Federal Aviation Administration

DRAFT
ENVIRONMENTAL ASSESSMENT

Reentry, Splashdown, and Recovery Operations of an Inversion Space Company Capsule within the Pacific Ocean off the Coast of Central California

May 2024

Environmental Assessment for Reentry, Splashdown, and Recovery Operations of an Inversion Space Company Capsule within the Pacific Ocean off the Coast of Central California

AGENCIES: Federal Aviation Administration (FAA), lead federal agency; U.S. Coast Guard and U.S. Department of the Air Force, cooperating agencies.

This Environmental Assessment (EA) is submitted for review pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA), as amended (42 United States Code [USC] 4321, et seq.); Council on Environmental Quality NEPA-implementing regulations (40 Code of Federal Regulations Parts 1500 to 1508); and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*. In addition, this EA supports consultation between the National Marine Fisheries Service and FAA in accordance with the Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 USC 1801 *et seq*.).

DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION: The FAA is evaluating Inversion Space Company's (Inversion) proposal to conduct reentry, splashdown, and recovery (RSR) operations of the *Ray* capsule within the Pacific Ocean off the coast of Central California. Inversion must obtain a vehicle operator license from the FAA to conduct RSR operations for the *Ray* capsule. Issuing a license is considered a major federal action subject to environmental review under NEPA. Under the Proposed Action, the FAA would issue a license to Inversion that would allow Inversion to reenter, splashdown, and recover the *Ray* capsule within the Pacific Ocean off the coast of Central California. Inversion is proposing to conduct 2 (two) RSR operations: one in 2024 and one in 2025.

This EA considers the potential environmental impacts from the Proposed Action and No-Action Alternative on noise and noise-compatible land use and marine biological resources.

CONTACT INFORMATION: For questions, please contact: Andrew Leske, Environmental Protection Specialist, FAA, 800 Independence Avenue, SW, Suite 325, Washington, DC 20591; email andrew.h.leske@faa.gov.

This EA becomes a federal document when evaluated, signed, and dated by the Responsible FAA Official.

Responsible FAA Official:

STACEY MOLINICH ZEE

Digitally signed by STACEY MOLINICH ZEE
Date: 2024.05.29 14:27:12 -04'00'

_____ Date: _____

Stacey M. Zee
Manager, Operations Support Branch

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Acronyms & Abbreviations

AHA	Aircraft Hazard Area
AST	Office of Commercial Space Transportation
ATC	Air Traffic Control
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter(s)
DAF	U.S. Department of the Air Force
DPS	Distinct Population Segment
EA	Environmental Assessment
EFH	essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
ft	foot/feet
ft^2	square foot/feet
HAPC	Habitat Area of Particular Concern
in	inch(es)
kg	kilogram(s)
km	kilometer(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	above mean sea level
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Air Missions
NOTMAR	Notice to Mariners
PBF	physical and biological feature
PFMC	Pacific Fishery Management Council
psf	pounds per square foot
RSR	reentry, splashdown, and recovery
SFB	Space Force Base
SHA	Ship Hazard Area
U.S.	United States
USC	U.S. Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service

Chapter 1. Introduction

This Environmental Assessment (EA) evaluates the potential environmental impacts associated with the reentry, splashdown, and recovery (RSR) operations of a small, approximately 20.5 inches (in) (52.1 centimeters [cm]) in diameter and 11.8 in (30.0 cm) tall aluminum capsule, known as *Ray*, by Inversion Space Company (Inversion) within the Pacific Ocean off the coast of Central California. Alternative landing areas that were considered but dismissed are discussed in **Section 2.3**. Inversion would launch the capsule on a SpaceX Falcon 9 rocket from Vandenberg Space Force Base (SFB), California. Impacts associated with Falcon 9 launches at Vandenberg SFB have been addressed within the launch licensing and environmental review processes conducted for SpaceX standard rideshare missions from Vandenberg SFB (Space Launch Delta 30 2023) and therefore are not addressed in this EA.

Inversion must obtain a vehicle operator license from the Federal Aviation Administration (FAA), Office of Commercial Space Transportation (AST) for reentries pursuant to 14 Code of Federal Regulations [CFR] Part 450. The National Environmental Policy Act (NEPA) as amended (42 United States [U.S.] Code [USC] 4321 *et seq*.) requires an environmental analysis for major federal actions that have the potential to significantly impact the quality of the human environment. The issuance of a vehicle operator license by the FAA is considered a major federal action. Therefore, this EA has been prepared to comply with the requirements of NEPA; the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500–1508); FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*; and the U.S. Department of the Air Force's (DAF's) Environmental Impact Analysis Process (32 CFR Part 989). These regulations require a lead agency to prepare or supervise preparation of an EA for a federal action that does not qualify for a categorical exclusion or may not require preparation of an Environmental Impact Statement (EIS). A Finding of No Significant Impact (FONSI) will be issued if, as a result of this EA, the environmental impacts of implementing the Proposed Action are determined to be not significant. If a FONSI cannot be issued, the lead agency would publish a Notice of Intent to prepare an EIS. The completion of the environmental review process does not guarantee that the FAA will issue a vehicle operator license to Inversion for RSR operations. Inversion's license application must also meet FAA safety, risk, and financial responsibility requirements (14 CFR Chapter III).

The FAA is the lead agency for the preparation and coordination of this EA (40 CFR 1501.7) and the U.S. Coast Guard (USCG), and U.S. Department of the Air Force (DAF) are cooperating agencies (40 CFR 1501.8). See **Section 1.1.2** for further details.

1.1 Federal Agency Roles

1.1.1 Federal Aviation Administration

As the lead federal agency, the FAA is responsible for analyzing the potential environmental impacts of the Proposed Action. The Commercial Space Launch Act of 1984, as amended and codified at 51 USC 50901–50923, authorizes the Secretary of Transportation to oversee, license, and regulate commercial launch and reentry activities, and the operation of launch and reentry sites within the United States or as carried out by U.S. citizens. Section 50905 directs the Secretary to exercise this responsibility consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. In addition, Section 50903 requires the Secretary to encourage, facilitate, and promote commercial space launches and reentries by the private sector. As codified at 49 CFR § 1.83(b), the Secretary has delegated authority to carry out these functions to the FAA Administrator. The FAA is also

responsible for creating airspace closure areas in accordance with FAA Order 7400.2M, *Procedures for Handling Airspace Matters*, to ensure public safety.

To reenter a capsule from orbit and land it within the Pacific Ocean off the coast of California, Inversion must obtain a vehicle operator license from the FAA for reentries pursuant to 14 CFR Part 450, *Launch and Reentry License Requirements*. The FAA must also approve related airspace closures for reentry operations.

1.1.2 Cooperating Agencies

1.1.2.1 U.S. Coast Guard (USCG)

The FAA requested the USCG to participate in the NEPA process as a cooperating agency due to their jurisdiction by law and special expertise.[1] The USCG has authority over waters subject to jurisdiction of the U.S. pursuant to the Ports and Waterways Safety Act (46 USC Section 700); regulatory authority of vessels as outlined in CFR Title 33 and Title 46; and responsibility to review and advise the FAA and DAF on all launch and reentry site evaluation risk assessments regarding navigation safety. The USCG also supports the FAA and DAF with early warning communication to the maritime community with Notice to Mariners (NOTMAR) as outlined in 33 CFR Part 72. The USCG evaluates every launch and reentry activity for associated risks to the marine transportation system and waterway users.

1.1.2.2 U.S. Department of the Air Force (DAF)

DAF requested to be a cooperating agency in the NEPA process. Under 10 USC § 2276 (*Commercial Space Launch Cooperation*) and Department of Defense Instruction 3100.12 (*Space Support*) the DAF is responsible for conducting activities to support commercial launch and reentry activity. In addition, as the owner and operator of Vandenberg SFB from which the Inversion capsule would be launched on a SpaceX rideshare mission, the DAF has authority over space-related operations, to include ground-based operations on Vandenberg SFB. If necessary, the DAF could adopt this EA to support their own federal action and environmental findings associated with activities covered in this EA.

1.2 PURPOSE AND NEED

The purpose of Inversion's proposal is to implement capsule return test missions to assess the capability of safely reentering a small aluminum return capsule and recovering it upon completion of its orbital mission. Inversion is focused on addressing the needs of commercial, civil, and defense industries with high-cadence and low-cost reentry capabilities. Inversion's proposal is to conduct two test missions of its *Ray* reentry capsule. *Ray* contains and is intended to test and demonstrate many of Inversion's custom developed systems that allow for a decreased cost and increased cadence of reentry space capsules. After *Ray's* successful missions, Inversion would transition its focus to a separate, larger vehicle named *Arc* which would provide frequent missions to and from space stations, host scientific payloads, and deliver cargo from space around the world. Future reentry activities associated with *Arc* would be covered under separate licensing and environmental review.

[1] A cooperating agency means any federal agency (and a state, tribal, or local agency with agreement of the lead agency) other than a lead agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action that may significantly affect the quality of the human environment (40 CFR §1508.1(e)).

1.3 OTHER AUTHORIZATIONS

To proceed with all of its proposed operations identified in Chapter 2 below, Inversion would require environmental and regulatory approvals in addition to the FAA's license. The FAA has identified the following additional environmental approval for Inversion's proposal, but others may be required.

- The Proposed Action has the potential to adversely affect essential fish habitat (EFH) and federally managed fish species. Therefore, in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (16 USC 1801 *et seq*.), this EA incorporates an EFH Assessment to support an EFH effects determination.

Chapter 2. Description of the Proposed Action and Alternatives

NEPA requires the FAA to consider the purpose of and need for the proposed action and from that, "study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources" (42 USC 4332(E)). As discussed in Chapter 3, the FAA has not identified any unresolved conflicts concerning alternative uses of available resources associated with Inversion's proposal. Therefore, in accordance with NEPA, CEQ's NEPA-implementing regulations, and FAA Order 1050.1F (Section 6-2.1.d), this EA considers the No-Action Alternative and Inversion's Proposed Action.

2.1 NO-ACTION ALTERNATIVE

CEQ regulations require the inclusion of a No-Action Alternative in an EA to serve as the basis for comparing the environmental consequences of the Proposed Action with the baseline conditions. Under the No-Action Alternative, the FAA would not issue a license to Inversion for the reentry and recovery of the *Ray* capsule within the Pacific Ocean off the coast of Central California. Inversion would not be able to perform any space-based research or develop reentry capsule capabilities. Data collected in orbit or during reentry could not be compared with scientific models or ground-based testing intended to simulate those environments. Therefore, although the No-Action Alternative would not meet the purpose of and need for the Proposed Action, it is carried forward as a baseline analysis in this EA as required by NEPA and CEQ regulations.

2.2 PROPOSED ACTION

This chapter describes in detail the Proposed Action including the characteristics of Inversion's small capsule; the RSR operations; and the site screening criteria used to identify an appropriate splashdown area for the Inversion capsule, as well as alternatives considered but not carried forward. Under the Proposed Action, Inversion would conduct two daytime RSR operations within the Pacific Ocean off the coast of Central California: one in 2024 and one in 2025.

2.2.1 Location

The proposed Inversion capsule splashdown area would be approximately 77 nautical miles (nm) (143 kilometers [km]) from south to north and approximately 17 nm (31 km) from east to west, and would be located approximately 45 nm (83 km) from the closest points of land: Cooper Point and Point Piedras Blancas (**Figure 2.2-1**).

2.2.2 Reentry Vehicle: Inversion Capsule

The *Ray* capsule is an aluminum sphere-cone approximately 20.5 in (52.1 cm) in diameter, 11.8 in (30.0 cm) tall, and weighs approximately 40 pounds (lb) (18 kilograms [kg]) (**Figure 2.2-2**). The capsule would contain most of the capsule's avionics (flight computers, batteries, and telemetry systems), its parachute recovery systems, and a small ballast. The primary thermal protective shield is a carbon ablative material developed by the National Aeronautics and Space Administration (NASA), while the back-shell would experience less heat and would use a ceramic ablative material as its thermal protective shield. The capsule would contain two explosive devices, initiated by space standard initiators (filled with zirconium potassium perchlorate) and powered by smokeless powder, to deploy the drogue parachute and the main parachute. Upon splashdown, these devices would be fully consumed and pose no risk to personnel. In addition, the capsule would contain one 10-cell Panasonic 18650 lithium-ion battery to power its avionics system. The capsule would not contain any propellants, gasses, or toxic materials.

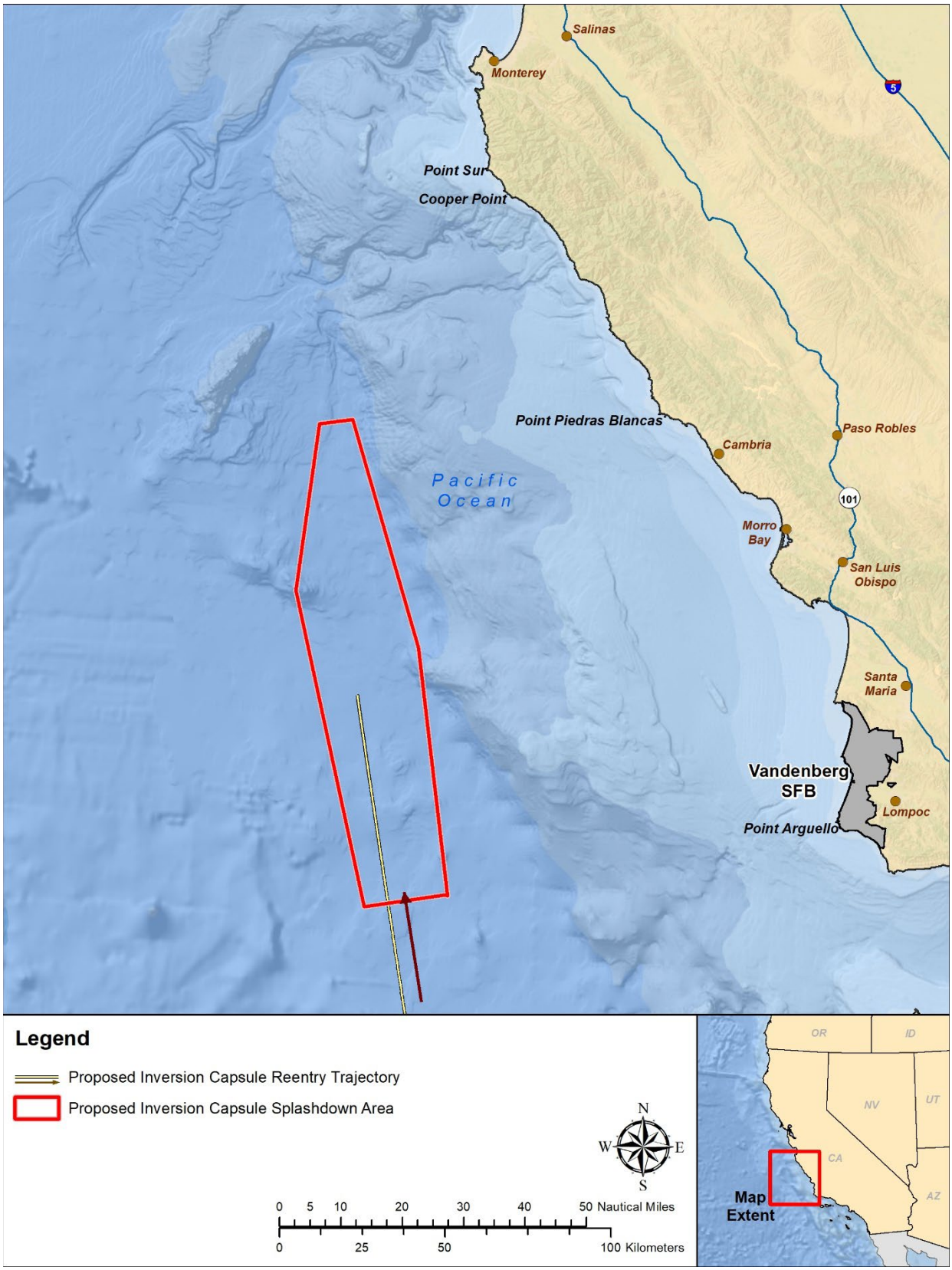

Figure 2.2-1. Proposed Inversion Capsule Reentry Trajectory and Splashdown Area within the Pacific Ocean off the Coast of Central California

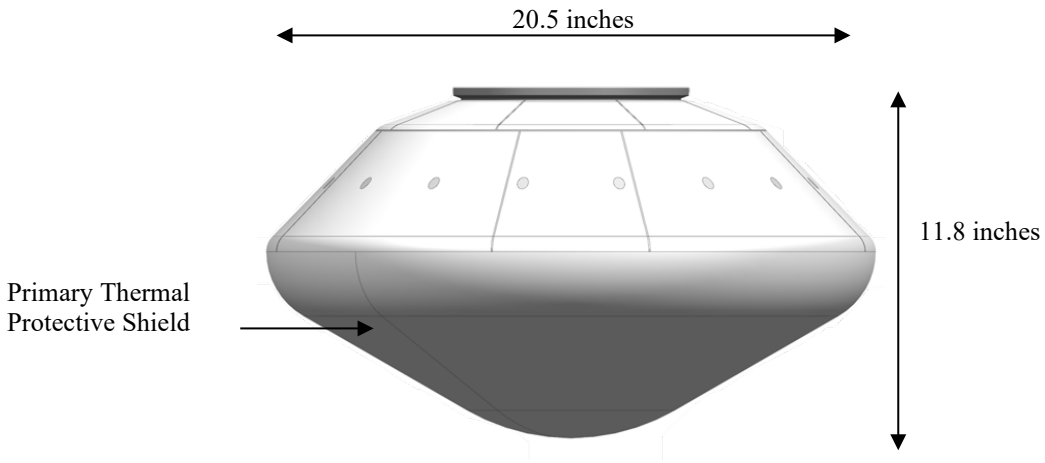

Figure 2.2-2. Inversion's *Ray* Capsule

2.2.3 Pre-Reentry Operations

All proposed reentry operations would comply with the necessary notification requirements, including issuance of a Notice to Air Missions (NOTAM) and a NOTMAR, as defined in agreements required for a reentry license issued by the FAA. Advance notice via NOTAMs and NOTMARs and the identification of an Aircraft Hazard Area (AHA) and a Ship Hazard Area (SHA) would assist pilots and mariners in scheduling around any temporary disruption of flight or shipping activities in the area of operation.

2.2.3.1 Issuance of NOTAM

Proposed Inversion reentry operations would comply with the necessary notification requirements, including establishing and issuing flight restrictions and NOTAMs and coordinating with FAA Air Traffic Organization (ATO). A NOTAM provides notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (NAS) (FAA Order 7930.2S, *Notices to Air Missions [NOTAM]*). The FAA issues a NOTAM at least 48 hours prior to a reentry activity in the airspace to notify pilots and other interested parties of temporary conditions.

To comply with the FAA's licensing requirements, Inversion would enter into a Letter of Agreement (LOA) with FAA ATO, Space Operations, and any other ATO Air Traffic Control (ATC) facilities affected to accommodate the flight parameters of Inversion reentry operations. The LOA outlines and defines procedures for notification and real-time communication prior to, during, and after an operation; procedures for issuance of a NOTAM; and any additional measures deemed necessary to protect public health and safety. The Proposed Action would not require the FAA to permanently alter the dimensions (shape and altitude) of the NAS. However, temporary closures of existing airspace would not exceed 30 minutes, and would realistically be closer to 15 minutes, and would be necessary to ensure public safety during the proposed reentry operations.

The FAA conducts an analysis of the constraints on airspace efficiency and capacity for each licensed reentry operation. This analysis is documented in an Airspace Management Plan, which is completed approximately 3-5 days prior to reentry. This information helps the FAA determine whether the proposed reentry would result in an unacceptable limitation on air traffic. If that were the case, the FAA may need to work with Inversion to identify appropriate mitigation strategies, such as shortening the requested reentry window or shifting the reentry time, if possible. The FAA

often provides data to operators to avoid operations during days with high aviation traffic volume. Prior analyses have concluded that the majority of commercial space reentry operations that occur in oceanic regions, such as where Inversion operations would occur, result in minor or minimal impacts on commercial and private users of airspace. This is largely due to the relatively low aircraft traffic density in oceanic regions and the ability of the FAA to manage the airspace for all users.

The published airways near the proposed Inversion capsule reentry trajectory and splashdown area include four oceanic routes and six Warning Areas west of Los Angeles and San Diego (**Figure 2.2-3** and **Figure 2.2-4**). The oceanic routes are used by arriving or departing aircraft for Los Angeles International Airport and San Diego International Airport. A number of Warning Areas comprise the U.S. Navy's Point Mugu Sea Range. Operated by the Naval Air Warfare Center Weapons Division at Naval Base Ventura County Point Mugu, the Point Mugu Sea Range provides test and evaluation information regarding open-ocean weapon system development programs and Department of Defense research needs.

Prior to the Inversion capsule reentry, the airspace that must be temporarily closed would be defined and published through a NOTAM. The specific reentry trajectory (including latitude and longitude coordinates) for Inversion operations would be based on mission-specific needs. The specific reentry trajectory and associated AHA would be provided in Inversion's Flight Safety Data Package and submitted to the FAA in advance of the reentry. This information would be used to determine the necessary airspace closures provided in the NOTAM.

All reentry operations would continue to comply with the necessary notification requirements, including issuance of a NOTAM, consistent with current procedures. RSR operations would be of short duration and scheduled in advance to minimize interruption to airspace. En-route flights would utilize established alternative routes to minimize interruption to air traffic. Safety and security factors dictate that use of airspace and control of air traffic be closely regulated. Accordingly, regulations applicable to all aircraft are promulgated by the FAA to define permissible uses of designated airspace. These regulations are intended to accommodate the various categories of aviation, whether military, commercial, or private aviation enthusiasts.

Airspace controlled by the FAA may be restricted specifically through activation of an Altitude Reservation (ALTRV). The FAA generally uses ALTRVs to protect oceanic airspace. The NOTAM would establish a closure window that is intended to warn aircraft to keep out of a specific region throughout the time that a hazard may exist. The duration, location, and size of the closure window is intended to allow the operator to meet its mission objectives and protect the public. The location and size of the closure area is defined to protect the public. For a reentry, typically the closure must begin at the time the reentry vehicle is at 60,000 feet (ft) (18,300 meters [m]) above mean sea level (MSL) and must end when any potential debris, including items that are planned to be jettisoned and any debris generated by a failure, has reached the bottom of the affected airspace.

ALTRVs are immediately released once the mission has successfully cleared the area and all planned reentry items no longer pose a risk to the public. The actual duration of airspace closure is normally much less than the original planned closure. The FAA typically begins to clear airspace and reroute aircraft in advance of a reentry and directs aircraft back into the released airspace after the completion of reentry operations to recover to normal flow and volume.

In sum, the reentry operation would be of short duration (approximately 30 minutes) and scheduled in advance to minimize interruption to airspace.

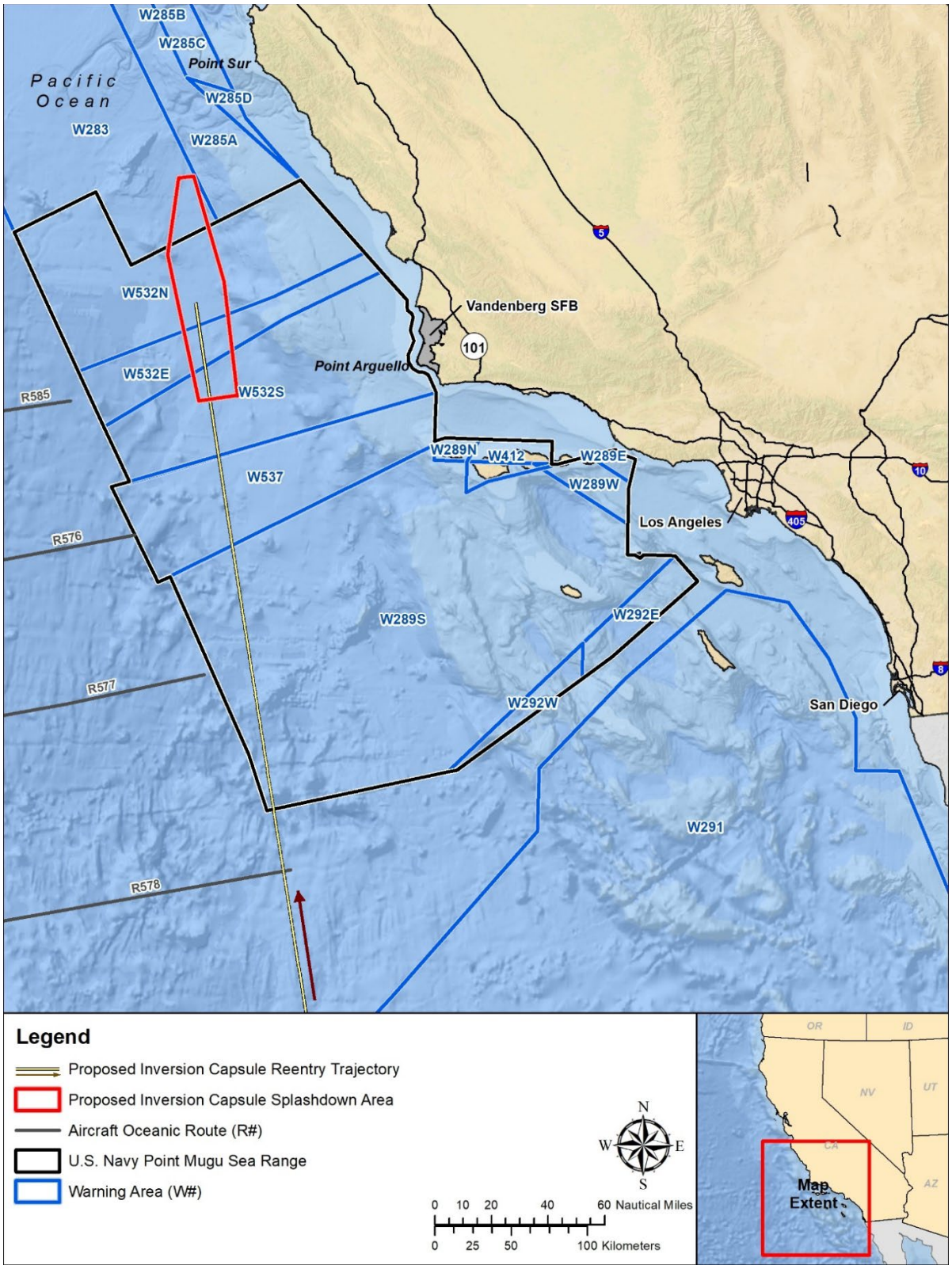

Figure 2.2-3. Air Traffic Oceanic Routes, Warning Areas, and Point Mugu Sea Range (Airspace) in the Vicinity of the Proposed Inversion Capsule Reentry Trajectory and Splashdown Area
(*Source*: FAA 2022)

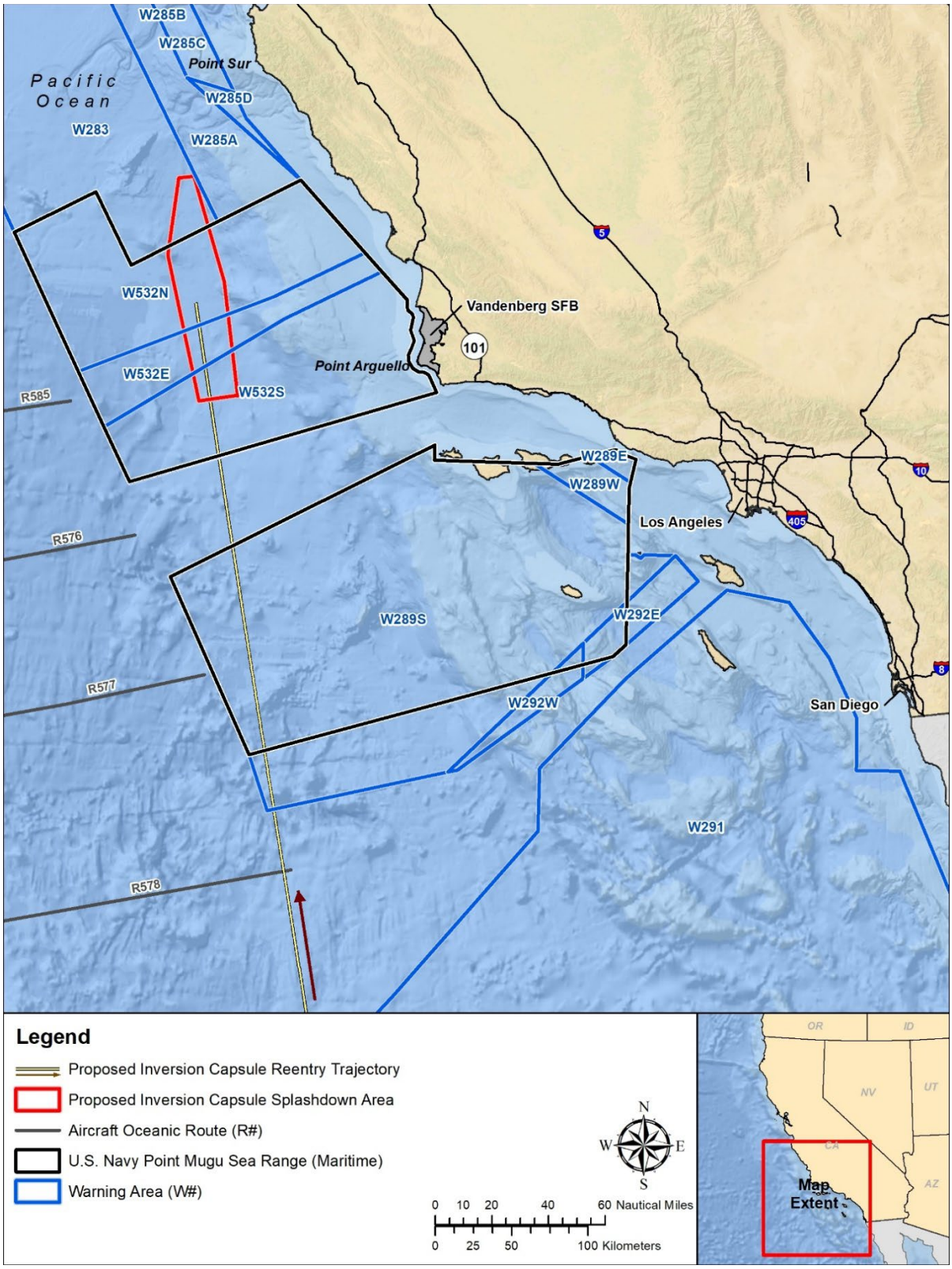

Figure 2.2-4. Air Traffic Oceanic Routes, Warning Areas, and Point Mugu Sea Range (Maritime) in the Vicinity of the Proposed Inversion Capsule Reentry Trajectory and Splashdown Area
(*Source*: FAA 2022)

2.2.3.2 Issuance of NOTMAR

Similar to the issuance of a NOTAM, the National Geospatial-Intelligence Agency, in conjunction with the USCG, publishes NOTMARs weekly and as needed, informing the maritime community of temporary changes in conditions or hazards in navigable waterways.

Inversion would enter into a Letter of Intent (LOI) with the USCG District 11 in order to safely conduct RSR operations over open ocean. The LOI describes the required responsibilities and procedures for both Inversion and USCG during a reentry operation, resulting in the issuance of a NOTMAR. The USCG would be responsible for issuing the NOTMAR for the SHA encompassing the proposed splashdown area (**Figure 2.2-5**). Inversion would provide the exact SHA location prior to reentry of the capsule.

Figure 2.2-5 provides the relative distribution of marine vessel traffic for 2021 within the vicinity and crossing the proposed splashdown area. The majority of the vessel traffic is to the east of the proposed splashdown area with some vessel traffic crossing the southern and central portions.

The Proposed Action would not alter or close shipping lanes as the FAA does not have the authority to alter or restrict vessel traffic. The USCG is the only agency with authority to restrict vessel operations. The NOTMAR does not alter or close shipping lanes; rather, the NOTMAR provides a notification regarding a temporary hazard within a defined SHA to ensure public safety during the proposed operations. The USCG manages the duration, location, and size of the SHA in a way that is similar to how the FAA manages its reserved airspace and the USCG and Inversion would take steps to reduce the duration of the SHA as a mission unfolds. FAA supports the use of NOTMARs to inform the maritime community of reentry risks to provide awareness of operations and provide early warning of operations being conducted on the High Seas.

Inversion uses its internal SHA analysis to provide risk assessments to support USCG operations in reviewing Inversion Operation Risk and the development of the NOTMAR. The coordinates are sent to the USCG where it is published in the Local NOTMAR. The length of the NOTMAR window is primarily intended to account for the time needed for the operator to meet its mission objectives. Typically, the NOTMAR and associated SHA risk must begin at the time of reentry and must end when any potential debris, including items that are planned to be jettisoned and any debris generated by a failure, has reached the ocean surface. The USCG reviews the risk and works with FAA and Inversion to develop a risk mitigation strategy.

In sum, the reentry operation would be of short duration (approximately 30 minutes) and scheduled in advance to minimize interruption to the maritime community.

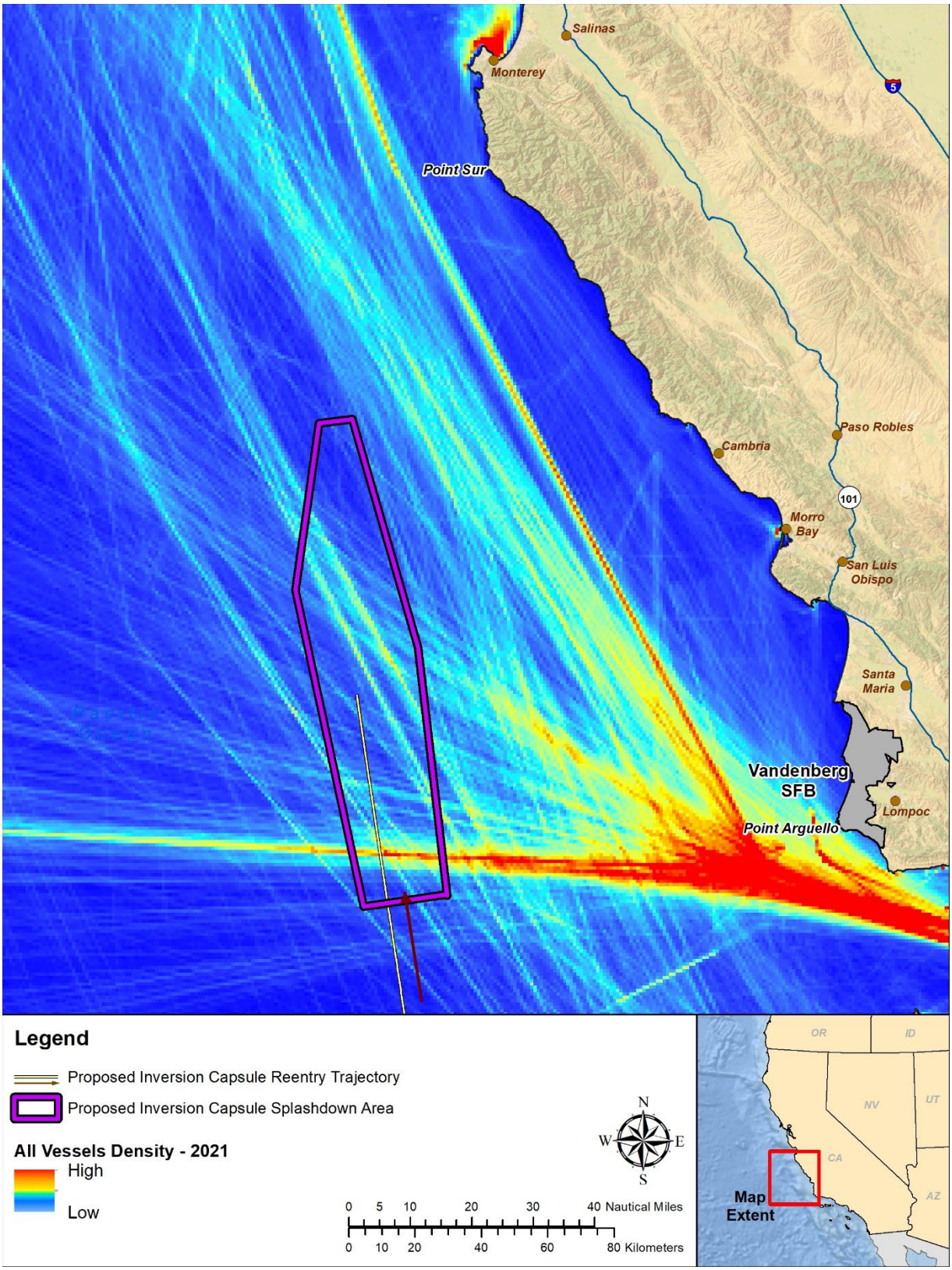

Figure 2.2-5. Relative Distribution of Commercial Marine Vessel Traffic (2021) in the Vicinity of the Proposed Inversion Capsule Reentry Trajectory and Splashdown Area
(*Source*: National Ocean Service 2022a)

2.2.4 Reentry and Splashdown Operations

The Inversion capsule would enter the proposed splashdown area within the Pacific Ocean from the south along a northerly trajectory (Figure 2.2-1). The capsule would implement a two-stage descent system. Inside the top of the capsule body is an approximate 18-ft (5.5-m) long by 1.9-ft (0.6-m) diameter Kevlar drogue parachute. This drogue parachute is contained in a 6.1 in (15.5 cm) diameter by 1.1 in (2.9 cm) tall stainless steel container with a 4.5 in (11.4 cm) diameter Teflon lid (Figure 2.2-6 and Figure 2.2-7). The Teflon lid is attached to a "slug gun" type deployment system powered by smokeless powder.

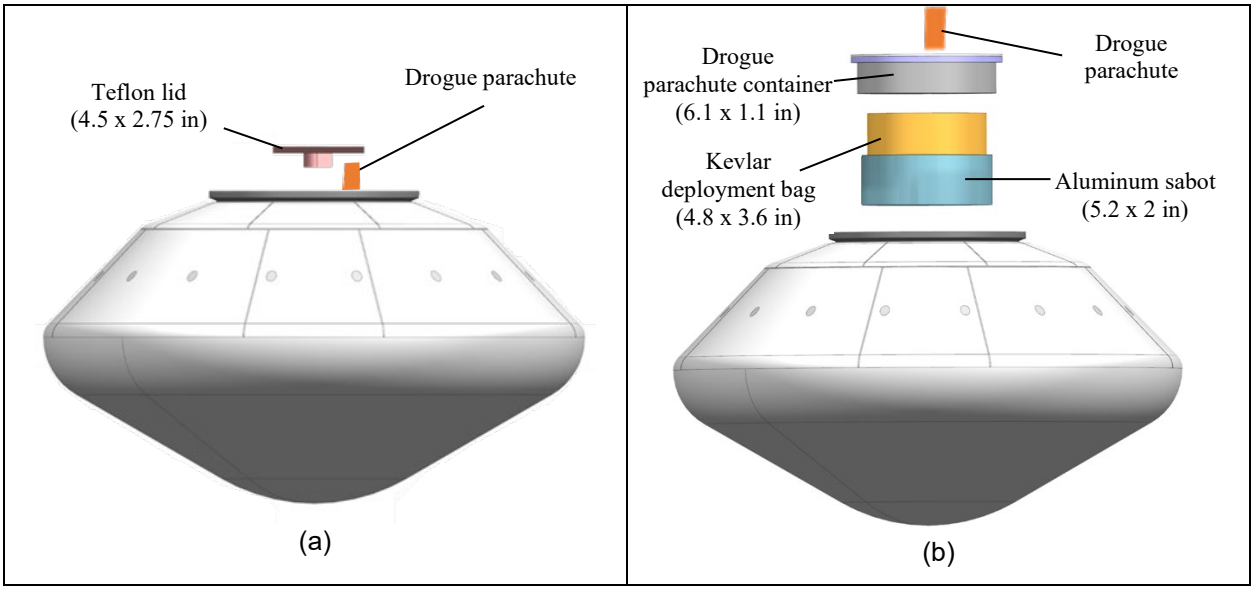

Figure 2.2-6. Proposed Inversion Capsule Descent System: (a) Drogue Parachute Deployment; (b) Main Parachute Deployment

At Mach 2.0 and approximately 108,600 ft (33,100 m) MSL, the capsule would deploy the Teflon lid and extract the drogue parachute (Figure 2.2-8). The drogue parachute is intended to help the capsule maintain stability from the transition from supersonic (i.e., Mach 5 to 1.2) to subsonic (i.e., less than the speed of sound) speeds. At approximately 6,000 ft (1,829 m) MSL, a 13.8-ft (4.20-m) diameter nylon and Kevlar main parachute is deployed (Figure 2.2-8). Upon main parachute deployment, the drogue parachute and its container are jettisoned and not recovered. They are expected to sink relatively quickly. The main parachute is contained within a Kevlar deployment bag and an aluminum hollow sabot. Recovery of the deployment bag and sabot would be attempted, but they are small and are expected to sink relatively quickly.

The capsule descends at approximately 15.5 miles per hour (25 km per hour) under the main parachute. Deployed alongside the main parachute is a recovery buoy that is attached to the capsule via a Kevlar lanyard. This recovery buoy broadcasts the capsule's location over Iridium satellite communications system's L-band frequency to Inversion's mission control center and the recovery team. The capsule is naturally buoyant, and the buoy does not contribute to the capsule's overall buoyancy. Upon splashdown, the main parachute will separate from the capsule to prevent the parachute from pulling the capsule underwater. The parachute is expected to sink within approximately 20 minutes of being in the water. Inversion will recover the parachute if it remains floating when the recovery team arrives in the area. If the parachute doesn't deploy, the buoy does not activate, or the recovery team is unable to locate the capsule, recovery operations would take place after the time that the capsule would have fully landed and would continue for up to 72

hours (not including night or poor weather). If the capsule is not found within that time it is presumed to have sunk and is not recoverable. Total time for RSR operations from when the capsule enters the atmosphere to splashdown in the Pacific Ocean would be approximately 15 minutes.

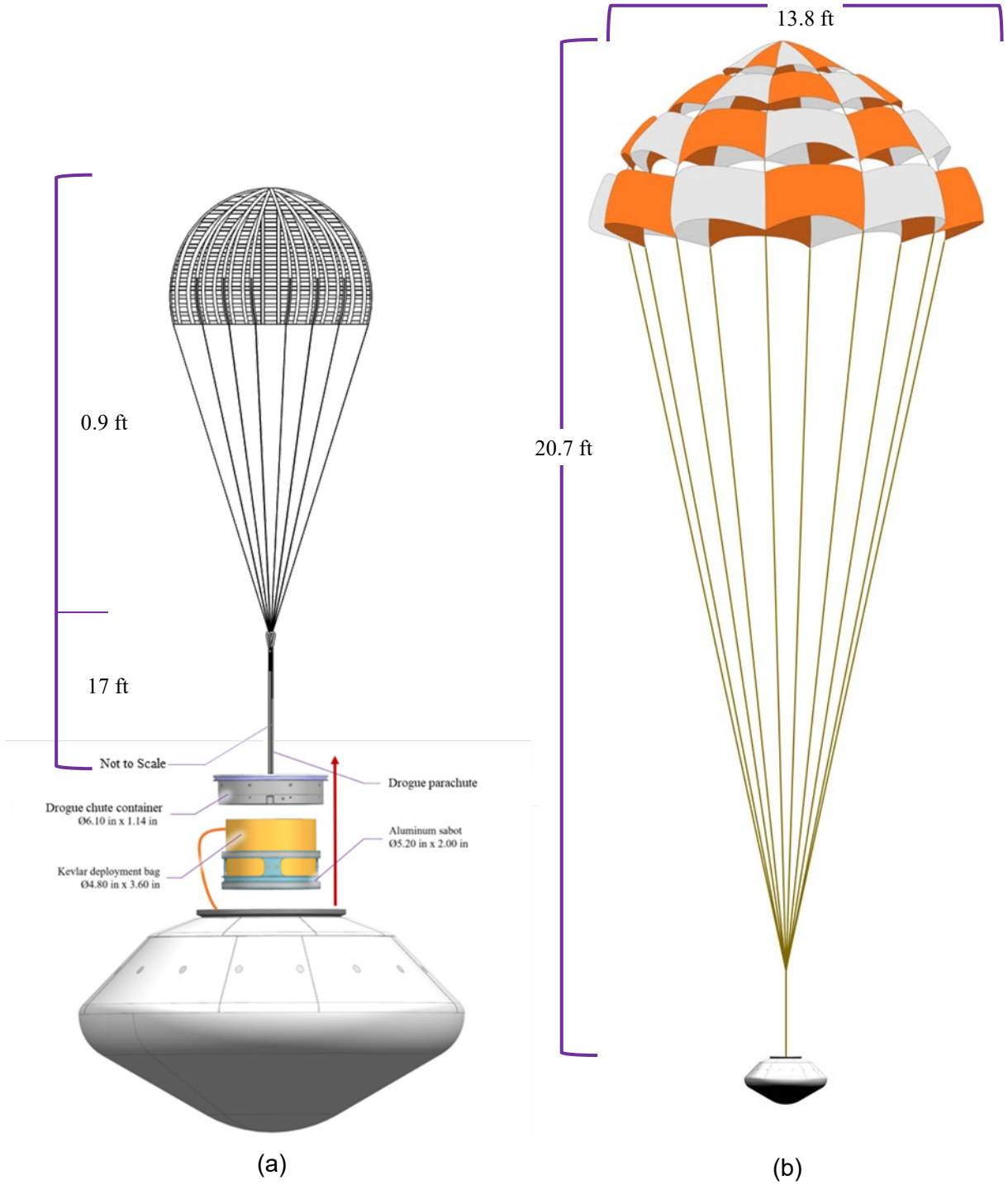

Figure 2.2-7. Proposed Inversion Capsule Recovery Systems: (a) Capsule with Initial Drogue Parachute; (b) Capsule within Main Parachute

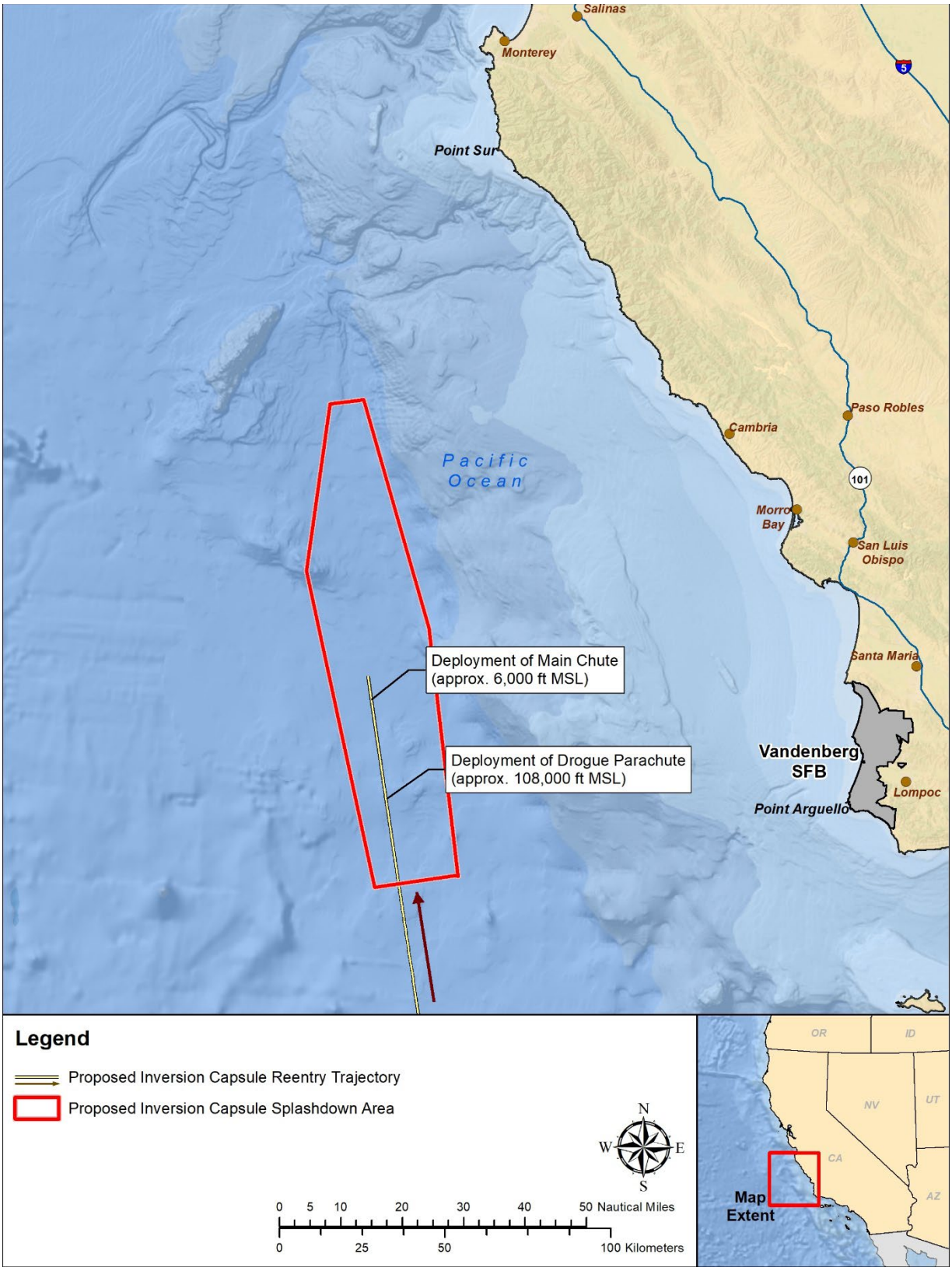

Figure 2.2-8. Proposed Inversion Capsule Reentry Trajectory, Location of Drogue Parachute and Main Parachute Deployments, and Splashdown Area within the Pacific Ocean off the Coast of Central California

Table 2.2-1 provides a summary of the expended and recovered items associated with the proposed Inversion capsule RSR operations. All items that are not recovered are expected to sink relatively quickly and settle on the ocean bottom at a depth >3,000 ft (914 m) (National Ocean Service 1985).

Table 2.2-1. Summary of Items Associated with the Reentry and Splashdown of the Inversion Capsule

Item	Size	Weight	Material	Recovered/Fate
Teflon lid for drogue parachute	4.5 x 2.75 in	0.4 lb	Teflon	No/ Sink to the sea floor
Container for drogue parachute	6.1 x 1.1 in	0.8 lb	stainless steel	No/Sink to the sea floor
Drogue parachute	1.2 x 18 ft	0.3 lb	Kevlar and nylon	No/Sink to the sea floor
Sabot	5.2 x 2.0 in	0.5 lb	aluminum	No/Sink to the sea floor
Kevlar deployment bag	4.8 x 3.6 in	0.04 lb	Kevlar	No/Sink to the sea floor
Main parachute	20.7 x 13.8 ft	1.4 lb	Kevlar and nylon	No/Sink to the sea floor*
Capsule, including recovery buoy and lanyard	20.5 x 11.8 in	38.9 lb	primarily aluminum	Yes

Note: *The capsule recovery team would attempt to recovery the main parachute if it has not sunk out of reach when they arrive to recover the capsule.

2.2.4.1 Contingency Abort Operations

In the event the capsule does not meet Inversion reentry criteria, the vehicle would remain in orbit. Inversion has budgeted a minimum of six contingency opportunities to reconcile issues for a final reentry attempt within the same proposed splashdown area. If the issue cannot be reconciled, the capsule would be abandoned in orbit. Abandonment in orbit would likely result in a random reentry at some unknown future date and time, estimated at 5 to 20 years. During the random reentry, the capsule would have an off-nominal trajectory which would cause significant instability resulting in an incorrect orientation or flight path angle. This would result in higher total heat loads than the heatshield could withstand, resulting in likely destruction of the capsule within the atmosphere.

2.2.5 Recovery Operations

The recovery team would consist of a captain, a pilot, and four Inversion personnel on a 48 ft (14.6 m) fishing vessel. They would depart from Morro Bay Harbor at approximately 0000 local time (0800 Coordinated Universal Time [UTC]) and be stationed just outside the SHA communicated in the NOTMAR (see Section 2.2.3.2). After receiving communications from the recovery buoy following the capsule's parachute deployment, the fishing vessel would begin its search pattern to recover the capsule.

The recovery of the approximately 41-lb (18-kg) capsule would be conducted via a net on the fishing vessel. As the capsule would not contain any hazardous materials or fuels, it would not need to be safed prior to recovery. Following recovery of the capsule and the main parachute (if available), the fishing vessel would return to Morro Bay Harbor where the capsule would then be transported by truck back to Inversion's headquarters in Torrance, California.

The proposed recovery operations would occur only during daytime hours and during suitable weather and sea state conditions. If unsafe conditions arise during the recovery attempt (e.g., bad weather), the recovery effort would be halted and resumed once conditions were favorable.

If during reentry operations there are structural integrity issues with the capsule, it would likely mean that the capsule would not survive reentry. Recovery operations would be attempted without location information from the recovery buoy. Given the small size of the capsule, if it breaks up upon reentry or on impact with the ocean surface, it is likely that capsule debris would quickly sink and would not be recoverable.

2.3 Alternatives Considered but Eliminated from Further Consideration

2.3.1 Recovery Site Selection Criteria

Selecting a recovery or landing area for a capsule return depends largely on matching the safety and mission-critical criteria to the facilities and capabilities of the prospective landing area. Issues of concern include minimal risk to public safety and to the returned capsule payload. Due to the capsule's size and reentry flight characteristics, the impact to the capsule from a terrestrial landing would result in the destruction of the capsule and loss of all data. A site within U.S. waters is also required given, (a) the time, uncertainty, and complexity associated with obtaining the necessary agreements between the U.S. and a foreign government; (b) the time to return a capsule to Inversion headquarters from a foreign country would be unacceptable; and (c) maintaining integrity, safety, and security of the capsule during recovery and transport back to the U.S. would be very challenging or prohibitive. Therefore, only a landing area within the marine environment within proximity of the U.S. was carried forward. The following criteria were used to assess potential sites to be considered as a potential landing area for the Inversion capsule:

1. *Safety*: The site must accommodate a landing area of 78 nm (145 km) from south to north and approximately 20 nm (37 km) from east to west.
2. *Capsule Return*: The locale must enable prompt delivery of the capsule back to Inversion headquarters in Torrance, California for further investigation, analysis, and processing.
3. *Range Recovery Assets*: Existing ocean recovery operations are required to expedite the recovery and return of the capsule.
4. *Marine Protected Areas*: The splashdown area must avoid existing marine protected areas (e.g., National Marine Sanctuaries) and critical habitat for Endangered Species Act (ESA)-listed species. The proposed splashdown area avoids the Monterey Bay National Marine Sanctuary (**Figure 3.1-1**). Areas of critical habitat within the vicinity of the proposed splashdown area are discussed in **Section 3.4.3.2**.

2.3.2 Alternative Landing Sites Considered but Not Carried Forward

In addition to the proposed landing area off the coast of California, two other landing locations were considered.

- Gulf of Alaska: Does not meet Criteria 2 and 3. Due to the inclination of capsule's orbit, recovery operations would be required to travel further from the coast requiring more complex logistics and costs, including the need to utilize multiple and larger ships. The location was not convenient, cost effective, or efficient with respect to the location of Inversion's headquarters in southern California where the capsule would be returned. In addition, there are no current marine assets in the vicinity of the Gulf of Alaska that have experience in recovery operations of commercial space components.
- Off the Atlantic Coast of Florida: Does not meet Criteria 2 and 4. In addition to potential impacts to ESA-listed species critical habitat (loggerhead turtle [*Caretta caretta*] and North Atlantic right whale [*Eubalaena glacialis*]), the location was not convenient, cost effective, or efficient with respect to the location of Inversion's headquarters in southern California where the capsule would be returned.

Of the potential areas assessed, only the Pacific Ocean off the coast of Central California was determined to be the best-suited splashdown area based on the site selection criteria.

Chapter 3. Affected Environment and Environmental Consequences

3.1 INTRODUCTION

This chapter provides a description of the affected environment and potential environmental consequences for the environmental impact categories that have the potential to be affected by the Proposed Action and No-Action Alternative. The environmental impact categories assessed in this EA include noise and noise-compatible land use and biological resources. The study area varies based on the environmental impact category being analyzed and is defined for each environmental impact category in this chapter. The level of detail provided in this chapter is commensurate with the importance of the potential impact on the environmental impact categories. The following environmental impact categories are not analyzed in detail for the reasons stated.

- **Air Quality and Climate**. Under the Proposed Action, the only activities that would result in emissions that would impact regional air quality and climate are those associated with the fishing vessel used during the recovery of the Inversion capsule and a pickup truck used to transport the capsule from Morro Bay to Torrance, California. Although Morro Bay is located in San Luis Obispo County, which is in nonattainment for ozone, the Proposed Action is exempt from a General Conformity Evaluation given the emissions from (1) a single fishing vessel travelling from Morro Bay, conducting the recovery operation, and returning to Morro Bay and (2) a single pickup truck making one round trip between Morro Bay and Torrance are expected to be below *de minimis* levels and would not exceed National or California Ambient Air Quality Standards. In addition, the majority of a proposed RSR operations would occur more than 30 nm (55 km) from the 12-nm (22-km) territorial boundary from the coast of California where the National or California Ambient Air Quality Standards apply. Therefore, there would be no significant impacts to air quality or climate from conducting a single proposed Inversion RSR operation in 2024 and in 2025.

  Airspace closures associated with commercial space operations would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel. These emissions include carbon dioxide (CO_2), which is a greenhouse gas (GHG). Minimal, if any, additional emissions would be generated from aircraft departure delays because the FAA has rarely, if ever, received reportable departure delays associated with reentry operations. Any delays in aircraft departures from affected airports would be short-term. Affected airports potentially include San Francisco International Airport, San Luis Obispo County Regional Airport, Santa Barbara Airport, and Los Angeles International Airport. However, given how far offshore the AHA is from these airports (150 nm, 85 nm, 140 nm, and 210 nm, respectively), and the relatively short time period from capsule entering the atmosphere entry to splashdown (approximately 15 minutes), aircraft grounding is not anticipated. Thus, increases in air emissions from grounded aircraft are not expected. Therefore, these emissions increases are not expected to result in an exceedance of a National or California Ambient Air Quality Standard for any criteria pollutant. Emissions from aircraft being re-routed would occur above 3,000 ft (the mixing layer) and thus would not affect ambient air quality. Therefore, airspace closures associated with commercial space operations are not expected to result in significant air quality impacts.

  In addition, the number of aircraft that would be impacted per reentry would not be expected to produce additional emissions that would have a notable impact on climate. Therefore, the increases in GHGs caused by short-term airspace closures during commercial space

operations is not expected to result in significant climate-related impacts. The scientific community is continuing efforts to better understand the impact of aviation emissions on the global atmosphere. The FAA is leading and participating in a number of initiatives intended to clarify the role that commercial aviation plays in GHG emissions and climate. The FAA, with support from the U.S. Global Change Research Program and its participating federal agencies, has developed the Aviation Climate Change Research Initiative in an effort to advance scientific understanding of regional and global climate impacts of aircraft emissions.

- **Coastal Resources.** The coastal zone refers to land and water areas of the State of California from the Oregon border to the border of the Republic of Mexico extending seaward to the state's outer limit of jurisdiction (3 miles offshore) including all offshore islands and extending inland generally 1,000 yards from the mean high tide line of the sea. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents. Per FAA Order 1050.1F, coastal resources include all natural resources occurring within coastal waters and their adjacent shorelands on any coastal use or resource. As the only proposed activity that would occur within coastal waters would be the transit of the recovery vessel from Morro Bay to the recovery area more than 45 nm (83 km) from the coast of California, and then returning to Morro Bay, there would be no impacts to coastal resources. The proposed activities would not require consultation with the California Coastal Commission due to the location, type of activities, and analysis of impacts.
- **Department of Transportation Act, Section 4(f)**. Section 4(f) of the U.S. Department of Transportation Act of 1966 (49 USC §303) protects significant publicly owned parks, recreational areas, wildlife and waterfowl refuges, and public and private historic sites. Section 4(f) provides that the Secretary of Transportation may approve a transportation program or project requiring the use of publicly owned land of a public park, recreation area, or wildlife or waterfowl refuge of national, state, or local significance, or land of an historic site of national, state, or local significance, only if there is no feasible and prudent alternative to using that land and the program or project includes all possible planning to minimize harm resulting from the use.

  The only Section 4(f) property within the vicinity of the proposed Inversion reentry trajectory and splashdown area is the Monterey Bay National Marine Sanctuary (**Figure 3.1-1**). Located approximately 5 nm (9 km) from the northernmost extent of the proposed splashdown area, proposed Inversion reentry operations would not impact National Marine Sanctuary resources. Therefore, no further discussion of Section 4(f) properties is warranted.
- **Farmlands and Land Use.** The Proposed Action would occur completely in the marine environment and therefore would not impact farmlands or land use.
- **Natural Resources and Energy Supply.** The Proposed Action would not result in any measurable effect on local supplies of energy or natural resources. The Proposed Action would not result in the development of new facilities, changes in local energy demands, consumption of other natural resources, and would not require additional sources of power or other public utilities. Therefore, there would be no significant impacts to natural resources and energy supply from the proposed Inversion RSR operations in 2024 and 2025.

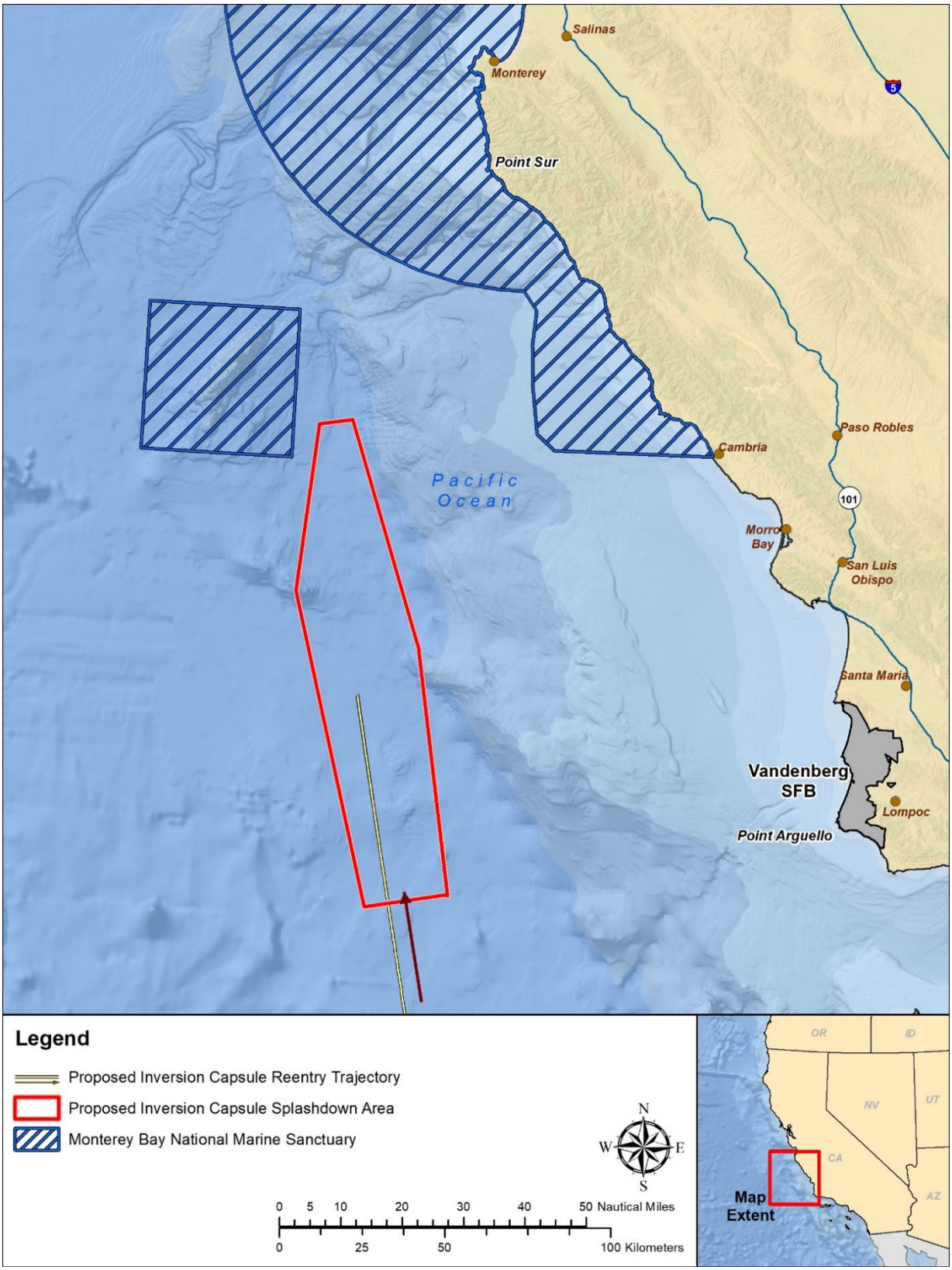

Figure 3.1-1. Location of the Monterey Bay National Marine Sanctuary and the Proposed Inversion Capsule Reentry Trajectory and **Splashdown Area**
(*Source*: National Ocean Service 2023)

- **Hazardous Materials, Solid Waste, and Pollution Prevention**. Upon reentry and splashdown, the Inversion capsule would not contain any hazardous materials or fuels. However, the capsule would contain one 10-cell Panasonic 18650 lithium-ion battery. As the batteries are expected to remain intact inside the capsule upon splashdown and be fully recovered, the potential for the lithium-ion batteries to be exposed to the marine environment is considered very low. In the unlikely event that the capsule is not recovered or breaks apart upon splashdown thereby exposing the lithium-ion battery to the environment, there would only be an approximately 10 grams of lithium released into the marine environment.[1] Therefore, given the very small amount of lithium within the battery, that the battery would descend through depths reaching >3,000 ft (914 m), and the lithium would be quickly diluted within the water column, adverse effects to the marine environment are not expected.

  The proposed RSR operation in 2024 and 2025 would only result in the deposition on the ocean bottom of six items each year totaling 23.5 square feet (ft^2) (2.2 square meter [m^2]) in area (see **Table 2.2-1**). In addition, these items would be dispersed across a wide area and not settle within the same spot on the ocean bottom after the single proposed RSR operation in 2024 and 2025.

  In addition, those items that would not be recovered and would sink to the sea floor (see Table 2.2 1) are comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials, are anticipated to sink relatively quickly. Accordingly, they would not affect the marine environment in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats). Therefore, there would be no significant impacts to the marine environment from hazardous materials or solid waste from proposed Inversion reentry operations.

- **Historical, Architectural, Archeological, and Cultural Resources**. Given the location of the proposed Inversion reentry operations more than 45 nm (83 km) from the coast of California in waters >3,000 ft (914 m) deep, the potential for the occurrence of submerged cultural resources (historical and archaeological) is considered very low. Current databases and studies regarding cultural resources along the coast of California address areas much closer to shore (e.g., within 3 miles [4.8 km]) and do not provide an inventory or assessment of cultural resources further from shore (Smith and Hunter 2003; Bureau of Ocean Energy Management 2013; National Ocean Service 2022b). Although the potential for a submerged cultural resource to occur within the Inversion splashdown area exists, even if a submerged cultural resource was present, the proposed Inversion reentry operations would only result in the deposition on the ocean bottom of six items totaling 23.5 ft^2 (2.2 m^2) in area (see **Table 2.2-1**). Additionally, these items would be dispersed across a wide area and not settle within the same spot on the ocean bottom after the single proposed RSR operation in 2024 and 2025. Therefore, there would be no significant impacts to any known or undiscovered submerged cultural resources from proposed Inversion reentry operations.
- **Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks.** The Proposed Action would not require construction or development. Only existing Inversion personnel would be used to conduct the single reentry operation and

[1]The amount of lithium contained in a single 18650 lithium-ion battery = 0.3 x rated capacity (in ampere hours [Ah]). For the Inversion capsule battery: 3,200 milliampere-hrs (mAh) = 3.2 Ah x 10 batteries = 32 Ah; therefore, 32 Ah x 0.3 = ~10 grams of lithium (FedEx 2022).

therefore would not induce population growth or affect the number of jobs in Torrance, California or in the nearby communities.

Potential socioeconomic impacts from re-routing aircraft due to commercial space operations are expected to be negligible relative to other causes leading to the re-routing of aircraft and marine vessels. Other issues or activities such as weather and military exercises also require airspace or seaspace closures and may have longer and larger closure areas than the single proposed Inversion RSR operation per year in 2024 and 2025. Each RSR operation would comply with the necessary notification requirements, including issuance of NOTAMs and NOTMARs, consistent with current procedures.

Potential socioeconomic impacts include additional airline operating costs for increased flight distances and times resulting from re-routing aircraft and increased passenger costs as a result of impacted passenger travel, including time lost from delayed flights, flight cancellations, and missed connections. Operations would not result in the closure of any public airport during the operation nor so severely restrict the use of the surrounding airspace as to prevent access to an airport for an extended period of time. Given the proposed airspace closure for the single Inversion operation would be temporary as discussed above and the FAA's previous analyses related to the NAS over oceanic areas have concluded minor or minimal impacts on the NAS from commercial space operations, the FAA does not expect the airspace closures from Inversion's single proposed RSR operation in 2024 and 2025 would result in significant socioeconomic impacts. Further, local ATC facilities would coordinate with airports and aircraft operators to minimize the effect of the single RSR operation per year on airport traffic flows as well as traffic flows in en-route airspace.

As the Proposed Action would occur completely within the marine environment, there would be no impacts that disproportionately affect environmental justice populations. Additionally, no component of the Proposed Action would result in a disproportionate health and safety risk to children. Therefore, there would be no significant impacts related to socioeconomics, environmental justice, or children's environmental health and safety risks from the single proposed Inversion RSR operation per year in 2024 and 2025.

- **Visual Effects.** Visual effects are related to the extent to which the Proposed Action would produce light emissions that create annoyance or interfere with activities; or the extent to which the Proposed Action would detract from, or contrast with, visual resources or the visual character of the existing environment. As the Proposed Action would occur more than 45 nm (83 km) from shore in the Pacific Ocean, the single Inversion reentry operation would not affect visual resources. The Proposed Action would not degrade the existing visual character or quality of the area of the Pacific Ocean where proposed RSR operations would occur and would have no adverse effect on a scenic vista or scenic resources. Under the Proposed Action, no new source of substantial light or glare would be created that would adversely affect day or nighttime views in the area. Therefore, there would be no significant visual effects from proposed Inversion reentry operations.
- **Water Resources**. Upon reentry and splashdown, the Inversion capsule would not contain any hazardous materials or fuels. However, the capsule would contain one 10-cell Panasonic 18650 lithium-ion battery. As the batteries are expected to remain intact inside the capsule upon splashdown and be fully recovered, the potential for the lithium-ion batteries to be exposed to the marine environment is considered very low. In the unlikely event that the capsule is not recovered or breaks apart upon splashdown thereby exposing the lithium-ion battery to the environment, there would only be an approximately 10 grams

of lithium released into the marine environment (see above discussion under *Hazardous Materials, Solid Waste, and Pollution Prevention*). Therefore, given the very small amount of lithium within the battery, that the battery would descend through depths reaching >3,000 ft (914 m), and the lithium would be quickly diluted within the water column, adverse effects to the marine environment are not expected.

In addition, those items that would not be recovered and would sink to the sea floor (see Table 2.2-1) are comprised of inert materials which are neither chemically or biologically reactive and contain no hazardous materials, are anticipated to sink relatively quickly. Accordingly, they would not affect the marine environment in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats). Therefore, there would be no significant impacts to water resources from proposed Inversion reentry operations.

3.2 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, the FAA would not issue a license to Inversion for the Ray capsule RSR operations in the Pacific Ocean off the coast of Central California. Under the No-Action Alternative, there would be no new impacts on the environmental impact categories analyzed in this EA.

3.3 NOISE AND NOISE-COMPATIBLE LAND USE

As the proposed Inversion reentry operations would occur wholly within the marine environment, noise-compatible land use is not relevant and is not discussed. The following section focuses on the noise associated with the Inversion capsule during reentry.

3.3.1 Definition of Resource and Regulatory Setting

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air, and are sensed by an auditory receiver, the ear. How the receiver (e.g., human or wildlife species) of a sound reacts depends largely on the receiver's activity at the time of exposure, experience, and attitude toward the source of the sound.

Noise is defined as unwanted or annoying sound that interferes with or disrupts normal activities, such as eating, sleeping, or communication. The response of different individuals to similar noise events is diverse and is influenced by the type of noise, perceived importance of the noise, its appropriateness in the setting, time of day, type of activity during which the noise occurs, and sensitivity of the individual receiving the noise. Noise sources can be constant or of short duration and contain a wide range of frequency (pitch) content. Determining the character and level of sound aids in predicting the way it is perceived. Noise associated with sonic booms is classified as a short-duration event.

The measurement and perception of sound involves three basic physical characteristics:

- Intensity – the acoustic energy, which is expressed in terms of sound pressure, in decibels (dB).
- Frequency – the number of cycles per second the air vibrates, in hertz (Hz).
- Duration – the length of time the sound can be detected.

The dB is measured on a logarithmic scale and its values are referred to generally as sound levels. A sound level of 0 dB is approximately the lower threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB; sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels ranging from 130 to 140 dB are toward the upper threshold and are felt as pain (Berglund and Lindvall 1995).

A *sonic boom* is an impulsive sound similar to thunder and is associated with the shock waves created by a vehicle traveling through air faster than the speed of sound. The boom forms a cone that trails behind the vehicle and where that cone intersects the surface of the Earth is usually called a sonic boom "carpet" under the vehicle's trajectory. The duration of a sonic boom is brief (less than 1 second), and the intensity and width of a sonic boom path, as well as the potential for the boom to intercept the surface of the earth, depends on the physical characteristics of the vehicle (size, shape, and weight), how it is operated (trajectory and speed), and the atmospheric conditions at the time. In general, the greater a vehicle's altitude, the lower the overpressure on the Earth's surface. Greater altitude also increases the boom's lateral spread, exposing a wider area to the boom. Overpressures in the sonic boom impact area, however, will not be uniform. The sonic boom levels vary along the lateral extent of the "carpet" with the highest levels directly underneath the flight track and weakens as distance from the flight track increases.

The peak pressure or intensity of the front shock wave of a sonic boom is quantified with physical pressure units (pounds per square foot [psf]) rather than levels. This additional pressure above normal atmospheric pressure is called overpressure. The change in air pressure associated with a sonic boom is only a few psf greater than normal atmospheric pressure. This is about the same pressure change experienced by a change in elevation of 20-30 ft (6-9 m) or riding an elevator down two or three floors. It is the sudden onset of the pressure change that makes the sonic boom audible. Overpressures >1 psf generally elicit public reaction (NASA 2017). For context, 2 psf is similar to thunder at 0.6 mile (1 km) (FAA 2002).

3.3.2 Noise Modelling of Inversion Capsule Reentry Operations

To determine the potential for a sonic boom, the modelling program PCBOOM was used. PCBoom is an acoustic modelling program developed by Wyle, Inc. in response to the need for a sonic boom model suitable for environmental analysis of commercial space vehicles and operations. For the current analysis, PCBoom version 4.99 was used and will be referred to simply as PCBoom hereafter. PCBoom is used to predict the peak overpressures and impact locations of a potential sonic boom generated by the Inversion capsule during reentry. During reentry and its descent from orbit, the Inversion capsule exceeds the speed of sound (i.e., becomes supersonic) and produces a sonic boom. PCBoom considers the size and shape of the vehicle and the trajectory in relationship to the thrust, drag, and weight of the vehicle, which vary during the flight of the vehicle, to estimate the initial signature of the overpressure.

PCBoom propagates the overpressure through site and seasonally specific meteorological conditions obtained from a 10-year rawinsonde database profile. A rawinsonde is a method of upper air observation consisting of an evaluation of the wind speed and direction, temperature, pressure, and relative humidity aloft by means of a balloon-borne radiosonde tracked by a radar or radio direction finder. The 10-year rawinsonde database is queried for data available for dates surrounding the proposed reentry date and approximately 120 meteorological conditions (each representing a single day in the database) are graphically presented. The data profile includes the high wind, low wind, low temperature, high temperature, and median profiles sampled evenly throughout each month of the year. Between 30 and 35 individual meteorological profiles are selected, which encompasses the range of potential conditions that could be encountered near the proposed reentry date. In addition, the meteorological condition that lies nearest the center of distribution is noted as the median profile. The PCBoom model is run for each meteorological profile and the results of each PCBoom run is projected within a Geographic Information System (GIS) as a scatterplot to illustrate the potential variance of boom locations. The median meteorological profile is also projected and contours (using psf as the interval) are generated to show the most "likely" sonic boom footprint.

PCBoom has been used for numerous environmental documents, including EAs, EISs, and to fulfil pre-launch monitoring requirements. Per FAA's *1050.1F Desk Reference* (FAA 2020), it is the only sonic boom modelling program approved by the FAA to support the environmental review of commercial space operations and associated licenses.

3.3.3 Study Area

The study area for noise includes the area of the Pacific Ocean potentially subject to the sonic boom during the proposed reentry of the Inversion capsule, as shown in **Figure 3.3-1**.

3.3.4 Existing Conditions

Existing noise levels within the study area are generally quite low due to the location within the open ocean more than 45 nm (83 km) from shore and relatively sparse noise sources. Wind and waves are the primary drivers of ambient in-air and in-water sound levels, with some louder intermittent noise levels from passing marine vessels.

3.3.5 Environmental Consequences

Based on the modeling results, the sonic boom would not intersect with land (**Figure 3.3-1.**). Received sonic boom levels at the water's surface would be a maximum of 0.02 psf. As the modeled sonic boom event does not overlap or otherwise affect the coastal zone, terrestrial areas, or marine protected areas (e.g., Monterey Bay National Marine Sanctuary), noise impacts to the marine environment related to the sonic boom would be less than significant. Further discussion regarding potential impacts to marine biological resources is provided below.

Airspace closures associated with the Proposed Action could result in temporarily grounded aircraft at affected airports and re-routing of en-route flights on established alternate flight paths. As noted above, the FAA has rarely received reportable departure delays associated with commercial space transportation reentry operations. Ground delays are also used under some circumstances to avoid airborne reroutes. If aircraft were grounded, noise levels at the airport could temporarily increase if the planes sit idle; some aircraft would likely shut down engines altogether until the closure has lifted. Also, depending on the altitude at which aircraft approach an airport, there could be temporary increases in noise levels in communities around the airports. Aircraft would travel on existing routes and flight paths that are used on a daily basis to account for weather and other temporary restrictions. Reentry missions would not affect the same aircraft routes or the same airports, and re-routing associated with potential reentry-related closures represents a small fraction of the total amount of rerouting that occurs from all other reasons in any given year. Any incremental increases in noise levels at individual airports would only last the duration of the airspace closure on a periodic basis and are not expected to meaningfully change existing day-night average sound levels at the affected airports and surrounding areas. Therefore, airspace closures due the Proposed Action are not expected to result in significant noise impacts.

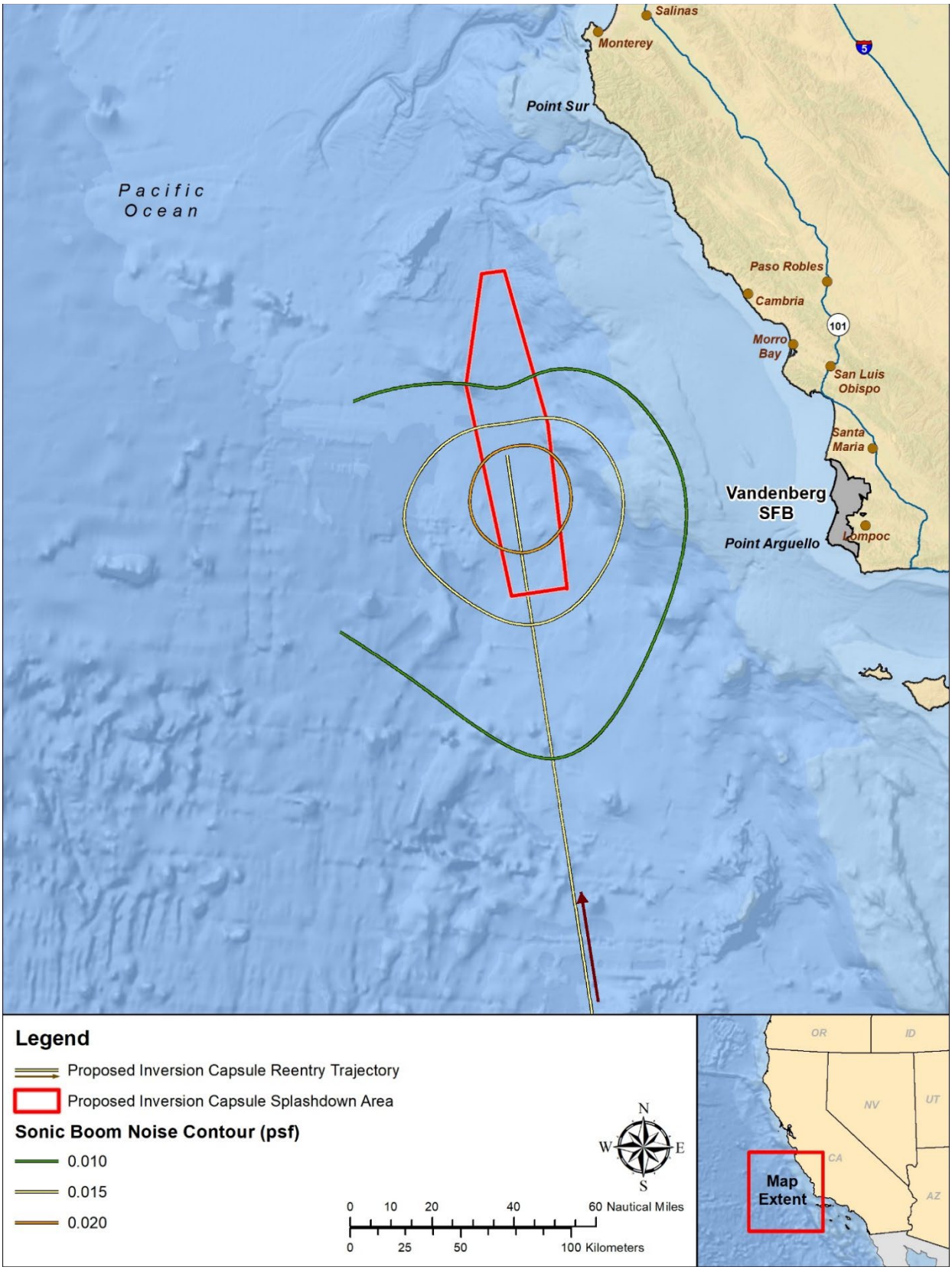

Figure 3.3-1. Modeled Potential Sonic Boom Contours from the Inversion Capsule during Reentry

3.4 MARINE BIOLOGICAL RESOURCES AND EFH ASSESSMENT

3.4.1 Definition of Resource and Regulatory Setting

Marine biological resources include living, native, or naturalized plant and animal species and the habitats within which they occur. Habitat can be defined as the resources and conditions present in an area that support a plant or animal. For the purposes of this EA, marine biological resources are divided into two categories: EFH and special-status species.

3.4.1.1 Essential Fish Habitat (EFH)

The MSA, enacted in 1976 and amended by the Sustainable Fisheries Act in 1996 and the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, mandates identification and conservation of EFH. EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities. In addition to EFH designations, areas called Habitat Areas of Particular Concern (HAPCs) are also designated by the regional Fishery Management Councils. Designated HAPCs are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. In accordance with Section 305(b)(2) of the MSA, Federal agencies are required to consult with the National Marine Fisheries Service (NMFS) and to prepare an EFH assessment if potential adverse effects on EFH are anticipated from their activities.

3.4.1.2 Special-status Species

Special-status species includes marine species within the study area that are listed under the federal ESA, including associated critical habitat; marine mammals listed under the Marine Mammal Protection Act (MMPA); and bird species listed pursuant to the Migratory Bird Treaty Act (MBTA).

Endangered Species Act (ESA)

The ESA of 1973 (16 USC 1531–1544) provides for the conservation of endangered and threatened species and the ecosystems on which they depend. The ESA defines an endangered species as a species in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The U.S. Fish and Wildlife Service (USFWS) and NMFS jointly administer the ESA and are responsible for listing species as threatened or endangered and for designating critical habitat for listed species. The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species. Section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species, that agency is required to consult with the service (NMFS or USFWS) that has jurisdiction over the species (50 CFR section 402.14(a)).

Marine Mammal Protection Act (MMPA)

The MMPA of 1972 established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The Act further regulates "takes" of marine mammals on the high seas by vessels or persons subject to U.S. jurisdiction. The term "take," as defined by the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the

MMPA, which provided two levels of harassment: Level A (potential injury) and Level B (potential behavioral disturbance).

The MMPA directs the Secretary of Commerce (through National Oceanic and Atmospheric Administration [NOAA] Fisheries, also known as NMFS) and the Secretary of the Interior (through the USFWS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens or agencies who engage in a specified activity (other than commercial fishing) within a specified geographical region if NMFS or USFWS finds that the taking will have a negligible impact on the species or stock(s), and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant).

Migratory Bird Treaty Act (MBTA)

The MBTA of 1918 (16 USC 703–712) and the Migratory Bird Conservation Act of 1929 (16 USC 715-715d, 715e, 715f–715r), are the primary laws in the United States established to conserve migratory birds. The MBTA prohibits the taking, killing, or possessing of migratory birds or the parts, nests, or eggs of such birds, unless permitted by regulation. The migratory bird species protected by the MBTA are listed in 50 CFR 10.13.

3.4.2 Study Area

The study area for marine biological resources includes those areas of the Pacific Ocean potentially subject to (1) the sonic boom during the proposed reentry of the Inversion capsule; (2) the splashdown area where capsule debris would impact the ocean's surface, water column, and bottom habitat; and (3) the transit corridor for the fishing vessel from Morro Bay to the recovery area and back (see **Figure 3.3-1**).

3.4.3 Existing Conditions

3.4.3.1 Essential Fish Habitat (EFH)

The Proposed Action is located within an area designated by the Pacific Fishery Management Council (PFMC) as EFH for three Fishery Management Plans: Coastal Pelagic Species (PFMC 2019), Pacific Coast Groundfish (PFMC 2022a), and Highly Migratory Species (PFMC 2022b). The PFMC is responsible for designating EFH for all federally managed species occurring in the coastal and marine waters off California, Oregon, and Washington. In addition to designating EFH, the PFMC is also responsible for identifying HAPCs for federally managed species. EFH that is important to the long-term productivity of populations of one or more managed species, or particularly vulnerable to degradation, may also be identified by NMFS as a HAPC.

EFH for Coastal Pelagic Species and Highly Migratory Species is defined both through geographic boundaries and by sea surface temperature ranges and includes all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the U.S. Exclusive Economic Zone (EEZ). Pacific Coast Groundfish EFH is defined as all waters and substrate within:

- depths less than or equal to 11,483 ft (3,500 m) to mean higher high-water level or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean derived salts measure less than 0.5 parts per thousand during the period of average annual low flow;
- seamounts in depths greater than 11,483 ft (3,500 m); or
- areas designated as HAPCs not already identified by the above criteria.

The entire study area overlies EFH for Coastal Pelagic Species and Highly Migratory Species. Pacific Coast Groundfish EFH is shown in **Figure 3.4-1**. As the proposed Inversion capsule

splashdown area does not overlie any HAPC (**Figure 3.4-1**), there would be no impacts to HAPCs from proposed Inversion RSR operations and HAPCs are not discussed further.

3.4.3.2 Special-Status Species

ESA-listed Species and MMPA-listed Species

A total of 12 ESA-listed species are known to occur or potentially occur within the deep open ocean waters of the study area: 6 marine mammals (4 baleen whales, 1 toothed whale, and 1 pinniped [seals and sea lions]), 5 sea turtles, and 1 fish (**Table 3.4-1**). Critical habitat for the Central America Distinct Population Segment (DPS) and Mexico DPS of the humpback whale (*Megaptera novaeangliae*) and leatherback turtle (*Dermochelys coriacea*) occurs within the study area (**Figure 3.4-2**).

Table 3.4-1. ESA-listed and MMPA-listed Species within the Inversion Capsule Reentry Study Area

Common Name (Scientific Name)	ESA Status
MARINE MAMMALS	
Suborder Mysticeti (baleen whales)	
Blue whale (*Balaenoptera musculus*)	Endangered
Bryde's whale (*Balaenoptera brydei/edeni*)	
Fin whale (*Balaenoptera physalus*)	Endangered
Gray whale (*Eschrichtius robustus*)	
Humpback whale (*Megaptera novaeangliae*) • Central America DPS • Mexico DPS	 Endangered/CH† Threatened/CH†
Minke whale (*Balaenoptera acutorostrata*)	
Sei whale (*Balaenoptera borealis*)	Endangered
Suborder Odontoceti (toothed whales)	
Baird's beaked whale (*Berardius bairdii*)	
Bottlenose dolphin (*Tursiops truncates*)	
Cuvier's beaked whale (*Ziphius cavirostris*)	
Dall's porpoise (*Phocoenoides dalli*)	
Dwarf sperm whale (*Kogia sima*)	
Killer whale (*Orcinus orca*)	
Long-beaked common dolphin (*Delphinus delphis bairdii*)	-
Mesoplodont beaked whales (*Mesoplodon* spp.)*	-
Northern right whale dolphin (*Lissodelphis borealis*)	
Pygmy sperm whale (*Kogia breviceps*)	
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)	
Pygmy killer whale (*Feresa attenuata*)	
Risso's dolphins (*Grampus griseus*)	
Short-beaked common dolphin (*Delphinus delphis*)	
Short-finned pilot whale (*Globicephala macrorhynchus*)	
Sperm whale (*Physeter macrocephalus*)	Endangered
Striped dolphin (*Stenella coeruleoalba*)	
Family Phocidae (true seals)	
Northern elephant seal (*Mirounga angustirostris*)	
Family Otariidae (eared seals)	
California sea lion (*Zalophus californianus*)	
Guadalupe fur seal (*Arctocephalus townsendi*)	Threatened
Northern fur seal (*Callorhinus ursinus*)	

Table 3.4-1. ESA-listed and MMPA-listed Species within the Inversion Capsule Reentry Study Area

Common Name (Scientific Name)	ESA Status
SEA TURTLES	
Green turtle (*Chelonia mydas*) – East Pacific DPS	Threatened
Hawksbill turtle (*Eretmochelys imbricata*)	Endangered
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered
Leatherback turtle (*Dermochelys coriacea*)	Endangered/CH†
Loggerhead turtle (*Caretta caretta*) – North Pacific DPS	Endangered
FISH	
Steelhead trout (*Oncorhynchus mykiss*) – Southern California DPS	Endangered

Notes: *The six Mesoplodont beaked whale species off California are *M. densirostris*, *M. carlhubbsi*, *M. ginkgodens*, *M. perrini*, *M. peruvianus*, and *M. stejnegeri*.
†CH = designated critical habitat within the study area.
Source: NOAA Fisheries 2022.

When critical habitat is proposed and then designated for a species in the Federal Register it describes the location and boundaries of the critical habitat and its physical and biological features (PBFs), also referred to as primary constituent elements (PCEs), that are essential to the conservation of an endangered or threatened species and that may require special management and protection. PBFs or PCEs may include: space for individual and population growth and for normal behavior; cover or shelter; food, water, air, light, minerals, or other nutritional or physiological requirements; sites for breeding and rearing offspring; and habitats that are protected from disturbances or are representative of the historical geographical and ecological distributions of a species. The PBF or PCE for critical habitat for both the humpback whale and leatherback turtle includes the presence of prey species of sufficient quality, abundance, and accessibility necessary to support individual as well as population growth, reproduction, and development of humpback whales and leatherback turtles. Both species feed on prey species in the water column – jellyfish for leatherback turtles and dense aggregations of small fish and krill for humpback whales (NMFS 2012, 2021).

In addition to the previously mentioned 6 ESA-listed marine mammals, which are also listed under the MMPA, an additional 27 marine mammal species listed only under the MMPA may occur within the study area, including 3 baleen whales, 21 toothed whales, and 3 pinnipeds (**Table 3.4-1**).

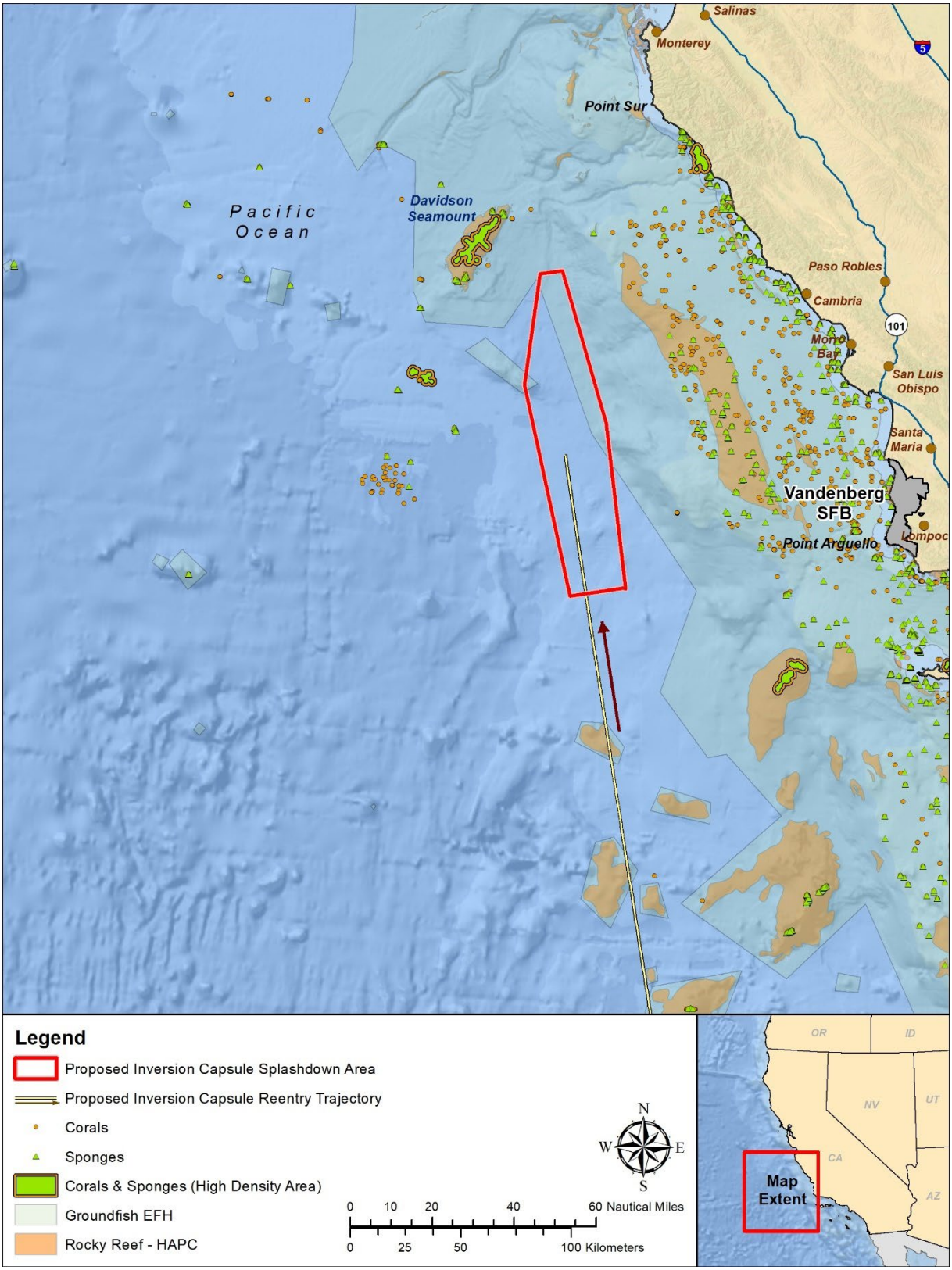

Figure 3.4-1. Occurrence of EFH in the Vicinity of the Proposed Inversion Capsule Splashdown Area
(*Source*: NOAA Fisheries 2021)

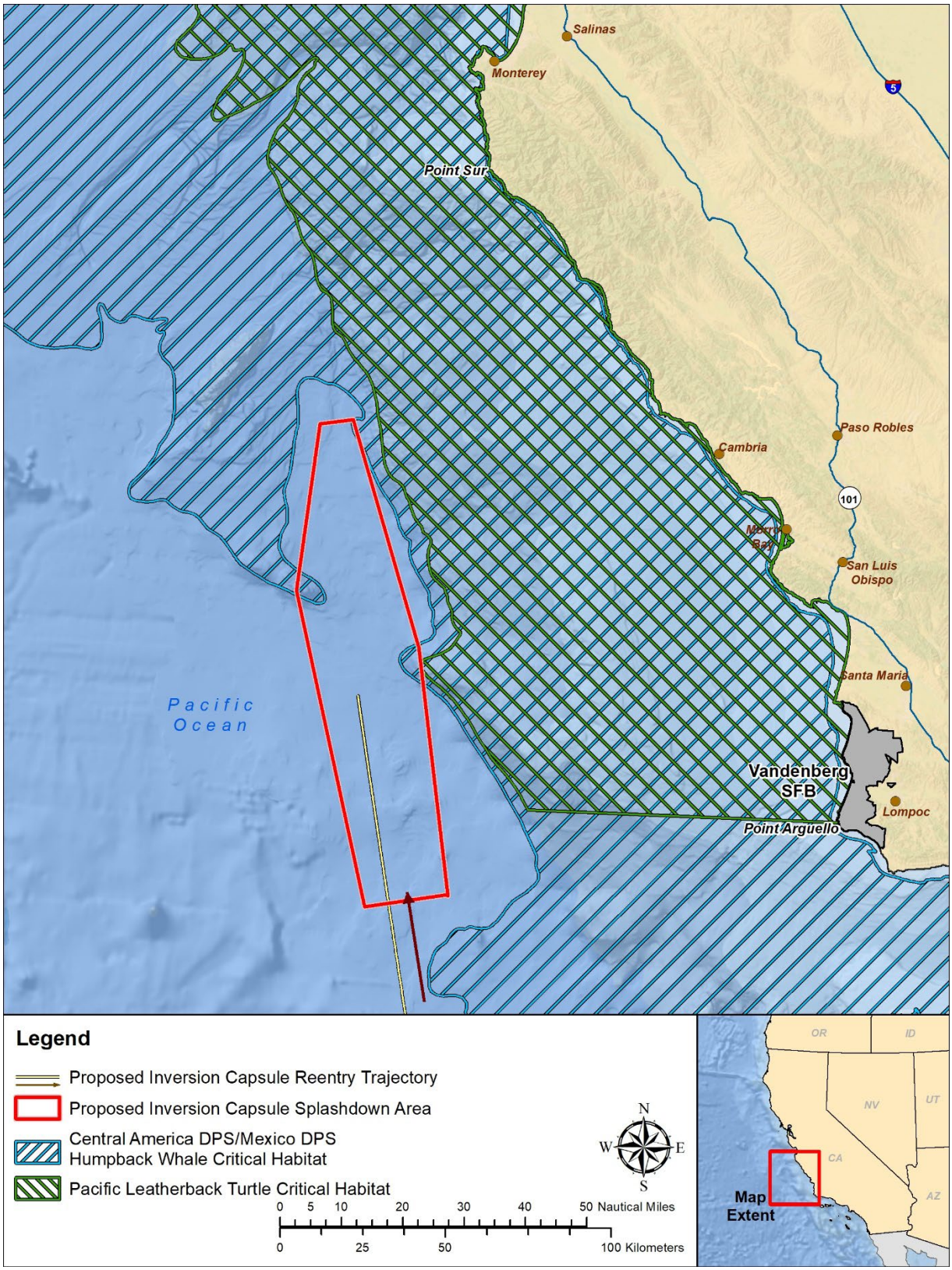

Figure 3.4-2. Occurrence of Designated Critical Habitat within the Vicinity of the Proposed Inversion Capsule Reentry Trajectory and Splashdown Area
(*Sources*: NMFS 2012, 2021)

MBTA-listed Species

The study area is immediately adjacent to the Southern California Bight, an indentation of the coastline at Point Conception, just southeast of Point Arguello, that creates a large backwater eddy or transition zone between warm equatorial waters and cold subarctic waters of the California Current (USFWS 2005). The California Channel Islands to the southeast of the study area provide important breeding sites for several seabirds, and the open waters within the study area are used by resident and migratory seabirds during a variety of life stages. A total of 47 MBTA-listed seabird species may occur within the study area, with shearwaters, storm-petrels, phalaropes, gulls, terns, and alcids being the most numerous. Of these species, 17 are known to breed in the area, 10 overwinter, and 20 migrate through (Baird 1990).

3.4.4 Environmental Consequences

Implementation of the Proposed Action may result in impacts to marine biological resources, particularly marine wildlife, from (1) capsule debris settling on the ocean bottom; (2) potential strikes of marine species from capsule debris and the capsule during reentry and splashdown, respectively; and (3) in-air and underwater acoustic impacts from the sonic boom under the Inversion capsule trajectory. During reentry the Inversion capsule would generate a sonic boom as it travels along its flight path or trajectory (**Figure 3.3-1**). The sonic boom would occur approximately 70 nm (130 km) from the closest point of land and would occur entirely over open ocean. Only one proposed Inversion reentry operation is proposed per year in 2024 and 2025.

3.4.4.1 Essential Fish Habitat (EFH)

During proposed Inversion capsule reentry operations, up to six items would be jettisoned from the capsule and not recovered (**Table 3.4-2** and **Figure 2.2-6(b)**). All of these items are expected to sink relatively quickly and settle on the ocean bottom at a depth >3,000 ft (914 m).

Table 3.4-2. Summary of Jettisoned Items Associated with the Reentry and Splashdown of the Inversion Capsule

Item	Material	Recovered/Fate	Size	Surface Area
Teflon lid for drogue parachute	Teflon	No/Sink to the sea floor	4.5 in x 2.75 in	0.4 ft^2
Container for drogue parachute	stainless steel	No/Sink to the sea floor	6.1 in x 1.1 in	0.05 ft^2
Drogue parachute	Kevlar and nylon	No/Sink to the sea floor	1.2 ft in x 18 ft	21.6 ft^2
Sabot	aluminum	No/Sink to the sea floor	5.2 in x 2.0 in	0.1 ft^2
Kevlar deployment bag	Kevlar	No/Sink to the sea floor	4.8 in x 3.6 in	0.1 ft^2
			Subtotal	**22.2 ft^2**
Main parachute	Kevlar and nylon	No/Sink to the sea floor*	20.7 ft x 13.8 ft	285.7 ft^2
			Potential Maximum Total	**307.9 ft^2**

Note: *The capsule recovery team would attempt to recovery the main parachute if it has not sunk when they arrive to recover the capsule.

The proposed splashdown area where the jettisoned items would potentially impact the ocean overlies approximately 105 square miles (272 square km) of EFH for Coastal Pelagic Species, Pacific Coast Groundfish, and Highly Migratory Species (**Figure 3.4-1**). The capsule and associated jettisoned materials are expected to splashdown within the center of the splashdown area. However, the total area of EFH that would be impacted with the settling of the jettisoned items onto the ocean bottom would be a maximum of approximately 308 ft^2 (28.6 m^2). Given the potential impact to EFH from this very small area of debris relative to the total area of EFH in the study area, there would be minimal adverse effects to EFH with implementation of the Proposed

Action. Therefore, in accordance with 50 CFR § 600.920(f), the FAA will consult with NMFS regarding impacts to EFH and this EA will be used as the EFH Assessment to support the EFH consultation process.

3.4.4.2 Special-status Species

As shown in **Figure 3.4-2**, the proposed Inversion capsule splashdown area overlies a small portion of humpback whale critical habitat along the western and eastern edges of the proposed splashdown area; it does not overlie leatherback critical habitat. However, the capsule and associated jettisoned materials are expected to splashdown within the center of the splashdown area. The PBF for critical habitat for the humpback whale includes the presence of prey species (small fish and krill) within the water column. All debris items associated with the proposed Inversion RSR operations would quickly sink to the bottom and would not impact prey species.

In January 2022, NMFS completed a programmatic ESA section 7 consultation with the FAA, NASA, and U.S. Space Force that focused on commercial space launches and reentries and their potential impacts to ESA-listed marine species (NMFS 2022). The programmatic consultation addressed the effects of similar reentry activities as currently proposed by Inversion. Therefore, the programmatic consultation applies to the proposed Inversion activities and further consultation is not required. The conclusions from the programmatic consultation are summarized below.

Debris Strikes and Entanglement

The action area (or study area) where objects could splashdown from proposed reentry operations encompasses vast expanses of ocean. ESA-listed species are sparsely distributed across these ocean expanses, resulting in very low densities of species overall. The probability of any ESA-listed species being in the same spot where reentry materials happen to strike the ocean is highly unlikely, and therefore, the risk of being directly hit by any falling objects from reentry operations is extremely low. In summary, because it would be extremely unlikely for an ESA-listed species to be directly struck by reentry-related debris, the potential for effects to ESA-listed species from a direct impact by those fallen objects are discountable. Therefore, NMFS (2022) concluded that direct impacts from fallen objects to ESA-listed marine mammals, sea turtles, and fish because of reentry activities may affect, but are not likely to adversely affect these species.

Implementation of the proposed Inversion RSR operations would include recovery of the main parachute to the maximum extent practicable. With the proposed recovery of parachutes associated with reentry operations, and in the rare occasion they are not recovered, NMFS (2022) concluded that due to the limited time they would spend in the water column and settling typically in the deep ocean (> 9,800 ft [3,000 m]), exposure of ESA-listed mammals, sea turtles, or fishes to the parachutes is extremely unlikely and therefore the risk of entanglement is discountable. In addition, none of the ESA-listed species considered in NMFS (2022) and in this EA forage that deep. Therefore, the likelihood of them encountering ingestible material or becoming entangled once it has settled over the long-term is expected to be extremely unlikely to occur and thus discountable (NMFS 2022).

Inversion Capsule Sonic Boom

Given the acoustic energy from a sonic boom in the air does not effectively cross the air/water interface and most of the noise is reflected off the water surface (Richardson et al. 1995), overpressure from a sonic boom is not expected to affect marine species underwater. In addition, underwater sound pressure levels from in-air noise are not expected to reach or exceed threshold levels for injury or harassment to ESA-listed species (NMFS 2022). Although ESA-listed marine

mammals and sea turtles could be exposed to the overpressures from sonic booms in the air when they are surfacing for air, the chances of both events happening at same time (i.e., species surfacing and a sonic boom occurring) is extremely unlikely, especially considering the length of a sonic boom is less than 1 second (100 milliseconds). Therefore, given it is extremely unlikely that an ESA-listed sea turtle or marine mammal would surface at the exact moment to be exposed to a sonic boom of 0.02 psf in the air from the Inversion capsule reentry, the effects are discountable. Any ESA-listed sea turtle, marine mammal or fish underwater are not expected to be exposed to measurable acoustic effects from a sonic boom therefore, the effects are insignificant (NMFS 2022). In addition, as there is no sound-related essential feature (or PBF) defined for either humpback whale or leatherback turtle critical habitat (NMFS 2012, 2021), the occurrence of a sonic boom would have no impact on humpback whale or leatherback turtle critical habitat.

3.4.4.3 MBTA-listed Species

Debris Strikes and Entanglement

Potential impacts to seabirds from Inversion capsule debris during reentry operations would be the same as that previously discussed above for special-status species. Because it would be extremely unlikely for a seabird species to be directly struck by reentry-related debris, the potential for effects to MBTA-listed species from a direct impact by those fallen objects are discountable.

Inversion Capsule Sonic Boom

Although there have been no specific studies on the effects of sonic booms on seabirds in the marine environment (i.e., on or flying above the ocean's surface), the following discussion presents a summary of some of the more relevant studies addressing the potential effects of sonic booms on birds.

Teer and Truett (1973) examined reproductive success in mourning dove (*Zenaida macroura*), northern mockingbird (*Mimus polyglottus*), northern cardinal (*Cardinalis cardinalis*), and lark sparrow (*Chondestes grammacus*) when exposed to sonic booms >1 psf and found no adverse effects. Rylander et al. (1974) conducted experiments to observe the reaction of various bird species (ducks, gulls, and eiders) when exposed to sonic booms ranging from 1.2 to 13.4 psf. Reactions were small, with slight startle responses among all species. Awbrey and Bowles (1990) in a review of the literature on the effects of aircraft noise and sonic booms on raptors found that the available evidence shows very marginal effects on reproductive success. Ellis et al. (1991) examined the effects of sonic booms (actual and simulated) on eight nesting raptor species. While some individuals did respond by leaving the nest, the response was temporary and, overall, there were no adverse effects on nesting. Robinette and Rice (2019) found no differences in overall abundance or nest attendance of threatened western snowy plovers (*Charadrius nivosus nivosus*) or endangered California least tern (*Sterna antillarum browni*) before, during, and after the launch of a SpaceX Falcon 9 rocket and the associated sonic boom. Incubating snowy plovers were observed to startle and then either jump or hunker down in response to the sonic boom. The estimated received sonic boom overpressure level at the monitored western snowy plover nest area was 3.6 psf. Although incubating least terns at five nests left their nests prior to the sonic boom, all were back on their nests within less than a minute after the sonic boom. The estimated received sonic boom overpressure level at the monitored least tern nesting area was 2.6 psf (Robinette and Rice 2019).

The most important factor to consider with respect to the impact of the proposed Inversion capsule sonic boom on wildlife species is the fact that the event is relatively short (1 second) and would

only occur once. Although noise disturbance may cause animals to startle, flee, or have increased short-term energetic needs, these effects are expected to be relatively brief and last only as long as it will take for an individual to reach an alternate foraging area or for the effect to dissipate. In addition, the majority of studies have found that wildlife species displaced by a short-term noise event such as a sonic boom returned shortly after the event to the area where they occurred prior to the sonic boom and resumed normal activities (e.g., resting, foraging, and attending a nest with eggs or nestlings). In addition, the maximum modelled sonic boom level of the Inversion capsule upon reentry is 0.02 psf. Based on the studies discussed above, this is significantly below psf levels of 2 and up to 13.4 that had no significant effects to bird species. Therefore, in-air noise from a sonic boom from the Inversion capsule during reentry would not have a significant impact on MBTA-listed species underlying the sonic boom footprint.

3.4.5 Mitigation

In accordance with the 2022 Programmatic Concurrence Letter issued by NMFS for effects on ESA-listed species from commercial space launch and reentry operations, the following Project Design Criteria (PDCs) would be implemented by Inversion as part of the Proposed Action. As stated in the programmatic consultation, PDCs include environmental protection measures developed by the FAA to limit the effects of launch and reentry operations. These environmental protection measures will lead to avoidance and minimization of effects to ESA-listed species and MBTA-listed species in the study area to assist in the conservation of these resources (NMFS 2022).

3.4.5.1 General PDCs

No activities will occur in or affect a National Marine Sanctuary unless the appropriate authorization has been obtained from the Sanctuary.

3.4.5.2 Recovery 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. Marine vessel operators will ensure the vessel strike avoidance measures and reporting are implemented and will maintain a safe distance by following these protective measures:

- Maintain a minimum distance of 150 ft from sea turtles.
- Maintain a minimum distance of 300 ft (100 yards) from all other ESA-listed and MMPA-listed species. If the distance ever becomes less than 300 ft, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area.
- Watercraft operators will reduce speed to 10 knots or less when mother/calf pairs or groups of marine mammals are observed.
- Attempt to remain parallel to an ESA-listed or MMPA-listed species' course when sighted while the watercraft is underway (e.g., bow-riding) and avoid excessive speed or abrupt changes in direction until the animal(s) has left the area.

3.4.5.3 Annual Reporting

To assist the FAA in its annual reporting requirements to NMFS in accordance with the programmatic consultation (NMFS 2022), Inversion will provide the following at the conclusion of the proposed capsule RSR operation:

1) The date and location of the reentry operations, including reentry vehicle and any relevant license or permit that authorized the activities;
2) Contact information for the agencies and commercial entities involved in the reentry event;

3) Details of reentry operation that may affect the marine environment, such as entry of materials into the marine environment;
4) Dates of reentry and recovery operations if different from launch date;
5) Approximate locations with GPS coordinates when available of all splashdown areas, including parachute recoveries and capsule recovery. Information should also be provided regarding support vessels used during operations and transit routes;
6) Any available information on the location and fate of unrecovered parachutes, expended components and debris;
7) Information regarding the implementation of the Environmental Protection Measures described above, including any issues identified by an observer or other crew member, divers or other personnel engaged in in-water activities;
8) Any information regarding effects to ESA-listed and MMPA-listed species due to the capsule recovery activities; and
9) Sighting logs with observations of ESA-listed and MMPA-listed species with date, time, location, species (if possible, to identify), number of animals, distance and bearing from the vessel, direction of travel, and other relevant information

Chapter 4. Cumulative Effects

Cumulative impacts are defined by CEQ as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR §1508.1(g)(3)). The FAA analyzed the potential cumulative impacts in accordance with CEQ regulations and FAA Order 1050.1F.

For this EA, spatial and temporal boundaries were delineated to determine the area and projects the cumulative analysis would address. For this cumulative analysis, the spatial boundary is the Inversion capsule splashdown area (see **Figure 2.2-1**). The temporal boundary includes past actions that have occurred within the last 3 years, and reasonably foreseeable future actions include those that are planned to occur within the next 5 years. The projects identified in the following sections include those that had or have the potential to affect the environmental impact categories that are analyzed in this EA.

4.1 Past Actions

No projects within the last 3 years have been identified within or in the vicinity of the proposed splashdown and recovery activities that would result in potential cumulative effects when combined with the Proposed Action.

4.2 Present Actions

Present actions within the Inversion capsule splashdown and recovery area that may result in potential cumulative effects when combined with the Proposed Action include on-going commercial marine vessel operations and military activities, particularly aircraft operations. Given the very short duration and limited spatial extent of the proposed Inversion splashdown and recovery activities, there would be no cumulative effects from current marine vessel and military activities when combined with the Proposed Action.

4.3 Reasonably Foreseeable Future Actions

No future actions or projects were identified within or in the vicinity of the proposed splashdown and recovery activities that would result in potential cumulative effects when combined with the Proposed Action.

4.4 Environmental Consequences

This EA uses information presented in Sections 4.1, 4.2, and 4.3 to determine potential cumulative impacts. The Proposed Action's impacts were analyzed for their potential to result in cumulative impacts when added to past, present, and reasonably foreseeable future actions.

As discussed in Section 3.1, implementation of the Proposed Action would result in no impact to the following impact categories: air quality; climate; coastal resources; Department of Transportation Act, Section 4(f) properties; farmlands; land use; natural resources and energy supply; hazardous materials, solid waste, and pollution prevention; historical, architectural, archeological, and cultural resources; socioeconomics, environmental justice, and children's environmental health and safety risks; visual effects; and water resources. Therefore, when combined with past, present, and reasonably foreseeable projects, the Proposed Action would not result in cumulative impacts to these impact categories.

Implementation of the Proposed Action would result in less than significant impacts related to noise and marine biological resources. As no past or reasonably foreseeable projects and actions have been identified within the Inversion capsule splashdown area spatial boundary, implementation of the Proposed Action would not result in significant cumulative impacts to any resource area assessed in this EA.

Chapter 5. List of Preparers and Agencies and Persons Consulted

5.1 LIST OF PREPARERS

FAA

Lonnie Covalt, Lead Environmental Protection Specialist
Air Traffic Operations (ATO), Western Service Center, Operations Support Group

Daniel Czelusniak, Project Manager, Environmental Protection Specialist
Office of Commercial Space Transportation

Leslie Grey, Deputy Project Manager, Environmental Protection Specialist
Office of Commercial Space Transportation

Andrew Leske, Project Manager, Environmental Protection Specialist
Office of Commercial Space Transportation

USCG

LT Katie Clark, Eleventh Coast Guard District, Waterways

Tyrone Conner, Space and Maritime Safety Senior Program Manager, USCG Headquarters

Inversion Space Company

Austin Briggs, Chief Technical Officer and Co-Founder

Collin Corey, Head of Regulatory Licensing

ManTech Advanced Systems International Corp.

Rick Spaulding, Senior Biologist/Project Manager
MS, Wildlife and Fisheries Science
BA, Biology
Years of Experience: 34

Karen Waller, Vice President/Quality Assurance
MBA
BS, Public Affairs
Years of Experience: 30

Lawrence Wolski, Marine Scientist/Noise Specialist
MS, Marine Sciences
BS, Biology
Years of Experience: 22

Nicholas Look, Graphics & GIS
Graduate Certificate, GIS
BS, Database Administration
Years of Experience: 23

5.2 AGENCIES AND PERSONS CONSULTED

NOAA – Monterey Bay National Marine Sanctuary
99 Pacific Street, Bldg. 455A
Monterey, CA 93940

NOAA - National Marine Fisheries Service
Southwest Regional Office
501 West Ocean Blvd
Long Beach, CA 90802-4213

U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726

U.S. Environmental Protection Agency, Region 9
Environmental Review Branch
Tribal, Intergovernmental and Policy Division
75 Hawthorne St. TIP-2
San Francisco, CA 94105

California Coastal Commission - Energy, Ocean Resources and Federal Consistency Division
455 Market Street, Suite 228
San Francisco, CA 94105-2219

California Environmental Protection Agency
1001 I Street
P.O. Box 2815
Sacramento, CA 95812-2815

Office of the Governor
Office of Planning and Research
Attn: State Clearinghouse
1400 10th Street
Sacramento CA 95814

Santa Barbara County Air Pollution Control District
260 N. San Antonio Road, Suite A
Santa Barbara, CA 93110-1315

Environmental Defense Center
906 Garden Street
Santa Barbara, CA 93101

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