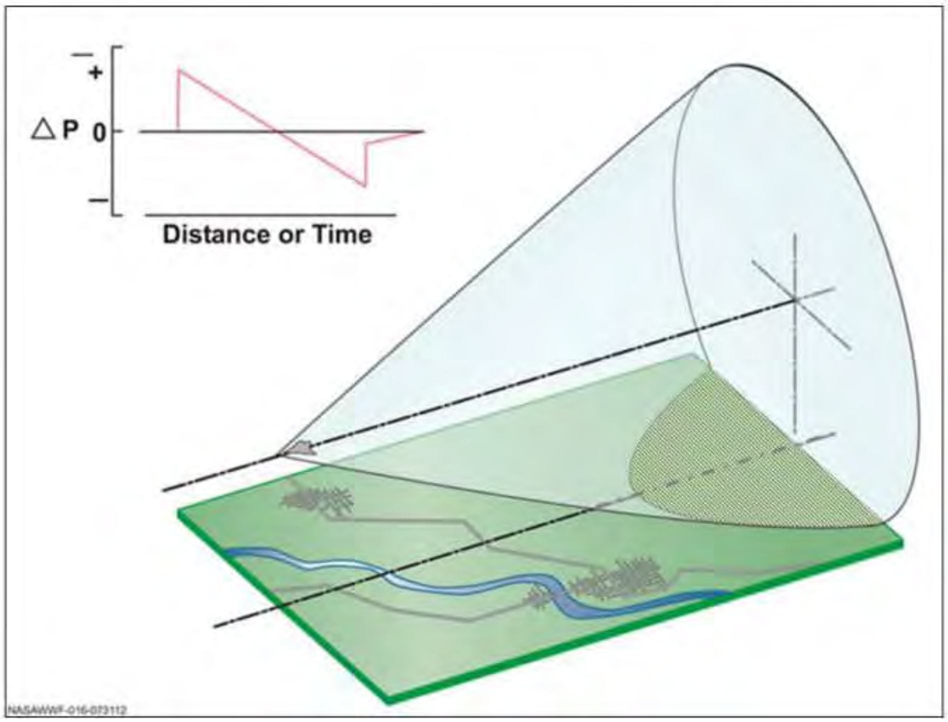


Figure 7. Sonic Boom Wavefield (Vehicle in Level Flight)

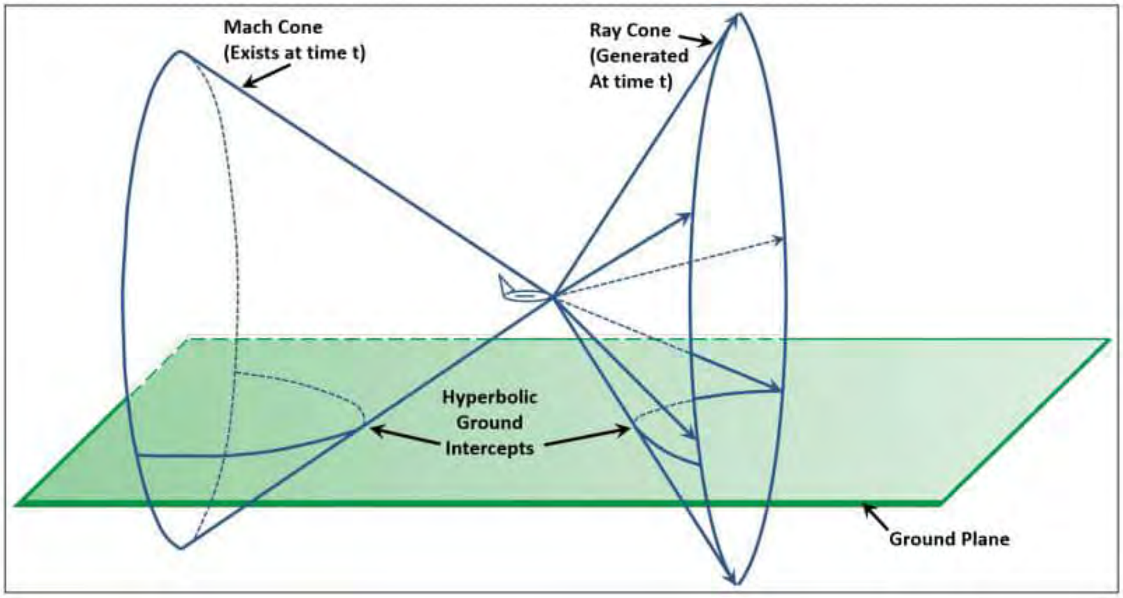


Figure 8. Wave versus Ray Viewpoints

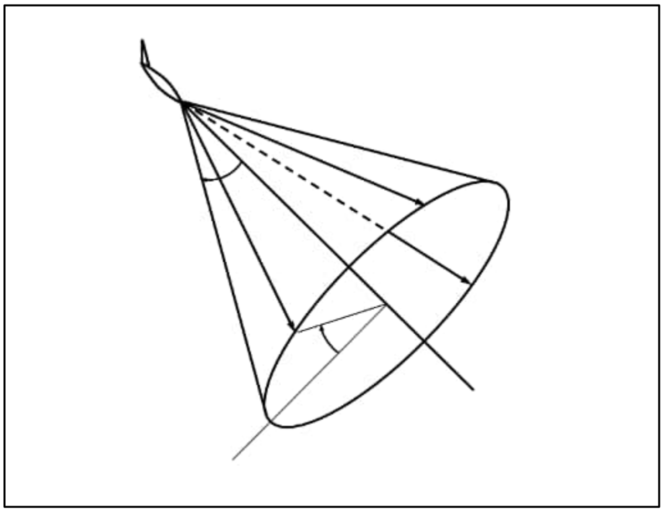


Figure 9. Ray Cone in Diving Flight

Figures 7 and 8 are drawn for steady level flight. If the aircraft climbs or dives, the ray cone tilts along with it. Figure 9 shows a ray cone in diving flight. At the angle in the figure the isopemp would still be a forward-facing crescent but would wrap around further than shown in Figure 8. In a steeper dive the isopemp could go full circle. If the vehicle is climbing at an angle steeper than the ray cone angle, there will be no boom at the ground. During very steep descent (near vertical) and at high Mach numbers the rays can be emitted at a shallow enough angle that they would refract upward and not reach the ground. For a descending vehicle that eventually decelerates to subsonic speed, some part of the trajectory will generate boom that reaches the ground.

Supersonic vehicles can turn and accelerate or decelerate. That affects the boom loudness, and under some conditions cause focused superbooms. Figure 10 is a sketch of rays from an accelerating aircraft. As the Mach number increases the ray angles steepen. The rays cross and overlap, with the focus along the "caustic" line indicated in the figure. The boom on a focusing ray is a normal N-wave before it gets close to the caustic, is amplified by a factor of two to five as it reaches the caustic, then is substantially attenuated as a "post-focus" boom after it passes the caustic.

Figure 11 shows the isopemps for this type of acceleration focus. The focal zone is the concentrated region at the left end of the footprint. The maximum focus area – where the boom is more than twice the unfocused normal boom – is very narrow, generally a hundred yards or less.

Sonic boom levels were estimated for SpaceX operations at KSC and CCSFS, including proposed Starship, Starship spacecraft, and booster flight operations at SLC-37 and LC-39A, using the PCBoom model[3,4]; PCBoom computes single-event sonic boom footprints, including contours of peak overpressure and signatures from any supersonic vehicle executing arbitrary maneuvers in a three-dimensional atmosphere.

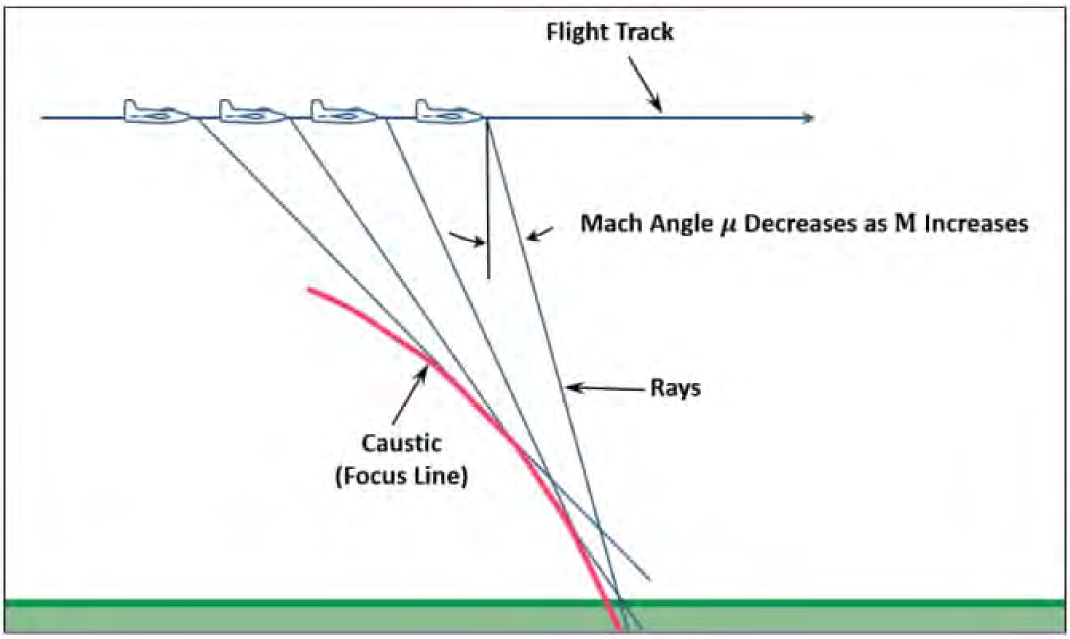


Figure 10. Ray Crossing and Overlap in an Acceleration Focus

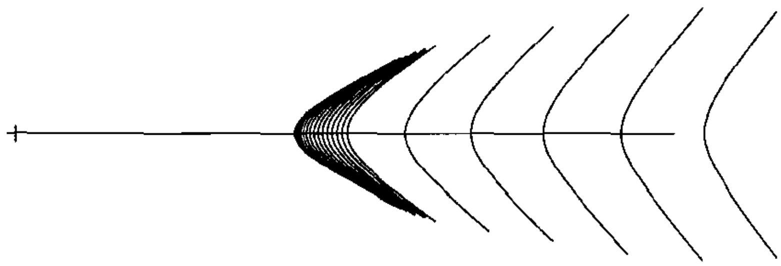


Figure 11. Isopemp Overlap in an Acceleration Focus

2.2.2 Sonic Boom Metrics

Sonic boom exposure is reported for single events as peak overpressure, within the boom footprint or at a particular location, in units of pounds per square foot (psf). Cumulative sonic boom exposure is reported using the C-weighted Day-Night Average Sound Level (CDNL) metric.

2.2.2.1 Supplemental Analyses for Sonic Boom Assessment

Two supplemental analyses are used in this report to further characterize noise impacts from supersonic operations; residential sleep disturbance and the potential for structural damage.

Residential Sleep Disturbance – Based on a review of existing sleep studies, Pearsons, Barber, and Tabachnick (1989)[25] developed a preliminary dose-response relationship for awakenings due to impulsive noise exposure as follows: % Awakened or Aroused = 2.32(CSEL) - 184.9

Potential for Structural Damage – Based on the FAA's Hershey and Higgins 1976 report "*Statistical Model of Sonic Boom Structural Damage*",[26] and the Department of the Air Force's (DAF) Haber and Nakaki 1989 report "*Sonic Boom Damage to Conventional Structures*",[27] which describe similar damage probabilities for different structural components for various sonic boom exposure levels; 2 psf and 4 psf are used in this report to assess the potential for structural damage, since areas off KSC and CCSFS properties are most likely to be exposed to booms, within this range of levels, from booster landing operations; 2 psf is also considered to be the low threshold level for glass breakage.

This report continues with descriptions and results of the noise modeling and assessments conducted for all the operational scenarios studied in connection with the proposed Starship operations at SLC-37:

- Baseline Scenario at CCSFS and KSC – Section 3
- No Action Scenario at CCSFS and KSC – Section 4
- Proposed Starship operations at SLC-37 – Section 5
- Proposed Action Scenario, including proposed Starship operations at SLC-37 plus all KSC and CCSFS operations that define the No Action Scenario – Section 6
- Reasonably Foreseeable Future Actions Scenario, including the Proposed Action Scenario (for SLC-37) plus the Proposed Action Starship operations at LC-39A – Section 7

3 BASELINE SCENARIO

3.1 BASELINE OPERATIONS AT KSC AND CCSFS

Baseline launch vehicle flight and test operations at KSC and CCSFS are listed in Table 2. These operations are organized in the launch, landing, and static fire event categories and then by facility (KSC or CCSFS), launch complex, and by vehicle or program name, followed by the annual number of daytime (7 a.m. - 10 p.m.) and nighttime (10 p.m. - 7 a.m.) operations. These represent the operations that were conducted over the 12-month period (1 September 2023 – 31 August 2024).

Table 2. Baseline Launch, Landing, and Static Fire Test Operations at KSC and CCSFS

Event	Facility	Complex	Vehicle/Program	Day	Night	Total
Launch	KSC	LC-39A	SpaceX Falcon 9	10.2	6.8	17
		LC-39A	SpaceX Falcon Heavy	1.8	1.2	3
	CCSFS	SLC-37	ULA Delta IV Heavy	1	0	1
		SLC-40	SpaceX Falcon 9	37.2	24.8	62
		SLC-41	ULA Atlas V 501 (0 SRBs)	1	0	1
		SLC-41	ULA Atlas V N22 (2 SRBs)	1	0	1
		SLC-41	ULA Atlas V 551 (5 SRBs)	1	1	2
		SLC-41	ULA Vulcan VC2S	0	1	1
			Total	**53.2**	**34.8**	**88**
Landing	CCSFS	LZ-1/LZ-2	SpaceX Falcon 9 Booster	4.2	2.8	7
		LZ-1/LZ-2	SpaceX Falcon Heavy Booster	3.6	2.4	6
			Total	**7.8**	**5.2**	**13**
Static Fire	KSC	LC-39A	SpaceX Falcon 9	10.2	6.8	17
		LC-39A	SpaceX Falcon Heavy	1.8	1.2	3
	CCSFS	SLC-40	SpaceX Falcon 9	37.2	24.8	62
			Total	**49.2**	**32.8**	**82**

3.2 BASELINE ROCKET NOISE EXPOSURE: DNL CONTOURS

Figure 12 shows the DNL contours for the Baseline operations in Table 2, including DNL 65-85 dBA in 5 dB increments; these contours represent the cumulative subsonic noise environment due to rocket noise. The DNL 65 dBA contour, which represents the significance threshold for noise sensitive areas, is entirely within the KSC and CCSFS properties. Baseline DNL exposure is summarized in Section 8.

3.3 BASELINE SONIC BOOM EXPOSURE: CDNL CONTOURS

Figure 13 shows the CDNL contours for the Baseline operations in Table 2, including only the CDNL 60 dBC contour, which represents the significance threshold for noise sensitive areas. The CDNL 60 dBC contour does not extend beyond the CCSFS property line due to the low annual number of landing events; landings are the only type of spacecraft operation that results in sonic boom exposure over land in Florida. Section 8, which summarizes and compares the noise results for each operational scenario, includes more details about the Baseline CDNL exposure.

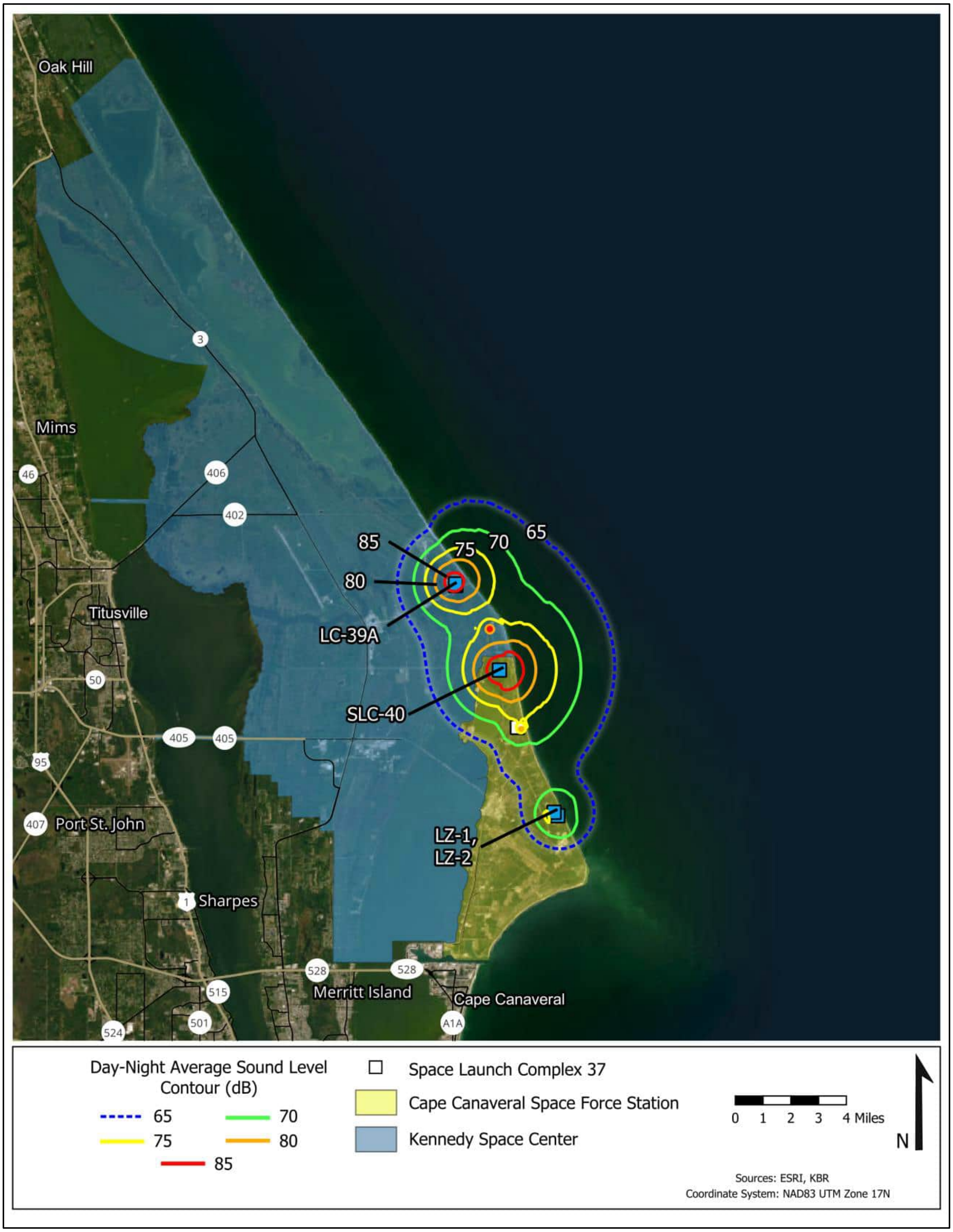


Figure 12. KSC and CCSFS Baseline Rocket Noise Exposure: DNL Contours

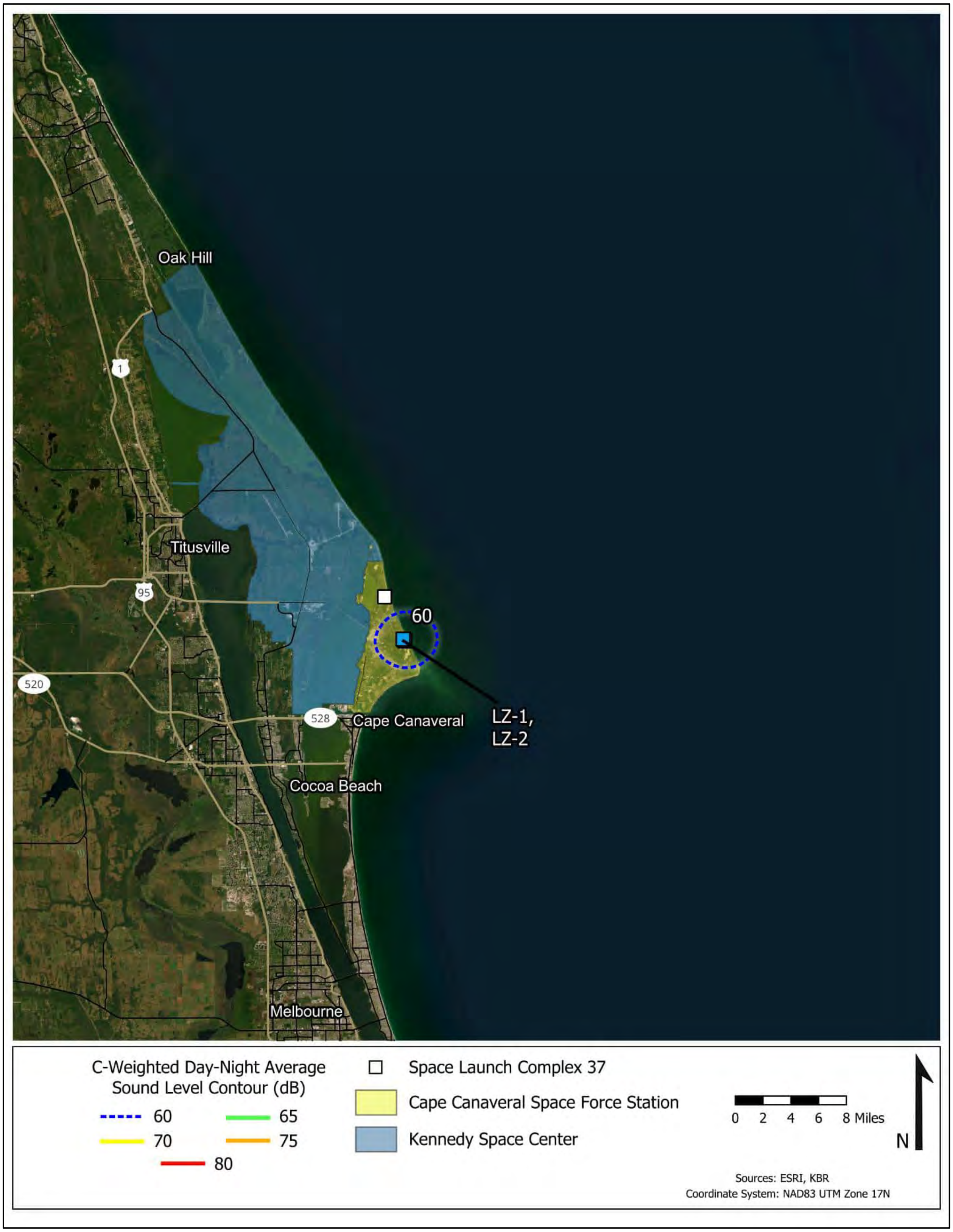


Figure 13. KSC and CCSFS Baseline Sonic Boom Exposure: CDNL Contours

4 NO ACTION SCENARIO

4.1 NO ACTION OPERATIONS AT KSC AND CCSFS

No Action launch vehicle flight and test operations at KSC and CCSFS are listed in Table 3. These operations are organized in the launch, landing, and static fire event categories and then by facility (KSC or CCSFS), launch complex, and by vehicle or program name, followed by the annual number of daytime (7 a.m. - 10 p.m.) and nighttime (10 p.m. - 7 a.m.) operations. These represent a maximum scenario of the launch, landing, and static fire test events that have undergone review and approval, but have not occurred yet (i.e., they are not part of the baseline).

Table 3. No Action Launch, Landing, and Static Fire Test Operations at KSC and CCSFS

Event	Facility	Complex	Vehicle/Program	Day	Night	Total
Launch	KSC	LC-39A	SpaceX Falcon 9	0	36	36
		LC-39A	SpaceX Falcon Heavy	0	5	5
		LC-39B	NASA Space Launch System	0.6	0.4	1
		LC-48N	NASA SCLV	32.5	19.5	52
		LC-48S	NASA SCLV	32.5	19.5	52
	CCSFS	SLC-16	Relativity Terran R	18	6	24
		SLC-36	Blue Origin New Glenn Launch	10	2	12
		SLC-40	SpaceX Falcon 9 Launch	0	70	70
		SLC-41	ULA Atlas V 551 (5 SRBs)	6.25	3.75	10
		SLC-41	ULA Vulcan VC6S	13	7	20
		SLC-46	Liquid Propellant Vehicle	7.5	4.5	12
		SLC-46	Solid Propellant Vehicle	7.5	4.5	12
			Total	**127.8**	**178.2**	**306**
Landing	CCSFS	LZ-1/2	SpaceX Falcon Booster	0	54	54
		LZ-1/2	SpaceX Falcon Heavy Booster	0	10	10
			Total	**0**	**64**	**64**
Static Fire	KSC	LC-39A	SpaceX Falcon 9	0	36	36
		LC-39A	SpaceX Falcon Heavy	0	5	5
		LC-48N	NASA SCLV	32.5	19.5	52
		LC-48S	NASA SCLV	32.5	19.5	52
	CCSFS	SLC-11	Blue Origin BE-4 Engine Testing	108	0	108
		SLC-16	Relativity Terran R Static Fire	18	6	24
		SLC-16	Relativity Terran R Stage MDC Hot Fire	10	4	14
		SLC-36	Blue Origin New Glenn Static Fire	10	2	12
		SLC-40	SpaceX Falcon 9 Static Fire	0	70	70
			Total	**211**	**162**	**373**

4.2 NO ACTION: ROCKET NOISE EXPOSURE: DNL CONTOURS

Figure 14 shows the DNL contours for the No Action operations in Table 3, including DNL 65-85 dBA in 5 dB increments; these contours represent the cumulative subsonic noise environment due to rocket noise. The DNL 65 dBA contour, which represents the significance threshold for noise sensitive areas, is entirely within the KSC and CCSFS properties. Additional details of the No Action DNL exposure, and comparison with the DNL exposure estimates for the other operational scenarios are provided in Section 8.

4.3 NO ACTION: SONIC BOOM EXPOSURE: CDNL CONTOURS

Figure 15 shows the CDNL contours for the No Action operations in Table 3, including the CDNL 60, 65, and 70 dBC contours. The CDNL 60 dBC contour, which represents the significance threshold for noise sensitive areas, extends beyond the KSC and CCSFS property lines into Merritt Island to the west and the City of Cape Canaveral, and parts of Cocoa and Cocoa Beach to the south. The primary reason these CDNL contours extend into residential areas is the high number of annual nighttime landing operations (Table 3) which include a 10-decibel penalty compared to daytime operations. Additional details of the No Action CDNL exposure, and comparison with the CDNL exposure estimates for the other operational scenarios are provided in Section 8, which summarizes the results.

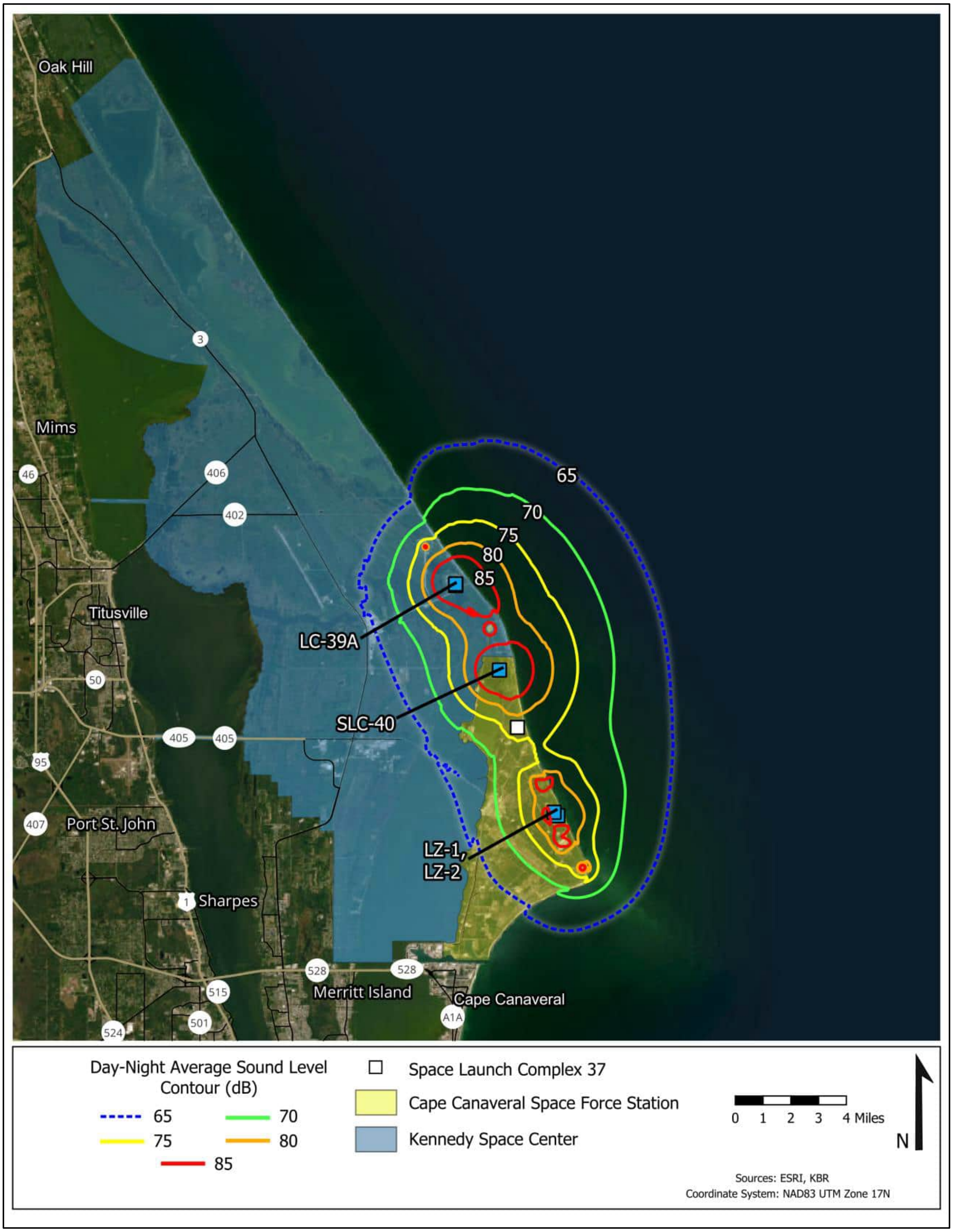


Figure 14. KSC and CCSFS No Action Rocket Noise Exposure: DNL Contours

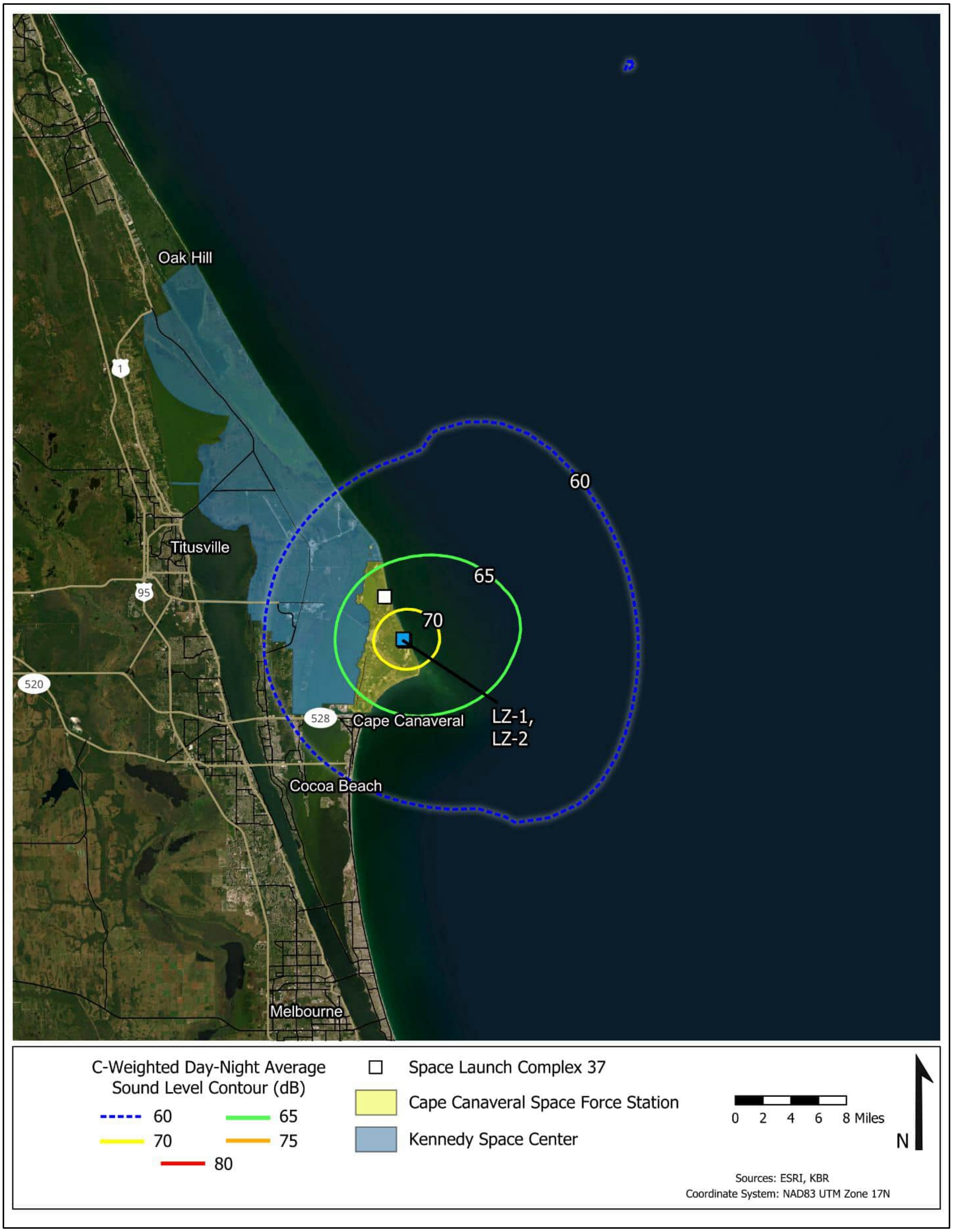


Figure 15. KSC and CCSFS No Action Sonic Boom Exposure: CDNL Contours

5 PROPOSED STARSHIP AND SUPER HEAVY BOOSTER FLIGHT AND TEST OPERATIONS AT SLC-37

5.1 PROPOSED ANNUAL OPERATIONS AT SLC-37

This section describes the noise modeling and assessment results for the proposed Starship operations at SLC-37 only; whereas Section 6 describes the results for the Proposed Action, which includes the Starship operations presented here plus all the launch and landing operations associated with the No Action Scenario (Section 4). The proposed Starship flight and test operations at SLC-37 that are expected to fulfill mission and test requirements at CCSFS are listed in Table 4. The number of annual daytime (7 a.m. to 10 p.m.) and nighttime (10 p.m. to 7 a.m.) operations are listed for each type of operation and associated vehicle. For each operation type, there are a total of 76 proposed annual operations and, in each case, 38 (50 percent) are modeled as daytime operations and 38 as nighttime operations.

Table 4. Proposed Annual Starship Operations at SLC-37

Operation Type	Annual Operations by Vehicle						Total Annual Operations
	Starship + Super Heavy Booster		Starship		Super Heavy Booster		
	Day	Night	Day	Night	Day	Night	
Orbital Launch	38	38	-	-	-	-	76
Starship Spacecraft Landing	-	-	38	38	-	-	76
Super Heavy (Booster) Landing	-	-	-	-	38	38	76
Starship Static Fire Test	-	-	38	38	-	-	76
Super Heavy (Booster) Static Fire Test	-	-	-	-	38	38	76

5.2 ROCKET NOISE EXPOSURE AT SLC-37

In this section, noise levels are estimated for the Starship proposed flight and test operations at SLC-37. The single event noise levels for each type of operation are assessed in the following sections: Starship Orbital Launch Noise Levels (Section 5.2.1), Descent/Landing Noise Levels (5.2.2), and Static Fire Test Noise Levels (5.2.3). The cumulative noise exposure from all operations combined are assessed using the DNL metric in Section 5.2.4 including the noise exposed population, acreage, and households within each DNL contour band (from 65 to 85 dB in 5 dB increments) and at the study points of interest (POIs) using guidelines approved by DAF and the FAA. Following this, in Section 5.2.5, is a supplemental noise metrics assessment at the same POIs including: Speech Interference (5.2.5.1), Classroom Learning Interference (5.2.5.2), Probability of Awakening (5.2.5.3), and Potential for Hearing Loss (5.2.5.4). The supplemental noise metrics assessment follows DoD guidelines for noise impact analysis[17]. Section 5 concludes with an assessment of the sonic boom exposures that would result from the proposed Starship flight operations at SLC-37.

5.2.1 Starship Orbital Launch Noise Levels at SLC-37

RNOISE was used to estimate the L_{Amax}, SEL, and L_{max} contours for Starship orbital launches at SLC-37 using trajectory data, from liftoff to stage separation, provided by SpaceX in file 'Starship_Bottom_Up_Ascent_Nominal_80_12_r2.ASC'. The L_{Amax} contours indicate the A-weighted maximum sound level at each location over the duration of the launch where engine thrust varies according to the ascent thrust profile provided. For orbital launches, the Starship launch vehicle is comprised of the Starship spacecraft (vehicle with payload) and the Super Heavy Booster.

RNOISE computations were done using a radial grid consisting of 128 azimuths and 500 intervals out to 500,000 feet from the launch pad. Land areas were modeled using a single ground impedance value representing soft ground cover in the vicinity of SLC-37 and offshore water areas modeled as acoustically hard. Ground effect (i.e., the difference in sound pressure level in the presence of ground compared with free field conditions) is based on a weighted average over the propagation path. As will be shown in the resulting noise contour maps (Figures 16 through 21), the shape of the innermost contours is approximately circular. The shape of the outermost contours is due to rocket noise directivity and the difference between acoustically hard water and acoustically soft ground. The launch pad location at SLC-37 is indicated in the map legends as are the boundaries of Cape Canaveral Space Force Station and Kennedy Space Center. All the maps depicting noise contours for operations at SLC-37 also show the nearby cities including Titusville, Cape Canaveral, and Cocoa Beach, FL. Throughout this report, two different map scales are used as appropriate to show the extent of the noise contours.

The L_{Amax} 90 dB through 140 dB contours shown on Figures 16 and 17 represent the A-weighted maximum levels estimated for a Starship orbital launch at SLC-37. Figure 17 shows these contours using a zoomed in map scale to better show the extent of the noise exposure relative to the local towns and cities in the close vicinity of SLC-37. The higher L_{Amax} contours (100 – 140 dB) are located within about 8 miles of SLC-37; the 100 dB contour is located mostly within the KSC and CCSFS properties. In all cases following, where noise exposures are reported to be off KSC and/or off CCSFS properties, this refers to contours that extend to the north, south, and west into populated areas, rather than to contours that extend east over the Atlantic Ocean. The 90 dB contour extends west of the Indian River into Titusville. If a Starship orbital launch occurs during the day, when background levels are in the 50 dB to 60 dB range, residents of Titusville may notice launch noise levels above 70 dB. If the same launch occurs during the night, when background levels are lower than during the day (e.g., below 40 dB to 50 dB range), these residents may notice launch noise levels that exceed 60 dB. A prevailing on-shore or off-shore breeze may also strongly influence noise levels in nearby communities.

Estimated SEL contours of 90 dB through 150 dB, in 10 dB increments, are shown on Figures 18 and 19 for Starship orbital launch at SLC-37 with Figure 19 showing a zoomed in map scale. As mentioned previously, SEL is an integrated metric and is expected to be greater than the L_{Amax} because the launch event is up to several minutes in duration whereas the maximum sound level (L_{Amax}) occurs instantaneously. On Figure 18, the 100 dB SEL contour is estimated to extend to the west side of Titusville.

Starship orbital launch events are the loudest single events of all the flight and test operations assessed in this modeling study. Accordingly, orbital launch single event noise levels are related to guidelines in

Section 2.1.3 for hearing conservation and potential for structural damage. These guidelines are also used later in the report to assess noise from the other Starship flight and test operations.

An estimate of the areas, in the vicinity of Starship orbital launches, where a hearing conservation program should apply was made using KSC's permissible daily noise exposure limit of 108 dBA (slow response) for a duration of 2 minutes or less[15]. Figure 17 shows that noise levels (L_{Amax}) are less than DAF's 108 dBA upper noise limit guideline at distances greater than approximately 5 miles from the launch pad. Starship orbital launch noise events will last a few minutes at most, at a single location, with the highest noise levels occurring for less than a minute such that KSC's 108 dBA daily noise exposure limit is not expected to be exceeded.

The potential for structural damage due to Starship orbital launch events is assessed using two different criteria as described in Section 2.1.3. The first criteria indicates that, based on Maximum Unweighted Sound Level (L_{max}), approximately one damage claim will result per 100 households exposed at 120 dB and one damage claim will result per 1,000 households exposed at 111 dB[16]. The L_{max} 110 dB through 150 dB contours estimated for Starship orbital launch events are shown on Figures 20 and 21 (zoomed in) including the L_{max} 111 dB and 120 dB contours used for damage claim assessment. Starship orbital launch events are estimated to generate L_{max} of 120 dB approximately 10 miles from the launch pad (Figure 20); the 120 dB contour would extend west to the Indian River and north to Wilson, but remain mostly on KSC and CCSFS properties. The 111 dB contour would extend approximately 24 miles from the launch pad into residential areas west of Titusville, south along the coast between Cocoa Beach and Satellite Beach, and north to Oak Hill; for residences located between the 111 dB and 120 dB contours, between one and ten damage claims per 1,000 households would be expected based on assessment using this criteria. The second, less conservative criteria, is based on a study that concludes that structural damage becomes improbable below 140 dB L_{max}. No glass or plaster damage is expected below 140 dB and no damage is expected below 134 dB[17]. Figure 21 shows that the 140 dB and 130 dB, and thus the 134 dB contour (not shown but located about halfway between the 140 dB and 130 dB contours), are all located within KSC and CCSFS properties. No structural damage is expected to occur to residences located off KSC and CCSFS properties based on assessment using this criteria.

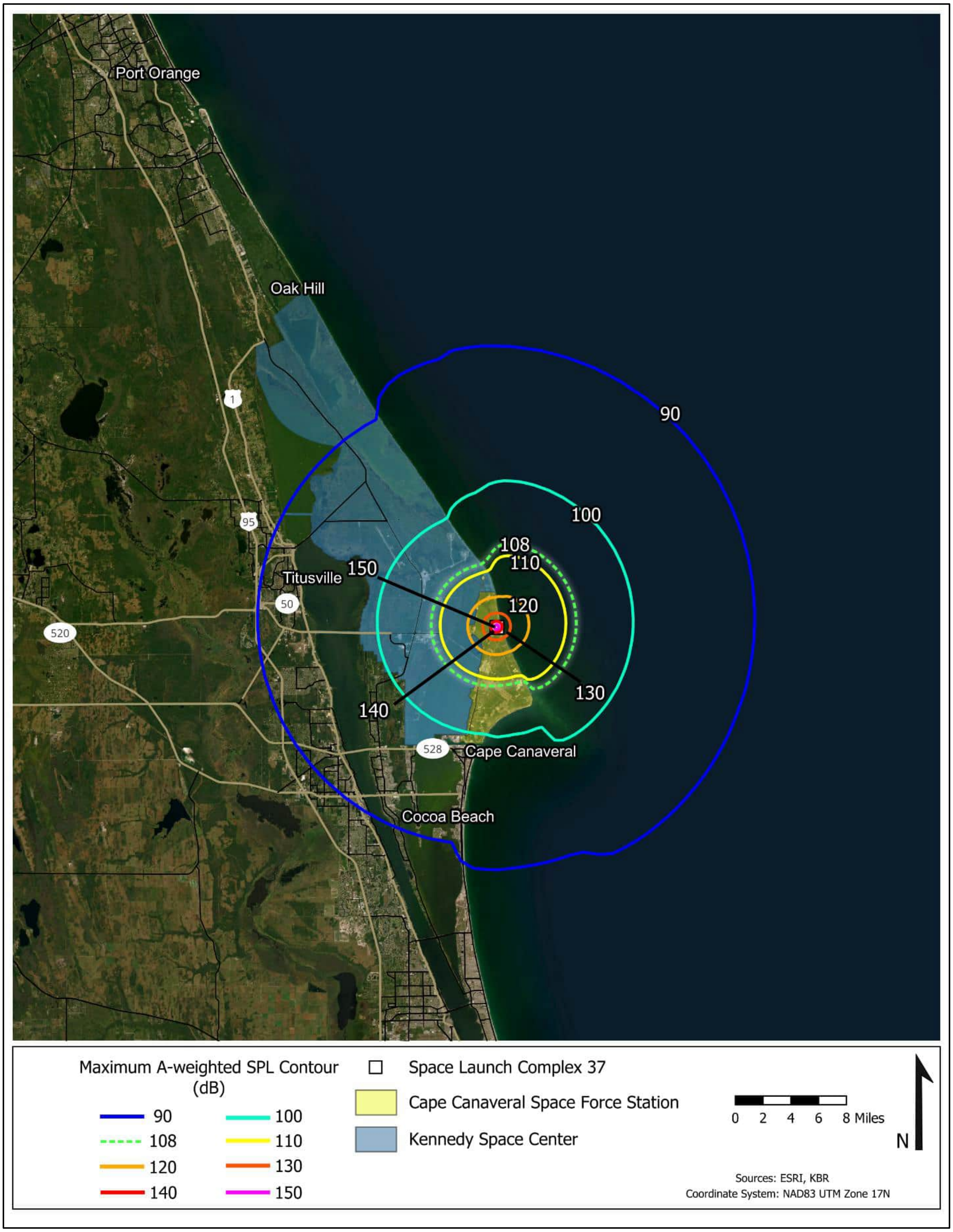


Figure 16. Starship Orbital Launch from SLC-37: Maximum A-Weighted Sound Levels

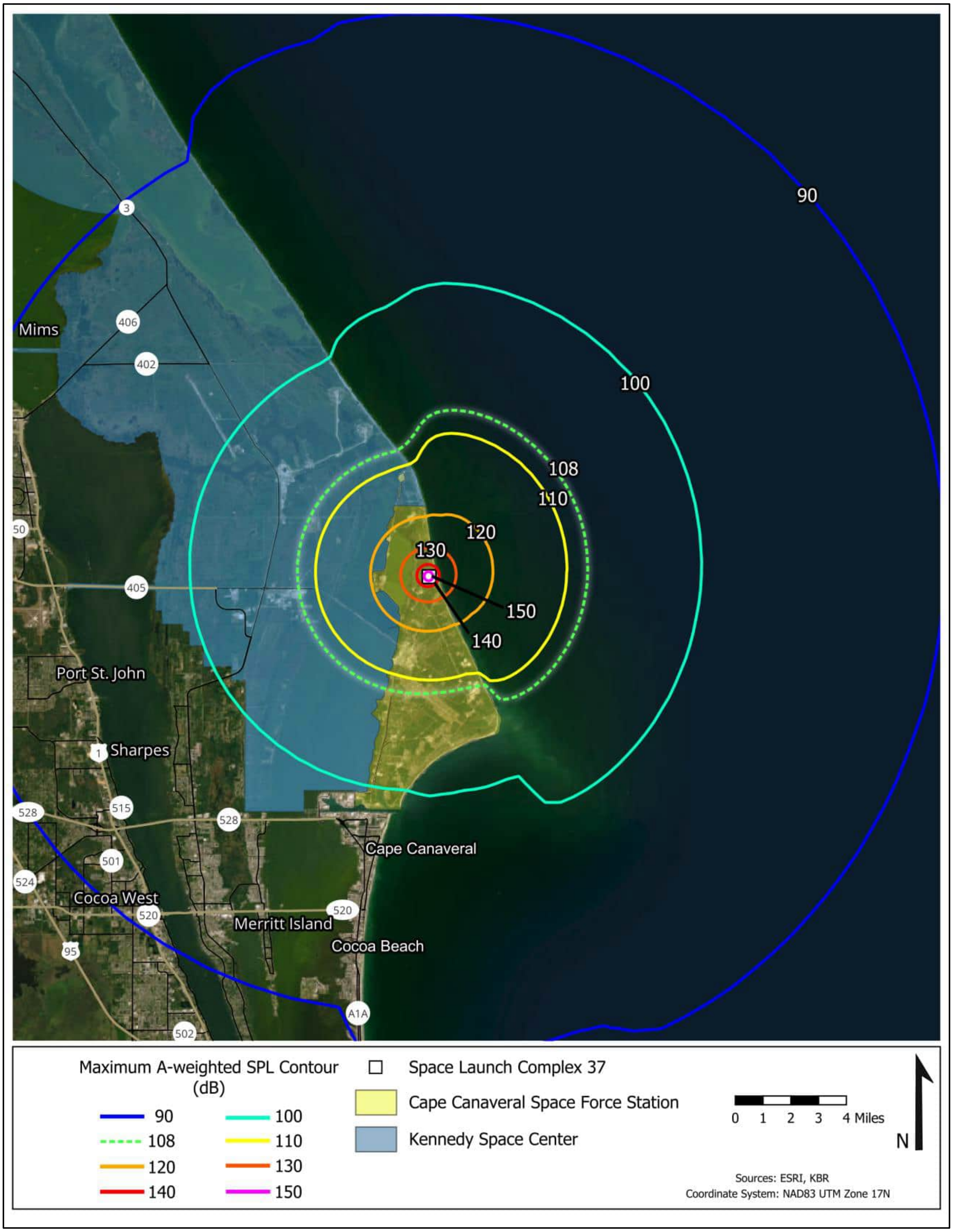


Figure 17. Starship Orbital Launch from SLC-37: Maximum A-Weighted Sound Levels (Zoom In)

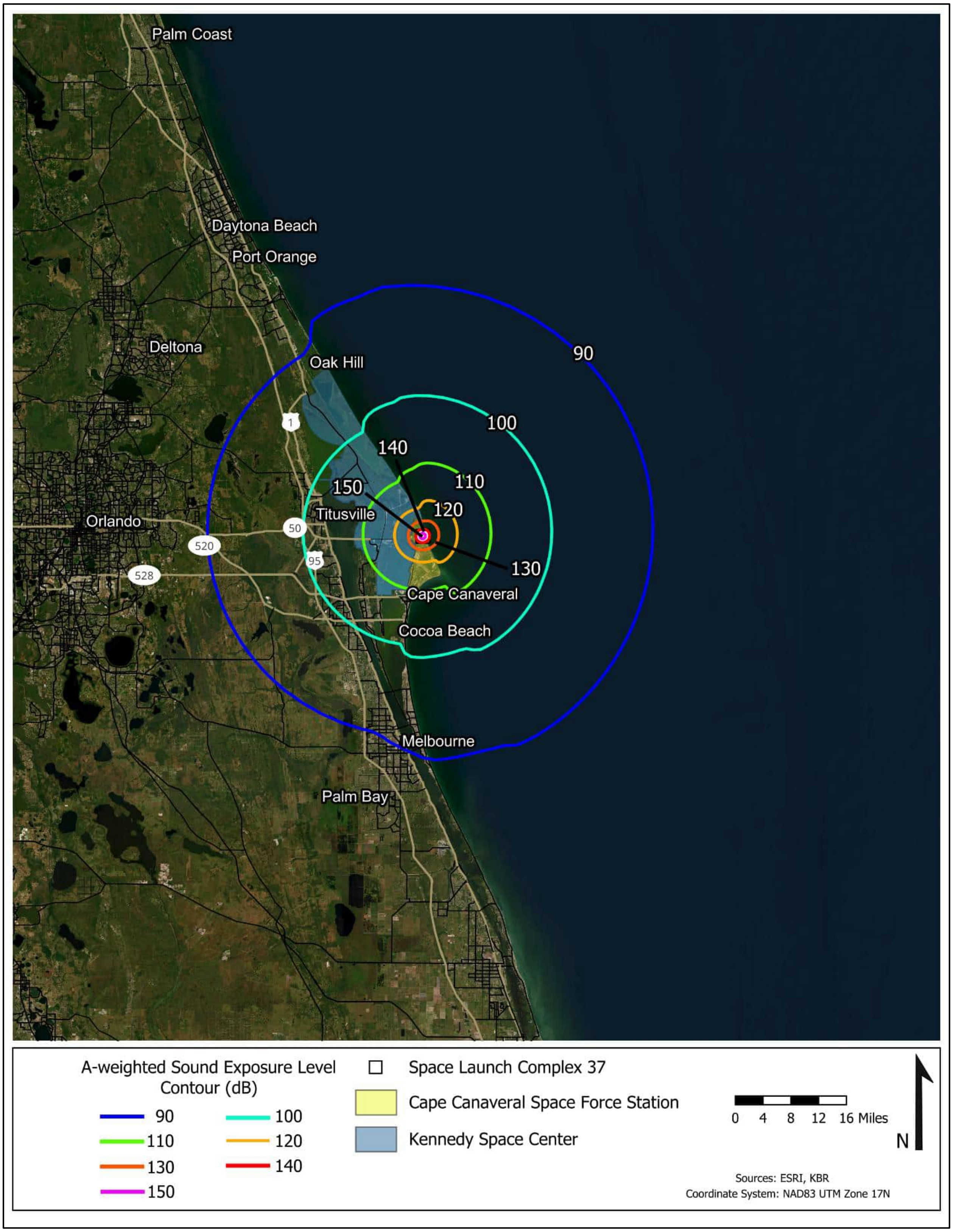


Figure 18. Starship Orbital Launch from SLC-37: Sound Exposure Levels

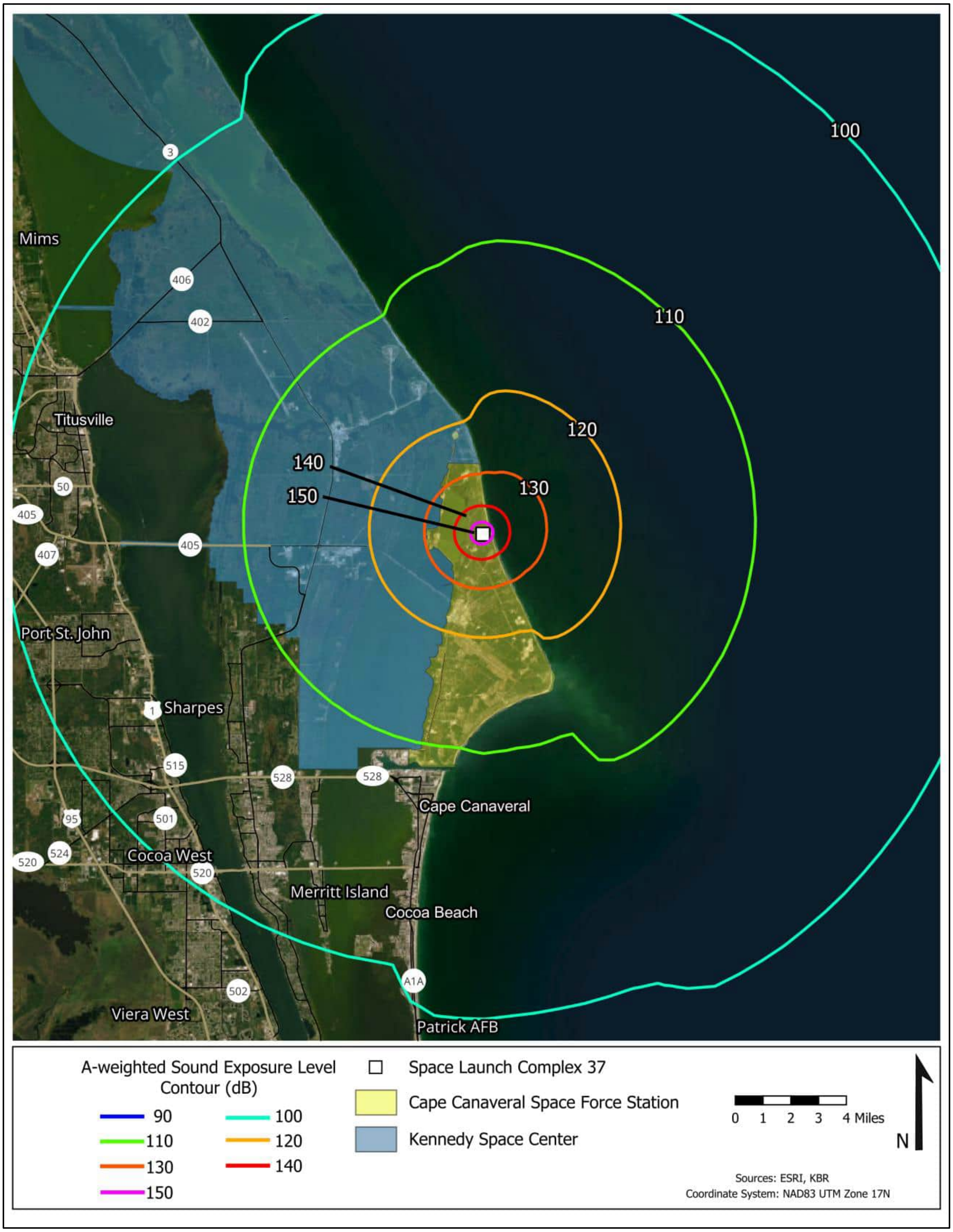


Figure 19. Starship Orbital Launch from SLC-37: Sound Exposure Levels (Zoom In)

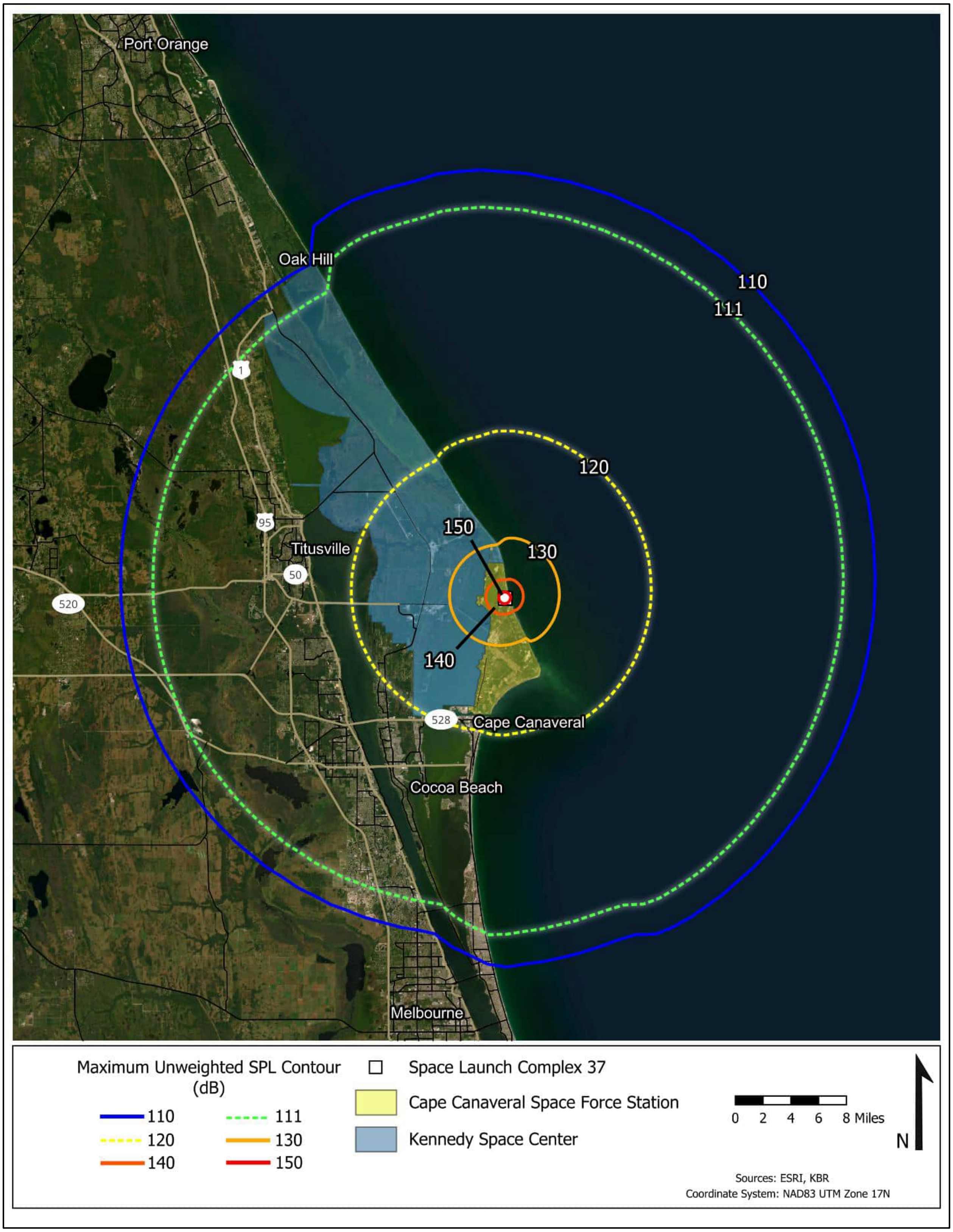


Figure 20. Starship Orbital Launch from SLC-37: Maximum Unweighted Sound Levels

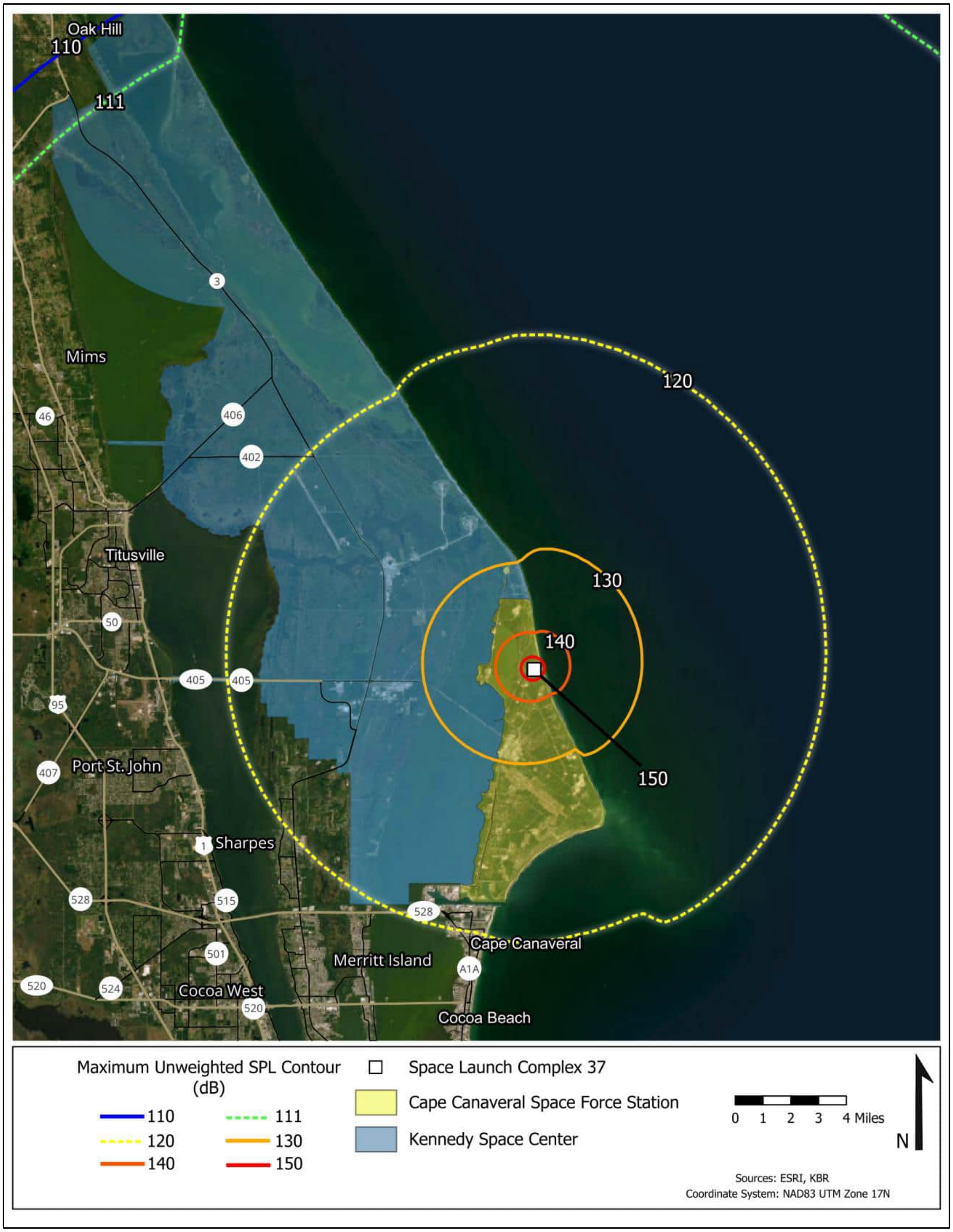


Figure 21. Starship Orbital Launch from SLC-37: Maximum Unweighted Sound Levels (Zoom In)

5.2.2 Descent/Landing Noise Levels at SLC-37

5.2.2.1 Starship Spacecraft Landings

RNOISE was used to estimate the L_{Amax}, SEL, and L_{max} contours for Starship spacecraft descent/landings at SLC-37. L_{Amax} contours indicate the maximum A-weighted sound level at each location over the duration of the landing where engine thrust varies according to the descent/landing thrust schedule provided.

RNOISE computations were performed as noted previously in Section 5.2.1. The L_{Amax}, SEL, and L_{max} contours for a Starship spacecraft landing at SLC-37 are shown on Figures 22 through 24, respectively. The landing site location at SLC-37 is indicated in the map legends as are the boundaries of Cape Canaveral Space Force Station and Kennedy Space Center. On Figure 22 the 90 dB L_{Amax} contour is about 5 miles from the SLC-37 landing site and lies entirely within the CCSFS and KSC properties. The 108 dB L_{Amax} contour, which can be used as a threshold limit for hearing conservation, is located approximately 1.5 miles from the landing pad. Compared with the Starship orbital launch noise levels reported in Section 5.2.1, Starship spacecraft descent/landing noise levels are considerably lower due to the much lower total engine thrust used for landing operations. On Figure 23, the SEL 90 and 100 dBA contours are estimated to remain entirely on the CCSFS and KSC properties. The L_{max} 111 dB and 120 dB contours, shown on Figure 24 and used as the more conservative measure to assess the potential for structural damage, are entirely within the KSC and CCSFS properties. Similarly, the L_{max} 130 dB and 140 dB contours, along with the 134 dB contour (not shown) are entirely within the KSC and CCSFS properties. No structural damage is expected to occur to residences located off KSC and CCSFS properties based on assessment using either criteria.

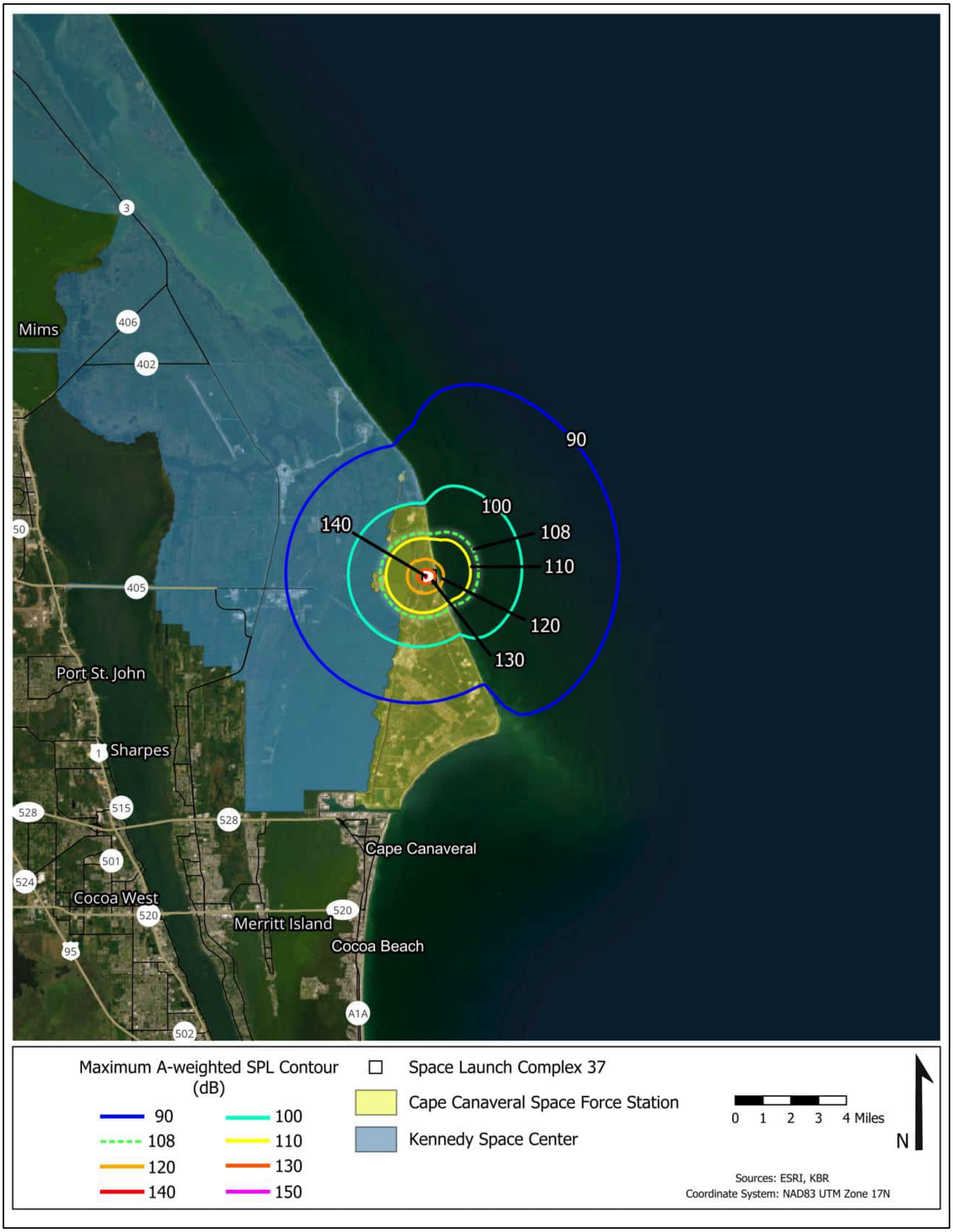


Figure 22. Starship Spacecraft Landing at SLC-37: Maximum A-Weighted Sound Levels

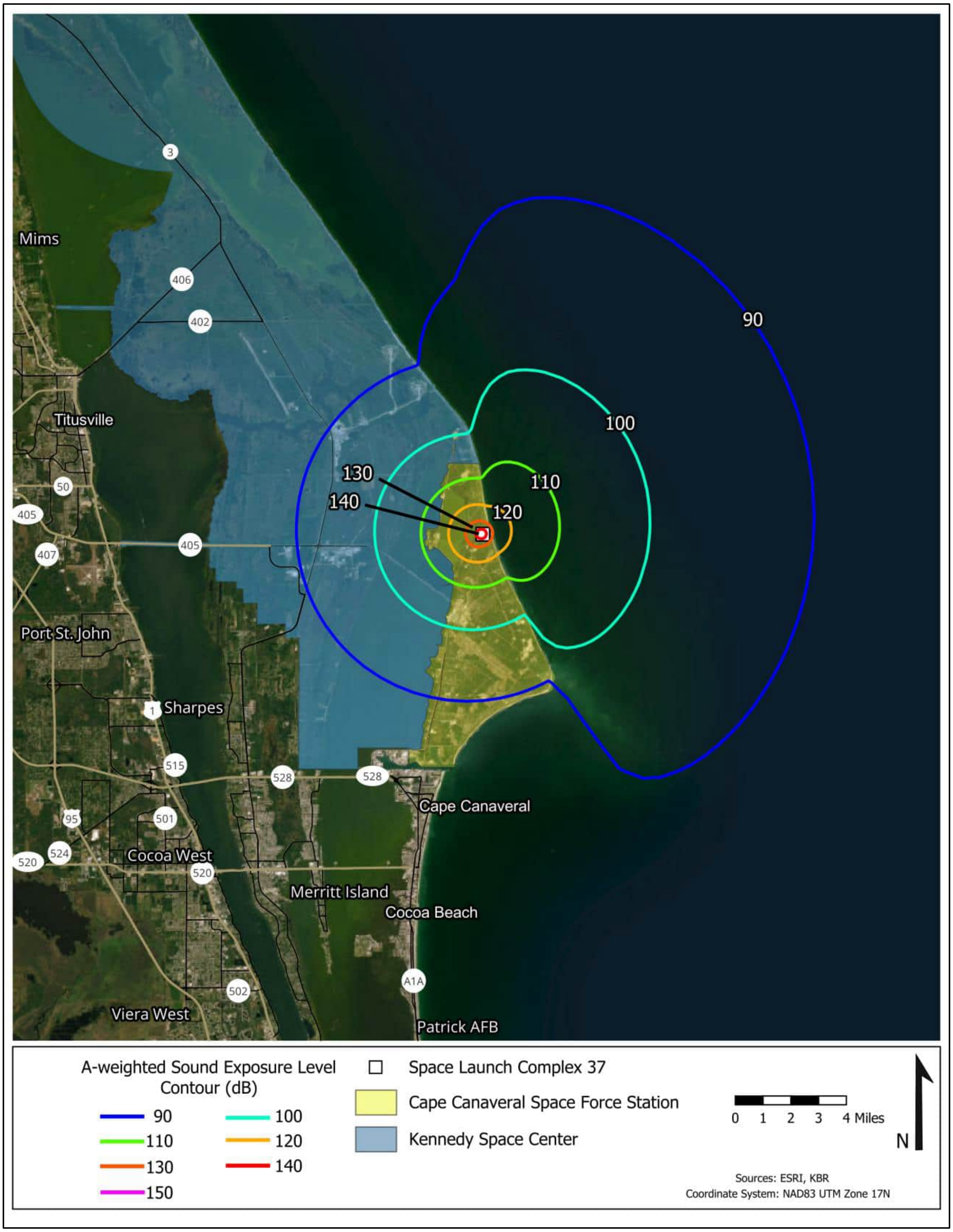


Figure 23. Starship Spacecraft Landing at SLC-37: Sound Exposure Levels

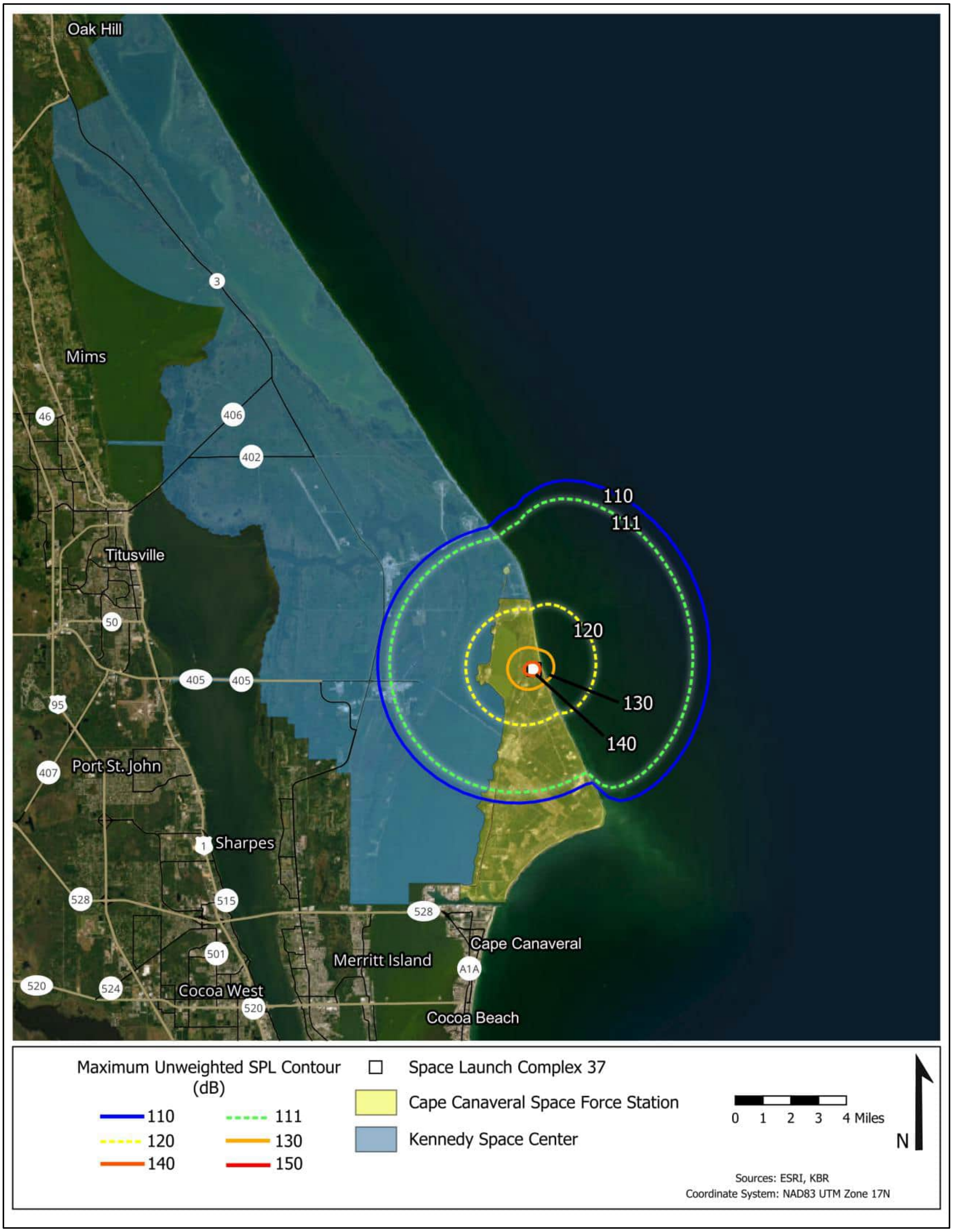


Figure 24. Starship Spacecraft Landing at SLC-37: Maximum Unweighted Sound Levels

5.2.2.2 Super Heavy (Booster) Landings

RNOISE was used to estimate the L_{Amax}, SEL, and L_{max} contours for Super Heavy descent/landings at SLC-37. The nominal booster reentry and landing trajectory (descending from an approximate 80-degree heading) was provided by SpaceX in file 'Starship_Bottom_Up_Flyback_Nominal_80_12_r2.ASC' and two additional landing trajectories were provided which represent the northern bounding trajectory (from 40-degrees) and the southern bounding trajectory (from 115-degrees). The L_{Amax} contours for each case indicate the maximum A-weighted sound level at each location over the duration of the landing where engine thrust varies according to the reentry/descent thrust schedule provided.

RNOISE computations were performed as noted previously in Section 5.2.1. The L_{Amax}, SEL, and L_{max} contours for each of the three Super Heavy landings at SLC-37 are shown sequentially in Figures 25 through 33. The landing site location at SLC-37 is indicated in the map legends as are the boundaries of Cape Canaveral Space Force Station and Kennedy Space Center. On Figure 25 the 90 dB L_{Amax} contour is about 9 miles from the SLC-37 landing site and lies almost entirely within the CCSFS and KSC properties. The 108 dB L_{Amax} contour, which can be used as a threshold limit for hearing conservation, is located approximately 2.5 miles from the landing pad. Compared with the Starship orbital launch noise levels reported in Section 5.2.1, Super Heavy descent/landing noise levels are considerably lower due to the much lower total engine thrust used for landing operations. On Figure 28, the SEL 90 dB and 100 dB contours are estimated to remain almost entirely on the CCSFS and KSC properties. The L_{max} 111 dB and 120 dB contours, as well as the 130 dB and 140 dB contours shown on Figure 31, and thus the 134 dB contour (not shown), used to assess the potential for structural damage, are located almost entirely on the KSC and CCSFS properties. No structural damage is expected to occur to residences located off KSC and CCSFS properties based on assessment using either criteria.

Note that on the three figures shown for each metric, the noise contours associated with the nominal (80-degree), 40-degree, and 115-degree booster landing trajectories change location although the changes are not easily observed; more so when examining the larger sound exposure level contours (Figures 28 through 30) for comparison. The reason the location of the contours (noise exposure) does not change much is because the booster thrust on landings occurs within about the final 5,000 feet of altitude, relatively close to the ground, on each of the three trajectory headings. As will be shown in Section 5.3, sonic boom exposures on the ground, from each of the three booster landing trajectories, are more spatially separated than the subsonic (rocket) noise contours just presented, since sonic boom is generated at much higher altitudes where the trajectories would have more separation.

The next section presents single event noise levels for proposed Starship spacecraft and Super Heavy (Booster) static fire tests at SLC-37.

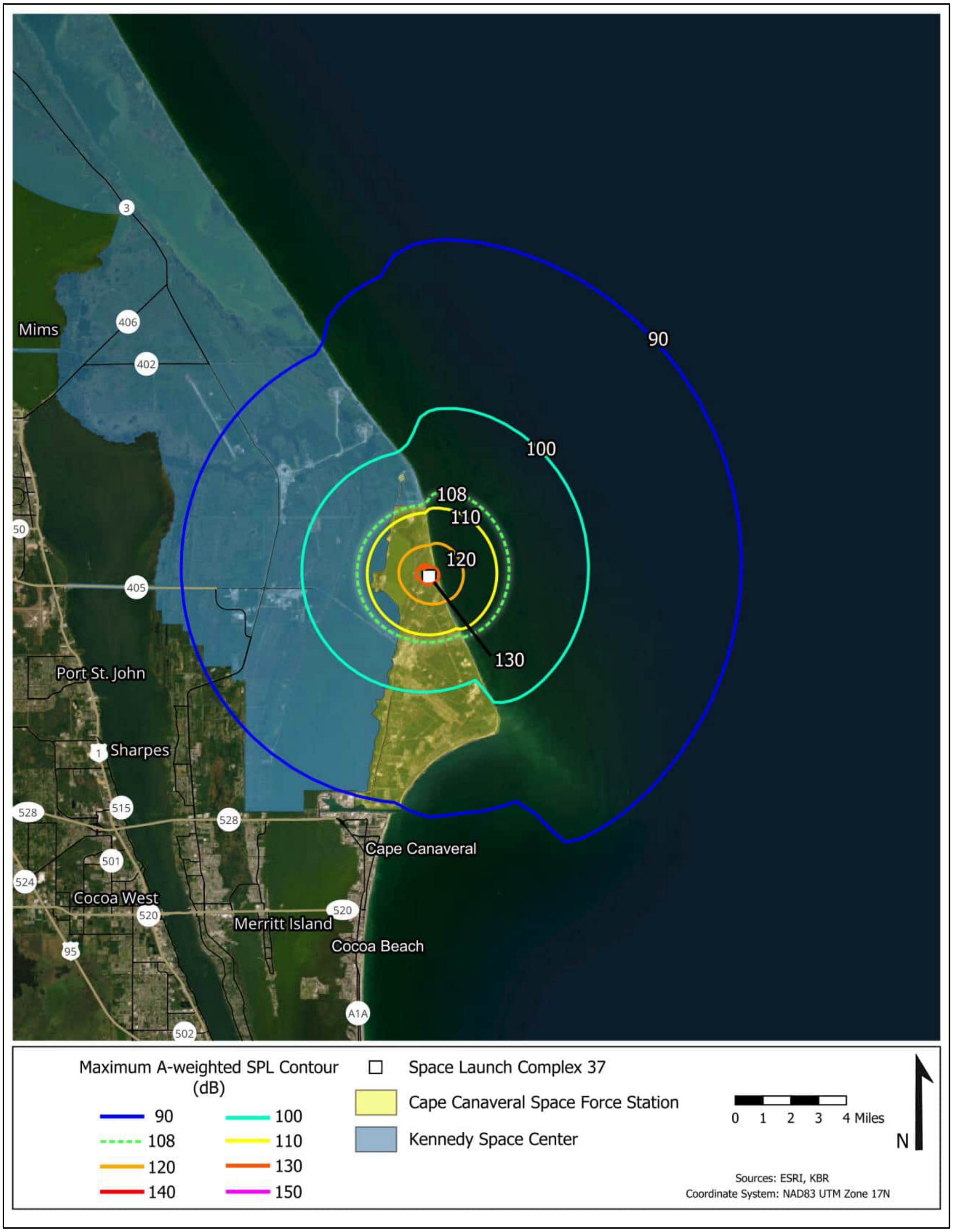


Figure 25. Super Heavy Landing at SLC-37 (Nominal): Maximum A-Weighted Sound Levels

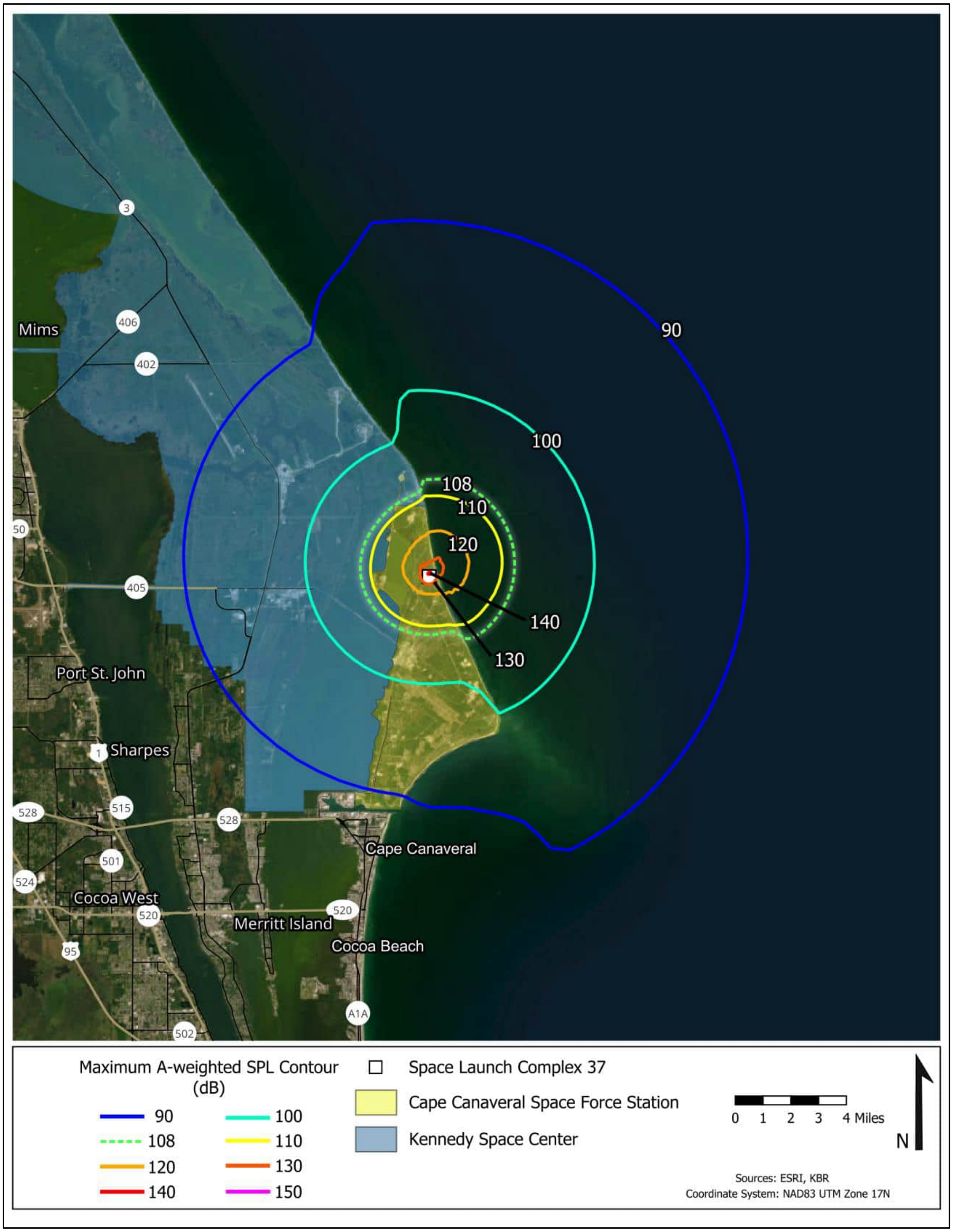


Figure 26. Super Heavy Landing at SLC-37 (40-Degrees): Maximum A-Weighted Sound Levels

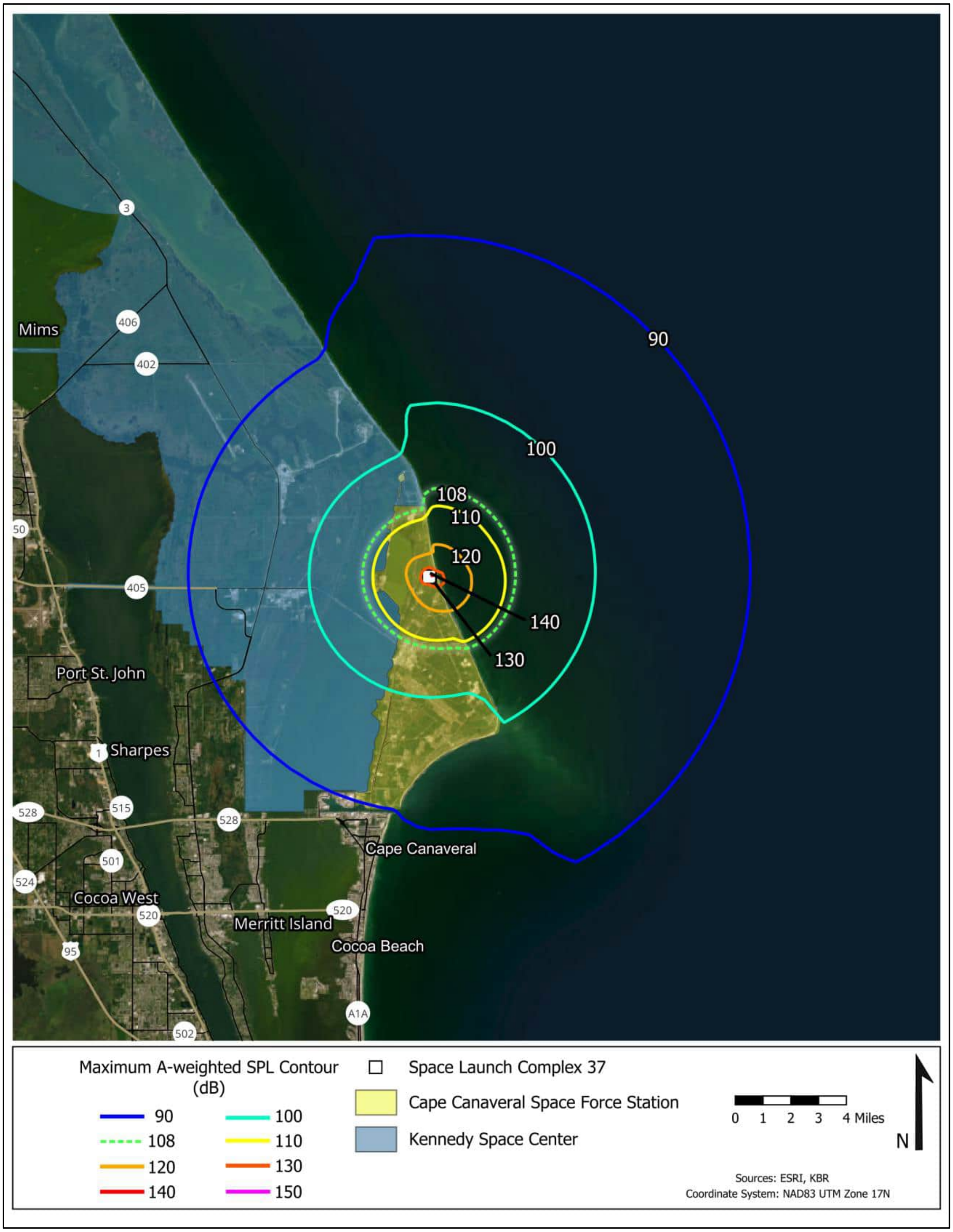


Figure 27. Super Heavy Landing at SLC-37 (115-Degrees): Maximum A-Weighted Sound Levels

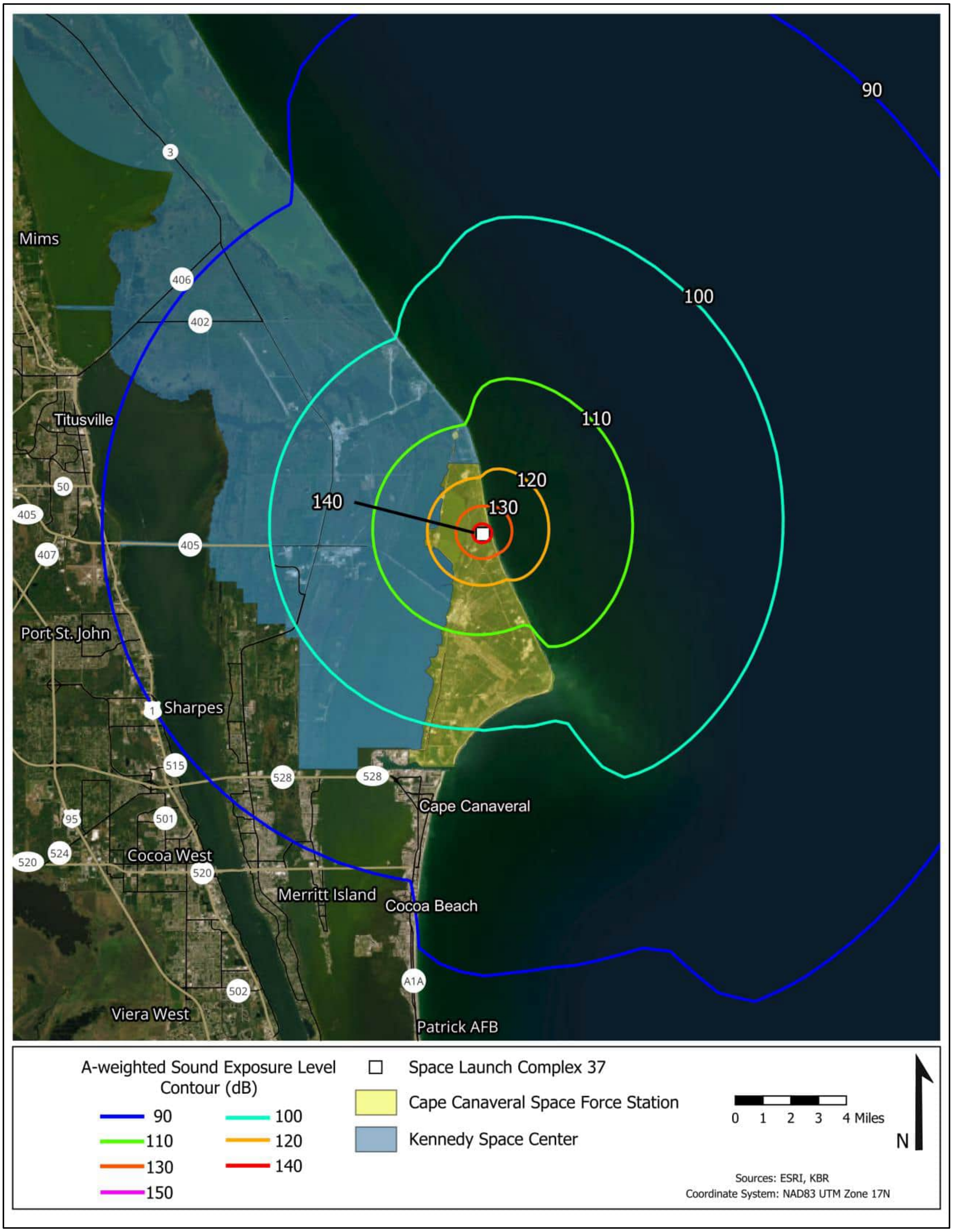


Figure 28. Super Heavy Landing at SLC-37 (Nominal): Sound Exposure Levels

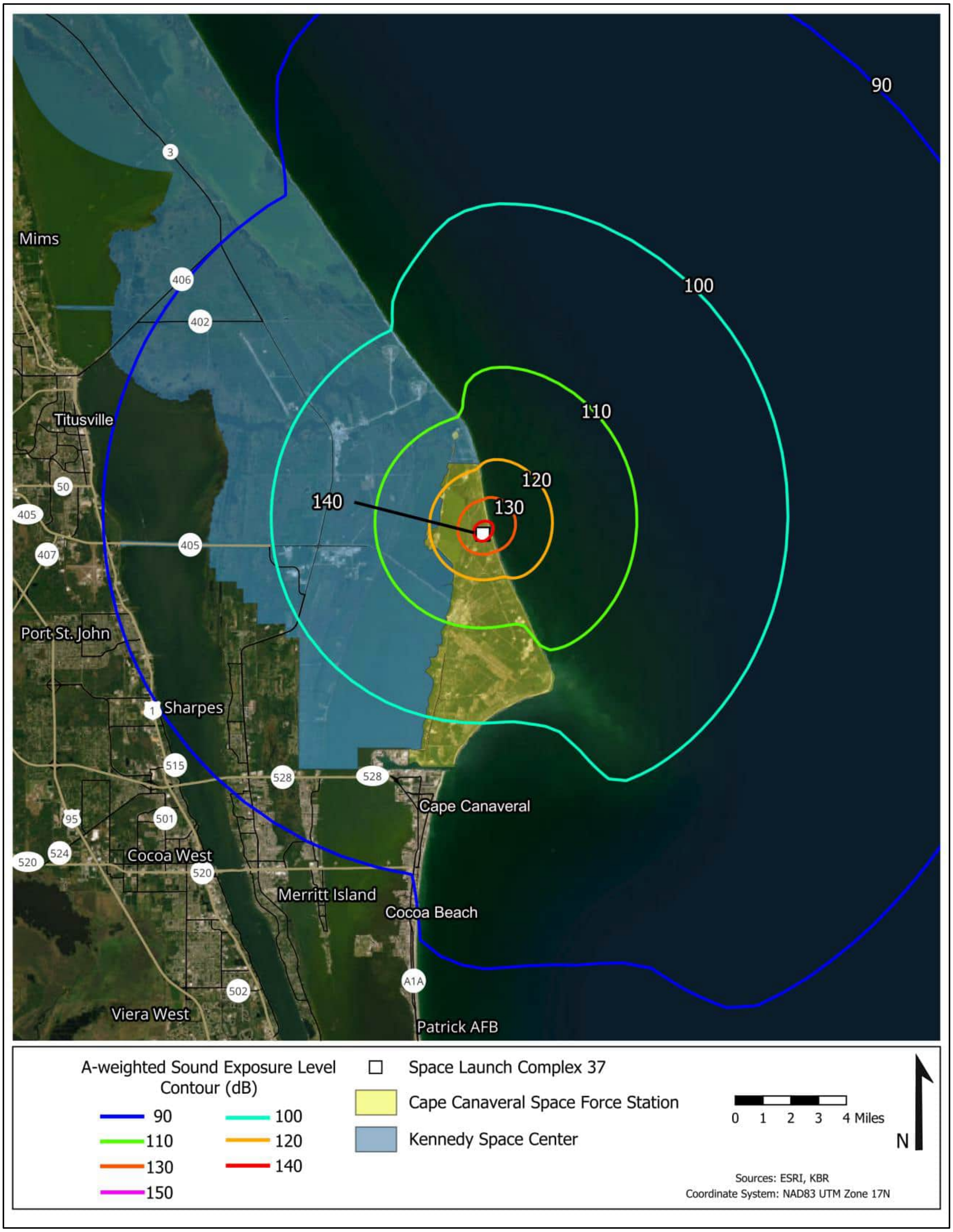


Figure 29. Super Heavy Landing at SLC-37 (40-Degrees): Sound Exposure Levels

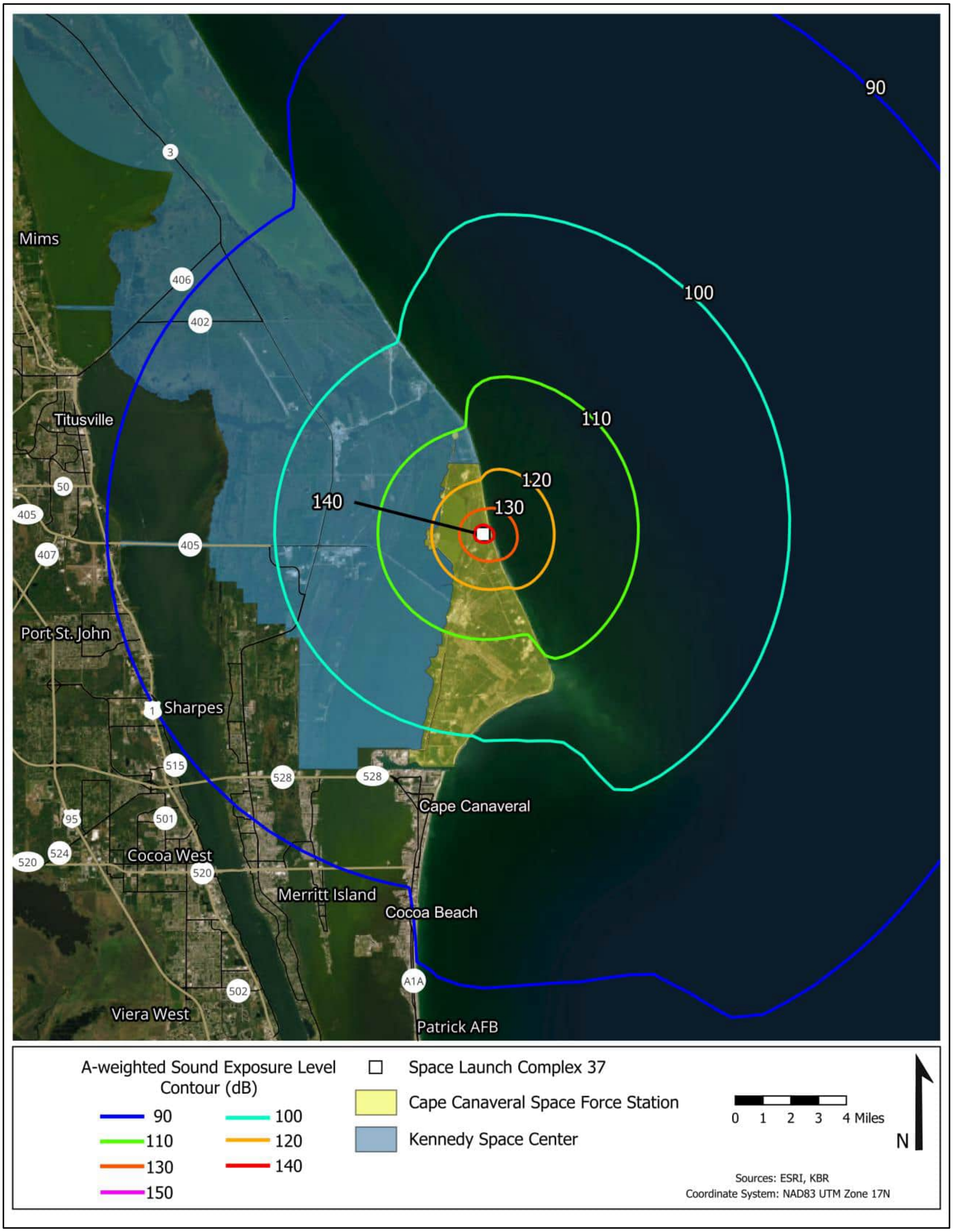


Figure 30. Super Heavy Landing at SLC-37 (115-Degrees): Sound Exposure Levels

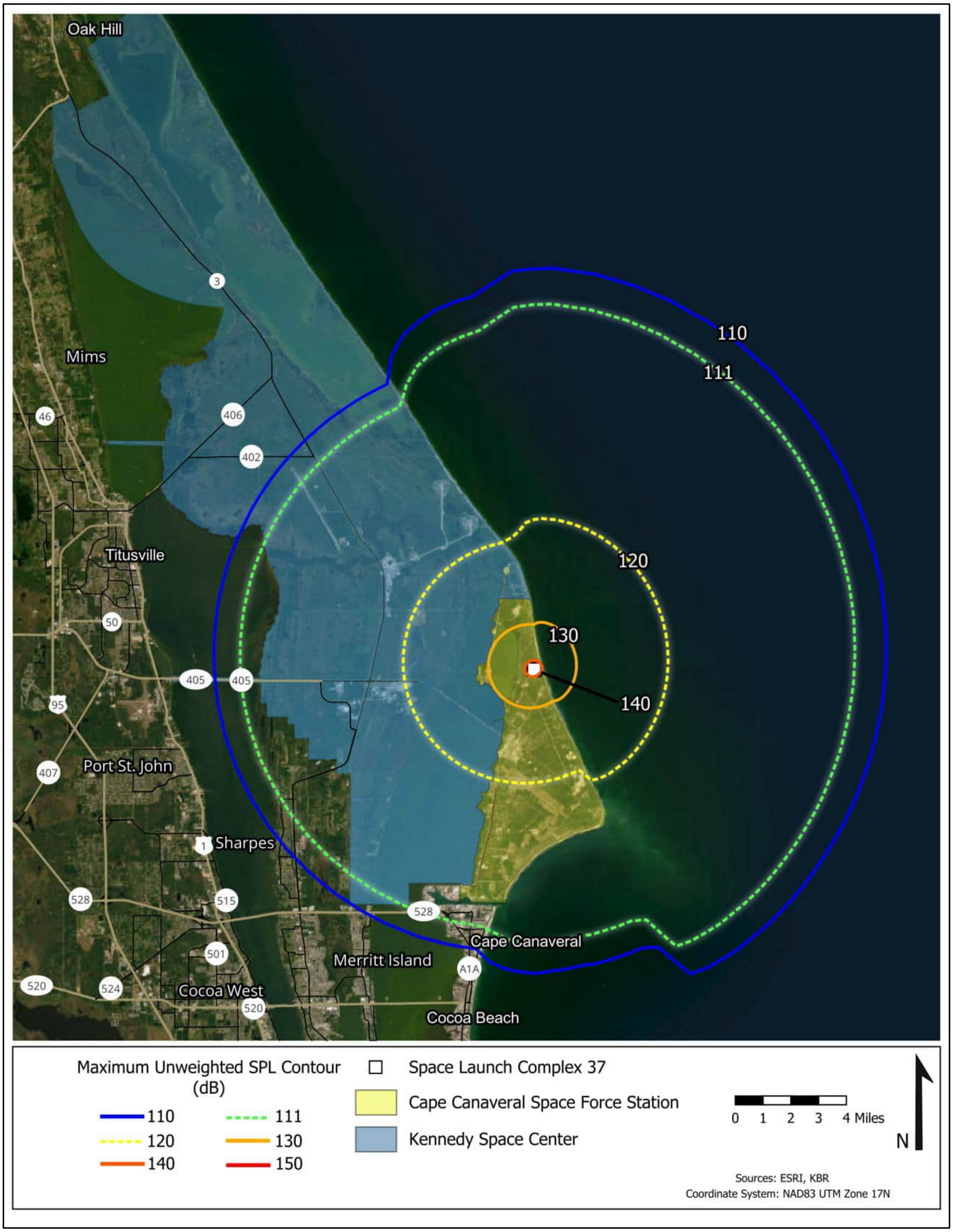


Figure 31. Super Heavy Landing at SLC-37 (Nominal): Maximum Unweighted Sound Levels

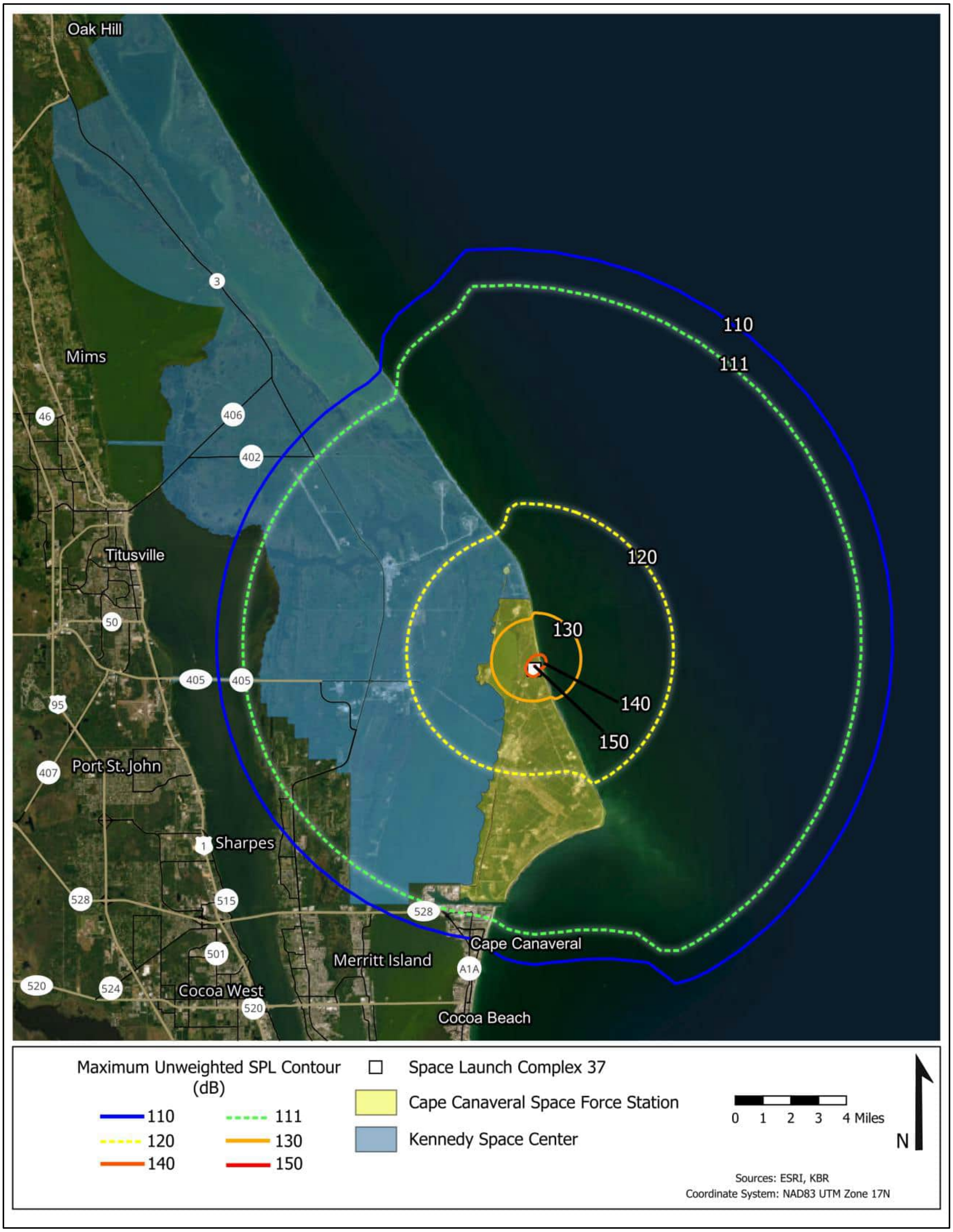


Figure 32. Super Heavy Landing at SLC-37 (40-Degrees): Maximum Unweighted Sound Levels

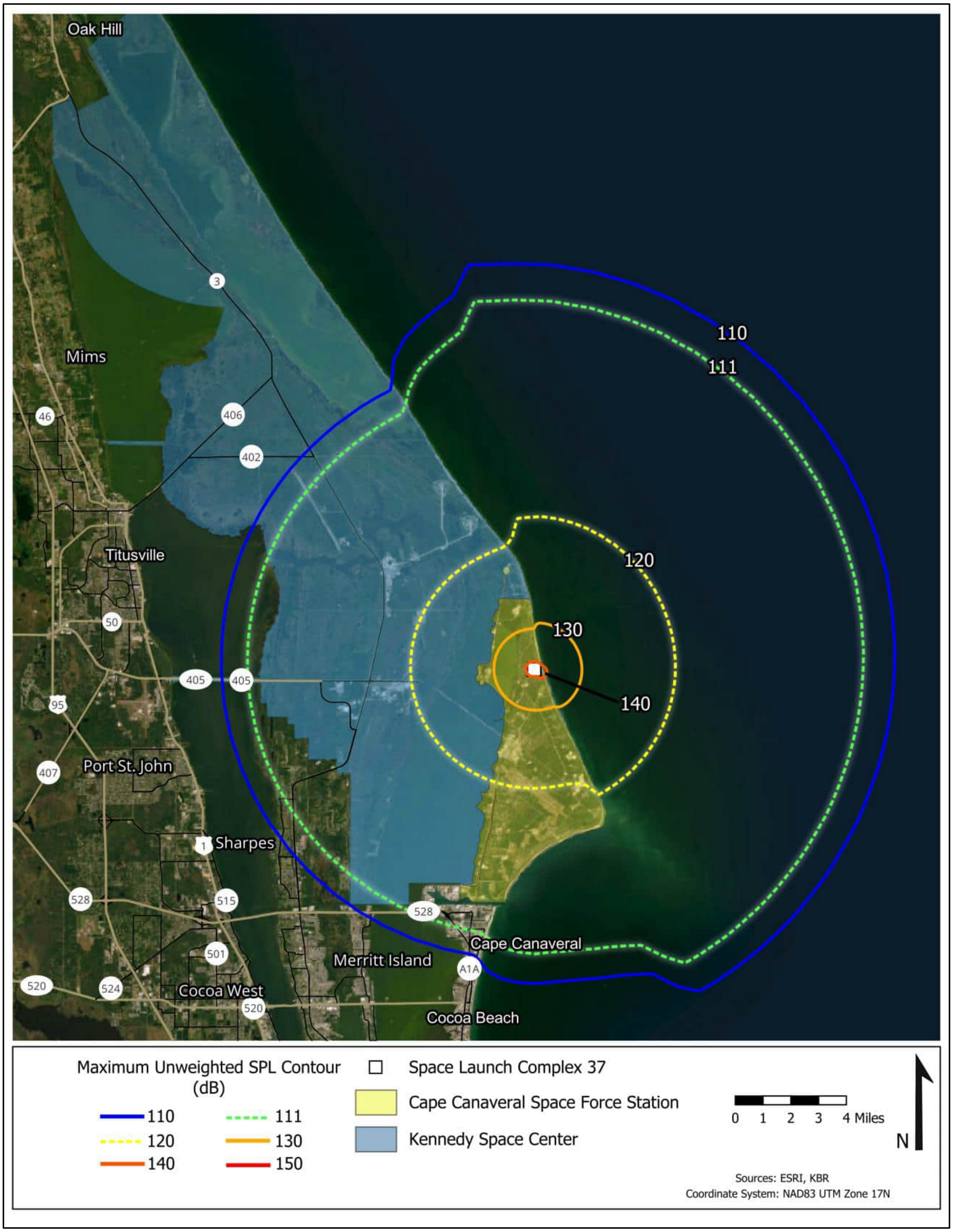


Figure 33. Super Heavy Landing at SLC-37 (115-Degrees): Maximum Unweighted Sound Levels

5.2.3 Static Fire Test Noise Levels at SLC-37

5.2.3.1 Starship Spacecraft Static Fire Tests

Starship spacecraft static fire tests are planned to occur at SLC-37 where nine engines, that each generate 3.11 MN of thrust at sea level, will be fired for 15 seconds per test. RNOISE computations were performed as noted previously in Section 5.2.1. The L_{Amax}, SEL, and L_{max} contours for a Starship spacecraft static fire test at SLC-37 are shown in Figures 34 through 36, respectively.

The L_{Amax} 90 dB contour (Figure 34) extends about 3 miles west of the SLC-37 test site while the SEL 90 dB contour (Figure 35) extends about 6 miles west of the test site. Residents of Titusville, the City of Cape Canaveral, and other nearby communities may hear Starship spacecraft static test events above 60 dB, depending on wind conditions (onshore or offshore) at the time of the test and if the test occurs during daytime or nighttime hours. The L_{Amax} 108 dB contour, which is shown on Figure 34 and used as a threshold limit for hearing conservation, is located about 1 mile west of the static test site.

The L_{max} 111 dB and 120 dB contours, as well as the 130 dB and 140 dB contours shown on Figure 36, and the 134 dB contour (not shown), used to assess the potential for structural damage, are located almost entirely on the KSC and CCSFS properties (only the 111 dB contour extends just west of these properties over the Indian River). No structural damage is expected to occur to residences located off KSC and CCSFS properties based on assessment using either criteria.

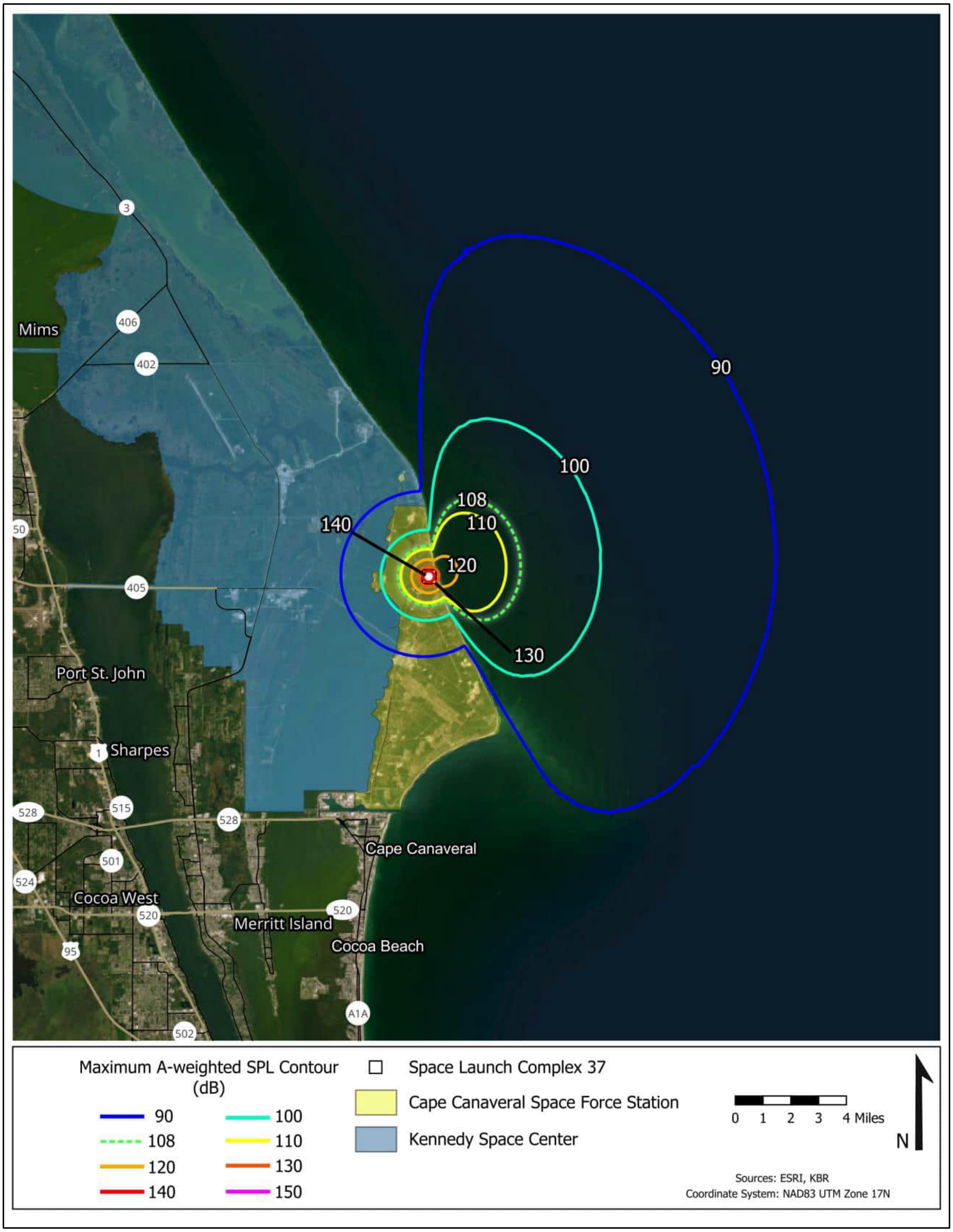


Figure 34. Starship Spacecraft Static Fire Test at SLC-37: Maximum A-Weighted Sound Levels

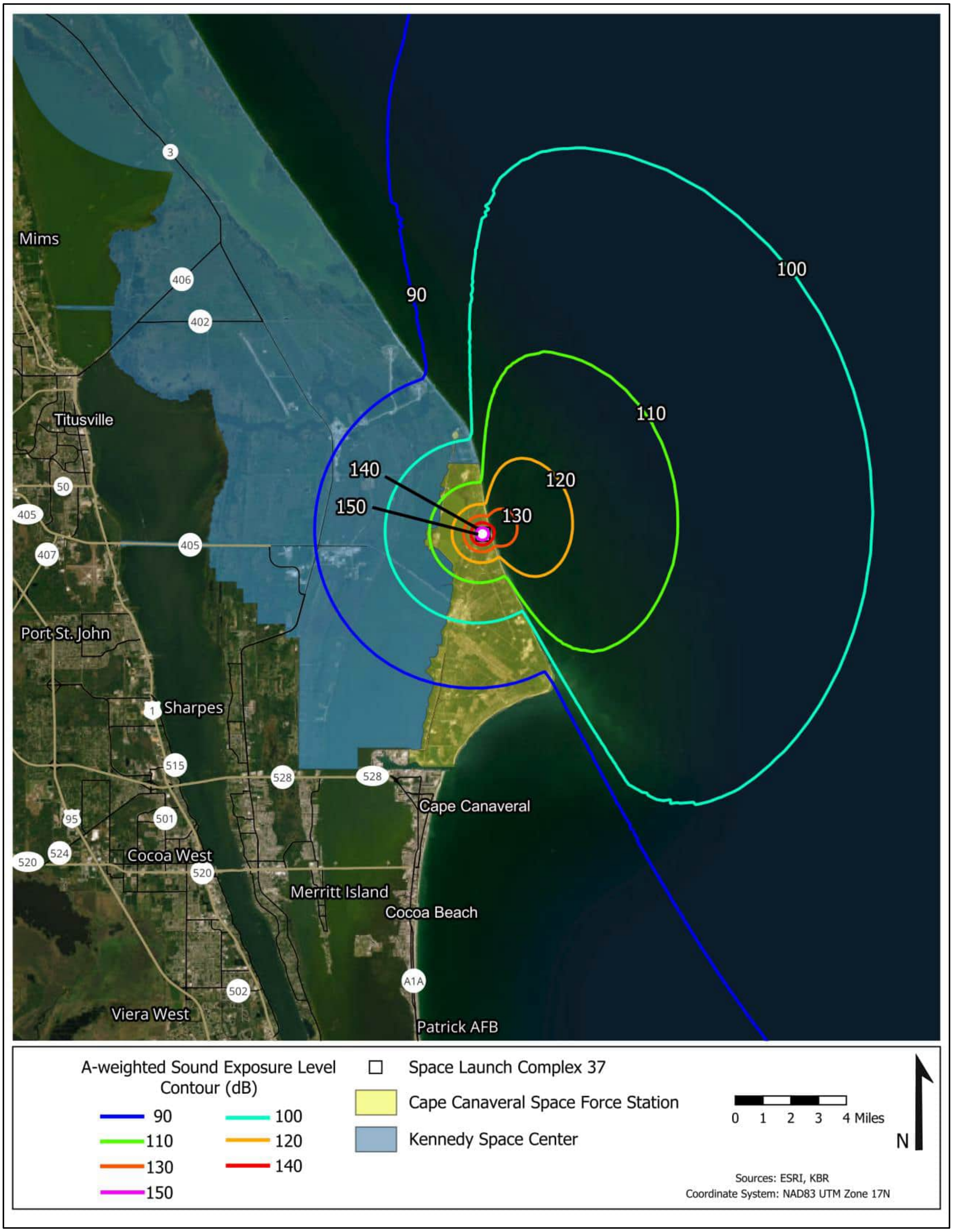


Figure 35. Starship Spacecraft Static Fire Test at SLC-37: Sound Exposure Levels

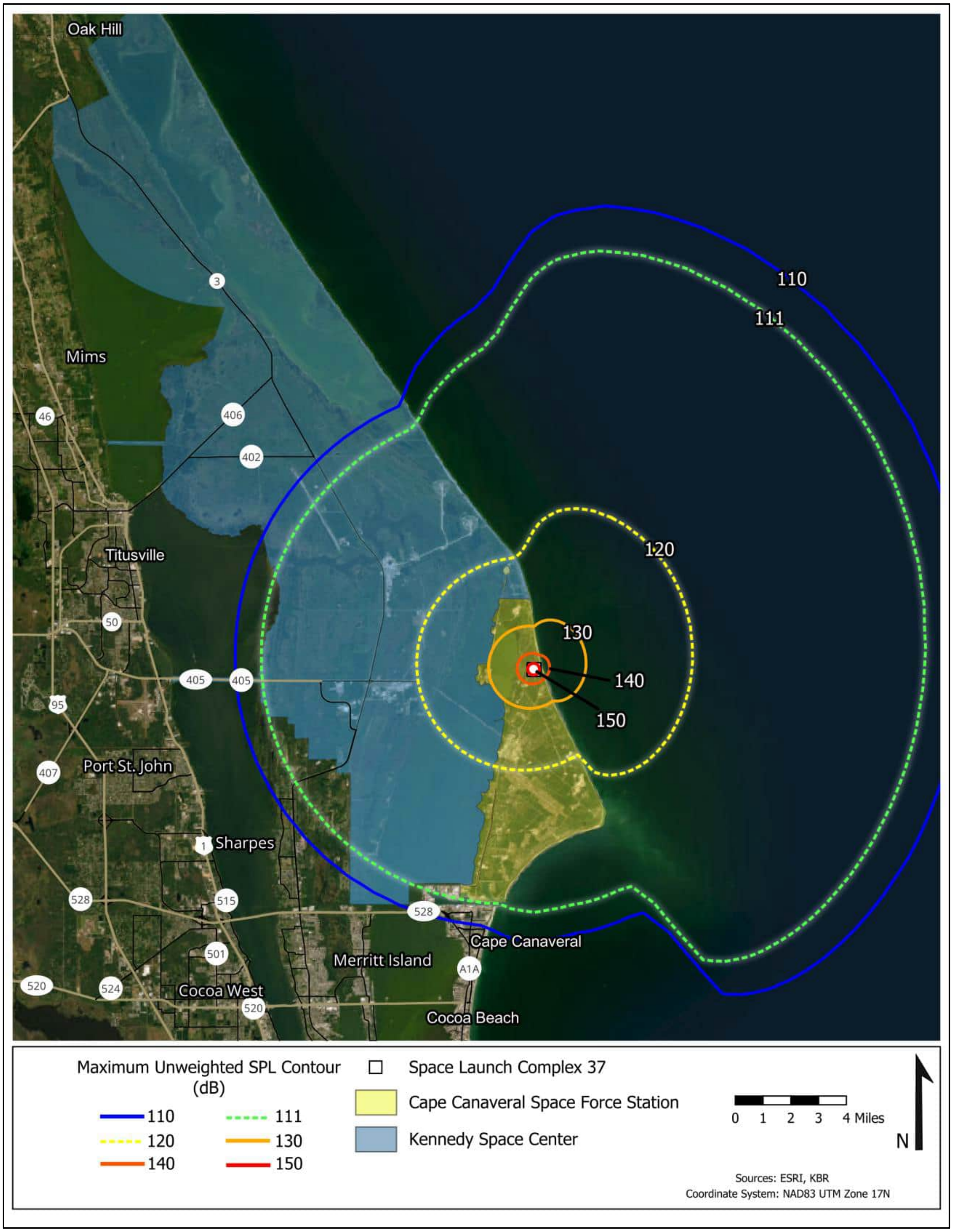


Figure 36. Starship Spacecraft Static Fire Test at SLC-37: Maximum Unweighted Sound Levels

5.2.3.2 Super Heavy Static Fire Tests

Super Heavy static fire tests are planned to occur at SLC-37 where thirty-five engines, that each generate 2.94 MN of thrust at sea level, will be fired for 15 seconds per test. RNOISE computations were performed as noted previously in Section 5.2.1. The L_{Amax}, SEL, and L_{max} contours for a booster static fire test at SLC-37 are shown in Figures 37 through 39, respectively.

The L_{Amax} 90 dB contour (Figure 37) extends about 4.5 miles west of the SLC-37 test site while the SEL 90 dB contour (Figure 38) extends about 8 miles west of the test site. Residents of Titusville, the City of Cape Canaveral, and other nearby communities may hear booster static test events above 60 dB, depending on wind conditions (onshore or offshore) at the time of the test and if the test occurs during daytime or nighttime hours. The L_{Amax} 108 dB contour, which is shown on Figure 37 and used as a threshold limit for hearing conservation, is located about 1.5 miles west of the static test site.

The L_{max} 111 dB and 120 dB contours, shown on Figure 39 are used as the more conservative measure to assess the potential for structural damage as described in Section 2.1.3. While the 120 dB contour is located almost entirely within the KSC and CCSFS properties, the 111 dB contour extends west of Titusville. The potential for structural damage is assessed using the potential for structural damage claims where approximately one damage claim will result per 1,000 households exposed at 111 dB[16]. Residences located within the L_{max} 111 dB contour therefore have a low probability of structural damage occurring (1 in 1,000 residences up to 1 in several hundred residences). No structural damage is expected to occur to residences located off KSC and CCSFS properties based on the less conservative criteria using the L_{max} 134 dB and 140 dB contours which are entirely within KSC and CCSFS properties.

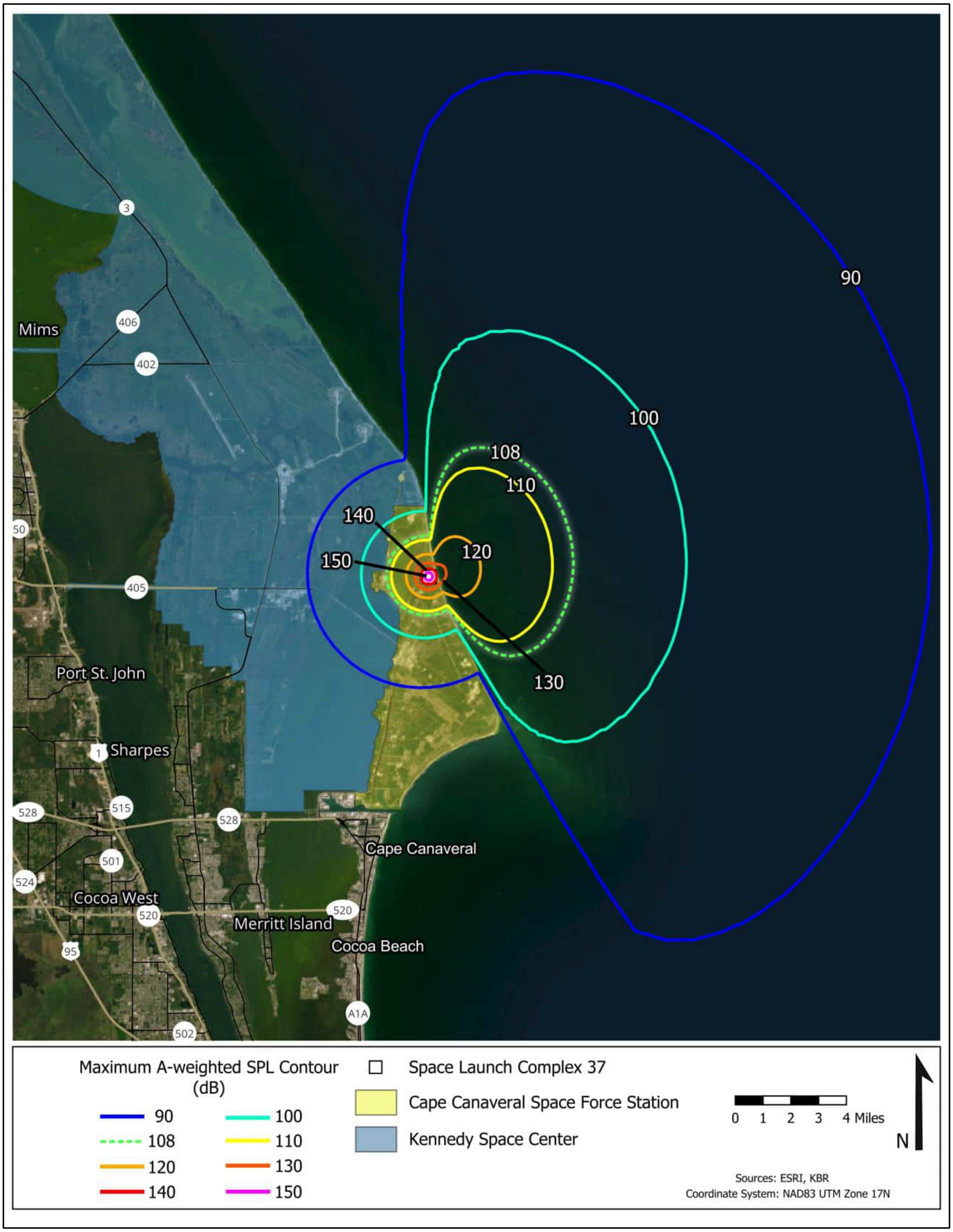


Figure 37. Super Heavy Static Fire Test at SLC-37: Maximum A-Weighted Sound Levels

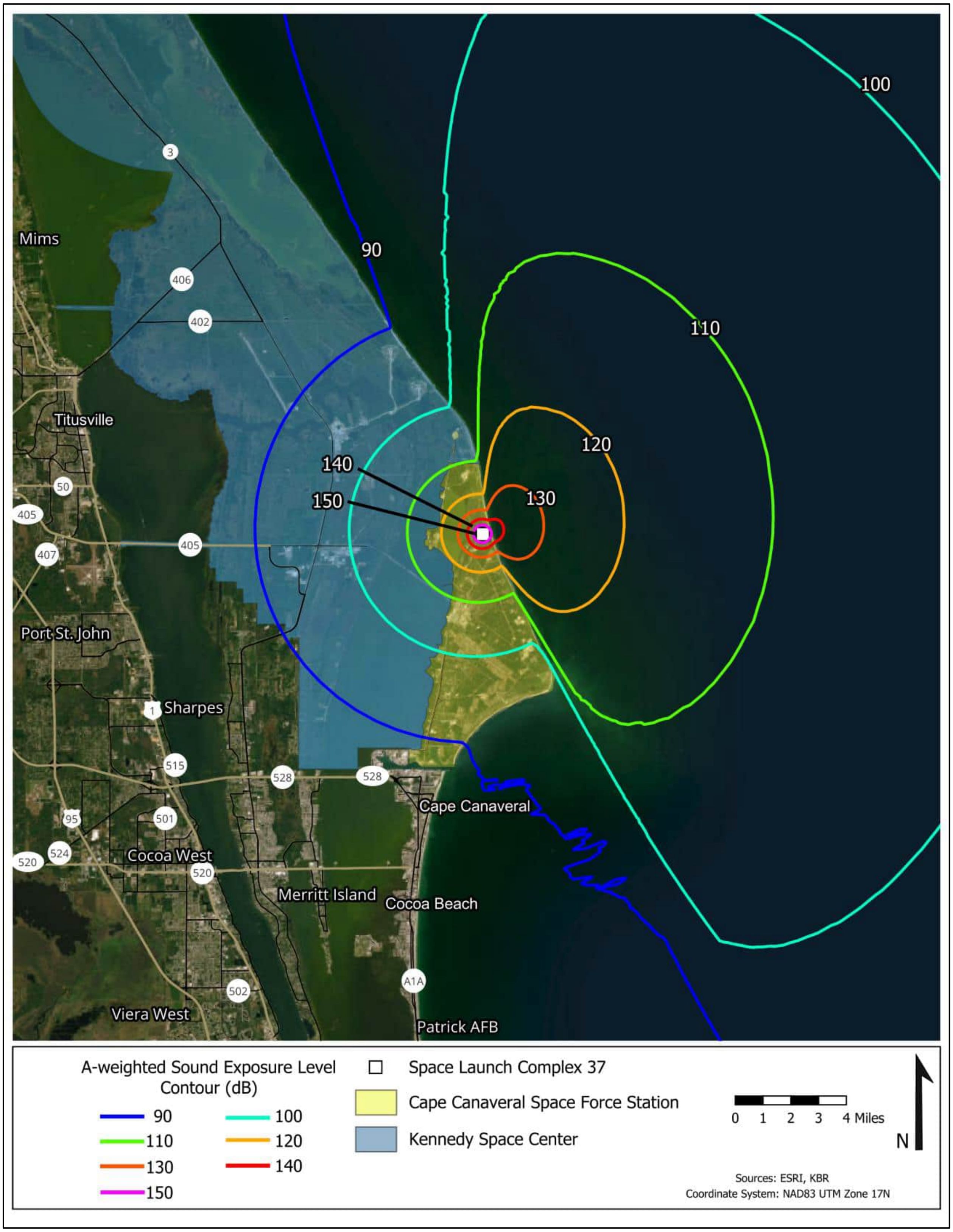


Figure 38. Super Heavy Static Fire Test at SLC-37: Sound Exposure Levels

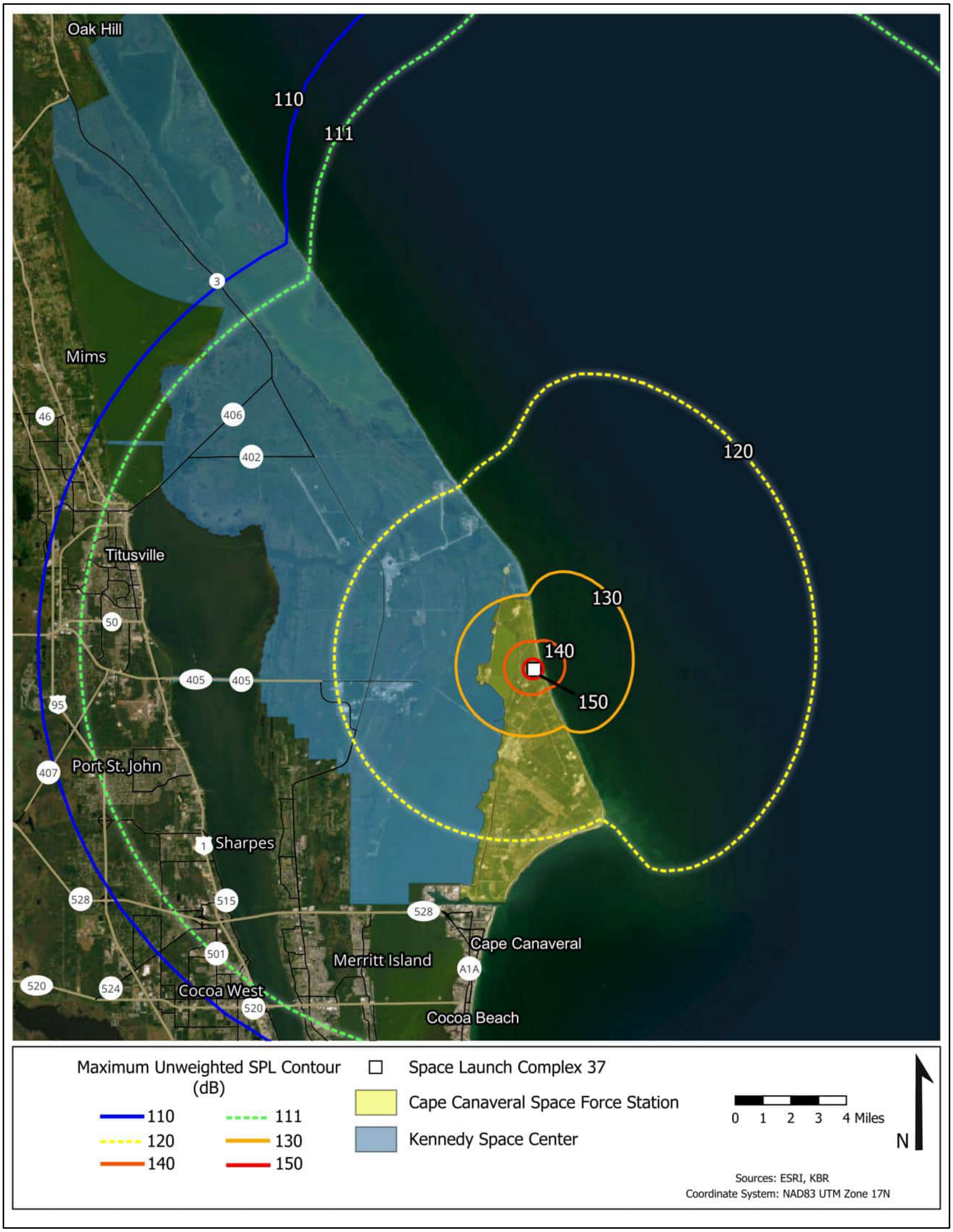


Figure 39. Super Booster Static Fire Test at SLC-37: Maximum Unweighted Sound Levels

5.2.4 Cumulative Noise Levels for All Starship Operations at SLC-37

5.2.4.1 Day-Night Average Sound Level (DNL) Contours

Cumulative noise levels were estimated, using DNL, for projected annual launch, landing, and static fire test operations at SLC-37 that are expected to fulfill Starship mission and test requirements at CCSFS. For orbital launches, the Super Heavy Booster total thrust would be 103 MN (about 23 MM lbf). Starship landings would use a maximum total thrust of 770 Klbf and Super Heavy Booster landings would use a maximum total thrust of 3.5 MM lbf. Static fire tests would be conducted by both vehicles for 15 seconds per test; the booster would use 35 engines, each with a thrust of 2.94 MN, and the Starship would use 9 engines, each with a thrust of 3.11 MN. Seventy-six annual operations of each type of event would be conducted with a 50% daytime and 50% nighttime split as described previously in Section 5.1 and summarized here as follows:

Projected Starship Operations at SLC-37

- 76 Starship orbital launches
- 76 Starship spacecraft landings
- 76 Super Heavy Booster landings
- 76 Starship spacecraft static fire tests (15 seconds each)
- 76 Super Heavy Booster static fire tests (15 seconds each)

The estimated DNL contours in the vicinity of SLC-37 for the combined annual operations are shown in Figure 40. Results indicate that when cumulative noise is assessed for all projected Starship operations (combined) at SLC-37, the 65 DNL contour is estimated to be entirely within the CCSFS and KSC properties.

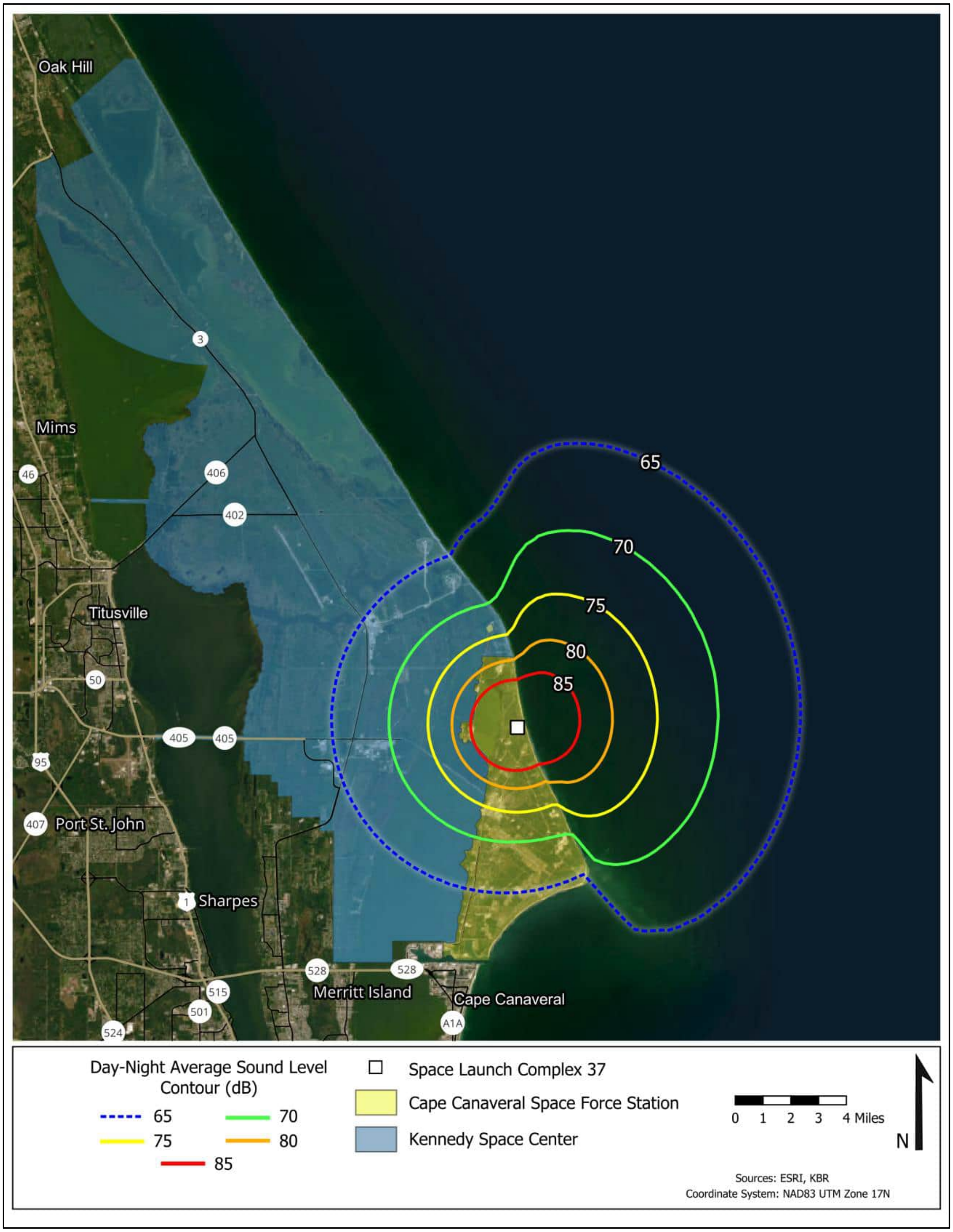


Figure 40. Starship Combined Operations at SLC-37: DNL Contours

5.2.4.2 DNL Exposure at Noise Sensitive Receptors

The twenty-four noise sensitive receptors or points of interest (POIs) assessed in this study are listed in Table 5 and Figure 41 shows their locations relative to SLC-37. For each POI, Table 5 includes the POI number identifier (ID) which is shown on the map in Figure 41, POI name, location, type of POI (e.g., residential, school, place of worship, or wildlife conservation area), and the estimated DNL for proposed Starship operations at SLC-37. DNL values range from 45.5 dB, at The Rock Church in Fontaine Grant to 76.7 dB at CCSFS (nearest POI location to SLC-37). Five POIs are exposed to DNL 65 dB or greater, which is the DAF and FAA threshold for land use compatibility (the DNL values for these five POIs are highlighted in Table 5); all of these POIs (1, 2, 3, 6, and 23) are located on either KSC or CCSFS property.

Table 5. Proposed Starship Operations at SLC-37: DNL Exposure at POIs

POI ID	POI Name	Location	Type	DNL(dB)
1	Cape Canaveral Space Force Station (CCSFS)	Cape Canaveral	CCSFS Representative	76.7
2	SpaceX Operations Area	Merritt Island	SpaceX Facility	66.5
3	Titusville Beach	Titusville	Recreational (Private)	69.9
4	Playalinda Beach	Titusville	Recreational Area	59.3
5	Kennedy Space Center Visitor Complex	Merritt Island	KSC Representative	64.3
6	KSC Child Development Center	Merritt Island	School	66.4
7	Merrit Island National Wildlife Refuge Visitor Center	Merritt Island	Wildlife Conservation Area	56.2
8	Pine Island Conservation Area/Pine Island Estates	Merritt Island	Wildlife Conservation Area/Residential Area	60.0
9	Kings Park Estates - Courtenay	Courtenay	Residential	59.2
10	Jetty Park Campground	Cape Canaveral	Recreational Area	59.8
11	Rockledge High School	Rockledge	School	51.3
12	Merritt Island	Merritt Island	Residential	53.3
13	Oak Park Elementary School	Titusville	School	50.2
14	Titusville High School	Titusville	School	53.6
15	Summerwood Villas	Titusville	Residential	54.1
16	Atlantis Elementary School	Port St. John	School	54.1
17	Fairglen Elementary School	Cocoa	School	54.8
18	Lewis Carroll Elementary School	Merritt Island	School	55.5
19	Cocoa	Cocoa	Residential	53.2
20	Cocoa Beach	Cocoa Beach	Residential	53.4
21	Pinegrove Estates	MIMS	Residential	48.6
22	Fern Meadows	West Cocoa	Residential	49.1
23	KSC Office Outside BDA	KSC	Office	66.8
24	The Rock Church	Fontaine Grant	Place of Worship	45.5

Notes: POI = Point of Interest; ID = Identification; Day Night Average Sound Level; dB = decibel.

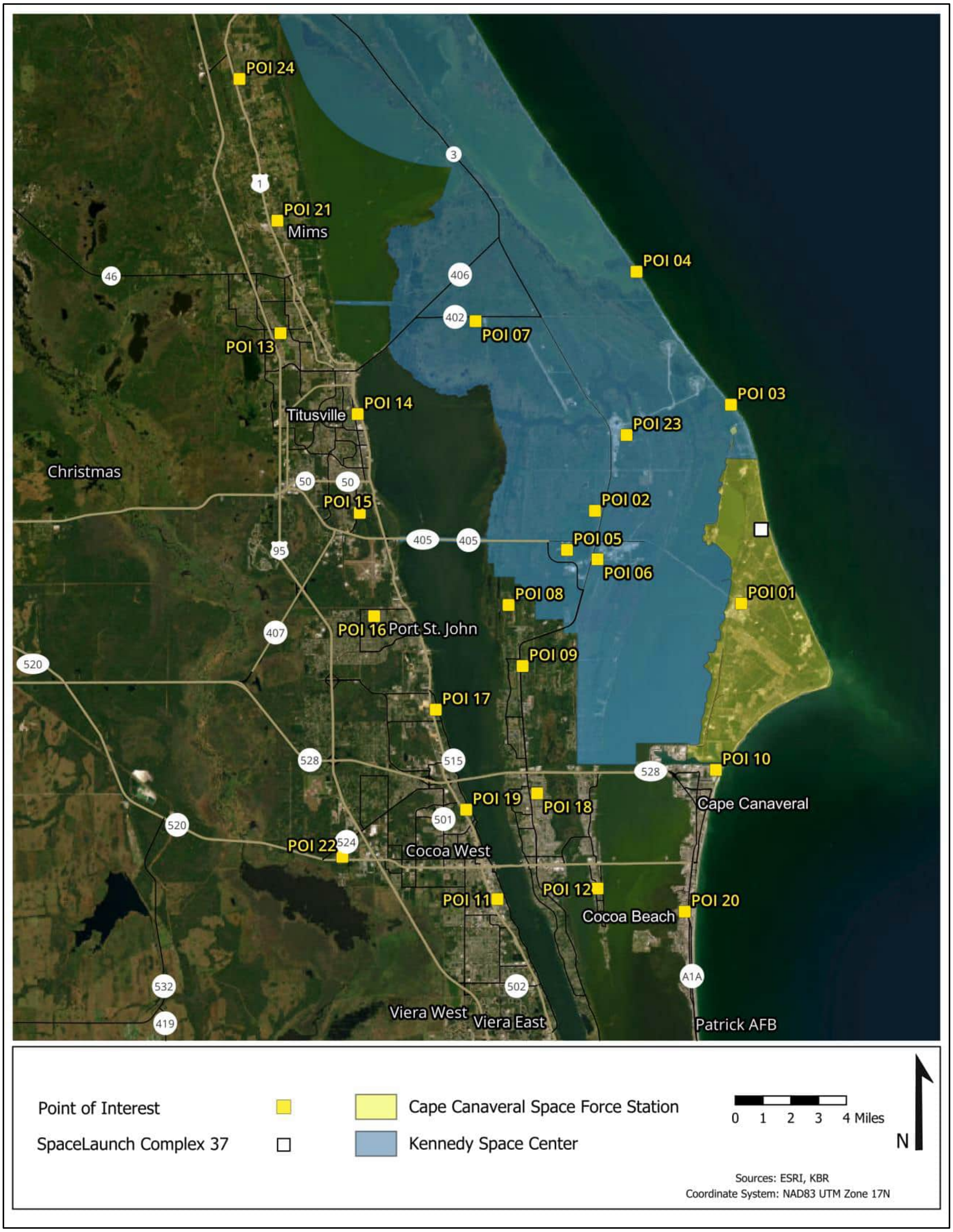


Figure 41. Points of Interest (POIs) In the Vicinity of SLC-37

5.2.4.3 Acreage, Housing, and Population Within DNL Contours

Table 6 shows the total acreage within each DNL contour band, resulting in a total of 32,612 acres that would be exposed to DNL 65 dB or greater due to noise from the proposed Starship operations at SLC-37. This acreage excludes water bodies and is comprised of 17,129 acres exposed to DNL 65 to 70 dB, 7,677 acres exposed to DNL 70 to 75 dB, 2,611 acres exposed to DNL 75 to 80 dB, 1,809 acres exposed to DNL 80 to 85 dB, and 3,386 acres exposed to DNL greater than 85 dB.

Table 6. Proposed Starship Operations at SLC-37: DNL Exposure Acreage

DNL Band (dB)	Acreage
	Total
65-70	17,129
70-75	7,677
75-80	2,611
80-85	1,809
85+	3,386
Total	**32,612**

Note: DNL = Day-Night Average Sound Level; dB = decibel.

Geographic Information System (GIS) analysis was used to estimate the population and households within each DNL contour band. If a block group was partially within a DNL contour band the number of households and population were scaled based upon the proportion of the block group area within each DNL contour band. Table 7 lists estimated total households and population that would be exposed to each DNL contour band under the proposed Starship operations at SLC-37. Since the DNL 65 dBA contour is entirely within the KSC and CCSFS properties, there are no houses or people exposed to DNL greater than 65 dBA.

Table 7. Proposed Starship Operations at SLC-37: DNL Exposure (Households and Population)

DNL Band (dB)	Households	Population
65-70	0	0
70-75	0	0
75-80	0	0
80-85	0	0
85+	0	0
Totals	**0**	**0**

Note: DNL = Day-Night Average Sound Level; dB = decibel.

5.2.5 Supplemental Metrics Assessment for Rocket Noise Events at SLC-37

A supplemental metrics assessment was conducted for the twenty-four POIs in this study to further characterize the noise exposures due to proposed Starship operations at SLC-37. Descriptions of each supplemental metric evaluated are provided in Section 2.3. The following sections report results for these metrics including the potential for Speech Interference (Section 5.2.5.1), Classroom Learning Interference (5.2.5.2), Residential Sleep Disturbance (5.2.5.3), Potential for Hearing Loss (5.2.5.4), and Potential for Structural Damage (5.2.5.5). In most cases, this report provides a supplemental metrics assessment for all these metrics at each noise sensitive receptor. For example, residences are often located close to schools, such that determining percent awakenings at a school location, which would not normally apply, could be applied to nearby residences. This method of assessment, which is becoming more common, provides additional useful information at some of the noise sensitive receptors, but not in every case.

5.2.5.1 Speech Interference

This study assesses the potential for Starship noise events to interfere with speech communication, or non-school speech, at all POIs during the acoustic daytime (7 a.m. to 10 p.m.). Table 8 presents the number of potential speech interference events based upon the number of Starship noise events per average hour during the daytime period for both windows open and windows closed cases. The number of events that could interfere with speech per average daytime hour is low at all POIs due to the infrequency of Starship noise events. The highest number of speech interfering events per daytime hour (0.035), that would potentially be experienced at 11 of the 24 POIs, is equal to 15.75 speech interfering events per month or nearly 190 speech interfering events per year which is equal to the number of proposed daytime Starship operations per year. The other 13 POIs would experience fewer speech interference events; 0.028 speech interfering events per average daytime hour with windows open equals 151 speech interfering events per year; 0.014 speech interfering events per average daytime hour with windows closed equals about 75 speech interfering events per year.

Table 8. Proposed Starship Operations at SLC-37: Speech Interference Events per Daytime Hour

POI ID	POI Name	Location	Windows Open[1]	Windows Closed[2]
1	Cape Canaveral Space Force Station (CCSFS)	Cape Canaveral	0.035	0.035
2	SpaceX Operations Area	Merritt Island	0.035	0.035
3	Titusville Beach	Titusville	0.035	0.035
4	Playalinda Beach	Titusville	0.035	0.028
5	Kennedy Space Center Visitor Complex	Merritt Island	0.035	0.035
6	KSC Child Development Center	Merritt Island	0.035	0.035
7	Merrit Island National Wildlife Refuge Visitor Center	Merritt Island	0.035	0.014
8	Pine Island Conservation Area/Pine Island Estates	Merritt Island	0.035	0.028

POI ID	POI Name	Location	Windows Open[1]	Windows Closed[2]
9	Kings Park Estates - Courtenay	Courtenay	0.035	0.021
10	Jetty Park Campground	Cape Canaveral	0.035	0.028
11	Rockledge High School	Rockledge	0.028	0.014
12	Merritt Island	Merritt Island	0.028	0.014
13	Oak Park Elementary School	Titusville	0.021	0.014
14	Titusville High School	Titusville	0.028	0.014
15	Summerwood Villas	Titusville	0.028	0.014
16	Atlantis Elementary School	Port St. John	0.028	0.014
17	Fairglen Elementary School	Cocoa	0.028	0.014
18	Lewis Carroll Elementary School	Merritt Island	0.028	0.014
19	Cocoa	Cocoa	0.028	0.014
20	Cocoa Beach	Cocoa Beach	0.028	0.014
21	Pinegrove Estates	MIMS	0.014	0.014
22	Fern Meadows	West Cocoa	0.014	0.014
23	KSC Office Outside BDA	KSC	0.035	0.035
24	The Rock Church	Fontaine Grant	0.014	0.007

Notes: [1]Assumes 15 dB Noise Level Reduction; [2] Assumes 15 dB Noise Level Reduction; POI = Point of Interest; ID = Identification;

5.2.5.2 Classroom Learning Interference

Table 9 presents the analysis of classroom learning interference for the POIs that are schools (POI IDs 6, 11, 13, 14, 16, 17, and 18) that would experience noise from proposed Starship operations. The school screening threshold of a 60 dB L_{eq}(8hr) exterior level equates to an interior noise level of 45 dB L_{eq}(8hr) with windows open and represents the threshold at which studies have found classroom learning is affected[13,15]. None of the seven schools listed in Table 9 are exposed to exterior L_{eq}(8hr) levels greater than 60 dB, therefore no further analysis is warranted for the proposed Starship operations.

Table 9. Proposed Starship Operations at SLC-37: Classroom Learning Interference

POI ID	POI Name	City/Community	L_{eq}(8hr) (dB)
6	KSC Child Development Center	Merritt Island	59.0
11	Rockledge High School	Rockledge	43.9
13	Oak Park Elementary School	Titusville	42.8
14	Titusville High School	Titusville	46.2
16	Atlantis Elementary School	Port St. John	46.7
17	Fairglen Elementary School	Cocoa	47.4
18	Lewis Carroll Elementary School	Merritt Island	48.1

Notes: POI = Point of Interest; ID = Identification;
LAeq,8 = 8-Hour Energy Average Sound Level ; dB = decibel.

5.2.5.3 Residential Sleep Disturbance

The potential for residential sleep disturbance is assessed at each POI as percent awakenings (PA) for a proposed Starship nighttime launch. Estimating PA involves taking the outdoor SEL at each POI, computing the indoor SEL (assuming a 15 dB building noise reduction for windows open and 25 dB building noise reduction for windows closed) and using the FICAN updated (1997) recommended dose -response curve[22], interpreted to be the "maximum percent awakened" for a given residential population. Table 10 presents the estimated PA with windows open as ranging from 22 percent at the CCSFS POI (nearest to the launch pad) to 6 percent at The Rock Church POI. These percentages represent the percentage of the population that would be awakened at least once per night due to proposed Starship launches. Although PA has been estimated at all 24 study POIs, only about 7 POIs were listed as residential areas in Table 5; POIs 1 through 6 are well within the CCSFS and KSC properties. Super Heavy Booster landing SELs are approximately 10 dB lower than launch SELs (PA would decrease by about 4 percent at all POIs and, as a result, most residential area POIs would have a PA of less than 10 percent). All the other operations (Starship spacecraft landings and Starship spacecraft and booster static fire tests) generate SELs that are lower than launch SELs by more than 20 dB (PA would decrease by about 8 percent at all POIs and, as a result, most residential area POIs would have a PA of less than 5 percent).

Table 10. Proposed Starship Launch at SLC-37: Estimated Percent Awakenings

POI ID #	Receptor Name	Starship Launch SEL (dB)	PA (Windows Open)	PA (Windows Closed)
1	Cape Canaveral Space Force Station (CCSFS)	125.0	22	17
2	SpaceX Operations Area	114.9	17	13
3	Titusville Beach	118.2	19	15
4	Playalinda Beach	107.8	14	11
5	Kennedy Space Center Visitor Complex	112.7	16	12
6	KSC Child Development Center	114.8	17	13
7	Merritt Island National Wildlife Refuge Visitor Center	104.8	13	9
8	Pine Island Conservation Area/Pine Island Estates	108.5	15	11
9	Kings Park Estates - Courtenay	107.7	14	11
10	Jetty Park Campground	108.3	15	11
11	Rockledge High School	99.9	11	8
12	Merritt Island	101.9	12	9
13	Oak Park Elementary School	98.8	11	8
14	Titusville High School	102.2	12	9
15	Summerwood Villas	102.7	12	9
16	Atlantis Elementary School	102.7	12	9
17	Fairglen Elementary School	103.4	13	9
18	Lewis Carroll Elementary School	104.1	13	9
19	Cocoa	101.8	12	9
20	Cocoa Beach	102.0	12	9

POI ID #	Receptor Name	Starship Launch SEL (dB)	PA (Windows Open)	PA (Windows Closed)
21	Pinegrove Estates	97.2	10	7
22	Fern Meadows	97.7	11	7
23	KSC Office Outside BDA	115.2	18	13
24	The Rock Church	94.2	9	6

Notes: POI = Point of Interest; ID = Identification; PA = Percent Awakening; dB = decibel.

5.2.5.4 Potential for Hearing Loss

The potential for hearing loss in the residential areas off KSC and CCSFS properties is low enough to be considered improbable; the highest noise levels experienced in these populated areas from the loudest proposed Starship event (orbital launch, see Figure 17) do not exceed any criteria thresholds for hearing loss including NASA's 108 dBA upper noise limit guideline for hearing conservation[15].

5.2.5.5 Potential for Structural Damage

The potential for structural damage due to Starship orbital launch events is assessed using the potential for structural damage claims. An applicable study of structural damage claims from rocket static firing tests indicates that, based on Maximum Unweighted Sound Level (L_{max}), approximately one damage claim will result per 100 households exposed at 120 dB and one damage claim will result per 1,000 households exposed at 111 dB[16]. The L_{max} 111 dB and 120 dB contours estimated for Starship orbital launch events are shown on Figure 20. Starship orbital launch events are estimated to generate L_{max} of 120 dB approximately 10 miles from the launch pad; the 120 dB contour would extend west to the Indian River, but not into Titusville, and north of Wilson. The 111 dB contour would extend approximately 22 miles from the launch pad to areas west of Titusville, south along the coast between Cocoa Beach and Satellite Beach, and north to Oak Hill. The second structural damage assessment using the 134 dB and 140 dB criteria levels[17] does not indicate any potential for structural damage.

Table 11 shows the L_{max} values estimated at each of the study POIs for a proposed Starship launch at SLC-37. The level at each POI is compared with the 111 dB and 120 dB thresholds and a checkmark in either of the two rightmost columns in the table indicates the potential for damage claims to occur with the probability per household shown. Note that not all the POIs listed have existing residential or other structure types, however, this assessment was done for all POIs since there may be other structures nearby, in the vicinity of the listed POI.

Table 11. Proposed Starship Launch at SLC-37: Assessment of Potential for Structural Damage

POI ID #	Receptor Name	Starship Launch Lmax (dB)	@ 111 dB Damage Claim % (1/1,000)	@ 120 dB Damage Claim % (1/100)
1	Cape Canaveral Space Force Station (CCSFS)	132.2	√	√
2	SpaceX Operations Area	126.2	√	√
3	Titusville Beach	128.5	√	√
4	Playalinda Beach	120.8	√	√
5	Kennedy Space Center Visitor Complex	124.5	√	√
6	KSC Child Development Center	126.0	√	√
7	Merritt Island National Wildlife Refuge Visitor Center	118.7	√	
8	Pine Island Conservation Area/Pine Island Estates	121.4	√	√
9	Kings Park Estates - Courtenay	120.7	√	√
10	Jetty Park Campground	120.9	√	√
11	Rockledge High School	115.0	√	
12	Merritt Island	116.3	√	
13	Oak Park Elementary School	114.6	√	
14	Titusville High School	116.9	√	
15	Summerwood Villas	117.2	√	
16	Atlantis Elementary School	117.2	√	
17	Fairglen Elementary School	117.6	√	
18	Lewis Carroll Elementary School	118.0	√	
19	Cocoa	116.4	√	
20	Cocoa Beach	116.3	√	
21	Pinegrove Estates	113.5	√	
22	Fern Meadows	113.6	√	
23	KSC Office Outside BDA	126.4	√	√
24	The Rock Church	111.4	√	

Notes: POI = Point of Interest; ID = Identification; % = Percentage;
Lmax = Maximum Unweighted Sound Level; dB = decibel.

The second structural damage assessment using the 134 dB and 140 dB criteria levels does not indicate any potential for structural damage.

5.3 Sonic Boom Exposure At SLC-37

Sonic boom exposure footprints were computed for the Starship launch (Section 5.3.1) and, after stage 1 separation, for Starship spacecraft reentry from low Earth orbit and landing at SLC-37 (Section 5.3.2), and the Super Heavy Booster descent and landing at SLC-37 (Section 5.3.3).

5.3.1 Sonic Boom From Starship Launch at SLC-37

The sonic boom from a Starship launch at SLC-37 would occur over the Atlantic Ocean after the vehicle pitches over during ascent. The sonic boom analysis uses the same trajectory that was used in the launch noise analysis (Section 5.2.1.), though primarily the ascent part of the trajectory is supersonic above approximately 23,000 feet altitude until Stage 1 apogee. The vehicle is a cylinder, with tapered nose cone. During launch, the Starship ascends to an altitude of about 450Kft reaching hypersonic speeds above Mach 12. Sonic boom would be generated while the vehicle is supersonic and pitching over (starting at about t=91 seconds at 77Kft altitude, Mach 2.7, and a flight path angle of 38 degrees).

The boom footprint for Starship launch was computed using PCBoom.[3,4] Figure 42 shows the sonic boom footprint, in the form of overpressure contours, pounds per square foot (psf). The ground track of the Starship launch trajectory is also shown in Figure 42. The ascent phase of the launch generates a broad forward-facing crescent region; crescent shaped overpressure contours (primarily 1 psf through 6 psf) are shown along and to the side of the trajectory. Overpressure levels within the boom carpet are generally less than 6 psf but reach 10 psf to 15 psf at several small focal regions on the eastern edge of the footprint. The entire boom footprint would be located offshore approximately 35 miles from the SLC-37 launch site, making it unlikely that people would be exposed to this noise event.

5.3.2 Starship Spacecraft Reentry/Landing Sonic Boom at SLC-37

The proposed operations indicate that Starship launches at SLC-37 would result in the same number of Starship spacecraft (stage 2 vehicle) recoveries at SLC-37 via landing operations. The Starship spacecraft landing trajectory for SLC-37 is the same as the one used in the landing noise analysis (Section 5.2.2), though a higher altitude part of the trajectory is used in the sonic boom analysis. The reentry/decent portion of the landing is supersonic from the apogee (or deorbit point) until it passes through an altitude just below 75,000 feet. Most of the Starship spacecraft descent is unpowered with landing thrust applied during approximately the last 1,800 feet of altitude.

The Starship spacecraft landing sonic boom is generated above 75,000 feet altitude as the vehicle follows a reentry/descent flight path from west to east like past Space Shuttle landings at KSC. The sonic boom footprints for this landing were computed using PCBoom.[3,4] Figure 43 shows the sonic boom footprint, in the form of overpressure contours, pounds per square foot (psf) for the Starship spacecraft landing at SLC-37. The ground track of the trajectory, as the vehicle approaches the landing site at SLC-37 from the west, is also shown in Figure 43. The part of the reentry provided starts at hypersonic speeds above Mach

15 and slows to supersonic speeds until it passes through an altitude of about 75,000 feet, after which vehicle speeds are subsonic until landing.

Overpressure contours on Figure 43 ranging from 1 psf to 1.7 psf are shown along and to the side of the trajectory. Near the landing site there is an oval shaped boom footprint region generated with levels from 1 psf to 1.7 psf (the estimated maximum overpressure level is 1.72 psf). The 1 psf contour is estimated to be about 30 miles west of the landing site, extending well beyond Titusville.

In general, booms in the 0.2 to 0.3 psf range could be heard by someone who is expecting it and listening for it, but usually would not be noticed. Booms of 0.5 psf are more likely to be noticed, and booms of 1.0 psf and above are certain to be noticed. Therefore, people in the vicinity of the SLC-37 landing site to areas west of Titusville are expected to notice booms from Starship spacecraft landings; those located on the KSC and CCSFS properties, within the 2.0 psf region, could possibly be startled. Announcements of upcoming Starship launches and landings serve to warn people about these noise events and are likely to help reduce adverse reactions to these noise events. The boom levels over land are not likely to cause property damage; while structures in good condition have been undamaged by overpressures of up to 11 psf, rare minor damage may result from boom levels with peak overpressures between 2 and 5 psf[26].

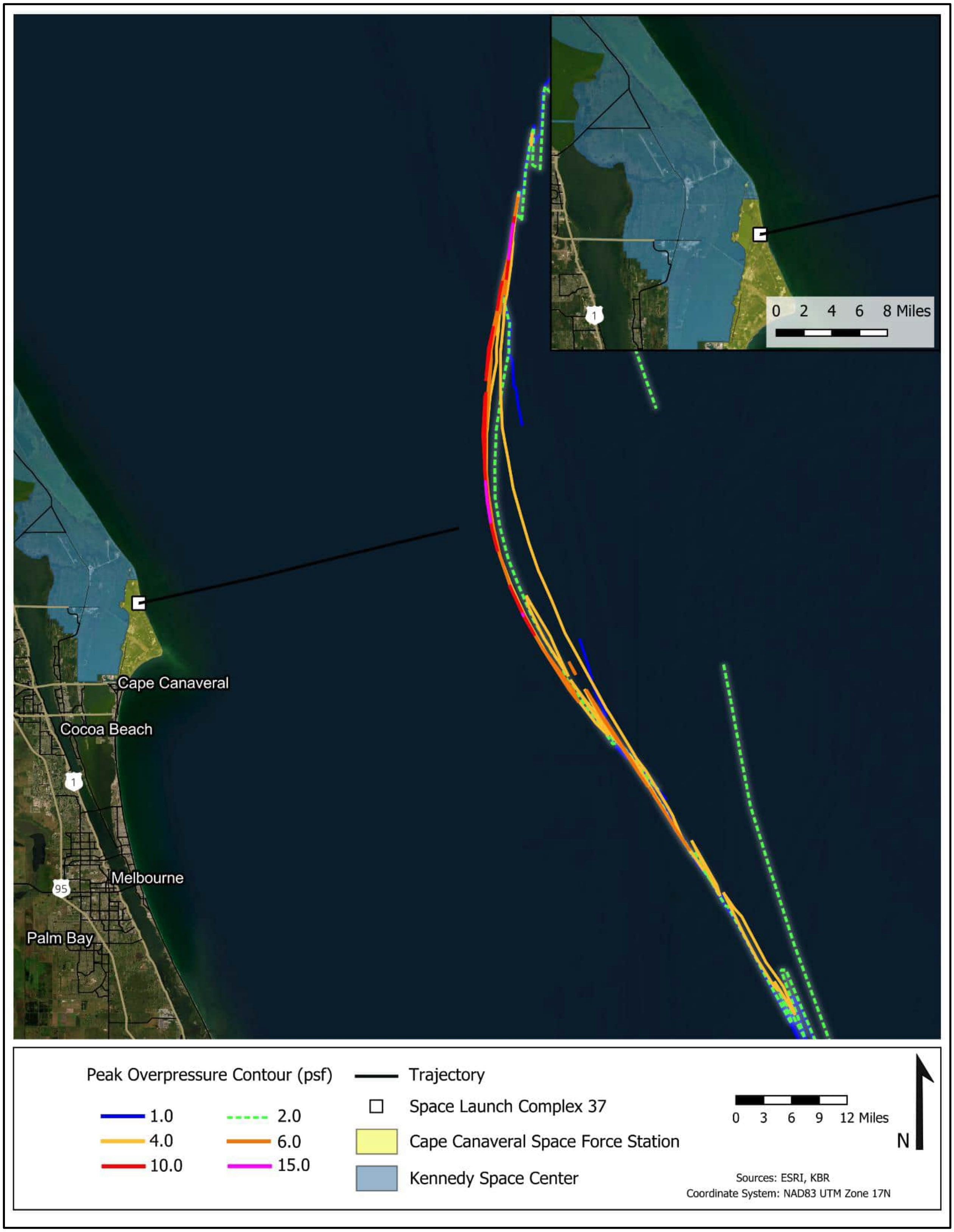


Figure 42. Sonic Boom from Starship Launch at SLC-37: psf Contours

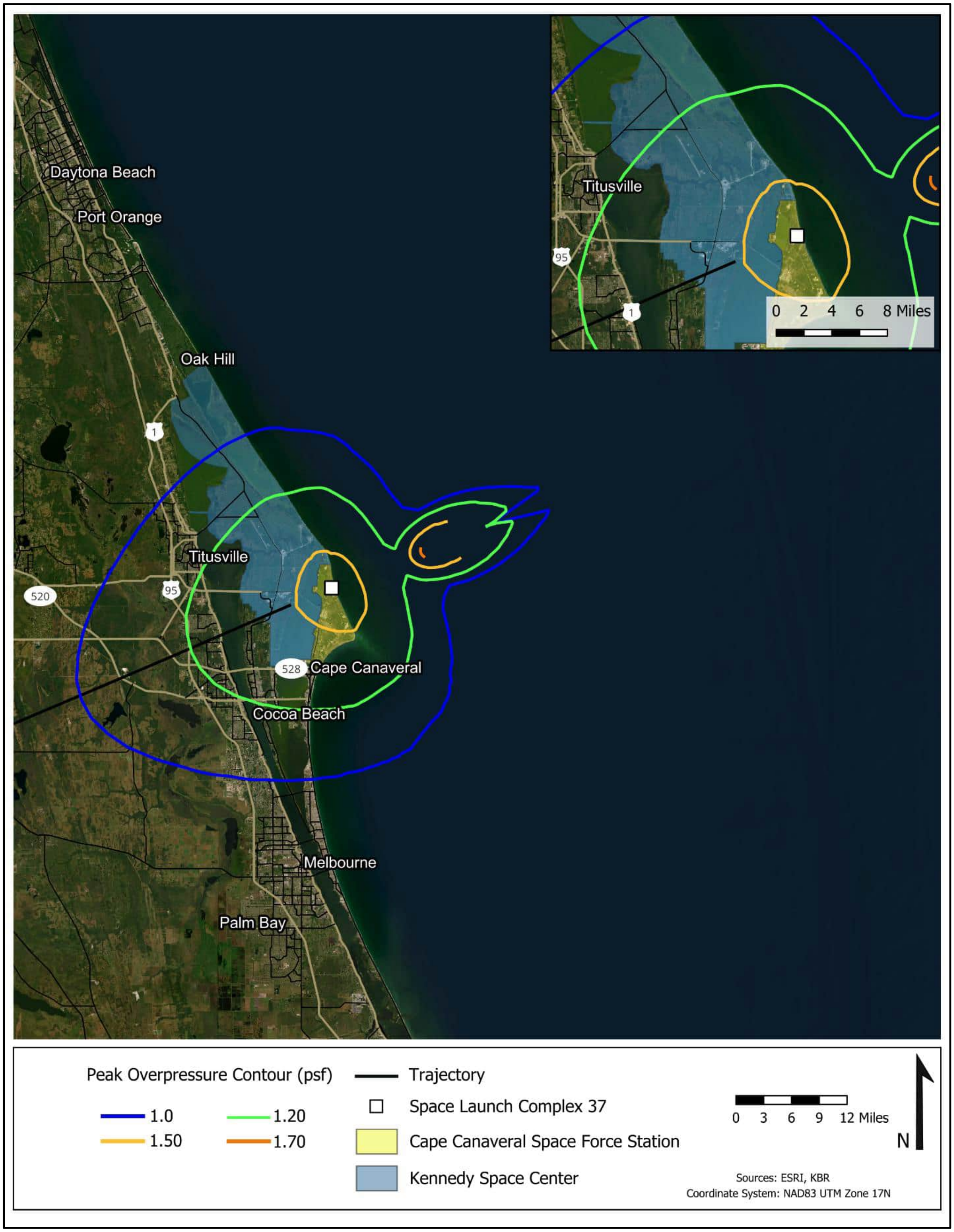


Figure 43. Sonic Boom from Starship Spacecraft Descent/Landing at SLC-37: psf Contours

5.3.3 Super Heavy Booster Descent/Landing Sonic Boom at SLC-37

The proposed operations indicate that Starship launches at SLC-37 would result in the same number of Super Heavy Booster (stage 1) recoveries at SLC-37 via landing operations. The Super Heavy landing trajectory for SLC-37 is the same as the one used in the landing noise analysis (Section 5.2.2.2), though a higher altitude part of the trajectory is used in the sonic boom analysis. The decent portion of the booster landing at SLC-37 is supersonic until it passes through an altitude just below 9,000 feet. Most of the booster descent is unpowered. As described in Section 5.2.2.2, three Booster landing trajectories were analyzed, including the nominal trajectory from a heading of 80-degrees (projected to be used 80 percent of the time), north bounding trajectory from 40-degrees (10 percent use), and south bounding trajectory from 115-degrees (10 percent use).

The sonic boom footprints at SLC-37 were computed using PCBoom.[3,4] The vehicle is a cylinder generally aligned with the velocity vector, descending engines first. The landing trajectory kinematics includes the effect of atmospheric drag and the retro burn in each case.

As Figure 44 shows that for descent on the nominal trajectory, there is a broad forward-facing crescent region generated as the vehicle descends below 200,000 feet at a heading of approximately 260 degrees. After the burn finishes there is a roughly oval boom footprint region that ends when vehicle speed becomes subsonic. Levels within this oval footprint range from 6 psf to 20 psf close to the landing site.

- Boom levels at the SLC-37 landing pad would be 20 (+) psf.
- Boom levels on CCSFS and KSC properties would range from 4 to 10 psf in areas away from the landing pad.
- Residents outside of the CCSFS and KSC properties would experience lower boom levels ranging from 1 psf to 2 psf except the northern half of Cape Canaveral and parts of Merritt Island could experience booms up to up to 5 psf.
- The highest boom levels offshore are between 10 psf and 20 psf just east of SLC-37.

Similar sonic boom levels are expected from landings using the 40-degree north bounding trajectory (Figure 45) and the 115-degree south bounding trajectory (Figure 46) although the exposures, away from the landing pad, would be in different areas depending on the landing trajectory used. Super Heavy landing booms would likely be noticed by residents of Titusville, Merritt Island, Cocoa, and Cocoa Beach ; lower-level booms (below 1 psf) could be heard by people even farther away from the landing site. Residents of Merritt Island, the City of Cape Canaveral, and those working or visiting CCSFS or KSC are likely to experience booms greater than 2 psf and could possibly be startled. Announcements of upcoming Starship launches and landings serve to warn people about these noise events and are likely to help reduce adverse reactions to these noise events. The boom levels over land are not likely to cause property damage in residential areas; rare minor damage may result from boom levels with peak overpressures between 2 and 5 psf[26]. For all Starship operations discussed for SLC-37, the location of maximum overpressure will vary with weather conditions, so it is unlikely that any given location will experience the maximum estimated level more than once over multiple events.

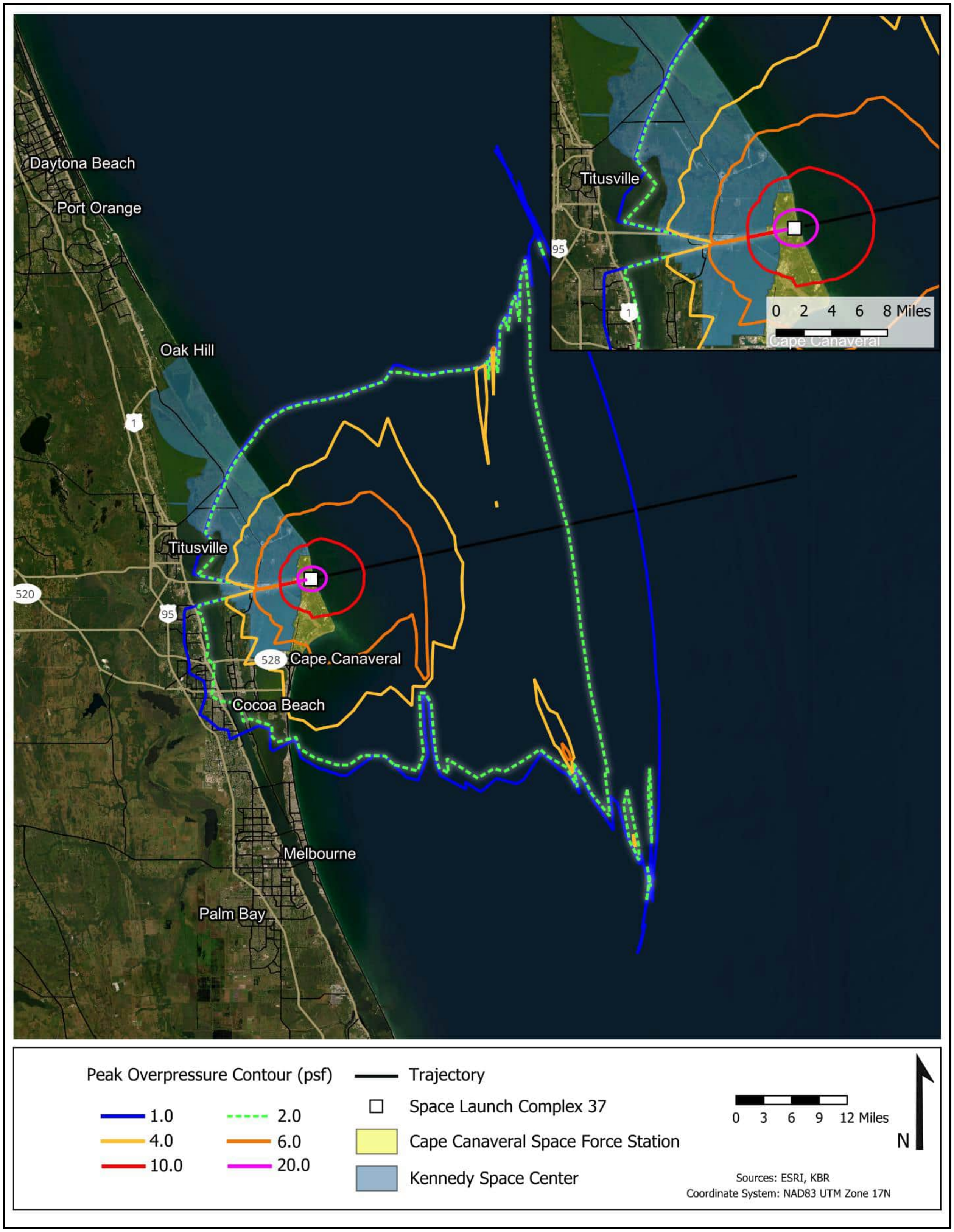


Figure 44. Sonic Boom from Super Heavy Descent (Nominal) at SLC-37: psf Contours

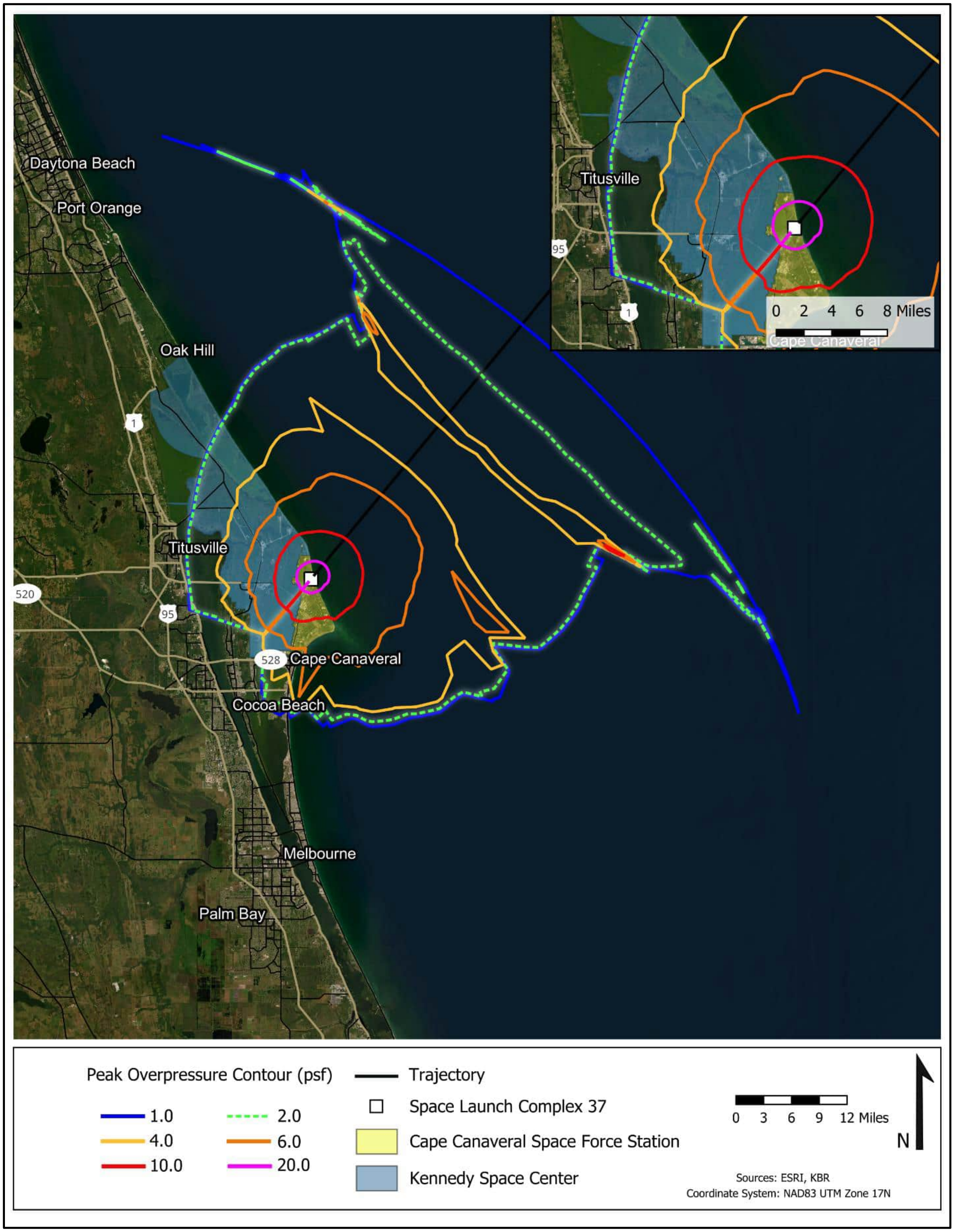


Figure 45. Sonic Boom from Super Heavy Descent (40-Degrees) at SLC-37: psf Contours

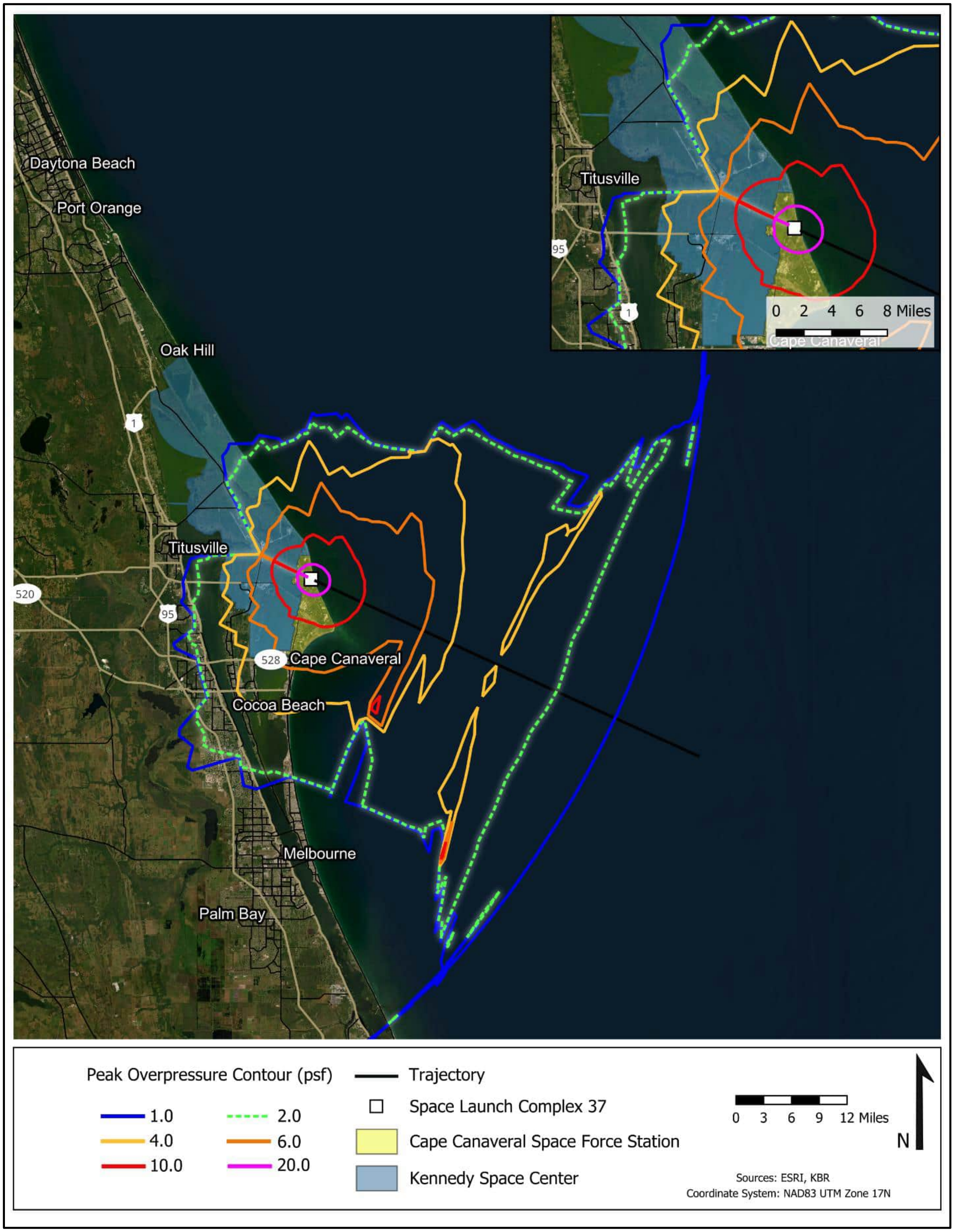


Figure 46. Sonic Boom from Super Heavy Descent (115-Degrees) at SLC-37: psf Contours

5.3.4 Cumulative Sonic Boom Levels at SLC-37

Cumulative sonic boom levels were estimated, using C-weighted Day-Night Average Sound Level (CDNL), for projected annual Starship and Booster landing operations at SLC-37. CDNL is DNL computed with C-weighting (more emphasis is placed on low frequencies below 1,000 hertz). The CDNL metric is used as a cumulative measure of noise events having lower frequency content and higher levels (e.g., sonic booms, large caliber weapons, and blast noise events). Cumulative sonic boom levels would include the CDNL exposure due to all annual Starship spacecraft landings and Super Heavy Booster landings combined.

The estimated CDNL results are shown as contours on Figure 47 and as levels at the study points of interest (Table 12). CDNL exposure is also presented as the number of acres (Table 13) and population and housing (Table 14) within each 5 dB contour band from CDNL 60 dBC to 80 dBC; where CDNL 60 dB is the FAA's significance threshold for noise sensitive land uses.

Figure 47 shows that most of the areas exposed to CDNL 60 dB or above are on KSC and CCSFS property. Other areas outside of KSC and CCSFS property that are exposed to CDNL 60 dB or above include parts of Merritt Island, Cape Canaveral, Cocoa, Cocoa Beach, and a small area south of Titusville near Port St. John and Sharpes. Table 12 shows that the CDNL values from Starship landing operations exceed the CDNL 60 dBC threshold at seventeen of the twenty-four POIs. About half of these CDNL exposures above 60 dB are at POIs located within KSC or CCSFS properties. Section 5.3.4.2 includes more details about the CDNL estimates at the POIs and Section 5.3.4.3 describes the CDNL exposed acreage, housing, and population that would result from the proposed annual Starship and Booster landing operations at SLC-37.

Though the cumulative sonic boom levels estimated would include the CDNL exposure due to all annual Starship spacecraft landings and Super Heavy Booster landings combined, the single event levels and CDNL values for the Super Heavy Booster landings in these areas are much higher than Starship spacecraft landing single event levels and CDNL values, by more than 10 dB in most cases. The Starship spacecraft landing boom levels therefore do not contribute much to the combined CDNL result (i.e., the Super Heavy Booster landing CDNL values dominate the cumulative sonic boom exposure from all landings).

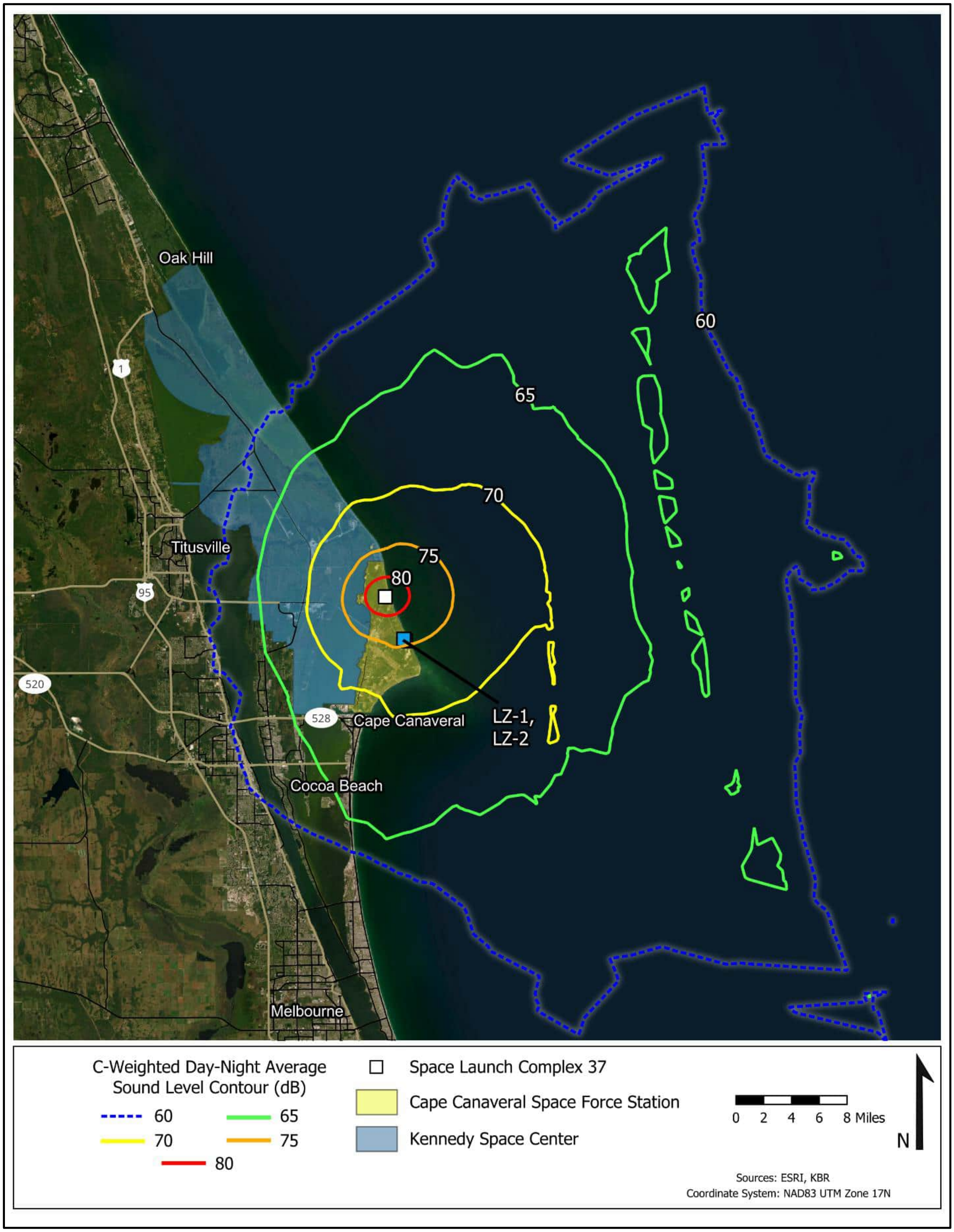


Figure 47. Cumulative Sonic Boom Exposure (All Starship Operations) at SLC-37: CDNL Contours

5.3.4.2 CDNL Exposure at Points of Interest

The twenty-four POIs assessed in this study are listed in Table 12 and Figure 41 shows their locations relative to SLC-37. For each POI, Table 12 includes the POI number identifier (ID) which is shown on the map in Figure 41, POI name, location, POI type (residential, school, place of worship, etc.) and the estimated CDNL due to proposed Starship operations at SLC-37. CDNL values range from 52.2 dBC, at The Rock Church, to 76.0 dBC at CCSFS (nearest POI to SLC-37). Seventeen POIs are exposed to CDNL 60 dB or greater (highlighted cells in the table), where CDNL 60 dB is the FAA threshold for land use compatibility. POIs 1-7 and 23 are located on CCSFS or KSC property while the other POIs (above CDNL 60 dB) are in Merritt Island (8, 12, and 18), Courtenay (9), Cape Canaveral (10), Cocoa (17, 19), and Cocoa Beach (20).

Table 12. Proposed Starship Operations at SLC-37: CDNL Exposure at POIs

POI ID	POI Name	Location	Type	CDNL(dB)
1	Cape Canaveral Space Force Station (CCSFS)	Cape Canaveral	CCSFS Representative	76.0
2	SpaceX Operations Area	Merritt Island	SpaceX Facility	69.3
3	Titusville Beach	Titusville	Recreational (Private)	73.0
4	Playalinda Beach	Titusville	Recreational Area	66.3
5	Kennedy Space Center Visitor Complex	Merritt Island	KSC Representative	67.9
6	KSC Child Development Center	Merritt Island	School	69.6
7	Merritt Island National Wildlife Refuge Visitor Center	Merritt Island	Wildlife Conservation Area	60.9
8	Pine Island Conservation Area/Pine Island Estates	Merritt Island	Wildlife Conservation Area/Residential Area	64.6
9	Kings Park Estates - Courtenay	Courtenay	Residential	64.6
10	Jetty Park Campground	Cape Canaveral	Recreational Area	68.4
11	Rockledge High School	Rockledge	School	61.1
12	Merritt Island	Merritt Island	Residential	63.7
13	Oak Park Elementary School	Titusville	School	53.6
14	Titusville High School	Titusville	School	54.5
15	Summerwood Villas	Titusville	Residential	54.9
16	Atlantis Elementary School	Port St. John	School	55.3
17	Fairglen Elementary School	Cocoa	School	58.7
18	Lewis Carroll Elementary School	Merritt Island	School	64.5
19	Cocoa	Cocoa	Residential	60.9
20	Cocoa Beach	Cocoa Beach	Residential	65.8
21	Pinegrove Estates	MIMS	Residential	53.1
22	Fern Meadows	West Cocoa	Residential	54.4
23	KSC Office Outside BDA	KSC	Office	70.0
24	The Rock Church	Fontaine Grant	Place of Worship	52.2

Notes: POI = Point of Interest; ID = Identification; CDNL = C-weighted Day-Night Average Sound Level; dBC = decibel (C-weighted).

5.3.4.3 Acreage, Housing, and Population Within CDNL Contours

Table 13 shows the acreage within each CDNL contour band, resulting in a total of 105,915 acres exposed to DNL 60 dB or greater due to noise from proposed Starship operations at SLC-37. This total acreage excludes water bodies and is comprised of 34,278 acres exposed to CDNL 60 to 65 dB, 42,486 acres exposed to CDNL 65 to 70 dB, 20,937 acres exposed to CDNL 70 to 75 dB, 5,673 acres exposed to CDNL 75 to 80 dB, and 2,541 acres exposed to CDNL greater than 80 dB.

Table 13. Proposed Starship Operations at SLC-37: CDNL Exposure Acreage

CDNL Band (dBC)	Acreage
	Total
60-65	34,278
65-70	42,486
70-75	20,937
75-80	5,673
80+	2,541
Total	**105,915**

Note: CDNL = C-weighted Day-Night Average Sound Level; dBC = decibel (C-weighted).

Geographic Information System (GIS) analysis was used to estimate the population and households within each CDNL contour band. If a block group was partially within a CDNL contour band the number of households and population were scaled based upon the proportion of the block group area within each CDNL contour band. Table 14 lists estimated households and population outside of CCSFS and KSC properties that would be exposed to each CDNL contour band due to the Proposed Starship operations at SLC-37. Currently, 24,983 households and 50,175 people would be within the CDNL 60 to 65 dB contour band which includes parts of Titusville, Merritt Island, and areas south of Cocoa Beach; 18,711 households and 24,236 people would be within the CDNL 65 to 70 dB contour band which includes Cape Canaveral and Cocoa Beach.

Table 14. Proposed Starship Operations at SLC-37: CDNL Exposure (Households and Population)

CDNL Band (dBC)	Households	Population
60-65	24,983	50,175
65-70	18,711	24,236
70-75	0	0
75-80	0	0
80+	0	0
Totals	**43,694**	**74,411**

Note: CDNL = C-weighted Day-Night Average Sound Level;
dBC = decibel (C-weighted).

5.3.5 Supplemental Metrics Assessment for Sonic Boom Exposure at SLC-37

The Supplemental metrics for assessing sonic boom exposures, described in Section 2.3, are used here to further characterize the noise environment from Starship supersonic flight operations. The following sections provide assessments of two supplemental metrics, Residential Sleep Disturbance (Section 5.3.5.1) and the Potential for Structural Damage (Section 5.3.5.2), two impacts that could occur from sonic booms generated by the proposed Starship spacecraft and Super Heavy landing operations at SLC-37, along with a discussion of the unlikely Potential for Hearing Loss in Section 5.3.5.3.

As with all the supplemental analysis presented in this report, these assessments use the 24 study POIs to describe the noise exposures from Starship operations, but in a general sense, where the assessment would be applicable to all areas with the same level of noise exposure.

5.3.5.1 Residential Sleep Disturbance from Proposed Starship Sonic Boom Events

Half of all proposed Starship spacecraft and Booster landings are expected to be conducted at nighttime (i.e., 22 nighttime landings annually per vehicle). Nighttime landings and the sonic booms they generate are a new type of noise event that recently began occurring with SpaceX Falcon 9 and Falcon Heavy first stage recovery landings at Cape Canaveral. With the addition of proposed Starship operations at SLC-37, these types of events would become more regular and there is the potential that some residents in nearby communities could be awakened from sleep during these nighttime events. Some who may regularly sleep during the day may also be awakened by landing events that occur during daytime hours.

As reported by the Department of Defense (DOD) Noise working Group (DNWG)[25], direct empirical evidence of the ability of sonic booms to disturb sleep is very scarce. During the SST Program, only four studies were conducted on sleep awakenings from both simulated and actual sonic booms (Collins and Lampietro, 1973; Ludlow and Morgan, 1972; Lukas, Dobbs, and Kryter, 1971; and Lukas and Dobbs, 1972). A review of these studies combined their results to develop a relationship between sonic boom levels and awakenings (Pearsons et al., 1989). A preliminary dose-response relationship for awakenings is as follows:

% Awakened or Aroused = 2.32(CSEL) - 184.9

where CSEL is the C-weighted sound exposure level of an impulsive noise event such as a sonic boom. Applying this dose-response relationship to the booster landing operations, that are expected to generate the highest sonic boom levels, yields the example results for the percent awakened shown in Table 15. Results shown in Table 15 reflect a booster landing on the nominal (80-degree) trajectory, and landings on other trajectories would yield different results. Since most of the acoustic energy in a sonic boom occurs at low frequencies (below 100 Hz), typical houses of good construction are not expected to provide noise reductions (NR) for sonic boom that are as high as those for subsonic noise (i.e., typically in the 15 to 25 dB range with windows open and windows closed, respectively). Table 15 shows the estimated percent awakened for 0 dB NR and 15 dB NR (provided as an example upper limit); for 0 dB NR, the percent awakened ranges from about 66-85 percent in residential areas whereas for 15 dB NR, the percent awakened ranges from about 32-51 percent.

Table 15. Proposed Super Heavy Landing On Nominal Trajectory at SLC-37: % Awakened at POIs

POI ID	POI Name	Location	Type	CSEL (dBC)	% Awakened (0 dB Noise reduction)	% Awakened (15 dB Noise reduction)
1	Cape Canaveral Space Force Station (CCSFS)	Cape Canaveral	CCSFS Representative	124.7	100%	69.6
2	SpaceX Operations Area	Merritt Island	SpaceX Facility	118.4	89.8	55.0
3	Titusville Beach	Titusville	Recreational (Private)	121.4	96.7	61.9
4	Playalinda Beach	Titusville	Recreational Area	115.1	82.1	47.3
5	Kennedy Space Center Visitor Complex	Merritt Island	KSC Representative	117.8	88.4	53.6
6	KSC Child Development Center	Merritt Island	School	117.0	86.5	51.7
7	Merrit Island National Wildlife Refuge Visitor Center	Merritt Island	Wildlife Conservation Area	109.6	69.4	34.6
8	Pine Island Conservation Area/Pine Island Estates	Merritt Island	Wildlife Conservation /Residential Area	116.2	84.7	49.9
9	Kings Park Estates - Courtenay	Courtenay	Residential	113.6	78.7	43.9
10	Jetty Park Campground	Cape Canaveral	Recreational Area	116.7	85.8	51.0
11	Rockledge High School	Rockledge	School	108.7	67.3	32.5
12	Merritt Island	Merritt Island	Residential	112.5	76.1	41.3
13	Oak Park Elementary School	Titusville	School	-	-	-
14	Titusville High School	Titusville	School	-	-	-
15	Summerwood Villas	Titusville	Residential	-	-	-
16	Atlantis Elementary School	Port St. John	School	-	-	-
17	Fairglen Elementary School	Cocoa	School	109.6	69.4	34.6
18	Lewis Carroll Elementary School	Merritt Island	School	113.3	78.0	43.2
19	Cocoa	Cocoa	Residential	108.4	66.6	31.8
20	Cocoa Beach	Cocoa Beach	Residential	114.6	81.0	46.2
21	Pinegrove Estates	MIMS	Residential	-	-	-
22	Fern Meadows	West Cocoa	Residential	-	-	-
23	KSC Office Outside BDA	KSC	Office	118.9	90.9	56.1
24	The Rock Church	Fontaine Grant	Place of Worship	-	-	-

Notes: POI = Point of Interest; ID = Identification; CSEL = C-weighted Sound Exposure Level; dBC = decibel (C-weighted); % = Percent. The POIs without noise values reported are located outside of the sonic boom footprint.

5.3.5.2 Potential for Structural Damage from Proposed Starship Sonic Boom Events

Proposed Starship landing operations also have the potential to cause damage to structures depending on the overpressure levels which are highest at the landing pad and, in general, are progressively lower with distance away from the landing pad. In this report, we assess the potential for structural damage using the proposed Super Heavy landing (which is expected to generate the highest sonic boom overpressures of all the Starship operations) as an example, as was done in the previous section to assess the potential for sleep disturbance. The overpressure values listed in Table 16 reflect a booster landing on the nominal (80-degree) trajectory, and results would differ for landings on other trajectories.

We assess the potential for structural damage based on data in the FAA's Hershey and Higgins 1976 report "*Statistical Model of Sonic Boom Structural Damage*",[26] which is also supported in DAF's Haber and Nakaki 1989 report',[27] which describes damage probabilities for different structural components, for various sonic boom overpressure levels. We use 2 psf (pounds per square foot) and 4 psf primarily to assess the potential for structural damage, since areas off KSC and CCSFS properties are most likely to be exposed to booms, within this range of overpressure levels, from Super Heavy landing operations; 2 psf is also considered to be the low threshold level for glass breakage.

The peak overpressure levels (psf) estimated for a Super Heavy nominal landing at SLC-37 are highest at the POIs on KSC and CCSFS property (POI IDs 1-6 and 23) with the highest level occurring at Titusville Beach (closest to the landing pad at SLC-37 and closed to the public during landings). Off KSC and CCSFS property, levels are below 4 psf except at the Jetty Park Campground in Cape Canaveral (5.0 psf) and the Pine Island Conservation Area (4.0) and Cocoa Beach (4.0). Overpressure levels at many of the other POIs, where data exists, are at 2 psf or lower; data were not available in several cases (for POIs located outside of the sonic boom footprint). A summary of the structural damage potential, for overpressure levels of 2 and 10 psf, indicates:

2 psf

Windows: The probability of window breakage at 2 psf is relatively low but not negligible. Studies have shown that the breakage probability for windows can range from about 1 in 10,000 to 1 in 1,000,000.

Plaster and Bric-a-Brac: Items like plaster and small decorative objects (bric-a-brac) have a slightly higher probability of damage, but it is still quite low. For plaster, the probability can range from about 1 in 1,000 to 1 in 10,000.

Structural Damage: Significant structural damage, such as to brick walls, is very unlikely at 2 psf. The probability is extremely low, often less than 1 in 1,000,000.

4 psf

- Windows: The probability of window breakage increases significantly at 4 psf. Studies suggest that the breakage probability for windows can range from about 1 in 100 to 1 in 1,000.
- Plaster and Bric-a-Brac: Items like plaster and small decorative objects have a higher probability of damage at 4 psf. For plaster, the probability can range from about 1 in 100 to 1 in 1,000.

- Structural Damage: While significant structural damage to well-built buildings is still relatively low, the probability increases. For example, brick walls might have a damage probability ranging from about 1 in 10,000 to 1 in 100,000.

Overall, while 4 psf sonic booms are more likely to cause damage compared to 2 psf, the extent of damage still depends on several factors, including the construction quality and maintenance of the structures.

Table 16. Proposed Super Heavy Landing On a Nominal Trajectory at SLC-37: Overpressure at POIs

POI ID	POI Name	Location	Peak Overpressure (psf)
1	Cape Canaveral Space Force Station (CCSFS)	Cape Canaveral	12.4
2	SpaceX Operations Area	Merritt Island	5.9
3	Titusville Beach	Titusville	8.6
4	Playalinda Beach	Titusville	4.1
5	Kennedy Space Center Visitor Complex	Merritt Island	5.1
6	KSC Child Development Center	Merritt Island	5.9
7	Merritt Island National Wildlife Refuge Visitor Center	Merritt Island	2.3
8	Pine Island Conservation Area/Pine Island Estates	Merritt Island	4.0
9	Kings Park Estates - Courtenay	Courtenay	3.3
10	Jetty Park Campground	Cape Canaveral	5.0
11	Rockledge High School	Rockledge	2.0
12	Merritt Island	Merritt Island	3.0
13	Oak Park Elementary School	Titusville	-
14	Titusville High School	Titusville	-
15	Summerwood Villas	Titusville	-
16	Atlantis Elementary School	Port St. John	-
17	Fairglen Elementary School	Cocoa	1.8
18	Lewis Carroll Elementary School	Merritt Island	3.4
19	Cocoa	Cocoa	1.7
20	Cocoa Beach	Cocoa Beach	4.0
21	Pinegrove Estates	MIMS	-
22	Fern Meadows	West Cocoa	-
23	KSC Office Outside BDA	KSC	6.3
24	The Rock Church	Fontaine Grant	-

Notes: POI = Point of Interest; ID = Identification; psf = pounds per square foot. The POIs without noise values reported are located outside of the sonic boom footprint.

5.3.5.3 Potential for Hearing Loss from Proposed Starship Sonic Boom Events

Sonic boom research summarized by the Defense Noise Working Group (DNWG) indicates that impulsive noise exposure produced by occasional overflights of supersonic aircraft poses no meaningful risk of hearing damage (including evidence that the high-frequency spectral content of sonic booms is inadequate to damage hearing). This is supported by several sonic boom field studies where researchers were exposed to high boom levels (e.g., in 1968 at Tonopah, Nevada, sonic booms with overpressures ranging from 50 to 144 psf caused no direct injury to exposed test subjects)[25].

6 PROPOSED ACTION SCENARIO

6.1 PROPOSED ACTION ANNUAL OPERATIONS

Proposed Action launch vehicle flight and test operations at KSC and CCSFS are listed in Table 17. These operations are organized in the launch, landing, and static fire event categories and then by facility (KSC or CCSFS), launch complex, and by vehicle or program name, followed by the annual number of daytime (0700-2200) and nighttime (2200-0700) operations. These represent the No Action operations (Table 3) plus the proposed Starship annual operations at SLC-37 described in Section 5. For each Starship operation type, there are a total of 76 proposed annual operations and, in each case, 38 (50 percent) are modeled as daytime operations and 38 as nighttime operations.

Table 17. Proposed Action Launch, Landing, and Static Fire Test Operations at KSC and CCSFS

Event	Facility	Complex	Vehicle/Program	Day	Night	Total
Launch	KSC	LC-39A	SpaceX Falcon 9	0	36	36
		LC-39A	SpaceX Falcon Heavy	0	5	5
		LC-39B	NASA Space Launch System	0.6	0.4	1
		LC-48N	NASA SCLV	32.5	19.5	52
		LC-48S	NASA SCLV	32.5	19.5	52
	CCSFS	SLC-37	Starship	38	38	76
		SLC-14	Stoke Nova	5	5	10
		SLC-16	Relativity Terran R	18	6	24
		SLC-20A	SCLV	4.2	1.8	6
		SLC-20B	MCLV	12.6	5.4	18
		SLC-36	Blue Origin New Glenn Launch	10	2	12
		SLC-40	SpaceX Falcon 9 Launch	0	70	70
		SLC-41	ULA Atlas V 551 (5 SRBs)	6.25	3.75	10
		SLC-41	ULA Vulcan VC6S	13	7	20
		SLC-46	Liquid Propellant Vehicle	7.5	4.5	12
		SLC-46	Solid Propellant Vehicle	7.5	4.5	12
			Total	**187.6**	**228.4**	**416**
Landing	CCSFS	SLC-37	Starship Spacecraft RTLS	38	38	76
		SLC-37	Super Heavy Booster RTLS	38	38	76
		LZ-1/2	SpaceX Falcon Booster	0	54	54
		LZ-1/2	SpaceX Falcon Heavy Booster	0	5	5
			Total	**76**	**135**	**211**
Static Fire	KSC	LC-39A	SpaceX Falcon 9	0	36	36
		LC-39A	SpaceX Falcon Heavy	0	5	5
		LC-48N	NASA SCLV	32.5	19.5	52

Event	Facility	Complex	Vehicle/Program	Day	Night	Total
		LC-48S	NASA SCLV	32.5	19.5	52
	CCSFS	SLC-37	Starship	38	38	76
		SLC-37	Super Heavy Booster	38	38	76
		SLC-11	Blue Origin BE-4 Engine Testing	108	0	108
		SLC-14	Stoke Nova	10	0	10
		SLC-16	Relativity Terran R Static Fire	18	6	24
		SLC-16	Relativity Terran R Stage MDC Hot Fire	10	4	14
		SLC-20A	SCLV Static Fire	4.2	1.8	6
		SLC-20A	SCLV Acceptance Test	4.2	1.8	6
		SLC-20B	MCLV Static Fire	12.6	5.4	18
		SLC-20B	MCLV Acceptance Test	12.6	5.4	18
		SLC-36	Blue Origin New Glenn Static Fire	10	2	12
		SLC-40	SpaceX Falcon 9 Static Fire	0	70	70
			Total	**330.6**	**252.4**	**583**

6.2 Proposed Action: Rocket Noise Exposure: DNL Contours

The DNL contours for the Proposed Action operations in Table 17, including DNL 65-85 dBA in 5 dB increments are shown on Figure 48; these contours represent the cumulative subsonic noise environment due to rocket noise. The DNL 65 dBA contour, which represents the significance threshold for noise sensitive areas, is almost entirely within the KSC and CCSFS properties. Additional details of the Proposed Action DNL exposure, and comparison with the DNL exposure estimates for the other operational scenarios are provided in Section 8.

6.3 Proposed Action: Sonic Boom Exposure: CDNL Contours

Figure 49 shows the CDNL contours for the Proposed Action operations in Table 17, including the CDNL 60 through 80 dBC contours in 5 dB increments. The CDNL 60 dBC contour, which represents the significance threshold for noise sensitive areas, extends beyond the KSC and CCSFS property lines into parts of Titusville to the west, and the City of Cape Canaveral and parts of Cocoa and Cocoa Beach to the south. The primary reason these CDNL contours extend into residential areas is the overall high number of annual nighttime landing operations (Table 17) which include a 10-decibel penalty compared to daytime operations. Additional details of the Proposed Action CDNL exposure, and comparison with the CDNL exposure estimates for the other operational scenarios are provided in the noise exposure assessment summary in Section 8.

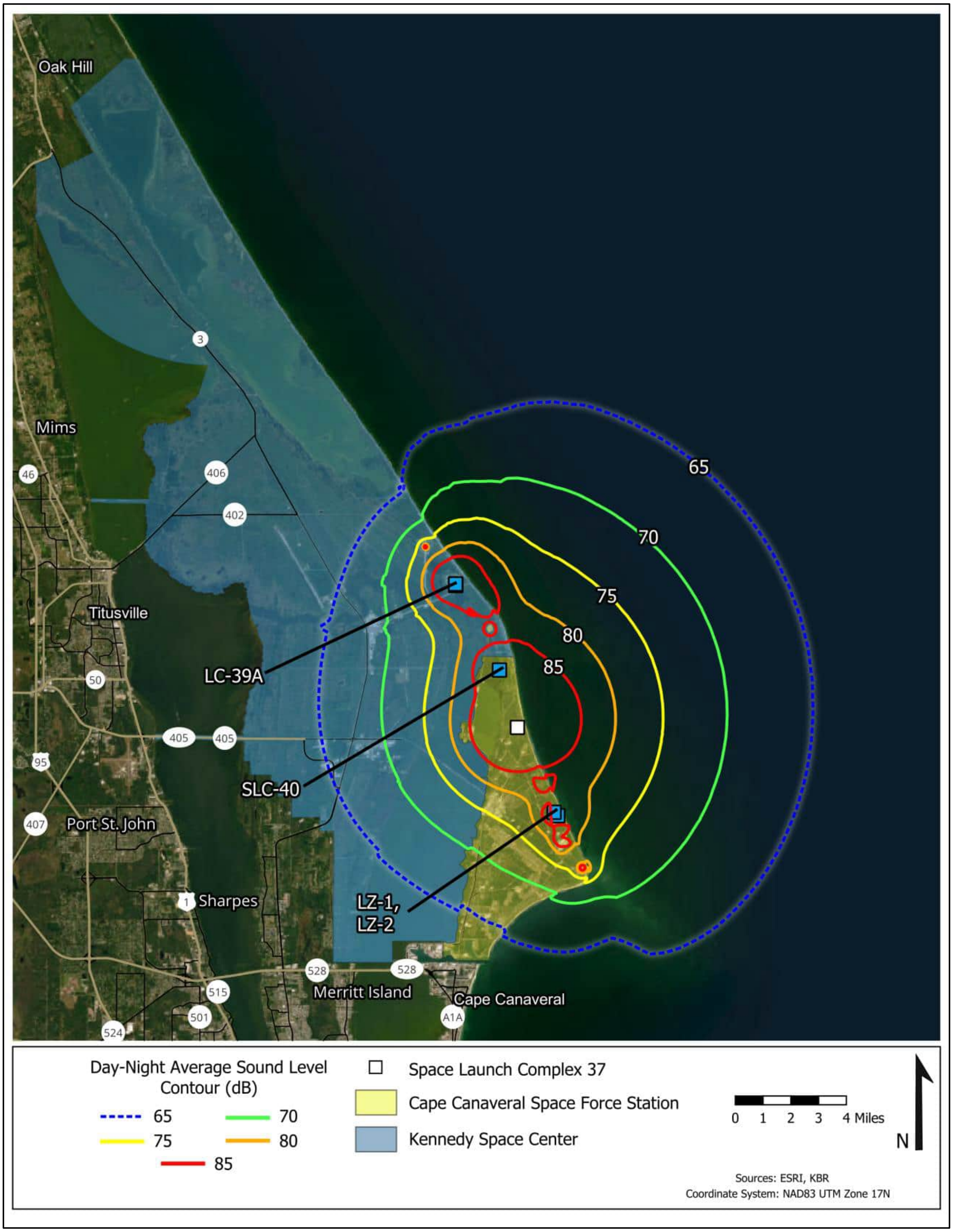


Figure 48. Proposed Action Rocket Noise Exposure: DNL Contours

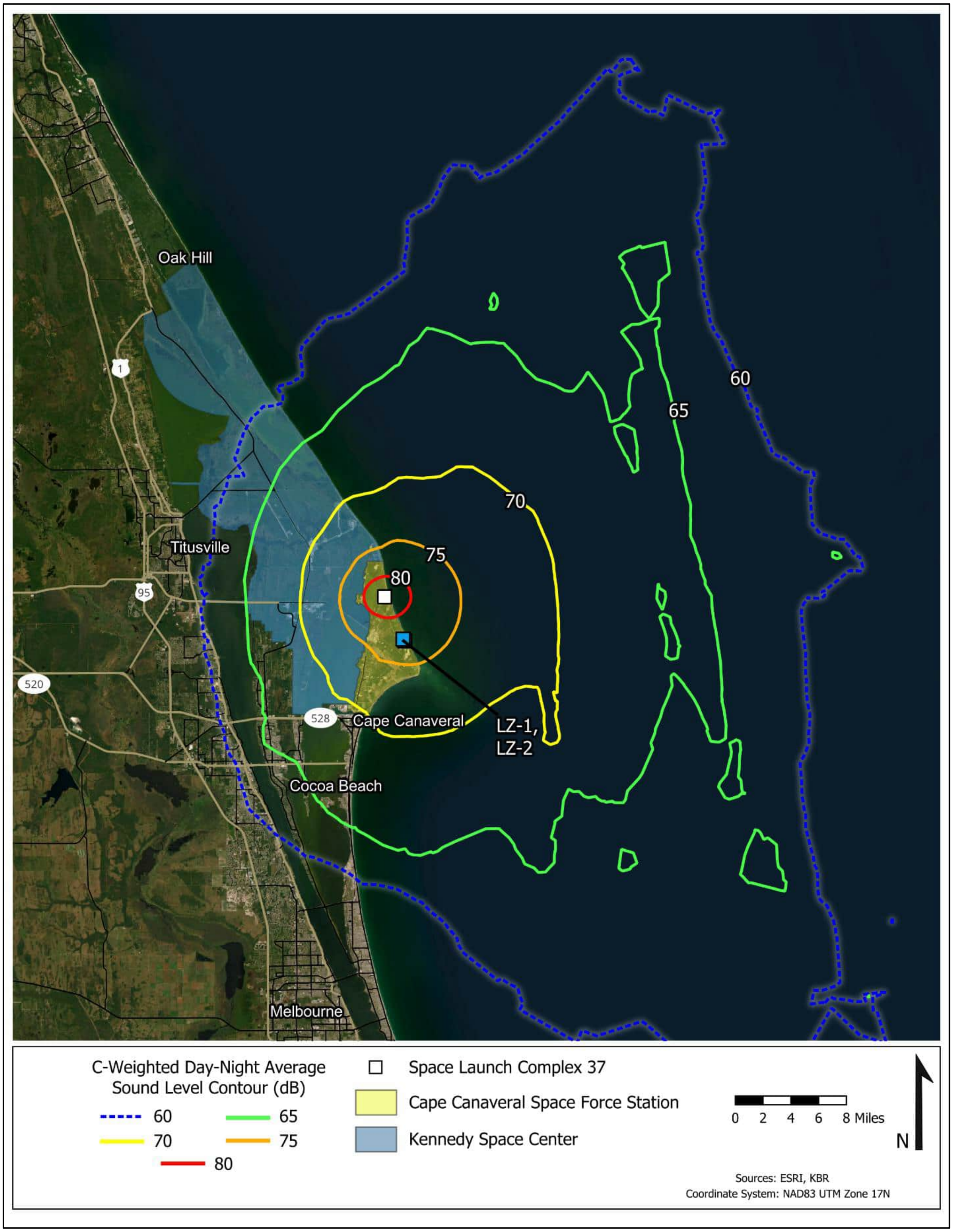


Figure 49. Proposed Action Sonic Boom Exposure: CDNL Contours

7 REASONABLY FORSEEABLE FUTURE ACTIONS SCENARIO

7.1 REASONABLY FORSEEABLE FUTURE ACTION OPERATIONS

The Reasonably Foreseeable Future Action operations at KSC and CCSFS are listed in Table 18 organized by the launch, landing, and static fire event categories and including the annual number of daytime (7 a.m. – 10 a.m.) and nighttime (10 a.m. – 7 a.m.) operations. These represent the Proposed Action operations (Table 17) plus the proposed Starship annual operations at LC-39A. For each Starship operation type at SLC-37, there are a total of 76 proposed annual operations and, in each case, 38 (50 percent) are modeled as daytime operations and 38 as nighttime operations. For each Starship operation type at LC-39A, there are a total of 44 proposed annual operations with the same 50/50 daytime/nighttime split.

Table 18. Reasonably Foreseeable Future Action Launch, Landing, and Test Operations at KSC and CCSFS

Event	Facility	Complex	Vehicle/Program	Day	Night	Total
Launch	KSC	LC-39A	Starship	22	22	44
		LC-39A	SpaceX Falcon 9	0	36	36
		LC-39A	SpaceX Falcon Heavy	0	5	5
		LC-39B	NASA Space Launch System	0.6	0.4	1
		LC-48N	NASA SCLV	32.5	19.5	52
		LC-48S	NASA SCLV	32.5	19.5	52
	CCSFS	SLC-14	Stoke Nova	5	5	10
		SLC-16	Relativity Terran R	18	6	24
		SLC-20A	SCLV	4.2	1.8	6
		SLC-20B	MCLV	12.6	5.4	18
		SLC-36	Blue Origin New Glenn Launch	10	2	12
		SLC-37	Starship	38	38	76
		SLC-40	SpaceX Falcon 9 Launch	0	70	70
		SLC-41	ULA Atlas V 551 (5 SRBs)	6.25	3.75	10
		SLC-41	ULA Vulcan VC6S	13	7	20
		SLC-46	Liquid Propellant Vehicle	7.5	4.5	12
		SLC-46	Solid Propellant Vehicle	7.5	4.5	12
			Total	**209.6**	**250.4**	**460**
Landing	KSC	LC-39A	Starship Spacecraft RTLS	22	22	44
		LC-39A	Super Heavy Booster RTLS	22	22	44
	CCSFS	LZ-1/2	SpaceX Falcon Booster	0	54	54
		LZ-1/2	SpaceX Falcon Heavy Booster	0	5	5
		SLC-37	Starship RTLS	38	38	76
		SLC-37	Super Heavy Booster RTLS	38	38	76
			Total	**120**	**179**	**299**
Static Fire	KSC	LC-39A	Starship	22	22	44
		LC-39A	Super Heavy Booster	22	22	44
		LC-39A	SpaceX Falcon 9	0	36	36
		LC-39A	SpaceX Falcon Heavy	0	5	5

Event	Facility	Complex	Vehicle/Program	Day	Night	Total
		LC-48N	NASA SCLV	32.5	19.5	52
		LC-48S	NASA SCLV	32.5	19.5	52
	CCSFS	SLC-11	Blue Origin BE-4 Engine Testing	108	0	108
		SLC-14	Stoke Nova	10	0	10
		SLC-16	Relativity Terran R Static Fire	18	6	24
		SLC-16	Relativity Terran R Stage MDC Hot Fire	10	4	14
		SLC-20A	SCLV Static Fire	4.2	1.8	6
		SLC-20A	SCLV Acceptance Test	4.2	1.8	6
		SLC-20B	MCLV Static Fire	12.6	5.4	18
		SLC-20B	MCLV Acceptance Test	12.6	5.4	18
		SLC-36	Blue Origin New Glenn Static Fire	10	2	12
		SLC-37	Starship	38	38	76
		SLC-37	Super Heavy Booster	38	38	76
		SLC-40	SpaceX Falcon 9 Static Fire	0	70	70
			Total	**374.6**	**296.4**	**671**

7.2 Reasonably Forseeable Future Actions: Rocket Noise Exposure: DNL Contours

The DNL contours for the Reasonably Foreseeable Future Action operations in Table 18, are shown on Figure 50 including the DNL 65-85 dBA contours in 5 dB increments; these contours represent the cumulative subsonic noise environment, due to rocket noise, for all proposed actions combined. The DNL 65 dBA contour, which represents the significance threshold for noise sensitive areas, is still almost entirely within the KSC and CCSFS properties (with some off-station exposure over the Banana River). Additional details of the Reasonably Foreseeable Future Actions DNL exposure, and comparison with the DNL exposure estimates for the other operational scenarios are provided in the noise exposure assessment summary (Section 8).

7.3 Reasonably Forseeable Future Actions: Sonic Boom Exposure: CDNL Contours

Figure 51 shows the CDNL contours for the Reasonably Foreseeable Future Action operations in Table 18, including the CDNL 60 through 80 dBC contours in 5 dB increments. The CDNL 60 dBC contour, which represents the significance threshold for noise sensitive areas, extends beyond the KSC and CCSFS property lines into parts of Titusville to the west and extends beyond the City of Cape Canaveral, and parts of Cocoa and Cocoa Beach to the south. The primary reason these CDNL contours extend as far as they do into residential areas is the overall high number of annual nighttime landing operations (Table 18) which include a 10-decibel penalty compared to daytime operations. Additional details of the Reasonably Foreseeable Future Action CDNL exposure, and comparison with the CDNL exposure estimates for the other operational scenarios, are provided in the noise exposure assessment summary (Section 8).

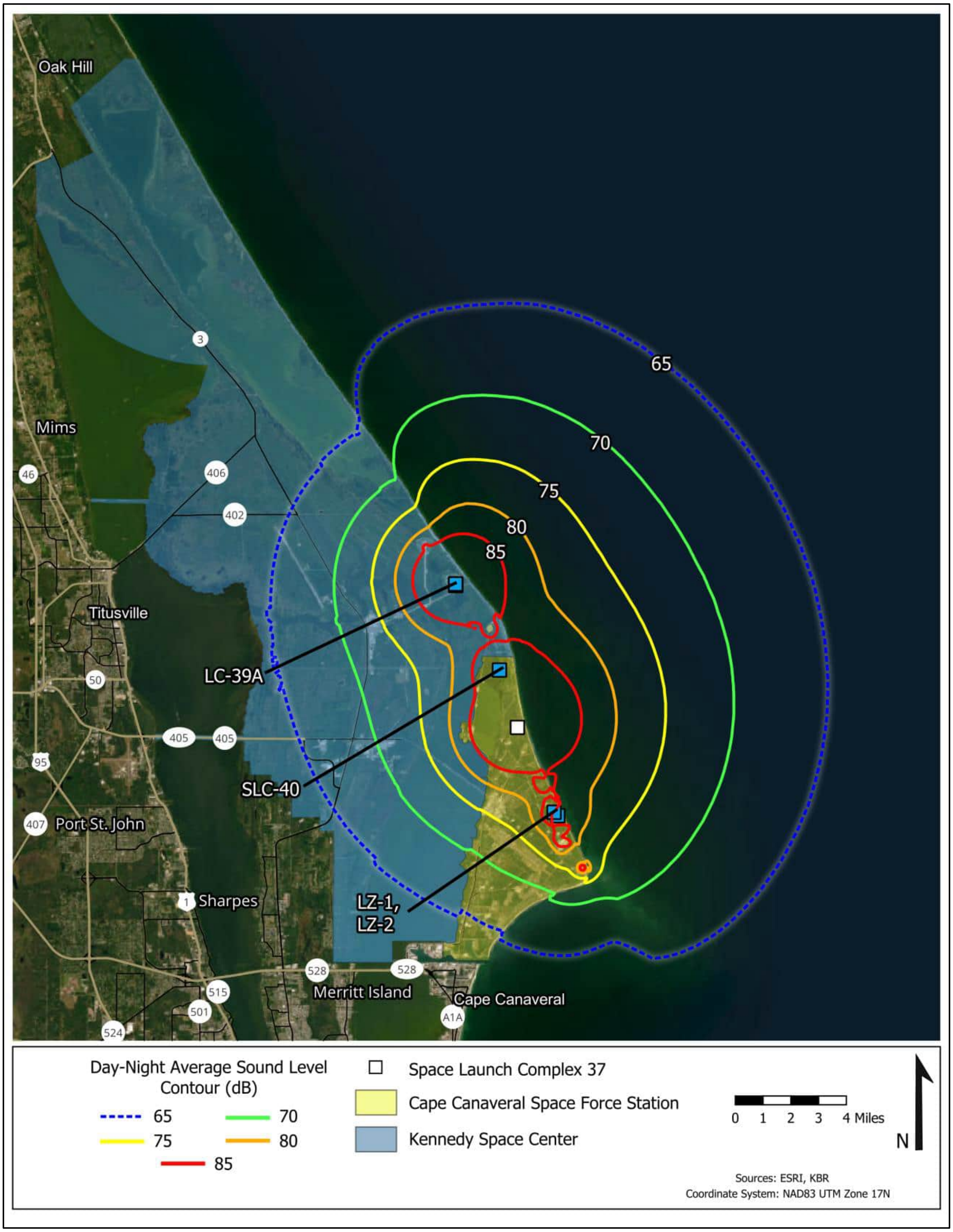


Figure 50. Reasonably Foreseeable Future Actions Rocket Noise Exposure: DNL Contours

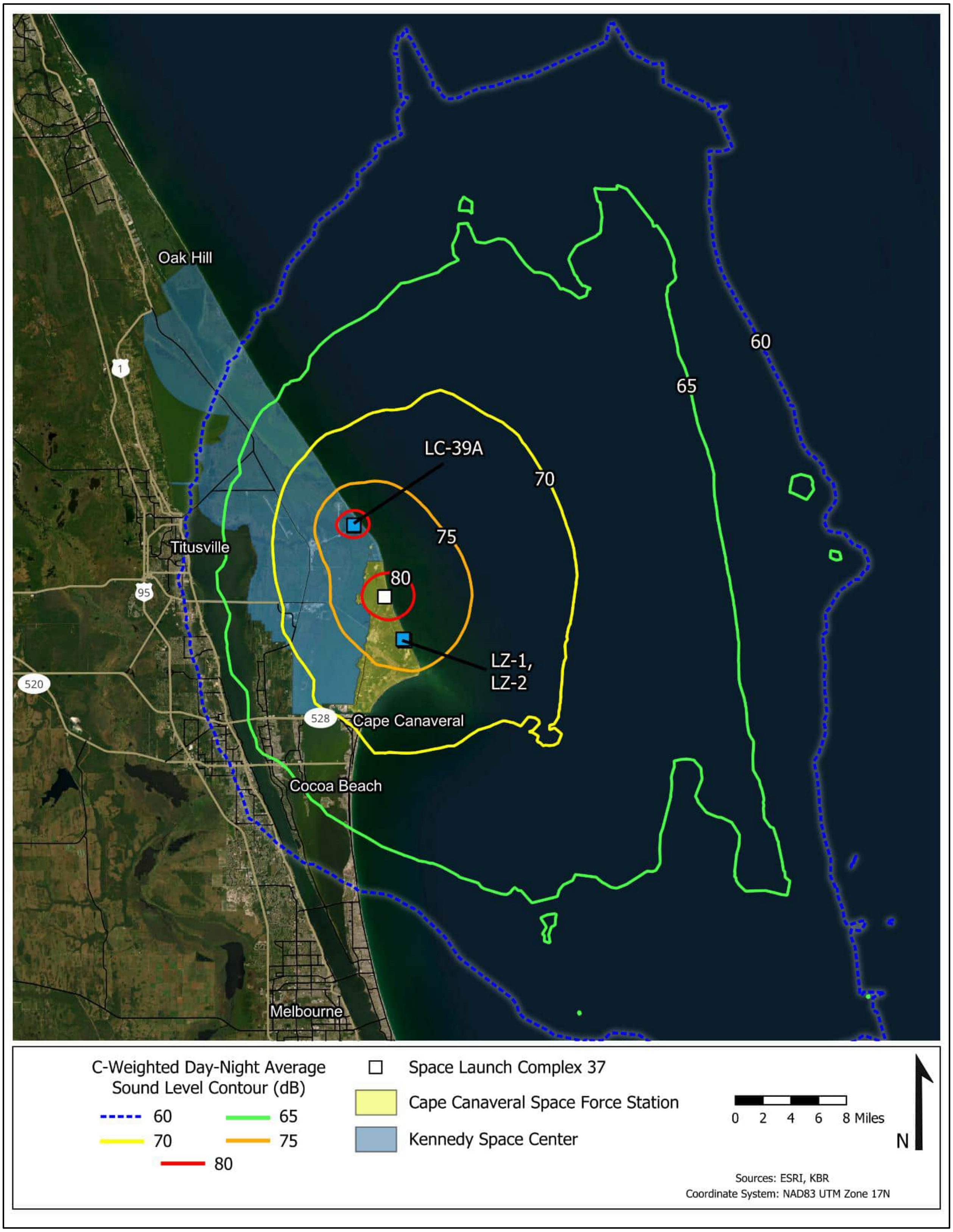


Figure 51. Reasonably Foreseeable Future Actions Sonic Boom Exposure: CDNL Contours

8 NOISE EXPOSURE ASSESSMENT SUMMARY

This section presents the primary modeling study results, for each of the operational scenarios examined in this study, shown together in figures and tables so the results can be easily compared. First, the rocket noise exposures for each operational scenario are compared using the DNL metric, followed by a comparison of the sonic boom exposures using the CDNL metric.

8.1 ROCKET NOISE EXPOSURE SUMMARY

A comparison of the DNL 65 dBA contours for all operational scenarios is shown in Figure 52 which also includes the study POIs for reference. The 65 DNL contours are color coded to represent each operating scenario which are identified in the legend. As mentioned previously, proposed Starship operations at SLC-37 represent Starship operations alone, as described in Section 5, to understand what the potential impacts are from these operations only, whereas the Proposed Action represents Starship operations at SLC-37 plus all the launch and landing operations associated with the No Action Scenario. Also noted previously, none of the DNL 65 dBA contours, for any of the operating scenarios, extend beyond the KSC and CCSFS properties. The DNL 65 dBA contours do not extend into any residential areas, except for Merritt Island.

The DNL contours shown on Figure 52 are associated with the DNL contour exposure data presented in Table 19 and the DNL estimates at the points of interest in Table 20. Table 19 lists, for each operational scenario, the total acreage inside each DNL contour band (from 65 to 85 dBA in 5 dB increments) along with the number of households and population in each contour band. Table 20 shows a comparison of the DNL values estimated at each POI, for each operating scenario including the Proposed Action. Noise levels less than 45 dBA DNL are similar to typical ambient sound levels and are listed as “<45”.

Potential impacts from noise associated with the Proposed Action would be beneficial if the number of sensitive receptors exposed to unacceptable noise levels is reduced. Adverse impacts would occur if noise associated with the Proposed Action permanently exceeded the 65 dBA cumulative noise threshold below which most types of land use are compatible.

The FAA defines a threshold for significant noise impacts as an increase in noise by 1.5 dB DNL or more in a noise sensitive area that is exposed to noise at or above the 65 dB DNL noise exposure level, or that will be exposed at or above the 65 dB DNL level due to a 1.5 dB or greater increase, when compared to the No Action DNL exposure for the same timeframe (FAA Order 1050.1F)[7].

FAA requires that an action proponent identify where noise will change by the following specified amounts in noise sensitive areas (FAA Order 1050.1F):

- For DNL 65 dB and higher: +/- DNL 1.5 dB (significant)
- For DNL 60 dB to <65 dB: +/- DNL 3 dB (reportable)
- For DNL 45 dB to <60 dB: +/- DNL 5 dB (reportable)

According to the above definitions for noise impacts, significant impacts are identified at the POIs in Table 20 for the Proposed Action and Reasonably Foreseeable Future Actions by the shaded cells in the columns including (Δ dBA wrt No Action). DNL increases at many of the other POIs would be considered reportable.

Per FAA Order 1050.1F[7], a noise sensitive area is defined as an area where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites, cultural and historical sites, and parks, recreational areas, wilderness areas, and wildlife refuges. The FAA recognizes that there are settings where the 65 dB DNL standard for land use compatibility may not apply. These areas would likely be areas of extreme quiet, very rural areas, or natural areas with little human activity, such as wilderness areas or other protected natural areas.

The primary effect of recurring aircraft noise on exposed communities is long-term annoyance. The scientific community has adopted the use of long-term annoyance as a primary indicator of community response because it attempts to account for all negative aspects of effects from noise, including sleep disturbance, speech interference, and distraction from other human activities. Attitudinal surveys conducted over the past 30 years show a consistent relationship between DNL and the percentages of people who express annoyance. DNL estimates for the operational scenarios addressed in this study can be evaluated using Table 21 to provide an estimate of the percentage of the population that would be “highly annoyed” by the noise[28].

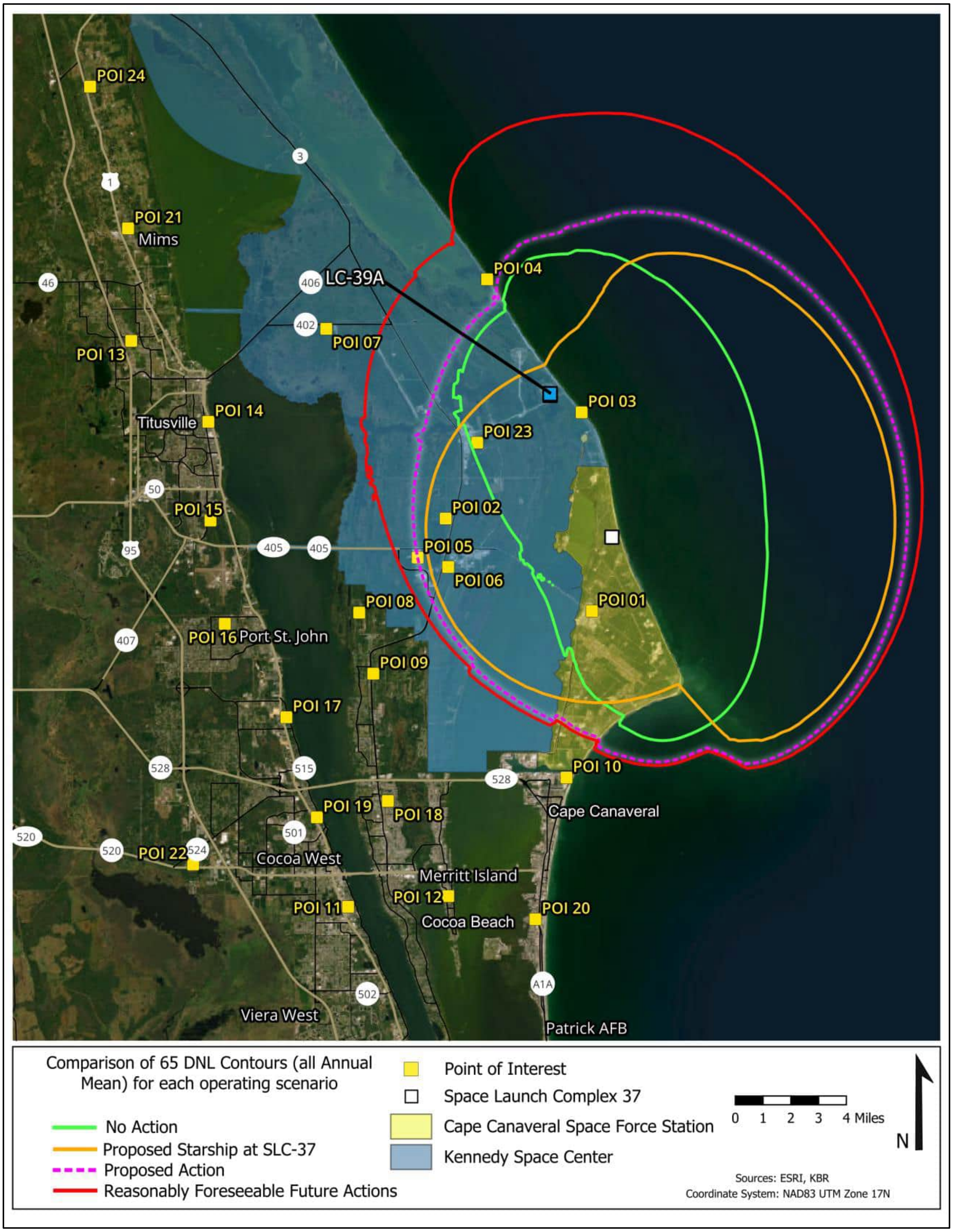


Figure 52. Comparison of 65 DNL Contours for All Operation Scenarios

Table 19. Comparison of DNL Contour Exposure Estimates for all Operation Scenarios Examined

No Action: Day-Night Average Sound Level Exposure			
DNL Band (dB)	Acreage Total	Households	Population[1]
65-70	8,683	0	0
70-75	7,075	0	0
75-80	3,609	0	0
80-85	3,000	0	0
85+	3,079	0	0
Total	**25,446**	**0**	**0**
Proposed Starship Operations (only): Day-Night Average Sound Level Exposure			
DNL Band (dB)	Acreage Total	Households	Population[1]
65-70	17,129	0	0
70-75	7,677	0	0
75-80	2,611	0	0
80-85	1,809	0	0
85+	3,386	0	0
Total	**32,613**	**0**	**0**
Proposed Action: Day-Night Average Sound Level Exposure			
DNL Band (dB)	Acreage Total	Households	Population[1]
65-70	17,036	0	0
70-75	9,803	0	0
75-80	4,852	0	0
80-85	3,702	0	0
85+	6,487	0	0
Total	**41,881**	**0**	**0**
Reasonably Foreseeable Future Action: Day-Night Average Sound Level Exposure			
DNL Band (dB)	Acreage Total	Households	Population[1]
65-70	23,783	0	0
70-75	13,211	0	0
75-80	7,175	0	0
80-85	4,313	0	0
85+	7,972	0	0
Total	**56,454**	**0**	**0**

Note: DNL = Day-Night Average Sound Level; dB = decibel (A-weighted).

1. Because there are no full-time residents living on KSC/CCSFS, and DNL exceeding 65 dB remains within the boundaries of KSC/CCSFS, the number of residents within the 65 dB DNL contour is zero. According to the 2020 Census, six people reside within the Census Tract that includes KSC/CCSFS. However, there is no on-base housing on CCSFS, and those individuals are assumed to live in parts of the Census Tract outside KSC/CCSFS.

Table 20. Comparison of DNL at the Points of Interest for all Operation Scenarios Examined

Point of Interest	Day-Night Average Sound Level (dBA)						
	Baseline	No Action	Proposed Starship Operations	Proposed Action	Proposed Action Δ dBA wrt No Action	Reasonably Foreseeable Future Actions (RFFA)	RFFA Δ dBA wrt No Action
Cape Canaveral Space Force Station (CCSFS)	61.9	70.4	76.7	77.6	7.2	77.7	7.3
SpaceX Operations Area	54.3	60.1	66.5	67.4	7.3	68.9	8.8
Titusville Beach	75.0	92.8	69.9	92.8	0.0	93.3	0.6
Playalinda Beach	53.7	61.1	59.3	63.3	2.2	69.6	8.5
Kennedy Space Center Visitor Complex	51.0	57.0	64.3	65.0	8.0	66.2	9.2
KSC Child Development Center	52.5	58.4	66.4	67.0	8.6	67.9	9.5
Merritt Island National Wildlife Refuge Visitor Center	46.2	52.8	56.2	57.8	5.1	61.9	9.1
Pine Island Conservation Area/Pine Island Estates	46.2	52.6	60.0	60.7	8.1	61.9	9.3
Kings Park Estates - Courtenay	<45	51.5	59.2	59.9	8.3	60.8	9.3
Jetty Park Campground	48.4	56.8	59.8	61.6	4.8	62.0	5.2
Rockledge High School	<45	<45	51.3	52.2	7.2	53.1	8.1
Merritt Island	<45	46.9	53.3	54.2	7.3	54.9	8.0
Oak Park Elementary School	<45	45.0	50.2	51.4	6.4	54.2	9.3
Titusville High School	<45	48.2	53.6	54.7	6.5	57.4	9.2
Summerwood Villas	<45	47.9	54.1	55.1	7.1	57.2	9.3
Atlantis Elementary School	<45	47.2	54.1	54.9	7.7	56.5	9.3
Fairglen Elementary School	<45	47.6	54.8	55.6	8.0	56.7	9.2
Lewis Carroll Elementary School	<45	48.4	55.5	56.3	7.9	57.1	8.7
Cocoa	<45	46.1	53.2	54.0	7.9	55.0	8.9
Cocoa Beach	<45	48.7	53.4	54.7	6.0	55.3	6.6
Pinegrove Estates	<45	<45	48.6	49.8	4.8	53.0	8.0
Fern Meadows	<45	<45	49.1	49.9	4.9	51.1	6.1
KSC Office Outside BDA	59.7	65.9	66.8	69.4	3.5	74.2	8.2
The Rock Church	<45	<45	45.5	46.7	1.7	49.8	4.8

Note: Shaded cells indicate DNL increase greater than 1.5 dB.

Table 21. Relationship of Annoyance to DNL

DNL (dBA)	Percent Highly Annoyed
45	0.83
50	1.66
55	3.31
60	6.48
65	12.29
70	22.10

Source: Federal Interagency Committee on Aviation Noise[28].

8.2 Sonic Boom Exposure Summary

A comparison of the C-weighted Day-Night Average Sound Level (CDNL) 60 dBC contours for all operational scenarios is shown on Figure 53 which also includes the study POIs for reference. In 1981, the National Research Council (NRC) determined that CDNL was the most suitable metric to evaluate how communities would react to high-energy impulsive noise, essentially signifying that this measurement best captured the community annoyance caused by loud, sudden sounds like explosions or sonic booms[29]. CDNL 60 dBC is equivalent to DNL 65 dBA in terms of the percent of people highly annoyed. The 60 CDNL contours are color coded to represent each operating scenario which are identified in the legend. As described previously in this report, all the CDNL 60 dB contours shown on Figure 53 extend off KSC and CCSFS property into adjacent residential areas.

The CDNL contours shown on Figure 53 are associated with the CDNL contour exposure data presented in Table 22 and the CDNL estimates at the points of interest in Table 23. Table 22 lists, for each operational scenario, the total acreage inside each CDNL contour band (from 60 to 80 dBA in 5 dB increments) along with the number of households and population in each contour band. Table 22 shows a comparison of the CDNL values estimated at each POI, for each operating scenario including the Proposed Action.

Using the FAA definition for significant noise impacts (Section 8.1) except taking 60 CDNL as the threshold level, in this case, significant impacts are identified at the POIs in Table 23 using shaded cells in the columns including (Δ dBA wrt No Action). Sonic boom noise levels less than 45 dB CDNL are below relevant impact thresholds and are similarly listed as “<45” where values are below 45 dB. As can be seen for both the Proposed Action and the Reasonably Foreseeable Future Actions scenarios, most of the POIs including many of the POIs located off KSC and CCSFS properties would have a significant impact (i.e., resulting CDNL above 60 dBC and greater than a 1.5 dB increase).

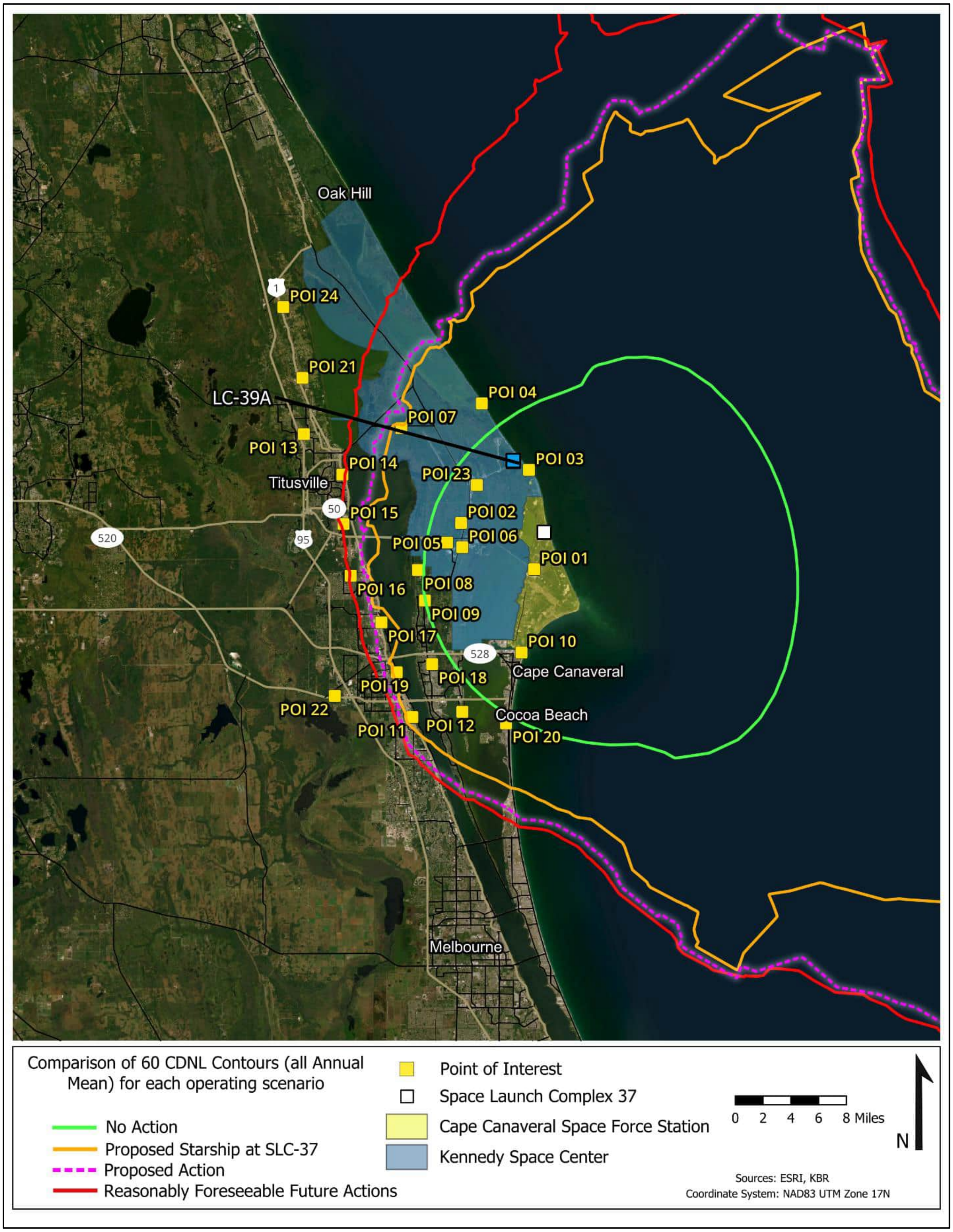


Figure 53. Comparison of 60 CDNL Contours for All Operation Scenarios

Table 22. Comparison of CDNL Exposure Estimates for all Operation Scenarios Examined

No Action: C-Weighted Day-Night Average Sound Level Exposure			
CDNL Band (dB)	**Acreage Total**	**Households**	**Population**
60-65	43,849	15,035	18,824
65-70	10,434	0	0
70-75	5,179	0	0
75-80	0	0	0
80+	0	0	0
Total	**59,462**	**15,035**	**18,824**
Proposed Starship Operations (only): C-Weighted Day-Night Average Sound Level Exposure			
CDNL Band (dB)	**Acreage Total**	**Households**	**Population**
60-65	34,278	24,983	50,175
65-70	42,486	18,711	24,236
70-75	20,937	0	0
75-80	5,673	0	0
80+	2,541	0	0
Total	**105,915**	**43,694**	**74,411**
Proposed Action: C-Weighted Day-Night Average Sound Level Exposure			
CDNL Band (dB)	**Acreage Total**	**Households**	**Population**
60-65	29,932	24,023	49,579
65-70	53,756	28,654	44,730
70-75	22,405	0	0
75-80	8,454	0	0
80+	2,799	0	0
Total	**117,346**	**52,677**	**94,309**
Reasonably Foreseeable Future Action: C-Weighted Day-Night Average Sound Level Exposure			
CDNL Band (dB)	**Acreage Total**	**Households**	**Population**
60-65	36,427	29,575	69,774
65-70	46,931	30,803	47,499
70-75	33,537	2,958	3,665
75-80	17,089	0	0
80+	4,605	0	0
Total	**138,589**	**63,336**	**120,938**

Note: CDNL = C-Weighted Day-Night Average Sound Level; dBC = decibel (C-weighted).

Table 23. Comparison of CDNL at the Points of Interest for all Operation Scenarios Examined

Point of Interest	C-Weighted Day-Night Average Sound Level (dBC)						
	Baseline	No Action	Proposed Starship Operations	Proposed Action	Proposed Action Δ dBA wrt No Action	Reasonably Foreseeable Future Actions (RFFA)	RFFA Δ dBA wrt No Action
Cape Canaveral Space Force Station (CCSFS)	59.6	70.0	76.0	77.0	7.0	77.5	7.5
SpaceX Operations Area	50.2	61.6	69.3	70.0	8.4	72.1	10.5
Titusville Beach	52.1	62.7	73.0	73.3	10.6	79.4	16.7
Playalinda Beach	45.2	58.8	66.3	67.0	8.2	71.8	13.0
Kennedy Space Center Visitor Complex	48.9	61.2	67.9	68.7	7.6	70.5	9.3
KSC Child Development Center	51.5	62.2	69.6	70.3	8.1	72.0	9.9
Merritt Island National Wildlife Refuge Visitor Center	<45	57.0	60.9	62.4	5.4	66.4	9.3
Pine Island Conservation Area/Pine Island Estates	46.6	59.7	64.6	65.8	6.1	67.6	7.9
Kings Park Estates - Courtenay	46.8	60.0	64.6	65.9	5.9	67.5	7.5
Jetty Park Campground	53.0	63.6	68.4	69.6	6.0	70.7	7.2
Rockledge High School	<45	56.4	61.1	62.4	5.9	62.9	6.5
Merritt Island	45.0	58.8	63.7	65.0	6.1	65.5	6.7
Oak Park Elementary School	<45	<45	53.6	53.6	8.6	56.0	11.0
Titusville High School	<45	<45	54.5	55.2	10.2	59.3	14.3
Summerwood Villas	<45	55.3	54.9	58.1	2.8	60.5	5.1
Atlantis Elementary School	<45	55.5	55.3	58.4	2.9	60.1	4.7
Fairglen Elementary School	<45	57.4	58.7	61.1	3.7	63.7	6.3
Lewis Carroll Elementary School	45.3	59.1	64.5	65.6	6.6	66.8	7.7
Cocoa	<45	57.3	60.9	62.5	5.2	63.2	5.9
Cocoa Beach	46.0	59.6	65.8	66.7	7.0	67.5	7.9
Pinegrove Estates	<45	<45	53.1	53.1	8.1	55.5	10.5
Fern Meadows	<45	<45	54.4	54.4	9.4	56.2	11.2
KSC Office Outside BDA	50.4	61.4	70.0	70.6	9.2	74.7	13.4
The Rock Church	<45	<45	52.2	52.2	7.2	54.6	9.6

Notes: Shaded cells indicate CDNL increase greater than 1.5 dB. The POIs without noise values reported are located outside of the sonic boom footprint.

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Appendix 3.7A
Section 106 Initiation Letters

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From: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Sent: Thursday, March 6, 2025 5:17 PM
To: CompliancePermits@dos.myflorida.com; THPO Compliance <THPOCompliance@semtribe.com>; Victoria Menchaca <VictoriaMenchaca@semtribe.com>; Jeffery Harjo <harjo.je@sno-nsn.gov>; kdonaldson@miccosukee.com
Cc: NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; Rau, Michelle <Michelle.Rau@jacobs.com>; Kim Tice <Kim.Tice@spacex.com>; Price, Lori <Lori.Price@jacobs.com>; THRASH, SHERRY E CIV USAF AFMC AFCEC/CIEE <sherry.thrash@us.af.mil>
Subject: [EXTERNAL] SpaceX Starship Super Heavy EIS and Section 106 consultation

CUI

Good Afternoon,

Attached is the EIS and CRAS report in compliance with Section 106 for the proposed reuse of Launch Complex 37 for the Starship Super Heavy launches. We request a response by April 5, 2025.

v/r

Tom Penders

CUI

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

6 March 2025

FROM: Michael Blaylock
Chief, Environmental Conservation
45 CES/CEIE-C
1224 Jupiter Street
Patrick SFB FL 32925-3343

To: State Historic Preservation Office
R.A. Gray Building, 4th Floor
500 South Bronough Street
Tallahassee, Florida 32399-250
Attn: Dr Alissa Slade Lotane

Subject: *SpaceX Starship-Super Heavy* at Cape Canaveral Space Force Station (CCSFS), Brevard County, Florida

Dr. Slade-Lotane,

In accordance with Section 106 of the National Historic Preservation Act (NHPA) (*United States Code*[U.S.C.] Title 54, Section 306108) and its implementing regulations (*Code of Federal Regulations* [CFR]Title 36, Part 800), the United States Department of the Air Force (DAF), the United States Space Force (USSF), and Space Launch Delta (SLD) 45 have determined that the proposed Space Exploration Technologies Corp (SpaceX) Starship-Super Heavy at Cape Canaveral Space Force Station (CCSFS) (the undertaking) has the potential to affect historic properties (36 CFR 800.3). This letter serves to initiate consultation under Section 106 of the NHPA, as outlined in Air Force Manual (AFMAN) 32-7003, *Environmental Conservation,* for the undertaking at Space Launch Complex 37 (SLC-37).

In February 2024, the DAF provided your office with a National Environmental Policy Act (NEPA) scoping letter describing the Environmental Impact Statement (EIS) being prepared to evaluate the potential environmental impacts associated with the undertaking. Section 106 is required because the undertaking requires (1) the execution of a real property agreement between the DAF and SpaceX, which would enable SpaceX to develop a launch site to support Starship-Super Heavy operations, including launch and landing at CCSFS, and (2) the Federal Aviation Administration's (FAA's) issuance of a vehicle operator license at the selected launch site.

During public scoping, the DAF provided an additional alternative, Alternative 1: Space Launch Complex 50 (SLC-50). Under Alternative 1, SpaceX would construct a new

launch complex to be known as SLC-50 in a previously undeveloped area at CCSFS to support Starship-Super Heavy launch and landing operations. SLC-50 was removed from the EIS. However, if SLC-50 was to become the preferred alternative, the DAF would reinitiate Section 106 consultation with the State Historic Preservation Office for that undertaking.

Under the SLC-37 undertaking, SpaceX would reuse and rebuild the existing SLC-37 infrastructure at CCSFS to support Starship-Super Heavy operations (refer to Attachment 1, Map of the Undertaking atSLC-37). In the 2022, *Range of the Future Cape Canaveral Space Force Station District Plan*, USSF identified a need to reallocate SLC-37 to a future launch provider because the Delta IV Heavy operations have concluded at the complex; it became available at the end of 2024. A1-mile segment of Old A1A and a 7-mile segment of Phillips Parkway would be widened at SLC-37, and two turn radiuses would be added to accommodate the transportation requirements for the launch vehicle components. One turn radius would be at the northeast corner of Phillips Parkway and Patrol Road, and the second turn radius would be at the southwest corner of Patrol Road and Beach Road.

The DAF has determined and documented the Area of Potential Effects (APE) for the undertaking in accordance with 36 CFR 800.16(d) and seeks your office's comment. The APE includes all areas where project elements (the demolition of existing facilities including most of the existing structures at SLC-37, construction of new facilities, improvements to existing infrastructure, visual changes from the project, and noise and vibration from operations could affect historic properties. The FAA has identified 2 pounds per square foot (psf) as the measure where sonic boom overpressures could feasibly result in damage to plaster and bric-a-brac, window breakage, and structural damage to highly vulnerable buildings and structures. The probability of window breakage or damage to bric-a-brac at 2-psf sonic boom overpressure is approximately 1 in 10,000 to 1 in 100,000. Therefore, the DAF defined the APE as the 2-psf sonic boom overpressure contour. The construction area, included within the APE, is where ground disturbance from construction could disturb buried archaeological resources and physically alter standing structures and buildings. The construction area includes SLC-37 and the roadway improvement areas (refer to Attachment 2, Area of Potential Effects for the Undertaking).

The 1,122,520-acre (ac) APE spans terrestrial and submerged areas, with approximately 115,708 acres on land and approximately 1,006,812 ac over water. All ground disturbance would occur on land in the 139-acre construction area (comprising 105 ac for SLC-37 and 34 ac for roadway improvements); no impacts to submerged areas are expected. Although the APE extends over both water and land, it does not cover water landings such as those that could occur from some of the Starship or Super Heavy landing scenarios, because those scenarios would not disturb the ocean floor and would not be expected to encounter potential historic properties. The APE covers CCSFS and extends to the adjacent Kennedy Space Center (KSC). The APE encompasses federal and nonfederal land, intersecting with portions of the Canaveral National Seashore, Merritt Island National Wildlife Refuge, and municipalities near the Indian River and CCSFS. These municipalities include administered communities of Brevard County, Titusville (a Certified Local Government [CLG]), and incorporated and unincorporated municipalities,

including Cape Canaveral, Cocoa, Cocoa Beach, Merritt Island, and Rockledge.

A literature search was conducted using existing records available from SLD 45 and the Florida Master Site File of the Department of Historical Resources to identify historic properties that may be affected by the undertaking. Supplemental research reviewed local historic property inventories maintained by Titusville (CLG) and Brevard County to identify locally significant historic resources. Research revealed that the federal terrestrial lands in the APE at CCSFS and KSC have been subjected to comprehensive and systematic studies, as have nonfederal terrestrial lands in the surrounding municipalities. In total, 236 cultural resource assessment surveys (CRAS) are recorded in the APE, of which 61 have notable historic structure components.

Because of the size of the APE and the low likelihood of adverse effects to historic properties, the DAF made a reasonable and good faith effort to identify historic properties through background research, consultation, and limited field survey (36 CFR 800.4(b)(1)). A CRAS work plan was prepared at the direction of SLD 45, and Phase I archaeological and historic structures surveys and associated reports were completed for the construction area at SLC-37. A literature review identified previously recorded historic properties within the APE. The CRAS were conducted to identify additional historic properties in the construction area as guided by AFMAN 32-7003; SLD 45's *Integrated Cultural Management Plan* (ICRMP); Secretary of the Interior's *Standards for Archaeology and Historic Preservation* (the Standards); and Department of Historical Resources' *Module Three Guidelines for use by Historic Preservation Professionals* (Module Three) (refer to Attachment 3 for the CRAS reports).

The Phase I archaeological survey covered 112.2 acres that included portions of the construction area for the undertaking at SLC-37 and for Alternative 1 at SLC-50, which is no longer being considered as an alternative. The survey was conducted from August 5 to 23, 2024. The archaeological investigation at SLC-37 occurred along targeted portions of Phillips Parkway and Old A1A. It focused on moderate-to-high potential areas with proposed ground-disturbing activities. Because of known prior disturbance, environmentally sensitive areas, contaminated soils, and human burials and grave sites within the survey areas, fieldwork was limited to previously undisturbed soils outside ecologically sensitive or contaminated areas and outside the boundaries of known human burials and grave sites. The literature review identified one archaeological resource in the construction area for SLC-37 (Site 8BR0083). Site 8BR0083 was previously determined eligible for listing in the NRHP and contained human burials; thus, the survey did not revisit the site. Two isolates were discovered during the Phase I survey along Old A1A; however, both are determined not eligible for NRHP listing. *The DAF requests your concurrence with the determinations of not eligible for the two archaeological occurrences along Old A1A road.* Refer to Attachment 3 for the Phase I archeological resources survey report.

A historic structures survey was conducted at SLC-37 on July 18, 2024, for previously unevaluated or insufficiently evaluated properties. Ten buildings/structures were surveyed south of the launch complex fence line along Beach Road (Facilities 34316,

38105, 38200, 38201, 38315, 43302, 43311, 43313, 43400, and 43407). SLC-37 (BR02274) was previously recorded as a resource group in the Florida Master Site File and was determined not eligible for listing in the NRHP in 2021. However, SLC-37 (BR02274) contains one NRHP-eligible property: Facility 33000/Launch Control Center (LCC) (BR02790). The LCC (BR02790) was determined eligible for listing in the NRHP in 2021. All other architectural resources at SLC-37 were determined not eligible by the 2021 survey, and the 2024 survey identified no new historic properties. The DAF requests your concurrence with the determination of not eligible for listing in the NRHP for the ten buildings/structures along Beach Road (Facilities 34316, 38105, 38200, 38201, 38315, 43302, 43311, 43313, 43400, and 43407) (refer to Appendix D of the historic structures survey report in Attachment 3 for Florida Master Site File forms). No structures are present in SLC-50. Thus, no historic structures survey was conducted there.

Based on the records search and the CRAS results, 692 historic properties (691 standing structures and 1 archaeological site) have been identified in the APE for SLC-37: 1 NRHP-eligible archeological site in the construction area (8BR0083), 3 bridges, 5 cemeteries, 291 individual buildings or standing structures, 41 districts or resource groups, and 351 contributing resources. Of the 692 historic properties, there are 2 in the SLC-37 construction area: 1 previously recorded archaeological site (8BR0083) and 1 previously identified building (the Blockhouse [BR02790]).

Site 8BR0083 is adjacent to the construction area for the Delta Substation but no new disturbance is planned for the substation improvements. Because of the proximity of human burials and grave sites, construction monitoring would occur for work in the Delta Substation's construction area in compliance with AFMAN 32-7003 for unanticipated discoveries. If unanticipated discoveries are made, including cultural resources or human remains, all work in the vicinity of the discovery would cease immediately. The SLD 45 Cultural Resources Manager would notify all appropriate parties to ensure the finds are managed in accordance with federal regulations, including the Native American Graves Protection and Repatriation Act. The DAF requests your concurrence with the finding of no adverse effect for Site 8BR0083.

The blockhouse at SLC-37 (BR02790), was constructed in 1962. The building was erected as the control center for *Saturn I* and *Saturn IB* launches at SLC-37. The building has a circular plan and dome design similar to other CCSFS launch control centers of the same period, including those at SLC-13, SLC-14, SLC-19, and SLC-34. Of these, the building at SLC-37 is larger, as each building was scaled to the systems used at their complex. The building was previously determined eligible for listing in the NRHP under Criteria A, B, C, and D, including for its significant engineering and construction methods displayed in its domical form. Although SpaceX proposes to rebuild SLC-37, the undertaking proposes no changes to the LCC (BR02790), and the building would be maintained as part of an active launch complex, in keeping with its historic use. The DAF requests your concurrence with the finding of no adverse effect for the LCC (BR02790).

Current and previous CRAS have sufficiently covered the CCSFS portion of the APE, and no further survey is recommended for the SLC-37 undertaking. Although several

historic properties were previously identified within CCSFS, including the National Historic Landmark (NHL) Cape Canaveral Air Force Station (CCAFS) NHL District (FMSF No. BR00216), these fall outside the construction area at SLC-37. Most of these properties are significant for their association with the space program and the finding of effect is no adverse effect. The CCAFS NHL district, its contributing resources, and most historic properties at CCSFS were historically constructed to facilitate space launches; therefore, the undertaking is appropriate for SLC-37 and is not expected to have adverse effects on the CCAFS NHL district or most other historic properties at CCSFS. The two exceptions are the Beach House (BR02990) built in 1962 and Cape Canaveral Lighthouse (BR00212) built in 1868 and relocated in 1894, and its associated resources. These properties may have material vulnerabilities that could be subject to possible damage from noise and vibration associated with *Starship-Super Heavy* launches and landings, and the finding of effect for them is currently undetermined.

A good faith effort to identify historic properties in the Indian River communities within the APE found 691 historic properties (340 individual historic properties and 351 contributing resources, including an additional NHL, the Aladdin Theater [FMSF No. BR00282] in Cocoa), as well as unevaluated historic age resources. Some of these properties have potential material vulnerabilities to noise and vibrations. Though the potential for Starship-Super Heavy operations to cause adverse effects to historic properties in the APE is low, some of these properties may have character-defining features that would be vulnerable to damage from the noise and vibration associated with Starship-Super Heavy launches and landings. It is unknown at this time whether that damage would occur or whether it would be sufficient to diminish the integrity of the characteristics that qualify the properties for inclusion in the NRHP.

Because the DAF cannot fully determine how the undertaking will affect historic properties before making a final decision and, therefore, cannot yet make a finding of effect for the undertaking as a whole, the DAF recommends a project-specific programmatic agreement to provide a process to assess these potential effects and resolve any adverse effects that may occur.

Section 106 of the NHPA will be completed before any demolition, construction, or operations proceed, as specified in the SLD 45 ICRMP.

The DAF respectfully requests your review and comment on the APE and the CRAS reports, and your concurrence with the following:

- Determinations of not eligible for listing in the NRHP for 10 properties in the SLC-37 construction area (Facilities 34316, 38105, 38200, 38201, 38315, 43302, 43311, 43313, 43400, and 43407) and 2 archaeological occurrences along Old A1A.

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The DAF also seeks your opinion on the appropriateness of proceeding with the development of a project-specific programmatic agreement to provide a process to assess potential effects on other historic properties and to resolve any adverse effects that may occur. A programmatic agreement would be attached to the Record of Decision for the EIS.

For MICHAEL A. BLAYLOCK, NH-III, DAF
Chief, Environmental Conservation

Enclosures:
1) Report
2) Electronic data

Cc:
Victoria Menchaca, THPO, Seminole Tribe of Florida
Jeff Harjo, THPO, Seminole Nation of Oklahoma
Ken Donaldson, THPO, Miccosukee Tribe of Indians of Florida

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

6 March 2025

FROM: Michael Blaylock
Chief, Environmental Conservation
45 CES/CEIE-C
1224 Jupiter Street
Patrick SFB FL 32925-3343

To: Tribal Historic Preservation Office
Seminole Tribe of Florida
30290 Josie Billie Highway, PMB 1004,
Clewiston, FL 33440
Attn: Victoria Menchaca

Subject: *SpaceX Starship-Super Heavy* at Cape Canaveral Space Force Station (CCSFS), Brevard County, Florida

Ms. Menchaca,

In accordance with Section 106 of the National Historic Preservation Act (NHPA) (*United States Code*[U.S.C.] Title 54, Section 306108) and its implementing regulations (*Code of Federal Regulations* [CFR]Title 36, Part 800), the United States Department of the Air Force (DAF), the United States Space Force (USSF), and Space Launch Delta (SLD) 45 have determined that the proposed Space Exploration Technologies Corp (SpaceX) Starship-Super Heavy at Cape Canaveral Space Force Station (CCSFS) (the undertaking) has the potential to affect historic properties (36 CFR 800.3). This letter serves to initiate consultation under Section 106 of the NHPA, as outlined in Air Force Manual (AFMAN) 32-7003, *Environmental Conservation,* for the undertaking at Space Launch Complex 37 (SLC-37).

In February 2024, the DAF provided your office with a National Environmental Policy Act (NEPA) scoping letter describing the Environmental Impact Statement (EIS) being prepared to evaluate the potential environmental impacts associated with the undertaking. Section 106 is required because the undertaking requires (1) the execution of a real property agreement between the DAF and SpaceX, which would enable SpaceX to develop a launch site to support Starship-Super Heavy operations, including launch and landing at CCSFS, and (2) the Federal Aviation Administration's (FAA's) issuance of a vehicle operator license at the selected launch site.

During public scoping, the DAF provided an additional alternative, Alternative 1: Space Launch Complex 50 (SLC-50). Under Alternative 1, SpaceX would construct a new

launch complex to be known as SLC-50 in a previously undeveloped area at CCSFS to support Starship-Super Heavy launch and landing operations. SLC-50 was removed from the EIS. However, if SLC-50 was to become the preferred alternative, the DAF would reinitiate Section 106 consultation with the State Historic Preservation Office for that undertaking.

Under the SLC-37 undertaking, SpaceX would reuse and rebuild the existing SLC-37 infrastructure at CCSFS to support Starship-Super Heavy operations (refer to Attachment 1, Map of the Undertaking atSLC-37). In the 2022, *Range of the Future Cape Canaveral Space Force Station District Plan*, USSF identified a need to reallocate SLC-37 to a future launch provider because the Delta IV Heavy operations have concluded at the complex; it became available at the end of 2024. A1-mile segment of Old A1A and a 7-mile segment of Phillips Parkway would be widened at SLC-37, and two turn radiuses would be added to accommodate the transportation requirements for the launch vehicle components. One turn radius would be at the northeast corner of Phillips Parkway and Patrol Road, and the second turn radius would be at the southwest corner of Patrol Road and Beach Road.

The DAF has determined and documented the Area of Potential Effects (APE) for the undertaking in accordance with 36 CFR 800.16(d) and seeks your office's comment. The APE includes all areas where project elements (the demolition of existing facilities including most of the existing structures at SLC-37, construction of new facilities, improvements to existing infrastructure, visual changes from the project, and noise and vibration from operations could affect historic properties. The FAA has identified 2 pounds per square foot (psf) as the measure where sonic boom overpressures could feasibly result in damage to plaster and bric-a-brac, window breakage, and structural damage to highly vulnerable buildings and structures. The probability of window breakage or damage to bric-a-brac at 2-psf sonic boom overpressure is approximately 1 in 10,000 to 1 in 100,000. Therefore, the DAF defined the APE as the 2-psf sonic boom overpressure contour. The construction area, included within the APE, is where ground disturbance from construction could disturb buried archaeological resources and physically alter standing structures and buildings. The construction area includes SLC-37 and the roadway improvement areas (refer to Attachment 2, Area of Potential Effects for the Undertaking).

The 1,122,520-acre (ac) APE spans terrestrial and submerged areas, with approximately 115,708 acres on land and approximately 1,006,812 ac over water. All ground disturbance would occur on land in the 139-acre construction area (comprising 105 ac for SLC-37 and 34 ac for roadway improvements); no impacts to submerged areas are expected. Although the APE extends over both water and land, it does not cover water landings such as those that could occur from some of the Starship or Super Heavy landing scenarios, because those scenarios would not disturb the ocean floor and would not be expected to encounter potential historic properties. The APE covers CCSFS and extends to the adjacent Kennedy Space Center (KSC). The APE encompasses federal and nonfederal land, intersecting with portions of the Canaveral National Seashore, Merritt Island National Wildlife Refuge, and municipalities near the Indian River and CCSFS. These municipalities include administered communities of Brevard County, Titusville (a Certified Local Government [CLG]), and incorporated and unincorporated municipalities,

including Cape Canaveral, Cocoa, Cocoa Beach, Merritt Island, and Rockledge.

A literature search was conducted using existing records available from SLD 45 and the Florida Master Site File of the Department of Historical Resources to identify historic properties that may be affected by the undertaking. Supplemental research reviewed local historic property inventories maintained by Titusville (CLG) and Brevard County to identify locally significant historic resources. Research revealed that the federal terrestrial lands in the APE at CCSFS and KSC have been subjected to comprehensive and systematic studies, as have nonfederal terrestrial lands in the surrounding municipalities. In total, 236 cultural resource assessment surveys (CRAS) are recorded in the APE, of which 61 have notable historic structure components.

Because of the size of the APE and the low likelihood of adverse effects to historic properties, the DAF made a reasonable and good faith effort to identify historic properties through background research, consultation, and limited field survey (36 CFR 800.4(b)(1)). A CRAS work plan was prepared at the direction of SLD 45, and Phase I archaeological and historic structures surveys and associated reports were completed for the construction area at SLC-37. A literature review identified previously recorded historic properties within the APE. The CRAS were conducted to identify additional historic properties in the construction area as guided by AFMAN 32-7003; SLD 45's *Integrated Cultural Management Plan* (ICRMP); Secretary of the Interior's *Standards for Archaeology and Historic Preservation* (the Standards); and Department of Historical Resources' *Module Three Guidelines for use by Historic Preservation Professionals* (Module Three) (refer to Attachment 3 for the CRAS reports).

The Phase I archaeological survey covered 112.2 acres that included portions of the construction area for the undertaking at SLC-37 and for Alternative 1 at SLC-50, which is no longer being considered as an alternative. The survey was conducted from August 5 to 23, 2024. The archaeological investigation at SLC-37 occurred along targeted portions of Phillips Parkway and Old A1A. It focused on moderate-to-high potential areas with proposed ground-disturbing activities. Because of known prior disturbance, environmentally sensitive areas, contaminated soils, and human burials and grave sites within the survey areas, fieldwork was limited to previously undisturbed soils outside ecologically sensitive or contaminated areas and outside the boundaries of known human burials and grave sites. The literature review identified one archaeological resource in the construction area for SLC-37 (Site 8BR0083). Site 8BR0083 was previously determined eligible for listing in the NRHP and contained human burials; thus, the survey did not revisit the site. Two isolates were discovered during the Phase I survey along Old A1A; however, both are determined not eligible for NRHP listing. The DAF requests your concurrence with the determinations of not eligible for the two archaeological occurrences along Old A1A road. Refer to Attachment 3 for the Phase I archeological resources survey report.

A historic structures survey was conducted at SLC-37 on July 18, 2024, for previously unevaluated or insufficiently evaluated properties. Ten buildings/structures were surveyed south of the launch complex fence line along Beach Road (Facilities 34316,

38105, 38200, 38201, 38315, 43302, 43311, 43313, 43400, and 43407). SLC-37 (BR02274) was previously recorded as a resource group in the Florida Master Site File and was determined not eligible for listing in the NRHP in 2021. However, SLC-37 (BR02274) contains one NRHP-eligible property: Facility 33000/Launch Control Center (LCC) (BR02790). The LCC (BR02790) was determined eligible for listing in the NRHP in 2021. All other architectural resources at SLC-37 were determined not eligible by the 2021 survey, and the 2024 survey identified no new historic properties. The DAF requests your concurrence with the determination of not eligible for listing in the NRHP for the ten buildings/structures along Beach Road (Facilities 34316, 38105, 38200, 38201, 38315, 43302, 43311, 43313, 43400, and 43407) (refer to Appendix D of the historic structures survey report in Attachment 3 for Florida Master Site File forms). No structures are present in SLC-50. Thus, no historic structures survey was conducted there.

Based on the records search and the CRAS results, 692 historic properties (691 standing structures and 1 archaeological site) have been identified in the APE for SLC-37: 1 NRHP-eligible archeological site in the construction area (8BR0083), 3 bridges, 5 cemeteries, 291 individual buildings or standing structures, 41 districts or resource groups, and 351 contributing resources. Of the 692 historic properties, there are 2 in the SLC-37 construction area: 1 previously recorded archaeological site (8BR0083) and 1 previously identified building (the Blockhouse [BR02790]).

Site 8BR0083 is adjacent to the construction area for the Delta Substation but no new disturbance is planned for the substation improvements. Because of the proximity of human burials and grave sites, construction monitoring would occur for work in the Delta Substation's construction area in compliance with AFMAN 32-7003 for unanticipated discoveries. If unanticipated discoveries are made, including cultural resources or human remains, all work in the vicinity of the discovery would cease immediately. The SLD 45 Cultural Resources Manager would notify all appropriate parties to ensure the finds are managed in accordance with federal regulations, including the Native American Graves Protection and Repatriation Act. The DAF requests your concurrence with the finding of no adverse effect for Site 8BR0083.

The blockhouse at SLC-37 (BR02790), was constructed in 1962. The building was erected as the control center for *Saturn I* and *Saturn IB* launches at SLC-37. The building has a circular plan and dome design similar to other CCSFS launch control centers of the same period, including those at SLC-13, SLC-14, SLC-19, and SLC-34. Of these, the building at SLC-37 is larger, as each building was scaled to the systems used at their complex. The building was previously determined eligible for listing in the NRHP under Criteria A, B, C, and D, including for its significant engineering and construction methods displayed in its domical form. Although SpaceX proposes to rebuild SLC-37, the undertaking proposes no changes to the LCC (BR02790), and the building would be maintained as part of an active launch complex, in keeping with its historic use. The DAF requests your concurrence with the finding of no adverse effect for the LCC (BR02790).

Current and previous CRAS have sufficiently covered the CCSFS portion of the APE, and no further survey is recommended for the SLC-37 undertaking. Although several

historic properties were previously identified within CCSFS, including the National Historic Landmark (NHL) Cape Canaveral Air Force Station (CCAFS) NHL District (FMSF No. BR00216), these fall outside the construction area at SLC-37. Most of these properties are significant for their association with the space program and the finding of effect is no adverse effect. The CCAFS NHL district, its contributing resources, and most historic properties at CCSFS were historically constructed to facilitate space launches; therefore, the undertaking is appropriate for SLC-37 and is not expected to have adverse effects on the CCAFS NHL district or most other historic properties at CCSFS. The two exceptions are the Beach House (BR02990) built in 1962 and Cape Canaveral Lighthouse (BR00212) built in 1868 and relocated in 1894, and its associated resources. These properties may have material vulnerabilities that could be subject to possible damage from noise and vibration associated with *Starship-Super Heavy* launches and landings, and the finding of effect for them is currently undetermined.

A good faith effort to identify historic properties in the Indian River communities within the APE found 691 historic properties (340 individual historic properties and 351 contributing resources, including an additional NHL, the Aladdin Theater [FMSF No. BR00282] in Cocoa), as well as unevaluated historic age resources. Some of these properties have potential material vulnerabilities to noise and vibrations. Though the potential for Starship-Super Heavy operations to cause adverse effects to historic properties in the APE is low, some of these properties may have character-defining features that would be vulnerable to damage from the noise and vibration associated with Starship-Super Heavy launches and landings. It is unknown at this time whether that damage would occur or whether it would be sufficient to diminish the integrity of the characteristics that qualify the properties for inclusion in the NRHP.

Because the DAF cannot fully determine how the undertaking will affect historic properties before making a final decision and, therefore, cannot yet make a finding of effect for the undertaking as a whole, the DAF recommends a project-specific programmatic agreement to provide a process to assess these potential effects and resolve any adverse effects that may occur.

Section 106 of the NHPA will be completed before any demolition, construction, or operations proceed, as specified in the SLD 45 ICRMP.

The DAF respectfully requests your review and comment on the APE and the CRAS reports, and your concurrence with the following:

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For MICHAEL A. BLAYLOCK, NH-III, DAF
Chief, Environmental Conservation

cc:
Alissa Slade Lotane, Florida SHPO
Jeff Harjo, THPO, Seminole Nation of Oklahoma
Ken Donaldson, THPO, Miccosukee Tribe of Indians of Florida

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

6 March 2025

FROM: Michael Blaylock
Chief, Environmental Conservation
45 CES/CEIE-C
1224 Jupiter Street
Patrick SFB FL 32925-3343

To: Tribal Historic Preservation Office
Miccosukee Tribe of Indians of Florida
Tamiami Station,
PO Box 440021,
Miami, FL 33114
Attn: Kevin Donaldson

Subject: *SpaceX Starship-Super Heavy* at Cape Canaveral Space Force Station (CCSFS), Brevard County, Florida

Mr. Donaldson,

In accordance with Section 106 of the National Historic Preservation Act (NHPA) (*United States Code*[U.S.C.] Title 54, Section 306108) and its implementing regulations (*Code of Federal Regulations* [CFR]Title 36, Part 800), the United States Department of the Air Force (DAF), the United States Space Force (USSF), and Space Launch Delta (SLD) 45 have determined that the proposed Space Exploration Technologies Corp (SpaceX) Starship-Super Heavy at Cape Canaveral Space Force Station (CCSFS) (the undertaking) has the potential to affect historic properties (36 CFR 800.3). This letter serves to initiate consultation under Section 106 of the NHPA, as outlined in Air Force Manual (AFMAN) 32-7003, *Environmental Conservation,* for the undertaking at Space Launch Complex 37 (SLC-37).

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The DAF respectfully requests your review and comment on the APE and the CRAS reports, and your concurrence with the following:

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for MICHAEL A. BLAYLOCK, NH-III, DAF
Chief, Environmental Conservation

Enclosures:
As stated

cc:
Alissa Slade Lotane, Florida SHPO
Victoria Menchaca, THPO, Seminole Tribe of Florida
Jeff Harjo, THPO, Seminole Nation of Oklahoma

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Appendix 3.7B
SLC-37 Historic Structures Survey Report

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Final

SpaceX Starship-Super Heavy
Cape Canaveral Space Force Station
SLC-37 Historic Structures Survey Report

Department of the Air Force

February 2025

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Executive Summary

The Department of the Air Force (DAF), as the lead federal agency, has determined that the following Proposed Action is an undertaking that requires compliance with Section 106 of the National Historic Preservation Act (*United States Code* [U.S.C.] Title 54, Section 306108). The Proposed Action is (1) the DAF's authorization of the redevelopment of Space Launch Complex (SLC)-37 to support Starship-Super Heavy (Starship) operations, including launches and booster landings at Cape Canaveral Space Force Station (CCSFS); (2) the DAF's authorization of a set cadence of Starship launches and landings at CCSFS; and (3) the Federal Aviation Administration's (FAA's) issuance or modification of a vehicle operator license to Space Exploration Technologies Corporation (SpaceX) for Starship operations at CCSFS and approval of related airspace closures. The Proposed Action includes the potential execution of a real property agreement between the United States Space Force and SpaceX.

The DAF is also preparing an environmental impact statement under the National Environmental Policy Act to evaluate the potential environmental impacts associated with the Proposed Action.

This cultural resources technical report was prepared in compliance with Air Force Manual 32-7003, *Environmental Conservation*; Section 106 of the National Historic Preservation Act (54 U.S.C. Section 306108); the regulations for implementing Section 106 (*Code of Federal Regulations* [CFR] Title 36, Part 800); and in accordance with the definition for sufficiency in *Florida Administration Code*, Chapter 1A-46.001, *Standards and Guidelines for Reports* (Chapter 1A-46.001(r)) as presented in *Module Three Guidelines for use by Historic Preservation Professionals* (Florida DHR 2021). The report defines the undertaking and Area of Potential Effects (APE), presents the results from a literature review and a historic structures survey at CCSFS, and recommends continued Section 106 consultation.

The DAF developed the APE, which includes areas where project elements could affect historic properties. These project elements are the demolition of existing facilities, including removal of most of the existing structures at SLC-37, the construction of new facilities, improvements to existing infrastructure, visual changes from the project, and noise and vibration from operations. The FAA has identified 2 pounds per square foot (psf) as the measure where sonic boom overpressures could feasibly result in damage to plaster and bric-a-brac, structural damage to highly vulnerable buildings and structures, and window breakage. The probability of window and plaster damage is approximately 1 in 10,000 to 1 in 100,000 at 2 psf (FAA 1976; NASA 2014). Thus, the DAF has defined the APE as the 2 psf sonic boom overpressure contour.

The 1,122,520.89-acre APE spans terrestrial and submerged areas, including 115,708.11 acres on land and 1,006,812.79 acres over water. All ground disturbance would occur on land in the construction area; no impacts to submerged areas would be expected. The 139-acre construction area would be limited to where ground distance would occur within SLC-37and roadway improvement areas. The APE covers CCSFS and extends to the adjacent Kennedy Space Center (KSC). The APE intersects with portions of the Canaveral National Seashore, Merritt Island National Wildlife Refuge, and municipalities near the Indian River and CCSFS. These municipalities include administered communities of Brevard County, Titusville (a certified local government), and incorporated and unincorporated municipalities, including Cape Canaveral, Cocoa, Cocoa Beach, Merritt Island, and Rockledge. The APE covers federal and nonfederal land, of which CCSFS property accounts for less than 1.5 percent of the total APE.

Because of the size of the APE and the low likelihood of adverse effects to historic properties beyond CCSFS's boundaries, the DAF made a reasonable and good faith effort to identify historic properties through background research, consultation, and limited field survey (36 CFR

800.4(b)(1)). Most of the APE is outside of CCSFS property, and the literature review gathered records from the SLD 45, Florida Master Site Files (FMSF), National Aeronautics and Space Administration (NASA), National Park Service (NPS), Titusville, and Brevard County. The records were reviewed to aid in identifying known historic properties and assessing where the APE has been subjected to historic property identification. Supplemental literature was collected from additional local and regional sources, such as historical societies and other affiliated groups. The State of Florida provided parcel data with building information. The collected information was entered into an ArcGIS dashboard for further analysis. The ArcGIS dashboard included previously recorded resources and parcel data with construction dates and materials from the State of Florida, SLD 45, FMSF, NPS, and supplemental data.

The literature review concluded that SLC-37 (FMSF No. BR02274) is not eligible for listing in the National Register of Historic Places (NRHP) as a district, but it contains one historic property: the Launch Control Center (LCC). The LCC is also known as the Blockhouse and Facility 33000 (FMSF No. BR02790). Built in 1962, the LCC is eligible for listing in the NRHP under Criteria A, B, C, and D for its association with the Apollo program; with significant persons such as Werner Von Braun, Gunter Wendt, and the Apollo astronauts; and for its significant engineering and construction methods as the final blockhouse of its type, as displayed in its domical form, to be used in the crewed space program. The LCC would remain preserved in place, and no alteration is proposed by the undertaking. SLD 45 maintains an Integrated Cultural Resources Management Plan with historic property monitoring that would be followed to ensure no adverse effects occur to the LCC from Starship-Super Heavy operations.

In addition to the LCC at SLC-37, FMSF records revealed an extensive history of historic structures surveys at CCSFS, KSC, and the greater surroundings, supporting an understanding of what types of resources are present and where potential historic properties may be identified.

The literature review found 236 Cultural Resources Assessment Surveys in the APE, of which 61 included notable historic structures survey components. The surveys documented the following:

- 1,759 previously recorded resources documented in the FMSF, with additional locally significant resources identified in inventories kept by municipalities and Brevard County
- National Historic Landmarks (NHLs), including the Cape Canaveral Air Force Station (CCAFS) NHL District (FMSF No. BR00216) and the Aladdin Theater (FMSF No. BR00282) in Cocoa
- 340 previously recorded individual historic properties and 351 previously recorded contributing resources (691 historic properties total, including the 2 NHLs)
- 665 previously recorded resources with undetermined eligibility for listing in the NRHP

Although 340 individual historic properties and 351 contributing resources (691 total historic properties) are identified in the APE, only one is located in the project's construction area—the LCC (FMSF No. BR02790). The Canaveral National Seashore and Merritt Island National Wildlife Refuge are within the APE, but these resources do not qualify as a historic property or contain any historic properties. Outside these two areas, the APE contains 24,373 parcels (47 percent of parcels in the APE) with historic age resources built in or before 1980 (or 45 years before the time of reporting), most of which lack an eligibility determination. Most of these parcels have historic age resources constructed in the 1960s (12,908 parcels) and most are masonry construction (86 percent of parcels in the APE). No comprehensive data are available for building condition assessments in the APE, and the available sampling is not statistically viable for derived opinions on the physical condition or historic integrity of historic properties identified in the APE beyond the CCSFS property. Thus, the physical conditions and historic integrity of historic properties outside of the CCSFS are unknown.

On July 18, 2024, a historic structures survey was completed for SLC-37 at CCSFS. SLD 45 identified 10 unevaluated historic structures (3 were recorded but unevaluated, and 7 were unrecorded) associated with SLC-37 and requested further consideration of them. The cultural resources team evaluated these 10 resources within their appropriate contexts using guidelines presented by the Advisory Council on Historic Preservation (ACHP) in *Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities* (ACHP 1991). The team recommended the resources not eligible for listing in the NRHP under any criteria in this report. Because the team did not identify any new historic properties in the construction area for SLC-37, the LCC (FMSF No. BR02790) remains the only historic property identified in the construction area.

Based on the information gathered for this report, one historic property, the LCC (FMSF No. BR02790), is in the construction area for SLC-37, and a total of 340 individual historic properties and an additional 351 contributing resources were previously recorded in the APE. At CCSFS and KSC, the identified historic properties are associated with the properties' historic use as part of an active launch ground since the late 1950s or are utilitarian structures for public infrastructure. The exceptions are the Beach House (FMSF No. BR02990) (built 1962) and Cape Canaveral Lighthouse (FMSF No. BR00212) (built 1868 and relocated in 1894) and its associated resources. No further historic structures surveys are recommended for CCSFS because the construction area is limited to the existing launch complex; all historic-era resources in its immediate vicinity have been thoroughly documented and evaluated. Historic property identification outside of CCSFS was limited to a desktop identification, and no further historic structures survey is recommended. FMSF forms were prepared for the 10 newly evaluated historic structures, and the forms are included in Appendix D.

Noise and vibrations from Starship-Super Heavy operations would have the potential to affect historic properties in the APE and outside of CCSFS. Although this potential would be low, sonic boom overpressures could result in damage to plaster and bric-a-brac; structural damage to highly vulnerable buildings and structures; and window breakage. It is unknown at this time if that damage would occur or if it would be sufficient to diminish the integrity of the characteristics that qualify the properties for inclusion in the NRHP. Because of the potential for noise and vibration to affect highly vulnerable resources in poor condition and those with windows that are a character-defining feature, continued Section 106 consultation is recommended for the undertaking. Because the DAF cannot fully determine how the undertaking would affect historic properties before making a final decision, a project-specific programmatic agreement is recommended for the undertaking pursuant to 36 CFR 800.14(b)(1)(2).

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Acronyms and Abbreviations

°F	degree(s) Fahrenheit
3D	three-dimensional
ACHP	Advisory Council on Historic Preservation
AFMAN	Air Force Manual
APE	Area of Potential Effects
ASU	air separation unit
CCAFS	Cape Canaveral Air Force Station
CCSFS	Cape Canaveral Space Force Station
CFR	*Code of Federal Regulations*
CLG	certified local government
CO_2	carbon dioxide
CRAS	Cultural Resources Assessment Survey
DAF	U.S. Department of Air Force
dB	decibel(s)
DOD	U.S. Department of Defense
EIS	environmental impact statement
FAA	Federal Aviation Administration
FMSF	Florida Master Site File
FPL	Florida Power and Light Company
ICBM	intercontinental ballistic missile
ICRMP	Integrated Cultural Resources Management Plan
KSC	Kennedy Space Center
LCC	Launch Control Center
L_{max}	maximum unweighted sound level
LMU	land management unit
LN2	liquid nitrogen
LOX	liquid oxygen
LZ	landing zone
MT	metric ton(s)

NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NPS	National Park Service
NRHP	National Register of Historic Places
PEA	programmatic environmental assessment
psf	pound(s) per square foot
SHPO	State Historic Preservation Officer
SLC	space launch complex
SLD	Space Launch Delta
SOI	Secretary of the Interior
SpaceX	Space Exploration Technologies Corp
U.S.C.	*United States Code*
ULA	United Launch Alliance
USAF	U.S. Air Force
USSF	U.S. Space Force

1. Introduction

The Department of the Air Force (DAF) is developing an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA) to evaluate the potential environmental impacts associated with the Proposed Action that is (1) the DAF's authorization of the redevelopment of Space Launch Complex (SLC)-37 to support Starship-Super Heavy (Starship) operations, including launches and booster landings at Cape Canaveral Space Force Station (CCSFS); (2) the DAF's authorization of a set cadence of Starship launches and landings at CCSFS; and (3) the Federal Aviation Administration's (FAA's) issuance or modification of a vehicle operator license to Space Exploration Technologies Corporation (SpaceX) for Starship operations at CCSFS and approval of related airspace closures. The Proposed Action includes the potential execution of a real property agreement between the United States Space Force and SpaceX.

Under this Proposed Action, SpaceX would modify, reuse, and/or demolish the existing SLC-37 infrastructure at CCSFS to support Starship launch and landing operations. The DAF, as the lead federal agency, has determined that the Proposed Action is an undertaking that requires compliance with Section 106 of the National Historic Preservation Act (NHPA) (*United States Code* [U.S.C.] Title 54, Section 306108).

This technical report was prepared in compliance with Air Force Manual (AFMAN) 32-7003, *Environmental Conservation*; Section 106 of the NHPA (54 U.S.C. Section 306108); the regulations for implementing Section 106 (*Code of Federal Regulations* [CFR] Title 36, Part 800); and in accordance with the definition for sufficiency in the *Florida Administration Code*, Chapter 1A-46.001, *Standards and Guidelines for Reports* (Chapter 1A-46.001(r)) as presented in *Module Three Guidelines for use by Historic Preservation Professionals* (Florida DHR 2021). The literature review and reporting included records from SLD 45, the Florida Division of Historical Resources, and the National Park Service (NPS).

This report was prepared by a Secretary of the Interior (SOI)-qualified architectural historian and an archaeologist and historian. Jessica R. Wobig, MA is an architectural historian with 15 years of experience, and Kyle Spurgeon, RPA is an archaeologist and historian with 11 years of experience. The resumes for Ms. Wobig and Mr. Spurgeon are attached as Appendix A.

1.1 Definition of Undertaking

The DAF is the lead federal agency under Section 106 and is also preparing an EIS in accordance with NEPA, the Air Force Environmental Impact Analysis Process promulgated at 32 CFR 989 et seq., and as applicable, FAA 1050.1F, *Environmental Impacts Policy and Procedures*.

The DAF determined that the Proposed Action to support the Starship operations at CCSFS is a federal undertaking (36 CFR 800.16(y)) that requires compliance with Section 106 of the NHPA (54 U.S.C. Section 306108) and the *Protection of Historic Properties* (36 CFR Part 800) and as directed in Section 2.9.3.1.2 of AFMAN 32-7003, *Environmental Conservation*. The Section 106 process establishes the Area of Potential Effects (APE); identifies and evaluates historic properties in the APE; and assesses whether the undertaking would cause adverse effects on historic properties (36 CFR 800.3 through 800.6).

1.2 Project Description

Under the Proposed Action, the real property agreements and FAA license would allow SpaceX to modify, reuse, and/or demolish the existing SLC-37 infrastructure at CCSFS and build new facilities to support Starship launch and landing operations. In the *Range of the Future Cape*

Canaveral Space Force Station District Plan (AFSPC 2020), USSF identifies a need to reallocate SLC-37 to a future launch provider as a medium- or heavy-lift after the completion of the Delta IV Heavy launches. Under the Proposed Action, the DAF would issue two lease agreements to SpaceX for the use of SLC-37. Separate lease agreements are necessary to accommodate the differing availability of each area. The first lease agreement would include the area to the north of Patrol Road, which includes the existing SLC-37 boundary. This area is currently available. The second lease agreement would include the areas to the south of Patrol Road. This area would be available at the end of 2027. The leases would be for an area larger than SpaceX's current need; however, no construction or land modifications would occur outside the construction area (Figure 1-1).

Various road modifications at CCSFS and Kennedy Space Center (KSC) are necessary to facilitate vehicle transport. SpaceX would widen Phillips Parkway to approximately 34 feet of pavement to create an approximately 60-foot corridor from Saturn Causeway to the launch site for approximately 7 miles, primarily within the existing maintained roadway corridor. Old A1A would be improved and widened approximately 34 feet for approximately 1 mile between SLC-37 and Phillips Parkway. SpaceX would add two turn radiuses to accommodate the transportation requirements for the launch vehicle components. One turn radius would be at the northeast corner of Phillips Parkway and Patrol Road, and the second turn radius would be at the southwest corner of Patrol Road and Beach Road.

1.3 Project Location

CCSFS occupies approximately 15,800 acres along the Atlantic Coast of Brevard County, Florida, southeast of National Aeronautics and Space Administration's (NASA's) KSC on adjacent Merritt Island. It includes 81 miles of paved roads and a 10,000-foot runway or skid strip. Natural areas near CCSFS include the Merritt Island National Wildlife Refuge and the Canaveral National Seashore. CCSFS is flanked by the Banana River and the Atlantic Ocean, as shown in Figure 1-2. CCSFS is the primary launch site for the Eastern Range and is managed by SLD 45.

CCSFS contains an area commonly called Missile Row or Intercontinental Ballistic Missile (ICBM) Row along the east side of ICBM Road and the Atlantic Coast. In the 1950s, eight launch complexes were built to support Atlas and Titan missile program testing, which required four complexes per program. Originally, the launch complexes (now known as SLC-11 to SLC-14) were built as one of four identical launch complexes for the Atlas program, while the other four launch complexes (now known as SLC-15, SLC-16, SLC-19, and SLC-20) were built for the Titan program. Six launch complexes contribute to the Cape Canaveral Air Force Station (CCAFS) National Historic Landmark (NHL) District: SLC-5/6, SLC-14, SLC-19, SLC-26, SLC-34, and the nonextant SLC-13. The NASA-owned Mission Control Center is also a contributing resource to the CCAFS NHL District (Figure 1-3).

Figure 1-1. Proposed Action: SLC-37

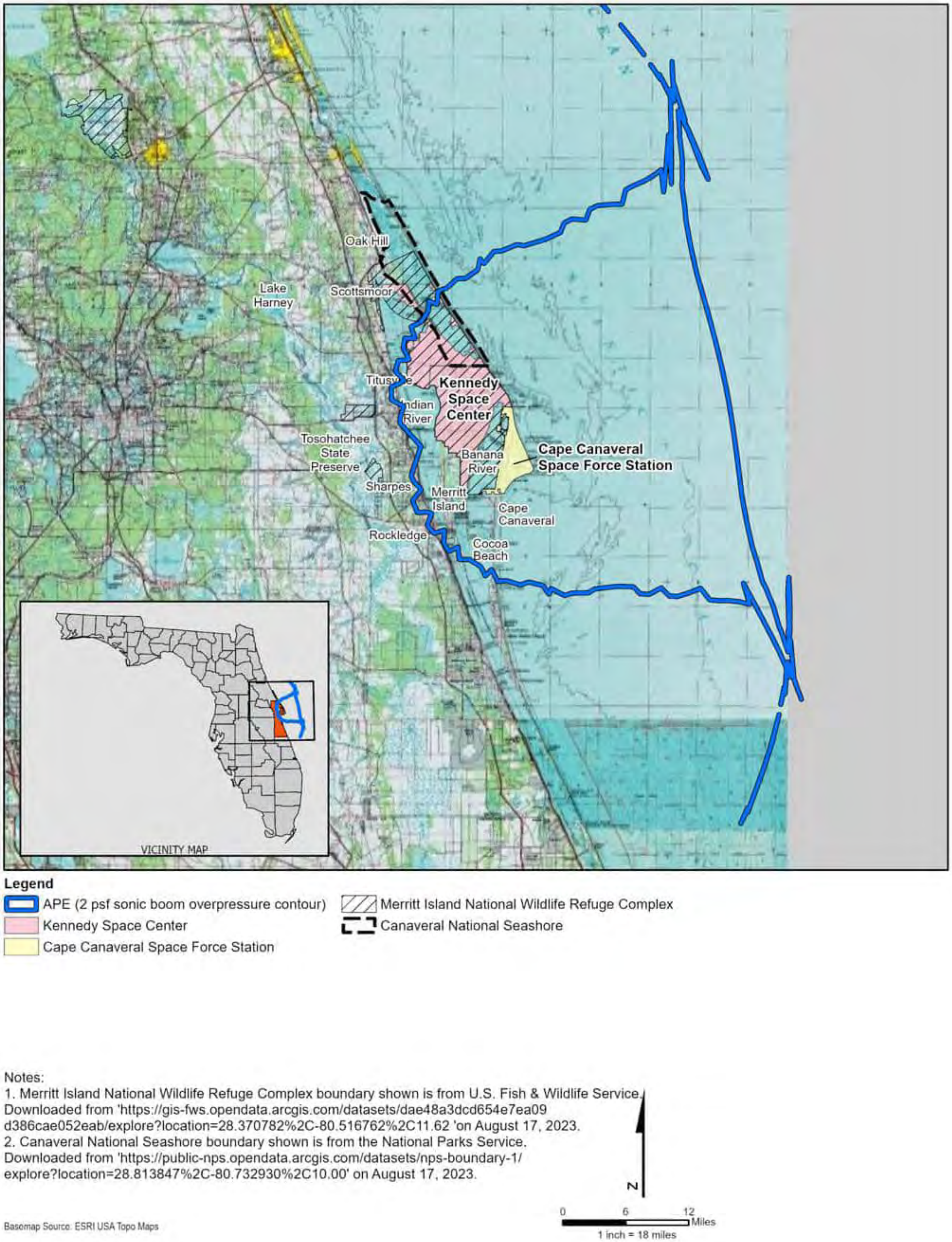


Figure 1-2. Project Location

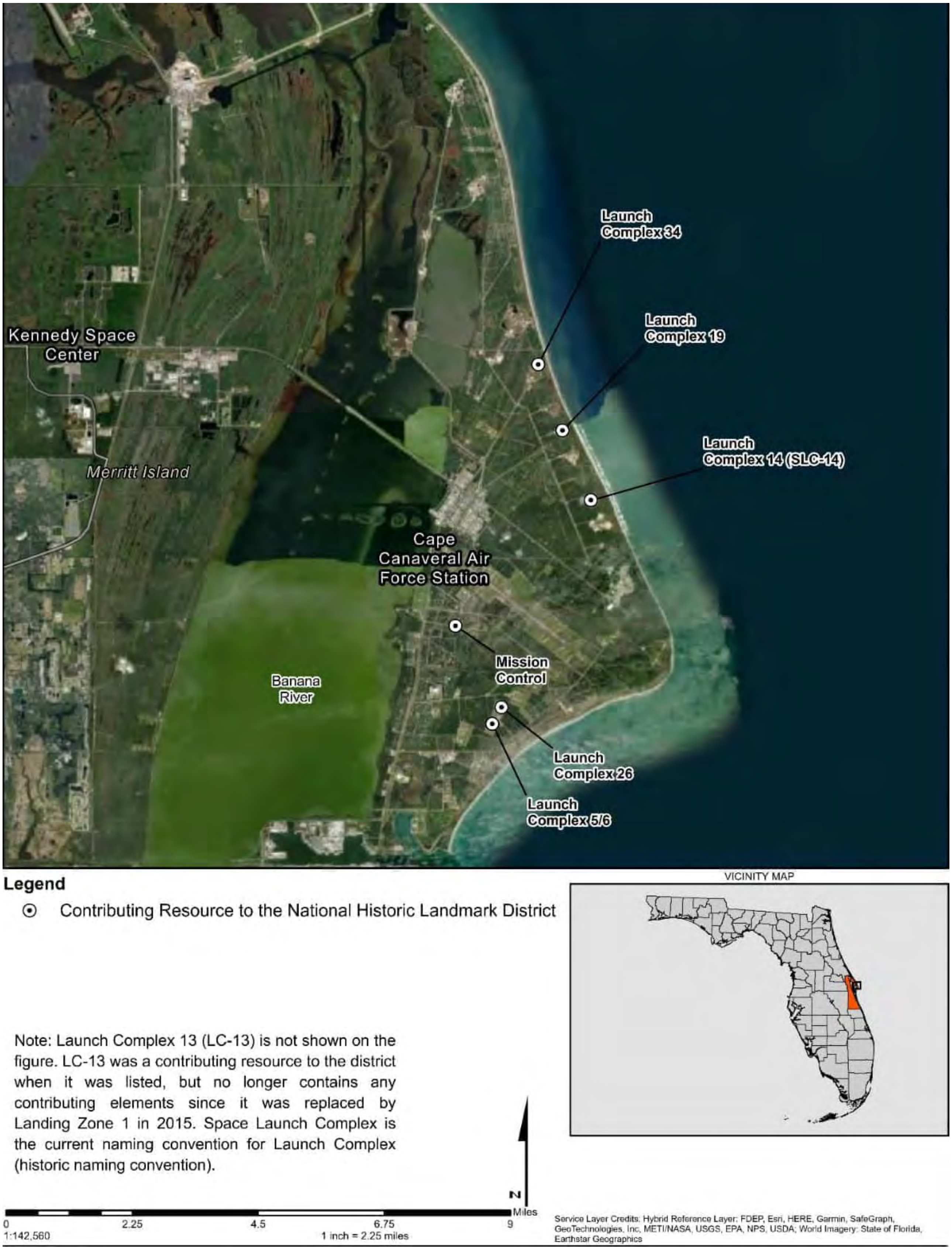


Figure 1-3. CCAFS NHL District

1.3.1 Starship-Super Heavy Launch Vehicle

The Starship-Super Heavy launch vehicle includes two stages (Figure 1-4): (1) Super Heavy, which is the first stage (or booster), and (2) Starship, which is the second stage. As designed, both stages are reusable. The fully integrated launch vehicle is up to 492 feet tall depending on configuration and 30 feet in diameter. Super Heavy includes 35 Raptor engines and Starship includes 9 Raptor engines; each engine is powered by liquid oxygen (LOX) and liquid methane. Super Heavy holds up to 4,100 metric tons (MT) of propellant and Starship up to 2,600 MT of propellant. As built, Super Heavy has a maximum lift-off thrust of up to 103 meganewtons (MN); Starship has a maximum lift-off thrust of approximately 28 meganewtons. Launch propellant and commodities include liquid nitrogen (LN2), water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, hydraulic fluid, LOX, and liquid methane.

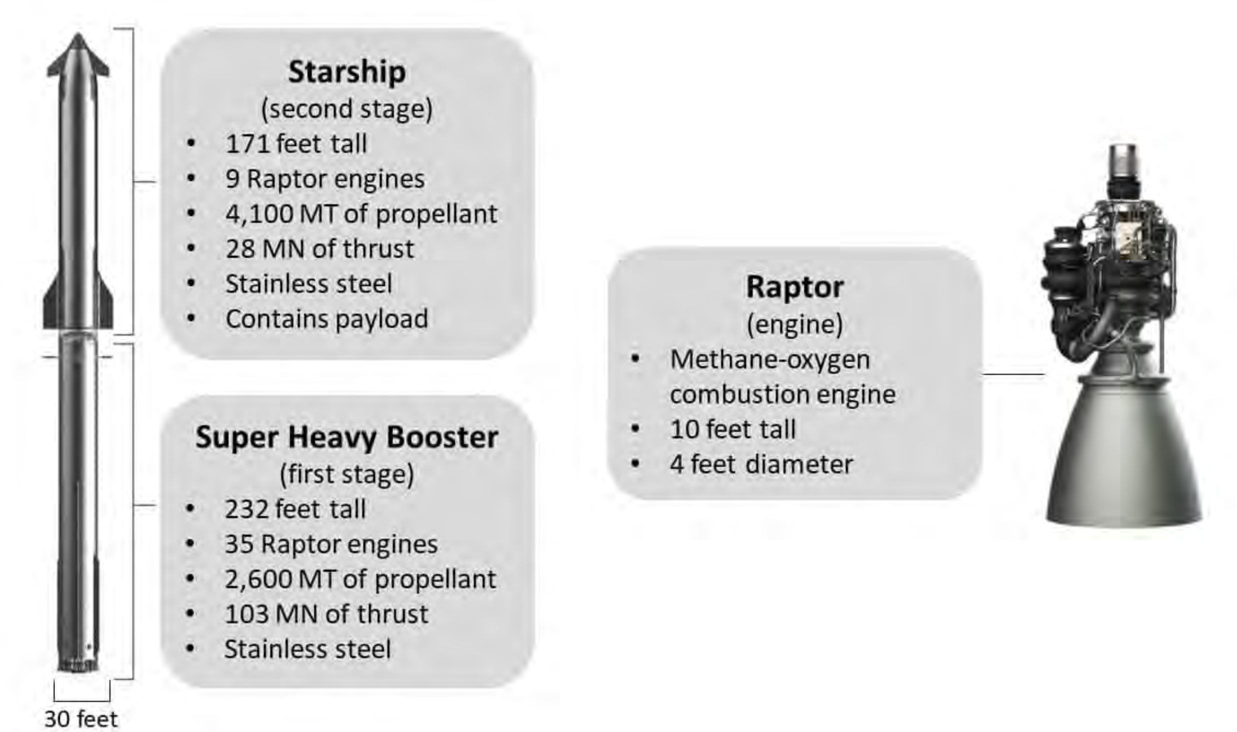


Figure 1-4. Starship-Super Heavy Launch Vehicle Design

1.3.2 Operations

Starship-Super Heavy operations would include the transport of the launch vehicle's components to the launch pad, pre-launch operations (including static fire testing), launches, and landings. The first Starship-Super Heavy launch from SLC-37 would be planned to occur in 2026. SpaceX's goal is to launch Starship-Super Heavy from the new launch site up to 76 times per year; for the environmental review, a maximum annual launch rate of 76 Starship-Super Heavy launches is assumed. Up to 450 additional fulltime employees or contractors would be needed to support launch activities 24 hours per day, 7 days per week, throughout the year. A detailed listing of the Starship-Super Heavy operations is provided in Table 1-1.

Table 1-1. Starship-Super Heavy Operations

Activity	Description
Transportation of Launch Vehicle Components	Starship, Super Heavy, and/or vehicle components would arrive from SpaceX Starbase in Texas. The components would be transported horizontally via a barge from the Port of Brownsville, Texas to CCSFS, Port Canaveral, Hanger AF Wharf, or KSC wharfs, and then delivered to the launch site via over-the-road transport. The transport of vehicle components from Texas to Florida would be episodic and would use established marine shipping and roadway corridors, which already experience similarly sized traffic. SpaceX's goal is for Starship-Super Heavy to require minimal refurbishment (including fabrication, assembly, delivery, and integration) to achieve rapid reusability of the launch vehicle. To achieve this, SpaceX plans to perform vehicle integration (process of assembling components of the launch vehicle) and refurbishment, if needed, at the launch site. Nonetheless, SpaceX may use its additional existing SpaceX facilities at CCSFS or KSC for refurbishment, if necessary.
Pre-launch Operations	Pre-launch operations would include ground-testing, tank testing, spin tests, mission rehearsals (wet and dry dress rehearsals), and static-fire engine tests[1]. These tests are needed to verify that all vehicle and ground systems are functioning properly and in accordance with documented procedures prior to launch. Except for static-fire engine testing, no propellant release or ignition would occur. It is anticipated that there would be one static-fire engine test per stage per launch operation, lasting up to 15 seconds in duration. All propellant transfers would maximize recapture methods. Tank tests confirm the launch vehicle fuel tank's reliability. The tanks are pressurized to confirm their structural integrity with appropriate factors of safety. These proof pressure tests are designed not to release any propellant to the environment. All propellant is recycled back into the ground system tanks after the test is completed. Tank tests do not involve mixing explosive commodities; thus, they are not expected to explode or spread debris. Spin tests are conducted to test engine components. During a spin test, the vehicle engines are chilled, and pumps are spun to operating speed but are stopped prior to engine ignition. Static-fire testing verifies engine control and performance. During a static-fire engine test, the launch vehicle engines are ignited for a short duration and then shut down. SpaceX would perform a Starship static-fire engine test before integrating Starship with Super Heavy. SpaceX would also perform a Super Heavy static-fire engine test, either by itself or with Starship integrated. If an engine test is unsuccessful, SpaceX would attempt another. After the wet dress rehearsal and static-fire engine test, SpaceX would transfer the propellant back into the commodity tanks.
Launch	During a launch, the ignition of the Starship-Super Heavy Raptor engines would generate a heat plume that would appear clear and consist of water vapor, carbon dioxide (CO_2), carbon monoxide, hydrogen, methane, nitrogen oxides (NOx), and oxygen. The maximum heat plume would occur during engine ignition and would travel away from the launch pad, reaching approximately 120 degrees Fahrenheit at 0.1 mile from the launch pad, and last for approximately 20 seconds before dissipating. Various designs, such as a diverter and deluge water, would be used to limit the extent of the heat plume so it remains within the launch complex fence line.
Super Heavy Landing (Return to Launch Site [RTLS])	After the Super Heavy booster separates from Starship, it would perform a controlled descent using atmospheric resistance to slow down and guide it for a precise return to the tower at the launch site to be caught with the tower's arms. Once near the landing location, Super Heavy would ignite its engines to conduct a controlled landing. Super Heavy could land vertically at the catch tower and would enter a safe state. The Super Heavy landing would generate a sonic boom. Following a Super Heavy landing, LOX and liquid methane (approximately 26 MT) would remain in the Super Heavy booster. The remaining LOX would be vented to the atmosphere and all the remaining liquid methane would be released to the atmosphere or safely combusted.

[1] A dry dress rehearsal simulates launch day conditions, where a full launch countdown is conducted but the vehicle is not fueled. A wet dress rehearsal is similar to a dry dress rehearsal, except the vehicle is fueled. This test allows the launch team to practice timelines and procedures used for launch and identify potential issues.

Activity	Description
Super Heavy Landing (Floating Platform Scenario)	After the Super Heavy booster separates from Starship, it would land in the Atlantic Ocean on a floating platform no closer than 5 nautical miles off the coast. Super Heavy would be delivered by barge and roadways to CCSFS for refurbishment. If a landing were to occur within the territorial seas of a nation other than the U.S., appropriate coordination through the State Department would occur. The Super Heavy landing would generate a sonic boom. Following a Super Heavy landing, LOX and liquid methane (approximately 26 MT) would remain in the Super Heavy booster. The remaining LOX would be vented to the atmosphere and all the remaining liquid methane would be released to the atmosphere or combusted.
Super Heavy Landing (Expendable Scenario)	While SpaceX intends for Super Heavy to be fully reusable following most operational flights, expending (that is, not recovering) vehicles may be required. After the booster separates from Starship, the Super Heavy could be expended, by a controlled or uncontrolled descent, in a target area in the Atlantic Ocean approximately 950 miles from the shore. Every effort would be made to avoid collisions with marine vessels. An expended Super Heavy would break up on impact with the ocean's surface and would be expected to sink. SpaceX would expect to expend approximately four Super Heavy boosters per year. An expended mission may result in an overpressure event or sonic boom, but SpaceX would not exceed 20 overpressure events of the Super Heavy expendable landings annually.
Starship Landing (Launch Pad or Floating Platform Scenario)	The Starship landing would closely resemble the Super Heavy landing and could occur either at the launch site or on a floating platform in the open ocean between 55°S and 55°N latitudes. The Starship landing would generate a sonic boom. Starship would have approximately 5 MT of liquid methane onboard following a flight. Any LOX remaining in the vehicle would be vented to the atmosphere and liquid methane would be released or safely combusted.
Starship Landing (Expendable Scenario)	If necessary, Starship could be expended in the ocean by controlled or uncontrolled descent, in seven potential areas in the Pacific Ocean and Indian Ocean. In a controlled descent, after ascent engine cutoff, Starship would vent residual main tank propellant during the in-space coast phase of the launch at or above 74.5 miles above ground level. Following the in-space coast phase, Starship would conduct a deorbit burn to begin its controlled descent. Upon ocean impact, structural failure could allow the remaining LOX and methane to mix, resulting in an explosive event. Alternatively, Starship could conduct a soft water landing during which the vehicle's engines would fire prior to impact with the ocean's surface, causing the vehicle to land vertically and intact. The vehicle would then take on water and sink or be scuttled[2]. In an unanticipated and unlikely uncontrolled descent, Starship would break up during atmospheric entry. Most of the launch vehicle debris would sink because it is made of steel. Lighter items not made of steel, such as composite overwrapped pressure vessels, may float but would be expected to become waterlogged and sink. If there were reports of large debris, SpaceX would coordinate with marine debris specialists to survey the situation and sink or recover, as necessary, any large floating debris. SpaceX would coordinate with all land and water regulatory authorities including the USCG and the State Department prior to recovering debris. Every effort would be made to avoid collisions with marine vessels.
Launch Trajectories	The launch trajectories for the Starship-Super Heavy program need to accommodate eastward trajectories, which allow the spacecraft to benefit from the Earth's natural rotation. Specific flight trajectories vary based on mission and depend on desired payload orbit Starship-Super Heavy launch azimuths would range from 40° to 115°, from a reference of due north at 0° and due east at 90°. Existing restricted airspace parameters would not need to be modified for Starship-Super Heavy operations.
Payloads	Starship-Super Heavy program payloads would be similar to, but larger than, current and planned payloads launched on Falcon 9 and Falcon Heavy. Payloads and their associated materials/fuels/volumes are mission dependent but would be in keeping with the current commercial and government payloads analyzed in the Launch of NASA *Routine Payloads Environmental Assessment* (NASA 2011). Any unique payloads that are not covered under existing NEPA documents would be addressed under a separate mission-specific NEPA analysis. The integration of payloads would be dependent on mission and would occur at existing government or SpaceX facilities.

[2] A scuttle is a procedure to intentionally sink a launch vehicle by opening the hatches or creating holes to allow water to flood the vehicle, causing it to sink.

1.3.3 Launch, Landing, and Support Infrastructure

A detailed description of the launch, landing, and support infrastructure that would be constructed at the allocated launch site is provided in Table 1-2.

Table 1-2. Starship-Super Heavy Launch and Landing Facilities

Structure	Description
Roadway Improvements	To facilitate vehicle transport, SpaceX would widen Phillips Parkway to approximately 34 feet of pavement from Saturn Causeway to the launch site for approximately 7 miles, primarily within the existing 60-foot roadway corridor. Old A1A would be improved and widened to approximately 34 feet for approximately 1 mile between SLC-37 to Phillips Parkway. SpaceX would add two turn radiuses. One turn radius would be located at the northeast corner of Phillips Parkway and Patrol Road, and the second turn radius would be located at the southwest corner of Patrol Road and Beach Road.
Launch Pads	Two concrete launch pads, approximately 400 feet long by 400 feet wide, would be constructed on site[3].
Launch Mounts	Two launch mounts, 38 feet tall and 38 feet wide, would be used as the foundation for stacking the two stages of the Starship-Super Heavy launch vehicle.
Launch Integration Towers	Two integration towers, each approximately 600 feet tall, 40 feet wide, and 40 feet long, would be used to vertically integrate the Starship-Super Heavy vehicle on the launch mount. The integration towers would be located on the launch pads.
Launch Flame Trenches, Deluges, and Diverters	A launch diverter or flame trench structure would be placed directly underneath the launch mount to divert the heat plume away from the ground. Flame trenches and diverters would reduce the acoustic and thermal energy to the launch vehicle, payload, and ground systems during launch and landing. Water would be required for these systems. The water would discharge via a water-cooled diverter and/or deluge. Water would be retained in ponds within the launch site boundary. Whenever possible, the wastewater would be reused for the next launch. The water retention ponds would be filled with water from the existing mainline depending on capability. At this time, the size of the line is uncertain and there may be upgrades to the supply line. Various engineering designs would be used to limit the heat plume temperature dispersion, including deluge, lofted diverter, or berms. The specific design of the diverter has not been developed yet; however, it is possible for the diverters to be bifurcated or directional. These design features would be developed to keep the heat plume within the fence line.
Landing Pads	Two concrete landing pads, approximately 225 feet in diameter, would be constructed on site.[3]
Landing Catch Towers/Test Stands	Two catch towers, similar to the integration towers, would support Super Heavy landings and serve as pre-flight operation test stands.
Propellant Generation – Natural Gas Pretreatment System	A natural gas pretreatment system would remove impurities such as mercury, sulfur, water, CO_2, and hydrocarbons heavier than methane from the pipeline-quality natural gas to produce a stream of higher purity gaseous methane. Surplus natural gas would be used for process work or power generation. The natural gas pretreatment system would include a small amine treating unit for CO_2 removal; a heavies scrub column[4] that would be up to 100 feet tall and 10 feet in diameter; and multiple smaller vessels approximately 6 feet in diameter and up to 30 feet tall. The system would be in the launch complex.

[3] The locations of launch and landing pad are to be determined, as site access is limited.

[4] A scrub column is used to remove heavy components from natural gas used for propellant generation.

Structure	Description
Propellant Generation – Methane Liquefier	A methane liquefier would supercool pretreated natural gas into a liquid state for storage and transportation. Together, the natural gas pretreatment and liquefier would comprise several structures, each up to 65 feet tall. The methane liquefier could be up to 3 acres. The methane liquefier would be cooled by a typical evaporative cooling tower requiring up to approximately 132 gallons per minute of water and producing up to approximately 13 gallons per minute of wastewater (approximately 5.3 million gallons annually) that would be treated onsite via evaporation or retention ponds or hauled off site by trucks. The system would be in the launch complex.
Propellant Generation – Air Separation Unit (ASU)	An ASU would be constructed to generate the LN2 and LOX required for launch operations. An ASU dehumidifies, liquefies, and separates ambient air into oxygen and nitrogen. In addition to the primary oxygen and nitrogen liquid products, the ASU would produce a waste nitrogen stream composed of rejected atmospheric gases, principally nitrogen, oxygen, and argon that would be vented to the atmosphere. The ASU would comprise a primary cold box structure up to 180 feet tall and a smaller supporting infrastructure up to 60 feet tall. The ASU would be cooled by a typical evaporative cooling tower requiring up to approximately 660 gallons per minute of water and producing up to approximately 66 gallons per minute of wastewater (12.4 million gallons annually) that would be treated onsite via evaporation and retention ponds or hauled off site by trucks. The system would be located in the launch complex.
Propellant Commodity Storage	Onsite propellant storage would be sized to support up to 2.3 launches at any given time; however, the storage could be incrementally expanded to meet increased propellant demands. Increases to storage would be assessed for potential environmental effect and additional NEPA analysis would be conducted, as necessary. Commodity tanks would hold LOX, LN2, water, helium, gaseous nitrogen, gaseous methane, and liquid methane. The approximate sizes of the commodity tanks include 16,500 tons for LOX, 6,500 tons for LN2, and 5,000 tons for LCH_4. The location of the tanks would comply with LOX and liquid natural gas location siting regulations (National Fire Protection Association [NFPA] 251 and NFPA 59A).
Lighting	Nighttime launch activities require bright spotlighting for short durations to illuminate the launch vehicle at the launch site. Lighting is needed to ensure the protection and safety of SpaceX personnel and hardware. In addition to potential nighttime test, launch, and landing activities, SpaceX would need to perform ground-support operations 24 hours a day, 7 days a week, throughout the year; however, these routine operations would not require engine ignition or bright spotlighting.
Utilities – Power	An electrical substation of up to 130 kilovolts is proposed for the launch site; Florida Power and Light would provide up to 250 megawatts of power via the existing Delta substation. If it is determined that the existing available power is insufficient to serve SpaceX's needs, power needs would be supplemented using Tesla Mega packs[5]. No additional power upgrades are proposed.
Utilities – Fiber	New fiber connectivity lines would be routed underground within the right-of-way along Phillips Parkway.
Utilities – Water	The launch site would use existing water and sewer system, and use or relocate lines, where practicable.
Utilities – Natural Gas	Natural gas would be brought to the launch site through a multi-user pipeline that serves all commercial launch providers and government agencies at the installations. The natural gas pipeline would extend from the existing natural gas mainline on KSC. The main natural gas pipeline enters KSC where NASA and Kennedy Parkways intersect. Florida City Gas is in the process of extending the pipeline underground at KSC and CCSFS to provide additional service; however, the extension of the pipeline is not part of the Action for this EIS. SpaceX would connect to the existing natural gas pipeline; however, this would not be required for launch.

[5] Tesla Megapack is a large-scale rechargeable lithium-ion battery stationary energy storage product, intended for use at battery storage power stations.

Structure	Description
Utilities – Nitrogen and Helium	Nitrogen and helium utilities would connect to the existing systems on CCSFS. All utilities would tie into a proposed utilities yard at the launch site.
Staging, Storage, Support Infrastructure	Infrastructure would include tie-down foundations for short-term storage and a crane staging area. SpaceX would also construct an approximately 23,000-square-foot, 30-foot-tall ground support equipment fabrication building; an approximately 40,000-square-foot ground support equipment outdoor storage space; and an approximately 20,000-square-foot, 20-foot-tall office building with approximately 100 permanent parking spaces.
Water Infrastructure	Water storage and stormwater ponds would be built on site. The water storage would be used to provide potable water for deluge, which includes water needed for launch, landing, and static fires. SpaceX would retain wastewater for reuse in properly sized retention ponds.

1.3.4 Existing Structures at SLC-37

SpaceX would modify, reuse, and/or demolish the existing SLC-37 infrastructure (refer to representative image in Photograph 1). SpaceX's notional site plan is included on Figure 1-5. If changes in the site plan warrant further consultation, the DAF would notify the State Historic Preservation Officer (SHPO), cooperating agencies, and consulting parties and reinitiate consultation, as appropriate.

Photograph 1. Built in 2001, Launch Pad 37B (FMSF No. BR02366) and Launch Tower B, CX 37 (FMSF No. BR02539) within SLC-37 (FMSF No. BR02274), facing northeast.

Figure 1-5. SpaceX's Notional Site Plan

In 2021, SLC-37 (Florida Master Site File [FMSF] No. BR02274) was recorded as 18 facilities, of which 17 were determined not eligible for listing in the National Register of Historic Places (NRHP) (ineligible), including the complex itself. One facility, the Launch Control Center (LCC), also known as the Blockhouse and Facility 33000 (FMSF No. BR02790), was determined individually eligible for listing in the NRHP (Florida DHR 2021). SLC-37 (FMSF No. BR02274) was constructed in 1962 to support Saturn I and Saturn IB launches. It was substantially modified in the late 1990s and early 2000s when it was reactivated by United Launch Alliance (ULA) for the Delta program. As a result of extensive modification, it contains ineligible resources except for one historic property, the LCC. Built in 1962, the LCC is eligible for listing in the NRHP under Criteria A, B, C, and D for its association with the Apollo program that put humans on the Moon; with significant persons such as Werner Von Braun, Gunter Wendt, and the Apollo astronauts; and for its significant engineering and construction methods as the final blockhouse of its type as displayed in its domical form; and for information potential. It is similar in design to blockhouses in SLC-13, SLC-14, SLC-19, and SLC-34 but was designed to be larger than the other blockhouses to support the increased power of the Saturn rockets. The LCC would remain preserved in place, and no alteration is proposed by the undertaking. SLD 45 maintains an Integrated Cultural Resources Management Plan (ICRMP) with historic property monitoring, which would be followed to ensure no adverse effects occur to the LCC from Starship operations.

For this analysis, all ineligible facilities inside the SLC-37 fence line would be removed except for the NRHP-eligible LCC (FMSF No. BR02790) (refer to Photograph 2). SLC-37 (FMSF No. BR02274) would be reused, the NRHP-eligible LCC (FMSF No. BR02790) would remain in place, and the 16 ineligible facilities would be removed. The removal would include site features counted as part of the ineligible SLC-37 district, such as retaining ponds, roads, slabs, walkways, miscellaneous pipeline stands, and cableway (refer to Table 1-3 and Figure 1-6).

Photograph 2. Built in 1962, the LCC (FMSF No. BR02790) and Cableways (FMSF. No. BR02334) within SLC-37, facing southwest.

Table 1-3. SLC-37 Existing Structures

Resource Name	Facility No.	FMSF No.	Year Built and Modified	NRHP Status	Proposed for Removal
SLC-37	Facility	BR02274	1962, circa 1990s and 2000s	Not eligible and not an eligible district	No

Resource Name	Facility No.	FMSF No.	Year Built and Modified	NRHP Status	Proposed for Removal
Launch Control Center	33000	BR02790	1962	NRHP-eligible under Criteria A, B, C and D	No
Cableways	25300 AW	BR02334	1962 – Abandoned in place	Not eligible and not in an eligible district	Yes
Valve Pit	25300 S	BR02335	1962 – Abandoned in place	Not eligible and not in an eligible district	Yes
Launch Pad 37B	25320	BR02366	2001	Not eligible and not in an eligible district	Yes
Theodolite Building	25324	BR02399	2001	Not eligible and not in an eligible district	Yes
Launch Support Shelter	25409	BR02452	2001	Not eligible and not in an eligible district	Yes
Launch Tower B, CX 37	25410	BR02539	2001	Not eligible and not in an eligible district	Yes
Gas Storage Area Power Control Center	32911	BR02788	2002	Not eligible and not in an eligible district	Yes
South Treatment Building	32912	BR02789	1962	Not eligible and not in an eligible district	Yes
Automatic Ground Control Station/Utility Building Pad 37B	33002	BR02791	1962	Not eligible and not in an eligible district	Yes
Automatic Ground Control Station/Utility Building Pad 37A	33006	BR02792	1962	Not eligible and not in an eligible district	Yes
Storage Building	33007	BR02793	2007	Not eligible and not in an eligible district	Yes
Water Pump House	33012	BR02794	2001	Not eligible and not in an eligible district	Yes
G2N Metering Station Building, Gas Storage Area Power Control Center	33014	BR02788	1996	Not eligible and not in an eligible district	Yes
Security Entry Control Building	33015	BR02796	2002	Not eligible and not in an eligible district	Yes
Uninterrupted Power Supply Building	33021	BR02797	2007	Not eligible and not in an eligible district	Yes
Emergency Evacuation Assistance Program Shelter	33022	BR02798	2007	Not eligible and not in an eligible district	Yes

Figure 1-6. SLC-37 Existing Facilities

1.3.5 Additional Facilities at SLC-37

There are 10 additional facilities associated with SLC-37 that are outside the fence line (Table 1-4 and Figure 1-6). These facilities would be part of the lease agreement between USSF, SLD 45, and SpaceX. They include seven previously unrecorded resources and three recorded but unevaluated resources. Two of these facilities could be removed for a new LOX storage area, but none of the other resources are considered for removal (refer to Photograph 3).

Photograph 3. Built in 1962, the Delta IV Precision Clean Lab (FMSF No. BR04029) in foreground is one building proposed for removal. Built in 2000, the Storage Building (unrecorded) in the background is also proposed for removal.

Table 1-4. Additional Facilities at SLC-37

Resource Name	Facility No.	FMSF No.	Year Built and Modified	NRHP Status	Proposed for Removal
Electrical Switch Station	38015	Unrecorded	2000	Unevaluated	No
Horizontal Integration Facility	38200	Unrecorded	2000	Unevaluated	No
Security Entry Control Building	38201	Unrecorded	2000	Unevaluated	No
Storage Building	43407	Unrecorded	2000	Unevaluated	Yes
AF Warehouse II	38315	BR04028	1963	Unevaluated	No
Delta IV Precision Clean Lab	43400	BR04029	1962	Unevaluated	Yes
Hazardous Storage	38316	Unrecorded	1997	Unevaluated	No
Delta IV Warehouse	43302	BR4030	1963	Unevaluated	No
FPL Substation Building	43311	Unrecorded	1999	Unevaluated	No
Delta IV Power Control Center	43313	Unrecorded	1999	Unevaluated	No

1.4 Area of Potential Effects

The APE is "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties if such properties exist. The APE is influenced by the scale and nature of the undertaking and may be different for various kinds of effects caused by the undertaking" (36 CFR 800.16(d)). The APE includes all areas where demolition, construction of new facilities, improvements to existing infrastructure, and noise and vibration from operations, including launch and landing activities, could affect historic properties.

Previously the FAA has assessed the effects of sonic booms with threshold criteria defined in *Noise and Sonic Boom Impact Technology: Sonic Boom Damage to Conventional* (Haber and Nakiki 1989). In 2022, the FAA issued the *Final Programmatic Environmental Assessment for the SpaceX Starship/Super Heavy Launch Vehicle Program At The Boca Chica Launch Site In Cameron County, Texas* (FAA 2022). With regard to possible building damage, the 2022 Programmatic Environmental Assessment (PEA) referenced Haber and Nakiki's sonic boom peak overpressure levels, which show that generally, the "threshold for building damage due to sonic booms is 2 psf" (Haber and Nakiki 1989). The probability of window and plaster damage is approximately 1 in 10,000 to 10 in 1,000,000 at 2 psf (FAA 1976; NASA 2014).

Based on this precedent, the DAF has defined the APE as the area of the 2-psf contour (Figure 1-7)[6]. An initial APE of a 130-decibel (dB) maximum unweighted sound level (L_{max}) noise contour was used, which indicates where possible structural damage from noise and vibration could occur at CCSFS and KSC. The DAF revised the APE from the 130-dB area to the 2-psf area based on the FAA's precedent in the 2022 PEA for assessing the potential for noise and vibrations from potential acceleration and deceleration events for the undertaking.[7] The initial area reviewed was 34,000 acres, including approximately 11,000 acres on land and approximately 23,000 acres over water. The expanded 2-psf APE includes this initial area and spans 1,122,520.89 acres. The 1,122,520.89-acre APE covers terrestrial and submerged areas, with 115,708.11 acres on land and 1,006,812.79 acres over water.

The construction area, which is included in the APE, contains all areas where ground disturbance from construction could occur. Ground disturbance would occur inside the SLC-37 existing fence line, outside the fence along roadways for widening, and for other associated infrastructure such as utility upgrades. The depth of ground disturbance would extend to the depth necessary for grading and excavation associated with the removal and replacement of the launch facilities and is limited to the construction area. The construction area also contains the physical changes from demolition, new construction, and operations that may be visible within the setting. The APE is larger than the construction area because it considers noise and vibration that could result from the undertaking.

SLC-37 is flanked to the south by SLC-34, an NRHP-eligible district and contributing resource to the CCAFS NHL District. Like SLC-37, SLC-34 was built for the Apollo program, but unlike SLC-37, it retains sufficient integrity to qualify for listing in the NRHP. A previously determined ineligible segment of Phillips Parkway is west of SLC-37 and runs north-south. A previously determined ineligible segment of Old A1A runs to the north of SLC-37. The coastline intersects the APE to the east, and the Banana River intersects the APE to the west. The existing launch

[6] The APE extends over both water and land but does not include water landings such as the Super Heavy Landing–Floating Platform Scenario, the Starship Landing–Floating Platform Scenario, or the Starship Landing–Expendable Scenario, as these scenarios do not disturb the ocean floor and would not be expected to encounter cultural resources.

[7] The *Written Re-Evaluation of the 2022 Final Programmatic Environmental Assessment for the SpaceX Starship/Super Heavy Launch Vehicle Program At The Boca Chica Launch Site In Cameron County, Texas* clarifies that the potential for superficial damage increases at 10 psf but remains low, while the threshold for window breakage is more possible for most windows at 20 psf (FAA 2024a). The initial 130-dB area reviewed is approximate to the 10-psf area and is within the CCSFS and KSC properties.

complex has a relatively low profile within a coastal environment. The horizontal launch complex features are set back and are not visible to, or accessible by, the public.

The APE covers CCSFS and extends to the adjacent KSC. The APE intersects with portions of the Canaveral National Seashore, Merritt Island National Wildlife Refuge, and municipalities near the Indian River and CCSFS. These municipalities include administered communities of Brevard County, a certified local government (CLG), and incorporated and unincorporated communities, including Cape Canaveral, Cocoa, Cocoa Beach, Merritt Island, Titusville, and Rockledge. The CCSFS setting is a relatively flat coastal area with expansive land and water features that separate CCSFS from adjacent communities. CCSFS is a prominent feature in the built landscape with extensive view lines along the coastal communities in the APE. However, SLC-37 is not directly visible from most of the urban areas because of intruding landscape and vertical aboveground infrastructure. The APE covers federal and nonfederal land, of which CCSFS property accounts for less than 1.5 percent of the total APE.

Representative photographs are provided showing the setting outside SLC-37 for the portion of the APE at CCSFS (Photographs 4 to 7).

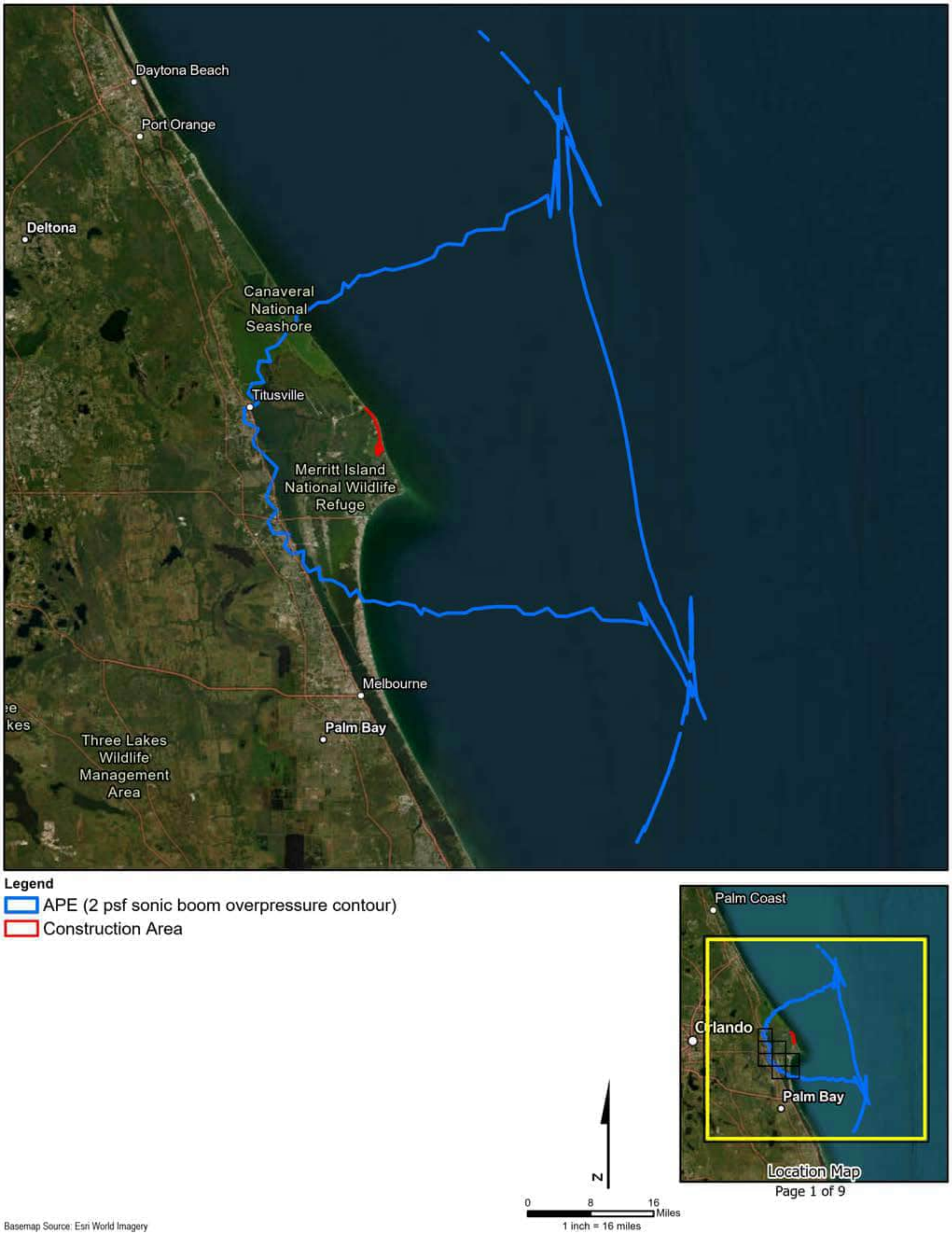


Figure 1-7. Area of Potential Effects (Page 1 of 9)

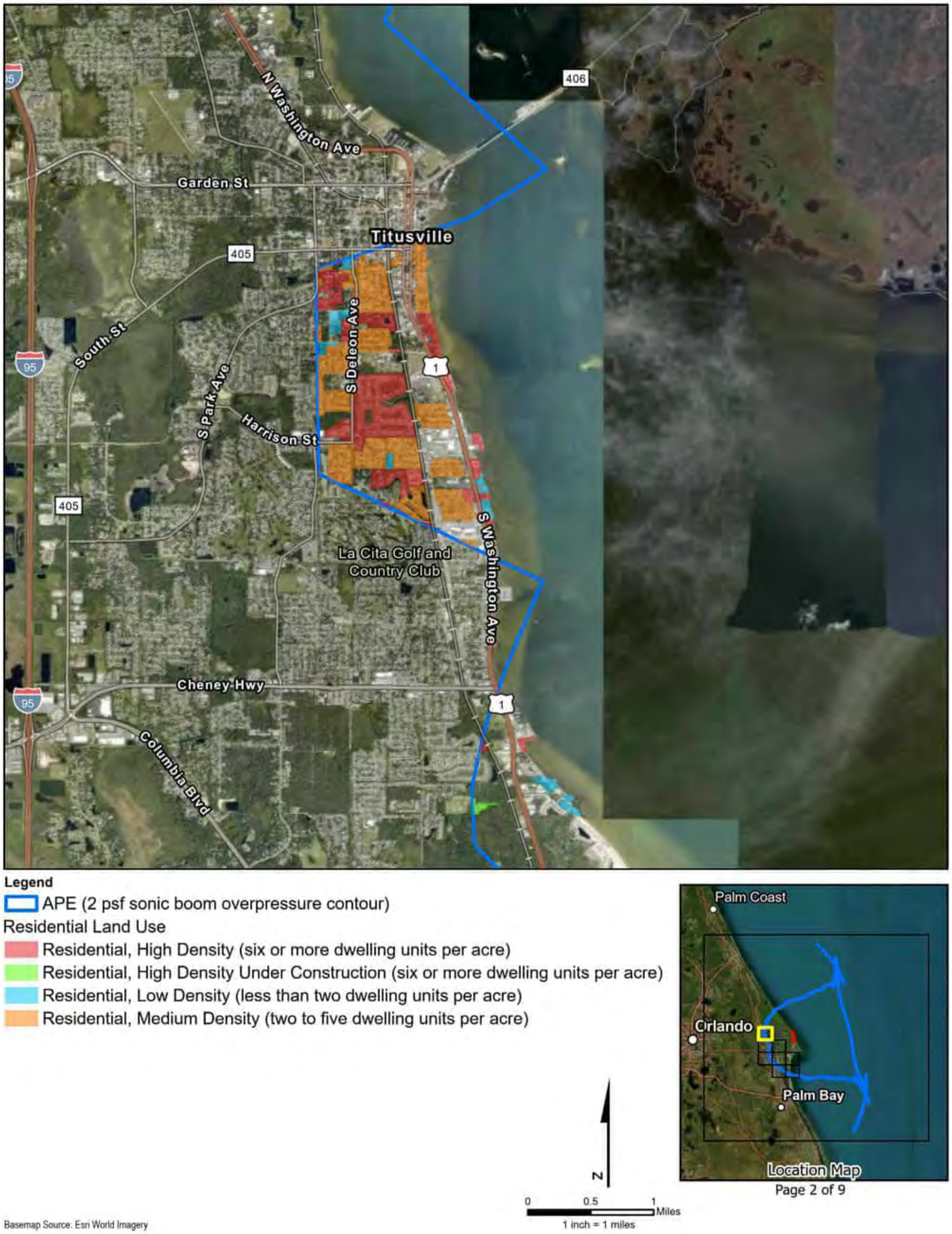


Figure 1-7. Area of Potential Effects (Page 2 of 9)

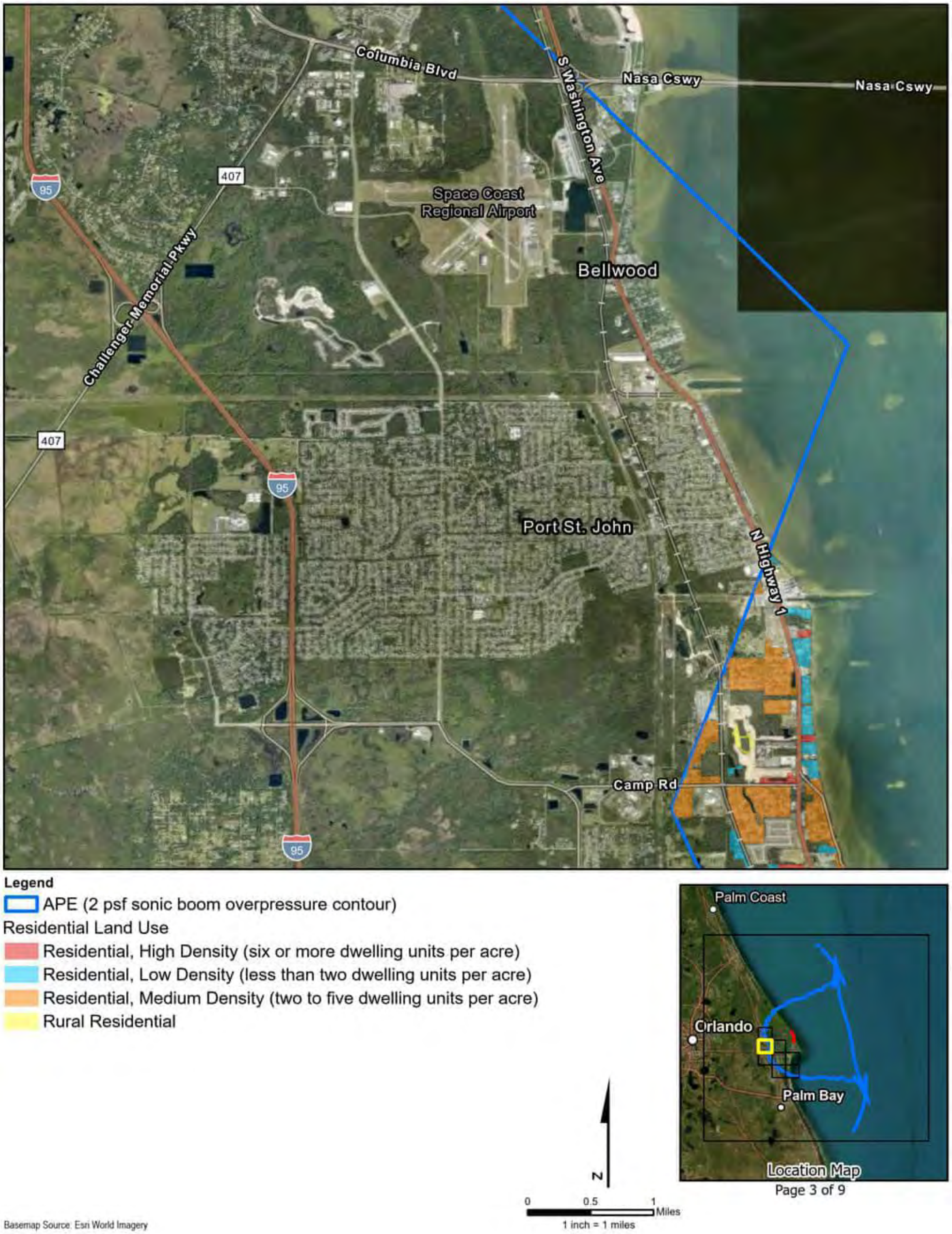


Figure 1-7. Area of Potential Effects (Page 3 of 9)

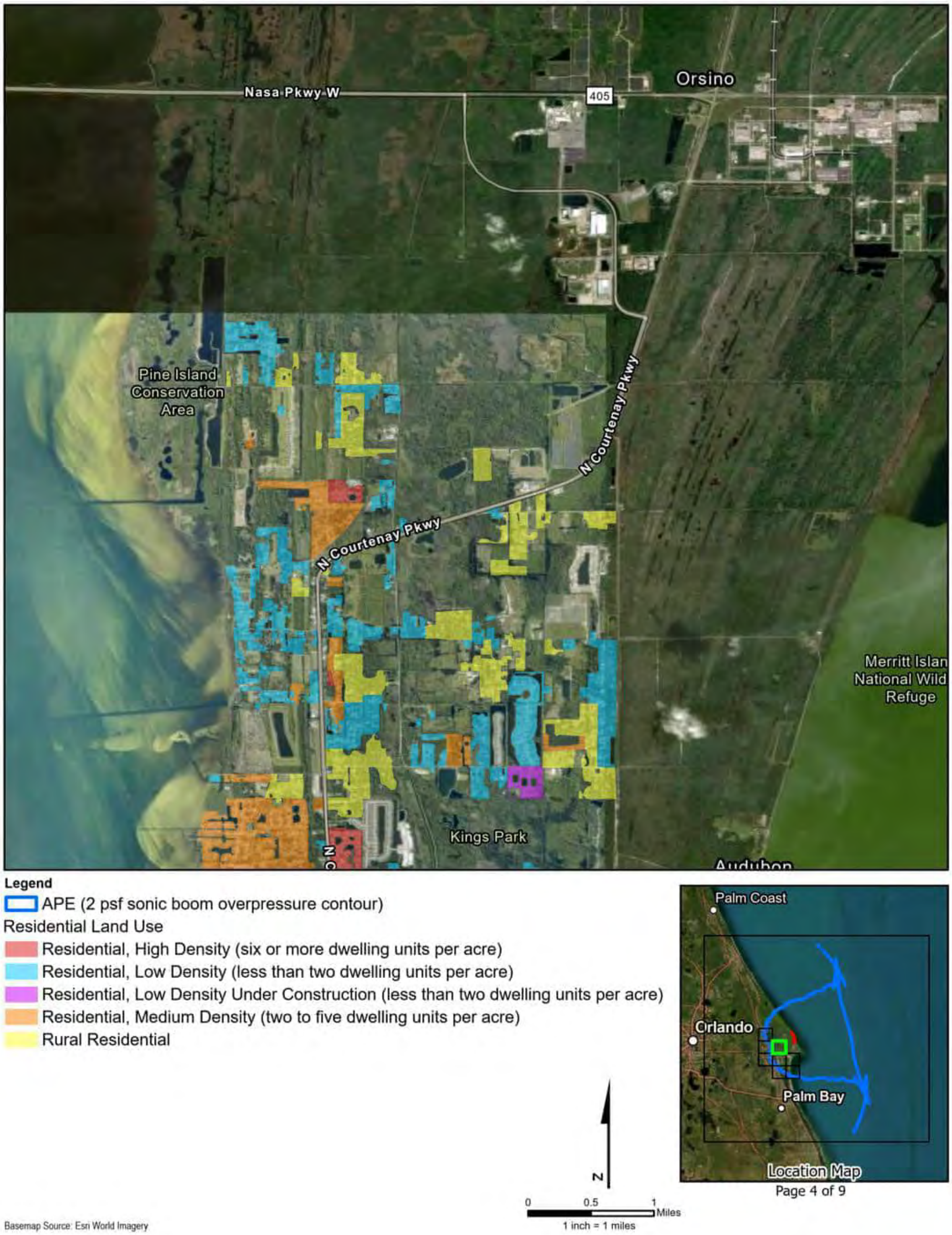


Figure 1-7. Area of Potential Effects (Page 4 of 9)

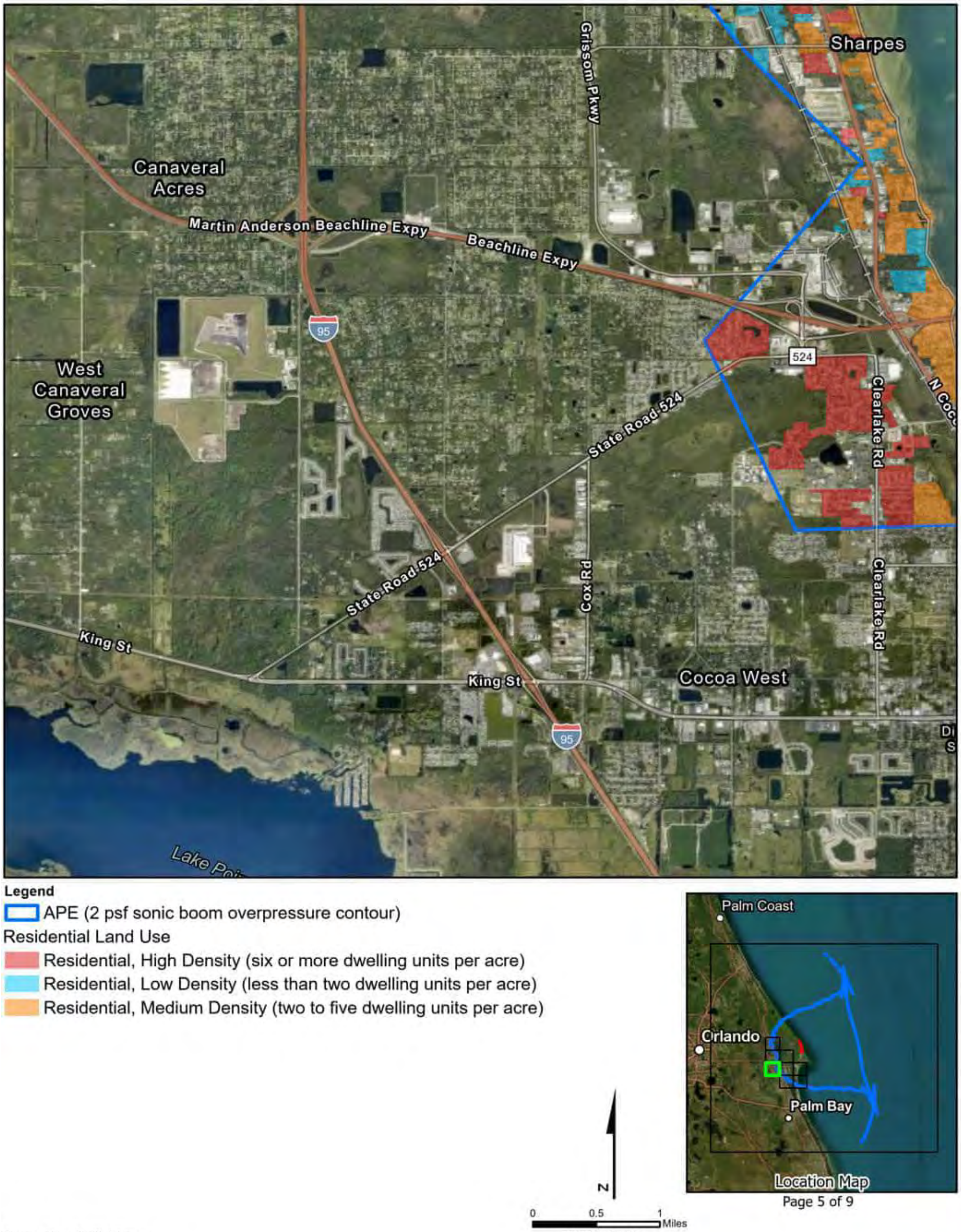
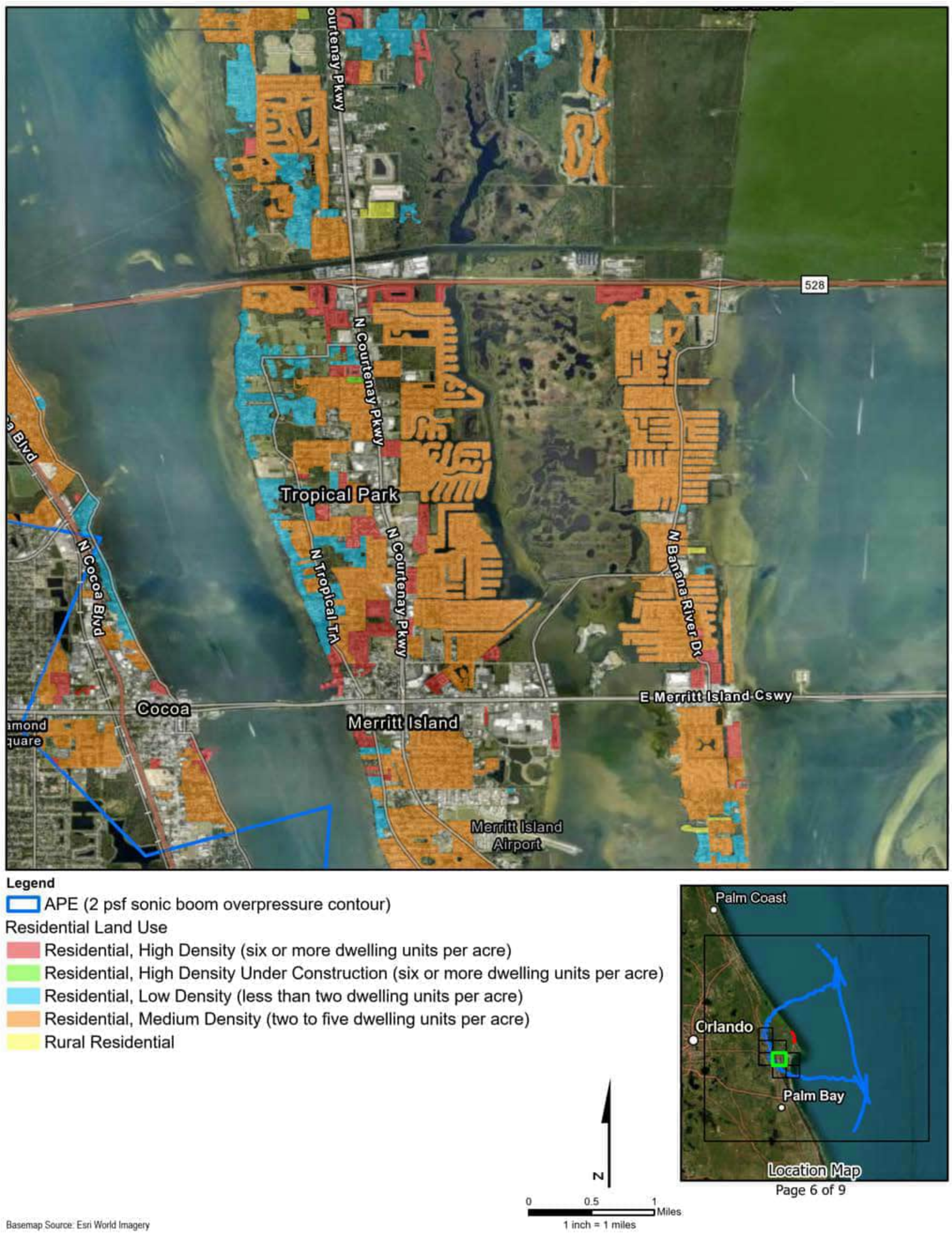


Figure 1-7. Area of Potential Effects (Page 5 of 9)



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2 **Figure 1-7. Area of Potential Effects (Page 6 of 9)**

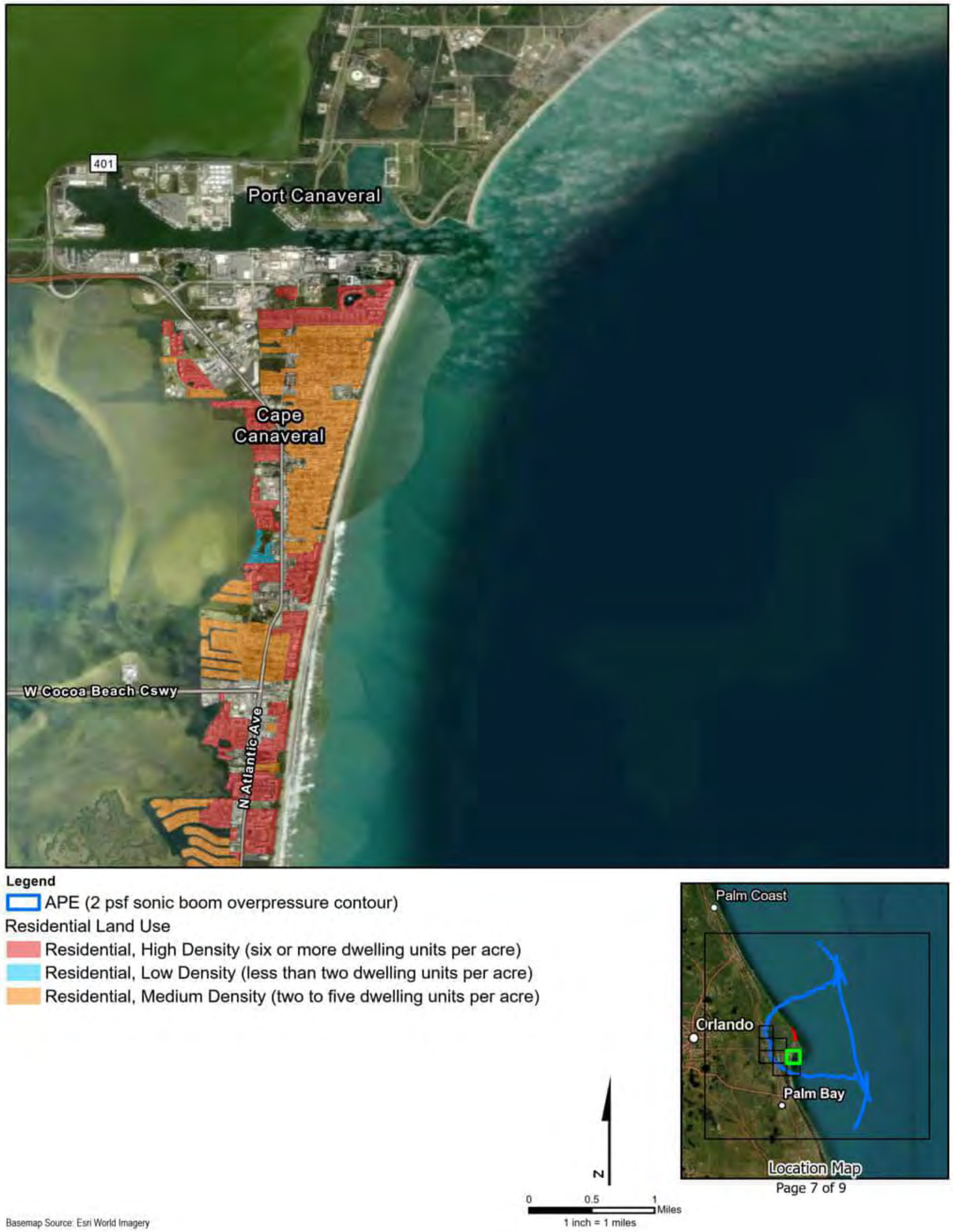


Figure 1-7. Area of Potential Effects (Page 7 of 9)

Figure 1-7. Area of Potential Effects (Page 8 of 9)

Figure 1-7. Area of Potential Effects (Page 9 of 9)

Photograph 4. A representative photograph of the APE taken to the north along Phillips Parkway and south of Astronaut Beach House, facing south (Jacobs, August 2024)

Photograph 5. A representative photograph of the APE taken near the Banana River west of Phillips Parkway and north of SLC-37, facing west (Jacobs, August 2024)

Photograph 6. A representative photograph of the APE taken north of SLC-37 along Phillips Parkway, facing east (Jacobs, August 2024)

Photograph 7. A representative photograph of the APE taken to the west of SLC-37 to Phillips Parkway, facing southwest (Jacobs, August 2024)

1.5 Government to Government Consultation

Historic properties of cultural importance to federally recognized tribes are present within the boundaries of CCSFS and likely intersect with the APE. These historic properties include archaeological sites, human burials, and grave sites. A separate Phase I archaeological survey report prepared for the CRAS discusses these properties.

The DAF is responsible for tribal consultation to comply with Section 106 of the NHPA. The Miccosukee Tribe of Indians of Florida, Seminole Nation of Oklahoma, and Seminole Tribe of Florida have expressed interest in serving as consulting parties for undertakings at CCSFS. If federally recognized tribes require government-to-government consultation, the DAF, through SLD 45, would direct such consultation.

2. Project Background

2.1 Environmental Context

Environmental variables, such as geology and climate, significantly influenced the type and extent of settlement patterns. Baseline information, including the U.S. Air Force's (USAF's) Integrated Cultural Resource Management Plan: 45th Space Wing (USAF 2023), the FMSF, and NRHP records, were reviewed. Jacobs' SOI-qualified staff reviewed historical and topographic maps, soil data, and other sources.

2.1.1 Climate and Elevation

The APE is in a humid subtropical climate with a dry season from December through May and a wet season from June through November. The average low is 51°F in January, and the average high is 90°F in August. April is the driest month, while September is typically the wettest month. Offshore ocean temperatures trend more moderate. Nearly half of Brevard County is classified as prone to flooding, particularly areas adjacent to water bodies (Brevard County 2024). The average elevation in the APE is approximately 6 feet above sea level (USGS 1976).

2.2 Cultural Context

The following section summarizes the historical period in Brevard County, which provides context for evaluating cultural resources identified in the APE. For further information on the prehistoric cultural setting, refer to the ICRMP (USAF 2023), which includes archaeological probability zones, and the archaeological report for the undertaking submitted under separate cover (Jacobs 2024).

2.2.1 Cultural Setting

CCSFS is within the archaeological east and central cultural area that stretches from the Florida border with south-eastern Georgia to the northern terminus of the Kissimmee River drainage wetlands and from the east coast of Florida west to within 30 miles (48 kilometers) of Tampa Bay (Milanich 1994). The earliest known evidence of human occupation at CCSFS dates to at least 5000 Before the Common Era, though exact dates are uncertain because of the lack of radiometric data.

2.2.2 Native American Tribes

Early cultural associations in the region are linked with the Ais people, who inhabited the area along the Indian River and east coast of Florida during the sixteenth and seventeenth centuries. Although no definitive lineage has been determined for the Ais, the Ais people are recognized as ancestors by the present-day Miccosukee and Seminole tribes. Thus, the Seminole Tribe of Florida, the Seminole Nation of Oklahoma, and the Miccosukee Tribe of Florida are consulted in treating Ais sites at CCSFS (USAF 2023).

2.2.3 Historical Cultural Setting

The following section provides an evaluative historical context for understanding the historic-era resources within the APE and surrounding area. The following historical context is summarized from the CCSFS ICRMP (USAF 2023). It has been expanded upon with other references, where necessary.

2.2.3.1 Cape Canaveral, Brevard County (before 1940)

Before Spanish exploration of Florida began in the early 1500s, the Native Americans that occupied the Cape Canaveral Peninsula (Cape) and Indian River region were known as the Ais (Rouse 1951). This group of people, whose population was approximately 600 to 1,500, relied on hunting, fishing, and gathering and were semi-nomadic. In 1513, Ponce de Leon reported that, while anchored offshore and attempting to land, the Ais attacked his crew. After this voyage, maps began referring to the Cape as Cabo de Canaveral, meaning "Cape of the Cane Break." In addition to the potential for previously unrecorded prehistoric sites, undiscovered historic sites may also be present at CCSFS. Maritime transport was prevalent during the historical period in the region, and numerous shipwrecks have been found submerged along the east coast of Florida (USAF 2023).

Several Spanish and French expeditions took place in Florida throughout the sixteenth century. By 1565, St. Augustine had been founded in northeastern Florida by the Spanish, which officially began the Spanish occupation of Florida that lasted 200 years. While the Cape and Indian River areas were still home to the Ais, they became fishing grounds for Spaniards by the mid-1700s. The French and English were also eager to explore Florida. They attacked Spaniards and Native Americans alike through the 1700s until Florida was given to Great Britain as part of the 1763 Treaty of Paris. When the American Revolution broke out in 1775, the Florida colony stayed loyal to the crown. Because of this loyalty, the crown distributed land grants for plantations throughout the region, including in the Indian River area. The final naval battle of the American Revolution occurred off the coast of Cape Canaveral in 1783, after the colonies and Great Britain signed a peace treaty (USAF 2023).

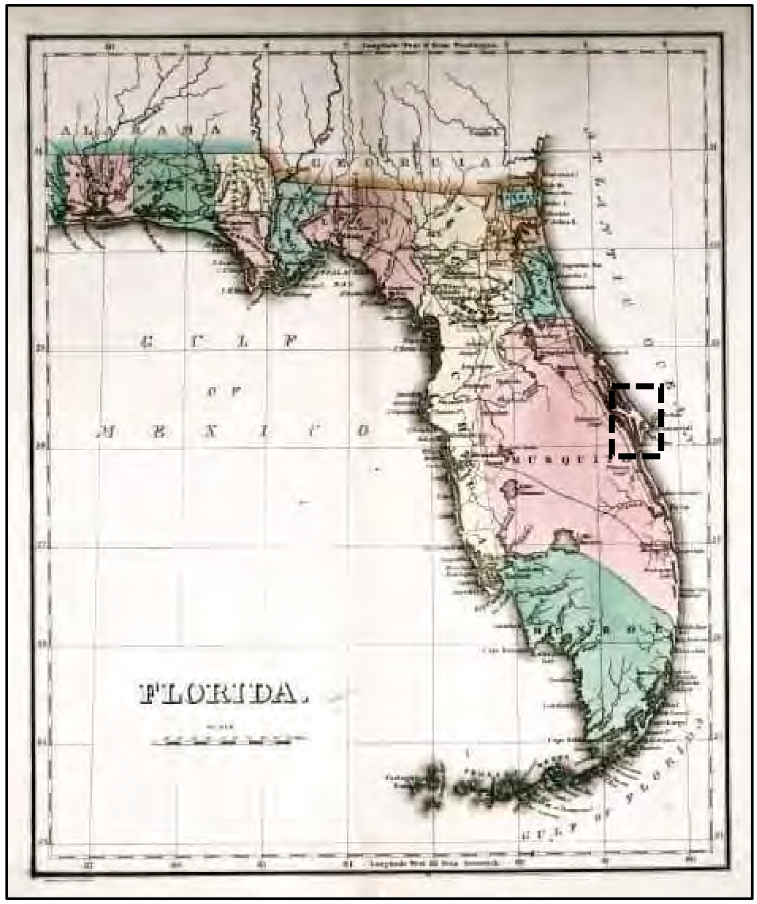
After the American Revolution, the British transferred Florida back to Spain, and Spain began issuing land grants. Many Americans were attracted to Florida, but Cape Canaveral was not a popular location for new landowners because of its isolation, sandy soils, and dense vegetation. Domingo Reyes, the inspector and overseer of the Spanish Royal Hospital, was a prestigious landowner in current-day Brevard County during this time. His sugar cane plantation was 43 miles north of Cape Canaveral and operated from 1804 to 1835. The U.S. wished to acquire Florida in the decades following the Revolution. After many failed military attempts and purchasing efforts to attain the Spanish colony, Spain transferred Florida to the U.S. by signing the Adams-Onis Treaty in 1819. In 1821, Florida became an official territory of the U.S. (USAF 2023).

At the time of U.S. acquisition, Cape Canaveral was part of Mosquito County, which extended from central Florida to the east coast (Drayton 1827). Figure 2-1 depicts Mosquito County in 1827, which had a population of only 700 counted persons by 1830. The Seminoles, a Muscogee-speaking Native American group, contested the U.S. occupation of Florida and fought a series of battles. After the First Seminole Indian War ended with the Treaty of Moultrie Creek in 1818, the Seminole people were placed into reservation lands. The American Indian Removal Act of 1830 established Indian Territory west of the Mississippi River. This was followed by the Treaty of Payne's Landing, ratified in 1834, which required Seminole Indians to cede their lands and move west. Although these treaties provided the means to expel the Seminole people, the southeastern tribe had forged alliances with Black warriors to combat U.S. forces (Monaco 2018; Florida Memory n.d.; Office of the Historian n.d.).

By 1835, the Seminoles led a rebellion against sugar plantations in Mosquito County, ending sugar production in central Florida (USAF 2023). The U.S. government sought to enforce the Treaty of Payne's Landing and suppress the Seminoles and their alliances so that no more extensive uprisings would occur among the Indigenous people in the Indian Territory and Black people in slavery (Monaco 2018). The Dade Battle between the Seminoles and the U.S. Army in December 1835 sparked the Second Seminole War (Florida Department of State n.d.a).

In response, U.S. military forces, composed of the St. Augustine Guard and led by General Joseph Hernandez, moved southward until reaching the Seminoles around Lake Monroe, northeast of Cape Canaveral. Hernandez established Fort Kingsbury at Lake Monroe before moving toward the Indian River, where they combined forces with the local militia Mosquito Roarers. These combined forces continued south while a naval force moved south along the Indian River.

Along the way, the U.S. military constructed Fort Ann, near Mosquito Lagoon; Fort Pierce, located at the southern mouth of the Indian River; and Haulover Canal, which gave access to the Atlantic Ocean from the Indian River (USAF 2023; Florida Department of State n.d.a). Although no peace treaty was ever signed, the Second Seminole War was considered over by 1842, when most Seminoles had been moved to Oklahoma.



Source: Drayton 1827
Blue dashed rectangle indicates approximate location of current day CCSFS.

Figure 2-1. Map of Florida from 1827

In 1842, the U.S. Congress passed the Armed Occupation Act with the intent of keeping Indigenous people from returning. The act gave tracts of land to any adult male head of household, provided they had lived in a farmstead for 5 years and cultivated at least 5 acres of land (Covington 1961). This act spurred settlement in parts of Florida that had been ignored, including current-day Brevard County, which had changed its name from Mosquito County to St. Lucie County in 1844. The name change occurred hoping to attract new residents, though it was not a successful campaign (Florida Memory 2018).

Douglas Dummett was given a tract of land near Fort Ann, where he established an orange grove in the 1840s. In 1848, a brick and wood lighthouse was built at Cape Canaveral to address safety concerns regarding shoaling off the Cape. The first lighthouse keepers were Nathaniel C. Scobie, followed by Ora B. Carpenter. Captain Mills Olcott Burnham was an engineer who became the lighthouse's keeper in 1853 and served there until he died in 1886. The fertile land along the Banana River was suitable for planting citrus trees and offered bountiful locations for making homesteads in the latter half of the nineteenth century (Manning and Hudson 1999; USAF 2023).

In 1845, Florida officially became a state, and Brevard County was established 9 years later. Theodore W. Brevard, the Florida Comptroller throughout much of the 1850s, is the namesake of Brevard County, and the current boundaries do not reflect the original county boundaries. Before Brevard County was formalized, it underwent a series of revisions. Brevard County originally encompassed St. Lucie County from Melbourne, extending south along the east coast to Broward County in south Florida. Cape Canaveral was originally part of Volusia County (Drew 1856) (Figure 2-2). By the 1840s, Euro-Americans settled Fort Ann and Haulover Canal in present-day Brevard County, and much of the Seminole population was pushed out of the state to Oklahoma. However, many Seminoles found a home in the Everglades (USAF 2023, Florida Department of State n.d.a).

Shows Cape Canaveral in Volusia County and part of Brevard County (Drew 1856). Blue dashed rectangle at right center of the figure indicates approximate location of present-day CCSFS.

Figure 2-2. Detail from 1857 Map of Florida

Florida remained relatively unscathed during the Civil War (1861 to 1865), as no significant battles were fought within the state. Union forces occupied many coastal towns, while the Confederacy occupied much of Florida's interior. Many Brevard County residents fought for the Confederacy, including citrus grove owner Douglas Dummett. On Cape Canaveral, the lighthouse was vandalized after Captain Burnham moved his family inland for safety, though they returned once the war was over (USAF 2023; Florida Department of State n.d.b).

Before the outbreak of war, the state was on track to become a major cotton producer. During the war, Floridians leveraged their success of supplying the Confederate army with meat. The meat was cured with salt to preserve it, making salt production a significant part of the Florida economy. Additionally, citrus from the Indian River region was used by both Union and Confederate doctors as a treatment method. Union ships had anchored off the shore of Cape Canaveral and controlled ports along the east coast of Florida, though the Confederacy used Mosquito Lagoon and Indian River (in Volusia and Brevard Counties) to smuggle in goods from British-controlled islands in the Caribbean. These goods were brought inland and then transported to Georgia and Tallahassee. Union forces launched unsuccessful raids throughout the Indian River region in 1862 and 1863 until they finally stopped Confederate smugglers by allocating a large number of ships along the coast of the Mosquito Lagoon (USAF 2023; Florida Department of State n.d.b).

By 1870, the population of Brevard County was approximately 1,216 (USF n.d.). Citrus growers in the Indian River region attracted residents and laborers by advertising available jobs, and Douglas Dummett's orange grove became one of the leading producers in the area. This increase brought recognition to Florida, which soon became a winter resort destination, attracting tourists and settlers alike. People traveled by railroads and tramways to Titusville, established in 1867 by Colonel Henry Titus, and took steamboats down the Indian River. This was the primary means of access to Cape Canaveral (Penders 2010; USAF 2023).

A new lighthouse was constructed on Cape Canaveral in 1868. By 1881, there were nine homesteads on the Cape along Banana River, most of which consisted of orange groves or residences with docks on the water. The first homes built on the Cape were one or two-story rectangular-frame buildings on pine post piers with cypress shingles. A post office was established on Cape Canaveral in 1882. The 1885 census lists seven households and a total population of 34 people. In 1885, a rail line was built through Titusville, and the town became a transportation hub for the Indian River area (Adams n.d.; USAF 2023).

In the 1890s, citrus groves were decimated by a series of freezes. Growers were forced to diversify their crops and grew tomatoes, guava, and pineapple. In 1895, a pier was built in Titusville on the Indian River that became a transfer point for freight and passengers to board steamboats headed south down the coast. The construction of this pier significantly increased the economy of the surrounding region, bringing new tourists, residents, and businesses, such as ice plants and canneries, to the area (Welcher 1989; USAF 2023).

Although the economy on the Cape had become diversified as a result of the development and growth related to the railroad and the construction of the Dixie Highway in 1915, Cape Canaveral remained rural, with under 100 people until the 1900s. The fruit industry was expanded further by the highway and truck transportation. Large cargo trucks could move freely along the expanded highway system to efficiently ship fruit to local markets. Trucks could also connect cargo between different modes of transportation, such as from ships to trains. As the commercial profitability of the area increased, the potential for investment in other regions followed. In 1917, a bridge was constructed between Cocoa Beach and Merritt Island at the south end of the Cape. This infrastructure created a real estate boom in Cocoa Beach, doubling the community's population from the previous decade. This boom was short-lived, however, as it collapsed by 1926 with the rest of the Florida economy after an embargo was enacted on shipments of lumber headed south (Welcher 1989; USAF 2023).

Present-day Cape Canaveral is located on the former location of smaller communities that developed in the late nineteenth and early twentieth centuries. Artesia was present on the southern peninsula of Canaveral. The community was established in the 1880s and had a post office by the 1890s. It remained sparsely populated, with approximately 25 homes and 1 school at its height in the 1920s. When the USAF bought Cape Canaveral, the Artesia post office and a few select homes were moved to North Atlantic Avenue in Cocoa Beach. The post office was reestablished in its new location and eventually renamed in 1954 (Penders 2014a; USAF 2023).

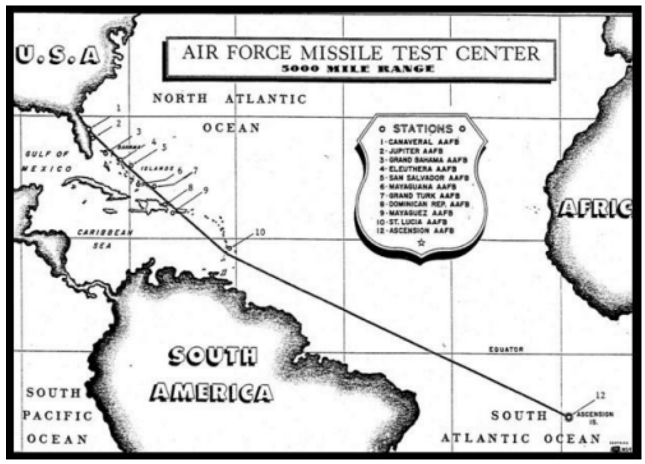
Through the 1920s and early 1930s, small communities developed on Cape Canaveral, including an art colony of approximately 20 houses in Lansing Beach. Canaveral Town was south of the art colony and included a library, post office, and school. Whidden's Center consisted of a store and a gas pump and was established near what is now the present-day Cape Canaveral landfill (Welcher 1989; Penders 2014a; USAF 2023). By the late 1920s, commercial enterprises had cropped up along with the residential communities. The Cape Fish Company, a commercial fishery, was on the beach southeast of the lighthouse. The fishery was a place to render sharks, using their fins, liver oil, and hides. In 1936, the fishery became a fishermen's cooperative. As the fishery served as home for many fishermen, the Cape Fish Company constructed dormitories and a communal dining room. The company was dissolved soon after the USAF purchased Cape Canaveral (Buchner et al. 2008; USAF 2023).

2.2.3.2 Cape Canaveral, Brevard County (post-1940 to 2020s)

In the 1940s, the federal government became interested in establishing a long-range proving ground in Florida. A committee formed by the DOD chose Cape Canaveral for a mission test center in 1946. The government chose this location because of the area's weather conditions and geographic isolation, proximity to the West Indies and South Atlantic islands, affordable land prices, and proximity to other nearby government-owned property. First known as Cape Canaveral Launch Area in 1949, it was renamed Operating Subdivision No. 1 in 1950. It was then known as Cape Canaveral Auxiliary Air Force Base from 1951 to 1955 and Cape Canaveral Missile Test Annex from 1955 to 1964. The facility was known as Cape Kennedy Air Force Station from 1964 to 1974, and as CCAFS from 1974 to 1994 and from 2000 to 2020, taking the designation Cape Canaveral Air Station from 1994 to 2000. The facility was renamed its present name (CCSFS) in December 2020 (USAF 2023; Thacker 2020).

Cape Canaveral was first used for military aviation during World War II. Authorized by the Naval Expansion Act of 1939, the Banana River Naval Air Station was established in 1940 to support antisubmarine sea-patrol planes until it was deactivated in 1947 (Lethbridge 2023). In 1948, the facility was transferred to USAF to become Patrick Air Force Base, renamed Patrick Space Force Base in 2020 (Space Coast Daily 2020). SLD 45 operates from Patrick Space Force Base, which is about 20 miles south of what is now CCSFS.

After World War II ended, an increased desire to secure the skies placed a demand on prime coastal locations where missile tracking and launch capabilities were possible. Low-populated areas were prioritized, but so were accessibility and weather. The former Banana River Naval Air Station site quickly became the prime candidate for a testing range in the eastern U.S. (McCormick 2016). In 1949, the Cape Canaveral Launch Area and Long Range Proving Ground was selected as part of a Joint Long Range Proving Ground for the USAF before being renamed Patrick Air Force Base. In 1950, an agreement was reached between the USAF and Great Britain that permitted a 1,000-mile range, with later extensions that increased the range to 5,063 miles (Figure 2-3). The installation was redesignated multiple times throughout the twenty-first century, reaching a coverage area of 10,000 miles from the Florida mainland, through the South Atlantic, and into the Indian Ocean. The range was renamed the Eastern Range when the 45th Space Wing, now known as SLD 45, assumed operational control in 1991.



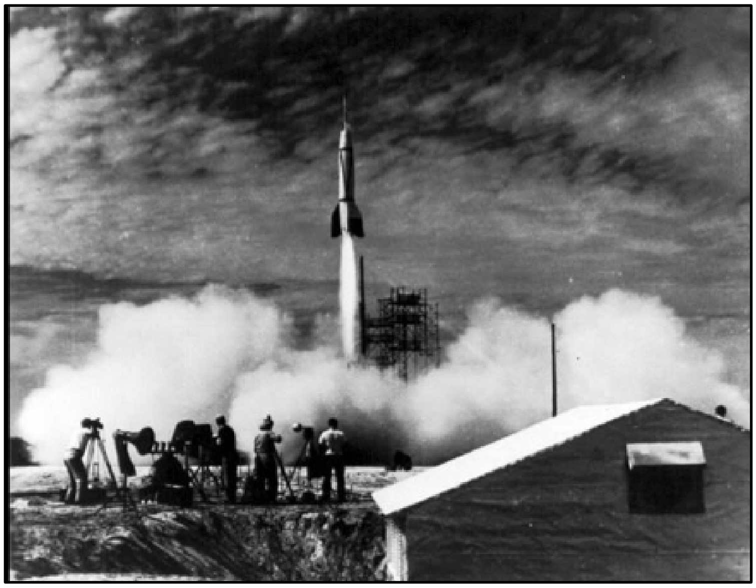
Source: Air Mobility Command Museum 2024

Figure 2-3. The Eastern Test Range, circa 1950

CCSFS was built as the primary launch site for the Eastern Range. The infrastructure supporting the CCSFS, such as missile launch pads, support facilities, new roads, and tracking stations, was constructed in the early 1950s. In the 1960s, support buildings were developed to be flexible to support operational changes needed for research programs testing new missile types and missile control systems, and this period in military aviation and engineering focused on exploring fundamental performance principles at high velocity and even higher altitudes. It also offered a glimpse into the astronautical future.

In the mid-1940s, modified German V-2 and WAC Corporal sounding rockets or two-stage combination liquid-fuel Bumper-WAC sounding missiles were tested at the White Sands Proving Grounds, now known as White Sands Missile Range, in New Mexico. The Bumper program is attributed to a research-focused missile policy authored by General Toftoy at a June 13, 1946, meeting held between Army Ordnance, General Electric, and Jet Propulsion Laboratory. The Bumper-WAC, however, was built by Douglas Aircraft and the Guggenheim Aeronautical Laboratory in association with the Jet Propulsion Laboratory at the California Institute of

Technology. The seventh Bumper-WAC missile, Bumper 8, was notably the first missile launched at CCSFS on July 25, 1950 (Starr 2001; Lethbridge 2023) (Figure 2-4).



Source: USAF 1950

Figure 2-4. Launch of First Missile from CCSFS, Bumper 8, on July 25, 1950

Cruise missile weapons testing at CCSFS was followed by additional testing in 1953, including the Matador, Snark, and Bomarc missiles (NPS n.d.). Cruise missiles are similar to their predecessors, the German V-1 missiles. During World War II, thousands of jet-propelled V-1 missiles, commonly known as buzz bombs, were used to strategically target London from 1944 to 1945. V-1s were designed to carry sizable loads to guided locations with a basic pulse-jet engine speed between 150 and 400 miles per hour after they were unloaded from airplanes or catapults. The first large American ballistic missile, the Redstone, was launched from CCSFS in 1953. LC-5/6 was constructed specifically for the Redstone. The U.S. and Soviet Union “Space Race” reached its zenith with the launch of Sputnik I in 1957. Juno 1, a version of the Redstone missile, launched Explorer 1, the first U.S. orbital satellite, in 1958.

The Atlas was the first U.S. ICBM. Although the U.S. Army Air Force initiated the Atlas program to study its potential to carry nuclear warheads in 1946, the first full-range launch of the Atlas missile was in 1958 (Neufeld 1990). The first satellite launches and manned missions that tested potential astronaut abilities in space, known as the Mercury and Gemini flights, were launched from CCSFS. The Gemini flights are noted as the beginning of sophisticated manned space flights (NPS n.d.; USAF 2023). Project Gemini bridged the Mercury and Apollo programs and tested equipment and mission procedures in Earth orbit (NASA 2023).

When the Manned Lunar Landing Program was initiated in 1961, the land across the Banana River from CCSFS on Merritt Island was chosen as the launch center for the Apollo program and later became KSC. By the early 1960s, the existing CCSFS facilities were modified, and new facilities were constructed to assist with the new manned and unmanned space programs (USAF 2023). Project Mercury had flown two successful suborbital crewed missions and was readying its first orbital mission in early 1962 (Uri 2021).

On February 20, 1962, Project Mercury launched Astronaut John Glenn from SLC-14 aboard Friendship 7. This was the first crewed American orbital spaceflight and the fifth human spaceflight following two Soviet orbital flights and two American suborbital flights (Figure 2-5). This event garnered Glenn the honor of being the first American to orbit the Earth. In 1984, the event was declared nationally significant as part of the CCAFS NHL District; in 2011, the event was named an Institute of Electrical and Electronics Engineering Milestone (USAF 1983; IEEE 2024).

Source: NARA 2023

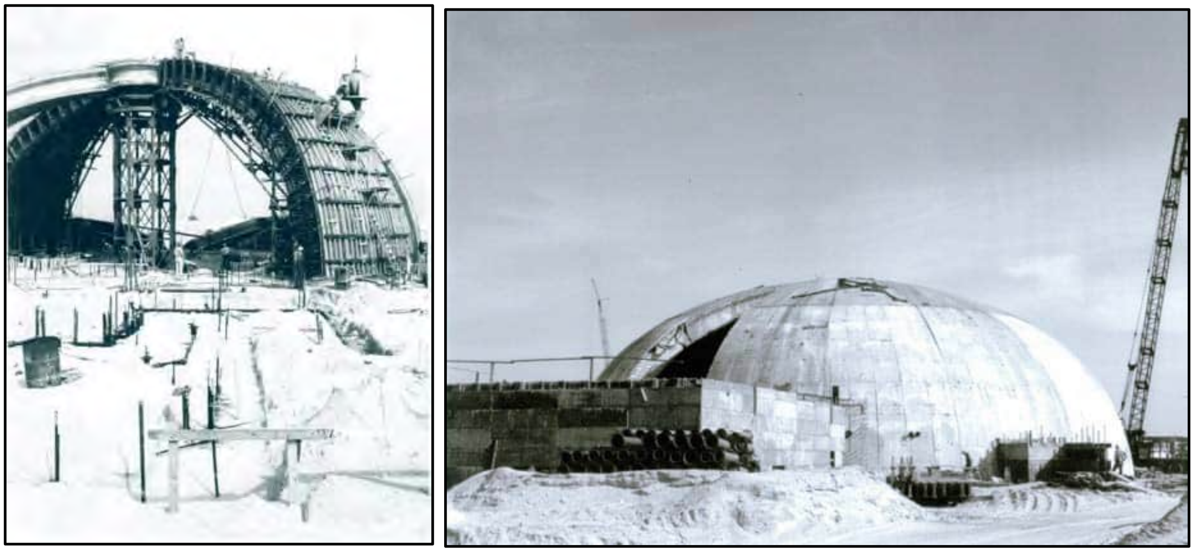
Figure 2-5. Project Mercury Astronaut Glenn Boards Friendship 7 on February 20, 1962

Following Glenn's successful mission, President John Kennedy broadly declared, "We choose to go to the Moon", when he addressed the American public at Rice University on September 12, 1962 (Rice University 2024). Kennedy's impassioned speech further described the Saturn program, which facilities at CCSFS supported:

> In the last 24 hours, we have seen facilities now being created for the greatest and most complex exploration in man's history. We have felt the ground shake and the air shattered by the testing of a Saturn C-1 booster rocket, many times as powerful as the Atlas which launched John Glenn, generating power equivalent to 10,000 automobiles with their accelerators on the floor. We have seen the site where five F-1 rocket engines, each one as powerful as all eight engines of the Saturn combined, will be clustered together to make the advanced Saturn missile, assembled in a new building to be built at Cape Canaveral as tall as a 48-story structure, as wide as a city block, and as long as two lengths of this field (President John F. Kennedy at Rice University on September 12, 1962) (Rice University 2024).

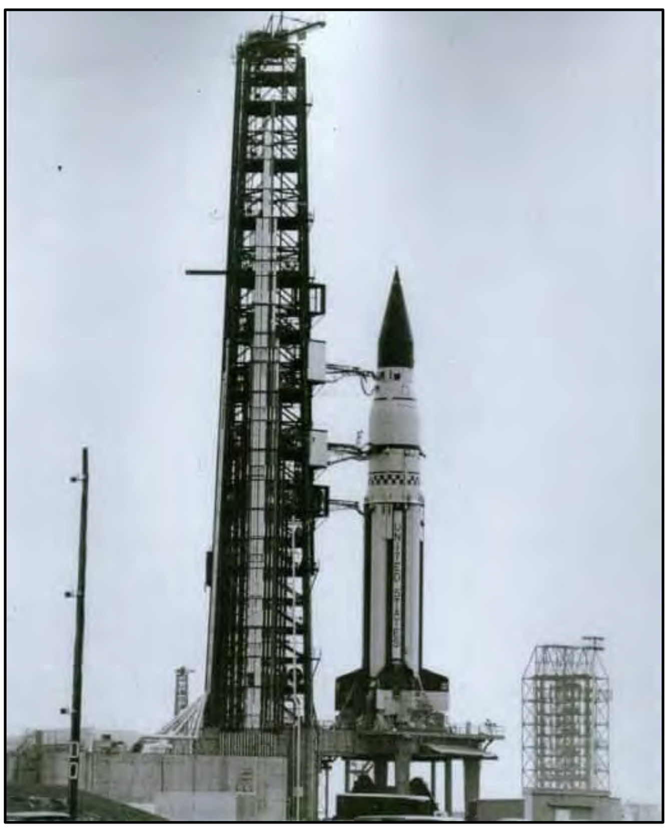
SLC-37 was designed to support the Saturn program. It was designed with a single blockhouse and two launch pads (Launch Pad 37A and Launch Pad 37B), though only Launch Pad 37B was fully completed. The program launched large Saturn rockets capable of reaching the Moon. The program began in 1957. At this time, Wernher von Braun and fellow engineers, who were at the Army Ballistic Missile Agency at the Redstone Arsenal in Huntsville, Alabama, devised a new rocket with a 1.5 million-pound thrust that would become Saturn I. On February 3, 1959, the DOD's Advanced Research Project Agency authorized the engineers to proceed with Saturn, a medium-lift launch vehicle, with the newly formed NASA (Uri 2021; Lethbridge 2023).

SLC-37 was constructed in 1962 (Figure 2-6). The complex's LCC (FMSF No. BR02790) blockhouse was erected as the control center for Saturn I and Saturn IB launches. The building was constructed with a circular plan and dome design similar to other CCSFS launch control centers of the same period, including those at SLC-13, SLC-14, SLC-19, and SLC-34. Of these, the building at SLC-37 is the largest, as each building was scaled to the systems used at their complex. Though two launch pads were planned (Launch Pad 37A and Launch Pad 37B), Launch Pad 37B was the only one completed (Figure 2-7).



Source: Lethbridge 2023

Figure 2-6. The LCC at SLC-37 under construction in 1962



Source: Lethbridge 2023

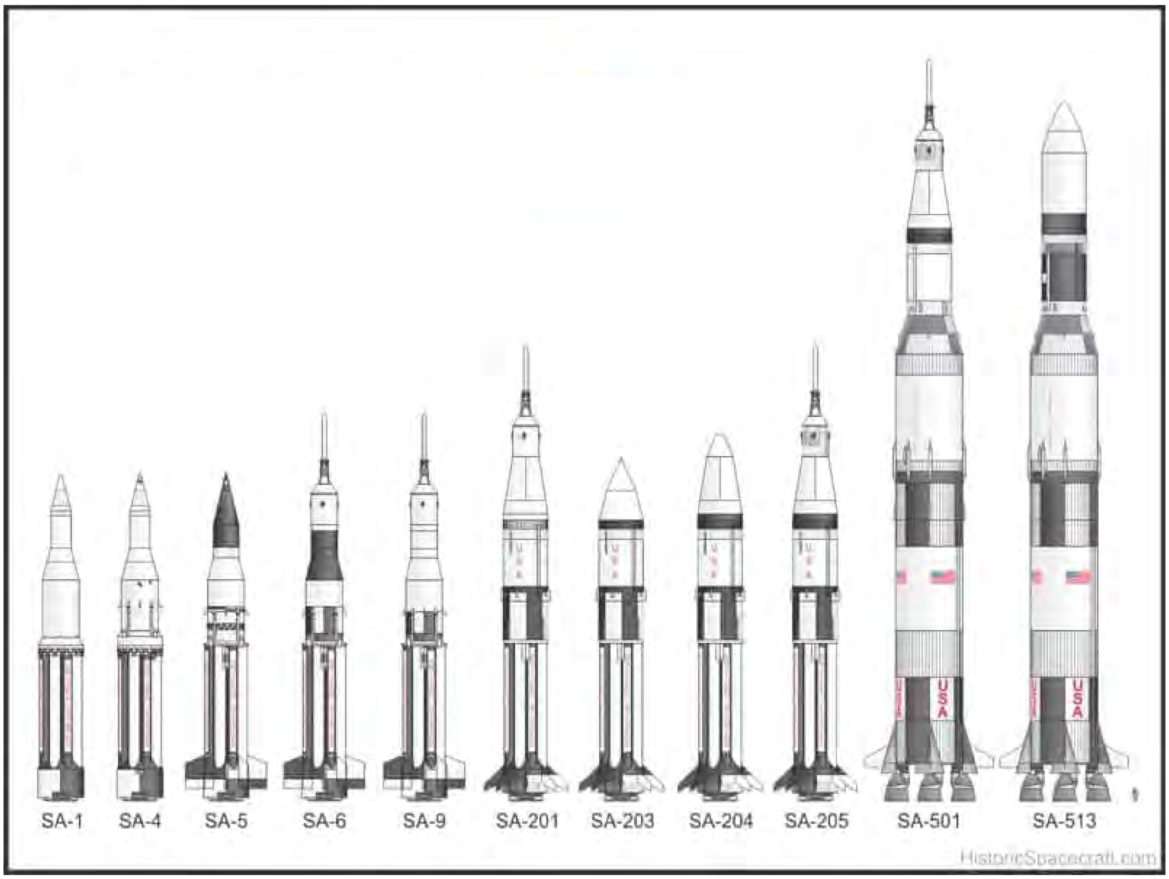
Note: Saturn I Block II stood in place at SLC-37's Launch Pad 37B in 1964 and was later substantially modified in 2009.

Figure 2-7. Saturn I Block II

The Saturn rocket was designed with legacy hardware (Figure 2-8). John Uri describes the rocket in *60 Years Ago: First Launch of a Saturn Rocket* (Uri 2021):

> The booster stage consisted of a core liquid oxygen (LOX) tank derived from the Jupiter rocket surrounded by eight tanks modified from the Redstone missile, four containing RP-1 kerosene and four containing LOX, powering a cluster of eight H-1 engines, upgraded versions of powerplants used on Thor and Jupiter rockets. Use of legacy hardware minimized the retooling needed and lowered overall development costs.

The Saturn rocket family saw 32 launches between 1961 and 1975 at CCSFS. These rockets included the Saturn I (10 launches), Saturn IB (9 launches), the three-stage Saturn V (12 launches), and the two-stage Saturn V (1 launch). The Saturn rockets supported the Apollo lunar missions, the launch of the Skylab space station, ferried crews to and from Skylab, launched the American half of the Apollo-Soyuz Test Project, and experienced no catastrophic failures in flight (Historic Spacecraft 2023).



Source: Historic Spacecraft 2023

Figure 2-8. Saturn Rocket Family

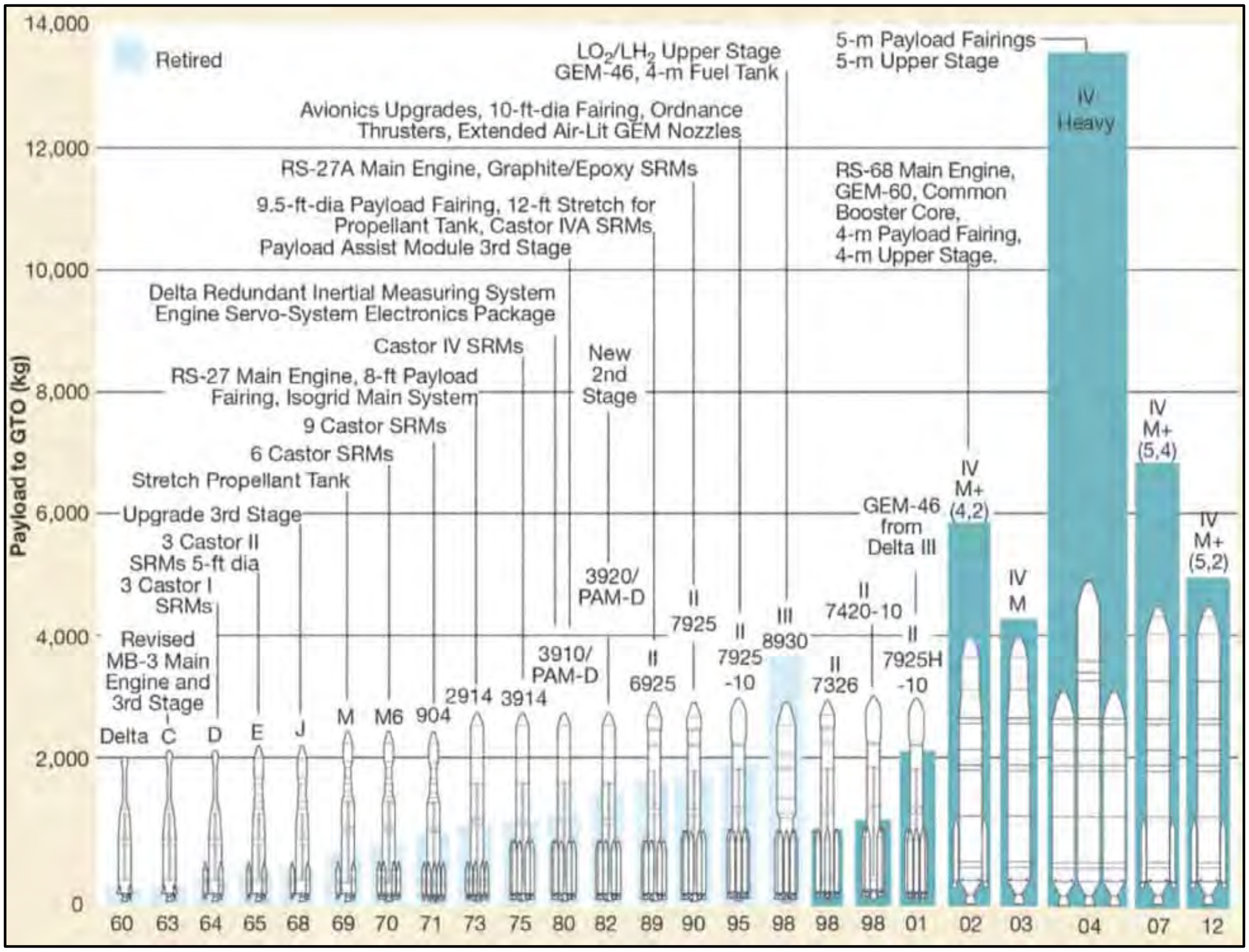
In the latter half of the 1960s, a gradual decline of operations at CCSFS occurred as the station could no longer house new rocket facilities (NPS n.d.). The Saturn was retired in 1965, and SLC-37 was mothballed in the 1970s. NASA operations were moved to KSC, and most facilities were either adapted for other uses or deactivated. Some facilities were transferred to NASA in the early 1960s, while others were returned to USAF control, such as SLC-37. Eventually, USAF launch programs consisted of only ballistic missile operations and commercial launch vehicles. The Patrick Space Force Base operates as the center of administrative activities of the CCSFS (USAF 2023).

In 2001, SLC-37 was reactivated for the Delta IV launch system operated by ULA, a Boeing and Lockheed Martin partnership. The original launch pedestal and umbilical towers had been removed when the complex was mothballed in the 1970s. Except for the LCC, the complex was unused for approximately 30 years. The LCC had remained in use as storage and offices. To accommodate the new vehicle, SLC-37 was rehabilitated by ULA. The complex saw substantial changes to Launch Pad 37B (FMSF No. BR02366) and new facilities were built, such as the Launch Support Shelter (FMSF No. BR02452).

As one of the longest-running rocket programs, the Delta rocket came online when the USAF launched its first operational ballistic missile on May 13, 1960, from SLC-17 (ULA 2024a). The Delta was one of the oldest and most reliable American rockets until its last generation of Delta IV Heavy was launched by ULA for the National Reconnaissance Office’s NROL-70 mission from SLC-37 on April 9, 2024 (Klotz 2024). This was the sixteenth launch of a Delta IV Heavy rocket (ULA 2024c). The NROL-70 launch marked the end of the Delta era and the future of Heavy lift through ULA’s next-generation Vulcan rocket.

In total, over the Delta era, there were 389 Delta launches, with 294 from the East Coast and 95 from Vandenberg Space Force Base in California. The Delta rockets initially measured 90 feet in height and had a mass of 112,000 pounds (50,800 kilograms) and increased in size with the Delta IV Heavy measuring 235 feet tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Lift-off thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a, 2024b) (Figure 2-9).

The twentieth century saw the development of the space industry, which transformed the surrounding communities, including Cocoa Beach and Titusville. Populations increased, meaning social and educational amenities also had to be modified to accommodate the influx of new residents. Additionally, a new tourism industry emerged as the area became known as the “Space Coast” (USAF 2023). The CCSFS now includes six launch pads, a mobile service tower, and the original Mission Control Center used for Mercury and three Gemini flights (NPS n.d.).



Source: ULA 2024a, 2024b

Figure 2-9. Delta Rocket Family

2.2.3.3 Starship-Super Heavy Launch Vehicle (2020s and beyond)

To further national security and space exploration, SpaceX's Starship spacecraft and Super Heavy rocket, known as Starship, is a fully reusable transportation system designed to carry crew and cargo to Earth's orbit, the Moon, Mars, and beyond (SpaceX 2024). Starship follows the path of technological advancements and the long history of both Saturn and Delta rocket families, having launched from SLC-37 at CCSFS. Physical changes and technological upgrades help further space exploration and contribute to the enduring legacy of CCSFS and the national space program.

Super Heavy-lift rockets are powerful and versatile technology. They are designed to carry crew and large-volume payloads, such as habitats, probes, space stations, or telescopes, into low Earth orbit at one time. This method reduces the number of launches and rendezvous required for complex missions, making such complex missions possible. Starship can carry up to 100 people or 150 MT (330,000 pounds) of cargo each mission (Wall 2022; Keep Track 2023; SpaceX 2024). Starship is one of several Super Heavy-lift vehicles being explored by countries such as China, Russia, India, and the U.S. Another Super Heavy rocket is NASA's Space Launch System, which is being used for deep space exploration and the Artemis program (NASA 2024).

3. Methodology

Chapter 2 in AFMAN 32-7003, *Environmental Conservation,* is dedicated to the Cultural Resources Management of USAF properties, such as those at CCSFS. As defined in Section 2.2: "The Air Force's mission includes protecting our nation's heritage, as well as its people and borders" (USAF 2020). Thus, CCSFS has been extensively and continuously inventoried and documented using conventional and innovative methodologies. To identify historic properties in the APE, this report presents the information gathered using both desktop research and fieldwork methods.

Between January and June 2024, Jacobs' SOI-qualified cultural resources specialists reviewed the record results for the initial 130-dB APE from SLD 45, SHPO, and NASA, and the NPS's online databases and interactive maps. In November and December 2024, the cultural resources team conducted supplemental desktop research for the expanded 2-psf APE, reviewing SHPO records in the FMSF and additional previous cultural resources investigations provided by SLD 45. The team contacted local historic preservation agencies to identify locally significant resources; Titusville and Brevard County had historic inventories readily available for review. The team also accessed supplemental literature from SLD 45, NASA, NPS, and other online sources to review interactive maps and historical contexts, such as the space race and associated development. The team collected supplementary information from the ICRMP (USAF 2023), FMSF, and other credible sources to confirm construction dates, modifications, and other pertinent information. In addition, the team gathered parcel data from Brevard County and the State of Florida, including construction dates and materials for parcels in the APE.

In light of the highly scientific and technical nature of the CCSFS, the cultural research team referenced *Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities* (ACHP 1991) to aid in understanding the application of Section 106 to technical resources, specifically when assessing effects. Additionally, the team evaluated structures recorded from the Cold War era (1945–1991) within historical contexts, following guidance in the CCAFS NHL nomination; DOD's *Programmatic Approaches to the Management of Cold War Historic Properties* and *Historic Context for Evaluating Mid-Century Modern Military Buildings*; NPS's *Protecting America: NHL Cold War Theme Study*; and the USAF's *Cold War Historic Properties of the of the 21st Space Wing* (NPS 1984; Van Critters 2015; Hampton et al. 2012; Salmon 2022; Hoffecker et al. 1996).

The NHPA requires federal agencies to consider effects to historic properties when carrying out an undertaking. Because of the size of the APE and the low likelihood of adverse effects on historic properties beyond CCSFS boundaries, the DAF made a reasonable and good faith effort to identify historic properties through background research, consultation, and limited field survey (36 CFR 800.4(b)(1)). The current NRHP status of known historic properties in the APE was not reviewed or changed.

For new evaluations, the cultural resources team consulted National Register Bulletins published by NPS, such as *How to Apply the National Register Criteria for Evaluation* (*National Register Bulletin* 15), to evaluate possible historic properties for this report. To be eligible for inclusion in the NRHP, a property must meet the requirements of at least one of the following four primary NRHP criteria (Shrimpton and Andrus 1997):

- Criterion A–Event: Associated with events that have made a significant contribution to the broad patterns of our history.
- Criterion B–Person: Associated with the lives of persons significant in our past.

- Criterion C–Design: Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction.
- Criterion D–Information Potential: Have yielded or may be likely to yield information important in prehistory or history.

Additionally, properties must retain enough integrity to demonstrate their significance under the criteria. The NRHP recognizes seven aspects of integrity: setting, feeling, association, location, materials, design, and workmanship. Even if a property meets the criteria, it must retain sufficient integrity to convey that significance to be eligible for listing in the NRHP. Generally, properties must be at least 50 years of age to be eligible for the NRHP unless proven to have exceptional importance.

The APE was reviewed for resources built in or before 1980 (or 45 years before the time of reporting). The APE spans CCSFS, most of KSC, and several Indian River communities in Brevard County. The communities are densely built urban areas with 24,373 parcels (47 percent of the parcels in the APE) having historic age resources built in or before 1980. Most of these historic age resources were constructed in the 1960s (12,908 parcels), and most are masonry construction (86 percent of the parcels in the APE). To present the many properties in the APE in a more accessible manor, the cultural resources team created an ArcGIS dashboard to show the historic properties previously identified in the APE along with some of their characteristics, such as date of construction, and to aid in future analysis. With the DAF's and SpaceX's consent, it can be made available to share with consulting parties.

Because of the large scale of the APE and low probability of effects, new historic property evaluation was limited to the unevaluated resources at SLC-37. SLD 45 had identified the need for a historic structures survey of previously unrecorded or unevaluated historic structures associated with SLC-37, including some resources outside the fence line that were constructed to support SLC-37. SLC-37 was previously determined not eligible for listing in the NRHP and, therefore, did not qualify as a historic property or require reevaluation. On July 18, 2024, the cultural resources team conducted a historic structures survey as part of a CRAS for SLC-37. The historic structures survey was carried out at the direction of the DAF through the SLD 45 Cultural Resources Manager following AFMAN 32-7003 and in compliance with Section 106 (54 U.S.C. Section 306108) and its implementation regulations (36 CFR Part 800).

An FMSF form was prepared for each extant historic structures identified in the construction area and these structures are evaluated in this report using federal standards published by the *Federal Register* as the *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* on September 29, 1983, and AFMAN 32-7003 with guidance from *Module Three Guidelines for use by Historic Preservation Professionals* (Florida DHR 2021). Extant historic structures were evaluated if they were either unrecorded and/or unevaluated resources built 45 years ago or before 1980. FMSF forms were not prepared for resources outside the construction area or for those with eligibility determinations on file with SLD 45. In total, 10 FMSF forms were prepared for previously unevaluated historic structures associated with SLC-37 (refer to Table 1-2 for the list). Information on municipal properties identified by the literature review is provided in Appendix B.

A summary of previous studies and previously recorded resources is presented in Section 4.

4. Literature Review Results

The literature review revealed that the portion of the APE that covers CCSFS has been studied through cultural resources investigations since the 1970s. The FMSF records revealed an extensive history of historic structures surveys at CCSFS and KSC, as well as the greater surroundings, supporting an understanding of what types of resources are present and where potential historic properties may be identified in the future. The literature review found 236 previous Cultural Resources Assessment Surveys in the APE, of which 61 included notable historic structures survey components. The surveys documented the following:

- 1,759 previously recorded resources documented in the FMSF, with additional locally significant resources in inventories kept by municipalities and Brevard County
- Two NHLs–the CCAFS NHL District (FMSF No. BR00216) and the Aladdin Theater (FMSF No. BR00282) in Cocoa
- 340 previously recorded individual historic properties and 351 previously recorded contributing resources (691 historic properties, including the 2 NHLs)
- 665 previously recorded resources with undetermined eligibility for listing in the NRHP

Although 691 historic properties are identified in the APE, only one is in the construction area: the LCC (FMSF No. BR02790).

The APE contains 24,373 parcels (47 percent of parcels in the APE) with historic-age resources built in or before 1980 (or 45 years before the time of reporting), most of which lack an eligibility determination. Most of these historic-age resources were constructed in the 1960s (12,908 parcels). Most resources are masonry construction (86 percent of parcels in the APE). No comprehensive data are available for condition assessments in the APE, and the available sampling is not statistically viable for derived opinions on the current status of historic integrity or condition for resources outside of CCSFS. Thus, the physical condition and historic integrity of historic properties outside CCSFS is unknown.

The historic properties are recorded in the FMSF and maintained in a historic structure inventory by the SLD 45. The FMSF categorizes historic structures into Resource Groups and Individual Structures or Standing Structures. Resource Groups are historic districts, archaeological districts, or building complexes; contributing resources are usually, but not always, recorded separately as Individual Structures in the FMSF (Bureau of Archaeological Research 2019).

Of the 340 individual historic properties identified in the APE, the FMSF records indicate that the previously recorded historic properties include the following:

- 3 bridges
- 5 cemeteries
- 41 districts
- 291 individual buildings or structures

The FMSF contains records for 351 contributing resources in the APE.

Each previously recorded historic property is either individually eligible, a district, or a contributing resource to an eligible or listed NRHP district or the CCAFS NHL District. At CCSFS and KSC, the historic properties are associated with CCSFS and its historical use as an active launch ground since the late 1950s or are utilitarian structures for public infrastructure, except for the Beach House (FMSF No. BR02990) (built 1962) and Cape Canaveral Lighthouse (FMSF No. BR00212) (built 1868 and relocated in 1894) and its associated resources. The

CCAFS NHL District is designated a nationally significant historic property (refer to Section 4.2 and Appendix C for further detail).

4.1 Previously Conducted Cultural Resources Surveys

The FMSF indicates that 236 Cultural Resource Assessment Surveys were previously conducted in the APE, 61 of which had notable historic structure components (Table 4-1). Seven surveys intersect with the construction area at SLC-37. Table 4-1 is an overview of cultural resources surveys with notable historic structure components.

Table 4-1. Previously Conducted Historic Structures Surveys within APE

Survey No. (MS No.)	Year	Project Title	Organization	Authors
00260[a]	1978	*Cultural Resource Reconnaissance of Merritt Island National Wildlife Refuge*	Cultural Resource Management, Inc.	Griffin, John W., and James J. Miller
00751	1982	*Archaeological and Historical Survey of the United Space Booster facility Tract, Merritt Island*	Ankerson, Stottler & Stag	Miller, James J.
01150[a]	1984	*An Architectural and Engineering Survey and Evaluation of Facilities at Cape Canaveral Air Force Station, Brevard County, Florida*	Resource Analysts, Inc.	Barton, David F., and Richard S. Levy
01339	1976	*Canaveral National Seashore: Assessment of Archaeological and Historical Resources*	Sponsored by U.S. National Park Service	Ehrenhard, John E.
01472	1987	*Historic Properties Survey: Cocoa, Florida*	City of Cocoa	Historic Property Associates, Inc.
01567	1987	*Historic Properties Survey, Titusville, Florida*	City of Titusville	Historic Property Associates, Inc.
01676	1988	*A Cultural Resource Survey of Three Project Areas at Merritt Island National Wildlife Refuge, Brevard County, Florida*	Sponsored by U.S. Fish and Wildlife	Ehrenhard, John E.
02037	1989	*Historic Properties Survey of Cocoa, Florida*	City of Cocoa	Adams, William R., Steve Olausen, and Paul Weaver
02368	1990	*Historic Properties Survey of Rockledge, Florida*	Florida Division of Historical Resources	Olausen, Stephen A.
02835	1991	*Historic Properties Survey within the City of Cocoa, Florida*	Historic Property Associates, Inc.	Adams, William R., and Rober Bennett Jr.
02844	1991	*Historic Building Survey: Merritt Island, Florida*	Historic Property Associates, Inc.	Olausen, Stephen A.
02860	1991	*Historic Resources Survey: Payload Spintest Facility, Cape Canaveral Air Force Station, Brevard County, Florida*	Eastern Space and Missile Center	Neilsen, Jerry, and Ernie Seckinger

Survey No. (MS No.)	Year	Project Title	Organization	Authors
02947	1991	*Historic Resources Survey, Chemical Testing Laboratory, Wastewater Treatment Facility, Command Control Building Addition Fence, Cape Canaveral Air Force Station, Brevard County, Florida*	Eastern Space and Missile Center	Neilsen, Jerry, and Ernie Seckinger
05474	1998	*Survey and Evaluation of the Historic Facilities within the Industrial, Launch Complex 39 (LC-39), Vehicle Assembly Building (VAB), and Shuttle Landing Facility (SLF) areas of the John F. Kennedy Space Center (KSC), Brevard County, Florida*	Archaeological Consultants, Inc.	Delahaye, Daniel, Joan Deming, and Kimberly Hinder
07782	2001	*Cultural Resource Survey: Proposed Cell Tower #812297 Cape Canaveral, Brevard County, Florida*	Southeastern Archaeological Research, Inc.	Carlson, Betsy
11239	1991	*Multiple Property Submission for Historic Cultural Resources of the John F. Kennedy Space Center, Florida*	Archaeological Consultants, Inc.	Delahaye, Daniel, and Kimberly Hinder
11658	2005	*An Inventory and Evaluation of the Cocoa National Guard Armory, Brevard County, Florida*	Sponsored by Florida National Guard	Stokes, Anne V.
13170	1994	*Historic American Engineering Record of Complex 19, Cape Canaveral Air Station, Cape Canaveral, Florida*	Tri-Services Cultural Resources Research Center	McCarthy, Shiela, Susan Enscore, and Patrick Nowlan
13171	1994	*Historic American Engineering Record of Complex 13, 26, 36, Cape Canaveral Air Station< Cape Canaveral, Florida*	Tri-Services Cultural Resources Research Center	McCarthy, Sheila, Susan Enscore, and Patrick Nowlan
13600	2006	*Launch Complex 21/22 District, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
14138[a]	1994	*Historic Properties Survey, Cape Canaveral Air Force Station, Brevard County, Florida*	Ebasco Services Inc. and New South Associates	Cantley, Charles E., Mary Beth Reed, Leslie Raymer, and Joe Joseph
14319	2007	*A Historic Property Survey of the Vertical Integration Building (VIB), Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
15932	2008	*Historic Properties Survey, Cape Canaveral Air Force Station, Brevard County, Florida*	Archaeological Consultants, Inc.	Deming, Joan, Elizabeth Horvath, and Justin Winkler
16231	2010	*Determination of Eligibility for Launch Complex 25/29, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, US Air Force Environmental Flight	Penders, Thomas E.

Survey No. (MS No.)	Year	Project Title	Organization	Authors
16288	2009	*National Register Determination of Eligibility and Documentation for the North Cable Terminal Building (Facility 1664), Cape Canaveral Air Force Station, Florida*	45th Space Wing, USAF	Hawkins, Dale K.
17581	1993	*Determination of Eligibility of Launch Complexes and Related Facilities for Listing on the National Register of Historic Places, Cape Canaveral Air Force Station, Cape Canaveral, Florida*	US Army Corps of Engineering, CERL	McCarthy, Sheila
17646	2003	*Cape Canaveral Air Force Station Launch Complex 14 East Side of ICBM Road, 1.3 Miles North of Intersection with Central Control Road*	Archaeological Consultants, Inc.	Hinder, Kimberly
17880	2006	*Cultural Resources Evaluations of the Original Lighthouse Site (8BR234), the Cape Canaveral Lighthouse Site (BR212), and the New Lighthouse Site (BR1660), Cape Canaveral Air Force Station, Brevard County, Florida*	Sponsored by 45th Space Wing, USAF	Baxter, Carey L., and Tad Britt
18046	2010	*Historical Survey and Evaluation of the Space Station Processing Facility, John F. Kennedy Space Center, Brevard County, Florida*	Archaeological Consultants, Inc.	Deming, Joan, Christine Newman, and Patricia Slovinac,
18373	2011	*Historic Structures Assessment Survey US 1 from Rosa L. Jones Drive to Pine Street and US 1 from Pine Street to Cidco Road, Brevard County, Florida*	E Sciences, Inc.	Salo, Edward, and Ryan Vandyke
18709	2011	*An Update and Revision of Three Historic Properties Surveys, Patrick Air Force Base, Brevard County, Florida, Volume I: Report, Volume II: Supporting Documentation*	45th Space Wing, USAF	Penders, Thomas E.
18710	2003	*Draft 45th Space Wing Historical Building Survey, Patrick Air Force Base, Florida*	Sponsored by 45th Space Wing, USAF	SpecPro, Inc.
18711	1994	*Historical and Architectural Documentation Reports of Patrick Air Force Base, Cocoa Beach, Florida, May 1994*	Patrick Air Force Base	US Army CERL
18826	2012	*A Cultural Resource Assessment Survey of Land Management Unit 5, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.

Survey No. (MS No.)	Year	Project Title	Organization	Authors
18829	2011	*A Cultural Resource Assessment Survey of Land Management Unit 6, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
19482	2012	*Historical Survey and Evaluation of the Jay Jay Bridge, Railroad System, and Locomotives, John F. Kennedy Space Center, Brevard County, Florida*	Archaeological Consultants, Inc.	Deming, Joan, Patricia Slovinac, Christopher Berger, and Beth Horvath
19642	2012	*Determination of Eligibility for Area 55: Delta Operations Support Area, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
19644	2012	*Determination of Eligibility for the Facility 49800: Heavy Equipment Shop (8BR2480), Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
20744[a]	2013	*Architectural Survey and Evaluation of 45 Facilities That Have Reached the Age of 45-50 Years, John F. Kennedy Space Center, Brevard County, Florida*	New South Associates	Reed, Mary Beth, and David Price
20760[a]	2014	*Architectural Survey and Evaluation of NASA-owned Facilities on Cape Canaveral Air Force Station, John F. Kennedy Space Center, Brevard County, Florida.*	New South Associates	Reed, Mary Beth, and David Price
20766	2013	*A Cultural Resources Assessment Survey for the New Space X Hangar Complex, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
20772	2014	*Determination of Eligibility for the Launch Complex 5/6 Spin Test Facility, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
20796	2014	*Determination of No Adverse Effect: Painting of Four Facilities within the Cape Canaveral Air Force Station (CCAFS) Industrial Area, CCAFS, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
21172	2014	*Cultural Resource Assessment Survey for the Proposed Falcon Vertical Landing Site, Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.

Survey No. (MS No.)	Year	Project Title	Organization	Authors
21251	1990	*Historic Properties Investigations of Centaur Processing Facility Interim Spin Test Facility Missile Assembly Building Parking Cape Canaveral Air Force Station Brevard County, Florida*	Sponsored by Cape Canaveral Air Force Station	U.S. Army Corps of Engineers
21667	2015	*Determination of Eligibility for Launch Complex 20 (8BR3272), Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
21951	2015	*A Cultural Resources Assessment Survey of Launch Complex 16 (8BR2321), Cape Canaveral Air Force Station, Brevard County, Florida*	45th Space Wing, USAF	Penders, Thomas E.
22740	2015	*3D Digital Documentation of Historic Launch Complex Structures at Cape Canaveral Air Force Station: A Workflow Methodology for DOD Cultural Resources*	University of South Florida	Collins, Lori, Travis Doering, Steven Fernandez, and Jorge Gonzalez
22746	2015	*Inventory and Evaluation of Buildings in the Industrial Area, Cape Canaveral Air Force Station*	US Army Corps of Engineers, Engineer Research and Development Center	Enscore, Susan I. and Julie L. Webster
23553	2016	*Cape Canaveral Air Station Launch Complexes 11 and 36 Phase I Cultural Resources Assessment Survey*	Blue Origin	Healey, Martin, Christine Mavrick, and Wendy Puckett
24166	2017	*Cultural Resources Assessment Surveys for the Proposed Skid Strip Area Development Plan, Cape Canaveral Air Force Station, Brevard County, Florida Volume I: Report, Volume II: Supporting Documents*	45th Space Wing, USAF	Penders, Thomas E.
24721	2016	*3D Digital Documentation of Historic Launch Complex Structures at CCAFS: A Workflow Methodology for Cultural Resource Documentation LC19 and LC34 Areas of Interest*	University of South Florida	Collins, Lori and Travis Doering
25006	2018	*Cape Canaveral Air Force Station Launch Complex 34 Hot Spot Area 6 Cultural Resource Assessment Survey*	Tetra Tech, Inc.	Lackett, Matthew M. and James T. Marine
25307	2017	*City of Titusville Survey of Historical Resources*	City of Titusville	Powell, Meghan, and Patricia Davenport-Jacobs
25799[a]	2018	*Cold War Era Historic Architecture Survey for the Cape Canaveral Air Force Station, Brevard County, Florida*	New South Associates, Inc.	Turco, Ellen and Mary Beth Reed

Survey No. (MS No.)	Year	Project Title	Organization	Authors
26342	2019	*Phase I Cultural Resources Assessment Survey of Three Historic Cottages on Patrick Air Force Station, Brevard County, Florida*	University of South Florida	Collins, Lori D., Travis Doering, and Jaime A. Rogers
27494	2020	*Cultural Resources Assessment Survey (CRAS) Prior to Contaminated Soil Removal at Cape Canaveral Air Force Station Launch Complex 41, Brevard County, Florida*	Search, Inc.	Bach, Jaime and Geoff DuChemin
27737	2019	*Determination of No Adverse Effect: Construct Walkway on the Launch Complex 34 Launch Pad (8BR2290)*	45th Space Wing, USAF	Penders, Thomas E.
27798[a]	2021	*Historic Building Inventory and Evaluation of Space Launch Complexes 37, 40, 41, and 46, Cape Canaveral Space Force Station, Brevard County, Florida*	Argonne National Laboratory, Environmental Science Division	Sennott, Stephen, Daniel J. O'Rourke, Andrew B. Orr, Lynn M. Gierek, and Konnie L. Wescott
27962	2020	*Phase I Cultural Resources Assessment Survey along ICBM Road, Cape Canaveral Air Force Station, Brevard County, Florida*	University of South Florida Libraries Digital Heritage and Humanities Collections	Collins, Lori D., and Travis Doering
28260	2020	*Phase I Cultural Resources Assessment Survey of Land Management Units 13-17, Cape Canaveral Space Force Station, Brevard County, Florida*	University of South Florida	Collins, Lori, Travis Doering, Jaume A Rogers, and Benjamin Mittler

[a] Indicates that the report is associated with a cultural resources survey intersecting the construction area at SLC-37. SLD 45 and SHPO GIS data were used to determine survey coverage.

The cultural resources team summarized select cultural resources surveys identified in the literature search to inform the historic structures survey and aid in identifying historic properties in the APE. These summaries are as follows:

- *Cultural Resource Reconnaissance of Merritt Island National Wildlife Refuge* (MS No. 00260): This literature review included a systematic survey for three areas of fire lane construction that totaled approximately 14 spot-checked areas for proposed water management construction, 11 spot-checked areas for proposed recreation development, and a surface survey of 26 miles of existing dikes. The sugar mill on the Creyon Grant, Fort Ann, the Haulover Canal, and the Dummett homestead were recommended eligible for listing in the NRHP (Griffin and Miller 1978).
- *An Architectural and Engineering Survey and Evaluation of Facilities at Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 01150): This intensive survey covered portions of CCAFS. A total of 1,325 facilities at Cape Canaveral were evaluated for NRHP eligibility. Moreover, 21 Cape Canaveral launch complexes were selected as representative of engineering resources and recommended as eligible for listing in the NRHP as a district. The Cape Canaveral Lighthouse, original Mission Control Center, and Hanger S were also recommended as potentially eligible for listing in the NRHP (Barton and Levy 1984).
- *A cultural resource survey of three project areas at Merritt Island National Wildlife Refuge, Brevard County, Florida* (MS No. 01676): This survey covered portions of CCAFS west of

LC-41 and within Merritt Island National Wildlife Refuge. Three areas were evaluated for archaeological and historic resources ahead of proposed rotary ditching activities. No subsurface testing was performed because the project areas were inundated and no above ground historic properties were identified (Ehrenhard 1988).

- *Cultural Resource Survey: Proposed Cell Tower #812297 Cape Canaveral, Brevard County, Florida* (MS No. 07782): This phase I cultural resources survey was for a proposed cell tower within CCAFS off Heavy Launch Road. A Finding of No Adverse Effect was recommended for the viewshed of SLC-19 (Carlson 2001).
- *A Cultural Resource Assessment Survey of Land Management Unit 5, Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 18826): This cultural resources survey included the 111 acres of Land Management Unit (LMU) 5 inside CCAFS. The survey area is north of LC-37 and east of Old Highway A1A (BR2544). The DeSoto Beach Site (BR237) was re-surveyed and a larger site boundary was recommended as a result. The DeSoto Beach Site was a cluster of single-family homes that existed between 1916 and 1950. Seven artifact scatters, unpaved trails, and remnants of Highway A1A were identified. A single wooden pole associated with the Cold War era Project Teepee was also identified. No further investigation of the identified resources was recommended (Penders 2012).
- *A Cultural Resource Assessment Survey of Land Management Unit 6, Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 18829): This cultural resources survey included the 172 acres of LMU 6 inside CCAFS. The survey area is located north of LC-37 and on the east side of Cape Road. Two historic-age resources were identified as a result of the survey. The False Cape Scatter (BR2029) includes 1920 to 1959 era refuse artifacts. A section of Old Highway A1A (BR2544) was also identified within the survey area. The survey area was also within the DeSoto Beach subdivision, which is discussed in more detail in FMSF Report No. 18826. No further investigation of the identified resources was recommended (Penders 2011).
- *Historical Survey and Evaluation of the Jay Jay Bridge, Railroad System, and Locomotives, John F. Kennedy Space Center, Brevard County, Florida* (MS No. 19482): This historic resources survey evaluated the Jay Jay Railroad Draw Bridge, rail system, and railcars at KSC. The survey identified 81 total assets, including 38 miles of railroad track, the Jay Jay Draw Bridge, 3 locomotives, 75 freight cars, and a locomotive maintenance facility. None of these resources were recommended individually eligible for listing in the NRHP. However, the NASA KSC Railroad System Historic District (BR2932) was defined with numerous contributing resources and recommended eligible for listing in the NRHP (Deming et al. 2012).
- *Determination of Eligibility for the Facility 49800: Heavy Equipment Shop (BR2480), Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 19644): This historic resource investigation evaluated Facility 49800 at CCAFS. Facility 49800 was constructed in 1958 as a shelter and test launch facility for the Goose and Bull Goose missile project. The program was eventually canceled, and the structure was relocated to the CCAFS Industrial Area in 1959. The evaluation found that Facility 49800 is eligible under NRHP Criteria A, C, and D because of its unique free-standing construction, likelihood to yield information important in history, and association with Cold War events (Penders 2012).
- *Architectural Survey and Evaluation of 45 Facilities that have reached the age of 45-50 years, John F. Kennedy Space Center, Brevard County, Florida* (MS No. 20744): This architectural survey recorded 37 buildings from KSC’s Merritt Island facilities and 8 on the CCAFS. Six were recommended eligible for listing in the NRHP: the Engineering Development Laboratory, Missile Assembly Building AE, Beach House (K8-1699), Banana River Bridge (M7-1150), Indian River Bridge (M3-0003), and Haulover Canal Bridge (E4-2414). The Barge Terminal

Facility was also recommended as a contributing resource to the NRHP-eligible Vehicle Assembly Building (Reed and Price 2013).

- *Architectural Survey and Evaluation of NASA-owned Facilities on Cape Canaveral Air Force Station, John F. Kennedy Space Center, Brevard County, Florida* (MS No. 20760): This architectural survey recorded 12 CCAFS buildings. The authors recommended the facilities as a historic district with a discontiguous boundary, with two of the buildings (Hangar S and Missile Assembly Building AE) individually eligible for listing in the NRHP and contributing to the newly identified historic district, "NASA-owned CCAFS Industrial Area Historic District" (Reed and Price 2014).
- *A Cultural Resources Assessment Survey for the New Space X Hangar Complex, Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 20766): This Phase I archaeological and historic architecture survey covered 3 acres for SpaceX's proposed expansion of LC-40 for Heavy vehicle launches. The author identified no archaeological or historic structure resources within the project area as a result of the survey. The project area was also noted to be heavily disturbed. No additional investigation of the area was recommended (Penders 2013).
- *Determination of No Adverse Effect: Painting of Four Facilities within the Cape Canaveral Air Force Station (CCAFS) Industrial Area, CCAFS, Brevard County, Florida* (MS No. 20796): Four facilities within the CCAFS Industrial Area were evaluated for a determination of effect ahead of proposed power washing and painting. These structures include Facility 1612 (Hanger E), Facility 1623 (AF Supply Warehouse), Facility 1646 (Mechanical Building), and Facility 1722 (Information Technology Systems Support Building). These buildings were constructed between 1951 and 1961. The author determined that the power washing and painting would have no adverse effect on any of the four facilities. All four buildings were also found to be individually potentially eligible for listing in the NRHP (Penders 2014a).
- *Cultural Resource Assessment Survey for the Proposed Falcon Vertical Landing Site, Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 21172): This cultural resources assessment was conducted for the construction of a proposed SpaceX vertical landing pad for the Falcon at LC-13. The author found that LC-13, associated with the Atlas missile program, had been previously determined not eligible for listing in the NRHP. Nearby sites 8BR3178 and 8BR3176 were also found not eligible for listing in the NRHP. The adjacent LC-12 and site 8BR3177 were determined not eligible for listing in the NRHP, and the project was recommended to proceed (Penders 2014b).
- *Determination of Eligibility for Launch Complex 20 (8BR3272), Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 21667): This study evaluated the NRHP eligibility of LC-20 and its 14 associated facilities at CCAFS. The author noted that LC-20 was originally constructed in 1959 as a testing facility for Titan ICBM testing. However, the complex's contribution to Titan I and Titan III was minimal compared to activities at LC-19. The complex was also used for minor testing in the 1990s. The complex was determined not eligible (Penders 2015a).
- *Inventory and Evaluation of Buildings in the Industrial Area, Cape Canaveral Air Force Station* (MS No. 22746): This architectural survey inventoried 85 structures that were previously undocumented within the Industrial Area at CCAFS and determined their NRHP eligibility. These buildings were constructed between 1951 and 1968 and have a period of significance during the Cold War era. Of the 85 structures, 19 were found eligible for listing in the NRHP, either individually or as contributors to the CCAFS Industrial Area Historic District. An additional 15 previously recorded structures were reevaluated and 4 were recommended individually eligible for listing in the NRHP, 5 were recommended as contributing properties, and 6 were recommended as non-contributing (Enscore and Webster 2015).

- *Cultural Resources Assessment Surveys for the Proposed Skid Strip Area Development Plan, Cape Canaveral Air Force Station, Brevard County, Florida Volume I: Report, Volume II: Supporting Documents* (MS No. 24166): This report presents the results of intensive cultural resources surveys conducted between 2009 and 2015 within the Skid Strip District and adjacent parcels. By the end of 2015, 5 previously recorded resources and 21 newly recorded cultural resources were documented, including 2 historic objects, 6 historic properties, and 11 archaeological sites. Twelve of these resources are noted as contributing elements to the Skid Strip Historic District (8BR3186). The author also noted that most of the resources identified retained little integrity, and planned land clearing was recommended to proceed (Penders 2017).
- *3D Digital Documentation of Historic Launch Complex Structures at CCAFS: A Workflow Methodology for Cultural Resource Documentation LC19 and LC34 Areas of Interest* (MS No. 24721): This digital survey and documentation reports on the results of terrestrial laser scanning, monitoring, and spatial recordation for multiple associated structures at LC-19 and LC-34. The authors also used aerial LiDAR, GIS data, photographic and video imaging, and CAD drawings to assist with documenting the conductions of the facilities at the complexes. The three-dimensional (3D) data collected was used to create accurate sectional details, models, and drawings of selected structures at the complexes. The authors also note that the 3D data obtained will be useful for future digital preservation and analysis of CCAFS (Collins and Doering 2016).
- *Cape Canaveral Air Force Station Launch Complex 34 Hot Spot Area 6 Cultural Resource Assessment Survey* (MS No. 25006): This CRAS was completed at LC-34 in support of groundwater remediation efforts within a designated solid waste management unit (SWMU-CC054). The survey covered 3.98 acres at LC-34 and no cultural material was recovered as a result of the 244 shovel tests that were completed. The authors concluded there would be no effect on archaeological or structural resources and no additional work was recommended (Lackett and Marine 2018).
- *Cold War Era Historic Architecture Survey for the Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 25799): This architectural survey recorded 93 resources in 9 discontinuous areas within an approximately 16,239-acre area of CCAFS. Each resource was evaluated individually and as a potential contributor to a district for its association with U.S. Cold War history. Seven resources were recommended eligible for listing in the NRHP: BR3467, BR3478, BR3483, BR3490, BR3497, BR3499, and BR3501. The Graduate Engineering Education System Complex, Hangar Y Area, Missile Checkout Area, and Integrate-Transfer-Launch Area were recommended eligible for listing in the NRHP as districts (Turco and Reed 2018).
- *Cultural Resources Assessment Survey (CRAS) Prior to Contaminated Soil Removal at Cape Canaveral Air Force Station Launch Complex 41, Brevard County, Florida* (MS No. 27494): This Phase I cultural resources survey investigated a 0.28-acre area surrounding Facility 29166 (camera tower) at LC-41 ahead of proposed soil remediation efforts. The survey resulted in one prehistoric isolated find (a lithic flake fragment), and no historic structures were identified. No additional work was recommended prior to the soil remediation activities (Bach and DuChemin 2020).
- *Historic Building Inventory and Evaluation of Space Launch Complexes 37, 40, 41, and 46, Cape Canaveral Space Force Station, Brevard County, Florida* (MS No. 27798): This architectural survey inventoried and evaluated LC-37 (8BR2274), LC-40 (8BR0279), LC-41 (8BR4316), and LC-46 (8BR4336), as well as 72 of their associated facilities at CCAFS. The authors found that LC-37, LC-40, LC-41, and LC-46 are not eligible for listing in the NRHP. An additional 71 associated facilities were also recommended ineligible for listing in the NRHP. However, Facility 33000 (8BR2790), the blockhouse at LC-37, was recommended

eligible for listing in the NRHP. The report notes that Facility 33000 is in good condition and has a similar construction to other NRHP-listed blockhouses at CCAFS. It is also larger due to the proximity of increased blast power from associated Saturn rocket launches (Sennott et al. 2021).

- *Phase I Cultural Resources Assessment Survey along ICBM Road, Cape Canaveral Air Force Station, Brevard County, Florida* (MS No. 27962): The phase I survey covered 1,045 acres within CCAFS. Eleven sites were recorded during the survey, ten of which were associated with USAF activities. Two of the 11 recorded sites were recommended eligible for listing in the NRHP: 8BR4181 (Air Vent and Escape Tunnel) associated with SLC-19 and 8BR4191 (ICBM Road) (Collins and Doering 2020).
- *Phase I Cultural Resources Assessment Survey of Land Management Units 13-17, Cape Canaveral Space Force Station, Brevard County, Florida* (MS No. 28260): The Phase I survey covered 754 acres within CCAFS across five LMUs. A total of 12 newly recorded historic structures were inventoried during the survey, including 8BR4028 through 8BR4039. Of these 12 structures, the following 4 were recommended eligible for listing in the NRHP under Criteria A and D because of their association with activities at LC-34 and the crewed Apollo space missions (Figure 4-1):
  - 8BR4033 (Facility 21900BH, Slide Wire Terminal),
  - 8BR4034 (CCSFS LC-34 Blast Wall)
  - 8BR4035 (Facility 21900ZZ, Dual CZR Camera Site)
  - 8BR4036 (Facility 1755, Camera Site U191L122) (Collins et al. 2020)

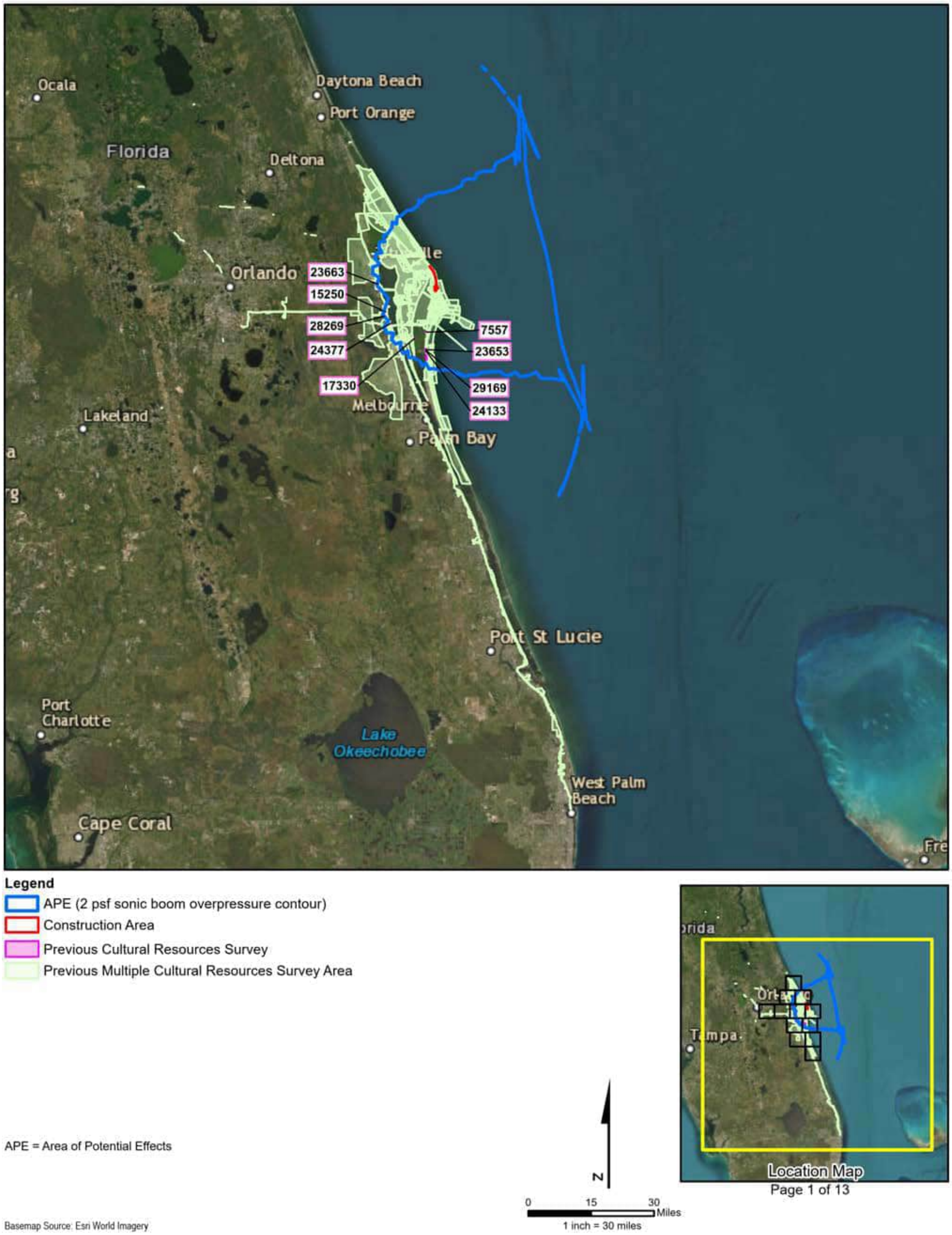


Figure 4-1. Cultural Resources Surveys (Page 1 of 13)

Figure 4-1. Cultural Resources Surveys (Page 2 of 13)

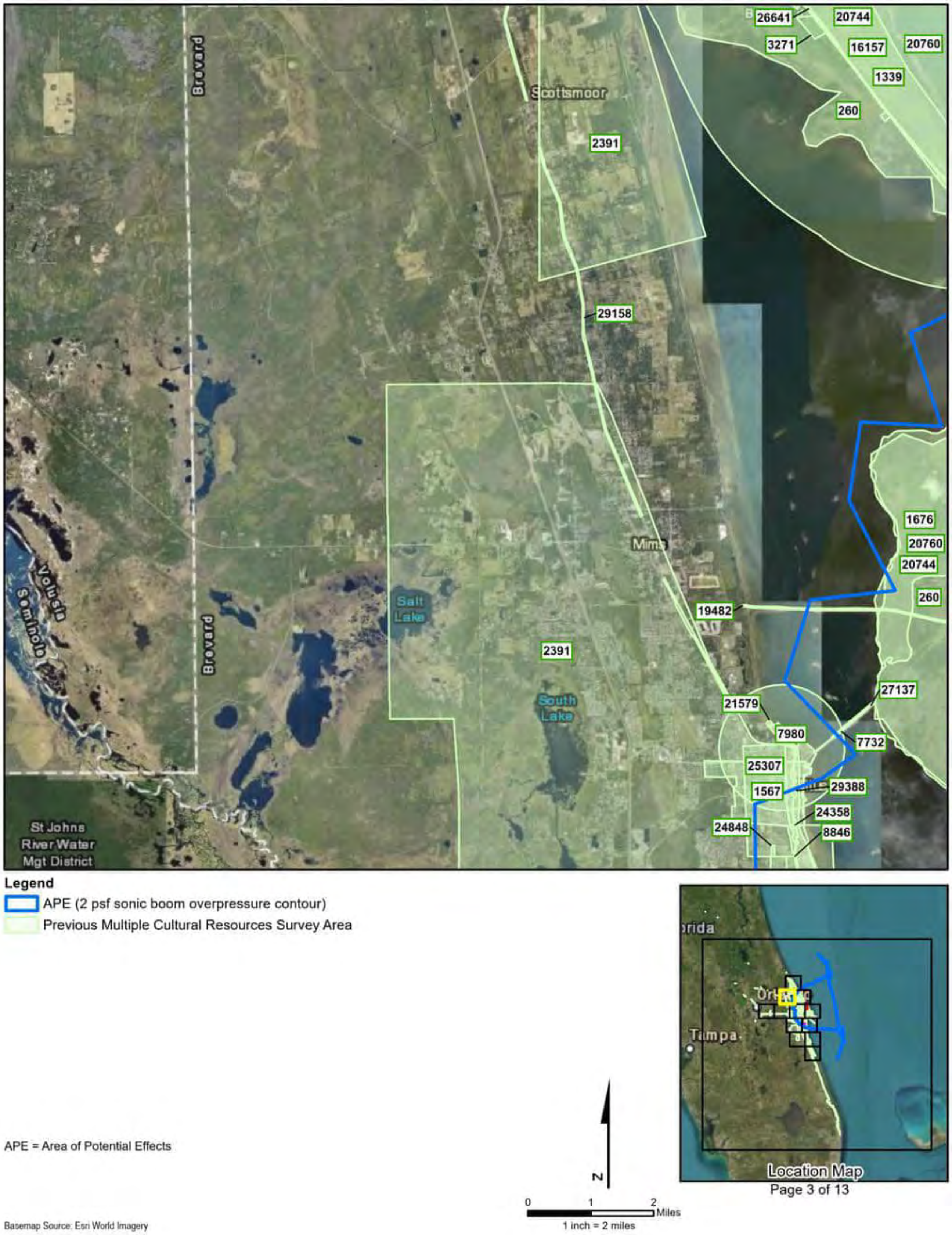


Figure 4-1. Cultural Resources Surveys (Page 3 of 13)

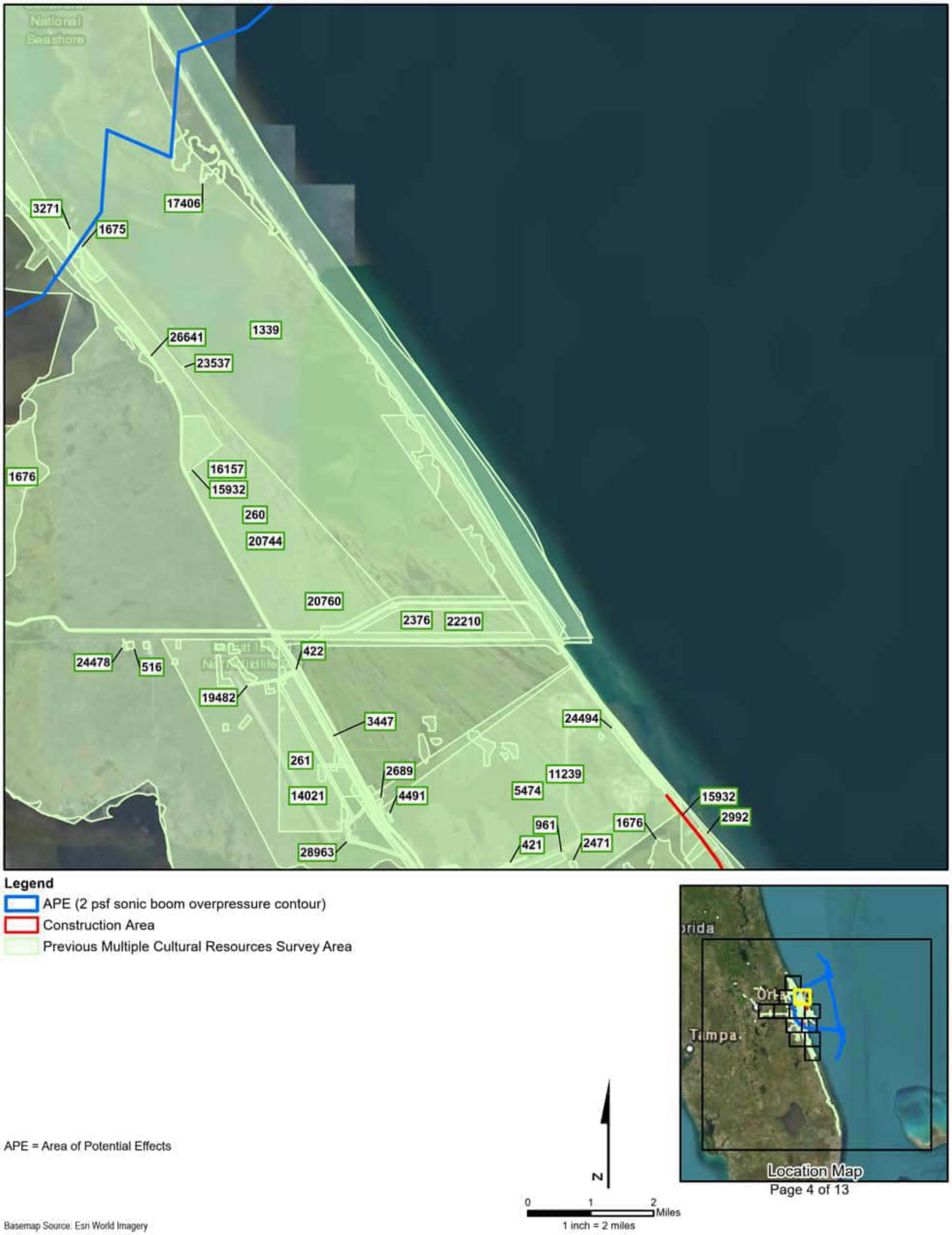


Figure 4-1. Cultural Resources Surveys (Page 4 of 13)

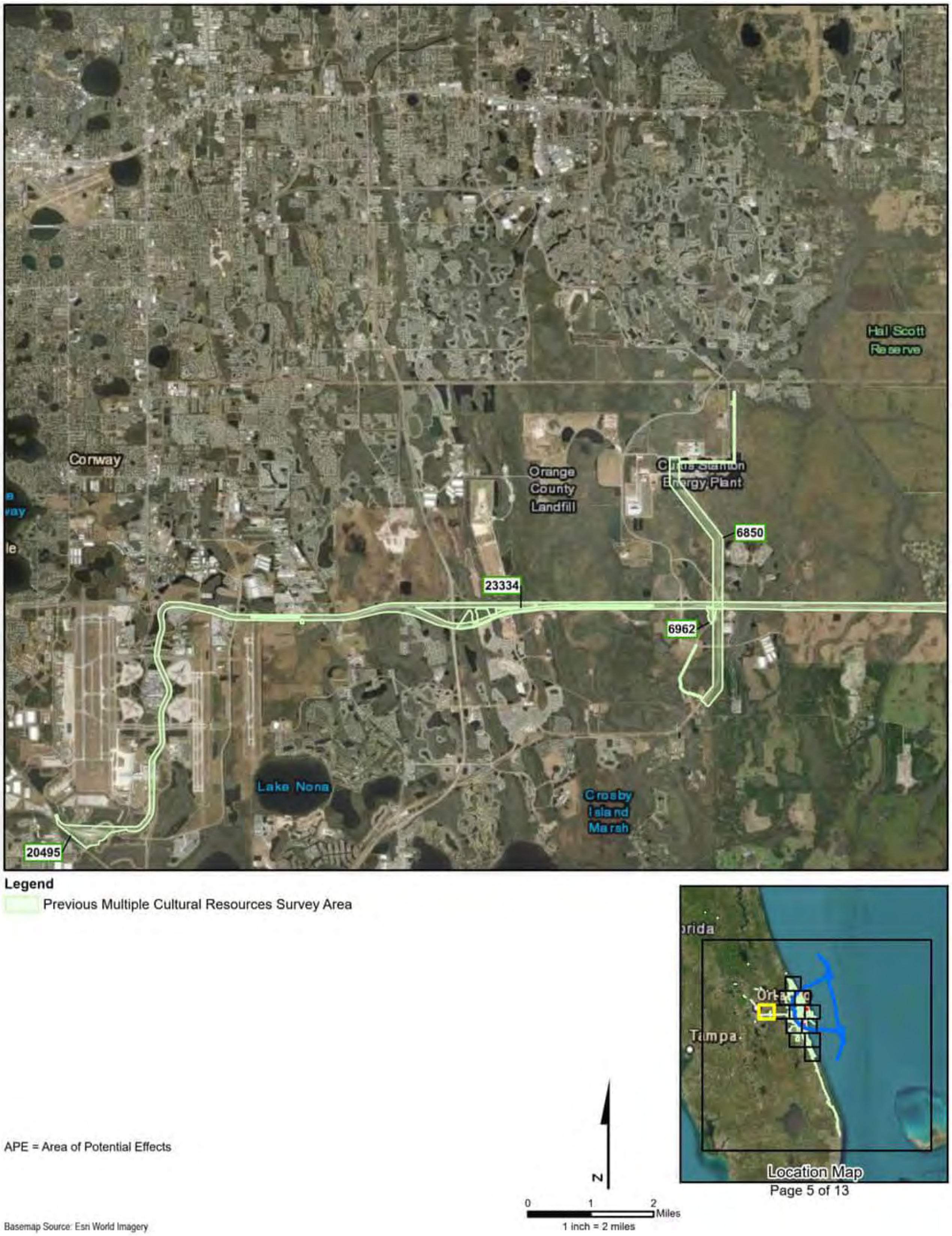


Figure 4-1. Cultural Resources Surveys (Page 5 of 13)

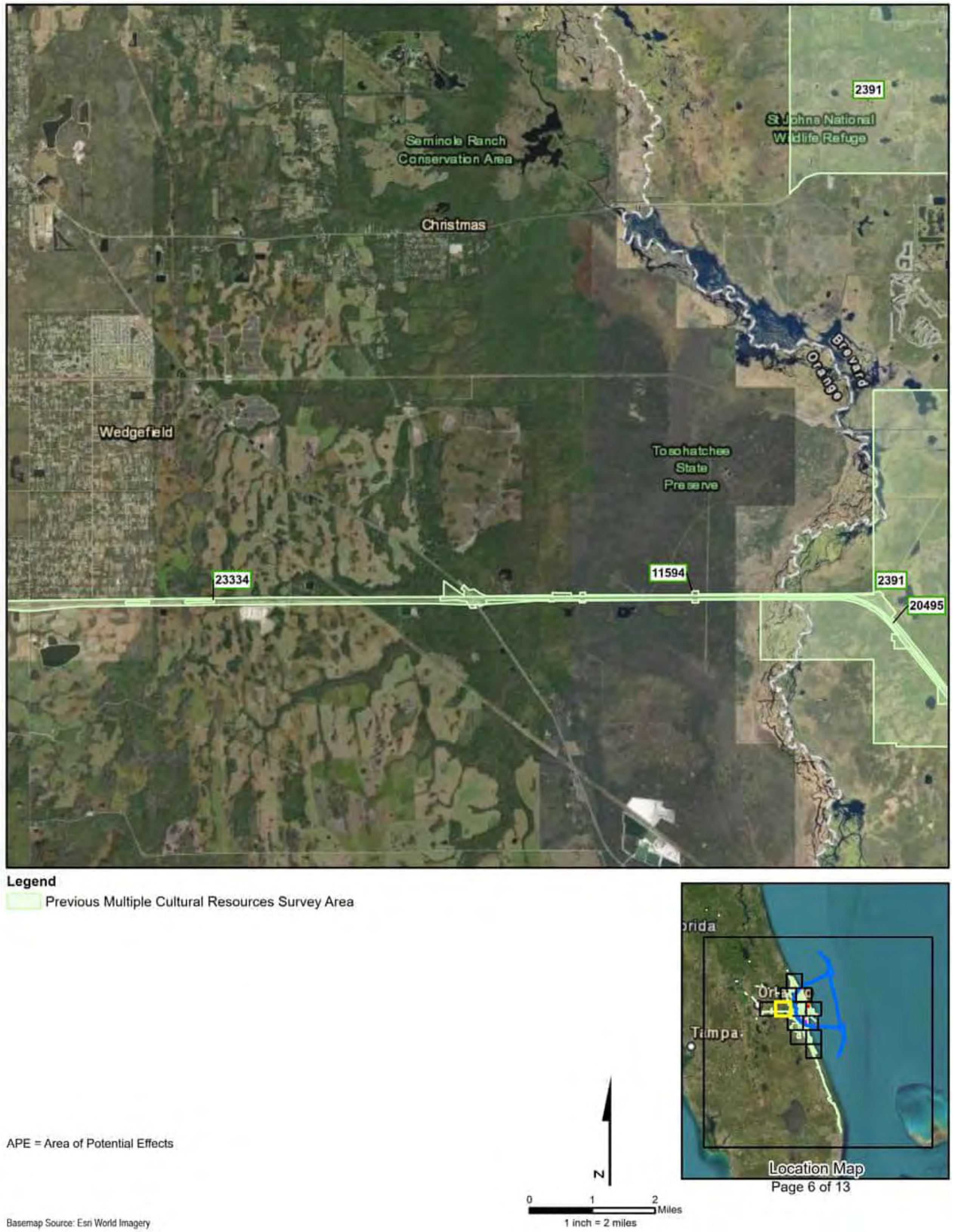
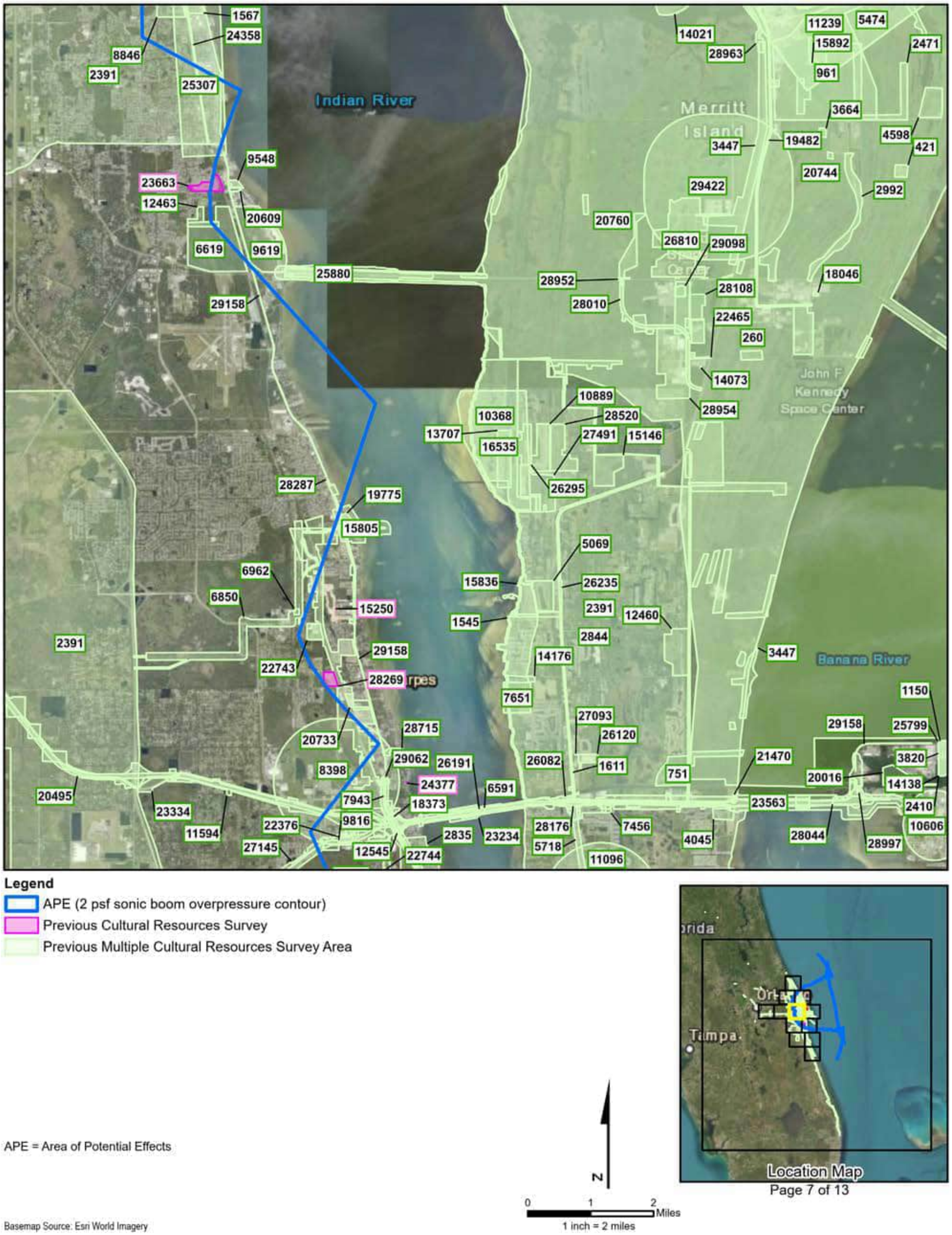


Figure 4-1. Cultural Resources Surveys (Page 6 of 13)



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2 **Figure 4-1. Cultural Resources Surveys (Page 7 of 13)**

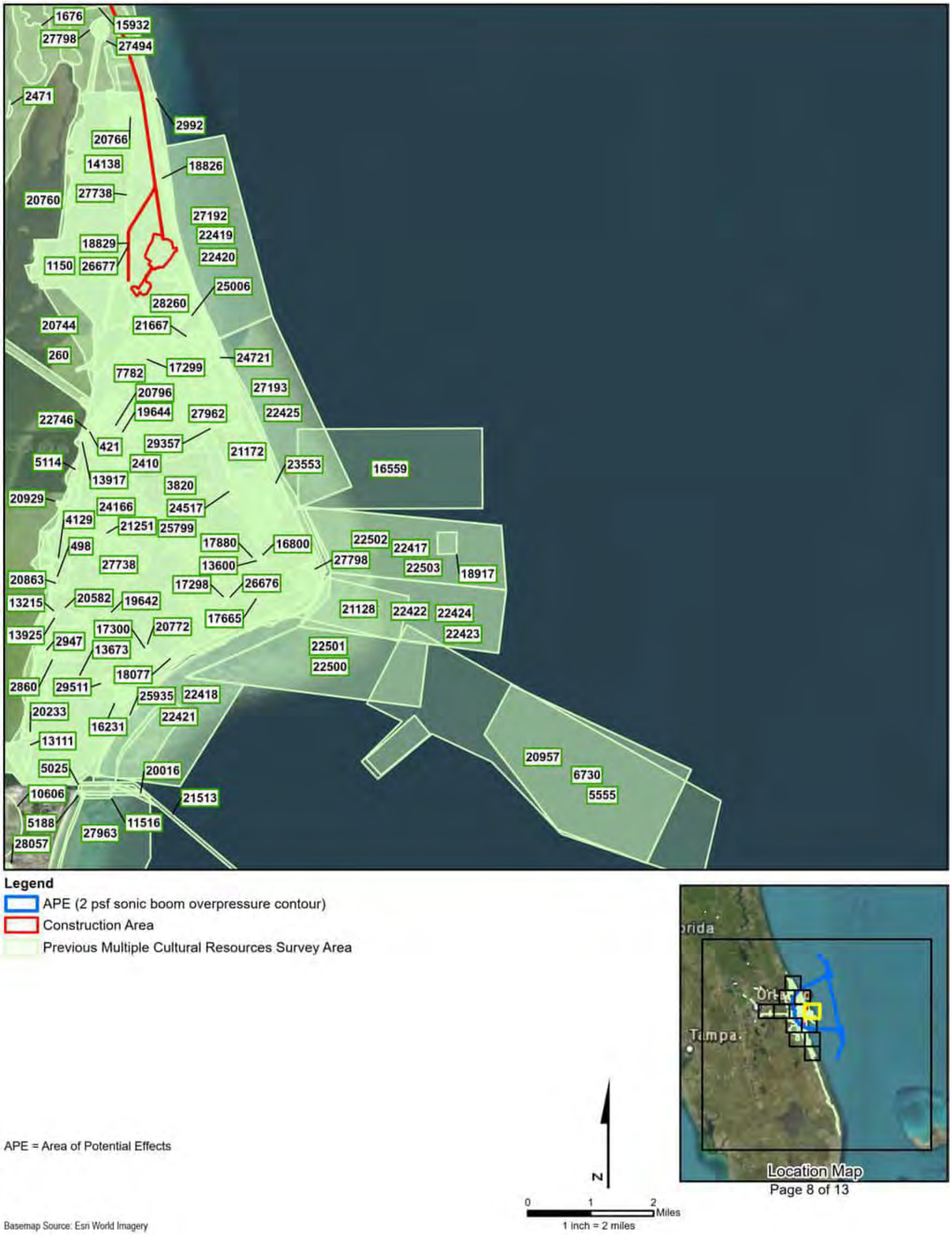


Figure 4-1. Cultural Resources Surveys (Page 8 of 13)

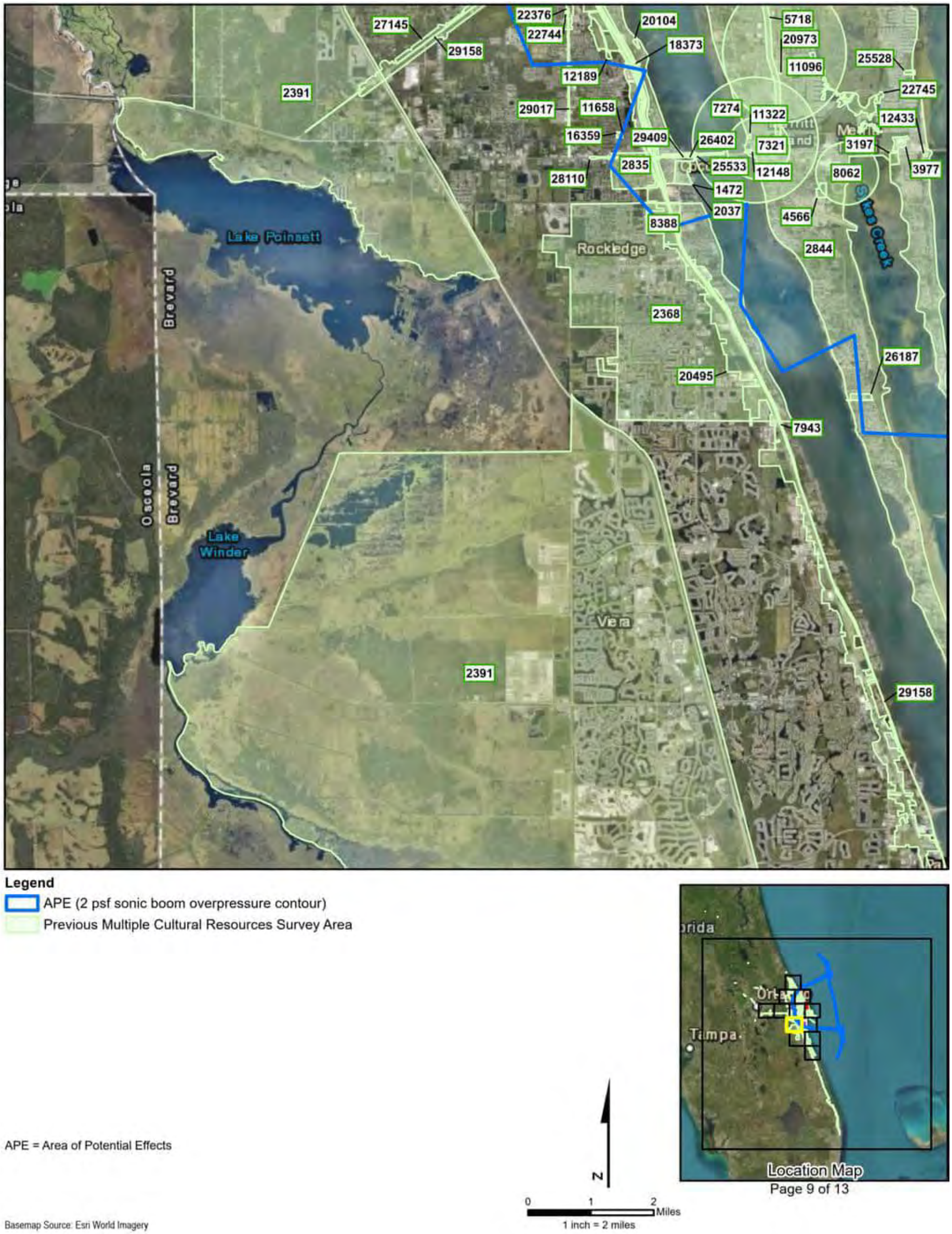
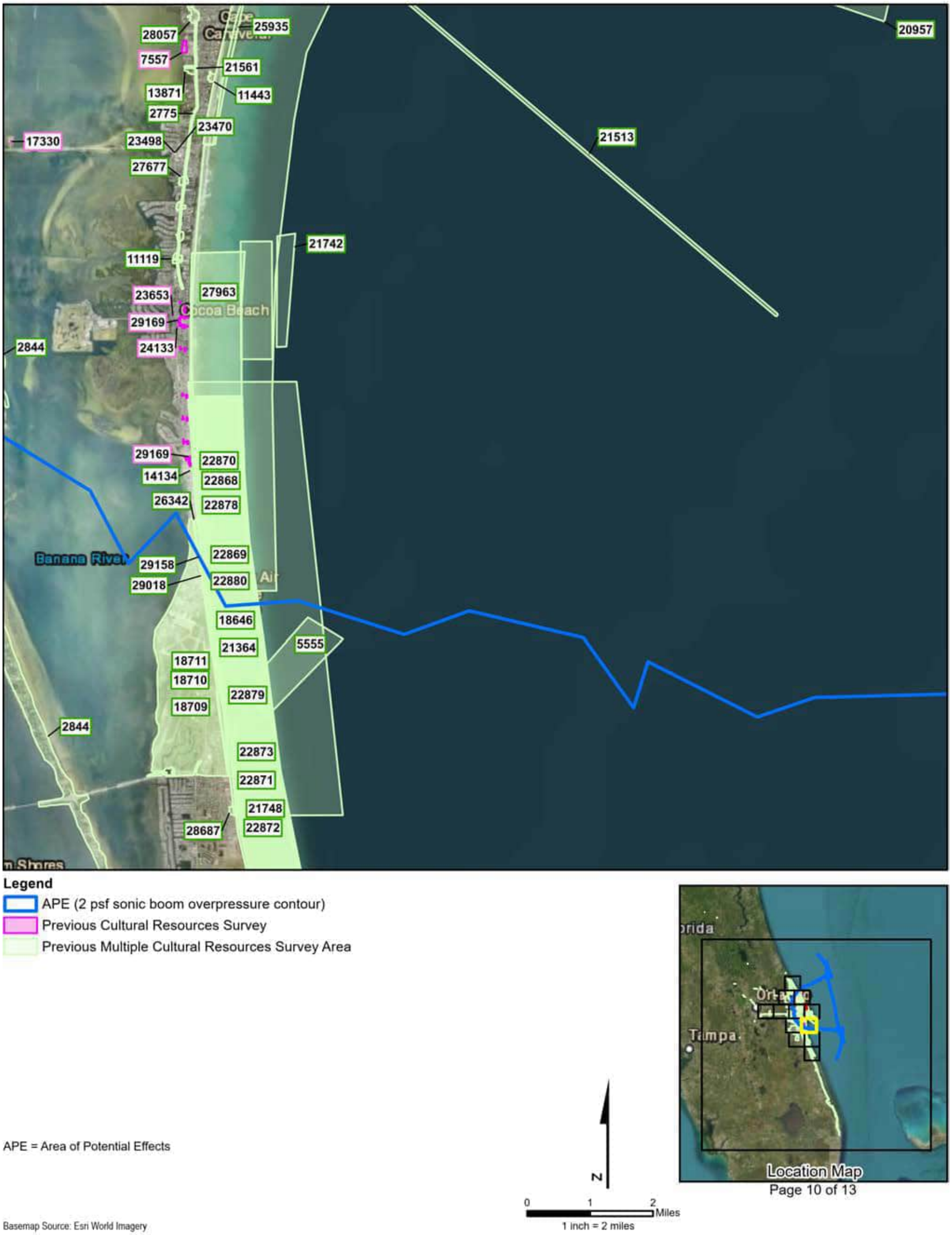


Figure 4-1. Cultural Resources Surveys (Page 9 of 13)



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2 **Figure 4-1. Cultural Resources Surveys (Page 10 of 13)**

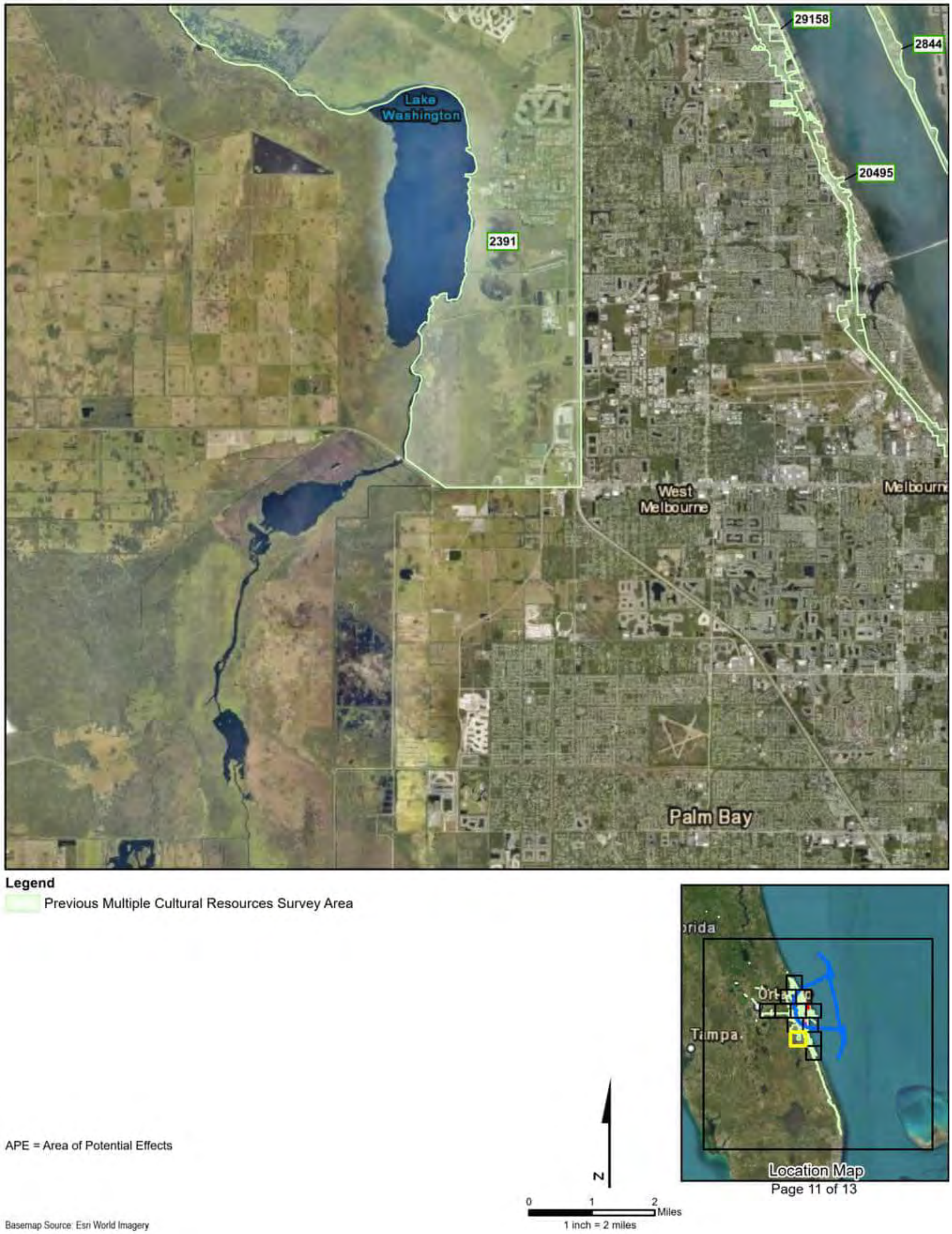
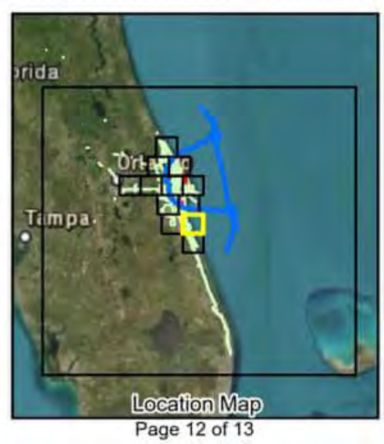


Figure 4-1. Cultural Resources Surveys (Page 11 of 13)

Legend

Previous Multiple Cultural Resources Survey Area

APE = Area of Potential Effects



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0 1 2 Miles

1 inch = 2 miles

Basemap Source: Esri World Imagery

Figure 4-1. Cultural Resources Surveys (Page 12 of 13)

Figure 4-1. Cultural Resources Surveys (Page 13 of 13)

4.2 Historic Property Results

The previously recorded historic properties identified in SLD 45 records and the FMSF include 340 individual historic properties and 351 contributing resources in the APE (refer to Figure 4-2 and Appendix B for a complete list of these historic properties). The historic properties are listed in, or are eligible for listing in, the NRHP individually or as a contributing resource to an eligible or listed district (refer to selected summaries for identified districts near SLC-37 in the following subsections). The CCAFS NHL District and four of its six launch complexes (SLC-14, SLC-19, SLC-34, and the nonextant SLC-13) are within the vicinity of SLC-37. SLC-34 is approximately 2,500 feet to the south of SLC-37 and is the nearest contributing resource to the CCAFS NHL District, but it is not within the construction area. SLC-5/6, SLC-26, and the NASA-owned Mission Control Center also contribute to the CCAFS NHL District and are within the APE but outside the construction area.

Only one historic property is in the construction area: the LCC (FMSF No. BR02790). SLC-37 was previously determined not eligible for listing in the NRHP as a district, and no other historic structures that qualify for consideration as historic properties are within the complex fence line. The LCC, Facility 33000 (BR02790), also known as the Blockhouse at SLC-37, was constructed in 1962. The building was erected as the control center for Saturn I and Saturn IB launches at SLC-37. The building has a circular plan and dome design similar to other CCSFS launch control centers of the same period, including those at SLC-13, SLC-14, SLC-19, and SLC-34. Of these, the building at SLC-37 is larger, as each building was scaled to the systems used at their complex. The building was determined eligible for listing in the NRHP for significant engineering and construction methods, as displayed in its domical form. The building is determined eligible for listing in the NRHP under Criteria A, B, C, and D (Sennott 2021).

Although SpaceX proposes to reuse SLC-37, the undertaking proposes no changes to the LCC (FMSF No. BR02790). Other historic properties within the vicinity of SLC-37 include the NASA-controlled property known as the Beach House (FMSF No. BR02990) (built 1962) and the Cape Canaveral Lighthouse (FMSF No. BR00212) (built 1868 and relocated in 1894) and its associated resources on CCSFS. Unlike other historic properties in the vicinity of SLC-37, these historic properties were not specifically designed to accommodate launches.

Historic properties not on federal lands were identified in the Indian River communities of Brevard County, including portions of Cape Canaveral, Cocoa, Cocoa Beach, Merritt Island, Titusville, and Rockledge. The FMSF and local historic resource inventories were reviewed for previously recorded historic properties and locally significant resources. Of the Indian River communities, only Titusville and Brevard County have inventories readily available for review, with Titusville being the only CLG on file with the NPS and SHPO. The historic properties range in age from the late 1800s to the 1990s. NRHP-listed historic properties and NHLs in the APE have the potential for vulnerable character-defining features to be intact, such as windows. Nine examples of NRHP-listed historic properties outside of CCSFS and KSC that are significant for architecture (Criterion C) and have potentially vulnerable characteristics include the following:

- Judge George Robbins House (FMSF No. BR00399), Titusville – a Dutch Colonial Revival building
- Wager House (FMSF No. BR00397), Titusville – a wood-frame vernacular building with decorative elements and wood sash windows
- Spell House (FMSF No. BR00480), Titusville – a Queen Anne building
- Imperial Towers (FMSF No. BR04215), Titusville – a mid-century modern apartment complex

- City Point Community Church (FMSF No. BR01657), Cocoa – a wood-frame vernacular building with decorative elements and wood sash windows
- Dr. George E. Hill House (FMSF No. BR00860), Merritt Island – a wood-frame vernacular building with decorative elements and wood sash windows
- Old St. Luke's Episcopal Church and Cemetery (FMSF No. BR00581), Merritt Island – a Late Gothic Revival building
- Rockledge Drive Residential District (FMSF No. BR01611), Rockledge – a residential district built in the late 1800s to 1920s
- Aladdin Theater (FMSF No. BR00282), Cocoa – an Italian Renaissance Revival building with ornamental windows

These 9 NRHP-listed historic properties were constructed in the late 1800s to 1960s and are examples of historic property types that have significant architectural features with potential vulnerabilities to noise and vibrations from Starship-Super Heavy operations. The Aladdin Theater (FMSF No. BR00282) is both NRHP and NHL listed. Undetermined resources, additional NRHP-eligible historic properties and contributing resources are also present in the APE, such as the NRHP-eligible John H. Sams Farmstead (FMSF No. BR04229), a late 1800s homestead with two vernacular wood frame buildings in Merritt Island (refer to Appendix C).

4.2.1 Historic District Summaries

The literature review yielded 84 Resource Groups or districts, of which 41 qualify as historic properties. The following summaries provide a sample of historic districts identified in the APE. The historic district summaries focus on previously recorded Resource Groups or districts either in the vicinity of SLC-37 or with potentially vulnerable resources.

4.2.1.1 Cape Canaveral Air Force Station National Historic Landmark (BR00216)

The CCAFS NHL District (BR00216) is listed in the NRHP and was designated an NHL on April 16, 1984, by the NPS at the recommendation of the Man in Space NHL Theme Study (Butowsky 1984) (Figure 1-2).

The NHL nomination identified the discontinuous 132.5-acre CCAFS NHL District. The NHL district spans CCSFS and NASA properties and at the time of listing, covered six launch complexes (SLC-5/6, SLC-26, SLC-13, SLC-14, SLC-19, and SLC-34), Hangar S, and the Mission Control Center (NASA owns SLC-5/6, Hangar S, and the Mission Control Center). The NHL district nomination states that the CCAFS NHL District is significant at the national level under NRHP Criterion A in the areas of communications, science, and space exploration and under Criterion C for its engineering, with a period of significance from 1949 to 1984 (the time of designation). The NHL nomination recognizes the need for CCSFS to contribute to future space exploration and that the nomination should not encumber this mission; this applies not only to operational matters but also to the use of existing facilities and the design flexibility needed to add, expand, or adapt facilities. When agreeing to the CCAFS NHL designation, the Secretary of the Interior's Advisory Board, NPS, and USAF agreed that the designation should not interfere with the USAF's mission at CCSFS.

4.2.1.2 SLC-13 (BR02198) and Associated Resources

SLC-13 was historically known as LC-13 and is now known as Landing Zone (LZ) 1 and LZ-2 (BR02198). SLC-13 and SLC-14 were constructed from 1956 to 1958 for the Atlas program from the same set of site plans along with two other originally identical launch complexes (SLC-11 and

SLC-12) on Missile Row. SLC-13 was modified in 1966 and deactivated in 1978. The Mobile Tower was demolished in 2005, and the LC-13 Blockhouse (BR02135) was demolished in 2012. In 2015, SLC-13 was reactivated for vertical orbital class rocket fly-back operations. All standing structures and buildings were removed before the reactivation of SLC-13, when it was renamed LZ-1 (CCSF Museum 2023). Remnants of the SLC-13 foundation were determined not eligible for listing in the NRHP by SLD 45 with the SHPO's concurrence, though the site remains honorarily listed as one of the six launch complexes in the CCAFS NHL District. SLC-13 had 11 contributing resources, but none are extant.

4.2.1.3 SLC-14 (BR02209) and Associated Resources

SLC-14 (BR02209), historically known as LC-14, was constructed from 1956 to 1958 to support the Atlas research and development program and is a contributing resource to the CCAFS NHL District. Since the NHL nomination, SLD 45, in consultation with the SHPO, determined in 1993 that SLC-14 is also individually eligible for listing in the NRHP (McCarthy et al. 1993). Based on the information gathered during the literature review for this technical report, SLC-14 retains 9 of the 12 contributing resources identified when it was last recorded in the FMSF in 2008. A review of SLD 45, SHPO, and NPS records indicates that all of the historic structures at SLC-14 were recorded in the FMSF. The 1984 NHL nomination lists six extant resources as contributing to the NHL; SLD 45 and SHPO records list nine NRHP-eligible contributing resources, including the six in the NHL nomination.

4.2.1.4 SLC-19 (BR02260) and Associated Resources

SLC-19 (8BR226), historically known as LC-19, was constructed from 1956 to 1959 to support Titan I and II ICBM research and development. It is one of four complexes built at CCAFS from identical plans between 1957 and 1959 (LC-15, LC-16, LC-19, and LC-20). The complex supported Titan testing for 7 years following its completion. SLC-19 was also used for manned launches as part of the Gemini program. Between 1965 and 1966, 10 two-man Gemini missions were launched from the complex (GT-3 through GT-12). SLC-19 is considered eligible for listing in the NRHP for its association with the Cold War and famous individuals (astronauts) affiliated with the manned Gemini program, as well as Mercury and Apollo missions. It is also an NHL as a contributor to the CCAFS NHL District and has eight contributing structures.

4.2.1.5 SLC-34 (BR02279) and Associated Resources

LC-34 was built at CCAFS between 1959 and 1961 for testing the Saturn missile and later the manned Apollo missions. The first Saturn missile was launched from the complex in October of 1961, and all subsequent Saturn I tests were conducted at LC-34 through 1963. The USAF transferred the complex to NASA in 1963 to complete modifications needed for Saturn IB testing. These modifications were constructed between 1963 and 1965. Following initial Saturn IB testing at LC-34, the launch complex was the site of the first NASA loss of life when the Apollo I tragedy claimed the lives Virgil Grissom, Edward White, and Roger Chaffee in January 1967. LC-34 was later the site of the first manned Apollo launch in October 1968 for the Apollo 7 mission. The complex was deactivated in November 1971 following the development of LC-39 at the KSC to accommodate the larger and more powerful Saturn V rocket. The complex is considered eligible for listing in the NRHP under Criteria A, C, D for its association with the Cold War, Apollo missions, and the Apollo I tragedy. It is also an NHL as contributor to the CCAFS NHL District with 20 contributing structures.

4.2.1.6 Solid Rocket Booster Disassembly and Refurbishment Complex Historic District (BR01996)

The Solid Rocket Booster Disassembly and Refurbishment Complex Historic District includes 9 contributing and 11 non-contributing structures. The district is within the Industrial Area of CCAFS and is defined by the concrete hardscape that surrounds Hangar AF. The district is associated with the U.S. Space Shuttle Program between 1969 and 2011. The majority of the structures in the district were designed for Solid Rocket Booster processing, including pre-launch manufacture and assembly and post-launch recovery, disassembly, cleaning, and refurbishment before the next use. The contributing resources include Hangar AF (8BR2001), High Pressure Gas Building (8BR2002), High Pressure Wash Facility (8BR2003), First Wash Building (8BR2004), Solid Rocket Booster Recovery Ship (8BR2005), Solid Rocket Booster Paint Building (8BR2006), Robot Wash Building (8BR2007), Thrust Vector Control Deservicing Building (8BR2008), and Multi-Media Blast Facility (8BR2009). The district has been determined eligible for listing in the NRHP with SHPO concurrence under Criterion A. The district itself also contributes to the CCAFS Industrial Area Historic District under Criterion A.

4.2.1.7 Facility 50305: Skid Strip (BR02336), Skid Strip Historic District (BR03186), and Control Tower Road Tracking Sites (BR03433)

Facility 50305: Skid Strip (Skid Strip) (BR02336), the Skid Strip Historic District (BR03186), and Control Tower Road Tracking Sites (BR03422) are described together because they are closely associated.

The Skid Strip (BR02336) was completed between 1951 and 1952 to launch and recover the Snark and Navaho missile programs. It included a paved runway of different lengths to support the landing of both missile types, a control facility, parking pads, antennas, and unpaved road access. The Skid Strip was modified further in 1955 with updates for the Navaho missile program. The Skid Strip was heavily used between 1957 and 1959, when the runway was further enlarged. Camera sites were added during this time, and the strip included two control towers. Testing at the Skid Strip expanded in 1959 and included the Bold Orion, High Virgo, Hound Dog, X-10, and QB-17 drone programs. The Skid Strip continued to be used for deliveries of components for Atlas, Titan, and Saturn operations at CCAFS. It also hosted returning astronauts from the Mercury and Gemini flights, the Space Shuttle, Air Force One, and limited missile testing from the 1970s to 1990s (Penders 2017).

The area near the Skid Strip was also the location of several tracking systems used for various launches at CCAFS, first developed in the 1950s and early 1960s. These include Ballistic Cameras (used to provide highly accurate trajectory data), CRZ camera sites (used to record azimuth, elevation, and roll angles for early stages of missile flights), the AN/FPS-16 Radar (highly accurate radar system used extensively by NASA for the Mercury program and other satellite launches), the MOD IV Radar System (a modified NIKE-AJAX missile target system used to provide real-time missile data with radar, infrared, and TV aids), Range Safety and Telemetry systems (Beat-Beat Doppler Velocity and Position System used for missile tracking), Sky Screen systems (used to determine if missiles were following a safe trajectory), and Telemetry Electron Sky Screen Equipment (a passive tracking system for missile telemetry). By the time of the Mercury launches, many of these systems were already obsolete and were largely abandoned in place as more sophisticated camera and radar systems were introduced (Penders 2017).

The Skid Strip (BR02336) has been determined eligible for listing in the NRHP because of its association with the Cold War and manned spaceflight operations (Penders 2017). The Skid Strip Historic District (BR03186) includes 14 contributing resources, including the Skid Strip itself (BR02336). It is eligible for listing in the NRHP under Criteria A, C, and D. The Control

Tower Road Tracking Sites Historic District (BR03433) includes nine contributing resources and is eligible for listing in the NRHP under Criteria A, C, and D.

4.2.1.8 CCAFS Industrial Area Historic District (BR03369 and BR03073)

The CCAFS Industrial Area Historic District was recorded twice in the FMSF, as BR03369 and as BR03073. It is recorded as two districts with the same name, each containing different buildings with different agency ownership, some NASA and some USAF. Therefore, it is counted twice in the historic property count.

Development of the CCAFS first began in 1953 after the USAF learned that transporting missiles and components from Patrick Air Force Base to the Cape resulted in broken parts from transporting them over bumpy roads. As a result, an effort was launched to construct facilities to assemble the missile components directly on the Cape. Hangars C and O were built in 1953 for this purpose but were found to be too close to the launch pads for safe operation. A new location for missile assembly was chosen between 1954 and 1955 on the west side of the Cape near the Banana River, which provided both water access for component delivery and a safe distance from the launch pads. The first assembly structure built in the new Industrial Area was Hangar I, completed in 1955.

In all, 21 missile assembly buildings were built, which were generally steel truss hangars based on standard 1950s military design. As a whole, the Industrial Area included 110 permanent facilities such as shops, chemical storage buildings, standards laboratories, heating plants, a cafeteria, fire station, operations buildings, emergency facilities, and other utility structures. The CCAFS Industrial Area has been determined eligible for listing in the NRHP under Criteria A, B, and C and has 16 contributing resources. In addition, Hangar S (8BR3070) and Mission Assembly Building AE (8BR2976) have been determined individually eligible. An additional 32 facilities within the district have been determined not eligible for the NRHP (Reed and Price 2013).

4.2.1.9 ICBM Road (BR04191)

The ICBM Road (BR04191) is within the APE. The road was found eligible under Criterion A for its association with the launch complexes. From 1956 to 1957, ICBM Road was constructed for the four original complexes and provided access for early missile and space exploration programs (Rogers et al. 2020).

4.2.1.10 Launch Complex 39A (BR01686)

Launch Complex 39A (LC39A) was constructed between 1963 and 1965 to support the Man in Space and Apollo programs associated with Saturn V rocket launches. Following President John F. Kennedy's 1961 directive to develop a program to land a man on the Moon before the end of the decade, NASA quickly identified that CCAFS already had 22 launch complexes and did not have sufficient space available to support the construction of the new complexes needed to facilitate the larger and more powerful Saturn V rockets that were in development for the Apollo program. As a result, NASA obtained more than 83,000 acres of undeveloped land on Merritt Island for the purpose of establishing new rocket facilities that were named the John F. Kennedy Space Center in 1963. The Apollo program progressed rapidly, and in 1967, the first Saturn V launch was conducted at LC-39A with the unmanned Apollo 4 mission. All the subsequent manned Apollo missions and successful moon landings launched from LC-39A. The final manned mission to the Moon launched from the complex in December 1972 with the Apollo 17 mission.

LC-39A was also used during the Skylab program, which was an extension of the Apollo program to develop an early space station. The first Skylab mission launched from LC-39A on May 13, 1973, carrying the space station into orbit. The space station was used until February 1974 for crewed launches in modified Apollo command and service modules.

Following the Apollo era, LC-39A was modified to support launch operations for the Space Shuttle program. Modifications started with construction in 1975 and included the conversion of the Apollo-era mobile launcher to a Space Shuttle mobile launcher platform and the addition of a Shuttle-era fixed service structure, a rotating service structure, a payload changeout room and ground handling mechanism, and new flame deflectors. Other improvements included Space Shuttle ground support equipment such as piping, cabling, environmental control system cooling towers, and hypergolic fuel facility and oxidizer facility. On April 12, 1981, the first Space Shuttle launch (Space Transportation System [STS]-1) was conducted at LC-39A with the Orbiter Columbia. NASA launched the following 23 STS missions from LC-39A, including the first flights of the Challenger, Discovery, and Atlantic Orbiters, which also witnessed the first flight of an American Woman (Sally Ride) and African American (Guion Bluford) into space. LC-39A was deactivated following the Challenger STS-32 accident in January 1986 for modifications, including new weather protection structures and upgrades to emergency exit systems. LC-39A was reactivated in 1989 and launched 40 more STS missions, including the final launch of Space Shuttle Columbia in 2003. LC-39A was reactivated in 2007 with the launch of STS-118.

LC-39A was listed in the NRHP in 1973 for its association with the Apollo program. In 1996, it was reevaluated for a larger context spanning between 1961 and 1975. In 2000, it was redefined as “Launch Complex 39: A Historic District,” which includes its gained significance as part of the Space Shuttle program from 1980 through 2010. The district includes 21 contributing and 23 non-contributing resources.

4.2.1.11 Launch Complex 39B (BR01687)

Similar to LC39A, Launch Complex 39B (LC-39B) was completed in 1966 as the second launch pad in NASA’s initiative to construct new facilities to support larger and more powerful Saturn V rockets. Along with LC-39A, LC-39B was used during the Apollo program and launched the Apollo 10 mission. After the final manned Moon landing mission in 1972, LC-39B continued to support Saturn IB launches, including crewed flights for the Skylab missions. LC-39B was also host to the Apollo-Soyuz Test Project program in 1975, which launched the final application of the Apollo program that marked the first international rendezvous and docking in space between U.S. and Russian crews.

LC-39B was also extensively modified in the 1970s to accommodate Space Shuttle flights and launched numerous shuttle missions. In 1988, LC-39B was the site of the first Return-to-Flight after the Challenger accident. LC-39B launched thirty-eight more Space Shuttle missions between 1990 and 2004. Similar to the Columbia tragedy, LC-39B was the site of the second Return-to-Flight in 2005 following the Challenger accident in 2003.

LC-39B was also listed in the NRHP in 1973 for its association with the Apollo program and reevaluated in 1996 using an expanded context between 1961 and 1975. In 2000, LC39B was redefined as “Launch Complex 39: B Historic District,” which includes its additional significance as part of the Space Shuttle program from 1980 through 2010. The district includes 21 contributing and 24 non-contributing resources.

4.2.1.12 Jonathan H. Sams Farmstead (BR04229)

The Jonathan H. Sams Farmstead dates from 1878 and remains extant. The district includes the oldest standing house in Brevard County. It once belonged to Jonathan H. Sams, a significant figure in the development of Brevard County. Sams moved his family to Merritt Island in 1878 from South Carolina and went on to become a successful farmer of citrus, sugar cane, and pineapple. Sams also became the superintendent of schools in Brevard County in 1880. The Sams Farmstead includes the family cabin built in 1875 in South Carolina and relocated to Merritt Island, as well as the two-story home built adjacent to the cabin in 1888. The district also includes Malabar I and Malabar II prehistoric components, including a burial mound. In total, the resource group includes six contributing resources and has been determined to be NRHP eligible.

4.2.1.13 Rockledge Drive Residential District

The Rockledge Drive Residential District was listed in the NRHP in 1992 and is significant under Criteria A and C for varied architecture relating to the development of the city of Rockledge in the late nineteenth and early twentieth centuries. The Rockledge Drive area is the oldest settled community within Rockledge and began development prior to the incorporation of the city. Residents were drawn to the area beginning in the 1880s as citrus farming became prominent. The majority of buildings within the district are along Rockledge Drive and are single-family houses that overlook the Indian River. The houses include wood frame vernacular, frame vernacular boathouses, Colonial revival, Mediterranean revival, and Queen Anne architecture consistent with building practices of late nineteenth-century Florida. The earliest residences in the district are representative of Rockledge's success in the citrus industry, tourism, and Florida's railroad development. The later Colonial revival, Craftsman, and Mediterranean revival houses also demonstrate the community's stability and boom period in the 1920s. In total, the district includes 100 contributing and 24 non-contributing resources.

4.2.2 Summary

There are 340 identified individual historic properties and 351 contributing resources in the APE, including two NHL properties, the CCAFS NHL District and Aladdin Theater (FMSF No. BR00282) (Figure 4-2). Previously recorded historic properties range in age from the late 1800s to the 1990s. Nine examples of NRHP-listed historic properties outside of CCSFS and KSC with potentially vulnerable characteristics are presented in this section, and a comprehensive list of known historic properties is provided in Appendix C. Municipal properties may have special local designations associated with local permitting considerations outside of the Section 106 regulations and may be dually recorded in the FMSF; these are listed in Appendix B.

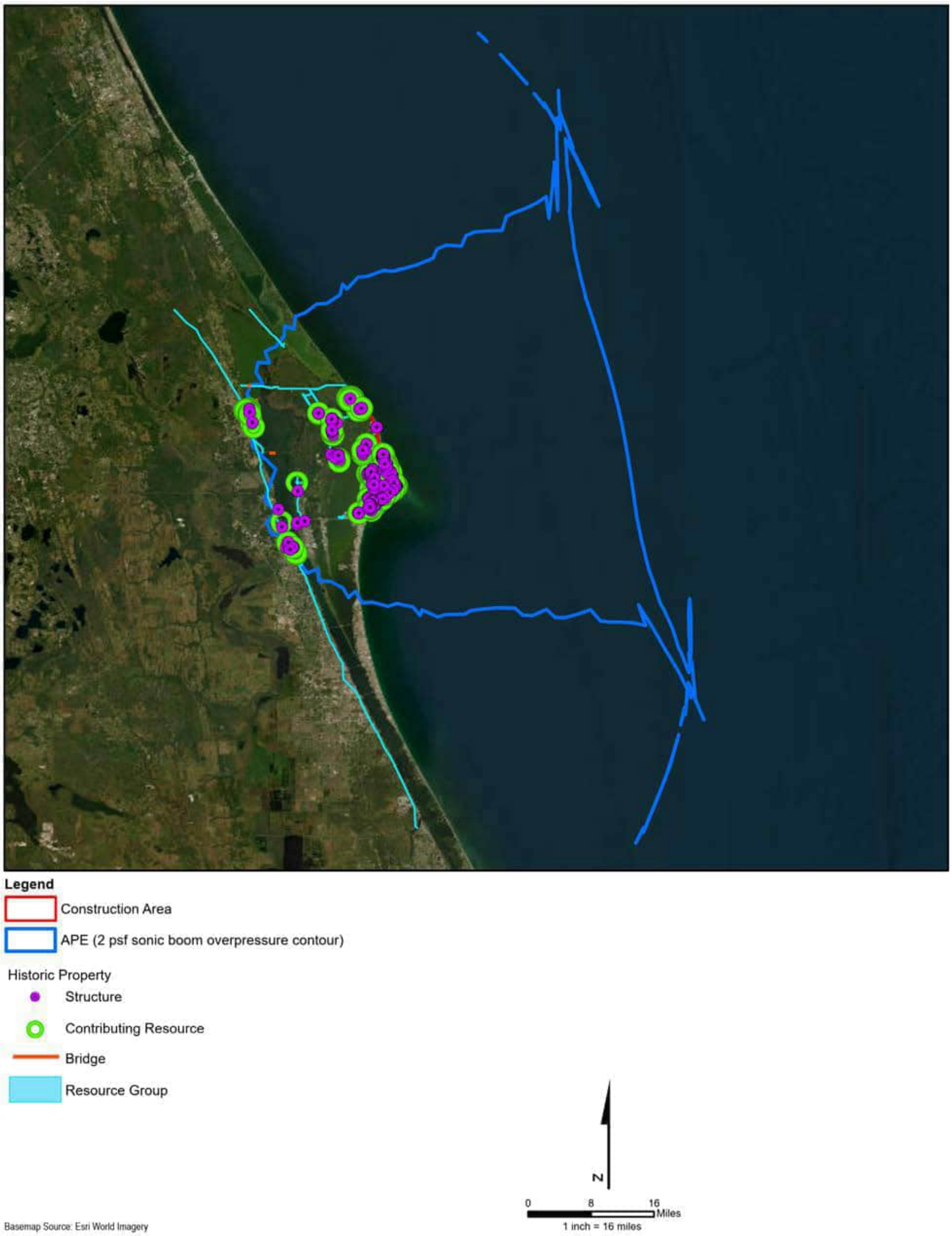


Figure 4-2. Historic Properties Identified in the APE (Overview)

Figure 4-2. Historic Properties Identified in the APE (Page 1 of 19)

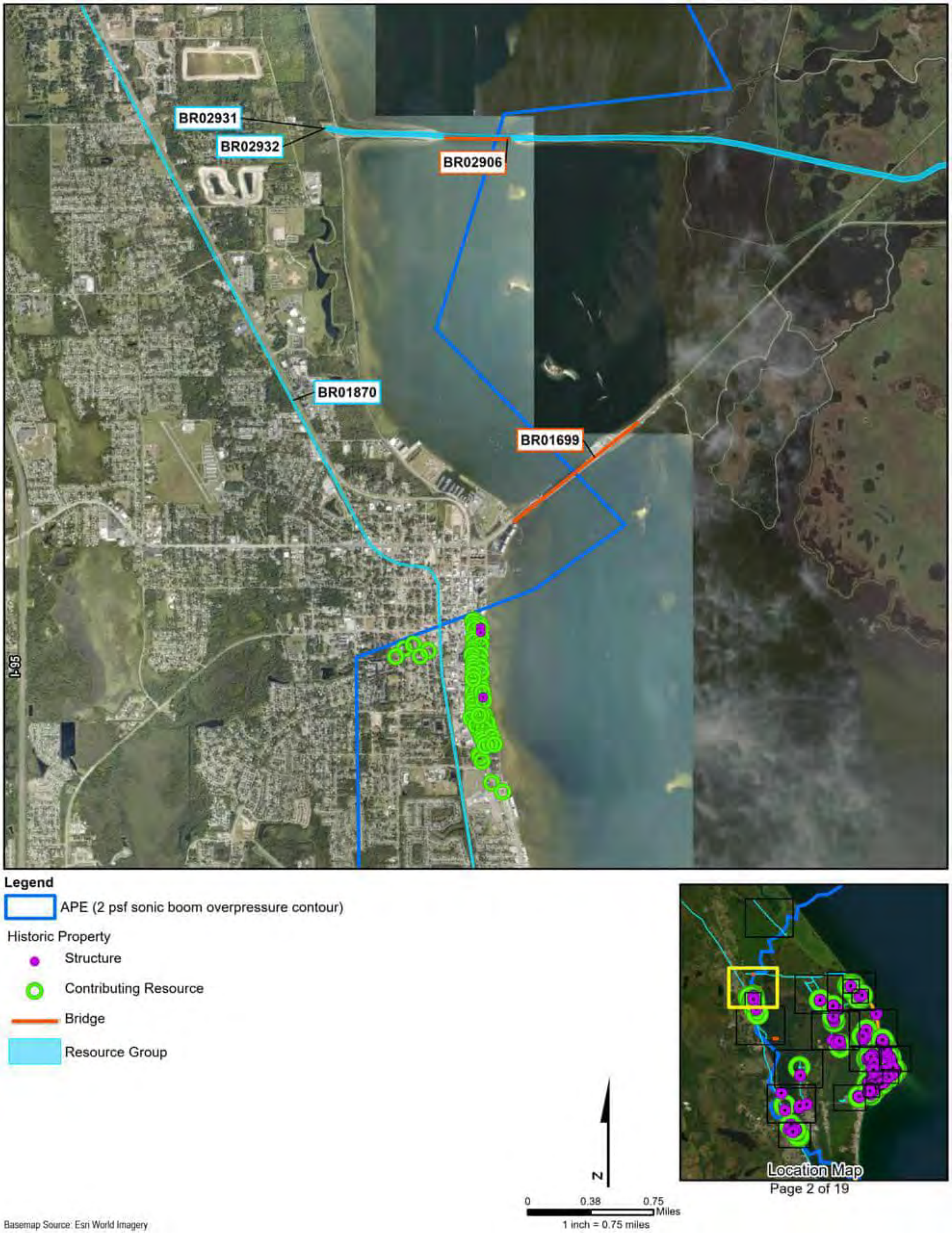


Figure 4-2. Historic Properties Identified in the APE (Page 2 of 19)

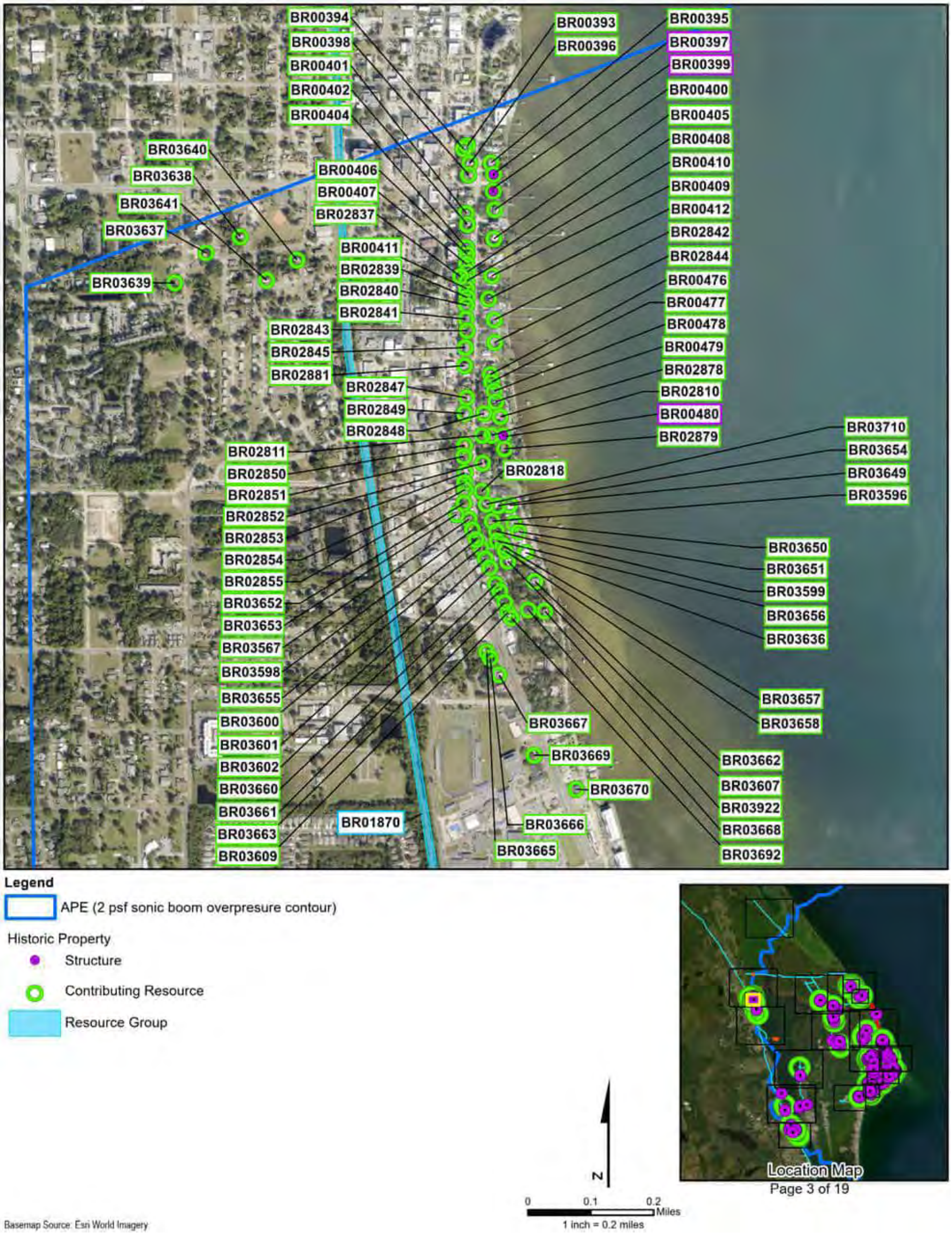


Figure 4-2. Historic Properties Identified in the APE (Page 3 of 19)

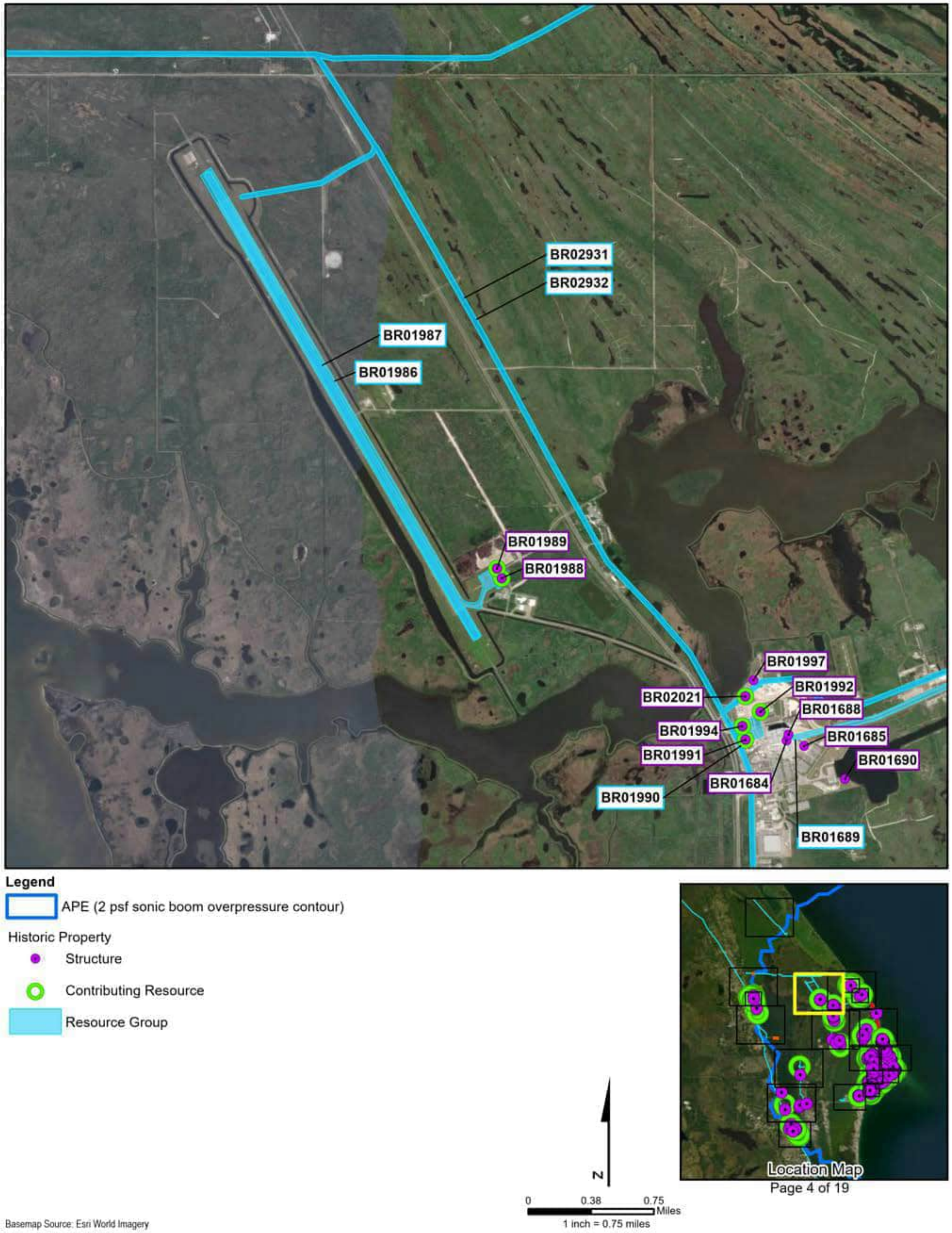


Figure 4-2. Historic Properties Identified in the APE (Page 4 of 19)

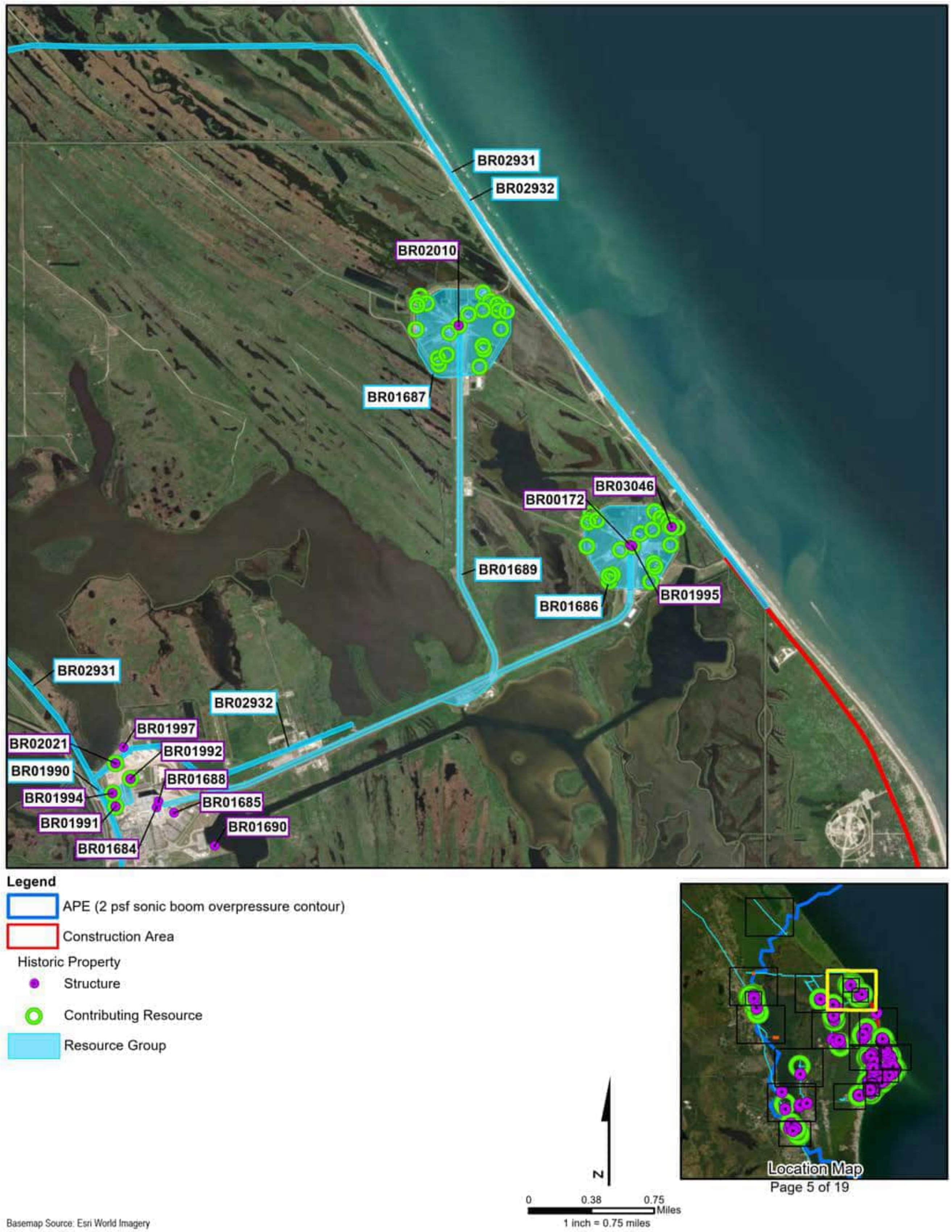


Figure 4-2. Historic Properties Identified in the APE (Page 5 of 19)

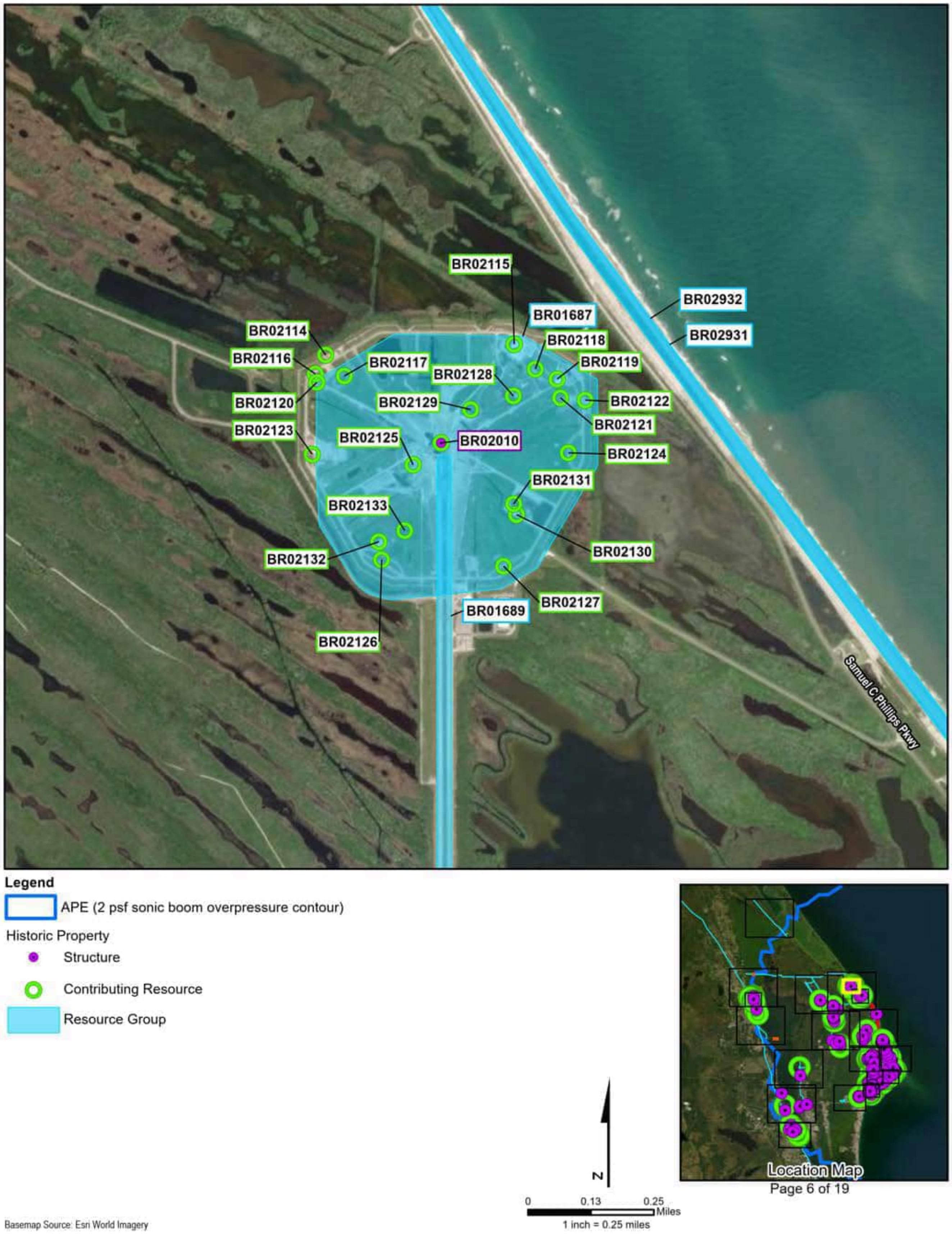


Figure 4-2. Historic Properties Identified in the APE (Page 6 of 19)

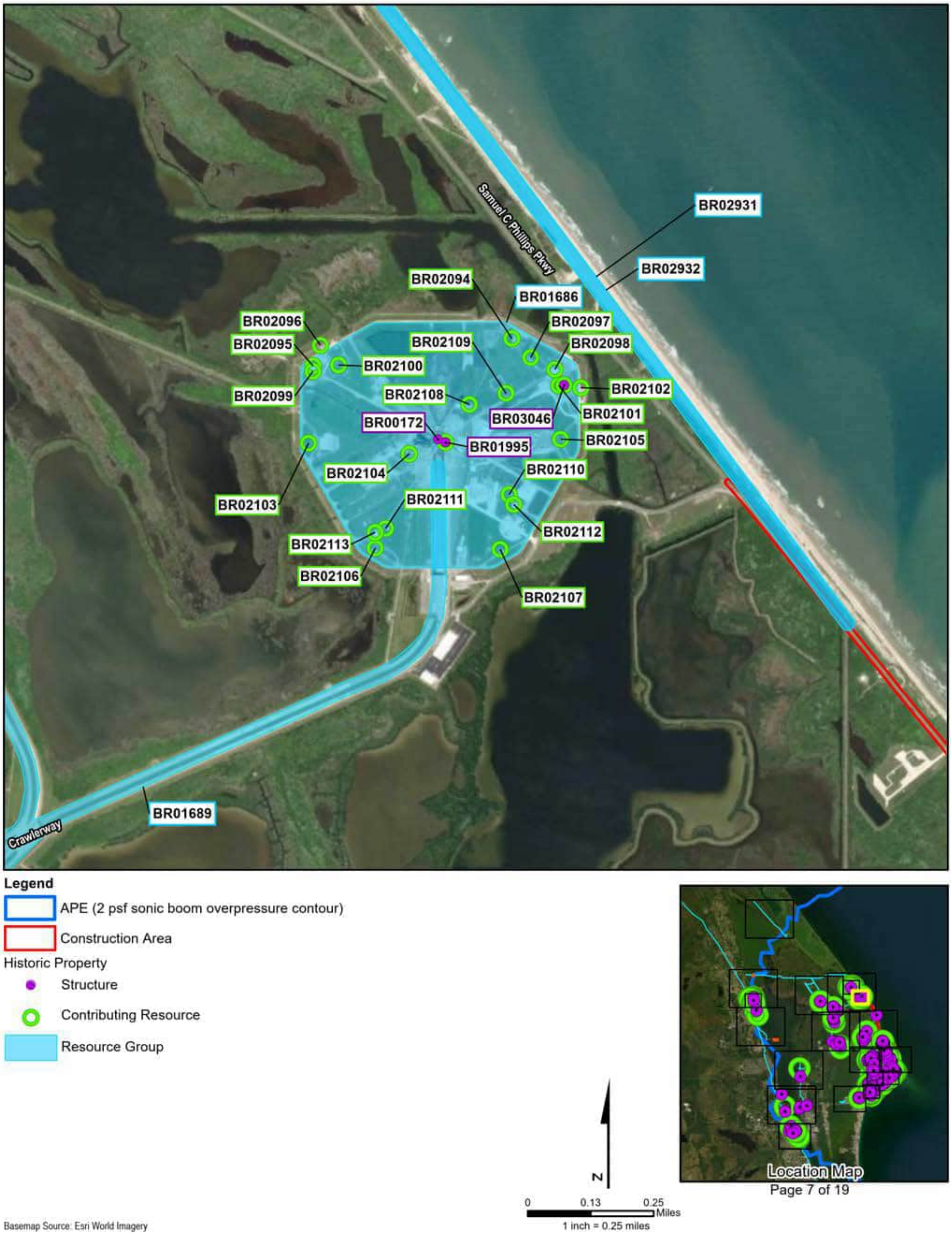


Figure 4-2. Historic Properties Identified in the APE (Page 7 of 19)

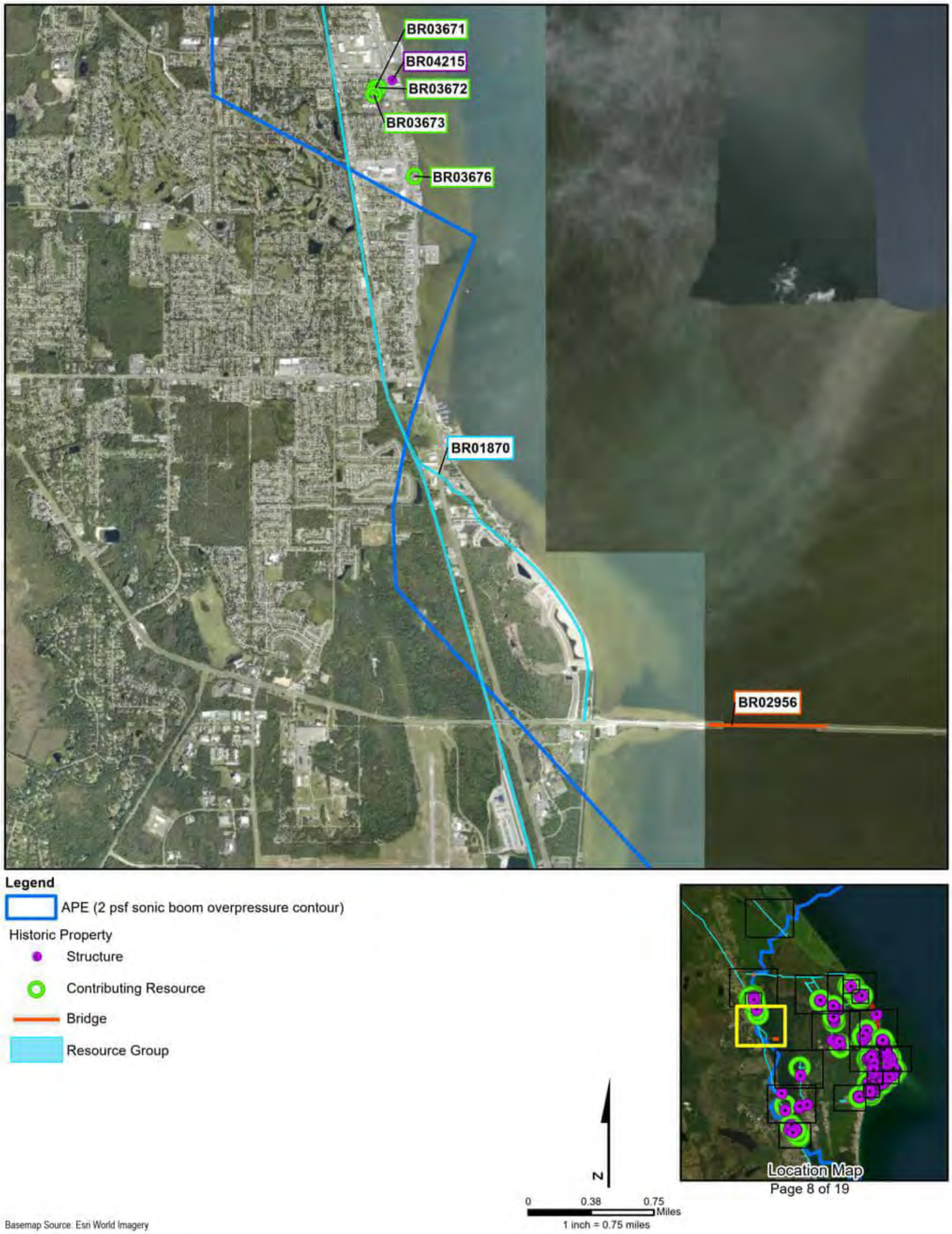


Figure 4-2. Historic Properties Identified in the APE (Page 8 of 19)

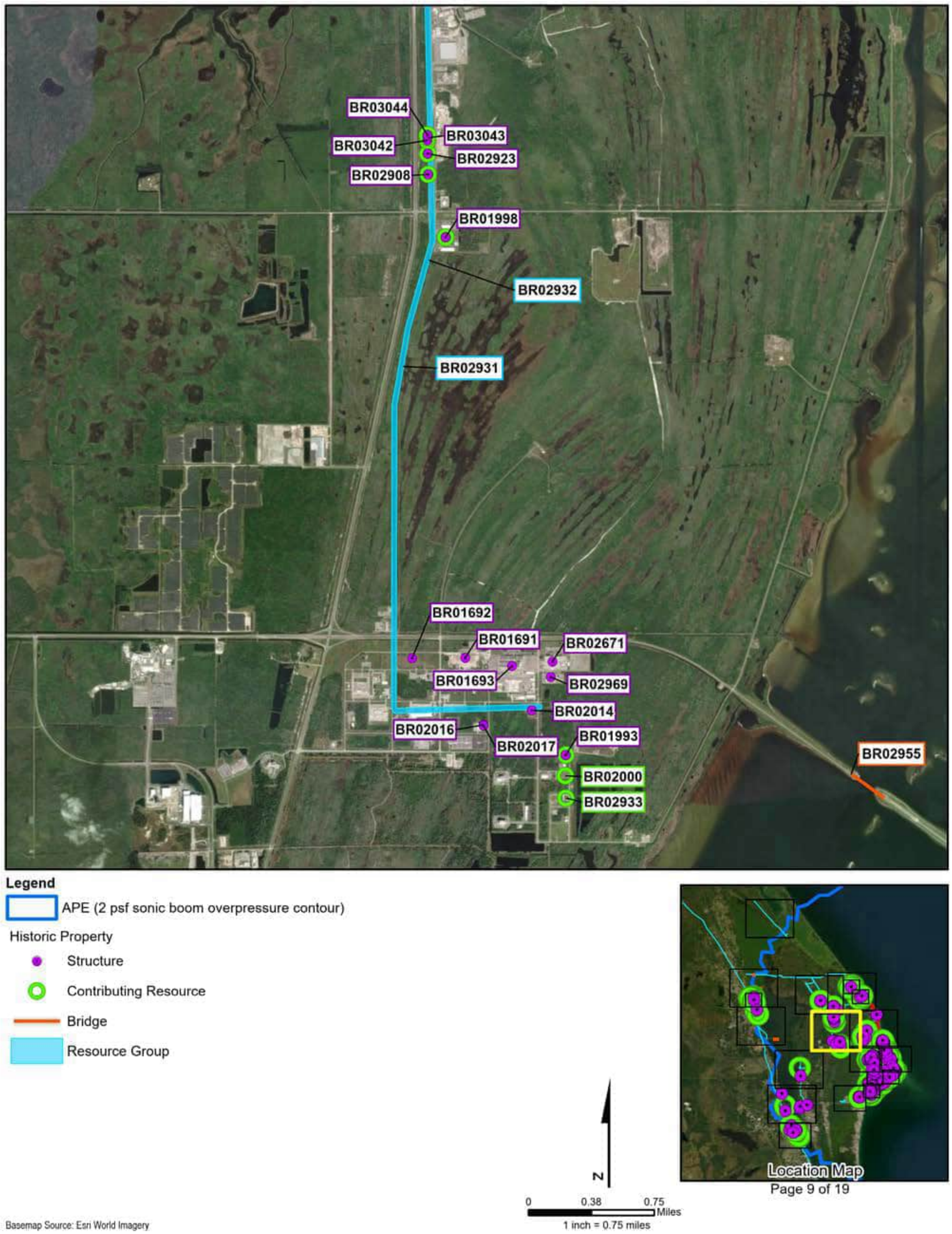


Figure 4-2. Historic Properties Identified in the APE (Page 9 of 19)

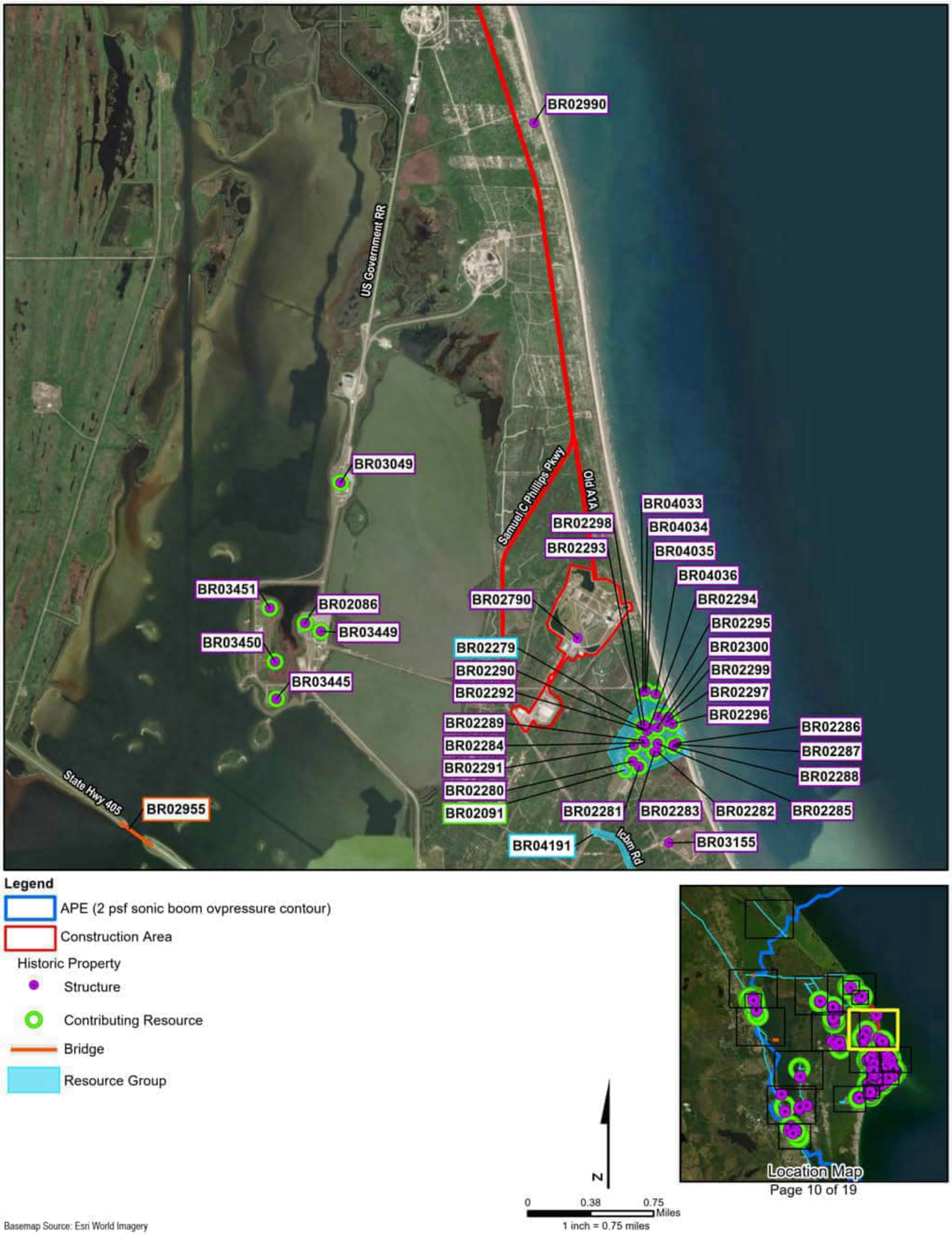


Figure 4-2. Historic Properties Identified in the APE (Page 10 of 19)

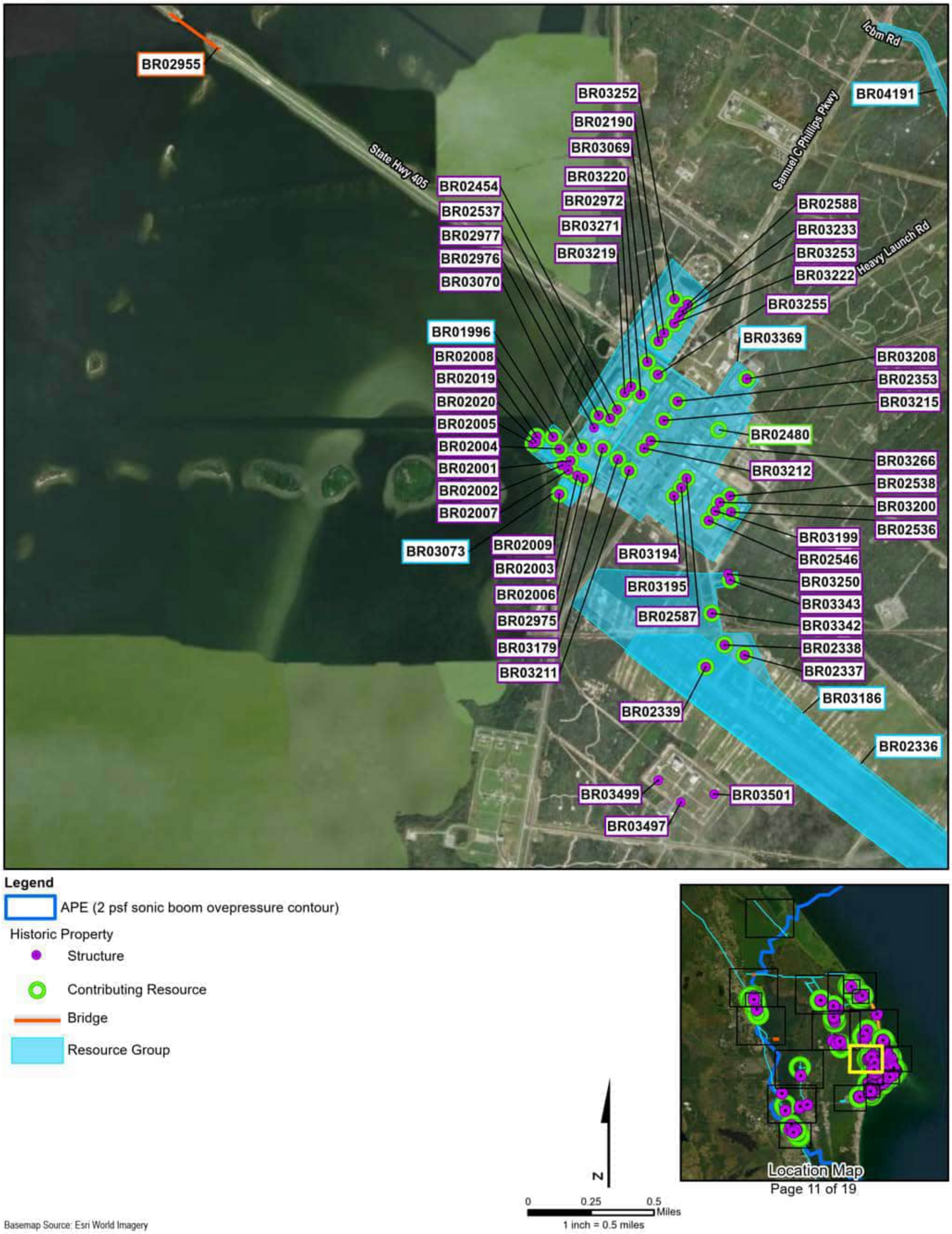


Figure 4-2. Historic Properties Identified in the APE (Page 11 of 19)

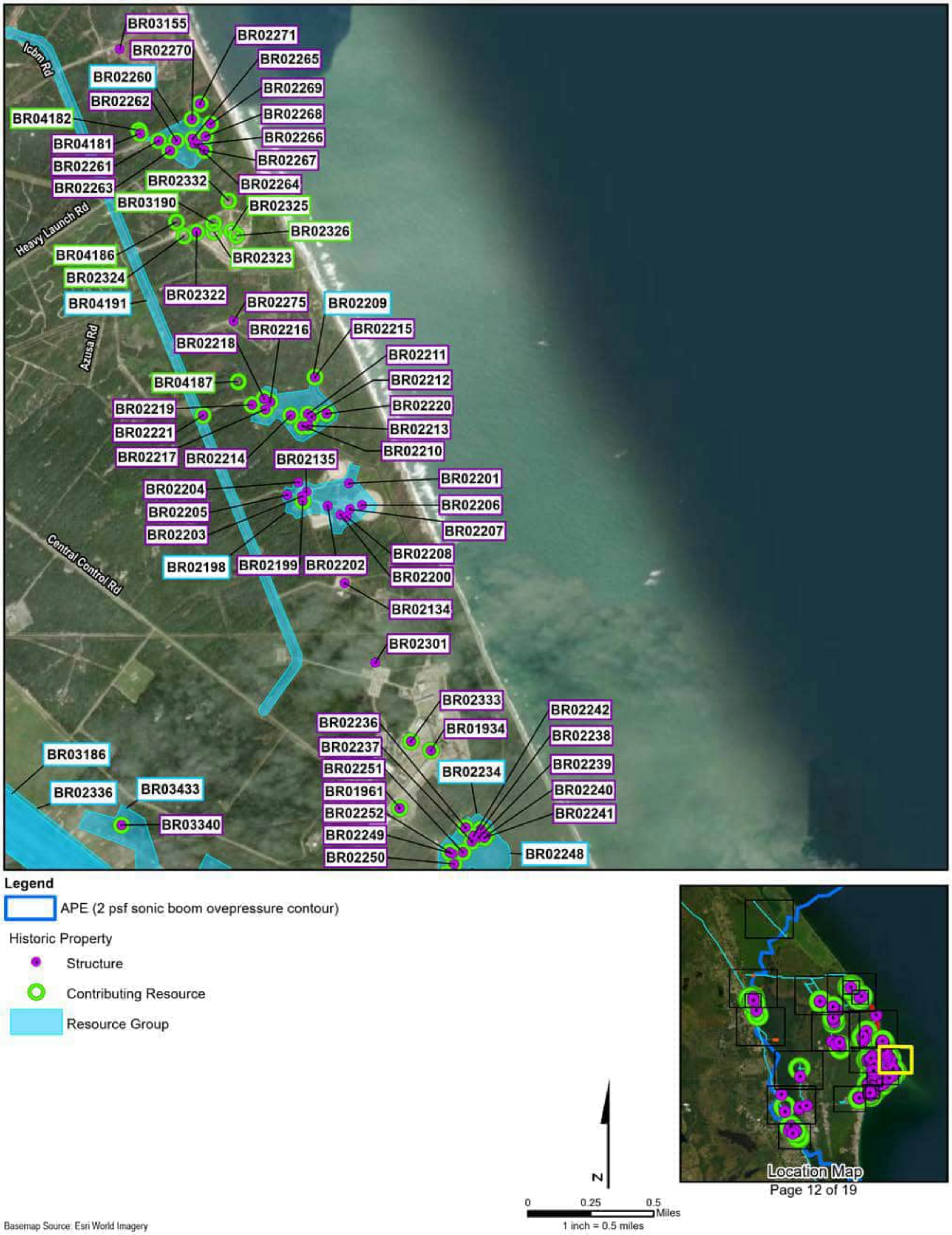


Figure 4-2. Historic Properties Identified in the APE (Page 12 of 19)

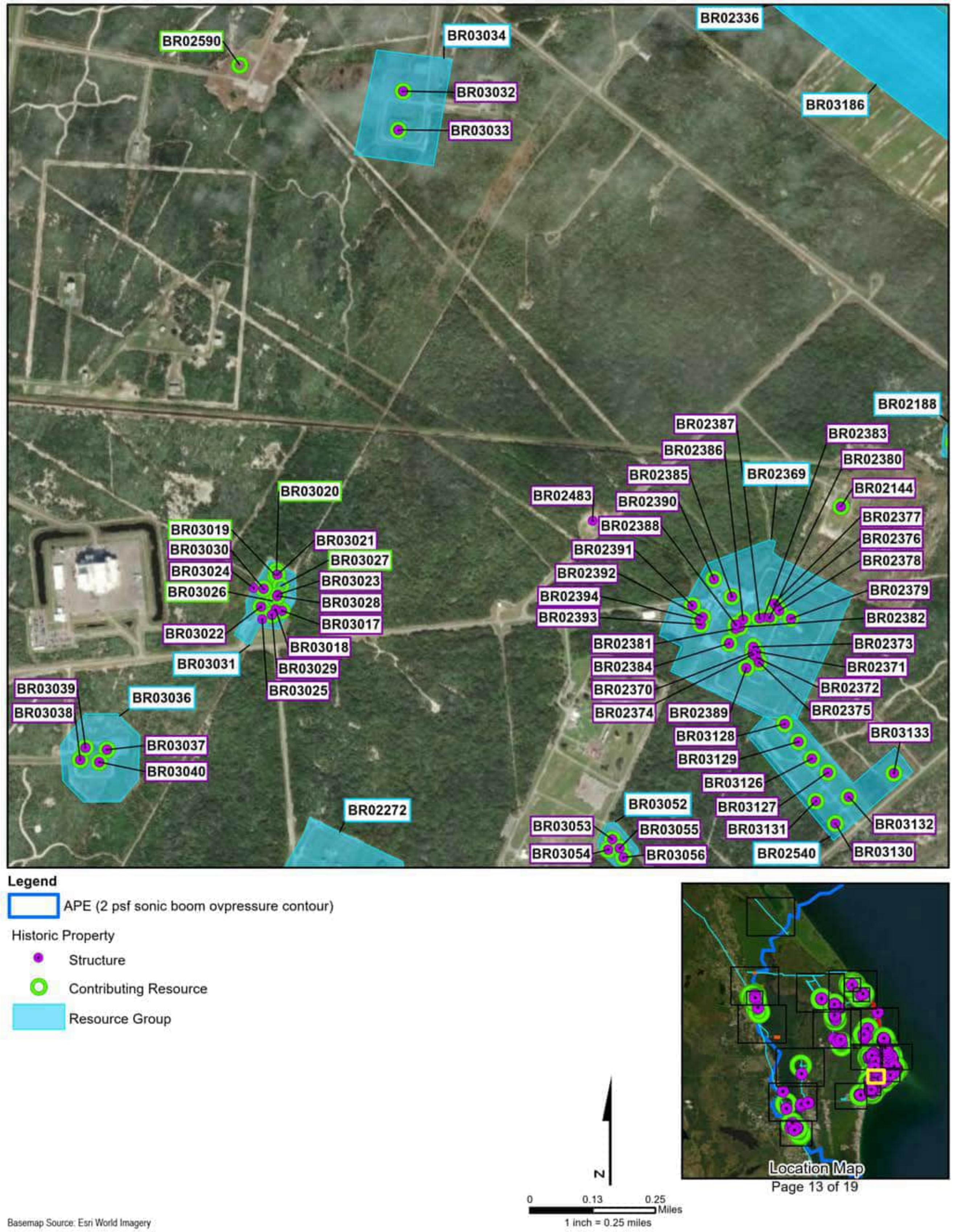


Figure 4-2. Historic Properties Identified in the APE (Page 13 of 19)

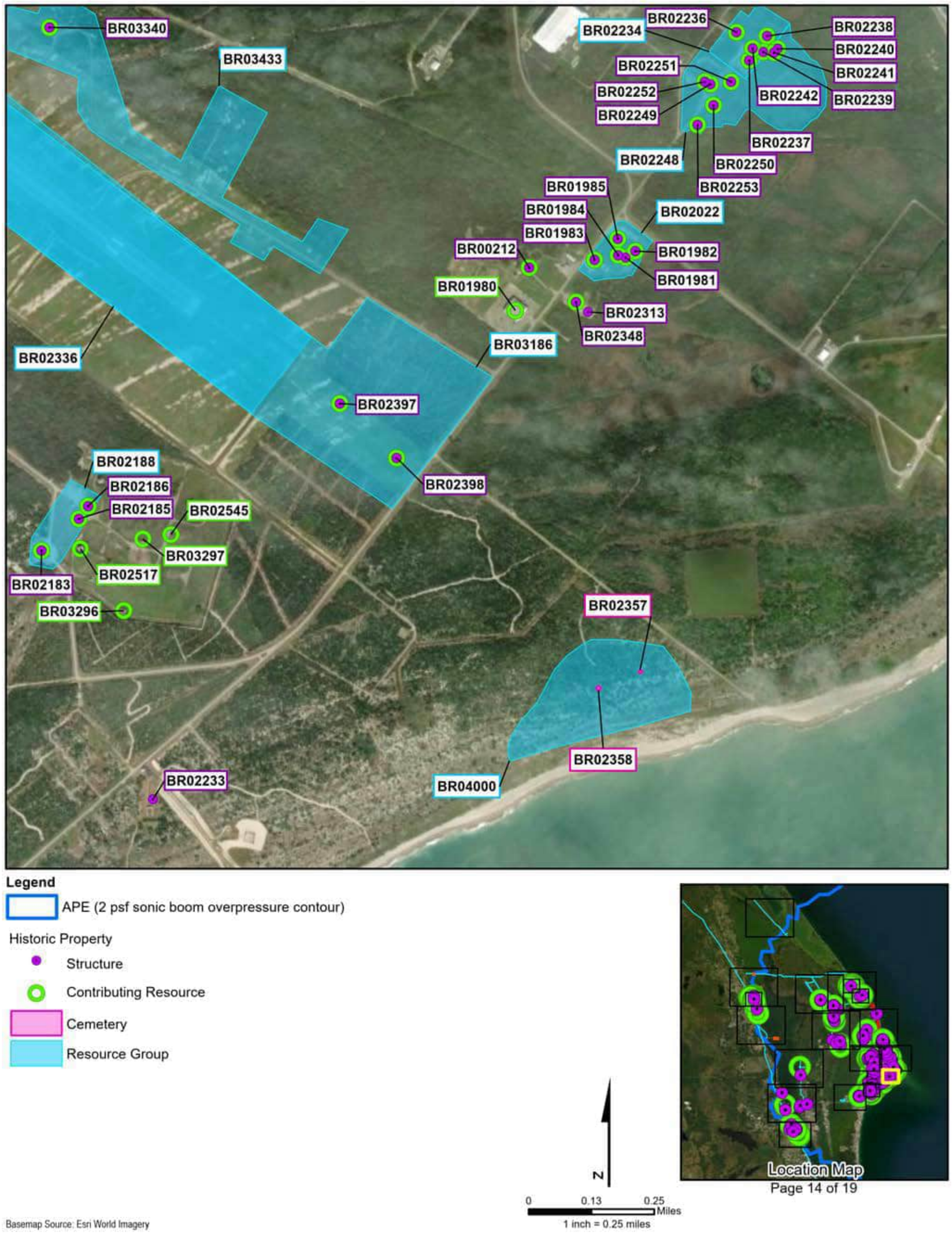


Figure 4-2. Historic Properties Identified in the APE (Page 14 of 19)

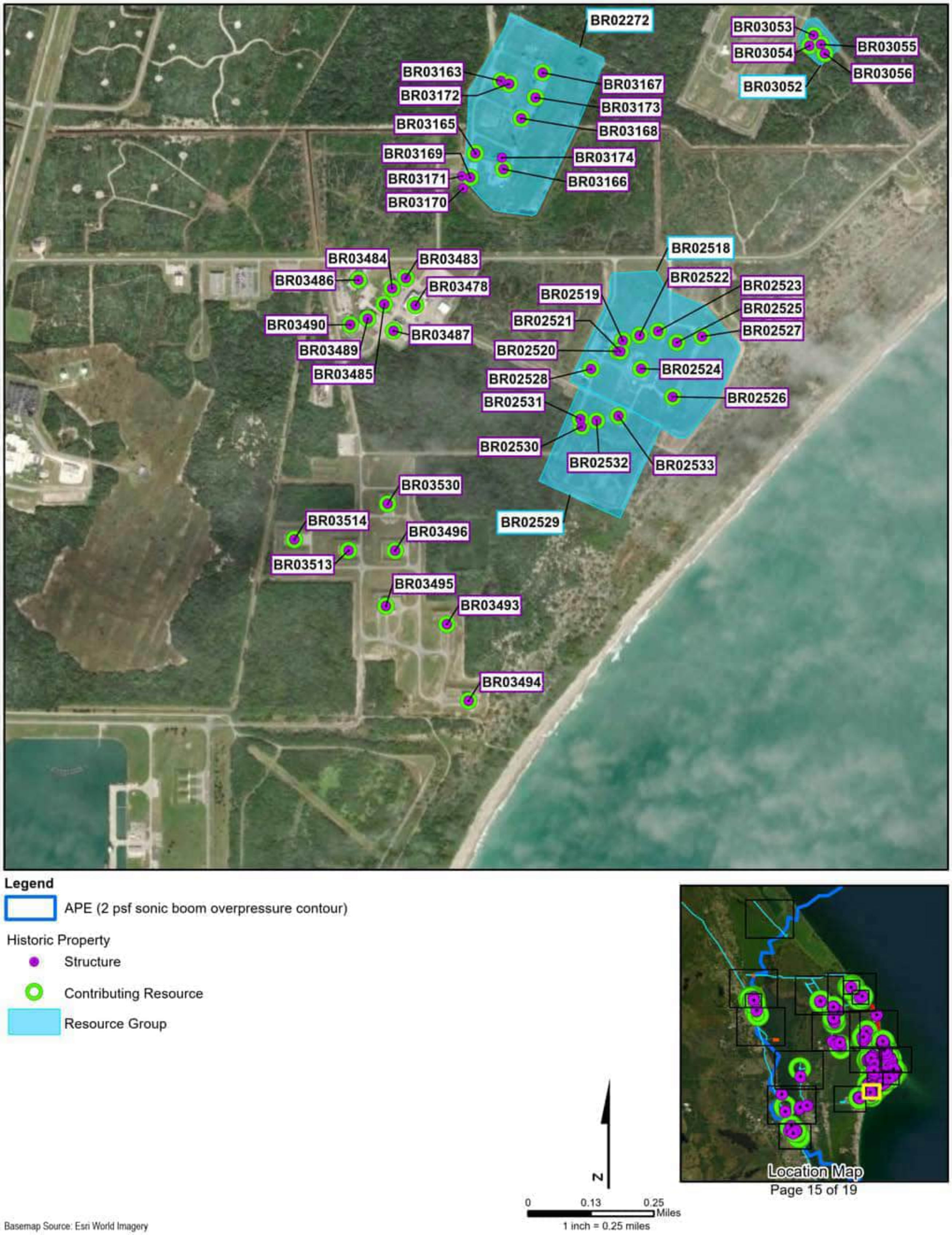
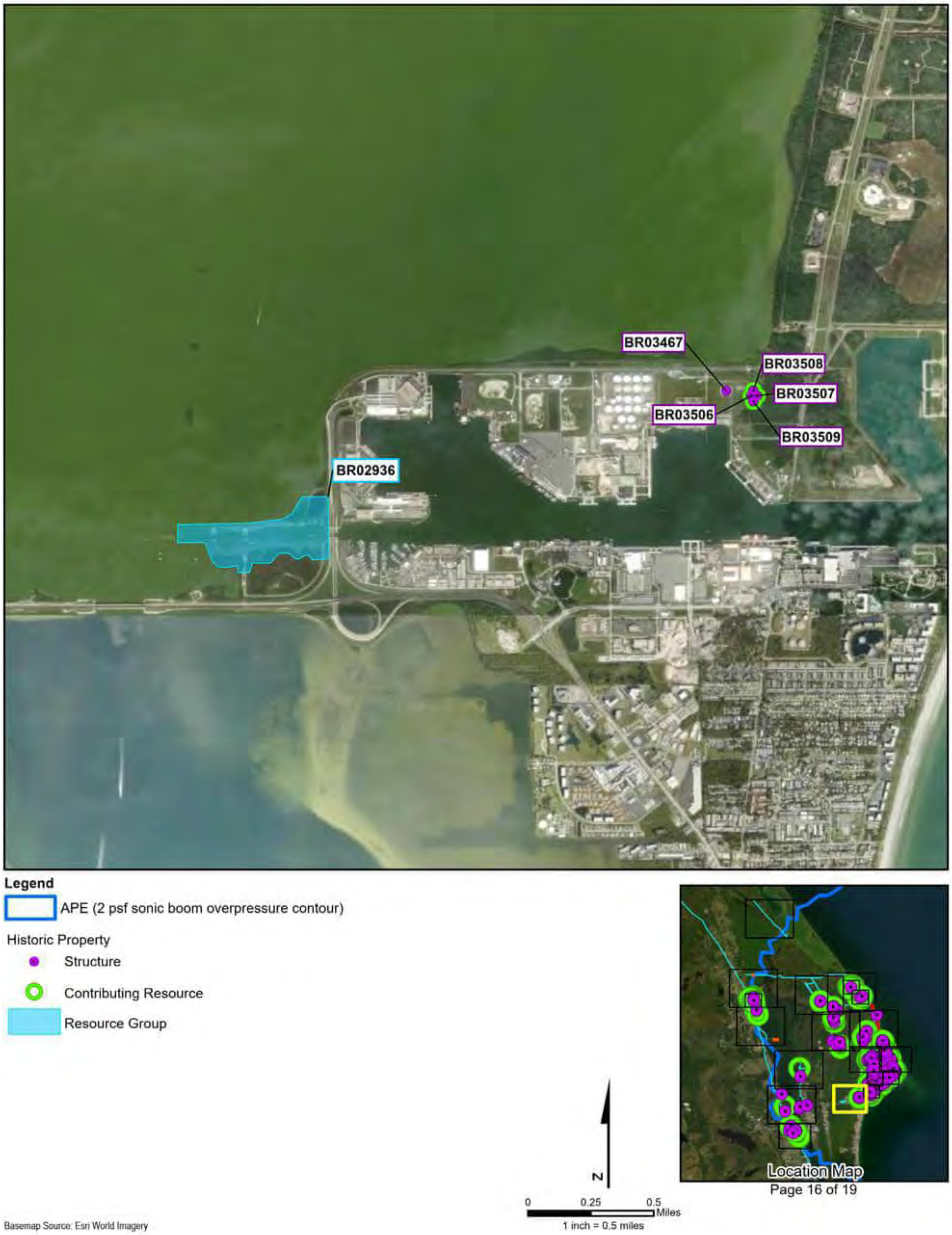


Figure 4-2. Historic Properties Identified in the APE (Page 15 of 19)



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2 **Figure 4-2. Historic Properties Identified in the APE (Page 16 of 19)**

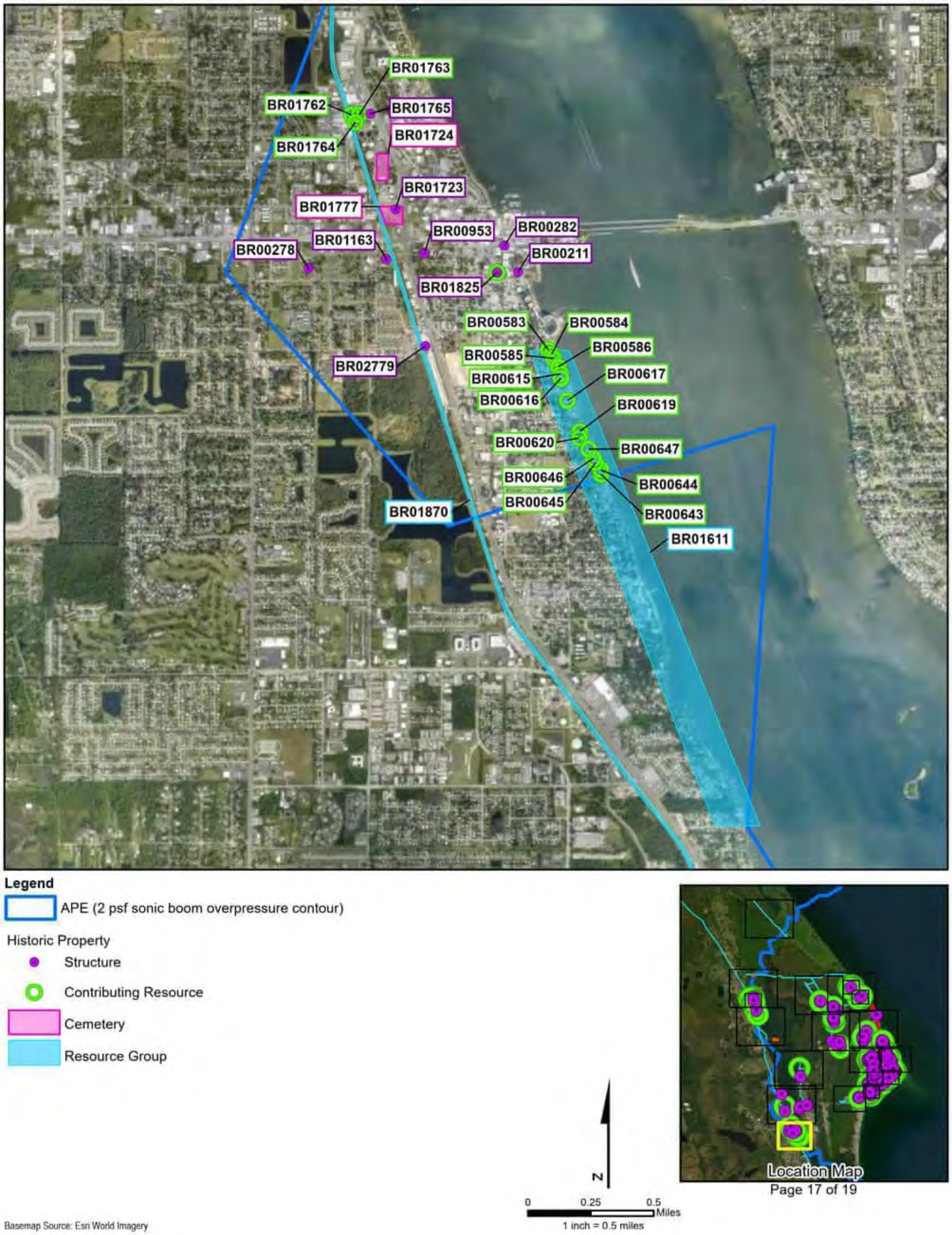

Figure 4-2. Historic Properties Identified in the APE (Page 17 of 19)

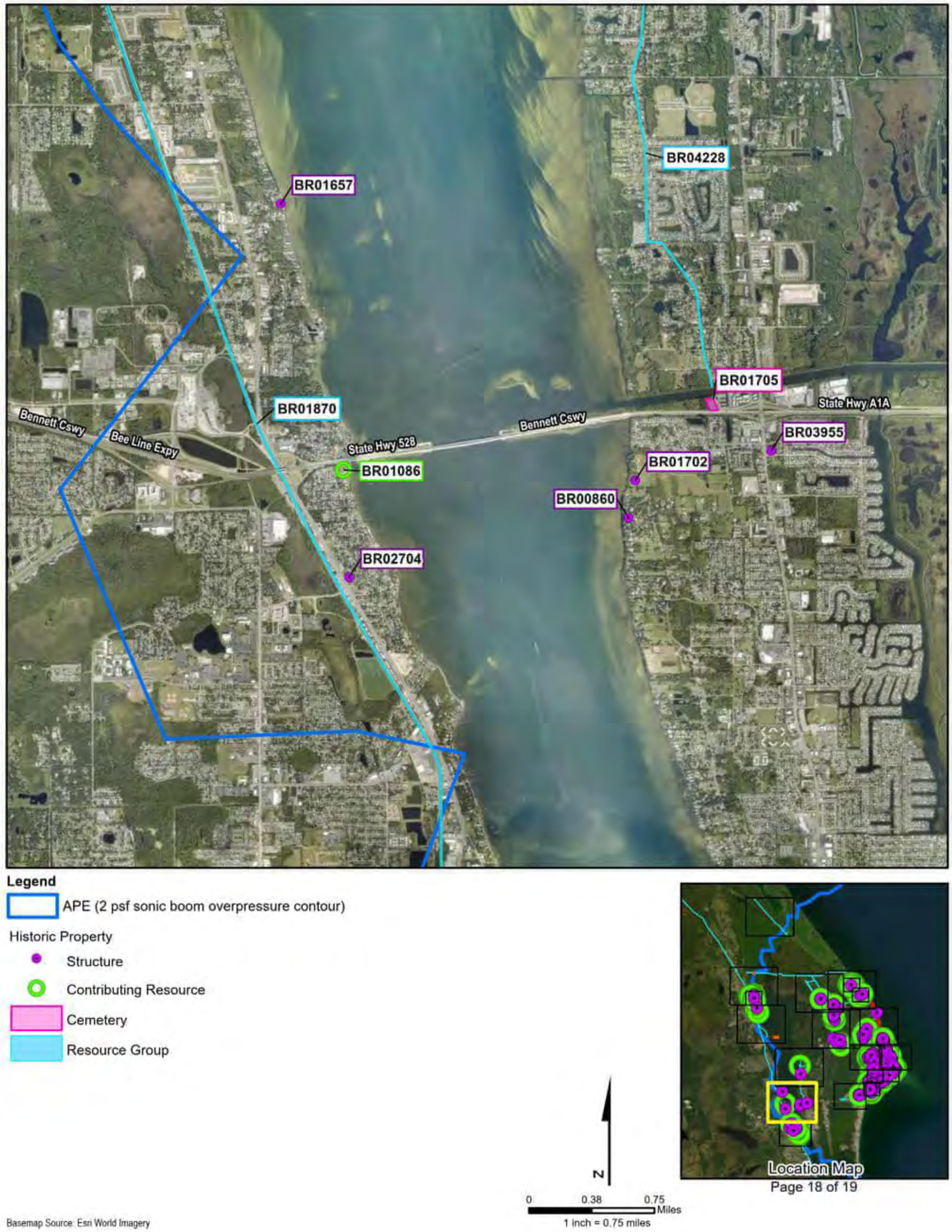

Figure 4-2. Historic Properties Identified in the APE (Page 18 of 19)

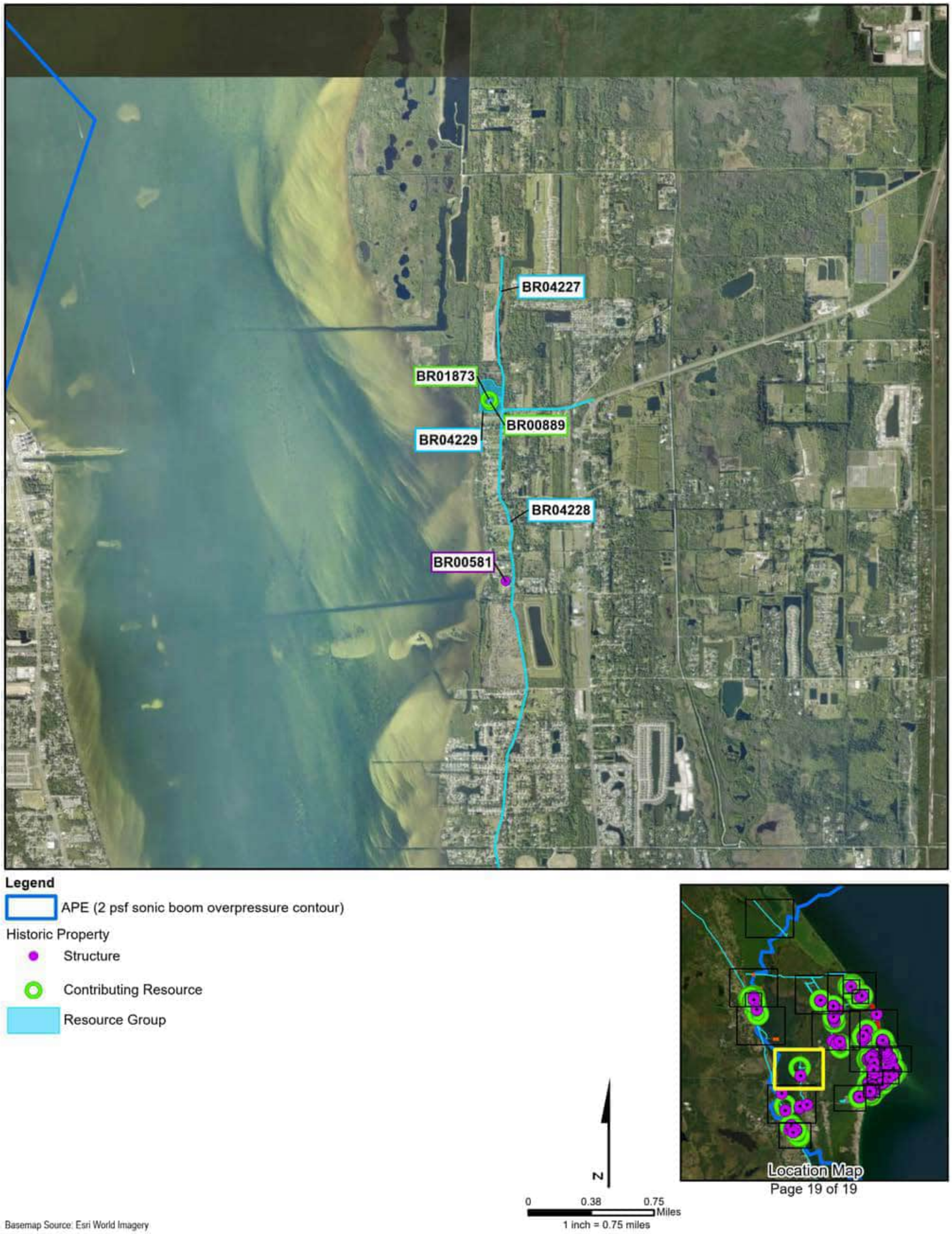

Figure 4-2. Historic Properties Identified in the APE (Page 19 of 19)

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5. Determination of Eligibility

This section presents the results of the historic structure survey completed for SLC-37. No recommendations on determinations of eligibility for resources outside the undertaking's construction area are provided in this report. A list of known historic properties is provided in Appendix C, and new eligibility determinations are provided in FMSF in Appendix D.

5.1 Historic Properties Identified in Construction Area

SLC-37 (FMSF No. BR02274) was previously determined not eligible for listing in the NRHP, with determinations on file with SLD 45 and SHPO, and thus, SLC-37 does not qualify as a historic property or require reevaluation as part of this undertaking. Because SLC-37 was evaluated in 2021, no reevaluation was completed for this undertaking. The LCC (FMSF No. BR02790) was previously determined eligible for listing in the NRHP under Criteria A, B, C, and D and is within the construction area. Because no changes were noted from the recent eligibility determination in 2021, no revaluation was completed for the LCC. Thus, the 2021 eligibility determinations remain valid.

SLD 45 identified the need for a historic structures survey of previously unrecorded or unevaluated historic-age structures associated with SLC-37. These resources are outside the SLC-37 fence line but were constructed to support the complex. In total, 10 structures were surveyed and 10 FMSFs were prepared for previously unevaluated structures associated with SLC-37. The following subsections provide summaries of the 10 resources surveyed and evaluated for NRHP eligibility by this survey. Table 1-2 provides a list of the resources and Appendix D contains the completed FMSF structure forms.

5.1.1 Electrical Switch Station

Built in 2000, the Electrical Switch Station, Facility 38015, was previously unrecorded and unevaluated for NRHP eligibility (refer to Photograph 4). The structure is associated with SLC-37 and was constructed by ULA for the Delta program. It is a utilitarian structure constructed less than 25 years ago and is not exceptionally important. It lacks historical significance and has no architectural style. It is a common portable trailer with a concrete foundation and metal stairs. Therefore, the structure is recommended not eligible for listing in the NRHP under any criteria, either individually or as part of an eligible district.

Photograph 4. Electrical Switch Station, Facility 38015, facing west.

5.1.2 Horizontal Integration Facility

Built in 2000, the Horizontal Integration Facility, Facility 38200, was previously unrecorded and unevaluated for NRHP eligibility (refer to Photograph 5). It is associated with SLC-37 and was constructed by ULA for the Delta program. It is a utilitarian building that lacks historical significance. It has a metal structure and concrete slab foundation. The exterior lacks architectural style and is not significant for engineering or method of construction. The interior, however, was built with a level floor designed for the necessary precision needed for assembly. Although the interior construction is specific to the facility type, it was constructed less than 25 years ago and is not exceptionally important. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria, either individually or as part of an eligible district.

Photograph 5. Horizontal Integration Facility, Facility 38200, facing south.

5.1.3 Security Entry Control Building

Built in 2000, the Security Entry Control Building, Facility 38201, was previously unrecorded and unevaluated for NRHP eligibility (refer to Photograph 6). It is associated with SLC-37 and was constructed by ULA for the Delta program. It is a utilitarian building that lacks historical significance. It has a flat roof with a rectangular plan. The exterior is concrete block construction with minimal ornamentation. It lacks architectural style and is not significant for engineering or method of construction. It was constructed less than 25 years ago and is not exceptionally important. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria, either individually or as part of an eligible district.

Photograph 6. Security Entry Control Building, Facility 38201, facing west.

5.1.4 Storage Building

Built in 2000, the Storage Building, Facility 43407, was previously unrecorded and unevaluated for NRHP eligibility (refer to Photograph 7). It is associated with SLC-37 and was constructed by ULA for the Delta program. It is a utilitarian building that lacks historical significance. It is a metal building of a type commonly constructed for storage. It lacks architectural style and is not significant for engineering or method of construction. It was constructed less than 25 years ago and is not exceptionally important. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria, either individually or as part of an eligible district.

Photograph 7. Storage Building, Facility 43407, facing north.

5.1.5 AF Warehouse II

Built in 1963, the AF Warehouse II, Facility 38315 (FMSF No. BR04028) was previously recorded but was unevaluated for NRHP eligibility (refer to Photograph 8). The building is associated with SLC-37 and was constructed by the USAF for the Saturn program. It is a utilitarian building erected to serve significant programs in the history of CCSFS but was used for ancillary storage. Because the building was constructed during the Cold War era (1945 to 1991), this eligibility recommendation applied guidance available in the existing historical context and NRHP registration requirements (NPS 1984; Van Critters 2015; Hampton et al. 2012; Salmon 2022; Hoffecker et al. 1996). As a warehouse, the building does not share an association with a significant event and does not contribute to broad thematic associations important to the past. Although the warehouse may have stored technology and equipment, the building is not associated with direct space exploration or engineering achievements completed elsewhere at CCSFS, such as at NRHP-eligible launch complexes. Further, the building is a common type and lacks sufficient characteristics to qualify for architecture or engineering. Therefore, the building is recommended not eligible under any criteria, either individually or as part of an eligible district.

Photograph 8. AF Warehouse II, Facility 38315 (FMSF No. BR04028), facing north.

5.1.6 Delta IV Precision Clean Lab

Built in 1962, the Delta IV Precision Clean Lab, Facility 43400 (FMSF No. BR04029) was previously recorded but unevaluated for NRHP eligibility (refer to Photograph 9). The building is associated with SLC-37 and was constructed by the USAF for the Saturn program. It is a utilitarian building erected to serve significant programs in the history of CCSFS but was used for an ancillary purpose. Because the building was constructed during the Cold War era (1945 to 1991), this eligibility recommendation applied guidance available in the existing historical context and NRHP registration requirements (NPS 1984; Van Critters 2015; Hampton et al. 2012; Salmon 2022; Hoffecker et al. 1996). The building does not share an association with a significant event and does not contribute to broad thematic associations important to the past. The building is not associated with direct space exploration or engineering achievements completed elsewhere at CCSFS, such as at NRHP-eligible launch complexes. Further, the building is a common type and lacks sufficient characteristics to qualify for architecture or engineering. Therefore, the building is recommended not eligible under any criteria, either individually or as part of an eligible district.

Photograph 9. Delta IV Precision Clean Lab, Facility 43400 (FMSF No. BR04029), facing southwest.

5.1.7 Hazardous Storage

Built in 1997, Hazardous Storage Facility 38316 was previously unrecorded and unevaluated for NRHP eligibility (refer to Photograph 10). The building is associated with SLC-37 and was constructed by ULA for the Delta program. It is a utilitarian building that lacks historical significance. It lacks architectural style and is not significant for engineering or method of construction. It was constructed less than 27 years ago and is not exceptionally important. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria, either individually or as part of an eligible district.

Photograph 10. Hazardous Storage Facility 38316, facing east.

5.1.8 Delta IV Warehouse

Built in 1963, the Delta IV Warehouse, Facility 43302 (FMSF No. BR4030) was previously recorded but unevaluated for NRHP eligibility (Photograph 11). The building is associated with SLC-37 and was constructed by the USAF for the Saturn program. It is a utilitarian building erected for significant programs in the history of CCSFS, but was used for ancillary storage. Because the building was constructed during the Cold War era (1945 to 1991), this eligibility recommendation applied guidance available in the existing historical context and NRHP registration requirements (NPS 1984; Van Critters 2015; Hampton et al. 2012; Salmon 2022; Hoffecker et al. 1996). As a warehouse, the building does not share an association with a significant event and did not contribute to broad thematic associations important to the past. Although the warehouse may have stored technology and equipment, the building is not associated with direct space exploration or engineering achievements completed elsewhere at CCSFS, such as at NRHP-eligible launch complexes. The building is a common type and lacks sufficient characteristics to qualify for architecture or engineering. Therefore, the building is recommended not eligible under any criteria, either individually or as part of an eligible district.

Photograph 11. Delta IV Warehouse, Facility 43302 (FMSF No. BR4030), facing east.

5.1.9 FPL Substation Building

Built in 1999, the Florida Power and Light Company (FPL) Substation Building, Facility 43311, was previously unrecorded and unevaluated (Photograph 12). It is associated with SLC-37 and was constructed to transfer power from the FPL Cape Canaveral Power Plant (no longer extant) to SLC-37. It is a utilitarian building that lacks historical significance. It lacks architectural style and is not significant for engineering or method of construction. It was constructed less than 25 years ago and is not exceptionally important. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria, either individually or as part of an eligible district.

Photograph 12. FPL Substation Building, Facility 43311, facing north.

5.1.10 Delta IV Power Control Center

Built in 1999, the Delta IV Power Control Center, Facility 43313, was previously unrecorded and unevaluated (refer to Photograph 13). The structure is associated with SLC-37 and was constructed by ULA for the Delta program. It is a utilitarian structure that lacks historical significance. It lacks architectural style and is not significant for engineering or method of construction. It was constructed less than 25 years ago and is not exceptionally important. Therefore, the structure is recommended not eligible for listing in the NRHP under any criteria, either individually or as part of an eligible district.

Photograph 13. Delta IV Power Control Center, Facility 43313 (previously unrecorded), facing west.

6. Finding of Effect

According to 36 CFR 800.5(a)(1), an adverse effect is found when an undertaking affects, directly or indirectly, any characteristic of a historic property that qualifies the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. The NPS's *How to Apply the National Register Criteria for Evaluation* (Shrimpton and Andrus 1997), defines the seven aspects of integrity and how to use them to evaluate the integrity of a property. The criteria for adverse effects provided at 36 CFR 800.5(a)(1) must be applied to federal undertakings that have the potential to affect historic properties. All reasonable and foreseeable effects must be considered when evaluating the potential for adverse effects, including direct, indirect, and cumulative effects (36 CFR 800.5(a)).

As noted in Section 1.4, the DAF based the APE on the FAA precedent of 2 psf to capture the potential for damage to historic properties from launch and landing operations of Starship-Super Heavy. The 2024 Re-evaluation of the PEA stated that "sonic boom modeled contours are a representation of approximated anticipated [psf] levels [and] actual exposure at any particular location or time during a sonic boom event can vary depending on a number of different factors including atmospheric, physical, and operational parameters" (FAA 2024a). The 2024 Re-evaluation also noted that sonic booms of 2 psf had a 1-in-10,000 chance to break a large window. With an increase to 4 psf, there was a 1-in-10,000 chance to break a small window, but even a sonic boom of 4 psf was "still extremely unlikely to cause damage" (FAA 2024a). At 10 psf, there was greater probability of superficial damage (plaster and bric-a-brac) and glass breakage but that "is generally still expected to be very low probability and predominantly due to poor existing conditions" (FAA 2024a). Standard windows in normal condition become more likely to break when the threshold reaches 20 psf (FAA 2024a).

The assessment of adverse effects would consider potentially vulnerable historic properties in the APE with significant architectural characteristics that noise and vibrations could damage, such as decorative bric-a-brac and windows. Visual changes and temporary changes associated with construction activities are possible but are not expected to cause adverse effects. Potentially vulnerable historic properties could include late nineteenth to early twentieth century property types, or later period properties in poor condition with important glass features. Properties that achieve significance in areas other than architecture are not anticipated to have the potential for their qualifying characteristics to meet this criterion unless their character-defining features are potentially vulnerable to noise and vibrations from the undertaking. As noted in Section 1.4, the undertaking has a low potential for adverse effects on historic properties in the 2-psf APE, and even 4 psf is "extremely unlikely to cause damage," (FAA 2024a).

Many structures at CCSFS that qualify as historic properties are highly technical and scientific facilities, such as the CCAFS NHL District and its contributing launch complexes in the APE (SLC-14, SLC-19, SLC-34, and the honorarily listed SLC-13). The Advisory Council on Historic Preservation's (ACHP's) guidance in *Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities* was referenced to assess adverse effects in this study because those types of historic properties were identified in the APE, including contributing resources to the CCAFS NHL District (ACHP 1991). The guidance explicitly recognizes the challenge of agencies with missions involving active research and highly technical operations, such as space launch complexes, given their continuous need to modify or replace historic facilities, and how long-term operation of these facilities can result in "significant alterations" (ACHP 1991). The guidance asserts that historic properties associated with highly scientific and technical operations require an "unusual degree of flexibility" and notes that "a special effort should be made toward maintaining flexibility in the planning and execution of research work and meeting the time constraints of priority programs" (ACHP 1991).

For such scientific and technical properties to remain in use, the properties must be changed and modified to accommodate operations over the long term. Scientific achievements must be evaluated within the historical context recognized by the scientific community. The ACHP recommends that federal agencies with missions involving the active use of scientific and highly technical facilities develop innovative measures, such as documentation, material conservation, and public history programming, to preserve the historic properties' significance while the facilities continue to be used so that future generations may benefit from this history. In line with this recommendation, the SLD 45 Cultural Resources Management Program has implemented a comprehensive documentation program, including a digital preservation portfolio with 3D scanning and models, documentaries, oral histories, and material object conservation. The previously completed documentation and other information are publicly available from the Space Force Museum, Smithsonian Air and Space Museum, and the University of South Florida Libraries and Digital Heritage and Humanities Collections.

The ACHP's guidance specifically notes that "modifications that result in a historic property's loss of integrity *can* have a beneficial effect, however, if those modifications result in the continued use of a facility or structure." It notes that "active facilities must constantly evolve to continue to make scientific or engineering advancements. Under the right circumstances, this process can preserve the historic property's preservation." Historic properties are also preserved through the reuse of non-historic facilities. The qualities embedded in eligible historic properties are preserved by reusing ineligible existing facilities and avoiding changes to eligible historic properties.

In total, 691 previously recorded historic properties were identified in the APE, including 340 individual historic properties and 351 contributing resources. Historic properties identified at CCSFS and KSC are associated with space exploration, communications, science (Criterion A), as well as important persons (Criterion B), significant architectural and engineering achievements (Criterion C), and important information to history (Criterion D). The CCAFS NHL District is one of the historic properties identified in the APE. The CCAFS NHL District is listed in the NRHP under Criteria A and C and is recognizable for its location and setting. Location and setting are two important aspects of the integrity of this historic property. The CCAFS NHL District and its contributing resources are character-defining features of Cape Canaveral, an active USSF facility adjacent to the ocean. It is nationally significant for contributing to space exploration and the U.S. space program. The CCAFS NHL District and its contributing resources were historically constructed to facilitate launches. Thus, the Proposed Action is appropriate for SLC-37 and is not expected to have adverse effects on the CCAFS NHL District or any of its contributing resources.

Two potentially vulnerable historic properties at CCSFS and KSC require further consideration for adverse effects from the undertaking—the Beach House (FMSF No. BR02990) (built 1962) and Cape Canaveral Lighthouse (FMSF No. BR00212) (built 1868 and relocated in 1894). These two historic properties are unlike others at CCSFS or KSC because they were not explicitly designed to accommodate launches. The Beach House (FMSF No. BR02990) and Cape Canaveral Lighthouse (FMSF No. BR00212) have architectural characteristics that require further consideration for their potential to be adversely affected by noise and vibrations.

Historic properties outside of the CCSFS and KSC properties were identified with potential vulnerabilities to noise and vibrations that may require further study, such as the nine NRHP-listed historic property examples identified in this report:

- Judge George Robbins House (FMSF No. BR00399)

- Wager House (FMSF No. BR00397)
- Spell House (FMSF No. BR00480
- Imperial Towers (FMSF No. BR04215)
- City Point Community Church (FMSF No. BR01657)
- Dr, George E. Hill House (FMSF No. BR00860)
- Old St. Luke's Episcopal Church and Cemetery (FMSF No. BR00581)
- Rockledge Drive Residential District (FMSF No. BR01611)
- Aladdin Theater (FMSF No. BR00282)

Because this study is limited to the desktop review of historic properties outside of CCSFS, the list of nine NRHP-listed historic property examples identified previously is suggestive of what property types could be potentially vulnerable historic properties. Additional NRHP-eligible historic properties and undetermined resources are present in the APE. Some of these properties may have character-defining features, such as decorative glass in churches, lenses in the lighthouse, or Queen Anne wooden bric-a-brac on houses, that would be vulnerable to damage from the noise and vibration associated with Starship-Super Heavy launches and landings. It is unknown at this time if that damage would occur or if it would be sufficient to diminish the integrity of the characteristics that qualify the properties for inclusion in the NRHP. Because there may be potential for adverse effects, Section 106 consultation is recommended to draft a project-specific programmatic agreement that can provide a process to assess these potential effects and resolve any adverse effects that may occur.

In the construction area, all structures within SLC-37 have been evaluated, and no new historic properties have been identified in this assessment. SLC-37 contains one previously determined eligible historic property, the LCC (FMSF No. BR02790). The LCC (FMSF No. BR02790) would remain in place, and the proposed material changes and upgrades would be in keeping with the facility's use as an active launch complex. Thus, the Proposed Action would result in retaining the one historic property within the construction area and allowing scientific and engineering advancements to continue through the use of SLC-37. No adverse effects on the LCC (FMSF No. BR02790) are expected from the undertaking. SLD 45 also maintains an ICRMP and has a monitoring program for historic properties at CCSFS that would aid in protecting this historic property.

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7. Recommendations and Conclusion

To support Starship-Super Heavy, SpaceX would remove most of the existing structures at SLC-37, which is ineligible for listing in the NRHP. The LCC (FMSF No. BR02790) is the only historic property within the construction area. The LCC would remain in place, and no physical changes are planned for the historic property. This assessment evaluated 10 previously unrecorded or unevaluated structures within the construction area but outside the fence line at SLC-37. The 10 structures are recommended not eligible for listing in the NRHP (refer to Appendix C for FMSF). The Proposed Action includes demolishing ineligible structures at SLC-37; however, the LCC (FMSF No. BR02790), the only eligible historic property, would remain in place and unaltered. The recommended finding of effect for the LCC is no adverse effect.

The investigation for this study and previous cultural resources investigations have sufficiently covered the CCSFS portion of the APE, and no further survey of historic structures is recommended. Although several historic properties were previously identified in the APE, they are almost all associated with the space program, so the recommended finding of effect for these properties is no adverse effect.

The APE intersects with portions of Brevard County, Titusville (a CLG), and incorporated and unincorporated communities, including Cape Canaveral, Cocoa, Cocoa Beach, Merritt Island, and Rockledge. A good faith effort to identify historic properties in the Indian River communities found 705 historic properties, including some with potential material vulnerabilities to noise and vibrations, and unevaluated historic age resources. Although the potential for Starship-Super Heavy operations to cause adverse effects on historic properties in the APE is low, some of these properties may have character-defining features that would be vulnerable to damage from the noise and vibration associated with Starship-Super Heavy launches and landings. It is unknown at this time if that damage would occur or if it would be sufficient to diminish the integrity of the characteristics that qualify the properties for inclusion in the NRHP.

Because the DAF cannot fully determine how the undertaking would affect historic properties before making a final decision, Section 106 consultation is recommended to draft a project-specific programmatic agreement that can provide a process to assess these potential effects and resolve any adverse effects that may occur.

Section 106 of the NHPA would be completed before any demolition, construction, or operations proceed, as specified in the SLD 45 ICRMP (USAF 2023).

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Appendix A
Resumes

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Lori Durio Price

SENIOR CULTURAL RESOURCES TECHNOLOGIST/
ARCHITECTURAL HISTORIAN

EDUCATION/QUALIFICATIONS

M.F.A., Historic Preservation, 1995, Savannah College of Art and Design,

B.A., English and Political Science, 1985, Louisiana State University

REGISTRATIONS/ CERTIFICATIONS

Qualified as a historian, architectural historian, and historic preservationist under the Secretary of the Interior's Historic Preservation Professional Qualification Standards as defined in 36 CFR 61

OTHER

- 29 years professional cultural resources experience
- Joined Jacobs in 2003

Lori is an architectural historian/planner with a diverse background in cultural resources. Prior to her 21 years with Jacobs, she held positions as State Historic Preservation Office staff and as the Principal Architectural Historian for the City of New Orleans. Her experience includes managing environmental reviews; conducting and facilitating Section 106 and tribal consultation; handling agency coordination; developing mitigation strategies and drafting MOAs/PAs; and performing cultural resources field surveys. She currently serves as the US national Cultural Resources Community of Practice Lead.

Areas of Expertise

- 29 years of experience in dealing with cultural resources issues through local, state, and federal regulations
- Experience with National Register of Historic Places (NRHP) and state and local landmark eligibility issues
- Extensive survey, evaluation, and preservation planning experience
- Thorough knowledge of Section 106 and Section 110 of the National Historic Preservation Act (NHPA), including drafting and implementation of Programmatic Agreements (PAs) and Memoranda of Agreement (MOAs)
- Previous regulatory experience as State Historic Preservation Office (SHPO) staff, municipal Historic District Commission staff, and Federal Emergency Management Agency (FEMA) contracted field office staff
- National Environmental Policy Act (NEPA) compliance experience, Department of Transportation Act Section 4(f) evaluation experience, and Land and Water Conservation Fund Act Section 6(f) experience
- Nationwide experience, including Hawaii, Alaska, and Puerto Rico

Project Experience

202-220 South State Street, Chicago, Illinois

Client: General Services Administration (GSA)

Title: Cultural Resources Senior Technical Staff

Start/End Dates: November 2022 to present

Scope/Description: Section 106 and NEPA compliance

Responsibilities: Assisting GSA with compliance with Section 106 of the NHPA and with NEPA for a project to determine the future of the historic buildings at 202 and 220 South State Street in the historic Loop district of downtown Chicago. This high profile and controversial project involves multiple consulting parties, including the ACHP and federal law enforcement. Project includes preparation of an EIS for NEPA with potentially significant impacts to cultural resources, and drafting a Programmatic Agreement under Section 106 to resolve potential adverse effects. Also responsible for technical review of work by local subconsultant and Jacobs internal team.

Bandelier National Monument Rehabilitate Underground Utilities Project; Bandelier National Monument Historic Preservation Guide and Cultural Landscape Inventory

Client: National Park Service

Title: Cultural Resources Program Lead

Start/End Dates: September 2021 to November 2023

Scope/Description: Cultural Resources Senior Technical Staff

Responsibilities: Responsible for senior review of cultural resources report for underground utilities project in two National Register historic districts. Project included multiple New Mexico SHPO survey forms and resulted in a finding of No Adverse Effect to historic properties. Original project then led to follow-on work for a Historic Preservation Guide (HPG) for Bandelier that included a Cultural Landscape Inventory (CLI) for their Mission 66 Village historic district. The HPG and CLI were completed on an expedited timeline and entailed working closely with Bandelier and NPS cultural resources and park staff.

Arecibo Observatory Proposed Divestment Environmental Impact Statement, Arecibo, Puerto Rico

Client: National Science Foundation (NSF), Directorate for Mathematical and Physical Sciences, Division of Astronomical Science

Title: Cultural Resources Program Lead

Start/End Dates: March 2016 to November 2017

Scope/Description: Cultural resources compliance for NEPA and Section 106 for divestment of NRHP-listed Observatory Historic District.

Responsibilities: Responsible for senior review of all Section 106 deliverables related to impacts on the National Astronomy and Ionosphere Center Historic District. Drafted the Programmatic Agreement to resolve potential adverse effects to the historic district and assisted NSF with Section 106 consultation involving the Puerto Rico SHPO, Advisory Council on Historic Preservation, and numerous stakeholders. Authored the cultural resources section of the EIS. Included successful execution of the PA after Hurricanes Maria and Irma. Resulted in a successful resolution for this locally controversial project. Performance on this project led to an additional Task Order to assist the NSF with implementation of the PA. ***Project received the 2020 Citation Award from the Federal Planning Division of the American Planning Association for Outstanding Environmental Planning Project.***

Implementation of Programmatic Agreement among the National Science Foundation, the Advisory Council on Historic Preservation, and the Puerto Rico State Historic Preservation Officer Regarding Potential Changes to Arecibo Observatory Operations in the Vicinity of Arecibo, Puerto Rico

Client: National Science Foundation (NSF), Directorate for Mathematical and Physical Sciences, Division of Astronomical Science

Title: Cultural Resources Program Lead

Start/End Dates: July 2017 to October 2022

Scope/Description: Cultural resources compliance under Section 106, assisting NSF with implementing the stipulations for mitigation in the Programmatic Agreement.

Responsibilities: Responsible for senior review of all deliverables stipulated in the Programmatic Agreement. Assist NSF with strategy to implement deliverables in a timely and cost-efficient method. Consult with Puerto Rico SHPO and local stakeholders to ensure continued communication and coordination as the Agreement is implemented. Included adapting to COVID-19 pandemic by changing a full-day, in-person, bi-lingual preservation training required for Observatory staff to an on-line Zoom training. Training was attended by 52 people, including client representatives, and received very positive feedback from client and attendees.

Horseshoe Canyon, Green Bank, and Sacramento Peak Telescopes Decommissioning Environmental Compliance, Arizona, West Virginia, and New Mexico

Client: National Science Foundation (NSF), Directorate for Mathematical and Physical Sciences, Division of Astronomical Science

Title: Cultural Resources Program Lead

Start/End Dates: July 2014 to February 2021

Scope/Description: Cultural resources compliance for NEPA and Section 106 for divestment of NRHP eligible observatories in multiple states, including a Tribal Traditional Cultural Property and a National Historic Landmark

Responsibilities: Worked with legal staff of NSF to continue Section 106 consultation on the Horseshoe Canyon site, a tribal Traditional Cultural Property on land leased from a tribal nation with historically contentious federal relationships. Successfully achieved a finding of No Adverse Effect with concurrence from the THPO. Responsible for strategy and senior review of all cultural resources deliverables for the Green Bank and Sacramento Peak sites, including conducting Consulting Party meetings, meeting with SHPO staff, and drafting Programmatic Agreements.

Environmental Compliance for National Ecological Observatory Network (NEON) Proposed Site at Pu’u Maka’ala Natural Area Reserve, Hawai’i Island

Client: National Science Foundation (NSF), Directorate for Biological Sciences

Title: Cultural Resources Senior Technical Staff

Start/End Dates: February 2016 to March 2017

Scope/Description: Cultural resources compliance for NEPA and Section 106 for a new National Ecological Observatory Network (NEON) site in Hawai’i. NEON is a continental-scale ecological observation facility sponsored by NSF and operated by Battelle Ecology, Inc. It is designed to gather and synthesize data needed to study the impacts of climate change, land use change, and invasive species on natural resources and biodiversity. NSF proposed to establish a NEON field study site within the Pu’u Maka’ala Natural Area Reserve (NAR) on the eastern side of Hawai’i Island, part of the statewide Natural Area Reserves System (NARS). The proposed field study site would provide data for NEON’s Pacific Tropical Domain (Domain 20), and would be the only site representing this domain for the continental-wide network.

Responsibilities: Worked with NSF staff to identify and evaluate potential historic properties at the site and prepared an assessment of effects, reaching a finding of No Adverse Effect to historic properties. Prepared cultural resources section of Environmental Assessment. Included on-site literature search at Hawai’i SHPO, on-site meeting with local agencies and stakeholders, and on-site Consulting Parties meeting. Project was located in a culturally sensitive area and included a culturally sensitive bird species.

Section 106 Consultation for Corrective Action for Impacted Sediments, Cooling Water Canal, Peñuelas Technology Park LLC, Peñuelas, Puerto Rico

Client: Peñuelas Technology Park LLC (PTPLLC), a wholly owned subsidiary of the Dow Chemical Company

Title: Cultural Resources Senior Technical Staff

Start/End Dates: November 2016 to March 2017

Scope/Description: To support Section 106 compliance for U.S. Environmental Protection Agency (EPA). PTPLLC planned to implement a corrective action for impacted sediments in the Cooling Water Canal (CWC) at the former Union Carbide Caribe site in the Municipality of Peñuelas, Puerto Rico. This action was in compliance with a Resource Conservation and Recovery Act (RCRA) permit issued by the EPA.

Responsibilities: Responsible for strategy for cultural resources compliance. Supported client and EPA by availing existing relationship with PR SHPO and facilitating consultation. Conducted research to prove that remediation area was previously disturbed and complex was not eligible for the NRHP. Successfully argued that no historic properties would be affected by the project.

Howard Street South Channel Bridge Replacement and Riverfront Park Master Planning Project, Spokane, Washington

Client: City of Spokane

Title: Cultural Resources Senior Technical Staff

Start/End Dates: April 2015 to 2019

Scope/Description: Cultural Resources Compliance and Planning

Responsibilities: Prepare strategy, advise project management team, and review all technical deliverables for SEPA and Section 106 compliance for a historic bridge replacement within historic Riverfront Park. Also assist City with inventory, evaluation, and impacts assessment for all other elements of new master plan for revitalization of the historic park, which is significant for its role in Spokane history and for its association with the 1974 World's Fair.

Environmental Impact Statement and Section 106 Compliance for Next NGA West Project, St. Louis, Missouri

Client: USACE Kansas City District and National Geospatial Intelligence Agency (NGA)

Title: Cultural Resources Senior Technical Staff

Start/End Dates: September 2014 to May 2016

Scope/Description: Cultural resources compliance for NEPA and Section 106 for a new NGA facility.

Responsibilities: Responsible for approach and strategy for cultural resources compliance for this complex multi-agency project. Managed subcontracts for initial architectural and archaeological surveys and performed quality assurance review on the resulting reports. Coordinated with both Missouri and Illinois SHPOs as well as City of St. Louis historic preservation officer, USACE cultural resources staff, US Air Force, Advisory Council on Historic Preservation, Native American tribes, and neighborhood groups for a total of 13 consulting parties. Assisted with drafting and review of EIS sections. Coordinated multi-agency Section 106 consultation process and drafted Programmatic Agreement covering all four alternatives, each with different potential effects to historic properties, to resolve potential Adverse Effects from demolition of historic buildings and impacts to eligible archaeological site.

Pacific Northwest National Laboratories Section 110 Evaluation, Richland, Washington

Client: Pacific Northwest National Laboratories/Battelle

Title: Architectural Historian

Start/End Dates: May 2012 to May 2013

Scope/Description: Section 110 evaluation report for the Pacific Northwest National Laboratories campus and buildings in preparation for transfer of the property to federal ownership.

Responsibilities: Included Washington State Historic Property Inventory forms for each building. Properties were evaluated individually and as part of a potential district. Also included evaluations under NRHP Criterion G for exceptional importance.

Rail and Transit

Ongoing Cultural Resources Support, Western Region

Client: Union Pacific Railroad

Title: Cultural Resources Program Lead

Start/End Dates: July 2011 to present

Scope/Description: Cultural Resources Compliance

Responsibilities: Serves as Cultural Resources Lead for the UPRR Program. Perform senior technical review of multiple, on-going rail projects covering states west of the Mississippi River. Assists program management with cultural resources issues, including staffing, technical review, day-to-day cultural resources support, and strategy for addressing high profile or sensitive issues, such as determination of eligibility for Great Salt Lake Causeway railroad bridge in Utah and removing a historic railroad bridge across the Willamette River in Oregon. Works closely with multiple UPRR project managers as well as their environmental program staff. A limited selection of projects is shown below.

Clinton Railroad Bridge Replacement, Clinton, Iowa and Garden Plain, Illinois

Client: Union Pacific Railroad

Title: Cultural Resources Senior Technical Staff

Start/End Dates: February 2017 to August 2020

Scope/Description: Section 106 consultation and NEPA compliance for historic rail bridge replacement

Responsibilities: Advise client on Section 106 process and assist project team with NEPA compliance for this historic rail bridge replacement project. Work closely with US Coast Guard and facilitate Section 106 consultation with multiple consulting parties, including two SHPOs. Perform senior technical review of all deliverables and draft programmatic agreement that includes both Iowa and Illinois.

Robert Street Lift Bridge, Saint Paul, Minnesota

Client: Union Pacific Railroad

Title: Cultural Resources Senior Technical Staff

Start/End Dates: March 2019 to present

Scope/Description: Section 106 consultation and NEPA compliance for historic rail bridge replacement

Responsibilities: Assist UPRR with Section 106 and NEPA compliance for replacement of lift span on historic rail bridge in downtown Saint Paul. Project includes visual simulations to inform visual effects assessment under Section 106 due to high visibility and prominent place of bridge. Section 106 consultation involves multiple parties, including the National Park Service, Tribes, Minnesota DOT, and US Coast Guard. Responsible for cultural resources strategy, leading the consultation process, review of all cultural resources deliverables, and drafting Memorandum of Agreement to resolve adverse effects.

Westlake Rail Bridge, Lake Charles, Louisiana

Client: Union Pacific Railroad

Title: Cultural Resources Senior Technical Staff

Start/End Dates: September 2019 to October 2022

Scope/Description: Section 106 compliance for rail bridge improvements

Responsibilities: Assist UPRR with Section 106 compliance for the removal and replacement of the existing fender system for the railroad bridge at Milepost 220.35 along the Lafayette Subdivision. The bridge, which is known as Westlake Bridge, spans the Calcasieu River between the cities of Westlake and Lake Charles in Calcasieu Parish, Louisiana. Jacobs prepared a cultural resources report to determine the movable bridge, most of which dated from 1904, was not eligible for the National Register and that the project would have no effect on historic properties. The determination relied on use of an ACHP Program Comment to exempt part of the bridge from Section 106, and also on the changes to the bridge over time that had resulted in a lack of integrity. SHPO concurred with the findings and no further Section 106 compliance was required.

North Fueling Facility, Dunsmuir Railyard, Siskiyou County, California

Client: Union Pacific Railroad

Title: Cultural Resources Senior Technical Staff

Start/End Dates: March 2022 to August 2022

Scope/Description: Section 106 compliance for U.S. EPA response action activities

Responsibilities: Assist UPRR with Section 106 compliance for soil remediation activities. UPRR proposed to excavate oil-impacted soil along approximately 1,000 feet of shoreline along the Sacramento River and remove the retaining wall adjacent to the Dunsmuir Railyard, as well as buildings within the railyard. The wall, a concrete and wood retaining wall comprised of four sections, was constructed between 1920 and 1950. Removal of the wall will affect waters of the U.S. within the jurisdictional boundaries of the U.S. Army Corps of Engineers, Sacramento District. The retaining wall, the Administrative Building, and the City of Dunsmuir Maintenance Building in the Dunsmuir Railyard were evaluated the NRHP eligibility and recorded on California Department of Parks and Recreation 523 Forms. Jacobs determined there were no historic properties present at the site and the project would have no effect on historic properties, facilitating the permitting of the remediation project.

Bismarck Rail Bridge Replacement, Bismarck, North Dakota

Client: BNSF Railway

Title: Cultural Resources Senior Technical Staff

Start/End Dates: March 2017 to present

Scope/Description: Section 106 consultation for historic rail bridge replacement

Responsibilities: Advise client on Section 106 process for this highly visible and publicly contentious project, work closely with US Coast Guard, facilitate Section 106 consultation with ACHP and multiple consulting parties, perform senior technical review of all deliverables, and draft programmatic agreement and memorandum of agreement. Currently overseeing implementation of stipulated mitigation measures.

Trinity River Rail Bridge Replacement and Addition of Second Mainline, Fort Worth, Texas

Client: BNSF Railway

Title: Cultural Resources Senior Technical Staff

Start/End Dates: March 2017 to present

Scope/Description: Section 106 consultation for historic rail bridge replacement and capacity project

Responsibilities: This high profile project includes the relocation and eventual adaptive reuse of a historic rail bridge. Advise client on Section 106 process for removal of historic rail bridge adjacent to two other historic rail bridges. Requires working closely with USACE. Perform senior technical review of all deliverables and assist with drafting memorandum of agreement.

Emporia Rail Bridge Replacements, Lyon County, Kansas

Client: BNSF Railway

Title: Cultural Resources Senior Technical Staff

Start/End Dates: January 2020 to April 2022

Scope/Description: Section 106 consultation for historic rail bridge replacements

Responsibilities: Assist BNSF with Section 106 compliance for the replacement of two historic rail bridges. Project included archaeological survey for access roads, drafting single Memorandum of Agreement to cover both bridge projects, and implementation of all mitigation measures, which entailed HAER Level II documentation.

Sabine River Rail Bridge Replacements, Gregg and Harrison Counties, Texas

Client: BNSF Railway

Title: Cultural Resources Senior Technical Staff

Start/End Dates: May 2019 to December 2020

Scope/Description: Section 106 consultation for historic rail bridge replacements

Responsibilities: Assist BNSF with Section 106 compliance for the replacement of three rail bridges. Project involved multiple design and access changes, resulting in extensive archaeological survey in an area of high archaeological probability, including deep testing (trenching) in a remote area. Required intense consultation with USACE and Texas SHPO, and resulted in a finding that the bridges were not historic and the project would not adversely affect archaeological sites. Responsible for client interface, project strategy, leading the consultation, and review of all project deliverables.

TEX Rail Commuter Rail Project, Tarrant County, Texas

Client: The Fort Worth Transportation Authority (The T)

Title: Cultural Resources Senior Technical Staff

Start/End Dates: October 2014 to 2019

Scope/Description: The TEX Rail Project is a 26.2-mile commuter rail system with ten stations (two of which are existing and would be shared with the Trinity Railway Express [TRE] service in downtown Fort Worth) planned to operate between downtown Fort Worth and DFW Airport. The corridor includes portions of the Fort Worth and Western Railroad, Union Pacific Railroad, and Dallas Area Rapid Transit (DART)-owned Cotton Belt railroad, and will pass through the Cotton Belt Railroad Industrial Historic District, listed in the NRHP. Multiple historic properties will be adversely affected by the project.

Responsibilities: Jacobs is tasked with performing the mitigation measures stipulated in the MOA, including investigation of potential burials at Mitchell Cemetery, preparation of HAER-style documentation of the Cotton Belt Underpass, development and installation of interpretive signage, replacement of historic markers, and conducting a Worker Education Program for construction and planning personnel. Responsible for strategy, senior review, and oversight of task implementation.

Central City Line Transit Project, Spokane, Washington

Client: Spokane Transit Authority

Title: Senior Cultural Resources Technical Staff

Start/End Dates: March 2016 to 2019

Scope/Description: Building a new six-mile transit route through Spokane that would connect Browne's Addition to Spokane Community College through Downtown Spokane, the University District, and Gonzaga University. The project runs through multiple National Register historic districts and adjacent to numerous historic buildings.

Responsibilities: Cultural Resources Lead for Section 106 and NEPA. Responsibilities include coordinating with the City of Spokane Historic Preservation Program and Washington Department of Archaeology and Historic Preservation, reviewing all cultural resources documents for the project, and advising the client and Environmental Lead on approaches for resolving cultural resources issues.

Center City Connector Light Rail Transit Project, Seattle, Washington

Client: City of Seattle

Title: Senior Cultural Resources Technical Staff

Start/End Dates: July 2014 to March 2018

Scope/Description: Environmental Assessment and SEPA for a new 1.8-mile streetcar through downtown Seattle, connecting two existing streetcar lines. The project runs through three National Register historic districts and adjacent to numerous historic buildings. Primary issues include balancing project needs with effects to a National Historic Landmark and effects to unique historic underground areaways, and facilitating communication among agencies regarding effects to locally designated districts and individual City landmarks.

Responsibilities: Cultural Resources Lead. Responsibilities include evaluating potential historic properties, coordinating with the City of Seattle Historic Preservation Program and Washington Department of Archaeology and Historic Preservation, analyzing potential effects of the project, reviewing all cultural resources documents for the project, and advising the client and Environmental Lead on approaches for resolving cultural resources issues. Project included preparation of nearly 50 Historic Property Inventory forms.

Design Services for Valley View Bridge and Double Tracking, Irving, Texas

Client: Dallas Area Rapid Transit (DART)

Title: Cultural Resources Task Lead

Start/End Dates: September 2015 to April 2016

Scope/Description: Section 106 compliance for double tracking and bridge replacement on a section of the Trinity Railway Express

Responsibilities: Responsible for review of all Section 106 documentation and correspondence for the project. Coordinated strategy to determine that the railway and bridge were not historic properties to facilitate timely completion of the double tracking project.

Federal Way Link Extension Light Rail Transit Project, King County, Washington

Client: Puget Sound Regional Transit (Sound Transit)

Title: Cultural Resources Task Lead

Start/End Dates: September 2012 to May 2016

Scope/Description: Environmental Impact Statement and Section106 compliance for new light rail line through multiple municipalities. Primary project issues were evaluation of mid-century buildings along a traditional highway corridor, and evaluation of 1960s-era water tanks.

Responsibilities: Provided team coordination and senior cultural resources support for the project. Responsibilities included working with client on strategy for cultural resources compliance and review of all cultural resources reports, inventory forms, correspondence, and EIS report sections.

Tacoma Link Extension Light Rail Transit Project, Tacoma, Washington

Client: Puget Sound Regional Transit (Sound Transit)

Title: Cultural Resources Task Lead

Start/End Dates: August 2013 to May 2015

Scope/Description: Extension of light rail line 2.4 miles through part of downtown Tacoma, including the Old City Hall historic district, and past many historic properties. Primary project issues were assessment of effects from new stations on historic buildings in an urban environment, and potential effects on a known archaeological site adjacent to the project.

Responsibilities: Provided team coordination and senior cultural resources support for the project. Responsibilities included field survey, working with client on strategy for cultural resources compliance, and either author or review of all cultural resources reports, inventory forms, correspondence, and DCE report sections.

East Link Light Rail Transit Project, Seattle, Washington

Client: Puget Sound Regional Transit (Sound Transit)

Title: Cultural Resources Senior Technical Staff

Start/End Dates: June 2009 to July 2011

Scope/Description: New light rail transit project through multiple urban areas.

Responsibilities: Responsible for review of all cultural resources reports and findings for the project. Assisted Project Manager with strategy and planning for cultural resources issues. At the client's request, drafted the NRHP nomination that resulted in a determination of eligibility for a section of Interstate 90, (Interstate 90 Lake Washington Highway Segment, Milepost 3.44 – 8.9, including Mount Baker Ridge Tunnel). Drafted the Section 106 MOA to resolve potential adverse effects from the project on multiple historic properties.

Northwest Rail Passenger Line Environmental Evaluation, Denver to Longmont, Colorado

Client: Colorado Regional Transportation District/URS

Title: Cultural Resources Task Lead

Start/End Dates: May 2008 to July 2009

Scope/Description: Environmental Evaluation that formed the basis for a USACE Environmental Assessment for a new passenger rail line along 44 miles of existing freight railroad right of way.

Responsibilities: Extensive 44-mile survey including locations for proposed new stations; identification and evaluation of potentially eligible sites for the NRHP, including buildings, agricultural structures, rail lines and beds, irrigation ditches, bridges, and culverts; and assessment of project impacts on historic properties.

DOT/FHWA, Airport/FAA, and Ports

SR 520 Bridge Replacement and HOV Program, King County, Washington

Client: Washington Department of Transportation

Title: Cultural Resources Program Lead

Start/End Dates: March 2004 to July 2011

Scope/Description: The SR 520 Program encompassed three separate projects to replace a floating bridge from Seattle to Medina, with associated highway improvements and construction of pontoons. The project included extensive survey of over 300 built environment properties within urban freeway project area, including residential, institutional, and commercial buildings, as well as historic landscapes, historic bridges, and an NRHP-eligible traditional cultural property (TCP). Culminated in a Section 106 Programmatic Agreement, two Environmental Assessments, and a Final Environmental Impact Statement

Responsibilities: Managed a blended team of agency staff and consultants from multiple firms, responsible for cultural resources, Section 106, Section 4(f), and Section 6(f) compliance for the SR520 Program. Included identification of and adverse effects to a tribal TCP, involving support and assistance to WSDOT tribal liaison and cultural staff in their government-to-government responsibilities dealing with multiple area tribes. Involved management of ethnographic documentation for multiple tribes. Also included working with State Department of Archaeology and Historic Preservation (WA SHPO), Advisory Council on Historic Preservation, Seattle Historic Preservation Officer, Seattle Landmarks Board staff, NOAA staff, as well as numerous other stakeholders. This project also included Section 6(f) compliance and a complex Section 4(f) Evaluation.

I-30 Crossing Project, Little Rock, Arkansas

Client: Arkansas Highway and Transportation Department

Title: Cultural Resources Task Lead

Start/End Dates: June 2016 to 2019

Scope/Description: Urban highway improvement and bridge replacement project that impacts historic properties and contains four historic districts in the APE.

Responsibilities: Responsible for Section 106 compliance. Involved interacting with the Advisory Council on Historic Preservation, FHWA, AHTD staff, Arkansas SHPO staff, and a blended team of agency and consultant staff. Duties include preparing for and conducting Consulting Party meetings, gathering and evaluating information to make recommendations on findings of effect, reviewing all cultural resources-related reports, and drafting a Programmatic Agreement to address known and potential adverse effects.

Benton Street Bridge Rehabilitation, Pocatello, Idaho

Client: Idaho Transportation Department

Title: Cultural Resources Task Lead

Start/End Dates: October 2014 to April 2015

Scope/Description: Rehabilitation of urban overpass that crosses a major rail yard.

Responsibilities: Prepared Historic Site Inventory forms, ITD Historic Building/Structure forms, and Archaeological and Historic Survey Report for repair of Benton Street Bridge. Successfully obtained ID SHPO concurrence that neither the bridge nor the Pocatello Railyard were historic.

Center Street Railroad Bridge Underpass Rehabilitation, Pocatello, Idaho

Client: Idaho Transportation Department

Title: Cultural Resources Task Lead

Start/End Dates: January 2015 to March 2016

Scope/Description: Project to rehabilitate a historic railroad bridge underpass that carries a city street beneath a major rail yard, and add a pedestrian overpass. Project runs between two historic districts.

Responsibilities: Prepared Historic Site Inventory forms and ITD Historic Building/Structure forms to determine the underpass was historic. Supported ITD cultural staff to reach a compromise on the design of the new overpass and reach a finding of No Adverse Effect to the historic underpass and the two adjacent historic districts.

Sullivan Road West Bridge Replacement, Spokane Valley, Washington

Client: City of Spokane Valley and Washington State Department of Transportation

Title: Cultural Resources Task Lead

Start/End Dates: February to July 2012

Scope/Description: Project to replace an overpass.

Responsibilities: Responsible for preparation of all Section 106 documentation and correspondence for the bridge replacement project. Determined that the bridge was not historic and successfully achieved concurrence from WA SHPO on a finding of No Historic Properties Affected.

Latah Bridge Rehabilitation Study, Spokane, Washington

Client: City of Spokane

Title: Cultural Resources Task Lead

Start/End Dates: July 2011 to May 2012

Scope/Description: The City of Spokane initiated the Latah Bridge Rehabilitation Study in an effort to identify and develop preliminary alternatives that would support public use of the historic Latah Bridge, listed in the National Register of Historic Places in 1982.

Responsibilities: To support this study, the character-defining features of the bridge were identified and information was reviewed to determine the archaeological and cultural sensitivity of the Latah Bridge site. This included meeting with members of the Spokane Tribe, and collecting information from the Spokane and Coeur d'Alene tribes that they believe the area under the Latah Bridge may be a Traditional Cultural Property. In addition, there are two NRHP historic districts in the vicinity of the bridge – Browne's Addition and Ninth Avenue. Prepared a Technical Memorandum that presented the background research on the bridge and surrounding area, delineated the important features of the bridge, and made recommendations for compliance with Section 106 and Section 4(f) should the rehabilitation project move forward.

Downtown Couplet Conversion Project, Redmond, Washington

Client: City of Redmond

Title: Cultural Resources Task Lead

Start/End Dates: October 2012 to September 2013

Scope/Description: Transportation improvement project in downtown Redmond.

Responsibilities: Surveyed an urban, downtown area that contained commercial, residential, and religious properties, including some of the earliest buildings in the community. Washington State Historic Property Inventory forms were prepared for each building.

Seward Highway Reconstruction: O'Malley Road to Dimond Boulevard, Anchorage, Alaska

Client: Alaska Department of Transportation

Title: Cultural Resources Senior Technical Staff

Start/End Dates: 2017

Scope/Description: Transportation improvement project.

Responsibilities: Responsible for review of all Section 106 documentation and correspondence for the project. Coordinated strategy to limit the amount of survey required for the project and to determine that neither the highway nor an adjacent mobile home park were historic properties, enabling a finding of No Historic Properties Affected.

Seward Highway Reconstruction: Dimond Boulevard to Dowling Road, Anchorage, Alaska

Client: Alaska Department of Transportation

Title: Architectural Historian

Start/End Dates: July 2012 to May 2013

Scope/Description: Transportation improvement project.

Responsibilities: Surveyed, documented, and evaluated commercial and residential properties for a transportation improvement project. A technical memorandum was prepared, including Alaska Building Inventory Forms for each structure.

Trunk Road Extension South, Vicinity of Wasilla and Palmer, Alaska

Client: Matanuska-Susitna Borough

Title: Architectural Historian

Start/End Dates: August 2012 to April 2013

Scope/Description: Transportation improvement project.

Responsibilities: Surveyed, documented, and evaluated rural properties for a transportation improvement project. The project area contained former barns, commercial buildings, and a historic rail line. Alaska Building Inventory Forms were prepared for each structure.

Salem River Crossing Project, Salem, Oregon

Client: Oregon Department of Transportation

Title: Architectural Historian

Start/End Dates: November 2011 to September 2012

Scope/Description: Bridge replacement project.

Responsibilities: Surveyed, documented, and evaluated residential and commercial properties for a bridge replacement project. Properties were evaluated for individual eligibility, district potential, and Multiple Property Documentation potential. Oregon Inventory of Historic Properties Section 106 Documentation Forms were prepared for each property.

SH-44, Linder Road to Ballantyne Lane Improvement Project, Ada County, Idaho

Client: Idaho Transportation Department

Title: Architectural Historian

Start/End Dates: February to July 2012

Scope/Description: The intersection of N. Linder Road and State Highway-44 (SH-44) improvement project proposed to reconstruct SH-44 from approximately Ballantyne Road to east of Idaho 16, and build a new intersection at Linder Road and SH-44.

Responsibilities: Project entailed survey of the built environment, including preparation of new and updated Historic Site Inventory forms and ITD Historic Building forms, and preparation of the Archaeological and Historic Survey Report.

Mercer Corridor Improvements, Seattle, Washington

Client: Seattle Department of Transportation

Title: Architectural Historian

Start/End Dates: August 2004 to December 2008

Scope/Description: Surface street improvement project

Responsibilities: Surveyed urban project area for surface street improvement project and identified historic properties eligible for the NRHP, WA State Register, or as local landmarks. Analyzed potential effects of the alternatives on the historic built environment and guided the project through the regulatory process, including Section 4(f). Assisted in the formulation of an MOA to mitigate the adverse effects to a significant architectural building. **Project won a national award from the American Public Works Association in the transportation category—$25 million to $75 million**.

I-5: Delta Park to Lombard Project, Portland, Oregon

Client: Oregon Department of Transportation

Title: Architectural Historian

Start/End Dates: August 2004 to November 2005

Scope/Description: Project to improve and expand interstate system

Responsibilities: Surveyed an urban area adjacent to the existing interstate. Developed determinations of eligibility and findings of effect for multiple historic properties, including residential, industrial, and commercial properties, as well as a historic cemetery and a historic levee system. The levee system was determined eligible for the NRHP. The project included a Section 4(f) Programmatic Evaluation for the levee system.

Hobby International Airport Expansion Project, Houston, Texas

Client: Houston Airport System (HAS)

Title: Cultural Resources Task Lead

Start/End Dates: March 2013 to June 2013

Scope/Description: Project assisted the City of Houston, through the Houston Airport System (HAS), prepare a NEPA Environmental Assessment for Federal Aviation Administration approval for improvements at Hobby Airport. The undertaking included the expansion of the Hobby airport facilities to accommodate international service and increase the amount of convenient on-airport parking. Expansion of Hobby Airport required demolition of various airport structures and further alteration of the main terminal.

Responsibilities: Responsibilities included coordination and communication with HAS staff, survey of airport facilities, strategy for addressing cultural resources compliance, and senior review of all deliverables. Successfully attained Texas SHPO concurrence on No Historic Properties Affected.

Great Falls International Airport Runway 16-34 Upgrade Project, Great Falls, Cascade County, Montana

Client: Great Falls International Airport Authority

Title: Senior Cultural Resources Technical Staff

Start/End Dates: October 2014 to November 2015

Scope/Description: The project consisted of rehabilitating Runway 16/34; demolishing a portion of Runway 7/25 and converting a portion of it to a taxiway connector; and construction of a connector taxiway to Runway 3/21 and a runway exit at the end of Runway 16/34. At the request of Federal Aviation Administration, the total geographic area of the airport was determined as the APE in order to encompass all buildings and structures on the property that were 45 years old or older to determine if the airport constituted a potential historic district.

Responsibilities: Responsibilities included strategy for addressing cultural resources compliance and senior review of all deliverables. Successfully attained Montana SHPO concurrence that although there were historic properties present at the airport, the airport itself was not a historic district, with a finding of No Historic Properties Affected.

Seattle-Tacoma International Airport Comprehensive Development Plan Environmental Review, Sea-Tac, Washington

Client: Port of Seattle

Title: Architectural Historian

Start/End Dates: December 2004 to July 2005

Scope/Description: Airport Comprehensive Plan

Responsibilities: Surveyed potential historic properties that could be affected by the Sea-Tac Airport Comprehensive Development Plan near-term projects, and evaluated potential effects to the properties from multiple project scenarios.

Talkeetna Airport Improvements Project, Talkeetna, Alaska

Client: Alaska Department of Transportation and Public Facilities, and Federal Aviation Administration

Title: Architectural Historian

Start/End Dates: September 2003 to December 2003

Scope/Description: Drainage improvement project for the Talkeetna Airport

Responsibilities: Conducted research to determine NRHP eligibility of a historic railroad bridge, including an assessment of historical significance of the railroad and the bridge structure. The bridge was determined eligible for the NRHP which helped guide the choice for the most appropriate project alternative.

Washington State Ferries Colman Dock Improvement Project, Seattle, Washington

Client: Washington Department of Transportation

Title: Architectural Historian

Start/End Dates: August 2004 to January 2006

Scope/Description: Part of a planning project to improve the Washington State Ferries facility on the Seattle waterfront

Responsibilities: Researched and evaluated Pier 48 and the Washington State Ferries Colman Dock Terminal building for National Register, Washington State Register, and local landmark eligibility. This culminated in a determination of eligibility for each property. Worked with project partners to analyze alternatives and their effect on the historic built environment of Seattle's waterfront and the historic downtown area.

Berth 206-209 Container Terminal Reuse Project, Terminal Island, Los Angeles, California

Client: Port of Los Angeles

Title: Architectural Historian

Start/End Dates: October 2003 to January 2004

Scope/Description: An 86-acre site planned for redevelopment by the Los Angeles Harbor Department, including improvements to the terminal area, access road realignment, and railroad crossing improvements.

Responsibilities: Surveyed the former Matson Stevedoring Services of America Terminals facility to determine the presence and eligibility of cultural resources, including research and writing brief history of Terminal Island, California, culminating in the Cultural Resources section of the EIS.

Fireboat *Ralph J. Scott* Preservation Plan, Los Angeles, California

Client: Port of Los Angeles

Title: Architectural Historian

Start/End Dates: August 2003 to February 2005

Scope/Description: Preservation Plan for National Historic Landmark vessel.

Responsibilities: Developed and wrote a preservation plan for historic marine vessel, a National Historic Landmark, for the Port of Los Angeles and the Los Angeles Fire Department. The project included assessments of multiple sites on port property as potential locations for the vessel display, presentations to City and Port leaders, as well as public involvement including the National Park Service, the California SHPO, and other stakeholders in the community.

Federal Emergency Management Agency (FEMA)

Section 106 Consultation and Finding of Effect for FEMA Public Assistance Disaster Operations – Gulf Shore Boulevard Road Relocation, Alligator Point, Franklin County, Florida

Client: Federal Emergency Management Agency (FEMA) Region IV

Title: Senior Architectural Historian

Start/End Dates: October 2016 to December 2016

Scope/Description: Section 106 Consultation and NEPA Environmental Assessment for disaster operations project. FEMA proposed to rebuild and relocate Gulf Shore Boulevard in Alligator Point, Franklin County, Florida. The section of road proposed for relocation was initially washed away in 2012 by Tropical Storm Debby. A replacement road was subsequently washed away by Hurricane Hermine in September 2016.

Responsibilities: Responsible for planning cultural resources approach and reviewing all deliverables. Prepared finding of no adverse effect to historic properties for the project and coordinated consultation with state and local consulting parties.

FEMA Public Assistance Disaster Operations - Environmental & Historic Compliance Support for Environmental Assessment for a Public Assistance Grant Project for Franklin County, Alligator Point, Franklin County, Florida

Client: Federal Emergency Management Agency (FEMA) Region IV

Title: Senior Architectural Historian

Start/End Dates: May 2017 to October 2017

Scope/Description: Section 106 Consultation and NEPA Environmental Assessment for disaster operations project. Between August 31 and September 9, 2016, Hurricane Hermine produced a 9-foot-high storm surge, heavy rainfall, and high winds in the coastal areas of Franklin County, including the Alligator Drive portion of Alligator Point, Florida. The tidal surge and large waves severely eroded and washed away approximately 1,000 linear feet of Alligator Drive between Tom Roberts Road and George Vause Road. The asphalt road surface, road base, road sub-base, riprap, and concrete barriers were washed away during the storm. Alligator Drive serves as the sole access and evacuation route for approximately 500 residential lots. FEMA proposed to repair the damaged portion of Alligator Drive in the same location with hazard mitigation protection to guard against future storm damage. This alternative would consist of rebuilding the road and implementing hazard mitigation including the installation of a sheet-pile retaining wall with associated rock revetment and a 10-foot-wide shoulder seaward of the road, and a 6-foot-wide shoulder landward of the road.

Responsibilities: Responsible for planning cultural resources approach and reviewing all deliverables. Prepared finding of no historic properties affected for the project.

Southern Flow Corridor Flood Mitigation and Estuarine Restoration Project, **Tillamook, Oregon**

Client: Federal Emergency Management Agency (FEMA) Region X

Title: Architectural Historian

Start/End Dates: March 2014 to July 2015

Scope/Description: Flood mitigation project

Responsibilities: Surveyed large, rural area for flood mitigation project and prepared determinations of eligibility for levee system, drainage structures, and irrigation system. Prepared cultural resources technical report and successfully received Oregon SHPO concurrence with a finding of No Historic Properties Affected.

Hazard Mitigation Technical Assistance Program (HMTAP), **Oakland, California**

Client: Federal Emergency Management Agency (FEMA) Region IX

Title: Senior Cultural Resources Technical Staff

Start/End Dates: July 2011 to July 2012

Scope/Description: Nine HMTAP projects submitted by the State of California as a result of the November 2008 Southern California Wildfires (FEMA-1810-DR-CA). Included a total of nine projects: one wildfire, two flood control, and six seismic retrofit projects.

Responsibilities: Devised strategy for cultural resources compliance for all nine projects. Performed senior review of cultural resources technical reports for those projects located in the Tahoe/Truckee, Orinda, and Moreno Valley areas.

Recovery for Hurricanes Katrina and Rita, **Louisiana**

Client: Federal Emergency Management Agency (FEMA)

Title: Special Considerations Liaison for Public Assistance/Historic Preservation

Start/End Dates: March 2007 to December 2007

Scope/Description: Section 106 compliance for hurricane recovery

Responsibilities: Embedded position in the local New Orleans FEMA office to help ensure FEMA's compliance under Section 106 of the NHPA for a variety of projects that could result in adverse effects, including recommending creative solutions for mitigation. Managed government-to-government consultation with as many as 11 Native American tribes; interacted with state agencies and other federal agencies such as the National Guard Bureau and National Park Service; drafted Programmatic Agreements and MOAs; and worked closely with FEMA's NEPA staff to engage in innovative public involvement. Included consultation with US Army National Guard and the Seminole Tribal Historic Preservation Officer regarding undertakings at Jackson Barracks in New Orleans.

Recovery for Hurricanes Katrina and Rita, **Louisiana**

Client: Federal Emergency Management Agency (FEMA)

Title: Liaison to the Louisiana State Historic Preservation Office (LA SHPO)

Start/End Dates: January 2006 to March 2007

Scope/Description: Section 106 compliance for hurricane recovery

Responsibilities: Embedded position in the local New Orleans FEMA office, representing LA SHPO in FEMA undertakings related to Hurricanes Katrina and Rita involving standing structures. Ensured Section 106 compliance, working closely with both FEMA and SHPO staff on various issues, including determinations of eligibility, findings of effect, Programmatic Agreements, MOAs, and public outreach. Extensive contact with the FEMA Federal Preservation Officer, staff of the Advisory Council on Historic Preservation, and local stakeholders. Reviewed potential demolition candidates, proposed mitigation measures, and worked toward resolution of adverse effects on a variety of projects statewide.

Energy/Public Utilities

City of Vernon Light and Power Station A, **Vernon, California**

Client: City of Vernon

Title: Architectural Historian

Start/End Dates: November 2013

Scope/Description: CEQA compliance for Power Station Improvements

Responsibilities: Re-evaluated the historic 1933 power plant and updated the California Primary Record form.

Repowering Applications for Certification for Three Power Plants, **Los Angeles and Orange Counties, California**

Client: Confidential Client

Title: Architectural Historian

Start/End Dates: August 2011 to August 2014

Scope/Description: California Energy Commission certification process

Responsibilities: Documented and evaluated three natural gas-powered generating stations, culminating in recordation on California Primary Record, District, and Building, Structure, and Object forms, and three Applications for Certification.

Henderson Basin 44 Combined Sewer Overflows (CSO) Reduction Project, **Seattle, Washington**

Client: Seattle Public Utilities

Title: Cultural Resources Senior Technical Staff

Start/End Dates: September 2011 to August 2012

Scope/Description: CSO improvement project in historic park

Responsibilities: Advise on and assist with strategy for cultural resources compliance for CSO improvement project that would affect historic landscapes. Perform senior review of cultural resources technical reports. Author cultural resources section of Environmental Impact Statement. Was requested by the agency to represent them as an expert witness for cultural resources.

Due Diligence Report for White River Hydroelectric Facilities Acquisition, **Pierce County, Washington**

Client: Cascade Water Alliance

Title: Architectural Historian

Start/End Dates: June 2005 to October 2005

Scope/Description: Due Diligence Report, whose objective was to help guide Cascade Water Alliance plan its future operations to protect historic properties, once they acquired the White River property.

Responsibilities: Produced a Technical Memorandum that provided a historical, cultural, and archaeological resources assessment of the White River Hydroelectric system, owned by Puget Sound Energy. The White River system, determined eligible for the NRHP, is a former power generation facility, constructed in 1910, that is no longer in service for electrical power generation. The facility incorporates not only the power plant structure, but also the entire White River Project system from headgate to tailrace and its accompanying structures.

Bengal Pipeline Route, **South Louisiana**

Client: Shell Pipeline Company LP

Title: Architectural Historian

Start/End Dates: May 2004 to December 2004

Scope/Description: A proposed 75-mile-long, 24-inch petroleum pipeline from Garyville, Louisiana, to north of Port Hudson, Louisiana

Responsibilities: Analyzed potential historic properties along the proposed pipeline route, documenting previously unrecorded properties on Louisiana Historic Resource Inventory forms. The project included five parishes and crossed the Mississippi River twice. In addition, part of the Port Hudson State Historic Site and National Historic Landmark battlefield lay within the project area.

Jefferson-Martin 230kV Transmission Project, San Mateo County, California

Client: Pacific Gas and Electric Company

Title: Architectural Historian

Start/End Dates: May 2004 to July 2004

Scope/Description: Electrical line installation project along the Lower Crystal Springs Dam

Responsibilities: The Lower Crystal Springs Dam, determined eligible for the NRHP and a California State Point of Historical Interest, was impacted as part of an electrical line installation project. Performed field inspection, assessed project effects, and recommended mitigation for restoring the unique historic concrete surface of the dam, which is a character-defining feature of the historic property.

Klamath River Hydroelectric Facilities FERC Re-licensing, **Klamath County, Oregon and Siskiyou County, California**

Client: PacifiCorp

Title: Architectural Historian

Start/End Dates: May 2003 to March 2004

Scope/Description: FERC re-licensing application

Responsibilities: Conducted survey to document seven historic hydroelectric facilities and their associated sites and properties spanning two states, culminating in post-field recordation on Oregon Inventory of Historic Properties forms; California State 523 Primary Record forms; and California Building, Structure, and Object forms.

Department of Defense Projects

Section 110 Review, MSG Dionisio M. Claudio US Army Reserve Center, Caguas, Puerto Rico

Client: US Army Corps of Engineers, Louisville District

Title: Senior Architectural Historian

Start/End Dates: December 2013 to January 2015

Scope/Description: Phase I Cultural Resources Survey and Section 110 compliance for U.S. Army Reserve, 81st Regional Support Command (RSC). The 81st RSC identified the MSG Dionisio M. Claudio U.S. Army Reserve Center (USARC), located at Calle Pino, Villa Turabo, Caguas, Puerto Rico, as excess to mission requirements. All U.S. Army Reserve operations had been moved to a new facility, and the MSG Dionisio M. Claudio USARC had been vacated. The 81st RSC intended to excess the property and dispose of it through the General Services Administration. As part of real property disposal, compliance with NHPA and NEPA were required.

Responsibilities: Reviewed all Section 110 documentation and correspondence for the project. Managed the archaeological sub-contractor that performed the field survey. Responsible for managing consultation with PR SHPO and advising client on compliance procedures when multiple efforts to obtain SHPO responses were not successful. Project resulted in a Categorical Exclusion for NEPA and no historic properties affected under Section 106.

Section 110 Review, Ramey Local Training Area Tract, Aguadilla, Puerto Rico

Client: US Army Corps of Engineers, Louisville District

Title: Senior Architectural Historian

Start/End Dates: May 2013 to January 2015

Scope/Description: Phase I Cultural Resources Survey and Section 110 compliance for U.S. Army Reserve, 81st Regional Support Command (RSC). The 81st RSC identified the former Ramey Local Training Area (LTA), in Aguadilla, Puerto Rico, as excess to mission requirements. All U.S. Army Reserve operations had been moved to a new facility, and the property had been vacated. The 81st RSC intended to excess the property and dispose of it through the General Services Administration. As part of real property disposal, compliance with NHPA and NEPA were required.

Responsibilities: Reviewed all Section 110 documentation and correspondence for the project. Managed the archaeological sub-contractor that performed the field survey. Responsible for managing consultation with PR SHPO and advising client on compliance procedures. Project resulted in a Categorical Exclusion for NEPA and no historic properties affected under Section 106.

Nashville National Cemetery, **Madison, Tennessee**

Client: National Cemetery Administration, Department of Veterans Affairs

Title: Senior Architectural Historian

Start/End Dates: January to September 2014

Scope/Description: Section 106 consultation for cemetery renovation project

Responsibilities: Reviewed all Section 106 consultation documentation and correspondence for the revised renovation of the Lodge at Nashville National Cemetery, including demolition and new construction at the site. Included advising and working with an outside architectural firm to help revise the design to reach a finding of No Adverse Effect.

Renovation of the Rostrum at Fort Scott National Cemetery, **Fort Scott, Kansas**

Client: National Cemetery Administration, Department of Veterans Affairs

Title: Senior Architectural Historian

Start/End Dates: September 2014 to June 2015

Scope/Description: Section 106 consultation for cemetery renovation project

Responsibilities: Reviewed all Section 106 consultation documentation and correspondence to ensure technical accuracy and quality for the renovation of the historic Rostrum at Fort Scott National Cemetery. Also advised on technical restoration approaches. Assisted with KS State Historic Preservation Office consultation to reach a finding of No Adverse Effect.

Installation of a 1,000 Traditional Burial Casket Site at the Santa Fe National Cemetery, **Santa Fe, New Mexico**

Client: National Cemetery Administration, Department of Veterans Affairs

Title: Senior Architectural Historian

Start/End Dates: June to September 2014

Scope/Description: Section 106 consultation for cemetery addition project

Responsibilities: Responsible for review of all Section 106 consultation documentation and correspondence for the development of an addition to the Santa Fe National Cemetery to accommodate burials. Determined that the addition was not a contributing element of the historic cemetery and its development would have No Adverse Effect on the surrounding historic properties. Assisted with NM State Historic Preservation Office consultation.

U.S. Army Yuma Proving Ground (YPG) Programmatic Environmental Impact Statement, **Yuma, Arizona**

Client: U.S. Army Corps of Engineers, Mobile District

Title: Cultural Resources Senior Technical Staff

Start/End Dates: June 2012 to July 2015

Scope/Description: NEPA and Section 106 cultural resources compliance for a Programmatic EIS that addresses operations, maintenance, and development projects at the U.S. Army's Yuma Proving Ground.

Responsibilities: Advise on and assist with strategy for NEPA and Section 106 compliance. Included tribal consultation and drafting a complex Programmatic Agreement to address all operations, maintenance, and development at YPG.

Fort Campbell Schools National Register of Historic Places Evaluation Investigation Report, **Christian County, Kentucky and Montgomery County, Tennessee**

Client: U.S. Department of Defense Education Activity and U.S. Army Corps of Engineers, Louisville District

Title: Senior Architectural Historian

Start/End Dates: May 2013 to September 2013

Scope/Description: NRHP evaluation of six schools

Responsibilities: Surveyed and evaluated six mid-century schools in the cantonment area of Fort Campbell to determine their NRHP eligibility. Prepared an evaluation report and documentation forms for each property. Involved consultation with both the Kentucky and Tennessee SHPOs.

Environmental Assessment for Installation Development at Joint Base Charleston – Weapons Station and Air Base, North Charleston, South Carolina

Client: U.S. Air Force

Title: Senior Architectural Historian

Start/End Dates: July 2012 to November 2015

Scope/Description: NEPA and Section 106 compliance

Responsibilities: Surveyed and evaluated military properties at the Weapons Station and analyzed installation development projects for their potential effects. Included drafting cultural resources section of Environmental Assessment and reviewing South Carolina Intensive Documentation Forms for each property. This project focused on Cold War history.

Environmental Assessment for Closure of Cesspools and Implementation of Wastewater Management and Treatment Measures, Bellows Air Force Station, Hawaii

Client: U.S. Air Force

Title: Cultural Resources Senior Technical Staff

Start/End Dates: September 2013 to July 2014

Scope/Description: NEPA and Section 106 compliance

Responsibilities: This project is located in an area of high probability for Native Hawaiian archeological sites, including ancient burial sites, and previously identified NRHP-eligible archaeological sites. Managed the NHPA Section 106 process for this project, including review of the local archaeologist subcontractor's deliverables. Involved working with AFCEC staff and the Bellows cultural resources manager to address consultation strategy, prepare consultation documents, and review cultural resources reports.

U.S. Air Force Academy (USAFA) Integrated Cultural Resource Management Plan, Colorado Springs, Colorado

Client: USAFA

Title: Architectural Historian

Start/End Dates: March 2003 to May 2003

Scope/Description: Integrated Cultural Resource Management Plan for the USAFA

Responsibilities: Assisted with the research and writing of an Integrated Cultural Resource Management Plan for the USAFA. The plan focused on integrating the ongoing management of the facility and its significant cultural resources with the unique mission of the Academy. The project included developing a comprehensive, user-friendly document to be used by Academy personnel, as well as coordinating with the Colorado SHPO and other interested agencies during development of the plan.

Other Information

Presentations

2022. "BNSF Sabine River Bridges Project: Keys to a Successful Section 106 Process." Urbana, Illinois. National Railroad Environmental Conference.

2018. "National Geospatial-Intelligence Agency (NGA) West Facilities Modernization - Next NGA West (N2W) Environmental Impact Statement (EIS) and Programmatic Agreement (PA)." Tacoma, Washington. National Association of Environmental Professionals Annual Conference.

2018. "Cultural Resources - From Trailers to Trees to Trash: Adaptations for Addressing Unusual Cultural Resources." Tacoma, Washington. National Association of Environmental Professionals Annual Conference.

2017. "Successfully Integrating NEPA and the Section 106 Process into Railroad Bridge Permits with the US Coast Guard - Angleton 305 Bridge Replacement, Brazoria County, Texas." Urbana, Illinois. National Railroad Environmental Conference.

2016. "Leveraging Technology: 3-D Laser Recordation for Historic Structures, Brooklyn Subdivision Bridge, Oregon." Plenary Session Presentation. Urbana, Illinois. National Railroad Environmental Conference.

2016. "Evaluating Historic Structures and Assessing Impacts under Section 106 of the National Historic Preservation Act for Linear Transportation Projects." Urbana, Illinois. National Railroad Environmental Conference.

2013. "Laser Beams and Historic Structures, Brooklyn Subdivision Bridge, Oregon." Urbana, Illinois. National Railroad Environmental Conference.

2009. "Rolling on the River: New Orleans' Riverfront Revitalization." New Orleans, Louisiana. National Brownfields Conference.

2007. "Innovative Response Under Section 106 in a Disaster – Hurricane Katrina." Savannah, Georgia. Vernacular Architecture Forum Annual Conference.

2001. "Urban Revitalization Tools." New Orleans, Louisiana. Tulane Institute for Environmental Law and Policy Annual Conference.

2000. "Revitalization of the Warehouse District." New Orleans, Louisiana. American Planning Association Annual Conference.

Experience Prior to Jacobs

Principal Architectural Historian; City of New Orleans, Historic District Landmarks Commission; New Orleans, Louisiana; 1997 to 2003. Conducted research and wrote reports on potential landmarks, historic districts, and other historic properties. Performed complete surveys of potential new local historic districts and prepared and delivered public presentations to the New Orleans and the Central Business District Historic District Landmarks Commissions and to the New Orleans City Council. Assisted applicants with historical accuracy and appropriateness of renovation and restoration projects, and assisted with outreach projects in the community, including informational presentations to the public. Worked with preservation programs at local universities through student projects and internships. Served on the Housing Conservation District Review Committee to review proposed demolitions outside of local historic districts. Assisted the public citywide with architectural history queries and worked with other city agencies, the State Historic Preservation Office, National Park Service, and other assorted federal agencies on Restoration Tax Credit projects and Section 106 Environmental Reviews.

Architectural Historian II; State of Louisiana, Office of Cultural Development, Division of Historic Preservation; Baton Rouge, Louisiana; 1995 to 1997. Responsible for coordination of all historic preservation grants, including federally funded grants and Louisiana Main Street Program facade grants. Conducted site visits to render technical and design advice to owners of historic properties statewide. Monitored covenants and MOAs on previous grantees and assisted with Section 106 Review for potential impact on grantees and Main Street communities. Administered the federal Restoration Tax Credit program for projects in Main Street communities and the National Park Service Historic American Buildings Survey/Historic American Engineering Record program, working with Schools of Architecture at universities throughout the state. Performed public presentations statewide to provide information on SHPO programs.

Kyle Spurgeon, M.A., RPA

EDUCATION/QUALIFICATIONS

Master of Arts, 2012, Anthropology (Public Archaeology), The University of New Mexico

Bachelor of Arts, 2008, History, The Ohio State University

REGISTRATIONS/ CERTIFICATIONS

Registered Professional Archaeologist

Meets the Secretary of the Interior's Historic Preservation Professional Qualification Standards in Archaeology and History (36 CFR 61) of 36 CFR Part 61

MEMBERSHIPS AND AFFILIATIONS

Register of Professional Archaeologists

AWARDS/HONORS

Environmental Resources Management Global Innovation Award, 2017

OTHER

- 10+ years of experience
- Years at Jacobs: 2017-2020 and 2023
- Office location: Pittsburgh, Pennsylvania

ARCHAEOLOGIST / ENVIRONMENTAL PROJECT MANAGER

Kyle is a Registered Professional Archaeologist specializing in cultural resource management. Kyle has more than eight years' experience in cultural resource management, has been involved in all phases of archaeological field investigations, and has contributed to archaeological research, analysis, and report writing. His professional experience has focused on directing and assisting field surveys and excavations, providing NEPA and Section 106 consultation and advisory services, and tribal consultation. These efforts have been in support of the telecommunication, oil and gas, energy, coal and mining, and transportation industries. He has led and assisted archaeological investigations in Ohio, Kentucky, Indiana, Maryland, Illinois, Iowa, Pennsylvania, Missouri, Utah, Texas, Minnesota, Nevada, Wyoming, Washington, DC., and Hawaii. In addition, he has conducted research and provided project review for undertakings located in Colorado and Kansas and has curatorial internship experience working with cultural material in New Mexico.

Areas of Expertise

- Experienced in completing cultural resources fieldwork, artifact analysis, report writing, Native American consultation, Section 106 consultation, and NEPA consultation for both federal and private clients
- Technical expertise in prehistoric archaeology, lithic analysis, background research, Phase I archaeological surveys, Phase II National Register of Historic Places (NRHP) Testing, and Phase III Data Recovery
- Permitting/regulatory expertise related to Cultural Resources investigations for the Federal Communications Commission, National Environmental Policy Act, United States Army Corps of Engineers, and state/local level permitting

Relevant Project Experience

Roundhouse Wind Energy Project, Laramie County, Wyoming

Client: NextEra Energy Resources

Title: Archaeologist

Start/End Dates: May 2018-current

Scope/Description: Class III Survey and Section 106 coordination

Responsibilities: Archaeologist for the Roundhouse Wind Energy Project in Laramie County, Wyoming. Primary tasks included serving as field director for more than 6,000 acres of Class III survey, compiling and analyzing field data, coordinating with SHPO for background research, and report writing. Project conducted in support of Section 106 consultation documents in support of USACE 401/404 permitting requirements.

Silvara Rectifier and Ground Bed Installation Project, Bradford County, Pennsylvania

Client: Kinder Morgan

Title: Archaeologist

Start/End Dates: August 2018-October 2018

Scope/Description: Phase I Archaeological Survey

Responsibilities: Archaeologist and report author for the Silvara Rectifier and Ground Bed Installation Project in Bradford County, Pennsylvania. Primary tasks included conducting 4.21-acre Phase I survey, compiling and analyzing field data, and report writing.

South Capitol Street Trail Project, District of Columbia

Client: District of Columbia Department of Transportation

Title: Archaeologist

Start/End Dates: July 2018-December 2018

Scope/Description: Phase I Archaeological Survey and Section 106 coordination

Responsibilities: Field director and report author for the South Capitol Street paved and multiuse trail project in Washington, DC. Primary tasks included conducting 0.54-acre Phase I survey, compiling and analyzing field data, conducting background research, and report writing.

Clark-Urbana 138 kV Loop to Broadview Substation and East Springfield to Tangy 138 kV Loop to Broadview Projects, Clark County, Ohio

Client: First Energy

Title: Archaeologist

Start/End Dates: April 2018 – June 2018

Responsibilities: Archaeologist and report author for 33.3 acres of Phase I surveys of rerouted transmission line segments and laydown areas for the Clark-Urbana 138 kV Loop to Broadview Substation and East Springfield to Tangy 138 kV Loop to Broadview Projects in Clark County, Ohio. Primary tasks included directing field crew during intensive pedestrian, shovel testing, and test unit excavation, as well as artifact analysis and report writing.

Washington Republic, North and South Wind Energy Projects, Washington and Republic Counties, Kansas

Client: NextEra Energy Resources

Title: Archaeologist

Start/End Dates: March 2018-current

Scope/Description: Cultural Resources and Section 106 coordination

Responsibilities: Archaeological researcher and cultural resource assessment report author, for the proposed Washington Republic North and South Kansas Wind Energy Project in Republic, Washington, Marshall, and Nemaha Counties, Kansas. Primary tasks included compiling recorded archaeological data, analysis, and report writing.

Clinton Bridge Replacement Project, Whiteside County, Illinois

Client: Union Pacific Railroad Company (UPRR)

Title: Archaeologist

Start/End Dates: November 2017 – July 2018

Scope/Description: Phase I Archaeological Reconnaissance and Section 106 coordination

Responsibilities: Field director and report author for proposed Clinton Bridge Replacement Project in Whiteside County, Illinois. Fieldwork consisted of approximately 57.73 acres of systematic archaeological survey. Primary tasks included directing field crew during Phase I survey, compiling and analyzing field data, artifact analysis, and report writing.

Southeast Ohio Area Improvements Project, Monroe and Washington Counties, Ohio

Client: American Electric Power

Title: Archaeologist

Start/End Dates: November 2017 – current

Scope/Description: Phase I archaeological investigations for several transmission lines upgrade or rebuild projects across southeastern Ohio.

Responsibilities: Archaeologist and report author for multiple Phase I surveys of transmission line segments for the Southeast Ohio Area Improvements in Monroe and Washington Counties, Ohio. This includes serving as archaeologist for Phase Ia archaeological reconnaissance of 15.38 acres within Wayne National Forest, according to ARPA requirements. Primary tasks included directing field crew during intensive pedestrian, shovel testing, and test unit excavation, as well as artifact analysis and report writing.

Sorenson-Deer Creek 138 kV Transmission Line Project, Huntington County, Indiana

Client: Indiana Michigan Transmission Company, a Unit of American Electric Power

Title: Archaeologist

Start/End Dates: November 2017 – December 2018

Scope/Description: Phase I archaeological investigations for several transmission lines upgrade or rebuild projects across eastern Indiana.

Responsibilities: Field director and report author for Phase Ib intensive archaeological survey of Site 12HU1387, for the proposed Sorenson-Deer Creek 138 kV Rebuild Project in Union Township, Huntington County, Indiana. Mr. Spurgeon also served as archaeologist for Phase Ia archaeological reconnaissance of 8.9 acres within the J. Edward Roush Lake Fish and Wildlife Area, according to ARPA requirements. Primary tasks included directing field crew during intensive pedestrian and GPS piece plotting survey, shovel testing, and test unit excavation, as well as artifact analysis and report writing.

Runway 6 Instrument Landing System (ILS) Project, Naval Air Station Patuxent River, St. Mary's County, Maryland

Client: BAE Systems, Inc. and Department of the Navy, Naval Facilities Engineering Command

Title: Archaeologist

Start/End Dates: November 2017 – July 2018

Scope/Description: Phase I archaeological investigations for runway improvements at NAS Patuxent River.

Responsibilities: Archaeologist and report author for proposed runway improvements at NAS Patuxent River in St. Mary's County. Fieldwork consisted of approximately 8.46 acres of systematic archaeological survey. Primary tasks included directing field crew during standard Phase I (pedestrian and shovel testing) survey, compiling and analyzing field data, artifact analysis, and report writing.

Previous Experience

Project Manager; Confidential Technology Companies; 2020-2023: Provided quality control and oversight for data management, visualization, and VR/AR products for clients.

Cultural Resources Specialist and Archaeologist; Nationwide NEPA Program Management Services; National Telecommunications Client; 2013-2017: *(With ERM)* Member of NEPA Program Management Team serving a major national telecommunications carrier by providing QA/QC oversight on cultural resources submittals and client deliverables. Key tasks included: serving as lead tribal consultation specialist, assuring that all cultural resource submittals conform to regulatory requirements and meet client standards, and assuring that required documentation of regulatory compliance is included in all client deliverables. This included SHPO, tribal, local government, and public consultation under the National Historic Preservation Act and the National Environmental Policy Act.

Cultural Resources Specialist and Archaeologist; Atlantic Coast Pipeline Telecommunications Towers Project; Dominion Energy Transmission, Inc., West Virginia, Virginia, North Carolina; 2017: *(With ERM)* FCC NEPA compliance effort in support of proposed telecommunication towers located in West Virginia, Virginia, and North Carolina. Served as project coordinator, SHPO records researcher, report writer, and lead tribal consultation specialist.

Archaeologist; Multiple Satellite Communication Dish Installation Sites; ViaSat Inc., Texas, Minnesota, Nevada, Missouri, Iowa; 2016-2017: *(With ERM)* FCC NEPA and Section 106 permitting efforts in support of proposed satellite access node installations located in Texas, Minnesota, Nevada, Missouri, and Iowa. Served as principal investigator, primary SHPO researcher, report writer, and lead tribal consultation specialist.

Principal Investigator; Confidential Soil Remediation Project; Franklin County, Ohio; 2016: *(With ERM)* Archaeological trenching investigation in support of due diligence efforts of a contaminated former industrial facility located in Franklin County, OH. Served as principal investigator for archaeological trenching, contributing researcher and report writer and as co-presenter of findings to state agency.

Archaeologist; Phase I Investigations for a Proposed Nitrogen Fertilizer Manufacturing Facility; Client Confidential; Posey County, Indiana; 2016: (*With ERM)* Field director for Phase I archaeological survey on approximately 40 acres private land for improvements for a proposed fertilizer manufacturing facility, located in Posey County, Indiana. Primary tasks included directing field crew during Phase I survey.

Archaeologist; Phase I Investigations for the Gallatin Direct Reduced Iron (DRI) Conveyor System; Nucor Steel Gallatin; Gallatin County, Kentucky; 2015: *(With ERM)* Field director for the proposed construction of a DRI conveyor system in Gallatin County, Kentucky. Fieldwork consisted of approximately 35 acres of systematic archaeological survey. Primary tasks included directing field crew during Phase I survey, compiling and analyzing field data, artifact analysis, and report writing.

Archaeologist; Battle Creek FM Broadcast Tower; Calhoun County, Michigan; 2015: *(With ERM)* NEPA effort in support of proposed FM broadcast tower located in Battle Creek, Michigan. Served as field supervisor, primary SHPO researcher, and contributing report writer.

Archaeologist; Class III Cultural Resource Investigation for El Dorado Exploratory Drilling Project; Kennecott Exploration Company; Tooele County, Utah; 2015: *(With ERM)* Served as a field director and report writer for Phase I archaeological survey on private and BLM land for 3 drill pad locations and approximately 2.5 miles of access road located in Tooele County, Utah.

Cultural Resources Specialist; Cultural Resources Assessment for Exploratory Drilling Program; Client Confidential; Uintah County, Utah; 2015: *(With ERM)* Primary researcher responsible for examination of State Historic Preservation Office records of previous sites, surveys, and historic properties. Effort in support of an approximately 1,230-acre exploratory drill program in Uintah County, Utah.

Cultural Resources Specialist; Point-to-Multipoint Telecommunication Installations; Anadarko Petroleum Corporation; Weld County; Colorado; 2015: (*With ERM)* FCC NEPA and Section 106 efforts to support 64 telecommunications installations within existing Wattenberg, Colorado facilities within Weld County. Served as primary tribal consultant and co-researcher and report writer.

Cultural Resources Specialist; Thirteen Telecommunication Installations; Anadarko Petroleum Corporation; Sweetwater County; Wyoming; 2014: *(With ERM)* FCC NEPA and Section 106 efforts to support 13 telecommunications projects within existing Monell, Wyoming facilities in Sweetwater County. Served as field results reviewer and analyst, primary researcher, and report writer.

Archaeologist; Phase I Archaeological Investigation for NRG Ohio Pipeline Project, NRG Ohio Pipeline Company; Lorain County, Ohio; 2014: *(With ERM*) Primary researcher responsible for examination of State Historic Preservation Office records of previous sites, surveys, and historic properties. Served as a field director for Phase I archaeological survey of high potential areas along an approximately 20 mile proposed natural gas pipeline.

Cultural Resources Specialist; Cultural Resources Investigation for Exploratory Drilling Program; Client Confidential; Sweetwater County, Wyoming; 2014: (*With ERM)* Primary researcher responsible for examination of State Historic Preservation Office records of previous sites, surveys, and historic properties. In addition, served as field results reviewer and analyst. Effort in support of exploratory drill program at 14 drill sites in Sweetwater County, Wyoming.

Archaeologist; Proposed Pipeline Project; Client Confidential; Columbiana County, Ohio; 2013: (*With ERM)* Field director and report writer for limited Phase I survey for proposed pipeline project. Primary researcher and report writer. Field efforts involved locating and assessing a previously identified historic resource, field mapping of above ground features, shovel testing, and photographing condition of resource. Post-field efforts included laboratory analysis and cataloging of artifacts, analysis of historic aerial images, and assessing potential NRHP eligibility of identified historic resource using available historic context.

Field Archaeologist; Multiple Counties, Ohio; 2012-2013: (*With PAST*) Engaged in numerous field surveys as archaeological field technician, including both pedestrian reconnaissance and sub-surface testing. These efforts supported wetland reclamation projects for the Ohio Department of Natural Resources.

Field Archaeologist; Multiple Counties, Ohio; 2009-2010: (*With PAST*) Engaged in all phases of field work as archaeological field technician: Phase I Survey, Phase II Evaluative Testing, and Phase III Mitigation Excavations. Field duties included GPS navigation and mapping as well as making determinations regarding appropriate field methods to apply and where to test. Pre-field research into SHPO records of previously recorded properties, area history, and land-owner histories were conducted. Post-field efforts included laboratory analysis and cataloging of artifacts. Duties also included documenting historic structures. These efforts supported coal-mining applications by clients.

JACOBS

Jessica R. Wobig

SENIOR ARCHITECTURAL HISTORIAN

Ms. Wobig serves as an architectural historian on cultural resources management and preservation planning projects for the corporate sector, national government, and state and local agencies. She is experienced with the Standards set forth by the National Historic Preservation Act (NHPA), National Environmental Policy Act (NEPA), International Finance Corporation (IFC) Performance Standard 8 (Cultural Heritage), and state and local historic preservation laws. Her experience ranges from oversight and quality control to serving as a principal architectural historian within the continental U.S., Alaska, Hawaii, and Puerto Rico, and internationally in places like sub-Saharan Africa, Japan, and the Republic of Georgia.

Areas of Expertise

- Coordinating Section 106 consultation with federal agencies, consulting parties, and American Indian Tribes
- Identifying historic properties through remote and field-based architectural survey
- Applying the National Register of Historic Places (NRHP) Eligibility Criteria
- Preparing historic building and engineering documentation
- Conducting adverse effects assessments
- Developing historic property management plans
- Developing and implementing Programmatic Agreements (PA)
- Authoring internal and external publications
- Producing mixed media and interpretive exhibits for museums and other agencies

Relevant Project Experience

Reactivation of Space Launch Complex 14, Cape Canaveral Space Force Station, Florida

Client: Stoke Space

Title: Architectural Historian

Start/End Dates: May 2023 – May 2024

Scope/Description: Conducted research and authored cultural resource topic for the Environmental Assessment and Section 106 consultation documents.

Responsibilities: Researched and authored publication.

EDUCATION/QUALIFICATIONS

Master of Art, Historic Preservation, Ursuline College

Bachelor of Art, Film and Video, University of Toledo

REGISTRATIONS/ CERTIFICATIONS

Meets the Secretary of the Interior's Historic Preservation Professional Qualification Standards in Architectural History and History (36 CFR 61)

MEMBERSHIPS AND AFFILIATIONS

AmeriCorps Alumni

ARCUS Leadership Fellow

Cleveland Heights Planning Commissioner

National Alliance for Preservation Commissions, CAMP Trainer

AWARDS/HONORS

American Planning Association Citation Award, 2019

Environmental Resources Management Global Innovation Award, 2017

Cleveland Landmarks Commission Service Excellence Award, 2014

Distinguished AmeriCorps Alumni, 2014

LANGUAGES

French

Russian

JACOBS

Jessica R. Wobig

SENIOR ARCHITECTURAL HISTORIAN

Preservation Sensitivity Training, Central Radio Propagation Laboratory (Building 1) at the Department of Commerce Boulder Laboratory Campus, Boulder, Colorado

Client: National Institute of Standards and Technology (NIST) Preservation

Title: Cultural Resources Specialist

Start/End Dates: June 2021

Scope/Description: Developed preservation sensitivity training for non-historic preservation professionals (contractors and facility staff) in partial fulfillment of a Programmatic Agreement between NIST and Colorado State Historic Preservation Officer (SHPO).

Responsibilities: Developed the learning methods and approach, designed the training, and collaborated with NIST cultural resources experts.

Cultural Resources and Heritage Assets Almanac, Nationwide

Client: Marine Forces Reserves (MARFORRES)

Title: Architectural Historian

Start/End Dates: May 2021 - April 2022

Scope/Description: Authored a cultural resources and heritage assets almanac for MARFORRES internal use. The publication supplied an overview of MARFORRES history, featured cultural resources under MARFORRES responsibility, and provided an overview of the cultural resources management program.

Responsibilities: Researched and authored publication. Developed heritage asset categories to streamline cataloguing and access. Identified graphics for inclusion within the publication. Collaborated with graphic designer, editor, GIS specialists, cultural resources specialists and client.

Environmental Protection Agency (EPA), Notice of Intent (NOI), Jayuya, Puerto Rico

Client: Baxter Healthcare of Puerto Rico, Inc.

Title: Cultural Resources Specialist

Start/End Dates: April 2021 – May 2021

Scope/Description: Review a stormwater project for appropriateness and carried out NOI-Technical Consultation Related with Historic Places under the New EPA Multi-Sector General Permit (MSGP) 2021 for Stormwater Discharges Associated with Industrial Activities.

Responsibilities: Review and submitted NOI to Puerto Rico State Historic Preservation Officer (SHPO)

Barn Survey of Gilliam County, Oregon

Client: Avangrid Renewables, LLC

Title: Architectural Historian

Start/End Dates: February 2021 - December 2021

Jessica R. Wobig

SENIOR ARCHITECTURAL HISTORIAN

Scope/Description: Completed a countywide historic architectural survey of barns in Gilliam, Oregon for historic resource mitigation. Developed a historic context for Gilliam County. Inventoried and evaluated 25 barns built before 1950 for NRHP eligibility. Submitted a historic survey report and database to the Oregon State Historic Preservation Officer (SHPO).

Responsibilities: Developed survey method and authored report.

Implementation for Programmatic Agreement for Ogden Subdivision Bridge Replacement, Utah

Client: Union Pacific Railroad (UPRR)

Title: Architectural Historian

Start/End Dates: March 2020 - April 2022

Scope/Description: Authored cultural resources reports and historic site forms. Documented a historic railroad bridge along the Ogden Subdivision in Utah. Produced an interpretive panel for the Utah State Railroad Museum at Union Station. Coordinated with consulting parties.

Responsibilities: Completed field work, led consultation, and authored all reporting and interpretive panel content.

Historic Preservation Recovery Efforts, Region IX, Hawaii and the Pacific Islands

Client: Federal Emergency Management Agency (FEMA)

Title: Architectural Historian

Start/End Dates: March 2020 - July 2020

Scope/Description: Supported FEMA Region IX with historic preservation considerations under the PA among FEMA, the Hawaii SHPO, the Office of Hawaiian Affairs and the State of Hawaii Department of Defense as executed in 2016.

Responsibilities: Prepared determination of eligibilities and adverse effects assessments for properties in Hawaiʻi, Kauaʻi, and Oʻahu.

Highway Reconstruction Projects for Interstate 41 and 94, Wisconsin

Client: Wisconsin Department of Transportation (WisDOT)

Title: Architectural Historian

Start/End Dates: February 2020 – August 2021

Scope/Description: Supported WisDOT with architecture/history survey and adverse effect assessment for two highway reconstruction projects.

Responsibilities: Prepared an architecture/history survey report and cultural resources reports.

Boone Subdivision Bridge Replacement, Denison, Iowa

Client: Union Pacific Railroad (UPRR)

Title: Architectural Historian

Start/End Dates: August 2019 - August 2021

Jessica R. Wobig

SENIOR ARCHITECTURAL HISTORIAN

Scope/Description: Prepared Section 106 assessments for SHPO, and implemented a PA to resolve adverse effects to an eligible segment of the first transcontinental railroad and eligible railroad bridge. Utilized *How to Complete the National Register Registration Form* (NRB 16A) to amend *the Advent and Development of Railroads in Iowa* Multiple Property Documentation Form (MPDF) for the development of railroad industry and townsite of Denison. Developed a historic context and registration requirements for the evaluation of historic properties in Denison, a railroad town built in speculation of the first transcontinental railroad. Historic documentation was collected, and photographic documentation was also prepared for the bridge.

Responsibilities: Served as architectural historian for cultural resources technical reports and PA implementation. Authored the MPDF amendment.

Perry's Victory and International Peace Monument (PEVI), Put-In-Bay, Ohio

Client: National Park Service (NPS)

Title: Cultural Resources Specialist

Start/End Dates: November 2019 – January 2021

Scope/Description: Prepared an Environmental Assessment (EA) for a seawall repair and stormwater management project at PEVI. Utilized a cultural landscape treatment plan to identify character-defining features, significant and nonsignificant spaces, historic boundaries, and apply the criteria adverse effect.

Responsibilities: Served as the cultural resources lead and supervised maritime archaeological subcontractors. Carried out research, authored cultural resource topic for the EA, and prepared documentation for SHPO.

10 Tangible Cultural Resources Profiles, sub-Saharan Africa

Client: U.S. Army

Title: Cultural Resources Specialist

Start/End Dates: June 2019 – March 2021

Scope/Description: Prepared 10 tangible cultural resources profiles for countries in sub-Saharan Africa for use by newly deployed cultural resources experts. Anthropological profile and historical development for each country with special emphasis on military and political history were provided. Multi-lingual research was carried out. A geospatial database was created with significant cultural resources in each country.

Responsibilities: Transitioned from a support role to the lead cultural resources specialist, who carried out research, writing, and coordinated other tasks within a team of experts.

Implementation for Programmatic Agreement at Arecibo Observatory, Puerto Rico; Green Bank Observatory, West Virginia; Sacramento Peak Observatory, New Mexico

Client: National Science Foundation (NSF)

Jessica R. Wobig

SENIOR ARCHITECTURAL HISTORIAN

Title: Architectural Historian

Start/End Dates: June 2018 – February 2021

Scope/Description: Part of a divestment portfolio and PA implementation for three, federally owned, historic observatories. A NRHP nomination was submitted to New Mexico SHPO for Sacramento Peak Observatory that assessed the property as a planned landscape and historic district. A NRHP addendum was accepted by the NPS Keeper of the Register for Arecibo Observatory that expanded the period of significance from 1963 to 2008 through 2017 and added more contributing resources. Preservation plans were prepared for all three observatories.

Responsibilities: Consulted with the New Mexico, Puerto Rico, and West Virginia SHPOs and the Advisory Council on Historic Preservation (ACHP), conducted an architectural survey, oral histories, organized consulting party meetings, developed preservation plans, completed NRHP nominations, and delivered technical training.

Clinton Railroad Bridge Replacement, Illinois and Iowa

Client: UPRR

Title: Cultural Resources Specialist

Start/End Dates: January 2018 - May 2019

Scope/Description: Prepared and EA and supplemental tasks, including the completion of Section 106 compliance efforts. The project included eligible segments of the First Transcontinental Railroad and the Lincoln Highway. More than 150 historic building inventories, as well as bridge and railroad inventories, were submitted to the Illinois and Iowa SHPOs, concurrently. Utilized *the Advent and Development of Railroads in Iowa* MPDF to make determinations of eligibility and apply the criteria of adverse effect. Consulted with local experts to identify historic properties.

Responsibilities: Supported field efforts during a Phase I archeological survey under the supervision of a Registered Professional Archaeologist, and served as architectural historian for cultural resources technical reports and supplemental building surveys in both states.

United States Route 20 (US 20) Highway Improvement, Idaho

Client: Idaho Department of Transportation (IDT)

Title: Architectural Historian

Start/End Dates: January 2018

Scope/Description: The project includes the completion of Section 106 compliance efforts, including the eligibility assessment of Mission 66 properties, to take into consideration the potential effects on historic properties from the construction of a transportation corridor. Four segments were assessed, including eligible segments of the Yellowstone Highway. The NPS Mission 66 MPDF and associated guidance documents were used to develop historic contexts and assess potential historic properties along the route.

Jessica R. Wobig

SENIOR ARCHITECTURAL HISTORIAN

Experience Prior to Jacobs Engineering, Inc.

Environmental Resources Management (ERM), Architectural Historian/Project Scientist, 2014-2017.

Jessica R. Wobig, Consulting, Principal Architectural Historian and Historian, 2012-2014.

AmeriCorps, Ohio History Service Corps, Community Surveyor, 2010-2013

Appendix B
Municipal Properties in APE

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Table B-1. Municipal Properties Identified within the Area of Potential Effects

Property	Location	Description	NRHP Eligibility / Local Status
St. Gabriel's Episcopal Church	414 Pine Avenue Titusville, FL 32796	Built 1888; Neo-Gothic style	Listed in the NRHP in 1973/ Titusville City Register / Brevard County Register
The Pritchard House	424 Washington Avenue Titusville, FL 32796	Built 1891; Queen Anne style	Listed in the NRHP in 1990/ Titusville City Register / Brevard County Register
The Wager House	621 Indian River Avenue Titusville, FL 32796	Built 1891; Colonial Revival style	Listed in the NRHP/ Titusville City Register/ Brevard County Register
Judge Robbins House	703 Indian River Avenue Titusville, FL 32780	Built 1901; Dutch Colonial Revival style	Listed in the NRHP/ Titusville City Register/ Brevard County Register
The Spell House	1200 Riverside Drive Titusville, FL 32780	Built 1911; Queen Anne style	Listed in the NRHP/ Titusville City Register / Brevard County Register
Imperial Towers	2825 S Washington Avenue Titusville, Fl 32780	Built 1964	Listed in the NRHP/ Titusville City Register
The Carter House	126 Grannis Avenue Titusville, FL 32796	Built 1915; Cracker Vernacular	Titusville City Register
The Norwood House	715 Tropic Street Titusville, FL 32796	Built 1920; Frame Vernacular	Titusville City Register
Hill Grocery	428 Julia Street Titusville, FL 32796	Built 1905; Commercial Masonry Vernacular	Titusville City Register
Hill Hotel & Apartments	422 Julia Street Titusville, FL 32796	Built 1926; Spanish Mission style	Titusville City Register
Duren Building	214 Julia Street Titusville, FL 32796	Built 1925; Masonry Vernacular and Pueblo-Spanish Revival style	Eligible for listing in the NRHP; Potential contributor to district/ Titusville City Register
The Brady House	602 Indian River Avenue Titusville, FL 32796	Built ca.1902 – 1908; Queen Anne style	Eligible for listing in the NRHP; Potential contributor to district/ Titusville City Register
The Carlton House	820 Indian River Avenue Titusville, FL 32780	Built ca.1924; Masonry Vernacular and Colonial Revival style	Eligible for listing in the NRHP; Potential contributor to district/ Titusville City Register
The Dobson House	902 Indian River Avenue Titusville, FL 32780	Built ca. 1915 – 1920; Bungalow	Eligible for listing in the NRHP/ Titusville City Register
The Conkling House	1120 Riverside Drive Titusville, FL 32780	Built 1914	Eligible for listing in the NRHP; Ineligible as contributor to district/ Titusville City Register

Property	Location	Description	NRHP Eligibility / Local Status
Gibson House	723 S Palm Ave Titusville, FL 32780	Built ca. early 1920s; Frame Vernacular	Titusville City Register
Liberty House	4050 Coquina Ave Titusville, FL 32780	Built ca. 1915 – 1920; Craftsman bungalow	Titusville City Register
Garage/Grocery Building	219 Washington Ave Titusville, FL 32796	Built 1926; Mission Revival style	Titusville City Register
Stewart's Cash Store	106 Main St Titusville, FL 32796	Built 1913; Masonry Vernacular	Titusville City Register
Bank of Titusville and Trust Company	300 South Washington Ave Titusville, FL 32796	Built 1925; Neo-Classical Revival style, Masonry Vernacular	Titusville City Register
Van Croix Theater	21 Main St Titusville, FL 32796	Built 1926	Titusville City Register
Old Titusville Post Office	13 Main St Titusville, Fl 32796	Built 1926	Titusville City Register
Titusville Hardware Store	305 Washington Ave Titusville, FL 32796	Built ca. 1913; Masonry Vernacular	Titusville City Register
Walker Apartment Building	322 Washington Ave Titusville, FL 32796	Built 1924; Spanish Mission style	Titusville City Register
The Spell Building	317 Washington Ave Titusville, FL 32796	Built 1912; Masonry Vernacular	Titusville City Register
Florida Power Light Company	326 Washington Ave Titusville, FL 32796	Built 1910; Masonry Vernacular	Titusville City Register
Downtown Titusville	303-317 Washington Ave Titusville, FL 32796	Built 1910; Multiple Storefronts	Titusville City Register
Titusville Veterans Memorial Fishing Pier	2 A. Max Brewer Memorial Parkway, Titusville, FL	Built 1922	Brevard County Register
Titusville Commercial District	Bounded by Julia Street, Hopkins Avenue, Main Street, and Indian River Avenue, Titusville, FL	Built ca. 1895-1926; 24 Historic resources	Brevard County Register
Brevard County Courthouse	506 Palm Avenue, Titusville, FL	Built ca. 1912 (original courthouse)	Brevard County Register
St. Luke’s Episcopal Church of Courtney	5555 North Tropical Trail, Merritt Island, FL	Built 1888	Brevard County Register
Field Manor	750 Field Manor Drive, Merritt Island, FL	Built ca. 1880	Brevard County Register
Artesia Post Office (BR02570)	8901 North Atlantic Boulevard, Cape Canaveral, FL	Built ca. 1950	Brevard County Register
William Chandler Log Cabin (BR01883)	122 Oak Lane, Cape Canaveral, FL	Built ca. 1930-1935	Brevard County Register

Property	Location	Description	NRHP Eligibility / Local Status
City Point Community Church	3783 North Indian River Drive, Cocoa, FL	Built 1885	Listed in the NRHP in 1995/ Brevard County Register
Community Woman's Club	5 Rosa L. Jones Drive, Cocoa, FL	Built ca. 1950	Brevard County Register
S.F. Travis Building	300-302 Delannoy Avenue, Cocoa, FL	Built 1907; Masonry Vernacular	Brevard County Register
Porcher House	434 Delannoy Avenue, Cocoa, FL	Built 1916; Classical Revival style	Listed in the NRHP in 1986/ Brevard County Register
Harry T. Moore Center (Cocoa Colored School #102)	307 Blake Avenue, Cocoa, FL	Built 1923	Brevard County Register
Monroe Center (Monroe High School)	705 Blake Avenue, Cocoa, FL	Built 1954-1955	Brevard County Register
St. Mark's Episcopal Church	4 Church Street, Cocoa, FL	Built ca. 1886	Brevard County Register
Library of Florida History	435 Brevard Avenue, Cocoa, FL	Built 1939	Brevard County Register
Derby Street Chapel	121 Derby Street, Cocoa, FL	Built 1924	Brevard County Register

Note:

Municipal properties are listed in inventories maintained by Titusville and Brevard County and may be dually recorded in the FMSF.

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Appendix C
Historic Properties in the APE

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Table C-1. Individual Historic Property Count

Property Type	Total
Bridge	3
Cemetery	5
Resource Group/District	41
Structure	291
Total	**340**

Note:

Does not include contributing resources to Resource Groups/Districts

Table C-2. Individual Historic Properties Identified within the Area of Potential Effects

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
1	Indian River Bridge	BR01699	Bridge	1948	Eligible for NRHP
2	Jay Jay Bridge	BR02906	Bridge	circa 1963	Eligible for NRHP
3	Banana River Bridge	BR02955	Bridge	1964	Eligible for NRHP
4	Pioneer Cemetery	BR01705	Cemetery	circa 1890	Eligible for NRHP
5	Hilltop Cemetery	BR01724	Cemetery	circa 1887	Eligible for NRHP
6	Cocoa Cemetery	BR01777	Cemetery	circa 1890	Eligible for NRHP
7	Facility 6403 – Osmon Grave	BR02357	Cemetery	circa 1913	Eligible for NRHP
8	Fac. 6405 – Canaveral Fish Company Grave	BR02358	Cemetery	1913	Eligible for NRHP
9	Old Haulover Canal	BR00188	Resource Group/District	Spanish Second Period, 1783-1821	NRHP Listed, 1978-12-19
10	Cape Canaveral Air Force Station	BR00216	Resource Group/District	Modern era, 1950-present	NHL and NRHP Listed, 1984-04-16
11	Rockledge Drive Residential District	BR01611	Resource Group/District	Post-Reconstruction, 1880-1897; Boom Times, 1921-1929	NRHP Listed, 1992-08-21
12	Launch Complex 39: Pad A	BR01686	Resource Group/District	Modern era, 1950-present; U.S. Apollo Program (circa 1965-1975)	NRHP Listed, 2000-01-21
13	Launch Complex 39: Pad B	BR01687	Resource Group/District	Modern era, 1950-present; U.S. Apollo Program (circa 1965-1975)	NRHP Listed, 2000-01-21

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
14	Crawlerway	BR01689	Resource Group/District	U.S. Space Shuttle Program (circa 1969 to 2010)	NRHP Listed, 2000-01-21
15	Florida East Coast Railroad	BR01870	Resource Group/District	American, 1821-present; Boom Times, 1921-1929	Eligible for NRHP
16	Shuttle Landing Facility Area HD	BR01986	Resource Group/District	U.S. Space Shuttle Program (circa 1969 to 2010)	Eligible for NRHP
17	Shuttle Landing Facility Runway	BR01987	Resource Group/District	U.S. Space Shuttle Program (circa 1969 to 2010)	Eligible for NRHP
18	Orbiter Processing Historic District	BR01990	Resource Group/District	circa 1969 to 2010	Eligible for NRHP
19	Solid Rocket Booster Disassembly & Refurbishment Complex	BR01996	Resource Group/District	U.S. Space Shuttle Program, circa 1969 to 2010	Eligible for NRHP
20	Launch Complex 21/22	BR02022	Resource Group/District	Twentieth century American, 1900-present	Eligible for NRHP
21	Launch Complex 9 Resource Group	BR02188	Resource Group/District	Twentieth century American, 1900-present	Eligible for NRHP
22	Launch Complex 13	BR02198	Resource Group/District	Atlas ICBM program,1956-1966	Eligible for NRHP
23	Launch Complex 14	BR02209	Resource Group/District	Twentieth century American, 1900-present; Modern, 1950-present, 1957-1966	Eligible for NRHP
24	New Smyrna to Haulover Canal Road	BR02230	Resource Group/District	Nineteenth century American, 1821-1899; 2nd Seminole Indian War, American Territorial Period	Eligible for NRHP
25	Launch Complex 3 & 4	BR02234	Resource Group/District	Twentieth century American, 1900-present	Eligible for NRHP
26	Launch Complex 1-2	BR02248	Resource Group/District	Twentieth century American, 1900-present	Eligible for NRHP
27	Launch Complex 19	BR02260	Resource Group/District	Titan I & II ICBMs, 1956-1966	Eligible for NRHP
28	Launch Complex 30	BR02272	Resource Group/District	Twentieth century American, 1900-present; Cold War	Eligible for NRHP
29	Launch Complex 34	BR02279	Resource Group/District	Apollo Program, 1961-1971	Eligible for NRHP
30	Facility 50305: Skid Strip	BR02336	Resource Group/District	Twentieth century American, 1900-present; Modern, 1950-present; Cold War	Eligible for NRHP
31	Launch Complex 17	BR02369	Resource Group/District	1957-1960	Eligible for NRHP
32	Launch Complex 25	BR02518	Resource Group/District	1958-1969	Eligible for NRHP

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
33	Launch Complex 29	BR02529	Resource Group/District	1958-1969	Eligible for NRHP
34	Fuel Storage Area 3	BR02540	Resource Group/District	Cold War and Post-Cold War, 1952-present	Eligible for NRHP
35	NASA Railroad at Kennedy Space Center	BR02931	Resource Group/District	Modern, 1950-present; circa 1963-2010	Eligible for NRHP
36	NASA KSC Railroad System	BR02932	Resource Group/District	circa 1978-2010	Eligible for NRHP
37	Canaveral Lock	BR02936	Resource Group/District	Modern, 1950-present	Eligible for NRHP
38	Area 55: Delta Operations Support Area	BR03031	Resource Group/District	Cold War, 1956-1980	Eligible for NRHP
39	Delta II Solid Rocket Motor Area	BR03034	Resource Group/District	Blue Scout Program,1963-1965	Eligible for NRHP
40	Delta Spin Test Facility	BR03036	Resource Group/District	Delta II Program,1966-2010	Eligible for NRHP
41	LC 5/6 Spin Test Facility	BR03052	Resource Group/District	Twentieth century American, 1900-present; Cold War	Eligible for NRHP
42	CCAFS Industrial Area	BR03073	Resource Group/District	1958-present	Eligible for NRHP
43	Skid Strip Historic District	BR03186	Resource Group/District	Modern, 1950-present; Twentieth century American, 1900-present; Cold War	Eligible for NRHP
44	CCAFS Industrial Area Historic District	BR03369	Resource Group/District	1946-1989	Eligible for NRHP
45	Control Tower Road Tracking Sites	BR03433	Resource Group/District	Modern, 1950-present; Twentieth century American, 1900-present; Cold War	Eligible for NRHP
46	ICBM Road	BR04191	Resource Group/District	Twentieth century American, 1900-present; Cold War	Eligible for NRHP
47	Homesteaders' Trail	BR04227	Resource Group/District	Nineteenth century American, 1821-1899; Reconstruction, 1866-1879	Eligible for NRHP
48	North Tropical Trail	BR04228	Resource Group/District	Nineteenth century American, 1821-1899; Reconstruction, 1866-1879	Eligible for NRHP
49	Jonathan H. Sams Farmstead	BR04229	Resource Group/District	Malabar I; Malabar II	Eligible for NRHP
50	Launch Complex 39	BR00172	Structure	1968	NRHP Listed, 1973-05-24
51	E.P. Porcher House	BR00211	Structure	1916	NRHP Listed, 1986-01-06
52	Cape Canaveral Lighthouse	BR00212	Structure	1867	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
53	Cocoa Junior High	BR00278	Structure	circa 1924	NRHP Listed, 2019-04-03
54	Aladdin Theater Building	BR00282	Structure	1924	NHL and NRHP Listed, 1991-10-17
55	Wager House	BR00397	Structure	circa 1891	NRHP Listed, 1990-01-12
56	Judge George Robbins House	BR00399	Structure	circa 1892	NRHP Listed, 1990-01-12
57	Spell House	BR00480	Structure	circa 1911	NRHP Listed, 1990-01-12
58	St Luke's Episcopal Church	BR00581	Structure	1889	NRHP Listed, 1990-06-15
59	Dr George E. Hill House	BR00860	Structure	circa 1880	NRHP Listed, 1993-08-12
61	Mattie Lamar House	BR01163	Structure	1917	NRHP Eligible
62	City Point Community Church	BR01657	Structure	1885	NRHP Listed, 1995-06-20
63	Vehicle Assembly Building	BR01684	Structure	circa 1966	NRHP Listed, 2000-01-21
64	Launch Control Center	BR01685	Structure	circa 1966	NRHP Listed, 2000-01-21
65	Missile Crawler Transporter Facilities	BR01688	Structure	circa 1965	NRHP Listed, 2000-01-21
66	Press Site: Clock and FlagPole	BR01690	Structure	1969	NRHP Listed, 2000-01-21
67	Operations Checkout	BR01693	Structure	1964	NRHP Listed, 2000-01-21
68	J.R. Field Homestead	BR01702	Structure	circa 1900	NRHP Listed, 1997-09-11
69	Cocoa Cemetery Storage Building	BR01723	Structure	circa 1931	NRHP Eligible
70	Bohn Equipment Company	BR01765	Structure	circa 1927	NRHP Eligible
71	Cocoa Post Office	BR01825	Structure	1940	NRHP Listed, 2019-04-02
72	Launch Bldg. 21/22 (#5912)	BR01981	Structure	1958	NRHP Eligible
73	CX 21/22 Utility Room (#5914)	BR01982	Structure	1958	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
74	Block House CX 21/22 (#5951)	BR01983	Structure	1958	NRHP Eligible
75	Storage Building (#5959)	BR01984	Structure	circa 1960s	NRHP Eligible
76	Launch Complex 21/22	BR01985	Structure	1956	NRHP Eligible
77	Landing Aids Control Building (LACB)	BR01988	Structure	circa 1976	NRHP Eligible
78	Orbiter Processing Facility	BR01991	Structure	circa 1977	NRHP Eligible
79	Orbiter Processing Facility High Bay 3	BR01992	Structure	1987	NRHP Eligible
80	Thermal Protection System Facility	BR01994	Structure	circa 1988	NRHP Eligible
81	Launch Complex 39: Pad A	BR01995	Structure	circa 1965	NRHP Eligible
82	Rotation/Processing Building	BR01997	Structure	1982	NRHP Eligible
83	SRB ARF Manufacturing Building	BR01998	Structure	1986	NRHP Eligible
84	Hangar AF	BR02001	Structure	1962	NRHP Eligible
85	High Pressure Gas Building	BR02002	Structure	1963+	NRHP Eligible
86	High Pressure Wash Facility	BR02003	Structure	1979+	NRHP Eligible
87	SRB Recovery Slip	BR02005	Structure	1979+	NRHP Eligible
88	SRB Paint Building	BR02006	Structure	1984+	NRHP Eligible
89	Thrust Vector Control Deservicing Building	BR02008	Structure	1985+	NRHP Eligible
90	Multi-Media Blast Facility	BR02009	Structure	1992+	NRHP Eligible
91	Launch Complex 39: Pad B	BR02010	Structure	circa 1966	NRHP Eligible
92	Canister Rotation Facility	BR02016	Structure	circa 1993	NRHP Eligible
93	Recovery Ship "Liberty Star"	BR02019	Structure	circa 1980	NRHP Eligible
94	Recovery Ship "Freedom Star"	BR02020	Structure	circa 1981	NRHP Eligible
95	Vertical Integration Bldg	BR02086	Structure	1964	NRHP Eligible, Destroyed
96	Launch Complex 12 Blockhouse	BR02134	Structure	circa 1956	NRHP Eligible
97	Launch Complex 18 Blockhouse	BR02144	Structure	1956	NRHP Eligible
98	Facility 17780 – LC9 Launch Platform	BR02183	Structure	1953	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
99	Facility 17767– LC9 & 10 Block House	BR02185	Structure	1953	NRHP Eligible
100	Facility 17768 – LC9 & 10 Pump House	BR02186	Structure	1953	NRHP Eligible
101	Little N Storage Bldg.	BR02190	Structure	1958+	NRHP Eligible
102	LC 13 Ready Bldg/Contractors Support...	BR02199	Structure	circa 1956	NRHP Eligible
103	LC 13 Launch Stand and Ramp...	BR02200	Structure	circa 1956	NRHP Eligible
104	LC 13 Flume and Skimming Basin	BR02201	Structure	circa 1956	NRHP Eligible
105	LC 13 LOX/GN2 Storage Area...	BR02202	Structure	circa 1956	NRHP Eligible
106	LC 13 Guard Shack (Fac. 8809)	BR02203	Structure	circa 1956	NRHP Eligible
107	LC 13 POL Building (Fac. 8807)	BR02204	Structure	1960	NRHP Eligible
108	LC 13 Water Demineralization Station	BR02205	Structure	1957	NRHP Eligible
109	LC 13 Gantry rails and Parking Area	BR02206	Structure	circa 1956	NRHP Eligible
110	LC 13 Propellant (RP-1) Facility ...	BR02207	Structure	circa 1956	NRHP Eligible
111	LC 13 POL Building (Fac. 8814)	BR02208	Structure	circa 1956	NRHP Eligible
112	LC 14 Launch Stand and Ramp...	BR02210	Structure	1957-	NRHP Eligible
113	LC 14 Propellant Transfer Unit (Fac. ...	BR02211	Structure	1957-	NRHP Eligible
114	LC 14 Jet Propellant-4 Facility	BR02212	Structure	circa 1957	NRHP Eligible
115	LC 14 POL (Fac. 1684W/8602)	BR02213	Structure	circa 1957	NRHP Eligible
116	LC 14 Liquid Oxygen/Gaseous Nitrogen...	BR02214	Structure	circa 1957	NRHP Eligible
117	LC 14 Flume and Skimming Basin ...	BR02215	Structure	circa 1957	NRHP Eligible
118	LC 14 Blockhouse	BR02216	Structure	circa 1957	NRHP Eligible
119	LC 14 Ready Building	BR02217	Structure	circa 1957	NRHP Eligible
120	LC 14 Communications Cable Building	BR02218	Structure	circa 1957	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
121	LC 14 Demineralization Station ...	BR02219	Structure	circa 1957	NRHP Eligible
122	LC 14 Rails and Service Tower Parking...	BR02220	Structure	circa 1957	NRHP Eligible
123	Mercury Memorial	BR02221	Structure	circa 1957	NRHP Eligible
124	Recreational Storage Building	BR02233	Structure	1958	NRHP Eligible
125	Launch Complex 3 & 4 Blockhouse	BR02236	Structure	1951	NRHP Eligible
126	Launch Pad 3 (Facility 4101)	BR02237	Structure	1951	NRHP Eligible
127	Launch Pad 4 (Facility 4101)	BR02238	Structure	1951	NRHP Eligible
128	High Pressure Air Bldg 4 (Facility 2805)	BR02239	Structure	1950	NRHP Eligible
129	Bomarc Building (Facility 2841)	BR02240	Structure	1955	NRHP Eligible
130	Comp. & Cool Bldg (Facility 2842)	BR02241	Structure	1955	NRHP Eligible
131	High Pressure Air Facility	BR02242	Structure	1951	NRHP Eligible
132	LC 1 & 2 Blockhouse (Fac. 4140)	BR02249	Structure	1951	NRHP Eligible
133	Launch Pad 1 (Fac. 4210)	BR02250	Structure	1951	NRHP Eligible
134	Launch Pad 2 (Fac. 4141)	BR02251	Structure	1951	NRHP Eligible
135	Transformer Bldg (Fac. 4120)	BR02252	Structure	1951	NRHP Eligible
136	Snark Pad (LC 23/24)	BR02253	Structure	1953	NRHP Eligible
137	Launch Complex 19 Blockhouse	BR02261	Structure	1959	NRHP Eligible
138	LC 19 Decontamination Building	BR02263	Structure	1959	NRHP Eligible
139	Launch Complex 19 Launch Stand, Ramp	BR02264	Structure	1959	NRHP Eligible
140	Launch Complex 19 Erector	BR02265	Structure	1959	NRHP Eligible
141	LC 19 Instrumental Building	BR02266	Structure	1959	NRHP Eligible
142	LC 19 Oxidizer Holding Area	BR02267	Structure	1959	NRHP Eligible
143	LC 19 Oxidizer Holding Area	BR02268	Structure	1959	NRHP Eligible
144	LC 19 Fuel Holding Area	BR02269	Structure	1959	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
145	LC 19 Flume and Catchment Basin	BR02270	Structure	circa 1956	NRHP Eligible
146	LC 19 Theodolite Building #2	BR02271	Structure	1961	NRHP Eligible
147	Launch Complex 15 Blockhouse	BR02275	Structure	circa 1957	NRHP Eligible
148	Launch Complex 34 Blockhouse	BR02280	Structure	1959	NRHP Eligible
149	LC 34 High Pressure Gas Storage Facility	BR02281	Structure	1960	NRHP Eligible
150	LC 34 Oxidizer Storage Facility	BR02282	Structure	1959	NRHP Eligible
151	LC 34 Liquid Oxygen (LOX) Storage Area	BR02283	Structure	1959	NRHP Eligible
152	LC 34 Theodolite Building	BR02284	Structure	1965	NRHP Eligible
153	LC 34 Toxic Vapor Disposal Pad	BR02285	Structure	1959	NRHP Eligible
154	LC 34 RP-1 Storage Facility	BR02286	Structure	1960	NRHP Eligible
155	LC 34 RP-1 Electrical Equipment Building	BR02287	Structure	1960	NRHP Eligible
156	LC 34 RP-1 Special Liquid Storage...	BR02288	Structure	1960	NRHP Eligible
157	LC 34 Cableway and Amplifier Facility	BR02289	Structure	1960	NRHP Eligible
158	LC 34 Launch Pad	BR02290	Structure	1959	NRHP Eligible
159	LC 34 Mobile Service Tower Parking Area	BR02291	Structure	1959	NRHP Eligible
160	LC 34 Launch Pedestal	BR02292	Structure	1959	NRHP Eligible
161	LC 34 Flame Deflectors and Deflector...	BR02293	Structure	1959	NRHP Eligible
162	LC 34 Launch Pad Environmental...	BR02294	Structure	1959	NRHP Eligible
163	LC 34 Flume and Skimming Basin	BR02295	Structure	1961	NRHP Eligible
164	LC 34 LH2 Electrical Equipment...	BR02296	Structure	1963	NRHP Eligible
165	LC 34 High Pressure Hydrogen Storage...	BR02297	Structure	1965	NRHP Eligible
166	LC 34 High Pressure Hydrogen Storage...	BR02298	Structure	1959	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
167	LC 34 Liquid Hydrogen Storage...	BR02299	Structure	1963	NRHP Eligible
168	LC 34 High Pressure Gas...	BR02300	Structure	1959	NRHP Eligible
169	Launch Complex 11 Blockhouse	BR02301	Structure	circa 1956	NRHP Eligible
170	NRC Experimentation Facility Storage Bldg	BR02313	Structure	1959	NRHP Eligible
171	Launch Complex 16 Blockhouse	BR02322	Structure	1959-	NRHP Eligible
172	Launch Complex 36 Blockhouse	BR02333	Structure	1959	NRHP Eligible
173	Fac. 1375: Skid Strip Parking Apron	BR02337	Structure	circa 1953	NRHP Eligible
174	Facility 50210: Strip Control Tower	BR02338	Structure	circa 1963	NRHP Eligible
175	Facility 50300: Warm-Up Pad	BR02339	Structure	circa 1968	NRHP Eligible
176	NRC Experimentation Facility	BR02348	Structure	1952	NRHP Eligible
177	Facility 1725-Hangar K	BR02353	Structure	circa 1957	NRHP Eligible
178	Launch Complex 17 Blockhouse	BR02370	Structure	circa 1956	NRHP Eligible
179	Launch Complex 17 Alignment Building	BR02371	Structure	1970	NRHP Eligible
180	Launch Complex 17B Launch Pad	BR02372	Structure	1959	NRHP Eligible
181	Launch Complex 17B Mobile Service Tower	BR02373	Structure	1959	NRHP Eligible
182	Launch Complex 17B Umbilical Tower	BR02374	Structure	1956	NRHP Eligible
183	Launch Complex 17B Deluge Basin	BR02375	Structure	1956	NRHP Eligible
184	Launch Complex 17A Launch Pad	BR02376	Structure	1959	NRHP Eligible
185	Launch Complex 17A Mobile Service Tower	BR02377	Structure	1956	NRHP Eligible
186	Launch Complex 17A Umbilical Tower	BR02378	Structure	1956	NRHP Eligible
187	Launch Complex 17A Deluge Basin	BR02379	Structure	1956	NRHP Eligible
188	Launch Complex 17 Switch Control Bldg	BR02380	Structure	1958	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
189	LC 17 Electrical Distribution Building	BR02381	Structure	1958	NRHP Eligible
190	LC 17 Change and Rest Home...	BR02382	Structure	1968	NRHP Eligible
191	LC 17 Cases Storage Area	BR02383	Structure	1956	NRHP Eligible
192	LC 17 Pad B DIGs Bldg (Fac. 28413)	BR02384	Structure	1973	NRHP Eligible
193	LC 17 Pad A DIGs Bldg (Fac. 28415)	BR02385	Structure	1973	NRHP Eligible
194	LC 17 Chiller Bldg (Fac. 28422)	BR02386	Structure	1994	NRHP Eligible
195	LC 17 UPS Building (aka White Room AC ...)	BR02387	Structure	1969	NRHP Eligible
196	LC 17 RP-1 Storage Area (Fac 28503)	BR02388	Structure	1956	NRHP Eligible
197	LC 17 LH2 Storage Area (Fac. 28509)	BR02389	Structure	1956	NRHP Eligible
198	LC 17 Paint, Oil, and Lubricant Building	BR02390	Structure	1967	NRHP Eligible
199	LC 17 Delta Operations Admin. Bldg.	BR02391	Structure	1958	NRHP Eligible
200	LC 17 Battery Laboratory (Fac. 36002)	BR02392	Structure	1958	NRHP Eligible
201	LC 17 Electrical Distribution Bldg.	BR02393	Structure	1958	NRHP Eligible
202	LC 17 Locker and Storage Facility (36004)	BR02394	Structure	1958	NRHP Eligible
203	Facility 1334A: GPI Camera Pad U24R56	BR02397	Structure	circa 1956	NRHP Eligible
204	Facility 1334C: GPI Camera Pad U2R56	BR02398	Structure	circa 1956	NRHP Eligible
205	Facility 60530-Hangar AO	BR02454	Structure	circa 1964	NRHP Eligible
206	Facility 40906-Water Pump Station #1	BR02483	Structure	1958	NRHP Eligible
207	LC 25 Blockhouse (Fac. 51900)	BR02519	Structure	1958	NRHP Eligible
208	LC Ele. Distribution Bldg.	BR02520	Structure	1958	NRHP Eligible
209	LC 25 Substation	BR02521	Structure	1958	NRHP Eligible
210	LC 25 Pads A&B Instrumentation Ditches	BR02522	Structure	1958	NRHP Eligible
211	LC 25 Pads A (Fac. 51901)	BR02523	Structure	1958	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
212	LC 25 Pads B (Fac. 51902)	BR02524	Structure	1958	NRHP Eligible
213	LC 25 Pads C&D Instrumentation Ditches	BR02525	Structure	1968	NRHP Eligible
214	LC 25 Pads C&D (Fac. 51903/51904)	BR02526	Structure	1968	NRHP Eligible
215	LC 25 C Missile Access Stand	BR02527	Structure	1968	NRHP Eligible
216	Pad Service Building (Fac. 51903)	BR02528	Structure	1958	NRHP Eligible
217	LC 29 Blockhouse (Fac 52001)	BR02530	Structure	1960	NRHP Eligible
218	LC 29 Substation (Fac 52004)	BR02531	Structure	1960	NRHP Eligible
219	LC 29 Instrumentation Tunnel	BR02532	Structure	1960	NRHP Eligible
220	LC 29 Pad A (Fac. 52000)	BR02533	Structure	1960	NRHP Eligible
221	Facility 44810-Hangar AA	BR02536	Structure	1959	NRHP Eligible
222	Hangar AM (Facility 60550)	BR02537	Structure	1964	NRHP Eligible
223	Facility 49904: Satellite Proc. Fac. C	BR02538	Structure	1964	NRHP Eligible
224	Hangar F (Facility 1611)	BR02546	Structure	1955	NRHP Eligible
225	Hangar G	BR02587	Structure	1956	NRHP Eligible
226	Hangar U	BR02588	Structure	1958	NRHP Eligible
227	Space Station Processing Facility	BR02671	Structure	1992	NRHP Eligible
228	400 Lucerne Dr	BR02704	Structure	Circa 1966	NRHP Eligible
229	317 Rosa Jones Drive	BR02779	Structure	1962-	NRHP Eligible
230	LC 37 Launch Control Center (Fac. 33000)[a]	BR02790	Structure	1962	NRHP Eligible
231	NLAX 170	BR02908	Structure	circa 1985	NRHP Eligible
232	Locomotive 1	BR02923	Structure	1968+	NRHP Eligible
233	Engineering Development Laboratory	BR02969	Structure	1966	NRHP Eligible
234	Engineering & Operations (E&O) Building	BR02975	Structure	1961	NRHP Eligible
235	Missile Assembly Building AE (Hangar AE)	BR02976	Structure	1959	NRHP Eligible
236	Beach House	BR02990	Structure	1962	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
237	Fac. 1106 – Receiver Rate Antenna Pad	BR03017	Structure	1958	NRHP Eligible
238	Fac. 1305P – MOD III Radar Antenna Pad	BR03018	Structure	1958	NRHP Eligible
239	Fac. 256608 – Wave Guide Access Structure	BR03021	Structure	1957	NRHP Eligible
240	Fac. 56620 – Delta Admin. and Supp. Bldg.	BR03022	Structure	1956	NRHP Eligible
241	Fac. 56621 – Delta POL Building	BR03023	Structure	1957	NRHP Eligible
242	Fac. 56623 – Water Pump Station	BR03024	Structure	1963	NRHP Eligible
243	Fac. 56624 – Storage Shed	BR03025	Structure	1963	NRHP Eligible
244	Fac. 56631 – Mobile Radar Van Ramp and...	BR03028	Structure	1957	NRHP Eligible
245	Fac. 56632 – MOD III Radar Bldg/Delta Lab	BR03029	Structure	1958	NRHP Eligible
246	Fac. 56636 – Delta Sec. Stage Checkout Bldg	BR03030	Structure	1957	NRHP Eligible
247	Facility 50801 Rocket Storage Building	BR03032	Structure	1963	NRHP Eligible
248	Facility 50803 Rocket Checkout Building	BR03033	Structure	1963	NRHP Eligible
249	Facility 67900 – Spin Test Building	BR03037	Structure	1967	NRHP Eligible
250	Facility 67901 – Control Building	BR03038	Structure	1967	NRHP Eligible
251	Blast Protective Berm	BR03039	Structure	1967	NRHP Eligible
252	Cableway	BR03040	Structure	1967	NRHP Eligible
253	NLAX 171	BR03042	Structure	circa 1985	NRHP Eligible
254	Locomotive 2	BR03043	Structure	1970+	NRHP Eligible
255	Locomotive 3	BR03044	Structure	1970+	NRHP Eligible
256	Foam Building	BR03046	Structure	1965+	NRHP Eligible
257	Fac. 70000: Solid Motor Assembly Bldg	BR03049	Structure	circa 1964	NRHP Eligible
258	Fac 1221 – Ordnance Storage Bldg	BR03053	Structure	circa 1952	NRHP Eligible
259	Fac 41301 – Payload Holding Building	BR03054	Structure	circa 1963	NRHP Eligible
260	Fac 41302 – Ordnance Storage Building	BR03055	Structure	circa 1952	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
261	Fac 41303 – Museum Storage Bldg-Spin Test	BR03056	Structure	circa 1957	NRHP Eligible
262	Hangar N	BR03069	Structure	1958+	NRHP Eligible
263	Hangar S	BR03070	Structure	1958-	NRHP Eligible
264	Facility 1240: Magazine #3	BR03126	Structure	1952	NRHP Eligible
265	Facility 1241: Magazine #4	BR03127	Structure	1952	NRHP Eligible
266	Facility 1242: Magazine #1	BR03128	Structure	1952	NRHP Eligible
267	Facility 1243: Magazine #2	BR03129	Structure	1952	NRHP Eligible
268	Facility 1244: Magazine #7	BR03130	Structure	1952	NRHP Eligible
269	Facility 1245: Magazine #11	BR03131	Structure	1952	NRHP Eligible
270	Facility 1246: Magazine #8	BR03132	Structure	1952	NRHP Eligible
271	Facility 1247: Magazine #10	BR03133	Structure	1952	NRHP Eligible
272	Fac. 18800-Launch Complex 20 Blockhouse	BR03155	Structure	circa 1959	NRHP Eligible
273	LC-30 Blockhouse	BR03163	Structure	circa 1959	NRHP Eligible
274	Facility 56928 – Navy Diver Support Bldg	BR03165	Structure	circa 1961	NRHP Eligible
275	Facility 56940 – Navy Weapons Shop	BR03166	Structure	circa 1960	NRHP Eligible
276	Facility 56941 – Launch Pad LC30A	BR03167	Structure	circa 1960	NRHP Eligible
277	Facility 56942-Launch Pad LC30B	BR03168	Structure	circa 1960	NRHP Eligible
278	Reentry System Assembly & Checkout Bldg	BR03169	Structure	circa 1961	NRHP Eligible
279	Facility 56948 – Storage Building	BR03170	Structure	circa 1960	NRHP Eligible
280	Facility 56949 – Storage Building	BR03171	Structure	circa 1962	NRHP Eligible
281	LC-30 Instrumentation Trenches	BR03172	Structure	circa 1960	NRHP Eligible
282	Helicopter Parking Apron	BR03173	Structure	circa 1960	NRHP Eligible
283	North Revetment	BR03174	Structure	circa 1960	NRHP Eligible
284	Facility 1704 – Engineering & Laboratory	BR03179	Structure	1957	NRHP Eligible
286	Facility 1604 – Hangar H	BR03194	Structure	1956	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
287	Facility 1605 – Motion Picture Laboratory	BR03195	Structure	1954	NRHP Eligible
288	Facility 1612 – Hangar E	BR03199	Structure	1956	NRHP Eligible
289	Facility 1613 – Satellite Process/C Annex	BR03200	Structure	1954	NRHP Eligible
300	Facility 1645-Spacecraft Support Center	BR03208	Structure	1951	NRHP Eligible
301	Facility 1708 – Hangar R & D	BR03211	Structure	1956	NRHP Eligible
302	Facility 1711 – Hangar I	BR03212	Structure	1955	NRHP Eligible
303	Facility 1721 – Hangar J	BR03215	Structure	1956	NRHP Eligible
304	Facility 1731 – Hangar M	BR03219	Structure	1957	NRHP Eligible
305	Facility 1733 – Engineering & Analysis	BR03220	Structure	1959	NRHP Eligible
306	Facility 1739 – Hangar T	BR03222	Structure	1958	NRHP Eligible
307	Facility 49536 – Paint & Body Shop (Ltl U)	BR03233	Structure	1958	NRHP Eligible
308	Facility 50166 – Radar 1.16	BR03250	Structure	1958	NRHP Eligible
309	Facility 54815 – Navy Training	BR03252	Structure	1964	NRHP Eligible
310	Facility 54820 – Little T Storage	BR03253	Structure	1958	NRHP Eligible
311	Facility 54915 – Engineering	BR03255	Structure	1964	NRHP Eligible
312	Facility 55150 – Hangar I Annex	BR03266	Structure	1960	NRHP Eligible
313	Facility 60501 – Little M Machine Shop	BR03271	Structure	1956	NRHP Eligible
314	Facility 20395: Universal Camera Pad 21	BR03340	Structure	circa 1965	NRHP Eligible
315	Facility 1601: Test Stand	BR03342	Structure	circa 1953	NRHP Eligible
316	West Compass Rose	BR03343	Structure	circa 1953	NRHP Eligible
317	Facility 75251 – Atlas V Spacecraft Ops	BR03445	Structure	circa 1964	NRHP Eligible
318	Facility 70510 – ITL Warehouse	BR03449	Structure	circa 1964	NRHP Eligible
319	Facility 70659 – ITL X-Ray Facility	BR03450	Structure	circa 1987	NRHP Eligible
320	Facility 70451 – Segment Ready Storage	BR03451	Structure	circa 1964	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
321	Facility 90302 – DASO HQ Building	BR03467	Structure	circa 1978	NRHP Eligible
322	Facility 1115 – Hangar Y	BR03478	Structure	circa 1958	NRHP Eligible
323	Facility 1118 – Engineering Lab Building	BR03483	Structure	circa 1958	NRHP Eligible
324	Facility 62610 – Hangar Z	BR03484	Structure	circa 1959	NRHP Eligible
325	Facility 1117 – OPNS Equipment Storage Building	BR03485	Structure	circa 1958	NRHP Eligible
326	Facility 62615 – Test Operations Facility	BR03486	Structure	circa 1985	NRHP Eligible
327	Facility 62637 – Equipment Storage Building	BR03487	Structure	circa 1985	NRHP Eligible
328	Facility 62630 – Support Services Building	BR03489	Structure	circa 1960	NRHP Eligible
329	Facility 62700 – Guidance Test Bldg	BR03490	Structure	circa 1968	NRHP Eligible
330	Facility 57511 – Missile Checkout Bldg AP	BR03493	Structure	circa 1985	NRHP Eligible
331	Facility 57512 – Missile Checkout Bldg AQ	BR03494	Structure	circa 1985	NRHP Eligible
332	Facility 63000 – Missile Checkout Bldg AH	BR03495	Structure	circa 1968	NRHP Eligible
333	Facility 62960 – Missile Checkout Bldg AJ	BR03496	Structure	circa 1962	NRHP Eligible
334	Facility 55871 – Satellite Processing Supp	BR03497	Structure	1960	NRHP Eligible
335	Facility 55840 – Propellant Servicing	BR03499	Structure	circa 1960	NRHP Eligible
336	Facility 55815 – Satellite Storage Fac A	BR03501	Structure	circa 1962	NRHP Eligible
337	Facility 90327 – SpaceX Admin Building	BR03506	Structure	circa 1964	NRHP Eligible
338	Facility 90328 - Museum	BR03507	Structure	circa 1964	NRHP Eligible
339	Facility 90326 – Masten Admin Building	BR03508	Structure	circa 1964	NRHP Eligible
340	Facility 90329 – Admin Building (vacant)	BR03509	Structure	circa 1964	NRHP Eligible
341	Facility 62980 – Missile Checkout Bldg AK	BR03513	Structure	circa 1962	NRHP Eligible
342	Facility 62990-Missile Checkout Bldg AL	BR03514	Structure	circa 1963	NRHP Eligible

No.	Property Name	FMSF No.	Property Type	Period(s) of Significance	Eligibility Status
333	Facility 62820 – Motor Assembly AG	BR03530	Structure	circa 1962	NRHP Eligible
334	2460 Courtenay Parkway N	BR03955	Structure	circa 1965	NRHP Eligible
335	CCSFS Slide Wire Terminal (F.21900BH)	BR04033	Structure	circa 1968	NRHP Eligible
336	CCSFS LC-34 Blast Wall	BR04034	Structure	circa 1965	NRHP Eligible
337	CCSFS Dual CZR Camera Site (F.21900ZZ)	BR04035	Structure	circa 1961	NRHP Eligible
338	CCSFS Camera Site U191L122 (F 1755)	BR04036	Structure	circa 1957	NRHP Eligible
339	LC-19 Air Vent and Escape Tunnel	BR04181	Structure	circa 1956	NRHP Eligible
340	Imperial Towers	BR04215	Structure	circa 1963	NRHP Listed, 2023-04-19

[a] Denotes historic property in construction area.

Appendix D
Florida Master Site Files

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Facility Number 38105

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Site#8 ______
Field Date ______
Form Date ______
Recorder # ______

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) Electrical Switch Station
Multiple Listing (DHR only) ______
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ______
National Register Category (please check one) ☒building ☐structure ☐district ☐site ☐object
Ownership: ☐private-profit ☐private-nonprofit ☐private-individual ☐private-nonspecific ☐city ☐county ☐state ☒federal ☐Native American ☐foreign ☐unknown

LOCATION & MAPPING

	Street Number	Direction	Street Name	Street Type	Suffix Direction
Address:			Beach	Road	

Cross Streets (nearest / between) ______
USGS 7.5 Map Name CAPE CANAVERAL
USGS Date 2024
Plat or Other Map ______
City / Town (within 3 miles) Cape Canaveral
In City Limits? ☒yes ☐no ☐unknown
County Brevard
Township 22S Range 37E Section ______ ¼ section: ☐NW ☐SW ☐SE ☐NE Irregular-name: ______
Tax Parcel # ______ Landgrant ______
Subdivision Name ______ Block ______ Lot ______
UTM Coordinates: Zone ☐16 ☐17 Easting ______ Northing ______
Other Coordinates: X: 28.5264833333 Y: -80.570608333
Coordinate System & Datum ______
Name of Public Tract (e.g., park) ______

HISTORY

Construction Year: 2000 ☐approximately ☐year listed or earlier ☐year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 2000 To (year): 2024
Current Use Air Force/Army/Navy/Military base From (year): 2000 To (year): 2024
Other Use ______ From (year): ______ To (year): ______
Moves: ☐yes ☒no ☐unknown Date: ______ Original address ______
Alterations: ☐yes ☒no ☐unknown Date: ______ Nature ______
Additions: ☐yes ☒no ☐unknown Date: ______ Nature ______
Architect (last name first): ______ Builder (last name first): ______
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐yes ☒no ☐unknown Describe ______

DESCRIPTION

Style No style
Exterior Plan Rectangular
Number of Stories 1
Exterior Fabric(s) 1. Aluminum 2. ______ 3. ______
Roof Type(s) 1. Flat 2. ______ 3. ______
Roof Material(s) 1. Unspecified 2. ______ 3. ______
Roof secondary strucs. (dormers etc.) 1. ______ 2. ______
Windows (types, materials, etc.)
None

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
NA

DHR USE ONLY — OFFICIAL EVALUATION — DHR USE ONLY

NR List Date ______
☐Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐yes ☐no ☐insufficient info Date ______ Init. ______
KEEPER – Determined eligible: ☐yes ☐no Date ______
NR Criteria for Evaluation: ☐a ☐b ☐c ☐d (see *National Register Bulletin 15*, p. 2)

Florida Master Site File / Div. of Historical Resources / R. A. Gray Bldg / 500 S Bronough St., Tallahassee, FL 32399-0250
Phone **850.245.6440** / Fax **850.245.6439** / E-mail **SiteFile@dos.myflorida.com**

HISTORICAL STRUCTURE FORM

Site #8 ____________

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ____________ 2. ____________
Structural System(s): 1. Metal skeleton 2. ____________ 3. ____________
Foundation Type(s): 1. Slab 2. ____________
Foundation Material(s): 1. Concrete, Generic 2. ____________

Main Entrance (stylistic details)

NA

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐ excellent ☒ good ☐ fair ☐ deteriorated ☐ ruinous

Narrative Description of Resource

Prefabricated metal trailer set on concrete foundation with three sets of metal stairs.

Archaeological Remains ____________ ☐ Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

- ☐ FMSF record search (sites/surveys)
- ☐ library research
- ☐ building permits
- ☐ Sanborn maps
- ☐ FL State Archives/photo collection
- ☐ city directory
- ☐ occupant/owner interview
- ☐ plat maps
- ☐ property appraiser / tax records
- ☐ newspaper files
- ☐ neighbor interview
- ☐ Public Lands Survey (DEP)
- ☒ cultural resource survey (CRAS)
- ☐ historic photos
- ☐ interior inspection
- ☐ HABS/HAER record search
- ☒ other methods (describe) USSF Real Property Records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐ yes ☒ no ☐ insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐ yes ☒ no ☐ insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1.____________ 3.____________ 5.____________
2.____________ 4.____________ 6.____________

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ____________

2) Document type ____________ Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ____________

RECORDER INFORMATION

Recorder Name Jessica R. Wobig Affiliation Jacobs
Recorder Contact Information 216-777-1023/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

1. **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
2. **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
3. **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable). Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

Built in 2000, the Electrical Switch Station, Facility No. 38015, is unrecorded and unevaluated. The structure is associated with Space Launch Complex 37 (SLC-37) and was constructed by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership, for the Delta program. It is a common portable trailer with a concrete foundation and metal stairs lacking architectural style. The structure has a flat roof and rectangular plan and is clad with aluminum siding. The structure rests on a concrete pad. Three sets of metal stairs extend along Beach Road from the front elevation's west, middle, and east end. There are no windows, and the three irregularly spaced openings are filled with cooling units on the front elevation that faces Beach Road. It is in good physical condition.

The structure is laterally to the west of Beach Road, which runs southwest to northeast between Patrol Road and SLC-37 (BR02274). It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west and the Atlantic Ocean to the east.

National Register of Historic Places (NRHP) Evaluation

The structure was constructed for the Delta program, which ULA had operated from SLC-37 from the early 2000s until 2024. Originally built in 1962, SLC-37 was constructed for the Saturn program. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the U.S. Air Force Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17 (Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a).

Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles. It was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California. ULA launched the Delta IV heavy-lift rocket family on April 9, 2024. ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The conclusion of the Delta program marked ULA's 160th mission and its 35th for the National Reconnaissance Office (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The Electric Switch Station, Facility No. 38015 lacks historical significance and thus does not convey any aspects of integrity. It was constructed less than 25 years ago and is not exceptionally significant. It functions as an electrical switch station and is part of common infrastructure. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. The structure is a common utilitarian trailer with no architectural style or notable construction method. The structure is recommended not eligible for listing in the NRHP under Criterion C. The structure does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The structure would not likely yield important information, and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the structure is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. “End of an era: Delta 4 Heavy soars one last time.” *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Ganoung, J.K., and H. Eaton. 1981.”The Delta Launch Vehicle: Past, Present, and Future.” *The Space Congress Proceedings*. https://commons.erau.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2554&context=space-congress-proceedings#:~:text=On%20May%2013%2C%201960%2C%20the,this%20launch%20was%20not%20successful.

Pearlman, Robert Z. 2024. “’ Heavy’ history: ULA Launch final Delta rocket after 64 years.” Space. April 9. https://www.space.com/final-delta-4-heavy-rocket-launch-nrol-70.

Sennott, Stephan, Daniel J. O’Rouke, Andrew B. Orr, and Lynn M. Glerek. 2021. *Historic Building Inventory and evaluation of Space Launch Complexes 37,40, 41, and 46*. Survey Number 27798.

United Launch Alliance (ULA). 2024a. *NROL-70: Celebrating the Legacy of Delta*. March 26. https://blog.ulalaunch.com/blog/nrol-70-celebrating-the-legacy-of-delta.

United Launch Alliance (ULA). 2024b. *Delta IV*. https://www.ulalaunch.com/rockets/delta-iv.

U.S. Space Force Historical Foundation. 2024a. Launch Complex 17. https://ccspacemuseum.org/facilities/launch-complex-17/.

U.S. Space Force Historical Foundation 202b. Launch Complex 37. https://ccspacemuseum.org/facilities/launch-complex-37/.

Figure 1. USGS 7.5' Map with Structure Location

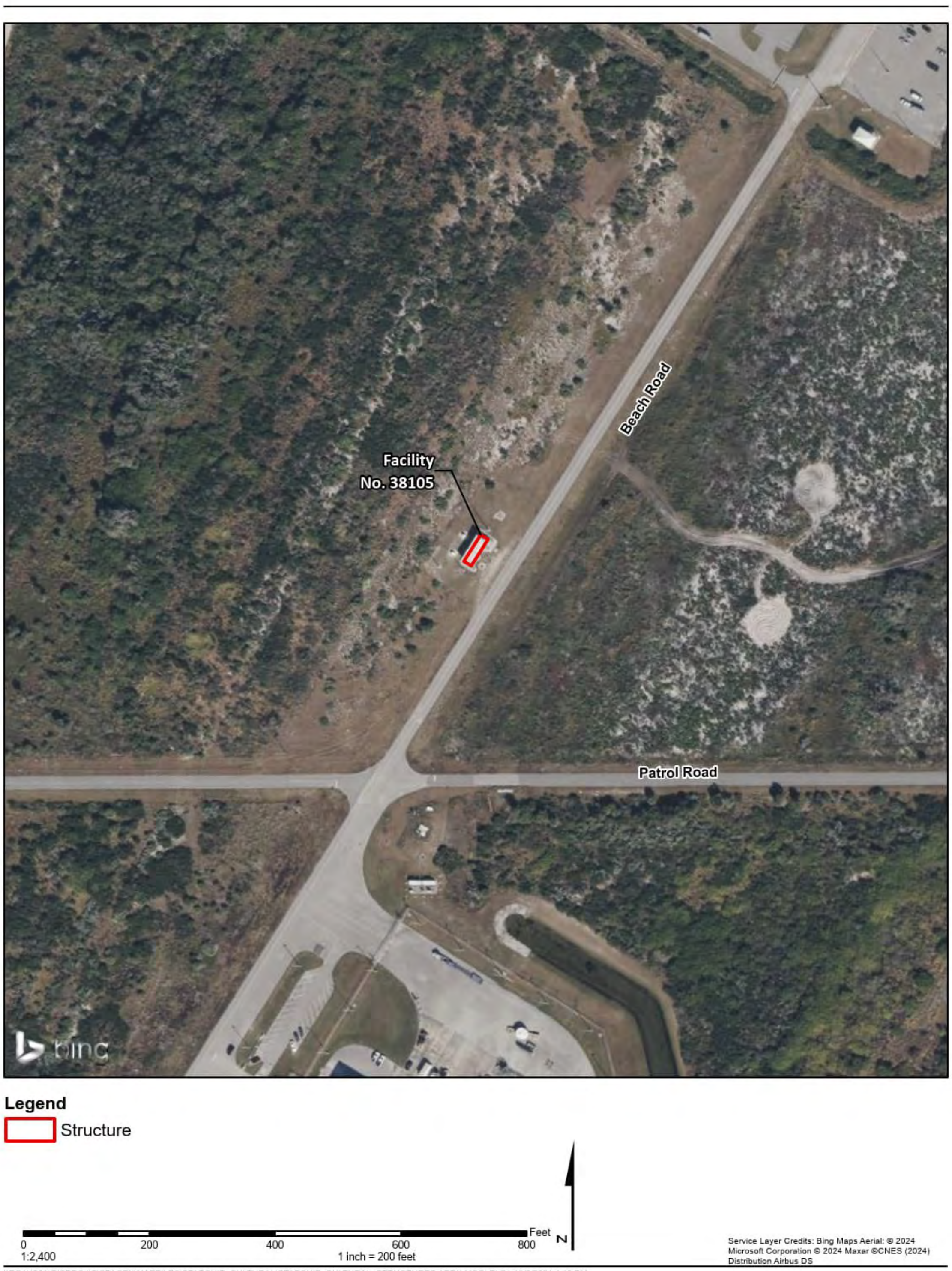

Figure 2. Aerial Street Map with Structure Location


Photograph 1. The Electrical Switch Station, Facility No. 38015 (previously unrecorded) from Beach Road, facing northwest.

Facility Number 38200

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Site#8 ____
Field Date ____
Form Date ____
Recorder # ____

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) Horizontal Integration Facility
Multiple Listing (DHR only) ____
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ____
National Register Category (please check one) ☒building ☐structure ☐district ☐site ☐object
Ownership: ☐private-profit ☐private-nonprofit ☐private-individual ☐private-nonspecific ☐city ☐county ☐state ☒federal ☐Native American ☐foreign ☐unknown

LOCATION & MAPPING

Street Number	Direction	Street Name	Street Type	Suffix Direction
Address:		Beach	Road	

Cross Streets (nearest / between) ____
USGS 7.5 Map Name CAPE CANAVERAL USGS Date 2024 Plat or Other Map ____
City / Town (within 3 miles) Cape Canaveral In City Limits? ☒yes ☐no ☐unknown County Brevard
Township 23S Range 38E Section ____ ¼ section: ☐NW ☐SW ☐SE ☐NE Irregular-name: ____
Tax Parcel # ____ Landgrant ____
Subdivision Name ____ Block ____ Lot ____
UTM Coordinates: Zone ☐16 ☐17 Easting ____ Northing ____
Other Coordinates: X: 28.5237583333 Y: -80.57142777 Coordinate System & Datum ____
Name of Public Tract (e.g., park) ____

HISTORY

Construction Year: 2000 ☐approximately ☐year listed or earlier ☐year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 2000 To (year): 2024
Current Use Air Force/Army/Navy/Military base From (year): 2000 To (year): 2024
Other Use ____ From (year): ____ To (year): ____
Moves: ☐yes ☒no ☐unknown Date: ____ Original address ____
Alterations: ☐yes ☒no ☐unknown Date: ____ Nature ____
Additions: ☐yes ☒no ☐unknown Date: ____ Nature ____
Architect (last name first): ____ Builder (last name first): ____
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐yes ☒no ☐unknown Describe ____

DESCRIPTION

Style No style Exterior Plan Other Number of Stories 1
Exterior Fabric(s) 1. Metal 2. ____ 3. ____
Roof Type(s) 1. Other 2. ____ 3. ____
Roof Material(s) 1. Other 2. ____ 3. ____
Roof secondary strucs. (dormers etc.) 1. ____ 2. ____
Windows (types, materials, etc.)
Metal continous sill casement windows on front elevation

Distinguishing Architectural Features (exterior or interior ornaments)
Large overhead rolling doors and level concrete assembly floor

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
See continuation sheet

DHR USE ONLY OFFICIAL EVALUATION DHR USE ONLY

NR List Date ____
☐Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐yes ☐no ☐insufficient info Date ____ Init. ____
KEEPER – Determined eligible: ☐yes ☐no Date ____
NR Criteria for Evaluation: ☐a ☐b ☐c ☐d (see *National Register Bulletin 15*, p. 2)

HISTORICAL STRUCTURE FORM

Site #8 ____________

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ____________ 2. ____________
Structural System(s): 1. Metal skeleton 2. ____________ 3. ____________
Foundation Type(s): 1. Slab 2. ____________
Foundation Material(s): 1. Concrete, Generic 2. ____________
Main Entrance (stylistic details)

Protruding, metal hipped covered entrance with simple concrete column supports

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐ excellent ☒ good ☐ fair ☐ deteriorated ☐ ruinous

Narrative Description of Resource

See continuation sheet

Archaeological Remains ____________ ☐ Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

☐ FMSF record search (sites/surveys)
☐ FL State Archives/photo collection
☐ property appraiser / tax records
☒ cultural resource survey (CRAS)
☐ library research
☐ city directory
☐ newspaper files
☐ historic photos
☐ building permits
☐ occupant/owner interview
☐ neighbor interview
☐ interior inspection
☐ Sanborn maps
☐ plat maps
☐ Public Lands Survey (DEP)
☐ HABS/HAER record search
☒ other methods (describe) CCSFS real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐ yes ☒ no ☐ insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐ yes ☒ no ☐ insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1. ____________ 3. ____________ 5. ____________
2. ____________ 4. ____________ 6. ____________

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs Maintaining organization Jacobs
Document description ArcGIS Field Collector photograp File or accession #'s ____________

2) Document type Field notes Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ____________

RECORDER INFORMATION

Recorder Name Jessica R. Wobig Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
❷ **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
❸ **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description
Built in 2000, the Horizontal Integration Facility, Facility 38200, is unrecorded and evaluated. It is associated with Space Launch Complex 37 (SLC-37) and was constructed by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership, for the Delta program. The five-bay building features a multiple-roof configuration and an irregular plan. It is metal construction with a concrete slab foundation. The front elevation faces northwest onto Beach Road. The front elevation is a single-story building with five bays and a single-bay, off-center entrance. Along the upper portion of the front elevation are two sets of metal continuous sill casement windows on the first three bays, followed by a single window and single door balcony on the fourth bay, and no openings on the fifth bay. At the ground level of the front elevation, there is an off-center covered entrance with a hipped metal roof set on simple columns that protrude to the west, followed by several double-leaf doors at each bay and no window openings. Behind the front elevation is a multi-story central block with a low-pitched gable roof that runs laterally to the front elevation. There are no openings on the upper level of the central block. At the ground level, two over-scaled overhead rolling doors on the north and south elevations are used to load and unload rocket boosters and components. A lower block with a flat roof extends east of the central block. The east wing has over-scaled rolling overhead doors on the north and south elevations with a single-leaf security door at the corner and a central balcony with a fire escape above a single-leaf security door on the ground level along the east elevation. The exterior is clad in vertical metal panels, and the roof is rolled aluminum. The interior space is primarily open for rocket assembly and has a poured concrete level floor. There is a sign on the assembly floor noting the precision of the floor required for assembly. It is in good physical condition.

The structure is laterally along the east side of Beach Road, which runs southwest to northeast between Patrol Road and SLC-37 (BR02274). It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west and the Atlantic Ocean to the east.

National Register of Historic Places (NRHP) Evaluation
The building was constructed for the Delta program, which ULA had operated from SLC-37 from the early 2000s until 2024. SLC-37 was originally constructed for the Saturn program in 1962. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the U.S. Air Force Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17 (Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a).

Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles. It was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California. ULA launched the final Delta IV heavy-lift rocket family on April 9, 2024. ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The conclusion of the Delta program marked ULA’s 160th mission and its 35th for the National Reconnaissance Office (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The Horizontal Integration Facility, Facility 38200, is a utilitarian structure that lacks architectural style and is not notable for its engineering or construction methods. The structure's interior was built with a level floor designed for the necessary precision needed for assembly. Although the interior construction is specific to the facility type, it was constructed less than 25 years ago and is not exceptionally significant. It functioned as an assembly building associated with SLC-37. SLC-37 was reactivated by 2000 after being mothballed in the 1970s and supported the Delta program, with Delta launches occurring elsewhere at CCSFS and Vandenberg Space Force Station in Santa Barbara, California. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the building shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. The building is a utilitarian metal building, lacking an architectural style or notable construction method. Though the interior floor was designed for rocket assembly, it is not the only assembly building at CCSFS and is neither rare nor exceptional in its construction. The building is recommended not eligible for listing in the NRHP under Criterion C. The building does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The rockets and their material history convey significant activities associated with space launches. Space Launch Delta 45 (SLD 45) maintains a comprehensive cultural resources management program. This program involves historical documentation of launch complexes and publicly accessible information available through the Cape Canaveral Space Force Museum and other repositories. The building would not likely yield important information that is not otherwise already retained in documentation retained by SLD 45, and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Ganoung, J.K., and H. Eaton. 1981."The Delta Launch Vehicle: Past, Present, and Future." *The Space Congress Proceedings*. https://commons.erau.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2554&context=space-congress-proceedings#:~:text=On%20May%2013%2C%201960%2C%20the,this%20launch%20was%20not%20successful.

Pearlman, Robert Z. 2024. "' Heavy' history: ULA Launch final Delta rocket after 64 years." Space. April 9. https://www.space.com/final-delta-4-heavy-rocket-launch-nrol-70.

Sennott, Stephan, Daniel J. O'Rouke, Andrew B. Orr, and Lynn M. Glerek. 2021. *Historic Building Inventory and evaluation of Space Launch Complexes 37,40, 41, and 46*. Survey Number 27798.

United Launch Alliance (ULA). 2024a. *NROL-70: Celebrating the Legacy of Delta*. March 26. https://blog.ulalaunch.com/blog/nrol-70-celebrating-the-legacy-of-delta.

United Launch Alliance (ULA). 2024b. *Delta IV*. https://www.ulalaunch.com/rockets/delta-iv.

U.S. Space Force Historical Foundation. 2024a. Launch Complex 17. https://ccspacemuseum.org/facilities/launch-complex-17/.

U.S. Space Force Historical Foundation 202b. Launch Complex 37. https://ccspacemuseum.org/facilities/launch-complex-37/.

Figure 1. USGS 7.5' Map with Structure Location

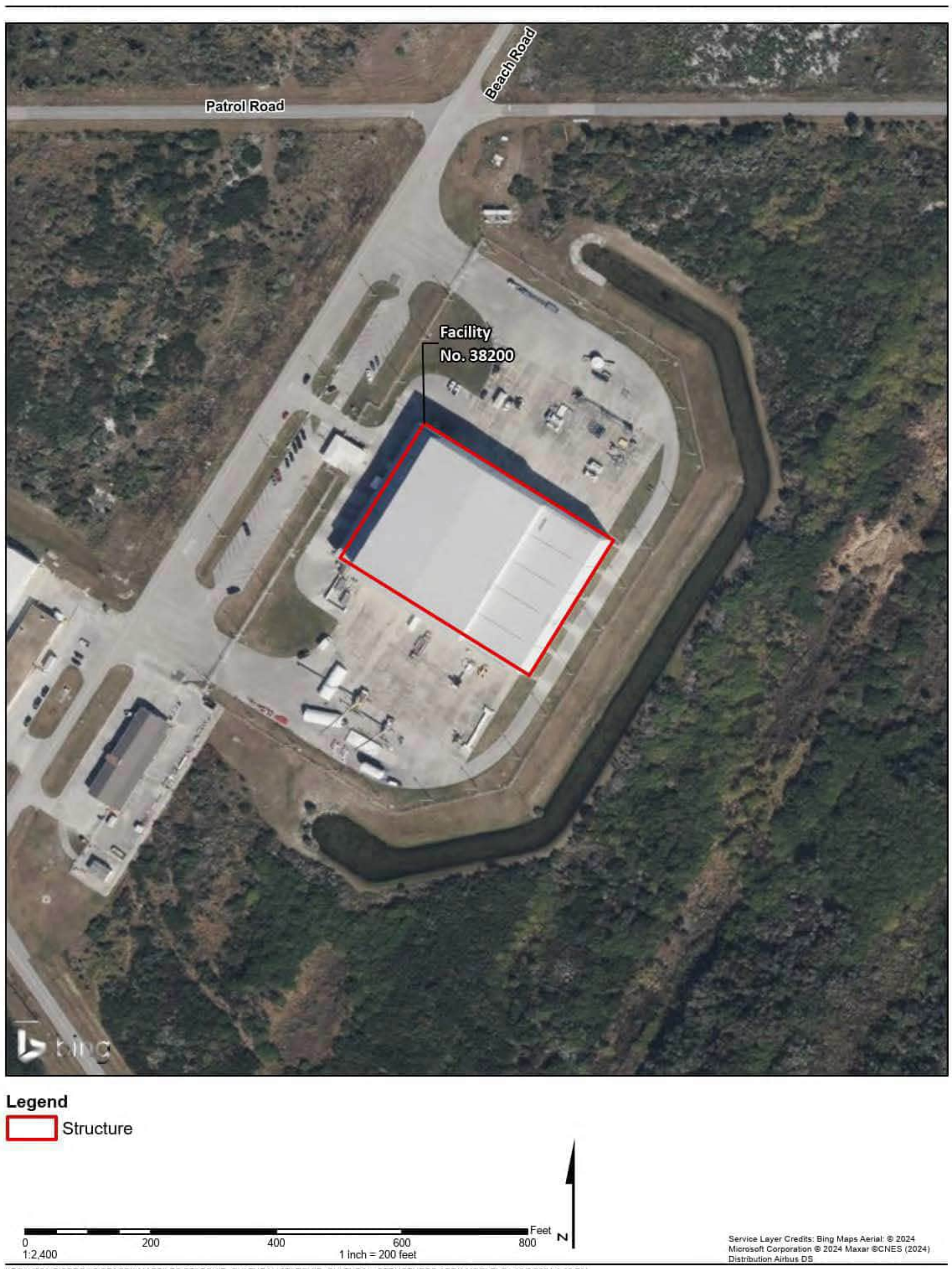

Figure 2. Aerial Street Map with Structure Location

Photograph 1. The Horizontal Integration Facility, Facility 38200 (previously unrecorded) from Beach Road with SLC-37 in distance, facing northeast.

Facility Number 38201

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM

FLORIDA MASTER SITE FILE

Version 5.0 3/19

Site#8 ____
Field Date ____
Form Date ____
Recorder # ____

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) Security Entry Control Building
Multiple Listing (DHR only) ____
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ____
National Register Category (please check one) ☒ building ☐ structure ☐ district ☐ site ☐ object
Ownership: ☐ private-profit ☐ private-nonprofit ☐ private-individual ☐ private-nonspecific ☐ city ☐ county ☐ state ☒ federal ☐ Native American ☐ foreign ☐ unknown

LOCATION & MAPPING

	Street Number	Direction	Street Name	Street Type	Suffix Direction
Address:			Beach	Road	

Cross Streets (nearest / between) ____
USGS 7.5 Map Name CAPE CANAVERAL
USGS Date 2024
Plat or Other Map ____
City / Town (within 3 miles) Cape Canaveral
In City Limits? ☒ yes ☐ no ☐ unknown
County Brevard
Township 23S Range 38E Section ____ ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE Irregular-name: ____
Tax Parcel # ____ Landgrant ____
Subdivision Name ____ Block ____ Lot ____
UTM Coordinates: Zone ☐ 16 ☐ 17 Easting ____ Northing ____
Other Coordinates: X: 28.5240027778 Y: -80.57163055 Coordinate System & Datum ____
Name of Public Tract (e.g., park) ____

HISTORY

Construction Year: 2000 ☐ approximately ☐ year listed or earlier ☐ year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 2000 To (year): 2024
Current Use Air/Bus/Rail terminal or depot From (year): 2000 To (year): 2024
Other Use ____ From (year): ____ To (year): ____
Moves: ☐ yes ☒ no ☐ unknown Date: ____ Original address ____
Alterations: ☐ yes ☒ no ☐ unknown Date: ____ Nature ____
Additions: ☐ yes ☒ no ☐ unknown Date: ____ Nature ____
Architect (last name first): ____ Builder (last name first): ____
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐ yes ☒ no ☐ unknown Describe ____

DESCRIPTION

Style No style
Exterior Plan L-shaped
Number of Stories 1
Exterior Fabric(s) 1. Block-concrete 2. ____ 3. ____
Roof Type(s) 1. Hip 2. ____ 3. ____
Roof Material(s) 1. Sheet metal:standing seam 2. ____ 3. ____
Roof secondary strucs. (dormers etc.) 1. ____ 2. ____
Windows (types, materials, etc.)
Fixed glass windows near front elevation

Distinguishing Architectural Features (exterior or interior ornaments)
Cantilever overhang with exposed metal structural members and concrete column supports

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
NA

DHR USE ONLY **OFFICIAL EVALUATION** **DHR USE ONLY**

NR List Date ____ ☐ Owner Objection	SHPO – Appears to meet criteria for NR listing: ☐ yes ☐ no ☐ insufficient info Date ____ Init. ____ KEEPER – Determined eligible: ☐ yes ☐ no Date ____ NR Criteria for Evaluation: ☐ a ☐ b ☐ c ☐ d (see *National Register Bulletin 15*, p. 2)

Florida Master Site File / Div. of Historical Resources / R. A. Gray Bldg / 500 S Bronough St., Tallahassee, FL 32399-0250
Phone **850.245.6440** / Fax **850.245.6439** / E-mail **SiteFile@dos.myflorida.com**

HISTORICAL STRUCTURE FORM

Site #8 ______

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ______ 2. ______
Structural System(s): 1. Concrete block 2. ______ 3. ______
Foundation Type(s): 1. Slab 2. ______
Foundation Material(s): 1. Concrete Block 2. ______

Main Entrance (stylistic details)

L-plan covered security entrance and guard house

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐excellent ☒good ☐fair ☐deteriorated ☐ruinous

Narrative Description of Resource

See continuation sheet

Archaeological Remains ______ ☐Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

☐FMSF record search (sites/surveys)
☐FL State Archives/photo collection
☐property appraiser / tax records
☒cultural resource survey (CRAS)
☐library research
☐city directory
☐newspaper files
☐historic photos
☐building permits
☐occupant/owner interview
☐neighbor interview
☐interior inspection
☐Sanborn maps
☐plat maps
☐Public Lands Survey (DEP)
☐HABS/HAER record search
☒other methods (describe) CCSFS real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐yes ☒no ☐insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐yes ☒no ☐insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1.______ 3.______ 5.______
2.______ 4.______ 6.______

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ______

2) Document type Field notes Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ______

RECORDER INFORMATION

Recorder Name Jessica R.Wobig Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
❷ **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
❸ **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

Built in 2000, the Security Entry Control Building, Facility 38201, is unrecorded and unevaluated. The building is associated with Space Launch Complex 37 (SLC-37) and was constructed by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership, for the Delta program. It is a simple concrete block building with a low-pitched hipped metal cantilever roof set on concrete column supports lacking architectural style. The L-plan building has standing seam metal roofing with metal flashing and a gutter system. The roof system has exposed metal structural members and simple concrete column supports. The grey-toned concrete block is rough cut and assembled in running bond. There are a few fixed glass windows on the front elevation and front corners of the building and two security doors on the west elevation. Electrical and cooling units on rear and side elevations. It is in good physical condition.

The building fronts onto the east side of Beach Road, which runs southwest to northeast between Patrol Road and SLC-37 (BR02274). It is a security entrance for the Horizontal Integration Facility, Facility 38200, located to the south within a fenced area. It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west, and the Atlantic Ocean is located to the east.

National Register of Historic Places (NRHP) Evaluation

The building was constructed for the Delta program, which ULA had operated from SLC-37 from the early 2000s until 2024. Built in 1962, SLC-37 was initially constructed for the Saturn program. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the U.S. Air Force Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17 (Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a).

Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles. It was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California. ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket and launched the final Delta IV heavy-lift rocket family on April 9, 2024. The conclusion of the Delta program marked ULA's 160th mission and its 35th for the National Reconnaissance Office (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The Security Entry Control Building, Facility 38201, lacks historical significance and thus does not convey any aspects of integrity. It was constructed less than 25 years ago and is not exceptionally significant. It functions as a security entrance for the Horizontal Integration Facility, Facility 38200, and is a support facility. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. It is a common concrete block building with a metal roof and no architectural style or notable construction method. The building is recommended not eligible for listing in the NRHP under Criterion C. The building does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The building would not likely yield important information and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Ganoung, J.K., and H. Eaton. 1981."The Delta Launch Vehicle: Past, Present, and Future." *The Space Congress Proceedings*. https://commons.erau.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2554&context=space-congress-proceedings#:~:text=On%20May%2013%2C%201960%2C%20the,this%20launch%20was%20not%20successful.

Pearlman, Robert Z. 2024. "' Heavy' history: ULA Launch final Delta rocket after 64 years." Space. April 9. https://www.space.com/final-delta-4-heavy-rocket-launch-nrol-70.

Sennott, Stephan, Daniel J. O'Rouke, Andrew B. Orr, and Lynn M. Glerek. 2021. *Historic Building Inventory and evaluation of Space Launch Complexes 37,40, 41, and 46*. Survey Number 27798.

United Launch Alliance (ULA). 2024a. *NROL-70: Celebrating the Legacy of Delta*. March 26. https://blog.ulalaunch.com/blog/nrol-70-celebrating-the-legacy-of-delta.

United Launch Alliance (ULA). 2024b. *Delta IV*. https://www.ulalaunch.com/rockets/delta-iv.

U.S. Space Force Historical Foundation. 2024a. Launch Complex 17. https://ccspacemuseum.org/facilities/launch-complex-17/.

U.S. Space Force Historical Foundation 202b. Launch Complex 37. https://ccspacemuseum.org/facilities/launch-complex-37/.

Figure 1. USGS 7.5' Map with Structure Location

Figure 2. Aerial Street Map with Structure Location

Photograph 1. Security Entry Control Building, Facility 38201 (previously unrecorded) from Horizontal Integration Facility, Facility 38200 parking area to Beach Road, facing northwest.

Facility Number 38315

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Site#8 BR04028
Field Date
Form Date
Recorder #

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) AF Warehouse II
Multiple Listing (DHR only)
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only)
National Register Category (please check one) ☒building ☐structure ☐district ☐site ☐object
Ownership: ☐private-profit ☐private-nonprofit ☐private-individual ☐private-nonspecific ☐city ☐county ☐state ☒federal ☐Native American ☐foreign ☐unknown

LOCATION & MAPPING

Address:	Street Number	Direction	Street Name	Street Type	Suffix Direction
			Beach	Road	

Cross Streets (nearest / between)
USGS 7.5 Map Name CAPE CANAVERAL USGS Date 2024 Plat or Other Map
City / Town (within 3 miles) Cape Canaveral In City Limits? ☒yes ☐no ☐unknown County Brevard
Township 23S Range 38E Section ¼ section: ☐NW ☐SW ☐SE ☐NE Irregular-name:
Tax Parcel #
Landgrant
Subdivision Name Block Lot
UTM Coordinates: Zone ☐16 ☐17 Easting Northing
Other Coordinates: X: 28.5226166667 Y: -80.572711111 Coordinate System & Datum
Name of Public Tract (e.g., park)

HISTORY

Construction Year: 1963 ☐approximately ☐year listed or earlier ☐year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 1963 To (year): 1969
Current Use Air Force/Army/Navy/Military base From (year): 1999 To (year): 2024
Other Use Abandoned/Vacant From (year): 1969 To (year): 1999
Moves: ☐yes ☒no ☐unknown Date: Original address
Alterations: ☐yes ☒no ☐unknown Date: Nature
Additions: ☐yes ☒no ☐unknown Date: Nature
Architect (last name first): Builder (last name first):
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐yes ☒no ☐unknown Describe

DESCRIPTION

Style No style Exterior Plan Rectangular Number of Stories 1
Exterior Fabric(s) 1. Aluminum 2. 3.
Roof Type(s) 1. Gable 2. 3.
Roof Material(s) 1. Asphalt shingles 2. Sheet metal:standing seam 3.
Roof secondary strucs. (dormers etc.) 1. 2.
Windows (types, materials, etc.)
NA

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
NA

DHR USE ONLY OFFICIAL EVALUATION DHR USE ONLY

NR List Date

☐Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐yes ☐no ☐insufficient info Date Init.
KEEPER – Determined eligible: ☐yes ☐no Date
NR Criteria for Evaluation: ☐a ☐b ☐c ☐d (see *National Register Bulletin 15*, p. 2)

Florida Master Site File / Div. of Historical Resources / R. A. Gray Bldg / 500 S Bronough St., Tallahassee, FL 32399-0250
Phone **850.245.6440** / Fax **850.245.6439** / E-mail **SiteFile@dos.myflorida.com**

HISTORICAL STRUCTURE FORM

Site #8 BR04028

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ____ 2. ____
Structural System(s): 1. Metal skeleton 2. ____ 3. ____
Foundation Type(s): 1. Slab 2. ____
Foundation Material(s): 1. Concrete, Generic 2. ____

Main Entrance (stylistic details)

Hood and stoop, single-leaf security door

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐ excellent ☒ good ☐ fair ☐ deteriorated ☐ ruinous

Narrative Description of Resource

See continuation sheet

Archaeological Remains ____ ☐ Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

☒ FMSF record search (sites/surveys)
☐ library research
☐ building permits
☐ Sanborn maps
☐ FL State Archives/photo collection
☐ city directory
☐ occupant/owner interview
☐ plat maps
☐ property appraiser / tax records
☐ newspaper files
☐ neighbor interview
☐ Public Lands Survey (DEP)
☒ cultural resource survey (CRAS)
☐ historic photos
☐ interior inspection
☐ HABS/HAER record search
☒ other methods (describe) CCSFS real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐ yes ☒ no ☐ insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐ yes ☒ no ☐ insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1. ____ 3. ____ 5. ____
2. ____ 4. ____ 6. ____

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ____

2) Document type Field notes — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ____

RECORDER INFORMATION

Recorder Name Jessica R. Wobig — Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
❷ **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
❸ **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

Built in 1963, the AF Warehouse II, Facility 38315, is previously recorded as FMSF No. BR4028 and is unevaluated for listing in the National Register of Historic Places (NRHP). The building is associated with Space Launch Complex 37 (SLC-37) and was initially constructed by the U.S. Air Force (USAF) for the Saturn program. The two-bay shed features a gable roof and a rectangular plan. It is made of metal construction with an asphalt shingle roof and a metal gutter system. The building has a single-leaf security door and an overhead rolling door on the north and south elevations. A full-length shed roof extension with a standing seam metal roof and metal supports is located along the east elevation. Three single-leaf security doors with awnings are equally spaced along the west elevation, which faces onto Beach Road. There are no windows. It is in good physical condition.

The structure is laterally along the east side of Beach Road, which runs southwest to northeast between Patrol Road and SLC-37 (BR02274). It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west and the Atlantic Ocean to the east.

NRHP Evaluation

The building was constructed for the Saturn program, which operated from SLC-37 from 1962 until 1969. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999 by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership. ULA repurposed the complex to support the Delta program by 2000. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the USAF Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17 (Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a).

Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles. It was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California. On April 9, 2024, ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The conclusion of the Delta program marked ULA's 160th mission and its 35th for the National Reconnaissance Office (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The AF Warehouse II, Facility 38315 (FMSF No. BR4028), is a utilitarian structure erected for significant programs in the history of CCSFS but was used for ancillary storage. Because the building was constructed during the Cold War era (1945 to 1991), this eligibility recommendation applied guidance available in the existing historical context and NRHP registration requirements (NPS 1984; Van Critters 2015; Hampton et al. 2012; Salmon 2022; Hoffecker et al. 1996). As a warehouse, the building does not share an association with a significant event or contribute to broad thematic associations important to the past. Although the warehouse may have stored technology and equipment, the building is not associated with direct space exploration or engineering achievements completed elsewhere at CCSFS, such as at NRHP-eligible launch complexes. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. The building is a common utilitarian warehouse with no architectural style or notable construction method. The building is recommended not eligible for listing in the NRHP under Criterion C. The building does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The building would not likely yield important information and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Ganoung, J.K., and H. Eaton. 1981."The Delta Launch Vehicle: Past, Present, and Future." *The Space Congress Proceedings*. https://commons.erau.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2554&context=space-congress-proceedings#:~:text=On%20May%2013%2C%201960%2C%20the,this%20launch%20was%20not%20successful.

Hampton, Roy, Maria Burkett, and Christina Trebellas. 2012. *Historic Context for Evaluating Mid-Century Modern Military Buildings. Project Number 11-448*. Department of Defense Legacy Resource Management Program. https://www.denix.osd.mil/legacy/denix-files/sites/33/2022/01/Historic-Context-for-Evaluating-Mid-Century-Modern-Military-Buildings-Report-2012-Legacy-11-448.pdf.

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National Park Service (NPS). 1984. *National Register of Historic Places Nomination Form, Cape Canaveral Air Force Station*. Revised. U.S. Department of the Interior. https://catalog.archives.gov/id/77841869.

Pearlman, Robert Z. 2024. "' Heavy' history: ULA Launch final Delta rocket after 64 years." Space. April 9. https://www.space.com/final-delta-4-heavy-rocket-launch-nrol-70.

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U.S. Space Force Historical Foundation 202b. Launch Complex 37. https://ccspacemuseum.org/facilities/launch-complex-37/.

Van Critters, Historic Preservation, LLC (Van Critters). 2015. *Programmatic Approaches to the Management of Cold War Historic Properties*. Department of Defense. https://www.denix.osd.mil/cr/denix-files/sites/19/2016/03/01_Programmatic-Approaches-to-the-Management-of-Cold-War.pdf.

Figure 1. USGS 7.5' Map with Structure Location

Figure 2. Aerial Street Map with Structure Location

Photograph 1. The AF Warehouse II, Facility 38315 (FMSF No. BR04028) from the parking lot with the Delta IV Precision Clean Lab, Facility 43400 (FMSF No. BR04029) in the distance, facing north.

Facility Number 38316

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site#8 ____
Field Date ____
Form Date ____
Recorder # ____

Site Name(s) (address if none) Hazardous Storage
Multiple Listing (DHR only) ____
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ____
National Register Category (please check one) ☒ building ☐ structure ☐ district ☐ site ☐ object
Ownership: ☐ private-profit ☐ private-nonprofit ☐ private-individual ☐ private-nonspecific ☐ city ☐ county ☐ state ☒ federal ☐ Native American ☐ foreign ☐ unknown

LOCATION & MAPPING

	Street Number	Direction	Street Name	Street Type	Suffix Direction
Address:			Beach	Road	

Cross Streets (nearest / between) ____
USGS 7.5 Map Name CAPE CANAVERAL
USGS Date 2024
Plat or Other Map ____
City / Town (within 3 miles) Cape Canaveral
In City Limits? ☒ yes ☐ no ☐ unknown
County Brevard
Township 23S
Range 38E
Section ____
¼ section: ☐ NW ☐ SW ☐ SE ☐ NE
Irregular-name: ____
Tax Parcel # ____
Landgrant ____
Subdivision Name ____
Block ____
Lot ____
UTM Coordinates: Zone ☐ 16 ☐ 17 Easting ____ Northing ____
Other Coordinates: X: 28.522175 Y: -80.572844444
Coordinate System & Datum ____
Name of Public Tract (e.g., park) ____

HISTORY

Construction Year: 1997 ☐ approximately ☐ year listed or earlier ☐ year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 1997 To (year): 2024
Current Use Air Force/Army/Navy/Military base From (year): 1997 To (year): 2024
Other Use ____ From (year): ____ To (year): ____
Moves: ☐ yes ☒ no ☐ unknown Date: ____ Original address ____
Alterations: ☐ yes ☒ no ☐ unknown Date: ____ Nature ____
Additions: ☐ yes ☒ no ☐ unknown Date: ____ Nature ____
Architect (last name first): ____
Builder (last name first): ____
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐ yes ☒ no ☐ unknown Describe ____

DESCRIPTION

Style No style
Exterior Plan Rectangular
Number of Stories ____
Exterior Fabric(s) 1. Concrete 2. ____ 3. ____
Roof Type(s) 1. Flat 2. ____ 3. ____
Roof Material(s) 1. Other 2. ____ 3. ____
Roof secondary strucs. (dormers etc.) 1. ____ 2. ____
Windows (types, materials, etc.)
None

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
NA

DHR USE ONLY **OFFICIAL EVALUATION** **DHR USE ONLY**

NR List Date ____
☐ Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐ yes ☐ no ☐ insufficient info Date ____ Init. ____
KEEPER – Determined eligible: ☐ yes ☐ no Date ____
NR Criteria for Evaluation: ☐ a ☐ b ☐ c ☐ d (see *National Register Bulletin 15*, p. 2)

HISTORICAL STRUCTURE FORM

Site #8 ____________

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ______________ 2. ______________
Structural System(s): 1. Concrete block 2. ______________ 3. ______________
Foundation Type(s): 1. Slab 2. ______________
Foundation Material(s): 1. Concrete, Generic 2. ______________

Main Entrance (stylistic details)

NA

Porch Descriptions (types, locations, roof types, etc.)

None

Condition (overall resource condition): ☐excellent ☐good ☐fair ☐deteriorated ☐ruinous

Narrative Description of Resource

Two-bay concrete block shed with metal double-leaf security doors.

Archaeological Remains ______________ ☐Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

- ☐FMSF record search (sites/surveys)
- ☐FL State Archives/photo collection
- ☐property appraiser / tax records
- ☒cultural resource survey (CRAS)
- ☐library research
- ☐city directory
- ☐newspaper files
- ☐historic photos
- ☐building permits
- ☐occupant/owner interview
- ☐neighbor interview
- ☐interior inspection
- ☐Sanborn maps
- ☐plat maps
- ☐Public Lands Survey (DEP)
- ☐HABS/HAER record search
- ☒other methods (describe) USSF real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐yes ☒no ☐insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐yes ☒no ☐insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1. ______________ 3. ______________ 5. ______________
2. ______________ 4. ______________ 6. ______________

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ______________

2) Document type Field notes Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ______________

RECORDER INFORMATION

Recorder Name Jessica R. Wobig Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED
❷ LARGE SCALE STREET, PLAT OR PARCEL MAP (available from most property appraiser web sites)
❸ PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

Built in 1997, the Hazardous Storage, Facility 38316 is unrecorded and evaluated. The structure is associated with Space Launch Complex 37 (SLC-37) and was constructed by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership, for the Delta program. The two-bay shed features a flat roof and a rectangular plan. It is concrete block construction with a metal roof and gutter system. The front elevation faces northwest onto Beach Road. It features two sets of double-leaf metal security doors. The rear elevation has a single-leaf metal security door near the southeastern corner. There are no windows. It is in good physical condition.

The structure is laterally along the east side of Beach Road, which runs southwest to northeast between Patrol Road and SLC-37 (BR02274). It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west and the Atlantic Ocean to the east.

National Register of Historic Places (NRHP) Evaluation

The structure was constructed in anticipation of the Delta program, which ULA had operated from SLC-37 from the early 2000s until 2024. Built in 1962, SLC-37 was originally constructed for the Saturn program. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the U.S. Air Force Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17 (Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a).

Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles. It was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California. ULA launched the final Delta IV heavy-lift rocket on April 9, 2024, as it sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The conclusion of the Delta program marked ULA's 160th mission and its 35th for the National Reconnaissance Office (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The Hazardous Storage structure, Facility No. 38316, is a utilitarian structure that lacks historical significance and thus does not convey any aspects of integrity. It lacks architectural style and is not notable for its engineering or construction methods. It was constructed less than 27 years ago and is not exceptionally significant. It functions as a hazardous storage area and is part of common infrastructure. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under

Criterion B. The structure is a common utilitarian shed with no architectural style or notable construction method. The structure is recommended not eligible for listing in the NRHP under Criterion C. The structure does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The structure would not likely yield important information, and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the structure is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Ganoung, J.K., and H. Eaton. 1981."The Delta Launch Vehicle: Past, Present, and Future." *The Space Congress Proceedings*. https://commons.erau.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2554&context=space-congress-proceedings#:~:text=On%20May%2013%2C%201960%2C%20the,this%20launch%20was%20not%20successful.

Pearlman, Robert Z. 2024. "' Heavy' history: ULA Launch final Delta rocket after 64 years." Space. April 9. https://www.space.com/final-delta-4-heavy-rocket-launch-nrol-70.

Sennott, Stephan, Daniel J. O'Rouke, Andrew B. Orr, and Lynn M. Glerek. 2021. *Historic Building Inventory and evaluation of Space Launch Complexes 37,40, 41, and 46*. Survey Number 27798.

United Launch Alliance (ULA). 2024a. *NROL-70: Celebrating the Legacy of Delta*. March 26. https://blog.ulalaunch.com/blog/nrol-70-celebrating-the-legacy-of-delta.

United Launch Alliance (ULA). 2024b. *Delta IV*. https://www.ulalaunch.com/rockets/delta-iv.

U.S. Space Force Historical Foundation. 2024a. Launch Complex 17. https://ccspacemuseum.org/facilities/launch-complex-17/.

U.S. Space Force Historical Foundation 202b. Launch Complex 37. https://ccspacemuseum.org/facilities/launch-complex-37/.

Figure 1. USGS 7.5' Map with Structure Location

Figure 2. Aerial Street Map with Structure Location


Photograph 1. Hazardous Storage, Facility No. 34316 (previously unrecorded) from Beach Road, facing southeast.

Facility Number 43302

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Site#8 BR4030
Field Date
Form Date
Recorder #

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) Delta IV Warehouse
Multiple Listing (DHR only)
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only)
National Register Category (please check one) ☒ building ☐ structure ☐ district ☐ site ☐ object
Ownership: ☐ private-profit ☐ private-nonprofit ☐ private-individual ☐ private-nonspecific ☐ city ☐ county ☐ state ☒ federal ☐ Native American ☐ foreign ☐ unknown

LOCATION & MAPPING

Address:	Street Number	Direction	Street Name	Street Type	Suffix Direction
			Beach	Road	

Cross Streets (nearest / between)
USGS 7.5 Map Name CAPE CANAVERAL USGS Date 2024 Plat or Other Map
City / Town (within 3 miles) Cape Canaveral In City Limits? ☒ yes ☐ no ☐ unknown County Brevard
Township 23S Range 37E Section ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE Irregular-name:
Tax Parcel # Landgrant
Subdivision Name Block Lot
UTM Coordinates: Zone ☐ 16 ☐ 17 Easting Northing
Other Coordinates: X: 28.5250361111 Y: -80.575675 Coordinate System & Datum
Name of Public Tract (e.g., park)

HISTORY

Construction Year: 1963 ☐ approximately ☐ year listed or earlier ☐ year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 1963 To (year): 2024
Current Use Air Force/Army/Navy/Military base From (year): 1963 To (year): 2024
Other Use From (year): To (year):
Moves: ☐ yes ☒ no ☐ unknown Date: Original address
Alterations: ☒ yes ☐ no ☐ unknown Date: Nature Window infill
Additions: ☐ yes ☒ no ☐ unknown Date: Nature
Architect (last name first): Builder (last name first):
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐ yes ☒ no ☐ unknown Describe

DESCRIPTION

Style No style Exterior Plan Rectangular Number of Stories 1
Exterior Fabric(s) 1. Block-concrete 2. 3.
Roof Type(s) 1. Flat 2. 3.
Roof Material(s) 1. Composition roll 2. 3.
Roof secondary strucs. (dormers etc.) 1. 2.
Windows (types, materials, etc.)
NA

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
See continuation sheet

DHR USE ONLY **OFFICIAL EVALUATION** **DHR USE ONLY**

NR List Date
☐ Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐ yes ☐ no ☐ insufficient info Date Init.
KEEPER – Determined eligible: ☐ yes ☐ no Date
NR Criteria for Evaluation: ☐ a ☐ b ☐ c ☐ d (see *National Register Bulletin 15*, p. 2)

HISTORICAL STRUCTURE FORM

Site #8 BR4030

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ____ 2. ____

Structural System(s): 1. Concrete block 2. ____ 3. ____

Foundation Type(s): 1. Slab 2. ____

Foundation Material(s): 1. Concrete, Generic 2. ____

Main Entrance (stylistic details)

Hood and stood, flush, single-lead security door

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐excellent ☒good ☐fair ☐deteriorated ☐ruinous

Narrative Description of Resource

See continuation sheet

Archaeological Remains ____ ☐Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

☒FMSF record search (sites/surveys)
☐FL State Archives/photo collection
☐property appraiser / tax records
☒cultural resource survey (CRAS)
☐library research
☐city directory
☐newspaper files
☐historic photos
☐building permits
☐occupant/owner interview
☐neighbor interview
☐interior inspection
☐Sanborn maps
☐plat maps
☐Public Lands Survey (DEP)
☐HABS/HAER record search
☒other methods (describe) CCAFS real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐yes ☒no ☐insufficient information

Appears to meet the criteria for National Register listing as part of a district? ☐yes ☒no ☐insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1.____ 3.____ 5.____
2.____ 4.____ 6.____

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ____

2) Document type Field notes — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ____

RECORDER INFORMATION

Recorder Name Jessica R. Wobig — Affiliation Jacobs

Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED
❷ LARGE SCALE STREET, PLAT OR PARCEL MAP (available from most property appraiser web sites)
❸ PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

Built in 1963, the Delta IV Warehouse, Facility 43302, is previously recorded as FMSF No. BR4030 and is unevaluated for listing in the National Register of Historic Places (NRHP). The building is associated with Space Launch Complex 37 (SLC-37) and was initially constructed by the U.S. Air Force (USAF) for the Saturn program. The seven-bay, concrete block building has a flat roof covered by composite material. There are two single-leaf security doors with concrete hoods and stoops. The first entrance is between the third and fourth back near the south elevation, and the second is in the seventh bay near the north end. Along the front elevation, each bay is framed by a two-part, poured concrete structural member, following the roof and floor line for up to two stories. The building, however, is a single story. One-and-a-half-story overhead doors are on the north and south ends, flanked by two infilled windows with concrete slip sills. It is in good physical condition.

The building is situated south of Patrol Road, west of Phillips Parkway, west of SLC-37 (BR02274), and on federally managed land. An electrical substation is located directly to the west. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west, and the Atlantic Ocean is to the east.

NRHP Evaluation

Initially, the warehouse was constructed as storage for the Saturn program, which operated at SLC-37 from 1962 until 1969. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999 by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership. The complex was repurposed SLC-37 to support the Delta program by 2000. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the USAF Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17 (Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a).

Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions (Erwin 2024). The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles. It was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California. ULA launched the Delta IV heavy-lift rocket family on April 9, 2024. ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The conclusion of the Delta program marked ULA's 160th mission and its 35th for the National Reconnaissance Office (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The Delta IV Warehouse, Facility 43302 (FMSF No. BR4030), is a utilitarian structure erected for significant programs in the history of CCSFS but was used for ancillary storage. Because the building was constructed during the Cold War era (1945 to 1991), this eligibility recommendation applied guidance available in the existing historical context and NRHP registration requirements (NPS 1984; Van Critters 2015; Hampton et al. 2012; Salmon 2022; Hoffecker et al. 1996). As a warehouse, the building does not share an association with a significant event or contribute to broad thematic associations important to the past. Although the warehouse may have stored technology and equipment, the building is not associated with direct space exploration or engineering achievements completed elsewhere at CCSFS, such as at NRHP-eligible launch complexes. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. The building is a common utilitarian warehouse with no architectural style or notable construction method. The building is recommended not eligible for listing in the NRHP under Criterion C. The building does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The building would not likely yield important information and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

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Figure 1. USGS 7.5' Map with Structure Location

Figure 2. Aerial Street Map with Structure Location

Photograph 1. Delta IV Warehouse, Facility 43302 (FMSF No. BR4030) from the parking lot with the electrical substation at the rear, facing southwest.

Facility Number 43311

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Site#8 ____
Field Date ____
Form Date ____
Recorder # ____

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) FPL Substation Building
Multiple Listing (DHR only) ____
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ____
National Register Category (please check one) ☒ building ☐ structure ☐ district ☐ site ☐ object
Ownership: ☐ private-profit ☐ private-nonprofit ☐ private-individual ☐ private-nonspecific ☐ city ☐ county ☐ state ☒ federal ☐ Native American ☐ foreign ☐ unknown

LOCATION & MAPPING

	Street Number	Direction	Street Name	Street Type	Suffix Direction
Address:			Patrol	Road	

Cross Streets (nearest / between) ____
USGS 7.5 Map Name CAPE CANAVERAL USGS Date 2024 Plat or Other Map ____
City / Town (within 3 miles) Cape Canaveral In City Limits? ☒ yes ☐ no ☐ unknown County Brevard
Township 23S Range 37E Section ____ ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE Irregular-name: ____
Tax Parcel # ____ Landgrant ____
Subdivision Name ____ Block ____ Lot ____
UTM Coordinates: Zone ☐ 16 ☐ 17 Easting ____ Northing ____
Other Coordinates: X: 28.5249111111 Y: -80.575869444 Coordinate System & Datum ____
Name of Public Tract (e.g., park) ____

HISTORY

Construction Year: 1999 ☐ approximately ☐ year listed or earlier ☐ year listed or later
Original Use Electrical distribution From (year): 1999 To (year): 2024
Current Use Electrical distribution From (year): 1999 To (year): 2024
Other Use ____ From (year): ____ To (year): ____
Moves: ☐ yes ☒ no ☐ unknown Date: ____ Original address ____
Alterations: ☐ yes ☒ no ☐ unknown Date: ____ Nature ____
Additions: ☐ yes ☒ no ☐ unknown Date: ____ Nature ____
Architect (last name first): ____ Builder (last name first): ____
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐ yes ☒ no ☐ unknown Describe ____

DESCRIPTION

Style No style Exterior Plan Rectangular Number of Stories 1
Exterior Fabric(s) 1. Concrete 2. ____ 3. ____
Roof Type(s) 1. Hip 2. ____ 3. ____
Roof Material(s) 1. Sheet metal:corrugated 2. ____ 3. ____
Roof secondary strucs. (dormers etc.) 1. ____ 2. ____
Windows (types, materials, etc.)
NA

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
See continuation sheet

DHR USE ONLY **OFFICIAL EVALUATION** **DHR USE ONLY**

NR List Date ____
☐ Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐ yes ☐ no ☐ insufficient info Date ____ Init. ____
KEEPER – Determined eligible: ☐ yes ☐ no Date ____
NR Criteria for Evaluation: ☐ a ☐ b ☐ c ☐ d (see *National Register Bulletin 15*, p. 2)

HISTORICAL STRUCTURE FORM

Site #8 ______

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ______ 2. ______
Structural System(s): 1. Concrete 2. ______ 3. ______
Foundation Type(s): 1. Slab 2. ______
Foundation Material(s): 1. Concrete, Generic 2. ______

Main Entrance (stylistic details)
NA

Porch Descriptions (types, locations, roof types, etc.)
NA

Condition (overall resource condition): ☐ excellent ☒ good ☐ fair ☐ deteriorated ☐ ruinous

Narrative Description of Resource
See continuation sheet

Archaeological Remains ______ ☐ Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

☐ FMSF record search (sites/surveys)
☐ FL State Archives/photo collection
☐ property appraiser / tax records
☒ cultural resource survey (CRAS)
☐ library research
☐ city directory
☐ newspaper files
☐ historic photos
☐ building permits
☐ occupant/owner interview
☐ neighbor interview
☐ interior inspection
☐ Sanborn maps
☐ plat maps
☐ Public Lands Survey (DEP)
☐ HABS/HAER record search
☒ other methods (describe) CCSFS real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)
See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐ yes ☒ no ☐ insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐ yes ☒ no ☐ insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)
See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)
1.______ 3.______ 5.______
2.______ 4.______ 6.______

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ______

2) Document type Field notes — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ______

RECORDER INFORMATION

Recorder Name Jessica R. Wobig — Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com.
(address / phone / fax / e-mail)

Required Attachments

❶ **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
❷ **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
❸ **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

The Florida Power and Light Company (FPL) Substation Building, Facility 43311, was built in 1999 and is unrecorded and unevaluated. It supported Cape Canaveral Space Force Station (CCSFS) power infrastructure. It is a utilitarian structure that lacks architectural style. The single-bay building features a hipped roof with corrugated metal and a concrete exterior. A single-leaf security door and concrete stoop are on the south elevation. There are no windows. It is in good physical condition.

The building is directly east of the FPL substation and west of the Delta IV Warehouse, Facility 43302 (FMSF No. BR4030). The building is south of Patrol Road and west of Phillips Parkway and Space Launch Complex 37 (SLC-37) (BR02274). A porta-potty is located outside the entrance. It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west, and the Atlantic Ocean is located to the east.

National Register of Historic Places (NRHP) Evaluation

In 1999, the FPL Substation Building was constructed for FPL's Cape Canaveral Plant as a substation to facilitate power transfer to SLC-37 at CCSFS. A substation is a high-voltage electric system facility that switches generators, equipment, and circuits or lines in and out of a system, changes voltages, and switches between direct to alternating current (OSHA 2024). Initially built in 1962, SLC-37 was erected for the Saturn program, was deactivated in 1969, and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999 by United Launch Alliance (ULA), a Boeing and Lockheed Martin Partnership. The FLP substation was upgraded to support SLC-37's reactivation. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. In 2010, FPL replaced the 1960s-era Cape Canaveral Plant with a new Cape Canaveral Next Generation Clean Energy Center near NASA's Kennedy Space Center. On April 9, 2024, ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle (Erwin 2024, Pearlman 2024).

FPL Substation Building, Facility 43311, lacks historical significance and thus does not convey any aspects of integrity. It was constructed less than 25 years ago and is not exceptionally significant. It functions as a substation control house and is a support facility. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. It is a common building type with no architectural style or notable construction method. The building is recommended not eligible for listing in the NRHP under Criterion C. The building does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The building would not likely yield important information and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

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Sennott, Stephan, Daniel J. O'Rouke, Andrew B. Orr, and Lynn M. Glerek. 2021. *Historic Building Inventory and evaluation of Space Launch Complexes 37,40, 41, and 46*. Survey Number 27798.

Figure 1. USGS 7.5' Map with Structure Location

Figure 2. Aerial Street Map with Structure Location


Photograph 1. FPL Substation Building, Facility 43311 (previously unrecorded), with a porta-potty in front and an electrical substation in the background, facing northwest.

Facility Number 43313

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Site#8 ____
Field Date ____
Form Date ____
Recorder # ____

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) Delta IV Power Control Center
Multiple Listing (DHR only) ____
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ____
National Register Category (please check one) ☒building ☐structure ☐district ☐site ☐object
Ownership: ☐private-profit ☐private-nonprofit ☐private-individual ☐private-nonspecific ☐city ☐county ☐state ☒federal ☐Native American ☐foreign ☐unknown

LOCATION & MAPPING

Address: Street Number ____ Direction ____ Street Name ____ Street Type ____ Suffix Direction ____
Cross Streets (nearest / between) ____
USGS 7.5 Map Name CAPE CANAVERAL USGS Date 2024 Plat or Other Map ____
City / Town (within 3 miles) Cape Canaveral In City Limits? ☒yes ☐no ☐unknown County Brevard
Township 23S Range 37E Section ____ ¼ section: ☐NW ☐SW ☐SE ☐NE Irregular-name: ____
Tax Parcel # ____ Landgrant ____
Subdivision Name ____ Block ____ Lot ____
UTM Coordinates: Zone ☐16 ☐17 Easting ____ Northing ____
Other Coordinates: X: 28.5246222222 Y: -80.5758 Coordinate System & Datum ____
Name of Public Tract (e.g., park) ____

HISTORY

Construction Year: 1999 ☐approximately ☐year listed or earlier ☐year listed or later
Original Use Electrical distribution From (year): 1999 To (year): 2024
Current Use Electrical distribution From (year): 1999 To (year): 2024
Other Use ____ From (year): ____ To (year): ____
Moves: ☐yes ☒no ☐unknown Date: ____ Original address ____
Alterations: ☐yes ☒no ☐unknown Date: ____ Nature ____
Additions: ☐yes ☒no ☐unknown Date: ____ Nature ____
Architect (last name first): ____ Builder (last name first): ____
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐yes ☒no ☐unknown Describe ____

DESCRIPTION

Style No style Exterior Plan Rectangular Number of Stories 1
Exterior Fabric(s) 1. Aluminum 2. ____ 3. ____
Roof Type(s) 1. Flat 2. ____ 3. ____
Roof Material(s) 1. Sheet metal:corrugated 2. ____ 3. ____
Roof secondary strucs. (dormers etc.) 1. ____ 2. ____
Windows (types, materials, etc.)
NA

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
See continuation sheet

DHR USE ONLY — OFFICIAL EVALUATION — DHR USE ONLY

NR List Date ____
☐Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐yes ☐no ☐insufficient info Date ____ Init. ____
KEEPER – Determined eligible: ☐yes ☐no Date ____
NR Criteria for Evaluation: ☐a ☐b ☐c ☐d (see *National Register Bulletin 15*, p. 2)

HISTORICAL STRUCTURE FORM

Site #8 ____________

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ____________ 2. ____________
Structural System(s): 1. Metal skeleton 2. ____________ 3. ____________
Foundation Type(s): 1. Piers 2. ____________
Foundation Material(s): 1. Poured Concrete Footing 2. ____________

Main Entrance (stylistic details)

NA

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐ excellent ☒ good ☐ fair ☐ deteriorated ☐ ruinous

Narrative Description of Resource

See continuation sheet

Archaeological Remains ____________ ☐ Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

☐ FMSF record search (sites/surveys)
☐ library research
☐ building permits
☐ Sanborn maps
☐ FL State Archives/photo collection
☐ city directory
☐ occupant/owner interview
☐ plat maps
☐ property appraiser / tax records
☐ newspaper files
☐ neighbor interview
☐ Public Lands Survey (DEP)
☒ cultural resource survey (CRAS)
☐ historic photos
☐ interior inspection
☐ HABS/HAER record search
☒ other methods (describe) CCSFS real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐ yes ☒ no ☐ insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐ yes ☒ no ☐ insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1. ____________ 3. ____________ 5. ____________
2. ____________ 4. ____________ 6. ____________

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ____________

2) Document type Field notes — Maintaining organization Jacobs
Document description ArcGIS Field Collector — File or accession #'s ____________

RECORDER INFORMATION

Recorder Name Jessica R. Wobig — Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
❷ **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
❸ **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

Built in 1999, the Delta IV Power Control Center, Facility 43313, is unrecorded and unevaluated. It is a prefabricated trailer that lacks architectural style. It was constructed to support CCSFS power infrastructure and is associated with the Florida Power and Light Company (FPL) Substation, a high-voltage electric system facility, and Space Launch Complex 37 (SLC-37). The trailer features a flat roof with corrugated metal and a metal panel exterior with a metal-skirted concrete pier foundation. There are two single-leaf security doors on the trailer; one is on the east elevation facing Phillips Parkway, and one is on the north elevation near FPL Substation Building, Facility 43311. There are no windows. It is in good physical condition.

The trailer is east of the FPL substation and south of the Delta IV Warehouse, Facility 43302 (FMSF No. BR4030) and FPL Substation Building, Facility 43311. The trailer is south of Patrol Road and west of Phillips Parkway and SLC-37 (BR02274). It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west, and the Atlantic Ocean is located to the east.

National Register of Historic Places (NRHP) Evaluation

In 1999, the Delta IV Power Control Center, Facility 43313, was constructed as a power control building to facilitate power transfer to SLC-37. Originally built in 1962, SLC-37 was erected for the Saturn program, was deactivated in 1969, and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999 by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership. The FLP substation associated with SLC-37 was upgraded to support the complex's reactivation, and support facilities were erected, such as Delta IV Power Control Center, Facility 43313. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. On April 9, 2024, ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle (Erwin 2024, Pearlman 2024).

The Delta IV Power Control Center, Facility 43313, lacks historical significance and thus does not convey any aspects of integrity. It was constructed less than 25 years ago and is not exceptionally significant. It functions as a power control center and support facility. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. It is a common building type with no architectural style or notable construction method. The building is recommended not eligible for listing in the NRHP under Criterion C. The building does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The building would not likely yield important information and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Pearlman, Robert Z. 2024. "' Heavy' history: ULA Launch final Delta rocket after 64 years." *Space*. April 9. https://www.space.com/final-delta-4-heavy-rocket-launch-nrol-70.

Sennott, Stephan, Daniel J. O'Rouke, Andrew B. Orr, and Lynn M. Glerek. 2021. *Historic Building Inventory and evaluation of Space Launch Complexes 37,40, 41, and 46*. Survey Number 27798.

Figure 1. USGS 7.5' Map with Structure Location

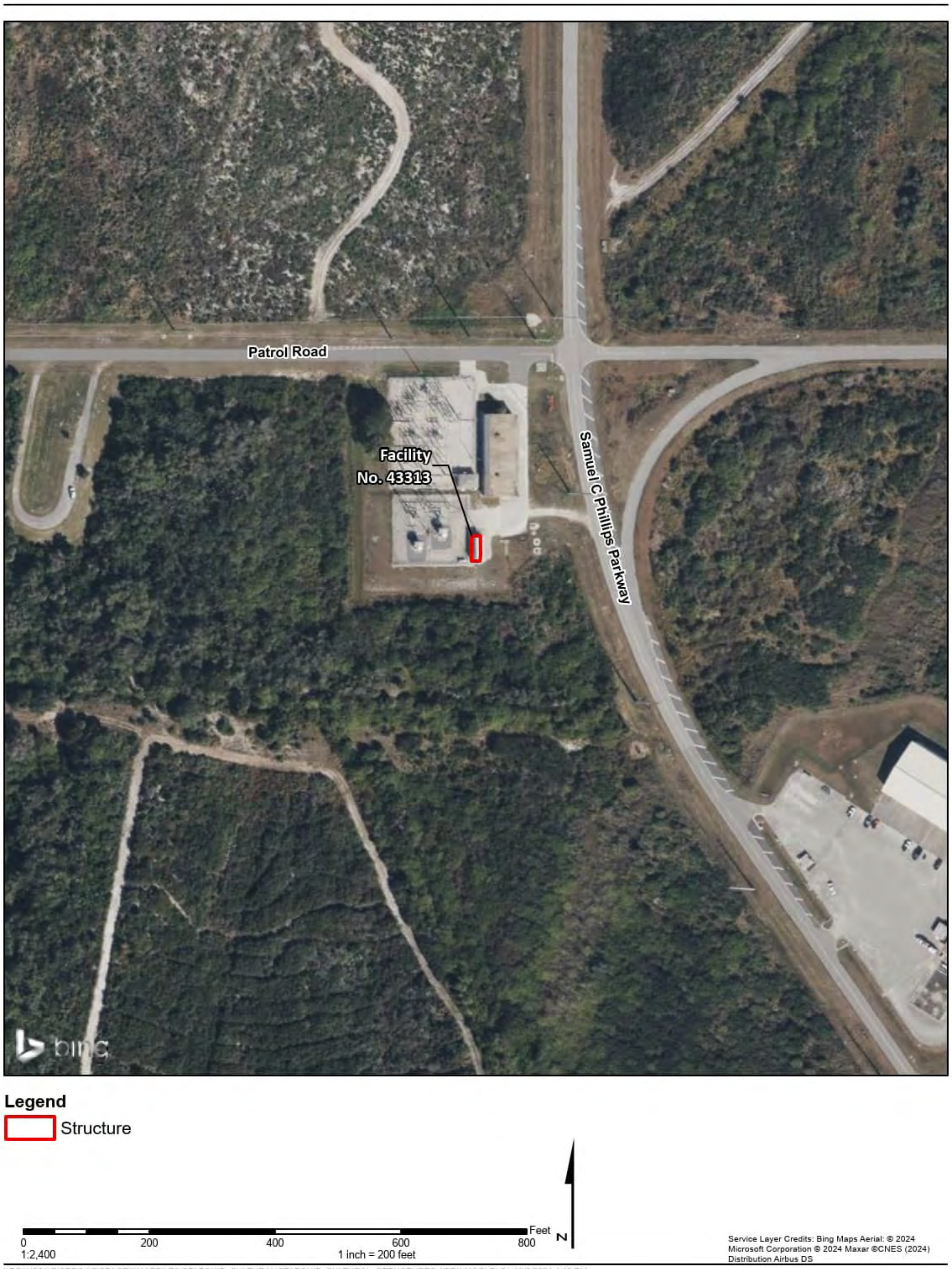

Figure 2. Aerial Street Map with Structure Location

Photograph 1. Delta IV Power Control Center, Facility 43313 (previously unrecorded), with an electrical substation in the background, facing west.

Facility Number 43400

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM

FLORIDA MASTER SITE FILE

Version 5.0 3/19

Site#8 BR04029
Field Date ______
Form Date ______
Recorder # ______

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) Delta IV Precision Clean Lab
Multiple Listing (DHR only) ______
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ______
National Register Category (please check one) ☒ building ☐ structure ☐ district ☐ site ☐ object
Ownership: ☐ private-profit ☐ private-nonprofit ☐ private-individual ☐ private-nonspecific ☐ city ☐ county ☐ state ☒ federal ☐ Native American ☐ foreign ☐ unknown

LOCATION & MAPPING

Street Number	Direction	Street Name	Street Type	Suffix Direction
Address:		Beach	Road	

Cross Streets (nearest / between) ______
USGS 7.5 Map Name CAPE CANAVERAL USGS Date 2024 Plat or Other Map ______
City / Town (within 3 miles) Cape Canaveral In City Limits? ☒ yes ☐ no ☐ unknown County Brevard
Township 23S Range 38E Section ______ ¼ section: ☐ NW ☐ SW ☐ SE ☐ NE Irregular-name: ______
Tax Parcel # ______ Landgrant ______
Subdivision Name ______ Block ______ Lot ______
UTM Coordinates: Zone ☐ 16 ☐ 17 Easting ______ Northing ______
Other Coordinates: X: 28.5230166667 Y: -80.57325 Coordinate System & Datum ______
Name of Public Tract (e.g., park) ______

HISTORY

Construction Year: 1962 ☐ approximately ☐ year listed or earlier ☐ year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 1962 To (year): 1969
Current Use Air Force/Army/Navy/Military base From (year): 1999 To (year): 2024
Other Use Vacant From (year): 1969 To (year): 1999
Moves: ☐ yes ☒ no ☐ unknown Date: ______ Original address ______
Alterations: ☐ yes ☒ no ☐ unknown Date: ______ Nature ______
Additions: ☐ yes ☒ no ☐ unknown Date: ______ Nature ______
Architect (last name first): ______ Builder (last name first): ______
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐ yes ☒ no ☐ unknown Describe ______

DESCRIPTION

Style No style Exterior Plan Rectangular Number of Stories 1
Exterior Fabric(s) 1. Concrete 2. Concrete block 3. ______
Roof Type(s) 1. Flat 2. ______ 3. ______
Roof Material(s) 1. Composition roll 2. ______ 3. ______
Roof secondary strucs. (dormers etc.) 1. ______ 2. ______
Windows (types, materials, etc.)
NA

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
See continuation sheet

DHR USE ONLY OFFICIAL EVALUATION DHR USE ONLY

NR List Date ______
☐ Owner Objection

SHPO – Appears to meet criteria for NR listing: ☐ yes ☐ no ☐ insufficient info Date ______ Init. ______
KEEPER – Determined eligible: ☐ yes ☐ no Date ______
NR Criteria for Evaluation: ☐ a ☐ b ☐ c ☐ d (see *National Register Bulletin 15*, p. 2)

Florida Master Site File / Div. of Historical Resources / R. A. Gray Bldg / 500 S Bronough St., Tallahassee, FL 32399-0250
Phone **850.245.6440** / Fax **850.245.6439** / E-mail **SiteFile@dos.myflorida.com**

HISTORICAL STRUCTURE FORM

Site #8 ______________

DESCRIPTION (continued)

Chimney: No. 3 Chimney Material(s): 1. Metal 2. ______
Structural System(s): 1. Concrete 2. Concrete block 3. ______
Foundation Type(s): 1. Slab 2. ______
Foundation Material(s): 1. Concrete, Generic 2. ______

Main Entrance (stylistic details)

See continuation sheet

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐excellent ☒good ☐fair ☐deteriorated ☐ruinous

Narrative Description of Resource

See continuation sheet

Archaeological Remains ______ ☐Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

☒FMSF record search (sites/surveys)
☐FL State Archives/photo collection
☐property appraiser / tax records
☒cultural resource survey (CRAS)
☐library research
☐city directory
☐newspaper files
☐historic photos
☐building permits
☐occupant/owner interview
☐neighbor interview
☐interior inspection
☐Sanborn maps
☐plat maps
☐Public Lands Survey (DEP)
☐HABS/HAER record search
☒other methods (describe) USSF real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐yes ☒no ☐insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐yes ☒no ☐insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)
1. ______ 3. ______ 5. ______
2. ______ 4. ______ 6. ______

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ______

2) Document type Field notes Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ______

RECORDER INFORMATION

Recorder Name Jessica R. Wobig Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
❷ **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
❸ **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description
Built in 1962, the Delta IV Precision Clean Lab, Facility 43400, is previously recorded as FMSF No. BR4029 and is unevaluated for listing in the National Register of Historic Places (NRHP). The building is associated with SLC-37 and was constructed by the U.S. Air Force (USAF) for the Saturn program. The 12-bay building features a flat roof and a rectangular plan. It has a poured concrete frame and concrete block construction with a composite roof and overhanging eaves. A large metal external chimney and several more minor metal external chimneys are on the front elevation facing Beach Road. There are asymmetrical door arrangements, partially centralized on the front elevation, though the north and south ends have symmetrical door arrangements. There are no windows. It is in good physical condition.

The structure is laterally along the west side of Beach Road, which runs southwest to northeast between Patrol Road and SLC-37 (BR02274). It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west and the Atlantic Ocean to the east.

NRHP Evaluation
The building was constructed for the Saturn program, which operated from SLC-37 from 1962 until 1969. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999 by United Launch Alliance (ULA), a Boeing and Lockheed Martin partnership. Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions. The Delta rocket family was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California (Erwin 2024, Pearlman 2024). The Delta IV Precision Clean Lab, Facility 43400, is one of the buildings repurposed by ULA. It is used for precision cleaning systems containing aerospace fluids before assembly (NASA 2024).

The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the USAF Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17 (Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a). The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. On April 9, 2024, the final Delta IV heavy-lift rocket was launched from SLC-37 after ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The conclusion of the Delta program marked ULA's 160th mission and its 35th for the National Reconnaissance Office. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The Delta IV Precision Clean Lab, Facility 43400 (FMSF No. BR4029), is associated with SLC-37 and was constructed by the USAF for the Saturn program. It is a utilitarian structure erected for significant programs in the history of CCSFS but was used for an ancillary purpose. Because the building was constructed during the Cold War era (1945 to 1991), this eligibility recommendation applied guidance available in the existing historical context and NRHP registration requirements (NPS 1984; Van Critters 2015; Hampton et al. 2012; Salmon 2022; Hoffecker et al. 1996). As a precision cleaning facility, the building broadly shares thematic associations significant to the past, particularly the Saturn program. Although the precision cleaning lab may have serviced technology and equipment before assembly, the building is not associated with direct space exploration or engineering achievements completed elsewhere at CCSFS, such as at NRHP-eligible launch complexes. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the building shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. The building is a standard utilitarian design with no architectural style or notable construction method. The building is recommended not eligible for listing in the NRHP under Criterion C. The building does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The building would not likely yield important information and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the building is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. “End of an era: Delta 4 Heavy soars one last time.” *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Ganoung, J.K., and H. Eaton. 1981.”The Delta Launch Vehicle: Past, Present, and Future.” *The Space Congress Proceedings*. https://commons.erau.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2554&context=space-congress-proceedings#:~:text=On%20May%2013%2C%201960%2C%20the,this%20launch%20was%20not%20successful.

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Hoffecker, John F., Mandy Whorton, and Casey R. Buechler. 1996. *Cold War Properties in the 21st Space Wing. Air Force Command*. Prepared for the 1996 Cold War Workshop, Eglin Air Force Base, Pensacola, Florida.

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National Park Service (NPS). 1984. *National Register of Historic Places Nomination Form, Cape Canaveral Air Force Station*. Revised. U.S. Department of the Interior. https://catalog.archives.gov/id/77841869.

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U.S. Space Force Historical Foundation 202b. Launch Complex 37. https://ccspacemuseum.org/facilities/launch-complex-37/.

Van Critters, Historic Preservation, LLC (Van Critters). 2015. *Programmatic Approaches to the Management of Cold War Historic Properties*. Department of Defense. https://www.denix.osd.mil/cr/denix-files/sites/19/2016/03/01_Programmatic-Approaches-to-the-Management-of-Cold-War.pdf.

Figure 1. USGS 7.5' Map with Structure Location

Figure 2. Aerial Street Map with Structure Location

Photograph 1. The Delta IV Precision Clean Lab, Facility 43400 (FMSF No. BR4029), from the parking lot, facing southwest.

Facility Number 43407

☐ Original
☐ Update

HISTORICAL STRUCTURE FORM
FLORIDA MASTER SITE FILE
Version 5.0 3/19

Site#8 ____
Field Date ____
Form Date ____
Recorder # ____

Shaded Fields represent the minimum acceptable level of documentation.
Consult the *Guide to Historical Structure Forms* for detailed instructions.

Site Name(s) (address if none) Storage Building
Multiple Listing (DHR only) ____
Survey Project Name SpaceX Starship-Super Heavy Operations at CCSFS
Survey # (DHR only) ____
National Register Category (please check one) ☒building ☐structure ☐district ☐site ☐object
Ownership: ☐private-profit ☐private-nonprofit ☐private-individual ☐private-nonspecific ☐city ☐county ☐state ☒federal ☐Native American ☐foreign ☐unknown

LOCATION & MAPPING

Address:	Street Number	Direction	Street Name	Street Type	Suffix Direction
			Beach	Road	

Cross Streets (nearest / between) ____
USGS 7.5 Map Name CAPE CANAVERAL USGS Date 2024 Plat or Other Map ____
City / Town (within 3 miles) Cape Canaveral In City Limits? ☒yes ☐no ☐unknown County Brevard
Township 23S Range 38E Section ____ ¼ section: ☐NW ☐SW ☐SE ☐NE Irregular-name: ____
Tax Parcel # ____ Landgrant ____
Subdivision Name ____ Block ____ Lot ____
UTM Coordinates: Zone ☐16 ☐17 Easting ____ Northing ____
Other Coordinates: X: 28.5234138889 Y: -80.573288888 Coordinate System & Datum ____
Name of Public Tract (e.g., park) ____

HISTORY

Construction Year: 2000 ☐approximately ☐year listed or earlier ☐year listed or later
Original Use Air Force/Army/Navy/Military base From (year): 2000 To (year): 2024
Current Use Air Force/Army/Navy/Military base From (year): 2000 To (year): 2024
Other Use ____ From (year): ____ To (year): ____
Moves: ☐yes ☒no ☐unknown Date: ____ Original address ____
Alterations: ☐yes ☒no ☐unknown Date: ____ Nature ____
Additions: ☐yes ☒no ☐unknown Date: ____ Nature ____
Architect (last name first): ____ Builder (last name first): ____
Ownership History (especially original owner, dates, profession, etc.)

Is the Resource Affected by a Local Preservation Ordinance? ☐yes ☒no ☐unknown Describe ____

DESCRIPTION

Style No style Exterior Plan Rectangular Number of Stories 1
Exterior Fabric(s) 1. Metal 2. ____ 3. ____
Roof Type(s) 1. Gable 2. ____ 3. ____
Roof Material(s) 1. Sheet metal:standing seam 2. ____ 3. ____
Roof secondary strucs. (dormers etc.) 1. ____ 2. ____
Windows (types, materials, etc.)
NA

Distinguishing Architectural Features (exterior or interior ornaments)
NA

Ancillary Features / Outbuildings (record outbuildings, major landscape features; use continuation sheet if needed.)
See continuation sheet

DHR USE ONLY — OFFICIAL EVALUATION — DHR USE ONLY

NR List Date ____
☐Owner Objection
SHPO – Appears to meet criteria for NR listing: ☐yes ☐no ☐insufficient info Date ____ Init.____
KEEPER – Determined eligible: ☐yes ☐no Date ____
NR Criteria for Evaluation: ☐a ☐b ☐c ☐d (see *National Register Bulletin 15*, p. 2)

HISTORICAL STRUCTURE FORM

Site #8 ____________

DESCRIPTION (continued)

Chimney: No.____ Chimney Material(s): 1. ____________ 2. ____________
Structural System(s): 1. Metal skeleton 2. ____________ 3. ____________
Foundation Type(s): 1. Slab 2. ____________
Foundation Material(s): 1. Concrete, Generic 2. ____________

Main Entrance (stylistic details)

NA

Porch Descriptions (types, locations, roof types, etc.)

NA

Condition (overall resource condition): ☐ excellent ☒ good ☐ fair ☐ deteriorated ☐ ruinous

Narrative Description of Resource

See continuation sheet

Archaeological Remains ____________ ☐ Check if Archaeological Form Completed

RESEARCH METHODS (select all that apply)

- ☐ FMSF record search (sites/surveys)
- ☐ FL State Archives/photo collection
- ☐ property appraiser / tax records
- ☒ cultural resource survey (CRAS)
- ☐ library research
- ☐ city directory
- ☐ newspaper files
- ☐ historic photos
- ☐ building permits
- ☐ occupant/owner interview
- ☐ neighbor interview
- ☐ interior inspection
- ☐ Sanborn maps
- ☐ plat maps
- ☐ Public Lands Survey (DEP)
- ☐ HABS/HAER record search
- ☒ other methods (describe) CCSFS real property records

Bibliographic References (give FMSF manuscript # if relevant, use continuation sheet if needed)

See continuation sheet

OPINION OF RESOURCE SIGNIFICANCE

Appears to meet the criteria for National Register listing individually? ☐ yes ☒ no ☐ insufficient information
Appears to meet the criteria for National Register listing as part of a district? ☐ yes ☒ no ☐ insufficient information

Explanation of Evaluation (**required**, whether significant or not; use separate sheet if needed)

See continuation sheet

Area(s) of Historical Significance (see *National Register Bulletin 15*, p. 8 for categories: e.g. "architecture", "ethnic heritage", "community planning & development", etc.)

1.____________ 3.____________ 5.____________
2.____________ 4.____________ 6.____________

DOCUMENTATION

Accessible Documentation Not Filed with the Site File - including field notes, analysis notes, photos, plans and other important documents

1) Document type Photographs Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ____________

2) Document type Field notes Maintaining organization Jacobs
Document description ArcGIS Field Collector File or accession #'s ____________

RECORDER INFORMATION

Recorder Name Jessica R. Wobig Affiliation Jacobs
Recorder Contact Information 216-777-1030/jessica.wobig@jacobs.com
(address / phone / fax / e-mail)

Required Attachments

❶ **USGS 7.5' MAP WITH STRUCTURE LOCATION CLEARLY INDICATED**
❷ **LARGE SCALE STREET, PLAT OR PARCEL MAP** (available from most property appraiser web sites)
❸ **PHOTO OF MAIN FACADE, DIGITAL IMAGE FILE**
When submitting an image, it must be included in digital AND hard copy format (plain paper grayscale acceptable).
Digital image must be at least 1600 x 1200 pixels, 24-bit color, jpeg or tiff.

Historic Structure Form
Continuation Sheet

Structure Description

Built in 2000, the Storage Building, Facility 43407 is unrecorded and evaluated. The structure is associated with SLC-37 and was constructed by United Launch Alliance (ULA) for the Delta program. The three-by-seven-bay warehouse features a gable roof and a rectangular plan. It is made of metal construction with a metal roof and gutter system. The front elevation faces southeast onto Beach Road. It features two sets of overhead rolling doors and single-leaf security doors on the east end, two on the west end, and an asymmetrical agreement of doors and metal-infilled windows along the north and south elevations. The rear elevation has a single-leaf metal security door near the southeastern corner. There are no exposed windows. It is in good physical condition.

The structure is on the west side of Beach Road, which runs southwest to northeast between Patrol Road and SLC-37 (BR02274). It is on federally managed land. The setting consists of a scrub-covered landscape and launch complex facilities associated with Cape Canaveral Space Force Station (CCSFS). The Banana River is located to the west and the Atlantic Ocean to the east.

National Register of Historic Places (NRHP) Evaluation

The structure was constructed in anticipation of the Delta program, which ULA, a Boeing and Lockheed Martin partnership, had operated from SLC-37 from the early 2000s. Built in 1962, SLC-37 was constructed for the Saturn program. The launch complex was deactivated in 1969 and mothballed until it was reactivated for the Delta IV medium-lift rocket in 1999. The Delta program was one of the longest-running launch vehicle programs at CCSFS and the most used non-military launch vehicle. Based on its predecessor, the U.S. Air Force Thor Intermediate Range Ballistic Missile (Thor Delta), the first Delta rocket was launched on May 13, 1960, from CCSFS, then Cape Canaveral Air Force Station, at Launchpad 17A at SLC-17(Ganoung and Eaton 1981, U.S. Space Force Historical Foundation 2024a).

Since the early 2000s, SLC-37 supported Delta launches for predominantly classified missions. The first Delta IV (medium) launched from SLC-37 on November 20, 2002, and the Delta IV (heavy) launched on December 21, 2004. It was launched from SLCs-17 and 37 at CCSFS and Vandenberg Space Force base in California. The Delta program evolved over its 64-year lifespan to increase its capability to launch larger, heavier space vehicles. On April 9, 2024, ULA sunset the Delta IV heavy rocket to pursue its next-generation Vulcan Centaur rocket. The conclusion of the Delta program marked ULA's 160th mission and its 35th for the National Reconnaissance Office (Erwin 2024, Pearlman 2024).

Over the Delta era, there were 389 Delta launches, including 294 from the East Coast and 95 from Vandenberg Space Force Base. The Delta rockets initially measured 90 feet (27.4 m) in height and had a mass of 112,000 pounds (50,800 kg) and increased in size with the Delta IV Heavy having measured 235 feet (71.6 m) tall and weighing 1.6 million pounds (725,750 kilograms) at launch. Liftoff thrust also increased over the generations from 150,000 pounds (667 kiloNewtons) in 1960 to 2.1 million pounds (9,341 kiloNewtons) in 2024 (ULA 2024a and 2024b).

The Storage Building, Facility 43407, is a utilitarian structure that lacks historical significance and thus does not convey any aspects of integrity. It lacks architectural style and is not notable for its engineering or construction methods. It was constructed less than 25 years ago and is not exceptionally significant. It functions as a warehouse. It does not convey an important event or significant historical association; thus, it is recommended not eligible for listing in the NRHP under Criterion A. Research did not reveal that the structure shares a direct linkage with important persons and thus is recommended not eligible for listing in the NRHP under Criterion B. The structure is a common utilitarian shed with no architectural style or notable construction method. The structure is recommended not eligible for listing in the NRHP under Criterion C. The structure does not contribute to an eligible district, as SLC-37 (BR02274) is determined ineligible for listing in the NRHP (Sennott et al. 2021). The structure would not likely yield important information, and thus is recommended not eligible for listing in the NRHP under Criterion D. Therefore, the structure is recommended not eligible for listing in the NRHP under any criteria.

References

Erwin, Sandra. 2024. "End of an era: Delta 4 Heavy soars one last time." *Space News*. April 9. https://spacenews.com/end-of-an-era-delta-4-heavy-soars-one-last-time/.

Ganoung, J.K., and H. Eaton. 1981."The Delta Launch Vehicle: Past, Present, and Future." *The Space Congress Proceedings*. https://commons.erau.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2554&context=space-congress-proceedings#:~:text=On%20May%2013%2C%201960%2C%20the,this%20launch%20was%20not%20successful.

Pearlman, Robert Z. 2024. "' Heavy' history: ULA Launch final Delta rocket after 64 years." Space. April 9. https://www.space.com/final-delta-4-heavy-rocket-launch-nrol-70.

Sennott, Stephan, Daniel J. O'Rouke, Andrew B. Orr, and Lynn M. Glerek. 2021. *Historic Building Inventory and evaluation of Space Launch Complexes 37,40, 41, and 46*. Survey Number 27798.

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United Launch Alliance (ULA). 2024b. *Delta IV*. https://www.ulalaunch.com/rockets/delta-iv.

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U.S. Space Force Historical Foundation 202b. Launch Complex 37. https://ccspacemuseum.org/facilities/launch-complex-37/.

Figure 1. USGS 7.5' Map with Structure Location

Figure 2. Aerial Street Map with Structure Location

Photograph 1. Storage Building, Facility 43407 (previously unrecorded) from Beach Road, facing west.

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Appendix 3.9A
USFWS Biological and Conference Assessment

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Final

SpaceX Starship-Super Heavy Cape Canaveral Space Force Station Biological and Conference Assessment for SLC-37

Department of the Air Force

May 29, 2025

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Contents

Appendices

Tables

Figures

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Acronyms and Abbreviations

Acronym	Definition
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
ASEL	A-weighted sound exposure level
ASU	air separation unit
BCA	Biological and Conference Assessment
BO	biological opinion
CANA	Canaveral National Seashore
CCSFS	Cape Canaveral Space Force Station
CFR	*Code of Federal Regulation*
CO_2	carbon dioxide
DAF	Department of the Air Force
dB	decibel(s)
DOD	Department of Defense
DPS	distinct population segment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
EXPN	Experimental Population Non-Essential
FAA	Federal Aviation Administration
FLUCCS	Florida Land Use, Cover, and Forms Classification System
FR	*Federal Register*
Fund	Canaveral Conservation Fund
FWC	Florida Fish and Wildlife Conservation Commission
g	gram(s)
HIF	Horizontal Integration Facility
INRMP	Integrated Natural Resources Management Plan
IPaC	Information for Planning and Consultation

kHz	kilohertz
KSC	Kennedy Space Center
L_{Amax}	maximum A-weighted sound level
L_{max}	maximum unweighted sound level
LMP	Lighting Management Plan
LN_2	liquid nitrogen
LOX	liquid oxygen
MINWR	Merritt Island National Wildlife Refuge
MN	meganewton(s)
MT	metric ton(s)
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NMFS	National Marine Fisheries Service
PBF	physical and biological feature
PCE	primary constituent element
psf	pound(s) per square foot
PTS	permanent threshold shift
ROW	right-of-way
RTLS	return to launch site
SA	Similarity of Appearance
SLC	Space Launch Complex
SLD 45	Space Launch Delta 45
SpaceX	Space Exploration Technologies Corporation
SWPPP	stormwater pollution prevention plan
TTS	temporary threshold shift
U.S.C.	*United States Code*
ULA	United Launch Alliance

USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
USSF	United States Space Force

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1. Background/History

The Department of the Air Force (DAF) is preparing an Environmental Impact Statement (EIS) for future operations of the Space Exploration Technologies Corporation's (SpaceX's) Starship-Super Heavy launch vehicle at Space Launch Complex (SLC)-37 at Cape Canaveral Space Force Station (CCSFS). The Proposed Action is the potential execution of a real property agreement between the United States Space Force (USSF) and SpaceX at CCSFS, the issuance of a vehicle operator license for Starship-Super Heavy non-Department of Defense (DOD) operations at CCSFS by the Federal Aviation Administration (FAA), and approval of related airspace closures by the FAA for operations. SLC-37 was built for the United Launch Alliance (ULA) Delta IV Heavy launch vehicle, and launches occurred at the site until 2024. The Proposed Action would involve the demolition of the current launch facilities at SLC-37 and the construction of launch infrastructure to accommodate the Starship-Super Heavy launch vehicle. Demolition activities covered under this formal consultation include any required beyond those performed as part of the previous informal consultation under FWS Log No. 2025-0098469 (May 2025). The Proposed Action would also include the operational activities of transport, launch, landing, and recovery of Starship-Super Heavy launch vehicle at CCSFS and the Atlantic, Pacific, and Indian Oceans.

The Starship-Super Heavy launch vehicle was developed at the SpaceX launch site in Boca Chica, Texas, and includes two stages (Figure 1-1): (1) Super Heavy, which is the first stage (or booster), and (2) Starship, which is the second stage. As designed, both stages are reusable. The fully integrated launch vehicle is 493 feet tall depending on the configuration and 30 feet in diameter. The configuration includes 35 Raptor engines for Super Heavy and 9 raptor engines for Starship, each powered by liquid oxygen (LOX) and liquid methane. Super Heavy holds up to 4,100 metric tons (MT) of propellant and Starship up to 2,650 MT of propellant. As built, Super Heavy has a maximum lift-off thrust of up to 103 meganewtons (MN), whereas Starship has a maximum lift-off thrust of approximately 28 MN. Launch propellant and commodities include liquid nitrogen (LN_2), water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, hydraulic fluid, LOX, and liquid methane. Starship-Super Heavy launch and landing operations would occur at SLC-37 at CCSFS in Florida (Figure 1-2).

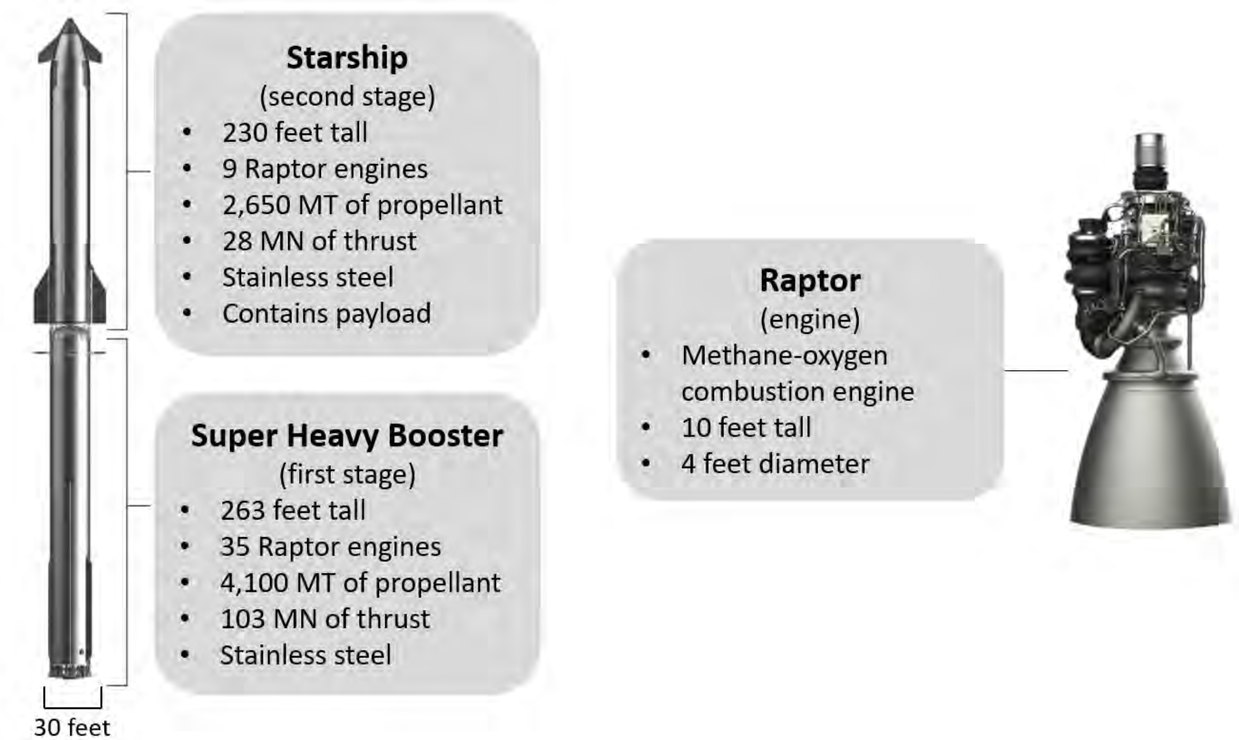
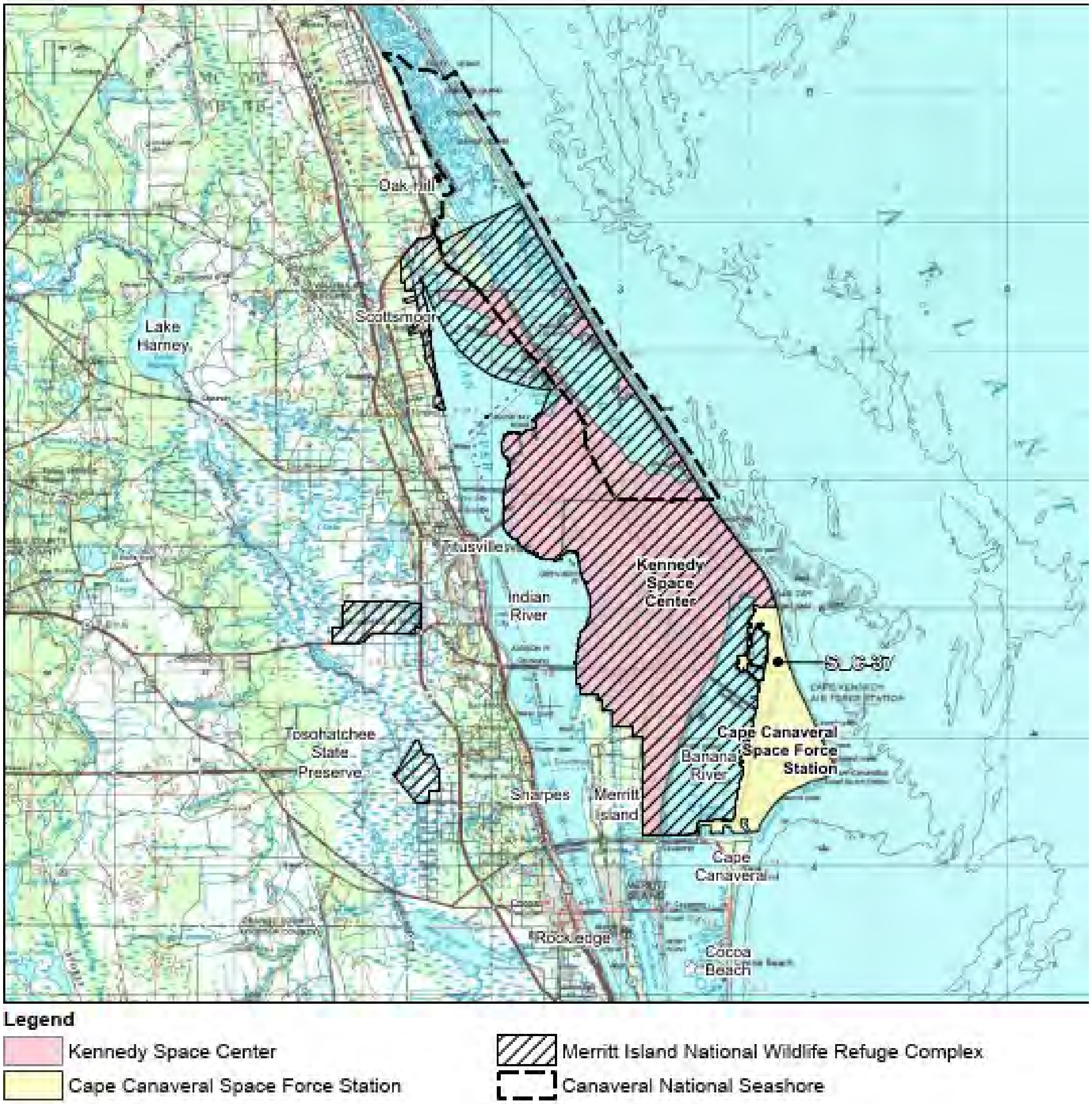


Figure 1-1. Starship-Super Heavy Launch Vehicle Design



Notes:
1. Merritt Island National Wildlife Refuge Complex boundary shown is from U.S. Fish & Wildlife Service. Downloaded from https://gis-fws.opendata.arcgis.com/datasets/dae48a3dcd654e7ea09d386cae052eab /explore?location=28.370782%2C-80.516762%2C11.62 on August 17, 2023.
2. Canaveral National Seashore boundary shown is from the National Parks Service. Downloaded from https://public-nps.opendata.arcgis.com/datasets/nps-boundary-1 /explore?location=28.813847%2C-80.732930%2C10.00 on August 17, 2023.
3. Topographic basemap shown is the U.S. Geological Survey, Orlando [map], 1:250000, Topographic Quadrangle Map, Orlando, FL, 1955. Downloaded from https://livingatlas.arcgis.com/topoexplorer/ on January 25, 2024.

0 7 14 21 28 Miles
1:443,520
1 inch = 7 miles
N
Service Layer Credits:

Figure 1-2. SLC-37 Location

1.1 Project Purpose and Objectives

The purpose of the Proposed Action is to advance U.S. space capabilities by providing launch and landing infrastructure in furtherance of U.S. policy to ensure capabilities to launch and insert national security payloads into space (*United States Code* [U.S.C.] Title 10, Section 2273, "Policy regarding assured access to space: national security payloads"). The Proposed Action would increase the space launch mission capability of DOD, the National Aeronautics and Space Administration (NASA), and other federal and commercial customers and enhance the resilience and capacity of the nation's space launch infrastructure, while promoting a robust and competitive national space industry.

The need for the Action is to ensure increasingly assured access to space without compromising current launch capabilities and fulfill (in part) the U.S. Congress's grant of authority to the Secretary of Defense, pursuant to 10 U.S.C. Section 2276(a), "Commercial space launch cooperation," permitting the Secretary of Defense to take action to:

- Maximize the use of the capacity of the space transportation infrastructure of the DOD by the private sector in the U.S.
- Maximize the effectiveness and efficiency of the space transportation infrastructure of the DOD.
- Reduce the cost of services provided by the DOD related to space transportation infrastructure at launch support facilities and space recovery support facilities.
- Encourage commercial space activities by enabling investment by covered entities[1] in the space transportation infrastructure of the DOD.
- Foster cooperation between the DOD and covered entities.

1.2 Project History

This document initiates the Section 7 consultation process with the U.S. Fish and Wildlife Service (USFWS). An Official Species List from the USFWS was originally obtained in 2023 to serve as the basis for the analysis; however, as the project has developed, the action area has been updated and inclusion of listed species amended. The USFWS's online Information for Planning and Consultation (IPaC) species list retrieved in January 2025 (Appendix A) identifies species and other resources that may occur within the updated action area and serves as the basis for analysis in this Biological and Conference Assessment (BCA).

1.2.1 Correspondence

A species list identifying federally threatened, endangered, and proposed species and other resources that may occur within the action area was retrieved from the USFWS's online IPaC in January 2025 (Appendix A). An early coordination meeting with USFWS personnel was held on September 15, 2023, to discuss the National Environmental Policy Act (NEPA) action and strategy for this BCA.

The USFWS is responsible for the recovery and conservation of all federally listed terrestrial wildlife and plant species. The National Marine Fisheries Service (NMFS) shares jurisdiction with the USFWS for the recovery and conservation of threatened and endangered marine species. The NMFS has jurisdiction over all marine species except for manatees and nesting sea turtles. A separate Section 7 consultation with the NMFS has been initiated for sea turtles and other protected species under the Endangered Species Act (ESA) in the offshore portions of the action area where they may be subject to noise and possible impacts from falling debris from landings that would occur in the ocean. A consultation with the NMFS will also be initiated to assess Marine Mammal Protection Act and Essential Fish Habitat potential impacts on marine species within the action area. This BCA focuses on the effects of the Proposed Action on terrestrial species, West Indian manatee, and nesting sea turtles.

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[1] The term "covered entity" means a non-federal entity that is organized under the laws of the U.S. or of any jurisdiction within the U.S. and is engaged in commercial space activities.

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2. Description of the Action and Action Area

The following sections detail the Proposed Action and the considerations in determining and defining the action area.

2.1 Federal Action and Legal Authority/Agency Discretion

The DAF is the lead federal agency for this consultation because the Proposed Action includes the execution of a real property agreement between USSF and SpaceX. The DAF is the parent organization to USSF.

Other permits and approvals that may be required include the following:

- FAA Licenses under *Code of Federal Regulations* (CFR) Title 14, Part 450
- U.S. Department of Transportation Act Section 4(f) Consideration
- National Historic Preservation Act Section 106 Consultation
- U.S. Army Corps of Engineers Clean Water Act Section 404 Permit

2.2 Proposed Action

The Proposed Action is the potential execution of a real property agreement between USSF and SpaceX at CCSFS, the issuance of a vehicle operator license for Starship-Super Heavy non- DOD operations at CCSFS by the FAA, and approval of related airspace closures by the FAA for operations.

SpaceX would redevelop SLC-37 at CCSFS to support Starship-Super Heavy launch and landing operations. SLC-37 previously supported the ULA Delta IV Heavy launch vehicle. In the *Range of the Future Cape Canaveral Space Force Station District Plan*, USSF identified a need to reallocate SLC-37 as a medium- or heavy-lift to a future launch provider after the completion of the remaining scheduled Delta IV Heavy launches (USSF 2022).

USSF would issue two lease agreements to SpaceX for the use of SLC-37. The first agreement would lease the area north of Patrol Road containing the existing SLC-37, which is currently available. The second agreement would lease the area south of Patrol Road, which includes the Horizontal Integration Facility (HIF) and would be available at the end of 2027. Separate lease agreements are necessary to accommodate the differing availability of each area. The leased areas would form an area larger than SpaceX's current needs; all construction and earth-moving activities would occur within the "construction area."

SpaceX has developed a notional site plan for SLC-37. The site plan is subject to change as SpaceX refines the design for construction and approvals are obtained from the DAF. Modifications to building location and design would not affect the findings of this BCA.

Various road improvements at CCSFS and the Kennedy Space Center (KSC) would be necessary to facilitate Starship-Super Heavy launch vehicle transport. SpaceX would widen Phillips Parkway to approximately 34 feet from Saturn Causeway to the launch site for approximately 7 miles, primarily within the existing maintained roadway 60-foot corridor. Old A1A would be improved and widened approximately 34 feet for approximately 1 mile between SLC-37 to Phillips Parkway, and a maintained 60-foot corridor would be established for Old A1A. SpaceX would add two turn radiuses to accommodate the efficient movement of the launch vehicle components. One turn radius would be located at the northeast corner of Phillips Parkway and Patrol Road, and the second turn radius would be located at the northwest corner of Patrol Road and Beach Road.

The Proposed Action also includes the operational activities of Starship-Super Heavy operations, that is, the transport of the launch vehicle's components to the launch pad, pre-launch operations (including static-fire testing), launches, and landings. The Proposed Action also consists of conservation measures to minimize the effects of these activities on ESA-listed species, critical habitats, and overall wildlife. The following is a detailed explanation of the Proposed Action details, including construction and operational activities.

2.2.1 Construction Activities

Table 2-1 provides a summary of the launch and landing support facilities, as well as transportation infrastructure, that would need to be constructed at the existing SLC-37 and along existing roadways.

Table 2-1. Starship-Super Heavy Launch, Landing, and Support Infrastructure

Structure	Description
Roadway Improvements	To facilitate vehicle transport, SpaceX would widen Phillips Parkway to approximately 34 feet of pavement from SLC-37 to Pad A Bypass Road on KSC for approximately 7 miles, primarily within the existing 60-foot roadway corridor. Approximately 4 miles of Phillips Parkway widening would occur on CCSFS and approximately 3 miles on KSC. Old A1A would be improved and widened to approximately 34 feet for approximately 1 mile between SLC-37 to Phillips Parkway (Figure 2-1). SpaceX would add two turn radiuses. One turn radius would be located at the northeast corner of Phillips Parkway and Patrol Road, and the second turn radius would be located at the northwest corner of Patrol Road and Beach Road.
Launch Mounts	Two launch mounts, approximately 38 feet tall and 38 feet wide, would be used as the foundation for stacking the two stages of the Starship-Super Heavy launch vehicle (Figure 2-7). The launch mounts would be placed on two concrete launch pads approximately 400 feet long by 400 feet wide.
Launch Integration Towers	Two integration towers, each approximately 600 feet tall, 40 feet wide, and 40 feet long, would be used to vertically integrate the Starship-Super Heavy vehicle on the launch mount (Figure 2-7). The integration towers would be located on the launch pads.
Launch Flame Trenches, Deluges, and Diverters	A launch diverter or flame trench structure would be placed directly underneath the launch mount to divert the heat plume away from the ground. Flame trenches and diverters would reduce the acoustic and thermal energy to the launch vehicle, payload, and ground systems during launch and landing. Water would be required for these systems. The water would discharge via a water-cooled diverter and/or deluge. Water would be retained in ponds within the launch site boundary. Whenever possible, the deluge water would be reused for the next launch. The water retention ponds would be filled with water from the existing mainline. Various engineering designs would be used to limit the heat plume temperature dispersion, including deluge, lofted diverter, or berms. The specific design of the diverter has not been developed yet; however, it is possible for the diverters to be bifurcated or directional. These design features would be developed to keep the heat plume within the fence line.
Landing Pads	Two concrete landing pads, approximately 225 feet in diameter, could be constructed on site, if space allows within the SLC-37. Two catch towers, similar to the integration towers, would be placed on the landing pads.
Propellant Generation – Natural Gas Area	A natural gas pretreatment system would remove impurities such as mercury, sulfur, water, CO_2, and hydrocarbons heavier than CH_4 from the pipeline-quality natural gas to produce a stream of higher purity gaseous CH_4. Surplus natural gas would be used for process work or power generation. The natural gas pretreatment system would include a small amine treating unit for CO_2 removal; a heavies scrub column[a] that would be up to 100 feet tall and 10 feet in diameter; and multiple smaller vessels approximately 6 feet in diameter and up to 30 feet tall. The system would be in the launch complex.

Structure	Description
Propellant Generation – Methane Liquefier	A CH_4 liquefier would supercool pretreated natural gas into a liquid state for storage and transportation. Together, the natural gas pretreatment and liquefier would comprise several structures, each up to 65 feet tall. The CH_4 liquefier could be up to 3 acres. The CH_4 liquefier would be cooled by a typical evaporative cooling tower requiring up to approximately 132 gallons per minute of water and producing up to approximately 13 gallons per minute of wastewater (approximately 5.3 million gallons annually) that would be treated onsite via evaporation or retention ponds or hauled off site by trucks. The system would be in the launch complex and would comply with all regulatory requirements
Propellant Generation – ASU	An ASU would be constructed to generate the LN_2 and LOX required for launch operations. An ASU dehumidifies, liquefies, and separates ambient air into oxygen and nitrogen. In addition to the primary oxygen and nitrogen liquid products, the ASU would produce a waste nitrogen stream composed of rejected atmospheric gases, principally nitrogen, oxygen, and argon that would be vented to the atmosphere. The ASU would comprise a primary cold box structure up to 180 feet tall and a smaller supporting infrastructure up to 60 feet tall. The ASU would be cooled by a typical evaporative cooling tower requiring up to approximately 660 gallons per minute of water and producing up to approximately 66 gallons per minute of wastewater (12.4 million gallons annually) that would be treated onsite via evaporation and retention ponds or hauled off site by trucks.
Propellant Commodity Storage	Onsite propellant storage would be sized to support up to 2.3 launches at any given time; however, the storage could be incrementally expanded to meet increased propellant demands. Increases to storage would be assessed for potential environmental effect and additional NEPA analysis would be conducted, as necessary. Commodity tanks would hold LOX, LN_2, water, helium, gaseous nitrogen, gaseous CH_4, and liquid CH_4. The approximate sizes of the commodity tanks include 16,500 tons for LOX, 6,500 tons for LN_2, and 5,000 tons for liquid CH_4. The location of the tanks would comply with LOX and liquid natural gas location siting regulations (NFPA 251 and NFPA 59A).
Lighting	Nighttime launch activities require bright spotlighting for short durations to illuminate the launch vehicle at the launch site. Lighting is needed to ensure the protection and safety of SpaceX personnel and hardware. In addition to potential nighttime test, launch, and landing activities, SpaceX would need to perform ground-support operations 24 hours a day, 7 days a week, throughout the year; however, these routine operations would not require engine ignition or bright spotlighting.
Utilities – Power	An electrical substation of up to 130 kilovolts is proposed for the launch site; Florida Power and Light would provide up to 250 megawatts of power via the existing Delta substation. If it is determined that the existing available power is insufficient to serve SpaceX's needs, power needs would be supplemented using Tesla Mega packs[b]. No additional power upgrades are proposed.
Utilities – Fiber	New fiber connectivity lines would be routed underground within the right-of-way along Phillips Parkway.
Utilities – Water	The launch site would use existing water and sewer systems, and use or relocate lines, where practicable.
Utilities – Natural Gas	Natural gas would be brought to the launch site through a multi-user pipeline that serves all commercial launch providers and government agencies at the installations. The natural gas pipeline would extend from the existing natural gas mainline on KSC. The main natural gas pipeline enters KSC where NASA and Kennedy Parkways intersect. Florida City Gas is in the process of extending the pipeline underground at KSC and CCSFS to provide additional service; however, the extension of the pipeline is not part of this EIS. SpaceX would connect to the existing natural gas pipeline; however, this would not be required for launch.
Utilities – Nitrogen and Helium	Nitrogen and helium utilities would connect to the existing systems on CCSFS. All utilities would tie into a proposed utilities yard at the launch site.

Structure	Description
Staging, Storage, and Support Infrastructure	Infrastructure would include tie-down foundations for short-term storage and a crane staging area. SpaceX would also construct an approximately 23,000-square-foot, 30-foot-tall ground support equipment fabrication building; an approximately 40,000-square-foot ground support equipment outdoor storage space; and an approximately 20,000-square-foot, 20-foot-tall office building with approximately 100 permanent parking spaces.
Water Infrastructure	Water storage and stormwater ponds would be built on site. The water storage would be used to provide potable water for deluge, which includes water needed for launch, landing, and static-fire tests. SpaceX would retain wastewater for reuse in properly sized retention ponds.

[a] A scrub column is used to remove heavy components from natural gas used for propellant generation.

[b] Tesla Megapack is a large-scale rechargeable lithium-ion battery stationary energy storage product, intended for use at battery storage power stations.

ASU = Air Separation Unit

NFPA = National Fire Protection Association

2.2.1.1 SLC-37

SpaceX would redevelop SLC-37 at CCSFS to support Starship-Super Heavy launch and landing operations. The redevelopment of SLC-37 would include the construction of launch pads, launch mounts, launch integration towers, launch flame trenches and diverters, landing pads, landing catch towers/test stands, propellant generation and commodity storage, lighting, utilities, staging, storage, support infrastructure, fence line, ASU, HIF, substation, and parking lot for a total area of 177.8 acres. Figure 2-1 provides the SLC-37 notional site plan. For purposes of this BCA, it is assumed that the entire area within the construction area would be disturbed during construction activities. SLC-37 would be generally unsuitable for ESA-listed species' habitat postconstruction due to operations.

2.2.1.2 Transport Infrastructure

Starship and Super Heavy vehicle components would be transported across KSC on existing roadways to CCSFS and SLC-37 by trucks. To facilitate vehicle transport, SpaceX would widen Phillips Parkway for approximately 7 miles from Saturn Causeway to SLC-37 (Figure 2-2). The roadway would be widened to approximately 34 feet of pavement (on center), creating an approximately 60-foot corridor within the existing mowed roadway ROW, for a total improvement of 1.4 acres excluding existing paved roadway surface (Figure 2-3). Additionally, two turn radiuses at the northeastern corner of the intersection of Phillips Parkway and Patrol Road and one at the northwestern corner of the intersection of Patrol Road and Beach Road would be required to accommodate the larger turning radius needed for vehicle transport, resulting in less than 1 acre of widening within existing maintained ROW. The additional turning radius acreage is included in the Phillips Parkway total (Figure 2-1) for a total of 11.4 acres, excluding impervious areas.

SpaceX would also widen Old A1A, a historic fallow roadway, for approximately 1 mile from Phillips Parkway to SLC-37 (Figure 2-2). The roadway would be improved and widened to approximately 38 feet (17 feet west of center and 21 feet east of center), creating an approximately 64-foot corridor for a total improvement of 2.4 acres, excluding existing paved roadway surface (Figure 2-3). Roadway widenings and turn radius improvements (referred to hereafter as the roadway improvement construction areas) would result in the creation of 13.8 acres of impervious surfaces.

Construction vehicles and construction materials transport will use existing CCSFS roadways. Construction is expected to take approximately 12 months, during which time construction traffic will increase existing CCSFS traffic. Construction activities will occur during the day and the night.

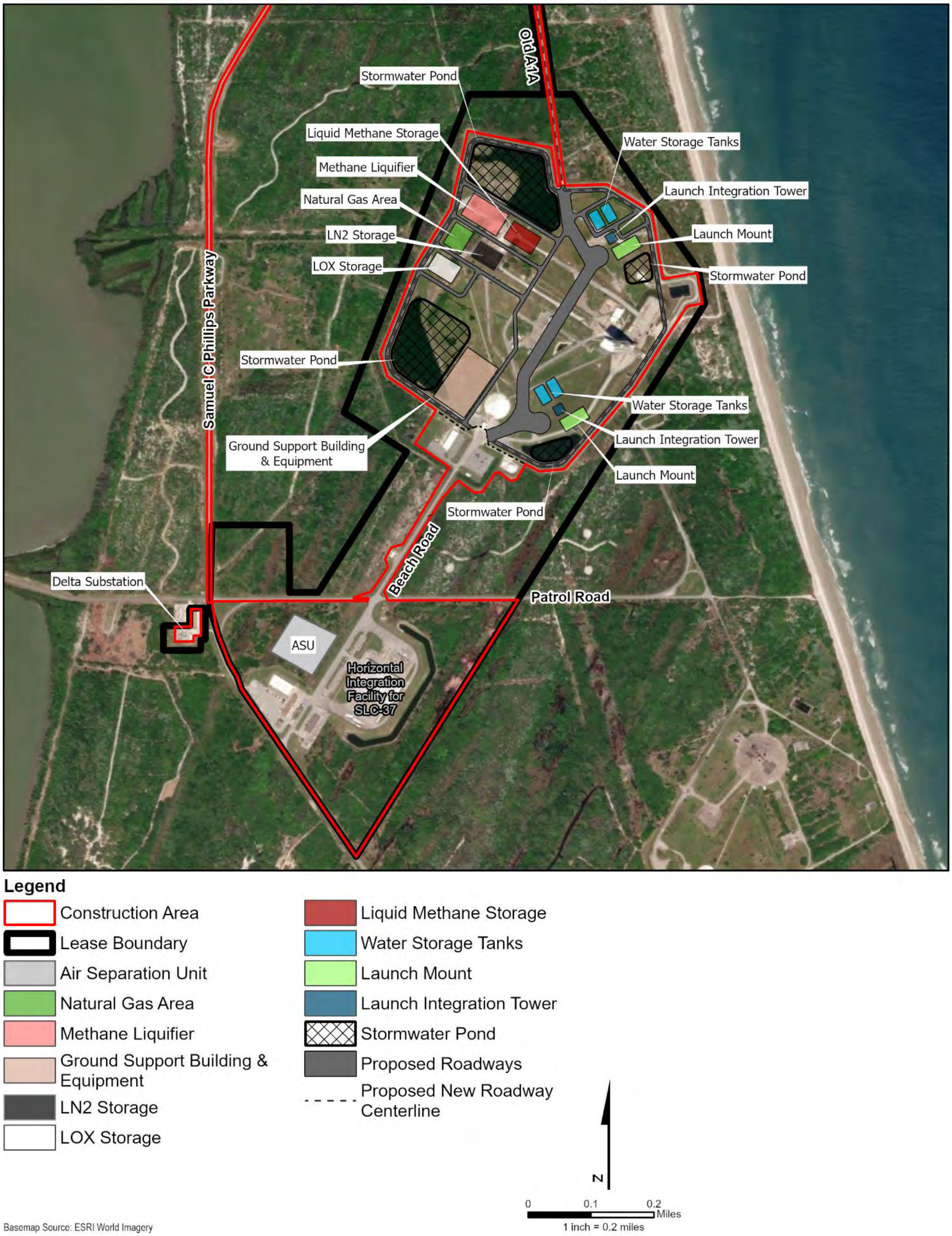

Figure 2-1. SLC-37 Construction Area Notional Site Plan

Figure 2-2. Roadway Construction Area Overview

Figure 2-3. Roadway Construction Areas – Typical Widening

2.2.2 Operational Characteristics

Starship-Super Heavy operations would include the transport of the launch vehicle's components, pre-flight operations, including static-fire testing; launches; and landings. The Starship and Super Heavy booster landings would primarily occur at SLC-37; however, depending on mission requirements, a few launches may involve expending in the ocean or landing it on a floating platform. Table 2-2 provides details of the Starship-Super Heavy operations at CCSFS.

Table 2-2. Summary of Starship-Super Heavy Operations

Activity	Description
Transportation of Launch Vehicle Components	Starship, Super Heavy, and vehicle components would be transported via a tug and barge from the Port of Brownsville, Texas, to CCSFS Port Canaveral or KSC wharfs. The vehicle components would then be delivered to the launch site via over-the-road transport.
Pre-Flight Operations	Pre-launch operations would include ground tests, tank tests, spin tests, mission rehearsals (wet and dry), and static-fire tests. These tests are needed to verify that all vehicle and ground systems are functioning properly and in accordance with documented procedures before launch. Except for static-fire testing, no propellant release or ignition would occur. It is anticipated that there would be one static-fire test per stage per launch operation, lasting up to 15 seconds in duration. That is, 76 static-fire tests for Starship and 76 for the Super Heavy booster.
Launch	There would be a maximum of 76 launches per year: • 38 during daytime (sunrise to sunset) • 38 during nighttime (sunset to sunrise) • Scrubs (20% of launches) = 16 events A heat and exhaust plume would be created: • Bifurcated diverter and deluge water design • At or below ambient[a] temperatures (facility fence line) • Duration = 20 seconds A sonic boom would be generated offshore.
Super Heavy Landing (Return to Launch Site)	After the Super Heavy booster separates from Starship, it would perform a controlled descent using grid fins, engines, and atmospheric resistance to slow down and guide it for a precise return to the tower at the launch site to be caught with the tower's arms. The Super Heavy booster landing would generate a sonic boom over land. Following Super Heavy booster landing, any remaining LOX would be vented to the atmosphere, and the remaining liquid methane would be released to the atmosphere or safely combusted.
Super Heavy Landing (Floating Platform Scenario)	After the Super Heavy booster separates from Starship, Super Heavy booster could land in the Atlantic Ocean on a floating platform (mobile vessel not attached to the sea floor) no closer than 5 nautical miles off the coast. Super Heavy would be delivered by barge and roadways to a SpaceX facility for refurbishment. The landing would generate a sonic boom over the ocean. Following a Super Heavy landing, remaining LOX would be vented to the atmosphere, and the remaining liquid methane would be released to the atmosphere or safely combusted.

Activity	Description
Super Heavy Landing (Expendable Scenario)	After the booster separates from Starship, Super Heavy would be expended in a target area in the Atlantic Ocean at least 1 nautical mile from the shore. An expended Super Heavy would break up above the ocean's surface or on impact with the ocean's surface and is expected to sink. SpaceX would expend approximately four Super Heavy boosters per year. An expended mission would result in a sonic boom.
Starship Landing (Launch Pad or Floating Platform Scenario) *Primary Landing Method*	The Starship landing would closely resemble the Super Heavy landing and could occur either at the launch site or on a floating platform in the open ocean between 55°S and 55°N latitudes. The Starship landing would generate a sonic boom over land. Starship would have approximately 5 MT of liquid methane onboard following a flight. Any LOX remaining in the vehicle would be vented to the atmosphere, and liquid methane would be released or safely combusted. For the purposes of the environmental review, this analysis assumes all residual methane is released to the atmosphere.
Starship Landing (Expendable Scenario)	If necessary, Starship could be expended in the Pacific, Atlantic, Gulf of America, or Indian Oceans. Controlled descent: After ascent engine cutoff, Starship could vent residual main tank propellant at or above 74.5 miles above ground level. Starship would either conduct a deorbit burn to begin its controlled descent, resulting in structural failure upon impact, or would conduct a soft water landing, during which the vehicle's engines would fire before impact with the ocean's surface, causing the vehicle to land vertically and intact. The vehicle would then take on water and sink or be scuttled. Uncontrolled descent: Starship would break up during atmospheric entry. Most of the launch vehicle debris is made of steel and would sink. Floating debris would be recovered or eventually sink or be sunk intentionally.
Launch Trajectories	Starship-Super Heavy launch azimuths would range from 40° to 115°, from a reference of due north at 0° and due east at 90°.
Landing Trajectories	The Super Heavy booster would perform a flip remover midflight and return to the launch pad or a nearby platform. Starship could land at SLC-37 or on a platform in the open ocean between 55°S and 55°N latitudes. Following an in-space cost phase, Starship would conduct a deorbit maneuver and return to Earth from the west to the east over central Florida. Existing restricted airspace parameters would not need to be modified for Starship operations.
Payloads	Payloads would be similar to, but larger than, current and planned payloads launched on the Falcon 9 or Falcon Heavy. Payloads and their associated materials, fuels, and volumes are mission dependent.
Area Closures	Pre-launch ground and airspace closures will occur for the time needed for the operation to meet its mission objectives. Closures associated with operations are intended to keep aircraft and the public out of a specific area throughout the duration of the operational activities.

[a] Ambient is defined as 100 degrees Fahrenheit (°F), which equates to the high summer temperatures for Brevard County.

2.2.2.1 Vehicle Transport

Starship, Super Heavy, and vehicle components would arrive from SpaceX Starbase in Texas. The components would be transported via a tug and barge from the Port of Brownsville, Texas, to CCSFS Port Canaveral or KSC wharfs (Figure 2-4). The vehicle components would then be delivered to the launch site via over-the-road transport. The transport of vehicle components from Texas to Florida would be episodic and would use common shipping and roadway corridors, which already experience similar sized traffic.

SpaceX’s goal is for Starship-Super Heavy to require minimal refurbishment to achieve rapid reusability of the launch vehicle. To achieve this, SpaceX plans to perform vehicle integration (process of assembling components of the launch vehicle) and refurbishment, if needed, at the launch site. However, SpaceX may use its additional existing SpaceX facilities on CCSFS or KSC for refurbishment, if necessary.

Larger Starship and Super Heavy vehicle components would be transported from Boca Chica, Texas, to Port Canaveral, Florida, via barge (Figure 2-4). The barge operations would follow U.S. Coast Guard requirements and are in keeping with normal operations in the area.

Figure 2-4. Vehicle Barge Transport

2.2.2.2 Pre-Launch

Pre-launch operations would include ground tests, tank tests, spin tests, mission rehearsals (wet and dry), and static-fire engine tests to verify that all vehicle and ground systems are functioning properly and in accordance with documented procedures before launch. Except for static-fire engine testing, no propellant release or ignition would occur. It is anticipated that there would be one static-fire test per stage per launch operation (76 events maximum), conducted separately, each lasting up to 15 seconds in duration. All propellant transfers would maximize recapture methods.

A dry dress rehearsal simulates launch day conditions, where a full launch countdown is conducted, but the vehicle is not fueled. A wet dress rehearsal is similar to a dry dress rehearsal, except the vehicle is fueled. This test allows the launch team to practice timelines and procedures used for launch and identify potential issues.

Tank tests are used to verify the reliability of the launch vehicle tanks and involve performing proof pressure tests to confirm the structural integrity of the launch vehicle tanks. The tanks are pressurized past their rated limit to confirm their structural integrity with appropriate factors of safety. These proof pressure tests are designed not to release any propellant to the environment. All propellant is recycled back into the ground system tanks after the test is completed. Tank tests do not involve mixing explosive commodities and are designed to test an accepted safety limit; thus, they are not expected to explode or spread debris.

Spin tests are conducted to test engines. During a spin test, the vehicle engines are chilled, and pumps are spun to operating speed but stopped before engine ignition.

Static-fire testing verifies engine control and performance. During a static-fire test, the launch vehicle engines are ignited for a short duration to generate a heat plume and then shut down. SpaceX would perform a Starship static-fire test before integrating Starship with Super Heavy. SpaceX would also perform a Super Heavy static-fire test, either by itself or with Starship integrated (76 events maximum). It is possible, though not expected, that a static-fire test could be unsuccessful. If an static-fire test is unsuccessful, SpaceX would attempt another. A static-fire test may be unsuccessful if one or more engine(s) fail to properly ignite or if other issues are identified with the vehicle or ground safety equipment. SpaceX plans to conduct one static-fire test per stage, per launch operation. Static fires would be up to 15 seconds in duration.

After the wet dress rehearsal and static-fire test, SpaceX would transfer the propellant back into the commodity tanks. During Starship fuel loading for a static-fire test of the integrated launch vehicle, gaseous methane could be released to the atmosphere or combusted; however, SpaceX intends to recapture methane, where practicable. This release would be minimal because the liquid methane would be released as gaseous methane vented from the stage to maintain pressure, and only a small percentage of the vehicle tank’s propellant would be vented. It is standard practice for all launch vehicles to vent cryogenics to maintain pressure.

Ground and airspace closures will occur pre-launch to keep aircraft and the public out of a specific region during hazardous activities. SLD 45 would establish mission-specific Launch Safety Exclusionary Zones for every Starship-Super Heavy launch and landing event. Figure 2-5 presents a notional restricted area map for a generic Starship-Super Heavy launch/landing and static-fire test at SLC-37. The figure is meant to demonstrate the extent of potential closures; however, the actual Launch Safety Zones for specific missions may differ. SpaceX will work with SLD 45 to confirm that monitoring requirements for CCSFS are met.

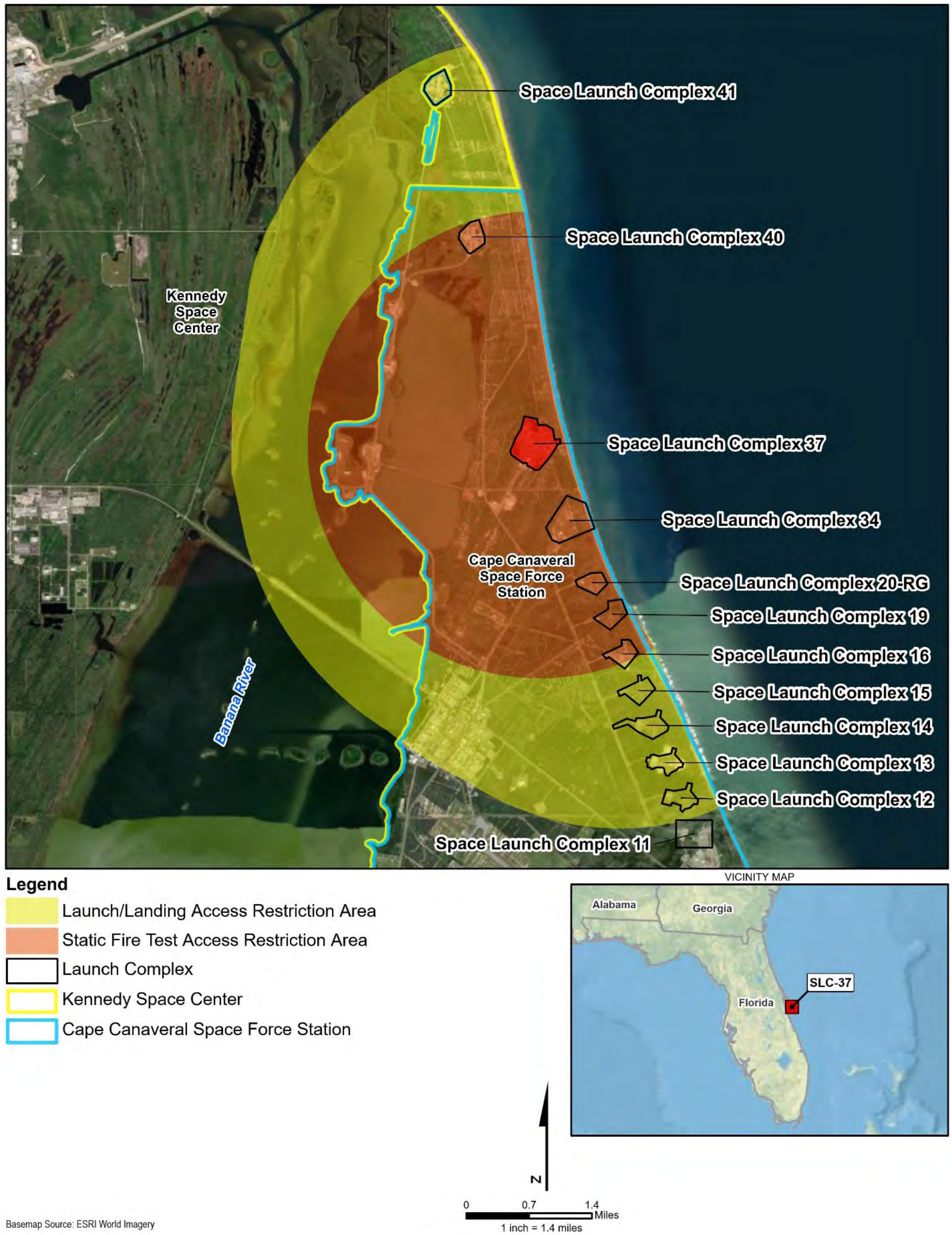

Figure 2-5. Notional Access Restriction Areas

2.2.2.3 Launch

During launch, the ignition of the Starship-Super Heavy Raptor engines would generate a heat and exhaust plume that would appear clear and consist of water vapor, CO_2, carbon monoxide, hydrogen, methane, nitrogen oxides, and oxygen. Two launch pads will be constructed at SLC-37, each with a bifurcated diverter and deluge water design used to limit the extent of heat and exhaust plume. The maximum heat plume would occur during engine ignition and would travel away from the launch pad, reaching approximately at or below ambient temperatures at the SLC-37 fence line, lasting approximately 20 seconds before dissipating. The bifurcated divert will direct the heat and exhaust upward and away from the ground surface from opposing sides of the launch pad. The diverter will further be oriented such that the heat and exhaust plume will remain within the launch complex fence line dropping to or below ambient temperatures at the SLC-37 fence line.

The launch trajectories for the Starship-Super Heavy program need to accommodate eastward trajectories, which allow the spacecraft to benefit from the earth's natural rotation. Specific flight trajectories vary based on mission and depend on desired payload orbit. Starship-Super Heavy launch azimuths would range from 40° to 115°, from a reference of due north at 0° and due east at 90°. Existing restricted airspace parameters would not need to be modified for Starship-Super Heavy operations (Figure 2-6).

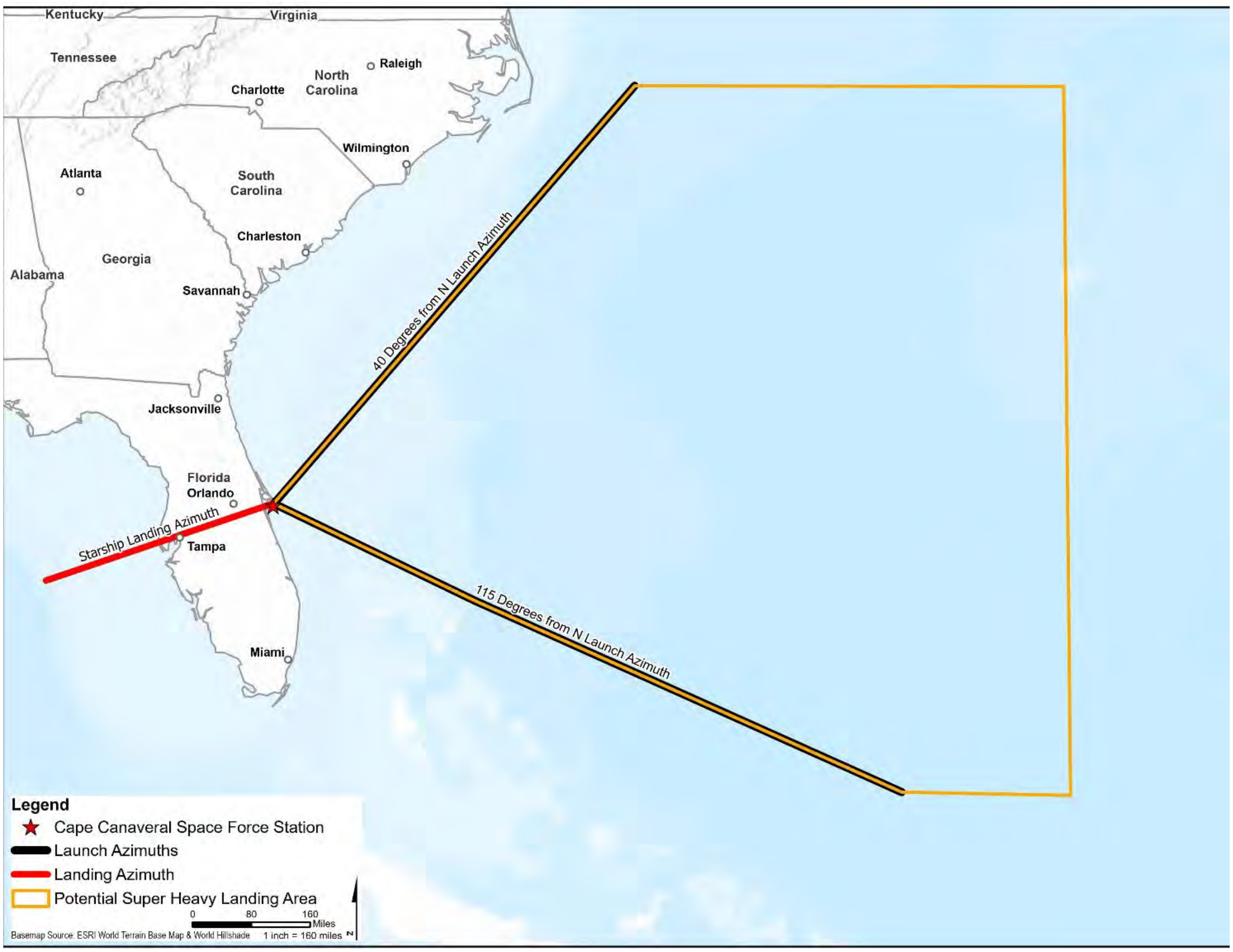

Figure 2-6. Launch Azimuths

2.2.2.4 Landing

The following sections describe the landings of the Super Heavy booster and Starship.

2.2.2.4.1 Super Heavy Booster

After separating from Starship, the Super Heavy booster would perform a controlled descent using atmospheric resistance to slow it down and guide it for a precise return to the tower at SLC-37 to be caught with the tower's arms. Once near the landing location, Super Heavy would ignite its engines to conduct a controlled landing. Super Heavy would land vertically at the catch tower and go into an automated safing sequence (that is, would enter a safe state). During landing the Super Heavy booster would generate a sonic boom. The maximum anticipated landings at SLC-37 would be 76 times per year.

Following a Super Heavy landing, LOX and liquid methane would remain in the Super Heavy booster. The remaining LOX would be vented to the atmosphere, and the remaining liquid methane would be released to the atmosphere or safely combusted. SpaceX would be unable to reconnect the vehicle to ground systems while liquid methane remains in the vehicle because of the risks to personnel. For the purposes of this environmental review, this analysis assumes all residual methane is released to the atmosphere.

After the booster separates from Starship, Super Heavy could also land in the Atlantic Ocean on a floating platform (mobile vessel not attached to the sea floor) no closer than 5 nautical miles off the coast. Super Heavy would be delivered by barge and roadways to a SpaceX facility for refurbishment. If a landing were to occur within the territorial seas of a nation other than the U.S., appropriate coordination through the U.S. Department of State would occur. The landing of the Super Heavy Booster on the floating platform would cause a sonic boom. The number of floating platform landings are unknown because atmospheric and vehicle conditions dictate where the booster can land post-launch, though the preference will always be to return to the launch pad. For the purposes of this assessment, all landings were assumed to occur at SLC-37 where the potential for effects on ESA-listed species and critical habitat are greatest. Venting of remaining LOX and liquid methane would be the same as under the floating platform scenario as is with the return to the launch complex scenario.

Although SpaceX intends for Super Heavy to be fully reusable following most operational flights, expending (that is, not recovering) vehicles may be required. After the booster separates from Starship, Super Heavy could be expended in a target area in the Atlantic Ocean at least 1 nautical mile from the shore. Expendable Super Heavy landings would occur during program development and/or if mission payload or desired orbit requirements would result in too little propellant remaining in Super Heavy to return to the launch site. An expended Super Heavy would break up above the ocean's surface or on impact with the ocean's surface, and it is expected to sink. As the booster breaks up, propellants still onboard would mix causing an explosive reaction. SpaceX would expect to expend approximately four Super Heavy boosters per year. An expended mission will result in the creation of a sonic boom.

2.2.2.4.2 Starship

The Starship landing would closely resemble the Super Heavy landing and could occur either at the launch complex or on a floating platform in the open ocean between 55°S and 55°N latitudes. However, Starship landing returning from orbit would occur from westerly heading relative to the launch complex or floating platform as the vehicle re-enters the atmosphere. The Starship landing would also generate a sonic boom.

Starship would have approximately 5 MT of liquid methane onboard following a flight. Any LOX remaining in the vehicle would be vented to the atmosphere, and liquid methane would be released or safely combusted. For the purposes of the environmental review, this analysis assumes all residual methane is released to the atmosphere.

If necessary, Starship could be expended in the ocean, by controlled or uncontrolled descent, in seven potential areas in the Pacific Ocean, Atlantic Ocean, Gulf of America, and Indian Ocean (Figure 2-7). In a controlled descent, after ascent engine cutoff, Starship could vent residual main tank propellant during the in-space coast phase of the launch at or above 74.5 miles above ground level. Following the in-space coast phase, Starship would conduct a deorbit burn to begin its controlled descent. Upon ocean impact, structural failure would allow the remaining LOX and methane to mix, resulting in an explosive event. Alternatively, Starship could conduct a soft water landing during which the vehicle's engines would fire before impact with the ocean's surface, causing the vehicle to land vertically and intact. The vehicle would then take on water and sink or be scuttled.

In an unanticipated and unlikely, but still possible, uncontrolled descent, Starship would break up during atmospheric entry. Most of the launch vehicle debris is made of steel and would sink. Lighter items not made of steel, such as composite overwrapped pressure vessels, may float but are expected to eventually become waterlogged and sink. If there were reports of large debris, SpaceX would coordinate with marine debris specialists to survey the situation and sink or recover any large floating debris, as necessary. SpaceX would coordinate with all land and water regulatory authorities, including the U.S. Coast Guard before recovering debris.

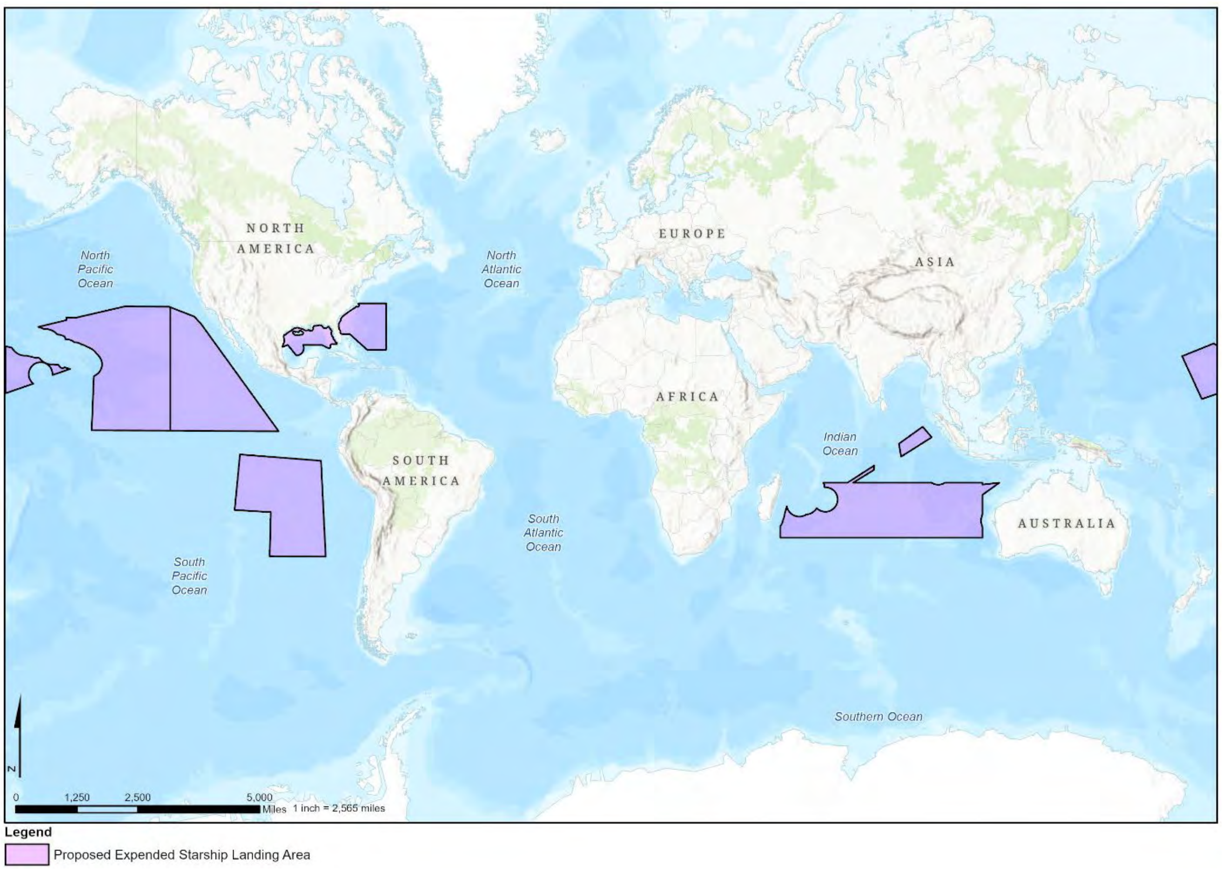

Figure 2-7. Starship Expendable Landing Areas

2.2.2.5 Payloads

Starship-Super Heavy program payloads would be similar to, but larger than, current and planned payloads launched on Falcon 9 and Falcon Heavy. Payloads and their associated materials, fuels, and volumes are mission dependent but would be in keeping with the current commercial and government payloads analyzed in the *Environmental Assessment for Launch of NASA Routine Payloads* (NASA 2011). Any unique payloads that are not covered under existing NEPA documents would be addressed under a separate mission-specific NEPA analysis. The integration of payloads would be dependent on mission and would occur at existing government or SpaceX facilities.

2.2.3 Proposed Conservation Measures

To eliminate, avoid, minimize, and mitigate the effects on ESA-listed species and critical habitat, the following conservation measures would be implemented during the construction and operation phases of the Proposed Action. Conservation measures are defined as “actions to benefit or promote the recovery of listed species that are included by the Federal agency as an integral part of the Proposed Action. These actions will be taken by the Federal agency or applicant and serve to minimize or compensate for project effects on the species under review. These may include actions taken before the initiation of consultation, or actions which the Federal agency or applicant have committed to complete in a Biological Assessment (BA) or similar document” (USFWS and NMFS 1998). Some of the measures described in the sections that follow are required by other regulations that are applicable to the proposed construction and operations (for example, Clean Water Act).

2.2.3.1 Natural Resource Training

NRT1 – SpaceX will generate natural resources training for employees and contractors that will include the following:

- Instruction on implemented the conservation measures in this BCA and any terms and conditions issued under the associated biological opinion (BO), as well as potential penalties for noncompliance
- Guidance on wildlife encounters, photos of species and habitats
- Contact and reporting requirements for listed species observations, injury, or mortality
- Instructions on minimizing the spread of invasive plant species
- Notice of posted speed limits, designated parking areas, and road closures
- Wildfire prevention
- Proper disposal of litter, garbage, and construction site housekeeping

NRT2 – Conducting natural resources training for all onsite personnel annually or before a new construction or operations activity is initiated or new initiated personnel are brought onsite.

2.2.3.2 General Construction Measures

These measures are applicable during the construction phase of the Proposed Action:

GC1 – SpaceX will limit vehicle operations outside of construction areas to designated paved and unpaved roads and parking areas.

GC2 – SpaceX will report any instances of ESA-listed species occurrence within construction activity areas to Space Launch Delta 45 (SLD 45) and will not attempt to remove them.

GC3 – SpaceX will instruct contractors to minimize impacts on adjacent natural habitats outside of construction areas, such as maintenance and use of heavy equipment including regularly inspecting for insurance that hydraulic hoses and fittings are in good condition and that there are no petroleum leaks.

GC4 – Reduced speed limits within the construction area will be implemented to minimize the potential risk of direct mortality of listed species as a result of collisions with vehicles.

GC5 – SpaceX and CCSFS will work with the USFWS with respect to light barriers to reduce artificial light emitted on shoreline/beach habitats.

2.2.3.3 General Operation Measures

These measures are applicable during the operations of the Proposed Action:

GO1 – For the purposes of habitat restoration and hazardous fuels reduction, the fire management program on CCSFS is coordinated by 45 CES/CEIE-C for SLD 45 and administered by the Air Force Wildland Fire Branch (AFCEC/CZOF). The fire management program on KSC is managed by MINWR (USFWS). Unless superseded or revised, the Prescribed Burn Memorandum of Understanding (MOU), KCA-4205 Revision C (2025) between SLD 45, NASA, and the USFWS outlines the procedures these agencies will use to schedule and coordinate prescribed burning with launch operations. While the Proposed Action could cause a loss of burn days as a result of an increased cadence of launch and landing operations, SpaceX will continue efforts through interagency coordination to ensure current fire management program activities will not be significantly impacted and SLD 45, KSC, and MINWR can continue to meet burn requirements and goals.

GO2 – SpaceX will report any instances of ESA-listed species occurrence where they may conflict with SLC-37 operations to SLD 45 and will not attempt to remove them.

GO3 – SpaceX will immediately report any distressed, injured, or dead federally listed species to SLD 45. If launch-related mortality of a federally listed species is documented, SpaceX will report it to the USFWS within 24 hours.

GO4 – SpaceX will confirm that all operations will adhere to LMP requirements.

2.2.3.4 Species-Specific Measures

2.2.3.4.1 Southeastern Beach Mouse

SEBM 1 – Implementing a spill prevention, control, and countermeasure plan would minimize the potential for spills to occur and would promote prompt containment if a spill were to occur. This will help encourage potential contaminants to not leave the construction area and enter nearby habitats for species such as the southeastern beach mouse.

2.2.3.4.2 Florida Scrub-Jay

FSJ1 – Before construction, Florida scrub-jay surveys would be conducted throughout all suitable scrub-jay habitat to confirm no active nests of scrub-jays are within 300 feet of construction. Any nests encountered would be flagged, and no construction would be allowed within 300 feet until all birds have fledged.

2.2.3.4.3 Eastern Indigo Snake

EIS1 – The SLD 45 *Indigo Snake Protection/Education Plan* (USAF 2023a) would be provided to SpaceX construction personnel. Educational signs and posters would be displayed at SLC-37 and at road widening areas, providing contact information and work stoppage in the event of an eastern indigo snake sighting. If an eastern indigo snake is encountered during clearing, work in the vicinity of the snake (50 feet) would stop, and the snake would be allowed to move safely out of the SLC-37 construction area of its own volition.

EIS2 – To the extent possible, gopher tortoise burrows would not be disturbed if a minimum 25-foot (7.6-meter) buffer around the mouth of the burrow can remain to connect the burrow to foraging areas in accordance with Florida Fish and Wildlife Conservation Commission (FWC) guidelines. Following FWC guidelines, no more than 90 days before and no fewer than 72 hours before any clearing or construction, a 100% pedestrian survey would be conducted to locate and flag or stake all burrows. Gopher tortoise burrows in areas to be cleared, areas for new construction, or on the shoulder of roads to be widened would be excavated by FWC-approved gopher tortoise agents, and captured tortoises would be relocated in accordance with FWC guidelines to the SLD 45-approved recipient site, located off CCSFS. If an eastern indigo snake is present in a burrow to be excavated, the snake would be allowed to voluntarily leave the area before excavation continues. Excavated burrows would collapse to prevent the inadvertent entombment of eastern indigo snakes in construction areas.

2.2.3.4.4 Sea Turtles

ST1 – SpaceX will design facilities and infrastructure at SLC-37 such that lighting impacts on nesting sea turtles and hatchlings are minimized while meeting safety and security requirements. Lighting will be coordinated with SLD 45 during the design phase. SpaceX will generate an LMP for SLC-37 for implementing temporary and long-term lighting.

ST2 – SpaceX will maintain responsibility for compliance of lighting conservation measures by SpaceX personnel. As a best practice, SpaceX will install lighting in a downward configuration unless it is operationally constrained. Lighting installation will be directed away from the coastline to minimize exposure to sea turtles. Uplighting and side lighting will only be used in the event that a mission-critical operational need arises. Lighting installed will be shielded or covered and directed to shine away from large reflective surfaces.

ST3 – SpaceX will develop a stormwater pollution prevention plan (SWPPP) and will obtain an Environmental Resource Permit and a Florida National Pollutant Discharge Elimination System Generic Permit for Stormwater Discharge from Large and Small Construction Activities.

ST4 – SpaceX will prepare and implement soil and sediment control measures and waste management during construction activities within the construction area. Erosion barriers and silt fencing would be installed to contain sediment runoff, inspected regularly, and maintained to promote effectiveness.

ST5 – SpaceX will work with SLD 45 and the USFWS to investigate the feasibility of transitioning to drone surveys if sea turtle monitoring from all-terrain vehicles and human presence is restricted because of launch activities.

2.2.3.4.5 West Indian Manatee

WIM1 – SpaceX will develop a SWPPP and will obtain an Environmental Resource Permit as well as a Florida National Pollutant Discharge Elimination System Generic Permit for Stormwater Discharge from Large and Small Construction Activities.

WIM2 – SpaceX will prepare and implement soil and sediment control measures and waste management during construction activities within the construction area. Erosion barriers and silt fencing would be installed to contain sediment runoff, inspected regularly, and maintained to promote effectiveness.

WIM3 – Boat and barge operations will follow standard manatee protection measures:

- Vessels will follow routes of deep water and previously established and maintained channels or basins whenever possible.
- Vessels will operate under no wake or idle speeds near docks or posted manatee areas (such as KSC turning basin).
- Boat speeds will be operated under 10 knots (11.5 miles per hour) outside of navigation channels where manatees are observed (that is, Port Canaveral and Indian River).
- Boats will maintain a minimum distance of 50 feet from observed manatees.
- Trained manatee observers will be present at the KSC dock during boat and barge arrival and departure.

2.2.3.4.6 Tricolored Bat

TCB1 – Seasonal restrictions on vegetation removal would be implemented for the tricolored bat to reduce the potential for physical harm during bat maternity season (May–July) or when ambient day time temperatures are 45°F or below.

TCB2 – SpaceX would coordinate with SLD 45 and the USFWS to determine any possible maternity roosts during construction.

2.2.4 Monitoring

SpaceX will work with SLD 45 to confirm that existing species monitoring requirements for CCSFS are met. Area closures during pre-launch and launch operations will be coordinated such that monitoring efforts can be maintained in meeting the goals of the CCSFS Integrated Natural Resource Management Plan (INRMP). Details of coordination for closures and monitoring will be determined through further discussions between SLD 45, USFWS, and SpaceX.

2.2.4.1 Noise and Vibration

SpaceX will implement noise and vibration monitoring for Starship-Super Heavy such that site-specific operational conditions can be documented and reported. Monitoring for noise and vibration should extend radially outward from SLC-37 to encompass the areas where species impacts may occur, including those for southeastern beach mice and sea turtles. SpaceX will implement noise and vibration monitoring for the first 10 launches and landings of Starship-Super Heavy.

2.2.4.2 Southeastern Beach Mouse

SLD 45 and SpaceX, in collaboration with USFWS, will develop and implement an operational monitoring study plan to assess the abundance, distribution, fitness, and habitat suitability of southeastern beach mouse in the vicinity of SLC-37. The results of this monitoring will be used to assess what impacts, if any, Starship-Super Heavy operations are having on southeastern beach mice. The extent of the area to be monitored, the time period for how long monitoring will take, and the components of the monitoring plan will be determined and agreed on by SLD 45, SpaceX, and USFWS. SLD 45, SpaceX, and USFWS will meet annually to discuss monitoring progress to determine if monitoring should continue, if results are showing a need to reinitiate, or if results are showing monitoring can be reduced or terminated. If similar monitoring is being done for Starship-Super Heavy on KSC, NASA will be invited to join in the collaboration to confirm that monitoring is consistent across both sites. It may be beneficial to use the same resources to perform monitoring at both sites for both consistency and cost savings.

2.2.4.3 Florida Scrub-Jay

In conjunction with SLD 45, SpaceX will expand the existing Florida scrub-jay monitoring taking place on CCSFS. SpaceX's roles and responsibility for Florida scrub-jay monitoring will be developed through coordination with SLD 45 and the USFWS.

2.2.4.4 Sea Turtles

SLD 45 and SpaceX, in collaboration with USFWS, will develop and implement an operational monitoring study plan to assess the abundance, distribution, fitness and habitat suitability of nesting sea turtles in the vicinity of SLC-37. The results of this monitoring will be used to assess what impacts, if any, Starship-Super Heavy operations are having nesting adult and hatchling sea turtles. The extent of the area to be monitored, the time period for how long monitoring will take, and the components of the monitoring plan will be determined and agreed on by SLD 45, SpaceX, and USFWS. SLD 45, SpaceX, and USFWS will meet annually to discuss the progress of monitoring to determine if monitoring should continue, if results are showing a need to reinitiate, or if results are showing monitoring can be reduced or terminated. If similar monitoring is being done for Starship-Super Heavy on KSC, NASA will be invited to join in the collaboration to confirm that monitoring is consistent across both sites. It may be beneficial to use the same resources to perform monitoring at both sites for consistency and cost savings.

2.2.5 Habitat Mitigation

USFWS is working to establish a Canaveral Conservation Fund (Fund) to streamline conservation offsets for actions occurring on CCSFS. The Fund will facilitate both on- and offsite habitat restoration, additional species and ecological research, and other recovery projects related to species effects. Projects related to the Fund will be coordinated with the USFWS and USSF. Currently site-specific mitigation of project-related impacts on habitats for the southeastern beach mouse and Florida scrub-jay use impact ratios, which are dependent on impact location. Mitigation is typically handled on CCSFS property; however, with the increase in commercial space launch projects, onsite mitigatable habitat may become increasingly less available.

2.2.5.1 Southeastern Beach Mouse Habitat

Southeastern beach mouse habitat is typically mitigated at a 1:1 ratio for impacts on CCSFS. Under the Proposed Action, SpaceX will be required to mitigate for the permanent loss of southeastern beach mouse habitat from construction activities, including non-paved habitats at SLC-37, mowed ROW along Phillips Parkway, and non-paved habitats along Old A1A. Onsite habitat restoration, if implemented for mitigation, may include mechanical cutting of overgrown scrub, treating invasive vegetation, creating openings, prescribed burning, and plantings.

2.2.5.2 Florida Scrub-Jay Habitat

Construction components would result in the removal of vegetation and an increase in the impervious area. Although SLC-37 is mostly developed, some ancillary features and access roadways do encroach on vegetated areas. The Phillips Parkway ROW is actively mowed, though there is the potential for Florida scrub-jay use of the mowed vegetation area for foraging; however, this habitat does not require mitigation. Old A1A is not actively maintained and contains potential habitat for the Florida scrub-jay requiring mitigation. The loss of Florida scrub-jay habitat from the construction area components would be mitigated at ratios depending on the specific conservation unit that is impacted. Mitigation ratios range from 0:0 to 4:1.

2.3 Action Area

The action area is defined under ESA regulations (50 CFR 402.02) as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” The Proposed Action involves multiple locations and stressors, where project construction and operation effects on ESA-listed species and critical habitats could be realized.

2.3.1 Delineation of the Action Area

In accordance with guidance provided through communication with the FAA and concurrence by the USFWS, the recommended modeled A-weighted sound exposure level (ASEL) 100-decibel (dB) contour and the modeled 1-pound-per-square-foot (psf) overpressure were used to define the action area around SLC-37. Noise is generated during launch, vehicle and booster static-fire tests, and landings at SLC-37. The outermost 100-dB (ASEL) contour is generated during Starship-Super Heavy launch and Super Heavy static-fire tests, although the latter noise contours only exceed the previous over the open ocean. The combination of these two outer 100-dB (ASEL) contours represent the delineation of the action area around SLC-37 from a noise perspective (Figure 2-8). Modeled noise parameters included annual mean conditions for seasonal and diurnal conditions, along with wind conditions. For Starship-Super Heavy launch and Super Heavy landing, three heading azimuths (40°, 115°, and nominal) were modeled and their maximum footprint combined into a single contour. The effects of the modeled noise exposures from the various launch, static-fire tests, and landing scenarios are discussed in Section 5.

Overpressures are generated by sonic booms created during Starship-Super Heavy launch, Starship landing, and Super Heavy landing. Launch sonic booms occur entirely over the Atlantic Ocean (Figure 2-8). Landing sonic booms occur partially over land under scenarios where Starship or Super Heavy land at SLC-37, over the Atlantic Ocean if Super Heavy lands on a floating platform, or over the Pacific Ocean, Atlantic Ocean, Gulf of America, or Indian Ocean if Starship is expended. For the action area around SLC-37, the 1-psf overpressure contour from Starship-Super Heavy landing has the greatest footprint and represents the delineation of the action area from an overpressure perspective (Figure 2-8). Modeled overpressure parameters included annual mean conditions for seasonal and diurnal conditions, along with wind conditions. For launch, three heading azimuths (40°, 115°, and nominal) were modeled. The potential effects from the modeled overpressure exposure from the various launch and landing scenarios are discussed in Section 5.

Other activities from the Proposed Action, whose change to the environment are wholly contained within the footprint of the delineated action area include the following:

- Construction areas, including SLC-37, surrounding support areas (Figure 2-1) and the roadway improvements to Phillips Parkway, Old A1A, and two turn radiuses (Figure 2-1 through Figure 2-3)
- Transportation area including the roadways on CCSFS and KSC, and boat/barge traffic (Figure 2-2 and Figure 2-4)
- Heat and exhaust plume area, associated with Starship-Super Heavy launch, testing, and landing activities
  - Heat exposure areas at or below ambient temperatures would be contained within the existing SLC-37 fence line.
- Lighting area surrounding the launch site
  - Nighttime launch operations require bright spotlighting to illuminate the launch vehicle at the launch site, which can be detected approximately 30 miles to the north and south along beach habitats. Nighttime launches are estimated to occur at 50% of scheduled launches (38 launches), with launch pad lighting occurring during with approximately 25 launches within sea turtle nesting season (March 1 to October 31).

Other activities from the Proposed Action, whose change to the environment are outside of the footprint of the delineated action area around SLC-37 include the following:

- Atlantic Ocean area including the nearshore areas and the open-ocean area where debris from launches and landings could occur, which includes the areas over the Atlantic Ocean within the defined launch azimuths and the potential area for expendable launches (Figure 2-5)
  - In addition, the area of the Atlantic Ocean approximately 49 miles east of the launch complex and SLC-37 would experience overpressures from sonic booms during launches and landings (Figure 2-9). Any effects from the Proposed Action on ESA-listed species would be discussed in a separate NMFS biological assessment and subsequent consultation.
- Up to seven areas (Figure 2-6) in the Global Commons of the Pacific Ocean, Atlantic Ocean, Gulf of America, and Indian Ocean where Starship landing may occur during an expendable launch scenario
  - Effects on aquatic species from the Proposed Action on ESA-listed species would be discussed in a separate NMFS biological assessment and subsequent consultation.
  - These ocean areas were not included in the delineated action area but were included when lists of ESA-listed species and critical habitats with the potential occur within areas affected by the Proposed Action were generated.

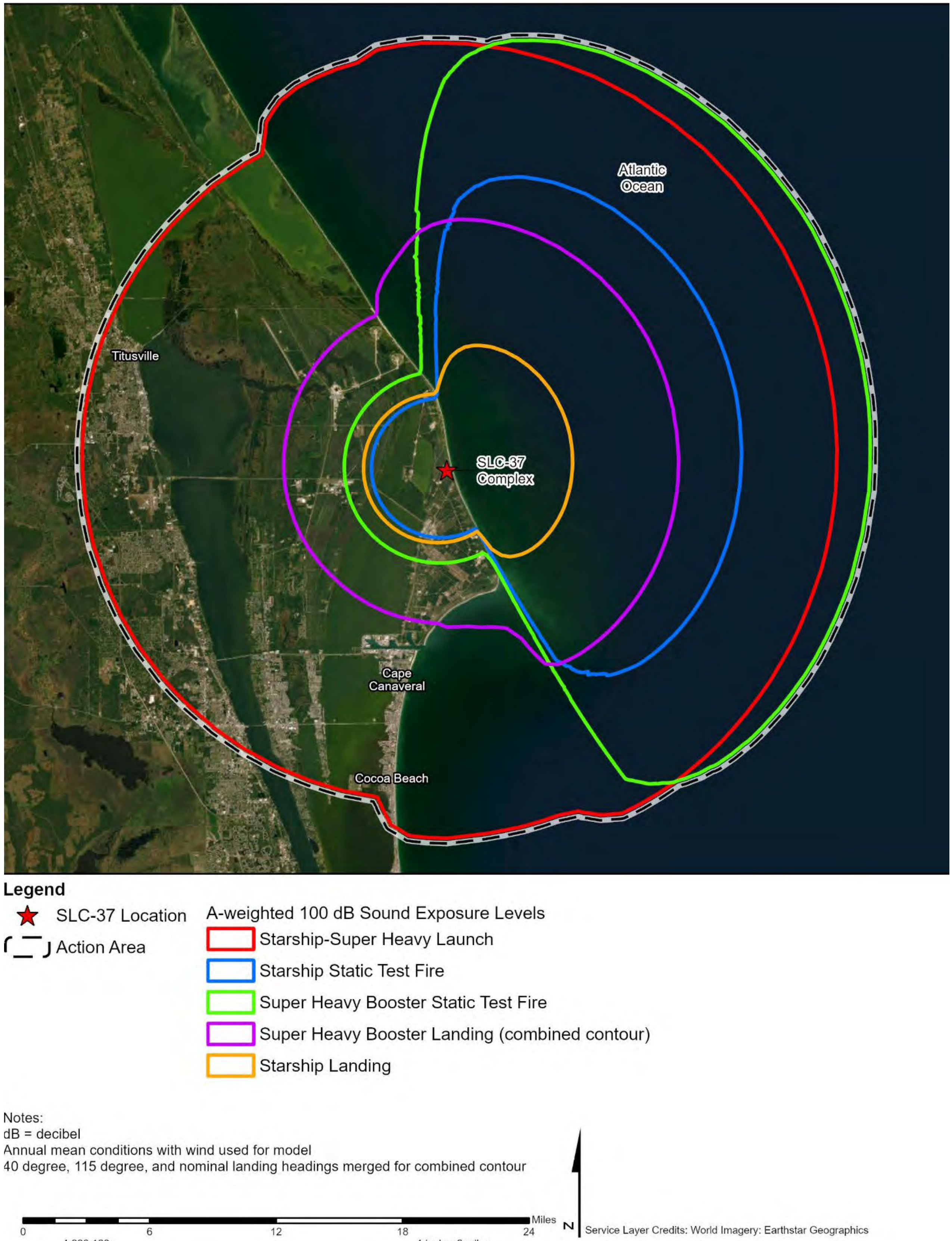

Figure 2-8. Starship-Super Heavy Launch, Static-Fire Test, and Landing Scenarios Noise Contours 100 dB (ASEL)

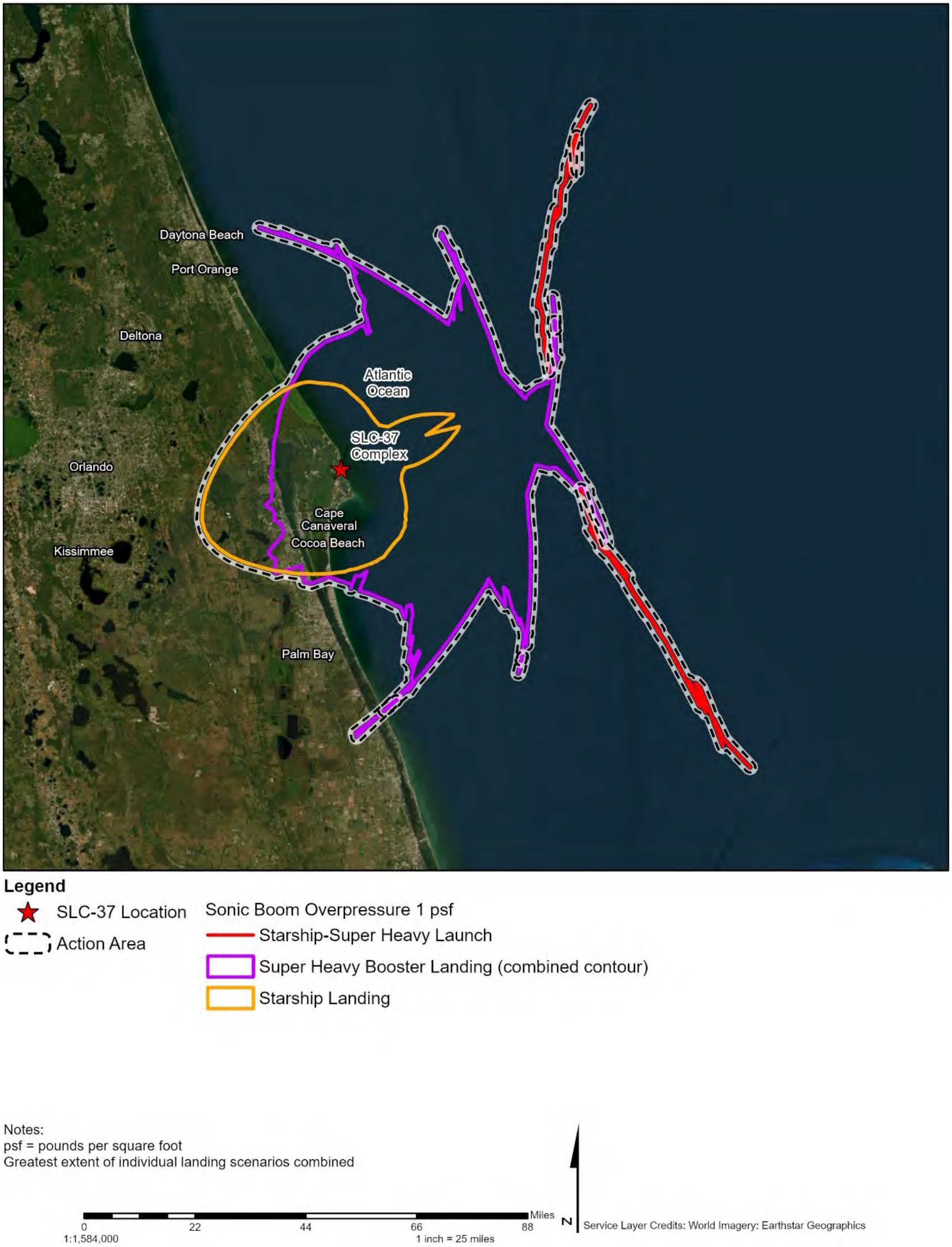

Figure 2-9. Starship-Super Heavy Reentry (Landing) 1-psf Sonic Boom Overpressure Contours

2.3.2 Hydrologic Unit Code, Watershed, Township, Range

The action area is within the Cape Canaveral watershed (Hydrologic Unit Code 03080202), Upper St. Johns (Hydrologic Unit Code 0308010), and the Atlantic Ocean. SLC-37 is centered at 28.531194°N and -80.567808°W (World Geodetic System 1984 Datum).

The action area encompasses portions of the following townships:

- Township 22S, Range 37E, Sections 1 through 36, 39, 40, and 42
- Township 22S, Range 38E, Section 31
- Township 23S, Range 37E, Sections 1 and 12
- Township 23S, Range 38E, Sections 5, 6, 7, and 8

2.3.3 Quantification

The areas potentially affected by the Proposed Action include the following:

- Construction (including impervious areas)
  - SLC-37 construction area: 177.8 acres
  - Roadway improvement construction areas: 30.5 acres
- Operations
  - 100-dB (ASEL) Starship-Super Heavy launch noise contour: 299,588 acres
  - 1-psf sonic boom overpressure from Starship landing (return to launch site [RTLS]): 534,919 acres
  - Heat plume, at or below ambient temperature (within SLC-37 fence line): 80 acres
  - Tower lighting during 38 nighttime launches: includes 57 nighttime events (19 Starship-Super Heavy launches, 19 Super Heavy booster landings, and 19 Starship landings) during sea turtle nesting season.

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3. Status of Species and Critical Habitat

3.1 Species Lists from the Service

The USFWS's online IPaC project planning tool was queried in January 2025, for an unofficial list of species that may occur with the action area around SLC-37 and the Atlantic and Pacific Ocean landing action areas. Thirty-six species listed under the ESA as threatened or endangered and 2 species proposed for listing under the ESA may occur in the action area. Table 3-1 provides a list of these species, as well as their potential presence in each of the action area components; however, several of these species are either unlikely to be present or would not be affected by the stimulus. Section 3.1.1 describes those species further. Appendix A provides the unofficial list of ESA-listed species provided by the USFWS online IPaC for the action area around SLC-37.

Table 3-1. Federally Listed Species Included in IPaC Lists for Action Area Components

Species	Common Name (Scientific Name)	Federal Status	Potentially Located in SLC-37 Construction Area/Heat Plume	Potentially Located in 100 dB (ASEL) Noise and 1-psf Overpressure Contour	Potentially Located in Atlantic Ocean and/or Pacific Ocean Landing Areas[a]
Mammals	Florida Panther (*Puma [= Felis] concolor coryi*)	Endangered	--	X	--
Mammals	Puma (= mountain lion) (Puma [= *Feils] concolor*	Threatened (SA)	--	X	--
Mammals	Southeastern beach mouse (*Peromyscus polionotus niveiventris*)	Threatened	X	X	--
Mammals	Tricolored bat (*Perimyotis subflavus)*	Proposed Endangered	X	X	--
Mammals	West Indian manatee *Trichechus manatus latirostris)*	Threatened	X	X	--
Birds	Band-rumped storm petrel (*Oceanodroma castro*)	Endangered	--	--	X
Birds	Bermuda petrel (*Pterodroma cahow*)	Endangered	--	--	X
Birds	Black-capped petrel (*Pterodroma hasitata*)	Endangered	--	X	X
Birds	Crested caracara (*Caracara plancus audubonii*)	Threatened	X	X	X
Birds	Eastern black rail (*Laterallus jamaicensis jamaicensis)*	Threatened	X	X	X
Birds	Everglade snail kite (*Rostrhamus sociabilis plumbeus*)	Endangered	X	X	X
Birds	Florida scrub-jay (*Aphelocoma coerulescens)*	Threatened	X	X	X
Birds	Hawaiian petrel (*Pterodroma sandwichensis*)	Endangered	--	--	X

Species	Common Name (Scientific Name)	Federal Status	Potentially Located in SLC-37 Construction Area/Heat Plume	Potentially Located in 100 dB (ASEL) Noise and 1-psf Overpressure Contour	Potentially Located in Atlantic Ocean and/or Pacific Ocean Landing Areas[a]
Birds	Newell's shearwater (*Puffinus auricularis newelli*)	Threatened	--	--	X
Birds	Piping plover (*Charadrius melodus)*	Threatened	--	X	X
Birds	Red-cockaded woodpecker (*Picoides borealis)*	Threatened	--	X	--
Bird	Roseate tern (*Sterna dougallii dougallii*)	Endangered	--	--	X
Birds	Rufa red knot (*Calidris canutus rufa)*	Threatened	X	X	X
Birds	Short-tailed albatross (*Phoebastria albatrus*)	Endangered	--	--	X
Birds	Whooping Crane (*Grus americana*)	Threatened (EXPN)	--	X	--
Birds	Woodstork (*Mycteria americana)*	Threatened	X	X	X
Reptiles	American alligator (*Alligator mississippiensis)*	Threatened (SA)	X	X	--
Reptiles	American crocodile (*Crocodylus acutus*)	Threatened	--	X	--
Reptiles	Atlantic salt marsh snake (*Nerodia clarkia taeniata*)	Threatened	--	X	X
Reptiles	Eastern indigo snake (*Drymarchon couperi)*	Threatened	X	X	X
Reptiles	Green sea turtle (*Chelonia mydas)*	Threatened	X	X	X
Reptiles	Hawksbill sea turtle (*Eretmochelys imbricata)*	Endangered	X	X	X
Reptiles	Kemp's ridley sea turtle[b] (*Lepidochelys kempii)*	Endangered	X	X	X
Reptiles	Leatherback sea turtle (*Dermochelys coriacea)*	Endangered	X	--	X
Reptiles	Loggerhead sea turtle (*Caretta caretta)*	Threatened	X	--	X
Insects	Monarch butterfly (*Danaus Plexippus)*	Proposed Threatened	X	X	X
Plants	Beautiful pawpaw (*Deeringothamnus pulchellus*)	Endangered	--	X	--
Plants	Carter's mustard (*Warea carteri*)	Endangered	X	X	X

Species	Common Name (Scientific Name)	Federal Status	Potentially Located in SLC-37 Construction Area/Heat Plume	Potentially Located in 100 dB (ASEL) Noise and 1-psf Overpressure Contour	Potentially Located in Atlantic Ocean and/or Pacific Ocean Landing Areas[a]
Plants	Fragrant prickly apple (*Cereus eriophorus* var. *fragrans*)	Endangered	--	X	--
Plants	Lewton's polygala (*Polygala lewtonii*)	Endangered	X	X	X
Plants	Papery whitlow-wort (*Paronychia chartacea*)	Threatened	--	X	--
Plants	Pigeon wings (*Clitoria fragrans*)	Threatened	--	X	--
Plants	Pygmy-Fringe-tree (*Chionanthus pygmaeus*)	Endangered	--	X	--
Plants	Sandlace (*Polygonella myriophylla*)	Endangered	--	X	--

Sources: USAF 2023; USFWS 2023b, 2024a, 2025; FNAI 2024

[a] Refer to Figure 2-6 for additional information.

[b] Kemp's ridley sea turtle included because it has been documented to nest on CCSFS.

EXPN = Experimental Population Non-Essential

SA = Similarity of Appearance

3.1.1 No Effects Determinations

The DAF has determined that the Proposed Action would have no effect on some of the species identified from the IPaC search, which was based on the availability of their preferred habitats within the action area, the type of stressor the Proposed Action would create, or records of occurrence for the species.

The following mammal, bird, and reptile species have been eliminated from further effects analysis in this BCA:

- Florida Panther (*Puma [= Felis] concolor coryi*)
- Puma (= mountain lion) (*Puma [= Feils] concolor*)
- Red-cockaded woodpecker (*Picoides borealis)*
- Whooping Crane (*Grus americana*)
- American alligator (*Alligator mississippiensis*)
- American crocodile (*Crocodylus acutus*)
- Atlantic salt marsh snake (*Nerodia clarkia taeniata*)

The following plant species have been eliminated from further effects analysis in this BCA:

- Beautiful pawpaw (*Deeringothamnus pulchellus*)
- Carter's mustard (*Warea carteri*)
- Fragrant prickly apple (*Cereus eriophorus* var. *fragrans*)
- Lewton's polygala (*Polygala lewtonii*)
- Papery whitlow-wort (*Paronychia chartacea*)
- Pigeon wings (*Clitoria fragrans*)
- Pygmy-Fringe-tree (*Chionanthus pygmaeus*)
- Sandlace (*Polygonella myriophylla*)

3.2 Description of Species

3.2.1 Southeastern Beach Mouse

The southeastern beach mouse is a subspecies of the widely distributed old field mouse, and this distinct subspecies has been designated as threatened under the ESA. The species was historically restricted to sand dunes vegetated primarily by sea oats (*Uniola paniculata*) and dune panic grass (*Paspalum amarulum*). The southeastern beach mouse has also been documented in coastal grasslands, disturbed areas, developed areas, and inland habitats, such as coastal strands and oak scrub dominated by oaks (*Quercus* spp.), sand pine (*Pinus calusa*), or palmetto (*Serenoa repens*) (USFWS 1989, 2019d).

The nest chamber is at a depth of 2 to 3 feet, whereas the escape tunnel rises to within 1 inch of the surface. Southeastern beach mice may also use ghost crab (*Ocypode quadrata*) burrows. The average depth of a ghost crab burrow is approximately 4 feet, with the opening averaging a few centimeters (Knott 2024; Shinoda et al. 2019). Southeastern beach mice are nocturnal, with most activity occurring on moonlit nights and less activity under stormy conditions or moonless nights. Breeding activity was most evident from November through early January, with large numbers of immature animals present. Young mice moved an average of 1,415 feet before establishing a home range. Movement of southeastern beach mice is primarily for foraging, breeding, and burrow maintenance (USFWS 1993).

3.2.2 Tricolored Bat

The tricolored bat (*Perimyotis subflavus*) is proposed for listing as endangered under the ESA. During the spring, summer, and fall, tricolored bats tend to roost among live and dead leaf clusters of live or recently dead deciduous hardwood trees. In Florida, tricolored bats also roost in Spanish moss (*Tillandsia usneoides*) on tree species such as oak. Tricolored bats have been observed roosting in artificial roosts like barns, porch roofs, bridges, and concrete bunkers, but roosting in structures have not been documented on CCSFS (USAF 2023). Female tricolored bats exhibit high site fidelity, returning year after year to the same summer roosting locations where they form maternity colonies and regularly switch roost trees. Males roost singly. In the southern part of their range, tricolored bats hibernate in road-associated culverts, tree cavities, and abandoned water wells (USFWS 2023c).

3.2.3 West Indian Manatee

The West Indian manatee is listed as threatened under the ESA and is protected under the Marine Mammal Protection Act under USFWS jurisdiction. Manatees occur in marine, estuarine, and freshwater environments. The West Indian manatee includes two distinct subspecies: the Florida manatee (*Trichechus manatus latirostris*) and the Antillean manatee (*Trichechus manatus manatus*). Although morphologically distinctive, the subspecies have many common features, including large, seal-shaped bodies with paired flippers and a round, paddle-shaped tail. They are typically gray in color and occasionally spotted with barnacles or colored by patches of green or red algae. Manatees feed on aquatic plants in both fresh water and salt water and enter freshwater areas to drink (USAF 2023). In Florida, manatees require warm water refugia to survive cold weather in the winter (USFWS 2017a). Critical habitat has been designated for the West Indian manatee.

3.2.4 Band-Rumped Storm Petrel

The band-rumped storm petrel (*Oceanodroma castro*) is listed as endangered under the ESA. The species is found throughout the Pacific Ocean basin, and nests on the Hawaiian Islands. When not nesting, adults spend their time foraging on the open ocean. This is a small-sized pelagic seabird with long, angular wings and a slightly notched tail, with an almost square appearance. This species is blackish brown with a white band across the rump, just above the tail.

3.2.5 Bermuda Petrel

The Bermuda petrel (*Pterodroma cahow*) is listed as endangered under the ESA. The species is a rare nocturnal ground-nesting seabird that only nests on six tiny islets in Bermuda from October to June (USFWS 2024b). When not nesting, adults spend their time foraging on the open North Atlantic Ocean, from areas offshore the east coast of North America to western European waters (USFWS 2024b). This is a medium-sized seabird with long wings and a brownish nape that extends towards the upper breast to form a partial collar (USFWS 2024c). The Bermuda petrel has a brownish-gray mantle and an upper wing and tail with entirely white underparts.

3.2.6 Black-Capped Petrel

The black-capped petrel (*Pterodroma hasitata*) was recently listed as endangered on January 29, 2024, under the ESA (88 FR 89611). The only known breeding location for this species is on the island of Hispaniola; however, it is believed that breeding populations may exist on Dominica and Martinique (NatureServe 2014). This is a medium-sized pelagic seabird with long wings and a distinctive black cap that travels long distances. The black-capped petrel generally resides in areas of deep water or persistent upwelling near the gulf stream (USFWS 2018). Foraging areas include the western Atlantic, southern Caribbean basins, and potentially the northern Gulf of Mexico (USFWS 2018).

3.2.7 Crested Caracara

Crested caracara (*Caracara plancus audubonii*) is listed as threatened under the ESA. USFWS changed the scientific name of this species from *Polyborus plancus audubonii* to *Caracara plancus audubonii* through a final rule published in the *Federal Register* (47 FR 58454–58460) on July 31, 2023 (USFWS 2023d). Crested caracara occurs in a wide variety of semi-open habitats offering open ground for hunting and dense cover for nesting (Audubon 2023). In Florida, the species inhabits wet prairies with cabbage palms and may occur in pastures and wooded areas with saw palmetto, cypress, and scrub oaks (FWC 2023a). Critical habitat has not been designated for this species.

3.2.8 Eastern Black Rail

The eastern black rail (*Laterallus jamaicensis jamaicensis)* is listed as threatened under the ESA. The eastern black rail is a wetland-dependent bird requiring dense emergent vegetation cover and extremely shallow-water depths (typically less than1.2 inches) over a portion of the wetland-upland interface to support its resource needs. The eastern black rail requires dense vegetative cover that allows movement underneath the canopy. Because birds are found in a variety of salt, brackish, and freshwater marsh habitats that can be tidally or nontidally influenced, plant structure is considered more important than plant species composition in predicting habitat suitability. Eastern black rail habitat can be tidally or nontidally influenced and can range in salinity from salt to brackish to fresh. Tidal height and volume vary greatly between the Atlantic and Gulf Coasts and, therefore, contribute to differences in salt marsh cover plants in the bird’s habitat (USFWS 2020c). Critical habitat has not been designated for the eastern black rail.

3.2.9 Everglade Snail Kite

The Everglade snail kite (*Sociabilis plumbeus*) is listed as endangered under the ESA. The Everglade snail kite is a medium-sized hawk with a wingspan of about 45 inches, similar to the marsh hawk but without wavering, tilting flight. The beak is slender and very hooked. The adult males are slate gray with black head and wing tips, a white patch at the base of a square tail, and red legs. The female has a buffy body, heavily streaked with dark lines, a white line above the eye, a white tail patch, yellow legs, and red eyes. The immatures resemble the females, only they are darker, and their eyes are brown. Because of its greatly curved beak, the Everglade snail kite is uniquely adapted for a diet almost exclusively of native freshwater apple snails (*Pomacea paludosa*). Exclusive use of the genus *Pomacea* is apparently because this is the only large Florida snail occurring near the surface (USFWS n.d.a). Critical habitat has not been designated for the Everglade snail kite.

3.2.10 Florida Scrub-Jay

The Florida scrub-jay (*Aphelocoma coerulescens*) is listed as threatened under the ESA. The Florida scrub-jay is nonmigratory, sedentary, and permanently territorial. Florida scrub-jays forage mostly on or near the ground, often along the edges of natural or human-made openings. They visually search for food by hopping or running along the ground beneath the scrub or by jumping from shrub to shrub. Insects make up the majority of the animal portion of the diet throughout most of the year. Acorns are the most important plant food, and Florida scrub-jays harvest and cache thousands of oak acorns throughout their territory from August to November. The species requires large and open landscapes of scrub habitat for long-term population persistence (USFWS 2019c). Critical habitat has not been designated for the Florida scrub-jay.

The Florida scrub-jay is endemic to oak-dominated scrub habitats in Florida. Degradation primarily through fire suppression and loss of habitat from human activities have resulted in substantial declines in the abundance and distribution of the species (Johnson et al. 2009). Remaining populations are reproductively isolated, of small size, and projected to continue to decline. KSC is home to one of three designated core populations of the species, and this population represents more than half of the remaining population of the species (USAF 2023).

3.2.11 Hawaiian Petrel

The Hawaiian petrel (*Pterodroma sandwichensis*) is listed as endangered under the ESA. The species is found throughout the central tropical and subtropical Pacific Ocean, and nests at high elevations on the Hawaiian Islands. When not nesting, adults spend their time foraging on the open ocean. This is a medium-sized nocturnal pelagic seabird that is uniformly dark grayish black with white coloration on its throat, forehead, cheeks, and underbody.

3.2.12 Newell’s Shearwater

The Newell’s shearwater (*Puffinus newelli)* is listed as threatened under the ESA. The species spends much of their lives in the Pacific Ocean, returning to land only during the breeding season. Newell’s shearwater’s nest at high elevations on the Hawaiian Islands. This is a medium-sized pelagic seabird that has a dark black back and white underside and underwing.

3.2.13 Piping Plover

The Atlantic Coast populations of the piping plover are listed as threatened under the ESA. The piping plover is a small, sand-colored shorebird that nests and feeds along coastal sand and gravel beaches. The species forages around the high-tide wrack zone and along the ocean edge as areas are exposed, eating mainly arthropods and marine worms (USAF 2023). There is critical habitat for piping plover north of the action area in New Smyrna Beach.

3.2.14 Roseate Tern

The roseate tern (*Sterna dougallii dougallii*) is a federally listed threatened bird that is known to use coastal areas in the Caribbean for nesting. The species is distributed throughout the region, with the largest populations occurring in the Lesser Antilles (USFWS 1993b). The species uses different habitats for nesting, including small offshore islands, marine rocks, cays, islets, areas near vegetation or jagged limestone rock, open sandy beaches, and among coral rubble (USFWS 1993b). Critical habitat has not been designated for the Caribbean roseate tern (USFWS n.d.b).

3.2.15 Rufa Red Knot

The rufa red knot is listed as threatened under the ESA. This species breeds in the northern Arctic region. The red knot forages along the shoreline (USAF 2023). The rufa red knot breeds in the tundra of the central Canadian Arctic Circle from northern Hudson Bay to the southern Queen Elizabeth Islands, and the species has four distinct wintering populations, including one in the southeastern U.S. (USFWS 2021c). In Florida, the rufa red knot forages in tidally exposed areas feeding on mussels, clams, crustaceans, and horseshoe crab eggs (USFWS 2021c). The Atlantic Coast of Florida also is a common stopover during spring and fall migrations of populations that winter farther south (USAF 2023). Proposed critical habitat was designated for the rufa red knot in 2021.

The red knot population within the southeastern U.S. is believed to be moderately resilient. Regional abundance estimates suggest the population in this region has mostly been stable since the 1980s.

3.2.16 Short-Tailed Albatross

The short-tailed albatross (*Phoebastria albatrus)* is listed as endangered under the ESA. The species primarily breeds on remote islands in the west Pacific Ocean, including on Midway Atoll in Hawaii. Short-tailed albatross occurs along the Pacific Rim from southern Japan to the west coast of Canada and the U.S. during the nonbreeding season. This is a large pelagic seabird with long, broad wings and a large pink bill. The short-tailed albatross has a white body, black tail, narrow black edge on white underwing, and a half black and half white upper side of wing.

3.2.17 Wood Stork

The wood stork (*Mycteria americanais*) listed as threatened under the ESA, but it is now proposed for delisting because of its recovery throughout its range. The wood stork is the only stork that occurs in North America. This bird nests colonially in a variety of inundated forested wetlands and can also be found nesting in artificial habitats (for example, impoundments). Colonies form in Central and North Florida from February to March (FWC 2024e). Foraging primarily occurs in shallow-water habitats with depths limited to less than 10 to 12 inches (FWC 2024e; USAF 2023).

3.2.18 Eastern Indigo Snake

The eastern indigo snake (*Drymarchon couperi*) is listed as threatened under the ESA. The eastern indigo snake is a nonvenomous, bluish-black colored snake that can reach a length of 8 feet. The chin, cheek, and throat are mostly red or brown but can also be white or black. The eastern indigo snake feeds on a variety of species, including small mammals, birds, toads, frogs, turtles and their eggs, snakes, lizards, and small alligators. Eastern indigo snakes breed between the months of November and April and nest between the months of May and August. Females may have the ability to hold sperm, which would allow them to defer fertilization of eggs. Females lay 4 to 12 eggs, with the eggs hatching 90 days later. The eastern indigo snake is a commensal species of the gopher tortoise, and females usually deposit their eggs in gopher tortoise burrows. The eastern indigo snake is known to use gopher tortoise burrows as a refuge from the elements, including cold temperatures and fire, but also use stump holes as refugia (USAF 2023).

Historically, the eastern indigo snake was classified as a subspecies (*Drymarchon corais couperi*) and was listed as threatened under this classification. Post-listing, the eastern indigo snake was elevated to a distinct species (*Drymarchon couperi*) (USFWS 2019a). Critical habitat has not been designated for the eastern indigo snake.

3.2.19 Sea Turtles

The following sections provide a description of different sea turtle species.

3.2.19.1 Green Sea Turtle

The North Atlantic distinct population segment (DPS) of green sea turtle (*Chelonia mydas*) is listed as threatened under the ESA. The green sea turtle is a hard-shelled sea turtle, with the adult’s carapace varying in color from black to gray to greenish or brown, often with bold streaks or spots, and a yellowish white plastron. On average, a green sea turtle belonging to the Florida population has a straight carapace length of 3.3 feet and weighs 300 pounds. Characteristics that distinguish them from other sea turtles are their small, rounded head and smooth carapace. Hatchlings weigh approximately 0.88 ounce, their black carapace is about 2 inches long, and the ventral surface is white (USAF 2023). Green turtles, like all sea turtles, are reptiles and must surface to breathe and lay their eggs on land. Green turtles migrate hundreds to thousands of miles each way between their foraging grounds and nesting beaches. They are solitary, nighttime nesters. Female green sea turtles nest from June through September.

The life history of green turtles involves a series of stages of development from hatchling to adult. After emerging from the nest, hatchlings swim to offshore areas, where they live for several years in pelagic habitat. Juveniles eventually leave the open-ocean habitat and travel to nearshore foraging grounds in shallow coastal habitats, where they mature to adulthood and spend the remainder of their lives. Adults migrate every 2 to 5 years from their coastal foraging areas to the waters off the nesting beaches where they originally hatched to reproduce.

Green turtles are the only herbivorous species of sea turtle. Their diet mainly consists of algae and seagrasses, though they may also forage on sponges, invertebrates, and discarded fish. The East Pacific green turtle tends to eat more animal prey than other populations. Before recruiting to nearshore foraging areas, pelagic juveniles forage on plant and animal life found in oceanic drift communities (such as pelagic *Sargassum* communities) (NMFS and USFWS 2013).

3.2.19.2 Hawksbill Sea Turtle

The hawksbill sea turtle (*Eretmochelys imbricata*) is listed as endangered under the ESA. Hawksbill sea turtles typically weigh around 176 pounds or less; hatchlings average about 1.6 inches straight length and range in weight from 0.5 to 0.7 ounce. The carapace is heart shaped in young turtles and becomes more elongated or egg-shaped with maturity. The top scutes are often richly patterned with irregularly radiating streaks of brown or black on an amber background. The head is elongated and tapers sharply to a point. The lower jaw is V-shaped (USAF 2023). Hawksbill sea turtles are omnivorous, but their preferred food in many areas are sea sponges. They also eat marine algae, corals, mollusks, tunicates, crustaceans, sea urchins, small fish, and jellyfish. The shape of their mouth and their sharp beaks enable them to reach into small holes and crevices in the reefs to find food.

Like other sea turtle species, hawksbills can migrate long distances between foraging areas and nesting beaches. In the Atlantic, a female hawksbill that nested at Buck Island Reef National Monument in the U.S. Virgin Islands was tracked 1,160 miles to foraging habitat in the Miskito Cays in Nicaragua. Solomon Island hawksbills can travel 500 to 1,000 miles between Arnavon nesting beaches and foraging areas off Australia (NMFS and USFWS 2013a). Female hawksbill sea turtles nest from April through November and nest at night, typically during an incoming tide.

3.2.19.3 Kemp’s Ridley Sea Turtle

The Kemp’s ridley sea turtle (*Lepidochelys kempii*) is listed as endangered under the ESA. The Kemp’s ridley sea turtle has a triangular-shaped head with a slightly hooked beak. Hatchlings are darkly colored on both sides. Adults are generally a grayish-green color on top with a pale, yellowish bottom shell. The top shell (carapace) is often as wide as it is long. Each of the front flippers has one claw, whereas the back flippers may have one or two. This turtle is a shallow-water benthic feeder with a diet consisting primarily of crabs. Female Kemp’s ridley sea turtles nest from April through July and are the only sea turtle species to nest during the daylight hours.

3.2.19.4 Leatherback Sea Turtle

The leatherback sea turtle (*Dermochelys coriacea*) is listed as endangered under the ESA. The leatherback sea turtle is the largest of all sea turtles, attaining a straight carapace length of 5 to 5.5 feet and a weight that occasionally reaches 1,100 pounds. Its unique shell is covered with a continuous layer of thin, black, and often white-spotted skin, instead of keratinized scutes. The carapace is raised into a series of seven longitudinal ridges. Other distinctive features are the absence of claws, the absence of scales, long forelimbs, a reduced skeleton, and a notable pink spot on the dorsal surface of the head in adults (USAF 2023). Leatherback sea turtles undertake the longest migrations between breeding and feeding areas of any sea turtle, averaging 3,700 miles each way. They spend most of their lives in the ocean, but females leave the water to lay eggs. Female leatherback sea turtles nest from March to May and nest at night, typically during an incoming tide. Leatherbacks are strong swimmers and can dive to depths of approximately 4,000 feet—deeper than any other turtle—and can remain underwater for up to 85 minutes.

Leatherbacks lack the crushing, chewing plates characteristic of other sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp-edged jaws that are perfectly adapted for a diet of soft-bodied, open=ocean prey such as jellyfish and salps. A leatherback’s mouth and throat also have backward-pointing spines that help retain gelatinous prey (NMFS and USFWS 2013b; USFWS 2020b).

3.2.19.5 Loggerhead Sea Turtle

The loggerhead sea turtle (*Caretta caretta*) is listed as threatened under the ESA. The loggerhead sea turtle is the most common nesting sea turtle on CCSFS. Adult and subadult loggerheads have reddish-brown carapaces and dull brown to yellowish plastrons. Adult loggerheads in the southeastern U.S. have an average straight carapace length of approximately 3 feet and a mean body weight of about 250 pounds. The brown hatchlings weigh approximately 0.70 ounce and are 1.7 inches long (USAF 2023). Critical habitat was designated for the loggerhead sea turtle in 2013. Loggerhead sea turtles, like all sea turtles, are marine reptiles and must come to the surface to breathe air. Adult female loggerhead sea turtles return to land, typically at night, during an incoming tide, to lay their eggs in the sand; they are remarkable navigators and usually return to a beach in the general area where they hatched decades earlier. Female loggerhead sea turtles nest from May and October.

The life history of loggerhead sea turtles involves a series of stages of development from hatchling to adult. Hatchlings and juveniles spend the first 7 to 15 years of their lives in the open ocean. Then, they migrate to nearshore coastal areas where they forage and continue to grow for several more years. Adult loggerhead sea turtles migrate hundreds to thousands of miles from their foraging grounds to their nesting beaches. Loggerhead sea turtles spend many years (possibly up to 20 years) growing to maturity and then migrate back to the beaches where they hatched in the western Pacific Ocean to mate and nest and live out the remainder of their lives.

Loggerhead sea turtles are carnivores, only occasionally consuming plant material. During their open-ocean phase, they feed on a wide variety of floating items. Juveniles and adults in coastal waters eat mostly bottom-dwelling invertebrates such as whelks, other mollusks, horseshoe crabs, and other crabs. Their powerful jaws are designed to crush their prey (NMFS and USFWS 2023f).

3.2.20 Monarch Butterfly

The monarch butterfly (*Danaus plexippus)* is a proposed threatened species for listing under the ESA. Consultation with the USFWS under Section 7 of the ESA is only required for proposed species if the Proposed Action is likely to jeopardize the continued existence of the species. However, the USFWS encourages agencies to take advantage of opportunities to conserve the species. Monarch butterflies are large and conspicuous, with bright orange wings surrounded by a black border and covered with black veins. The black border has a double row of white spots on the upper side of the wings.

Monarch butterflies lay their eggs on milkweed host plants (primarily *Asclepias* spp.), and larvae emerge after 2 to 5 days. Larvae develop through five larval instars, feeding on milkweed and sequestering toxic chemicals (cardenolides) as a defense against predators. Multiple generations of monarchs are produced during the breeding season, with most adult butterflies living 2 to 5 weeks. In many regions, monarchs breed year-round, and Florida has both year-round resident monarch butterflies, as well as those that migrate. Monarch butterflies in temperate climates undergo long-distance migration and live for an extended period of time. In the fall, in both eastern and western North America, Monarch butterflies begin migrating to their respective overwintering sites, a journey that can be more than 1,850 miles and last for over 2 months.

In early spring (February to March), surviving monarchs break diapause and mate at the overwintering sites before dispersing. The individuals that undertook the initial southward migration return to their breeding grounds, and the offspring start the cycle of generational migration over again (USFWS n.d.b).

3.3 Identification of Designated Critical Habitat

Section 4(a)(3)(B)(i) of the ESA was amended by the National Defense Authorization Act for Fiscal Year 2004 to preclude the Secretaries of Interior (the USFWS) and Commerce (the NMFS) from designating critical habitat on any lands or other geographical areas owned or controlled by DOD, or designated for its use, that are subject to an approved DOD INRMP developed under the Sikes Act Improvement Act (16 U.S.C. Section 670a), provided that the appropriate secretaries certify in writing that the INRMP benefits the federally listed species (USAF 2023).

Table 3-2 shows the final (designated) or proposed critical habitat within off-installation areas included in the SLC-37 action area. Final and proposed critical habitat for the West Indian manatee (Figure 3-1) has been identified as occurring within the noise and overpressure SLC-37 action area. For the purposes of this BCA, only designated or proposed critical habitat for sea turtles under the jurisdiction of USFWS (that is, nesting beaches) is discussed. Designated or proposed critical habitat for sea turtles within the marine environment is under the jurisdiction of NMFS and is discussed in a separate biological assessment document. Final critical habitat for the loggerhead sea turtle (Figure 3-2) has been identified in both the noise and overpressure SLC-37 and Atlantic Ocean action areas. Critical habitat for the green sea turtle (Figure 3-3) and rufa red knot (Figure 3-4) has been proposed within the noise and overpressure and Atlantic Ocean action areas. Each of these critical habitats are outside the SLC-37 construction area and heat plume areas.

Table 3-2. Designated Critical Habitat Occurring Within the Action Areas

Critical Habitat	Evolutionary Significant Unit or DPS	Federal Status	SLC-37 Construction Area/Heat Plume	100-dB (ASEL) Noise and 1-psf Overpressure Contour	Atlantic Ocean and Pacific Ocean Landing Areas
West Indian Manatee	Florida Stock	Final and Proposed	--	X	--
Loggerhead Sea Turtle	Northwest Atlantic Ocean DPS	Final	--	X	X
Green Sea Turtle	Northwest Atlantic Ocean DPS	Proposed	--	X	X
Rufa Red Knot	All	Proposed	--	X	X

Sources: Department of the Interior, Fish and Wildlife Service 2014, 2023b, 2024.

3.3.1 West Indian Manatee

Final-designated critical habitat for the West Indian manatee within the noise and overpressure SLC-37 action area includes the Banana River to the west of CCSFS, including partially isolated lagoons along the river, and the nearshore waters of the Atlantic Ocean adjacent to the beaches of CCSFS (42 FR 184 Pages 47840–47845 [September 1977]). At the time of designation, the USFWS did not establish physical or biological features (PBFs) essential to the conservation of the species.

Under the proposed revision of West Indian manatee critical habitat (89 FR 185 Page 78134), the USFWS has included new areas to designate as critical habitat (all outside of the action areas) and determined that the following PBFs are essential to the conservation of Florida manatee (89 FR 185 Page 78141 [September 2024]):

- **PBF1** – Areas of water warmed by natural processes (for example, spring discharges, passive thermal basins) that have either of the following:
  - Reliable thermal quality throughout the winter (that is, having at least a medium thermal quality as defined by the Florida Manatee Warm-Water Habitat Action Plan [Valade et al. 2020]), which consists of water temperatures that stay at or above the following:
    - 72°F (22 degrees Celsius [°C]) during mild weather
    - 68°F (20°C) during cold weather
    - 64°F (18°C) during severe cold weather
  - Established manatee use throughout the winter each year (refer to the Florida Manatee Warm-Water Habitat Action Plan [Valade et al. 2020]).
- **PBF2** – Areas supporting submerged, emergent, or floating aquatic vegetation within 18.6 miles of the following:
  - Natural warm-water sources described in PBF1
  - Other established winter manatee aggregation areas (for example, power plants with established manatee use)

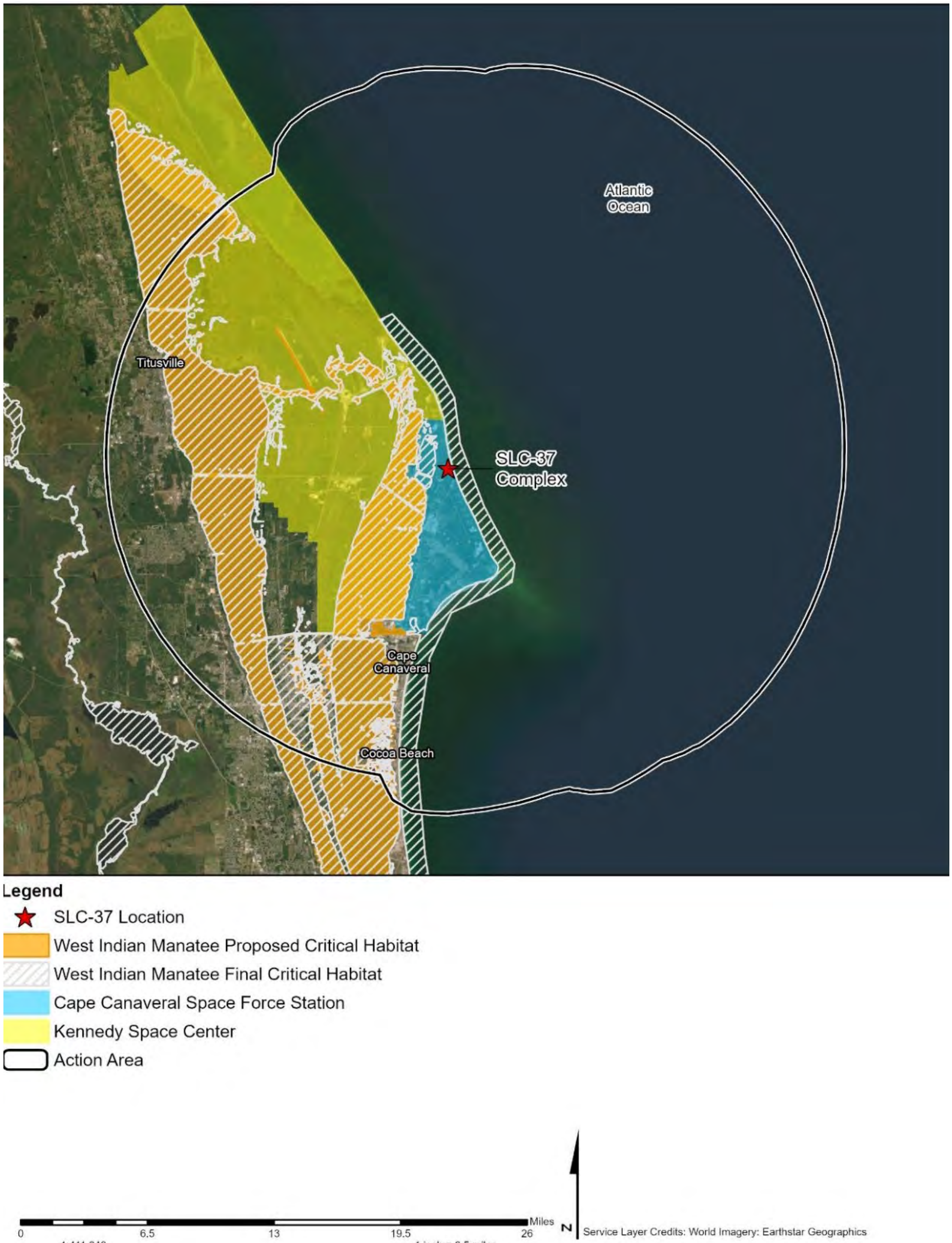

Figure 3-1. West Indian Manatee Critical Habitat

3.3.2 Loggerhead Sea Turtle

CCSFS is exempted from the designated critical habitat for sea turtles because of its INRMP, which specifies the implementation of measures to benefit the conservation of this species (USAF 2023). Designated critical habitat under USFWS jurisdiction for the loggerhead sea turtle Northwest Atlantic Ocean DPS includes nesting beach habitat along portions of the Gulf of Mexico and Atlantic Ocean coastlines. The beaches immediately north of CCSFS, and Satellite Beach, have been designated as critical habitat for the loggerhead sea turtle (Figure 3-2).

The USFWS determined that the following PBFs are essential to the conservation of the Northwest Atlantic Ocean DPS of loggerhead sea turtles (79 FR 132 Page 39771 [July 2014]):

- **PBF1** – Sites for breeding, reproduction, or rearing (or development) of offspring
  - Terrestrial nesting habitat known as the supralittoral zone (area above the spring high-tide line) of the beach, where oviposition (egg laying), embryonic development, and hatching occur
- **PBF2** – Habitats protected from disturbance or representative of the historical, geographic, and ecological distribution of the species
  - Areas where natural coastal processes of erosion and accretion are maintained or where projects that address erosion or shoreline protection reduce negative effects, or where loggerhead nesting beaches are allowed to respond naturally to coastal dynamic processes of erosion and accretion or mimic these processes

The USFWS further determined that the following primary constituent elements (PCEs) are specific elements of the PBFs that provide for a species' life history processes and are essential to the conservation of the species:

- **PCE1** – Suitable nesting beach habitat that has the following features:
  - Has relatively unimpeded nearshore access from the ocean to the beach for nesting females and from the beach for both post-nesting females and hatchlings.
  - Is located above mean high water to avoid being inundated frequently by high tides.
- **PCE2** – Sand that has the following features:
  - Allows for suitable nest construction.
  - Is suitable for facilitating gas diffusion conducive to embryo development.
  - Is able to develop and maintain temperatures and a moisture content conducive to embryo development.
- **PCE3** – Suitable nesting beach habitat with sufficient darkness to ensure nesting turtles are not deterred from emerging onto the beach and hatchlings and post-nesting females orient to the sea
- **PCE4** – Natural coastal process or artificially created or maintained habitat mimicking natural conditions

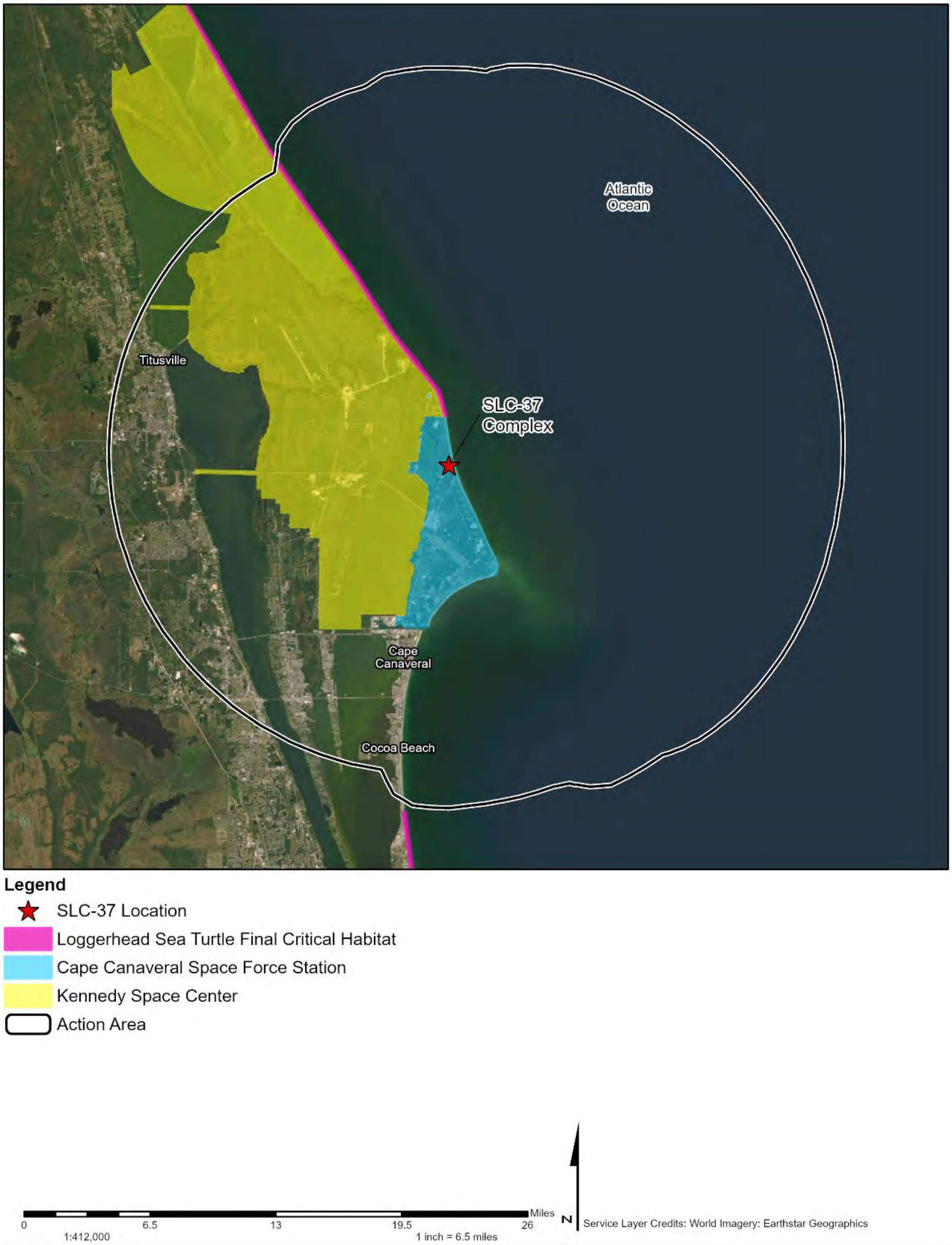

Figure 3-2. Loggerhead Sea Turtle Northwest Atlantic Ocean Distinct Population Segment Critical Habitat

3.3.3 Green Sea Turtle

CCSFS is exempted from the designated critical habitat for sea turtles because of its INRMP, which specifies the implementation of measures to benefit the conservation of this species (USAF 2023). The beaches immediately north of CCSFS, Satellite Beach, and the nearshore waters of the Atlantic Ocean adjacent to the beaches of CCSFS have been designated as proposed critical habitat for the green sea turtle (Figure 3-3).

The USFWS designated new areas of nesting beach critical habitat for the threatened and endangered DPSs of the green sea turtle (88 FR 137 Page 46376 [July 2023]). The USFWS identified terrestrial areas that support natural coastal processes, as well as localized areas where artificially created, maintained, or enhanced habitat supports important green turtle nesting or basking areas, as PBFs for the species:

- **PBF1** – Extra-tidal or dry sandy beaches from the mean high-water line—the line on a chart or map that represents the intersection of the land with the water surface at the elevation of mean high-water line—to areas of beach landward of the mean high-water line that contain the characteristics described herein:
  - Habitat for green turtles to transit across beaches and for nest placement includes the following:
    - Relatively unimpeded wet and dry sand or nearshore access areas from the ocean to the beach for nesting females and from the beach to the ocean for both post-nesting females and hatchlings
    - Drier sand areas located above mean high water in the supralittoral zone to avoid being inundated frequently by high tides
  - Sand substrate that has the following features:
    - Allows for suitable nest construction.
    - Is suitable for facilitating gas diffusion conducive to embryo development.
    - Can develop and maintain temperatures and a moisture content conducive to embryo development
    - Allows for emergence of hatchlings from eggshells, through sand substrate to the beach surface
- **PBF2** – Nesting beach habitat with sufficient darkness such that nesting turtles are not deterred from emerging onto the beach and hatchlings and post-nesting females can orient to the sea
- **PBF3** – Natural coastal processes or artificially created or maintained habitat mimicking natural conditions, including artificial habitat types that mimic natural conditions described in PBF1 and PBF2 for beach access, nest site selection, nest construction, egg deposition and incubation, and hatchling emergence and movement to the sea.

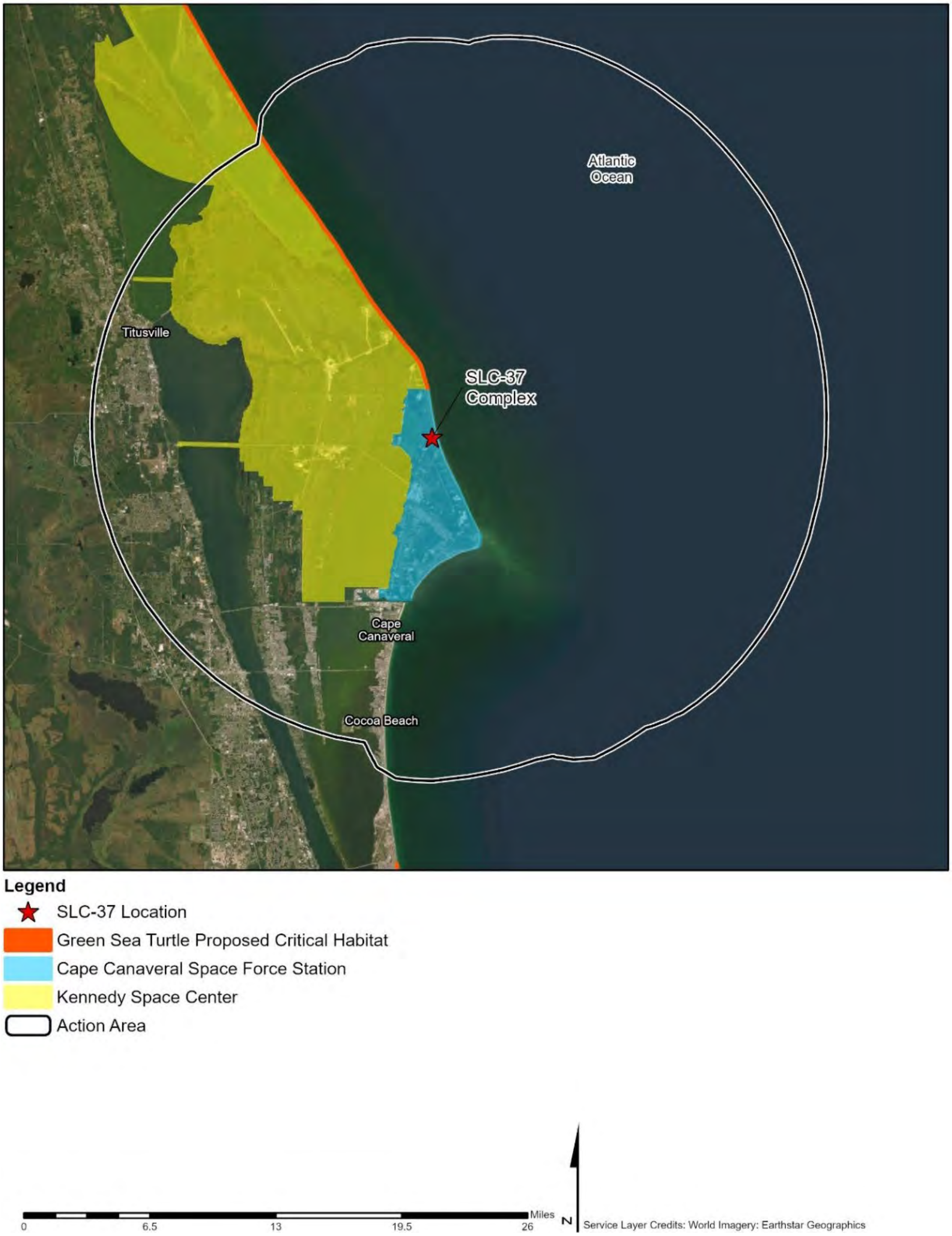

Figure 3-3. Green Sea Turtle Northwest Atlantic Ocean Distinct Population Segment Proposed Critical Habitat

3.3.4 Rufa Red Knot

MINWR and the shoreline north of CCSFS along the Canaveral National Seashore (CANA) are within rufa red knot critical habitat (Figure 3-4). The USFWS determined that the following PBFs are essential to the conservation of the rufa red knot (88 FR 71 Page 22530 [April 2023]):

- **PBF1** – Beaches and tidal flats used for foraging
- **PBF2** – Upper beach areas used for roosting, preening, resting, or sheltering
- **PBF3** – Ephemeral and/or coastal features used for foraging or roosting
- **PBF4** – Ocean vegetation deposits or surf-cast wrack used for foraging and roosting
- **PBF5** – Intertidal peat banks used for foraging and roosting
- **PBF6** – Features landward of the beach that support foraging or roosting
- **PBF7** – Artificial habitat mimicking natural conditions or maintaining PBF1 to PBF6

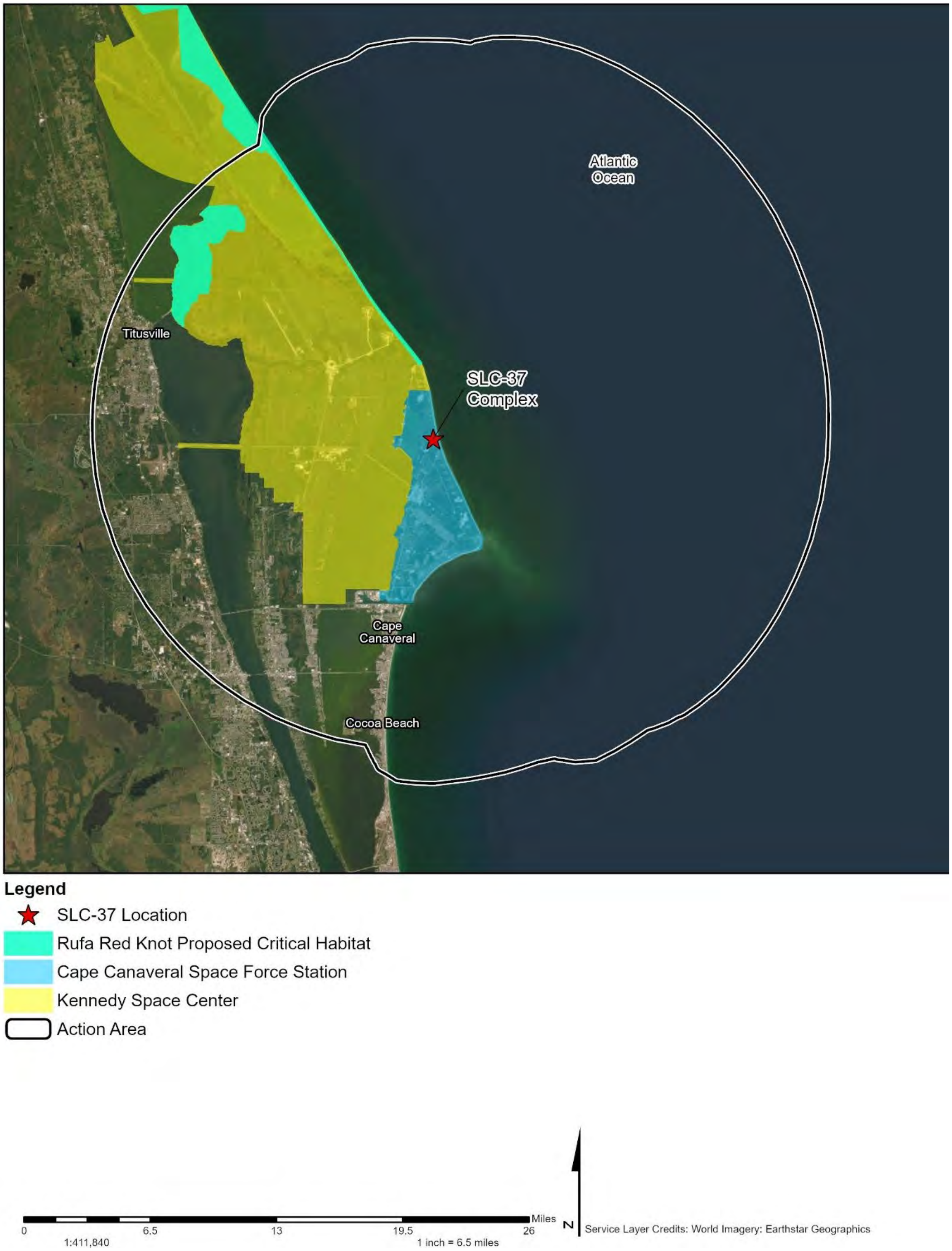

Figure 3-4. Rufa Red Knot Proposed Critical Habitat

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4. Environmental Baseline

The environmental baseline includes the past and present impacts of all federal, state, or private actions. Additionally, the environmental baseline includes other human activities in an action area; the anticipated impacts of all proposed federal projects in an action area that have already undergone formal or early Section 7 consultation; and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02).

4.1 Past, Present, and Future Launch Operations

Table 4-1 presents the total launches from 2018 through 2024 for CCSFS and KSC. Table 4-2 represents the anticipated number of launches from 2025 through 2028 for CCSFS and KSC.

Table 4-1. Past Vehicle Launches on CCSFS and KSC

Year	Total Launches
2018	20
2019	15
2020	31
2021	31
2022	57
2023	72
2024	101
Total Launches	**327**

Note:

Numbers provided by SLD 45.

Table 4-2. Planned Future and Potential Launch Actions on CCSFS and KSC

Year	Total Planned Launches
2025	135
2026	165
2027	120
2028	115
Total Launches	**535**

Note:

Number provided by SLD 45 as projections based on scheduling, the launch manifest, and other known information; therefore, these numbers are subject to change.

Planned launches include the increased cadence from SLC-40 and the Starship-Super Heavy launches from LC-39A.

4.2 Description of the Action Area

The Cape Canaveral Peninsula is part of the barrier island complex along the Atlantic Coast. The peninsula is Pleistocene- and Holocene-aged and contains beach ridges and dunes. The Cape Canaveral Peninsula is considered a cuspate foreland, which is a land formation characterized by the coastline (DAF 2023). CCSFS encompasses approximately 16,200 acres (25 square miles), representing about 2% of Brevard County's total land area. Land use types on CCSFS include airfield, port operations, launch operations, launch and range support, commercial aerospace ventures, station support, maintenance areas, and open space. The beaches along CCSFS are restricted from public use.

CCSFS is located within the Indian River Lagoon watershed. This watershed contains three primary water bodies: Banana River Lagoon to the west, Mosquito Lagoon to the north, and Indian River Lagoon west of Merritt Island (DAF 2023). Several neighboring water features have been designated as Outstanding Florida Waters, encompassing a significant portion of Mosquito Lagoon and Banana River Lagoon, along with the Indian River Aquatic Preserve, Banana River Aquatic Preserve, Pelican Island National Wildlife Refuge, and Canaveral National Seashore (FDEP 2023). In 1990, the Indian River Lagoon system received recognition as an Estuary of National Significance within the U.S. Environmental Protection Agency’s National Estuary Program. This designation identifies estuaries of national importance, aiming to balance conflicting uses of these ecosystems while restoring or preserving their inherent characteristics (EPA 2024).

The Florida Land Use and Cover Classification System (FLUCCS) shows that 13 natural communities and land cover types occur on CCSFS. The most common natural community type is coastal strand, followed by live oak and saw palmetto shrubland, live oak and saw palmetto hammock, and scrub (DAF 2023). The natural landscape of CCSFS is fragmented by SLCs, buildings, roads, ditches, sight lines, and an aircraft runway. A canal network has affected hydrology. Additionally, vegetative communities have been affected and altered by fire exclusion and the introduction and establishment of invasive, exotic vegetation (DAF 2023).

CCSFS is located on a barrier island that supports a diverse array of animal species, including nesting marine turtles and populations of small mammals, and serves as foraging and roosting habitat for a variety of resident and migratory birds. More than 25 mammalian species, 50 amphibian and reptile species, and 200 bird species are known to occur on or in the vicinity of CCSFS. Common terrestrial wildlife species on CCSFS include bobcats, feral hogs, deer, foxes, alligators, eastern diamondback rattlesnakes, passerine birds, shorebirds, wading birds, great horned owls, ospreys, and eagles (DAF 2023).

In total, 44 invasive and noxious plant species have been identified on CCSFS. The most common is the Brazilian pepper (*Schinus terebinthifolius*). CCSFS implements an Invasive Plant Species Control Plan to control or eradicate noxious and invasive plant species on CCSFS (DAF 2023).

The nearshore environment, oceanward from the CCSFS coastline, is present along the Florida East Coast continental shelf and is characterized by sand- and mud-covered plains with areas of hard-bottom habitats. The hard-bottom habitats are expected to harbor a diverse assemblage of reef fishes and macrocrustaceans (NASA 2015). The Atlantic Ocean coastline consists of open ocean with habitat for various life stages of a wide range of species, including mammals, fish, reptiles, birds, and invertebrates (NMFS 2023).

The action area would include the redevelopment of SLC-37, including various road improvements and utility upgrades. Operations to support Starship-Super Heavy launch and landing activities at the Proposed Action would include heat plume; noise; vibration contours, including sonic booms; lighting area; increased traffic area; and Atlantic, Pacific and Indian Oceans where expendable launches and debris could occur.

4.3 Description of the Environmental Baseline

The historical use of CCSFS as an USAF Station and then a USSF Station, which has supported space missions and other military missions, has shaped the habitats within its boundaries. KSC development and operation by NASA have also shaped the habitats on lands surrounding CCSFS.

The action area includes lands that have been developed and maintained to support the U.S. space mission; lands that are maintained in an early seral stage by regular mowing along transportation corridors; natural habitats such as beach, coastal strand, oak scrub, open water, salt marsh, ruderal-woody vegetation, ruderal herbaceous vegetation, and ruderal herbaceous and woody mix that support a variety of plant and wildlife species; nearshore waters of the Atlantic Ocean with sea grasses; and the open waters of the Atlantic Ocean (USAF 2023). Outside ruderal areas, the habitats range in quality from moderately disturbed to generally undisturbed.

4.3.1 Inventories and Surveys for Site-specific Habitat Types in the Action Area

Annual site-specific sea turtle nesting surveys, Florida scrub-jay surveys, and shorebird activity surveys have been completed for the action area on CCSFS. Nesting sea turtle surveys have occurred annually since 1986, Florida scrub-jay surveys have occurred annually since 1995, and shorebird surveys have occurred since 1992. Southeastern beach mouse monitoring along beach and dune habitats was conducted from 2008 to 2018, and ongoing monitoring for the species occurs throughout CCSFS. Tricolored bat surveys occurred on CCSFS in 2019. No other site-specific surveys have been conducted within the action area on CCSFS. Habitats managed by SLD 45, including locations and quality, are updated periodically within the CCSFS INRMP. Annual sea turtle surveys, Florida scrub-jay surveys, and wading birds' surveys occur at KSC. Sea turtle surveys have taken place at KSC since 1983, Florida scrub-jay surveys have occurred since 1988, and wading bird surveys have occurred since 1987. Annual sea turtle surveys at CANA have occurred since 1984. Beach mouse surveys also occur at CANA, with the most recent surveys occurring in 2023 through 2024. Bat surveys also occur at CANA, with the most recent survey occurring in 2023.

Figure 4-1 details CCSFS land management units of environmental concern ranked for mitigation and habitat diversity of Florida scrub-jay and southeastern beach mouse use. Mitigation ratios associated with the land management units degree of concern have been used to estimate the mitigation requirements to offset unavoidable impacts from the Proposed Action to the respective species and are detailed in the following sections.

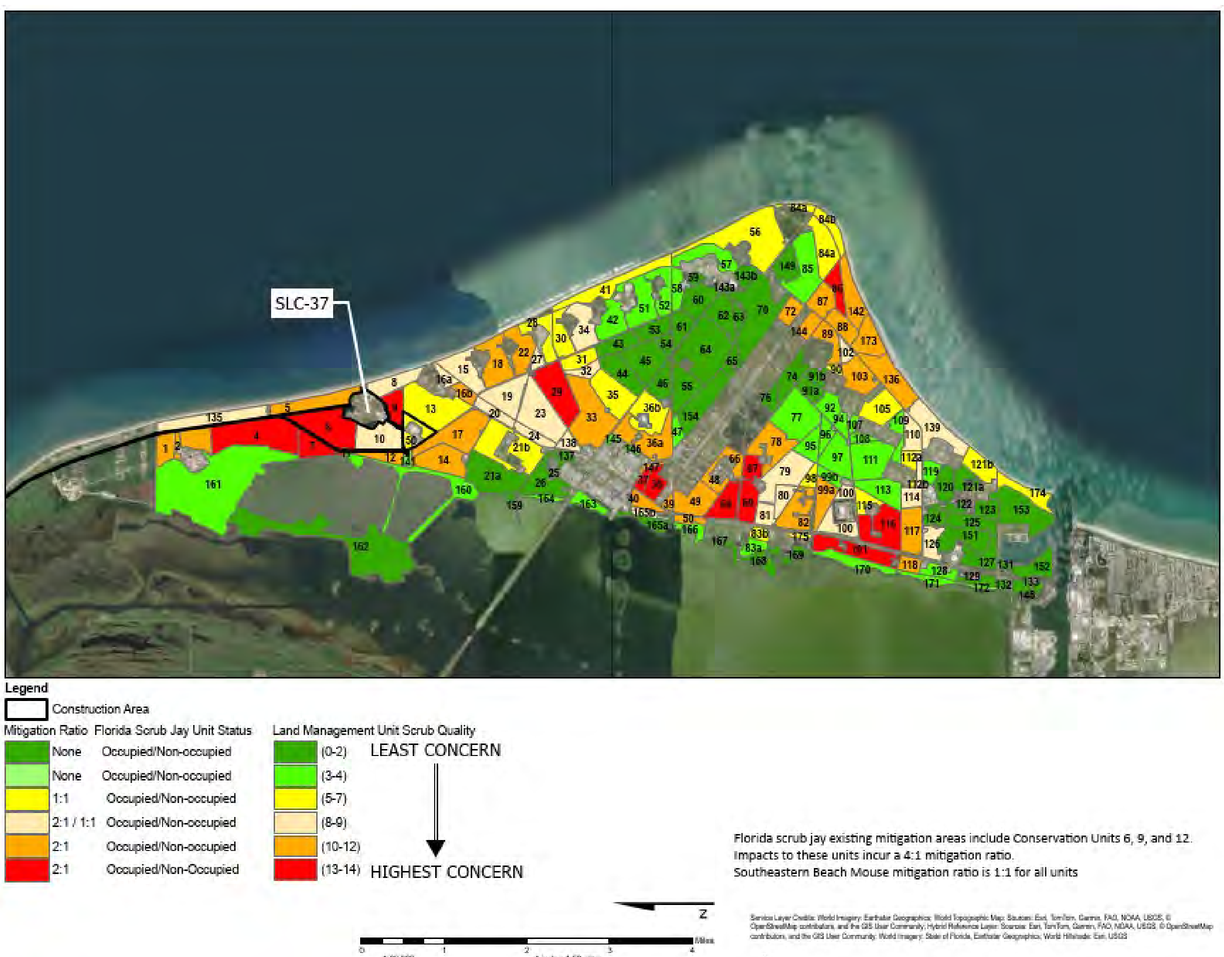

Figure 4-1. CCSFS Land Management Units of Conservation and Environmental Concern

4.3.1.1 Relationship Between Habitat in the Action Area and the Biological Requirements of the Species

The SLC-37 construction area supports the biological requirements for the southeastern beach mouse; the species is known to use developed land, including active and inactive buildings and around launch complex infrastructure. Proximity of the construction area to southeastern beach mouse nesting habitats (coastal dunes) makes it probable that southeastern beach mice use habitats within the construction area for foraging and burrowing. The construction area has soil conducive for gopher tortoise burrowing. Gopher tortoises have been observed within and along the fence line within SLC-37; therefore, there is the potential for gopher tortoises to have established burrows within and along the SLC-37 fence line, providing potential refugia for the eastern indigo snake. The Everglade snail kite has been observed throughout the MINWR at KSC and CSN.

The roadway improvement construction areas are in maintained ROWs that transect good quality scrub habitat that supports known Florida scrub-jay groups. Florida scrub-jays use the mowed ROW along Phillips Parkway to forage and cache acorns from adjacent scrub habitats. Both roadway ROWs provide foraging habitat for the southeastern beach mouse. The roadway improvement construction areas have low-quality habitat for the tricolored bat (foraging and roosting), crested caracara (foraging), eastern indigo snake (foraging and refugia), and monarch butterfly (foraging). The additional turning radii will be constructed entirely within the exiting ROW of Phillips Parkway, Parol, and Beach Roads such that habitat outside the existing ROW is removed. These ROW areas would provide habitat support for listed species similar to the other roadway widening areas.

The remainder of the action area provides some portion of the biological requirements for all the identified potentially occurring species. The landward portions provide the biological requirements for the southeastern beach mouse (foraging and nesting), tricolored bat (foraging and roosting), crested caracara (foraging), Florida scrub-jay, eastern indigo snake, and monarch butterfly. Wetland habitats such as emergent marsh and fringes of lagoons and ponds may provide roosting and foraging habitat for the eastern black rail and foraging for the Everglade snail kite. The shoreline provides stopover biological requirements for the rufa red knot and piping plover. The beaches and nearshore waters provide biological requirements (nesting) for sea turtles. The Banana River and Port Canaveral waters also provide biological requirements for the green sea turtle. The black-capped petrel has the potential to occur within the Atlantic Ocean action area as it migrates to and from seasonal nesting locations and may forage within the Atlantic Ocean The band-rumped storm petrel, Hawaiian petrel, Newell’s shearwater, and short-tailed albatross have the potential to occur within the Pacific Ocean action area during foraging in the Pacific Ocean. The Banana River and the nearshore waters of the Atlantic Ocean provide biological requirements for the West Indian manatee. The marine species potentially impacted from operations in the nearshore and offshore waters of the Atlantic Ocean, such as the green sea turtle, loggerhead turtle, leatherback turtles, hawksbill turtle, and Kemp’s ridley sea turtle, are covered under the NMFS consultation and are not further described in this BCA.

Available habitats occurring within the action area were mapped using FLUCCS geographic information system layers available from the St. Johns River Water Management District (SJRWMD 2021). These habitat classifications provide general information regarding upland versus aquatic habitats, forested versus herbaceous habitats, and developed areas such as buildings, roadways, and existing launch complex infrastructure. For the purposes of this BCA, FLUCCS labeling for habitats was reviewed for consistency with aerial imagery available for the SLC-37 construction area and roadway improvement construction areas components of the action area. Minor inconsistencies or inaccurate labeling are possible with Level 3 FLUCCS geographic information system layers, but the data generally provide a reasonable assessment of available habitats. Where necessary, those land uses were updated to reflect known, site-specific conditions from the INRMP and survey sources.

For the noise and sonic boom component of the action area beyond the SLC-37 construction area and roadway improvement construction areas, available FLUCCS mapping was used without interpretation. Mapped FLUCCS data were then considered for habitat suitability for the listed species identified. Habitats that provide biological requirements for each of the identified species were included in the effects determination for Proposed Action. Habitat information was reviewed from the CCSFS INRMP (USAF 2023), which provides further details regarding Florida scrub-jay management and CCSFS species surveys. Finer resolution of habitat delineations for listed species suitability would require site-specific surveys that are beyond the scope of this BCA.

4.4 Detailed Description of Habitat Features that May be Affected by the Proposed Action

Table 4-3 and Figure 4-2 provides Level 3 FLUCCS mapping for the SLC-37 construction area. Demolition and construction would occur within the approximately 178-acre SLC-37 construction area. Demolition activities covered under this formal consultation include any required beyond those performed as part of the previous informal consultation under FWS Log No. 2025-0098469 (May 2025). Habitats within the SLC-37 fence line are primarily low-quality foraging habitat and refugia that provide little support for listed species. Stormwater ponds provide permanent surface water sources that support aquatic flora and fauna. The SLC-37 construction includes approximately 132.6 acres of developed areas (of which 37.2 acres is impervious surfaces), less than 0.1 acre of herbaceous dry prairie, 0.8 acre of shrub and brushland, 19.3 acres of mixed rangeland, 0.1 acre of xeric oak, 8.7 acres of reservoirs (stormwater ponds), and 16.3 acres of treeless hydric savanna. Recent aerial imagery (FGDL 2020) indicates that some areas mapped as xeric oak are not accurate and are mostly maintained, grassed areas. SLC-37 is fully developed, and areas not converted to hardscape have been landscaped and are mowed regularly. While the area is heavily disturbed and landscaped, it still may provide potential habitat for the southeastern beach mouse, tricolored bat, and eastern indigo snake. SLD 45 and USFWS performed site visits of the SLC-37 construction area on April 24, 2025, to evaluate and quantify areas potentially used by southeastern beach mouse. The result was a reduction in suitable habitat for the species which is reflected in the discussion below.

The Phillips Parkway roadway improvement construction area (26.3 acres) include 14.9 acres of existing roadway impervious area and 11.4 acres of herbaceous dry prairie (Table 4-3). The roadway improvement construction areas provide potential nesting and forage habitat for the southeastern beach mouse, Florida scrub-jay, tricolored bat, crested caracara, eastern indigo snake, and monarch butterfly. Widening of Phillips Parkway would occur within the existing ROW, which is regularly mowed and maintained. Two areas of additional turn radius area (< 1 acre) would occur within the existing maintained (mowed) ROW, which was interpreted as herbaceous (dry prairie) (FLUCCS 3100) habitat and are included in the Phillips Parkway roadway widening herbaceous dry prairie total acres.

Widening of Old A1A (4.2 acres) includes 1.8 acres of fallow existing impervious area and would require clearing vegetation that has encroached on the road and ROW Table 4-3. The Old A1A widening area would take place in habitats that include 0.2 acre of developed area, 1.2 acres of herbaceous dry prairie, 0.4 acre of mixed rangeland, 0.2 acre of shrub and brushland, 0.3 acre of treeless hydric savanna, and 0.2 acre of xeric oak. Vegetated areas within the widening area of Old A1A could provide habitat for each of the formerly mentioned species.

Table 4-3. Mapped Land Uses for Construction Areas

FLUCCS Level 3	FLUCCS Type	SLC-37 Construction Area (acres)	Phillips Parkway (acres)	Old A1A (acres)
1750	Governmental	95.4	0.0	0.2
3100	Herbaceous (Dry Prairie)	< 0.1	11.4	1.2
3200	Shrub and Brushland	0.8	0.0	0.2
3300	Mixed Rangeland	19.3	0.0	0.4
4210	Xeric Oak	0.1	0.0	0.2
5300	Reservoirs	8.7	0.0	0.0
6460	Treeless Hydric Savanna	16.3	0.0	0.3
N/A	**Total**	**140.6**	**11.4**	**2.4**
N/A	Impervious Surface	37.2	14.9	1.8
N/A	**Grand Total**	**177.8**	**26.3**	**4.2**

N/A = not applicable

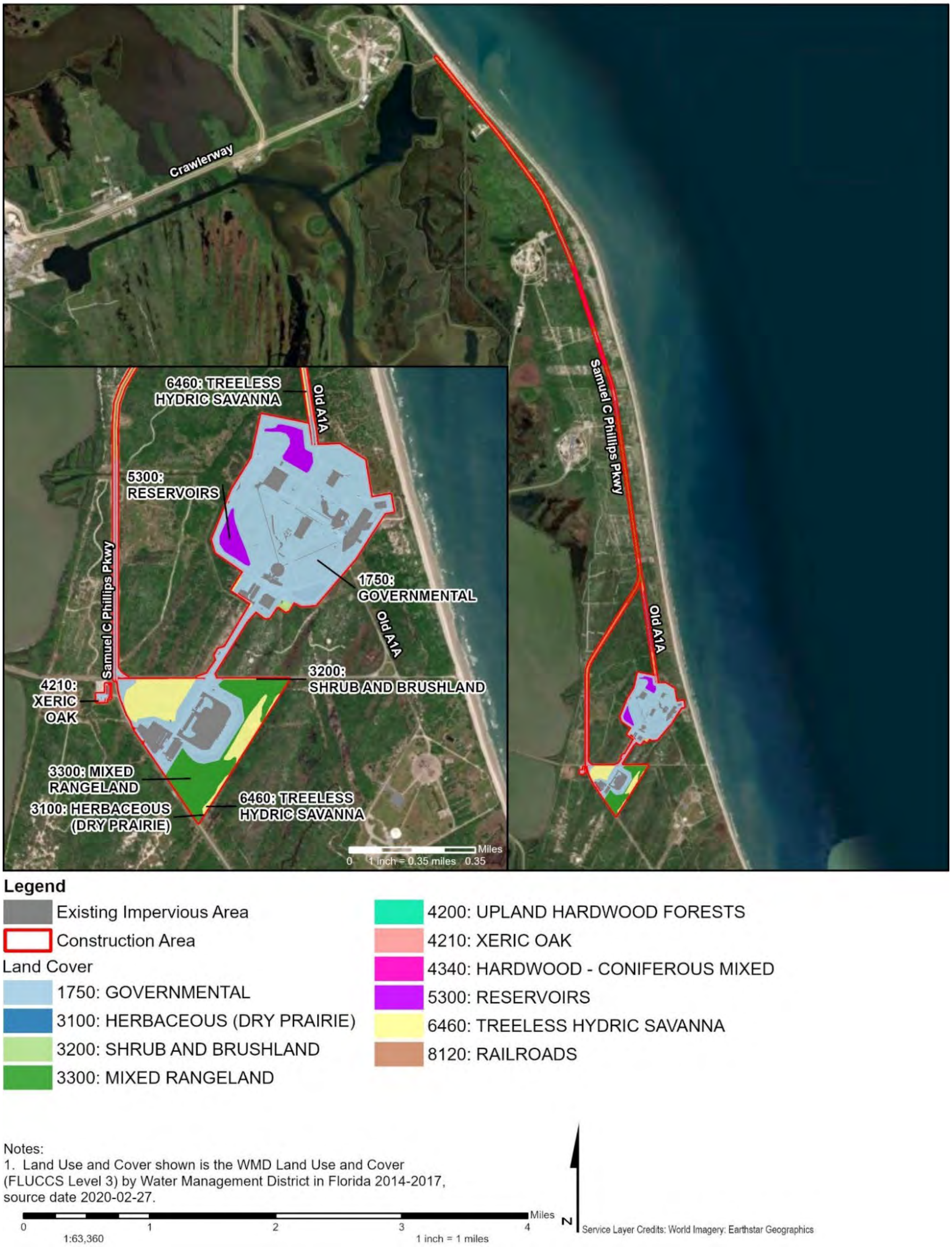

Figure 4-2. Construction Area Land Uses

4.4.1 Southeastern Beach Mouse

The southeastern beach mouse occurs throughout suitable habitat on CCSFS. The species typically occurs in coastal dune and strand communities with low vegetative density and areas of bare sand; these communities provide medium- to high-quality habitat for the species on CCSFS. Historically, southeastern beach mouse populations on CCSFS were restricted to the coastal dune and coastal strand communities, but research has shown that the southeastern beach mouse also occurs in interior oak scrub sites that are structurally similar to historical southeastern beach mouse habitat, as well as open fields and grassy road shoulders and medians. The species has also been documented using areas within the active launch pads on CCSFS and inside building facilities (Gillikin 2021).

The inland areas provide landward habitat that increases the resilience of the southeastern beach mouse on CCSFS and may also serve as refuge during extreme weather events (USAF 2023). The species also occurs at KSC, CANA, and MINWR. As a result of the continuity of the habitat at these four locations, the population has remained stable over the years. A study at KSC between 2003 and 2005 showed that the capture rates of southeastern beach mice in coastal dune areas were indicative of healthy populations. The study also indicated that the capture rate was higher on CCSFS because of an increase in suitable habitat there. Southeastern beach mice moved into a shoreline dune restoration area near KSC LC-39A and LC-29B within 4 months of vegetation planting. A 2021 study by FWC showed an increase in southeastern beach mouse detections from the previous year at CANA, though this is likely the result of removing tubes from the previous year, as there was not an observed beach mouse detection during that time. Data from surveys at Playalinda Beach detected the presence of the southeastern beach mouse in areas on or behind dunes. The 2021 survey included the monitoring of several locations on CCSFS. Areas that lack bare ground, such as recently restored areas, had low detection rates. Monitoring on CCSFS also included an analysis of the effects of prescribed burned areas on the species. CANA conducts annual monitoring of the southeastern beach mouse. In 2023, 113 beach mouse observations were made; in 2024, 111 observations were made (CANA 2024a).

There is ongoing monitoring for the southeastern beach mouse on CCSFS to better understand potential impacts on the species' habitat and to detect any decline in population. Monitoring for the species also occurs at KSC, CANA and by FWC. Overall population estimates for the southeastern beach mouse have not been determined, though estimates are available for some locations including the Cape Canaveral Complex population, which includes CCSFS. The overall population is considered stable (USFWS 2019d).

There are 72.3 acres of potential southeastern beach mouse forage habitat (excluding buildings, impervious areas, and reservoirs) within the SLC-37 construction area and the roadway improvement construction areas that would be affected from the Proposed Action (Table 4-4). SLC-37 is a predominantly hardened landscape of roads, buildings, and launch infrastructure, with some mowed grass areas. The southern beach mouse is assumed to occupy buildings and infrastructure, along with mowed and landscaped areas as habitats for foraging based on its known presence within the vicinity of SLC-37. SLD 45 and USFWS performed a qualitative survey for suitable southeastern beach mouse habitat within the existing fence line of SLC-37 on April 25, 2025. A total of 20.0 acres of suitable habitat was observed which would be impacted from the Proposed Project (Table 4-4). The habitat impacted from widening Phillips Parkway is characterized as herbaceous dry prairie that is routinely mowed. However, the southeastern beach mouse may occupy this habitat for foraging and is known to burrow within roadway ROWs on CCSFS (Chambers, pers. comm. 2024). Vegetation habitats within the Old A1A ROW (reestablished xeric oak and scrub) provides acres of foraging and refugia habitat for the southeastern beach mouse.

Impacts to southeastern beach mouse habitat are mitigated at 1:1 ratios throughout CCSFS, except in areas of impervious surface, buildings, wetlands, and surface waters. Table 4-4 provides the impacts from the Proposed Project construction area components and the estimated southeastern beach mouse habitat mitigation that will be required. A total of 72.3 acres of southeastern beach mouse habitat mitigation will be required to offset Proposed Project impacts. These include suitable habitats within SLC-37, the ROW adjacent to Phillips Parkway, and fallow habitats around Old A1A.

Table 4-4. Southeastern Beach Mouse Habitat Impacts from Construction and Required Mitigation

Construction Area	Impact (acres)	Mitigation 1:1 (acres)
SLC-37 and Associated Infrastructure	58.5	58.5
Phillips Parkway[a]	11.4	11.4
Old A1A[a]	2.4	2.4
Total	**72.3**	**72.3**

[a] Existing impervious areas excluded.

4.4.2 Tricolored Bat

Acoustic surveys conducted in 2019 detected tricolored bats at 31 various locations out of 77 survey points (40% occurrence rate) on CCSFS (Figure 4-3) (USAF 2023). The detection rate for this species during these surveys was 40%. Roost locations on CCSFS are unknown, but the species has not been observed roosting in structures on the facility (USAF 2023). The number of tricolored bats on CCSFS are unknown. Bat surveys at CANA occurred in 2023 and indicated the presence of tricolored bats. The population trend of tricolored bats has been trending downward for 14 years, and this trend is expected to continue (USFWS 2021b).

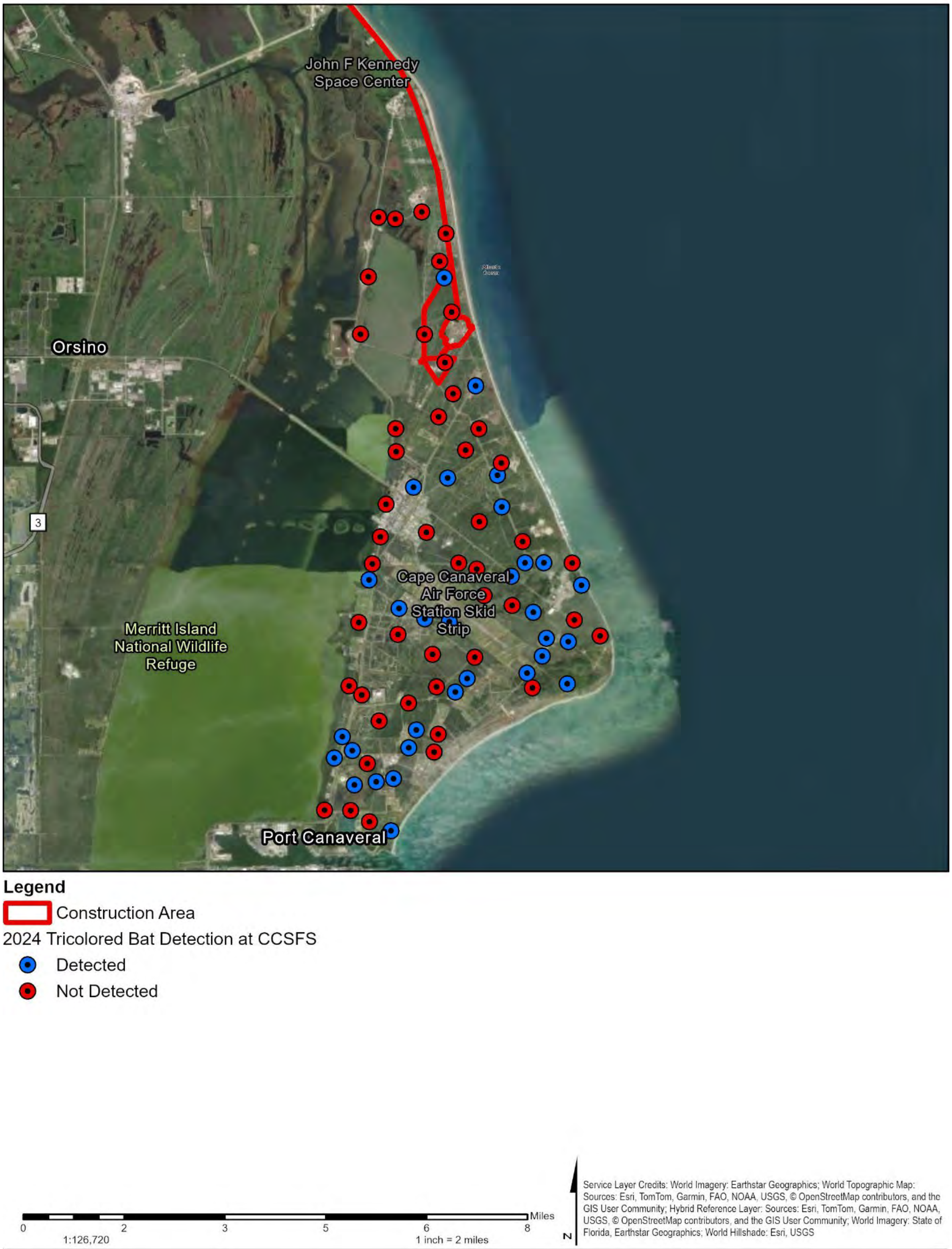

Figure 4-3. Tricolored Bat Occurrences

There are approximately 108.3 acres of hardened landscape such as buildings and launch infrastructure along with and herbaceous dry prairie (<0.1 acres) that is routinely mowed at SLC-37 that could be potential tricolored bat roosting and foraging habitat if colonies have become established during the sites nonuse. The widening of Phillips would be within existing roadway ROW, which is routinely mowed and is assumed to be marginal foraging habitat for the tricolored bat. Forest edges would remain intact from the widening. Old A1A is not in use or maintained. Encroaching vegetation within the ROW would be removed during the roadway widening. If the tricolored bat is using these habitats, they would generally remain for foraging postconstruction.

4.4.3 West Indian Manatee

Manatees are present in the action area year-round, except for periods of cold weather. The turning basin west of CCSFS facility Hangar AF typically has an exceptionally high concentration of manatees and is within designated critical habitat for the species (USAF 2023). Aerial surveys indicate use of all areas of the Banana River, from the Port Canaveral Locks north into the MINWR and KSC manatee sanctuary (Scheidt 2021). Individual surveys and combined seasonal surveys have indicated a consistent presence of manatees within the Port Canaveral Locks, which is the area directly adjacent and nearby waters (Scheidt 2021). The number of manatees using the Banana River have decreased since 2017 (Scheidt et al. 2023). There were only 33 manatees per aerial flight observed in 2019 (Scheidt 2021). Manatees may also occur in nearshore waters of the Atlantic Ocean along the eastern boundary of CCSFS. Aerial surveys for West Indian manatee began in 1991, when the estimated population in Florida was 1,267 manatees. There are an estimated 8,350 manatees that inhabit Florida, representing a significant increase over the past 33 years (USFWS 2024d).

The KSC turning basin within the Banana River typically has an exceptionally high concentration of West Indian manatees and is within the designated critical habitat for the species (USAF 2023). The construction area contains no habitat for the West Indian manatee, but the species may occur within the action area—beyond the construction area yet within the nearshore waters of the Atlantic Ocean—250 feet east of SLC-37 and the Banana River to the west.

4.4.4 Band-Rumped Storm Petrel

The band-rumped storm petrel has not been observed on CCSFS but may occur in the offshore areas of the Pacific Ocean. There is no information on local population levels for this species. Population trends for band-rumped storm petrel are uncertain because of low detectability of the species and lack of data.

4.4.5 Bermuda Petrel

The Bermuda petrel has not been observed on CCSFS but may be observed during foraging in the offshore areas of the Atlantic Ocean. There is no information on local population levels for this species. Population trends for the Bermuda petrel show an increase in population, including breeding pairs and reproductive success from 1962 to 2005 and increased precipitously between 2005 and 2023 (USFWS 2024b).

4.4.6 Black-Capped Petrel

The black-capped petrel has not been observed on CCSFS but may occur in the offshore areas of the Atlantic Ocean. There is no information on local population levels for this species. Population trends for black-capped petrel are uncertain because of low detectability of the species and lack of data on recruitment rates (USFWS 2018).

4.4.7 Crested Caracara

The crested caracara has been observed on CCSFS several times in recent years but it has not been documented nesting (USAF 2023). Most sightings have been around the airfield and on the northern portion of CCSFS near SLC-40 and SLC-41 (USAF 2023). Observations from iNaturalist (2024) show that the species has been observed at KSC, west of the Indian River along Interstate 95, along Cheney Highway, and within the River Lakes Conservation Area.

The crested caracara is occasionally observed on CCSFS but nesting has not been documented (USAF 2023). Population trends for the crested caracara are uncertain because of low detectability of the species, limited access to suitable habitat on private lands, and the lack of data on recruitment rates (USFWS 2009).

There are 19.3 acres of mixed rangeland and 16.3 acres of treeless hydric savanna within the SLC-37 construction area that may be used by crested caracara for foraging. Approximately 11.4 acres of herbaceous dry prairie exist within the Phillips Parkway ROW that may be used for foraging. Old A1A contains approximately 1.2 acres of herbaceous dry prairie and 0.3 acre of treeless hydric savanna that could be used for foraging by the species. These foraging habitats would be impacted from roadway improvements.

4.4.8 Eastern Black Rail

The eastern black rail has not been documented on CCSFS (USAF 2023). Because the species has not been observed on CCSFS, there is no monitoring program for this species. NASA, however, conducts annual black rail surveys at KSC. Three black rails were observed on KSC and MINWR during the 2022 breeding season (NASA 2023). There are no statistically valid abundance estimates for assessing eastern black rail population trends over time (USFWS 2020c). The small number of detections during the 2022 survey at KSC and MINWR did not allow for a detailed analysis of population density or habitat use (NASA 2023). Suitable habitat does not exist for eastern black rail within the SLC-37 construction area. There is no suitable habitat for the eastern black rail within the roadway improvement construction areas.

4.4.9 Everglade Snail Kite

The Everglade snail kite has not been documented on CCSFS (USAF 2023). There are six Everglade snail kite analysis units including Florida southeast coast, St. Johns, Lake Okeechobee, Kissimmee River Valley, Paynes Prairie, and the Everglades (USFWS 2023e). None of these analysis units are within the action area. The species has been observed in the MINWR at KSC and CANA (USFWS communication 2025). A decrease in the Everglade snail kite population occurred between 1999 and 2002 and again between 2007 and 2009. These population decreases were attributed to a severe drought that occurred across the species range (USFWS 2023e). Since 2010, populations for the Everglade snail kite have increased. The increase may have occurred as a result of the expansion of the species' main food source, the giant apple snail (*Pomacea maculate) (*USFWS 2023e*)*. However, juvenile survival has declined steadily since 2015; further research is needed to determine why the decline in juveniles is occurring (USFWS 2023e).

The Everglade snail kite has not been observed on CCSFS (USAF 2023) but has been observed in the vicinity, including MINWR. No suitable foraging habitat exists within the SLC-37 construction area and the roadway improvement construction areas. Suitable habitats within the construction area consist of freshwater aquatic wetland communities where specific prey items (that is, freshwater apple snails) may be found.

4.4.10 Florida Scrub-Jay

Florida scrub-jays occur within the action area (Figure 4-4). The 2024 census on CCSFS documented 442 birds (USAF 2025). Figure 4-3 provides the location of scrub-jay colonies and scrub quality units on CCSFS. The population was relatively stable between 1995 and 2024, with a slight decrease in individuals from 1997 to 2006 (Figure 4-5). The population peaked in 2014 with 480 individuals and has remained above 400 individuals for the past 10 years on CCSFS (CCSFS 2024a). Florida scrub-jay groups on CCSFS followed similar trends to the numbers of individual birds and have ranged from approximately 100 to 150 between 1995 to 2024.

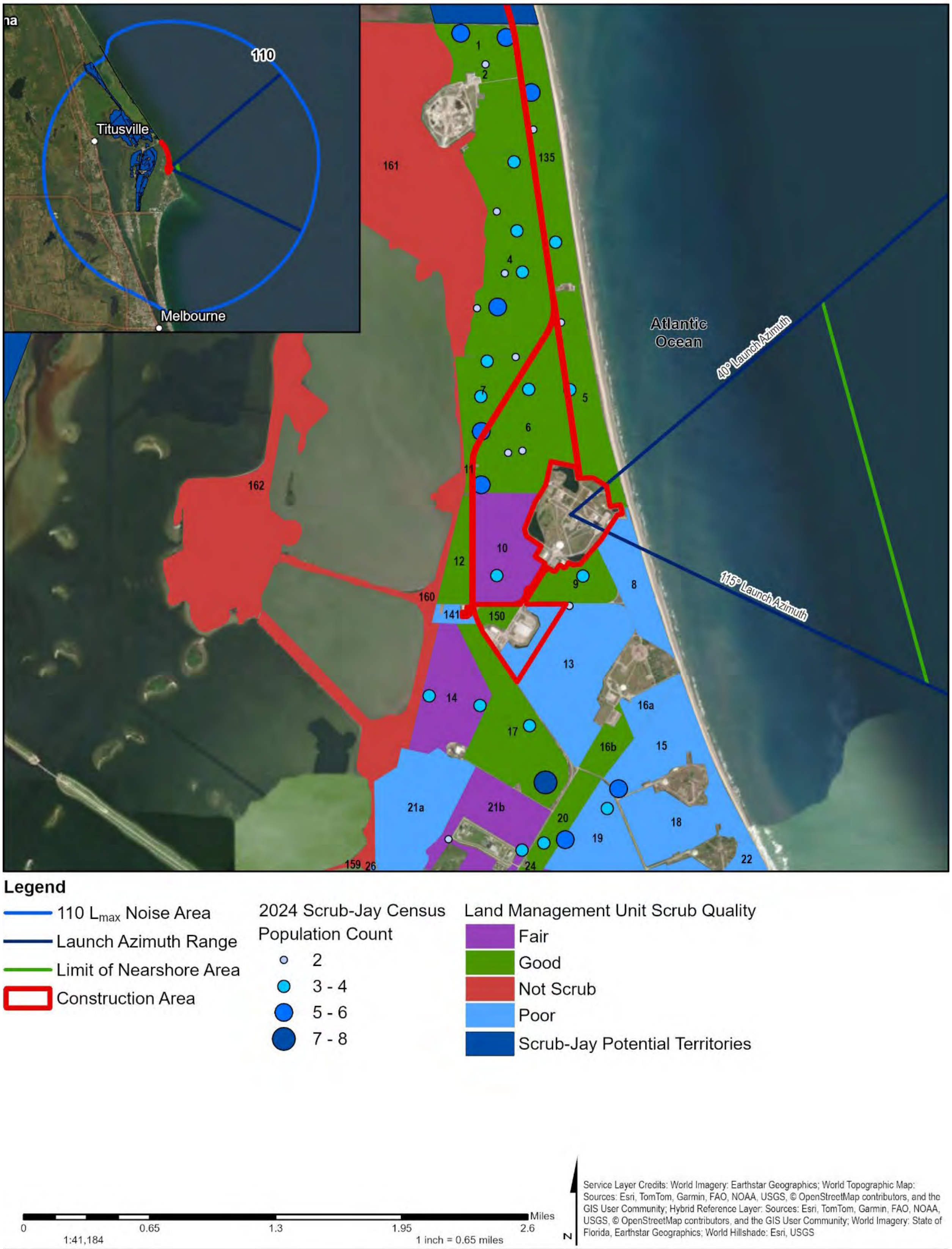

Figure 4-4. Land Management Units Scrub Quality

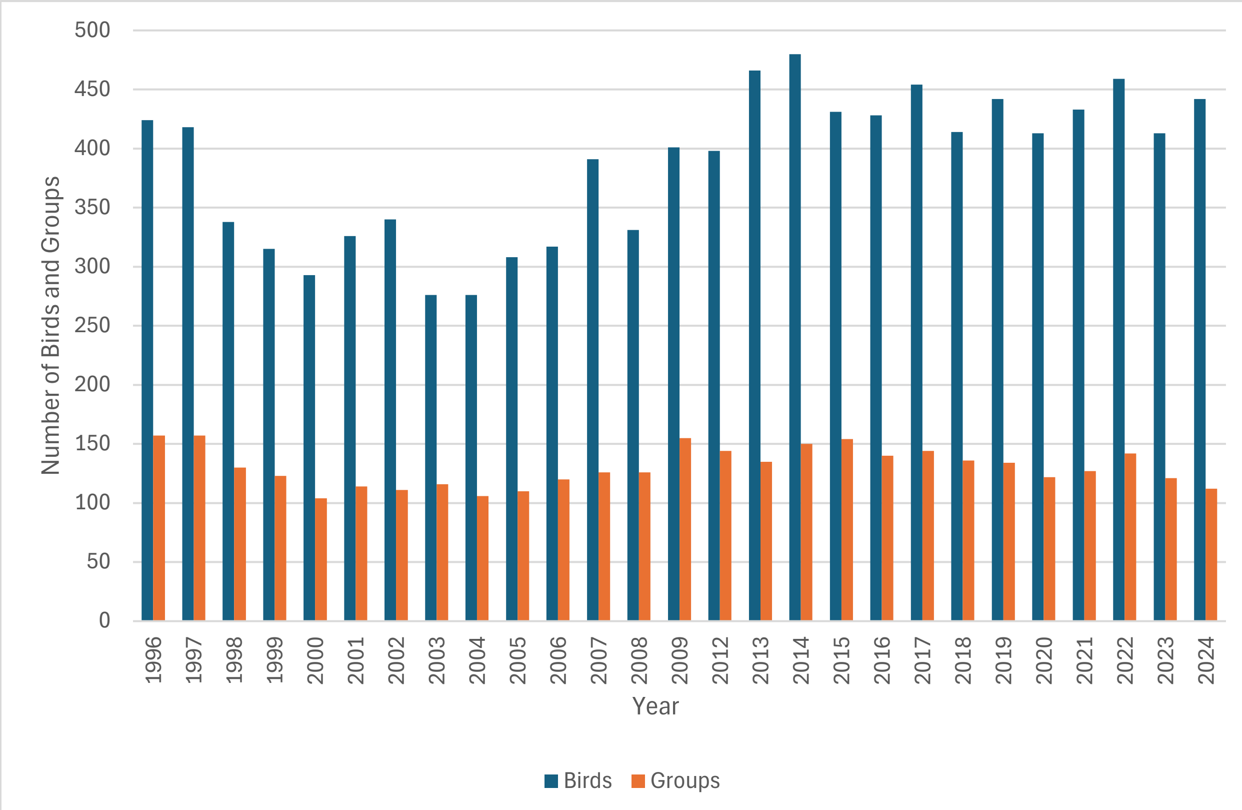

Figure 4-5. Florida Scrub-jay Surveys on CCSFS

Florida scrub-jay habitat is mitigated on CCSFS from land-disturbing activities that impact habitats managed by SLD 45 for conservation purposes. Figure 4-1 depicts designated land conservation units and their associated mitigation requirements for Florida Scrub-jays based on the degree of conservation and environmental concern along with whether the species occupies the unit. For scrub units that are already used for Florida Scrub-jay mitigation, the associated mitigation ratio is 4:1 and include Units 6, 9, and 12 adjacent to proposed construction components. Table 4-5 provides the impacts from the Proposed Project construction area components to land management units and the estimated Florida Scrub-jay habitat mitigation that will be required to offset impacts. The widening of Phillips Parkway is entirely within the existing maintained roadway ROW. While this area does provide foraging habitat for Florida Scrub-jays, it is not included in conservation land management units and does not require mitigation for Florida Scrub-jays from impacts. A total of 44.7 acres of impacts to land management units of varying conservation and environmental concern would result from the Proposed Action construction, which requires 50.5 acres of mitigation offset.

Table 4-5. Scrub Unit Impacts from Construction and Required Mitigation

Construction Area	Existing Mitigation Unit (acre[s])[a]	Moderate to Higher Concern Units (acre[s])[b]	Lesser to Moderate Concern Units (acre[s])[c]	Least Concern Units (acre[s])[d]	Total (acres)
SLC-37 and Associated Infrastructure	0.5	1.9	39.9	0.0	42.3
Phillips Parkway[e]	0.0	0.0	0.0	0.0	0.0
Old A1A[f[	<0.1	2.4	0.0	0.0	2.4

Construction Area	Existing Mitigation Unit (acre[s])[a]	Moderate to Higher Concern Units (acre[s])[b]	Lesser to Moderate Concern Units (acre[s])[c]	Least Concern Units (acre[s])[d]	Total (acres)
Impact Total	**0.5**	**4.3**	**39.9**	**0.0**	**44.7**
Mitigation Ratio (mitigation:impact)	4:1	2:1	1:1	0	N/A
Mitigation Total	**2.0**	**8.6**	**39.9**	**0.0**	**50.5**

[a] Land Management Units 6, 9, and 12

[b] Land Management Units ranked: 13 to 14, 10 to 12, and 8 to 9 (occupied)

[c] Land Management Units ranked: 8 to 9 (unoccupied) and 5 to 7

[d] Land Management Units ranked: 3 to 4 and 0 to 2

[e] Impacts entirely within roadway ROW, not requiring mitigation

[f] Existing impervious areas excluded

Annual scrub-jay surveys at specific monitoring sites at KSC have occurred since 1995 (Figure 4-6), but data from these surveys do not accurately represent population estimates because the monitoring effort has increased over time as additional monitoring sites have been added to the study (KSC 2024a). Further, KSC scrub-jay observations are not representative of property-wide populations estimates because the observations are only made from specific study sites. In 2024, 165 scrub-jay groups were observed within the study areas, with a total of 650 individuals. The 2022 annual scrub-jay report for NASA permit number TE106005-4 summarizes the scrub-jay habitat and population dynamics along the central Atlantic Coast of Florida (Breininger et al. 2023). Densities of breeding pairs have been relatively stable in recent years at long-term KSC monitoring sites (Breininger et al. 2023). Florida scrub-jay populations have declined to less than 10% of their historical, pre-European numbers. Overall population numbers have continued to decrease since its listing in 1987 (USFWS 2019c); however, monitoring at CCSFS and KSC indicate stable or increasing local populations (Figures 4-5 and 4-6).

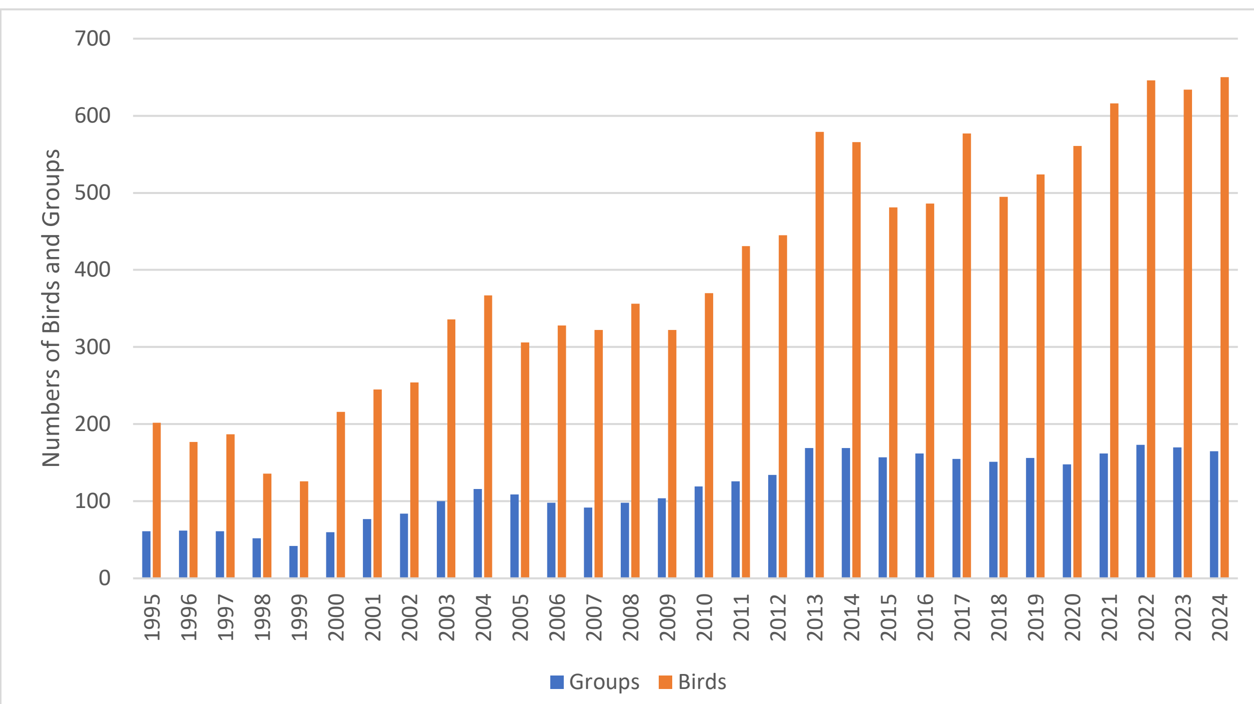

Figure 4-6. Florida Scrub-jay Surveys on KSC from Specific Study Sites

CCSFS conducts annual monitoring of scrub-jay numbers and distribution, but detailed monitoring of specific groups is no longer conducted unless required by a project-specific BO by the USFWS (USAF 2023). The data are used to assess minimum habitat size, basic biology, and distribution of the Florida scrub-jay on CCSFS and to evaluate and support management recovery efforts. Annual monitoring for scrub-jays has occurred at KSC since 1995. Monitoring also occurs under permit number TE106005-4 at KSC and includes MINWR and areas along the central Atlantic Coast of Florida. The Florida scrub-jay is not active within the SLC-37 construction area (USAF 2023). No Florida scrub-jays have been recorded within the SLC-37 construction area between 2016 and 2024 (Figure 4-4).

4.4.11 Hawaiian Petrel

The Hawaiian petrel has not been observed on CCSFS but may occur in the offshore areas of the Pacific Ocean. The species has the potential to forage or travel through the Pacific Ocean action area. There is no information on local population levels within the action area for this species. Surveys conducted between 1979 and 2013 on the islands of Kaua'i show a decline in populations of the Hawaiian petrel over the past two decades (Raine et al. 2017).

4.4.12 Newell's Shearwater

The Newell's shearwater has not been observed on CCSFS but may occur in the offshore areas of the Pacific Ocean. The species has the potential to forage or travel through the Pacific Ocean action area. There is no information on local population levels within the action area for this species. Surveys conducted between 1979 and 2013 on the islands of Kaua'i show a decline in populations of the Newell's shearwater over the past two decades (Raine et al. 2017).

4.4.13 Piping Plover

The piping plover does not nest in Florida but has been observed along the shoreline and intertidal area within the action area near the Cocoa Beach area outside its breeding season (iNaturalist 2024). There is no habitat for the piping plover within the construction area or roadway widening areas. There have been no observations of piping plover on CCSFS during annual shorebird surveys from 1992 through 2024; however, piping plovers have been documented on CCSFS through anecdotal observations over the years. The 2025 winter shorebird surveys detected two piping plovers on the beach adjacent to SLC-37. Piping plovers occasionally migrate through the CANA. Piping plover surveys have been conducted every 5 years on CCSFS from 1991 to 2016 and shorebird surveys are conducted annually; however, no observations of piping plover have been recorded along beaches on CCSFS during these surveys. Shorebird surveys from CANA did not include any observations of piping plover for 2024.

The piping plover has been observed within the action area between August and September (iNaturalist 2024). The species has the potential to occur within the action area during migratory season. There is no habitat for the piping within the SLC-37 construction area or the roadway improvement construction areas.

4.4.14 Roseate Tern

The species has the potential to forage or travel through the Atlantic Ocean action area. During 2010 shorebird surveys on CCSFS, one roseate tern was observed. Since this observation, the species has not been observed on CCSFS. There is no information on local population levels within the action area for this species.

4.4.15 Rufa Red Knot

Rufa red knots have been observed during shorebird surveys conducted on CCSFS from 2019 and 2024. Rufa red knot observations have ranged from 0 to 43 individuals with an average of 8.6 over the entire monitoring period. Monitoring is conducted along the CCSFS beaches.

Two wintering populations of the rufa red knot (U.S. and Caribbean wintering population and northern coast of South America wintering population) are considered stable: the western Gulf of Mexico and Central America wintering population appears to be declining, while the southern wintering population (Argentina and Chile) experienced a substantial decline in the 2000s but has remained stable since 2011, with no indication of recovery to previous numbers (USFWS 2021c).

The rufa red knot is not known to winter on CCSFS, but it has been observed as an occasional forager along the coastline (USAF 2023). There is no habitat for the rufa red knot within the SLC-37 construction area or the roadway improvement construction areas.

4.4.16 Short-tailed Albatross

The short-tailed albatross has not been observed on CCSFS but may occur in the offshore areas of the Pacific Ocean. The species has the potential to forage or travel through the Pacific Ocean action area. There is no information on local population levels within the action area for this species.

4.4.17 Wood Stork

Wood storks are occasionally observed on CCSFS foraging in wetland habitats, canals, and roadside ditches. No nesting colonies have been observed on CCSFS (USAF 2023). There are no population estimates of this species on CCSFS, MINWR, or CANA. Observations on iNaturalist indicate that the species has also been observed at MINWR and CANA (iNaturalist 2024). The 2022 wading bird report at KSC indicated declines in nesting. As such, abundance of wood stork individuals remains a concern (NASA 2023). NASA conducts annual wading bird surveys at KSC, which includes the wood stork. Monitoring for the wood stork also occurs at CANA.

The Southeast DPS of the wood stork was proposed for delisting under the ESA in February 2023 because of recovery and threats being adequately managed (USFWS 2024e). Final determination of the proposed delisting for the species has not yet been published.

4.4.18 Eastern Indigo Snake

The eastern indigo snake is rarely observed on CCSFS, with no evidence of the species in over 5 years. No eastern indigo snake has been documented using gopher tortoise burrows on CCSFS during the scoping and excavation of more than 1,000 burrows. In 2018, an eastern indigo snake was struck by a vehicle on KSC just north of the CCSFS boundary. An unconfirmed observation of an eastern indigo snake occurred in November 2023 at the end of Camera Road Alpha near the beach crossover. Little is known regarding demographic parameters and population trends for the eastern indigo snake, primarily because of the difficulties in obtaining adequate sample sizes. It is estimated that 36% of historical populations of the species have been extirpated (USFWS 2019a).

The eastern indigo snake is rarely observed on CCSFS, and there are no data on the size of the population on CCSFS and KSC. In Peninsular Flora, the average home range for males is 369 acres and 121 acres for females (Bauder et al. 2016). Females typically overlap with males, but males do not overlap with other males. The eastern indigo snake is often found in xeric pine-oak sandhills, commonly shares burrows (commensal) with the gopher tortoise, and is a diurnal forager. No suitable habitat exists within SLC-37 for eastern indigo snakes. Gopher tortoise burrows have been observed within the SLC-37 construction area and the roadway improvement construction areas, potentially providing refugia for the eastern indigo snake.

4.4.19 Sea Turtles

CCSFS, KSC, and CANA beaches support high densities of sea turtle nests during the nesting season (March 1 through October 31), providing over 47.6 miles of continuous federally owned nesting beaches. Table 4-6 provides sea turtle nesting data for the total of Brevard County and data specific to CCSFS, KSC, and CANA for a 5-year period from 2020 to 2024.

Table 4-6. Sea Turtle Nesting Counts for Brevard County: CCSFS, KSC, and CANA

Location	Sea Turtle Species	2020	2021	2022	2023	2024
Brevard County	Loggerhead	26,991	22,554	31,623	33,434	26,671
Brevard County	Green	12,203	15,281	17,464	37,920	6,312
Brevard County	Leatherback	98	95	143	88	128
Brevard County	**Total**	**39,292**	**37,930**	**49,230**	**71,442**	**33,111**
CCSFS	Loggerhead	3,058	2,820	3,804	4,275	2,943
CCSFS	Green	312	277	477	1,282	157
CCSFS	Leatherback	14	9	6	13	30
CCSFS	**Total**	**3,384**	**3,106**	**4,287**	**5,570**	**3,130**
KSC	Loggerhead	1,258	895	1,653	1,899	1,161
KSC	Green	636	390	645	2,176	169
KSC	Leatherback	3	3	7	6	1
KSC	**Total**	**1,897**	**1,288**	**2,305**	**4,081**	**1,331**
CANA	Loggerhead	4,192	3,706	6,188	5,674	5,570
CANA	Green	3,719	4,305	6,331	11,106	1,703
CANA	Leatherback	26	31	27	28	30
CANA	**Total**	**7,937**	**8,042**	**12,546**	**16,808**	**7,303**

Source: CCSFS 2024b; KSC 2024b; CANA 2024b; FWC 2024

Note:

Hawksbill and Kemp’s ridley sea turtle data is not available for Brevard County; therefore, these species were not included in this table.

Green, leatherback, loggerhead, and Kemp’s ridley sea turtles nest on the beaches within the action area. The action area receives on average 16,603 nests per year. The hawksbill sea turtle has not been documented nesting on any of the beaches within the action area. Sea turtle surveys have occurred on CCSFS since 1986 and have recorded an average of 2,561 nests per year (CCSFS 2024b). Sea turtle surveys have occurred at CANA since 1985 and have recorded an average of 3,744 nests (CANA 2024b). KSC has conducted annual sea turtle surveys since 1983 and recorded an average of 1,402 nests per year (KSC 2024b). The analysis of decades of sea turtle data for CCSFS, KSC, and CANA show an increase of nesting loggerhead, green, and leatherback sea turtles from 2021 through 2023, with a decrease in nesting for all species in 2024 (Table 4-6).

4.4.19.1 Green Sea Turtle

From 1986 through 2024, the number of green sea turtle nests deposited on CCSFS beaches ranged from 4 to 1,282, with the highest number recorded in 2023 (Figure 4-7) (CCSFS 2024b). During that same period, the number of green sea turtle nests deposited at KSC beaches ranged from 0 in 1993 to 169 in 2024, with 2023 having the highest number of recorded nests (Figure 4-7) (KSC 2024b). Sea turtle surveys at CANA have been performed from 1984 through 2024. Green sea turtle nests deposited at the beaches along CANA ranged from 5 in 1999 to 11,106 in 2023 (Figure 4-7). Over the past 5 years of monitoring, the highest number of green sea turtle nests recorded was in 2023 (Table 4-7). At all three locations, the number of nesting sea turtles has increased significantly over time, with a decrease in 2024, though monitoring efforts have remained the same (Figure 4-7). In 2024, CCSFS reported 157 nests, KSC reported 169 nests, and CANA reported 1,703 green sea turtle nests(CANA 2024b).

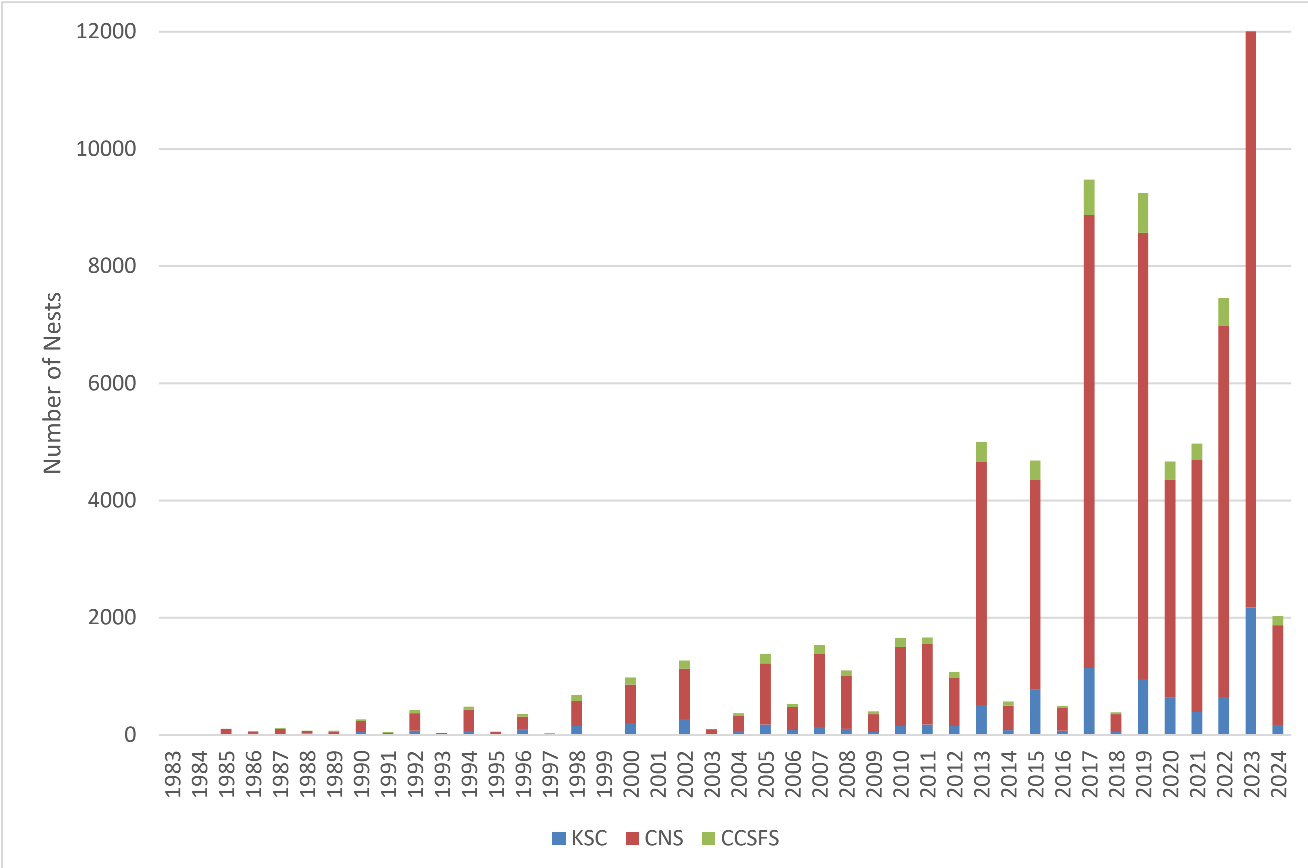

Figure 4-7. Green Sea Turtle Nests by Year on CCSFS, KSC, and CANA

4.4.19.2 Hawksbill Sea Turtle

The hawksbill sea turtle has not been documented nesting on CCSFS, KSC, or CANA, and there is no estimate on how many hawksbill sea turtles may reside in nearshore waters of the Atlantic Ocean within the action area.

4.4.19.3 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle rarely nests on CCSFS. Two nests were observed in 2015 and 2023, and one nest was observed in 2024 (Nicely, pers. comm. 2024). These were considered rare and not an annual event (USAF 2023). The first Kemp's ridley sea turtle observed nesting at CANA was documented in 2003 (CANA 2024b). One nest from this species was observed during the following years: 2006, 2006, 2012, 2022, and 2023 (CANA 2024b). Two Kemp's ridley nests were observed in 2008, 2021, and 2024 (CANA 2024b). Five nests were deposited at the beaches of CANA in 2020 (CANA 2024b). No Kemp's ridley sea turtles have been observed nesting on the beaches of KSC (KSC 2024b). In 2024 FWC reported a record number of Kemp's ridley turtles nesting in Florida, which may indicate the trend is increasing.

4.4.19.4 Leatherback Sea Turtle

Based on data from 1986 through 2024, the highest number of leatherback sea turtle nests observed in any given year on CCSFS was 15 in 2019 (Figure 4-8). For many years during this survey period, no leatherback sea turtle nests were observed on CCSFS (CCSFS 2024b). A total of 170 leatherback nests have been documented on CCSFS since surveys began in 1986 (CCSFS 2024b). The number of leatherback nests has declined each year since the high of 15 recorded in 2019 (Table 4-7) (USAF 2024).

From 1983 through 2024, the number of leatherback sea turtle nests deposited at KSC beaches ranged from 0 to 8, with 2012 having the highest number of recorded nests (Figure 4-8) (NASA 2024b). Leatherback sea turtle nests deposited at the beaches along CANA ranged from 0 to 34 (Figure 4-8) (CANA 2024b). At all three locations, the number of nesting sea turtles has increased significantly over time, though monitoring efforts have remained the same (Figure 4-8). In 2024, KSC reported 1 leatherback sea turtle nest, CCSFS reported 8 leatherback turtle nests, and CANA reported 30 leatherback turtle nests (CANA 2024b).

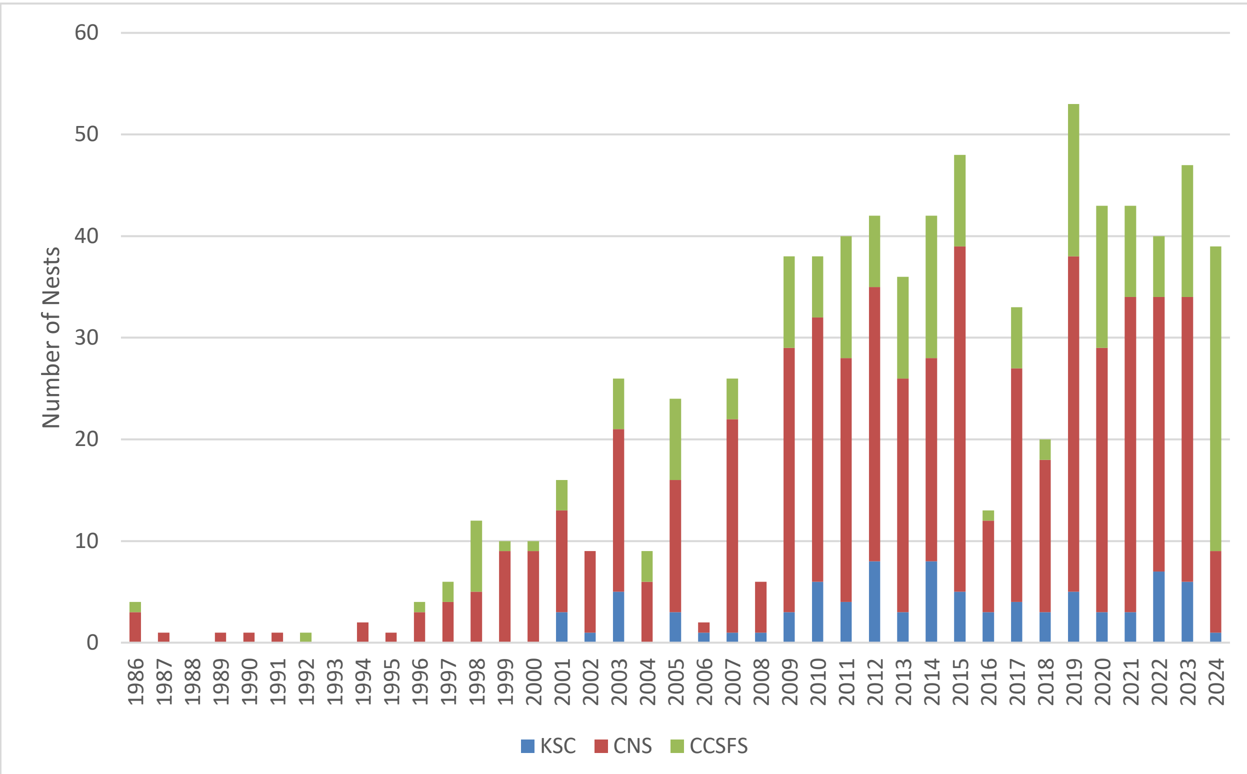

Figure 4-8. Leatherback Sea Turtle Nests by Year on CCSFS, KSC, and CANA

4.4.19.5 Loggerhead Sea Turtle

Nests are deposited on CCSFS each year between April and September. A record number of 4,275 loggerhead nests was documented on CCSFS in 2023. Based on nest surveys on CCSFS from 1986 through 2024, the mean annual number of loggerhead sea turtle nests is approximately 2,397 (Figure 4-9) (CCSFS 2024b). From 1983 through 2023, the number of loggerhead sea turtle nests deposited at KSC beaches ranged from 337 in 1985 to 1,161 in 2024, with 2023 having the highest number of recorded nests (Figure 4-9) (KSC 2024b). Loggerhead sea turtle nests deposited at the beaches along CANA ranged from 0 to 6,188 (Figure 4-9). Over the past 5 years of monitoring, the highest number of loggerhead sea turtle nests recorded was in 2023 (Table 4-6). At the three locations, the number of nesting sea turtles has increased significantly over time, with a decrease for all locations in 2024, though monitoring efforts have remained the same (Figure 4-9). In 2024, KSC reported 1,161 loggerhead sea turtle nests, CCSFS reported 2,943 loggerhead sea turtle nests deposited on CCSFS beaches and CANA reported 5,570 loggerhead sea turtle nests deposited at CANA beaches (CANA 2024b).

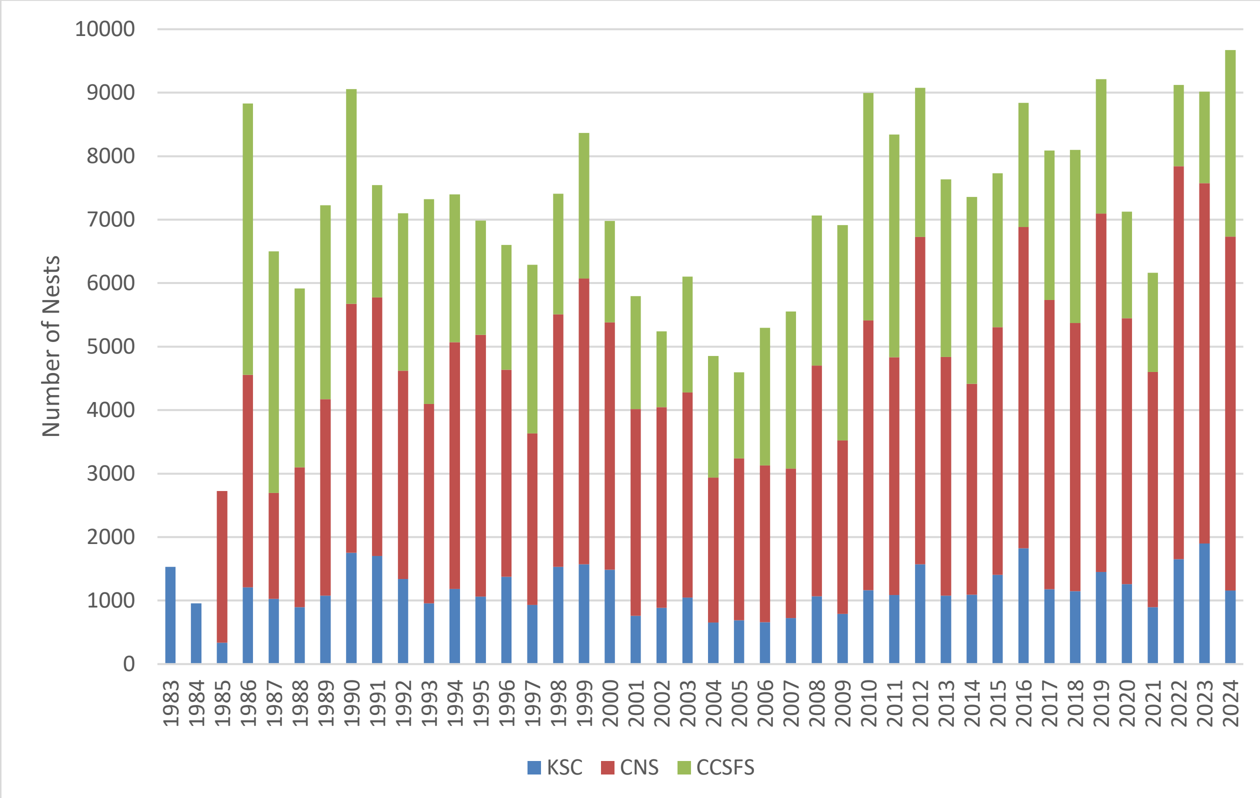

Figure 4-9. Loggerhead Sea Turtle Nests by Year on CCSFS, KSC, and CANA

CCSFS has been monitoring nest success rates since 1986. Loggerhead sea turtles have an average success rate of 50% and green sea turtles have an average success rate of 47% success rate, while the leatherback sea turtles have the highest average success rate at 91%. Overall, the average success rate for all species across 37 years is 63% (CCSFS 2024b). Figure 4-9 shows the nesting numbers of loggerhead sea turtles at KSC, CANA, and CCSFS from 1983 to 2023.

4.4.19.6 Disorientation

Disorientation monitoring has occurred on CCSFS since 1990. Figure 4-10 shows the disorientation rates from 1990 through 2024. The highest percentage of disoriented sea turtles was 7.5% in 1990. In 2021 and 2022, there was a 0% rate of disorientation. FWC monitors annual disorientation monitoring throughout Florida.

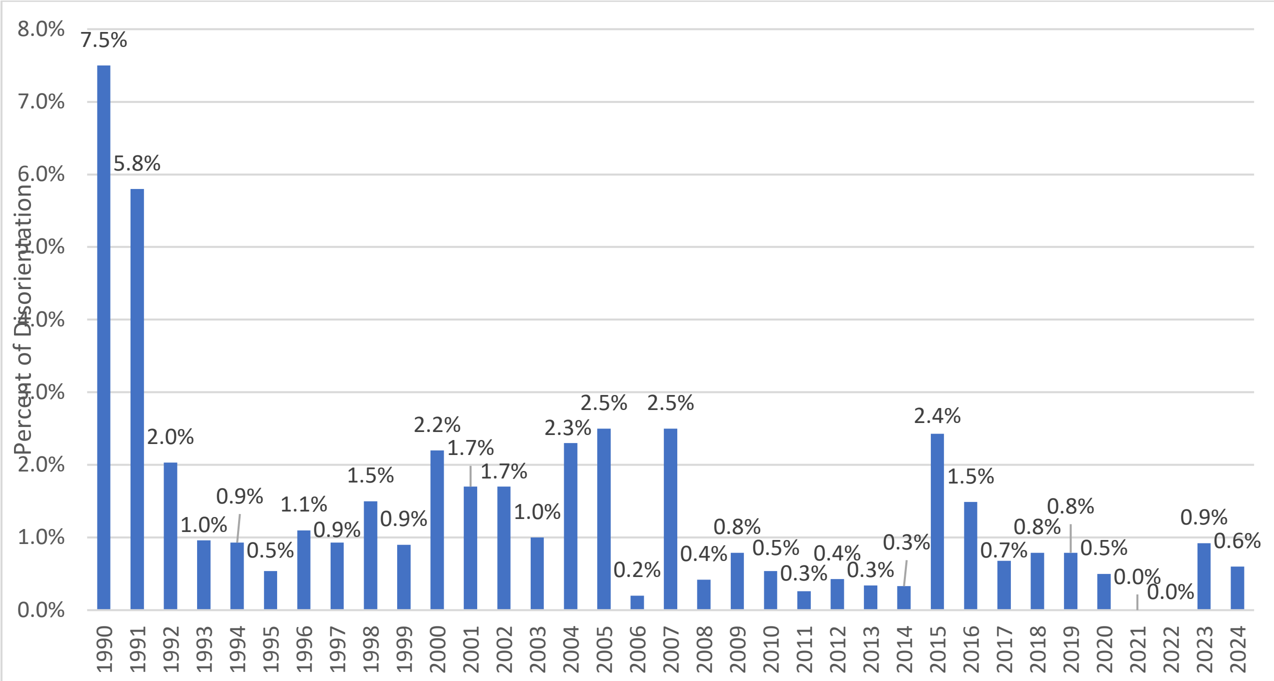

Figure 4-10. Disorientation Rates for Sea Turtles on CCSFS

4.4.19.7 Ongoing Monitoring Programs

CCSFS participates in annual sea turtle surveys, including disorientation surveys, that address all species that nest along the beaches of the facility KSC and CANA also conduct annual sea turtle surveys. The action area also includes beaches that are a part of the Statewide Nesting Beach Survey programs and the Index Nesting Beach Survey program. FWC monitors disorientation sea turtle surveys throughout Florida, breaking down data by county.

4.4.19.8 Population Trends of the Species

Green Sea Turtle: The numbers of the North Atlantic distinct population segment of the green sea turtle numbers have been increasing (USFWS 1998).

Hawksbill Sea Turtle: Analysis of breeding populations over the past 20 years in the Atlantic Ocean show 10 populations that are increasing, 10 populations that are decreasing, and 13 populations where a trend cannot be determined. Indian and Pacific Ocean populations have 3 stable populations, 18 decreasing populations, and 34 populations where a trend cannot be determined. No populations in these two oceans are increasing (NMFS and USFWS 2013a).

Kemp's Ridley Sea Turtle: As a result of conservation actions, the Kemp's ridley sea turtle began to rebound during the 1990s, with the number of nests increasing about 15% each year through 2009. In 2010, the rapid increase abruptly ended, and the number of nests has fluctuated since (NOAA Fisheries 2024).

Leatherback Sea Turtle: In Florida, leatherback sea turtle populations were increasing through 2008 (NMFS and USFWS 2013b). Recent data indicate that the northwest Atlantic population of the leatherback sea turtle, which occurs on CCSFS, has been trending downward based on available range-wide population data (USFWS 2020b).

Loggerhead Sea Turtle: Based on nesting data, the loggerhead sea turtle population in Florida decreased by 26% from 1988 to 2008 (USFWS 2008). Since 2008, the number of nests has remained stable with no observable trend (USFWS 2023f).

The SLC-37 construction area and the roadway improvement construction areas contain no habitat for sea turtle species and, therefore, no impacts on these habitats would occur from construction.

The USFWS-issued BO requires lighting management plans for any new facility that is close to the beach, not constructed in accordance with Space Wing Instruction 32-7001, or has lighting directly visible from the beach, or may cause significant sky glow.

4.4.20 Monarch Butterfly

There is no information on the abundance of the monarch butterfly within the action area, but the species has been observed on CCSFS. Monarch populations have declined substantially in recent years, and this downward trend in population numbers is expected to continue (USFWS 2020a).

No suitable foraging habitat for the monarch butterfly occurs within the SLC-37 construction area because the undeveloped habitats are regularly mowed and maintained. The roadway improvement construction areas contain suitable foraging habitat (herbaceous dry prairie [roadway ROW]) for the species. These areas are periodically mowed, reducing flowering plants and the quality of the habitat that monarch butterflies may use for foraging. The presence of milkweed plants the species uses as a host plant to support a portion of its lifecycle would not be expected to occur within either the SLC-37 construction area or the roadway improvement construction areas.

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5. Effects of the Action

This section includes a description of the effects of the Proposed Action within the action area and on the species and critical habitats. Factors considered in the analysis include proximity of the Proposed Action, distribution, timing, nature of the effect, duration and disturbance frequency, disturbance intensity, and disturbance severity.

Direct effects on listed species with the potential to occur within the action area include the loss of suitable habitats from construction (for example, vegetation clearing); exposure to heat and vapor plume during launch and static-fire tests; noise and vibration from launch, landing, and static-fire tests; overpressures generated from sonic booms during launch and landing; artificial light reaching beach habitats during nighttime operations; and exposure to strikes and collisions from construction equipment and increased vehicle and barge traffic associated with construction and operations.

5.1 Stressors Generated by the Proposed Action

5.1.1 Vegetation Disturbance and Clearing

The construction activities associated with the Proposed Action include the disturbance and permanent clearing of vegetation within the SLC-37 launch and landing support facilities, along with transportation infrastructure that would need to be constructed at the existing SLC-37 and along existing roadways. For purposes of this BCA, it is assumed that the entire area within the existing SLC-37 fence line would be disturbed during construction activities. SLC-37 would be generally unsuitable for ESA-listed species habitat postconstruction due to operations.

Mapped habitats within the approximate 177.8-acre, SLC-37 construction area and the approximate 29.5-acre roadway widening construction area were assumed to be removed or altered from the Proposed Action. Figure 4-1 and Table 4-3 provide the mapped land cover type (FLUCCS) classifications. The addition of impervious areas, buildings, and launch infrastructure would result in habitats no longer available to support listed species postconstruction. SLC-37 is fully developed, and areas not converted to hardscape have been landscaped and are mowed regularly. Although the area is heavily disturbed and landscaped, it still provides foraging habitat for listed species.

The Phillips Parkway widening project would occur within the existing maintained and mowed transportation corridor. The roadway improvement construction areas are mapped as herbaceous dry prairie, do not include the existing impervious roadway surfaces, and provide potential nesting and forage habitat for listed species. Habitats adjacent to and outside the existing roadway ROW would not be impacted by the widening of the road. Old A1A is fallow, and xeric oak and scrub have become reestablished, though at early successional stages. The road will be used for the access of larger launch vehicle component transport trucks and would not be used by regular traffic on CCSFS. The former ROW for Old A1A would be cleared and converted to dry prairie habitat that will be mowed and maintained. The ROW habitat will become similar to the maintained Phillips Parkway ROW in the ability to support listed species foraging and nesting; however, species have the potential to be directly impacted from the construction vegetation clearing activity.

It is estimated that construction activities will take place for up to 1 year as SLC-37 is redeveloped and roadways are widened. Vegetation clearing activities would take place primarily during daytime hours with the potential for some construction activities involving vegetation disturbance occurring at night.

Vegetation clearing from construction activities would impact foraging habitat of the southeastern beach mouse and Florida scrub-jays. The southeastern beach mouse uses all habitat types on CCSFS for foraging, nesting, and burrowing. Florida scrub-jays use herbaceous prairie habitat, particularly adjacent to scrub for foraging and caching of food sources. Eastern indigo snakes also potentially use habitats within construction areas. Vegetation clearing from construction activities would not affect any final or proposed critical habitat within the action area, as none of the designated critical habitat occurs within the areas of vegetation clearing.

5.1.2 Heat and Vapor Plume

During launch and static-fire testing operations, a heat and vapor plume lasting approximately 20 seconds would be created. The heat from launch would be controlled using a bifurcated diverter and reduced by flooding the launch base with deluge water. The bifurcated diverter will direct the plume laterally and upward into the atmosphere to minimize ground-level impacts in two directions situated 180° from one another at the base of the launch mount. The water would discharge on the plume via a water-cooled diverter and/or deluge, creating a water vapor plume. Up to 92% of the water used in the deluge would evaporate when exposed to the heat plume (FAA 2023). The remaining water would be collected and stored in the constructed stormwater ponds on SLC-37. No water treatment would be required for the recaptured deluge water because the LOX and methane fuel are nontoxic and will not contaminate the cooling water.

The bifurcated diverter will be oriented such that the heat from launch and static-fire tests would be at or below ambient temperatures at the SLC-37 fence line and surrounding habitats are not exposed to elevated heat. If habitats are reestablished within the launchpad fence line after construction, those habitats could be exposed to elevated heat. Heat would also be generated from Starship and Super Heavy landings at SLC-37, though the heat would be substantially less than from launch operations and concentrated at the landing pad.

The heat and vapor plume will be generated up to 380 times per year (76 Starship-Super Heavy launches, 76 Starship static-fire tests, 76 Super Heavy booster static-fire tests, 76 Super Heavy booster landing, and 76 Starship landings). Approximately half of the launch and landing events (114 events) would occur during the daytime (sunrise to sunset) and half during nighttime (sunset to sunrise). Static-fire tests would only occur during daytime.

Any animals present within the SLC-37 fence line during launch or landing would potentially be subject to mortality from exposure to elevated heat. These would more likely be bat or bird species aerial transiting SLC-37 during launch, not ground-dwelling animals as the diverter directs the heat plume upward. However, most animals would not be expected to be present within areas exposed to heat during operations because the habitats within SLC-37 would have been removed during construction and any reestablished habitat would be of low quality. Noise and activity from launch preparations would also further deter animals from the vicinity of the launch pad, greatly reducing the potential for exposure to heat. Heat would not impact any final or proposed critical habitat within the action area as the heat plume will be kept within the SLC-37 fence line where no critical habitat is designated.

5.1.3 Noise and Vibration

The Proposed Action includes the noise from construction activities and noise and vibrations generated from launch, static-fire tests, and landing of the Starship and Super Heavy vehicles. The 100-dB ASEL noise contour for the Starship-Super Heavy launch combined with Super Heavy booster static-fire tests establish the outermost boundary of the noise action area (Figure 2-7). All the other noise contours are contained within the contours of these scenarios (refer to the Noise Modeling Report provided as Appendix B). The 100-dB ASEL contour extends approximately 17 miles from the launch pad, reaching the Banana River, Indian River, Atlantic Ocean, and communities of Titusville and Cocoa. The 100-dB ASEL contours for the other scenarios (static-fire tests and landings) are located on KSC and CCSFC properties and over the Atlantic Ocean. Higher modeled ASEL contours (110 to 140 dB) are located within about 1.4 miles from SLC-37 and are on KSC and CCSFS properties.

The impact of noise on listed species is a function of the intensity (amplitude), source frequency, species hearing frequency, and duration of the exposure. The greatest intensity is experienced near the source (launch or landing pad). The noise generated from rocket launches such as Starship-Super Heavy is over a broad frequency band and includes infrasound.

Listed species within the 100-dB ASEL action area will be exposed to increased levels of noise 380 times per year. Approximately half of the launch and landing events would occur during the daytime (sunrise to sunset) and half during nighttime (sunset to sunrise). Static-fire tests would only occur during the daytime. The following a breakout of the launch activities:

- 76 Starship-Super Heavy launches for 2 minutes each (half at night)
- 76 Starship static-fire tests for 15 seconds each (daytime only)
- 76 Super Heavy booster static-fire tests for 15 seconds each (daytime only)
- 76 Super Heavy booster landings for 25 seconds each (half at night)
- 76 Starship landings for 25 seconds each (half at night)

Noise effects on wildlife range from acoustic perception and communication, physiological, and behavioral responses. Acoustic perception and communication include the detection and/or inhibition of sound stimuli, such as communication/masking of calls and detection of prey/predators. Physiological responses to noise can include increased mortality, permanent or temporary hearing threshold shifts, and stress. Behavioral effects from noise on wildlife cessation of activity, such as forgoing foraging, startle response, or nest/brooding abandonment. Each of these effects pathways alone or in coordination can influence wildlife fitness, such as survival rates or reproductive success (Engel et al. 2024).

Physiological responses to elevated noise stimuli can be expressed as hearing trauma through shifts in hearing ranges (either temporary or permanent), damage to tissue and cell damage in the ear or brain, changes in hormones, or more general changes in body condition (fitness) over time. Most studies on the physiological effects of anthropogenic noise were conducted on rodents and occurred in laboratory experiments, whereas some paired field behavioral studies with a physiological examination component. Laboratory studies have evaluated noise effects on animals at various exposure durations and levels, but most studies had longer-duration stimuli consistent with chronic noise. Mice have been shown to have damage to the cochlea when exposed from 1 to 24 hours at various frequencies (2, 4, 8 kilohertz [kHz]) and at sound pressure levels of 100 to 120 dB. The damage included temporary threshold shifts (TTSs) in hearing with some recovered after 4 days post exposure, whereas some were left with permanent threshold shifts (PTSs) (Ou et al. 2000).

Intense noises, such as explosions (greater than 140 dB), damage the cochlea of wildlife instantaneously from pressure resulting in abrupt severe hearing loss from which there is little recovery of function postexposure (Ward and Gloring 1961). Mice exposed to frequency ranges (2 to 20 and 9 to 13 kHz) at levels of 105 to 120 dB for 30 minutes in duration had partial hearing recovery up to 105 dB exposure, and permanent cochlear damage resulted from exposure to 120 dB (Sanz et al. 2015).

A laboratory study examined the effect of acute and repeated noise exposure on the behavior and lipid peroxidation in brain tissue of mice. Mice were exposed to noise for 3 minutes at 90 dB initially, then exposed to the same sound pressure level for 10 hours per day. The results indicated that the 3-week noise treatment did not cause clinically manifested stress in the mice (male or female). Mental stress in mice increases lipid peroxidation activity in the brain. Noise exposure did result in less lipid peroxidation in the brain of female mice with no difference in male mice test groups. Noise habituation and noise exposure did not induce stress, and noise habituation significantly improved noise tolerance in female mice, but not males. The same study also evaluated the behavioral response in the mice. The study reported that the noise treatment did not cause significant changes in mice behavior either between sexes or between treatment groups (sound vs. no sound) in terms of locomotive behavior in a maze (Korsós et al. 2023).

Anthropogenic sound has been shown to produce effects on pinyon mice, including body condition (weight and length metrics) and behavioral responses. Increases in low-frequency noise had physiological effects on rodents by triggering stress responses (Du et al. 2010) and altering organ tissue (Branco et al. 2004). Individuals captured in noisier areas at beginning of season had lower body condition than quieter areas; however, this difference was not observed later in the season. Although no conclusive explanation of the result was provided, it was hypothesized that later season activity had lower metabolic costs due to increased milder temperatures during nighttime foraging (Willems et al. 2021). Male rats exposed to chronic noise have shown decreases in testosterone (Ruffoli et al. 2006). Pregnant mice exposed to 85 to 95 dB alarm bells had pups with lower serum immunoglobulin levels indicating impaired immune responses (Sobrian et al. 1997). Chronic noise exposure in rats affected calcium regulation, leading to detrimental changes at the cellular level (Gesi et al. 2002).

Short-duration, episodic, high-intensity sound exposure studies are largely lacking from the available studies. One study of low-flying military aircraft at Barry M. Goldwater Air Force Range provided results of an acute noise exposure to natural rodent populations (that is, desert rats, mice, and squirrels) and their predator, the desert kit fox (Bowles et al. 1995). Jet flyovers produced a maximum noise exposure of 115.5 dB with the mean loudest at 103.4 dB (30 events). The 4-year study reported that differences between noise exposed areas and controls of kit fox and kangaroo populations were small and smaller than the natural variability observed during study. Studies on the effects of military noise on wildlife provide some evidence that young animals are more susceptible than adults to hearing loss from exposure to loud sounds (Larkin et al. 1996; Abrams 1980) and that wildlife is more apt to be exposed to low-frequency intense sound than to high-frequency intense sound because of greater atmospheric attenuation of high-frequency components (Bass et al. 1972).

Animal response to noise has been shown to vary with species (Manci et al. 1988). The most common reaction of birds and mammals to aircraft noise, particularly when the aircraft is visible to the animal, is some degree of behavioral response in the form of a startle response (Manci et al. 1988). In the event that a nesting bird is flushed from its nest, the nest may theoretically be exposed to a greater risk of predation, thereby affecting reproductive success (Larkin 1996). It was reported that red-cockaded woodpeckers were not flushed when exposed to sound exposure levels up to 102 dB generated by helicopters (greater than 100 feet) or sound exposure levels up to 90 dB generated by fixed-wing aircraft (greater than 2,000 feet) (Delaney et al. 2002). A 1984 study (Black et al. 1984) on the effects of low-altitude (less than 500 feet above ground level) F-16 training flights with sound levels from 55 to 100 dBA on wading bird colonies (such as great egret, snowy egret, tricolored heron, and little blue heron) concluded that the reproductive activity, including nest success, nestling survival, and nestling chronology, was independent of the overflights. Kushlan (1978) observed very low response in wading bird colonies to circling fixed-wing aircraft and helicopter overflights at altitudes of 195 to 390 feet above ground level. Burger (1986) reported that migrating shorebirds did not flush in response to aircraft overflights, but they did flush in response to more localized disturbance, such as humans and dogs on the beach. Wild birds typically react with disrupted sitting (Algers et al. 1978). Vocalization masking has been reported when the noise sources have amplitudes between 85 and 125 dBA.

Reptiles exposed to high-amplitude noise from aircraft flyovers have demonstrated stress responses and have altered foraging behavior (Kepas et al. 2023). Stress in eastern indigo snakes may be caused by physical displacement, habitat modification, and noise pollution, leading to immunosuppression, making them susceptible to pathogens (Bogan et al. 2024) and increasing mortality (Slabbekoorn et al. 2018; Van Waeyenberge et al. 2018).

Much of the literature reviewed suggests that domestic animals, such as cows, horses, and chickens, exhibit some behavioral responses to repeated exposure to aircraft noise; however, they generally habituate to the noise over time. Domestic fowl's reactions after exposure to sudden, intense noise was a short-term startle response, which ceased once the noise stimulus ended. Normal activity was resumed within a few minutes of the startle, suggesting that the birds habituate relatively quickly (Gladwin et al. 1988).

Chronic sources of sound in field studies were most commonly traffic from roadways. A TTS, which is temporary hearing damage, has been observed in birds exposed to chronic highway noises between 93 and 110 dBA in budgerigar (*Melopsittacus undulatus*) and small mammals (Dooling and Popper 2007).

If the prey species' ability to detect predators is diminished through hearing loss from chronic exposure, anthropogenic noise would have a negative impact. Bowles (1994) states that attraction to sources of noise and habituation to noise can have negative effects on wildlife. Desert kangaroo rats' ability to detect predators at distance was reported to be significantly diminished for about 3 weeks after noise exposure (95 dBA) from military off-road vehicles. The chronic noise exposure produced a TTS in the kangaroo rats' hearing because of their highly specialized ears (Brattstrom and Michael 1983).

The type of sound source (chronic vs. acute) and its predictableness may affect the level of habituation of rodents exposed to the noise. Wildlife may be affected less by similar, frequently occurring noise sources due to their ability to habituate than less frequent, less predictable noise sources (Larkin 1996). More predictable sources of disturbance can lead to greater apparent habituation in field situations than less predictable ones (Ward and Stehn 1989).

Studies that have evaluated the physiological effects of elevated noise exposure on wildlife have focused on chronic or longer-duration noise exposures than those that would be experienced under the Starship-Super Heavy operation scenarios, making inferences from study results difficult. Chronic studies do show physiological damage as TTS in noise levels ranging from 100 to 120 dB (1 to 24 hours of exposure) and 105 to 120 dB (30 minutes of exposure) in mice, and 93 to 110 dB (long duration roadway traffic) in birds. Physiological damage as PTS was demonstrated in some mice at noise levels of 100 to 120 dB (1 to 24 hours of exposure). Nearly all studies looked at maximum unweighted or A-weighted exposure levels (maximum unweighted sound level [L_{max}] or maximum A-weighted sound level [L_{Amax}]), which differs from the cumulative noise exposure metric of ASEL. Because the sound exposure level is normalized to 1 second, its value will always be larger than the L_{max} for an event longer than 1 second. For aircraft overflights, the sound exposure level is normally approximately 7 to 12 dB greater than L_{max} (FAA 2023). For the purposes of this BCA, the lower end of that range (+10) was used as a correlation of ASEL to L_{max}. This correlates to the possibility of temporary physiological damage occurring at approximately the 120-dB ASEL contour for operational events (110-dB L_{max} average value assumed), primarily TTS due to the short duration of the noise exposure.

In studies that characterized the behavioral responses to elevated noise exposure, more short-duration events (helicopter flyovers, military jet flyovers) were evaluated in field studies. Most results were inconclusive, but indications that animals, particularly birds, may startle around the 100-dB level were demonstrated. This correlates to approximately the 110-dB ASEL noise exposure contour (100-dB L_{max} average value assumed). The effects from the behavioral startle response for various species could not be directly inferred from the reviewed studies but could result in a decrease in overall species fitness due to the frequency of the exposures (380 events), resulting in startles during the year. However, it is also possible that the species will habituate to noise due to its frequency.

Vibration is the movement of particles in response to sound pressure. Vibration levels monitoring was conducted during a Starship-Super Heavy launch from Boca Chica, Texas, on March 14, 2024, using accelerometers placed in the dunes approximately 0.25 mile to the east of the launch pad at various depths (1 foot and 3 feet) below the ground surface. Acceleration values at 1-foot depth measured 0.728 grams (g) (approximately equal to the acceleration of gravity) to 1.025 g (7.14 to 10.05 feet per second squared). Acceleration values at 3-feet deep a had maximum responses below 0.1 g (0.981 feet per second squared). Measured vibration lasted approximately 30 seconds. The peak particle velocity of just over 1 inch per second had a dominant vertical direction that dissipated quickly (SpaceX 2025). Increased exposure to vibration during operational scenarios has potential to affect ground-dwelling and nesting species such as the southeastern beach mouse, eastern indigo snake, and sea turtles.

5.1.4 Sonic Boom Overpressures

Sonic boom overpressures are generated during Starship-Super Heavy launch, Starship landing, and Super Heavy booster landings when the rocket accelerates beyond the sound barrier or decelerates below the sound barrier. The 1-psf overpressure contour represents the action area in the vicinity of SLC-37 for the purposes of this BCA (Figure 2-8). The sonic boom from a Starship launch at SLC-37 would occur over the Atlantic Ocean during ascent, and exposure to listed species would be very unlikely. The estimated sonic boom exposure for Starship landing events at SLC-37 indicate overpressure contours from 0.1 to 1.6 psf would occur primarily over land along the landing trajectory. The 1-psf contour is estimated to be about 30 miles west of the landing site, extending west of Titusville. Near the landing site, there is an oval-shaped boom footprint region generated with levels from 1 to 1.6 psf (1.6 psf is close to the landing site, with a reported maximum overpressure level of 1.72 psf). Super Heavy booster landings would generate the greatest sonic boom exposure of the three operational scenarios with overpressure levels reaching 15 psf at the at the SLC-37 landing pad and 4 to 10 psf across CCSFS and KSC. Half of the city of Cape Canaveral could experience boom levels in the 2 to 4 psf range; the highest boom levels offshore are up to about 10 psf just east of SLC-37 and remaining on CCSFS (refer to the Noise Modeling Report provided as Appendix A).

Listed species within the 1-psf action area will be exposed to overpressures up to 152 times per year (76 Super Heavy booster landings and 76 Starship landings). Approximately half of launch and booster landing events would occur during the daytime (sunrise to sunset) and half during nighttime (sunset to sunrise). Starship landings would be mission dependent, but for the purposes of this BCA, half are expected to occur during the daytime and half during the nighttime.

Sonic boom overpressures can lead to behavioral responses in animals. Nesting lapwings were exposed to simulated sonic booms ranging from 1 to 18 psf, and no behavioral changes were observed (Ruddlesden 1971). The effects of sonic booms ranging from 2 to 2.5 psf, delivered 1 to 3 times per day on 301 nesting mourning doves, mockingbirds, cardinals, and lark sparrows, showed no indication that sonic booms affecting the nesting cycle or production rates compared to controls (Teer and Truett 1973). The same researchers also studied the effects of overpressures of 5.5 psf up to three times a day to bobwhite quail eggs. There were 7,025 eggs used in the study. The study concluded that overpressures had no effects on the eggs nor the mortality of the hatchlings (Teer and Truett 1973). Resting and feeding ducks stopped activities after being exposed to sonic booms (measurement not reported); herring gulls made sudden jerky movements; flying and flocks of passerines always left the ground and flew out of sight or circled after being exposed to booms (Rylander et al. 1974).

SpaceX has monitored the effects of sonic booms on nesting least terns and snowy plovers during launches of the Falcon 9 rocket from Vanderburg Space Force Base, California. Nesting least terns were monitored for five launches and nesting snowy plovers during 16 launches between April and September 2024. No differences in incubation rates were detected for either species before and after launches with and without sonic booms. Adult birds exhibited a startle response to initial launch noise. Adult least terns became alert during 90% of launches and were startled during almost 50% of launches. Adult least terns hunkered or shifted on their nests during less than 20% of events and flushed off their nests during less than 10% of events. Snowy plovers showed similar results but with adults hunkering or shifting during greater than 30% of launch events. Snowy plover adults were more likely to be startled or to hunker during a sonic boom than initial launch noise. The areas within nesting birds monitoring were exposed to 2- to 4-psf overpressures. During monitoring, one damaged egg was found in a snowy plover nest with an embryo that stopped developing close to a Starlink G9-1 launch event. The report summarized that, through a literature review, it was determined that the sound waves associated with the initial launch and sonic booms are not strong enough to cause eggshells to crack; however, it was possible that movement of an incubating adult in response to the launch (for example, hunkering or flushing) may have led to egg damage. Monitoring has documented four damaged eggs from 2019 through 2024, around the time of a launch (Robinette et al. 2025).

Chinchillas were exposed to simulated sonic booms ranging from 2.2 to 5.5 psf at a rate of either 1 or 10 booms (at 45-second intervals) and checked for the presence of blood clots in the scala vestibuli, scala tympani, and cochlea of the inner ear. No significance could be found in animals exposed to only one boom of 2.2 psf. However, when the animals were exposed to 10 booms of 2.2 psf or one super boom of 5.5 psf, bleeding was found in the inner ears (probability less than 0.05). The author indicated that inner ear bleeding may eventually cause permanent damage and impair hearing (Reinis 1978).

Elevated overpressures would have the potential to affect most listed species present within the action area, primarily through a behavioral response (startle). Physiological responses to overpressure ranges and frequency of occurrence from sonic booms generated during operational scenarios are not supported. Startle responses are expected to occur for exposure above 1 psf; however, the literature reviewed does not indicate that the startle response leads to reduced individual fitness or reductions in survivability or lower reproductive success.

5.1.5 Artificial Light

Artificial lighting would be used in the construction areas if activities were conducted at night. However, most of the construction activities are planned to be conducted during daytime (sunrise to sunset). For the purposes of this BCA, construction activities are assumed to all take place during the daytime. Artificial light will be used to illuminate the launch pad and allow SpaceX personnel to perform operations after dark during operations. Lighting for personnel, such as building lights, parking area lights, walkway lights, and lighted workspaces, would contribute to sky glow when illuminated. Lights atop of light poles would extend beyond SLC-37 and onto adjacent habitats. These areas include shrub and scrub, beaches, xeric oak, and mixed rangelands which provide habitat for ESA-listed species such as southeastern beach mice, bird species, and nesting sea turtles. Nocturnal animals such as southeastern beach mice, tricolored bats, or migrating birds may be disoriented by artificial lighting. Migrating birds would have the potential to collide with buildings and infrastructure.

Light associated with the infrastructure and additional light associated with night launch events would contribute to skyglow and would extend into habitats that support listed species. Approximately half of the launch and landing events would occur during the daytime (sunrise to sunset) and half during nighttime (sunset to sunrise). Static-fire tests would only occur during the daytime. Approximately half of these events would occur during sea turtle nesting season (6 months) for a total of 57 nighttime lighted events. The following presents a breakout of the launch activities:

- 76 Starship-Super Heavy launches for 2 minutes each (half at night [38]; half during sea turtle nesting season [19])
- 76 Super Heavy booster landings for 25 seconds each (half at night [38]; half during sea turtle nesting season [19])
- 76 Starship landings for 25 seconds each (half at night [38]; half during sea turtle nesting season [19]))

Light associated with the infrastructure and additional light associated with night launch events may result in disorientation of sea turtle adults and hatchlings that nest on the beaches within the action area. Lights placed atop the 600-foot launch integration towers would be visible at sea level along the beaches approximately 25 miles to the north and south of the launch pad based on atmospheric conditions. Lights from SLC-37 and infrastructure would contribute to skyglow visible from the beach.

Light would extend to sea turtle nesting beaches and designated loggerhead sea turtle critical habitat (nesting beaches) and proposed green sea turtle critical habitat (nesting beaches). This would cause disorientation to light-based cues, which help hatchlings and post-nesting females orient themselves for return to the ocean; may increase predation on disoriented hatchlings; and may interfere with nesting adult females. Specifically, the final loggerhead sea turtle critical habitat (PCE3) and the proposed green sea turtle critical habitat (PBF2) call for sufficient darkness on nesting beach habitat to support these species. Artificial lighting from towers would also have an effect on proposed rufa red knot critical habitat, as the migratory shorebird resting and foraging areas along beaches and shorelines would receive increased nighttime artificial lighting from the towers.

5.1.6 Strikes and Collisions

Strikes or crushing of listed species by construction vehicles causing mortality at SLC-37 and roadway widening areas could potentially occur, though it is considered unlikely. SLC-37 has been previously developed, and launches occurred as recently as 2024; therefore, making it a poor-quality habitat for most species. Most species would vacate construction areas due to noise and human presence. Most construction would take place during daytime hours (sunrise to sunset) and would not affect nocturnal animals, such as the southeastern beach mouse or bats. Ground-dwelling animals, such as eastern indigo snakes, would have a greater potential to be injured or killed during construction, but their presence within the action area is considered unlikely due to low observations of individuals.

Construction and operations would cause an increase in vehicle and heavy-equipment traffic on existing CCSFS roadways. Construction traffic could use roadways 24 hours per day for up to 1 to 2 years. The traffic increases would be experienced along CCSFS roadways between entry points to the base and SLC-37 (Figures 2-1 and 2-2). Posted speed limits help to reduce wildlife collisions with vehicles. These roadways experience regular traffic during daytime and nighttime operations, including movement of heavy equipment. A traffic study was developed for Phillips Parkway between ICBM Road to North of Rocket Road, which includes the segments that will be widened under the Proposed Action. The study found a low volume of traffic under existing and projected conditions (2055) along the segment (PMA 2025). The evaluation indicates a continued low likelihood of vehicle strikes on listed species even as areas of CCSFS become further developed under the projected conditions.

Slower-moving, ground-dwelling species, such as southeastern beach mice and eastern indigo snake, would have a greater potential for vehicle strikes because they cannot effectively move to safety at most vehicle speeds. Southeastern beach mice forage at night and would only be exposed to vehicle strikes during nighttime operations. The eastern indigo snake, as previously mentioned, is rarely observed on both CCSFS and KSC, is a diurnal animal, and would have minimal exposure to vehicle strikes. The last known vehicle strike of an eastern indigo snake was observed in 2018 at 0.5 mile north of the CCSFS and KSC property boundary.

Starship, Super Heavy, and vehicle components would arrive from the SpaceX Starbase in Texas. The components would be transported via a tug and barge from the Port of Brownsville, Texas, to CCSFS Port Canaveral or KSC wharfs (Figure 2-4). Super Heavy booster landings occurring in the Atlantic Ocean landing area would also return to the KSC wharf by barge, traveling through Port Canaveral. The vehicle components would then be delivered to the launch site via over-the-road transport. The transport of vehicle components from Texas to Florida would be episodic and would use common shipping and roadway corridors, which already experience similarly sized traffic. The barge operations would follow U.S. Coast Guard requirements and are in keeping with normal operations in the area. West Indian manatees would have the potential to be struck by barge traffic transporting vehicle components through the Port Canaveral area and Banana River where they are known to occur. Manatee numbers increase in these areas during the winter (November through March) when ocean temperatures are lower than shallower coastal bays and estuaries. During warmer months, manatees are more disperse throughout the nearshore aquatic environment and collisions with barges would be less likely.

Expendable Super Heavy booster landings may occur in the Atlantic Ocean at least 1 nautical mile east of SLC-37 (Figure 2-6). Expendable Starship landings may occur in the Pacific Ocean, Atlantic Ocean, Gulf of America, and Indian Oceans (Figure 2-7). These locations are well away from terrestrial habitats for most listed species, but listed pelagic sea birds would have the potential to occur within these action areas. SpaceX’s goal is to experience no expendable landings of the Super Heavy booster and Starship; however, if an expendable landing did occur, debris striking a listed species using foraging habitat in the open oceans would be unlikely. These expendable landing areas also occur well beyond the boundaries of final and proposed critical habitat and would have no effect on the habitat’s ability to support listed species from expendable launch debris.

5.2 Effects on Species

The effects from the stressors generated by the Proposed Action to species that have the potential or are known to occur within the action area are further discussed in this section. In addition, any conservation measures that may reduce the effects of the stressors on those species are referenced. Where necessary, gaps in best available scientific or commercially available data are recognized to provide context to the effects analysis particularly in cases of data from surrogate species.

5.2.1 Southeastern Beach Mouse

Conservation Measures: Implementation of **GC1** will limit construction vehicles to designated areas, thus reducing impacts on southeastern beach mouse habitat. Implementation of **GC3** will reduce the potential for petrochemicals leaking from heavy equipment to impact southeastern beach mouse habitat. The implementation of **GC4** will reduce the likelihood of mortality for vehicle strikes within the construction area by reducing speed limits. Implementing a spill prevention, control, and countermeasure plan under **SEMB1** will minimize the potential for spills to occur and outlie spill containment, reducing habitat impacts.

Vegetation Clearing: The southeastern beach mouse may forage and burrow within the SLC-37 construction area and roadway widening areas, resulting in a loss of 72.3 acres of southeastern beach mouse habitat (Figure 5-1). The habitat impacts would be mitigated at a ratio of 1:1. The USFWS is developing a mitigation fund to streamline conservation offsets for actions occurring on CCSFS, including impacts on southeastern beach mouse habitat. The funds will help to facilitate both on- and offsite mitigation for the species. The requirement for habitat mitigation would result in no long-term loss of southeastern beach mouse habitat. Onsite mitigation would improve the condition of the seaward and landward southeastern beach mouse habitat by ensuring sufficient areas of bare sand and plants known to support the species remain on the landscape. Vegetation management may include mechanical thinning or hand clearing of densely vegetated areas to create sparsely vegetated areas of low height. Because the loss of southeastern beach mouse habitat is required to be fully mitigated for, the negative impacts from loss of foraging and nesting habitat from the SLC-37 construction and roadway widening would be temporary.

Figure 5-1. Southeastern Beach Mouse Habitat within Construction Area

Heat and Vapor Plume: Effects from heat that would be generated during launches, static-fire tests, and landings will be entirely contained within the SLC-37 fence line using a bifurcated diverter and water deluge system. Habitats outside of SLC-37 will not be exposed to elevated heat. The bifurcated diverter will direct heat upward, away from ground level such that any ground-dwelling animals would not be exposed if present. SLC-37 will have been cleared of suitable southeastern beach mouse habitat during construction, decreasing the likelihood of the species being present and in proximity to the heat plume. The vapor plume is made up of water vapor that dissipates rapidly and poses no threat to wildlife. Because of the use of the bifurcated diverter and containment of heat within the SLC-37 fence line, the effects of exposure of southeastern beach to the heat plume are expected to be insignificant.

Noise and Vibration: Table 5-1 shows the potential acreage of beach mouse habitat exposed to increased noise levels during each launch activity. Approximately 15,408 acres of habitat used for foraging and nesting would be exposed to noise intensities above 110 dB ASEL during Starship-Super Heavy launch where a behavioral response (startle) would be expected (Figure 5-2). Generally, the startling noise events would last less than 1 minute; however, up to 9 minutes could elapse during the launch of the Starship-Super Heavy and the return of the Super Heavy booster, during which time species would be subjected to two startling noise events. Specific negative effects from a startle response on mice are not supported by the literature. However, generalized behavioral reposes noted in mice include cessation of activity, including foraging, hunkering down, and circling in place. It is reasonable to assume that exposure to elevated noise may impede the species ability to feed, breed, and shelter, causing harassment. An additional 6,893 acres of habitat would be exposed to noise more than 120 dB ASEL where the potential for the physiological effects of TTS may occur in the species. Although the threshold shift may be temporary, the exposure to four events within successive time periods (all occurring on day of launch) may harm the species hearing.

Table 5-1. Southeastern Beach Mouse Habitat (acres) Noise Exposure Within the Action Area

Noise Scenario	100 to 110 dB ASEL	110 to 115 dB ASEL	115 to 120 dB ASEL	120 to 130 dB ASEL	130 to 140 dB ASEL	140 to 150 dB ASEL	> 150 dB ASEL	Total 110 to > 150 dB ASEL
Starship-Super Heavy Launch	1,508	4,715	3,800	3,573	2,305	800	215	15,408
Starship Static-Fire Tests	3,087	1,093	452	579	379	194	24	2,721
Super Heavy Static-Fire Tests	3,895	1,585	1,211	824	482	289	112	4,503
Super Heavy Landing	7,771	2,097	1,620	2,269	963	181	0	7,130
Starship Landing	3,034	1,339	691	803	381	8	0	3,222

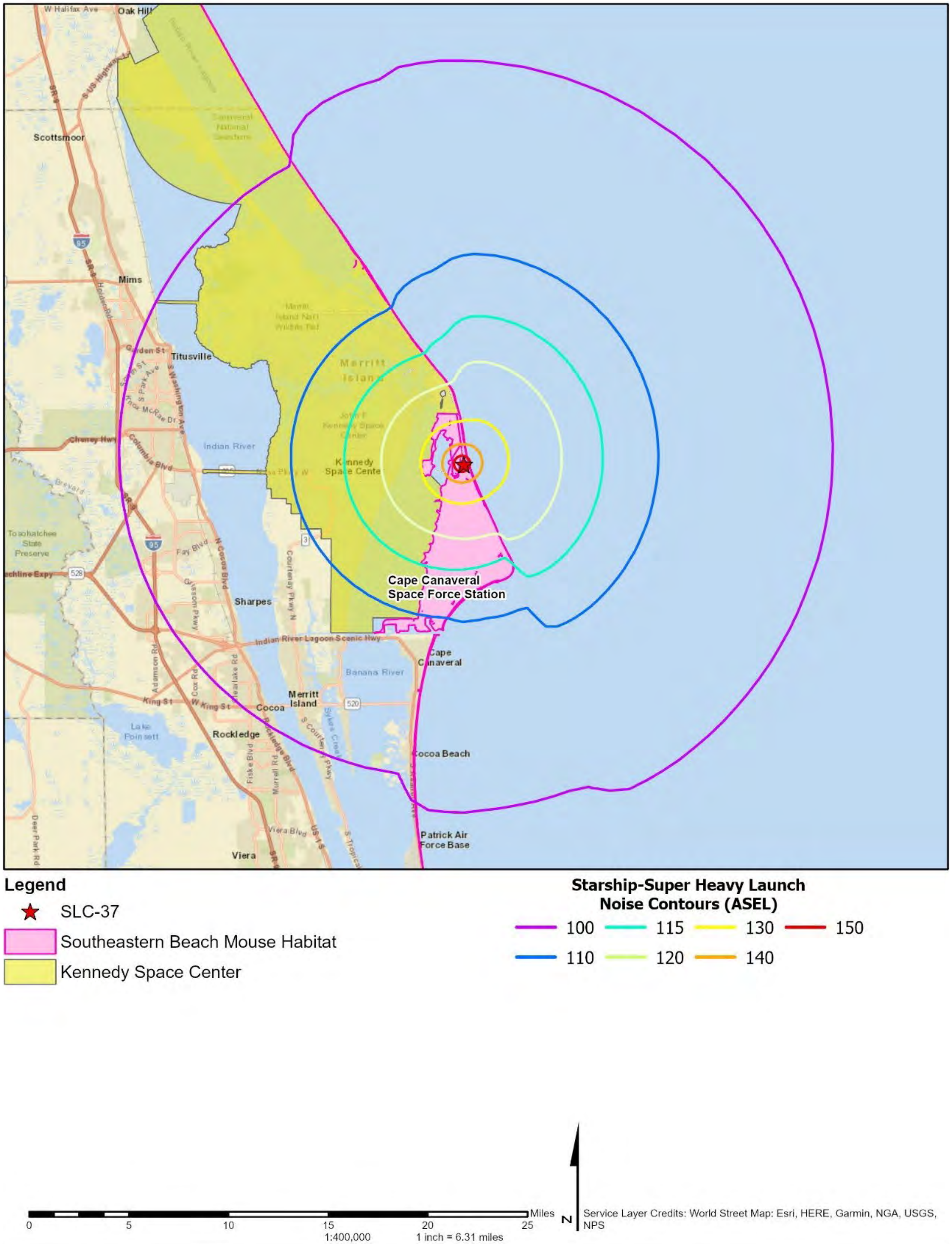

Figure 5-2. Southeastern Beach Mouse Habitat Relative to Launch Noise Contours (ASEL)

Vibration from operational scenarios, such as rocket launches, has not been evaluated on southeastern beach mice in the literature.

Sonic Boom: Sonic boom overpressures from Super Heavy booster and Starship landings may startle southeastern beach mice, causing a cessation in activity, such as foraging, and causing them to hunker down or stay in their burrow. From reviews of available literature, behavioral responses to overpressures would likely be observed within the greater-than-1-psf overpressure contours. Southeastern beach mouse habitat within the 1-psf action area is shown on Figures 5-3 and 5-4 and presented in Table 5-2. A total of 17,019 acres and 16,997 acres of southeastern beach mouse habitat may be exposed to overpressures above 1 psf from sonic booms occurring during Super Heavy landing and Starship landing respectively. These behavioral effects may constitute harassment to the species, but any reductions to fitness or survivability were not documented from available literature reviews. No physiological effects from exposure to overpressures are supported by the literature and a 2-psf overpressure event is similar to a thunderclap. Exposure to increased overpressures is likely to cause southeastern beach mice to startle.

Table 5-2. Southeastern Beach Mouse Habitat (acres) Overpressure Exposure Within the Action Area

Noise Scenario	1 to 1.2 psf	1.2 to 1.5 psf	1.5 to 2.0 psf	2.0 to 4.0 psf	4.0 to 6.0 psf	6.0 to 10.0 psf	> 10.0 psf	Total
Super Heavy Landing	7	7	7	266	300	6,528	7,449	17,019
Starship Landing	346	7,684	8,967	0	0	0	0	16,997

Notes:

Modeled overpressure contours were reported in different intervals for different scenarios.

Starship-Super Heavy launch sonic booms occur over ocean habitats and are not included in this table.

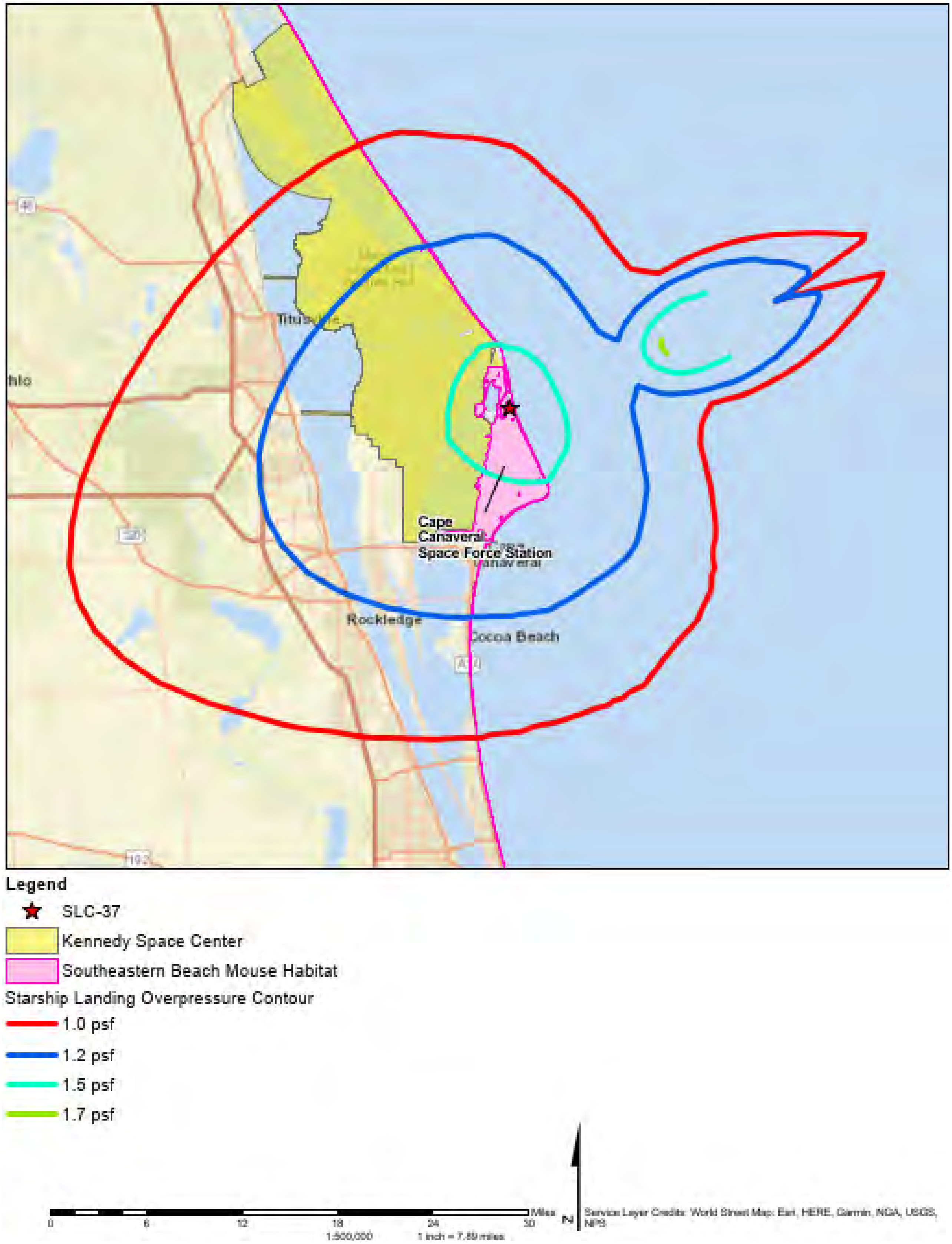

Figure 5-3. Southeastern Beach Mouse Habitat Relative to Starship Landing Overpressure Contours (psf)

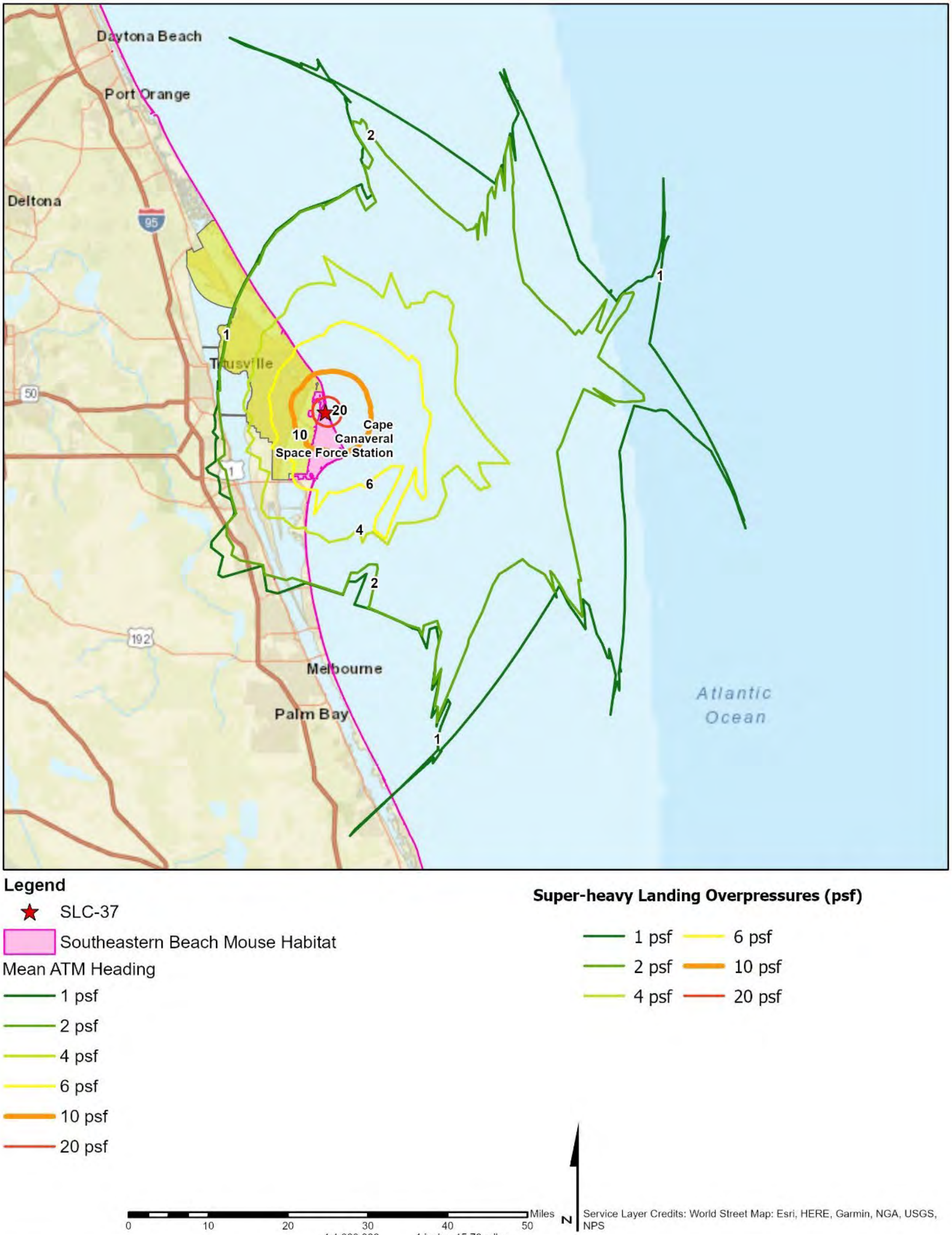

Figure 5-4. Southeastern Beach Mouse Habitat Relative to Super Heavy Landing Overpressure Contours (psf)

Artificial Light: Light during construction and operation may deter the southeastern beach mouse from foraging in suitable habitats. Foraging would be suspended while light is present if the launch pad was lit during nighttime. The estimated 38 lighted nighttime events would illuminate habitats in the vicinity of SLC-37. Nighttime illumination would have a negative effect on southeastern beach mice because the species avoid foraging in illuminated areas and potentially become more susceptible to predation during construction and operations.

Strikes and Collisions: Within the SLC-37 and roadway widening construction areas, southeastern beach mice may be struck (crushed) by heavy-vehicle traffic or entombed within burrows during site clearing and grading. Most motile organisms, however, would be expected to flee from ongoing construction activities, given the resulting sound, vibration, and light, before being directly impacted. Vehicular traffic on existing roadways and during construction and operations are not expected to result in increased mortality. Mortality by vehicles is a rare occurrence because of the nocturnal nature of the species and its natural tendency to flee from noise and human presence. No road kills of southeastern beach mice have been reported on CCSFS or KSC but would likely be unnoticeable if they did occur. Because of the potential for mortality during construction activities, strikes and collisions from construction equipment and possible entombment would have a negative effect on southeastern beach mice.

5.2.2 Tricolored Bat

Conservation Measures: Implementation **TCB1** will impose seasonal restrictions on vegetation removal to reduce the potential for physical harm to tricolored bats during the maternity season or when ambient day time temperatures are below 45°F, reducing impacts on roosting bats (May–July). Implementation of **TCB2** will help to determine any possible maternity roosts to avoid during construction.

Vegetation Clearing: Habitat for tricolored bat foraging within the SLC-37 construction area consists of stormwater ponds that provide aquatic habitats similar to natural wetland communities that the species uses for foraging. Stormwater ponds will be modified or replaced. Roosting habitat does not occur within the SLC-37 construction area. Should tricolored bats be found roosting in idle or abandoned structures that would be demolished, these bats would be allowed to leave the structures before replacement or renovation. Foraging along forested edges adjacent to roadway widening areas would remain. No removal of roosting habitat would occur as a result of roadway widening; only removal of smaller vegetation that has encroached on the fallow Old A1A would be removed. Vegetation clearing would have a discountable effect on the tricolored bat as there would be no net loss of foraging or roosting habitat.

Heat Plume and Vapor Plume: Tricolored bats would not be expected to forage in the area of the heat plume during nighttime operations due to increased human activity, and noise, thereby limiting their exposure to increased heat.

Noise and Vibration: The tricolored bat is a high-frequency (70 kHz down to 40 kHz [Robinson 2020]) echolocator, and noise frequencies from launches would generally be in a frequency lower than the bat can hear. Bat species that use echolocation for foraging such as the tricolored bat are affected only by ambient noise generated during launches if they use low-frequency echolocation (Bunkley et al. 2015). Vibrations would not be well transmitted to roosting sites in trees. The tricolored bat would not be expected to alter its activity as a result of increased noise and vibrations from operations, and noise would have an insignificant effect on the species.

Sonic Booms: Increased overpressures during Starship and Super Heavy booster landings may startle the tricolored bat, similar to other mammals, as the noise would occur within the action area over land. These events would be episodic and of short duration (less than 1 minute), and any effects on the species would be considered insignificant. If occurring during the daytime, the bat would be roosting and may only have sleep briefly interrupted. If sonic booms occurred during the nighttime while the bat was foraging, foraging may be suspended but would be quickly resumed as bats must continue flying to forage. The startle response from exposure to sonic booms would have an insignificant effect on tricolored bats.

Artificial Light: Lights from construction may serve to increase bat foraging near SLC-37 by attracting prey items (insects) to lighted areas but would subsequently increase the potential for collisions with infrastructure and may affect commuting and roosting. Increased light from construction and operations would have an insignificant effect on the tricolored bat

Strikes and Collisions: The tricolored bat forages at night when increased traffic volume from construction and operations would be reduced. Further, the species navigates by echolocation, giving it the ability to avoid most vehicle collisions; therefore, bat road kills are rare. Vehicular traffic on existing roadways during construction and operations would have a discountable effect on the tricolored bat.

5.2.3 West Indian Manatee

Conservation Measures: Implementation of **WIM1**—which provides that SpaceX will develop a SWPPP and will obtain a Florida Environmental Resource Permit and National Pollutant Discharge Elimination System permit for stormwater discharge—guarantees regulatory compliance and reduces impacts on the aquatic environment from the reduction in potential pollution discharges. Implementation of **WIM2** will further reduce aquatic pollution via the development and implementation of soil and sediment control measures along with waste management during construction. **WIM3** provides that boat and barge traffic will follow standard manatee protections, including following routes of deep water and established and maintained channels/basins, operating under no wake or at idle speeds in certain areas, operating under 10 knots in navigation channels, and maintaining distances from observed manatees.

Vegetation Clearing: The SLC-37 construction area and the roadway improvement construction areas contain no habitat for the West Indian manatee. The presence of this species within the action area would be limited to the Banana River, which is approximately 2,000 feet from SLC-37, and the nearshore waters of the Atlantic Ocean, which are approximately 250 feet east of SLC-37. Vegetation clearing in construction areas would have no effect on the species other than the potential for stormwater pollution from construction sites entering the adjacent waterways.

Heat and Vapor Plume: Increased heat from launch activities would be contained within the SLC-37 fence line through use of the bifurcated diverter and water deluge. No manatee habitat is present within SLC-37; therefore, the species would not be exposed to elevated heat.

Noise and Vibration: West Indian manatee spends the majority of its time below the surface of the water where sound intensity from launch and landings would be greatly reduced due to the transfer of energy from the different densities of air and water; thus, the potential for a startle response is considered insignificant.

Sonic Booms: Similar to noise from launch and landings, sonic boom overpressures poorly transmit into the water media from the air. As such, manatees may be startled by sonic boom overpressures if near or at the surface; however, the likelihood of this occurring during the instance of a sonic boom is considered unlikely. Sonic booms would have an insignificant effect on West Indian manatees.

Artificial Light: Light from construction activities would be localized to SLC-37 and roadway widening areas where no manatee habitat is present. Light from operational events may extend into aquatic environments used by manatees during the nighttime when manatees are active. However, the 38 infrequent launches during nighttime would have cause minimal disturbance and have an insignificant effect on nocturnal activities.

Strikes and Collisions: Increased barge traffic transporting vehicle components before and after launches would increase the potential for manatees to be struck, particularly when barges are operating in inshore waters during winter months. However, the operation of barges associated with operations would occur within areas that have high recreational and commercial boat traffic, including large cruise ships from the Port Canaveral. Debris from expendable launches would occur many miles from shore and would be very unlikely to strike a West Indian manatee, which prefers nearshore habitats. Because of the minor increase in vessel traffic and the absence of the species from offshore habitats, strikes and collisions would be considered insignificant.

5.2.4 Crested Caracara

Vegetation Clearing: Potential foraging habitat occurs for the Audubon's crested caracara within the SLC-37 construction areas. The Proposed Action would result in the permanent loss of 12.6 acres of suitable foraging habitat within the roadway improvement construction areas. This loss of foraging habitat is minimal, and foraging habitats within the action area would remain available to the species, resulting in an insignificant effect on this species.

Heat Plume and Vapor Plume: If present, the transitory species would be expected to vacate the area before engine ignition because of increased human activity, lighting, and noise. Impacts on foraging caracara from exposure to the heat plume are considered discountable.

Noise and Vibration: Launch and landing operational noise, as well as vibration within the 110 dB ASEL and greater contour, would cause crested caracara to startle, resulting in the species abandoning foraging or experiencing increased stress responses. However, because the species is infrequently observed on CCSFS, KSC, CANA, and MINWR, the effect of a startle response is considered insignificant.

Artificial Light: Light from construction and operations would not be expected to interfere with foraging as the species forages only during the day. Because the species is infrequently observed within the vicinity of SLC-37 and does not nest on CCSFS, increased light from the Proposed Action would have a discountable effect on the species.

Strikes and Collisions: Vehicular traffic from construction and operations would not be expected to result in an increased likelihood of a vehicle strike as the species is rare on CCSFS and would be expected to avoid collisions with vehicles. Vehicular traffic would have an insignificant effect on crested caracara.

5.2.5 Atlantic Sea Birds

The Bermuda petrel. black-capped petrel and roseate tern may be exposed to noise and sonic booms from launch, static-fire tests, and Super Heavy booster landings (RTLS and floating platform scenarios) if foraging in the open waters of the Atlantic Ocean. However, because of the range of these species, it would not be affected by vegetation clearing, heat and vapor plume, and artificial light occurring in the vicinity of SLC-37.

Noise and Vibration: Birds foraging within the 100-dB ASEL action area may startle and temporarily suspend foraging. However, because these species typically remain over 20 miles offshore near the launch site, the effects would be discountable. Foraging seabirds in the landing zone would flee from the area as the vehicle lands and continue foraging elsewhere.

Sonic Booms: Birds foraging within the 1-psf action area may startle and temporarily suspend foraging. However, these species typically remain over 20 miles offshore near the launch site, the effects would be discountable. Noise from the sonic boom may startle and cause seabirds to flee the area, temporarily suspending foraging.

Strikes and Collisions: Debris from expendable Starship landings in the Atlantic Ocean action area would be very unlikely to strike a Bermuda petrel, black-capped petrel or roseate tern due to the density of these species in the open-ocean environment and the unlikely scenario of an expendable landing. Thus, the effect of debris striking the species is considered discountable.

5.2.6 Pacific Sea Birds

The band-rumped storm petrel, Hawaiian petrel, Newell’s sheerwater, and short-tailed albatross are pelagic sea birds found throughout the Pacific Ocean. Because of the range of this species, it would not be affected by vegetation clearing, heat and vapor plume, noise and vibration, sonic booms, and artificial light occurring in the vicinity of SLC-37.

Strikes and Collisions: Debris from expendable Starship landings in the Pacific Ocean action area would be very unlikely to strike a band-rumped storm petrel due to the density of the species in the open-ocean environment and the unlikely scenario of an expendable landing. The effect of debris striking the species is considered discountable.

5.2.7 Eastern Black Rail

Vegetation Clearing: No suitable habitat occurs for the eastern black rail within the SLC-37 construction or roadway widening areas. Vegetation clearing would have no effect on this species.

Heat Plume and Vapor Plume: No suitable habitat is present for this species in the footprint of the heat and vapor plume. The species does not occur on CCSFS and there is minimal suitable habitat that occurs within SLC-37. There would be no effect on the eastern black rail from heat plume exposure during operations.

Noise and Vibration: Noise from operations (110-dB ASEL contour) would extend into KSC where the eastern black rail may occur. If present, launch, static-fire tests, and landing noise may startle the eastern black rail, causing the species to suspend foraging and possibly increasing stress. Exposure to noise would be episodic and of short duration. Because of the rare occurrence of this species within the action area, exposure to elevated noise is considered a discountable effect.

Sonic Booms: Sonic booms during launches would occur many miles offshore and, therefore, have no impact on the eastern black rail. Sonic booms from the Super Heavy booster landings (RTLS scenario) may startle the species if present because the overpressure would occur within the 1-psf action area over land. Because of the rare occurrence of this species within the action area, exposure to elevated overpressure is considered a discountable effect.

Artificial Light: Light from construction and operations would not be expected to interfere with foraging as the species forages only during the day. If present, artificial light could interfere with roosting (sleep) of this species. Because of the rare occurrence of this species within the action area, exposure to artificial light is considered a discountable effect.

Strikes and Collisions: Vehicular traffic from construction and operations would not be expected to increase the likelihood of a vehicle strike as the species is rare within the action area and would not be expected to be present adjacent to roadways. Because the species is rarely observed in the action area, increased vehicular traffic would have a discountable effect on the species.

5.2.8 Everglade Snail Kite

Though listed in the IPaC search as potentially occurring within the action area, the Everglade snail kite is primarily found in Central and South Florida including the Kissimmee Valley; St. Johns River headwaters; Lake Okeechobee; Loxahatchee National Wildlife Refuge; Water Conservation Areas 2A, 2B, 3A, and 3B in Broward, Palm Beach, and Dade Counties; and sections of Big Cypress National Preserve and Everglades National Park (Florida Natural Areas Inventory 2001). If present, the species would be a transient visitor to the action area, which it may use for foraging in freshwater marshes. Because the species is rarely observed in the action area, the effects from vegetation clearing, heat and vapor plume, noise and vibration, sonic booms, artificial light, and strikes and collisions are considered discountable.

5.2.9 Florida Scrub-Jay

Conservation Measures: In accordance with **GO1**, SpaceX will adhere to the Prescribed Burn MOU (USSF, USFWS, and NASA 2025) unless superseded or revised, SpaceX will continue efforts through interagency coordination to ensure current fire management program activities will not be significantly impacted and SLD 45, KSC and MINWR can continue to meet burn requirements and goals. Implementation of **FSJ1** before construction would ensure that no active nests or scrub-jays are within 300 feet of construction. Any nests encountered would be flagged, and no construction would be allowed within 300 feet unless birds have fledged from nests. This conservation measure will prevent impacts on Florida scrub-jays outside but adjacent to construction areas. **FSJ2** will expand existing monitoring on CCSFS and coordinate results with other adjacent property managers to help detect local and regional species trends. **FSJ3** will implement noise and vibration monitoring in the vicinity of SLC-37 such that operational conditions can be documented and reported.

Vegetation Clearing: No suitable habitat occurs for the Florida scrub-jay within the SLC-37 construction area (Figure 5-5). A small area mapped as xeric oak within the fence line is not accurately mapped and has been confirmed to be herbaceous prairie habitat. No Florida scrub-jays have been observed within the construction area during SLD 45 surveys (2016 to 2023). Preconstruction surveys of the construction area would be completed by a qualified biologist before land disturbance. If the species were detected in the construction area, additional consultation with the USFWS would be completed before the work. Nesting and foraging habitat for the Florida scrub-jay would be impacted in SLC-37 construction and roadway improvement areas by the removal of 12.2 acres of habitat that would be permanently converted to hardscape. Florida scrub-jays are known to use the roadway ROWs for acorn foraging. Florida scrub-jays nest near the road in scrub habitats and may even be attracted to these areas due to for access to better foraging habitat and detection of predators (USFWS 2019e). Roadway noise has not been found to have an effect on the species preference for nesting in these areas (Mumme et al. 2000).

Figure 5-5. Florida Scrub-jay Habitat Within Construction Area

The removal of foraging habitat from roadway improvements would have an insignificant effect on Florida scrub-jays as ample foraging habitat would remain postconstruction.

Heat and Vapor Plume: Florida scrub-jays would not be exposed to increased heat during operations as no suitable habitat is present in SLC-37 and no Florida scrub-jays have been observed using the site. Because the heat plume will be contained within the SLC-37 fence line, Florida scrub-jays that use adjacent habitats would only be exposed to the heat and vapor plume if they strayed from habitats during operations. However, most animals, particularly birds adjacent to SLC-37, would be expected to relocate or flush due to increase human presence, noise, and activity. Because it is unlikely that Florida scrub-jays will be exposed, the effects from increased heat are considered discountable.

Noise and Vibrations: Noise and vibration within the 110-dB ASEL and greater contours could cause Florida scrub-jays to startle and may result in the species temporarily suspending foraging, egg incubation, and social calling. Within the CCSFS portions of 110-dB ASEL (Table 5-3 and Figure 5-6), a total of 445 Florida scrub-jay individuals were observed during the 2024 population census. During 2023, 413 individuals were observed within the same CCSFS portions of the action area. Available data from KSC provided that at total of 488 Florida scrub-jay were observed within the KSC portion of the action area, although locations were not available. Exposure to these noise levels and areas closer to SLC-37 may cause Florida scrub-jays to experience behavioral changes, such as nest abandonment and increased physiological stress responses, leading to decreased fitness in individual birds exposed to noise/vibration; however, direct relationships to noise thresholds correlated to physiological response from stressor of similar characteristics (duration) raising the level of harm were not supported by the literature.

Laboratory studies indicate birds decreased their general activity and increased stationary and social behaviors in response to episodic noise stimuli (Corbani et al. 2021). In its BO regarding the effects of noise exposure from the increased cadence of rocket launches on snowy plovers and California least terns at Vandenberg Space Force Base, California, the USFWS acknowledged that it was unable to determine direct physiological effects (hearing trauma) and instead provided qualified discussions of potential behavioral effects (starling response). However, further effects from the starling response anticipated were not detailed, and the USFWS stated that responses would be unknown without monitoring. Monitoring data indicated no declines in snowy plover and California least terns. Noise and vibration from launch operations would be temporary, short in duration, and episodic, and are not expected to result in permanent physiological effects.

Noise and vibration energy from operational scenarios, such as rocket launches, has not been shown to damage eggs or developing embryos of birds; thus, vibration would have a discountable effect on Florida scrub-jays.

Table 5-3. Florida Scrub-jay Population Count (Individuals) Exposure Within the Action Area

Noise Scenario	100 to 110 dB ASEL	110 to 115 dB ASEL	115 to 120 dB ASEL	120 to 130 dB ASEL	130 to 140 dB ASEL	140 to 150 dB ASEL	> 150 dB ASEL	Total 110 to > 150 dB ASEL
Starship-Super Heavy Launch	164	89	84	67	36	5	0	445
Starship Static-Fire Tests	56	43	22	15	23	3	0	162
Super Heavy Static-Fire Tests	92	31	40	31	17	15	3	229
Super Heavy Landing[a]	250	34	45	72	41	0	0	442
Starship Landing	68	34	33	29	16	0	0	180

[a] 40°, 115°, and nominal heading merged for combined contour

Note: Based on 2024 scrub-jay census data.

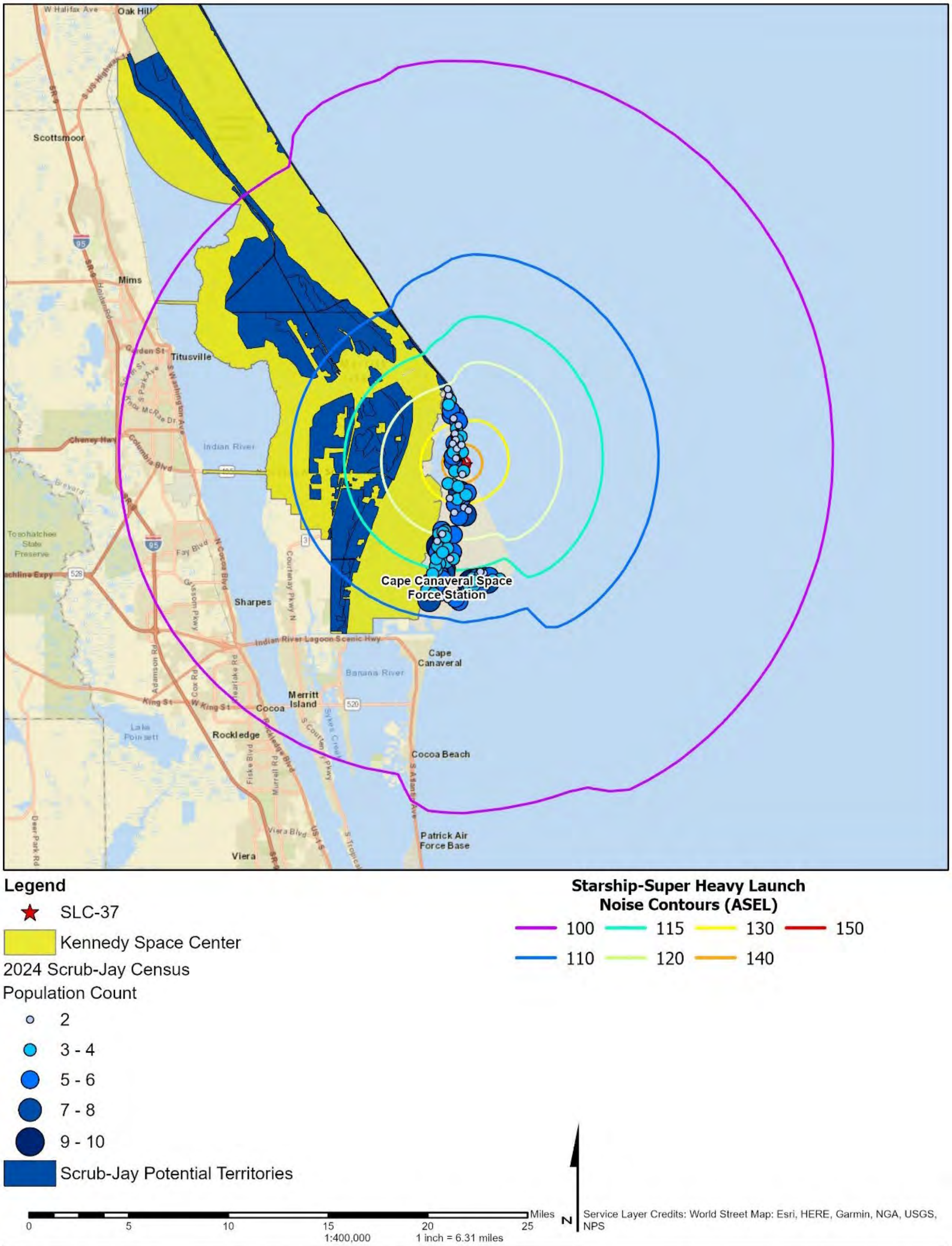

Figure 5-6. Florida Scrub-jay Populations Relative to ASEL Launch Noise Contours

Sonic Booms: Sonic boom overpressures created during Super Heavy booster and Starship landings may startle Florida scrub-jays, causing a cessation in activity such as foraging, egg incubation, or social calling. Any reductions to fitness or survivability are not supported by available literature. However, behavioral responses to overpressures would likely be observed within the greater-than-1-psf overpressure contours. Florida scrub-jay core habitat within the 1-psf action area is presented in Table 5-4 and shown on Figures 5-7 and 5-8. A total of 442 Florida scrub-jay individuals (2024 data) would be exposed to overpressures greater than 1 psf from sonic booms from Starship landings.

Table 5-4. Florida Scrub-jay Population Count (Individuals) Exposure Within the Action Area

Noise Scenario	1 to 1.2 psf	1.2 to 1.5 psf	1.5 to 2.0 psf	2.0 to 4.0 psf	4.0 to 6.0 psf	6.0 to 10.0 psf	10.0 to 20.0 psf	> 20.0 psf	Total
Super Heavy Landing	0	0	0	0	0	200	97	145	442
Starship Landing	0	213	229	0	0	0	0	0	442

Notes:

Modeled overpressure contours are reported in different intervals for different scenarios.

Starship-Super Heavy launch sonic booms occur over ocean habitats and are not included in this table.

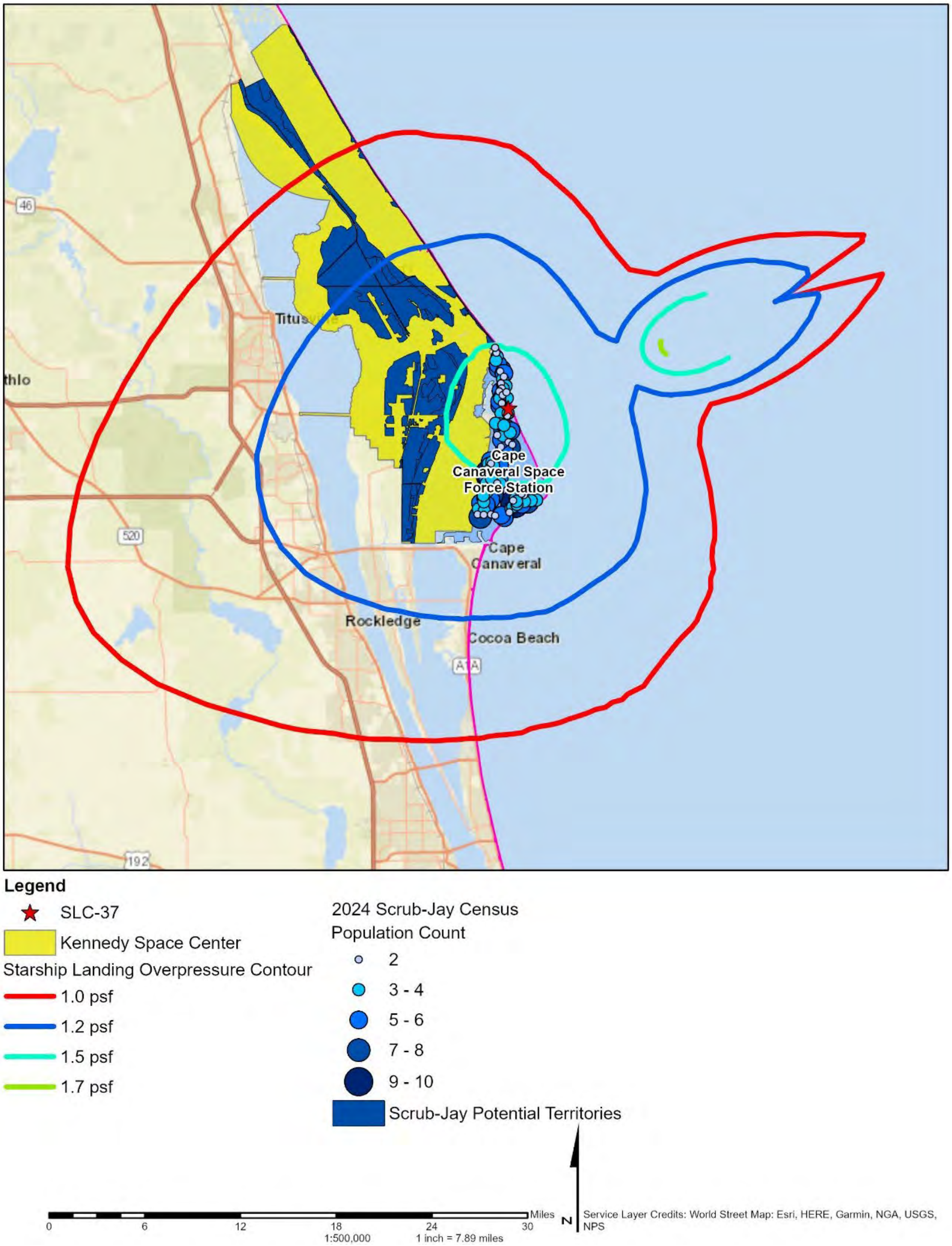

Figure 5-7. Florida Scrub-jay Habitat Relative to Starship-Super Heavy Landing Overpressure Contours (psf)

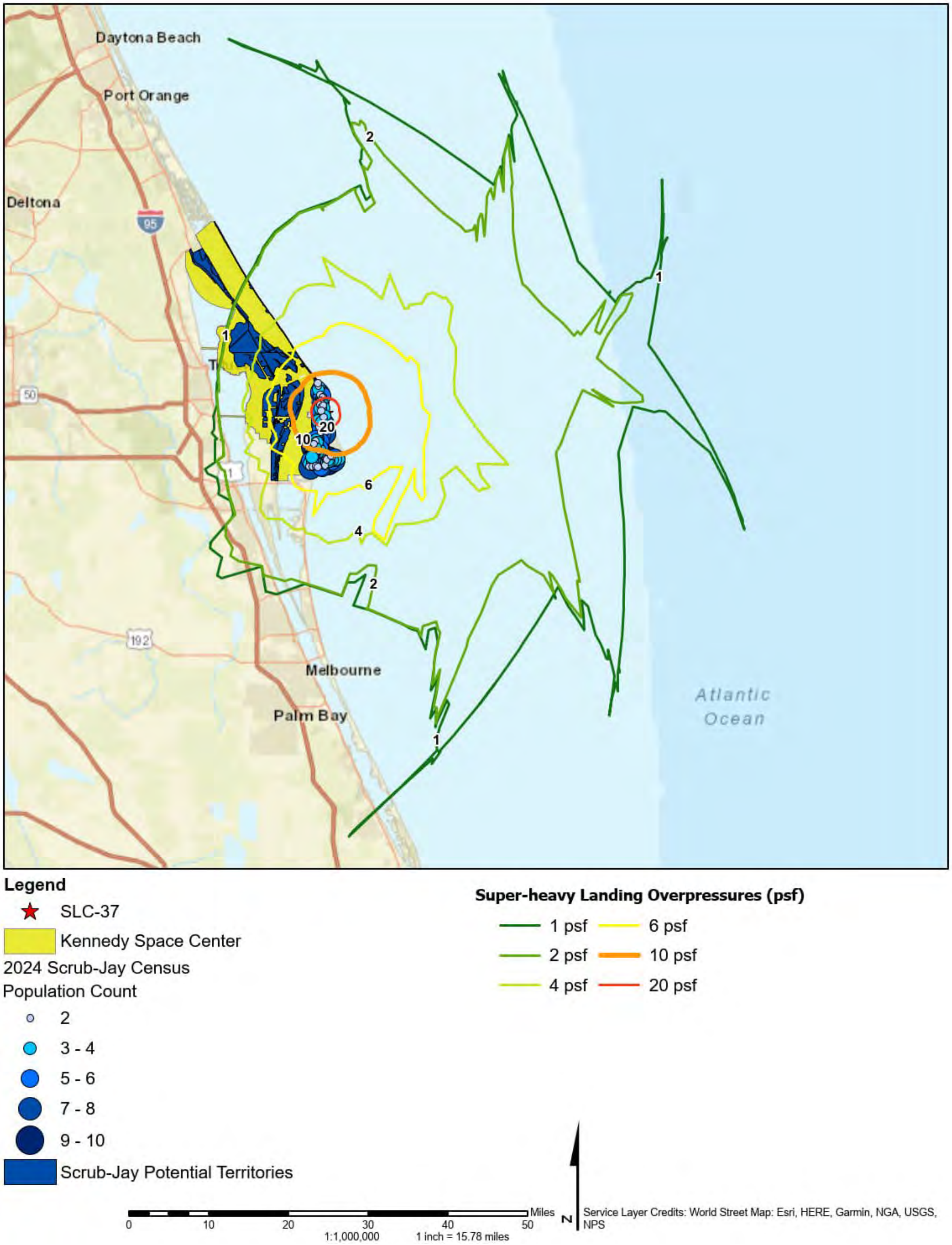

Figure 5-8. Florida Scrub-jay Habitat Relative to Starship-Super Heavy Landing Overpressure Contours (psf)

Artificial Light: Light from construction and operations would not be expected to interfere with foraging of the Florida scrub-jay as the species forages only during the day. Any Florida scrub-jays nesting in habitats exposed to nighttime lighting may be temporarily startled, but they would be expected to remain on nests (Corbani et al. 2021). If present, artificial light could interfere with roosting (sleep) of this species. Because the species is primarily diurnal, the effects from artificial lighting would be insignificant on the Florida scrub-jay.

Strikes and Collisions: Vehicular traffic on existing roadways during project construction and operations would not be expected to increase vehicle strikes of Florida scrub-jays foraging adjacent to roadways. Florida scrub-jays are regularly observed using roadway habitats for foraging, where scrub habitat is adjacent to the ROW, but vehicle strikes are rare. Florida scrub-jays are most active during post-dawn and pre-dusk, when temperatures are cooler and winds are calmer for vocal socialization. The roadway widening along Old A1A will be primarily used for launch vehicle component transport and not a thoroughfare for traffic. As transport of launch vehicle components is slow, no additional vehicle strikes from use of Old A1A are anticipated. Construction is expected to primarily occur during daylight hours. Increased vehicle traffic during construction and operational activities could result in some increased mortality from vehicle strikes.

5.2.10 Piping Plover

Conservation Measures: Continue winter shorebird surveys at CCSFS and KSC to track trends in the species.

Vegetation Clearing: The SLC-37 construction area and the roadway widening areas contain no suitable habitat for the piping plover. Because the species does not occur within SLC-37 and roadway widening areas, construction activities will have no effect on piping plover or habitats that the species uses.

Heat and Vapor Plume: Heat from the exhaust plume would not extend out toward the shoreline where piping plover foraging habitat occurs. It is unlikely that piping plover would be present within the area of the heat plume during launches or static tests unless the bird were to fly into SLC-37 where the heat plume would be contained. Given the low probability of piping plover exposure, the effects from increased heat generated during operations would be discountable.

Noise and Vibration: Piping plover have not been observed during surveys conducted along CCSFS beaches since 1991. However, they have been infrequently observed adjacent of SLC-37 near Port Canaveral and on the shorelines of KSC the Indian River Lagoon within the action area (eBird n.d.). Noise operational events within the 110-dB ASEL and greater contour areas could cause the piping plover to temporarily startle and temporarily suspend foraging or roosting during launch operations if present. However, given the rarity of the observations within the action area, and because there is ample habitat to support the species outside of elevated noise areas, the effects of noise on piping plover are considered insignificant. Because piping plovers do not nest within the action area, there would be no effect from vibration on eggs or incubating adults.

Sonic Booms: Elevated overpressures within the 1-psf and greater overpressure contours may create a startle response for foraging and resting piping plover if present. However, because piping plover are rarely present within the action area, and because ample habitat exists to support the species outside of the elevated overpressures, the effects of sonic booms are considered insignificant.

Artificial Light: Increased light during construction and operations may affect piping plover foraging activities, if present. Typically the species forages during the day when light from launches would not have an increased effect above ambient light conditions. Some scientific literature indicates that foraging shorebirds use increased nighttime lighting (natural or artificial) to forage, particularly if a low tidal cycle is present (Bullough et al. 2023), but that increased nighttime light leads to more flushing because of a perceived predation risk (Jolkkonen et al. 2023). Light from night operations may disturb piping plover resting along beach or shoreline habitats or migrating.

Piping plover are known to use CCSFS and KSC shorelines during winter where artificial light during construction and operations will reach. Approximately half of all lighting events from launch, Super Heavy booster landings, and Starship landings would be expected to take place at night (114 events, or 9.5 events per month) with approximately 76 occurring over the 8 months the species is present within the action area. Because piping plover may relocate away from artificial light disturbances of this frequency, artificial light would have an insignificant negative effect on species while roosting.

Strikes and Collisions: Vehicular roadway traffic from construction and operational activities would have no effect on the piping plover as suitable habitat does not occur adjacent to any roadways on CCSFS.

5.2.11 Rufa Red Knot

Conservation Measures: Continue winter shorebird surveys at CCSFS and KSC to track trends in the species.

Vegetation Clearing: The SLC-37 construction area and the roadway widening areas contain no suitable habitat for the rufa red knot. The nearest possible presence of this species is limited to the Atlantic Ocean beaches approximately 250 feet to the east of construction activities. Construction activities will have no effect on piping plover or habitats that the species uses.

Heat and Vapor Plume: Heat from the exhaust plume would not extend to the shoreline where rufa red knot foraging habitat occurs. It is unlikely that rufa red knot would be present within the area of the heat exhaust plume during launches or static tests unless the bird were to fly into SLC-37 where the heat plume would be contained. Because rufa red knots would not be exposed, the effects from increased heat generated during operations would be discountable.

Noise and Vibration: Rufa red knots have been observed during surveys conducted along CCSFS beaches since 2019. Noise operational events within the 110-dB ASEL and greater contour areas could cause the rufa red knots to startle, suspend foraging, interrupt roosting, and potentially cause stress. Approximately 477 acres of rufa red knot habitat would be exposed to elevated noise contours above 110 dB ASEL (Table 5-5 and Figure 5-9).

Because rufa red knots do not nest within the action area, there would be no effect from vibration on eggs or incubating adults.

Table 5-5. Rufa Red Knot Habitat (acres) Noise Exposure Within the Action Area

Noise Scenario	100 to 110 dB ASEL	110 to 115 dB ASEL	115 to 120 dB ASEL	120 to 130 dB ASEL	130 to 140 dB ASEL	140 to 150 dB ASEL	> 150 dB ASEL	Total 110 to > 150 dB ASEL
Starship-Super Heavy Launch	7,908	226	220	32	0	0	0	477
Starship Static-Fire Tests	0	0	0	0	0	0	0	0
Super Heavy Static-Fire Tests	122	0	0	0	0	0	0	0
Super Heavy Landing[a]	373	63	0	0	0	0	0	63
Starship Landing	0	0	0	0	0	0	0	0

[a] 40°, 115°, and nominal heading merged for combined contour.

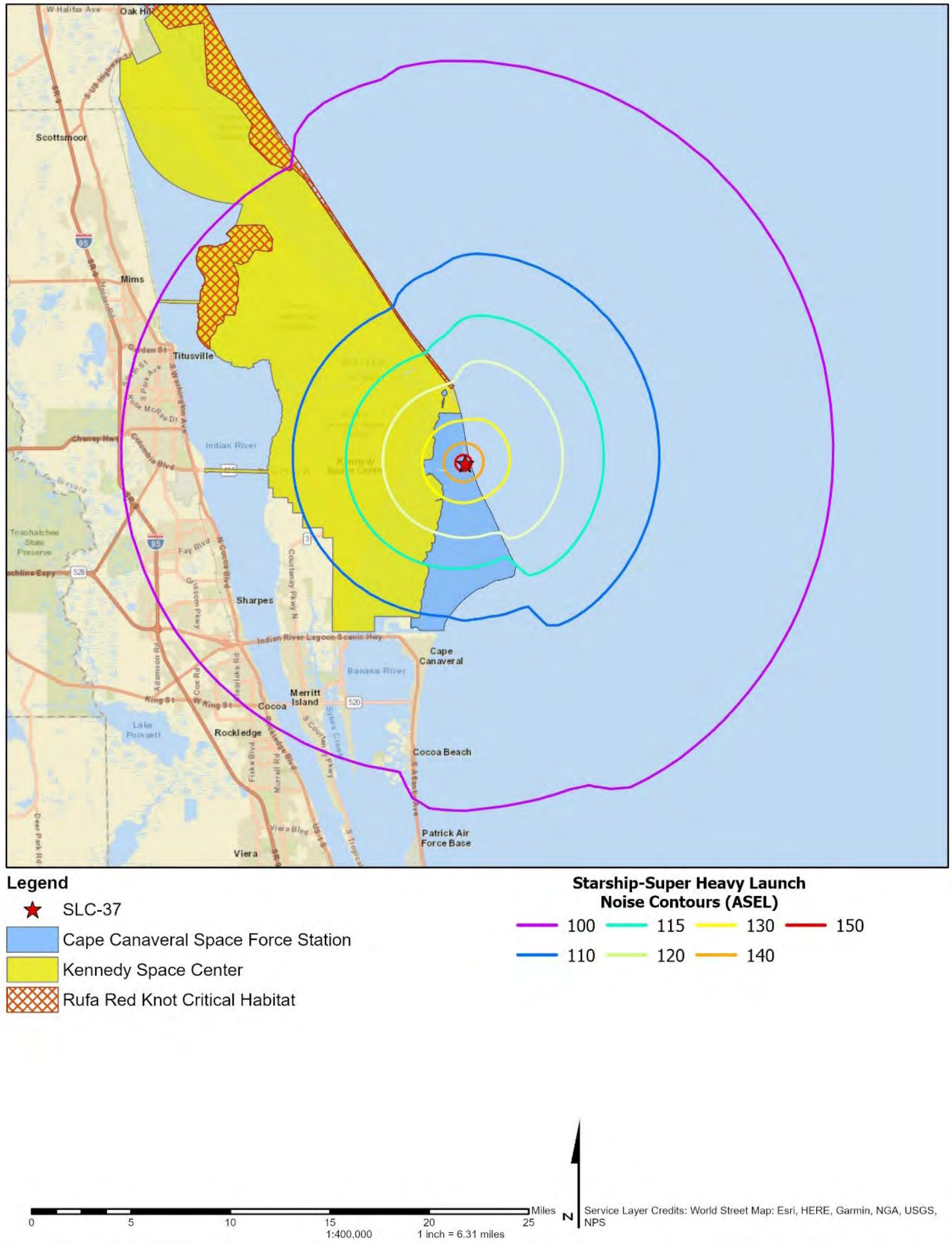

Figure 5-9. Rufa Red Knot Habitat Relative to Launch Noise Contours (ASEL)

Sonic Booms: Elevated overpressures within the 1-psf and greater contours (Figures 5-10 and 5-11) may create a startle response for foraging and resting rufa red knots using adjacent habitats. These effects are likely similar to noise exposure and would create a startle effect. Approximately 9,618 acres of suitable rufa red knot habitat exists within the 1-psf and greater overpressure contours during Starship landing (Table 5-6). Because of the known used habitat near SLC-37, noise would be considered a negative effect on rufa red knots.

Table 5-6. Rufa Red Knot Habitat (acres) Overpressure Exposure Within the Action Area

Noise Scenario	1 to 1.2 psf	1.2 to 1.5 psf	1.5 to 2.0 psf	2.0 to 4.0 psf	4.0 to 6.0 psf	6.0 to 10.0 psf	10.0 to 20.0 psf	> 20.0 psf	Total
Super Heavy Landing	419	419	419	6,382	266	346	141	0	7,554
Starship Landing	8,991	609	19	0	0	0	0	0	9,618

Notes:

Modeled overpressure contours are reported in different intervals for different scenarios.

Starship-Super Heavy launch sonic booms occur over ocean habitats and are not included in this table.

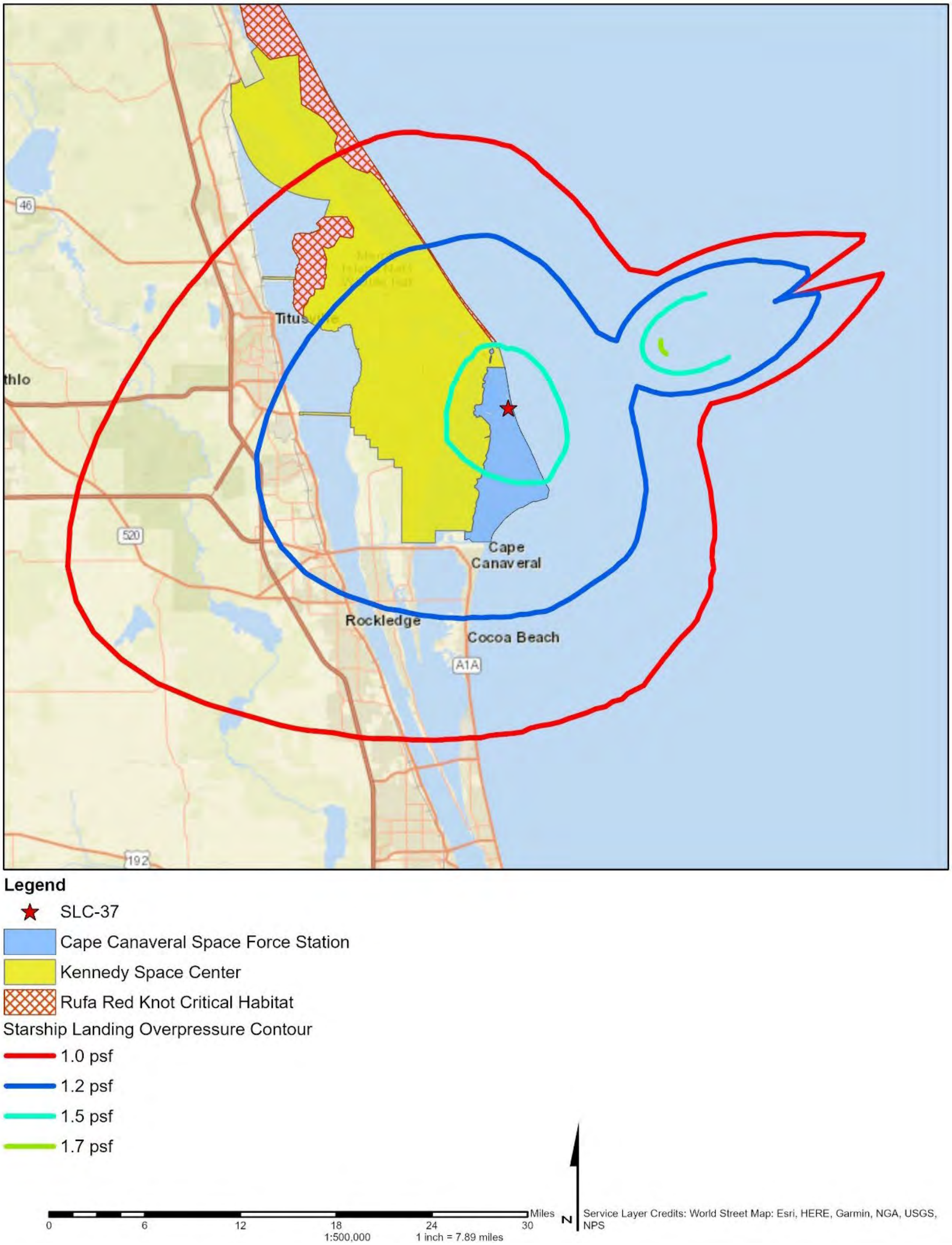

Figure 5-10. Rufa Red Knot Habitat Relative to Starship Landing Overpressure Contours (psf)

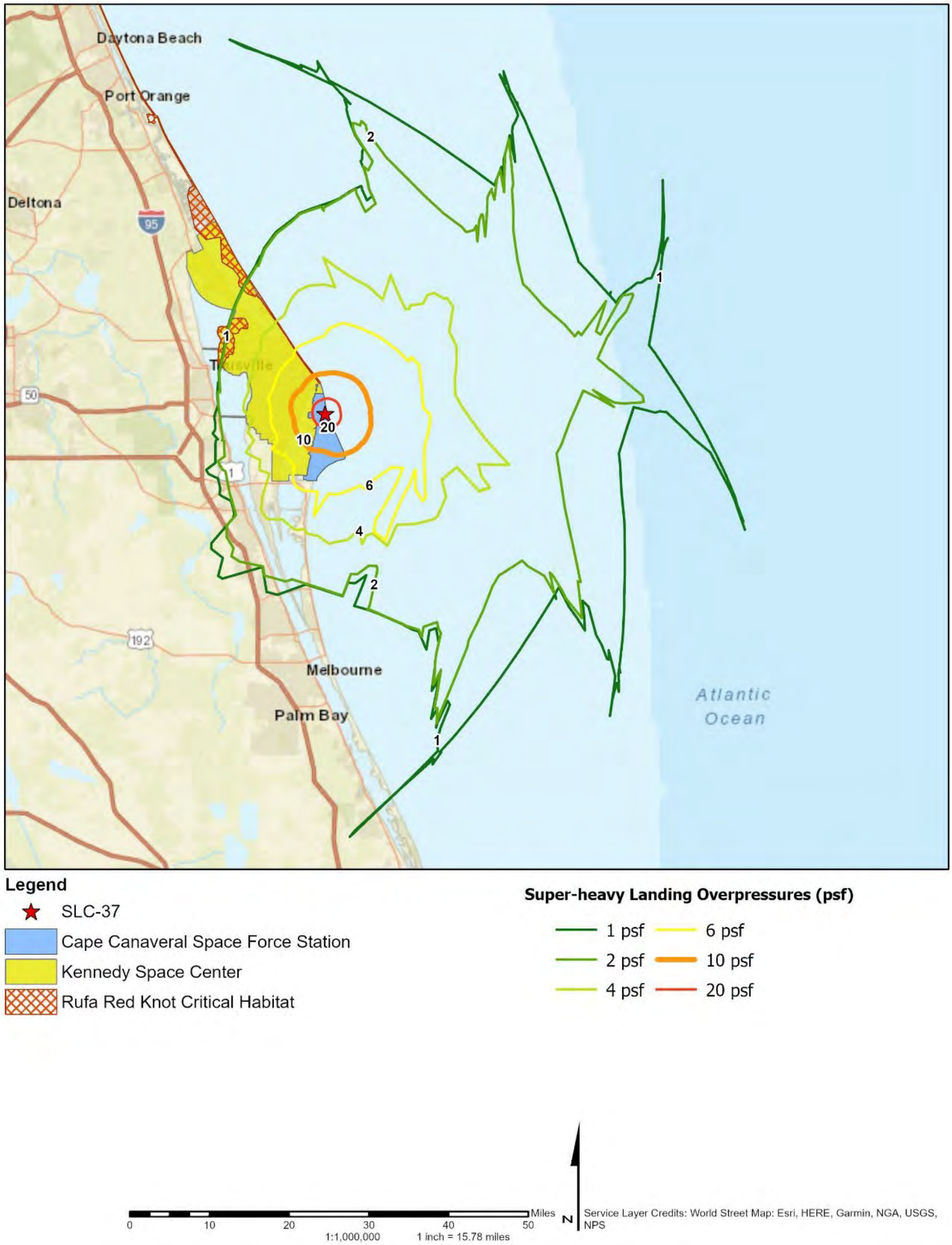

Figure 5-11. Rufa Red Knot Habitat Relative to Super Heavy Landing Overpressure Contours (psf)

Artificial Light: Similar to piping plover, increased light during construction and operations may interfere with rufa red knot foraging activities, if present. The species primarily forages during the day when launches would not have an increased effect above ambient light conditions. Some scientific literature indicates that foraging shorebirds use increased nighttime lighting (natural or artificial) to forage, particularly if a low tidal cycle is present (Bullough et al. 2023), but that increased nighttime light leads to more flushing because of perceived predation risk (Jolkkonen et al. 2023). Light from night operations may disturb rufa red knots resting along beach or shoreline habitats or migrating. However, the frequency of estimated nighttime events (38 launch/landing events) and the period of overwintering of rufa red knots (December to May [6 months]) means that overwintering birds may be exposed to approximately 57 nighttime events (19 Starship-Super Heavy launch, 19 Super Heavy booster landings, and 19 Starship landings). However, the requirement for when nighttime events may occur is ultimately unknown. Rufa red knots also could relocate to habitat less illuminated during nighttime events. Because of frequency of exposure to artificial lighting, the effects of artificial lighting are considered to be insignificant on the species.

Strikes and Collisions: Vehicular roadway traffic from construction and operational activities will have no effect on the rufa red knot as suitable habitat does not occur adjacent to any roadways at CCSFS.

5.2.12 Wood Stork

Vegetation Clearing: The wood stork occasionally forages in aquatic habitats, including wetlands, canals, and ditches within the action area. No active nesting colonies have been observed at CCSFS (FDEP 2024). No wetlands would be cleared as part of SLC-37 construction and roadway widening; therefore, this would not reduce suitable habitats for wood storks. Wood storks would not be expected to be present within construction areas as these areas are outside of key foraging areas (Figure 5-9). Effects from vegetation clearing on wood storks are considered discountable.

Noise and Vibration: Noise from launch and landing events may startle wood storks within the 110-dB ASEL and greater noise contours. These contours overlap with approximately 33,859 acres of wood stork foraging areas (Figure 5-12). Startled wood storks may temporarily suspend foraging. However, because of the abundance of foraging area beyond noise contours and because wood storks have large ranges throughout which they forage, they would likely to select areas where they are not exposed to elevated noise. Because of wood stork ample foraging areas, the effect of elevated noise is considered insignificant

Sonic Booms: Elevated overpressures within the 1-psf and greater contours generated from Starship landing would overlap with approximately 127,015 acres of wood stork foraging areas (Figure 5-13) and approximately 164,081 acres from Super Heavy booster landing (Figure 5-14). Similar to noise, exposure to overpressure may create a startle response for foraging wood storks. However, because wood storks have ample foraging areas and are highly mobile, they are likely to select areas outside of the 1-psf contour or become habituated to sonic booms; thus, the effects would be insignificant.

Artificial Light: Light from construction and operations would not be expected to interfere with foraging by the wood stork as the species forages only during the day. Wood stork colonies are not established in close enough proximity to artificial light generated from the Proposed Action; thus, the effect is considered discountable.

Strikes and Collisions: Vehicular roadway traffic during project construction and operations would not be expected increase vehicle strikes on wood storks because they are infrequently observed foraging along the roadways. The effect of vehicle strikes on wood storks is considered insignificant.

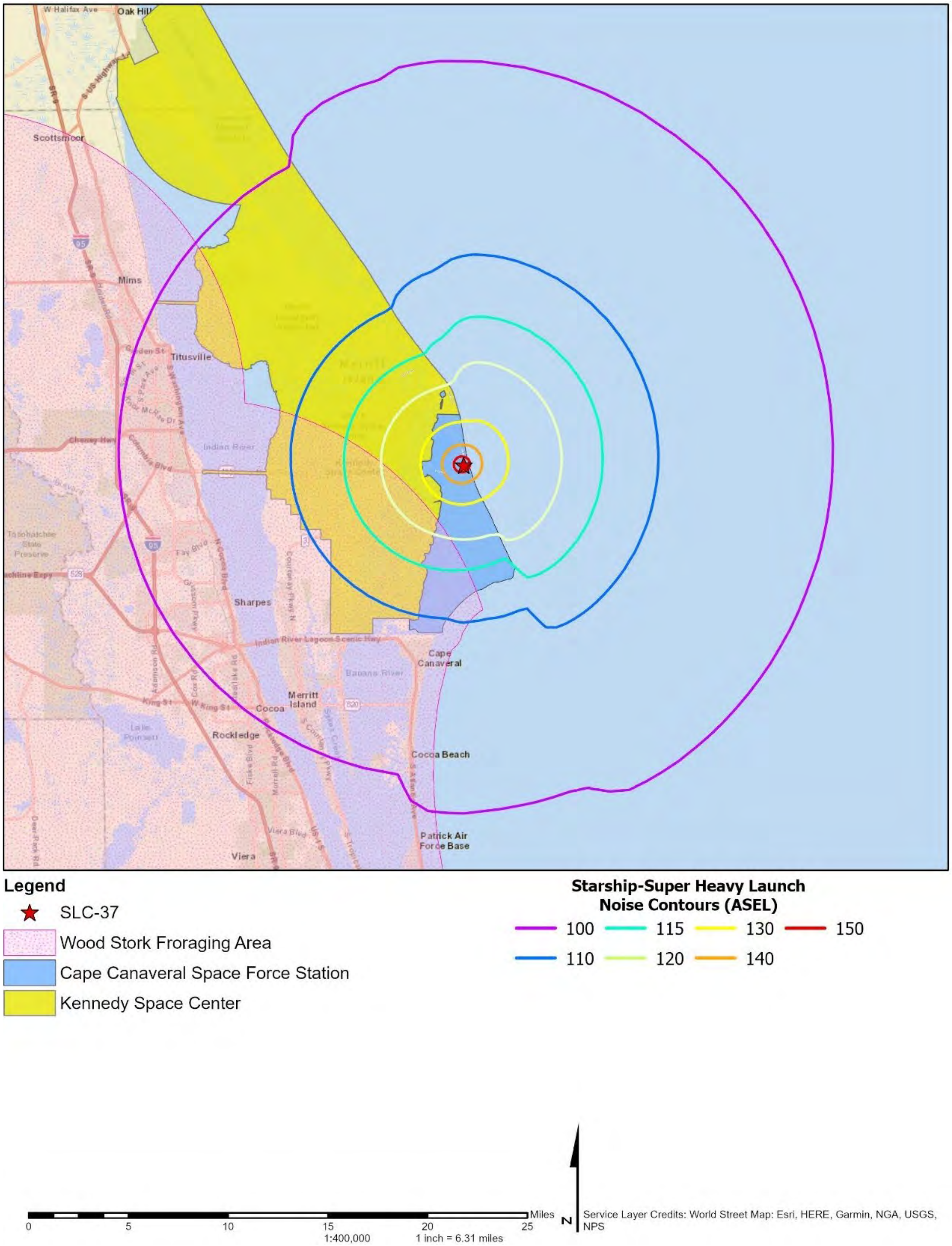

Figure 5-12. Wood Stork Foraging Habitat Relative to Launch Noise Contours (ASEL)

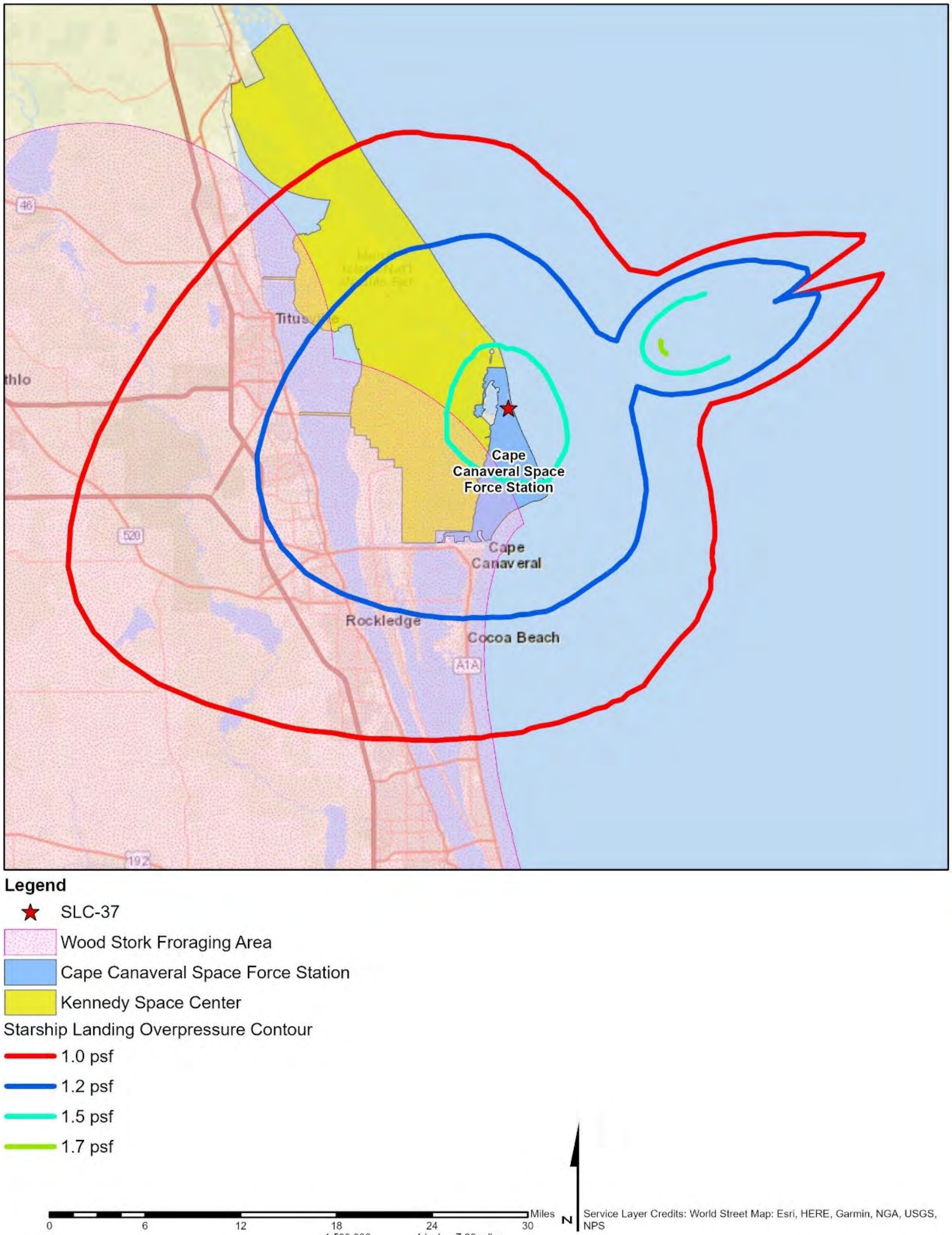

Figure 5-13. Wood Stork Foraging Habitat Relative to Starship Landing Overpressure Contours (psf)

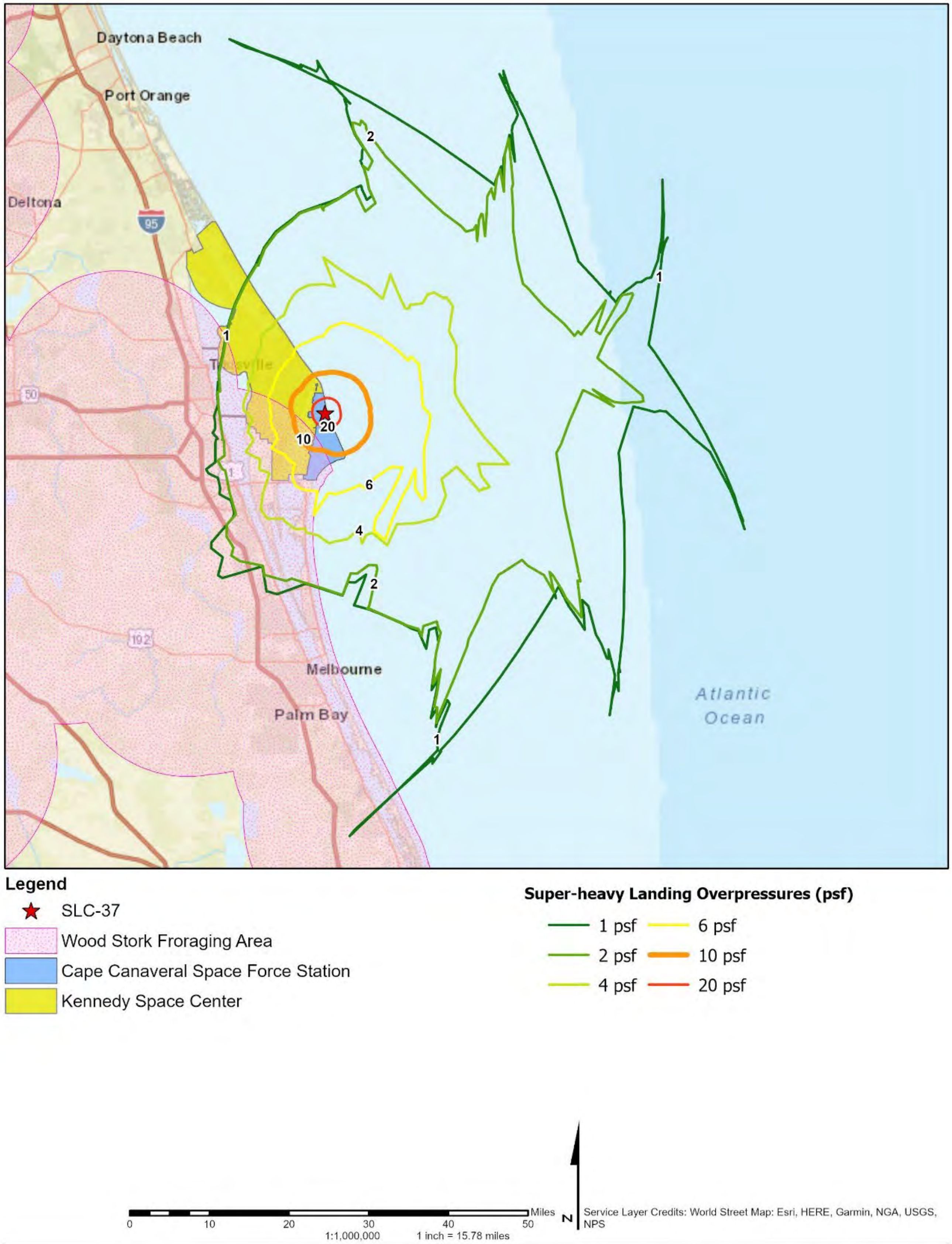

Figure 5-14. Wood Stork Foraging Habitat Relative to Super Heavy Landing Overpressure Contours (psf)

5.2.13 Eastern Indigo Snake

Conservation Measures: Implementation of **GC1** will limit construction vehicles to designated areas, thus reducing impacts on Eastern indigo snake habitat. Implementation of **GC3** will reduce the potential for petrochemicals leaking from heavy equipment to impact Eastern indigo snake habitat. Implementation of **GC4** will reduce the likelihood of mortality for vehicle strikes within the construction area by reducing speed limits. **EIS1** would require the implementation of the SLD 45 *Indigo Snake Protection/Education Plan* (USAF 2023a) for construction personnel. The plan will reduce incidental mortality by educating personnel on awareness to the potential presence of the species. **EIS2** would reduce the disturbance of gopher tortoise burrows that the eastern indigo snake uses for refugia by requiring surveys and flagging of burrows before land-disturbing construction activities. Burrows deemed clear of commensal organisms such as snakes would collapse so they could not be reoccupied.

Vegetation Clearing: The eastern indigo snake is a commensal species with the gopher tortoise. Gopher tortoise burrows occur throughout the action area within upland habitats, so there is the potential for use of burrows by eastern indigo snakes. The eastern indigo snake has not been documented using gopher tortoise burrows on CCSFS, based on scoping and excavation of more than 1,000 burrows. The most recent sighting of an eastern indigo snake was in 2018 from a vehicle strike on NASA property just north of the CCSFS property line (USAF 2023a). The construction area contains approximately 0.8 acre of suitable habitat (shrub and brushland) for eastern indigo snakes. Within the roadway improvement construction areas, 12.6 acres of suitable habitat (herbaceous dry prairie [roadway ROW]) exists that would be permanently removed. However, this habitat is considered low quality for the species because of periodic mowing and frequent vehicle presence. Because the species has been infrequently observed within the action area but is known to occur, and because of their slow movements and limited ability to flee from heavy machinery, vegetation clearing is like to expose eastern indigo snakes to harm and mortality and thus would have a negative effect.

Heat and Vapor Plume: Effects from heat that would be generated during launches, static-fire tests, and landings will be entirely contained within the SLC-37 fence line using a bifurcated diverter and water deluge system such that habitats outside of SLC-37 will not be exposed to elevated heat. The bifurcated diverter will direct heat upward, away from ground level such that any ground-dwelling animals would not be exposed if present. SLC-37 will have been cleared of suitable eastern indigo snake habitat during construction, decreasing the likelihood of the species being present and in proximity to the heat plume. The vapor plume is made up of water vapor that dissipates rapidly and poses no threat to wildlife. Because of the use of the bifurcated diverter and containment of heat within the SLC-37 fence line, the effects of exposure of eastern indigo snake to the heat plume are expected to be insignificant.

Noise and Vibration: Snakes can detect both noise through the air and vibrations through the ground. Exposure to elevated noise above the 110-dB ASEL and greater contours may startle eastern indigo snakes, causing them to temporarily suspend foraging and seek refuge. Approximately 23,490 acres of suitable habitat would be exposed to elevated noise above the 110-dB ASEL contour. The habitats included mapped areas of xeric oak, hardwood/coniferous mixed, shrub and brushland, and herbaceous dry prairie. At a density of 1 male per 369 acres, there would be an estimated 64 male eastern indigo snakes exposed to elevated noise. For females, at a density of 1 per 121 acres, an estimated 194 female eastern indigo snakes would be exposed. The effects of elevated noise and vibration would likely startle eastern indigo snakes in these habitats and potentially induce stress to the organism. Because of the likelihood of harassment through behavioral responses, the exposure to increase noise and vibration would be considered a negative effect on the species.

Sonic Booms: Snakes are not sensitive to sound pressure; they detect vibrations from the air through their skull (Knight 2012). Overpressures would not be detected by eastern indigo snakes; thus, there would be no effect from sonic booms on the species.

Artificial Light: Light from construction and operations would not be expected to interfere with eastern indigo snake foraging as the species forages only during the day when light would not have an increased effect above ambient conditions. The effect of increased artificial light on eastern indigo snakes would be considered discountable.

Strikes and Collisions: Vehicular traffic from construction and operations would not be expected to increase the likelihood of a vehicle strike on eastern indigo snakes. Snakes are particularly vulnerable to vehicle strikes as they are known to use roadways as a heat source and are unable to evade approaching vehicles. However, no eastern indigo snake vehicle strikes have previously been reported on CCSFS and only one has been reported on KSC, suggesting the event is unlikely to occur. Vehicular traffic would continue to have an insignificant effect on eastern indigo snakes.

5.2.14 Sea Turtles

Conservation Measures: Implementation of **GO4, ST1,** and **ST2** would require facilities and infrastructure at SLC-37 to be designed such that lighting impacts on nesting turtles and hatchlings will be minimized. An LMP will be developed. **ST3** and **ST4** include the development of a SWPPP for mitigating stormwater treatment and soil erosion controls to prevent potential pollution discharges to water. Implementation of **ST5** will minimize interference to sea turtle nesting monitoring to the extent possible from May 1 to October 31.

Vegetation Clearing: There is no sea turtle habitat within the SLC-37 construction area or roadway widening areas; thus, there will be no effect on nesting sea turtles or hatchlings from vegetation clearing (Figure 5-15).

Heat and Vapor Plume: Effects from heat that would be generated during launches, static-fire tests, and landings will be entirely contained within the SLC-37 fence line using a bifurcated diverter and water deluge system such that habitats outside of SLC-37, such as nesting beaches used by sea turtles, will not be exposed to elevated heat. The bifurcated diverter will direct heat upward, away from ground level such that any ground-dwelling animals would not be exposed. There will be no effect from the heat and vapor plume on nesting sea turtles or hatchlings.

Noise and Vibration: Noise from construction is unlikely to affect sea turtles because the construction area is about 250 feet from nesting beaches, with intervening vegetation to further reduce the noise. Approximately 344 acres of beach habitat where sea turtles may nest is within the 110-dB ASEL and greater noise area component of the action area generated by Starship-Super Heavy launch (Table 5-7 and Figure 5-16). Noise from launch events, static tests, and landings may startle sea turtles, resulting in false crawls. However, adults would be expected to return to searching for nesting habitat postexposure. Approximately 190 noise events (38 Starship-Super Heavy launch, 38 Starship static-fire tests, 38 Super Heavy booster static-fire tests, 38 Super Heavy Booster landings, and 38 Starship landings) may occur during nesting season (May to October [6 months]), with approximately 57 noise events (19 Starship-Super Heavy launch, 19 Super Heavy Booster landings, and 19 Starship landings) occurring at night. Exposure to elevated noise is expected to have an insignificant effect on nesting sea turtles as events will be of short duration and infrequent.

Vibrations caused by moving maintenance vehicles and/or equipment, launches, and static fire near the beach could frighten nesting turtles, causing them to false crawl (NMFS and Service 1991a, 1991b, 1992). Scientific literature regarding the effects of vibrations on incubating eggs and pre-emergent hatchlings is lacking, making an assessment difficult.

Figure 5-15. Sea Turtle Habitat Near Construction Area

Table 5-7. Sea Turtle Nesting Habitat (acres) Noise Exposure Within the Action Area

Noise Scenario	100 to 110 dB ASEL	110 to 115 dB ASEL	115 to 120 dB ASEL	120 to 130 dB ASEL	130 to 140 dB ASEL	140 to 150 dB ASEL	>150 dB ASEL	Total 110 to >150 dB ASEL
Starship-Super Heavy Launch	513	169	62	61	28	18	7	344
Starship Static-Fire Tests	46	13	9	11	8	8	0	49
Super Heavy Static-Fire Tests	73	18	14	15	9	10	2	69
Super Heavy Landing[a]	188	48	24	26	21	10	0	129
Starship Landing	49	13	11	18	7	0	0	49

[a] 40°, 115°, and nominal heading merged for combined contour.

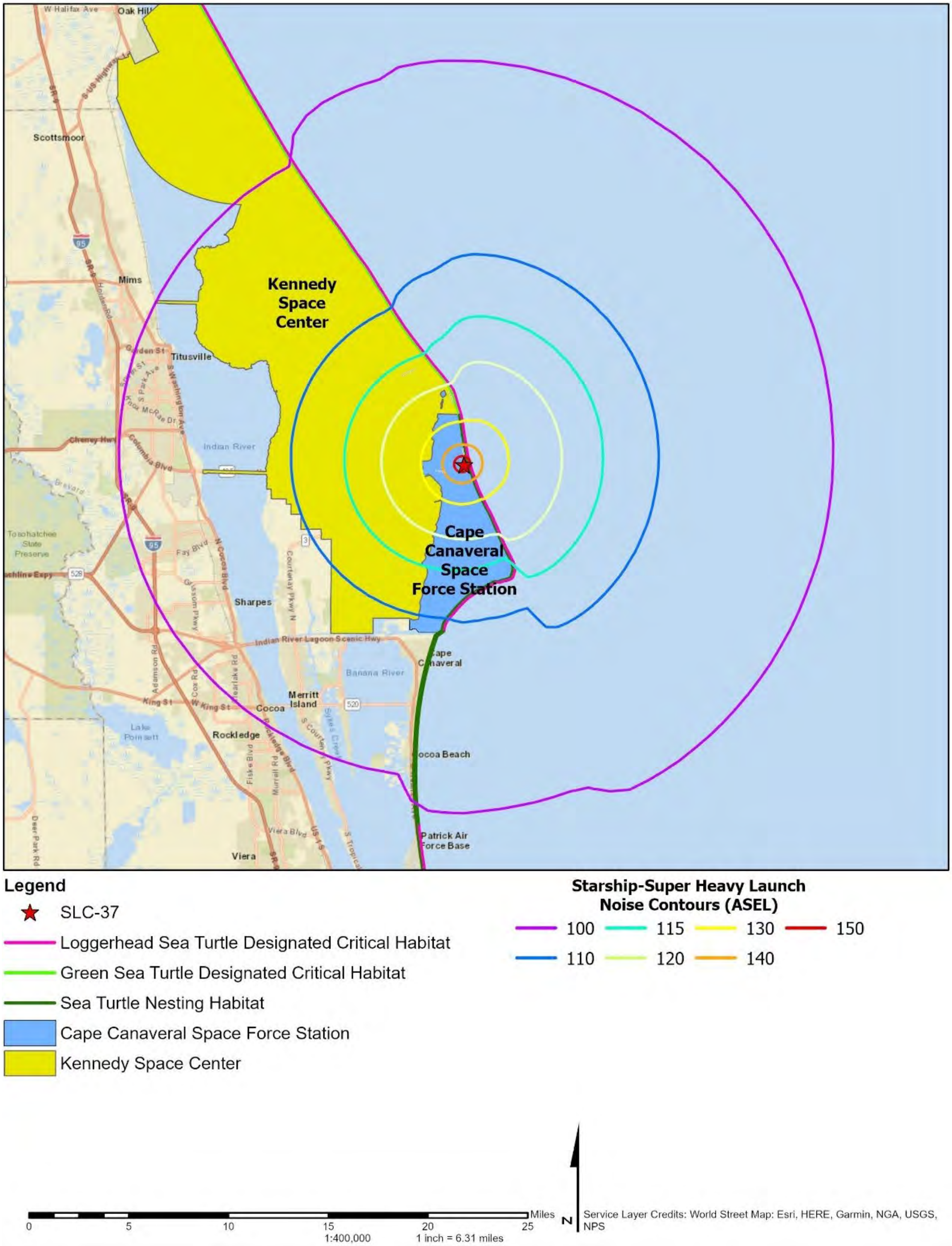

Figure 5-16. Sea Turtle Habitat Relative to Starship-Super Heavy Launch Noise Contours (ASEL)

Sonic Booms: Sonic booms created during launches would occur many miles offshore and have no effect on nesting sea turtles or hatchlings. Sonic booms created during Starship landings may startle nesting sea turtles within the 1-psf and greater overpressure contours. An estimated 96 acres (Figure 5-17) and 983 acres (Figure 5-18) of nesting habitat would be exposed during Starship landing and Super Heavy landing, respectively (Table 5-8). Similar to noise, startling of sea turtles may result in false crawls by adults. However, the adults would be expected to resume the searching for nesting habitat postexposure. Approximately 78 sonic boom events (38 Super Heavy booster landings and 38 Starship landings) may occur during nesting season (May to October [6 months]). Approximately 38 sonic boom events are estimated to occur at night. Increased overpressure exposure would occur before or after noise exposure, so the initial startle response would likely come from the one that occurs first. For the purposes of this BCA, the larger number of exposures (noise) was assumed to represent the total noise and sonic boom potential exposure to sea turtles.

Table 5-8. Sea Turtle Nesting Habitat (acres) Overpressure Exposure Within the Action Area

Noise Scenario	1 to 1.2 psf	1.2 to 1.5 psf	1.5 to 2.0 psf	2.0 to 4.0 psf	4.0 to 6.0 psf	6.0 to 10.0 psf	10.0 to 20.0 psf	>20.0 psf	Total
Super Heavy Landing	7	7	7	266	278	275	111	47	983
Starship Landing	346	488	127	0	0	0	0	0	961

Notes:

Modeled overpressure contours are reported in different intervals for different scenarios.

Starship-Super Heavy launch sonic booms occur over ocean habitats and are not included in this table.

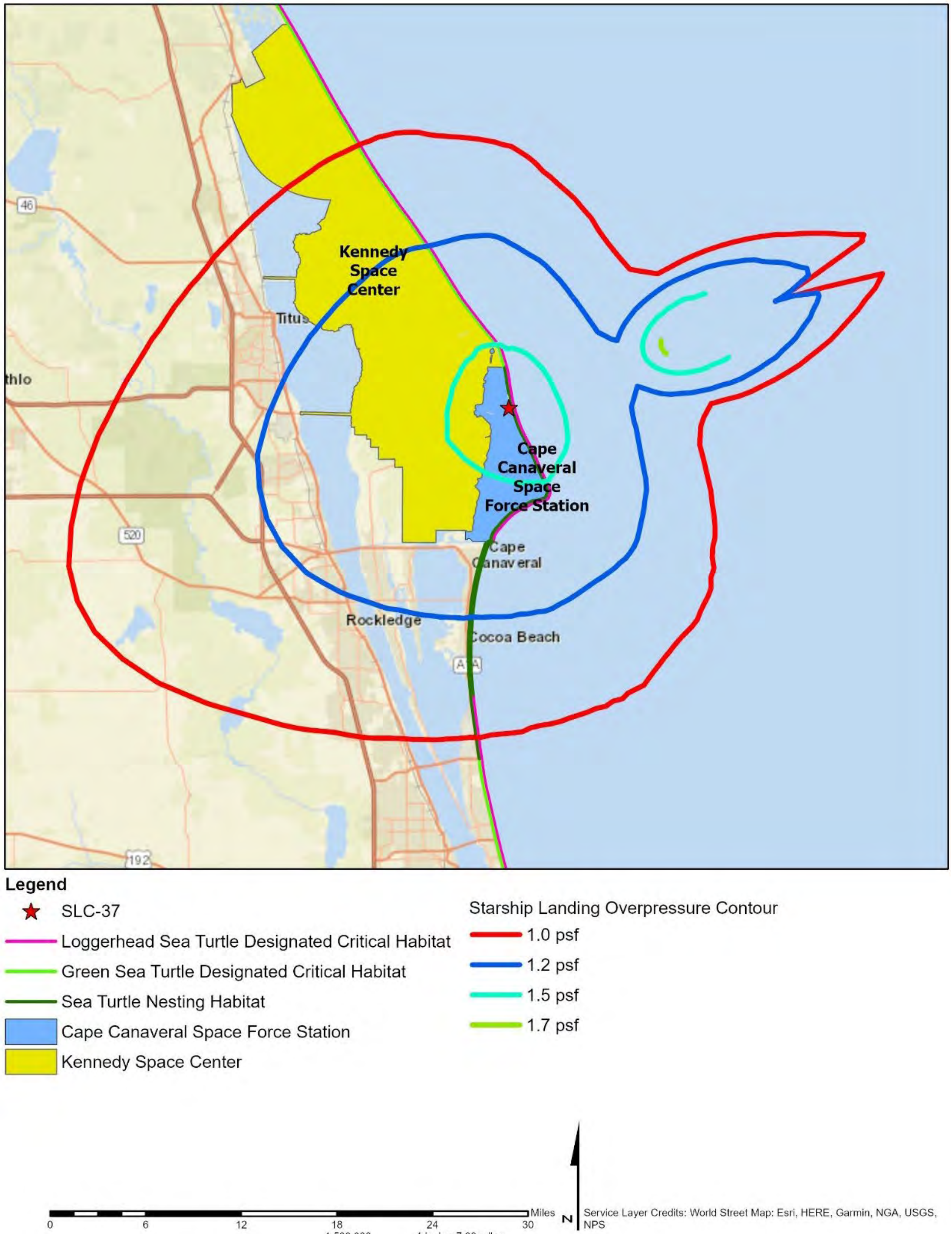

Figure 5-17. Sea Turtle Habitat Relative to Starship Landing Overpressure Contours (psf)

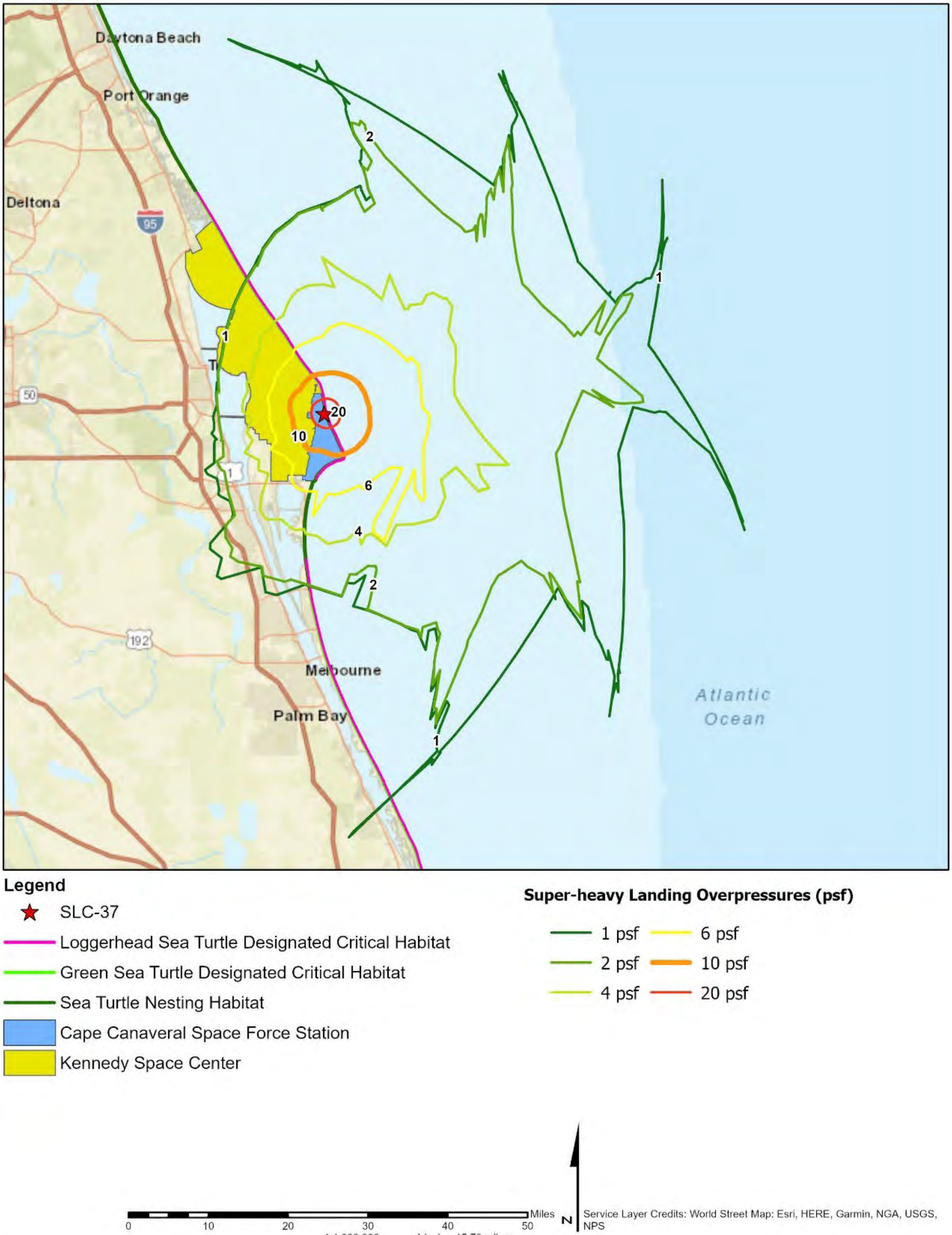

Figure 5-18. Sea Turtle Habitat Relative to Super Heavy Landing Overpressure Contours (psf)

Artificial Lighting: Artificial lighting reaching nesting beaches has a negative impact on adult and hatchling sea turtles. Artificial light can disorient hatchling sea turtles and potentially increase predation. Adult female turtles may be dissuaded from completing nesting due to artificial lights. Lighting from construction activities, if taking place during the night, could interfere with nesting sea turtles and hatchlings. However, construction activities are expected to be scheduled for daytime hours for the majority of the construction phase. Artificial light from towers associated with nighttime launch and land activities are likely to have the greatest effect on nesting sea turtles and hatchlings. SLD 45 has documented disorientations of nesting sea turtles beyond the immediate sources (launch facilities) of artificial light at launch facilities (Chambers, pers. comm. 2025). Thus, nesting beach habitat would be exposed to artificial light from approximately 57 nighttime launches/landings during the 6-month nesting season (May to October). Exposure to artificial light during nighttime operations would have a negative effect on nesting sea turtles and hatchlings within the lighted footprint.

Strikes and Collisions: Vehicular traffic from construction and operations would have no effect on sea turtles as the turtles would not be present within proximity to traffic.

5.2.15 Monarch Butterfly

Vegetation Clearing: No monarch butterfly foraging habitat occurs within the SLC-37 construction area as the area consists of mostly developed land uses and grassy areas that are regularly mowed and maintained. No milkweed host plants are expected in the SLC-37 construction area. The roadway improvement construction areas would permanently remove 12.6 acres of foraging habitat, reducing flowering plants and the quality of the habitat that monarch butterflies may use for foraging. However, foraging habitats along Phillips Parkway are considered lower in quality because of periodic mowing, not allowing flowering plants to provide a consistent nectar source. Within the fallow ROW of Old A1A, moderate quality of monarch butterfly foraging habitat may exist. These habitats would be replaced by new ROW of similar quality postconstruction. Because there would be no net loss of foraging habitat or change in quality, the effects from vegetation clearing would have an insignificant negative effect on the monarch butterfly.

Heat and Vapor Plume: Monarch butterflies would not be expected to be present in SLC-37 during launch and landing activities due to the lack of suitable habitat. If a transitory individual was within SLC-37, it could be exposed to increased heat, causing mortality. Exposure to heat and water vapor would have an insignificant effect on monarch butterflies due their likely lack of presence.

Noise and Vibration: The effect of noise on adult monarch butterflies from operational events is generally unknown as their ability to detect sound is lacking in the literature. Monarch caterpillars have shown behavioral responses to sound by contacting or freezing their motion, as they may interpret vibrations in the air through sensory hairs. The caterpillars' behavioral responses lasted between 1 and 60 seconds until returning to previous activities. No links to fitness or physiological changes have been established. (Taylor and Yack 2019). Monarch caterpillars would only be present on host milkweed plants present in the action area. Host milkweed plants may be present in action area habitats, such as pastures, open woods, sandhills, scrubland, wet prairies, and swamp edges. However, because the startle response in larval monarchs was short in duration, noise is expected to have an insignificant effect on the species.

Sonic Booms: Migrating monarch butterflies have been observed to exhibit behavioral changes, such as ceasing flight ahead of storms, indicating they may respond to changes in barometric pressure (Reppert et al. 2010). However, the exposure to increased overpressure from operational events would be short in duration compared with a storm event, and monarchs would be expected to return to flight shortly after the exposure. Because monarchs would be expected to only temporarily respond to overpressures, the effects are considered insignificant.

Artificial Light: Monarch butterflies are not active at night when increased artificial light would affect habitats adjacent to SLC-37; thus, there would be no effect on the species.

Strikes and Collisions: Vehicular traffic from construction and operations would not be expected to increase the potential for monarch butterflies to be struck by vehicles. Further, ROWs along roadways are routinely maintained by mowing reducing the density of flowing plants adult monarchs use as food sources. Because of the relative number of roads on CCSFS that traffic from the Proposed Action would use during construction and operation compared with natural habitats the monarch would use, the effect from vehicle strikes is considered insignificant.

5.3 Cumulative Effects on Species

Cumulative effects are defined under 50 CFR 402.02 as “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.”

Large portions of the action area are under the jurisdiction, management, and/or ownership of the federal government, such as CCSFS (the DAF), KSC (NASA/FAA), and CANA and MINWR (the National Park Service). All activities, such as this Proposed Action, occurring on those properties are regulated by federal action and, thus, are not subject to inclusion as a cumulative effect on these ESA-listed species. Outside of these properties, the action area includes the urban areas of coastal Central Florida, including Titusville, Cocoa, Cape Canaveral, Cocoa Beach, and smaller communities, primarily concentrated along the Interstate 95 corridor. Continued urban development terrestrial habitats would induce cumulative effects on ESA-listed species evaluated in this BCA. The western end of the action area is primarily rural lands dominated by livestock farming (cattle) and conservations areas associated with wetlands and surface waters of the St. Johns River. Most wetlands and surface waters within the action area are likely under the jurisdiction of federal government through regulation under the Clean Water Act and, thus, would require a federal action for any type of development or disturbance.

For species using terrestrial habitats, the predominant effect within the action area is habitat loss from development. Development of terrestrial habitats not only removes habitat used for foraging, shelter/refugia, and nesting, but it fragments the landscape removing species access to other suitable habitat areas. Population estimates for Brevard County in 2025 are 643,112 with future estimates of 671,329 (2030) and 733,563 (2045) (Office of Economic and Demographic Research 2025) and annual growth rates averaging approximately 1.5 to 2.0% (USAFACTS 2025). Growing populations bring increased development, anthropogenic noise, light, and human disturbance. Roadway infrastructure to connect developments will service increased traffic and, thus, increase effects of traffic on wildlife.

Most listed species in habitats experiencing increased development from population growth will be further limited to small and disconnected geographic areas. For endemic species like the Florida scrub-jay, a 2060 statewide assessment projects their habitat being reduced by 64 square miles (FWC 2008), reducing suitable habitat for foraging and nesting. Loss of habitat within the action areas would remove foraging-habitat species like the crested caracara and monarch butterfly. Land clearing (for example, tree clearing) would reduce roosting habitat for tricolored bats. Increased exposure to human disturbance will lead to mortality from land clearing for species like eastern indigo snakes and will increase vehicle strikes on eastern indigo snakes and Florida scrub-jays.

Listed plant species would be vulnerable to continued development of private property if that action of the development does not have some form of a federal nexus. Thus, any occurrences of these plant species on private property are likely susceptible to disturbance or mortality.

The majority of the action area is under some form of federal management, except for southern portions—from Port Canaveral down to Patrick Air Force Base—which affects species using beach and shoreline habitats. These coastal areas are highly developed and are at or near maximum development opportunities and population densities. Stressors in these areas on listed species would be expected to continue but not increase, including anthropogenic noise, artificial light, and human disturbance as people use the beach habitats for recreation. These would continue to have negative effects on sea turtles, piping plovers, and rufa red knots.

The southeastern beach mouse habitat range within the action area is solely contained within federally managed lands and would not be subject to cumulative effects through state or private actions.

For pelagic bird species using the landing zones in the Atlantic Ocean and expendable landing areas in the Pacific and Indian Oceans, cumulative effects would not be appreciable in foraging habitats of the open ocean. Effects on the species in areas where they nest are likely to include development pressures.

5.4 Effects on Critical Habitat

5.4.1 West Indian Manatee

PBFs established for final and proposed West Indian manatee critical habitat are related to the thermal quality of the habitat's ability to support the species and the presence of submerged, emergent, and floating aquatic plant species that manatees forage on. Stressors from the Proposed Action, such as noise and vibration, sonic booms, artificial light, and strikes and collisions, would not alter or modify the thermal quality of the habitat or presence of aquatic plants.

Conservation Measures: Implementation of **WIM1**, which provides for compliance with the SWPPP (USAF 2019), would require stormwater treatment and prevention of soil erosion from construction activities and would reduce effects on the aquatic environment from the reduction in potential pollution discharges.

Vegetation Clearing: Construction would occur approximately 250 feet from final critical habitat of the West Indian manatee in the Atlantic Ocean and approximately 2,000 feet from final and proposed critical habitat in the Banana River (Figure 3-1). Site-specific stormwater management during construction would prevent sedimentation from being transported from temporarily disturbed construction areas into critical habitat and changing the presence or abundance of aquatic vegetation communities. No disturbance or modification of designated critical habitat of the West Indian manatee would result from vegetation clearing in construction areas.

Heat and Vapor Plume: The heat plume will be entirely contained within SLC-37 by use of a bifurcated diverter and water deluge. The water vapor created from the water deluge may extend beyond SLC-37 but would quickly dissipate and would have no effect on the surrounding aquatic environments.

5.4.2 Loggerhead Sea Turtle

PBFs and PCEs established for final loggerhead sea turtle critical habitat focus on nesting habitat in the supralittoral zone that supports natural coastal dynamics (for example, erosion and accretion of sand); has unimpeded access from the nest to the sea; has sand that is appropriate for nest building, embryo developing, and hatching; and has areas of sufficient darkness for post-nesting females and hatchlings to properly orient to the sea. Stressors from vegetation clearing, heat and vapor plume, noise and vibration, sonic booms, and strikes and collisions would alter or modify the PBFs or PCEs for the loggerhead sea turtle's final critical habitat.

Conservation Measures: Implementation of **GO4, ST1,** and **ST2** would require facilities and infrastructure at SLC-37 to be designed such that lighting impacts on nesting turtles and hatchlings will be minimized. An LMP will be developed. **ST3** and **ST4** include the development of a SWPPP for mitigating stormwater treatment and soil erosion controls to prevent potential pollution discharges to water. Implementation of **ST5** will minimize interference to sea turtle nesting monitoring to the extent possible from May 1 to October 31.

Artificial Lighting: Construction activities would generally take place during daytime hours and would not require the use of lights that may reduce sufficient darkness for nesting turtles and hatchlings (**PCE3**). If nighttime constructions activities do take place, then lighting would contribute to skyglow and would be performed in accordance with the SpaceX-developed LMP. Nighttime launch operations require bright spotlighting to illuminate the launch vehicle at the launch site. Lighting is needed to ensure the safety of SpaceX personnel and protect the hardware. This lighting would decrease the darkness on the nesting beaches adjacent to SLC-37 and may cause disorientation and deter turtles from the beach during nesting periods. Artificial light from towers associated with nighttime launch and land activities are likely to have the greatest effect on nesting sea turtles and hatchlings. SLD 45 has documented disorientations of nesting sea turtles beyond the immediate sources (launch facilities) of artificial light at launch facilities (Chambers, pers. comm. 2025). Thus, nesting beach habitat would be exposed to artificial light from approximately 57 nighttime launches/landings during the 6-month nesting season (May to October). Of this area, approximately 43.5 acres of nesting beach habitat occurs on CCSFS where critical habitat for loggerhead sea turtles is not designated. Exposure to artificial light during nighttime operations would likely have a negative effect on loggerhead sea turtle critical habitat that supports nesting sea turtles and hatchlings.

5.4.3 Green Sea Turtle

PBFs for proposed green sea turtle critical habitat focus on nesting habitat in the supralittoral zone that supports natural coastal dynamics (for example, erosion and accretion of sand); has unimpeded access from the nest to the sea; has sand that is appropriate for nest building, embryo developing, and hatching; and has areas of sufficient darkness for post-nesting females and hatchlings to properly orient to the sea. Stressors from vegetation clearing, heat and vapor plume, noise and vibration, sonic booms, and strikes and collisions would alter or modify PBFs for the green sea turtle's proposed critical habitat.

Conservation Measures: Implementation of **GO4, ST1,** and **ST2** would require facilities and infrastructure at SLC-37 to be designed such that lighting impacts on nesting turtles and hatchlings will be minimized. An LMP will be developed. **ST3** and **ST4** include the development of a SWPPP for mitigating stormwater treatment and soil erosion controls to prevent potential pollution discharges to water. Implementation of **ST5** will minimize interference to sea turtle nesting monitoring to the extent possible from May 1 to October 31.

Artificial Lighting: Construction activities would generally take place during daytime hours and would not require the use of lights that may reduce sufficient darkness for nesting turtles and hatchlings (**PBF2**). If nighttime constructions activities do take place, then lighting would contribute to skyglow and would be performed in accordance with SpaceX-developed LMP. Nighttime launch operations require bright spotlighting to illuminate the launch vehicle at the launch site. Lighting is needed to ensure the safety of SpaceX personnel and protect the hardware. This lighting would decrease the darkness on the nesting beaches adjacent to SLC-37 and may cause disorientation and deter turtles from the beach during nesting periods. Artificial light from towers associated with nighttime launch and land activities are likely to have the greatest effect on nesting sea turtles and hatchlings. SLD 45 has documented disorientations of nesting sea turtles beyond the immediate sources (launch facilities) of artificial light at launch facilities (Chambers, pers. comm. 2025). Thus, nesting beach habitat would be exposed to artificial light from approximately 57 nighttime launches/landings during the 6-month nesting season (May to October). Of this area, approximately 43.5 acres of nesting beach habitat occurs on CCSFS where critical habitat for green sea turtles is not proposed. Exposure to artificial light during nighttime operations would likely negatively affect the proposed critical habitat that would support nesting green sea turtles and hatchlings.

5.4.4 Rufa Red Knot

PBFs for proposed rufa red knot critical habitat focus on beaches and other coastal habitats that provide habitat for foraging, preening, resting, sheltering, and roosting. Stressors created by the Proposed Action that do not contain areas described in **PBF1-PBF7** and, thus, would have no effect on the features, include vegetation clearing, heat and vapor plume, and strikes and collisions. Other stressors likely reduce the suitability of proposed critical habitat for foraging, resting, sheltering, and roosting.

Noise and Vibration: Approximately 477 acres (>110 dB ASEL) of proposed rufa red knot critical habitat occurs within areas of elevated noise that are likely to lead to a startle response during the Starship-Super Heavy launches. The presence of noise at these levels reduces foraging, resting, sheltering, and roosting opportunities for rufa red knots within proposed critical habitat areas (**PBF1-PBF6**). Vibration effects on rufa red knots using habitats within the 110-dB ASEL contours and greater would occur concurrently with noise, and the effect would likely be indistinguishable. Episodes of elevated noise would occur up to 380 times per year but would be short in duration (up to 2 minutes), allowing the habitat to support the species most of the year and, thus, are considered to be insignificant.

Sonic Boom: Approximately 9,618 acres (>1 psf) of proposed rufa red knot critical habitat occurs within areas of elevated overpressures that are likely to lead to a startle response during Starship landings. The presence of elevated overpressures reduces foraging, resting, sheltering, and roosting opportunities for rufa red knots within proposed critical habitat areas (**PBF1-PBF6**). Episodes of elevated overpressures would occur up to 152 times per year but would be short in duration, allowing the habitat to support the species most of the year and, thus, be considered an insignificant effect.

Artificial Lighting: Lighting is needed to ensure the safety of SpaceX personnel and protect the hardware. This lighting would decrease the darkness on proposed rufa red knot critical habitat and reduce the ability of the habitat to allow resting (**PBF2**) and roosting (**PBF3-PBF6**) of the species. Artificial light from towers associated with nighttime launch and land activities are likely to have the greatest effect on resting and roosting as the lights would illuminate the beach habitat near SLC-37 during 57 nighttime events. Exposure to artificial light during nighttime operations would happen infrequently and, thus, be considered an insignificant effect.

5.5 Effects Determination for Listed Species and Designated Critical Habitat

The following sections describe the effects determination for listed species and designated critical habitat.

5.5.1 Southeastern Beach Mouse

Vegetation clearing from construction will remove suitable habitat for the southeastern beach mouse, but this habitat would be mitigated to a net-zero loss. There will be a temporary reduction in available habitat within the action area as mitigation activities are undertaken. Exposure to noise is likely to cause behavioral responses (startle) and physiological effects (TTS) above the 110-dB ASEL and 120-dB ASEL, respectively. Exposure to sonic boom overpressure is likely to startle the species. Crushing or entombment by construction vehicles may cause mortality to southeastern beach mice present in the construction areas.

SLD 45 has determined that the Proposed Action **may affect and is likely to adversely affect** the southeastern beach mouse. Construction impacts on southeastern beach mouse habitat would be mitigated at a 1:1 ratio. The USFWS is developing a mitigation fund to streamline conservation offsets for actions occurring at CCSFS, including impacts on southeastern beach mouse habitat. The fund will help to facilitate both on- and offsite mitigation for the species.

5.5.2 Tricolored Bat

The evaluated stressors generally had insignificant effects on the species. Conservation measures will reduce the possibility of the species roosting at SLC-37. SpaceX would also avoid tree clearing during tricolored bat maternity season (May–July) and when ambient daytime temperatures are 45°F or below. The potential of directly affecting a tricolored bat during operations is low as the species would likely vacate effected areas before operations due to increased human activity, and the noise frequencies from launches would be lower than the bat can hear. SLD 45 has determined that the Proposed Action **would not jeopardize** the tricolored bat**.**

5.5.3 West Indian Manatee

The evaluated stressors generally had insignificant effects on the species. Conservation measures will prevent stormwater pollution entering the waterways and maintain boating requirements for slow and idle speeds, reducing exposure to vessel strikes. Increased noise and overpressures would have discountable effects on manatees in aquatic habitats as airborne sounds transmit only a small amount of energy to water (Peng and Zang 2016). Elevated heat would not leave SLC-37. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the West Indian manatee.

5.5.4 Crested Caracara

The crested caracara is infrequently observed on CCSFS, KSC, CANA, and MINWR and has not been observed nesting at these sites. No other documented observations of the species are available for the remainder of the action area. Given the infrequent presence of the crested caracara in the action area, it is unlikely it would be present during construction or operations and exposed to stressors; therefore, SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the crested caracara.

5.5.5 Atlantic Sea Birds

The Bermuda petrel, black-capped petrel and roseate tern are pelagic sea birds that forage in the Atlantic Ocean action area. Exposure to noise and overpressure during barge platform landings would be unlikely due to the low density of the species over the open ocean. Strikes or collisions with debris from expendable launches would be considered discountable. Because these species do not occur in the vicinity of the SLC-37 action area and are sparsely present in the Atlantic Ocean, SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the Bermuda petrel, black-capped petrel and roseate tern.

5.5.6 Pacific Sea Birds

The band-rumped storm petrel, Hawaiian petrel, Newell's sheerwater, and short-tailed albatross are pelagic sea birds found throughout the Pacific Ocean. Because of the range of these species, they would not be affected by stressors from the Proposed Action at SLC-37 or Atlantic Ocean action areas. Strikes or collisions with debris from expendable launches in the Pacific Ocean would be considered unlikely due to the size of the potential area, the unlikelihood of expendable launch, and the densities of the species. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the band-rumped storm petrel, Hawaiian petrel, Newell's sheerwater, and short-tailed albatross.

5.5.7 Eastern Black Rail

The eastern black rail has not been observed on CCSFS and has only been observed several times recently at KSC and MINWR, making its occurrence rare in the action area around SLC-37. Because it rarely occurs within the action area, exposure to stressors from the Proposed Action was generally deemed discountable. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the eastern black rail.

5.5.8 Everglade Snail Kite

The Everglade snail kite is primarily found in Central and South Florida. Because the species is rarely observed in the action area, the effects the stressors generated from the Proposed Action within the action area were deemed to have discountable effects on the species. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the Everglade snail kite.

5.5.9 Florida Scrub-Jay

Habitats supporting Florida scrub-jay would be removed from construction and roadway widening but would be mitigated, resulting in only temporary losses in available habitat. Given the high concentration and frequent observation of Florida scrub-jays in the action area, exposure of these populations to noise and overpressures could have a behavioral effect on the species from startling. This may interfere with foraging and egg incubation, and may increase stress, leading to overall reductions in fitness to birds and the local population. SLD 45 has determined that that the Proposed Action **may affect and is likely to adversely affect** the Florida scrub-jay.

5.5.10 Piping Plover

The piping plover has not been observed at CCSFS but has been infrequently observed at KSC. Because of only infrequent observations of this migratory species within the action area, the stressors generated from the Proposed Action are generally discountable. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the piping plover.

5.5.11 Rufa Red Knot

The rufa red knot has been infrequently observed on the beaches of CCSFS and is uncommon in the action area. Because of only infrequent observations of this migratory species within the action area, the stressors generated from the Proposed Action are generally discountable. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the rufa red knot.

5.5.12 Wood Stork

There are no wood stork colonies present in the action area, but foraging habitat is present within portions of the action area, including CCSFS (2 miles west of SLC-37), MINWR, the Banana River, the Indian River, and the area to the east of the Indian River. Because of the distance from foraging habitat, construction activities are not likely to affect wood storks, but noise and overpressure from operations may temporarily disturb or displace wood storks by interrupting roosting and foraging for brief periods of time. Given the infrequent presence of the wood stork in the action area and the wide range of foraging habitat beyond elevated noise and overpressures, exposure to stressors generated by the Proposed Action are generally insignificant. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** the wood stork.

5.5.13 Eastern Indigo Snake

The eastern indigo snake is rarely observed within the action area but is considered likely to occur due to the presence of the gopher tortoise, a commensal species. Conservation measures will reduce impacts on the species by educating contractors and increasing wildlife crossing signage. Impact avoidance and excavation of gopher tortoise burrows will further reduce impacts on the species during construction. Regardless, the slow nature and generally cryptic habits of this ground-dwelling species, could cause crushing by construction equipment. SLD 45 has determined that the Proposed Action **may affect and is likely to adversely affect** the eastern indigo snake.

5.5.14 Sea Turtles

Sea turtles that are known to nest on beaches within the action area include loggerhead, green, leatherback, Kemp's ridley, and hawksbill. Noise from operational events may startle adult sea turtles preparing to nest and may result in false crawls. Nesting sea turtles and hatchlings would be exposed to increases in artificial light, particularly during operational events if occurring at night and during the nesting season, causing disorientation and a negative effect on the species. SpaceX would be required to develop an LMP to reduce lighting impacts on nesting sea turtles. Conservations measures would also ensure that there would be no water quality impacts from construction or operations, lighting would be inspected ahead of nesting season, and beach activities around monitoring and operations would be turtle friendly. However, because of the effects from lighting on the beach habitats, SLD 45 has determined that the Proposed Action **may affect and is likely to adversely affect** the loggerhead, green sea, leatherback, Kemp's ridley, or hawksbill sea turtles.

5.5.15 Monarch Butterfly

Monarch butterfly foraging habitat is scattered throughout the action area wherever milkweed species are found, which serve as the host plant for the species. Further flowering plants provide nectar for adult monarch butterflies throughout the action area. Construction activities would cause a loss of foraging habitat from roadway widening. Most of the stressors generated by the Proposed Action were determined to have an insignificant effect on the species as they are less susceptible to noise, overpressures, and light. Because of the potential for loss of mostly marginal foraging habitat, SLD 45 has determined that the Proposed Action **would not jeopardize** the monarch butterfly.

5.5.16 West Indian Manatee Final and Proposed Critical Habitat

The action area includes portions of existing critical habitat and proposed revisions to critical habitat for the manatee. No critical habitat is present within the construction area of SLC-37. During operations launch and static-fire plumes would occur, but the plume would be directed upwards by diverters. As such, no changes to water temperature are expected and no foraging areas would be affected. Boats and barges have the potential to impact manatee foraging areas, such as seagrass and water quality, but only minimal degradation may occur after implementing the conservation measures. SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect** manatee existing critical and proposed critical habitat.

5.5.17 Loggerhead Sea Turtle Final Critical Habitat

The Proposed Action will result in an increase in artificial lighting on loggerhead sea turtle final critical habitat from construction, daily operations, launch-related safety lighting, and light from the launches and landings are likely to adversely affect critical habitat, by affecting the PBF regarding a sufficiently dark beach for nesting. Measures included in the LPM will reduce the amount of artificial lighting that reaches the beach, but some degree of adverse effects to critical habitat will still occur. Therefore, SLD 45 has determined that the Proposed Action would **not destroy or adversely modify** loggerhead sea turtle final critical habitat.

Any potential impacts on in water loggerhead sea turtle critical habitat would be addressed during consultation with the NMFS.

5.5.18 Green Sea Turtle Proposed Critical Habitat

The Proposed Action will result in an increase in artificial lighting on green sea turtle proposed critical habitat from construction, daily operations, launch-related safety lighting, and light from the launches and landings are likely to adversely affect critical habitat by affecting the PBF regarding a sufficiently dark beach for nesting. Measures included in the LPM will reduce the amount of artificial lighting that reaches the beach, but some degree of adverse effects to critical habitat will still occur. Therefore, SLD 45 has determined that the Proposed Action **not destroy or adversely modify** proposed green sea turtle critical habitat.

Any potential impacts on the green sea turtle proposed critical habitat would be addressed during consultation with the NMFS.

5.5.19 Rufa Red Knot Proposed Critical Habitat

The Proposed Action will result in modification of the rufa red knot proposed critical habitat by increasing noise and artificial light onto foraging, resting, sheltering, and roosting habitat. However, because of the frequency of events, the habitat would still be considered supportive of the species; therefore, SLD 45 has determined that the Proposed Action **not destroy or adversely modify** rufa red knot proposed critical habitat.

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6. Conclusions

Effects resulting from the Proposed Action were evaluated for each of the listed species potentially present within the action area. Tables 6-1 and 6-2 provide a summary of the BCA for special status species with the potential to be affected by the Proposed Action.

SLD 45 has determined that the Proposed Action **may affect but is not likely to adversely affect the** West Indian manatee, crested caracara, Atlantic sea birds, Pacific sea birds, eastern black rail, Everglade snail kite, piping plover, rufa red knot, and wood stork (Table 6-1). The Proposed Action **may affect and is likely to adversely affect** the southeastern beach mouse, Florida scrub-jay, eastern indigo snake, and the green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles. Clearing habitats, direct mortality from construction activities, and lighting are the primary impacts causing effects on these species. SLD 45 has determined that the Proposed Project will **not destroy or adversely modify** designated critical habitat for the northwest Atlantic DPS of loggerhead sea turtle, the Florida stock of the West Indian manatee, and the rufa red knot (Table 6-2).

Table 6-1. ESA Listed and Proposed Species Effects Determination Summary

Species	Common Name (Latin Name)	Federal Status	Determination
Mammals	Southeastern beach mouse (*Peromyscus polionotus niveiventris*)	Threatened	May Affect, Likely to Adversely Affect
Mammals	Tricolored bat (*Perimyotis subflavus)*	Proposed Endangered	Will Not Jeopardize
Mammals	West Indian manatee (*Trichechus manatus latirostris)*	Threatened	May Affect, Not Likely to Adversely Affect
Birds	Band-rumped storm-petrel (Oceanodroma castro)	Endangered	May Affect, Not Likely to Adversely Affect
Birds	Bermuda petrel (*Pterodroma cahow*)	Endangered	May Affect, Not Likely to Adversely Affect
Birds	Black-capped petrel (*Pterodroma hasitata*)	Endangered	May Affect, Not Likely to Adversely Affect
Birds	Crested caracara (*Caracara plancus audubonii)*	Threatened	May Affect, Not Likely to Adversely Affect
Birds	Eastern black rail (*Laterallus jamaicensis jamaicensis)*	Threatened	May Affect, Not Likely to Adversely Affect
Birds	Everglade snail kite (*Rostrhamus sociabilis plumbeus)*	Endangered	May Affect, Not Likely to Adversely Affect
Birds	Florida scrub-jay (*Aphelocoma coerulescens)*	Threatened	May Affect, Likely to Adversely Affect
Birds	Hawaiian petrel (Pterodroma sandwichensis)	Endangered	May Affect, Not Likely to Adversely Affect
Birds	Newell's shearwater (*Puffinus newelli)*	Threatened	May Affect, Not Likely to Adversely Affect
Birds	Piping plover (*Charadrius melodus)*	Threatened	May Affect, Not Likely to Adversely Affect
Birds	Roseate tern (*Sterna dougallii dougallii*	Endangered	May Affect, Not Likely to Adversely Affect
Birds	Rufa red knot (*Calidris canutus rufa)*	Threatened	May Affect, Not Likely to Adversely Affect
Birds	Short-tailed albatross (*Phoebastria albatrus)*	Endangered	May Affect, Not Likely to Adversely Affect
Birds	Wood stork (*Mycteria americana)*	Threatened	May Affect, Not Likely to Adversely Affect

Species	Common Name (Latin Name)	Federal Status	Determination
Reptiles	Eastern indigo snake (*Drymarchon corais couperi)*	Threatened	May Affect, Likely to Adversely Affect
Reptiles	Green sea turtle (*Chelonia mydas)*	Threatened	May Affect, Likely to Adversely Affect
Reptiles	Hawksbill sea turtle (*Eretmochelys imbricata)*	Endangered	May Affect, Likely to Adversely Affect
Reptiles	Kemp's ridley sea turtle (*Lepidochelys kempii)*	Endangered	May Affect, Likely to Adversely Affect
Reptiles	Leatherback sea turtle (*Dermochelys coriacea)*	Endangered	May Affect, Likely to Adversely Affect
Reptiles	Loggerhead sea turtle (*Caretta caretta)*	Threatened	May Affect, Likely to Adversely Affect
Insects	Monarch butterfly (*Danaus Plexippus)*	Proposed	Will Not Jeopardize

Table 6-2. Final and Proposed Critical Habitat Effects Determination Summary

Common Name (Latin Name)	Federal Status	Determination
West Indian Manatee (*Trichechus manatus latirostris)*	Final and Proposed	Will Not Destroy or Adversely Modify
Loggerhead Sea Turtle (*Caretta caretta)*	Final	Will Not Destroy or Adversely Modify
Green Sea Turtle (*Chelonia mydas*)	Proposed	Will Not Destroy or Adversely Modify
Rufa Red Knot (*Calidris canutus rufa)*	Proposed	Will Not Destroy or Adversely Modify

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Appendix A
USFWS Species List

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IPaC resource list

Please note that the Federal Highways Programmatic Consultation for Transportation Projects affecting NLEB or Indiana Bat Determination Key is temporarily offline for updates and will be available soon. We apologize for any inconvenience this may cause.

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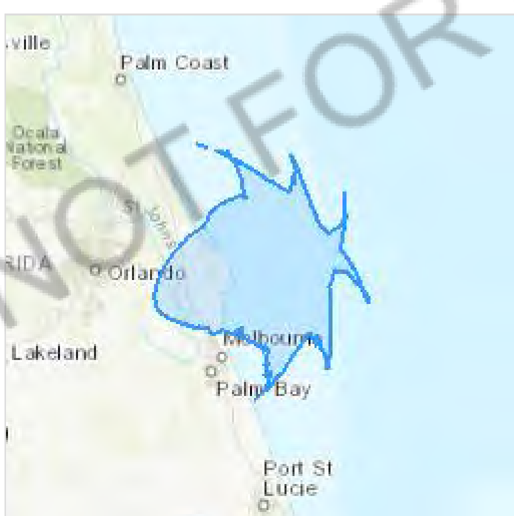
that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Florida



Local office

Florida Ecological Services Field Office

(352) 448-9151
(772) 562-4288
fw4flesregs@fws.gov

777 37th St
Suite D-101
Vero Beach, FL 32960-3559

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Florida Panther Puma (=Felis) concolor coryi Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1763	Endangered
Puma (=mountain Lion) Puma (=Felis) concolor (all subsp. except coryi) No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6049	SAT
Southeastern Beach Mouse Peromyscus polionotus niveiventris Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/3951	Threatened
Tricolored Bat Perimyotis subflavus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10515	Proposed Endangered
West Indian Manatee Trichechus manatus Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/4469	Threatened Marine mammal

Birds

NAME	STATUS
Black-capped Petrel Pterodroma hasitata Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4748	Endangered

Crested Caracara (audubon""s) [fl Dps] Caracara plancus audubonii — Threatened

No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/8250

Eastern Black Rail Laterallus jamaicensis ssp. jamaicensis — Threatened
Wherever found

No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/10477

Everglade Snail Kite Rostrhamus sociabilis plumbeus — Endangered
Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/7713

Florida Scrub-jay Aphelocoma coerulescens — Threatened
Wherever found

No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/6174

Piping Plover Charadrius melodus — Threatened

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/6039

Red-cockaded Woodpecker Dryobates borealis — Threatened
Wherever found

No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/7614

Rufa Red Knot Calidris canutus rufa — Threatened
Wherever found

There is **proposed** critical habitat for this species. Your location overlaps the critical habitat.
https://ecos.fws.gov/ecp/species/1864

Whooping Crane Grus americana — EXPN

No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/758

Wood Stork Mycteria americana | Threatened
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/8477

Reptiles

NAME	STATUS
American Alligator Alligator mississippiensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/776	SAT
American Crocodile Crocodylus acutus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/6604	Threatened
Atlantic Salt Marsh Snake Nerodia clarkii taeniata Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7729	Threatened
Eastern Indigo Snake Drymarchon couperi Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/646	Threatened
Green Sea Turtle Chelonia mydas There is **proposed** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/6199	Threatened
Hawksbill Sea Turtle Eretmochelys imbricata Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3656	Endangered

Leatherback Sea Turtle Dermochelys coriacea | Endangered

Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/1493

Loggerhead Sea Turtle Caretta caretta | Threatened

There is **final** critical habitat for this species. Your location overlaps the critical habitat.
https://ecos.fws.gov/ecp/species/1110

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/9743	Proposed Threatened

Flowering Plants

NAME	STATUS
Beautiful Pawpaw Deeringothamnus pulchellus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4069	Endangered
Carter's Mustard Warea carteri No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5583	Endangered
Fragrant Prickly-apple Cereus eriophorus var. fragrans No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/982	Endangered
Lewton's Polygala Polygala lewtonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6688	Endangered
Papery Whitlow-wort Paronychia chartacea No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1465	Threatened

Pigeon Wings Clitoria fragrans No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/991	Threatened
Pygmy Fringe-tree Chionanthus pygmaeus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1084	Endangered
Sandlace Polygonella myriophylla No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5745	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Green Sea Turtle Chelonia mydas https://ecos.fws.gov/ecp/species/6199#crithab	Proposed
Loggerhead Sea Turtle Caretta caretta https://ecos.fws.gov/ecp/species/1110#crithab	Final
Rufa Red Knot Calidris canutus rufa https://ecos.fws.gov/ecp/species/1864#crithab	Proposed

You should contact the local field office to determine whether critical habitat for the following species should be considered:

NAME	TYPE
West Indian Manatee Trichechus manatus https://ecos.fws.gov/ecp/species/4469#crithab	Final

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their nests, should follow appropriate regulations and implement required avoidance and minimization measures, as described in the various links on this page.

The data in this location indicates that no eagles have been observed in this area. This does not mean eagles are not present in your project area, especially if the area is difficult to survey. Please review the 'Steps to Take When No Results Are Returned' section of the Supplemental Information on Migratory Birds and Eagles document to determine if your project is in a poorly surveyed area. If it is, you may need to rely on other resources to determine if eagles may be present (e.g. your local FWS field office, state surveys, your own surveys).

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Bald and Golden Eagle information is not available at this time

Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

Proper interpretation and use of your eagle report
On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more

dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:
The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (FWS). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The FWS interprets the MBTA to prohibit incidental take.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Migratory bird information is not available at this time

Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Avoidance & Minimization Measures for Birds describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as "Vulnerable". See the FAQ "What are the levels of concern for migratory birds?" for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ "Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Marine mammals

Marine mammals are protected under the Marine Mammal Protection Act. Some are also protected under the Endangered Species Act[1] and the Convention on International Trade in Endangered Species of Wild Fauna and Flora[2].

The responsibilities for the protection, conservation, and management of marine mammals are shared by the U.S. Fish and Wildlife Service [responsible for otters, walruses, polar bears, manatees, and dugongs] and NOAA Fisheries[3] [responsible for seals, sea lions, whales, dolphins, and porpoises]. Marine mammals under the responsibility of NOAA Fisheries are **not** shown on this list; for additional information on those species please visit the Marine Mammals page of the NOAA Fisheries website.

The Marine Mammal Protection Act prohibits the take of marine mammals and further coordination may be necessary for project evaluation. Please contact the U.S. Fish and Wildlife Service Field Office shown.

1. The Endangered Species Act (ESA) of 1973.
2. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
3. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following marine mammals under the responsibility of the U.S. Fish and Wildlife Service are potentially affected by activities in this location:

NAME
West Indian Manatee *Trichechus manatus* https://ecos.fws.gov/ecp/species/4469

Coastal Barrier Resources System

Projects within the John H. Chafee Coastal Barrier Resources System (CBRS) may be subject to the restrictions on Federal expenditures and financial assistance and the consultation requirements of the Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 et seq.). For more information, please contact the local Ecological Services Field Office or visit the CBRA

Consultations website. The CBRA website provides tools such as a flow chart to help determine whether consultation is required and a template to facilitate the consultation process.

This location overlaps the following CBRS unit(s):

Otherwise Protected Area (OPA)

OPAs are denoted with a "P" at the end of the unit number. The only prohibition within OPAs is on Federal flood insurance. ***CBRA consultation is not required for projects within OPAs.*** *However, agencies providing disaster assistance that is contingent upon a requirement to purchase flood insurance after the fact are advised to disclose the OPA designation and information on the restrictions on Federal flood insurance to the recipient prior to the commitments of funds.*

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Data limitations

The CBRS boundaries used in IPaC are representations of the controlling boundaries, which are depicted on the official CBRS maps. The boundaries depicted in this layer are not to be considered authoritative for in/out determinations close to a CBRS boundary (i.e., within the "CBRS Buffer Zone" that appears as a hatched area on either side of the boundary). For projects that are very close to a CBRS boundary but do not clearly intersect a unit, you may contact the Service for an official determination by following the instructions here: https://www.fws.gov/service/coastal-barrier-resources-system-property-documentation

Data exclusions

CBRS units extend seaward out to either the 20- or 30-foot bathymetric contour (depending on the location of the unit). The true seaward extent of the units is not shown in the CBRS data, therefore projects in the offshore areas of units (e.g., dredging, breakwaters, offshore wind energy or oil and gas projects) may be subject to CBRA even if they do not intersect the CBRS data. For additional information, please contact CBRA@fws.gov.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
MERRITT ISLAND NATIONAL WILDLIFE REFUGE	129,290.76 acres
ST. JOHNS NATIONAL WILDLIFE REFUGE	6,431.26 acres

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Florida and Georgia

Local offices

Florida Ecological Services Field Office

(352) 448-9151
(772) 562-4288
fw4flesregs@fws.gov

777 37th St
Suite D-101
Vero Beach, FL 32960-3559

South Carolina Ecological Services

(843) 727-4707
(843) 727-4218

176 Croghan Spur Road, Suite 200
Charleston, SC 29407-7558

Raleigh Ecological Services Field Office

(919) 856-4520
(919) 856-4556

3916 Sunset Ridge Rd
Raleigh, NC 27607

Georgia Ecological Services Field Office

(706) 460-7161
(706) 613-6059

355 East Hancock Avenue
Room 320
Athens, GA 30601-2523

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Florida Panther Puma (=Felis) concolor coryi Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1763	Endangered
Puma (=mountain Lion) Puma (=Felis) concolor (all subsp. except coryi) No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6049	SAT
Southeastern Beach Mouse Peromyscus polionotus niveiventris Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/3951	Threatened
Tricolored Bat Perimyotis subflavus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

West Indian Manatee Trichechus manatus Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/4469	Threatened Marine mammal

Birds

NAME	STATUS
Bermuda Petrel Pterodroma cahow Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/3507	Endangered
Black-capped Petrel Pterodroma hasitata Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4748	Endangered
Crested Caracara (audubon""s) [fl Dps] Caracara plancus audubonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8250	Threatened
Eastern Black Rail Laterallus jamaicensis ssp. jamaicensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10477	Threatened
Everglade Snail Kite Rostrhamus sociabilis plumbeus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/7713	Endangered

NAME	STATUS
Florida Scrub-jay Aphelocoma coerulescens Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6174	Threatened
Piping Plover Charadrius melodus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/6039	Threatened
Roseate Tern Sterna dougallii dougallii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2083	Endangered
Rufa Red Knot Calidris canutus rufa Wherever found There is **proposed** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/1864	Threatened
Wood Stork Mycteria americana No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8477	Threatened

Reptiles

NAME	STATUS
American Alligator Alligator mississippiensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/776	SAT

Atlantic Salt Marsh Snake Nerodia clarkii taeniata | Threatened
Wherever found
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/7729

Eastern Indigo Snake Drymarchon couperi | Threatened
Wherever found
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/646

Green Sea Turtle Chelonia mydas | Threatened
There is **proposed** critical habitat for this species. Your location overlaps the critical habitat.
https://ecos.fws.gov/ecp/species/6199

Hawksbill Sea Turtle Eretmochelys imbricata | Endangered
Wherever found
There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/3656

Kemp's Ridley Sea Turtle Lepidochelys kempii | Endangered
Wherever found
There is **proposed** critical habitat for this species.
https://ecos.fws.gov/ecp/species/5523

Leatherback Sea Turtle Dermochelys coriacea | Endangered
Wherever found
There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/1493

Loggerhead Sea Turtle Caretta caretta | Threatened

There is **final** critical habitat for this species. Your location overlaps the critical habitat.
https://ecos.fws.gov/ecp/species/1110

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/9743	Proposed Threatened

Flowering Plants

NAME	STATUS
Carter's Mustard Warea carteri No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5583	Endangered
Fragrant Prickly-apple Cereus eriophorus var. fragrans No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/982	Endangered
Lewton's Polygala Polygala lewtonii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6688	Endangered
Tiny Polygala Polygala smallii No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/996	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Green Sea Turtle Chelonia mydas https://ecos.fws.gov/ecp/species/6199#crithab	Proposed
Loggerhead Sea Turtle Caretta caretta https://ecos.fws.gov/ecp/species/1110#crithab	Final
Rufa Red Knot Calidris canutus rufa https://ecos.fws.gov/ecp/species/1864#crithab	Proposed

You should contact the local field office to determine whether critical habitat for the following species should be considered:

NAME	TYPE
West Indian Manatee Trichechus manatus https://ecos.fws.gov/ecp/species/4469#crithab	Final

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their nests, should follow appropriate regulations and implement required avoidance and minimization measures, as described in the various links on this page.

The data in this location indicates that no eagles have been observed in this area. This does not mean eagles are not present in your project area, especially if the area is difficult to survey. Please review the 'Steps to Take When No Results Are Returned' section of the Supplemental Information on Migratory Birds and Eagles document to determine if your project is in a poorly surveyed area. If it is, you may need to rely on other resources to determine if eagles may be present (e.g. your local FWS field office, state surveys, your own surveys).

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Bald and Golden Eagle information is not available at this time

Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

Proper interpretation and use of your eagle report

On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:
The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (FWS). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The FWS interprets the MBTA to prohibit incidental take.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Migratory bird information is not available at this time

Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Avoidance & Minimization Measures for Birds describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence

Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as “Vulnerable”. See the FAQ “What are the levels of concern for migratory birds?” for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ "Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Marine mammals

Marine mammals are protected under the Marine Mammal Protection Act. Some are also protected under the Endangered Species Act[1] and the Convention on International Trade in Endangered Species of Wild Fauna and Flora[2].

The responsibilities for the protection, conservation, and management of marine mammals are shared by the U.S. Fish and Wildlife Service [responsible for otters, walruses, polar bears, manatees, and dugongs] and NOAA Fisheries[3] [responsible for seals, sea lions, whales, dolphins, and porpoises]. Marine mammals under the responsibility of NOAA Fisheries are **not** shown on this list; for additional information on those species please visit the Marine Mammals page of the NOAA Fisheries website.

The Marine Mammal Protection Act prohibits the take of marine mammals and further coordination may be necessary for project evaluation. Please contact the U.S. Fish and Wildlife Service Field Office shown.

1. The Endangered Species Act (ESA) of 1973.
2. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
3. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following marine mammals under the responsibility of the U.S. Fish and Wildlife Service are potentially affected by activities in this location:

NAME

West Indian Manatee Trichechus manatus
https://ecos.fws.gov/ecp/species/4469

Coastal Barrier Resources System

Projects within the John H. Chafee Coastal Barrier Resources System (CBRS) may be subject to the restrictions on Federal expenditures and financial assistance and the consultation requirements of the Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 et seq.). For more information, please contact the local Ecological Services Field Office or visit the CBRA Consultations website. The CBRA website provides tools such as a flow chart to help determine whether consultation is required and a template to facilitate the consultation process.

This location overlaps the following CBRS unit(s):

Otherwise Protected Area (OPA)

OPAs are denoted with a "P" at the end of the unit number. The only prohibition within OPAs is on Federal flood insurance. ***CBRA consultation is not required for projects within OPAs.*** *However, agencies providing disaster assistance that is contingent upon a requirement to purchase flood insurance after the fact are advised to disclose the OPA designation and information on the restrictions on Federal flood insurance to the recipient prior to the commitments of funds.*

FL-07P - FI 11/16/1991

Data limitations

The CBRS boundaries used in IPaC are representations of the controlling boundaries, which are depicted on the official CBRS maps. The boundaries depicted in this layer are not to be considered authoritative for in/out determinations close to a CBRS boundary (i.e., within the "CBRS Buffer Zone" that appears as a hatched area on either side of the boundary). For projects that are very close to a CBRS boundary but do not clearly intersect a unit, you may contact the Service for an official determination by following the instructions here: https://www.fws.gov/service/coastal-barrier-resources-system-property-documentation

Data exclusions

CBRS units extend seaward out to either the 20- or 30-foot bathymetric contour (depending on the location of the unit). The true seaward extent of the units is not shown in the CBRS data, therefore projects in the offshore areas of units (e.g., dredging, breakwaters, offshore wind energy or oil and gas projects) may be subject to CBRA even if they do not intersect the CBRS data. For additional information, please contact CBRA@fws.gov.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
MERRITT ISLAND NATIONAL WILDLIFE REFUGE	129,288.91 acres

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

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2 This page is intentionally left blank.

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Local office

Pacific Islands Fish And Wildlife Office

(808) 792-9400
(808) 792-9580

MAILING ADDRESS

300 Ala Moana Boulevard, Box 50088
Honolulu, HI 96850-5000

PHYSICAL ADDRESS
300 Ala Moana Boulevard, Room 3-122
Honolulu, HI 96850-0056

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Band-rumped Storm-petrel Hydrobates castro No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1226	Endangered
Hawaiian Petrel Pterodroma sandwichensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6746	Endangered
Newell''s Shearwater Puffinus newelli Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2048	Threatened
Short-tailed Albatross Phoebastria (=Diomedea) albatrus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/433	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their nests, should follow appropriate regulations and implement required avoidance and minimization measures, as described in the various links on this page.

The data in this location indicates that no eagles have been observed in this area. This does not mean eagles are not present in your project area, especially if the area is difficult to survey. Please review the 'Steps to Take When No Results Are Returned' section of the Supplemental Information on Migratory Birds and Eagles document to determine if your project is in a poorly surveyed area. If it is, you may need to rely on other resources to determine if eagles may be present (e.g. your local FWS field office, state surveys, your own surveys).

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

Proper interpretation and use of your eagle report
On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help

you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your “IPaC PROBABILITY OF PRESENCE SUMMARY” at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:
The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (Service). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The Service interprets the MBTA to prohibit incidental take.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Measures for Proactively Minimizing Migratory Bird Impacts

Your IPaC Migratory Bird list showcases birds of concern, including Birds of Conservation Concern (BCC), in your project location. This is not a comprehensive list of all birds found in your project area. However, you can help proactively minimize significant impacts to all birds at your project location by implementing the measures in the Nationwide avoidance and minimization measures for birds document, and any other project-specific avoidance and minimization measures suggested at the link Measures for avoiding and minimizing impacts to birds for the birds of concern on your list below.

Ensure Your Migratory Bird List is Accurate and Complete

If your project area is in a poorly surveyed area, your list may not be complete and you may need to rely on other resources to determine what species may be present (e.g. your local FWS field office, state surveys, your own surveys). Please review the Supplemental Information on Migratory Birds and Eagles document, to help you properly interpret the report for your specified location, including determining if there is sufficient data to ensure your list is accurate.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the "Probability of Presence Summary" below to see when these birds are most likely to be present and breeding in your project area.

Review the FAQs

The FAQs below provide important additional information and resources.

NAME	BREEDING SEASON
Sooty Shearwater *Ardenna grisea* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds elsewhere
Sooty Tern *Onychoprion fuscatus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.	Breeds Mar 10 to Jul 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12

(0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

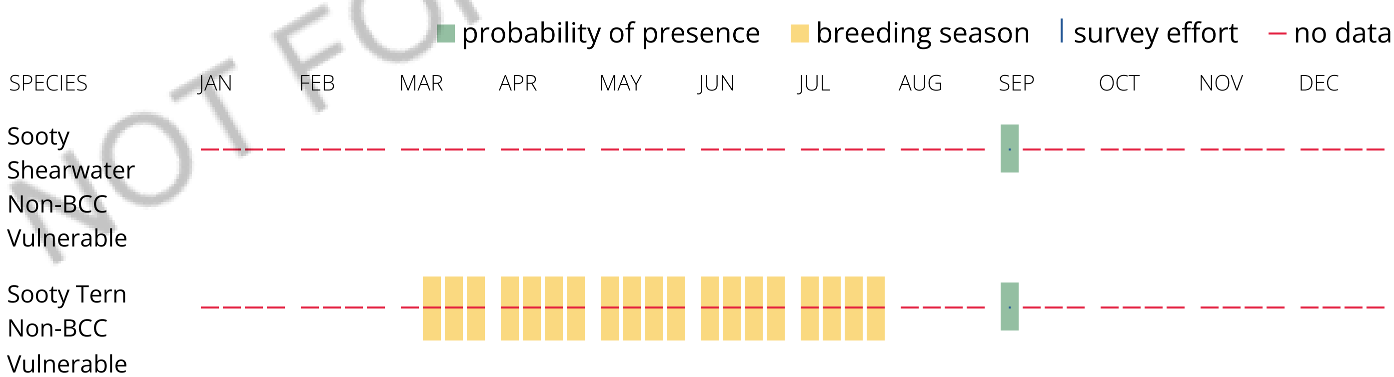
Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

[Nationwide Avoidance & Minimization Measures for Birds](#) describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as "Vulnerable". See the FAQ "What are the levels of concern for migratory birds?" for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your “IPaC PROBABILITY OF PRESENCE SUMMARY” at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ “Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds”.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs
Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:
The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location did not intersect any wetlands mapped by NWI.

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

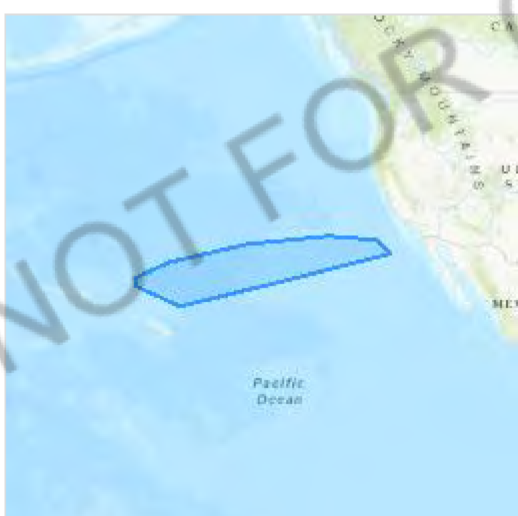
Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location



Local office

Pacific Islands Fish And Wildlife Office

(808) 792-9400
(808) 792-9580

MAILING ADDRESS

300 Ala Moana Boulevard, Box 50088
Honolulu, HI 96850-5000

PHYSICAL ADDRESS
300 Ala Moana Boulevard, Room 3-122
Honolulu, HI 96850-0056

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Band-rumped Storm-petrel Hydrobates castro No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1226	Endangered
Hawaiian Petrel Pterodroma sandwichensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6746	Endangered
Newell''s Shearwater Puffinus newelli Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2048	Threatened
Short-tailed Albatross Phoebastria (=Diomedea) albatrus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/433	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

There are no critical habitats at this location.

You are still required to determine if your project(s) may have effects on all above listed species.

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their nests, should follow appropriate regulations and implement required avoidance and minimization measures, as described in the various links on this page.

The data in this location indicates that no eagles have been observed in this area. This does not mean eagles are not present in your project area, especially if the area is difficult to survey. Please review the 'Steps to Take When No Results Are Returned' section of the Supplemental Information on Migratory Birds and Eagles document to determine if your project is in a poorly surveyed area. If it is, you may need to rely on other resources to determine if eagles may be present (e.g. your local FWS field office, state surveys, your own surveys).

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

Proper interpretation and use of your eagle report
On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help

you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your “IPaC PROBABILITY OF PRESENCE SUMMARY” at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:
The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (FWS). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The FWS interprets the MBTA to prohibit incidental take.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
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- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

The data in this location indicates that no migratory birds of concern have been observed in this area. This does not mean birds of concern are not present in your project area, especially if the area is difficult to survey. Please review the 'Steps to Take When No Results Are Returned' section of the Supplemental Information on Migratory Birds and Eagles document to determine if your project is in a poorly surveyed area. If it is, you may need to rely on other resources to determine what migratory birds of concern may be present (e.g. your local FWS field office, state surveys, your own surveys).

Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Avoidance & Minimization Measures for Birds describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as "Vulnerable". See the FAQ "What are the levels of concern for migratory birds?" for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ “Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds”.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location did not intersect any wetlands mapped by NWI.

NOTE: This initial screening does **not** replace an on-site delineation to determine whether wetlands occur. Additional information on the NWI data is provided below.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix B
Noise Modeling Report

(Provided under separate cover)

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Appendix 3.9B
NMFS Biological Opinion

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

4/18/25

Refer to NMFS No.: OPR-2025-00164

Ms. Stacey Zee
Manager, Operations Support Branch
U.S. Dept. Transportation, Federal Aviation Administration
Office of Commercial Space Transportation
800 Independence Ave SW, Suite 325
Washington, D.C. 20591

RE: Reinitiation of the Endangered Species Act Section 7 Conference and Biological Opinion on SpaceX Starship-Super Heavy Increased Launch Cadence and Operations in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), Gulf of America, North Pacific Ocean, South Pacific Ocean, and Indian Ocean Authorized by the Federal Aviation Administration

Dear Ms. Zee:

Enclosed is the National Marine Fisheries Service's (NMFS) biological opinion for the reinitiation of consultation on the effects on endangered and threatened species under NMFS's jurisdiction and critical habitat that has been designated for those species and conference on the effects on proposed species and critical habitat of the Federal Aviation Administration's licensing and authorization of Starship-Super Heavy launch and reentry operations in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), Gulf of America, North Pacific Ocean, South Pacific Ocean, and Indian Ocean. We have prepared the biological opinion and conference pursuant to section 7(a)(2) of the Endangered Species Act, as amended (ESA; 16 U.S.C. 1536(a)(2)).

Based on our assessment, we concluded the proposed action is likely to adversely affect, but not likely to jeopardize, the continued existence of the North Atlantic Distinct Population Segment (DPS) of green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and Northwest Atlantic Ocean DPS of loggerhead sea turtle (*Caretta caretta*), and that the proposed action is likely to adversely affect, but not likely to destroy or adversely modify, the designated critical habitat of the Northwest Atlantic Ocean DPS of loggerhead turtle. We also determined the proposed action may affect, but is not likely to adversely affect, the blue whale (*Balaenoptera musculus*), Main Hawaiian Islands Insular DPS of false killer whale (*Pseudorca crassidens*), fin whale (*Balaenoptera physalus*), Western North Pacific DPS of gray whale (*Eschrichtius robustus*), Mexico DPS and Central America DPS of humpback whale (*Megaptera novaeangliae*), North Atlantic right whale (*Eubalaena glacialis*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter microcephalus*), Rice's whale (*Balaenoptera ricei*), Guadalupe fur seal (*Arctocephalus townsendi*), Hawaiian monk seal (*Neomonachus schauinslandi*), South Atlantic DPS, East Pacific DPS, Central North Pacific DPS, East Indian-West Pacific DPS, North Indian DPS, and

Southwest Indian DPS of green turtle, hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*), North Pacific Ocean DPS, South Pacific Ocean DPS, North Indian Ocean DPS, Southwest Indian Ocean DPS, and Southeast Indo-Pacific Ocean DPS of loggerhead turtle, Mexico's Pacific Coast breeding colonies and all other areas/not Mexico's Pacific Coast breeding colonies of olive ridley turtle (*Lepidochelys olivacea*), Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), giant manta ray (*Manta birostris*), Gulf sturgeon (*Acipenser oxyrinchus desotoi*), Nassau grouper (*Epinephelus striatus*), oceanic whitetip shark (*Carcharhinus longimanus*), Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark (*Sphyrna lewini*), shortnose sturgeon (*Acipenser brevirostrum*), U.S. portion of range DPS of smalltooth sawfish (*Pristis pectinata*), South-Central California Coast DPS and Southern California DPS of steelhead trout (*Oncorhynchus mykiss*), black abalone (*Haliotis cracherodii*), boulder star coral (*Orbicella franksi*), elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), pillar coral (*Dendrogyra cylindrus*), rough cactus coral (*Mycetophyllia ferox*), staghorn coral (*Acropora cervicornis*), proposed sunflower sea star (*Pycnopodia helanthoides*); and designated critical habitat of the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, North Atlantic right whale, leatherback turtle, North Atlantic DPS of green turtle, Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and proposed critical habitat of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle, and Rice's whale.

This concludes consultation and conference under the ESA for ESA-listed or proposed species and designated or proposed critical habitat under NMFS' purview on this action by the Federal Aviation Administration. Reinitiation of consultation is required and shall be requested by the Federal Aviation Administration where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this consultation; (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not previously considered in this consultation; or (4) a new species is listed or critical habitat designated that may be affected by the action (50 CFR §402.16).

If you have any questions regarding this biological opinion, please contact Emily Chou, Consultation Biologist, at (301) 427-8483 or Emily.Chou@noaa.gov, or me at (301) 427-8400 or Kimberly.Damon-Randall@noaa.gov.

Sincerely,

For Kimberly Damon-Randall
Director
Office of Protected Resources

National Marine Fisheries Service
Endangered Species Act Section 7
Conference and Biological Opinion

Title:	Conference and Biological Opinion on SpaceX Starship-Super Heavy Increased Launch Cadence and Operations in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), Gulf of America, North Pacific Ocean, South Pacific Ocean, and Indian Ocean Authorized by the Federal Aviation Administration
Action Agency:	Federal Aviation Administration, U.S. Department of Transportation
In Consultation With:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
Publisher:	Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Approved:

For Kimberly Damon-Randall
Director, Office of Protected Resources

Date: 4/18/25

ECO Number: OPR-2025-00164

Digital Object Identifier: https://doi.org/10.25923/jwq8-r642

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1. INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1531 et seq.) establishes a national mandate for conserving and recovering threatened and endangered species of fish, wildlife, plants, and the habitats on which they depend. Section 7(a)(2) of the Act and its implementing regulations require every Federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Section 7(a)(4) of the ESA requires federal agencies to confer with the Secretary on any action that is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat. For actions that are not likely to jeopardize the continued existence of a proposed species or adversely modify critical habitat, a conference can be requested by the action agency, though it is not required. If requested by the federal action agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in 50 CFR §402.14. An opinion issued at the conclusion of the conference may be adopted as the biological opinion when the species is listed or critical habitat is designated.

Section 7(b)(3) of the ESA requires that, at the conclusion of consultation, the National Marine Fisheries Service (NMFS) provide an opinion stating whether the federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify their critical habitat. Similarly, when conferring on proposed species or proposed critical habitat, NMFS also reaches a conclusion as to whether the action will satisfy 7(a)(2) for those entities as proposed. If NMFS determines that the action is likely to jeopardize ESA-listed or proposed species or destroy or adversely modify designated or proposed critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If the action (or reasonable and prudent alternative) is expected to cause incidental take without violating section 7(a)(2), section 7(b)(4), as implemented by 50 CFR §402.14(i), requires NMFS to provide an incidental take statement (ITS) that specifies the amount or extent of incidental taking. Blue whale (*Balaenoptera musculus*), false killer whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular Distinct Population Segment (DPS), fin whale (*Balaenoptera physalus*), gray whale (*Eschrichtius robustus*) – Western North Pacific DPS, humpback whale (*Megaptera novaeangliae*) – Mexico DPS and Central America DPS, North Atlantic right whale (*Eubalaena glacialis*), North Pacific right whale (*Eubalaena japonica*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter microcephalus*), Rice's whale (*Balaenoptera ricei*), Guadalupe fur seal (*Arctocephalus townsendi*), and Hawaiian monk seal (*Neomonachus schauinslandi*) in this consultation are regulated under the Marine Mammal Protection Act (MMPA) and the ESA. Each statute has defined the meaning of take independently. The MMPA defines take as to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. Take under the ESA is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. §1532(19)). Actions considered 'take' under one statute do not necessarily rise to the level of take under the other statute. The ITS includes reasonable and prudent measures, which are actions necessary or appropriate to minimize impacts of incidental taking, and terms and conditions to implement the reasonable and prudent measures.

The action agency for this reinitiated consultation and conference is the Federal Aviation Administration (FAA). The Space Exploration Technologies Corporation (SpaceX) is the applicant. The FAA proposes to modify and issue a vehicle operator license authorizing SpaceX to conduct launches of SpaceX's Starship-Super Heavy launch vehicle, including Super Heavy landings in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), and Gulf of America[1], and Starship landings in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), Gulf of America, North Pacific Ocean, South Pacific Ocean, and Indian Ocean.

Updates to the regulations governing interagency consultation (50 CFR Part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). NMFS is applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act (89 Fed. Reg. 24268; 84 Fed. Reg. 45015). NMFS has considered the prior rules and affirms that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

Consultation in accordance with section 7(a)(2) of the statute (16 U.S.C. §1536(a)(2)), associated implementing regulations (50 CFR Part 402), and agency policy and guidance (USFWS and NMFS 1998) was conducted by the NMFS Office of Protected Resources (OPR) ESA Interagency Cooperation Division (hereafter referred to as 'we' or 'us'). We prepared this conference and biological opinion (opinion) and ITS in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR Part 402. The following listed and proposed species, and designated and proposed critical habitat, were considered in this consultation and conference: blue whale, false killer whale – Main Hawaiian Islands Insular DPS, fin whale, gray whale – Western North Pacific DPS, humpback whale – Mexico DPS and Central America DPS, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice's whale, Guadalupe fur seal, Hawaiian monk seal; green turtle (*Chelonia mydas*) – North Atlantic DPS, South Atlantic DPS, East Pacific DPS, Central North Pacific DPS, East Indian-West Pacific DPS, North Indian DPS, and Southwest Indian DPS, hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS, North Pacific Ocean DPS, South Pacific Ocean DPS, North Indian Ocean DPS, Southwest Indian Ocean DPS, and Southeast Indo-Pacific Ocean DPS, and olive ridley turtle (*Lepidochelys olivacea*) – Mexico's

[1] OPR-2024-01147, issued on January 17, 2025, referred to this area as the Gulf of Mexico. In accordance with Presidential Executive Order 14172, "Restoring Names that Honor American Greatness," we are updating this opinion to refer to the area formerly known as the Gulf of Mexico (U.S. waters), to the Gulf of America. We note that there are citations and references in this opinion that published prior to Executive Order 14172 and refer to the Gulf of America by its former name, the Gulf of Mexico. In those cases, and cases where 'Gulf of Mexico' is part of a formal name (e.g., loggerhead turtle Northern Gulf of Mexico Recovery Unit), we have not updated accordingly, because, at the time of this consultation, those names and references have not been updated.

Pacific Coast breeding colonies and all other areas/not Mexico's Pacific Coast breeding colonies; Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS, giant manta ray (*Manta birostris*), Gulf sturgeon (*Acipenser oxyrinchus desotoi*), Nassau grouper (*Epinephelus striatus*), oceanic whitetip shark (*Carcharhinus longimanus*), scalloped hammerhead shark (*Sphyrna lewini*) – Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS, shortnose sturgeon (*Acipenser brevirostrum*), smalltooth sawfish (*Pristis pectinata*) – U.S. portion of range DPS, steelhead trout (*Oncorhynchus mykiss*) – South-Central California Coast DPS and Southern California DPS, black abalone (*Haliotis cracherodii*), boulder star coral (*Orbicella franksi*), elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), pillar coral (*Dendrogyra cylindrus*), rough cactus coral (*Mycetophyllia ferox*), staghorn coral (*Acropora cervicornis*), proposed sunflower sea star (*Pycnopodia helanthoides*); and designated critical habitat of the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, North Atlantic right whale, leatherback turtle, North Atlantic DPS of green turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and proposed critical habitat of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle and Rice's whale.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA; section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file electronically with the NMFS OPR in Silver Spring, Maryland, and available in the National Oceanic and Atmospheric Administration (NOAA) Library Institutional Repository https://repository.library.noaa.gov/welcome.

1.1 Background

The FAA Office of Commercial Space Transportation oversees, licenses, and regulates U.S. commercial launch and reentry activities, as well as the operation of launch and reentry sites within the United States or as carried out by U.S. citizens, as authorized by the Commercial Space Launch Act of 1984, as amended and codified at 51 U.S.C. §§ 50901–50923. Section 50903 requires the Secretary of Transportation (or FAA Administrator, as codified in 49 CFR § 1.83(b)) to encourage, facilitate, and promote commercial space launches and reentries by the private sector. The same launch vehicle operators that receive a license or permit from the FAA may also conduct operations for the Department of Defense (DoD).

This opinion (OPR-2025-00164) is a reinitiation of OPR-2024-01147. In OPR-2024-01147, the FAA proposed to modify and issue a vehicle operator license authorizing SpaceX to conduct Starship-Super Heavy launch and reentry operations, with Starship and Super Heavy landings occurring at least five nautical miles (NM) from shore: Super Heavy in the North Atlantic Ocean, Gulf of Mexico (non-U.S. waters), and Gulf of America, and Starship in the North Pacific Ocean, South Pacific Ocean, and Indian Ocean. After our biological opinion was issued on January 17, 2025 concluding consultation (OPR-2024-01147), the FAA submitted a series of documents to NMFS regarding changes to the action after SpaceX notified FAA of these changes. The changes to the action are as follows: 1) the inclusion of Starship landings in all portions of the action area; 2) the expansion of the Gulf and Atlantic Ocean portions of the action area to include Starship and Super Heavy landings 1–5 NM from shore; 3) the consideration of a maximum of 20 explosive events, 25 soft water landings (with no explosive events), and 25 in-flight breakups of each vehicle in each portion of the action area; and 4) the extension of the timeline to reach a fully reusable vehicle (a fully reusable vehicle will be achieved October 2030).

This reinitiated opinion (OPR-2025-00164) considers the changes to the action and supersedes OPR-2024-01147.

1.2 Consultation History

- **January 28, 2025:** FAA submitted, via email to NMFS, an addendum to the proposed action consulted on in OPR-2024-01147, to include Starship contingency landings 1–5 NM from shore in the Gulf portion of the action area.
- **January 31, 2025:** NMFS requested, via email to FAA, additional information on the Starship contingency landings, including how Starship will be recovered, clarification on ensonified areas from explosive events, and potential mitigation measures.
- **February 12, 2025:** FAA provided, via email, revised boundaries of the Hawaii and Central North Pacific portion of the action area and conveyed SpaceX's concerns regarding two conservation measures related to North Atlantic right whales that were agreed upon and included in OPR-2024-01147.
- **February 14, 2025:** SpaceX, through FAA, provided responses, via email, to some of NMFS's January 31, 2025 requests for additional information.
- **February 20, 2025:** Via email to FAA, NMFS summarized telephone calls with FAA, confirming: 1) Starship recovery actions are not included in the consultation because they are not part of FAA's federal action; and 2) NMFS will include forthcoming Starship contingency landings in the Atlantic Ocean portion of the action area in the same consultation as the Starship contingency landings in the Gulf portion of the action area in order to ensure maximum efficiency.
- **March 11, 2025:** FAA submitted, via email to NMFS, a second addendum to the proposed action, including Starship contingency landings 1–5 NM from shore in the Atlantic Ocean portion of the action area, Starship operational landings in the Atlantic Ocean portion of the action area, and an extension of the time over which vehicles may be expended. NMFS requested, via email to FAA, clarification of the action area. On March 14, 2025, FAA requested the consultation be completed by the end of March 2025.
- **March 17, 2025:** NMFS requested, via email, additional information on the various changes to FAA's proposed action. These included clarification of the action area; number of explosive events, soft water landings, and in-flight breakups; landing locations; reporting requirements from previous consultations covering portions of SpaceX Starship-Super Heavy launch and reentry activities (OPR-2024-01147 and OPR-2024-00211); and revisions to the conservation measures associated with the changes to the action.

- **March 20, 2025:** NMFS and FAA met to discuss the necessary time to complete the reinitiated consultation. Given the extensive additional information needed to understand and analyze the nature and scope of the proposed action, which was still in flux, NMFS agreed to expedite the consultation's completion by April 18, 2025, in advance of FAA's license issuance. On March 21, 2025, NMFS met with FAA and SpaceX to clarify the changes to the proposed action. On the same day, SpaceX and NMFS continued to clarify the changes to the action and action areas via email. On March 21, 24, and 26, 2025, SpaceX provided responses, via email, to some of NMFS's March 17, 2025 requests for additional information and questions discussed in the March 21, 2025 meeting.
- **March 28, 2025:** FAA submitted, via email to NMFS, a revised addendum to the proposed action. The revised addendum did not differentiate between Starship contingency landings and operational landings, and included landing burns for all vehicle landings (landing burns are conducted to slow the vehicle for landing and require a large amount of propellant). Including landing burns for all vehicle landings are anticipated to result in much smaller explosive events than considered in OPR-2024-01147. On March 31, 2025, during a telephone call with FAA, NMFS requested clarification of discrepancies in the revised addendum related to the number of explosive events, soft water landings, and in-flight breakups that may occur before the vehicle achieves full reusability. During another telephone call on the same day, FAA notified NMFS that another revised addendum would be submitted.
- **April 1, 2025:** FAA submitted, via email to NMFS, a revised addendum to the proposed action, which did not consider landing burns. Excluding landing burns are anticipated to result in much larger explosive events (as considered in OPR-2024-01147), and would give FAA flexibility in ESA coverage while SpaceX's launch vehicle is still in development. On April 2, 2025, in an effort to expedite the process, NMFS responded to FAA via email and relayed our conclusions on discrepancies between the revised addendum and previous addenda or discussions. These included discrepancies related to vehicle landings in the expanded Gulf and Atlantic Ocean portions of the action area, recovery of Starship, and species densities. On April 3, 2025, NMFS received final responses from FAA clarifying vehicle landings in the expanded Gulf and Atlantic Ocean portions of the action area, and concurring with NMFS's conclusions that Starship recovery actions are not included in the consultation because they are not part of FAA's federal action, and that NMFS will conduct analyses to determine the appropriate species densities for the expanded Gulf and Atlantic Ocean portions of the action area.

1.3 Analytical Approach

This opinion includes a jeopardy analysis and an adverse modification or destruction of critical habitat analysis. Prior to 2016, the designation of critical habitat for Northwest Atlantic Ocean DPS of loggerhead turtle used the term primary constituent element (PCE), essential features, or generally identified aspects of critical habitat that were essential to the conservation of the species. The 2016 critical habitat regulations (50 CFR §424.12) replaced these terms with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether an action agency is able to insure its proposed action is not likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify all aspects of the proposed action (as defined in 50 CFR §402.02), including activities that rely on the action for their occurrence.
- Identify the physical, chemical, and biological modifications to land, water, and air (stressors) that result from those actions and subsequent activities.
- Establish the spatial extent of those stressors, which is the action area (50 CFR §402.02).
- Identify the listed and proposed species (as defined at 16 U.S.C. §1532(16)) and designated and proposed critical habitat (as defined at 16 U.S.C. §1532(5)) in the action area.
- Identify the species and critical habitats that are not likely to be adversely affected by the action.
- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline (as defined in 50 CFR §402.02) as it pertains to the species and critical habitat.
- Evaluate the effects of the proposed action on listed or proposed species and their designated or proposed critical habitat using a stressor-exposure-response approach. When complete, this section anticipates the amount or extent, as well as the forms (harass, harm, etc.), of take of listed species (or a surrogate) that is reasonably certain to occur as a result of the action, as well as the extent of effects to critical habitat.
- Evaluate cumulative effects (as defined at 50 CFR §402.02).
- Produce an integration and synthesis, where we add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat.
- Compile our jeopardy and destruction or adverse modification analysis relying on the justification in the integration and synthesis.
- If the opinion determines the action agency failed to insure its action is not likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat, we suggest a reasonable and prudent alternative to the proposed action and assess the effects of that alternative action.
- For actions that do not violate section 7(a)(2) of the ESA or an alternative action is identified that does not violate section 7(a)(2) of the ESA, after we conclude our opinion, we provide an incidental take statement that specifies the impact of the take on listed species (amount or extent), reasonable and prudent measures, and terms and conditions to implement those measures.

In each of the steps above, we rely on the best scientific and commercial data available. In order to ensure we reach supportable conclusions, we used information from FAA including the 2024

Biological Assessment (ManTech SRS Technologies Inc. 2024), Revised Draft Tiered Environmental Assessment (FAA 2024b), Starship addenda and revised addenda (FAA 2025a; FAA 2025b; FAA 2025c; FAA 2025d), responses to our requests for additional information, and peer-reviewed scientific literature, government reports, and commercial studies. We also relied on technical information from SpaceX on their launch vehicle and operations.

2. PROPOSED FEDERAL ACTION

Action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or on the high seas. Examples include, but are not limited to: 1) actions intended to conserve listed species or their habitat; 2) the promulgation of regulations; 3) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants in aid; or 4) actions directly or indirectly causing modifications to the land, water, or air (50 CFR §402.02).

2.1 Description of the Action

The following information was obtained from FAA's initiation materials, including the 2024 Biological Assessment (ManTech SRS Technologies Inc. 2024), Revised Draft Tiered Environmental Assessment (FAA 2024b), Starship addenda (FAA 2025a; FAA 2025b; FAA 2025c; FAA 2025d), FAA and SpaceX responses to our requests for additional information, NMFS meetings and telephone calls with FAA, NMFS meetings with FAA and SpaceX, and previous consultations regarding FAA's licensing of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, OPR-2021-02908, and OPR-2024-01147).

The FAA proposes to modify and issue vehicle operator license (VOL 23-129), authorizing SpaceX to conduct launch and reentry operations of their launch vehicle, Starship-Super Heavy. The modifications include Starship and Super Heavy landings more than 1 NM from shore in the Gulf of Mexico (non-U.S. waters), Gulf of America, and North Atlantic Ocean, and launches from Kennedy Space Center's Launch Complex 39A (LC-39A). While the current launch site, the Boca Chica Launch Site, is already operational, the launch site at LC-39A needs to be constructed for launches to begin in fall of 2025. The maximum number of launches per year from each launch site is as follows: 25 from the Boca Chica Launch Site and 44 from LC-39A. Launch cadence at both sites is expected to ramp up over time, although at an unknown rate. The Federal action is the modification and subsequent issuance of VOL 23-129, which expires April 14, 2028. Thus, this opinion and ITS are valid until April 14, 2028, corresponding with the FAA license.

This consultation supersedes all previous consultations related to FAA's authorization of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, OPR-2021-02908, and OPR-2024-01147).

Starship-Super Heavy Launch Vehicle

Starship-Super Heavy is a two-stage vertical launch vehicle that is designed to eventually be fully reusable. While working towards reusability, Starship and/or Super Heavy will be expended (i.e., discarded) in the ocean. Starship-Super Heavy is expected to be fully reusable by October 2030 (i.e., Starship and Super Heavy will land back at the launch site or on a floating platform/ocean-going barge, or autonomous spaceport drone ship [drone ship] after October 2030). Between the date of issuance of this opinion and October 2030, Starship and/or Super Heavy may be expended in the ocean. The interstage (see below) may still be expended in the Gulf of Mexico (non-U.S. waters) or Gulf of America through calendar year 2026. As noted above, the FAA license covers the period until April 2028, which is also the period considered in this consultation.

Starship-Super Heavy is approximately 404 feet (ft; 123 meters [m]) tall by 30 ft (9 m) in diameter: Super Heavy, the first stage (or booster), is approximately 233 ft (71 m) tall, and Starship, the second stage (or spacecraft), is approximately 171 ft (52 m) tall. Super Heavy will be equipped with up to 37 Raptor engines and Starship will be equipped with up to nine Raptor engines. The Raptor engine is powered by liquid oxygen (LOX) and liquid methane (LCH_4). Super Heavy can hold up to 3,748 tons (t; 3,400 metric tons [MT]) of propellant and Starship can hold up to 1,653 t (1,500 MT) of propellant.

During a Starship-Super Heavy launch, the launch vehicle reaches supersonic speeds, generating a sonic boom. After launch, Super Heavy's engines cut off at high altitude and Super Heavy separates from Starship. After Super Heavy separates from Starship, Super Heavy conducts a boost-back burn prior to descent and Starship flies to its desired orbit. Starship conducts an in-space coast phase before beginning its descent. A sonic boom is generated as Super Heavy and Starship reach supersonic speeds during descent. Super Heavy and/or Starship may conduct a landing burn as it returns to the launch site, lands on a floating platform/ocean-going barge or drone ship, or lands in the ocean.

The subsections below describe the ways each vehicle may be expended during operations to full reusability.

Super Heavy Operations

Super Heavy may be expended in the Gulf of Mexico (non-U.S. waters) or Gulf of America (Gulf portion of the action area; Figure 1), or the Northwest Atlantic Ocean (Atlantic Ocean portion of the action area; Figure 2). Super Heavy will be expended more than 5 NM from shore in the Gulf and Atlantic Ocean portions of the action area, or expended 1–5 NM from shore directly east of the Boca Chica Launch Site or LC-39A. In the Gulf portion of the action area, Super Heavy will be expended at least 20 NM from the Flower Garden Banks National Marine Sanctuary. Super Heavy landings are expected to generate an overpressure of up to 21 pounds per square foot (psf). A landing on a floating platform/ocean-going barge or drone ship would produce an overpressure of up to 8 psf.

Until full reusability is achieved, Super Heavy may be expended under the following conditions:

1. In-flight breakup: Super Heavy breaking up during reentry, resulting in debris falling into the Gulf or Atlantic Ocean portions of the action area.
2. Explosive event: Super Heavy lands in the ocean either at terminal velocity, breaking up upon impact with debris contained within approximately 0.6 miles (mi; 1 kilometer [km])

of the landing point, or conducts a soft water landing and tips over, impacting the ocean. Both result in an explosive event at the surface of the water.
3. Soft water landing: Super Heavy conducts a soft water landing, tips over, and sinks to the bottom of the ocean.

FAA and SpaceX stated there is no specific information on the Super Heavy landing locations, or on the probability or frequency that Super Heavy landings will occur more often in any given portion of the action area (e.g., closer to the launch site compared to further offshore, or within one portion of the action area more than another portion of the action area). Thus, we conclude that, based on the best available information, Super Heavy landings are equally likely to occur throughout the action area.

If Super Heavy is expended in an area where it becomes a navigational hazard, it will need to be removed from the seafloor. Activities related to the recovery or removal of Super Heavy or Super Heavy debris are not part of FAA's Federal action. Those activities would be subject to Section 7(a)(2) if they require authorization from, are funded by, or are carried out, in whole or in part, by a Federal agency.

SpaceX provided the best available information on how a Super Heavy explosive event will occur, based on previous launches and tests of similar vehicles. A Super Heavy explosive event is the result of a breakdown of the fuel transfer tube and subsequent mixing and igniting of residual propellant, which will be located approximately 9.8 ft (3 m) from the ocean's surface due to the vertical orientation of Super Heavy. SpaceX calculated an explosive weight of 14,551 pounds (lb; 6,660 kilograms [kg]) based on a 9% explosive yield and 82 t (74 MT) of residual propellant (no landing burn).

Super Heavy Interstage

The Super Heavy interstage (also known as the hot-staging ring or forward heat shield) will continue to be expended in the Gulf portion of the action area (see OPR-2024-02422), approximately 0.6–249 mi (1–400 km) from shore directly off of the Boca Chica Launch Site and approximately 18.6–248.5 mi (30–400 km) from shore in the western Gulf of Mexico (non-U.S. waters) and Gulf of America (Figure 1). The interstage landing area is at least 20 NM from the Flower Garden Banks National Marine Sanctuary. The interstage is comprised of stainless steel and is approximately 30 ft (9.1 m) in diameter, 5.9 ft (1.8 m) long, and weighs 20,000 lb (9,072 kg). It provides thermal protection against heat produced from Starship engines when the two stages separate. During Super Heavy landings in the Gulf portion of the action area or back at the Boca Chica Launch Site, the interstage will release from Super Heavy. After release, the interstage will gradually drift away from Super Heavy and is expected to land approximately 1.9–2.5 mi (3–4 km) downrange of where Super Heavy lands. Upon impact with the water at terminal velocity, the interstage will break up resulting in debris. The interstage will be expended in the Gulf portion of the action area up to five times a year through calendar year 2026, at which time the interstage will be a permanent fixture on Super Heavy and will no longer be expended.

Starship Operations

Starship may be expended in the Gulf portion of the action area (Figure 1), Atlantic Ocean portion of the action area (Figure 2), Indian Ocean (Indian Ocean portion of the action area; Figure 3), North Pacific Ocean (Hawaii and Central North Pacific portion of the action area and Northeast and Tropical Pacific portion of the action area; Figure 4), or Southeast Pacific (South Pacific portion of the action area; Figure 5). When Starship will be expended in the Gulf and Atlantic Ocean portions of the action area, it will be more than 5 NM from shore, 1–5 NM from shore between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site in the Gulf portion of the action area, or 1–5 NM from shore between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A in the Atlantic Ocean portion of the action area. Starship may also be expended in the Indian Ocean portion of the action area at least 200 NM from any land area. When landing in the Hawaii and Central North Pacific portion of the action area, Starship will be expended at least 100 mi (161 km) from Hawaii and at least 150 mi (241 km) from the Papahānaumokuākea National Marine Sanctuary. Starship landings are expected to generate an overpressure of up to 4 psf.

Until full reusability is achieved, Starship may be expended under the following conditions:

1. In-flight breakup: Starship breaking up during reentry, resulting in debris falling into the Gulf, Atlantic Ocean, Indian Ocean, Hawaii and Central North Pacific, Northeast and Tropical Pacific, and/or South Pacific portions of the action area.
2. Explosive event: Starship lands in the ocean either at terminal velocity, breaking up upon impact with debris contained within approximately 0.6 mi (1 km) of the landing point, or conducts a soft water landing and tips over, impacting the ocean. Both result in an explosive event at the surface of the water.
3. Soft water landing: Starship conducts a soft water landing, tips over, and sinks to the bottom of the ocean.

FAA and SpaceX stated there is no specific information on the Starship landing locations, or on the probability or frequency that Starship landings will occur more often in any given portion of the action area (e.g., closer to the launch site compared to further offshore, or within one portion of the action are more than another portion of the action area). Thus, we conclude that, based on the best available information, Starship landings are equally likely to occur throughout the action area.

As for Super Heavy, if Starship is expended in an area where it becomes a navigational hazard, it will need to be removed from the seafloor and the removal action may be subject to the section 7(a)(2) requirements.

SpaceX provided the best available information on how a Starship explosive event will occur, based on previous launches and tests of similar vehicles. A Starship explosive event is the result of a breakdown of the fuel transfer tube and subsequent mixing and igniting of residual propellant, which will be located, at minimum, 12.8 ft (4.5 m) from the ocean’s surface due to the horizontal orientation of Starship. SpaceX calculated an explosive weight of approximately 21,929 lb (9,947 kg) based on a 9% explosive yield and approximately 77 t (70 MT) of residual propellant in the main tanks, and an 11.9% yield and approximately 34 t (31 MT) of residual propellant in the header tanks (no landing burn).

Number of Launches and Expended Super Heavy and Starship Landings

As noted above, SpaceX anticipates there will be no more than 25 in-flight breakups, 25 soft water landings, and 20 explosive events of each vehicle in each portion of the action area, from the date of issuance of this opinion up to October 2030. Given the launch cadence will increase at an unknown rate before the maximum number of launches from each launch site is reached, NMFS estimated the number of launches and landings that could occur from each launch site for the duration of the proposed FAA license, which expires April 14, 2028 and is also the end date considered in this consultation.

The maximum number of launches that will occur from the Boca Chica Launch Site is 25 per year, and the maximum number of launches that will occur from LC-39A, once operational, is 44 per year. Given the launch cadence will ramp up over time, but the rate of increase is unknown and FAA and SpaceX do not have estimates of launch frequency, NMFS estimated launches will be evenly distributed throughout any given year. At the time of this reinitiation (April 2025), SpaceX has conducted two launches from the Boca Chica Launch Site in 2025 (January 16 and March 6). Thus, there could be an additional 23 launches from Boca Chica in 2025. Launches from LC-39A are expected to start in fall of 2025; the start of the fall season in the United States is approximately three-quarters into the year – September 22, 2025. Thus, a quarter of the maximum number of launches (11) may occur in the last quarter of 2025 from LC-39A. For 2026, there may be a maximum of 25 launches from the Boca Chica Launch Site, and, because there is no information on the rate of launch cadence increase, NMFS estimates the maximum number of launches (44) may occur from LC-39A. For 2027, there may be a maximum of 25 launches from the Boca Chica Launch Site and a maximum of 44 launches from LC-39A. For the portion of 2028 that falls under the current license (January–April 2028), which is approximately one-third of the year, NMFS estimates that one-third of the maximum number of launches from the Boca Chica Launch Site (approximately 9) and LC-39A (approximately 15) will occur. In summary, NMFS estimates that 34 launches will occur in 2025 (April–December), 69 launches will occur in 2026, 69 launches will occur in 2027, and 24 launches will occur in 2028 until the current license expires on April 14, 2028.

FAA and SpaceX do not have estimates of the frequency of in-flight breakups, soft water landings, or explosive events per year, or the distribution of in-flight breakups, soft water landings, or explosive events within a year. Unlike launches, estimating an even distribution of expended vehicle landings across a given year would be inaccurate given the goal is to reach full reusability of the launch vehicle. The launch vehicle is expected to be fully reusable by October of 2030. Thus, while the launch vehicle is still in development, it is reasonable to estimate that a larger proportion of expended vehicle landings will occur earlier within the April 2025 (estimated issuance of this opinion) to October 2030 timeframe (i.e., there should be zero expended vehicle landings by the time the launch vehicle is fully reusable in October 2030). However, there is no estimate on the rate of decrease of these expended vehicle landings, and changes made to the launch vehicle while in development may temporarily increase the number of expended vehicle landings because developing a fully reusable launch vehicle is not a linear process. Thus, NMFS estimates that the maximum number of in-flight breakups (25), soft water landings (25), and explosive events (20) indicated by SpaceX until full reusability will occur for each vehicle, in each portion of the action area over the duration of the license (through April 14, 2028).

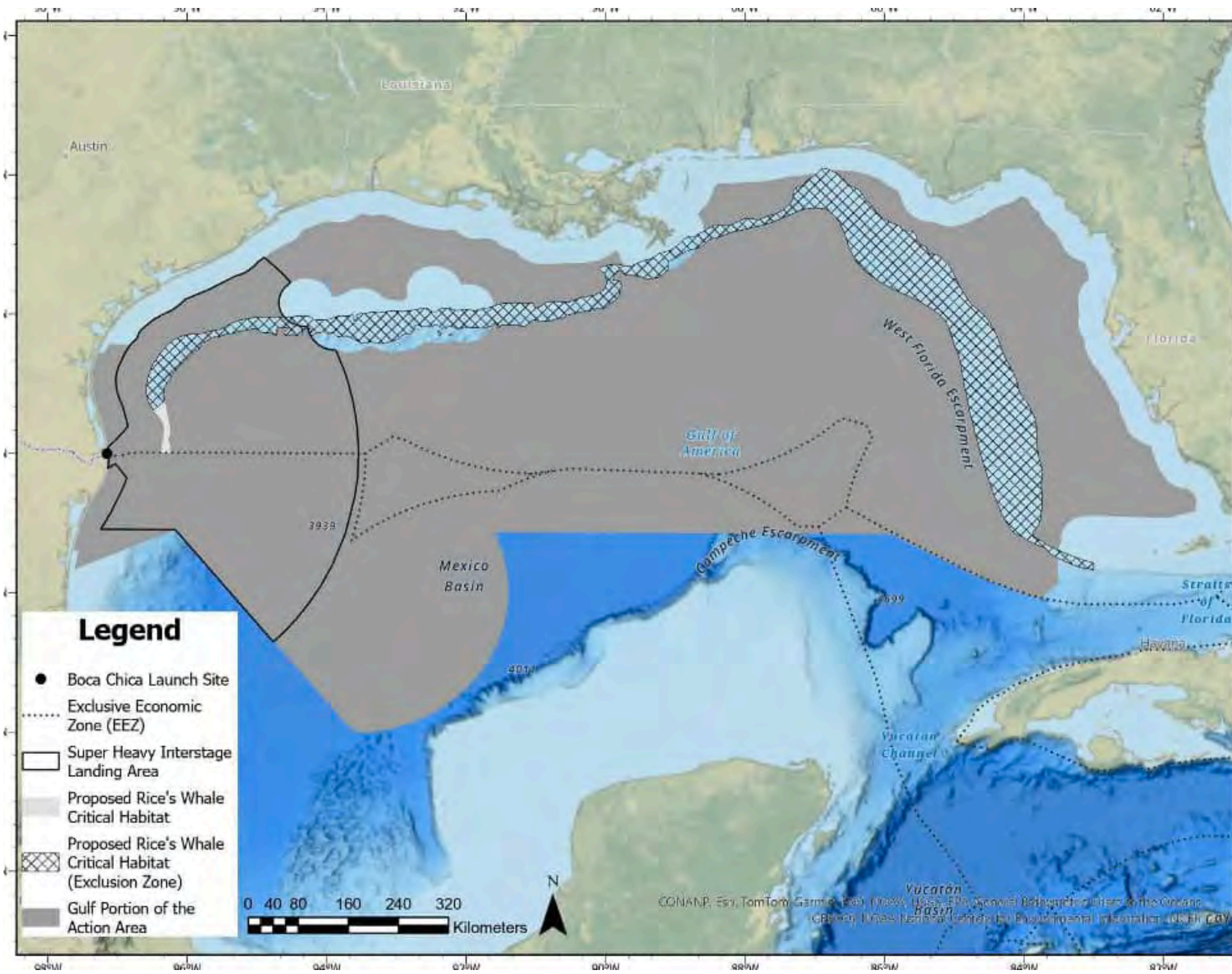

Figure 1. Map of the Gulf portion of the action area (dark grey) with the portion of proposed Rice's whale critical habitat that will be excluded (hatched) and portion of proposed Rice's whale critical habitat that will be included (light grey) in the area where Starship and Super Heavy may land, and Super Heavy interstage landing area (black outline).

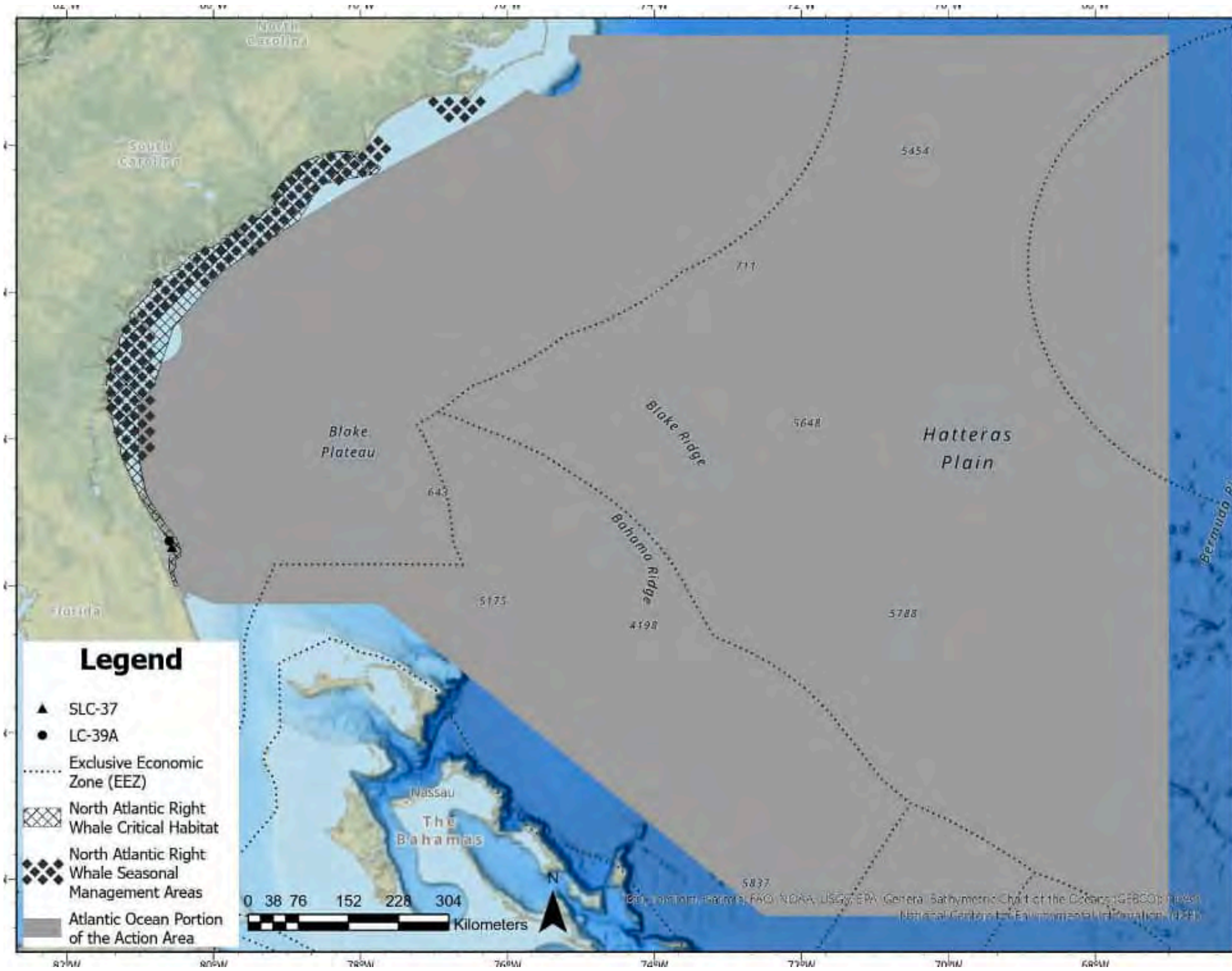

Figure 2. Map of the Atlantic Ocean portion of the action area (non-Gulf), North Atlantic right whale critical habitat (hatched) and Seasonal Management Area (diamonds) shown to illustrate overlap with the Atlantic Ocean portion of the action area.

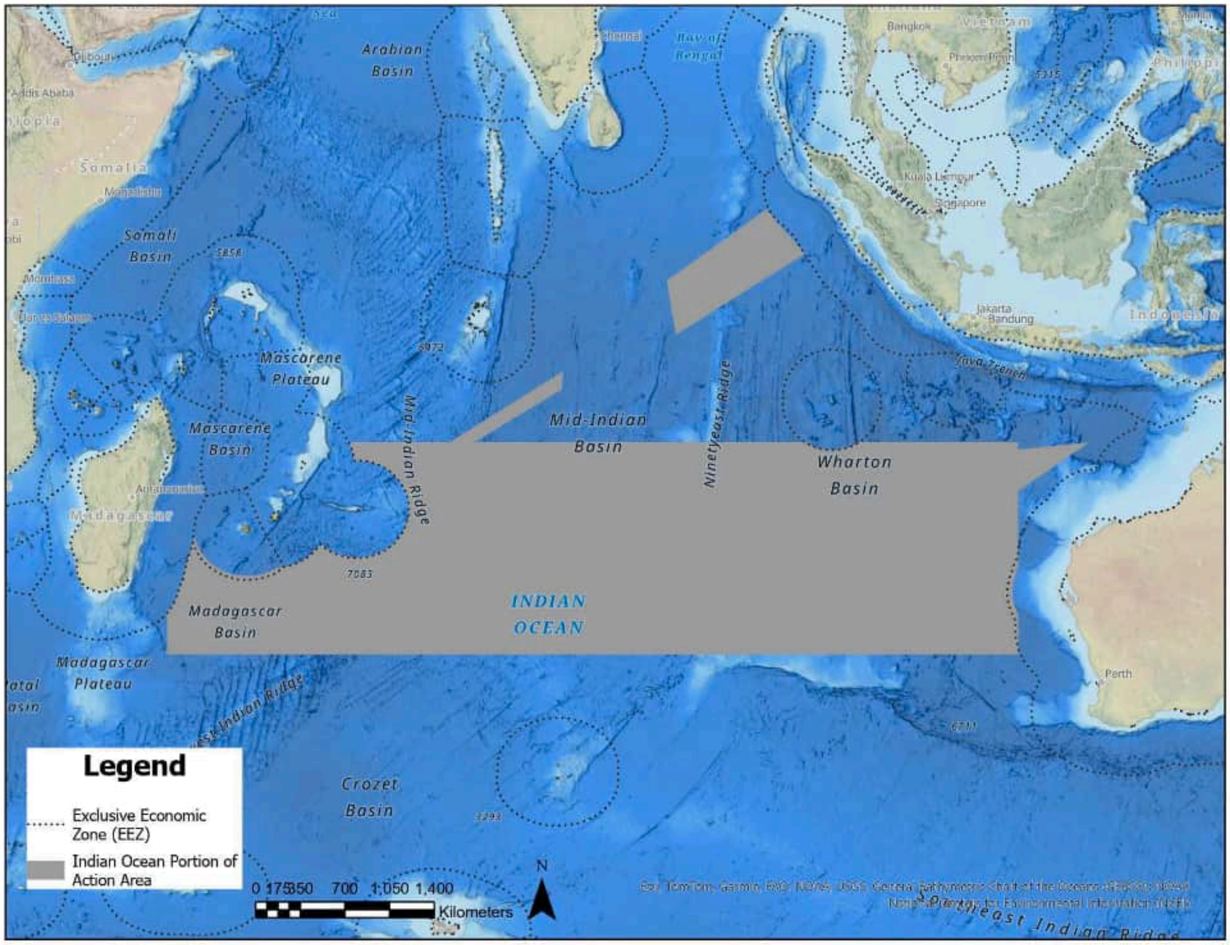

Figure 3. Map of the Indian Ocean portion of the action area.

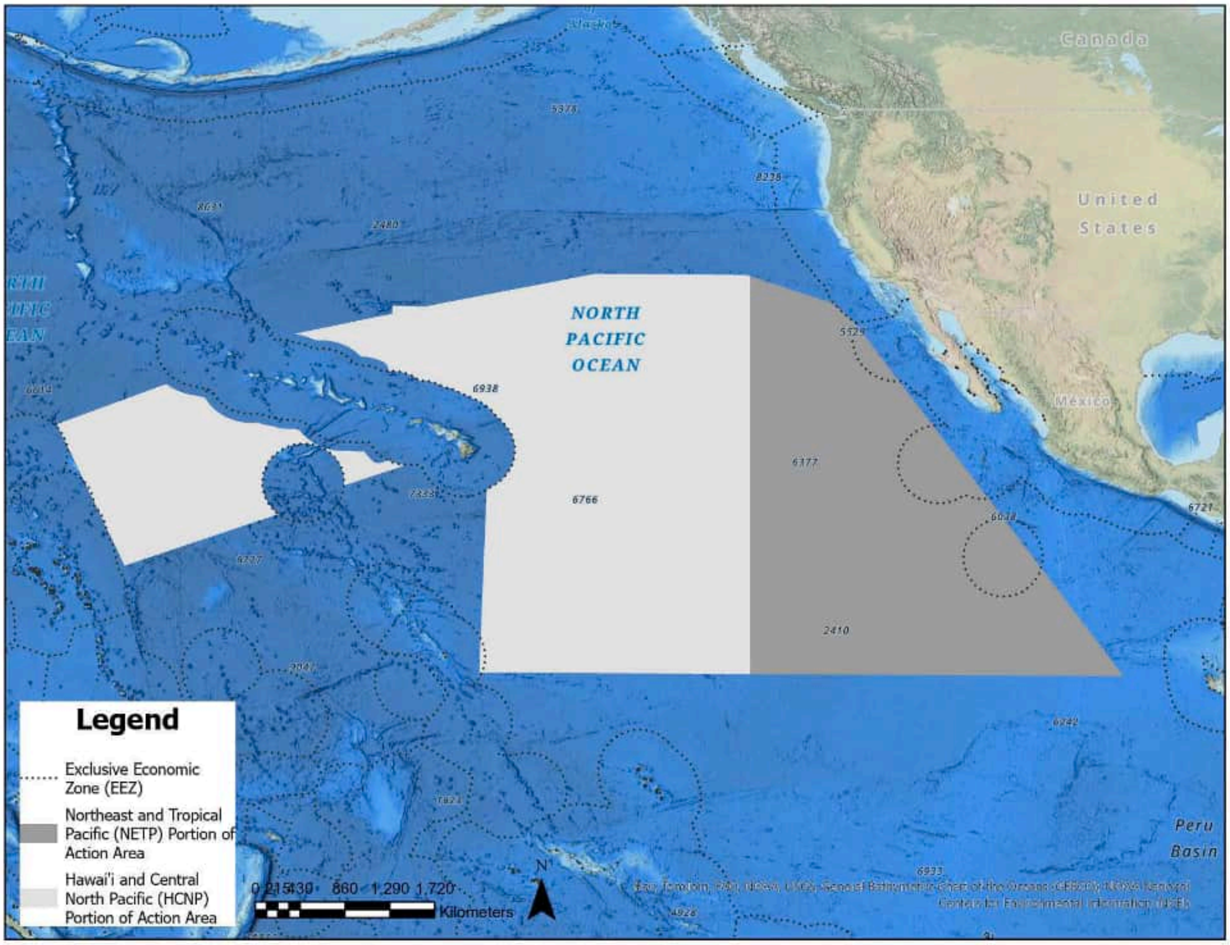

Figure 4. Map of the Hawaii and Central North Pacific portion of the action area (light grey) and Northeast and Tropical Pacific portion of the action area (dark grey).

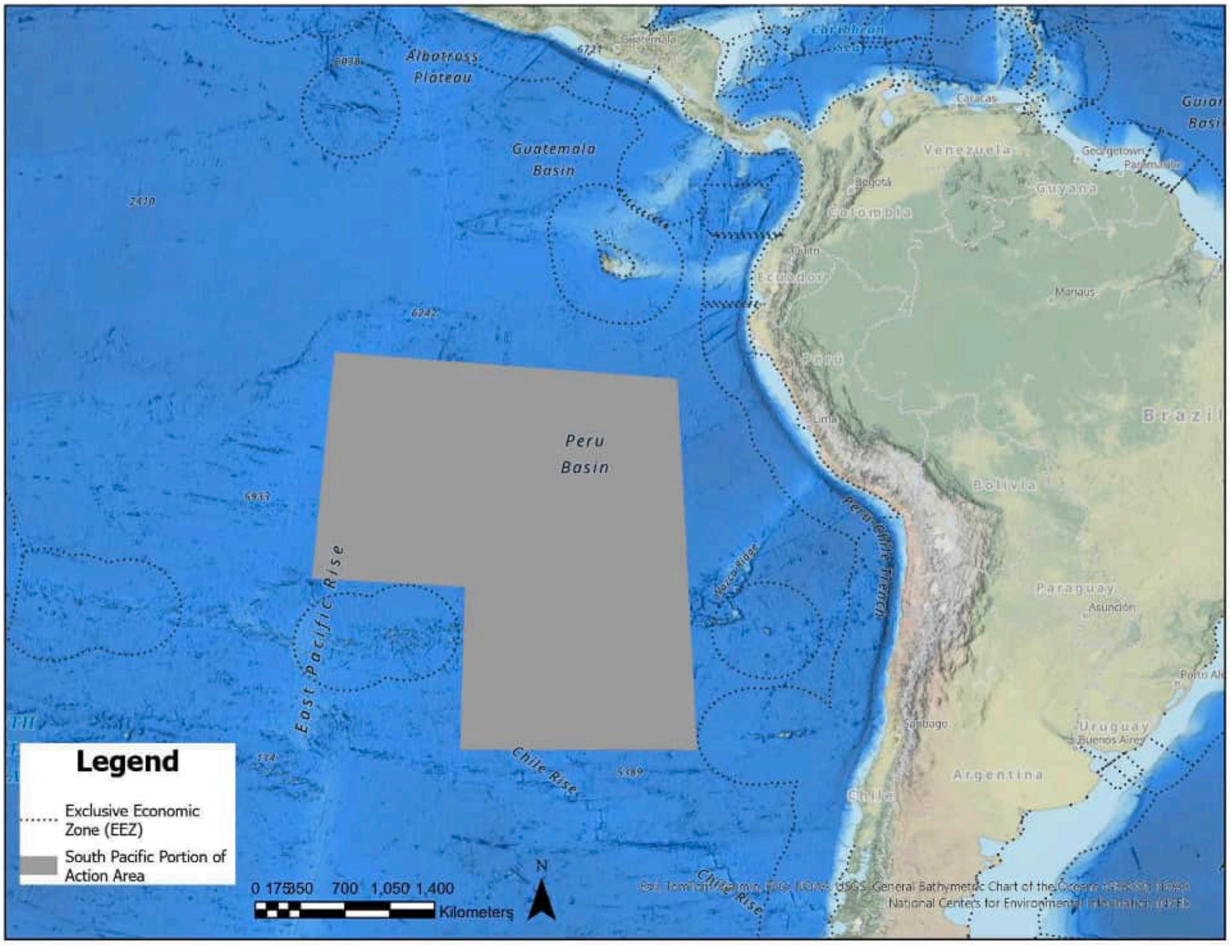

Figure 5. Map of the South Pacific portion of the action area.

Pre- and Post-Launch Activities

Prior to launch, weather balloons will be deployed to measure weather data. Between five and 15 weather balloons are used for each launch. The data, including wind speeds, are necessary to determine if it is safe to launch and land the vehicle. The weather balloons are made of latex with radiosondes attached to each balloon. A radiosonde, typically the size of a half-gallon milk carton, is attached to the weather balloon to measure and transmit atmospheric data to the launch operator. The latex balloon attached to each weather balloon typically has a diameter at launch of approximately four feet (1.2 m). When a balloon is deployed, it rises approximately 12–18 mi (19–29 km) into the air and then bursts. The radiosonde and shredded balloon pieces fall back to Earth and are not recovered. The radiosonde does not have a parachute and is expected to sink to the ocean floor when it lands over water.

A number of spotter aircraft, including drones, and surveillance vessels (or boats) are used during launch activities to ensure that designated hazard areas are clear of non-participating crafts. Combinations of radar, visual spotter aircraft, surface surveillance, and law enforcement vessels, may be deployed prior to launch. Most fixed wing aircraft operate at altitudes of 15,000 ft (4,572 m) but may drop to 1,500 ft (457 m) to obtain a call sign visually from a non-participating vessel.

2.2 Conservation Measures

The FAA will require the implementation of conservation measures in order for their action to result in the least practicable adverse impact to ESA-listed species and their habitat in the different portions of the action area. Conservation measures include measures that avoid or reduce the severity of the effects of the action on ESA-listed species and their critical habitats, and monitoring, which is used to observe or check the progress of the mitigation over time and to ensure that any measures implemented to reduce or avoid adverse effects on ESA-listed species and their critical habitats are successful. This consultation supersedes all previous consultations related to FAA's authorization of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, OPR-2021-02908, and OPR-2024-01147). Conservation measures from previous consultations are incorporated into this consultation and described below. General conservation measures applicable to all portions of the action area are listed first, followed by conservation measures applicable to specific portions of the action area.

General conservation measures:

1. Launch and reentry activities, including vehicle landing locations and breakups, will occur at least 5 NM from the coast of the United States or islands, except between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site and between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A, where launch and reentry activities will occur at least 1 NM from the coast. The only activities that will occur within 1 or 5 NM from the coast will be interstage landings in the Gulf portion of the action area (as described in Section 2.1) and vessel transits to and from a port for surveillance or when recovering launch vehicle components.
2. No vehicle landings or breakups will occur in coral reef areas.
3. No activities will occur in or affect a National Marine Sanctuary unless the appropriate authorization has been obtained from the Sanctuary.
4. If safe and feasible to do so, conduct surveillance via vessel, aircraft (including unmanned aircraft systems/vehicles), or remote camera 30 minutes prior to either vehicle's landing to document any protected species present in the vicinity of the landing area. After the vehicle lands and once safe to do so, conduct surveillance via vessel, aircraft (including unmanned aircraft systems/vehicles), or remote camera to document any potential impacts to protected species (presence, distribution, abundance, and behavior). This documentation will be included in the reports to NMFS prior to the launch vehicle reaching full reusability (see below).

Education and Observation

5. A dedicated observer(s) (e.g., biologist or person other than the vessel operator that can recognize ESA-listed and MMPA-protected species) will be provided by the launch operator to monitor for ESA-listed and MMPA-protected species with the aid of binoculars during all in-water activities, including transit for surveillance or to retrieve launch vehicle stages and components, other launch and reentry-related equipment, or debris.

    a. When an ESA-listed or MMPA-protected species is sighted, the observer will alert vessel operators to implement the appropriate measures (see *Vessel Operations* below).
    b. Dedicated observers will record the date, time, location, species, number of animals, distance and bearing from the vessel, direction of travel, and other relevant information such as behavior, for all sightings of ESA-listed or MMPA-protected species.
    c. Dedicated observers will survey the landing/recovery area for any injured or killed ESA-listed or MMPA-protected species and any discoveries will be reported as noted below.
6. The launch operator will instruct all personnel associated with launch and reentry operations about ESA-listed species and critical habitat, and species protected under the MMPA, that may be present in the operations areas. The launch operator will advise personnel of the civil and criminal penalties for harming, harassing, or killing ESA-listed or MMPA-protected species.

Vessel Operations

All vessel operators will be on the lookout for and attempt to avoid collision with ESA-listed and MMPA-protected species. A collision with an ESA-listed species will require reinitiation of consultation. Vessel operators will ensure the vessel strike avoidance measures and reporting are implemented, and will maintain a safe distance by following these measures:

7. All vessels will be in compliance with all area restrictions.
8. All vessels will slow to 10 knots (kt) or less when mother/calf pairs or groups of marine mammals are observed.
9. All vessels will maintain, at minimum, a distance of 300 ft (91.4 m) from all ESA-listed marine mammals and MMPA-protected species (except for greater distances specified below), and 150 ft (45.7 m) from sea turtles. If this distance becomes less than 300 ft (91.4 m) or 150 ft (45.7 m), the vessel will slow down and shift the engine to neutral until the animal(s) have left the area.
10. All vessels will attempt to remain parallel or transit away to an ESA-listed species' course when sighted while the vessel is in transit (e.g., bow riding) and avoid excessive speed or abrupt changes in direction until the animal(s) has left the area.

Reporting Stranded, Injured, or Dead Animals

11. Any ESA-listed species collision(s), injuries, mortalities, or strandings observed will be reported immediately to the appropriate NMFS regional contact listed below (see also (https://www.fisheries.noaa.gov/report), to Tanya Dobrzynski, Chief, ESA Interagency Cooperation Division, by email at Tanya.Dobrzynski@noaa.gov, and to nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2025-00164– Collision, Injury, or Mortality Report."
    a. For operations in the Gulf and Atlantic Ocean: for marine mammals (877) WHALE-HELP (877-942-5343) and for sea turtles (844) SEA-TRTL (844-732-8785)
    b. For operations in the North Pacific Ocean: (866) 767-6114 (West Coast) or (888) 256-9840 (Hawaii)

c. In the Gulf and Atlantic Ocean near Florida, report any smalltooth sawfish sightings to (844) 4SAWFISH or (844) 472-9347 or via email sawfish@fwc.com
d. Report any giant manta ray sightings to (727) 824-5312 or via email to manta.ray@noaa.gov
e. Report any injured, dead, or entangled North Atlantic right whales to (877) WHALE-HELP (877) 942-5343 and the U.S. Coast Guard via VHF Channel 16

Aircraft Procedures
Aircraft will maintain a minimum of 1,000 ft (304.8 m) over ESA-listed or MMPA-protected species and 1,500 ft (457.2 m) above North Atlantic right whales. Aircraft will avoid flying in circles, if marine mammals or sea turtles are spotted, and avoid any type of harassing behavior.

Hazardous Materials Emergency Response
In the event of a failed launch operation, launch operators will follow the emergency response and cleanup procedures outlined in their Hazardous Material Emergency Response Plan (or similar plan). Procedures may include containing the spill using disposable containment materials and cleaning the area with absorbents or other materials to reduce the magnitude and duration of any impacts.

Gulf portion of the action area conservation measures:

1. Reentry trajectories will be planned to avoid vehicle (Super Heavy and Starship) landings, explosions, and breakups within Rice's whale core distribution area and proposed critical habitat. Vehicles may only land in a small portion of Rice's whale proposed critical habitat (see Figure 1) off Boca Chica, Texas. For a single flight, Super Heavy and Starship will not both land in this small portion of Rice's whale proposed critical habitat.
2. All vessels will slow to 10 kt or less when Rice's whales are observed and maintain a minimum distance of 1,500 ft (457.2 m) from Rice's whales. If a whale is observed but cannot be confirmed as a species other than a Rice's whale, the vessel operator must assume that it is a Rice's whale and take appropriate action.
3. Avoid vessel transit in the Rice's whale core distribution area and proposed critical habitat. No vessel transit will occur at night in Rice's whale area or proposed critical habitat. If transit in the Rice's whale area or proposed critical habitat is required, avoid areas where water depth is 328–1,394 ft (100–425 m; where Rice's whale has been observed; Rosel et al. 2021) and transit as slowly as practicable, limiting speeds to 10 kt or less.

Atlantic Ocean portion of the action area (non-Gulf) conservation measures:

1. All vessels will slow to 10 kt or less when North Atlantic right whales are observed and maintain a minimum distance of 1,500 ft (457.2 m) from North Atlantic right whales. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take appropriate action.
2. All vessels will comply with applicable North Atlantic right whale speed rules, including Seasonal Management Areas, Slow Zones, and Dynamic Management Areas.

Information on Seasonal Management Areas, Slow Zones, Dynamic Management Areas, and how to sign up for alerts is available at NMFS's Reducing Vessel Strikes to North Atlantic Right Whales website.
3. For a single flight, Super Heavy and Starship will not both land in the portion of the Atlantic Ocean portion of the action area that overlaps North Atlantic right whale critical habitat and North Atlantic right whale Seasonal Management Areas from November 1 through April 30.
4. No vehicle (Super Heavy or Starship) landings, explosions, or breakups will occur within designated North Atlantic right whale Slow Zones or Dynamic Management Areas, if the Slow Zone or Dynamic Management Area is established prior to launch.

Indian Ocean portion of the action area conservation measures:
1. To the maximum extent practicable, Starship landings will avoid Important Marine Mammal Areas[2] and Ecologically or Biologically Significant Areas[3].
2. If possible, Starship landings will also avoid other physiographic features, such as seamounts, that may provide conservation benefits to listed species.

Hawaii and Central North Pacific portion of the action area conservation measures:
1. Although unlikely, to prevent debris from a Starship explosive event or in-flight breakup from entering the Papahānaumokuākea National Marine Sanctuary, SpaceX will have a vessel in the area of highest likelihood of debris that will identify large debris for salvage. SpaceX will use the vessel to survey for debris for approximately 24– 48 hours (using visual survey in the daytime and onboard vessel radar at night) depending on the outcome of the breakup. If there is floating debris detected by the vessel during the debris survey, SpaceX will sink or recover any debris before it can drift into the Papahānaumokuākea National Marine Sanctuary by removing the item using a net or boat hook, or puncturing the item using a firearm to cause it to sink. If debris is still identified after the 24–48 hour survey, SpaceX will use an aerial asset, additional vessel, or satellite imaging, to confirm and characterize any debris to verify that debris sinks within 10 days.

Reporting to NMFS

This consultation supersedes all previous consultations related to FAA's authorization of Starship-Super Heavy operations (OPR-2024-02422, OPR-2024-00211, OPR-2023-00318, OPR-2021-02908, and OPR-2024-01147). Reporting requirements from previous consultations are incorporated into this consultation and described below.

Prior to full reusability of the launch vehicle, FAA, in coordination with SpaceX, will provide a report after each Starship-Super Heavy flight. Reports after each flight, prior to achieving full

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[2] Important Marine Mammal Areas (IMMAs) are "discrete portions of habitat, important to marine mammal species that have the potential to be delineated and managed for conservation." For more information, see https://www.marinemammalhabitat.org/immas/ and https://www.marinemammalhabitat.org/imma-eatlas/

[3] Ecologically or Biologically Significant Areas (EBSAs) under the Convention on Biological Diversity are marine areas that are functionally important in supporting healthy oceans and ocean services. For more information, see https://www.cbd.int/ebsa/.

reusability, should be submitted no more than 30 days after the flight to NMFS electronically at nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2025-00164 [Flight #] Fate Report."

After each Starship-Super Heavy flight prior to achieving full reusability, FAA will provide information to NMFS detailing the results of launches and landings, based on available telemetry data received from the vehicles, including:

1. Whether Starship and Super Heavy resulted in an anomaly or nominal (i.e., all operations occurred as expected) landing, and where (expressed in the last known GPS location) the anomaly or landing occurred.
2. The debris catalog generation, approximate location, and any other information that can corroborate assumptions about the debris and/or debris field from an in-flight breakup or explosive event of each vehicle.
3. Whether Starship and Super Heavy landings occurred in the expected manner. For landings resulting in explosion, information reported to NMFS shall include: the amount of fuel/propellant remaining in main and header tanks, vehicle orientation upon landing and height of the explosive event above the surface of the water, debris catalog generation, and any other data that can corroborate whether the assumptions about the explosion and area of impact (physically and acoustically) were appropriate.
4. Any documentation of ESA-listed species pre- and post-landing, per items 4 and 5 under General Conservation Measures.

2.3 Activities Caused by the Action

Because the Starship-Super Heavy launch vehicle is designed to be a reusable transportation system, which is capable of carrying reusable payloads of up to 165 t (150 MT) and expendable payloads of up to 276 t (250 MT), there are various activities that will occur because of FAA's licensing of Starship-Super Heavy launch and reentry operations. These activities include, but are not necessarily limited to, launching satellites and capsules (or other payloads, and subsequent reentry of those satellites, capsules, and payloads later in time) and DoD projects (e.g., using Starship to explore rapid global mobility). Activities that use Starship-Super Heavy capabilities are more than likely to occur once the launch vehicle is fully reusable (after October 2030). Exact projects, missions, and payloads that may affect ESA-listed or proposed species and their designated or proposed critical habitat are currently unknown and may require separate consultation or conference.

Anomalies and mishaps have also occurred and may continue to occur as a result of FAA's licensing of Starship-Super Heavy launch and reentry operations. An *anomaly* is any condition during a licensed activity "that deviates from what is standard, normal, or expected, during the verification or operation of a system, subsystem, process, facility, or support equipment" and a *mishap* means "any event, or series of events associated with a licensed or permitted activity resulting in any of the following: (1) a fatality or serious injury; (2) a malfunction of a safety-critical system; (3) a failure of the licensee's or permittee's safety organization, safety operations, safety procedures; (4) high risk, as determined by the FAA, of causing a serious or fatal injury to any space flight participant, crew, government astronaut, or member of the public; (5) substantial damage, as determined by the FAA, to property not associated with licensed or permitted activity; (6) unplanned substantial damage, as determined by the FAA, to property associated with licensed or permitted activity; (7) unplanned permanent loss of a launch or reentry vehicle during licensed activity or permitted activity; (8) the impact of hazardous debris outside the planned landing site or designated hazard area; or (9) failure to complete a launch or reentry as planned as reported in" the licensee's mission information (14 CFR §401.7). At the time of this reinitiation, SpaceX had conducted eight flights of Starship-Super Heavy. The first three flights resulted in mishaps to both vehicles within the action area considered in the ESA section 7 consultations conducted for the flights. The most recent flights, Flights 7 and 8, resulted in mishaps to Starship outside the action area of previous consultations. Mishaps occurred due to a variety of reasons related to engine failure, propellant leaks, and vehicle malfunctions, and were characterized by the vehicle(s) exploding at altitude, with debris entering the ocean. As SpaceX works towards a fully reusable vehicle, mishaps are expected to continue.

2.4 Stressors Resulting from the Components of the Proposed Action

In this section, the direct or indirect modifications to the land, water, or air caused by an action are identified stressors. This section identifies all of the stressors that may affect listed species, as well as the sources of those stressors. Some stressors may have multiple sources. Likewise, multiple sources may combine to create a stressor that would not exist if only one of the sources were present. The following is a summarization of stressors that are reasonably certain to be caused by this action:

1. Sonic booms and impulse noise generated during launches and landings;
2. Direct impact by fallen objects (radiosonde, Super Heavy, Starship, interstage, debris);
3. Impacts from unrecovered debris;
4. Impacts from pollution (vessel and vehicle emissions, propellant);
5. Vessel presence, strike, and noise;
6. Aircraft overflight;
7. In-air acoustic effects from vehicle landings and explosive events;
8. Vibration, heat, and debris from launches;
9. Heat from vehicle landings and explosive events; and
10. Underwater acoustic effects from explosive events.

3. Action Area

Action area means "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). The action area is defined by the extent of the environmental changes the stressors cause on the physical environment (e.g., land, air or water, detailed in the previous section). The action area includes portions of the Gulf of Mexico (non-U.S. waters), Gulf of America, another area in the Atlantic Ocean, Indian Ocean, North Pacific Ocean, and South Pacific Ocean (see Figures 1–5) where Super Heavy and/or Starship will be expended until full reusability is achieved. The action area also includes waters between the Super Heavy and Starship landing areas and shore (except for in the Indian Ocean), where vessels are expected to transit between ports and landing locations for surveillance or recovery of launch vehicle components. These are coastal waters off the Hawaiian archipelago, Southern California (south of the Santa Maria River), Mexico, Central America, Peru, Chile, Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina.

They do not include ports or waters that occur within or adjacent to the critical habitats of ESA-listed anadromous fishes, and where those species aggregate for spawning, recruitment, and other important life functions.

The action area also includes waters where mishaps may occur. Based on limited information on where mishaps have previously occurred, NMFS estimated an additional area where mishaps may occur in the future based on limited knowledge of debris areas and trajectories from previous flights (Figure 6). We note that mishaps have occurred shortly after launch, and it is expected that mishaps could occur within the Gulf and Atlantic Ocean portions of the action area downrange of the launch sites.

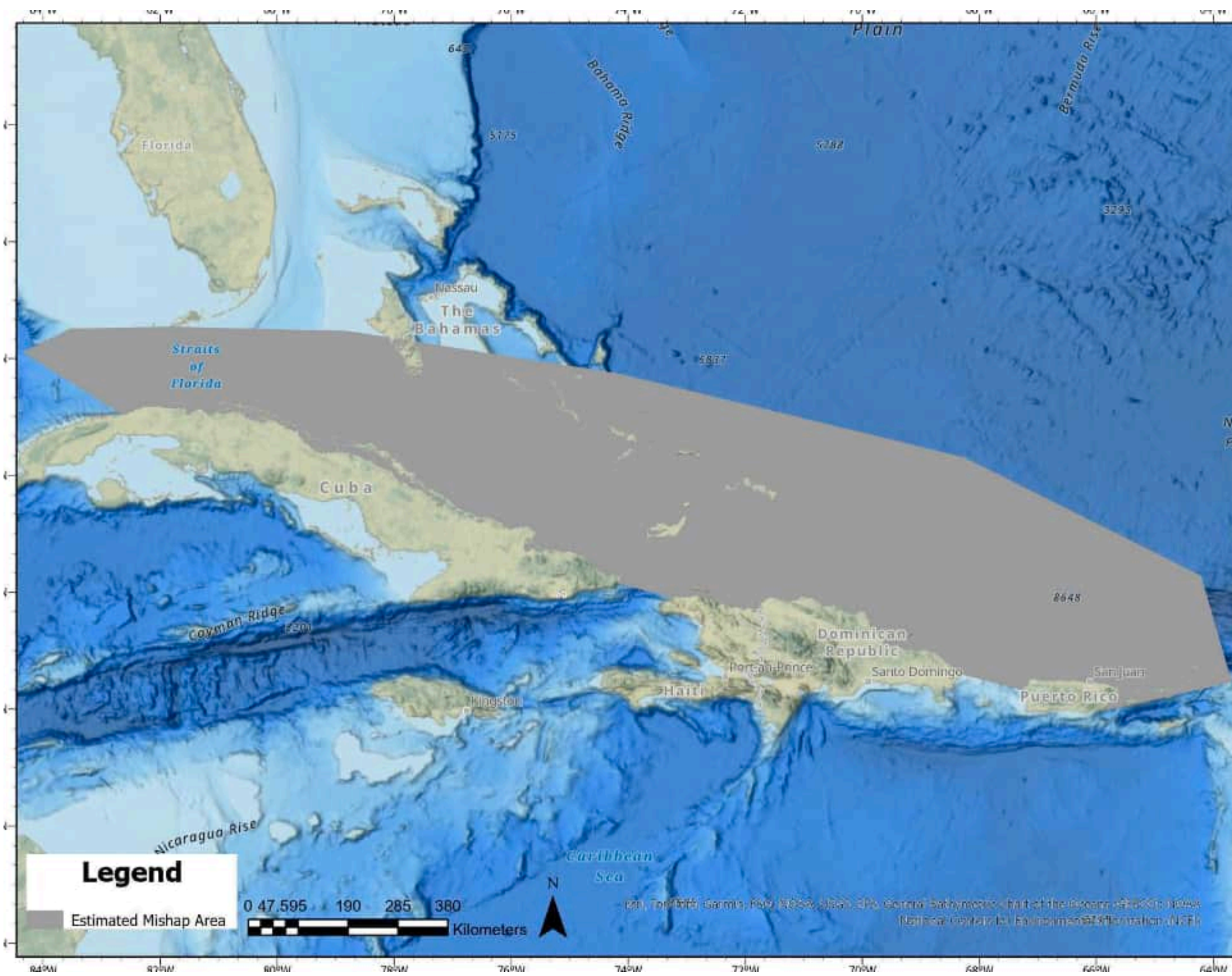

Figure 6. Mishap area estimated by NMFS included in the action area.

4. Species and Critical Habitat that May be Affected by the Proposed Action

The ESA allows for three general determinations for listed species and critical habitat: 1) no effect, 2) may affect, not likely to adversely affect (NLAA), and 3) may affect, likely to adversely affect (LAA). Action agencies, prior to requesting ESA consultation, determine whether their proposed action may affect ESA-listed or proposed species or their designated or proposed critical habitat. Generally, a "no effect" determination means there is no plausible exposure or response to stressors generated by the proposed action for any ESA-listed or proposed species or designated or proposed critical habitat. A "no effect" determination does not require consultation. Any scenario where there is a plausible exposure to stressors generated by the action, no matter how unlikely, is considered "may affect." For any action that "may affect" an ESA-listed species or its designated critical habitat, the action agency shall consult with the Services under section 7(a)(2) of the ESA. An action agency is also required to confer with the Services on any effects to proposed species or proposed critical habitat if those effects are likely to jeopardize the continued existence of the species, or destroy or adversely modify the proposed critical habitat. However, action agencies may voluntarily confer with the Services for all proposed species or proposed critical habitat in the action area when the action may affect those proposed entities without rising to a level requiring us to confer.

Table 1. Species and critical habitat present in the action area

Species	ESA Status	Critical Habitat	Recovery Plan
Blue Whale (*Balaenoptera musculus)*	E – 35 Fed. Reg. 18319	-- --	07/1998 11/2020
False Killer Whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular DPS	E – 77 Fed. Reg. 70915	83 Fed. Reg. 35062	86 Fed. Reg. 60615 10/2021
Fin Whale (*Balaenoptera physalus)*	E – 35 Fed. Reg. 18319	-- --	75 Fed. Reg. 47538 07/2010
Gray Whale (*Eschrichtius robustus*) – Western North Pacific DPS	E – 35 Fed. Reg. 18319	-- --	-- --
Humpback Whale (*Megaptera novaeangliae*) – Central America DPS	E – 81 Fed. Reg. 62259	86 Fed. Reg. 21082	11/1991 06/2022 (Outline)
Humpback Whale (*Megaptera novaeangliae*) – Mexico DPS	T – 81 Fed. Reg. 62259	86 Fed. Reg. 21082	11/1991 06/2022 (Outline)
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 Fed. Reg. 12024	81 Fed. Reg. 4837	70 Fed. Reg. 32293 08/2004
North Pacific Right Whale (*Eubalaena japonica*)	E – 73 Fed. Reg. 12024	73 Fed. Reg. 19000**	78 Fed. Reg. 34347 06/2013

Species	ESA Status	Critical Habitat	Recovery Plan
Sei Whale (*Balaenoptera borealis*)	E – 35 Fed. Reg. 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 Fed. Reg. 18319	-- --	75 Fed. Reg. 81584 12/2010
Rice's Whale (*Balaenoptera ricei*)	E – 84 Fed. Reg. 15446 and 86 Fed. Reg. 47022	88 Fed. Reg. 47453 (Proposed)	09/2020 (Outline)
Guadalupe Fur Seal (*Arctocephalus townsendi*)	T – 50 Fed. Reg. 51252	-- --	-- --
Hawaiian Monk Seal (*Neomonachus schauinslandi*)	E – 41 Fed. Reg. 51611	80 Fed. Reg. 50925	72 Fed. Reg. 46966 2007
Green Turtle (*Chelonia mydas*) – Central North Pacific DPS	T – 81 Fed. Reg. 20057	88 Fed. Reg. 46572 (Proposed)	63 Fed. Reg. 28359 01/1998
Green Turtle (*Chelonia mydas*) – East Indian-West Pacific DPS	T – 81 Fed. Reg. 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – East Pacific DPS	T – 81 Fed. Reg. 20057	88 Fed. Reg. 46572 (Proposed)	63 Fed. Reg. 28359 01/1998
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 Fed. Reg. 20057	63 Fed. Reg. 46693 88 Fed. Reg. 46572 (Proposed)	10/1991 – U.S. Atlantic
Green Turtle (*Chelonia mydas*) – North Indian DPS	T – 81 Fed. Reg. 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – South Atlantic DPS	T – 81 Fed. Reg. 20057	88 Fed. Reg. 46572** (Proposed)	10/1991 – U.S. Atlantic
Green Turtle (*Chelonia mydas*) – Southwest Indian DPS	T – 81 Fed. Reg. 20057	-- --	-- --
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 Fed. Reg. 8491	63 Fed. Reg. 46693**	57 Fed. Reg. 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico

Species	ESA Status	Critical Habitat	Recovery Plan
			63 Fed. Reg. 28359 05/1998 – U.S. Pacific
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 Fed. Reg. 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 Fed. Reg. 8491	44 Fed. Reg. 17710 77 Fed. Reg. 4170	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 Fed. Reg. 28359 05/1998 – U.S. Pacific
Loggerhead Turtle (*Caretta caretta*) – North Indian Ocean DPS	E – 76 Fed. Reg. 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – North Pacific Ocean DPS	E – 76 Fed. Reg. 58868	-- --	63 Fed. Reg. 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 Fed. Reg. 58868	79 Fed. Reg. 39855	74 Fed. Reg. 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific 01/2009 – Northwest Atlantic
Loggerhead Turtle (*Caretta caretta*) – South Pacific Ocean DPS	E – 76 Fed. Reg. 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – Southeast Indo-Pacific Ocean DPS	T – 76 Fed. Reg. 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) –	T – 76 Fed. Reg. 58868	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
Southwest Indian Ocean DPS			
Olive Ridley Turtle (*Lepidochelys olivacea*) – All Other Areas/Not Mexico's Pacific Coast Breeding Colonies	T – 43 Fed. Reg. 32800	-- --	-- --
Olive Ridley Turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast Breeding Colonies	E – 43 Fed. Reg. 32800	-- --	63 Fed. Reg. 28359
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS	E – 77 Fed. Reg. 5913	82 Fed. Reg. 39160**	02/2012 (Outline)
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Chesapeake Bay DPS	E – 77 Fed. Reg. 5880	82 Fed. Reg. 39160**	02/2012 (Outline)
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – South Atlantic DPS	E – 77 Fed. Reg. 5913	82 Fed. Reg. 39160**	02/2012 (Outline)
Giant Manta Ray (*Manta birostris*)	T – 83 Fed. Reg. 2916	-- --	12/2019 (Outline)
Green Sturgeon (*Acipenser medirostris*) – Southern DPS	T – 71 Fed. Reg. 17757	74 Fed. Reg. 52300**	8/2018
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	T – 56 Fed. Reg. 49653	68 Fed. Reg. 13370	09/1995
Nassau Grouper (*Epinephelus striatus*)	T – 81 Fed. Reg. 42268	89 Fed. Reg. 126**	8/2018 (Outline)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 Fed. Reg. 4153	-- --	89 Fed. Reg. 56865 7/2024
Scalloped Hammerhead Shark	T – 79 Fed. Reg. 38213	-- --	-- --

Species	ESA Status	Critical Habitat	Recovery Plan
(*Sphyrna lewini*) – Central and Southwest Atlantic DPS			
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Eastern Pacific DPS	E – 79 Fed. Reg. 38213	-- --	-- --
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Indo-West Pacific DPS	T – 79 Fed. Reg. 38213	-- --	-- --
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 Fed. Reg. 4001	-- --	63 Fed. Reg. 69613 12/1998
Smalltooth Sawfish (*Pristis pectinata*) – U.S. portion of range DPS	E – 68 Fed. Reg. 15674	74 Fed. Reg. 45353*	74 Fed. Reg. 3566 01/2009
Steelhead Trout (*Oncorhynchus mykiss*) – South-Central California Coast DPS	T – 71 Fed. Reg. 834	70 Fed. Reg. 52487**	78 Fed. Reg. 77430
Steelhead Trout (*Oncorhynchus mykiss*) – Southern California DPS	E – 71 Fed. Reg. 834	70 Fed. Reg. 52487**	77 Fed. Reg. 1669
Black Abalone (*Haliotis cracherodii*)	E – 74 Fed. Reg. 1937	76 Fed. Reg. 66805	85 Fed. Reg. 5396
Boulder Star Coral (*Orbicella franksi*)	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Elkhorn Coral (*Acropora palmata*)	T – 79 Fed. Reg. 53851	73 Fed. Reg. 72210	80 Fed. Reg. 12146
Lobed Star Coral (*Orbicella annularis*)	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Mountainous Star Coral (*Orbicella faveolata*)	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Pillar Coral (*Dendrogyra cylindrus*)	E – 89 Fed. Reg. 101993	88 Fed. Reg. 54026	03/2015 (Outline)

Species	ESA Status	Critical Habitat	Recovery Plan
Rough Cactus Coral *(Mycetophyllia ferox)*	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026	03/2015 (Outline)
Staghorn Coral (*Acropora cervicornis*)	T – 79 Fed. Reg. 53851	73 Fed. Reg. 72210	80 Fed. Reg. 12146
Sunflower Sea Star (*Pycnopodia helanthoides*)	T – 88 Fed. Reg. 16212 (Proposed)	-- --	-- --

Fed. Reg. = *Federal Register*; E = Endangered; T = Threatened; DPS = Distinct Population Segment
* Designated critical habitat overlaps with the action area but the action will have no effect on any PBFs
** Designated critical habitat does not overlap with the action area

Table 2. Physical or Biological Features (PBFs) of designated or proposed critical habitat (CH) present in the action area that may be affected by the proposed action

Designated or Proposed Critical Habitat	**PBFs**
False Killer Whale – Main Hawaiian Islands Insular DPS	Currently designated CH: Main Hawaiian Islands – waters 45 m to 3,200 m depth Designated CH PBFs: 1. Adequate space for movement and use within shelf and slope habitat 2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth 3. Waters free of pollutants of a type and amount harmful to Main Hawaiian Islands Insular DPS false killer whales 4. Sound levels that would not significantly impair false killer whales' use or occupancy
Humpback Whale – Central America DPS	Currently Designated CH: California – marine habitat within portions of the California Coastal Ecosystem Designated CH PBFs: 1. Prey species, primarily euphausiids (*Thysanoessa, Euphausia, Nyctiphanes,* and *Nematoscelis*) and small pelagic schooling fishes, such as Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), and Pacific herring (*Clupea pallasii*), of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth
Humpback Whale – Mexico DPS	Currently Designated CH: California – marine habitat within portions of the California Coastal Ecosystem Designated CH PBFs: 1. Prey species, primarily euphausiids (*Thysanoessa, Euphausia, Nyctiphanes,* and *Nematoscelis*) and small pelagic schooling fishes, such as Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasii*), capelin (*Mallotus villosus*), juvenile walleye pollock (*Gadus chalcogrammus*), and Pacific sand lance (*Ammodytes personatus*) of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth
Hawaiian Monk Seal	Currently Designated CH:

Designated or Proposed Critical Habitat	PBFs
	Northwestern Hawaiian Islands – all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and including marine habitat through the water's edge, including the seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, out to the 200-m depth contour line around the following 10 areas: Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island Main Hawaiian Islands – marine habitat from the 200-m depth contour line, including the seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, through the water's edge 5 m into the terrestrial environment from the shoreline between identified boundary points on the islands of: Ka'ula, Ni'ihau, Kaua'i, O'ahu, Maui Nui (including Kaho'olawe, Lana'i, Maui, and Moloka'i), and Hawai'i Designated CH PBFs: 1. Marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk sea foraging
North Atlantic Right Whale	Currently Designated CH: Southeastern U.S. Calving Area – Cape Fear, North Carolina to approximately 27 NM below Cape Canaveral, Florida Designated CH PBFs: 1. Calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale 2. Sea surface temperatures from a minimum of 7°C, and never more than 17°C
Leatherback Turtle	Currently Designated CH: California coast – Point Arena to Point Arguello east of the 3,000-m depth contour Designated CH PBFs: 1. Occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (e.g., *Chrysaora, Aurelia, Phacellophora,* and *Cyanea*), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks
Loggerhead Turtle – Northwest Atlantic Ocean DPS	Currently Designated CH:

<table>
<tr><th>Designated or Proposed Critical Habitat</th><th>PBFs</th></tr>
<tr><td></td><td>Northwest Atlantic Ocean DPS range – neritic (nearshore reproductive, foraging, winter, breeding, and migratory) and Sargassum habitat

Designated CH PBFs:
1. Nearshore Reproductive Habitat --
2. Foraging Habitat – (1) Sufficient prey availability and quality, such as benthic invertebrates, including crabs (spider, rock, lady, hermit, blue, horseshoe), mollusks, echinoderms and sea pens
3. Winter Habitat --
4. Breeding Habitat – (1) High densities of reproductive male and female loggerheads
5. Constricted Migratory Habitat – (1) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas
6. Sargassum Habitat – (1) Sargassum in concentrations that support adequate prey abundance and cover; (2) Available prey and other material associated with Sargassum habitat including, but not limited to, plants and cyanobacteria and animals native to the Sargassum community such as hydroids and copepods; and (3) Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by Sargassum for post-hatchling loggerheads, i.e., >10 m depth</td></tr>
<tr><td>Gulf Sturgeon</td><td>Currently Designated CH:
Gulf of America – estuarine and marine habitat

Designated CH PBFs:
1. Abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages
2. Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages</td></tr>
<tr><td>Nassau Grouper</td><td>Currently Designated CH:
Puerto Rico – Desecheo Island, Northeast, Vieques Island, Isla De Culebra/Culebrita
U.S. Virgin Islands – St. Thomas, St. John
Florida – Big Pine Key to Geiger Key, Key West, New Ground Shoal</td></tr>
</table>

Designated or Proposed Critical Habitat	**PBFs**
	Spawning Sites – Grammanik Bank and Hind Bank, and Riley's Hump Designated CH PBFs: 1. Recruitment and developmental habitat – Areas from nearshore to offshore necessary for recruitment, development, and growth of Nassau grouper containing a variety of benthic types that provide cover from predators and habitat for prey, consisting of the following: (1) Nearshore shallow subtidal marine nursery areas with substrate that consists of unconsolidated calcareous medium to very coarse sediments and shell and coral fragments and may also include cobble, boulders, whole corals and shells, or rubble mounds, to support larval settlement and provide shelter from predators during growth and habitat for prey; (2) Intermediate hardbottom and seagrass areas in closer proximity to the nearshore shallow subtidal marine nursery areas that provide refuge and prey resources for juvenile fish; (3) Offshore linear and patch reefs in close proximity to intermediate hardbottom and seagrass areas that contain multiple benthic types to provide shelter from predation during maturation and habitat for prey; and (4) Structures between the subtidal nearshore area and the intermediate hardbottom and seagrass area and the offshore reef area to support juveniles and adults as movement corridors that include temporary refuge that reduces predation risk as Nassau grouper move from nearshore to offshore habitats 2. Spawning habitat --
Black Abalone	Currently Designated CH: California – rocky intertidal and subtidal habitat from the Mean Higher High Water line to a depth of 6 m relative to the Mean Lower Low Water line, and coastal marine waters encompassed by these areas from Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula, as well as on the Farallon Islands, Año Nuevo Island, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Island Designated CH PBFs: 1. Suitable water quality including temperature, salinity, pH, and other chemical characteristics necessary for normal settlement, growth, behavior, and viability
Boulder Star Coral	Currently Designated CH:

Designated or Proposed Critical Habitat	PBFs
	Florida – Government Cut, Miami-Dade County to Dry Tortugas (0.5–40 m) Puerto Rico – All islands (0.5–90 m) U.S. Virgin Islands – St. Thomas and St. John (0.5–90 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Elkhorn Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Key West, Monroe County (Mean Low Water Line to 30 m); Dry Tortugas (Mean Low Water Line to 30 m) Puerto Rico – All islands (<30 m depth) U.S. Virgin Islands – St. Thomas and St. John (<30 m depth) Designated CH PBFs: Substrate of suitable quality and availability (natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover) to support larval settlement and recruitment, and reattachment and recruitment of asexual fragments
Lobed Star Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Dry Tortugas (0.5–20 m) Puerto Rico – All islands (0.5–20 m) U.S. Virgin Islands – St. Thomas and St. John (0.5–20 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column:

Designated or Proposed Critical Habitat	**PBFs**
	1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Mountainous Star Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Dry Tortugas (0.5–40 m) Puerto Rico – All islands (0.5–90 m) U.S. Virgin Islands – St. Thomas and St. John (0.5–90 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Pillar Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Dry Tortugas (1–25 m) Puerto Rico – All islands (1–25 m) U.S. Virgin Islands – St. Thomas and St. John (1–25 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae

Designated or Proposed Critical Habitat	PBFs
	2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Rough Cactus Coral	Currently Designated CH: Florida – Broward County to Dry Tortugas (5–40 m) Puerto Rico – All islands (5–90 m) U.S. Virgin Islands – St. Thomas and St. John (5–90 m) Designated CH PBFs: Sites that support the normal function of all life stages of the corals, including reproduction, recruitment, and maturation. These sites are natural, consolidated hard substrate or dead coral skeleton free of algae and sediment at the appropriate scale at the point of larval settlement or fragment reattachment, and the associated water column: 1. Substrate with presence of crevices and holes that provide cryptic habitat, the presence of microbial biofilms, or presence of crustose coralline algae 2. Reefscape with no more than a thin veneer of sediment and low occupancy by fleshy and turf macroalgae 3. Marine waters with levels of temperature, aragonite saturation, nutrients, and water clarity that have been observed to support any demographic function
Staghorn Coral	Currently Designated CH: Florida – Government Cut, Miami-Dade County to Key West, Monroe County (Mean Low Water Line to 30 m); Dry Tortugas (Mean Low Water Line to 30 m) Puerto Rico – All islands (<30 m depth) U.S. Virgin Islands – St. Thomas and St. John (<30 m depth) Designated CH PBFs: Substrate of suitable quality and availability (natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover) to support larval settlement and recruitment, and reattachment and recruitment of asexual fragments
Green Turtle – Central North Pacific DPS	Currently Proposed CH: Hawaiian Archipelago – all nearshore waters from the Mean High Water line to 20 m depth of Hawai'i, Maui, Kaho'olawe, Lana'i, Moloka'i, O'ahu, Kaua'i, Lalo/French Frigate Shoals, Kamole/Laysan Island, Kapou/Lisianski Island, Manawai/Pearl and Hermes Atoll, Kuaihelani/Midway Atoll, and Hōlanikū/Kure Atoll. These areas contain reproductive and benthic foraging/resting essential features

Designated or Proposed Critical Habitat	PBFs
	Proposed CH PBFs: 1. Benthic foraging/resting feature: from the Mean High Water line to 20 m depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction
Green Turtle – East Pacific DPS	Currently Proposed CH: California – from the Mexico border to and including North San Diego Bay, all nearshore areas from the Mean High Water line to 10 km offshore. These areas contain the migratory essential feature California – all nearshore areas from the Mean High Water line to 20 m depth, from and including San Diego Bay to and including Santa Monica Bay (except for the area between Oceanside and San Onofre) and surrounding Catalina Island. These areas contain benthic foraging/resting essential features Proposed CH PBFs: 1. Benthic foraging/resting feature: from the Mean High Water line to 20 m depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction
Green Turtle – North Atlantic DPS	Currently Designated CH: Culebra Island, Puerto Rico – waters surrounding the island of Culebra from the Mean High Water line to 5.6 km Designated CH PBFs: PBFs of green turtle critical habitat are not precisely defined; however, critical habitat was designated to provide protection for important developmental and resting/sheltering habitats Currently Proposed CH: Florida – all nearshore areas from the Mean High Water line to 20 m depth. These areas contain reproductive, migratory, benthic foraging/resting, and surface-pelagic foraging/resting essential features

Designated or Proposed Critical Habitat	PBFs
	Texas – from the Mexico border to and including Galveston Bay, all nearshore areas from the Mean High Water line to 20 m depth. These areas contain benthic foraging/resting essential features North Carolina – from the South Carolina border to but not including Albemarle and Currituck Sounds, all nearshore areas from the Mean High Water line to 20 m depth. These areas contain benthic foraging/resting essential features Gulf of America and Atlantic Ocean – in the Gulf of America, surface-pelagic areas from 10 m depth to the outer boundary of the U.S. Exclusive Economic Zone (EEZ). In the Atlantic Ocean, surface-pelagic areas from 10 m depth to the outer boundary of the U.S. EEZ, with the exception of areas north of Cape Canaveral, where the nearshore boundary follows the edge of the Gulf Stream. These areas contain surface-pelagic foraging/resting essential features Proposed CH PBFs: 1. Reproductive feature: sufficiently dark and unobstructed nearshore waters adjacent to nesting beaches proposed as critical habitat by the U.S. Fish and Wildlife Service, to allow for the transit, mating, and interesting of reproductive individuals, and the transit of post-hatchlings 2. Migratory feature: from the Mean High Water line to 20 m depth, sufficiently unobstructed waters that allow for unrestricted transit of reproductive individuals between benthic foraging/resting and reproductive areas 3. Benthic foraging/resting feature: from the Mean High Water line to 20 m depth, underwater refugia (e.g., caves, reefs, protective outcroppings, submarine cliffs, and "potholes") and food resources (i.e., seagrass, marine algae, and/or marine invertebrates) of sufficient condition, distribution, diversity, abundance, and density necessary to support survival, development, growth, and/or reproduction 4. Surface-pelagic foraging/resting feature: convergence zones, frontal zones, surface-water downwelling areas, the margins of major boundary currents, and other areas that result in concentrated components of the *Sargassum*-dominated drift community, as well as the currents which carry turtles to *Sargassum*-dominated drift communities, which provide sufficient food resources and refugia to support the survival, growth, and development of post-hatchlings and surface-pelagic juveniles, and which are located in sufficient water depth (at least 10 m) to ensure offshore transport via ocean currents to areas which meet forage and refugia requirements

Designated or Proposed Critical Habitat	PBFs
Rice's Whale	Currently Proposed CH: Gulf of America – continental shelf and slope associated waters between the 100-m isobaths to the 400-m isobath Proposed CH PBFs: 1. Sufficient density, quality, abundance, and accessibility of small demersal and vertically migrating prey species, including scombriformes, stomiiformes, myctophiformes, and myopsida 2. Marine water with (i) elevated productivity, (ii) bottom temperatures of 10–19°C, and (iii) levels of pollutants that do not preclude or inhibit any demographic function 3. Sufficiently quiet conditions for normal use and occupancy, including intraspecific communication, navigation, and detection or prey, predators, and other threats

CH = critical habitat; PBFs = physical or biological features; DPS = distinct population segment
-- The action will have no effect on PBFs

4.1 May Affect, Not Likely to Adversely Affect

Once we have determined the action may affect ESA-listed or proposed species or their designated or proposed critical habitat, the next step is differentiating between stressors that are NLAA and LAA for each listed species and critical habitat in the action area. An action warrants a NLAA finding when its effects are completely beneficial, discountable, or insignificant. Completely beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Completely beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected, albeit positively. Discountable effects are those that could occur while an ESA-listed species is in the action area but, because of the intensity, magnitude, frequency, duration, or timing of the stressor, exposure to the stressor is extremely unlikely to occur. Insignificant effects relate to the response of exposed individuals where the response, in terms of an individual's growth, survival, or reproduction, would be immeasurable or undetectable, or an impact to the conservation value of a PBF would be immeasurable or undetectable. For stressors that meet these criteria for completely beneficial, discountable, or insignificant, the appropriate conclusion is NLAA.

To assist in reaching a determination, we perform a two-step assessment that considers all of the stressors identified in Section 2.4 of this opinion and all of the species and critical habitats identified in Table 1 to understand the likelihood of the stressors having an effect on the ESA-listed or proposed species or their designated or proposed critical habitat. First, we consider whether it is likely that a listed species or critical habitat is exposed to a stressor or there is a reasonable expectation of the stressor and an individual or habitat co-occurring. If we conclude that exposure of a species or critical habitat to a stressor caused by the proposed action or activity is discountable, we must also conclude it is NLAA. However, if exposure is probable, the second step is to evaluate the probability of a response to the stressor. When all stressors of an action are found to be NLAA for a listed species or a critical habitat, we conclude informal consultation for that species or critical habitat. Likewise, if a stressor associated with this action is found to be NLAA for all listed species and all critical habitats, there is no need to continue analyzing the consequences of that stressor in the Analysis of Effects. Where the negative effects to any species or critical habitat or from any stressor to those species or critical habitat are found to exceed the standards of insignificant or discountable, we must analyze those consequences in the Analysis of Effects.

4.1.1 Stressors Not Likely to Adversely Affect Species or Critical Habitat

This section identifies the stressors that are NLAA for every ESA-listed species and their designated or proposed critical habitat in the action area and will not be analyzed further in this opinion.

4.1.1.1 Sonic Booms and Impulse Noise Generated During Launches and Landings

Sonic booms generated by Super Heavy and Starship landings are expected to be a maximum of 21 and 4 psf, respectively. A recent study also recorded a sonic boom of less than 1 psf from the interstage landing (Gee et al. 2024). An overpressure of 1 psf is similar to a thunderclap. Boom intensity, in terms of psf, is greatest under the flight path and progressively weakens with horizontal distance away from the flight path. Acoustic energy in the air does not effectively cross the air-water boundary and most of the sound energy is reflected off the water’s surface (Richardson et al. 1995). Previous research conducted by the U.S. Air Force determined that a peak pressure of 12 pounds per square inch (psi) in the water would be needed to meet the acoustic threshold at which harassment of marine mammals and sea turtles may occur from impulsive sound. Rather than responding primarily to sound pressure, invertebrates mainly detect particle motion and can sense local water movements (Solé et al. 2023). This detection is limited, as particle motion diminishes rapidly with distance from the sound source, making the impact of noise on invertebrates likely less than the impact on marine mammals and sea turtles. ESA-listed fishes have a slightly lower acoustic threshold for harassment than marine mammals and sea turtles (FHWG 2008); however, to produce even 12 psi in water, a surface (in-air) pressure of approximately 900 psf is needed. The researchers also note that a sonic boom of 50 psf at the ocean surface is rare (U.S. Air Force Research Laboratory 2000). Thus, it would take a much greater sonic boom than will be generated by either Super Heavy or Starship to create an acoustic impact underwater that could cause a measurable response in ESA-listed species exposed to the noise.

Impulse noise from vehicle launches and landings may affect ESA-listed species’ hearing underwater. Noise from a launch is unlikely to effectively cross the air-water boundary, as previously discussed. The likelihood that an animal occurs at the same time and place as a Super Heavy or Starship landing, and would be exposed to sound generated by the landing, is expected to be extremely unlikely given relatively low species densities, large areas over which either vehicle may be expended, and the short duration (only a few seconds) of landings. Therefore, any effect from the sonic booms or impulse noise on ESA-listed species while underwater would be insignificant or discountable.

ESA-listed marine mammals and sea turtles in the action area could be exposed to the overpressures from sonic booms and impulse noise in the air when they are surfacing to breathe. However, the chance of both events happening at the same time (i.e., an animal surfacing and a sonic boom/impulse noise occurring) is extremely low, considering the duration of the sonic boom is less than 1 second (less than 300 milliseconds) and the duration of an ocean landing is less than 1 minute. ESA-listed marine mammals and sea turtles may be exposed to in-air noise from launches, which lasts approximately 3 minutes (FAA 2024a). However, marine mammals and sea turtles typically surface for only a few seconds. Therefore, any effect from the sonic booms or impulse noise on ESA-listed marine mammals and sea turtles at the surface of the water would be discountable because exposure of these animals to the stressor is extremely unlikely to occur.

Given the low overpressures and short duration of the sonic booms or impulse noise described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Rice's whale, see Table 2), will be so small as to be immeasurable. Therefore, effects from sonic booms or impulse noise to designated or proposed critical habitat is insignificant.

In summary, the potential effects to ESA-listed species from sonic booms and impulse noise are discountable or insignificant. The potential effects to designated and proposed critical habitat from sonic booms and impulse noise are insignificant. We conclude that impacts from sonic booms and impulse noise to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species or their designated or proposed critical habitat.

4.1.1.2 Direct Impact by Fallen Objects

Radiosondes, Super Heavy, Starship, and associated debris (with a Super Heavy or Starship in-flight breakup, impact breakup, or mishap) falling and landing in the Gulf, Atlantic Ocean, Indian Ocean, Hawaii and Central North Pacific, Northeast and Tropical Pacific, and South Pacific portions of the action area, and estimated mishap area, have the potential to affect ESA-listed species. The primary concern is direct impact from these objects striking an ESA-listed species. An object striking an ESA-listed species may result in injury or mortality to the individuals struck.

Super Heavy and Starship are extremely small relative to the in-water area in which either vehicle could land (see Figures 1–5) and relative to the area over which species are distributed in the Gulf of Mexico (non-U.S. waters), Gulf of America, Atlantic, Indian, North Pacific, and South Pacific oceans. The likelihood that a vehicle strikes an ESA-listed species can be estimated by multiplying the species density by the area of the vehicle. Super Heavy measures approximately 233 ft (71 m) by 30 ft (9 m), is larger than Starship, and covers an area of approximately 6,878 square feet (ft^2; 639 square meters [m^2]) or 0.000247 square miles (mi^2; 0.000639 square kilometer [km^2]). Because NMFS estimates that the probability a vehicle will land in a specific location within a portion of the action area is equal across that portion, and each portion, of the action area (based on the best available information), we used the highest monthly mean species density across all portions of the action area as a proxy for all species considered in this consultation. The highest monthly mean species density is 0.834 Northwest Atlantic Ocean DPS loggerhead turtles per km^2, which occurs in an extremely small area of the Gulf portion of the action area. The species density, 0.834 individuals per km^2, multiplied by the vehicle area, 0.000639 km^2, results in an extremely small number of individuals that may be exposed to a direct impact from a falling object (0.00053).

There may be up to 25 soft water landings of each vehicle, and 20 landings with explosive events of each vehicle. It is extremely unlikely both vehicles would land in the same exact place (i.e., it is extremely unlikely that both would land in the small area where loggerhead turtle densities are highest). However, without information on landing locations of either vehicle, we estimate the likelihood of 90 total landings hitting an ESA-listed species by multiplying the total number of landings by 0.00053 individuals. This results in an estimated 0.048 individuals exposed to direct impact by falling objects. Thus, the likelihood that an ESA-listed species will be in the exact location at the exact same time that a Super Heavy or Starship landing occurs is extremely unlikely, and thus, discountable. Debris pieces from an in-flight breakup, impact breakup (for which debris is expected to be contained within 0.6 mi [1 km] of the landing location), or mishap of either stage will be smaller than the stage itself. Radiosondes are also much smaller than either stage. Thus, the likelihood of debris or a radiosonde striking an ESA-listed species will be even smaller than that of Super Heavy or Starship striking an ESA-listed species.

The likelihood of the interstage striking an ESA-listed species is the same as what was considered in OPR-2024-02422 (pages 14–16) because there are no proposed changes to interstage activities considered in that consultation. Using the same methodology as above, NMFS determined it is extremely unlikely an ESA-listed species will be directly struck by the interstage as it falls to the sea surface or by debris from its impact with the sea surface based on the interstage landing location, number of interstage landings, and species densities (NMFS 2024b).

Falling debris from a mishap may affect ESA-listed corals if debris sink and land directly on a coral. Based on limited information available from previous mishaps, a majority of the vehicle will be destroyed during the mishap. Debris pieces that remain are expected to be widely dispersed given the high altitude at which the mishap occurs and would not be concentrated in any specific area. For example, Flight 7 mishap debris occurred in an area over approximately 6,950 mi^2 (18,000 km^2). ESA-listed corals occur close to shore where debris is less likely to occur because of human safety concerns. After mishaps during Flights 7 and 8, debris was reported on the islands of Turks and Caicos, and the Bahamas, respectively. These debris pieces were found one to a couple of days after the mishaps, suggesting that debris pieces that arrived on shore floated there. Thus, based on the limited information currently available, it is extremely unlikely that debris from a mishap will directly strike an ESA-listed coral.

Falling objects may affect the following designated or proposed habitat present in areas where falling objects may occur: North Atlantic right whale, Northwest Atlantic Ocean DPS of loggerhead turtle, Nassau grouper, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, North Atlantic DPS of green turtle, and Rice's whale (Table 2).

Falling objects may affect PBFs related to the availability of benthic substrate or refugia (e.g., caves, boulders), because a direct impact may reduce the availability of that habitat feature, which applies to: Northwest Atlantic Ocean DPS of loggerhead turtle *Sargassum* habitat, Nassau grouper, corals, and North Atlantic DPS of green turtle (benthic foraging/resting feature and surface-pelagic foraging/resting feature). Super Heavy and Starship are relatively small (hundreds of square meters) compared to the critical habitats for sea turtles (thousands to hundreds of thousands of square kilometers). If a Super Heavy and Starship landing results in debris, the debris pieces will be smaller than either vehicle. For Nassau grouper and coral critical habitat, falling objects are only expected to occur if there is a mishap. In that case, the objects would be widely dispersed and scattered within an area much larger than the critical habitat area, given the high altitude at which the mishap occurs. Thus, the likelihood that falling objects directly impact benthic substrate and refugia/cover would be extremely unlikely.

Falling objects may also disturb the sea surface as they impact the ocean, and disturb the seafloor as they settle, and affect PBFs related to calm conditions and water quality (sediment), which apply to North Atlantic right whale and corals. Objects that are affecting the ocean surface are temporary, with the moment of impact lasting only seconds, and would not result in sea surface conditions more than Force 4 on the Beaufort Wind Scale for more than the duration of the actual impact. Sediment may be suspended by objects falling and hitting the seafloor, and affect water quality and the amount of sediment on top of corals. However, if debris impacts the seafloor in proximity to corals, the sediment would only be displaced temporarily, affecting water quality, but would settle after the debris stops moving; thus, water quality conditions would return to normal. It is extremely unlikely that the displaced sediment would completely cover the coral habitat because of the estimated location of debris (see above paragraph on falling debris from a mishap), and because sediment suspended in the water column will be dispersed by currents and water movement. Thus, effects of falling objects on surface conditions and water quality would be so small as to be immeasurable and, therefore, insignificant.

Falling objects may also temporarily displace prey species as they sink through the water column and temporarily affect PBFs related to prey availability as prey move away from the object (Northwest Atlantic Ocean DPS of loggerhead turtle foraging habitat and *Sargassum* habitat, Nassau grouper, North Atlantic DPS of green turtle proposed benthic foraging/resting feature and surface-pelagic foraging/resting feature, and Rice's whale). However, the temporary sinking of debris or vehicles is not expected to affect the overall density, abundance, availability, or accessibility of prey in a manner that would measurably affect prey populations. Thus, the effect from falling objects on critical habitat would be insignificant.

In summary, the potential effects to ESA-listed species from a direct impact by falling objects are discountable. The potential effects to designated and proposed critical habitat from falling objects are discountable or insignificant. We conclude that direct impacts from falling objects to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect, ESA-listed species and designated or proposed critical habitat.

4.1.1.3 Impacts from Unrecovered Debris

Unrecovered debris (from Super Heavy, Starship, weather balloons, and radiosondes) may affect ESA-listed species and their designated or proposed critical habitat.

Unrecovered debris may be ingested by ESA-listed species foraging in the action areas. ESA-listed marine mammals, sea turtles, and fishes can ingest marine debris while foraging and nearly all ingested debris is plastic (Alzugaray et al. 2020; de Carvalho et al. 2015; Im et al. 2020; Jacobsen et al. 2010; Rodríguez et al. 2022; Rosel et al. 2021; Schuyler et al. 2014b; Werth et al. 2024; Wilcox et al. 2018). In a recent global review on ingested marine debris, a majority of mortalities in marine mammals were caused by ingestion of film-like plastic (e.g., plastic bags), plastic fragments (hardness not specified), rope/nets, and fishing debris (Roman et al. 2021). For sea turtles, a majority of mortalities were caused by ingestion of hard plastic, film-like plastic, and fishing debris (Roman et al. 2021). Plastics are also the main type of debris ingested by fishes (Cliff et al. 2002; Germanov et al. 2018). It is extremely unlikely, and, therefore, discountable, that radiosondes, Super Heavy, Starship, and interstage debris, the majority of which are heavy-weight metals or composite materials like carbon fiber that will sink immediately due to their weight, would be ingested by ESA-listed species.

Latex weather balloons undergo "brittle fracture" at altitude, where the rubber shatters along grain boundaries of crystallized segments and the balloon bursts. The resultant pieces of rubber are small strands comparable to the size of a quarter (Burchette 1989; Cullis et al. 2017). As these small strands descend through the air and back to the ocean, their distribution is influenced by changes in atmospheric pressure and wind, which disperses the strands before they land on the surface of the ocean where they are further dispersed due to surface currents and wind. These latex fragments float on the surface of the water and start to degrade, eventually sinking due to the weight from biofouling (Burchette 1989; Foley 1990; Thompson et al. 2004). Out of 12 categories of ingested marine debris, balloons/latex were one of the least common types of ingested debris, and were recorded in fewer than 10 sea turtles compared to the largest category, film-like plastic, which was recorded in over 300 sea turtles (Roman et al. 2021). Given the small balloon shreds from the use of weather balloons as part of the proposed action are likely to be scattered and not concentrated, and they should only be available in the upper portions of the water column on the order of weeks, the potential for exposure of ESA-listed species to these shreds is extremely low and, therefore, discountable.

Unrecovered debris may also affect PBFs related to water/passage obstruction and water depth: Northwest Atlantic Ocean DPS of loggerhead turtle constricted migratory habitat and *Sargassum* habitat, and North Atlantic DPS of green turtle reproductive feature, migratory feature, and surface-pelagic foraging/resting feature of proposed critical habitat (Table 2). Unrecovered debris could create obstructions to waterways, or affect water depth if they land in shallow areas where the size of the debris blocks the water column. Based on the available information from FAA and SpaceX, Super Heavy and Starship may land intact and sink in a horizontal orientation (unless the vehicle landing results in debris, in which case, the debris pieces would be smaller than either Super Heavy or Starship). When Super Heavy and Starship are horizontal, the maximum height is 30 ft (9 m). Thus, the vehicles could obstruct areas or affect water depth in areas 30 ft (9 m) or shallower. However, this would be a temporary impact because an obstruction of a waterway is a clear navigational hazard (and would likely be a navigational hazard even if a portion of the water column was blocked by debris), and SpaceX would be required to remove any debris. Additionally, the size of Super Heavy and Starship are relatively small (hundreds of square meters) compared to the critical habitats of each species (thousands to hundreds of thousands of square kilometers). Thus, the effects would be temporary and geographically constrained, not expected to impact the habitat suitability of critical habitat in the long term, and would be too small to measure and, thus, insignificant.

In summary, the potential effects to ESA-listed species from unrecovered debris are discountable. The potential effects to designated critical habitat from unrecovered debris are insignificant. We conclude that impacts from unrecovered debris to ESA-listed species and designated critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect ESA-listed species and their designated or proposed critical habitat.

4.1.1.4 Impacts from Pollution

Pollution such as vessel pollutants and the launch vehicle propellant and emissions may affect ESA-listed species and their designated or proposed critical habitat.

Pollutants emitted by vessels used during Starship-Super Heavy surveillance or recovery operations can include exhaust (carbon dioxide, nitrogen oxides, and sulfur oxides), and fuel or oil spills or leaks. These pollutants may affect air-breathing ESA-listed species such as marine mammals and sea turtles. Although vessels may transit through areas where ESA-listed species are expected to occur in higher numbers or densities (e.g., close to shore, critical habitat), it is unlikely that pollutants in the air would have a measurable impact on ESA-listed marine mammals or sea turtles given the relatively short duration of vessel operations (approximately five days for each launch with a recovery), dispersion of pollutants in the air, and the brief amount of time that marine mammals and sea turtles spend at the water's surface to breathe. Thus, the effects of pollutants in the water on ESA-listed species due to the proposed action will be so small as to be immeasurable. Therefore, the effects to ESA-listed species from pollutants from vessel activities are insignificant.

Emissions from launching and landing each stage include nitrogen oxides, carbon monoxide, and other greenhouse gases (FAA 2024a). Stages and payloads (such as satellites launched via Starship) that burn up upon reentry also release vaporized metal particles. Recently, researchers have studied how these emissions and particles associated with rocket launches and reentries can lead to ozone depletion and cause detrimental effects to climate and ecosystems (Dallas et al. 2020; Ferreira et al. 2024; Kokkinakis and Drikakis 2022; Maloney et al. 2022; Murphy et al. 2023; Ross et al. 2004; Ryan et al. 2022). This may affect ESA-listed species because climate can drive range and distribution shifts in ESA-listed species and their prey (Record et al. 2019a). For a given 25 Starship-Super Heavy launches (and associated operations) from the Boca Chica Launch Site, an estimated 107,301 t (97,342 MT) of carbon dioxide equivalent is expected per year (FAA 2024a). Twenty-five launches is approximately one-sixth of the maximum number of launches expected annually, and the estimated amount of carbon dioxide equivalent is less than approximately two hundred-thousandths (0.00002) of the annual carbon dioxide equivalent emission rate of the United States (FAA 2024a). We currently do not have sufficient information on the magnitude of activities that will be caused by the action (e.g., satellites reentering and burning up in the atmosphere; see Section 2.3) to determine whether effects to ESA-listed species will be more than insignificant. At present, the effects to ESA-listed species from launch and reentry activities of Starship-Super Heavy are immeasurable and thus insignificant, as well as being extremely small compared to the global level of greenhouse gas emissions.

Residual propellant (LOX and LCH_4) may remain on Super Heavy and Starship (82 t [74 MT] and 111 t [101 MT], respectively). During Starship-Super Heavy Flight #3 and Flight #4, SpaceX verified the amount of residual propellant in each vehicle: Flight #3 Super Heavy contained 104 t (94 MT) of residual propellant and Starship contained 62 t (56 MT) of residual propellant; and Flight #4 Super Heavy contained 49 t (44 MT) of residual propellant and Starship contained 13 t (12 MT) of residual propellant (K. Condell, SpaceX, pers. comm. to E. Chou, NMFS OPR, October 18, 2024). SpaceX noted that both Super Heavy and Starship did not complete the planned flights during Flight #3, and, therefore, had higher estimated residual propellant than if the flights were completed (such as during Flight #4); thus, the estimated residual propellant is a conservative estimate. Propellant amounts for subsequent flights were not provided. LOX and LCH_4 are not hazardous and will be vented to the atmosphere following landing of either vehicle (FAA 2024). ESA-listed species that surface to breathe (marine mammals and sea turtles) could be exposed to the vented residual propellant. Given the limited number of times either stage will be expended (and residual propellant would be vented), dispersion of vented propellant due to weather conditions such as wind, and limited amount of time ESA-listed marine mammals and sea turtles spend at the surface to breathe, ESA-listed species are extremely unlikely to be exposed to residual propellant in the air, meaning the effects of this stressor are discountable.

In the event that Super Heavy or Starship residual propellant ends up in the ocean, residual propellant is expected to evaporate or be diluted relatively quickly due to surface currents and ocean mixing. It is unlikely that residual propellant from either vehicle measurably contributes to the overall pollutant levels in the action area given the limited number of times either stage will be expended (and residual propellant would reach the ocean), and the large action area. The effects of residual propellant in the ocean on ESA-listed species are immeasurable and, thus, insignificant.

Vessel pollution may affect designated or proposed critical habitats that have PBFs related to water quality, including those of the Main Hawaiian Islands Insular DPS of false killer whale, Gulf sturgeon, black abalone, and Rice's whale. Pollutants from vehicles may also affect the water quality PBF of Rice's whale proposed critical habitat (Table 2). As previously discussed, pollutants are expected to evaporate and quickly become diluted, limiting any impacts to a temporary duration. Given the limited use of vessels and brief exposure to pollutants, the effect of pollution on water quality PBFs will be so small as to be immeasurable. Thus, the effects of pollution on water quality-related PBFs of designated or proposed critical habitat are insignificant.

In summary, the potential effects to ESA-listed species from pollution are discountable or insignificant. The potential effects to designated and proposed critical habitat from pollution are insignificant. We conclude that impacts from pollution to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect ESA-listed species and their designated or proposed critical habitat.

4.1.1.5 Vessel Presence, Strike, and Noise

ESA-listed species may be affected by vessel transit and operations in all portions of the action area (except the Indian Ocean) during the proposed action. Vessel presence may disturb animals, vessel strike may result in injury or mortality, and vessel noise may cause disturbance because of elevated noise levels. The duration of vessel operations lasts approximately five days for each launch with a recovery. Vessel operations only apply to pre-launch surveillance and post-launch recovery (i.e., vessels are not active the entire day). The proposed action has a limited amount of vessel activity, especially compared to the amount of recreational and commercial vessel traffic across the action area. Given the relatively small contribution of the vessels associated with the proposed action to the overall vessel activity, effects from vessel presence are expected to be so minor that they cannot be meaningfully evaluated and are thus insignificant.

The potential for a vessel striking an ESA-listed species is unlikely because the proposed action consists of relatively little vessel use. Furthermore, ESA-listed marine mammals, sea turtles, and fish may spend time at or near the ocean surface but generally spend most of their time underwater where they would not be exposed to vessel strikes. A vessel grounding in an area where corals, black abalone, or the proposed sunflower sea star occur would be extremely unlikely because there is no planned vessel activity in coral reef areas, and because a vessel grounding has not occurred during any vessel activities related to the proposed action thus far. Implementation of the conservation measures listed in Section 2.2 further reduce the potential for vessel strike. Given vessel strike avoidance measures, vessel speed restrictions when the vessel is in proximity to certain ESA-listed species, presence of dedicated observers monitoring for ESA-listed species, and additional measures such as compliance with vessel speed rules for critically endangered species (North Atlantic right whale), vessel strikes are considered extremely unlikely to occur. Therefore, ESA-listed species' exposure to vessel strike is discountable.

Noise from vessels may produce an acoustic disturbance or otherwise affect ESA-listed species that spend time near the surface, such as marine mammals, sea turtles, and pelagic fishes, which may generally disrupt their behavior. Studies have shown that vessel operation can result in changes in the behavior of marine mammals, sea turtles, and fishes (Hazel et al. 2007b; Holt et al. 2009; Luksenburg and Parsons 2009; Noren et al. 2009; Patenaude et al. 2002a; Richter et al. 2003b; Smultea et al. 2008a). However, vessel noise will not exceed that of larger commercial shipping vessels and will only be temporary (approximately five days for each launch with a recovery, and only used for pre-launch surveillance and post-launch recovery) compared to the constant presence of commercial vessels. Additionally, while not specifically designed to do so, several aspects of the conservation measures will minimize effects associated with vessel acoustic disturbance to ESA-listed species (e.g., maintaining distance from protected species, slowing to 10 kt or less around certain species and in specific areas; see Section 2.2). Given the conservation measures and the relatively small contribution of the vessels associated with the proposed action to the overall soundscape, effects from vessel noise are expected to be so minor that they cannot be meaningfully evaluated and are thus insignificant.

Vessel presence may affect designated or proposed critical habitat with prey-related PBFs, including critical habitat for the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, leatherback turtle, Northwest Atlantic DPS of loggerhead turtle foraging habitat and *Sargassum* habitat, Gulf sturgeon, and proposed Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle (benthic foraging/resting feature and surface-pelagic foraging/resting feature), and Rice's whale (Table 2). Vessels may temporarily displace prey for the duration of the vessel transit through an area. However, limited and temporary vessel use is not expected to measurably affect the distribution, density, quantity, quality, or availability of prey. Therefore, effects from vessels to designated or proposed critical habitat are insignificant.

Given the limited use and low sound levels of vessel operations described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands Insular DPS of false killer whale and Rice's whale, see Table 2) will be so small as to be immeasurable.

Vessel noise may also affect the available space for movement and use within shelf and slope habitat for the Main Hawaiian Islands Insular DPS of false killer whale. In the final rule designating Main Hawaiian Islands Insular DPS of false killer whale critical habitat, long-term acoustic disturbance was identified as an obstacle to whale movement. However, given the limited use and temporary duration of vessel operations, the contribution of vessel noise due to the proposed action compared to the overall soundscape will be so small as to be immeasurable and, thus, insignificant.

In summary, the potential effects to ESA-listed species from vessel presence, strike and noise are discountable or insignificant. The potential effects to designated and proposed critical habitat from vessel presence and noise are insignificant. We conclude that impacts from vessel presence, strike and noise to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect ESA-listed species and their designated or proposed critical habitat.

4.1.1.6 Aircraft Overflight

Noise from aircraft overflight may enter the water, but, as stated in relation to sonic booms and impulse noise, very little of that sound is transmitted into water. Sound intensity produced at high altitudes is reduced when it reaches the water's surface. At lower altitudes, the perceived noise will be louder, but it will decrease rapidly as the aircraft moves away. ESA-listed species that occur at or very near the surface (e.g., marine mammals, sea turtles, and fish) at the time of an overflight could be exposed to some level of elevated sound. There could also be a visual stimulus from the overflight that could potentially lead to behavioral response. Both noise and visual stimulus impacts would be temporary and only occur if an individual is surfacing or very close to the surface at the same time an aircraft is flying over.

Studies have shown minor behavioral effects (e.g., longer time to first vocalization, abrupt dives, shorter surfacing periods, breaching, tail slaps) in marine mammals exposed to repeated fixed wing aircraft overflights (Patenaude et al. 2002b; Richter et al. 2003a; Smultea et al. 2008b; Würsig et al. 1998). However, most of these responses occurred when the aircraft was below altitudes of approximately 250 m, which is lower than the altitude to be flown by aircraft during surveillance for the activities considered in this consultation. Species-specific studies on the reaction of sea turtles to fixed wing aircraft overflight are lacking. Based on sea turtle sensory biology (Bartol and Musick 2002), sound from low-flying aircraft could likely be heard by a sea turtle at or near the ocean surface. Sea turtles might be able to detect low-flying aircraft via visual cues such as the aircraft's shadow, similar to the findings of Hazel et al. (2007a) regarding watercraft, potentially eliciting a brief reaction such as a dive or lateral movement. However, considering that sea turtles spend a significant portion of their time underwater and the low frequency and short duration of surveillance flights, the probability of exposing an individual to an acoustically or visually-induced stressor from aircraft momentarily flying overhead would be very low. The same is relevant for ESA-listed fishes in the action area, considering their limited time near the surface and brief aircraft overflight.

Given the temporary use and limited amount of acoustic energy that enters the water from aircraft activities described above, effects to designated or proposed critical habitat with acoustic-related PBFs (Main Hawaiian Islands Insular DPS of false killer whale and Rice's whale, see Table 2) will be so small as to be immeasurable and are therefore insignificant.

Given the limited and temporary behavioral responses documented in available research, the potential effects to ESA-listed species from aircraft overflight are insignificant. The potential effects to designated and proposed critical habitat from aircraft overflight are insignificant. We conclude that impacts from aircraft overflight to ESA-listed species and designated or proposed critical habitat in the action area because of activities covered under this consultation may affect, but are not likely to adversely affect ESA-listed species and their designated or proposed critical habitat.

4.1.1.7 In-Air Acoustic Effects from Vehicle Landings and Explosive Events

ESA-listed species that surface to breathe (marine mammals and sea turtles) may be exposed to the in-air acoustic effects from a Starship or Super Heavy landing or explosive event. To be exposed to this stressor, ESA-listed marine mammals and sea turtles would have to be in the exact same place at the exact same time that Starship or Super Heavy lands, or an explosive event subsequently occurs. ESA-listed marine mammals and sea turtles spend very little time at the surface, and generally only spend a few seconds to breathe before diving back underwater. Landings, whether they result in an explosive event or not, of Starship and Super Heavy will only occur 90 times in the Gulf and Atlantic Ocean portions of the action area, and only 45 times (for Starship) in the Indian Ocean, Hawaii and Central North Pacific, Northeast and Tropical Pacific, and South Pacific portions of the action area before the launch vehicle is fully reusable. Therefore, given the limited number of landings and explosive events, and the large areas over which ESA-listed species can be distributed, it is extremely unlikely that ESA-listed species will be exposed to in-air acoustic effects from vehicle landings and explosive events and, thus, the effects are discountable.

In-air acoustic effects from vehicle landings and explosive events may affect acoustic-related PBFs of proposed critical habitat (Rice's whale, see Table 2). However, because explosive events will only occur in a small portion of Rice's whale critical habitat, and the transmission of acoustic energy across the air-water boundary is not effective, and the effects on acoustic PBFs would be so small as to be immeasurable and, thus, insignificant.

We conclude that in-air acoustic effects from vehicle landings and explosive events to ESA-listed species in the action area because of activities covered under this consultation are discountable. We also conclude that effects to proposed critical habitat from in-air acoustic effects from vehicle landings and explosive events are insignificant. Therefore, in-air acoustic effects from vehicle landings and explosive events may affect, but are not likely to adversely affect ESA-listed species or proposed critical habitat.

4.1.1.8 Vibration, Heat, and Debris from Launches

NMFS estimated a maximum of 33 launches in 2025, 69 launches in 2026, 69 launches in 2027, and 24 launches in 2028, for the duration of the current license (see Section 2.1). During previous launches, vibration, heat, and debris were recorded impacting a radius of approximately 0.7 mi (1.1 km), 0.6 mi (1 km) and 0.3 mi (0.5 km), respectively, from the launch site (FAA 2024b). This information is limited because not all monitoring information is available, and, of the information that is available, monitoring only occurred for a handful of launches. Although FAA did not include these stressors in the 2024 Biological Assessment (ManTech SRS Technologies Inc. 2024), the estimated radius of impact extends to the ocean and may affect ESA-listed species that could occur in the immediate vicinity of the launch sites in the Gulf and Atlantic Ocean portions of the action area, including North Atlantic right whale, North Atlantic DPS of green turtle (Atlantic Ocean portion of the action area), Kemp's ridley turtle, leatherback turtle (Atlantic Ocean portion of the action area), Northwest Atlantic Ocean DPS of loggerhead turtle, and smalltooth sawfish (Atlantic Ocean portion of the action area).

Vibration from Starship-Super Heavy launches is likely only to affect smalltooth sawfish because fish are especially able to detect particle motion. Vibration monitoring of previous launches only occurred on land, but determined that a majority of the energy was distributed through the air and not the ground (FAA 2024b). Thus, based on the limited information, we believe that any effects to smalltooth sawfish from launch vibrations will be so small as to be immeasurable and, thus, insignificant.

Monitoring of heat plumes from Starship-Super Heavy launches observed temperatures of approximately 300°F (149°C) at the Boca Chica Launch Site, approximately 212°F (100°C) within a 0.3-mi (0.5-km) radius surrounding the launch site, and approximately 90°F (32°C) (ambient temperature during some seasons) within a 0.6-mi (1-km) radius surrounding the launch site. Water has a significantly higher specific heat capacity (the amount of heat that needs to be added to one unit of mass of a substance to cause an increase of one unit in temperature) than air, meaning it takes much more energy to raise the temperature of water than to raise the temperature of air. Thus, we expect that ocean temperatures are not affected by launches as significantly as the surrounding air. Additionally, ESA-listed marine mammals, sea turtles, and fishes spend a majority of their time underwater compared to at or just above the surface (when breathing, in the case of marine mammals and sea turtles), and water temperatures below the surface are unlikely to be changed by the heat plume from launches. Thus, based on the limited information, we believe that species' exposure to heat plumes from Starship-Super Heavy launches is extremely unlikely and, thus, discountable.

On June 6, 2024, the Coastal Bend Bays & Estuaries Program monitored debris from a Starship-Super Heavy launch and effects to shorebird nests. They observed dust and small debris emanating out from the engine thrust to approximately 1,411 ft (430 m) away, where the further monitored nest was located (LeClaire and Newstead 2024). FAA (2024) states that the report suggests a "gravel plume" consisting of small particles of mud, sand, and gravel, could travel at least 0.3 mi (0.5 km) from the launch site. Thus, it is reasonable to expect that the gravel plume will also enter the water where ESA-listed species may occur. Launch debris are small in size ("pea-sized"; LeClaire and Newstead 2024) and will be scattered across a radius of at least 0.3 mi (0.5 km) from the launch site. Thus, based on the limited information available, we believe that any effects to ESA-listed species in the water would be so small as to be immeasurable and, thus, insignificant.

Heat from Starship-Super Heavy launches may also affect designated critical habitats with PBFs related to water temperature for the North Atlantic right whale. However, because we expect ocean temperatures would not be significantly affected by launch heat plumes, it is extremely unlikely that the PBF will be affected and, thus, the effects are discountable.

We conclude that vibration, heat, and debris effects from Starship-Super Heavy launches to ESA-listed species in the action area because of activities covered under this consultation are discountable or insignificant. We also conclude that effects to designated critical habitat from heat plumes associated with launches are discountable. Therefore, vibration, heat, and debris from launches may affect, but are not likely to adversely affect, ESA-listed species or designated critical habitat.

4.1.1.9 Heat from Vehicle Landings and Explosive Events

Heat from a vehicle landing (produced by engines during the landing burn) or explosive event may affect ESA-listed marine mammals, sea turtles, and fishes. An explosive event would result in a temporary but significant increase in temperatures at the surface of the ocean because of the burning of propellant. To be exposed to this stressor, ESA-listed species would have to be in the exact same place at the exact same time that Starship or Super Heavy lands or an explosive event subsequently occurs. ESA-listed species spend a vast majority of time underwater, and it is unlikely species would occur at the surface at the same time as a landing or explosive event. Additionally, Super Heavy and Starship landings will occur 50 times, and explosive events 40 times, in the Gulf and Atlantic Ocean portions of the action area (and fewer in other portions of the action area where only Starship landings will occur) before the launch vehicle is fully reusable in 2030. Therefore, given the limited number of landings and explosive events and limited time ESA-listed marine mammals and sea turtles in particular spend at the surface, it is extremely unlikely that ESA-listed species will be exposed to heat from vehicle landings and explosive events.

Heat from vehicle landings and explosive events may also affect designated or proposed critical habitat with PBFs related to water temperature for North Atlantic right whale and Rice's whale. Sea surface temperatures in North Atlantic right whale critical habitat would be significantly affected if an explosive event were to occur within the critical habitat. However, the increase in temperature would be temporary, lasting minutes while the explosion consumes the remaining propellant, and, thus, the effects would be so small as to be immeasurable and, thus, insignificant. We expect that sea surface temperatures will return to temperatures prior to the explosive event once the event ends. Bottom temperatures (for proposed Rice's whale critical habitat) are not expected to be significantly affected by vehicle landings and explosive events because the water depth for proposed Rice's whale critical habitat is between 328–1,312 ft (100–400 m), and it is extremely unlikely that heat from the surface would travel to those depths and, thus, effects are discountable.

We conclude that the effects of heat from vehicle landings and explosive events to ESA-listed species in the action area because of activities covered under this consultation are discountable. We also conclude that effects to designated or proposed critical habitat from heat associated with landings and explosive events are discountable or insignificant. Therefore, heat from vehicle landings and explosive events may affect, but is not likely to adversely affect, ESA-listed species or designated or proposed critical habitat.

4.1.2 Species Not Likely to be Adversely Affected

In addition to the potential stressors that are not likely to adversely affect ESA-listed species discussed above in Section 4.1.1, other stressors (i.e., underwater acoustic effects from explosive events) resulting from the proposed action, may affect, but are not likely to adversely affect a majority of ESA-listed species that may be present in the action area. This section identifies the ESA-listed species for which underwater acoustic effects from explosive events are NLAA and are not analyzed further in this opinion.

4.1.2.1 ESA-Listed Marine Mammals

The ESA-listed marine mammal species that are not likely to be adversely affected by explosive events due to the proposed action are: blue whale, Main Hawaiian Islands Insular DPS of false killer whale, fin whale, Western North Pacific DPS of gray whale, Central America DPS and Mexico DPS of humpback whale, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice's whale, Guadalupe fur seal, and Hawaiian monk seal.

NMFS uses acoustic thresholds to predict how an animal's hearing will be affected by sound exposure (see NMFS's Acoustic Technical Guidance website). Acoustic thresholds differ based on marine mammal hearing groups (Table 3) because not all marine mammal species have identical hearing or susceptibility to noise-induced hearing loss. Marine mammal hearing groups are also used to establish marine mammal auditory weighting functions.

Table 3. Marine mammal hearing groups (NMFS 2024)

Hearing Group	Generalized Hearing Range
Low-frequency (LF) cetaceans	7 Hz to 36 kHz
High-frequency (HF) cetaceans	150 Hz to 160 kHz
Very High-frequency (VHF) cetaceans	200 Hz to 165 kHz
Phocid pinnipeds (PW)	40 Hz to 90 kHz
Otariid pinnipeds (OW)	60 Hz to 68 kHz

Hz = Hertz; kHz = kiloHertz

To calculate potential exposure of ESA-listed species (marine mammals and sea turtles) to the underwater acoustic effects of explosive events for both Starship and Super Heavy, SpaceX calculated the ensonified area (area filled with sound) resulting from a Starship and Super Heavy explosive event, and multiplied the ensonified area by available species densities to get an estimated number of animals exposed.

To calculate the ensonified area, SpaceX used a hemispherical model, estimating that half of the explosive weight on each vehicle will be directed towards the water and the other half released into the air. The model assumes an explosive weight of approximately 10,966 lb (4,974 kg) for Starship (half of approximately 21,929 lb or 9,947 kg) and 7,275 lb (3,330 kg) for Super Heavy (half of 14,551 lb or 6,660 kg) will enter the water. The model also considered the distance above the ocean's surface at which the explosive event will occur (14.8 ft or 4.5 m for Starship and 9.8 ft or 3 m for Super Heavy), and a transmission coefficient of 0.0326, to calculate the peak sound pressure level (SPL_{peak}) for both vehicle explosions. The SPL_{peak} for a Starship explosive event is 267.7 decibels referenced to a pressure of one microPascal (dB re 1µPa), and the SPL_{peak} for a Super Heavy explosive event is 270.7 dB re 1µPa. Using these SPL_{peak} values, SpaceX calculated the ensonified areas within which species could respond to the underwater acoustic stressor as a circle, using spherical spreading (generally used for deeper waters, where the sound waves propagate away from the source uniformly in all directions compared to cylindrical spreading where the sound waves cannot propagate uniformly in all directions because the sound will hit the sea surface or seafloor). Measurable responses are not anticipated outside of the ensonified areas identified below for each ESA-listed marine mammal for a Super Heavy and Starship explosive event (Table 4).

Table 4. ESA-listed marine mammals in the action area, hearing group, and minimum threshold for a response; and associated ensonified areas related to the underwater acoustic effects from a Super Heavy or Starship explosive event within which there could be a response

Species	Hearing Group	Minimum Threshold to Response* (dB re 1µPa)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)
Blue Whale	Low-frequency	216	0.9338	0.4625
False Killer Whale – Main	High-frequency	224	N/A	0.0733

Hawaiian Islands Insular DPS				
Fin Whale	Low-frequency	216	0.9338	0.4625
Guadalupe Fur Seal	Otariid	224	N/A	0.0733
Hawaiian Monk Seal	Phocid	217	N/A	0.37
Humpback Whale – Central America DPS	Low-frequency	216	N/A	0.4625
Humpback Whale – Mexico DPS	Low-frequency	216	N/A	0.4625
North Atlantic Right Whale	Low-frequency	216	0.9338	0.4625
Rice's Whale	Low-frequency	216	0.9338	0.4625
Sei Whale	Low-frequency	216	0.9338	0.4625
Sperm Whale	High-frequency	224	0.148	0.0733

* Note SPL_{peak} thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers
N/A = Not Applicable; Super Heavy explosive events will not occur where these species may occur

To estimate the number of exposures resulting from an explosive event, SpaceX multiplied the maximum species densities in each relevant portion of the action area by the ensonified areas. However, NMFS review of the species densities for the Gulf and Atlantic Ocean portions of the action area determined that there were discrepancies in the maximum densities used, and that there was not enough information on the Super Heavy landing area more than 1 NM from shore. FAA and SpaceX did not have information on whether vehicle landings and explosive events would occur in greater number or probability in certain areas (e.g., nearer to the launch site). Thus, based on the best available information on landing or explosive event locations, NMFS estimated there is an equal probability of a landing or explosion anywhere within each portion of the action area. Based on this assumption, the maximum species density is not an accurate representation of species densities across the action area. Thus, NMFS determined the maximum monthly mean density for each marine mammal species in the Gulf and Atlantic Ocean portions of the action area, and used those densities to estimate the number of exposures. All other portions of the action area use the species density identified by FAA/SpaceX.

Information provided by FAA and SpaceX included Super Heavy landings and explosive events 1–5 NM from shore "directly east" of the Boca Chica Launch Site and LC-39A. However, a specific area, which is needed to determine species density, was not provided. Thus, NMFS used the best available information on vehicle landings 1–5 NM from shore, which is between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site, and between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A (the same area as Starship landings and explosive events 1–5 NM from shore), to determine marine mammal densities.

Because the portions of the action area where explosive events could occur cover large swaths of the ocean, for some portions of the action area, multiple density datasets were used to have data coverage over as much of the action area as possible. For marine mammals, the best available density data in the Indian Ocean were obtained from the U.S. Navy's Final Supplemental Environmental Impact Statement/Supplemental Overseas Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency (SURTASS LFA) Sonar in 2019 (U.S. Navy 2019). Areas modeled in U.S. Navy (2019) do not completely cover the Indian Ocean portion of the action area, but the modeled area of Northwest Australia, does overlap with the eastern portion of the Indian Ocean portion of the action area. It is worth noting that the Northwest Australia modeled area is based on data from the Eastern Tropical Pacific (U.S. Navy 2019). This is because survey data in the Indian Ocean are limited or non-existent, while the Eastern Tropical Pacific has been extensively surveyed for marine mammals and is an area with similar oceanographic and ecological characteristics as the Northwest Australia modeled area (U.S. Navy 2019). Marine mammal density data for the South Pacific portion of the action area were not available. The following marine mammal density datasets were used for each action area (Table 5). Species densities and estimated numbers of exposures that would amount to more than insignificant (i.e., that would be enough to be meaningfully measured) are summarized in Tables 6–10 (excluding the South Pacific portion of the action area because no density data were available). Note that estimated exposures may not match the exact product of the density and ensonified area due to rounding.

Table 5. Marine mammal density data sources for each portion of the action area

Portion of the Action Area	Density Data Sources
Gulf	Roberts et al. (2023); Garrison et al. (2023a)
Atlantic Ocean	Roberts et al. (2023); Roberts et al. (2016); Roberts et al. (2024)*
Indian Ocean	U.S. Navy (2019)**
Hawaii and Central North Pacific	Becker et al. (2022b); Becker et al. (2021); Bradford et al. (2020); Forney et al. (2015); Forney et al. (2012)
Northeast and Tropical Pacific	Becker et al. (2020); Becker et al. (2022a); Forney et al. (2015); Ferguson and Barlow (2003); Forney et al. (2020)
South Pacific	Not available

* North Atlantic right whale densities were determined by using the most recent dataset (2010–2019), as suggested by the authors

** Densities were only available for blue, fin, and sperm whales

Table 6. ESA-listed marine mammal densities in the Gulf portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Rice's Whale	0.000024	0.93	0.46	0.00045	0.00022	0.00067
Sperm Whale	0.00499	0.15	0.07	0.0148	0.0073	0.022

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that Rice's whales and sperm whales in the Gulf portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 6).

Table 7. ESA-listed marine mammal densities in the Atlantic Ocean portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Blue Whale	0.0000122	0.93	0.46	0.00022	0.00011	0.000341
Fin Whale	0.000095	0.93	0.46	0.00177	0.00088	0.002653
North Atlantic Right Whale	0.000014	0.93	0.46	0.00026	0.00013	0.000389
Sei Whale	0.00014	0.93	0.46	0.00268	0.0013	0.004005
Sperm Whale	0.00528	0.15	0.07	0.0156	0.0077	0.023366

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue, fin, North Atlantic right, sei, and sperm whales in the Atlantic

Ocean portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 7).

Table 8. ESA-listed marine mammal densities in the Indian Ocean portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Maximum Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Blue Whale	0.0000281	0.46	0.00026
Fin Whale	0.0008710	0.46	0.008
Sperm Whale	0.002362	0.07	0.003

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue, fin, and sperm whales in the Indian Ocean portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 8). There are very little data on sei whales that may occur in the action area. Based on data from the Ocean Biodiversity Information System's Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP; Halpin et al. 2009), there have been observations of sei whales off Northwest Australia, near the eastern boundary of the Indian Ocean portion of the action area. However, sei whales generally prefer more temperate waters than those that make up the majority of the Indian Ocean portion of the action area, and have been detected between 40° and 50° South in the southern Indian Ocean and in the Southern Ocean (Miyashita et al. 1995; Calderan et al. 2014). Therefore, we expect that sei whale densities in the Indian Ocean portion of the action area will be lower than the available densities of blue, fin, and sperm whales. In addition, given the small ensonified area within which more than insignificant responses are expected for sei whales, we believe that the estimated number of exposures that would elicit a measurable response in sei whales would be lower than that for blue, fin, and sperm whales (Table 8).

Table 9. ESA-listed marine mammal densities in the Hawaii and Central North Pacific portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Maximum Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Blue Whale	0.00006	0.46	0.00055
False Killer Whale – Main Hawaiian Islands Insular DPS	0.000568	0.07	0.0008
Fin Whale	0.00008	0.46	0.00074
Hawaiian Monk Seal	0.00004	0.37	0.0003
Sei Whale	0.00016	0.46	0.0015

Sperm Whale	0.007734	0.07	0.01

km² = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue whales, Main Hawaiian Islands Isular DPS false killer whales, fin whales, Hawaiian monk seals, sei whales, and sperm whales in the Hawaii and Central North Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 9).

Table 10. ESA-listed marine mammal densities in the Northeast and Tropical Pacific portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Maximum Density (individuals per km²)	Ensonified Area (km²)	Estimated Number of Exposures more than Insignificant
Blue Whale	0.004515	0.46	0.04
Fin Whale	0.003897	0.46	0.036
Guadalupe Fur Seal	0.06283	0.07	0.088
Humpback Whale – Central America DPS	0.002713	0.46	0.025
Humpback Whale – Mexico DPS	0.003747	0.46	0.034
Sei Whale	0.0001	0.46	0.0009
Sperm Whale	0.003829	0.07	0.005

km² = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that blue whales, fin whales, Guadalupe fur seals, humpback whales, sei whales, and sperm whales in the Northeast and Tropical Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 10).

There were no density estimates available for ESA-listed marine mammals in the South Pacific portion of the action area; however, the South Pacific portion of the action area is located far from shore, where ESA-listed marine mammals are not expected to occur in high numbers. Sperm whales are known to congregate in waters around the Galápagos Archipelago (Eguiguren et al. 2021), but the Galápagos are more than 250 NM from the South Pacific portion of the action area. Thus, we do not expect ESA-listed marine mammals to occur in high numbers or congregate within the South Pacific portion of the action area.

In summary, given the low estimated exposures that could amount to an effect beyond insignificant, the small size of ensonified areas within which measurable responses would be expected, and anticipated densities of ESA-listed marine mammals, we believe that ESA-listed marine mammals are extremely unlikely to be exposed to underwater acoustic effects from vehicle explosive events, and, therefore, the effects are discountable.

We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed blue whale, Main Hawaiian Islands Insular DPS of false killer whale, fin whale, Western North Pacific DPS of gray whale, Central America DPS and Mexico DPS of humpback whale, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice's whale, Guadalupe fur seal, and Hawaiian monk seal.

4.1.2.2 ESA-Listed Sea Turtles

The ESA-listed sea turtle species that are not likely to be adversely affected by underwater acoustic effects from explosive events due to the proposed action are: Central North Pacific DPS, East Indian-West Pacific DPS, East Pacific DPS, North Indian DPS, South Atlantic DPS, and Southwest Indian DPS of green turtle, hawksbill turtle, leatherback turtle, North Indian Ocean DPS, North Pacific Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtle, and all other areas/not Mexico's Pacific coast breeding colonies and Mexico's Pacific coast breeding colonies of olive ridley turtle. The North Atlantic DPS of green turtle, Kemp's ridley turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle are discussed in Sections 4.2 and 6.

Using the same methodology described for marine mammals in Section 4.1.2.1, SpaceX estimated the number of sea turtle exposures that would be more than insignificant. Insignificant responses are anticipated outside of the ensonified areas identified for each ESA-listed sea turtle species for a Super Heavy and Starship explosive event. The ensonified areas are the same across all sea turtle species because all sea turtle species belong to the same hearing group and have the same minimum threshold to a response (SPL_{peak} 226 dB re 1µPa). The ensonified area for a Super Heavy explosive event is 0.0934 km^2 and the ensonified area for a Starship explosive event is 0.0463 km^2.

Similar to marine mammal densities (see Section 4.1.2.1), NMFS found discrepancies in the maximum sea turtle densities used to estimate the number of exposures in the Gulf and Atlantic Ocean portions of the action area. Because FAA and SpaceX did not have information on whether vehicle landings and explosive events would occur in greater number or probability in certain areas (e.g., nearer to the launch site), NMFS estimated there is an equal probability of a landing or explosion anywhere within each portion of the action area. Based on this assumption, the maximum species density is not an accurate representation of species densities across the action area. Thus, NMFS determined the maximum monthly mean density for each sea turtle species in the Gulf and Atlantic Ocean portions of the action area, and used those densities to estimate the number of exposures. All other portions of the action area use the species density identified by FAA/SpaceX. Additionally, because a specific area was not provided to determine species densities associated with Super Heavy explosive events 1–5 NM from shore in the Gulf and Atlantic Ocean portions of the action area, NMFS determined species densities 1–5 NM from shore, between 100 mi (161 km) north and 100 mi (161 km) south of the Boca Chica Launch Site, and between 50 mi (80 km) north and 50 mi (80 km) south of LC-39A.

The following sea turtle density datasets were used for each action area (Table 11). Species densities and estimated number of exposures that would amount to more than insignificant are summarized in Tables 12–15 (excluding the Indian Ocean and South Pacific portions of the action area because no density data were available). Experts noted caveats with the data used to determine sea turtle densities on the U.S. East Coast (DiMatteo et al. 2024; W. Piniak, NMFS OPR pers. comm. to E. Chou, NMFS OPR, March 19, 2025), including but not limited to: limitations in detecting turtles smaller than 16 inches (in; 40 centimeters [cm]) during surveys, apparent discrepancies in the estimated population abundance used to calculate densities, and the assumption of a Gulf species correction factor for the Atlantic. Despite these caveats, DiMatteo et al. (2024b) still represents the best available information on sea turtle densities along the U.S. East Coast. Note that estimated exposures may not match the exact product of the density and ensonified area due to rounding.

Table 11. Sea turtle density data sources for each portion of the action area

Portion of the Action Area	Density Data Sources
Gulf	Garrison et al. (2023b)
Atlantic Ocean	DiMatteo et al. (2024b)
Indian Ocean	Not available
Hawaii and Central North Pacific	U.S. Navy (2024)
Northeast and Tropical Pacific	U.S. Navy (2024)
South Pacific	Not available

Table 12. ESA-listed sea turtle densities in the Gulf portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Green Turtle	0.018254	0.093	0.046	0.0341	0.0169	0.051
Leather-back Turtle	0.019504	0.093	0.046	0.03643	0.01806	0.0545

km^2 = square kilometers

Note: no densities were available for hawksbill turtles. The Kemp's ridley turtle and Northwest Atlantic Ocean DPS of loggerhead turtle are analyzed in Section 6.

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that green and leatherback turtles in the Gulf portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 12). Hawksbill turtles nest at low densities throughout the southern Gulf (April–September; Cuevas et al. 2019) and wider Caribbean region (Piniak and Eckert 2011), with infrequent nesting in southern Texas and Florida (Eckert and

Eckert 2019; Valverde and Holzwart 2017). Based on telemetry data compiled by The State of the World's Sea Turtles (SWOT 2022) and sightings recorded in the OBIS-SEAMAP database, hawksbill turtles are rare in the Gulf portion of the action area. Thus, it is extremely unlikely that hawksbill turtles will be exposed to underwater acoustic effects of up to 20 Super Heavy and 20Starship explosive events so these effects would be discountable.

Table 13. ESA-listed sea turtle densities in the Atlantic Ocean portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Super Heavy and 20 Starship explosive events

Species	Maximum Monthly Mean Density (individuals per km^2)	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Exposures for 20 Super Heavy Explosive Events	Exposures for 20 Starship Explosive Events	Estimated Number of Exposures more than Insignificant
Kemp's Ridley Turtle	0.00883	0.093	0.046	0.01649	0.00817	0.024665
Leather-back Turtle	0.02812	0.093	0.046	0.0525	0.02604	0.078583

km^2 = square kilometers
Note: no densities were available for hawksbill turtles. The North Atlantic DPS of green turtle and Northwest Atlantic Ocean DPS of loggerhead turtle are analyzed in Section 6.

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that Kemp's ridley and leatherback turtles in the Atlantic Ocean portion of the action area will be exposed to underwater acoustic effects from up to 20 Super Heavy and 20 Starship explosive events and, thus, these effects are discountable (Table 13). It is also extremely unlikely that hawksbill turtles, for which there are no density estimates, will be exposed to the underwater acoustic effects of up to 20 Super Heavy and 20 Starship explosive events. Hawksbill turtles are relatively rare in the Atlantic Ocean portion of the action area, and only occasional nesting has been documented off Florida and North Carolina (Finn et al. 2016; NMFS and USFWS 2013c). Based on data from (SWOT 2022) and sightings recorded in OBIS-SEAMAP, hawksbill turtles are rare in the Atlantic Ocean portion of the action area. Thus, underwater acoustic effects to hawksbill turtles are discountable.

Data on sea turtles in the middle of ocean basins is limited because of challenging conditions and logistics of conducting surveys offshore. North Indian Ocean DPS, Southwest Indian Ocean DPS, and East Indian-West Pacific DPS of green turtles may occur in the Indian Ocean portion of the action area. Nesting beaches occur in countries near the western and eastern boundaries of the Indian Ocean portion of the action area, and coastlines much further north (NMFS 2007; Seminoff et al. 2015). These DPSs of green turtles forage mainly in seagrass beds found in coastal waters, but may move into and transit through oceanic zones.

Southwest Indian Ocean DPS, Southeast Indo-Pacific DPS, and North Indian Ocean DPS of loggerhead turtles may occur in the Indian Ocean portion of the action area. Foraging areas for these DPSs of loggerhead turtles are generally coastal (Rees et al. 2010; Harris et al. 2018; Robinson et al. 2018). Juveniles in the North Indian Ocean may undertake trans-equatorial movements (Dalleau et al. 2014). In fact, the few sighting records of ESA-listed sea turtles within the Indian Ocean portion of the action area are of a tagged loggerhead turtle migrating north-south through the westernmost portion of the Indian Ocean portion of the action area (Halpin et al. 2009; Dalleau et al. 2014). Southwest Indian Ocean DPS individuals also migrate between foraging and nesting areas, though these migration corridors are generally close to shore (Harris et al. 2015; Harris et al. 2018) and outside of the Indian Ocean portion of the action area. The Southeast Indo-Pacific DPS generally forages off coastal Western Australia to Indonesia (Casale et al. 2015).

Olive ridley turtles appear to be most abundant in coastal waters of the northern Indian Ocean (NMFS 2014b), although satellite tagging of one individual showed movement to waters deeper than 656 ft (200 m; Rees et al. 2012). Hawksbill turtles in the eastern Indian Ocean generally forage in waters less than 328 ft (100 m) deep (Fossette et al. 2021). Leatherback turtles occur throughout the Indian Ocean (Hamann et al. 2006; Nel 2012). Satellite tagging of post-nesting leatherback turtles in South Africa showed that less than half of the tagged individuals moved south and then east into oceanic waters of the Indian Ocean, below the Indian Ocean portion of the action area (Robinson et al. 2016). Leatherback nesting populations in the southwest Indian Ocean (e.g., South Africa) and northeast Indian Ocean (e.g., Sri Lanka, Andaman Islands) total approximately 100 nesting females, and between 100–600 nesting females per year, depending on the island, respectively (Hamann et al. 2006). The number of nesting females (the only population estimates available) is relatively small given the large Indian Ocean portion of the action area. Therefore, we expect that densities of ESA-listed sea turtles in the Indian Ocean portion of the action area will be lower than the available densities of blue, fin, and sperm whales (Table 8). In addition, given the small ensonified area within which significant responses would be expected for ESA-listed sea turtles, we believe that the estimated number of exposures that would be more than insignificant for ESA-listed sea turtles will be lower than that for blue, fin, and sperm whales.

Table 14. ESA-listed sea turtle densities in the Hawaii and Central North Pacific portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	0.00027	0.046	0.0003
Hawksbill Turtle	0.00005	0.046	0.00005
Leatherback Turtle	0.00115	0.046	0.001
Loggerhead Turtle	0.00184	0.046	0.002
Olive Ridley Turtle	0.00178	0.046	0.002

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that green, hawksbill, leatherback, loggerhead, and olive ridley turtles in the Hawaii and Central North Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 14).

Table 15. ESA-listed sea turtle densities in the Northeast and Tropical Pacific portion of the action area and calculations for the estimated number of exposures that would amount to more than insignificant for up to 20 Starship explosive events

Species	Density (individuals per km^2)	Ensonified Area (km^2)	Estimated Number of Exposures more than Insignificant
Green Turtle	0.00	0.046	0
Leatherback Turtle	0.001	0.046	0.001
Loggerhead Turtle	0.00	0.046	0

km^2 = square kilometers

Given the low estimated number of exposures that would amount to more than insignificant, it is extremely unlikely that green, leatherback, and loggerhead turtles in the Northeast and Tropical Pacific portion of the action area will be exposed to underwater acoustic effects from up to 20 Starship explosive events and, thus, these effects are discountable (Table 15). There have been no documented hawksbill turtle nests off the U.S. West Coast, and a majority of nesting occurs in Mexico, El Salvador, Nicaragua, Panama and Ecuador (Rguez-Baron et al. 2019). There is a small (< 20 females) nesting population in the Northwestern Hawaiian Islands; however, observations of hawksbill turtles in Hawaii are rare (Chaloupka et al. 2008; Van Houtan et al. 2012). Most juveniles and adults use nearshore habitats (Rguez-Baron et al. 2019). Olive ridley turtles are also rare in offshore areas of the Northeast and Tropical Pacific portion of the action area, likely because occurrence is typically associated with warmer waters further south (Eguchi et al. 2007; Montero et al. 2016). Therefore, hawksbill and olive ridley turtles are not expected to occur in high numbers or densities in the Northeast and Tropical Pacific portion of the action area, meaning they are unlikely to be exposed to the underwater acoustic effects from Starship explosive events, so exposure would be extremely unlikely to occur and the effects discountable.

There were no available density data, and limited data overall, for ESA-listed sea turtles in the South Pacific portion of the action area. Seminoff et al. (2015) summarized nesting sites for all DPSs of green turtles, including the DPSs that may occur in the South Pacific portion of the action area, which are the Central South Pacific DPS and East Pacific DPS. There are no nesting sites of the Central South Pacific DPS of green turtles within or near the South Pacific portion of the action area; thus, we expect that Central South Pacific DPS green turtles do not occur in high numbers or congregate within the South Pacific portion of the action area. The two primary nesting sites of the East Pacific DPS of green turtle are at Michoacán, Mexico and the Galápagos Islands, Ecuador (Seminoff et al. 2015). Neither occurs near the South Pacific portion of the action area, nor do any of the nesting sites monitored in Seminoff et al. (2015). Therefore, we expect that the East Pacific DPS of green turtle does not occur in high numbers or congregate within the South Pacific portion of the action area. Loggerhead, olive ridley, and hawksbill turtles are relatively rare in offshore waters where the South Pacific portion of the action area is located (OBIS-SEAMAP). Thus, we expect that loggerhead, olive ridley, and hawksbill turtles do not occur in high numbers or congregate within the South Pacific portion of the action area. Leatherback turtles transit to the South Pacific from nesting sites in Mexico and Costa Rica to forage, and are expected to transit through and search for prey within the South Pacific portion of the action area (Bailey et al. 2012a; Bailey et al. 2012b; Benson et al. 2015). However, given the relatively large area where leatherbacks have been documented (e.g., see Bailey et al. 2012a) compared to the size of the South Pacific portion of the action area, as well as patchy distribution of prey in offshore areas, movement of individual leatherbacks searching for prey aggregations, and the limited number of times Starship could explode, we expect it is extremely unlikely a leatherback turtle will be exposed to the underwater acoustic effects from Starship explosive events.

In summary, given the low estimated exposures that could amount to an effect beyond insignificant and small ensonified areas within which measurable responses could occur, we expect that ESA-listed sea turtles are extremely unlikely to be exposed to underwater acoustic effects from vehicle explosive events. Thus, effects from underwater acoustic effects from explosive events on ESA-listed sea turtles are discountable.

We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed Central North Pacific DPS, East Indian-West Pacific DPS, East Pacific DPS, North Indian DPS, South Atlantic DPS, and Southwest Indian DPS of green turtle, hawksbill turtle, leatherback turtle, North Indian Ocean DPS, North Pacific Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtle, and all other areas/not Mexico's Pacific coast breeding colonies and Mexico's Pacific coast breeding colonies of olive ridley turtle.

4.1.2.3 ESA-Listed Fishes

The ESA-listed fish species that are not likely to be adversely affected by underwater acoustic effects from explosive events due to the proposed action are: Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon, giant manta ray, Southern DPS of green sturgeon, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark, shortnose sturgeon, U.S. portion of range DPS of smalltooth sawfish, and South-Central California Coast DPS and Southern California DPS of steelhead trout.

Species that spend a majority of time in or congregate in coastal waters (from the coast to the continental shelf edge) and rivers such as the Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon, Southern DPS of green sturgeon, Gulf sturgeon, Nassau grouper, Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark (although scalloped hammerhead shark may occur off the continental shelf edge, the approximate species range does not overlap with portions of the action area where explosive events will occur), shortnose sturgeon, U.S. portion of range DPS of smalltooth sawfish, and South-Central California Coast DPS and Southern California DPS of steelhead trout, are not expected to be adversely affected by underwater acoustic effects from

Super Heavy or Starship explosive events. These species are not expected to occur in high numbers or densities in areas where Super Heavy or Starship explosive events are likely to occur. Additionally, based on NMFS's physical injury acoustic thresholds for large fish (> 2 grams), the ensonified area from a Super Heavy or Starship explosion is 9.34 km^2 and 4.63 km^2, respectively. Given the relatively small ensonified areas compared to the size of each portion of the action area, the limited number of explosive events, and the infrequent or rare occurrence of these species in areas where there could be an explosion, it is extremely unlikely these species will be exposed to underwater acoustic effects of Super Heavy or Starship explosive events. Thus, the effects are discountable.

Oceanic whitetip sharks are caught in the yellowfin tuna fishery in the Gulf and Northwest Atlantic Ocean. In the 1950s, during exploratory tuna surveys, nearly 400 oceanic whitetip sharks were caught, relative to only five caught in the 1990s during the commercial yellowfin tuna fishery in the Gulf (Baum and Myers 2004). Although Young et al. (2018) estimate oceanic whitetip shark abundance declined about 4% between 1992 and 2005, there was a significant historic decline in abundance (88% in the Gulf; FAO 2012). Young et al. (2018) conclude that oceanic whitetip sharks are now relatively rare in the Northwest Atlantic and Gulf.

The Flower Garden Banks National Marine Sanctuary serves as a nursery habitat for giant manta ray, given multiple studies on the prevalence of juvenile giant manta rays within the Sanctuary (Childs 2001; Stewart et al. 2018a; Stewart et al. 2018b). A buffer of 20 NM from the Flower Garden Banks National Marine Sanctuary will be implemented for any Super Heavy landings and potential explosive events to avoid the sanctuary. Based on sightings and survey data of giant manta ray along the U.S. East Coast and Gulf from 1925–2020, Farmer et al. (2022a) modeled the probability of occurrence for giant manta rays in the Gulf and Northwest Atlantic. Farmer et al. (2022a) modeled higher probabilities of occurrence nearshore compared to areas offshore. Overall, we do not expect oceanic whitetip sharks and giant manta rays to occur in high numbers or densities within the Gulf and Atlantic Ocean portions of the action area. Given the low probabilities of occurrence, relatively small ensonified areas within which measurable responses could be expected, and the limited number of times Super Heavy may explode in either portion of the action area, oceanic whitetip shark and giant manta ray exposure to the underwater acoustic effects of explosive events in the Gulf and Atlantic Ocean portions of the action area is extremely unlikely and, thus, discountable.

Very little data exist on oceanic whitetip sharks in the Indian Ocean portion of the action area. Most come from fisheries bycatch data, collected by the Indian Ocean Tuna Commission, and there are no quantitative stock assessments for the oceanic whitetip shark. Oceanic whitetip sharks are generally found offshore in the open ocean, on the outer continental shelf, or around oceanic islands in deep waters, and prefer warm (> 68°F or 20°C; Bonfil et al. 2008) open ocean waters between 10° North and 10° South latitude, which overlaps with the Indian Ocean portion of the action area (NMFS 2017c). Oceanic whitetip sharks have been caught in tuna purse seine fisheries adjacent to the western boundary of the Indian Ocean portion of the action area (Lopetegui-Eguren et al. 2022), and have also been caught in the Spanish longline swordfish fishery (Ramos-Cartelle et al. 2012) that overlaps the Indian Ocean portion of the action area. However, the majority of oceanic whitetip sharks caught as bycatch in the Indian Ocean were caught between latitudes 0° and 10° South, outside of the Indian Ocean portion of the action area. Oceanic whitetip shark bycatch within the Indian Ocean portion of the action area is likely higher than what would be expected with standard survey data, because fishing vessels put out bait that attracts predators like the oceanic whitetip shark. Anecdotal reports suggest that oceanic whitetip sharks have become rare throughout most of the Indian Ocean over the past 20 years (IOTC 2015). Giant manta rays are generally found in coastal waters in the Indian Ocean, outside of the Indian Ocean portion of the action area (Kashiwagi et al. 2011; Kitchen-Wheeler 2010; Miller and Klimovic 2017). Given the small ensonified area within which measurable responses could be expected and the limited number of Starship explosive events, we believe that the estimated number of exposures that would be more than insignificant for ESA-listed oceanic whitetip sharks and giant manta rays will be lower than that for blue, fin, and sperm whales (Table 8).

Oceanic whitetip shark and giant manta ray occurrence within the Hawaii and Central North Pacific portion of the action area were estimated from the NMFS Pacific Islands Regional Office's Protected Resources Division fisheries observer data. Data from 2023, the most recent year with complete data, were obtained from the Hawai'i deep-set long line fisheries observer data. There were 452 interactions with oceanic whitetip sharks and two interactions with giant manta rays in 2023. The deep-set long line fishery operates year-round and had a 17.41% average observer coverage in 2023 (between one in five or one in six fishing trips had an observer on board). This is likely higher than what would be expected with standard survey data, because fishing vessels put out bait that attracts predators like the oceanic whitetip shark. These are also observations, not targeted surveys to identify species densities in an area. These observations occurred over 12 months, representing individuals moving in and out of the action area, and are not representative of densities at any particular time of year. The Hawai'i deep-set long line fishery only overlaps a relatively small portion of the Hawaii and Central North Pacific portion of the action area, which is over 38 million mi^2 (10 million km^2) in size. Thus, given the low estimated number of possible exposures of oceanic whitetip shark and giant manta ray in the action area, small ensonified area within which measurable responses could be expected, and the limited number of Starship explosive events, it is extremely unlikely that the oceanic whitetip shark and giant manta ray would be exposed to underwater acoustic effects from Starship explosive events in the Hawaii and Central North Pacific portion of the action area.

Expected occurrence of oceanic whitetip sharks and giant manta rays in the Northeast and Tropical Pacific portion of the action area is similar to that in the Hawaii and Central North Pacific portion of the action area. Young et al. (2018) synthesize information from multiple studies showing a clear decline of approximately 80–95% in catches of oceanic whitetip sharks in fisheries operating in the Eastern Pacific. Giant manta rays are relatively scarce throughout the Northeast and Tropical Pacific portion of the action area except for the southeast corner of the action area, which overlaps with Isla Clarión of Mexico's Revillagigedo National Park (Revillagigedo Archipelago). Revillagigedo National Park is Mexico's largest fully protected marine reserve. Giant manta rays aggregate at the Revillagigedo National Park and Bahia de Banderas (Banderas Bay), Mexico with estimated populations of 1,172 and > 400 individuals, respectively (Cabral et al. 2023; Domínguez-Sánchez et al. 2023; Gómez-García et al. 2021; Harty et al. 2022). Tagged giant manta rays appeared to move between four main sites: the Gulf, Banderas Bay, Barra de Navidad, and the three eastern-most islands of Revillagigedo National Park (Rubin et al. 2024). Isla Clarión, which is the only island of Revillagigedo National Park that overlaps the Northeast and Tropical Pacific portion of the action area, was not one of the sites that tagged giant manta rays based on the Rubin et al. (2024) study. It appears giant manta rays do not frequent Isla Clarión to the same degree as the other islands in the Revillagigedo National Park, as giant manta ray cleaning sites (where animals aggregate in larger numbers) are located near the other three islands (Cabral et al. 2023; Rubin et al. 2024; Stewart et al. 2016). Thus, we do not expect oceanic whitetip sharks or giant manta rays to occur in high numbers or densities within the Northeast and Tropical Pacific portion of the action area. In addition, given the small ensonified area within which measurable responses could be expected and the limited number of Starship explosive events, it is extremely unlikely that oceanic whitetips sharks and giant manta rays will be exposed to the underwater acoustic effects of Starship explosive events and thus discountable.

In the South Pacific, oceanic whitetip sharks have also undergone a 80–95% decline in population abundance (Hall and Roman 2013). Oceanic whitetip sharks in the South Pacific portion of the action area are expected to be scarce and widely distributed, with no aggregations of sharks in large numbers or densities. The giant manta ray population is estimated at 22,316 individuals off Ecuador (Harty et al. 2022). Coastal aggregations of giant manta rays have been observed off the coast of Ecuador, and movements documented between foraging and cleaning aggregation sites, northern Peru, and the Galapagos Islands (Andrzejaczek et al. 2021; Burgess 2017). Thus, giant manta ray are not expected to occur in the South Pacific portion of the action area in high numbers or densities. In addition, given the small ensonified area within which non-insignificant responses could be expected for ESA-listed oceanic whitetip sharks and giant manta rays and the limited number of Starship explosive events, it is extremely unlikely that oceanic whitetips sharks and giant manta rays will be exposed to the underwater acoustic effects of Starship explosive events.

In summary, given the relatively sparse occurrence of ESA-listed fishes across the action area, small ensonified areas within which measurable responses could occur, and limited number of explosive events, we expect that ESA-listed fishes are extremely unlikely to be exposed to underwater acoustic effects from vehicle explosive events. Thus, effects from underwater acoustic effects from explosive events on ESA-listed fishes are discountable.

We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon, giant manta ray, Southern DPS of green sturgeon, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS of scalloped hammerhead shark, shortnose sturgeon, U.S. portion of range DPS of smalltooth sawfish, and South-Central California Coast DPS and Southern California DPS of steelhead trout.

4.1.2.4 ESA-Listed Invertebrates

The ESA-listed invertebrates that are not likely to be adversely affected by underwater acoustic effects from explosive events due to the proposed action are: black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and the proposed sunflower sea star.

Black abalone occur along the coast from Point Arena, California to Northern Baja California, Mexico in waters from the high intertidal zone to about 20 ft (6 m) depth (VanBlaricom et al. 2009). Because the range and distribution of black abalone is restricted to coastal waters, it is extremely unlikely that black abalone will be exposed to underwater acoustic effects from explosive events, which will occur offshore in the Northeast and Tropical Pacific portion of the action area. Boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, and staghorn coral occur in coastal areas (from the coast to continental shelf edge) throughout the Caribbean (NMFS 2022). The range of these coral species does not overlap with either the Gulf or Atlantic Ocean portions of the action area where explosive events will occur. Thus, it is extremely unlikely that ESA-listed corals will be exposed to underwater acoustic effects from explosive events. The proposed sunflower sea star occurs in coastal waters from the Aleutian Islands to Baja California, and is most commonly found in waters less than 82 ft (25 m) deep, and rare in waters deeper than 394 ft (120 m; Lowry et al. 2022). Because the proposed sunflower sea star does not occur where explosive events will occur, it is extremely unlikely that proposed sunflower sea star will be exposed to underwater acoustic effects from explosive events.

In summary, given the range and distribution of ESA-listed invertebrates across the action area, we expect that ESA-listed invertebrates are extremely unlikely to be exposed to underwater acoustic effects from explosive events. Thus, underwater acoustic effects from explosive events on ESA-listed invertebrates are discountable.

We conclude that the proposed action may affect, but is not likely to adversely affect ESA-listed black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and proposed sunflower sea star.

4.1.3 Critical Habitat Not Likely to be Adversely Affected

This section identifies the designated or proposed critical habitat for which effects are NLAA from stressors resulting from the proposed action and are not analyzed further in this opinion. Critical habitats that are not likely to be adversely affected by the proposed action include the designated critical habitats of the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, North Atlantic right whale, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and the proposed critical habitats of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle, and Rice's whale.

Designated critical habitat for the Main Hawaiian Islands Insular DPS of false killer whale may be affected, but is not likely to be adversely affected by the following stressors: vessel presence, vessel noise, vessel pollution, and aircraft overflight. Vessel presence may affect PBFs related to prey species of sufficient quantity and availability. Vessels may temporarily displace prey while the vessel transits through an area; however, limited and temporary vessel use is not expected to measurably affect the quantity, quality, or availability of prey. Pollution from vessels may affect the PBF: waters free of pollutants of a type and amount harmful to Main Hawaiian Islands Insular false killer whales. Given the limited use of vessels and the short amount of time action-related vessels will be in use, pollution is not expected to measurably affect the water quality, or increase the health risks in a manner that would be harmful to Main Hawaiian Islands Insular false killer whales. Vessel noise and aircraft overflight may affect PBFs: adequate space for movement and use within habitats, and sound levels that would not significantly impair false killer whales' use or occupancy. However, vessel and aircraft noise will be temporary and aircraft noise is extremely limited given that acoustic energy does not effectively cross the air-water boundary, and is not expected to measurably affect false killer whale movement, space use, or occupancy. Thus, effects from stressors from vessel and aircraft use on Main Hawaiian Islands Insular DPS of false killer whale critical habitat are too small to measure and thus insignificant.

Designated critical habitat for the Central America DPS and Mexico DPS of humpback whale may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Vessels may temporarily displace prey for the duration the vessel transits through an area; however, limited vessel use and the short amount of time action-related vessels will be in use are not expected to measurably affect the quality, abundance, or accessibility of prey. Thus, the effect from vessel presence on the Central America DPS and Mexico DPS of humpback whale critical habitat is expected to be too small to measure and thus insignificant.

Designated critical habitat for the Hawaiian monk seal may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Vessels may temporarily displace prey for the duration the vessel transits through an area; however, limited vessel use is not expected to measurably affect the quality or quantity of prey. Thus, the effect from vessel presence on the Hawaiian monk seal critical habitat is insignificant.

Designated critical habitat for the North Atlantic right whale may be affected, but is not likely to be adversely affected by the following stressors: direct impact from fallen objects, heat from launches, and heat from vehicle landings and explosive events. Falling objects, especially large objects like Starship and Super Heavy, hitting the ocean surface may temporarily affect calm conditions. However, impacts would only be in the immediate vicinity of the fallen object, and conditions would return to normal shortly after impact. Heat from launches, landings, and explosive events may affect sea surface temperatures. However, the increase in sea surface temperature would also be temporary and temperatures would return to normal shortly after the launch, landing, or explosive event. Temporary heat from these activities is not expected to affect North Atlantic right whale critical habitat conditions to an extent that would be measurable. Thus, the effects from stressors on North Atlantic right whale critical habitat are insignificant.

Designated critical habitat for the leatherback turtle may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Vessels may temporarily displace prey for the short time the vessel transits through an area; however, limited vessel use is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effect from vessel presence on the leatherback turtle critical habitat is insignificant.

Designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle may be affected, but is not likely to be adversely affected by the following stressors: direct impact by fallen objects, unrecovered debris, and vessel presence. Designated critical habitat of the Northwest Atlantic Ocean DPS of loggerhead turtle is categorized into different habitat types, each with their own set of PBFs. The habitat types that may be affected, but are not likely to be adversely affected by the proposed action include: foraging habitat, constricted migratory habitat, and *Sargassum* habitat. Breeding habitat is discussed in Sections 4.2.4 and 6. Direct impact by fallen objects may affect PBFs related to adequate cover. The area of critical habitat that Super Heavy, Starship, or associated debris could impact as it falls through the water column is relatively small (hundreds of square meters or less) compared to the area over which *Sargassum* habitat can be distributed (hundreds of thousands of square kilometers). Thus, it would be extremely unlikely that the amount of available cover in this critical habitat unit would be measurably affected by falling objects.

Unrecovered debris may affect PBFs related to passage conditions and water depth. Unrecovered debris could create obstructions to passageways or affect water depth if they land in shallow areas where the size of the debris blocks the water column. Based on the available information from FAA and SpaceX, Super Heavy and Starship may land intact and sink in a horizontal orientation (unless the vehicle landing results in debris, in which case, the debris pieces would be smaller than either Super Heavy or Starship). When Super Heavy and Starship are horizontal, the maximum height is 30 ft (9 m). Thus, the vehicles could obstruct areas or affect water depth in areas 30 ft (9 m) or shallower. However, this would be a temporary impact because the obstruction of a waterway is a clear navigational hazard (and would likely be a navigational hazard if a portion of the water column was blocked by debris), and SpaceX would be required to remove the obstruction. Super Heavy and Starship are relatively small compared to the size of critical habitat units of each species considered here, and the vehicle or debris would only temporarily obstruct a portion of the critical habitat related to passage and depth. Thus, the effects would not be expected to affect the long-term conditions of critical habitat.

Direct impact by fallen objects and vessel presence may affect PBFs related to prey availability. Vessels and falling objects may temporarily displace prey for the short time the vessel transits through an area or the object sinks through the water column; however, the duration of these stressors is brief (on the order of days or less), limited to the immediate vicinity of the vessel or object, and is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effects from stressors on the Northwest Atlantic Ocean DPS of loggerhead turtle critical habitat (foraging habitat, constricted migratory habitat, and *Sargassum* habitat) are discountable or insignificant.

Designated critical habitat for the Gulf sturgeon may be affected, but is not likely to be adversely affected by the following stressors: vessel presence and vessel pollution. Vessel presence may affect prey abundance and displace prey for the duration the vessel transits through the area; however, given the limited use of vessels and duration of activities requiring vessels, vessels are not expected to measurably affect the abundance of prey. Vessel pollution may affect the water quality PBF of Gulf sturgeon critical habitat. Pollutants are expected to evaporate and quickly become diluted, limiting any impacts to a temporary duration. Given the limited use of vessels and limited number of times either vehicle can be expended in the ocean, vessel pollution is not expected to measurably affect water quality of Gulf sturgeon critical habitat. Thus, effects from stressors on Gulf sturgeon critical habitat are insignificant.

Designated critical habitat for Nassau grouper may be affected, but is not likely to be adversely affected by the following stressors: direct impact by fallen objects and vessel presence. Falling objects may directly affect benthic habitat and habitat used for shelter. However, the debris that could occur in Nassau grouper critical habitat would result from a mishap, in which case, the debris would be widely dispersed and scattered across an area significantly larger than the area of the critical habitat. The likelihood that a falling object directly hits benthic habitat would be extremely unlikely. Vessel presence may affect prey abundance by temporarily displacing prey for the short time the vessel transits through an area. However, limited and temporary vessel use is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effect from stressors on Nassau grouper critical habitat is either discountable or insignificant.

Designated critical habitat for black abalone may be affected, but is not likely to be adversely affected by the following stressor: vessel pollution. Pollution from vessels may affect the water quality PBF of black abalone critical habitat. Given the limited and temporary use of vessels, pollution is not expected to measurably affect water quality of black abalone critical habitat. Thus, the effect from vessel pollution on black abalone critical habitat is insignificant.

Designated critical habitat for boulder star coral, lobed star coral, mountainous star coral, pillar coral, and rough cactus coral may be affected, but is not likely to be adversely affected by the following stressor: direct impact by fallen objects. Falling objects may directly affect substrate; however, it is extremely unlikely that debris from a mishap will occur within coral critical habitat (see Section 4.1.1.2). Falling objects may disturb the sediment at the seafloor as they settle, and affect water quality and the amount of sediment that settles on top of the reef. If debris impacts the seafloor in proximity to ESA-listed corals, the sediment would be temporarily resuspended, and would be dispersed by currents and water movement while in the water column. Water quality would be temporarily affected, only near the fallen object, and would return to normal conditions shortly after the object has settled. It is extremely unlikely that the displaced sediment would be of adequate volume to cover the coral habitat. Thus, the effect from direct impact by fallen objects on boulder star coral, lobed star coral, mountainous star coral, pillar coral, and rough cactus coral are discountable.

Designated critical habitat for elkhorn coral and staghorn coral may be affected, but is not likely to be adversely affected by the following stressor: direct impact by falling objects. Substrate quality and availability may be affected by falling objects; however, falling objects would only be present near critical habitat if there is a mishap. In that case, the objects would be widely dispersed within an area much larger than the critical habitat area, making it extremely unlikely critical habitat would be afffected. Thus, the effect from direct impact by falling objects on elkhorn coral and staghorn coral critical habitat is discountable.

Proposed critical habitat for the Central North Pacific DPS and East Pacific DPS of green turtle may be affected, but is not likely to be adversely affected by the following stressor: vessel presence. Proposed critical habitat for the Central North Pacific DPS and East Pacific DPS of green turtle is categorized into different habitat types, each of which has their own set of PBFs. The habitat type that may be affected, but is not likely to be adversely affected by the proposed action is the benthic foraging/resting feature. Vessel use may affect the PBF related to food resources (i.e., prey), as it may temporarily displace prey for the short time the vessel transits through an area. However, limited and temporary vessel use is not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, the effect from vessel presence on Central North Pacific DPS and East Pacific DPS of green turtle proposed critical habitat is insignificant.

Proposed critical habitat for the North Atlantic DPS of green turtle may be affected, but is not likely to be adversely affected by the following stressors: direct impact by fallen objects, unrecovered debris, and vessel presence. Proposed critical habitat for the North Atlantic DPS of green turtle is categorized into different habitat units, each of which has their own set of PBFs. The habitat units that may be affected, but are not likely to be adversely affected by the proposed action include reproductive, migratory, benthic foraging/resting, and surface-pelagic foraging/resting. Direct impact by fallen objects may affect the availability of refugia. The area of critical habitat that Super Heavy, Starship, or associated debris could affect as it falls through the water column is relatively small (hundreds of square meters or less) compared to the area of benthic foraging/resting and surface-pelagic foraging/resting habitat (hundreds of thousands of square kilometers). Thus, it would be extremely unlikely that the amount of refugia would be affected by falling objects. Unrecovered debris may affect PBFs related to unobstructed waters and water depth. Unrecovered debris could create obstructions or affect water depth if they land in shallow areas where the size of the debris blocks the water column, as described above. The vehicles could obstruct areas or affect water depth in areas 30 ft (9 m) or shallower. However, this would be a temporary impact because an obstruction of a waterway is a clear navigational hazard, and SpaceX would be required to remove any obstruction. The size of Super Heavy and Starship are relatively small compared to the area of proposed critical habitat of this DPS, and would only temporarily obstruct a portion of the proposed critical habitat. Thus, the effects would not be expected to measurably affect the conditions of proposed critical habitat. Direct impact by fallen objects may affect PBFs related to refugia and prey resources. Falling objects and vessel presence may temporarily displace prey for the duration the object moves through the water column or vessels transit through the area. This is temporary and localized, and not expected to measurably affect the condition, distribution, diversity, abundance, or density of prey. Thus, effects from stressors on North Atlantic DPS of green turtle proposed critical habitat are discountable or insignificant.

Proposed critical habitat for Rice's whale may be affected, but is not likely to be adversely affected by the following stressors: sonic booms and impulse noise, direct impact by fallen objects, vessel presence, vessel and vehicle pollution, vessel noise, aircraft overflight, in-air acoustic effects from vehicle landings and explosive events, heat from vehicle landings and explosive events, and underwater acoustic effects from explosive events. Acoustic-related stressors (sonic booms, impulse noise, vessel noise, in-air acoustic effects from vehicle landings and explosive events, and underwater acoustic effects from explosive events) may affect the PBF related to sufficiently quiet conditions for normal use and occupancy. Given the limited number of times and short duration that these activities will occur, in addition to the ineffective transmission of acoustic energy across the air-water boundary, these stressors are not expected to measurably affect acoustic conditions long-term. Direct impact by fallen objects and vessel presence may temporarily displace prey for the duration the object moves through the water column or vessels transit through an area. Given the temporary duration of those activities, these stressors are not expected to measurably affect the density, quality, abundance, or accessibility of prey. Vessel and vehicle pollution may affect the PBF related to the level of pollutants in marine water. However, given the limited vessel activity and number of times Starship and Super Heavy will be expended in a manner that facilitates pollutants entering the ocean and dispersion of pollutants in the ocean (i.e., explosive event), we expect the effects of vessel and vehicle pollution on proposed critical habitat will be so small as to be immeasurable. Heat from vehicle landings and explosive events may temporarily affect surface temperatures; however, the increase in temperature is extremely unlikely to affect the bottom temperature range specified in the PBF. Thus, effects from stressors on Rice's whale proposed critical habitat are discountable or insignificant.

We conclude the proposed action may affect, but is not likely to adversely affect designated or proposed critical habitats of the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, North Atlantic right whale, leatherback turtle, Northwest Atlantic Ocean DPS of loggerhead turtle (with the exception of breeding habitat), Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle, and Rice's whale.

4.2 Status of the Species and Critical Habitat Likely to be Adversely Affected

The remainder of this opinion examines the status of each species and critical habitat that is likely to be adversely affected by the proposed action (Kemp's ridley turtle and Northwest Atlantic Ocean DPS of loggerhead turtle in the Gulf portion of the action area, North Atlantic DPS of green turtle and Northwest Atlantic Ocean DPS of loggerhead turtle in the Atlantic Ocean portion of the action area, and designated critical habitat of Northwest Atlantic Ocean DPS loggerhead turtle – breeding critical habitat). The status is an assessment of the abundance, recent trends in abundance, survival rates, life stages present, limiting factors, and sub-lethal or indirect changes in population trends such as inter-breeding period, shifts in distribution or habitat use, and shifts in predator distribution that contribute to the extinction risk that the listed species face. The status of each species below is described in terms of life history, threats, population dynamics, critical habitat, and recovery planning. The status of each critical habitat is described in terms of the PBFs essential to the conservation of the species; the status, function, and extent of those PBFs based on best available scientific and commercial data; and the conservation needs of the species in terms of habitat to support a recovered population.

The information used in each of these sections is based on parameters considered in documents such as status reviews, recovery plans, and listing decisions and based on the best available scientific and commercial information. This section informs the description of the species' likelihood of both survival and recovery in terms of their "reproduction, numbers, or distribution" as described in 50 CFR §402.02. This section also examines the condition of critical habitat throughout the species' range, evaluates the conservation value of the various components of the habitat (e.g., watersheds, ocean basins, and coastal and marine environments) that make up the designated area, and discusses the function of the essential PBFs that help to form that conservation value. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register, status reviews, recovery plans, and on the NMFS OPR web site (https://www.fisheries.noaa.gov/species-directory/threatened-endangered).

4.2.1 Life History Common to Green, Kemp's Ridley, and Loggerhead Turtles

ESA-listed sea turtles in the Gulf and Atlantic portions of the action area undergo the same general life stages: adult females nest and lay multiple clutches on coastal beaches, eggs are incubated in the sand and after approximately 1.5–2 months of embryonic development, hatchlings emerge and swim offshore into deep, open ocean water where they feed and grow, until they migrate to the neritic zone (nearshore) as juveniles. Males generally arrive at breeding grounds before females and return to foraging grounds months before females (Hays et al. 2022). When individuals reach sexual maturity, adult turtles generally return to their natal beaches where they mate in nearshore waters and nest. North Atlantic DPS green, Kemp's ridley, and Northwest Atlantic Ocean DPS loggerhead turtles generally nest from late spring to late summer/early fall.

Sea turtles generally can hear low-frequency sounds, with a typical hearing range of 30 Hertz (Hz) to 2 kiloHertz (kHz) and a maximum sensitivity between 100–800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Ridgway et al. 1969).

4.2.2 Threats Common to Green, Kemp's Ridley, and Loggerhead Turtles

ESA-listed sea turtles in the Gulf and Atlantic Ocean portions of the action area face numerous natural and human-induced threats that shape their status and affect their ability to recover. Many of these threats are either the same or similar in nature among the North Atlantic DPS of green, Kemp's ridley, and Northwest Atlantic Ocean DPS of loggerhead turtle. The threats identified in this section apply to all three species. Information on threats specific to a particular species is discussed in the corresponding Status of the Species sections where appropriate.

ESA-listed sea turtles in the Gulf and Atlantic Ocean portions of the action area were threatened by overharvesting and poaching. Although intentional take of sea turtles and their eggs does not occur extensively within these portions of the action area currently, sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. Other major threats to ESA-listed sea turtles are habitat degradation and habitat loss (e.g., human-induced and coastal erosion, storm events, light pollution, coastal development or stabilization, plastic pollution, oil pollution), fisheries interactions and bycatch, changing environmental trends, oceanic events such as cold-stunning, natural predation, and disease.

4.2.3 Green Turtle – North Atlantic DPS

The green turtle was first listed as endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened for all other areas under the ESA in 1978 (43 Fed. Reg. 32800). On April 6, 2016, the NMFS listed 11 DPSs of green turtles, with the North Atlantic DPS listed as threatened (81 Fed. Reg. 20057).

Life History

Adult females in the North Atlantic DPS nest from May–September. Female age at first reproduction is 20–40 years. Green turtles lay an average of three nests per season with an average of 100 eggs per nest (Seminoff et al. 2015). The remigration interval (i.e., return to natal beaches) is two to five years. Nesting is geographically widespread within the action area, and occurs along the southeastern Atlantic coast of the U.S. and the northwestern Gulf coast. Nesting primarily occurs along the central and southeast Atlantic coast of Florida. Four regions support nesting concentrations of particular interest in the North Atlantic DPS: Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), U.S. (Florida), and Cuba. The largest nesting site occurs in Tortuguero, Costa Rica (Seminoff et al. 2015).

Green turtle juveniles are capable of hearing underwater sounds at frequencies of 50–1,600 Hz and experience maximum sensitivity at 200–400 Hz, although sensitivity is still possible outside of this range (Piniak et al. 2016; Lenhardt 1994; Bartol and Ketten 2006; Ridgway et al. 1969).

Population Dynamics

Accurate population estimates for sea turtles do not exist because of the difficulty in sampling turtles over their large geographic ranges and within their marine environments. Nonetheless, researchers have used nesting data to study trends in reproducing sea turtles over time. A summary of nesting trends and nester abundance is provided in the most recent status review for the species (Seminoff et al. 2015). The North Atlantic DPS is the largest of the 11 green turtle DPSs, with an estimated nester abundance of over 167,000 adult females from 73 nesting sites.

Florida accounts for approximately 5% of nesting for this DPS (Seminoff et al. 2015). According to data collected from Florida's index nesting beach survey from 1989–2024, green turtle nest counts across Florida have increased from a low of 267 in the early 1990s to a high of 40,911 in 2019. Nesting decreased by half from 2019–2020, although it increased to a new record high in 2023 before dropping substantially in 2024. Green turtles generally follow a two-year reproductive cycle, which may explain fluctuating nest counts. Tortuguero, Costa Rica is the predominant nesting site, accounting for an estimated 79% of nesting for the DPS (Seminoff et al. 2015). A recent long-term study spanning over 50 years of nesting at Tortuguero found that while nest numbers increased steadily over 37 years from 1971–2008, the rate of increase slowed gradually from 2000–2008. After 2008, nesting trends decreased, with current nesting levels having reverted to that of the mid-1990s and the overall long-term trend has now become negative (Restrepo et al. 2023). While nesting in Florida has shown increases over the past decade, individuals across North Atlantic DPS nesting sites intermix and share developmental and foraging habitat. Therefore, threats that have affected nesting in the Tortuguero region may ultimately influence the trajectories of nesting in the Florida region.

DiMatteo et al. (2024a) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult green turtles along the U.S. Atlantic Coast of 63,674 individuals (90% Confidence Interval [CI] = 23,381–117,610 individuals).

Threats

In addition to general threats common to all three sea turtle species considered, green turtles are especially susceptible to natural mortality from fibropapillomatosis (FP) disease (Blackburn et al. 2021; Foley et al. 2005; Manes et al. 2022; Shaver et al. 2019; Tristan et al. 2010). The prevalence of FP has reached epidemic proportions in some parts of the North Atlantic DPS of green turtle, including Florida, although the long-term impacts to North Atlantic DPS green turtles is unknown (Seminoff et al. 2015). FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). When these tumors are particularly large or numerous, they can debilitate turtles, affecting swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989), and can even result in mortality. Perrault et al. (2021b) observed reduced immune function in green turtles with FP. Although the exact cause of FP is unknown, it is believed to be related to an infectious agent, such as a virus, and/or environmental conditions such as habitat degradation and pollution (Foley et al. 2005).

Critical Habitat

Green turtle designated and proposed critical habitat was found to be NLAA (Section 4.1.3) and is not considered further in the opinion.

Recovery Planning

In response to the current threats facing the species, NMFS and U.S. Fish and Wildlife Service (USWFS) identified actions needed to recover the U.S. Atlantic population of green turtles. These threats are discussed in further detail in the environmental baseline of this consultation. See the NMFS and USFWS 1991 recovery plan for the U.S. Atlantic population of green turtles for complete down-listing/delisting criteria for each of the following major actions (NMFS and USFWS 1991). The following items were identified as priorities to recover U.S. Atlantic green turtles:

1. Provide long-term protection to important nesting beaches.
2. Ensure at least 60% hatch success on major nesting beaches.
3. Implement effective lighting ordinances or lighting plans on nesting beaches.
4. Determine distribution and seasonal movements for all life stages in the marine environment.
5. Minimize mortality from commercial fisheries.
6. Reduce threat to population and foraging habitat from marine pollution.

4.2.4 Kemp's Ridley Turtle

The Kemp's ridley turtle was listed as endangered on December 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Internationally, the Kemp's ridley turtle is considered the most endangered sea turtles (Groombridge 1982; TEWG 2000; Zwinenberg 1977).

Life History

Adult female Kemp's ridley turtles nest from April–July. Age to sexual maturity ranges greatly from five to 16 years, though NMFS et al. (2011a) determined the best estimate of age to maturity for Kemp's ridley turtles was 12 years. The average remigration rate for Kemp's ridley turtles is approximately two years. Females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Márquez M. 1994). Nesting is limited to the beaches of the western Gulf, primarily in Tamaulipas, Mexico but also in Veracruz, Mexico and Padre Island National Sea Shore, Texas.

Juvenile Kemp's ridley turtles can hear from 100–500 Hz, with a maximum sensitivity between 100–200 Hz at thresholds of 110 dB re 1µPa (Bartol and Ketten 2006).

Population Dynamics

Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. Nesting steadily increased through the 1990s, and then accelerated during the first decade of the 21st century. Following a significant, unexplained one-year decline in 2010, Kemp's ridley turtle nests in Mexico reached a record high of 21,797 in 2012 (NPS 2013). In 2013, there was a second significant decline, with 16,385 nests recorded. In 2014, there were an estimated 10,987 nests (approximately 4,395 females) and 519,000 hatchlings released from three primary nesting beaches in Mexico (NMFS and USFWS 2015a).

A small nesting population has emerged in the U.S., primarily in Texas, rising from six nests in 1996 to 42 in 2004, to a record high of 353 nests in 2017 (National Park Service data). It is worth noting that nesting in Texas has somewhat paralleled the trends observed in Mexico, characterized by a significant decline in 2010, followed by a second decline in 2013–2014, but with a rebound in 2015, the record high in 2017, and then a decrease back down to 190 nests in 2019, rebounding to 262 nests in 2020, and back down to 195 nests in 2021, and then rebounding again to 284 nests in 2022 (National Park Service data; (NMFS and USFWS 2015a). Gallaway et al. (2013) estimated the female population size for age 2 and older in 2012 to be 188,713 (standard deviation; SD = 32,529). If females comprise 76% of the population, the total population of Kemp's ridley turtles greater than two years in age was estimated to have been 248,307 in 2012 (Gallaway et al. 2013).

Kemp's ridley turtle nesting population was exponentially increasing (NMFS et al. 2011a); however, since 2009 there has been concern over the slowing of recovery (Gallaway et al. 2016a; Gallaway et al. 2016b; Plotkin 2016). From 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15% annually (Heppell et al. 2005a); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2015a). The species' limited range as well as low global abundance makes it particularly vulnerable to new and continued threats. The significant nesting declines observed in 2010 and 2013–2014 potentially indicate a serious population-level impact, and the ongoing recovery trajectory is unclear. DiMatteo et al. (2024a) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult Kemp's ridley turtles along the U.S. Atlantic Coast of 10,762 individuals (90% CI = 2,620–19,443 individuals).

Threats

In addition to general threats common to all three sea turtle species considered, fishery interactions and strandings appear to be the main threats to Kemp's ridley turtles. Since 2010, NMFS has documented (via the Sea Turtle Stranding and Salvage Network data) more Kemp's ridley turtle strandings in the Northern Gulf of America, compared to other sea turtle species. While a definitive cause for these strandings has not been identified, necropsy results indicate a significant number of stranded were forcibly submerged, which is commonly associated with fishery interactions (B. Stacy, NMFS, pers. comm. to M. Barnette, NMFS Protected Resources Division, March 2012). Given the nesting trends and habitat utilization of Kemp's ridley turtles, it is likely that fishery interactions in the Northern Gulf of America may continue to be an issue of concern for the species, and one that may potentially slow the rate of recovery for Kemp's ridley turtles. Kemp's ridley turtles are also especially vulnerable to threats that cause population-level impacts such as the Deepwater Horizon (DWH) oil spill and response, due to their already low numbers and location of nesting habitat. While the Kemp's ridley turtle population shows signs of increasing abundance, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness. Therefore, the species' resilience to future perturbation is considered low.

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to current threats facing the species, NMFS developed goals to recover Kemp's ridley turtle populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley turtles for complete down listing/delisting criteria for each of their respective recovery goals (NMFS and USFWS 2011). The following items were identified as priorities to recover Kemp's ridley turtles:

1. Protect and manage nesting and marine habitats.
2. Protect and manage populations on the nesting beaches and in the marine environment.
3. Maintain a stranding network.
4. Manage captive stocks.
5. Sustain education and partnership programs.
6. Maintain, promote awareness of and expand U.S. and Mexican laws.
7. Implement international agreements.
8. Enforce laws.

4.2.5 Loggerhead Turtle – Northwest Atlantic Ocean DPS

The loggerhead turtle was first listed as threatened under the ESA in 1978 (43 Fed. Reg. 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Northwest Atlantic Ocean DPS listed as threatened (75 Fed. Reg. 12598).

Life History

Adult female loggerhead turtles generally nest between April–September. They nest one to seven times in a season, with an internesting interval of approximately 14 days. Clutch sizes range from 95–130 eggs (NMFS and USFWS 2023b). Loggerhead turtles reach sexual maturity between 29–49 years of age, although this varies widely among populations (Chasco et al. 2020; Frazer and Ehrhart 1985; NMFS 2001). Mean age at first reproduction for female loggerhead turtles is 30 years. The average remigration interval is 2.7 years. Within the action area, Northwest Atlantic Ocean DPS loggerhead turtle nesting generally occurs along the Atlantic and Gulf coasts from North Carolina to Alabama and Florida, respectively, although additional nesting occurs along the entire north and western Gulf coast.

Bartol et al. (1999) reported effective hearing range for juvenile loggerhead turtles is from at least 250–750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re 1μPa and two-year olds: about 86 dB re 1μPa), with the threshold increasing rapidly above and below that frequency (Bartol and Ketten 2006). Underwater tones elicited behavioral responses to frequencies between 50 and 800 Hz and auditory evoked potential responses between 100 Hz and 1.1 kHz in one adult loggerhead turtle, with the lowest threshold recorded at 98 dB re 1μPa at 100 Hz (Martin et al. 2012). Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50–800 Hz, while juveniles responded to sounds in the range of 50 Hz to 1 kHz.

Population Dynamics

The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead turtles from Texas through Virginia and Quintana Roo, Mexico, is over 110,000 (NMFS and USFWS 2023b). In-water estimates of abundance are difficult to perform on a wide scale. In the summer of 2010, NMFS's Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC) estimated the abundance of juvenile and adult loggerhead turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, based on Atlantic Marine Assessment Program for Protected Species

(AMAPPS) aerial line-transect sighting survey and satellite tagged loggerheads (NMFS 2011c). They provided a preliminary regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000–817,000) based on positively identified loggerhead sightings (NMFS 2011c). A separate, smaller aerial survey, conducted in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, demonstrated uncorrected loggerhead turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (NMFS and USFWS 2023b). Ceriani et al. (2019) estimated the total number of adult females nesting in Florida to be 51,319 individuals (95% CI = 16,639–99,739 individuals), based on nest count data from 2014–2018. Over 90% of loggerhead sea turtle nesting in the U.S. occurs in Florida (Ceriani et al. 2021). Most recently, DiMatteo et al. (2024a) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). Overall, the latest 5-year status review concluded that the DPS as a whole demonstrates a stable (neither increasing nor decreasing) population trend (NMFS and USFWS 2023a). We are not aware of any current range-wide in-water estimates for the DPS.

Based on genetic analysis of subpopulations, the Northwest Atlantic Ocean DPS of loggerhead turtle is further categorized into five recovery units corresponding to nesting beaches. These are Northern Recovery Unit, Peninsular Florida Recovery Unit, Dry Tortugas Recovery Unit, Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit (Conant et al. 2009).

The Northern Recovery Unit, from North Carolina to northeastern Florida, is the second largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle, with an average of 5,215 nests from 1989 through 2008, and approximately 1,272 nesting females per year (NMFS and USFWS 2008b). The nesting trend from daily beach surveys showed a significant decline of 1.3% annually from 1989 through 2008. Aerial surveys of nests showed a 1.9% decline annually in nesting in South Carolina from 1980 through 2008. Overall, there is strong statistical data to suggest the Northern Recovery Unit has experienced a long-term decline over that period. Data since that analysis are showing improved nesting numbers and a departure from the declining trend. An annual increase of 1.3% nesting females was observed between 1983–2019 (Bolten et al. 2019). Nesting in Georgia has shown an increasing trend since comprehensive nesting surveys began in 1989. Nesting in North Carolina and South Carolina has begun to show a shift away from the declining trend of the past. Increases in nesting were seen from 2009 through 2012. Loggerhead nesting in Georgia, South Carolina, and North Carolina all broke records in 2015 and then topped those records again in 2016. Nesting in 2017 and 2018 declined relative to 2016, back to levels seen in 2013 to 2015, but then bounced back in 2019, breaking records for each of the three states and the overall recovery unit. Nesting in 2020 and 2021 declined from the 2019 records, but still remained high, representing the third and fourth highest total numbers for the Northern Recovery Unit since 2008. In 2022, Georgia loggerhead nesting broke the record at 4,071, while South Carolina and North Carolina nesting were both at the second-highest level recorded.

The Peninsular Florida Recovery Unit, defined as loggerheads originating from nesting beaches along the Gulf coast from the Georgia-Florida border to the northern shore of Tampa Bay, Florida, is the largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle. An average of 64,513 nests per year were documented from 1989 through 2007, and approximately 15,735 nesting females per year (NMFS and USFWS 2008a). Following a 52% increase between 1989 through 1998, nest counts declined sharply (53%) from 1998 through 2007. However, annual nest counts showed a strong increase (65%) from 2007 through 2017 (FFWCC 2018). Index nesting beach surveys from 1989 through 2013 have identified 3 trends. From 1989 through 1998, a 30% increase was followed by a sharp decline over the subsequent decade. Large increases in nesting occurred since then. From 1989 through 2013, the decade-long decline had reversed and there was no longer a demonstrable trend. Loggerhead nesting in 2016 reached a new record on Florida's core index beaches (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). While nest numbers subsequently declined from the 2016 high, the 2007–2021 period represents a period of increase, with a maximum number of nests in 2023 (70,945 nests). The statewide estimated total for 2022 was 116,765 nests and 18,293 of those from Florida's Gulf coast (FWRI nesting database). Experts are concerned that there have not been significant increases in the number of nesters in over 30 years (1989–2018; less than the 1% recovery criterion), which suggests that the Peninsular Florida Recovery Unit is not recovering (Bolten et al. 2019).

The Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean recovery units are much smaller nesting assemblages, but they are still considered essential to the continued existence of loggerhead turtles.

The Dry Tortugas Recovery Unit includes loggerhead turtles originating from nesting beaches on islands west of Key West, Florida. The only available data for the nesting subpopulation on Key West comes from a census conducted from 1995 through 2004 (excluding 2002), which provided a range of 168–270 (mean of 246) nests per year, or about 60 nesting females (NMFS and USFWS 2007b). There was no detectable trend during this period (NMFS and USFWS 2008a).

The Northern Gulf of Mexico Recovery Unit, defined as loggerheads originating from nesting beaches from Texas through the Florida panhandle, has 100–999 nesting females annually, and a mean of 910 nests per year. Analysis of a dataset from 1997 through 2008 of index nesting beaches in the northern Gulf of America shows a declining trend of 4.7% annually. Index nesting beaches in the panhandle of Florida has shown a large increase in 2008, followed by a decline in 2009 through 2010 before an increase back to levels similar to 2003 through 2007 in 2011. Experts have not observed the amount of increase in the number of nests needed to meet recovery criterion (3% annual increase; Bolten et al. 2019).

The Greater Caribbean Recovery Unit encompasses nesting subpopulations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903–2,331 nests annually (Zurita et al. 2003a). Other significant nesting sites are found throughout the Caribbean Sea, and including Cuba, with approximately 250–300 nests annually (Ehrhart et al. 2003), and over 100 nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008a). Survey effort at nesting beaches has been inconsistent, and not trend can be determined for this subpopulation (NMFS and USFWS 2008a). Zurita et al. (2003b) found an increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico from 1987 through 2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008a).

Threats

In addition to general threats common to all three species of sea turtle considered, loggerheads may be particularly affected by organochlorine contaminants; they have the highest organochlorine concentrations and metal loads (D'Ilio et al. 2011) in sampled tissues among the sea turtle species. Modeling suggests an increase of 3.6°F (2°C) in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 5.4°F (3°C) is likely to exceed the thermal threshold of most nests, leading to egg mortality (Hawkes et al. 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007; Weishampel et al. 2004), short inter-nesting intervals (Hays et al. 2002), and shorter nesting seasons (Pike et al. 2006).

Critical Habitat

Northwest Atlantic Ocean DPS loggerhead turtle critical habitat is categorized into different habitat types, each with their own set of PBFs. Foraging habitat, constricted migratory habitat, and *Sargassum* habitat were found to be NLAA (Section 4.1.3) and are not considered further in the opinion. The remaining habitat type that is likely to be adversely affected by the proposed action is breeding habitat.

Breeding habitat is defined as concentrated breeding sites, and are "core" areas where data indicate adult males congregate to gain access to receptive females during the breeding season. Loggerhead turtle breeding season off Florida occurs between April–September. NMFS designated two units of breeding habitat: (1) within the Southern Florida migration corridor from the shore out to the 656 ft (200 m) depth contour along the stretch of the corridor between the Marquesas Keys and the Martin County/Palm Beach County line; and (2) in nearshore waters just south of Cape Canaveral, Florida.

Physical and Biological Features

The PBFs of breeding habitat include:

1. High densities of reproductive male and female loggerheads;
1. Proximity to primary Florida migratory corridor; and
2. Proximity to Florida nesting grounds.

Only the first PBF, high densities of reproductive male and female loggerheads, may be affected by the proposed action.

Status, Function, and Extent of Physical and Biological Features

Breeding critical habitat may be affected by fishing activities that disrupt the use of habitat, and, thus, affect densities of reproductive loggerheads, dredging and disposal of sediments that affect densities of reproductive loggerheads, oil spills and response activities that affect densities of reproductive loggerheads, alternative offshore energy development that affects densities of reproductive loggerheads, and changing environmental trends that can affect currents and water temperatures, and affect densities of reproductive loggerheads (note this is not an exhaustive list of activities that may affect breeding critical habitat). Because of these activities, there may be relatively small numbers of loggerhead turtle lethal or sub-lethal take. For example, the number of Northwest Atlantic Ocean DPS loggerhead turtles that may be killed from U.S. Navy training and testing activities is four; and the number that may be taken (non-lethal take) by the same activities is 138 over a five-year period. The number of Northwest Atlantic Ocean DPS loggerhead turtles that may be killed from renewable energy development off Virginia is 249 over a 30-year period, and the number that may be taken (non-lethal take) from those activities is 1,214 over a two-year construction period. The number of Northwest Atlantic Ocean DPS loggerhead turtles that may be killed in the Commercial Anchored Gill Net Fisheries off North Carolina is 20 over a 10-year period.

The most recent population abundance estimate, DiMatteo et al. (2024a), modeled survey data to estimate a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). This is an underestimate of the Northwest Atlantic Ocean DPS's abundance due to limitations in detecting smaller (i.e., younger) turtles during surveys and geographic limitations of the model (i.e., the model does not estimate abundance across the entire range of the DPS). While there has been no indication that the DPS is increasing (NMFS and USFWS 2023a), the number of loggerhead turtles that may be killed or otherwise taken by past activities is relatively small compared to the population abundance overall. As such, the status and function of breeding critical habitat, particularly the high densities of reproductive male and female loggerheads, does not appear to be significantly affected by past activities.

Conservation Needs

Breeding critical habitat is essential to the conservation of Northwest Atlantic Ocean DPS loggerhead turtles because these areas host a high density of breeding individuals, and, thus, are important locations for breeding activities and the propagation of the species. Designation of breeding critical habitat relates directly to the recovery plan for this DPS, which includes recovery objectives that collectively describe the conditions necessary to ensure each recovery unit meets its recovery criteria alleviating threats to the species so that protections afforded under the ESA are no longer necessary.

Recovery criteria for each recovery unit includes specific measures for the number of nests and the number of nesting females (for more information, see the Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle Second Revision): (1) Northern Recovery Unit – a 2% or greater annual rate of increase over a generation time of 50 years, resulting in a total annual number of nests of 14,000 or greater; (2) Peninsular Florida Recovery Unit – a 1% annual rate of increase over a generation time of 50 years, resulting in a total annual number of nests of 106,100 or greater; (3) Dry Tortugas Recovery Unit – an annual rate of increase over a generation time of 50 years is 3% or greater, resulting in a total annual number of nests of 1,100 or greater; (4) Northern Gulf of Mexico Recovery Unit – an annual rate of increase over a generation time of 50 years is 3% or greater, resulting in a total annual number of nests of 4,000 or greater; and (5) Greater Caribbean Recovery Unit – a total annual number of nests at a minimum of three nesting assemblages, averaging greater than 100 nests annually, has increased over a generation time of 50 years.

A number of recovery objectives are directly or indirectly related to ensuring high densities of reproductive male and female loggerheads in breeding critical habitat, including, but not limited to: ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females; ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes; and manage sufficient feeding, migratory, and interesting marine habitats to ensure successful growth and reproduction (see Recovery Planning, below).

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover loggerhead turtle populations. These threats will be discussed in further detail in the environmental baseline of this consultation. See the Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle Second Revision for complete down-listing/delisting criteria for each of the following recovery objectives (NMFS 2008b):

1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
3. Manage sufficient nesting beach habitat to ensure successful nesting.
4. Manage sufficient feeding, migratory, and internesting marine habitats to ensure successful growth and reproduction.
5. Eliminate legal harvest.
6. Implement scientifically based nest management plans.
7. Minimize nest predation.
8. Recognize and respond to mass/unusual mortality or disease events appropriately.
9. Develop and implement local, state, Federal, and international legislation to ensure long-term protection of loggerheads and their terrestrial and marine habitats.
10. Minimize bycatch in domestic and international commercial and artisanal fisheries.
11. Minimize trophic changes from fishery harvest and habitat alteration.
12. Minimize marine debris ingestion and entanglement.
13. Minimize vessel strike mortality.

5. ENVIRONMENTAL BASELINE

The *environmental baseline* refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

In this section, we discuss the environmental baseline within the Gulf and Atlantic Ocean portions of the action area, as it applies to species that are likely to be adversely affected by the proposed action. This allows us to assess the prior experience and state (or condition) of the endangered and threatened species and designated critical habitat that will be exposed to effects from the proposed action. The environmental baseline is important to consider because in some life history stages or areas within their ranges, listed individuals or critical habitat features will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other life history stages or areas. These localized stress responses, or stressed baseline conditions, may increase the severity of the adverse effects expected from the proposed action.

5.1 Environmental Trends

Temperature profiles have been collected in the Gulf since the 1920s. The Gulf of America region has experienced a warming rate of approximately 0.347°F (0.193°C) per decade since 1970, and has warmed at least 1.8°F (1.0°C) in the past approximately 50 years (Wang et al. 2023). The rate at which the Gulf of America is warming is twice that for the global ocean (0.155°F or 0.086°C per decade), but only slightly higher than the warming trend in the subtropical northern Atlantic Ocean (0.329°F or 0.183°C per decade; Wang et al. 2023). Overall, the Atlantic Ocean region appears to be warming faster than all other ocean basins except the polar oceans, and is projected to continue to experience substantial warming in the upper 6,562 ft (2,000 m) of the ocean even under conservative emissions scenarios (Cheng et al. 2022). On average, the general warming trend in the North Atlantic Ocean over the last 80 years is 0.056±0.0011°F (0.031±0.0006 ºC) per decade in the upper 6,562 ft (2,000 m) of the ocean (Polyakov et al. 2009). One consequence of warming waters in the Gulf of America is exacerbation of hypoxic conditions in the "dead zone" caused by excessive nutrient pollution into and freshwater discharge from the Mississippi River basin, due to changes in oxygen solubility, water stratification, and primary productivity (Altieri and Gedan 2015; Bianchi et al. 2010; Laurent et al. 2018). Changes to the marine biophysical environment are also affecting the growth and movement dynamics of pelagic *Sargassum* in the Gulf of America; *Sargassum* is designated as critical habitat for juvenile green turtles and loggerhead turtles (Marsh et al. 2023; Sanchez-Rubio et al. 2018).

Recent peer-reviewed research has provided additional evidence that long-term warming has led to changes in ocean circulation which have altered the migration timing of marine species (Langan et al. 2021). In the Gulf of America, fish and invertebrate species shifted to regions with deeper waters, rather than exhibiting a pole-ward shift like other continental shelf species assemblages in North America (Pinsky et al. 2013). Along the Texas coast over a 35-year period, researchers observed 32 species exhibiting range shifts, either expanding or contracting their expected distribution due to changing environmental factors (Fujiwara et al. 2019). Chavez-Rosales et al. (2022) identified a northward shift of an average of 178 km when examining habitat suitability models for 16 cetacean species in the western North Atlantic Ocean. Record et al. (2019b) also documented a shift in North Atlantic right whale distribution, based on an environmentally-driven shift in their main prey source. Loggerhead turtle distributions are expected to shift northward in the North Atlantic Ocean so that animals can stay within the environmental characteristics of suitable habitat (Dudley et al. 2016; McMahon and Hays 2006; Patel et al. 2021). Bevan et al. (2019) predicted a northward shift in Kemp's ridley nests, from Tamaulipas, Mexico, where a majority of Kemp's ridley nesting currently occurs, to Texas, U.S. on North and South Padre Island, the largest Kemp's ridley nesting sites in the U.S., with warming temperatures. They also predicted that Kemp's ridley turtles would ultimately be unlikely to mitigate the effects of a rapidly warming environment such that highly skewed sex ratios or even mortality of eggs and hatchlings would occur. Key marine predators are predicted to experience a 35% change in core habitat area in the Pacific Ocean, with both losses and gains in habitat due to changing environmental conditions (Hazen et al. 2012) and we anticipate similar effects in the Atlantic, including the Gulf of America.

For sea turtle prey species such as mollusks, which form calcium carbonate shells, one of the greatest threats contributing to their extinction risk is ocean acidification driven by global changing environmental conditions. Ocean acidification occurs as carbon dioxide concentrations increase in the atmosphere, more carbon dioxide is absorbed by the oceans, causing lower pH and reduced availability of calcium carbonate. Because of the increase in carbon dioxide and other greenhouse gases in the atmosphere since the Industrial Revolution, ocean acidification has already occurred throughout the world's oceans and is predicted to increase considerably between now and 2100 (IPCC 2014; IPCC 2023b). Predicted rates of ocean acidification will have adverse impacts on species richness especially for strongly calcifying species, such as echinoderms and mollusks (Scherer et al. 2022) that provide food resources for sea turtle species. Changes in the marine ecosystem caused by changing environmental trends can also influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, and forage fish), ultimately affecting primary foraging areas of ESA-listed sea turtles. For migrating sea turtles, if either prey availability or habitat suitability is disrupted by changing ocean temperatures regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

Sea turtles are especially sensitive to temperature-related changes in their life history and habitat. Notably, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 77–95°F (25–35°C; Ackerman 1997). Increases in global temperature could skew future sex ratios toward higher numbers of females (NMFS and

USFWS 2007aa; NMFS and USFWS 2007bb; NMFS and USFWS 2013aa; NMFS and USFWS 2013bb; NMFS and USFWS 2015a). For example, modeling suggests an increase of 3.6°F (2°C) in air temperature would result in a sex ratio of over 80% female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100% female offspring. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of 5.4°F (3°C) is likely to exceed the thermal threshold of most nests, leading to egg mortality (Hawkes et al. 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007; Weishampel et al. 2004), short inter-nesting intervals (Hays et al. 2002), and shorter nesting seasons (Pike et al. 2006).

In addition to increased ocean warming and changes in species' distribution, changing environmental trends are linked to increased extreme weather events including, but not limited to, hurricanes, cyclones, tropical storms, heat waves, and droughts (IPCC 2023a). Research from IPCC (2023a) shows that it is likely extratropical storm tracks have shifted poleward in both the Northern and Southern Hemispheres, and heavy rainfalls and mean maximum wind speeds associated with hurricane events will increase with continued greenhouse gas warming. These extreme weather events have the potential to have adverse effects on ESA-listed sea turtles in the action area. For example, in 1999, off Florida, Hurricane Floyd washed out many loggerhead and green turtle nests, resulting in as many as 50,000–100,000 hatchling deaths (see https://conserveturtles.org/11665-2/). Rising sea levels can cause coastal erosion, inundation, and flooding, and can affect sea turtle nesting beaches (Fish et al. 2005; Fuentes et al. 2011; Fuentes et al. 2010a; Fuentes et al. 2010b). Warming ocean temperatures may also increase cold-stunning events of Kemp's ridley turtles in the northwest Atlantic (Griffin et al. 2019).

This review highlights evidence of significant changes in environmental conditions in the Gulf and Atlantic Ocean that may affect ESA-listed species and their habitats. While it is difficult to accurately predict the consequences of these changing environmental conditions to a particular species or habitat, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats. This is discussed further in the Integration and Synthesis (Section 8).

5.2 Sound

The ESA-listed sea turtles that occur in the action area are regularly exposed to several sources of anthropogenic sounds. These include, but are not limited to maritime activities (vessel sound and commercial shipping), aircraft, seismic surveys (exploration and research), and marine construction (dredging and pile driving as well as the construction, operation, and decommissioning of offshore structures), and military activities, which are summarized in the subsequent environmental baseline subsections. These activities occur to varying degrees throughout the year. Anthropogenic noise is a known stressor that has the potential to affect sea turtles, although effects to sea turtles are not well understood.

NMFS has established criteria to predict varying levels of responses of marine species to anthropogenic sound, based upon the best available science (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance-other-acoustic-tools). Responses to sound exposure may include lethal or nonlethal injury, permanent or temporary hearing impairment, behavioral harassment and stress, or no apparent response. Ambient noise consists of sound sources such as vocalizing animals, wind, and waves; however, anthropogenic activities such as vessels, geophysical exploration, and the construction, operational, and decommissioning of offshore structures, can contribute to, and increase, sound levels. Several policies on managing anthropogenic sound in the marine environment provide guidance for research permits involving sound-producing activities. For example, NOAA is working cooperatively with the ship building industry to find technologically-based solutions to reduce the amount of sound produced by commercial vessels.

Globally, commercial shipping's contribution to ambient noise in the ocean increased by as much as 12 dB between approximately the 1960s and 2005 (Hildebrand 2009a). Vessels are the greatest contributors to increases in low-frequency ambient sound in the sea (Andrew et al. 2011). It is predicted that ambient ocean sound will continue to increase at a rate of ½ dB per year (Ross 2005). Sound levels and tones produced are generally related to vessel size and speed. Larger vessels generally emit more sound than smaller vessels, and vessels underway with a full load, or those pushing or towing a load, are noisier than unladen vessels. Vessel operations associated with oil and gas activities, have been considered in previous ESA section 7 consultations. While commercial shipping vessels contribute a large portion of oceanic anthropogenic noise, other sources of maritime traffic can be present in large numbers and affect the marine environment particularly in nearshore and inland marine areas. These include recreational boats, whale-watching boats, research vessels, and ships associated with oil and gas activities.

The Gulf of America soundscape is being studied long-term by NOAA's Sound Reference Station Network (https://www.pmel.noaa.gov/acoustics/noaanps-ocean-noise-reference-station-network). This network uses static Passive Acoustic Monitoring (PAM) hydrophone (underwater sound recorder) units to monitor trends and changes in the ambient sound field in U.S. Federal waters. In addition to this network, there have been several other hydrophone units in the northern Gulf of America. A study by Wiggins et al. (2016) placed two high-frequency acoustic recording packages (HARPs) in 328–820 ft (100–250 m) water depths and three HARPs in approximately 3,280 ft (1,000 m) water depth to compare low-frequency sound pressure spectrum levels over three years. NOAA's Southeast Fisheries Science Center (SEFSC), University of California San Diego's Scripps Institution of Oceanography (SIO), and partners initiated a comprehensive, long-term, multi-scale passive acoustic monitoring program (LISTEN Gulf of Mexico [GoMex]; https://www.fisheries.noaa.gov/science-data/passive-acoustic-research-southeast-fisheries-science-center) throughout the U.S. and Gulf waters to expand upon the initial Wiggins et al. (2016) study. Through this program, scientists are collecting data to assess contributions of ambient noise sources to the Gulf soundscape. This collaborative study deploys moored HARPs, continuously recording over the 10 Hz–100 kHz band, from 2020–2025 (Figure 7). Additionally, the study leverages 10 years of historic HARP recordings at five long-term sites, collected by SIO as part of the DWH damage assessment to enhance the assessment of trends in cetacean density and noise (Rafter et al. 2022). Here, we include the preliminary results from the first year of the HARP recordings at sites collected under the LISTEN GoMex project from 2020–2021.

The low-frequency ambient soundscape, between 10–1,000 Hz, was dominated by sounds from anthropogenic activities, notably seismic exploration at deep sites and shipping at shallow sites. Seismic survey signals dominated the ambient soundscape below 100 Hz throughout the historic time series and at the new 2020–2021 sites, with the same surveys detected simultaneously at distant sites throughout the Gulf. Sound levels are most elevated in the airgun frequency band (10–100 Hz) at recording sites within or near active oil and gas lease blocks, and more moderately at sites further away, but with deep water where signals propagate effectively. During quieter periods between seismic surveys, moderately elevated sound levels in the 30–90 Hz frequency band are often evident, representing noise from vessel traffic.

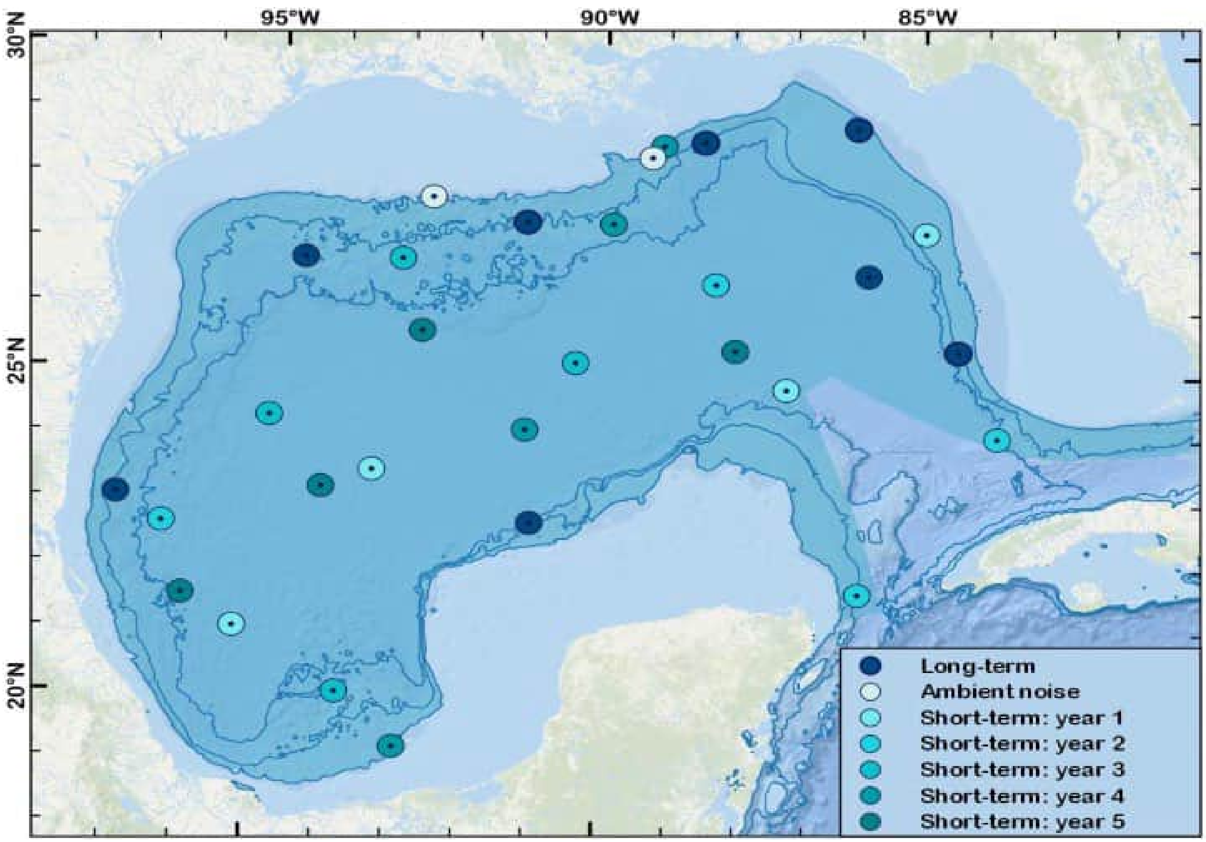

Figure 7. Location of long-term passive acoustic recording sites for the five-year LISTEN GoMex project. Figure from NMFS/Melissa Soldevilla.

The PAM data also demonstrate spatially and temporally variable patterns in noise concentration. The spatial distribution of monthly median octave bands at each site over the 2020–2021 period highlights some of the noise sources described in (Rafter et al. 2022): The 31.5 Hz octave band represents noise from shipping traffic; the 500 Hz octave band represents noise from weather; and the 31.5 Hz octave band are generally higher in the western Gulf than the eastern Gulf, which is expected given the distribution of airgun energy in the northwestern Gulf. April, May, and December have particularly high 31.5 Hz octave band levels across western sites, and in September, those levels were especially high at the central Gulf sites. These correspond with locations of seismic survey activity. Unsurprisingly, ship noise dominated the ambient soundscapes at the two shipping lane sites, where the highest number of ship detections and longest time with ship noise present occurred (Rafter et al. 2022). At the three monitoring sites with high levels of shipping traffic, daily average sound levels were consistently near, or higher than 100 dB re 1 µPa in both the 63 and 125 Hz one-third octave bands. In comparison, sound levels were approximately 20 dB lower year-round in Hawaii and approximately 10–20 dB lower in the Alaskan Arctic (depending on season).

5.3 Fisheries Bycatch and Interactions

Commercial and recreational fisheries can result in substantial detrimental impacts on populations of ESA-listed sea turtles. Although directed fishing for the species covered in this opinion is prohibited under the ESA, many listed species are still captured as "bycatch" in fishing operations targeting other species. Bycatch occurs when fishing operations interact with sea turtles that are not the target species for commercial harvest. Sea turtles are also susceptible to entanglement in fishing gear that is actively deployed, as well as derelict or "ghost fishing" gear that has been abandoned in the pelagic environment.

5.3.1 Federal Fisheries

Commercial and recreational fisheries managed by NMFS under the Magnuson-Stevens Act (MSA) in the Gulf and Atlantic Ocean have interacted with sea turtles throughout the past. Commercial fisheries bycatch represents a significant threat to sea turtles throughout the Gulf and Atlantic Ocean portions of the action area, as sea turtles are highly vulnerable to incidental capture in many fisheries gears including tangle nets, trawls and longlines.

Impacts to listed species and critical habitats have been evaluated via ESA section 7 consultation for all fisheries managed under a fishery management plan (FMP; 15 USC § 1853), or for which any federal action is taken to manage that fishery. Past consultations have addressed the effects of federally permitted fisheries on ESA-listed species, sought to minimize the adverse impacts of the action on ESA-listed species, and, when appropriate, have authorized the incidental taking of these species. Formal section 7 consultations have been conducted on the following federal fisheries that operate in the action area: Coastal Migratory Pelagics, Highly Migratory Species (HMS) Atlantic Shark and Smoothhound, Gulf of Mexico Reef Fish, Southeastern Shrimp Trawl Fisheries, and ten fisheries in the Atlantic (including Atlantic Bluefish, Jonah Crab, Spiny Dogfish, and Summer Flounder Fisheries). NMFS has issued an ITS for the take of sea turtles in each of these fisheries (NMFS 2011a; NMFS 2012a; NMFS 2014a; NMFS 2015b). A summary of each consultation is provided below, but more detailed information can be found in the respective biological opinions (NMFS 2011a; NMFS 2011b; NMFS 2012b; NMFS 2015a; NMFS 2021a).

Coastal Migratory Pelagics Fishery

In 2015, NMFS completed a section 7 consultation on the continued authorization of the coastal migratory pelagics fishery in the Gulf and South Atlantic (NMFS 2015a). In the Gulf of America and South Atlantic, hook-and-line, gillnet, and cast net gears are used commercially, while the recreational sector uses hook-and-line gear. The biological opinion concluded that green, Kemp's ridley, and loggerhead turtles may be adversely affected by operation of the fishery.

However, the proposed action was not expected to jeopardize the continued existence of any of these species. An ITS was provided for consecutive three-year periods authorizing 31 takes (nine of which could be lethal) for green turtles, 27 takes (seven of which could be lethal) for loggerhead turtles, and eight takes (two of which could be lethal) for Kemp's ridley turtles.

Highly Migratory Species Atlantic Shark and Smoothhound Fisheries

These fisheries include commercial shark bottom longline and gillnet fisheries and recreational shark fisheries under the FMP for Atlantic Tunas, Swordfish, and Sharks. NMFS has formally consulted several times on the effects of HMS shark fisheries on sea turtles (NMFS 2003; NMFS 2008a; NMFS 2012a). NMFS has also authorized a federal smoothhound fishery that will be managed as part of the HMS shark fisheries. NMFS (2012b) analyzed the potential adverse effects from the smoothhound fishery on sea turtles for the first time. Both bottom longline and gillnet are known to adversely affect sea turtles. From 2007–2011, the sandbar shark research fishery had 100% observer coverage, with 4–6% observer coverage in the remaining shark fisheries. During that period, ten sea turtle takes (all loggerheads) were observed on bottom longline gear in the sandbar shark research fishery and five were taken outside the research fishery. The five non-research fishery takes were extrapolated to the entire fishery, providing an estimate of 45.6 sea turtle takes (all loggerheads) for non-sandbar shark research fishery from 2007–2010 (Carlson and Gulak 2012; Carlson et al. 2016). No sea turtle takes were observed in the non-research fishery in 2011 (NMFS 2012a). Because the research fishery has a 100% observer coverage requirement, those observed takes were not extrapolated (Carlson and Gulak 2012; Carlson et al. 2016). Because few smoothhound trips were observed, no sea turtle captures were documented in the smoothhound fishery.

The most recent ESA section 7 consultation on the continued operation of Atlantic shark and smoothhound fisheries and Amendments 3 and 4 to the Consolidated HMS FMP was completed on December 12, 2012 (NMFS 2012b). The consultation concluded the proposed action was not likely to jeopardize the continued existence of sea turtles. An ITS was provided for consecutive three-year periods authorizing 57 takes (33 of which could be lethal) for green turtles, 126 takes (78 of which could be lethal) for loggerhead turtles, and 36 takes (21 of which could be lethal) for Kemp's ridley turtles.

Gulf Reef Fish Fishery

The Gulf reef fish fishery uses two basic types of gear: spear or powerhead, and hook-and-line gear. Hook-and-line gear used in the fishery includes both commercial bottom longline and commercial and recreational vertical line (e.g., handline, bandit gear, rod-and-reel).

Prior to 2008, the reef fish fishery was believed to have relatively moderate levels of sea turtle bycatch attributed to the hook-and-line component of the fishery (i.e., approximately 107 captures and 41 mortalities annually, all species combined, for the entire fishery; NMFS 2005a). In 2008, SEFSC observer programs and subsequent analyses indicated that the overall amount and extent of incidental take for sea turtles specified in the incidental take statement of the 2005 opinion on the reef fish fishery had been severely exceeded by the bottom longline component of the fishery with approximately 974 captures and at least 325 mortalities estimated for the period from July 2006–2007.

In response, NMFS published an Emergency Rule prohibiting the use of bottom longline gear in the reef fish fishery shoreward of a line approximating the 50-fathom depth contour in the eastern Gulf of America, essentially closing the bottom longline sector of the reef fish fishery in the eastern Gulf of America for six months pending the implementation of a long-term management strategy. The Gulf of Mexico Fishery Management Council developed a long-term management strategy via a new amendment (Amendment 31 to the Reef Fish FMP). The amendment included: (1) a prohibition on the use of bottom longline gear in the Gulf reef fish fishery, shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida, from June through August and; (2) a reduction in the number of bottom longline vessels operating in the fishery via an endorsement program and a restriction on the total number of hooks that may be possessed onboard each Gulf reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing.

On October 13, 2009, NMFS Southeast Regional Office completed an opinion that analyzed the expected effects of the continued operation of the Gulf reef fish fishery under the changes proposed in Amendment 31 (NMFS-SEFSC 2009). The opinion concluded that sea turtle takes would be substantially reduced compared to the fishery as it was previously prosecuted, and that operation of the fishery would not jeopardize the continued existence of any sea turtle species. Amendment 31 was implemented on May 26, 2010. In August 2011, consultation was reinitiated to address the DWH oil spill and potential changes to the environmental baseline. Reinitiation of consultation was not related to any material change in the fishery itself, violations of any terms and conditions of the 2009 opinion, or an exceedance of the ITS. The resulting September 30, 2011, opinion concluded the continued operation of the Gulf reef fish fishery is not likely to jeopardize the continued existence of any listed sea turtles (NMFS 2011a). An ITS was provided for consecutive three-year periods authorizing 116 takes (75 of which could be lethal) for green turtles, 1,044–1,065 takes (572–585 of which could be lethal) for loggerhead turtles, and 108 takes (41 of which could be lethal) for Kemp's ridley turtles.

Southeastern Shrimp Trawl Fisheries

The high activity of shrimp trawl fishing fleets in the Gulf poses risks of bycatch to listed sea turtles (NMFS 2014a). The shrimp trawl fishery FMP was amended March 9, 2020, increasing the allowable amount of fishing effort in several zones off the coasts of Mississippi, Louisiana, and Texas (Council 2019). The consultation history for this fishery is closely tied to the lengthy regulatory history governing the use of turtle excluder devices (TEDs) and a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial shrimp trawl fisheries. The level of annual mortality described in NRC (1990b) is believed to have continued until 1992–1994, when U.S. law required all shrimp trawlers in the Atlantic and Gulf to use TEDs, allowing at least some sea turtles to escape nets before drowning (NMFS 2002).[4] TEDs

[4] TEDs were mandatory on all shrimping vessels. However, certain shrimpers (e.g., fishers using skimmer trawls or targeting bait shrimp) could operate without TEDs if they agreed to follow specific tow-time restrictions.

approved for use have had to demonstrate 97% effectiveness in excluding sea turtles from trawls in controlled testing. These regulations have been refined over the years to ensure that TED effectiveness is maximized through proper placement and installation, configuration (e.g., width of bar spacing), flotation, and more widespread use.

Despite the apparent success of TEDs for some species of sea turtles (e.g., Kemp's ridley turtles), TEDs were later discovered to not adequately protect all species and size classes of sea turtles. Analyses by Epperly and Teas (2002b) indicated that the minimum requirements for the escape opening dimension in TEDs in use at that time were too small for some sea turtles and that as many as 47% of the loggerheads stranding annually along the Atlantic and Gulf were too large to fit the existing openings. On December 2, 2002, NMFS completed an opinion on shrimp trawling in the southeastern United States (NMFS 2002) under proposed revisions to the TED regulations requiring larger escape openings (68 FR 8456 2003). This opinion determined that the shrimp trawl fishery under the revised TED regulations would not jeopardize the continued existence of any sea turtle species. The determination was based in part on the opinion's analysis that shows the revised TED regulations are expected to reduce shrimp trawl related mortality by 94% for loggerheads. In February 2003, NMFS implemented the revisions to the TED regulations.

Although mitigation measures have greatly reduced the impact on sea turtle populations, the shrimp trawl fishery is still responsible for large numbers of turtle mortalities each year. The Gulf fleet accounts for a large percentage of the sea turtle bycatch in this fishery. In 2010, the Gulf shrimp trawl fishery had an estimated bycatch mortality of 5,166 turtles (including 778 loggerhead, 486 green, and 3,884 Kemp's ridley turtles). By comparison, the southeast Atlantic fishery had an estimated bycatch mortality of 1,033 turtles (including 673 loggerhead, 28 green, and 324 Kemp's ridley turtles) in 2010 (NMFS 2014c).

On May 9, 2012, NMFS completed a biological opinion that analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the MSA (NMFS 2012c). The opinion also considered a proposed amendment to the sea turtle conservation regulations to withdraw the alternative tow-time restriction at 50 CFR §223.206(d)(2)(ii)(A)(3) for skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) and instead require all of those vessels to use TEDs. The opinion concluded that the proposed action was not likely to jeopardize the continued existence of any sea turtle species. An ITS was provided that used anticipated trawl effort and fleet TED compliance (i.e., compliance resulting in overall average sea turtle catch rates in the shrimp otter trawl fleet at or below 12%) as surrogates for sea turtle takes. On November 21, 2012, NMFS determined that a Final Rule requiring TEDs in skimmer trawls, pusher-head trawls, and wing nets was not warranted and withdrew the proposal. The decision to not implement the Final Rule created a change to the proposed action analyzed in the 2012 opinion and triggered the need to reinitiate consultation. Consequently, NMFS reinitiated consultation on November 26, 2012. Consultation was completed in April 2014; the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the MSA was not likely to jeopardize the continued existence of any sea turtle species. The ITS maintained the use of anticipated trawl effort and fleet TED compliance as surrogates for numerical sea turtle takes.

More recent studies demonstrate continued take from the fisheries. From 2011–2016, mandatory fisheries observer data for the southeastern shrimp trawl fishery found that otter and skimmer shrimp trawls captured 158 listed sea turtles (Scott-Denton et al. 2020). Data from 2002, 2009, 2014, and 2015 in NOAA's National Bycatch Report Database System indicated that the shrimp trawl was likely to capture 709 sea turtles annually as bycatch (Savoca et al. 2020).

On April 26, 2021, NMFS completed reinitiation on the consultation that analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the MSA (NMFS-SERO 2021). Reinitiation of the 2014 consultation (NMFS 2014a) was triggered by three factors: 1) the listing of new species under the ESA (e.g., green sea turtle DPSs in 2016); 2) new bycatch information developed to better analyze the effects of the shrimp fisheries on sea turtle populations; and 3) the December 2019 Final Rule requiring TEDs for a portion of the skimmer trawl fisheries. The reinitiated biological opinion for the reinitiated consultation concluded that the proposed action was not likely to jeopardize the continued existence of any listed species, including sea turtle species. The ITS was revised for consecutive five-year periods authorizing 24,214 takes (1,700 of which could be lethal) for green turtles, 72,670 takes (2,150 of which could be lethal) for loggerhead turtles, and 84,495 takes (8,505 of which could be lethal) for Kemp's ridley turtles (NMFS SERO 2021).

Ten Fisheries in the Atlantic

In 2021, NMFS completed a section 7 consultation on the continued authorization of the American Lobster, Atlantic Bluefish, Atlantic Deep-Sea Red Crab, Mackerel/Squid/Butterfish, Monkfish, Northeast Multispecies, Northeast Skate Complex, Spiny Dogfish, Summer Flounder/Scup/Black Sea Bass Fisheries and the new authorization of the Jonah Crab Fishery (NMFS 2021b). In the Gulf of America and South Atlantic, sink gillnets, hook and line, bottom trawls, and pot/traps are the predominant gears used. The biological opinion concluded that green, Kemp's ridley, and loggerhead turtles may be adversely affected by operation of the fishery. However, the proposed action was determined not to jeopardize the continued existence of any of these species. An ITS was provided for authorizing annual takes of 8.4 North Atlantic DPS green turtles (4.8 of which could be lethal), 399 Northwest Atlantic Ocean DPS loggerhead turtles (257.8 of which could be lethal), and 58.4 Kemp's ridley turtles (42.8 of which could be lethal).

5.3.2 State Fisheries

Several coastal state fisheries are known to incidentally take listed species, and available information on these fisheries is documented through different agencies (NMFS 2014d). State commercial and recreational fisheries use gear types including trawling, pot fisheries, gillnets, pound net and weir, seines, channel nets, and vertical line, all of which are known to incidentally take sea turtles. However, most available state data are based on extremely low observer coverage, or sea turtles were not part of data collection. Thus, these data provide insight into gear interactions that could occur but are not indicative of the magnitude of the overall problem

(NMFS 2014d). The 2001 HMS biological opinion (discussed in the Federal Fisheries Section above) provides a summary of sea turtles taken in state fisheries throughout the action area.

In addition to commercial state fisheries, protected sea turtles can be incidentally captured by hook and line recreational fishers. Observations of state recreational fisheries have shown that loggerhead, Kemp's ridley, and green turtles are known to bite baited hooks. Further, observations show that loggerheads and Kemp's ridleys frequently ingest the hooks. Hooked turtles have been reported by the public fishing from boats, piers, beaches, banks, and jetties. A detailed summary of the known impacts of hook-and-line incidental captures to loggerhead turtles can be found in the Turtle Expert Working Group (TEWG) reports (TEWG 1998; TEWG 2000).

5.4 Oil and Gas

Oil and gas operations on the outer continental shelf (OCS) that have been ongoing for more than 50 years involve a variety of activities that may adversely affect ESA-listed sea turtles in the Gulf portion of the action area. As of 2022, Gulf federal offshore operations produce 1.7 million barrels (bbl) of crude oil per day, representing 15% of all U.S. crude oil production (EIA 2024). These activities and resulting impacts include vessels making supply deliveries, drilling operations, seismic surveys, fluid spills, oil spills and response, and oil platform removals. As technology has advanced over the past several decades, oil exploration and development has moved and will continue to move further offshore into deeper waters (Murawski et al. 2020).

The Bureau of Ocean and Energy Management (BOEM) administers the Outer Continental Shelf Lands Act (OCSLA) and authorizes the exploration and development of wells in Gulf leases. The sale of OCS leases in the Gulf of America and the resulting exploration and development of these leases for oil and natural gas resources has affected the status of ESA-listed species in the action area. As discussed above (Section 5.2), seismic exploration is an integral part of oil and gas discovery, development, and production in the Gulf of America. Year-round noise generated by oil and gas vessels and airguns used for seismic surveys has permanently changed the marine soundscape in the Gulf of America.

The development of wells often involves additional activities such as the installation of platforms, pipelines, and other infrastructure. Once operational, a platform will generate a variety of wastes including effluents and emissions. BOEM requires that oil and gas structures be removed from the seafloor within one year of lease termination. Many of these structures are removed by explosively severing the underwater supportive elements, which produces a shock wave that kills, injures, or disrupts marine life in the blast radius (Gitschlag et al. 1997). An underwater explosion is composed of an initial shock wave, followed by a succession of oscillating bubble pulses. A shock wave is a compression wave that expands radially out from the detonation point of an explosion. The direct shock wave results in the peak shock pressure (compression) and the reflected wave at the air-water surface produces negative pressure (expansion). Explosions are described by metrics such as amplitude, energy and time-space characteristics of the pressure wave (Popper et al. 2014a). Explosive detonations and their impacts on ESA-listed species are discussed in more detail this opinion (see Sections 2.4 and 6).

5.4.1 Oil Spills

Oil spills are accidental and unpredictable events, but are a direct consequence of oil and gas development and production from oil and gas activities in the Gulf of America. Oil releases can occur at any number of points during the exploration, development, production, and transport of oil. Any discharge of hydrocarbons into the environment is prohibited under U.S. law. Instances oil spills are generally small (less than 1,000 bbl) but there are spills that occur that are of larger size (NCCOS 2019). The summary presented here includes examples of recent events, but may not encompass all incidents. For more information, the Bureau of Safety and Environmental Enforcement (BSEE) tracks spills greater than one barrel and posts those data to their website: https://www.bsee.gov/stats-facts/offshore-incident-statistics.

Following Hurricane Ida's landfall in the Gulf of America region in September 2021, NOAA responded to 282 individual discharges of oil from wells, pipelines, and vessels caused by storm damage (NOAA 2021). On December 24, 2022, a pipeline failure at a crude oil terminal in Corpus Christi Bay, Texas, released around 14,000 gallons (gal; 52,996 liters [L]) of light crude oil, with recorded impacts to green turtles (NOAA 2024a). On November 16, 2023, a pipeline crude oil leak off the coast of Louisiana was reported to NOAA and other federal and state agencies, with an estimated 1.1 million gal (4,163,953 L) at risk of spill and an observed slick over 40 mi (64 km) in length (NOAA 2023).

When compared with the rest of the world, more than 50% of the loss of well control events come from the Federally-regulated waters of the Gulf (BSEE 2017). According to BSEE (2017) from 2000–2015, four of the 117 loss of well control events were categorized as a total loss. The event with the highest risk is the blowout or surface flow-type incident.

In addition to accidental spills, leakage from operating and decommissioned sites can pose an ongoing threat to the ocean ecosystem and listed species by potentially introducing hydrocarbons and other pollutants such as dispersants into surrounding waters. Under OCSLA, decommissioning regulations require that within one year after lease termination, operators must permanently plug wellbores and remove all platforms (30 CFR §250). A study from 2023 estimates that, as of 2020, a total of 7,188 inactive wells or inactive leases in Federal waters of the Gulf of America have not been permanently plugged (Agerton et al. 2023). The Government Accountability Office similarly determined that around 2,700 end-of-lease wells and 500 end-of-lease platforms were overdue for decommissioning as of June 2023 (GAO 2024). Deteriorating structures from delayed decommissioning can become more vulnerable to damage and destruction from storms that are increasingly frequent due to changing environmental trends, which increases the risk of oil spills and the introduction of harmful debris into species' habitat (GAO 2024).

5.4.2 Deepwater Horizon Spill

The largest spill within the Gulf portion of the action area occurred on April 20, 2010. The semi-submersible drilling rig DWH experienced an explosion and fire while working on an exploratory well approximately 50 mi (80 km) offshore of Louisiana. The rig subsequently sank and oil and natural gas began leaking into the surrounding waters of the Gulf of America. Oil flowed for 86 days, until the well was capped on July 15, 2010. By then, 134 million bbl of oil were spilled into the Gulf. In addition, approximately 1.84 million gal (6.97 million L) of chemical dispersant were applied both subsurface and on the surface to attempt to break down the oil. The unprecedented DWH event and associated response activities (e.g., skimming, burning, and application of dispersants) resulted in adverse effects on listed species and changed the baseline for the Gulf ecosystem. Effects of the spill went beyond the footprint visually detected using satellite imagery shown in Figure 8. Berenshtein et al. (2020b) used in situ observations and oil spill transport modeling to examine the full extent of the DWH spill, beyond the satellite footprint, that was at toxic concentrations to marine organisms. Figure 8 below displays visible and toxic (brown), invisible and toxic (yellow), and non-toxic (blue) oil concentrations.

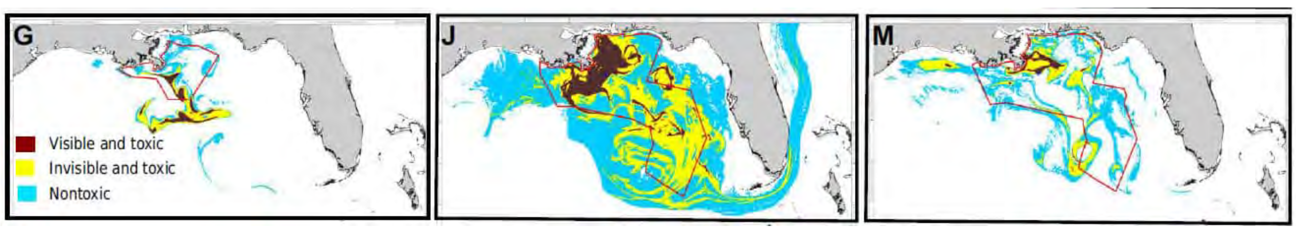

Figure 8. Figure from Berenshtein et al. (2020a) showing spatiotemporal dynamics of the DWH spill for dates showing cumulative oil concentrations in panels G (15 May 2010), J (18 June 2010), and M (2 July 2010).

The investigation conducted under the National Resource Damage Assessment regulations of the Oil Pollution Act (33 USC §2701 *et seq*.) assessed natural resource damages stemming from the DWH oil spill. The effort evaluated specific impacts to several ESA-listed species, including Kemp's ridley, green, and loggerhead sea turtles and habitats of these species (Trustees 2016b). The findings of this assessment provide details regarding impacts to the environmental baseline of listed species and critical habitats in the Gulf, summarized below, can be found at http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan. The unprecedented DWH spill and associated response activities (e.g., skimming, burning, and application of dispersants) also resulted in adverse effects to listed sea turtles.

Over a decade following DWH, multiple studies demonstrate both long-term impacts of the spill to species abundance and community structure, as well as the status of ecosystem recovery from the event. Despite natural weathering processes over the years since the DWH, oil persists in some habitats where it continues to expose and impact resources in the northern Gulf of America resulting in new baseline conditions (BOEM 2016; Trustees 2016a). A review of current literature by Patterson et al. (2023) found there were clear impacts of the DWH on shelf taxa at the population level, as well as shifts in community structure (especially for reef fish and invertebrates), and the shelf ecosystem overall has proven to be remarkably resilient. The true impacts to offshore megafauna populations and their habitats may never be fully quantified, though it was necessary to characterize these impacts for response, damage assessment and restoration activities (Frasier 2020).

According to Joye (2015), offshore oil and gas from the spill had the potential to disperse across the entire water column (both pelagic and benthic environments) during DWH (Figure 9). While post-spill restoration continues, the effects of the restoration efforts and potential benefits raise uncertainty regarding overall effectiveness of restoration efforts (Wallace et al. 2019). It is unclear how these restoration efforts have changed the baseline relative to what it would be if those efforts had not happened.

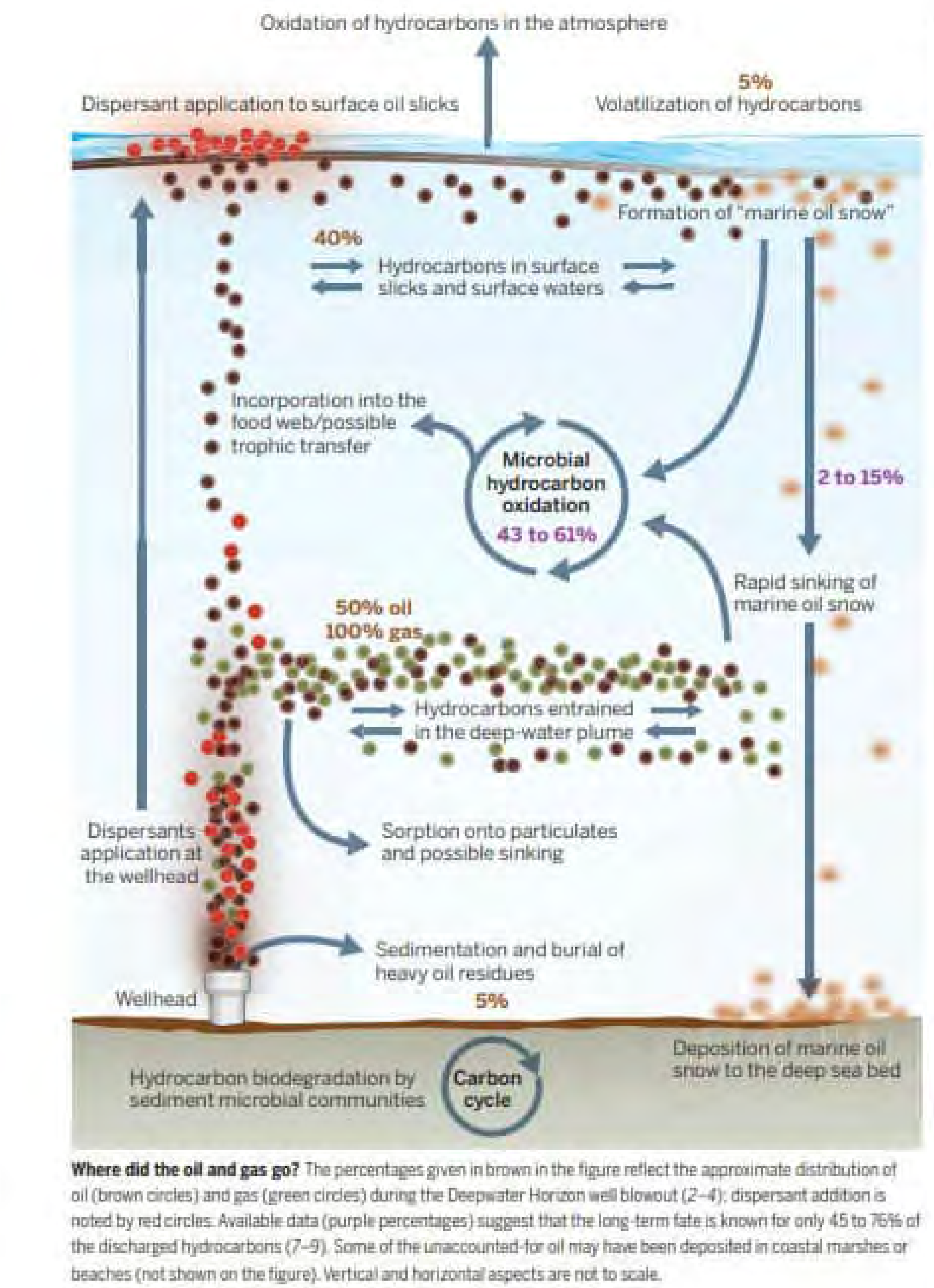

Figure 9. Diagram showing offshore distribution of oil and gas during DWH (Joye 2015)

The DWH oil spill extensively oiled vital foraging, migratory, and breeding habitats of sea turtles throughout the northern Gulf of America. *Sargassum* habitats, benthic foraging habitats, surface and water column waters, and sea turtle nesting beaches were all affected by DWH. Sea turtles were exposed to DWH oil in contaminated habitats; breathing oil droplets, oil vapors, and smoke; ingesting oil-contaminated water and prey; and by maternal transfer of oil compounds to developing embryos. Translocation of eggs from the Gulf of America to the Atlantic coast of Florida resulted in the loss of sea turtle hatchlings. Other response activities, including vessel strikes and dredging, also resulted in turtle deaths.

Three hundred and nineteen live oiled turtles were rescued and showed disrupted metabolic and osmoregulatory functions, likely attributable to oil exposure, physical fouling and exhaustion, dehydration, capture and transport (Stacy et al. 2017). Accounting for turtles that were unobservable during the response efforts, high numbers of small oceanic and large sea turtles are estimated to have been exposed to oil resulting from the DWH spill due to the duration and large footprint of the spill. It was estimated that as many 7,590 large juvenile and adult sea turtles (Kemp's ridleys, loggerheads, and unidentified hardshelled sea turtles), and up to 158,900 small juvenile sea turtles (Kemp's ridleys, green turtles, loggerheads, hawksbills, and hardshelled sea turtles not identified to species) were killed by the DWH oil spill. Small juveniles were affected in the greatest numbers and suffered a higher mortality rate than large sea turtles (NMFS USFWS 2013; Trustees 2016a).

Subsequent to the Programmatic Damage Assessment and Restoration Plan (PDARP) release, and as part of the DWH natural resource damage assessment, McDonald et al. (2017) estimated approximately 402,000 surface-pelagic sea turtles were exposed with 54,800 likely heavily oiled. Additionally, approximately 30% of all oceanic turtles affected by DWH and not heavily oiled were estimated to have died from ingestion of oil (Mitchelmore et al. 2017).

The DWH incident and associated response activities (e.g., nest relocation) saved animals that may have been lost to oiling, but resulted in some future fitness consequences for those individuals. Nests from loggerhead, Kemp's ridley, and green turtles were excavated prior to emergence and eggs were translocated from Florida and Alabama beaches in the northern Gulf of America between June 6 and August 19, 2010 to a protected hatchery on the Atlantic Coast of Florida. More than 28,000 eggs from 274 nests were translocated and nearly 15,000 hatchling turtles emerged and were released into the Atlantic Ocean.

Hatchlings from nesting beaches in the Gulf of America were released in the Atlantic Ocean and not the Gulf of America. Therefore, the hatchlings imprinted on the area of their release beach. Sea turtles are thought to use this imprinting information to return to the location of nesting beaches as adults. It is unknown whether these turtles will return to the Gulf of America to nest; therefore, the damage assessment determined that the 14,796 hatchlings will be lost to the Gulf of America breeding populations because of the DWH oil spill. It is estimated that nearly 35,000 hatchling sea turtles (loggerhead, Kemp's ridley, and green turtles) were injured by response activities, and thousands more Kemp's ridley and loggerhead hatchlings were lost due to unrealized reproduction of adult sea turtles that were killed by the DWH oil spill.

Kemp's ridley turtles were the most affected sea turtle species, as they accounted for 49% (239,000) of all exposed turtles (478,900) during DWH. Kemp's ridley turtles were the turtle species most impacted by the DWH event at a population level. The DWH damage assessment calculated the number of unrealized nests and hatchlings because all Kemp's ridley turtles nest in the Gulf and belong to the same population (NMFS et al. 2011b). The total population abundance of Kemp's ridley turtles could be calculated based on numbers of hatchlings because all individuals are reasonably expected to inhabit the northern Gulf of America throughout their lives. The loss of these reproductive-stage females would have contributed to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp's ridley nests is between 1,300 and 2,000, which translates to approximately 65,000 and 95,000 unrealized hatchlings. This is a minimum estimate because of the overall potential DWH effect because the sub-lethal effects of DWH oil on turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years and contributed substantially to additional nesting deficits observed following DWH. These sub-lethal effects could have slowed growth and maturation rates, increased remigration intervals, and decreased clutch frequency (number of nests per female per nesting season). The nature of the DWH effect on reduced Kemp's ridley nesting abundance and associated hatchling production after 2010 requires further evaluation.

Loggerhead turtles made up 12.7% (60,800 animals) of the total sea turtle exposures (478,900). A total of 14,300 loggerhead turtles died as a result of exposure to DWH oil. Unlike Kemp's ridley turtles, the majority of nesting for the Northwest Atlantic Ocean DPS of loggerhead turtles occurs on the Atlantic coast, and thus nesting was impacted to a lesser degree in this species. It is likely that impacts to the Northern Gulf of Mexico Recovery Unit of the Northwest Atlantic Ocean DPS of loggerhead turtle would be proportionally much greater than the impacts occurring to other recovery units, and likely included impacts to mating and nesting adults. Although the long-term effects remain unknown, the DWH impacts to the Northern Gulf of Mexico Recovery Unit may include some nesting declines in the future due to a large reduction of oceanic age classes during DWH. However, the overall impact on the population recovery of the entire Northwest Atlantic Ocean DPS of loggerhead turtle is likely small.

Green turtles made up 32.2% (154,000) of all turtles exposed to DWH oil with 57,300 juvenile mortalities out of the total exposed animals, which removed a large number of small juvenile turtles from the population. A total of four nests (580 eggs) were relocated during response efforts. While green turtles regularly use the northern Gulf of America, they have a widespread distribution throughout the entire Gulf, Caribbean, and Atlantic. Nesting is relatively rare on northern Gulf of America beaches. Although it is known that adverse impacts occurred and numbers of animals in the Gulf of America were reduced as a result of DWH, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event, and thus a population-level impact to green sea turtles, is not likely.

5.5 Vessel Operations

The Gulf and Atlantic Ocean are highly active regions for maritime vessel activity, including shipping, transit, fishing, and offshore operations, all of which have baseline impacts to listed species and their habitats. Propeller and collision injuries and mortalities from private and commercial vessels are a significant threat to ESA-listed sea turtles. Potential sources of adverse effects from federal vessel operations in the action area include operations of the U.S. DoD, BOEM, BSEE, Federal Energy Regulatory Commission (FERC), U.S. Coast Guard (USCG), NOAA, and U.S. Army Corps of Engineers (USACE).

Sea turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to vessel strikes, which can result in serious injury and death (Hazel et al. 2007b). Sea turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases (Hazel et al. 2007b). Green sea turtles cannot consistently avoid being struck by vessels moving at relatively moderate speeds (i.e., greater than 4 km per hour); most vessels move much faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007b; Work et al. 2010).

Many recovered sea turtles display injuries that appear to result from interactions with vessels and their associated propulsion systems (Work et al. 2010). This is particularly true in nearshore areas with high vessel traffic along the U.S. Atlantic and Gulf of America coasts. From 1997 to 2005, nearly 15% of all stranded loggerheads in the U.S. Atlantic and Gulf of America were documented as having sustained some type of propeller or collision injury; although it is not known what proportion of these injuries were before or after death. In one study conducted in Virginia, Barco et al. (2016) found that all 15 dead loggerhead turtles encountered with signs of acute vessel interaction were normal and healthy prior to the vessel interaction. The incidence of propeller wounds of stranded sea turtles from the U.S. Atlantic and Gulf of America doubled from about 10% in the late 1980s to about 20% in 2004. Singel et al. (2007) reported a tripling of boat strike injuries in Florida from the 1980s to 2005. Over this time period, in Florida alone, over 4,000 (approximately 500 live and 3,500 dead) sea turtle strandings were documented with propeller wounds, which represented 30% of all sea turtle strandings for the state (Singel et al. 2007). Stacy et al. (2020) analyzed Texas sea turtle stranding data for 2019, a year where sea turtle strandings were more than two times above average based on statewide stranding numbers for the previous 5 and 10 years, and analyzed causes of stranding by species and stranding zone. Vessel strike-type injuries were the most common type of trauma observed in Kemp's ridley, green, and loggerhead turtles (Stacy et al. 2020). Approximately 71% of stranded green turtles and 61% of Kemp's ridley turtles studied had documented vessel strike injuries (Stacy et al. 2020). These studies suggest that the threat of vessel strikes to sea turtles may be increasing over time as vessel traffic continues to increase in the south and southeastern U.S.

The Sea Turtle Stranding and Salvage Network reports a large number of vessel interactions (propeller injury) with sea turtles off coastal states such as New Jersey and Florida, where there are high levels of vessel traffic. The Virginia Aquarium & Marine Science Center Strandings Program reported an average of 62.3 sea turtle strandings per year in Virginia waters due to boat strikes from 2009–2014 (Barco 2015). The large majority of these (about 87%) were dead strandings. By sea turtle species, 73.3% of Virginia vessel strike strandings from 2009–2014 were loggerhead, 20.3% Kemp's ridley, and 3.5% green turtles (Barco 2015).

5.6 Dredging

Dredging involves the removal and relocation of submerged sediment in waterways, nearshore areas, and offshore, and supports activities such as maintaining coastal navigation channels, beach nourishment, levee construction, and coastal restoration. 29 of the Gulf of America lease areas that BOEM manages within the action area host blocks with significant sediment resources that may be dredged (BOEM 2024). Dredging activities can pose significant impacts to aquatic ecosystems by: (1) direct removal/burial of organisms; (2) turbidity/siltation effects; (3) contaminant re-suspension; (4) sound/disturbance; (5) alterations to hydrodynamic regime and physical habitat; and (6) loss of riparian habitat (Chytalo 1996; Winger et al. 2000).

Marine dredging vessels are common within U.S. coastal waters. Dredging may harm sea turtle species by injuring individuals with the equipment used or degrade and modify their foraging habitat (such as soft bottom and seagrass beds), affecting available food resources. Although the underwater sounds from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effect on sea turtles. However, the construction and maintenance of federal navigation channels and dredging in sand mining sites ("borrow areas") have been identified as sources of sea turtle mortality. Hopper dredges can lethally harm sea turtles by entraining them in dredge drag arms and impeller pumps. Hopper dredges in the dredging mode are capable of moving relatively quickly and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge overtakes a resting or swimming organism.

To reduce take of listed species, relocation trawling may be utilized to capture and move sea turtles. In relocation trawling, a boat equipped with nets precedes the dredge to capture sea turtles and then releases the animals out of the dredge pathway, thus avoiding lethal take. Relocation trawling has been successful and routinely moves sea turtles in the Gulf of America. In 2003, NMFS completed a regional biological opinion on USACE hopper dredging in the Gulf of America that included impacts to sea turtles via maintenance dredging. NMFS determined that Gulf of America hopper dredging would adversely affect four sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads) but would not jeopardize their continued existence. An ITS for those species adversely affected was issued.

Numerous other opinions have been produced that analyzed hopper dredging projects that did not fall under the scope of actions contemplated by the regional opinion, including the dredging of Ship Shoal in the Gulf Central Planning Area for coastal restoration projects in 2005, the Gulfport Harbor Navigation Project in 2007, the East Pass dredging in Destin, Florida in 2009, the Mississippi Coastal Improvements Program in 2010, and the dredging of City of Mexico beach canal inlet in 2012. Each of the above free-standing opinions had its own ITS and determined that hopper dredging during the proposed actions would not jeopardize the continued existence of any ESA-listed species, including sea turtles, or destroy or adversely modify critical habitat of any listed species.

5.7 Construction and Operation of Public Fishing Piers

The Gulf coast experienced an active hurricane season in 2020, as well as a destructive Category 4 hurricane in 2021, which required the reconstruction and repairs of several fishing piers along Mississippi, Louisiana, and Alabama. The USACE permits the building of these structures and, in many of these cases, the Federal Emergency Management Agency (FEMA) provides funding. Six FEMA funded projects along the Gulf coast were authorized in 2022 to repair piers damaged in recent storms. NMFS determined that the activities associated with the demolition/reconstruction/repair of each pier were not likely to adversely affect any ESA-listed species. However, NMFS also concluded that the fishing likely to occur following the completion of each pier project was likely to adversely affect certain species of sea turtles, but was not likely to jeopardize their continued existence. Incidental capture of sea turtles is generally nonlethal, though some captures result in severe injuries, which may later lead to death. Fishing effort is expected to continue at Gulf piers into the foreseeable future.

5.8 Research Permits

The ESA allows for the issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research (section 10(a)(1)(a)). In addition, section 6 of the ESA allows NMFS to enter into cooperative agreements with states to assist in recovery actions of listed species. The number of authorized directed and incidental takes by research permits varies widely depending on the research and species involved but may involve the taking of hundreds of sea turtles annually. Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). The proposal must be reviewed for compliance with section 7 of the ESA because issuance is a Federal activity.

The primary objective of most of these field studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued dozens of permits on an annual basis for various forms of "take" of marine mammals and sea turtles in the action area from a variety of research activities. Authorized research on ESA-listed sea turtles includes aerial and vessel surveys, close approaches, active acoustics, capture, handling, holding, restraint, and transportation, tagging, shell and chemical marking, biological sampling (i.e., biopsy, blood and tissue collection, tear, fecal and urine, and lavage), drilling, pills, imaging, ultrasound, antibiotic (tetracycline) injections, captive experiments, laparoscopy, and mortality. Most research activities involve authorized sub-lethal "takes," with some resulting mortality.

Currently, there are 24 active sea turtle research permits issued for work in the Atlantic and Gulf of America under the NMFS Sea Turtle Research and Enhancement Permitting Program and covered by the sea turtle research permit programmatic biological opinion (NMFS 2017a). The sea turtle research programmatic established mortality banks for each species, which represent the maximum total number of mortalities that could be authorized and used over a 10-year period (2018–2027). Only two sea turtle lethal takes (one Kemp's ridley and one loggerhead turtle) have been reported since 2018 when the programmatic opinion took effect.

5.9 Military Operations

Military testing and training affects listed species and their habitat through activities such as ordinance detonation, active sonar, and live munitions. The air space over the Gulf of America is used extensively by the DoD for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf of America. The western Gulf of America has four warning areas used for military operations. The areas total approximately 21 million acres or 58% of the Gulf of America. In addition, six blocks in the western Gulf of America are used by the Navy for mine warfare testing and training. The central Gulf of America has five designated military warning areas that are used for military operations.

The central Gulf of America has five designated military warning areas used for military operations. These areas total approximately 11.3 million acres (ac; 45,729 km^2). Portions of the Eglin Water Test Areas (EWTA) comprise an additional 0.5 million ac (2,023 km^2) in the Gulf of America. The total 11.8 million ac (47,753 km^2) is about 25% of the area of the Gulf of America.

Formal consultations on overall U.S. Navy activities in the Atlantic have been completed by NMFS, for U.S. Navy's Activities in East Coast Training Ranges (June 1, 2011); U.S. Navy Atlantic Fleet Sonar Training Activities (AFAST; January 20, 2011); Navy AFAST Letter of Authorization 2012–2014: U.S. Navy active sonar training along the Atlantic Coast and Gulf of America (December 19, 2011); Activities in the Gulf Range Complex from November 2010 to November 2015 (March 17, 2011); and Navy's East Coast Training Ranges (Virginia Capes, Cherry Point, and Jacksonville; June 2010). These opinions concluded that, although there is a potential for some U.S. Navy activities to affect sea turtles, those effects were not expected to affect any species on a population level. Therefore, the activities were determined to be not likely to jeopardize the continued existence of any ESA-listed species.

On October 22, 2018 NMFS issued a conference and biological opinion on the effects of the Navy's Atlantic Fleet Training and Testing (AFTT) Phase III activities on ESA-listed resources (NMFS 2018). The AFTT action area includes the Gulf of Mexico Range Complex, which encompasses approximately 17,000 square nautical miles (NM^2) of sea and undersea space and includes 285 NM of coastline. The four operating areas (OPAREAs) within this range complex are: Panama City OPAREA off the coast of the Florida panhandle (approximately 3,000 NM^2); Pensacola OPAREA off the coast of Florida west of the Panama City OPAREA (approximately 4,900 NM^2); New Orleans OPAREA off the coast of Louisiana (approximately 2,600 NM^2); and Corpus Christi OPAREA off the coast of Texas (approximately 6,900 NM^2). We concluded the action is not likely to jeopardize the continued existence of any ESA-listed species or result in the destruction or adverse modification of critical habitat. The AFTT Phase III opinion includes an ITS with exempted take for ESA-listed sea turtles (for details see https://repository.library.noaa.gov/view/noaa/31540). Through the section 7 consultation process with NMFS, the U.S. Navy has developed and implemented monitoring and conservation measures to reduce the potential effects of explosives, sonar, and vessel strikes on ESA-listed resources, including sea turtles, in the Atlantic Ocean and Gulf of America.

NMFS completed consultations on Eglin Air Force Base testing and training activities in the Gulf of America. These consultations concluded that adverse effects to sea turtles are likely to occur, but the action is not likely to jeopardize their continued existence or result in the destruction or adverse modification of critical habitat. These opinions included an ITS for these actions: Eglin Gulf Test and Training Range (NMFS 2004b), the Precision Strike Weapons Tests (NMFS 2005b), the Santa Rosa Island Mission Utilization Plan (NMFS 2005c), Naval Explosive Ordnance Disposal School (NMFS 2004a), Eglin Maritime Strike Operations Tactics Development and Evaluation (NMFS 2013), and Ongoing Eglin Gulf Testing and Training Activities (NMFS 2017b; NMFS 2023c).

5.10 Aquaculture

Marine aquaculture systems are diverse, ranging from highly controlled land-based systems to open water cages that release wastes directly to the environment. Species produced in the marine environment are also diverse, and include seaweeds, bivalve mollusks, echinoderms, crustaceans, and finfish (Langan 2004). Globally, aquaculture supplies more than 50% of all seafood produced for human consumption, and that percentage will likely continue to rise (NOAA Marine Aquaculture; https://www.fisheries.noaa.gov/topic/aquaculture). Marine aquaculture is expected to expand in the U. S. Exclusive Economic Zone (EEZ) due to increased demand for domestically grown seafood, coupled with improved technological capacity to farm in the open ocean. The National Offshore Aquaculture Act of 2005 (S. 1195) promotes offshore aquaculture development within the EEZ and established a permitting process that encourages private investment in aquaculture operations, demonstrations, and research. Although the marine aquaculture industry has been expanding in the U.S., development is highly variable among states (e.g., Virginia and Maine have productive and valuable industries, while Georgia and New York, have relatively minimal development; Lester et al. 2024).

Aquaculture is an emerging industry in the Gulf of America, though there are currently no active commercial offshore aquaculture operations. In 2020, Presidential Executive Order 13921, “Promoting American Seafood Competitiveness and Economic Growth,” identified the U.S. Gulf of America as one of the first regions to be evaluated for offshore aquaculture opportunities (85 FR 28471; May 12, 2020). Farmer et al. (2022b) developed a method to identify aquaculture opportunity areas (AOA’s) with the least conflict with protected species, including sea turtles. In November 2021, NOAA’s National Centers for Coastal Ocean Science published a comprehensive spatial modeling study, “An Aquaculture Opportunity Atlas for the U.S. Gulf of Mexico,” which identified nine potential options for AOA locations in federal waters in the Gulf of America (Figure 10). These nine locations were identified using spatial suitability modeling intended to minimize conflicts with protected/sensitive species and habitats, as well as other ocean user groups. The model included data layers relevant to administrative boundaries, national security (i.e., military), navigation and transportation, energy and industry infrastructure, commercial and recreational fishing, natural and cultural resources, and oceanography (i.e., non-living resources; Riley et al. 2021).

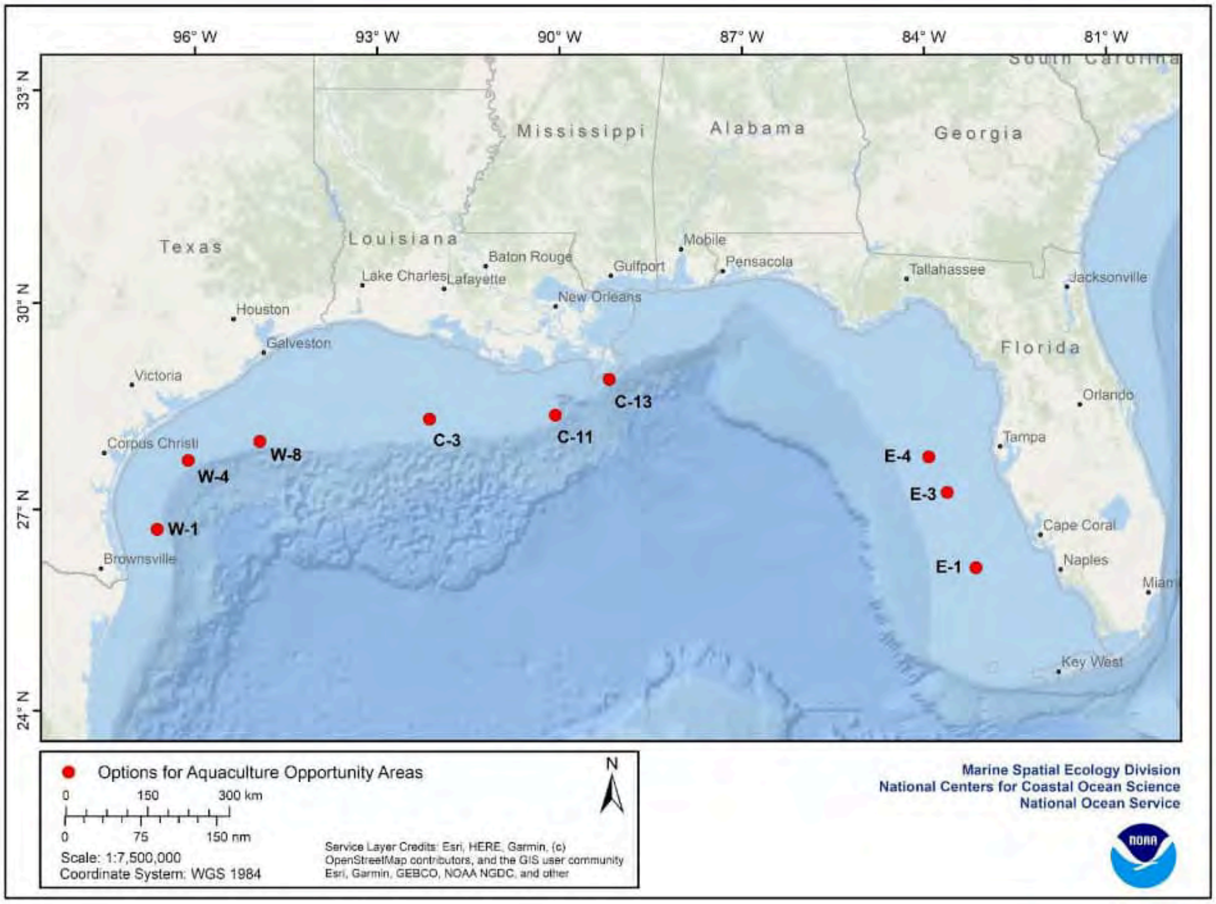

Figure 10. Nine potential locations for AOAs in federal waters of the Gulf of America (Source: NCCOS 2023)

Potential impacts to ESA-listed species can occur at all stages of aquaculture development, operation, and decommissioning, and can include attraction to farms or displacement from important habitats, resulting in changes to distribution, behaviors, or social structures (Clement 2013; Price et al. 2017). Aquaculture has the potential to affect protected species via entanglement and/or other interaction with aquaculture gear (i.e., buoys, nets, and lines), introduction or transfer of pathogens, increased vessel traffic and noise, impacts to habitat and benthic organisms, and water quality (Clement 2013a; Lloyd 2003; Price et al. 2017; Price and Morris 2013). Current data suggest that interactions and entanglements of ESA-listed marine mammals and sea turtles with aquaculture gear are rare (Price et al. 2017). This may be because worldwide the number and density of aquaculture farms are low, and thus there is a low probability of interactions, or because they pose little risk to ESA-listed marine mammals or sea turtles. There are limited data on sea turtle interactions, and very few reports of marine mammal interactions with aquaculture gear. It is not always possible to determine if the gear animals become entangled in originates from aquaculture or commercial fisheries (Price et al. 2017). Some aquaculture gear has the potential for behavioral effects on marine mammals. For example, aquaculture gear may act as a "fish aggregating device" which may attract marine mammals seeking prey for food, and subsequent marine mammal depredation may occur (Callier et al. 2018). Aquaculture gear may also block migration routes (MPI 2013) or at least cause animals to have to circumnavigate the aquaculture gear.

5.11 Invasive Species

Aquatic nuisance species are nonindigenous species that threaten the diversity or abundance of native species, the ecological stability of infested waters, or any commercial, agricultural or recreational activities dependent on such waters. Aquatic nuisance species or invasive species include nonindigenous species that may occur within inland, estuarine, or marine waters and that presently or potentially threaten ecological processes and natural resources. Invasive species have been referred to as one of the top four threats to the world's oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005; Wambiji et al. 2007). Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Wilcove et al. 1998). A variety of vectors are thought to have introduced non-native species including, but not limited to, aquarium and pet trades, recreation, and shipping. Shipping is the main vector of aquatic nuisance species (species hitchhiking on vessel hulls and in ballast water) in aquatic ecosystems; globally, shipping has been found to be responsible for 69% of marine invasive species (e.g., Drake and Lodge 2007; Keller and Perrings 2011; Molnar et al. 2008). Common impacts of invasive species are alteration of habitat and nutrient availability, as well as altering species' composition and diversity within an ecosystem (Strayer 2010). Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002; Norse et al. 2005), potentially affecting prey availability and habitat suitability for ESA-listed species. They have been implicated in the endangerment of 48% of ESA-listed species (Czech and Krausman 1997). Currently, there is little information on the level of aquatic nuisance species and the impacts of these invasive species may have on sea turtles in the action area through the duration of the project. Therefore, the level of risk and degree of impact to ESA-listed sea turtles is unknown.

Lionfish (*Pterois* sp.) have become a major invasive species in the western North Atlantic Ocean and have rapidly dispersed into the Caribbean Sea and Gulf. Since lionfish were first captured in the northern Gulf of America in 2010 and 2011, they have rapidly dispersed throughout the northern Gulf of America, with the western-most collection of lionfish off Texas (Fogg et al. 2013). Lionfish are voracious predators to native fishes having decimated native fish populations on Caribbean reefs, and have a broad habitat distribution with few natural predators in the region (Ingeman 2016; Mumby et al. 2011). It is unclear what impact lionfish will have on prey species for loggerhead and Kemp's ridley turtles in the Gulf portion of the action area. Although it is not possible to predict which aquatic nuisance species will arrive and thrive in the Gulf portion of the action area, it is reasonably certain that they will be yet another facet of change and potential stress to native biota which may affect either the health or prey base of native fauna.

5.12 Nutrient Loading and Hypoxia

Industrial and municipal activities can result in the discharge of large quantities of nutrients into coastal waters. Excessive nutrient enrichment results in eutrophication, a condition associated with degraded water quality, algal blooms (including harmful algal blooms), oxygen depletion, loss of seagrass and coral reef habitat, and in some instances the formation of hypoxic "dead zones" (USCOP 2004). Hypoxia (low dissolved oxygen concentration) occurs when waters become overloaded with nutrients such as nitrogen and phosphorus, which enter oceans from agricultural runoff, sewage treatment plants, bilge water, atmospheric deposition, and other sources. An overabundance of nutrients can stimulate algal blooms resulting in a rapid expansion of microscopic algae (phytoplankton). When excess nutrients are consumed, the algal population dies off and the remains are consumed by bacteria. Bacterial consumption decreases the dissolved oxygen level in the water which may result in mortality of fish and crustaceans, reduced benthic and demersal organism abundance, reduced biomass and species richness, and abandonment of habitat to sufficiently oxygenated areas (Craig et al. 2001; Rabalais et al. 2002). Higher trophic-level species (e.g., sea turtles) may be impacted by the reduction of available prey because of hypoxic conditions.

Nutrient loading from land-based sources, such as wastewater treatment plants and agriculture, and hypoxia remain a threat to protected species and their habitats and prey availability, which, in turn, can affect survival and reproductive fitness. In the Gulf of America, eutrophication from both point and non-point sources produces a large area with seasonally depleted oxygen levels (< 2 milligrams/liter; Rabalais et al. 2010) on the Louisiana continental shelf. The hypoxia begins in late spring, reaches a maximum in mid-summer, and disappears in the fall. Since 1993, the average extent of mid-summer, bottom-water hypoxia in the northern Gulf of America has been approximately 6,200 mi^2 (16,000 km^2), approximately twice the average size measured between 1985 and 1992. The hypoxic zone attained a maximum measured extent in 2002, when it was about 8,500 mi^2 (22,000 km^2), which is larger than the state of Massachusetts. The Mississippi River/Gulf of Mexico Watershed Nutrient Task Force's 2023 Report to Congress determined the midsummer extent of the hypoxic zone was 6,330 mi^2 (16,400 km^2) in 2021, and 3,270 mi^2 (8,480 km^2) in 2022 (US-HTF 2023). For 2024, NOAA measured a hypoxic zone in the Gulf of America of 6,507 mi^2 (16,853 km^2), the 12th largest zone in 38 years of measurement (NCCOS 2024; NOAA 2024b). Low-oxygen waters can induce fish kills, alter fish diets, growth, and reproduction (Rose et al. 2018), reduce habitat use by shrimp species (Craig 2012), and affect the habitat of sea turtles. Warming waters will likely exacerbate hypoxic conditions along the Gulf of America continental shelf, resulting in greater exposure to prolonged and severe hypoxic conditions (Laurent et al. 2018). Projected increases in precipitation over the next few decades in the Mississippi and Atchafalaya River Basin is anticipated to result in more water, sediment, and nutrients entering the coasts as well (US-HTF 2023).

In addition to inducing widespread hypoxia in the action area, nutrient loading and changing environmental trends can trigger the development of marine algal toxins. Marine algal toxins are produced by unicellular algae that are often present at low concentrations but may proliferate to form dense concentrations under certain environmental conditions (National Academies of Sciences and Medicine 2016). When high cell concentrations form, the toxins they produce can harm marine life, which is referred to as a harmful algal bloom (HAB). Excess nutrients from freshwater inputs enhance growth of phytoplankton that naturally occur in the ecosystem, forming "blooms" that can often produce a suite of toxins. The majority of HAB species observed in U.S. waters are present on the Gulf coast and there are frequent blooms, including, but not limited to, the dinoflagellates *Karenia brevis, Alexandrium,* and *Dinophysis*, and the diatom *Pseudo-nitzschia* in the Gulf of America (Anderson et al. 2021). Recent assessments and improved ocean monitoring capabilities have shown that the frequency, duration, and toxicity of HABs in the U.S. may be increasing overall (Anderson et al. 2021). Ocean warming has fostered the geographic expansion of new HAB species into the Gulf portion of the action area, such as Ciguatoxin-producing *Gambierdiscus* dinoflagellates into the northern Gulf of America (Anderson et al. 2021).

The various toxins produced by these species of HABs can biomagnify up the food chain, ultimately harming protected species (like sea turtles) when ingested (Perrault et al. 2021a); the toxins can affect neurological function, feeding and shelter behavior, and damage other organ systems. In the Gulf portion of the action area, researchers have determined HABs to be the cause of marine mammal unusual mortality events (Fire et al. 2020), large-scale fish kills (Overstreet and Hawkins 2017), and sea turtle deaths (NOAA 2024c). Capper et al. (2013) found that sea turtles were exposed to multiple HAB toxins (okadaic acid, brevetoxins, saxitoxins, and likely others) in Florida. Results from Vilas et al. (2023) suggest that severe red tide fisheries impacts have occurred on the West Florida Shelf, located in the eastern Gulf of America, at the ecosystem, community, and population levels in terms of biomass, catch, and productivity. Blooms of the toxic dinoflagellate *K. brevis* occur frequently on the west coast of Florida, killing fish and other marine life. The 2018 *K. brevis* harmful algal bloom experienced along the west coast of Florida was the worst red tide occurrence there since 2005 (Liu et al. 2022).

5.13 Marine Debris

Marine debris is an ecological threat introduced into the marine environment through ocean dumping, littering, or hydrological transport of these materials from land-based sources or weather events (Gallo et al. 2018). Sea turtles within the action area may ingest marine debris, particularly plastics, which can cause intestinal blockage and internal injury, dietary dilution, malnutrition, and increased buoyancy. These can result in poor health, reduced fitness, growth rates, and reproduction, or even death (Nelms et al. 2016).

Plastic pollution in the marine environment is of particular concern to endangered and threatened species because plastic materials are highly persistent and can degrade into microplastics rather than fully disintegrating. Globally, between 5.3–14 million t (4.8–12.7 million MT) of plastic waste entered the ocean from 192 coastal countries in 2010 (Jambeck et al. 2015). Debris can originate from a variety of marine industries including fishing, oil and gas, and shipping. Many of the plastics discharged to the sea can withstand years of saltwater exposure without disintegrating or dissolving. Further, floating materials concentrate in ocean gyres and convergence zones, notably in regions with *Sargassum* habitat where juvenile sea turtles are known to occur, and microplastics have consistently been detected in *Sargassum* mats in coastal ecosystems (Arana et al. 2024; Law et al. 2010). Changing environmental trends are further exacerbating marine plastic fluxes; increasing storms and flooding can transport large amounts of debris into aquatic systems and microplastics, in particular, are now being transported through the atmosphere as part of biogeochemical cycles (Ford et al. 2022).

Entanglement in plastic debris (including abandoned 'ghost' fishing gear) is known to cause lacerations, increased drag (thereby reducing the ability to forage effectively or avoid predators), and may lead to drowning or death by starvation. In a review of global studies evaluating debris ingestion, researchers found that the probability of green and leatherback turtles ingesting debris has increased significantly between 1985– 2012, and herbivorous or jellyfish-consuming species are at greatest risk of both lethal and sublethal effects (Schuyler et al. 2014). Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby reducing the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps providing a source of toxic chemicals (Laist 1987; Laist 1997). Weakened animals are more susceptible to predators and disease and are less fit to migrate, breed, or, in the case of turtles, nest successfully (Katsanevakis 2008; McCauley and Bjorndal 1999). There are limited studies of debris ingestion in sea turtles within the action area; however, Plotkin et al. (1993) found that over half of the studied loggerhead turtles had anthropogenic debris, mainly pieces of plastic bags, present in digestive tract contents. Plotkin et al. (1993) attributed the deaths of three loggerhead turtles to debris ingestion, including one loggerhead turtle whose esophagus was perforated by a fishing hook, one loggerhead turtle whose stomach lining was perforated by a piece of glass, and one loggerhead turtle whose entire digestive tract was impacted by plastic trash bags. Elsewhere in the Gulf, debris such as plastic, fishing gear, rubber, aluminum foil, and tar were found in green and loggerhead turtles (Bjorndal et al. 1994). At least two turtles died as a result of debris ingestion, although the volume of debris represented less than 10% of the volume of the turtle's gut contents; therefore, even small quantities of debris can have severe health and fitness consequences (Bjorndal et al. 1994).

Sea turtles can also become entangled in marine debris, namely fishing gear, as discussed in Section 5.3.

5.14 Other Marine Pollution

Chemical-based pollution from a variety of sources may also affect listed species in the action area. These sources include atmospheric loading of pollutants such as polychlorinated biphenyls (PCBs), stormwater from coastal or river communities, and discharges from ships and industries. In addition to legacy contaminants such as PCBs, heavy metals, and pesticides, several classes of contaminants of emerging concern also introduce risks to listed species. NOAA's National Status and Trends Mussel Watch Program monitors 85 long-term sites in coastal waters in the Gulf of America, and, in 2017, detected elevated concentrations of the following contaminants of emerging concern across the coastline: brominated flame retardants, pesticides such as highly toxic organophosphates, pharmaceutical compounds, and per- and poly-fluoroalkyl substances (PFAS; Swam et al. 2023). PFAS are a class of chemicals that are highly persistent, bioaccumulative, and have been linked to liver damage, cancer, and immune suppression in humans and aquatic vertebrate study species. Sources of marine pollution are often difficult to attribute to specific federal, state, local or private actions.

Chemical pollutants (e.g., DDT, PCBs, polybrominated diphenyl ethers, perfluorinated compounds, and heavy metals) accumulate up trophic levels of the food chain, such that high trophic level species like sea turtles have higher levels of contaminants than lower trophic levels (Bucchia et al. 2015b; D'Ilio et al. 2011; Mattei et al. 2015). These pollutants can cause adverse effects, including endocrine disruption, reproductive impairment or developmental effects, and immune dysfunction or disease susceptibility (Bucchia et al. 2015a; Ley-Quiñónez et al. 2011). In sea turtles, maternal transfer of persistent organic pollutants threatens developing embryos with a pollution legacy and poses conservation concerns due to its potential adverse effects on subsequent generations (Muñoz and Vermeiren 2020). Although there is limited information on chemical pollutants in sea turtles in the action area, there are studies that have investigated heavy metals, brevetoxins, and persistent organic pollutants in some sea turtle species in other areas of the Gulf portion of the action area and adjacent waters. Two studies investigated heavy metals in Kemp's ridley, loggerhead, hawksbill, and green turtles off eastern Texas and Louisiana (Kenyon et al. 2001; Presti et al. 2000). Heavy metal (mercury, copper, lead, silver, and zinc) concentrations in blood and scute (the scales on the shell, also known as carapace) samples increased with turtle size (Kenyon et al. 2001; Presti et al. 2000). After a red tide bloom near Florida's Big Bend, Perrault et al. (2017) found brevetoxins and heavy metals in Kemp's ridley and green turtles. Perrault et al. (2017) analyzed the turtles' health relative to the presence of brevetoxins and heavy metals, and found that the presence of toxic elements was related to oxidative stress, increased tumor growth, decreased body condition, inflammation, and disease progression.

Sea turtle tissues have been found to contain organochlorines and many other persistent organic pollutants. PCB concentrations in sea turtles are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (Davenport et al. 1990; Orós et al. 2009). The contaminants (organochlorines) can cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007) and are known to depress immune function in loggerhead turtles (Keller et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation. PFAS compounds have been detected in the plasma of loggerhead and Kemp's ridley turtles; adverse impacts could have endocrine and reproductive implications for turtle species (Khan et al. 2023). No information on detrimental threshold concentrations is available and little is known about the consequences of exposure of sea turtles to organochlorine compounds. More research is needed to better understand the short- and long-term health and fecundity effects of these chemical pollutants and heavy metal accumulation in sea turtles.

5.15 Other Launch and Reentry Operations

The FAA, National Aeronautics and Space Administration (commonly known as NASA), and the U.S. Space Force (USSF) are involved in space operations such as licensing and regulating U.S. commercial launch and reentry activity and launch sites, leasing launch facilities, and overseeing the preparation and launching of DoD missile launch activities, and government and commercial satellites. As part of these operations, a number of vehicles are launched from facilities across the U.S. each year, and may end up in the ocean.

Space activities may affect marine protected species including sea turtles, that inhabit or transit through areas where launch and reentry operations occur. These operations often involve the deployment of weather balloons, vessel and aircraft surveillance, and expending or landing a vehicle or component of the vehicle (parachutes, fairings) in the ocean, which can affect sea turtles, their prey, and their habitat.

The programmatic letter of concurrence for launch and reentry vehicle operations in the marine environment (OPR-2021-02908) sets maximum annual limits on commercial space operations in the Gulf and Atlantic Ocean. In the Gulf, maximum annual limits include five launches involving stages that are expended (not recovered) in the ocean, five launches involving attempted recovery of stages in the ocean, and ten spacecraft reentries and landings in the ocean. In the Atlantic Ocean, maximum annual limits include 30 launches involving stages and fairings that are expended in the ocean, 70 launches involving attempted recovery of stages and fairings in the ocean, 10 spacecraft reentries and landings in the ocean, and one launch abort test. At this time, it is unclear the extent to which the rapid expansion of the space industry and continuing disposal of stages and debris in the ocean will affect ESA-listed species and their critical habitat. FAA, NASA, and USSF are in the process of reinitiating the consultation to include all ongoing and future commercial space operations.

5.16 Impact of the Baseline on ESA-Listed Species

Collectively, the environmental baseline described above has had, and likely continues to have, lasting impacts on the ESA-listed species considered in this consultation. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strikes), whereas others result in more indirect (e.g., fishing that affects prey availability) or non-lethal (e.g., invasive species) impacts.

Assessing the aggregate impacts of these stressors on the species considered in this consultation is difficult. This difficulty is compounded by the fact that the sea turtle species in this consultation are wide-ranging and subject to stressors in locations throughout and outside the action area.

We consider the best indicator of the aggregate impact of the environmental baseline section on ESA-listed green, Kemp's ridley, and loggerhead turtles to be the status and trends of those species. As noted in Section 4.2, some of the species considered in this consultation are experiencing increases in population abundance, some are declining, and, for others, their status remains unknown. Taken together, this indicates that the environmental baseline is affecting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the environmental baseline. Therefore, while the environmental baseline may slow their recovery, recovery is not prevented. For the species that may be declining in abundance, it is possible the suite of conditions described in the environmental baseline section is preventing their recovery. However, it is also possible their populations are at such low levels (e.g., due to historical harvesting) that, even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself.

5.17 Conservation and Recovery Actions

NMFS has implemented a series of regulations aimed at reducing the potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for the Atlantic HMS, South Atlantic snapper-grouper, and Gulf reef fish fisheries, and TED requirements for the Southeast shrimp trawl fishery. In addition to regulations, outreach programs have been established and data on sea turtle interactions with recreational fisheries has been collected through the Marine Recreational Information Program. These measures are summarized below.

5.17.1 Federal Actions

To advance the conservation and recovery of ESA-listed sea turtles, each sea turtle recovery plan, developed jointly by NMFS and the USFWS, identifies and highlights the need to maintain an active stranding network. As a result, the Sea Turtle Stranding and Salvage Network (the Network) was formally established by NMFS in 1980 to document stranding of sea turtles along the coastal areas from Maine to Texas and in portions of the U.S. Caribbean. The Network is a cooperative effort comprised of federal, state, and permitted private partners working to inform causes of morbidity and mortality in sea turtles by responding to and documenting sea turtles, found either dead or alive (but compromised), in a manner sufficient to inform conservation management and recovery.

NMFS also formally established the Southeast Atlantic Coast Sea Turtle Disentanglement Network (STDN), an important component of the National Sea Turtle Stranding and Salvage Network. The STDN works to reduce serious injuries and mortalities caused by entanglements and is active throughout the action area responding to reports of entanglements. Where possible, sea turtles are disentangled and may be brought to rehabilitation facilities for treatment and recovery, helping to reduce death from entanglement.

Reducing Threats from Pelagic Longline and Other Hook-and-Line Fisheries

On July 6, 2004, NMFS published a Final Rule to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69 FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality.

NMFS published the Final Rule to implement sea turtle release gear requirements and sea turtle careful release protocols in the Gulf reef fish (August 9, 2006; 71 FR 45428) and South Atlantic snapper-grouper fisheries (November 8, 2011; Lopez-Pujol and Ren 2009). These measures require owners and operators of vessels with federal commercial or charter vessel/headboat permits for Gulf reef fish and South Atlantic snapper-grouper to comply with sea turtle release protocols and have specific sea turtle release gear aboard vessels.

Revised Use of Turtle Excluder Devices in Trawl Fisheries

NMFS has also implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial shrimp trawl fisheries. In particular, NMFS has required the use of TEDs in southeast U.S. shrimp trawls since 1989, and in summer flounder trawls in the mid-Atlantic area (south of Cape Charles, Virginia) since 1992. It is estimated that TEDs exclude 97% of the sea turtles caught in such trawls. The regulations have been refined over the years to ensure that TED effectiveness is maximized through more widespread use, and proper placement, installation, configuration (e.g., width of bar spacing), and floatation. The NMFS continues to work towards development of new, more effective gear specific to fishery needs.

Placement of Fisheries Observers to Monitor Sea Turtle Captures

On August 3, 2007, NMFS published a Final Rule that required selected fishing vessels to carry observers on board to collect data on sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle captures, and to determine whether additional measures to address prohibited sea turtle captures may be necessary (72 FR 43176). This Rule also extended the number of days NMFS observers could be placed aboard vessels, from 30 to 180 days, in response to a determination by the Assistant Administrator that the unauthorized take of sea turtles may be likely to jeopardize their continued existence under existing regulations.

5.17.2 State Actions

Under section 6 of the ESA, state agencies may voluntarily enter into cooperative research and conservation agreements with NMFS to assist in recovery actions of listed species. NMFS currently has an agreement with all states along the Gulf of America and Atlantic Ocean in the action area. Prior to issuance of these agreements, the proposals were reviewed for compliance with section 7 of the ESA.

5.17.3 Other Conservation Efforts

Sea Turtle Handling and Resuscitation Techniques

NMFS published a Final Rule (66 FR 67495) detailing handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the Final Rule. These measures help to prevent mortality of hardshell turtles (such as ESA-listed sea turtles) caught in fishing or scientific research gear.

Outreach and Education, Sea Turtle Entanglement, and Rehabilitation

A Final Rule (70 FR 42508), published on July 25, 2005, allows any agent or employee of NMFS, the USFWS, the USCG, or any other federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment, if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA (50 CFR §223.206(b)).

NMFS has also been active in public outreach efforts to educate fishers regarding sea turtle handling and resuscitation techniques. As well as making this information widely available to all fishers, NMFS recently conducted a number of workshops with Atlantic HMS pelagic longline fishers to discuss bycatch issues including protected species, and to educate them regarding handling and release guidelines. NMFS intends to continue these outreach efforts and hopes to reach all fishers participating in the Atlantic HMS pelagic longline fishery.

Recovery Plans and Reviews

The Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle Second Revision was completed in 2008 (NMFS 2008b). The recovery plan for the U.S. Atlantic population of green turtles was published in 1991 (NMFS and USFWS 1991), and the Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley turtles was published 2011 (NMFS et al. 2011a). Recovery teams comprised of sea turtle experts that were convened and are currently working towards revising these plans based upon the latest and best available science. Five-year status reviews were completed in 2015 for green (Seminoff et al. 2015) and Kemp's ridley turtles (NMFS and USFWS 2015). The five-year status review of the Northwest Atlantic Ocean DPS of loggerhead turtle status was conducted in 2023 (NMFS and USFWS 2023). These reviews comply with the ESA mandate for periodic status evaluation of listed species to ensure that their threatened or endangered listing status remains accurate.

6. Analysis of Effects

The ESA section 7 regulations (50 CFR §402.02) define *effects of the action* as "all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action." To understand the effects of the action to listed species and critical habitats, we employ a stressor-exposure-response analysis. The stressors resulting from this action were identified in Section 2.4 and the only stressor determined to be LAA is the underwater acoustic effects from explosive events in the Gulf and Atlantic Ocean portions of the action area. The following analysis separately assesses the exposure of listed sea turtles and then critical habitat, followed by separate assessments of the responses of listed species and critical habitat to that exposure. To conclude this section, we summarize the combination of exposure and response for each species and each critical habitat.

6.1 Exposure

In this section, we consider the exposure to the various stressors that could cause an effect to ESA-listed species and designated critical habitat that are likely to co-occur with the action's modifications to the environment in space and time, and identify the nature of that co-occurrence. We describe the timing and location of the stressors to identify the populations, life stages, or sexes of each listed species likely to be exposed. We then determine to which populations those exposed individuals belong. Similarly, we describe the location, duration, and frequency of those stressors to understand the alterations to the conservation value of designated critical habitat. We also describe the duration, frequency, and intensity of stressors to quantify the number or extent of exposures that are reasonably certain to occur.

6.1.1 ESA-Listed Sea Turtle Exposure

The ESA-listed sea turtles likely to be adversely affected by underwater acoustic effects from explosive events in the Gulf and Atlantic Ocean portions of the action area are the North Atlantic DPS of green turtle, Kemp's ridley turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle. As discussed in Section 4.2, these species' hearing ranges encompass the frequencies from an explosive event. To estimate the number of sea turtles exposed to underwater sound from the explosive events, FAA adopted SpaceX's methodology summarized in Sections 4.1.2.1 and 4.1.2.2. Sea turtle densities were obtained from Garrison et al. (2023b) for the Gulf portion of the action area and DiMatteo et al. (2024) for the Atlantic Ocean portion of the action area. NMFS acoustic thresholds for sea turtles corresponding to different levels of hearing threshold shifts (226 and 232 dB re 1µPa, respectively) were applied to estimate the ensonified areas, and the number of individuals of each species exposed to and potentially responding to the underwater sound from a maximum of 20 Super Heavy and 20 Starship explosions in each portion of the action area (Table 16 and Table 17). We note that the U.S. Navy has developed updated thresholds for sea turtles (U.S. Department of the Navy 2024). The U.S. Navy's updated thresholds for sea turtles are extrapolated from Salas et al. (2023), Salas et al. (2024a), and Salas et al. (2024b), all of which observed hearing shifts in response to noise in freshwater turtles (see below). While Salas et al. (2023), Salas et al. (2024a), and Salas et al. (2024b) represent the best available information on hearing shift in freshwater turtles, at the time of this consultation, NMFS has not adopted the U.S. Navy's sea turtle thresholds for non-Navy actions. Table 18 summarizes the total number of individuals exposed to underwater acoustic effects from explosive events by species. Note that estimated exposures may not match the exact product of the density and ensonified area due to rounding.

Table 16. Exposure estimates for ESA-listed sea turtles in the Gulf portion of the action area for up to 20 Super Heavy and 20 Starship explosive events

Species	Threshold (dB re 1µPa)*	Super Heavy Ensonified Area (km²)	Starship Ensonified Area (km²)	Maximum Monthly Mean Density (individuals per km²)	Exposure for 20 Super Heavy Explosive Events	Exposure for 20 Starship Explosive Events
Kemp's Ridley Turtle	226	0.093	0.046	0.753	1.4067	0.6973
	232	0.024	0.012	0.753	0.3539	0.1747
Loggerhead Turtle – Northwest Atlantic Ocean DPS	226	0.093	0.046	0.8336	1.5572	0.7720
	232	0.024	0.012	0.8336	0.3918	0.1934

* Note SPL_{peak} thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km² = square kilometers

Table 17. Exposure estimates for ESA-listed sea turtles in the Atlantic Ocean portion of the action area for up to 20 Super Heavy and 20 Starship explosive events

Species	Threshold (dB re 1µPa)*	Super Heavy Ensonified Area (km^2)	Starship Ensonified Area (km^2)	Maximum Monthly Mean Density (individuals per km^2)	Exposure for 20 Super Heavy Explosive Events	Exposure for 20 Starship Explosive Events
Green Turtle – North Atlantic DPS	226	0.093	0.046	0.05322	0.0994	0.0493
Loggerhead Turtle – Northwest Atlantic Ocean DPS	226	0.093	0.046	0.30404	0.5680	0.2815
	232	0.024	0.012	0.30404	0.1429	0.0705

* Note SPL_{peak} thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal; km^2 = square kilometers

Table 18. Total number of individuals exposed to underwater acoustic effects from explosive events in the Gulf and Atlantic Ocean portions of the action area

Species	Threshold (dB re 1µPa)*	Exposure for 20 Super Heavy Explosive Events	Exposure for 20 Starship Explosive Events	Total Estimated Individuals Exposed	Total Individuals Exposed
Green Turtle – North Atlantic DPS	226	0.0994	0.0493	0.15	1
Kemp's Ridley Turtle	226	1.4067	0.6973	2.10	3
	232	0.3539	0.1747	0.53	1
Loggerhead Turtle – Northwest Atlantic Ocean DPS	226	2.125	1.053	3.18	4
	232	0.535	0.264	0.8	1

* Note SPL_{peak} thresholds are used
dB re 1µPa = decibels referenced to a pressure of one microPascal

Green, Kemp's ridley, and loggerhead hatchlings, juveniles, and adults of either sex are likely to be exposed during the explosive events. Given that up to 40 explosive events (20 Super Heavy and 20 Starship) could occur at any time of year for the duration of the proposed action, we expect that animals will be foraging, mating, nesting, hatching, or transiting in the Gulf and Atlantic Ocean portions of the action area.

North Atlantic DPS Green Turtle – The estimated exposure is one individual in the Atlantic Ocean portion of the action area. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult green turtles along the U.S. Atlantic Coast of 63,674 individuals (90% CI = 23,381–117,610 individuals). Given this population estimate, the estimated exposure of one individual is approximately 0.00002% of the population.

Kemp's Ridley Turtle – The estimated exposure is four individuals in the Gulf portion of the action area. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult Kemp's ridley turtles along the U.S. Atlantic Coast of 10,762 individuals (90% CI = 2,620–19,443 individuals). Given this population estimate, the estimated exposure of four individuals is approximately 0.0004% of the population. This estimate is likely higher than the actual exposures because the population abundance estimate does not include turtles smaller than 16 in (40 cm) or turtles from the population's entire range.

Northwest Atlantic Ocean DPS Loggerhead Turtle – The estimated exposure of the population is five individuals in the Gulf and Atlantic Ocean portions of the action area. While there are no abundance estimates for the entire population, DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). Based on this population estimate, the estimated exposure of five individuals is approximately 0.00003% of the population. This estimate is likely higher than the actual exposures because the population abundance estimate does not include turtles smaller than 16 in (40 cm) or turtles from the population's entire range.

6.1.2 Designated Critical Habitat Exposure

The designated critical habitat that is likely to be adversely affected by the proposed action is the breeding habitat of the Northwest Atlantic Ocean DPS of loggerhead turtle. NMFS designated two units of breeding habitat: (1) within the Southern Florida migration corridor from the shore out to the 656 ft (200 m) depth contour along the stretch of the corridor between the Marquesas Keys and the Martin County/Palm Beach County line, and (2) in nearshore waters just south of Cape Canaveral, Florida.

Only breeding habitat around Cape Canaveral, Florida overlaps with the Atlantic Ocean portion of the action area where there will be explosive events.

6.2 Response

Given the potential for exposure to stressors associated with the explosive events discussed above, in this section, we describe the range of responses ESA-listed species and the PBFs of critical habitat may display because of exposure to those stressors from explosive events. Our assessment considers the potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals. We address the expected range of responses because of the types of exposure of the PBFs of critical habitat. When addressing critical habitat, we consider impairments to the function of the PBFs, the amount of time it may take for those PBFs to return to their present function, the extent of the critical habitat that is likely to be affected by the action, and whether the remaining critical habitat is sufficient to support the conservation of ESA-listed species.

6.2.1 ESA-Listed Sea Turtle Responses

For species, we discuss responses in terms of physiological, physical, or behavioral effects to the species. These responses may rise to the level of *take* under the ESA. *Take* is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (16 U.S.C. §1532(19)).

Super Heavy and Starship explosive events transmit acoustic energy into the water, creating a wave of pressure that can affect ESA-listed green, Kemp’s ridley, and loggerhead turtles considered in this opinion. Possible sea turtle responses include hearing threshold shifts, behavioral responses, physiological stress, and masking.

Hearing Loss and Threshold Shifts

Sea turtles are susceptible to noise-induced hearing loss, or noise-induced threshold shifts (i.e., a loss of hearing sensitivity), and auditory injury when exposed to high levels of sound within their limited hearing range (most sensitive from 100– 400 Hz and limited over 1 kHz). Types of noise-induced threshold shifts include temporary threshold shift (TTS) or a permanent threshold shift (PTS). TTS is a temporary, reversible increase in hearing threshold at a specified frequency or portion of an animal’s hearing range above a previously established reference level. PTS is a permanent, irreversible increase in hearing threshold at a specified frequency of portion of an animal’s hearing range above a previously established reference level. Sea turtles may also be susceptible to auditory injury, which is sometimes referred to as PTS. However, the term auditory injury acknowledges that auditory injury, such as the loss of cochlear neuron synapses or auditory neuropathy, may occur even if hearing thresholds return to previously established reference levels. In other words, auditory injury includes PTS, but can occur without resulting in PTS (U.S. Department of the Navy 2024). Auditory injury has not been directly observed in sea turtles; however, it has been observed in other animals such as mice and guinea pigs (Kujawa and Liberman 2006; Kujawa and Liberman 2009; Lin et al. 2011). We note that NMFS has not adopted the U.S. Navy’s updated TTS and auditory injury thresholds for sea turtles (see Section 6.1.1). The following discussion summarizes the best available information on hearing shifts in sea turtles.

Although no studies have directly measured underwater TTS or auditory injury in ESA-listed sea turtles, recent studies examined underwater TTS in freshwater turtles using broadband sound (analogous to sound from an explosion). Salas et al. (2023) exposed red-eared sliders (*Trachemys scripta elegans*) to sound exposure levels (a measure of the acoustic energy of a sound over a specified time period) between 155–193 decibels referenced to a pressure of one microPascal-squared second (dB re 1 μPa^2-s), and auditory sensitivity was measured at 400 Hz using auditory evoked potential methods. The mean predicted TTS onset was 160 dB re 1 μPa^2-s. In another study using Eastern painted turtles (*Chrysemys picta picta*), Salas et al. (2024) reported similar results, with TTS onset occurring at 154 dB re 1 μPa^2 s at 600 Hz and 158 dB re 1 μPa^2 s at 400 Hz.

Explosions create a sound that is broadband in frequency, and includes low frequencies that overlap sea turtle hearing ranges (Hildebrand 2009a). Because a greater frequency band would be affected due to explosives, there is an increased chance that the hearing impairment will affect frequencies utilized by sea turtles for acoustic cues, such as the sound of waves, coastline noise, or the presence of a vessel or predator. However, sea turtles are not known to rely heavily on sound for life functions (Nelms et al. 2016; Popper et al. 2014b) and instead may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al. 2013) and magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015). As such, the likelihood that the loss of hearing in a sea turtle would affect its fitness (i.e., survival or reproduction) is low when compared to marine mammals, which rely heavily on sound for basic life functions. Sea turtles may use acoustic cues such as waves crashing, wind, vessel, and/or predator noise to perceive the environment around them. If such cues increase survivorship (e.g., aid in avoiding predators, navigation), hearing loss may affect individual sea turtle fitness.

TTS in sea turtles is expected to last for a few hours to days, depending on the severity. TTS can significantly disrupt a turtle’s normal behavior patterns for the duration over which their hearing threshold is altered. However, given TTS is temporary and sea turtles are not known to rely heavily on acoustic cues, we do not anticipate that TTS exposure would result in long-term fitness impacts to individual turtles. PTS could permanently impair a sea turtle’s ability to hear environmental cues, depending on the frequency of the cue and the frequencies affected by the hearing impairment. Given this, we anticipate that at least some sea turtles that experience PTS may have a reduction in fitness either through some slight decrease in survivorship (e.g., decreased ability to hear predators or hazards such as vessels) or reproduction (e.g., minor effects to the animal’s navigation that may reduce mating opportunities).

Behavioral Responses

Any acoustic stimuli within sea turtle hearing ranges in the marine environment could elicit behavioral responses in sea turtles, including noise from explosive events. Based on a limited number of studies, sea turtle behavioral responses to impulsive sounds could consist of temporary avoidance, increased swim speed, startle response, dive response, changes in depth; or there may be no observable response (McCauley et al. 2000; O'Hara and Wilcox 1990; Kastelein et al. 2024; DeRuiter and Doukara 2012). There is no evidence to suggest that sea turtle behavioral responses to acoustic stressors would persist after the sound exposure.

Exposure to a single explosive event (which applies here because, although there could be up to 40 explosive events in each portion of the action area, explosive events will not happen in succession and are extremely unlikely to occur in the same location) will likely result in a short-term startle response. Sea turtles would presumably return to normal behaviors quickly after exposure to a single explosive event, assuming the exposure did not result in TTS or PTS.

Significant behavioral responses that result in disruption of important life functions, such as reproduction, would not be likely with exposure to a single explosive event. Therefore, while a large number of sea turtles may experience a behavioral response from exposure to explosive events, the anticipated impacts on fitness and survival of these individuals are minor and short-term.

Super Heavy and Starship explosive events transmit acoustic energy into the water, creating a wave of pressure that can result in TTS or PTS in ESA-listed loggerhead turtles, including potentially reproductive males and females, which may affect reproduction. There may be up to 80 explosive events within the range of Northwest Atlantic Ocean DPS loggerhead turtle (20 Super Heavy explosive events and 20 Starship explosive events, in the Gulf and the Atlantic Ocean portions of the action area), which could result in TTS or PTS to five loggerhead turtles. In the area of Cape Canaveral, Florida, Ceriani et al. (2019) estimated an annual average number of loggerhead nests between 1989–2018 at 31,144 nests (range: 19,416–43,583 nests) and 27,819 nests (range: 16,646–39,140 nests) based on data from the Florida Statewide Nesting Beach Survey program and the Florida Index Nesting Beach Survey program, respectively. Should all five expected loggerhead exposures be turtles of reproductive age, we anticipate a short-term effect to reproduction on the part of individuals exposed to the sound from an explosive event if it occurs during breeding season.

Physiological Stress

ESA-listed sea turtles that experience either TTS, PTS, or a significant behavioral response are also expected to experience a physiological stress response. A short, low-level stress response may be adaptive and beneficial for sea turtles in that it may result in sea turtles avoiding the stressor and minimizing their exposure. Whereas stress is an adaptive response that does not normally place an animal at risk, distress involves a chronic stress response resulting in a negative biological consequence to the individual. Stress responses from underwater acoustic effects of the explosive events are expected to be short-term in nature given that, in most cases, sea turtles would not experience repeated exposure to these stressors over a long period. As such, we do not anticipate stress responses would be chronic, involve distress, or have negative long-term impacts on any individual sea turtle's fitness.

Masking

Sea turtles likely use their hearing to detect broadband low-frequency sounds in their environment, so the potential for masking would be limited to sound exposures that have similar characteristics (i.e., frequency, duration, and amplitude). Continuous and near-continuous human-generated sounds that have a significant low-frequency component, are not brief, and are of sufficient received level (e.g., proximate vessel noise and high-duty cycle or continuous active sonar), are most likely to result in masking. Explosive events, even though they have low-frequency components, would have limited potential for masking because they are of short duration. Because sea turtles may rely primarily on senses other than hearing for interacting with their environment, any effect of masking may be mediated by reliance on other environmental inputs.

6.2.2 Critical Habitat Response – Northwest Atlantic Ocean DPS Loggerhead Turtle

Super Heavy and Starship explosive events transmit acoustic energy into the water, creating a wave of pressure that can affect the PBF for breeding critical habitat. Explosive events within the unit of breeding critical habitat that may be affected by the proposed action (Cape Canaveral, Florida), would affect the PBF of concentrating reproductive individuals. The sound levels during an explosive event would impair normal functions, such as breeding, at levels causing TTS or PTS, and cause behavioral responses such as startle responses, causing individuals to leave the area. Thus, the PBF for breeding habitat would be impaired because the habitat would, at least temporarily, not concentrate reproductive individuals.

6.3 Summary of Effects

In this section, we combine the exposure analysis and response analysis to produce estimates of the amount and extent of take anticipated because of the stressors caused by this action. This summary of the anticipated effects of the action considers all consequences caused by the action and its activities. The following subsections state the anticipated effects of the action for each species and designated critical habitat that will be adversely affected by the proposed action.

6.3.1 Green Turtle – North Atlantic DPS

We expect one North Atlantic DPS green turtle to be exposed to underwater sound from Super Heavy and Starship explosive events within the 226 dB re 1µPa ensonified area in the Atlantic Ocean portion of the action area and exhibit a response in the form of TTS or behavioral and physiological stress. This may affect North Atlantic DPS green turtles' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness or have population-level effects.

6.3.2 Kemp's Ridley Turtle

We expect up to three Kemp's ridley turtles to be exposed to underwater sound from Super Heavy and Starship explosive events within the 226 dB re 1µPa ensonified area in the Gulf portion of the action area and exhibit responses in the form of TTS or behavioral and physiological stress. We also expect one Kemp's ridley turtle to be exposed to underwater sound from Super Heavy and Starship explosive events within the 232 dB re 1µPa ensonified area in the Gulf portion of the action area and exhibit responses in the form of PTS.

TTS or behavioral and physiological stress may affect Kemp's ridley turtles' normal behavioral patterns but is not expected to result in a long-term reduction in individual fitness. PTS could permanently impair a sea turtle's hearing and result in a reduction in fitness through some decrease in survivorship or reproduction, but we do not expect population-level effects.

6.3.3 Loggerhead Turtle – Northwest Atlantic Ocean DPS

We expect up to four Northwest Atlantic Ocean DPS loggerhead turtles to be exposed to underwater sound from Super Heavy and Starship explosive events within the 226 dB re 1µPa ensonified area in the Gulf and Atlantic Ocean portions of the action area and exhibit responses in the form of TTS or behavioral and physiological stress. We also expect one Northwest Atlantic Ocean DPS loggerhead turtle to be exposed to underwater sound from Super Heavy and Starship explosive events within the 232 dB re 1µPa ensonified area in the Gulf and Atlantic Ocean portions of the action area and exhibit responses in the form of PTS.

TTS or behavioral and physiological stress may affect Northwest Atlantic Ocean DPS loggerhead turtles' normal behavior patterns but is not expected to result in a long-term reduction in individual fitness. PTS could permanently impair a sea turtle's hearing and result in a reduction in fitness through some decrease in survivorship or reproduction, but we do not expect population-level effects.

6.3.4 Critical Habitat – Northwest Atlantic Ocean DPS of Loggerhead Turtle

We examined underwater acoustic effects from explosive events on the designated breeding critical habitat for Northwest Atlantic Ocean DPS of loggerhead turtle. The PBF of breeding habitat that may be adversely affected is the suitability of the habitat to allow for high densities of reproductive male and female loggerheads. In our analysis of underwater acoustic effects from explosive events to breeding habitat, we determined sound levels would temporarily alter habitat conditions such that individuals would not be concentrated within the area with sound levels above sea turtle hearing thresholds, impairing critical habitat function for the designated breeding critical habitat unit for Northwest Atlantic Ocean DPS of loggerhead turtle.

7. CUMULATIVE EFFECTS

Cumulative effects are defined in regulations as "those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation" (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7(a)(2) of the ESA.

We assessed the action area of this consultation for any non-Federal activities that are reasonably certain to occur. The past and ongoing impact of existing actions was described in the environmental baseline (Section 5). During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than the activities described in the environmental baseline.

An increase in non-Federal activities described in the environmental baseline (Section 5) could increase their effect on ESA-listed resources and, for some, a future increase is considered reasonably certain to occur. Given current trends in global population growth, threats associated with changing environmental trends, pollution, fisheries, bycatch, aquaculture, vessel strikes, and sound are likely to continue to increase in the future, although any increase in effects may be somewhat countered by an increase in conservation and management, should these occur.

8. INTEGRATION AND SYNTHESIS

This opinion includes a jeopardy analysis for the ESA-listed threatened and endangered species and a destruction of adverse modification analysis for designated critical habitat that are likely to be adversely affected by the action. Section 7(a)(2) of the ESA and its implementing regulations require every federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The jeopardy analysis, therefore, relies upon the regulatory definitions of *jeopardize the continued existence of* and *destruction or adverse modification*.

Jeopardize the continued existence of means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). *Recovery*, used in that definition, means "improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act" (50 CFR §402.02).

Destruction or adverse modification means "a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR §402.02). *Conservation*, used in that definition, means "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary" (16 U.S.C. §1532(3)).

The Integration and Synthesis is the final step in our jeopardy analyses. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7), taking into account the status of the species and critical habitat (Section 4), to formulate the agency's biological opinion as to whether the action agency can insure its proposed action is not likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat as a whole for the conservation of the species.

8.1 Jeopardy Analysis

The jeopardy analysis assesses the proposed action's effects on ESA-listed North Atlantic DPS green, Kemp's ridley, and Northwest Atlantic Ocean DPS loggerhead turtle survival and recovery. The following sections summarize the relevant information in this opinion for each individual species considered.

8.1.1 Green Turtle – North Atlantic DPS

The North Atlantic DPS is the largest of the 11 green turtle DPSs, with an estimated nester abundance of over 167,000 adult females from 73 nesting sites (Seminoff et al. 2015). Florida accounts for approximately 5% of nesting for this DPS. According to data collected from Florida's index nesting beach survey from 1989–2024, green turtle nest counts across Florida have increased from a low of 267 in the early 1990s to a high of 40,911 in 2019. Nesting decreased by half from 2019–2020, although it increased to a new record high in 2023 before dropping substantially in 2024. Similar fluctuations were observed at Tortuguero, Costa Rica, which is the predominant nesting site, accounting for an estimated 79% of nesting for the DPS (Seminoff et al. 2015). Current nesting levels at Tortuguero, Costa Rica have reverted to that of the mid-1990s and the overall long-term trend has now become negative (Restrepo et al. 2023). Green turtles generally follow a two-year reproductive cycle, which may explain fluctuating nest counts; however, threats that have affected nesting in the Tortuguero region may ultimately influence the trajectories of nesting in the Florida region. DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult green turtles along the U.S. Atlantic Coast of 63,674 individuals (90% CI = 23,381–117,610 individuals). We are not aware of any current range-wide in-water estimates for the DPS.

North Atlantic DPS green turtles will experience TTS or behavioral and physiological stress responses throughout the Atlantic Ocean portion of the action area from Super Heavy and Starship explosive events. We anticipate one instance of TTS or behavioral and physiological stress is reasonably certain to occur over 40 total explosive events in the Atlantic Ocean portion of the action area.

As discussed in Section 6.2.1, TTS and behavioral and physiological stress is temporary and sea turtles do not rely heavily on acoustic cues. As such, we do not anticipate that TTS or behavioral and physiological stress exposure would result in a reduction in numbers and will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in one individual will not affect the distribution of this species. Therefore, one TTS or behavioral and physiological stress exposure will not have measurable impacts to the population to which that individual belongs and the effects of the stressors resulting from explosive events as part of the proposed action will not affect the survival of North Atlantic DPS green turtles in the wild.

The 1991 Recovery Plan for the U.S. Atlantic population of green turtles identified the major actions needed to recover this DPS (NMFS and USFWS 1991). Demographic criteria for delisting the species includes a level of nesting in Florida that has increased to an average of 5,000 nests per year for at least six years. There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that explosives can affect green turtles and cause negative impacts including, but not limited to, injury and mortality. While we anticipate North Atlantic DPS green turtles will be harassed by underwater sound during explosive events, this will not impede the potential for recovery of North Atlantic DPS green turtles. Therefore, the effects of the stressors resulting from explosive events as part of the proposed action will not appreciably diminish the ability of green turtles to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of North Atlantic DPS green sea turtles in the wild.

8.1.2 Kemp's Ridley Turtle

The Kemp's ridley turtle has declined to the lowest population level of all sea turtle species in the world. Nesting aggregations at a single location (Rancho Nuevo, Mexico), which were estimated at 40,000 females in 1947, declined to an estimated 300 females by the mid-1980s. From 1980 through 2003, largely due to conservation efforts, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico increased 15% annually (Heppell et al. 2005). By 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from these three primary nesting beaches. Because females lay approximately 2.5 nests each season they nest, 10,987 nests represents 4,395 females nesting in a season at these primary nesting sites. Increases in nest counts have also been documented over the past two decades at nesting beaches in Texas (NMFS and USFWS 2015). DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult Kemp's ridley turtles along the U.S. Atlantic Coast of 10,762 individuals (90% CI = 2,620–19,443 individuals).

Kemp's ridley turtles will experience TTS, PTS, and behavioral and physiological stress responses throughout the Gulf portion of the action area from Super Heavy and Starship explosive events. We anticipate three instances of TTS or behavioral and physiological stress, and one instance of PTS are reasonably certain to occur over the 40 total anticipated explosive events in the Gulf portion of the action area.

As discussed in Section 6.2.1, PTS could decrease an individual sea turtle's ability to detect danger such as approaching vessels or predators, and may reduce foraging or breeding opportunities or increase risks of sustaining other harm. Therefore, PTS could result in mortality or injury of one individual, leading to a slight reduction in numbers. This reduction in numbers, as well as the effects of TTS or behavioral and physiological stress responses in three other individuals, will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in three individuals and PTS in one individual will not affect the distribution of this species.

Therefore, the minor reduction in numbers and associated reduction in reproduction, along with the lack of impacts to the distribution of the species will not have measurable impacts to the populations to which these individuals belong. Thus, the effects of the stressors resulting from explosive events as part of the proposed action will not affect the survival of Kemp's ridley turtles in the wild.

The 2011 Bi-National Revised Recovery Plan for the Kemp's Ridley Sea Turtle identified the major actions needed to recover this species (NMFS et al. 2011). Relevant to the proposed action, this includes reducing impacts from explosives. Demographic recovery criteria for downlisting the species include the following: 1) a population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) in Mexico; and 2) recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches. Demographic recovery criteria for delisting the species include the following: 1) an average population of at least 40,000 nesting females per season (as measured by clutch frequency per female per season and annual nest counts) over a six-year period distributed among nesting beaches in Mexico and the U.S.; and 2) ensure average annual recruitment of hatchlings over a six-year period from *in situ* nests and beach corrals is sufficient to maintain a population of at least 40,000 nesting females per nesting season distributed among nesting beaches in Mexico and the U.S. into the future. While we anticipate Kemp's ridley turtles will be adversely affected by underwater sound from explosive events, this will not impede the recovery objectives for Kemp's ridley turtles. Therefore, the effects of the stressors resulting from explosive events as part of the proposed action will not appreciably diminish the ability of Kemp's ridley turtles to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of Kemp's ridley sea turtles in the wild.

8.1.3 Loggerhead Turtle – Northwest Atlantic Ocean DPS

The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead turtles from Texas through Virginia and Quintana Roo, Mexico, is over 110,000 (NMFS and USFWS 2023). NMFS's NEFSC and SEFSC estimated the abundance of juvenile and adult loggerhead turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, at 588,000 individuals (NMFS 2011). An aerial survey over the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, estimated an abundance ranging from 27,508–3,005 loggerheads (NMFS and USFWS 2023). Ceriani et al. (2019) estimated the total number of adult females nesting in Florida to be 51,319, based on nest count data from 2014–2018. The annual rate of nesting females increased 1.3% from 1983–2019 for the Northern Recovery Unit (i.e., loggerheads nesting in Georgia, North Carolina, South Carolina, and Virginia; Bolten et al. 2019; NMFS and USFWS 2023). There is no significant trend in the annual number of nesting females in either the Peninsular Florida (1989–2018) or Northern Gulf of Mexico (1997–2018) recovery units over the last several decades (NMFS and USFWS 2023). Overall, the latest 5-year status review concluded that the Northwest Atlantic DPS is stable (NMFS and USFWS 2023). DiMatteo et al. (2024) modeled survey data to estimate a mean annual in-water abundance of juvenile and adult loggerheads along the U.S. Atlantic Coast of 193,423 individuals (90% CI = 159,158–227,668 individuals). We are not aware of any current range-wide in-water estimates for the DPS.

Northwest Atlantic Ocean DPS loggerhead turtles are expected to experience TTS, PTS, and behavioral and physiological stress responses throughout the Gulf and Atlantic Ocean portions of the action area from Super Heavy and Starship explosive events. We anticipate four instances of TTS or behavioral and physiological stress, and one instance of PTS are reasonably certain to occur over 80 total explosive events across the Gulf and Atlantic Ocean portions of the action area.

As discussed in Section 6.2.1, PTS could decrease an individual sea turtle's ability to detect danger such as approaching vessels or predators; and may reduce foraging or breeding opportunities or increase risks of sustaining other harm. Therefore, PTS could result in mortality or injury of one individual, leading to a slight reduction in numbers. This reduction in numbers, as well as the effects of TTS or behavioral and physiological stress responses in four other individuals, will not have a measurable impact on the reproduction of the species. The anticipated effects leading to TTS or behavioral and physiological stress in four individuals and PTS in one individual will not affect the distribution of this species.

Therefore, the minor reduction in numbers and associated reduction in reproduction, along with the lack of impacts to the distribution of the species will not have measurable impacts to the populations to which these individuals belong. Thus, the effects of the stressors resulting from explosive events as part of the proposed action will not affect the survival of Northwest Atlantic Ocean DPS loggerhead turtles in the wild.

The 2009 Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle identified the major actions needed to recover this DPS (NMFS and USFWS 2008). There are no recovery actions that are directly relevant to the proposed action, although the recovery plan acknowledges that explosives can affect loggerheads and cause negative impacts including, but not limited to, injury and mortality. Demographic recovery criteria include the following statistically significant minimum levels of increase in the annual number of loggerhead nests over 50 years for each recovery unit: 1) Northern Recovery Unit: 2% (minimum of 14,000 nests); 2) Peninsular Florida Recovery Unit: 1% (minimum of 106,100 nests); 3) Dry Tortugas Recovery Unit: 3% (minimum of 1,100 nests); and 4) Northern Gulf of Mexico Recovery Unit: 3% (minimum of 4,000 nests). While we do anticipate Northwest Atlantic Ocean DPS loggerhead turtles will be adversely affected by exposure to underwater sound from explosive events, this will not impede recovery of Northwest Atlantic Ocean DPS loggerhead turtles. Therefore, the effects of the stressors resulting from explosive events as part of the proposed action will not appreciably diminish the ability of loggerhead turtles to recover in the wild.

In summary, based on the evidence available, including the status of the species, environmental baseline, analysis of effects, and cumulative effects, we determine that the proposed action would not appreciably reduce the likelihood of both survival and recovery of Northwest Atlantic Ocean DPS loggerhead turtles in the wild.

8.2 Destruction/Adverse Modification Analysis

Recovery of the Northwest Atlantic Ocean DPS of loggerhead turtle cannot occur without protecting the PBF that supports breeding critical habitat. Super Heavy and Starship explosive events will adversely affect Northwest Atlantic Ocean DPS loggerhead turtle critical habitat. Thus, our destruction or adverse modification analysis determines whether or not the proposed action is likely to appreciably diminish the value of critical habitat as a whole for the conservation of a listed species, in the context of the status of the critical habitat (Section 4), effects of the action (Section 6), the environmental baseline (Section 5), and cumulative effects (Section 7).

The PBF for breeding critical habitat considered in this consultation is high densities of reproductive male and female loggerhead turtles. Our effects analysis determined that explosive events are likely to adversely affect the PBF because underwater sound from explosive events will, at least temporarily, diminish habitat quality because individuals will not concentrate in areas where sound levels are sufficient to cause PTS, TTS, or behavioral and physiological stress responses. Because explosive events will not be continuous or regular in a particular portion of the breeding critical habitat unit, stressors from these explosive events will not appreciably diminish the conservation value of critical habitat as a whole. We determine that the proposed action would not result in the destruction or adverse modification of critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle.

9. CONCLUSION

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the consequences of the proposed action and associated activities, and the cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to jeopardize the continued existence of the North Atlantic DPS of green turtle, Kemp's ridley turtle, or Northwest Atlantic Ocean DPS of loggerhead turtle, or destroy or adversely modify designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle.

NMFS also determined the proposed action may affect, but is not likely to adversely affect: blue whale, false killer whale – Main Hawaiian Islands Insular DPS, fin whale, gray whale – Western North Pacific DPS, humpback whale – Mexico DPS and Central America DPS, North Atlantic right whale, North Pacific right whale, sei whale, sperm whale, Rice's whale, Guadalupe fur seal, Hawaiian monk seal; green turtle – North Atlantic DPS, South Atlantic DPS, East Pacific DPS, Central North Pacific DPS, East Indian-West Pacific DPS, North Indian DPS, and Southwest Indian DPS, hawksbill turtle, leatherback turtle, loggerhead turtle – North Pacific Ocean DPS, South Pacific Ocean DPS, North Indian Ocean DPS, Southwest Indian Ocean DPS, and Southeast Indo-Pacific Ocean DPS, and olive ridley turtle – Mexico's Pacific Coast breeding colonies and all other areas/not Mexico's Pacific Coast breeding colonies; Atlantic sturgeon – Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS, giant manta ray, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, scalloped hammerhead shark – Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPS, shortnose sturgeon, smalltooth sawfish – U.S. portion of range DPS, steelhead trout – South-Central California Coast DPS and Southern California DPS, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and proposed sunflower sea star and designated critical habitat of the Main Hawaiian Islands Insular DPS of false killer whale, Central America DPS and Mexico DPS of humpback whale, Hawaiian monk seal, North Atlantic right whale, leatherback turtle, North Atlantic DPS of green turtle, Northwest Atlantic Ocean DPS of loggerhead turtle, Gulf sturgeon, Nassau grouper, black abalone, boulder star coral, elkhorn coral, lobed star coral, mountainous star coral, pillar coral, rough cactus coral, staghorn coral, and proposed critical habitat of the Central North Pacific DPS, East Pacific DPS, and North Atlantic DPS of green turtle and Rice's whale.

10. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR §402.02). Section 7(b)(4) and section 7(o)(2) of the ESA, as well as in regulation at 50 CFR §402.14(i)(5) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

10.1 Amount or Extent of Take

In the opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Table 19. Anticipated number and type of ESA takes of sea turtles for up to 20 Super Heavy explosive events

Species	TTS/ significant behavioral response	PTS
Green Turtle – North Atlantic DPS	1	--
Kemp's Ridley Turtle	3	1
Loggerhead Turtle – Northwest Atlantic Ocean DPS	4	1

10.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of incidental take on the species (50 CFR §402.02). These measures "cannot alter the basic design, location, scope, duration, or timing of the action and may involve only minor changes" (50 CFR §402.14(i)(2)). NMFS believes the following reasonable and prudent measures are necessary and appropriate:

1. The FAA shall continue to coordinate with NMFS to minimize effects to ESA-listed green, Kemp's ridley, and loggerhead turtles from explosive events.
2. The FAA shall monitor and report to NMFS's Office of Protected Resources ESA Interagency Cooperation Division on impacts to ESA-listed green, Kemp's ridley, and loggerhead turtles from explosive events at nmfs.hq.esa.consultations@noaa.gov with the subject line "OPR-2025-00164 – [Flight #] ITS Report."

10.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the FAA must comply (or must ensure that any applicant complies) with the following terms and conditions. The FAA or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR §402.14(i)(3)).

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. The FAA shall continue to coordinate with NMFS to help inform future consultations on Starship-Super Heavy operations in the action area. Coordination should include provision and review of Starship-Super Heavy fate reports and annual reports, regular review of ESA section 7 reinitiation triggers (described in Section 12), and potential development of new measures to increase the effectiveness of mitigation and monitoring.

2. The following terms and conditions implement reasonable and prudent measure 2:
    a. The FAA shall monitor SpaceX and Starship-Super Heavy operations as licensed, and submit fate reports after each Starship-Super Heavy flight and annual reports to NMFS Office of Protected Resources ESA Interagency Cooperation Division.
    b. The FAA shall report any new information regarding the nature and extent of potential effects, and ranges to effects (e.g., ensonified areas), of explosive events on ESA-listed species.
    c. The FAA shall report to the NMFS Office of Protected Resources ESA Interagency Cooperation Division all observed injury or mortality of any ESA-listed species resulting from the proposed action within the action area.
    d. The FAA shall report to the NMFS Office of Protected Resources ESA Interagency Cooperation Division on impacts to ESA-listed green, Kemp's ridley, and loggerhead turtles from explosive events. The report should be submitted no more than 30 days after each flight prior to reusability. This may be submitted with the fate report.

11. CONSERVATION RECOMMENDATIONS

Conservation recommendations are "suggestions … regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information" (50 CFR §402.02).

The following conservation recommendations should be considered by the FAA to minimize or avoid effects to threatened and endangered species associated with this action:

1. We recommend FAA gather acoustic data (in-air and in-water) on Super Heavy and Starship landings and explosive events. Sound source verification will help to improve the accuracy of predictions of the underwater acoustic impacts of similar activities in the future.
2. During any nighttime vessel operations in any portion of the action area, we recommend vessel speeds do not exceed 10 kt to reduce the risk of lethal or injurious vessel strike. We also recommend that dedicated observers be equipped with nighttime visual equipment to identify protected species in the dark.
3. We recommend FAA monitor potential impacts to ESA-listed species and designated or proposed critical habitat from debris resulting from space launch and reentry activities.

This includes immediate impacts (e.g., reentry debris fields, expended stages), as well as potential long-term impacts from the accumulation of debris.

4. We recommend FAA monitor potential impacts to ESA-listed species and designated or proposed critical habitat from barge/floating platform landings (e.g., verification of overpressures, light pollution).
5. The FAA should coordinate with the NOAA Marine Debris Program (MDP) to determine how activities of the MDP may apply to space launch and reentry debris.
6. We recommend FAA utilize the Whale Alert app to report and identify where whale "safety zones" occur, so that vessel operators and observers can help reduce vessel strikes. For instance, recently, two North Atlantic right whales were observed off the Florida Gulf coast. NMFS did not declare a Dynamic Management Area because these whales were not observed off the U.S. East Coast; however, the endangered whales were reported on the Whale Alert app.
7. We recommend FAA analyze the underwater acoustic effects from explosive events in shallow water, should vehicle explosions occur there with greater frequency than is understood at the time of this consultation (see also Section 12), because sound propagates differently in shallow water compared to deep water.
8. We recommend FAA minimize the number of weather balloons released per launch and explore alternatives to the release of weather balloons, to reduce marine debris.

In order for NMFS Office of Protected Resources Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on ESA-listed species or their critical habitat, FAA should notify the Interagency Cooperation Division of any conservation recommendations implemented in the final action. Notice can be provided to nmfs.hq.esa.consultations@noaa.gov with the Environmental Consultation Organizer (ECO) number for this consultation (OPR-2025-00164) in the subject line.

12. Reinitiation of Consultation

This concludes formal consultation on FAA's proposed action to modify and issue a vehicle operator license authorizing SpaceX to conduct up to 145 launches annually of their Starship-Super Heavy launch vehicle including operations in the North Atlantic Ocean, Gulf, North Pacific Ocean, South Pacific Ocean, and Indian Ocean. Consistent with 50 CFR §402.16(a), reinitiation of consultation is required and shall be requested by the Federal agency, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

1. If the amount or extent of incidental taking specified in the ITS is exceeded;
2. If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
3. If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the opinion; or
4. If a new species is listed or critical habitat designated that may be affected by the identified action.

Examples of information that could change our effects analysis, or new information that will better inform our effects analysis, and may require reinitiation include, but are not limited to:

- Issuance of a new license or extension of the current license’s expiration date;
- A new launch site is proposed to become operational;
- Information on trajectories (e.g., from a new launch site, or to a another landing area), which will inform where a potential mishap may occur;
- Data regarding the likelihood or the number of times a specific trajectory is/will be used, which will better inform the assumptions on where a mishap or landing may occur;
- Data regarding landing locations of each vehicle (e.g., locations and how many times a vehicle lands in the vicinity of those locations, how often a landing area will be used compared to other landing areas, the likelihood that a vehicle will land in specific areas [e.g., nearer to launch sites] more than other areas [e.g., further offshore]), which will better inform the assumption that there is an equal probability a landing occurs anywhere within a portion of the action area, and subsequently the species densities and estimated exposure;
- Information on the ports and routes used by surveillance/recovery vessels and floating platforms/ocean-going barges/drone ships;
- Changes to the launch vehicle or flight plan that affect the performance of the launch vehicle or affect progress towards achieving a fully reusable vehicle, which will inform the likelihood of mishaps; and
- Potential impacts to listed species or critical habitat that occur after the vehicle has sunk (e.g., does propellant leak out at the seafloor or over time, how does the vehicle erode over time).

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Appendix 3.9C
Essential Fish Habitat Assessment

From: CHAMBERS, ANGY L CIV USSF SSC 45 CES/CEIE <angy.chambers@spaceforce.mil>
Sent: Thursday, April 10, 2025 1:13:31 PM
To: David.Duke@noaa.gov <David.Duke@noaa.gov>; Pace Wilber - NOAA Federal <Pace.Wilber@noaa.gov>
Cc: Rau, Michelle <Michelle.Rau@jacobs.com>; THRASH, SHERRY E CIV USAF AFMC AFCEC/CIEE <sherry.thrash@us.af.mil>
Subject: [EXTERNAL] Request for Essential Fish Habitat Consultation - SpaceX Starship-Super Heavy SLC 37

Please find attached a letter requesting EFH consultation for the proposed SpaceX Starship-Super Heavy Launch and Landing Operations at Space Launch Complex 37 located on Cape Canaveral Space Force Station, FL. Questions may be directed to myself with a copy to Ms. Michelle Rau, copied above. Thanks.

v/r

DEPARTMENT OF THE AIR FORCE
UNITED STATES SPACE FORCE
SPACE LAUNCH DELTA 45

10 April 2025

MEMORANDUM FOR NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SOUTHEAST REGIONAL OFFICE
263 13TH AVENUE SOUTH
ST PETERSBURG FL 33701-5505

FROM: 45 CES/CEIE
1224 Jupiter Street
Patrick SFB FL 32925-3343

SUBJECT: Essential Fish Habitat Assessment for SpaceX Starship-Super Heavy Launch and Landing Operations at Cape Canaveral Space Force Station Space Launch Complex-37

The Department of the Air Force (DAF) is preparing an Environmental Impact Statement (EIS) for future operations of the Space Exploration Technologies Corp's (SpaceX's) Starship-Super Heavy launch vehicle at Space Launch Complex (SLC)-37 at Cape Canaveral Space Force Station (CCSFS). The Proposed Action is the potential execution of a real property agreement between the United States Space Force (USSF) and SpaceX at CCSFS, the issuance of a vehicle operator license for Starship-Super Heavy non-Department of Defense (DOD) operations at CCSFS by the Federal Aviation Administration (FAA), and approval of related airspace closures by the FAA for operations. SLC-37 was built for the United Launch Alliance Delta IV launch vehicle and launches occurred at the site until 2024. An Environmental Impact Statement (EIS) is being prepared in accordance with the National Environmental Policy Act (NEPA) to assess the potential environmental impacts of these proposed actions.

As part of the NEPA process, the DAF requests Essential Fish Habitat (EFH) consultation under the Magnuson-Stevens Fishery Conservation and Management Act for the proposed activity. The DAF has determined that these projects are likely to have no greater than minimal adverse effect on EFH or federally managed fisheries. We request your written concurrence with our determinations. Our EFH Assessment for the Proposed Action is provided here for your review.

1.0 DESCRIPTION OF THE ACTION

The DAF proposes to execute a real property agreement between USSF and SpaceX which would result in the demolition of existing launch facilities at CCSFS SLC-37 (**Attachment 1, Figure 1-1**), the construction of new launch facilities at SLC-37 to accommodate the Starship-Super Heavy launch vehicle (**Attachment 1, Figure 1-2**), and the routine operation of the Starship-Super Heavy. Routine operations would include pre-flight operations, including assembly and static fire testing; launches; and landings. Starship and the Super Heavy booster landings are intended to occur on land at SLC-37; however, a few launches per year may involve expending the launch vehicle, or portions thereof, in the ocean, or landing it on a floating platform in the Atlantic Ocean.

SpaceX intends to launch Starship-Super Heavy from SLC-37 up to 76 times per year, with 76 Starship landings and 76 Super Heavy booster landings. The total number of launches per year may be less than 76; however, we are conservatively assuming 76 launches and associated landings starting in 2026.

2.0 DESCRIPTION OF PROJECT PURPOSE AND OBJECTIVES

The purpose of the Proposed Action is to advance U.S. space capabilities by providing launch and landing infrastructure in furtherance of U.S. policy to ensure capabilities to launch and insert national security payloads into space (*United States Code* [U.S.C.] Title 10, Section 2273, "Policy regarding assured access to space: national security payloads").

The Proposed Action is needed to ensure National Security Space Launch Assured Access to Space without compromising current launch capabilities and to fulfill (in part) the U.S. Congress's grant of authority to the Secretary of Defense, pursuant to 10 U.S.C. Section 2276(a), "Commercial space launch cooperation," that the Secretary of Defense is permitted to:

- Maximize the use of the capacity of the space transportation infrastructure of the DOD by the private sector in the U.S.
- Maximize the effectiveness and efficiency of the space transportation infrastructure of the DOD.
- Reduce the cost of services provided by the DOD related to space transportation infrastructure at launch support facilities and space recovery support facilities.
- Encourage commercial space activities by enabling investment by covered entities in the space transportation infrastructure of the DOD.
- Foster cooperation between the DOD and covered entities.

3.0 OPERATIONAL ACTIVITIES ASSOCIATED WITH THE PROPOSED PROJECT

3.1 Starship-Super Heavy Operations

Operational activities associated with Starship-Super Heavy operations are described in **Table 3-1** below. It should be noted that all payloads, including their materials, fuels, and volumes, are typical of current commercial and government payloads and consistent with those payloads analyzed in the *Environmental Assessment for Launch of NASA Routine Payloads* (NASA, 2011).

Table 3-1. Starship-Super Heavy Operations

Activity	Description
Pre-flight Operations	Pre-flight operations would occur at SLC-37 and include ground-testing, tank testing, spin tests, Mission rehearsals (wet and dry dress rehearsals), and static-fire engine tests to verify that all vehicle and ground systems are functioning properly and in accordance with documented procedures prior to launch. Except for static-fire engine testing, no propellant release or ignition would occur. It is anticipated that there would be one static fire engine test per stage per launch operation, lasting up to 15 seconds in duration. All propellant transfers would maximize recapture methods. After the wet dress rehearsal and static fire engine test, SpaceX would transfer the propellant back into the commodity tanks. During Starship fuel loading for a static-fire engine test of the integrated launch vehicle, gaseous methane could be released to the atmosphere or combusted; however, SpaceX intends to recapture methane, where practicable. This release would be minimal because the liquid methane would be released as gaseous methane vented from the stage to maintain pressure, and only a small percentage of the vehicle tank's propellant would be vented. It is standard practice for all launch vehicles to vent cryogenics to maintain pressure.
Launch	During a launch, the ignition of the Starship-Super Heavy Raptor engines would generate a heat plume that would appear clear and consist of water vapor, CO_2, carbon monoxide, hydrogen, methane, nitrogen oxides, and oxygen. The maximum heat plume would occur during engine ignition and would travel away from the launch pad, reaching approximately 120 degrees Fahrenheit at 0.1 mile from the launch pad, and last for approximately 20 seconds before dissipating. Various designs, such as a diverter and deluge water, would be used to limit the extent of the heat plume to remain on line and within the launch complex fence line.

Activity	Description
Super Heavy Return to Launch Site (RTKS) (RTLS)- preferred scenario	After separating from Starship, the Super Heavy booster would perform a controlled descent using atmospheric resistance to slow it down and guide it for a precise return to the tower at the launch site to be caught with the tower's arms. Once near the landing location, Super Heavy would ignite its engines to conduct a controlled landing. Super Heavy would land vertically at the catch tower and go into an automated safing sequence (that is, would enter a safe state). The Super Heavy landing would generate a sonic boom. Following a Super Heavy landing, liquid oxygen (LOX) and liquid methane would remain in the Super Heavy booster. The remaining LOX would be vented to the atmosphere and the remaining liquid methane would be released to the atmosphere or safely combusted. SpaceX would be unable to reconnect the vehicle to ground systems while liquid methane remains in the vehicle because of the risks to personnel. For the purposes of this analysis it is assumed all residual methane is released to the atmosphere.
Super Heavy Landing (Floating Platform Scenario)	After the booster separates from Starship, Super Heavy could land in the Atlantic Ocean on a floating platform (mobile vessel not attached to the sea floor) no closer than 1 nautical mile off the coast (Figure 3-1). Super Heavy would be delivered by barge and roadways to a SpaceX facility for refurbishment. The landing could cause a sonic boom. Following a Super Heavy landing, LOX and liquid methane would remain in the Super Heavy booster. The remaining LOX would be vented to the atmosphere and the remaining liquid methane would be released to the atmosphere or combusted. For the purposes of this analysis it is assumed all residual methane is released to the atmosphere.
Super Heavy Landing (Expendable Scenario)	While SpaceX intends for Super Heavy to be fully reusable following most operational flights, expending (that is, not recovering) vehicles may be required. After the booster separates from Starship, Super Heavy could be expended in a target area in the Atlantic Ocean approximately 950 miles from the shore and with the landing area shown in Figure 3-1. Expendable Super Heavy landings would occur when too little propellant to return to the launch site. An expended Super Heavy would break up above the ocean's surface or on impact with the ocean's surface and is expected to sink. SpaceX would expect to expend approximately four Super Heavy boosters per year. An expended mission may result in an overpressure event but will generate a sonic boom.

Activity	Description
Starship Landing (Launch Pad or Ocean Floating Platform Scenario)	The Starship landing would closely resemble the Super Heavy landing and could occur either at the launch site or on a floating platform in the open ocean between 55°S and 55°N latitudes. The Starship landing would generate a sonic boom. Starship would have approximately 5 MT of liquid methane onboard following a flight. Any LOX remaining in the vehicle would be vented to the atmosphere and liquid methane would be released or safely combusted. For the purposes of the environmental review, this analysis assumes all residual methane is released to the atmosphere.
Starship Landing (Ocean Expendable Scenario)	If necessary, Starship could be expended in the ocean, by controlled or uncontrolled descent, in seven potential areas in the Pacific Ocean and Indian Ocean (Figure 3-2). In a controlled descent, after ascent engine cutoff, Starship could vent residual main tank propellant during the in-space coast phase of the launch at or above 74.5 miles (120 kilometers) above ground level. Following the in-space coast phase, Starship would conduct a deorbit burn to begin its controlled descent. Upon ocean impact, structural failure would allow the remaining LOX and methane to mix, resulting in an explosive event. Alternatively, Starship could conduct a soft water landing during which the vehicle's engines would fire prior to impact with the ocean's surface, causing the vehicle to land vertically and intact. The vehicle would then take on water and sink or be scuttled. In an unanticipated and unlikely, but still possible, uncontrolled descent, Starship would break up during atmospheric entry. Most of the launch vehicle debris is made of steel and would sink. Lighter items not made of steel, such as composite overwrapped pressure vessels, may float but are expected to eventually become waterlogged and sink. If there were reports of large debris, SpaceX would coordinate with marine debris specialists to survey the situation and sink or recover as necessary any large floating debris. SpaceX would coordinate with all land and water regulatory authorities, including the U.S. Coast Guard and the U.S. Department of State, prior to recovering debris. Every effort would be made to avoid collisions with marine vessels.

Activity	Description
Launch Trajectories	The launch trajectories for the Starship-Super Heavy program need to accommodate eastward trajectories, which allow the spacecraft to benefit from the Earth's natural rotation. Specific flight trajectories vary based on mission and depend on desired payload orbit. Starship-Super Heavy launch azimuths would range from 40° to 115°, from a reference of due north at 0° and due east at 90° (Figure 3-1).
Payloads	Starship-Super Heavy program payloads would be similar to, but larger than, current and planned payloads launched on the Falcon 9 or Falcon Heavy. Payloads and their associated materials, fuels, and volumes are mission dependent but would be in keeping with the current commercial and government payloads analyzed in the *Environmental Assessment for Launch of NASA Routine Payloads* (NASA 2011). The integration of payloads would depend on the mission and would occur at existing government or SpaceX facilities.

[a] A dry dress rehearsal simulates launch day conditions, where a full launch countdown is conducted but the vehicle is not fueled. A wet dress rehearsal is similar to a dry dress rehearsal, except the vehicle is fueled. This test allows the launch team to practice timelines and procedures used for launch and identify potential issues.

°F = degree(s) Fahrenheit

RTLS = return to launch site

3.2 Expended Operations

SpaceX intends for both Starship and Super Heavy vehicle components to be reusable and to have them returned to the launch site following operational flights; however, either component could be expended in the open ocean during the initial stages of launch operations or on landing. There are six scenarios in which a component of the Starship-Super Heavy could be expended:

Super Heavy ocean hard landing: Super Heavy could be expended in the Atlantic Ocean (**Attachment 1, Figure 3-1**) during the initial stages of launch operations and/or if mission payload or desired orbit requirements would result in too little propellant remaining in Super Heavy to return to the launch site. This expenditure process would occur within several minutes after launch as Starship separates from the Super Heavy booster. A hard landing would result in the breakup of the vehicle on impact with the ocean. Some residual propellant would remain in an expended Super Heavy, and the impact would allow the remaining propellant to mix, resulting in an explosive event upon impact with the ocean's surface.

Super Heavy ocean soft landing: Super Heavy could be expended in the Atlantic Ocean (**Attachment 1, Figure 3-1**) during the initial stages of launch operations and/or if mission payload or desired orbit requirements would result in too little propellant remaining in Super Heavy to return to the launch site. This expenditure process would occur within several minutes after launch as Starship separates from the Super Heavy booster. A soft landing would result from the vertical "landing" of the vehicle intact on the ocean surface no closer than five nautical miles off the coast. The vehicle would take on water and likely sink. In the event that the vehicle remains buoyant, it would either be intentionally sunk or recovered and transported back to land.

***Starship ocean hard landing*:** Starship could be expended in the Atlantic Ocean (**Attachment 1, Figure 3-1**) following a controlled descent into the atmosphere. Prior to controlled descent, Starship would vent residual main tank propellant at or above approximately 74 miles (119 kilometers) above ground level. Controlled descent would burn much of the remaining propellant; however, some residual LOX and methane would remain in the vehicle. In a hard landing, Starship would impact the ocean intact but be dismantled on impact. The structural failure would allow the remaining LOX and methane to mix, resulting in an explosive event.

***Starship ocean soft landing*:** Starship could be expended in the Atlantic Ocean (**Attachment 1, Figure 3-1**) following a controlled descent into the atmosphere. Prior to controlled descent, Starship could vent residual main tank propellant at or above approximately 74 miles (119 kilometers) above ground level. Controlled descent would burn much of the remaining propellant; however, some residual LOX and methane would remain in the vehicle. In a soft landing, Starship would "land" intact and in a vertical position on the ocean's surface. The vehicle would take on water and likely sink. In the event that the vehicle remains buoyant, it would either be intentionally sunk or recovered and transported back to land.

***Starship uncontrolled descent*:** An uncontrolled descent of Starship would result in a breakup of the vehicle during atmospheric re-entry. Descent target areas would be the Pacific or Indian Ocean (**Attachment 1, Figure 3-2**). Because the vehicle is primarily comprised of steel, SpaceX anticipates that most debris would sink immediately. Lighter items are expected to eventually take on water and sink.

4.0 ADVERSE EFFECTS ANALYSIS

The potential effect of the proposed actions on Essential Fish Habitat (EFH) are described herein.

4.1 Definition of Essential Fish Habitat

EFH is defined under revisions to the Magnuson-Stevens Fishery Conservation and Management Act (67 FR 2343; MSA) as "*those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.*" The MSA requires the eight regional fishery management councils (Councils) to identify and describe the habitats, or habitat types, determined to be EFH for each life stage of every species for which the Councils promulgate a fishery management plan (FMP). The FMP must define the physical, biological, and chemical characteristics of EFH, describe how those characteristics influence the way in which each species/life stage utilizes EFH, and identify the specific geographic location or geographic boundaries within which EFH is found. Section 305(b)(2) of the MSA requires all federal agencies to consult with the National Marine Fisheries Service (NMFS) on any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, which has the potential to adversely affect EFH.

4.2 Potential Effects of the Proposed Project on Essential Fish Habitat

All proposed construction activities are within the existing footprint of SLC-37 and roadway widening areas. Construction activities are required to implement an approved Stormwater Pollution Protection Plan (SWPPP) to minimize construction area stormwater from entering neighboring aquatic environments and are thus unlikely to impact EFH. Of those activities associated with operations of the proposed project (Table 3-1), only those activities associated with the expendable scenarios described above have the potential to affect EFH. Potential effects include the chemical effects of propellant released into waters comprising EFH, and physical contact between expended vehicle components (“debris”) and the physical and biological components of water or substrate comprising EFH.

4.2.1 Chemical Effects of Propellant from Expended Starship-Super Heavy

The SpaceX Starship-Super Heavy launch vehicle will be powered by LOX and methane. An expended launch or landing is likely to result in the release of propellant into the waters where the vehicle, or its components, splash down. A hard landing will likely result in the combustion of much of the propellant, though small amounts may still be released and dispersed at the splashdown location. A soft landing may result in the release of propellant at the surface or from vehicle components on the ocean substrate. Since both propellants are non-toxic gases at ambient temperatures and atmospheric pressures, and will evaporate into the atmosphere when released, neither are anticipated to remain in or on ocean waters following release from an expended vehicle. As such, adverse impacts to EFH are not likely.

Furthermore, two prior environmental assessments/impact statements have evaluated similar activities from the same facility and found minimal effects:

The *Final Supplemental Environmental Impact Statement (FSEIS) for the Evolved Expendable Launch Vehicle (EELV), May 2000* evaluated the potential impacts of space vehicle expenditures from the same launch pad (SLC-37). That evaluation considered the impacts of an aluminum/ammonium percolate/binder propellant that, when combined with water, produces hydrochloric acid (HCl). Consultation with NMFS on the likelihood of adverse impacts to EFH resulting from expended space vehicles carrying aluminum/ammonium percolate/binder propellant resulted in a finding of “no greater than minimal adverse effects.”

The *Environmental Assessment For Launch of NASA Routine Payloads, November 2011* considered the impact of the release of potentially toxic substances from expended vehicles on water resources. That report concluded that:

> *Deep ocean release of toxic materials such as residual propellants, hydraulic fluids, and eroding metals from spent booster structures would not produce substantial concentrations due to the small amount of such materials and the large quantity of water available for dilution in the deep ocean environment.*

Due to the fact that the activity proposed herein is consistent with activities already determined to have minimal adverse effects on EFH and other resources, and due to the lower reactivity of the LOX and methane propellant utilized by the Starship-Super Heavy, it is the finding of DAF that the actions proposed herein will have a lower likelihood of impact on EFH relative to prior and existing activities with regard to chemical effects of propellant released by expended vehicles.

4.2.2 Physical Effects of Expended Starship-Super Heavy on EFH

As described above, expended Starship-Super Heavy or remaining debris will either float at the surface or sink to the bottom. SpaceX will make every effort to recover the Starship-Super Heavy or remnant debris following an expended launch/landing; however, it is possible that some debris will remain in the ocean and eventually sink to the bottom. The debris resulting from Starship-Super Heavy operations will be very small, and will have a very small physical footprint, relative to the very large geographic area over which EFH is distributed and within which the debris may be deposited. Furthermore, due to large variations in launch trajectories and variability in environmental conditions (wind, currents, etc.) unrecovered debris could not accumulate in a single area and result in cumulative local impacts. As such, it is expected that the physical effects of debris on EFH are unlikely to be of sufficient quantity and magnitude to result in more than minimal adverse effects to EFH for any species. The consideration for the potential debris impacts of this action are consistent with the considerations of prior actions evaluated and determined to have "no greater than minimal adverse effects" on EFH. Those prior evaluations include the *Final Supplemental Environmental Impact Statement (FSEIS) for the Evolved Expendable Launch Vehicle (EELV), May 2000* and the *Environmental Assessment for Launch of NASA Routine Payloads, November 2011*.

5. EFFECT DETERMINATION

The proposed action is consistent with prior activities occurring at the same location and previously evaluated and determined to have no more than minimal adverse effects on EFH. The use of LOX and liquid methane propellant to replace the aluminum/ammonium percolate/binder propellant utilized for prior activities, represents a relative reduction in risk to EFH, whereas all other aspects of the proposed action represent similar activities and similar levels of risk to EFH as prior actions already evaluated.

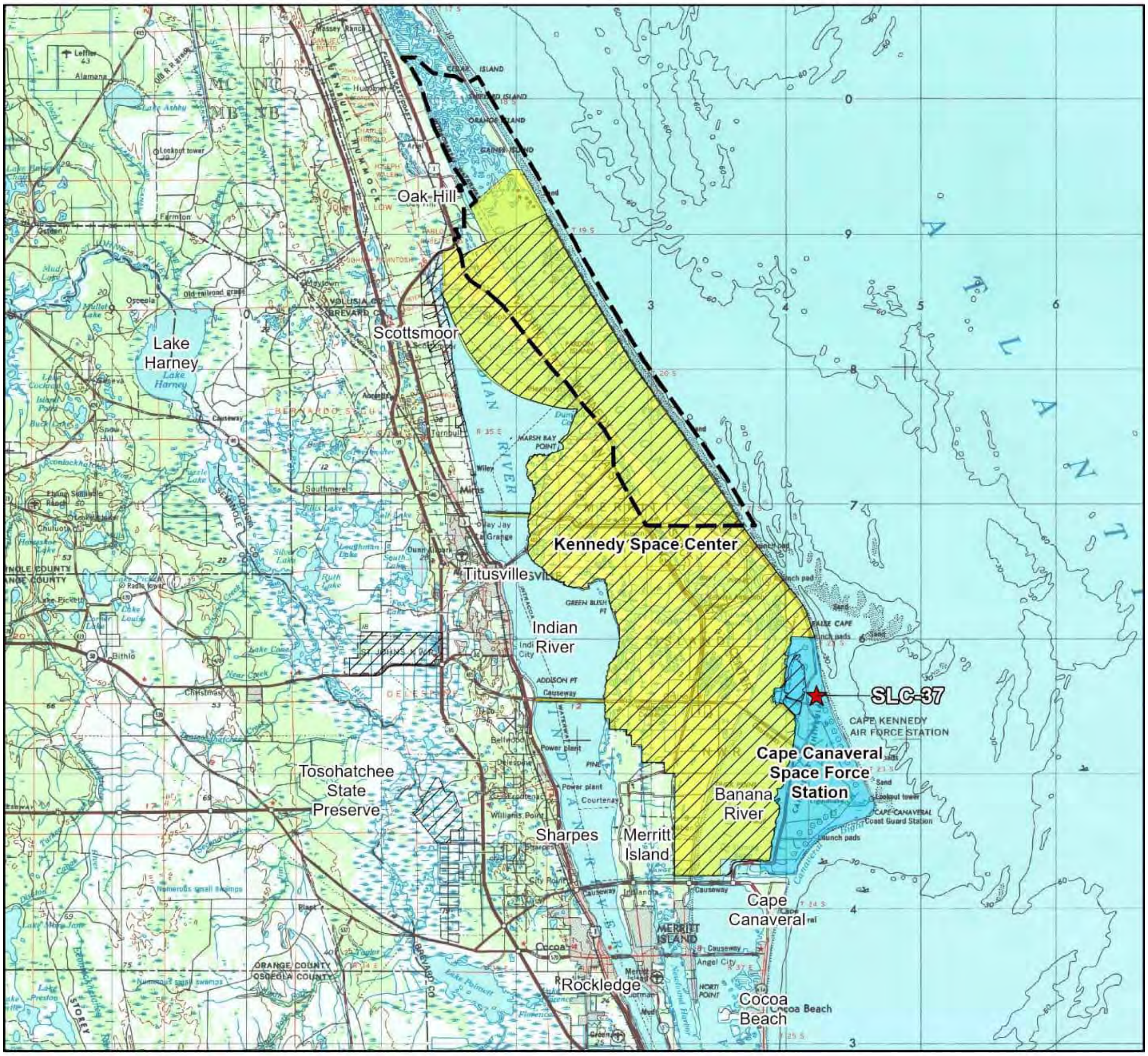
Based on the reduction in propellant reactivity relative to those propellants used for prior operations at SLC-37, the small physical impact of the proposed action relative to the very large geographic distribution of EFH in the potential effect area, and the consistency of the proposed actions with prior activities determined to have minimal effect on EFH, the DAF has determined that the proposed action would not adversely affect EFH or federally managed fisheries. We request your concurrence with this determination. If you have any questions or require additional information, please contact the SLD 45 Point of Contact, Ms. Angy Chambers, via email at angy.chambers@spaceforce.mil, or via telephone at 321-853-6822. Thank you for your assistance with this undertaking.

MICHAEL A. BLAYLOCK, NH-III, DAF
Chief, Environmental Conservation

Sent via email to:
David.Dale@noaa.gov
Pace.Wilber@noaa.gov

Attachments:
1. Figures

Figure 1-1 Proposed Action Location



Legend

★ SLC-37 Location

Merritt Island National Wildlife Refuge Complex

Canaveral National Seashore

Cape Canaveral Space Force Station

Kennedy Space Center

Notes:
1. Merritt Island National Wildlife Refuge Complex boundary shown is from U.S. Fish & Wildlife Service. Downloaded from <LINK>https://gis-fws.opendata.arcgis.com/datasets/dae48a3dcd654e7ea09d386cae052eab</LINK> /explore?location=28.370782%2C-80.516762%2C11.62 on August 17, 2023.
2. Canaveral National Seashore boundary shown is from the National Parks Service. Downloaded from <LINK>https://public-nps.opendata.arcgis.com/datasets/nps-boundary-1</LINK> /explore?location=28.813847%2C-80.732930%2C10.00 on August 17, 2023.
3. Topographic basemap shown is the U.S. Geological Survey, Orlando [map], 1:250000, Topographic Quadrangle Map, Orlando, FL, 1955. Downloaded from <LINK>https://livingatlas.arcgis.com/topoexplorer/</LINK> on January 25, 2024.

0 7 14 21 28 Miles N

1:443,520 1 inch = 7 miles

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Figure 1-2 SLC-37 Notional Site Plan

Figure 3-1 Super Heavy Potential Ocean Landing Areas

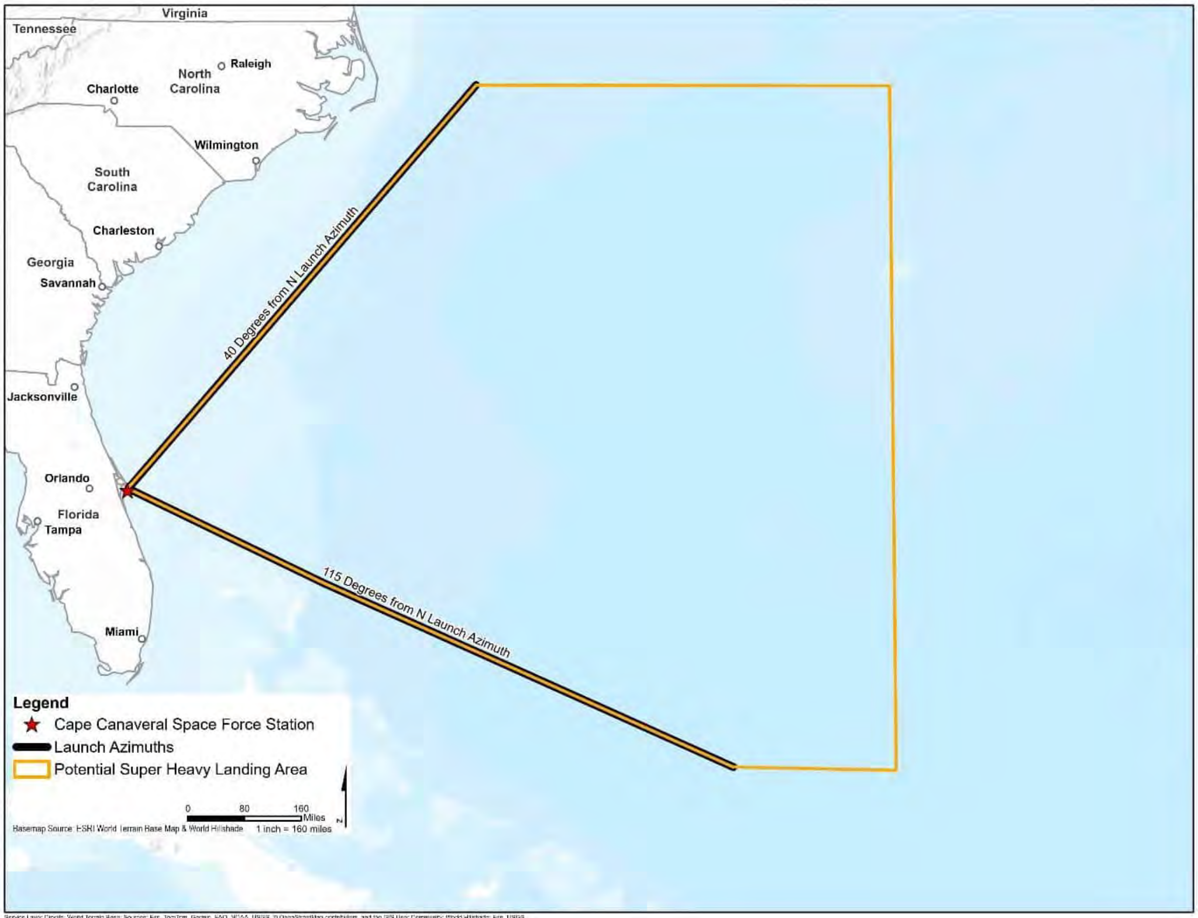
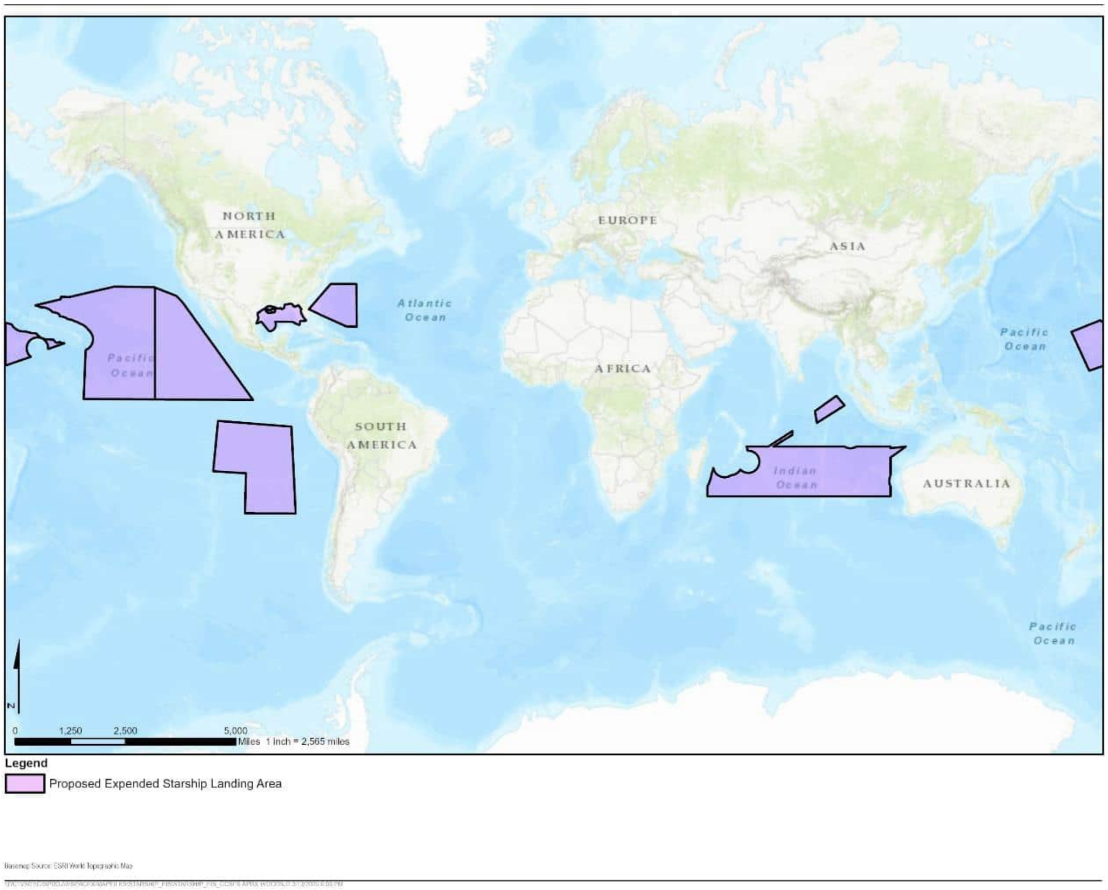


Figure 3-2 Starship Landing Area Worldwide



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Appendix 3.13A
CZMA Consistency Determination

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Florida Coastal Management Program Consistency Review

Statute	Consistency	Scope
Chapter 161 Beach and Shore Preservation	The Proposed Action would not significantly affect beach or shore management in Florida. All land activities would occur on existing federal facilities.	Authorizes the Bureau of Beaches and Coastal Systems within DEP to regulate construction on, or seaward of, the state's beaches.
Chapter 163, Part II Growth Policy; County and Municipal Planning; Land Development Regulation	The Proposed Action would not affect local government comprehensive plans.	Requires local governments to prepare, adopt, and implement comprehensive plans that encourage the most appropriate use of land and natural resources in a manner consistent with the public interest.
Chapter 186 State and Regional Planning	The Proposed Action would not affect Florida's plans for water use, land development, or transportation.	Details state-level planning efforts. Requires the development of special statewide plans governing water use, land development, and transportation.
Chapter 252 Emergency Management	The Proposed Action would not affect Florida's vulnerability to natural disasters. The Proposed Action would not affect emergency response or evacuation procedures.	Provides for planning and implementation of the state's response to, efforts to recover from, and the mitigation of natural and man-made disasters.
Chapter 253 State Lands	The Proposed Action would not significantly affect state public lands, as all activities would occur on federal property.	Addresses the state's administration of public lands and property of this state, and provides direction regarding the acquisition, disposal, and management of all state lands.
Chapter 258 State Parks and Preserves	The Proposed Action would not significantly affect state parks, recreational areas, and aquatic preserves.	Addresses administration and management of state parks and preserves.
Chapter 259 Land Acquisition for Conservation or Recreation	The Proposed Action is not likely to adversely affect tourism or outdoor recreation.	Authorizes acquisition of environmentally endangered lands and outdoor recreation lands.
Chapter 260 Florida Greenways and Trails Act	The Proposed Action would not include the acquisition of land and would not affect the Greenways and Trails Program.	Authorizes acquisition of land to create a recreational trails system and to facilitate management of the system.
Chapter 267 Historical Resources	The Proposed Action is not likely to adversely affect cultural resources of Florida.	Addresses management and preservation of the state's archaeological and historical resources.
Chapter 288 Commercial Development and Capital Improvements	The Proposed Action would not adversely affect future business opportunities on state lands or the promotion of tourism in the region.	Provides the framework for promoting and developing the general business, trade, and tourism components of the state economy.
Chapter 334 Transportation Administration	The Proposed Action would not significantly affect transportation.	Addresses the state's policy concerning transportation administration.
Chapter 339 Transportation Finance and Planning	The Proposed Action would not affect the finance and planning needs of the state's transportation system.	Addresses the finance and planning needs of the state's transportation system.
Chapter 373 Water Resources	The Proposed Action would not have significant impacts on water resources.	Addresses the state's policy concerning water resources.

Statute	Consistency	Scope
Chapter 375 Outdoor Recreation and Conservation Lands	The Proposed Action is not likely to adversely affect tourism and/or outdoor recreation.	Develops comprehensive multipurpose outdoor recreation plan to document recreational supply and demand, describe current recreational opportunities, estimate the need for additional recreational opportunities, and propose means to meet the identified needs.
Chapter 376 Pollutant Discharge Prevention and Removal	The Proposed Action would be consistent with Florida's statutes and regulations regarding the transfer, storage, or transportation of pollutants.	Regulates transfer, storage, and transportation of pollutants and cleanup of pollutant discharges.
Chapter 377 Energy Resources	The Proposed Action would not affect energy resource production, including oil and gas, and/or the transportation of oil and gas.	Addresses regulation, planning, and development of oil and gas resources of the state.
Chapter 379 Fish and Wildlife Conservation	The Proposed Action is not likely to significantly affect wildlife. The Proposed Action should not affect marine fisheries. The DAF will work with the U.S. Fish and Wildlife Service for potential effects to affect threatened or endangered species. The DAF will work with the U.S. National Marine Fisheries Service if there is any potential to affect fisheries.	Establishes public policy concerning marine fisheries resources and the hunting, fishing, and taking of game.
Chapter 380 Land and Water Management	The Proposed Action would not result in significant growth-inducing effects.	Establishes land and water management policies to guide and coordinate local decisions relating to growth and development.
Chapter 381 Public Health, General Provisions	The Proposed Action would not affect Florida's policy concerning the public health system.	Establishes public policy concerning the state's public health system.
Chapter 388 Mosquito Control	The Proposed Action would not affect mosquito control efforts.	Addresses mosquito control effort in the state.
Chapter 403 Environmental Control	The Proposed Action would not have a significant effect on water quality, air quality, pollution control, solid waste management, or other environmental control efforts in Florida.	Establishes public policy concerning environmental control in the state.
Chapter 553 Building Construction Standards	The Proposed Action would include construction in a coastal zone. Construction would be consistent with the Florida Coastal Management Program and CZMA.	Establishes policy concerning building and construction in coastal zone areas.
Chapter 582 Soil and Water Conservation	The Proposed Action would not have a significant effect on the State of Florida soil and water conservation efforts.	Provides for the control and prevention of soil erosion.
Chapter 597 Aquaculture	The Proposed Action would not have a significant effect on aquaculture production efforts.	Provides for the coordination, prioritization, and conservation of aquaculture production efforts.

DAF = U.S. Department of the Air Force