PRELIMINARY FINAL

ENVIRONMENTAL ASSESSMENT/OVERSEAS ENVIRONMENTAL ASSESSMENT

For

Flight Experiment 1 (FE-1)

Responsible Agencies

Cooperating Agency

Participating Agency

July 2017

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Abstract

Designation:	Environmental Assessment (EA)/Overseas Environmental Assessment (OEA)
Title of Proposed Action:	Flight Experiment 1 (FE-1)
Project Location:	Pacific Missile Range Facility, Hawai`i, and US Army Kwajalein Atoll, Republic of the Marshall Islands
Lead Agency for the EA/OEA:	Department of the Navy, US Navy Strategic Systems Programs
Cooperating Agency:	Department of Energy
Participating Agency:	US Army Space and Missile Defense Command/Army Forces Strategic Command
Affected Region:	Barking Sands, Kauai, Hawai`i, Broad Ocean Areas in the Pacific Ocean, and US Army Kwajalein Atoll, Republic of the Marshall Islands
Action Proponent:	US Navy Strategic Systems Programs
Point of Contact:	Mr. Fred Chamberlain Strategic Systems Programs 1250 10th Street, SE Washington Navy Yard, DC 20374-5127 Sp20161@ssp.navy.mil
Date:	July 2017

The Proposed Action, Flight Experiment 1 (FE-1), is sponsored by the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, which has designated the United States Department of the Navy (US Navy) Strategic Systems Programs (SSP) as the lead agency and action proponent of the Proposed Action. The US Navy, along with the Department of Energy (DOE) as cooperating agency and the US Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) as participating agency, has prepared this Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality Regulations and Navy regulations for implementing NEPA.

The purpose of the Proposed Action is to collect data on a developmental payload by testing range performance and to demonstrate technologies for prospective strike capabilities. Specifically, the FE-1 experiment would develop, integrate, and flight test the developmental payload concept to demonstrate the maturity of key technologies. These technologies include precision navigation, guidance and control, and enabling capabilities.

The need for the Proposed Action is to provide flight test data and information required by the DoD to provide a basis for ground testing, modeling, and simulation of developmental payload performance applicable to a range of possible FE-1 concepts being studied as a way to inform potential future strike capability determinations.

The Proposed Action would be one experimental flight test within a year after signing the Finding of No Significant Impact, if approved. This EA/OEA assesses all potential environmental impacts associated with the Proposed Action, any viable alternatives, and the No-Action Alternative, including the analysis of the following resource areas: air quality, air space, biological resources, cultural resources, hazardous materials and wastes, noise, public health and safety, and water resources.

EXECUTIVE SUMMARY

Proposed Action

The Proposed Action, Flight Experiment 1 (FE-1), is sponsored by the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, which has designated the United States (US) Department of the Navy (US Navy) Strategic Systems Programs (SSP) as the lead agency and action proponent of the Proposed Action. The US Navy SSP proposes to conduct a developmental flight test as described in this Environmental Assessment (EA)/Overseas Environmental Assessment (OEA). The US Navy, along with the Department of Energy (DOE) as cooperating agency and the US Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) as participating agency, has prepared this Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations and Navy regulations for implementing NEPA. The Proposed Action would be one experimental flight test within a year after signing a Finding of No Significant Impact (FONSI), if approved.

Purpose of and Need for the Proposed Action

The purpose of the Proposed Action is to collect data on a developmental payload by testing range performance and to demonstrate technologies for prospective strike capabilities. Specifically, the FE-1 experiment would develop, integrate, and flight test the developmental payload concept to demonstrate the maturity of key technologies. These technologies include precision navigation, guidance and control, and enabling capabilities.

The need for the Proposed Action is to provide flight test data and information required by the DoD to provide a basis for ground testing, modeling, and simulation of developmental payload performance applicable to a range of possible FE-1 concepts being studied as a way to inform potential future strike capability determinations.

Alternatives Considered

Alternatives were generated and evaluated using screening criteria of existing launch facilities and impact areas, to include their ability to support the flight test distances, infrastructure, equipment, instrumentation for data collection, and their availability to the Navy in the planned flight test timeframe. Only the Proposed Action meets the purpose and need, however, the US Navy is also considering the No Action Alternative, as required by the CEQ regulations.

Summary of Environmental Resources Evaluated in the EA/OEA

CEQ regulations, NEPA, and Navy instructions for implementing NEPA, specify that an EA/OEA should address those resource areas potentially subject to impacts. In addition, the level of analysis should be commensurate with the anticipated level of environmental impact.

The following resource areas have been analyzed in this EA/OEA:

Pacific Missile Range Facility:

Air quality, water resources, biological resources, air space, noise, public health and safety, hazardous materials and waste

Over-Ocean Flight Corridor:

Air quality, biological resources

US Army Kwajalein Atoll and Ronald Reagan Ballistic Missile Defense Test Site:

Cultural resources, biological resources, noise, public health and safety, hazardous materials and waste

Because potential impacts were considered to be negligible or nonexistent, the following resources were not evaluated in this EA/OEA:

Pacific Missile Range Facility:

Geological resources, cultural resources, land use, infrastructure, transportation, socioeconomics, environmental justice, visual resources, and marine sediments

Over-Ocean Flight Corridor:

Water resources, geological resources, cultural resources, land use, air space, noise, infrastructure, transportation, public health and safety, hazardous materials and wastes, socioeconomics, environmental justice, visual resources, and marine sediments

US Army Kwajalein Atoll and Ronald Reagan Ballistic Missile Defense Test Site:

Air quality, greenhouse gases, and climate change; water resources, geological resources, land use, air space, infrastructure, transportation, socioeconomics, environmental justice, visual resources, and marine sediments

Summary of Potential Environmental Consequences of the Action Alternatives and Major Mitigating Actions

Pacific Missile Range Facility:

Air Quality, Greenhouse Gases, and Climate Change – No impacts to air quality or air resources would occur with implementation of the No Action Alternative. The Strategic Target System (STARS) booster has been previously launched at SNL/KTF, and it is anticipated that the launch of the FE-1 flight test at the same site would have a similar air quality impact as described for the No Action Alternative. Because the STARS is relatively small and the launch is a short-term, discrete event, the time between launches of the Proposed Action and other launches scheduled from SNL/KTF would allow the dispersion of greenhouse gases and ozone depleting substances. Therefore, implementation of the FE-1 flight test would not result in significant impacts to air quality.

Water Resources – No significant impacts to water resources would occur with implementation of the No Action Alternative. Based on previous analysis and sampling, the Proposed Action activities do not adversely affect water resources. Therefore, implementation of the Proposed Action would not result in significant impacts to water resources.

Biological Resources – No significant impacts to biological resources would occur with implementation of the No Action Alternative. The area for the analysis of effects to biological resources associated with the Proposed Action includes SNL/KTF for the greatest launch effects. Surrounding terrestrial and marine areas of PMRF may also be affected by hazardous chemicals, increased sound pressure levels, and increased human and vessel activity. No long term adverse impacts on vegetation are expected. No threatened or endangered plants have been observed on PMRF and critical habitat for the ohai and lau`ehu would not be affected by the action. Wildlife species such as birds may be impacted by elevated sound pressure levels from launch as well as hazardous chemicals, increased human activity, and direct contact from debris. The launch site at KTF is in an area that has routine human activity, equipment operation, and launch activity. Pre-launch activities at KTF include final vehicle and experiment assembly, preflight checks, and demonstration of system performance. None of these activities will take place at night and lights will not be turned on at night for any FE-1 activities during the period of concern for Newell's shearwaters. If program activities are required to occur at night (outside the Newell's shearwater period of concern), the US Navy will coordinate these activities through PMRF to comply with the Dark Skies policy. Marine wildlife species, which include marine mammals and sea turtles, have the potential to be impacted by elevated sound pressure levels, hazardous chemicals, direct contact from debris, and disturbance from increase human or equipment operation. The offshore waters of PMRF is an area that has routine human activity, equipment operation, and launch activity. The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact along the flight corridor, potentially in offshore waters. If humpback whales, monk seals, or sea turtles were observed in the offshore launch safety zone, the launch would be delayed. Some fish near the surface could be injured or killed by larger pieces of debris. It is unlikely that the smaller pieces of sinking debris would have sufficient velocity to harm individual marine mammals or fish.

Air Space – No significant impacts to airspace would occur with implementation of the No Action Alternative. The advanced planning and coordination with the Federal Aviation Administration regarding: scheduling of special use airspace, and coordination of the proposed FE-1 flight test relative to en route airways and jet routes, would result in minimal impacts on airspace and implementation of the Proposed Action would not result in significant impacts to airspace.

Noise – No significant impacts due to the noise environment would occur with implementation of the No Action Alternative. The STARS booster has been previously launched at SNL/KTF, and noise levels would be the same as previous launches. The Proposed Action would produce similar noise levels to previous STARS launches at SNL/KTF. Therefore, implementation of the FE-1 flight test would not result in significant impacts to the noise environment.

Public Health and Safety – No significant impacts would occur with implementation of the No Action Alternative. The FE-1 flight test would include the launch of a STARS booster with the payload from SNL/KTF. The STARS booster has been previously launched at SNL/KTF. The testing of the developmental payload at the same site would have a similar potential health and safety impact as described for the No Action Alternative. The proposed solid propellants would be similar to past launches and would follow the same health and safety procedures developed under existing plans. The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact at PMRF or along the flight corridor. In most cases, an errant missile would be moving at such a high-speed that resulting missile debris would strike the water further downrange. Therefore, implementation of the Proposed Action would not result in significant impacts to public health and safety.

Hazardous Materials and Waste – No significant impacts would occur with implementation of the No Action Alternative. The STARS booster has been previously launched at SNL/KTF, and hazardous materials and wastes would be the same for these launches. The launch of the Proposed Action would be anticipated to use similar hazardous materials and produce similar hazardous waste. This launch is included in the overall number of missile launches proposed in previous environmental documentation. Hazardous material usage and waste generation would continue to be managed by PMRF under appropriate State and Federal requirements. Therefore, implementation of the Proposed Action would not result in significant impacts with hazardous materials and wastes.

Major Mitigating Actions are not required for any of the noted resources at PMRF. Minor mitigation activities are incorporated into the Proposed Action such that there are no significant impacts to any resource from the planned activities.

Over-Ocean Flight Corridor:

Air Quality, Greenhouse Gases, and Climate Change – No significant impacts would occur to air quality, the greenhouse gases, or climate change from the FE-1 flight test in the Over-Ocean Flight Corridor. The active flight time over the region of influence would be measured in minutes, the emissions would be from a single flight, the majority of emissions would be removed from the atmosphere through dry deposition and precipitation or diffusion and wind dispersion. The STARS booster would be relatively small compared to emissions released on a global scale. Due to the large air volume over which these emissions are spread, and the rapid dispersion of the emissions by stratospheric winds, a single launch of a STARS booster would not be expected to have a significant impact on the upper atmosphere. Ozone-depleting gas emissions from the single flight test would represent a minute increase and even incremental effects on the global atmosphere are not likely. Because of the solid propellant used, the launch would release only a small quantity of carbon dioxide. This limited amount of emissions would not likely contribute to global warming or climate change to any discernible extent.

Biological Resources – No significant impacts to biological resources would occur with implementation of the No Action Alternative. Potential impacts of the Action in the broad ocean area of the over-ocean flight corridor include the effects of elevated sound pressure levels, direct contact from missile debris, exposure to hazardous chemicals, and increased human and vessel activity. Seabirds, marine mammals, sea turtles, and fish may be affected by elevated sound pressure levels. Any disturbances from elevated sound pressure levels are likely to be temporary, behavioral modifications with no lasting effects. The chances of a marine mammal or sea turtle being directly contacted by falling vehicle components are so low as to be discountable. Any hazardous materials released into the waters of the broad ocean area would be rapidly diluted by seawater and larger and heavier components would sink to the ocean floor fairly quickly where organisms are not likely to be in contact with hazardous materials. No significant impacts from these stressors are expected for seabirds, marine mammals, sea turtles, or fish in the over-ocean flight corridor.

Major Mitigating Actions are not required for any of the noted resources within the Over-Ocean Flight Corridor. As this is a single flight test, impacts are very limited and temporary such that there are no significant impacts to either noted resource from the planned activities.

US Army Kwajalein Atoll and Ronald Reagan Ballistic Missile Defense Test Site:

Illeginni Islet

Cultural Resources – No significant impacts would occur to cultural resources on Illeginni Islet. The developmental payload would impact on the west side of Illeginni Islet. Existing surface cover and site disturbance from construction of a helipad, roads, and facilities, and operations including previous missile flight tests with land impacts encompass almost the entirety of Illeginni Islet. A land impact would not occur in proximity to known or potential cultural resources on Illeginni Islet. Personnel involved in the FE-1 flight test operational activities would be briefed on and would follow UES requirements in handling or avoiding any cultural resources uncovered during operational or monitoring activities.

Biological Resources – No significant impacts to biological resources would occur with implementation of the No Action Alternative. Potential impacts of the Action at and near Illeginni Islet include the effects of elevated sound pressure levels, direct contact from payload impact, exposure to hazardous chemicals, and increased human and vessel activity. The payload impact area at Illeginni is previously disturbed habitat and vegetation; therefore, terrestrial vegetation would not be adversely impacted. Nesting and roosting seabirds have the potential to be affected by elevated sound pressure levels, direct contact, and human disturbance. Mitigation measures would be employed to deter birds from nesting or roosting in the impact area and while birds may be temporarily startled by sounds, any behavioral or physiological response is likely to be brief. Mitigation measures would be employed to decrease the chances of there being effects on sea turtles from direct contact from payload impact, exposure to hazardous chemicals, and disturbance from human activity and equipment operation. The US Fish and Wildlife Service was provided a biological assessment for these activities and their Letter of Concurrence has been included as an appendix in the Final EA/OEA. Sea turtles in the water and fish may be exposed to elevated sound pressure levels high enough to elicit a behavioral response. Any responses are likely to be temporary, with organisms quickly returning to normal behaviors; therefore, no significant impacts are expected for sea turtles in the water, marine mammals, or most fish species near Illeginni Islet. Direct contact from payload impact as well as disturbance from human activity and equipment operation may adversely affect coral colonies, individual mollusks, and humphead wrasses. The National Marine Fisheries Service was provided a biological assessment for these activities and the findings of their Final Biological Opinion are included as an appendix in the Final EA/OEA.

Noise – No significant impacts would occur from noise generated during the pre-test and post-test activities or during the impact of the payload at Illeginni Islet. There is no resident population at or near Illeginni Islet, and during the flight test, RTS would verify that no non-mission vessels would be in the area. Ship-board personnel on mission vessels may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program. Sonic boom noise at impact would be audible only once and would last a fraction of a second.

Public Health and Safety – No significant impacts to public safety with occur from the FE-1 flight test during an Illeginni Islet impact. A flight termination system would perform a failsafe operation to ensure debris would fall short of any protected or inhabited area if performance were not within safety criteria. There are no resident populations at or near Illeginni Islet. A NOTMAR and NOTAM would be issued to clear commercial, private, and non-mission military vessel and aircraft traffic from caution areas and the Government of the RMI also would be informed in advance. Radar and visual sweeps of hazard areas would be regularly scheduled and conducted prior to launch to clear any non-mission ships and aircraft.

Hazardous Materials and Wastes – No significant impacts would occur to hazardous materials and waste from the FE-1 flight test with an impact at Illeginni Islet. Hazardous materials used in the developmental payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, DU, Be, or radioactive materials would be carried on the developmental payload. Following impact, all visible debris would be recovered, and all equipment and materials would be recovered from Illeginni Islet. Any hazardous waste resulting from FE-1 flight test activities on Illeginni Islet would be disposed of in accordance with the UES.

Major Mitigating Actions are not required for any of the noted resources at Illeginni Islet. As this is a single flight test, impacts are very limited and temporary such that there are no significant impacts to either noted resource from the planned activities.

Offshore Waters - Southwest and Northeast

Cultural Resources – No cultural resources have been identified in either Offshore Waters location. No impacts to cultural resources would occur from the FE-1 flight test.

Biological Resources – No significant impacts to biological resources would occur with implementation of the No Action Alternative. Potential impacts of the Action at and near Illeginni Islet include the effects of elevated sound pressure levels, direct contact from payload impact, exposure to hazardous chemicals, and increased human and vessel activity. Foraging and resting seabirds have the potential to be affected by elevated sound pressure levels, direct contact, and human disturbance. Mitigation measures will be employed to deter birds from roosting on sensor rafts and while birds may be temporarily startled by sounds, any behavioral or physiological response is likely to be brief and no significant impacts are expected. Sea turtles in the water, marine mammals, and fish may be exposed to elevated sound pressure levels high enough to elicit a behavioral response. Any responses are likely to be temporary, with organisms quickly returning to normal behaviors. Sea turtles, marine mammals, fish, and larval fish, coral, and mollusks have a small chance of being adversely affected by direct contact from payload impact. While these organisms also may be affected by vessel strike, exposure to hazardous chemicals, and disturbance from human activity; no significant impacts are expected for sea turtles, marine mammals, or fish in the offshore impact areas.

Noise – No significant impacts would occur from noise generated during the pre-test and post-test activities or during the impact of the payload in either Offshore Waters location. There is no resident population at or near either of these sites, and during the flight test, RTS would verify that no non-mission vessels would be in the area. Ship-board personnel on mission vessels may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program. Sonic boom noise at impact would be audible only once and would last no more than a fraction of a second.

Public Health and Safety – No significant impacts to public safety with occur from the FE-1 flight test during an Offshore Waters impact. A flight termination system would perform a failsafe operation to ensure debris would fall short of any protected or inhabited area if performance were not within safety criteria. There are no resident populations at or near either Offshore Waters location. A NOTMAR and NOTAM would be issued to clear commercial, private, and non-mission military vessel and aircraft traffic from caution areas and the Government of the RMI also would be informed in advance. Radar and visual sweeps of hazard areas would be regularly scheduled and conducted prior to launch to clear any non-mission ships and aircraft.

Hazardous Materials and Wastes – No significant impacts would occur to hazardous materials and waste from the FE-1 flight test with an impact at either Offshore Waters location. Hazardous materials used in the developmental payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, DU, Be, or radioactive materials would be carried on the developmental payload. Following impact, any floating debris would be recovered, and all equipment and rafts would be recovered. Any hazardous waste resulting from FE-1 flight test activities in the Offshore Waters would be disposed of in accordance with the UES.

Major Mitigating Actions are not required for any of the noted resources within the Offshore Waters – Southwest and Northeast. As this is a single flight test, impacts are very limited and temporary such that there are no significant impacts to either noted resource from the planned activities.

Table ES-1 provides a tabular summary of the potential impacts to the resources associated with each of the alternative actions analyzed.

Public Involvement

The Navy circulated the Draft EA/OEA for public review for 30-days from 19 May 2017 to 19 June 2017. Substantive comments received from US and Republic of the Marshall Island agencies on the Draft EA/OEA and their responses are provided in the Final EA/OEA. No comments were received from the public.

Table ES-1 Summary of the Potential Impacts to the Resources Associated with each of the Alternative Actions Analyzed

Location	Resource Area	No Action Alternative	Proposed Action Alternative
PMRF	Air Quality	No Change	Minor, short-term impact
	Water Resources	No Change	Minor, short-term impact
	Biological Resources	No Change	No significant impact
	Airspace	No Change	No impact
	Noise	No Change	Minor, short-term impact
	Public Health and Safety	No Change	Minor, short-term impact
	Hazardous Materials and Wastes	No Change	Minor, short term impact
Over-Ocean Flight Corridor	Air Quality	No Change	Minor, short-term impact
	Biological Resources	No Change	Minor, short-term impact
USAKA, RMI Illeginni Islet	Cultural Resources	No Change	No significant impact
	Biological Resources	No Change	No significant impact
	Noise	No Change	Minor, short-term impact
	Public Health and Safety	No Change	Minor, short-term impact
	Hazardous Materials and Wastes	No Change	No significant impact
USAKA, RMI Offshore Waters – Southwest and Northeast	Cultural Resources	No Change	No impact
	Biological Resources	No Change	No significant impact
	Noise	No Change	Minor, short-term impact
	Public Health and Safety	No Change	No significant impact
	Hazardous Materials and Wastes	No Change	Minor, short-term impact

Environmental Assessment/Overseas Environmental Assessment

for

FE-1 Flight Test

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Abbreviations and Acronyms

Acronym	Definition
µPa	micropascal
AAQS	Ambient Air Quality Standards
ACHP	Advisory Council on Historic Preservation
AFB	Air Force Base
AICUZ	Air Installation Compatible Use Zone
ALTRV	Altitude Reservation
APZ	Accident Potential Zone
ATCAA	Air Traffic Control Assigned Airspace
BA	Biological Assessment
Be	Beryllium
BMP	best management practices
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CNEL	community noise equivalent level
CO	carbon monoxide
CO_2	carbon dioxide
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted sound level
dBC	C-weighted sound level
DEP	Document of Environmental Protection
DNL	day-night average sound level
DoD	United States Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DPS	Distinct Population Segment
DU	Depleted Uranium
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
ESA	Endangered Species Act
ESQD	explosive safety quantity distance
FAA	Federal Aviation Administration
fm	Fathom
FONSI	Finding of No Significant Impact
ft	Foot/Feet
FTS	Flight Termination System
GHG	greenhouse gas
GRMI	Government of the Republic of the Marshall Islands
HAP	hazardous air pollutant
HAPC	habitat areas of particular concern
hr	hour(s)
HRC	Hawai'i Range Complex
Hz	hertz
IFR	Instrument Flight Rules
IRP	Installation Restoration Program
KEEP	Kwajalein Environmental Emergency Plan
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
KTF	Kauai Test Facility
lbs	pounds
LCU	Landing Craft Utility
LLNL	Lawrence Livermore National Laboratory
m	meter(s)
m^2	square meter
m^3	cubic meter
mi^2	square miles
MMIII	Minuteman III
mg	milligram(s)
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSAT	Mobile Source Air Toxics

Acronym	Definition
MSL	mean sea level
MUS	Management Unit Species
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Reparation Act
NHPA	National Historic Preservation Act
Ni	Nickel
nm	nautical mile(s)
nm^2	square nautical mile(s)
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	Office of the Chief of Naval Operations Instruction
Pb	Lead
PCB	polychlorinated biphenyl
PM_{10}	particulate matter less than or equal to 10 microns in diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in diameter
PMRF	Pacific Missile Range Facility
ppm	parts per million
PSD	Prevention of Significant Deterioration
RCRA	Resource, Conservation, and Recovery Act
RDT&E	Research, Development, Test, and Evaluation

Acronym	Definition
RMI	Republic of the Marshall Islands
RMIEPA	RMI Environmental Protection Authority
ROI	Region of Influence
RTS	Ronald Reagan Ballistic Missile Defense Test Site
RV	Re-entry Vehicle
SEL	sound exposure level
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SO_2	sulfur dioxide
SPL	sound pressure level
SSP	Strategic Systems Programs
STARS	Strategic Target System
TTS	temporary threshold shift
U	Uranium
US	United States
USACE	US Army Corps of Engineers
USAF	US Air Force
U.S.C.	United States Code
USAPHC	US Army Public Health Command
US Navy	United States Department of the Navy
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey

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1 Purpose of and Need for the Proposed Action

1.1 Introduction

The Proposed Action, Flight Experiment 1 (FE-1), is sponsored by the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, which has designated the Department of the Navy (US Navy) Strategic Systems Programs (SSP) as the lead agency and action proponent of the Proposed Action. The US Navy SSP proposes to conduct a developmental flight test as described in this Environmental Assessment (EA)/Overseas Environmental Assessment (OEA). The Proposed Action entails one experimental flight test to take place within a year of the sign

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1.2 Locations

The locations analyzed in this EA/OEA are the Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawai`i, and the US Army Kwajalein Atoll (USAKA) and the Ronald Reagan Ballistic Missile Defense Test Site (RTS), Republic of the Marshall Islands (RMI). These locations are shown in Figure 1-1. Various other government facilities would participate in support operations related to the Proposed Action. Those additional facilities maintain NEPA documentation and/or regulatory permitting for their ongoing activities. As such, analysis of these support operations is not included in this EA/OEA.

1.2.1 Pacific Missile Range Facility (PMRF), Barking Sands, Kauai, Hawai'i

PMRF is located in Hawai'i on and off the western shores of the island of Kauai and includes broad ocean areas to the north, south, and west. The relative isolation of PMRF, a year-round tropical climate, and an open ocean area relatively free of human presence are significant factors in PMRF's excellent record of safely conducting testing and training activities. PMRF's mission includes providing training for Navy and other Department of Defense (DoD) personnel using existing equipment and technologies to meet real world requirements to maintain and achieve required states of readiness. PMRF's mission also includes providing support to Research, Development, Test, and Evaluation (RDT&E) programs being developed by the DoD and the Missile Defense Agency.

PMRF is the worlds' largest instrumented, multi-environment, military test range capable of supporting subsurface, surface, air, and space operations. PMRF consists of over 2,850 square kilometers (km^2) [1,100 square miles (mi^2)] of instrumented underwater ranges, over 117,000 km^2 (42,000 mi^2) of controlled airspace (CNIC, 2016), and a Temporary Operating Area covering 7.2 million km^2 (2.1-million square nautical miles[nm^2]) of ocean area (US Navy, 2008). PMRF support to the FE-1 flight test would include base support, range safety, flight test support and test instrumentation.

1.2.2 Sandia National Laboratory/Kauai Test Facility (SNL/KTF)

The DOE, National Nuclear Security Administration's (NNSA's) Sandia National Laboratories (SNL) operates the Kauai Test Facility (KTF) on the western coast of Kauai in the Hawaiian Islands for the US DOE. The SNL/KTF, which is a tenant of the PMRF, fulfills multiple purposes in support

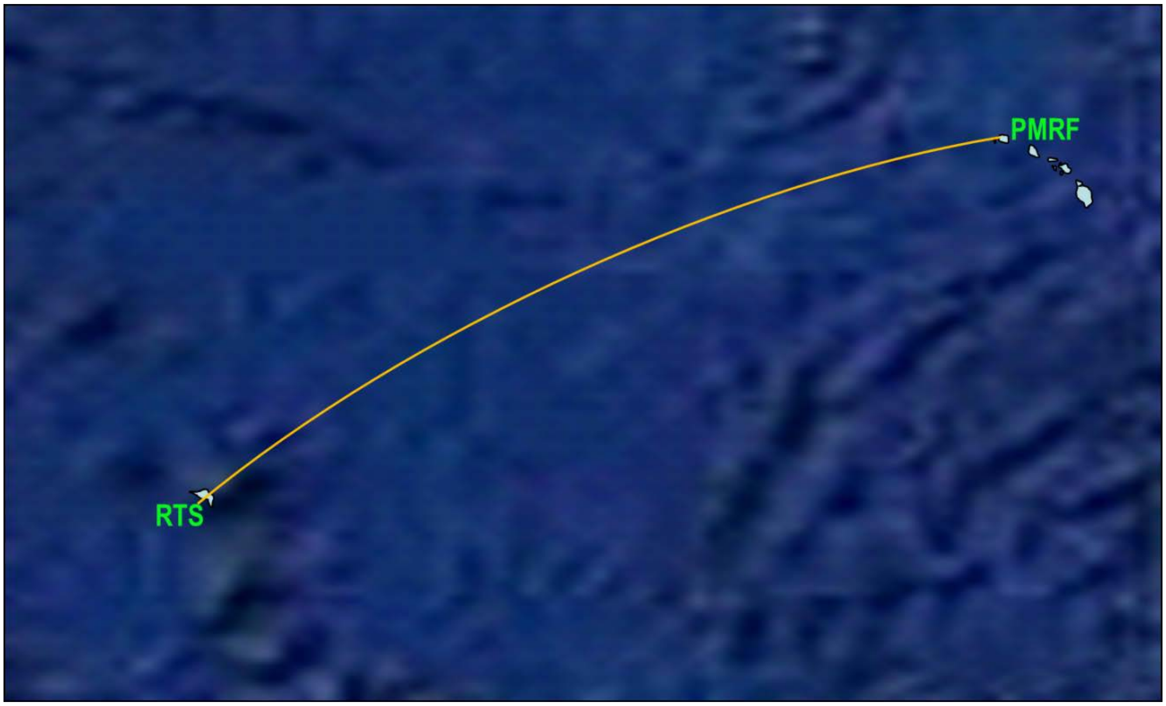

Figure 1-1 FE-1 Activity Location Map

of DOE research and development activities including launching of rockets carrying experimental non-nuclear payloads. SNL/KTF has been an active rocket launching facility since 1962. Most of these launches are targeted to various areas of the South Pacific, including the US Army Kwajalein Atoll (USAKA) in the RMI.

1.2.3 US Army Kwajalein Atoll (USAKA) and Reagan Test Site (RTS), Republic of the Marshall Islands (RMI)

The US Army's RTS resides on the US Army Garrison Kwajalein Atoll (USAG-KA), RMI. RTS is a premiere asset within the Department of Defense Major Range and Test Facility Base (MRTFB). The value of RTS to the MRTFB is based upon its strategic geographical location, unique instrumentation, and unsurpassed capability to support ballistic missile testing and space operations. For more than 40 years, RTS has been successfully supporting the research, development, test and evaluation effort of America's missile defense and space programs.

RTS hosts a suite of unique instrumentation, located on eight islands throughout the Kwajalein Atoll. This instrumentation includes a comprehensive suite of precision metric and signature radars, optical sensors, telemetry receiving stations, and impact scoring assets. RTS would provide both mobile and fixed ground and flight safety instrumentation.

Eleven islands in the RMI, referred to as USAKA, are used by USAG-KA under the terms of the Military Use and Operating Rights Agreement of the Compact of Free Association between the US and the RMI. USAG-KA provides complete base support facilities, including logistics, air, and marine services as well as community services for visiting mobile sensors and Range users.

1.3 Purpose of and Need for the Proposed Action

The purpose of the Proposed Action is to collect data on a developmental payload by testing range performance and to demonstrate technologies for prospective strike capabilities. Specifically, the FE-1 experiment would develop, integrate, and flight test the developmental payload concept to demonstrate the maturity of key technologies. These technologies include precision navigation, guidance and control, and enabling capabilities.

The need for the Proposed Action is to provide flight test data and information required by the DoD to provide a basis for ground testing, modeling, and simulation of developmental payload performance applicable to a range of possible FE-1 concepts being studied as a way to inform potential future strike capability determinations.

1.4 Scope of Environmental Analysis

This EA/OEA includes an analysis of potential environmental impacts associated with the Proposed Action and the No Action Alternative. The Navy has considered alternate launch and impact locations, and only the launch from SNL/KTF with impact near RTS meets the test requirements for vehicle performance and data collection. This EA/OEA analyzes potential impacts to the launch area (PMRF/KTF), the over-ocean flight corridor, and the three impact scenarios at RMI (Illeginni Islet and two ocean impact zones). The Navy's preferred impact scenario is Illeginni Islet because it best meets the requirements of the Purpose and Need for the Proposed Action.

The environmental resource areas analyzed in this EA/OEA include: air quality, water resources, geological resources, cultural resources, biological resources, land use, airspace, noise, infrastructure, public health and safety, hazardous materials and waste, socioeconomics, environmental justice, aesthetics/visual resources, and marine sediments. The study area for each resource analyzed may differ due to how the Proposed Action interacts with or impacts the resource. For instance, the study area for geological resources may only include the construction footprint of a building whereas the noise study area would expand out to include areas that may be impacted by airborne noise. Table 1-1 provides a tabular summary of the potential impacts to the resources associated with each of the alternative actions analyzed.

Key Documents

Key documents are sources of information incorporated by reference into this EA/OEA. These documents are considered to be key because they address similar actions, analyses, or impacts that may apply to this Proposed Action. CEQ guidance encourages incorporating documents by reference. Documents incorporated by reference in part or in whole include:

- *Environmental Assessment Missile Impacts, Illeginni Island at the Kwajalein Missile Range, Kwajalein Atoll Trust Territory of the Pacific Islands*, 1977. This assessment addresses the probable environmental effects of missile impacts on Illeginni Islands District, Trust Territory of the Pacific Islands.
- *Strategic Target System Environmental Assessment*, 1990. This EA/OEA documents the results of an analysis of the potential for and magnitude of impacts from pre-launch and launch activities of the STARS from PMRF.

Table 1-1 Summary of the Potential Impacts to the Resources Associated with each of the Alternative Actions Analyzed

Location	*Resource Area*	*No Action Alternative*	*Proposed Action Alternative*
PMRF	**Air Quality**	No Change	Minor, short-term impact
	Water Resources	No Change	Minor, short-term impact
	Biological Resources	No Change	No significant impact
	Airspace	No Change	No impact
	Noise	No Change	Minor, short-term impact
	Public Health and Safety	No Change	Minor, short-term impact
	Hazardous Materials and Wastes	No Change	Minor, short term impact
USAKA, RMI Illeginni Islet	**Air Quality**	No Change	Minor, short-term impact
	Biological Resources	No Change	Minor, short-term impact
	Cultural Resources	No Change	No significant impact
	Biological Resources	No Change	No significant impact
	Noise	No Change	Minor, short-term impact
	Public Health and Safety	No Change	Minor, short-term impact
	Hazardous Materials and Wastes	No Change	No significant impact
USAKA, RMI Offshore Waters – Southwest and Northeast	**Cultural Resources**	No Change	No impact
	Biological Resources	No Change	No significant impact
	Noise	No Change	Minor, short-term impact
	Public Health and Safety	No Change	Minor, short-term impact
	Hazardous Materials and Wastes	No Change	No significant impact

- *Strategic Target System Environmental Impact Statement*, 1992. This Environmental Impact Statement documents the results of an analysis of the potential for and magnitude of impacts from launch activities of the STARS from the KTF at the PMRF on the island of Kauai, Hawai`i.
- *Kauai Test Facility Environmental Assessment*, 1992. This EA documents the results of an analysis of the potential for and magnitude of impacts from pre-launch and launch activities from SNL/KTF.
- *US Army Kwajalein Atoll (USAKA) Supplemental Environmental Impact Statement*, 1993. This Final Supplemental EIS evaluates the environmental impacts of two proposed actions at USAKA. The first proposed action is the types and levels of test activities, including test facilities and support services at USAKA. The second proposed action is the adoption of new environmental standards and procedures for U.S government activities at USAKA.
- *Kodiak Launch Complex Environmental Assessment*, 1996. The purpose of this EA was to examine the potential for environmental impacts resulting from proposed Kodiak Launch Complex construction and operation. The proposed launch complex would support commercial rocket launches to place small satellites into orbit.

- *North Pacific Target Launch Environmental Assessment*, 2001. This EA analyzed the impacts of using the STARS launch vehicle for strategic target launch services from Kodiak Launch Complex, Kodiak Island, Alaska. The STARS target would also continue to be launched from KTF at the PMRF, Kauai, Hawai'i to the broad ocean area near the USAKA in the Marshall Islands. The proposed action was to increase the launch capability of the STARS by adding a new STARS flight trajectory from KTF and providing a launch capability from Kodiak Launch Complex. The proposed action would provide ballistic missile targets to test North American sensors, and for possible use in testing various sensors and ground-based interceptors at USAKA and various sensors and ship-based interceptors at PMRF.
- *Environmental Assessment for Minuteman III Modification*, 2004. This EA documents the potential environmental impacts of (1) Minuteman III (MMIII) missile flight tests using modified reentry system hardware/software, in addition to the continuation of Force Development Evaluation flight tests; (2) deployment of new and modified reentry system hardware/software; and (3) deployment activities for new command and control console equipment. The locations covered in this EA include: FE Warren Air Force Base (AFB), Wyoming; Hill AFB, Utah; Malmstrom AFB, Montana; Minot AFB, North Dakota; Vandenberg AFB, California; and USAKA, Republic of the Marshall Islands.
- *Hawaii Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement*, 2008. The Navy has identified the need to support and conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) activities in the Hawai`i Range Complex (HRC). The alternatives—the No Action Alternative, Alternative 1, Alternative 2, and Alternative 3—are analyzed in this Final EIS/OEIS. All alternatives include an analysis of potential environmental impacts associated with the use of mid-frequency active (MFA) and high-frequency active (HFA) sonar. The No Action Alternative stands as no change from current levels of HRC usage and includes HRC training, support, and RDT&E activities, Major Exercises, and maintenance of the technical and logistical facilities that support these activities and exercises.
- *Advanced Hypersonic Weapon Program Environmental Assessment*, 2011. This EA analyzes the impacts of launching a flight test vehicle from PMRF, Kauai, Hawai'i, using an existing STARS with three stages. The payload on the STARS vehicle would fly to a land or ocean impact at the USAKA/RTS (on or near Illeginni Islet) in the Republic of the Marshall Islands.
- *Advanced Hypersonic Weapon Flight Test 2 Hypersonic Technology Test Environmental Assessment*, 2014. This EA documents the demonstration flight test of a flight test vehicle launched from the Kodiak Launch Complex, using an existing three-stage STARS. Following booster separation, the test vehicle would fly to an impact site in the vicinity of Illeginni Islet at the USAKA in the Republic of the Marshall Islands.

1.5 Relevant Laws and Regulations

The Navy has prepared this EA/OEA based upon federal and state laws, statutes, regulations, and policies that are pertinent to the implementation of the proposed action, including the following:

- NEPA (42 United States Code (U.S.C.) sections 4321-4370h), which requires an environmental analysis for major federal actions that have the potential to significantly impact the quality of the human environment

- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR parts 1500-1508)
- Navy regulations for implementing NEPA (32 CFR part 775), which provides Navy policy for implementing CEQ regulations and NEPA
- Clean Air Act (CAA) (42 U.S.C. section 7401 et seq.)
- Clean Water Act (CWA) (33 U.S.C. section 1251 et seq.)
- Coastal Zone Management Act (CZMA) (16 U.S.C. section 1451 et seq.)
- National Historic Preservation Act (NHPA) (54 U.S.C. section 306108 et seq.)
- Endangered Species Act (ESA) (16 U.S.C. section 1531 et seq.)
- Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (16 U.S.C. section 1801 et seq.)
- Marine Mammal Protection Act (MMPA) (16 U.S.C. section 1361 et seq.)
- Migratory Bird Treaty Act (MBTA) (16 U.S.C. sections 703-712)
- Bald and Golden Eagle Protection Act (16 U.S.C. section 668-668d)
- EO 11988, Floodplain Management
- EO 12088, Federal Compliance with Pollution Control Standards
- EO 12114, Environmental Effects Abroad of Major Federal Actions
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations
- EO 13045, Protection of Children from Environmental Health Risks and Safety Risks
- EO 13089, Coral Reef Protection
- EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management
- EO 13175, Consultation and Coordination with Indian Tribal Governments
- EO 13693, Planning for Federal Sustainability in the Next Decade
- Compact of Free Association Between the United States and the Republic of the Marshall Islands, which became effective on October 21, 1986, under Presidential Proclamation No. 5564 on November 3, 1986; and was amended pursuant to Public Law 108-188 – December 17, 2003; 17 STAT 2723
- Compact of Free Association Military Use and Operating Rights Agreement between the United States of America and the Marshall Islands, March 23, 2004
- USAKA Environmental Standards (UES) 14th Edition, September 2016

A description of the Proposed Action's consistency with these laws, policies and regulations, as well as the names of regulatory agencies responsible for their implementation, is presented in Chapter 6.0 (Table 6-1).

1.6 Public and Agency Participation and Intergovernmental Coordination

The DOE NNSA SNL accepted the Navy SSP invitation to participate as a cooperating agency (40 CFR Part 1501.6) in the preparation of this EA/OEA (refer to Appendix A for relevant correspondence). Regulations from the CEQ (40 CFR part 1506.6) direct agencies to involve the public in preparing and implementing their NEPA procedures. The Navy circulated the Draft EA/OEA for public review from May 19, 2017 to June 19, 2017. Substantive comments received from US and RMI agencies on the Draft EA/OEA and their responses are provided in the Final EA/OEA (See Appendix C). No comments were received from the public.

The Navy has coordinated or consulted with the US Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the other UES Appropriate Agencies regarding the Proposed Action. A project specific Notice of Proposed Activity (NPA) and Document of Environmental Protection were prepared and submitted to the UES Appropriate Agencies and to the RMI public for a 30-day review and comment period.

The UES Appropriate Agencies include:

- RMI Environmental Protection Authority (RMIEPA)
- US Environmental Protection Agency (USEPA)
- USFWS
- NMFS
- US Army Corps of Engineers(USACE)

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2 Proposed Action and Alternatives

2.1 Proposed Action

The US Navy SSP FE-1 program would consist of a flight test designed to prove various aspects of the system's capabilities. The FE-1 launch vehicle consists of a three-stage Strategic Target System (STARS) booster system (Figure 2-1). This test would be designed to collect data to provide a basis for ground testing, modeling, and simulation of payload performance.

The Proposed Action entails ground preparations for the flight test at the DOE/NNSA's SNL/KTF located on PMRF, Barking Sands, Kauai, Hawai`i, KTF; the flight test to RTS; and post launch operations. Characteristics of the launch vehicle and the payload are presented in Table 2-1 and Table 2-2, respectively. The Proposed Action flight test would occur in within a year after signing of the FONSI, if approved.

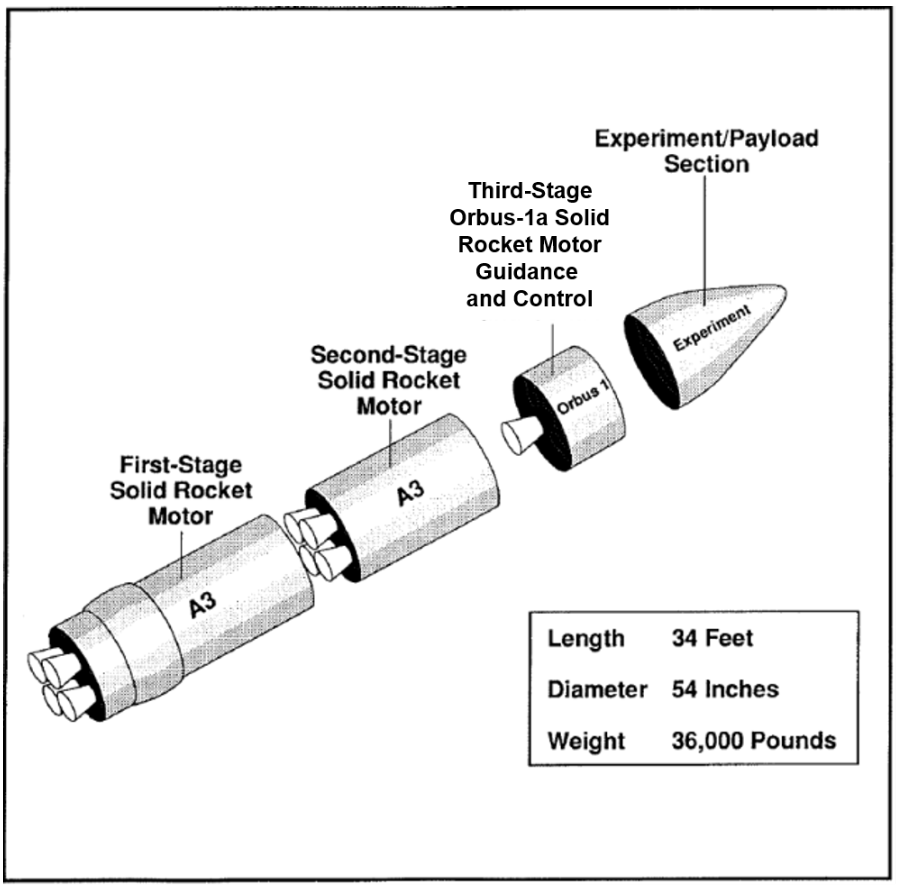


Figure 2-1 Typical Strategic Target System Vehicle

Table 2-1 Launch Vehicle Characteristics

Major components	Rocket motors, propellant, magnesium thorium (booster interstage)[1], nitrogen gas, halon, asbestos (contained in second stage), battery electrolytes (lithium-ion, silver zinc)
Communications	Various 5- to 20-watt radio frequency transmitters; one maximum 400-watt radio frequency transponder
Power	Up to nine lithium ion polymer and silver zinc batteries, each weighing between 1.36 and 22.68 kilograms (kg; 3 and 40 pounds [lbs])
Propulsion/Propellant	Solid Rocket propellant
Other	Small Class C (1.4) electro-explosive devices, ~1.36 kg (3 lbs) of pressurized nitrogen gas

Table 2-2 Payload System Characteristics

Structure	Aluminum, steel, titanium, magnesium and other alloys, copper, fiber glass, chromate coated hardware, tungsten, plastic, teflon, quartz, Room Temperature Vulcanizing silicone
Communications	Two less-than-20-watt radio frequency transmitters
Power	Up to four lithium ion polymer batteries, each weighing between 1.36 and 22.68 kg (3 and 50 lbs)
Propulsion/Propellant	None
Other	Class C (1.4) electro-explosive devices for safety and payload subsystems operations

2.2 Screening Factors

NEPA's implementing regulations provide guidance on the consideration of alternatives to a federally Proposed Action and require rigorous exploration and objective evaluation of reasonable alternatives. Only those alternatives determined to be reasonable and meet the purpose and need require detailed analysis.

The alternatives for the FE-1 flight test were derived through the following screening criteria/evaluation factors:

1. Launch facility and impact location must have the specialized infrastructure (e.g., equipment, instrumentation for data collection) and personnel capable of conducting an FE-1 flight test;
2. Launch facility and impact location must provide the required range distance to conduct the test; and
3. Launch facility and impact location must be available for conducting the test.

[1] The skin of the STARS first/second interstage structure was manufactured from a magnesium-thorium alloy (HK31A-H24). This is a surplus Polaris A3R asset that has been adapted to STARS and it contains less than 3% (<80 micro curies [µCi]) thorium. The interstage alloys are commercially available products containing magnesium-thorium alloy and are exempted from controls by the Nuclear Regulatory Commission (10 CFR 40.13) and the Radiological Procedures Protection Manual (RPPM) (Chapter 6, Attachment 6-2) since there is no physical, chemical or metallurgical processing performed on the items.

2.3 Alternatives Carried Forward for Analysis

Based on the reasonable alternative screening factors and meeting the purpose and need for the Proposed Action, no alternatives to the Proposed Action were identified that meet the program needs, and therefore no other alternatives were analyzed within this EA/OEA.

2.4 No Action Alternative

US Navy SSP has been directed by DoD to perform the FE-1 flight test. The flight test must meet certain mission and project objectives to provide the data desired by DoD. In accordance with Chief of Naval Operations Instruction (OPNAVINST) 5090.1D, *Environmental Readiness Program*, the no action alternative is an alternative that must be analyzed.

The no action alternative can either be stop all activities or continue the *status quo* without implementing the Proposed Action. In the FE-1 EA/OEA the no action is the continuation of the *status quo* as described in Chapter 3.0, *Affected Environment*. Environmental information on the alternative target areas is included in detail in the EA/OEA.

Under the No Action Alternative, the Proposed Action would not occur. Under the No Action Alternative, the Navy would not pursue the FE-1 program. The No Action Alternative would not meet the purpose and need for the Proposed Action; however, as required by NEPA and OPNAVINST 5090.1D, the No Action Alternative is carried forward for analysis in this EA/OEA and provides a baseline for measuring the environmental consequences of the action alternatives.

2.5 Flight Experiment 1 (FE-1) (Preferred Alternative)

2.5.1 Pre-Flight Activities

Various other government facilities would participate in pre-flight support operations related to the Proposed Action. Those additional locations maintain NEPA documentation and/or regulatory permitting for their ongoing activities. As such, analysis of these support operations is not included in this EA/OEA.

2.5.2 Rocket Motor Transportation

All transportation, handling, and storage of the rocket motors and other ordnance would occur in accordance with DoD, Navy, and US Department of Transportation (DOT) policies and regulations to safeguard the materials from fire or other mishap. All shipments would be inspected to prevent the introduction of alien species of plants and animals into the environment at Hawai'i and the RMI.

The Navy SSP would arrange for the US Air Force (USAF) to transport the rocket motors to PMRF airfield on Barking Sands, Kauai, Hawai'i. The Navy would transport the hazardous material and test items from PMRF airfield to SNL/KTF once the aircraft has landed in Hawai'i.

2.5.3 Launch Site Preparations and Operations

Prior to launch, routine activities would take place at the SNL/KTF to prepare for flight testing. These activities are described below. While working within the guidance and limitations of PMRF and SNL/KTF oversight, project personnel would execute ground equipment checkout, flight vehicle-to-booster assembly and checkout, and other preparations for flight testing. These activities would be directed by the Navy SSP representatives who would coordinate activities with PMRF, SNL/KTF and other range organizations. All activities would use existing facilities and infrastructure systems. Other launch supporting activities would include the following:

- Final motor and experiment assembly and integration
- Placement of missile on existing pad
- Mechanical and electrical checkouts (equipment tested, controls of electronic components-systems exercised before launch activities)
- Demonstration of system performance prior to launch
- Preflight checkouts, recommendations, consultation
- Advisory role throughout launch operations

As regular SNL routine operations for any launch at KTF, Sandia personnel would also conduct various range responsibilities to ensure appropriate launch preparation, including explosive safety, support to PMRF range safety and inter-range coordination.

These proposed activities would enable the FE-1 flight test to occur.

2.5.4 Flight Test

Flight testing activities would include the launch from the SNL/KTF and the impact of the payload at the Ronald Reagan Ballistic Missile Defense Test Site (RTS). Proposed activities at each location are described below. For the flight test, the booster would lift off from the SNL/KTF. The Navy developmental payload would impact at USAKA with three possible impact zone scenarios (Figure 2-2). Two of these scenarios would involve deep ocean impact while the third zone would involve a land impact. The first possible impact zone would be in the deep water region southwest of Illeginni Islet. This zone would have an approximate area of 488 meters [m] by 744 m (1,600 feet [ft] by 800 ft) (Figure 2-2). The second possible impact location would be a land impact on Illeginni Islet. This zone is approximately a 290 m by 137 m (950 ft by 450 ft) area on the northwest end of the Islet, as limited by available land mass. The third possible impact zone would be within the Kwajalein Missile Impact Scoring System (KMISS) area southeast of Gagan Islet and would have an approximate area of 2,400 m by 366 m (2,400 ft by 1,200 ft). The mission planning process would avoid to the maximum extent possible all potential risks to environmentally significant areas. All actual impact zones would be sized based on Range Safety requirements and chosen as part of the mission analysis process. Range Safety issues would also be part of selecting the impact scenario.

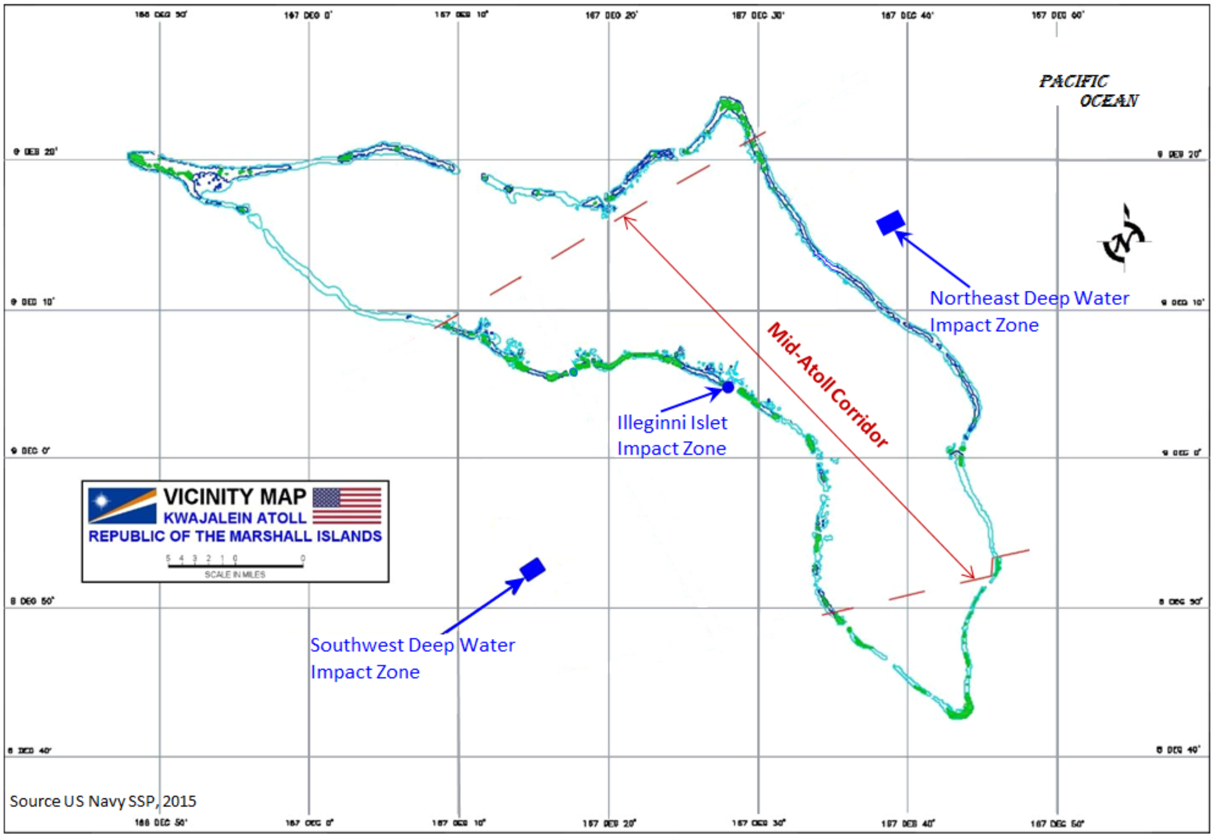


Figure 2-2 Notional Impact Areas in the Vicinity of Kwajalein Atoll

Efforts have been proposed to develop the instrumentation suite needed for the two deep water impact zone locations, while considering other past efforts. The leading proposal would be to develop a data collection instrumentation raft or barge. Previous environmental consideration of such a platform would be factored into the development, such as maritime safety (e.g., running lights and station-keeping), international policy (e.g., no intentional ocean dumping should the instrumentation raft be inadvertently struck during the conduct of the mission), and visual deterrents to birds loafing or resting on the raft (e.g., scarecrows, Mylar flags, helium-filled balloons, and strobe lights). It is anticipated that the instrumentation suite would be installed on the raft at the dock prior to being deployed to the test support location. After transit, it is expected that the raft would remain on station for up to two weeks while waiting for the test to occur. Once the test has been completed, the raft would be returned to port and the data would be delivered for analysis.

During ocean travel to and from impact and test support areas, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes and would report any observations to the USAG-KA Environmental Engineer. Vessel operators would also adjust their speed or raft deployment based on expected animal densities, and on lighting and turbidity conditions. Any marine mammal or sea turtle sightings during overflights or ship travel would be reported to the USAG-KA Environmental Engineer, the RTS Range Directorate, and the Flight Test Operations Director for consideration in approving the launch. Vessel operations, particularly in the BOA, would only occur when weather and sea conditions are acceptable for safe travel. Vessel operations would not involve any intentional ocean discharges of fuel, toxic wastes, or plastics and other solid wastes that could potentially harm marine life.

The main instrumentation raft would be supplemented with up to six self-stationing rafts (Figure 2-3) with associated radar, acoustic and optical sensors. The self-stationing rafts generally use twin battery-powered trolling motors for differential thrust navigation and station-keeping to ensure proper positioning for the flight impacts. Power to the trolling motors is provided by marine gel-cell batteries. None of the rafts would require an anchoring system. These rafts would also be outfitted and checked out at port prior to being emplaced for the test. This emplacement would also occur from the same seacraft that tows the main instrumentation raft to the test support location.

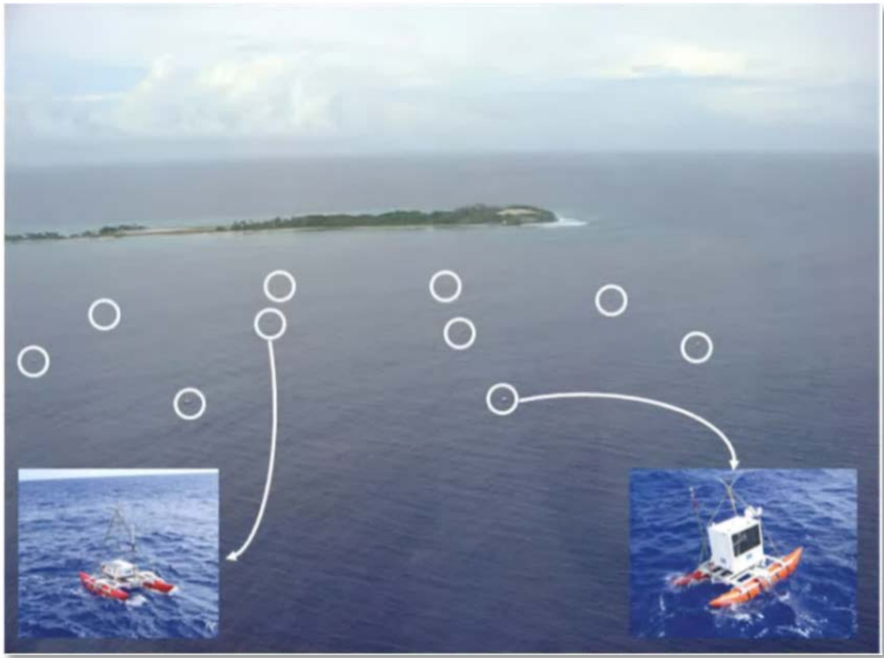


Figure 2-3 Notional Locations of Precision Scoring Augmentation Rafts

For the deep water impact zone to the northeast of Kwajalein Atoll, the use of the existing KMISS would be factored into the final data collection architecture.

Impacts in the deep water impact zones are a viable alternative to the land impact of the payload; however, the complementary suite of instrumentation necessary to collect the performance data does not provide the data resolution that can be obtained with a land impact.

For a nominal mission, it is anticipated that up to four weeks of increased activities would be required for either of the deep water impact zones. Included among these activities are:

- Set up mobile terminal area scoring using an ocean-going tug to tow and set up a station-keeping barge
- Deploy landing craft mechanized, landing craft utility (LCU), and Lawrence Livermore National Laboratory (LLNL) Independent Diagnostic Scoring System-type rafts (as many as a dozen)
- Deploy telemetry assets
- Recover all deployed assets from the specific deep water impact zone, and
- Perform marine and dive operations as needed to recover debris.

For the Proposed Action at Illeginni Islet, activities would include several vessel round-trips (likely with the Great Bridge) and helicopter trips. Additionally, raft-borne sensors would be deployed and recovered on both the ocean and lagoon sides. There would also be increased human activity on Illeginni that would involve up to 24 persons over a three-month period. Heavy equipment placement and use would occur at times.

Pre-flight monitoring by qualified personnel would be conducted on Illeginni Islet for sea turtles or sea turtle nests. On-site personnel would report any observations of sea turtles or sea turtle nests on Illeginni to appropriate test and USAG-KA personnel to provide to NMFS and USFWS. During travel to and from impact zones, including Illeginni Islet, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.

For at least 8 weeks preceding the FE-1 flight test launch, Illeginni Islet would be surveyed by qualified persons for sea turtles, sea turtle nesting activity, and sea turtle nests. If possible, these persons would also inspect the area within days of the launch. Pre-test persons at Illeginni Islet and in vessels traveling to and from Illeginni Islet would look for and report any observations of sea turtles, evidence of sea turtle haul out or nesting, or of sea turtle nests at or near Illeginni Islet.

2.5.4.1 Sandia National Laboratories, Kauai Test Facility, Pacific Missile Range Facility, Barking Sands, Kauai, Hawai`i

The SNL/KTF is located on and is a tenant activity of the PMRF. SNL/KTF is operated independently by Sandia personnel, but relies on base operations and logistic support from PMRF. For the purposes of this document, references to PMRF include all current range assets and tenants on Kauai and at remote locations regardless of ownership. PMRF is the standard reference for the land-based installations on Kauai, the underwater ranges, and their assets unless referring to a specific site or facility complex. PMRF on Kauai includes the main base complex (PMRF/Main Base), the DOE/NNSA's SNL/KTF, as a tenant within the base complex, Makaha Ridge, Kokee, Kamokala Magazines, and the Navy activities at Port Allen. In addition, there are range assets on Niihau, Oahu, and Maui.

Launches of the STARS boosters were initially analyzed in the *Strategic Target System Environmental Impact Statement* (STARS EIS) and most recently in the *Hawaii Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement* (US Navy, 2008). The FE-1 flight test would be scheduled within a year after signing of the FONSI, if approved. A modified 3,048-m (10,000-ft) ground hazard area adjacent to PMRF would be used.

2.5.4.2 US Army Garrison Kwajalein Atoll, Reagan Test Site, Republic of the Marshall Islands

USAG-KA and RTS support of the FE-1 flight test would include base support, range safety, flight test support and test instrumentation. The US Navy SSP would ensure that all relevant personnel associated with the Proposed Action are fully briefed on the best management practices (BMP) and the requirement to adhere to them for the duration of the Proposed Action. All activities would comply with the UES (USAG-KA, 2017). A project-specific Document of Environmental Protection (DEP) would be prepared to present requirements and limitations.

For an Offshore Waters impact, self-stationing sensor rafts would be placed around the targeted site to record and measure payload impacts. Shipboard and other radars and sensors would also gather information on the FE-1 flight test during terminal flight and impact, including a large instrumented raft that would be placed outside of the selected deep water impact zone. Following the flight test, all rafts would be collected or returned to dock for data collection and analysis.

On Illeginni Islet, the impact area would be searched for black-naped tern nests and chicks prior to any pre-flight equipment mobilization. Any discovered nests would be covered with an A-frame structure per USFWS guidance. The area would be monitored to ensure no black-naped tern nests are disturbed when heavy equipment would position diagnostic equipment. Additionally, radars could be placed on Illeginni Islet to gather information on the payload. Up to four radar units which are less than 0.4 m^3 (14 ft^3) would be placed within the impact area and may be destroyed by payload impact. These radars are powered by automobile batteries or shore/generator power. Following impact, all visible debris would be recovered.

To prevent birds from nesting on the support equipment after initial setup, the equipment would be appropriately covered with tarps or other materials and "scare" techniques (e.g., scarecrows, mylar ribbons, and/or flags) would be used on or near the equipment.

Flight Test Scenarios

Following motor ignition and liftoff from the launch location, the first-stage motor would burn out downrange and separate from the second stage. Farther into flight, the second-stage would also burn out and separate, with the shroud assembly also being jettisoned prior to third stage ignition. Farther into flight, the third-stage would also burn out and separate from the payload. Splashdown of all three spent motor stages and the shroud assembly would occur at different points in the open ocean between 70 and 1,500 nautical miles (nm) (130 and 2,778 kilometers [km]) from the launch pad. Figure 2-4 depicts the rocket motor drop zones for the launches from KTF toward USAKA. The payload would impact in the vicinity of Illeginni Islet.

Figure 2-4 Representative Drop Zones for Spent Motors and Nose Fairing Assembly

The booster would fly in a southwesterly direction from PMRF in the Hawaiian Islands. Jettison of the fairing and separation of the payload would occur inside the atmosphere, and the payload's flight path would avoid flying over the Northwestern Hawaiian Islands. The payload would fly toward pre-designated target sites at Illeginni Islet or in the Offshore Waters.

If the launch vehicle were to deviate from its course or should other problems occur during flight that might jeopardize public safety, the onboard flight termination system (FTS) would be activated. This action would initiate a predetermined safe mode for the vehicle, causing it to fall towards the ocean and terminate flight. No inhabited land areas would be subject to unacceptable risks of falling debris. Computer-monitored destruct lines, based on no-impact lines, are pre-programmed for the flight safety software to avoid any debris falling on inhabited areas, as per Space System Software Safety Engineering protocols and US range operation standards and practices. In accordance with US range operation standards, the risk of casualty (probability for serious injury or death) from falling debris for an individual of the general public cannot exceed 1 in 1,000,000 during a single flight test or mission (Range Commanders Council [RCC], 2007).

In addition to the commanded FTS operation, an FTS on the payload would include a failsafe operation to further ensure the safety of the Marshall Islands. This failsafe requires positive action to be taken by range safety personnel to allow the payload to continue flight to the vicinity of Illeginni Islet. Data would be transmitted to range safety personnel to allow a complete evaluation of the "health" of the FTS and the performance of the payload against the safety criteria.

The FTS also would contain logic to detect a premature separation of the booster stages and initiate a thrust termination action on all of the prematurely separated stages. Thrust would be terminated by initiation of an explosive charge to vent the motor chamber, releasing pressure and significantly reducing propellant combustion. This action would stop the booster's forward thrust, causing the launch vehicle to fall along a descending trajectory into the ocean.

The FTS would be designed to prevent any debris from falling into any protected area.

Sensor Coverage

The flight path would essentially be the same as that analyzed in the *Final Environmental Impact Statement for the Strategic Target System* (US Army Strategic Defense Command (USASDC), 1992). A series of sensors would overlap coverage of the flight from launch at KTF until impact at USAKA, as shown in Figure 2-5. The sensors would include:

- Ground based optics, telemetry and radars at PMRF
- Sea based sensors include the Mobile At-Sea System (MATSS), the Kwajalein Mobile Range Safety System (KMRSS) onboard the US Motor Vessel *Worthy*, and the Raytheon Portable Instrumented Range Augmentation Telemetry Equipment System (PIRATES)
- C-26 Safety Relay aircraft may be used as additional range safety support "off-axis" to ensure public safety. However, additional options would be considered. If the C-26 becomes the planned range safety support asset, takeoff and landing operations may be required at the PMRF airfield. These activities could occur in the day or night. Operations would be in compliance with the PMRF "Dark Skies" program, if required, or the C-26 would be based from another airfield in Hawai'i.
- Additional airborne and waterborne sensors on military or commercial aircraft are not planned as part of the FE-1 flight test. Other agencies might collect data on FE-1 for their own purposes, but these extra sensors are speculative and outside the scope of this EA/OEA.

All of these sensors are existing programs and would be scheduled for use based on availability.

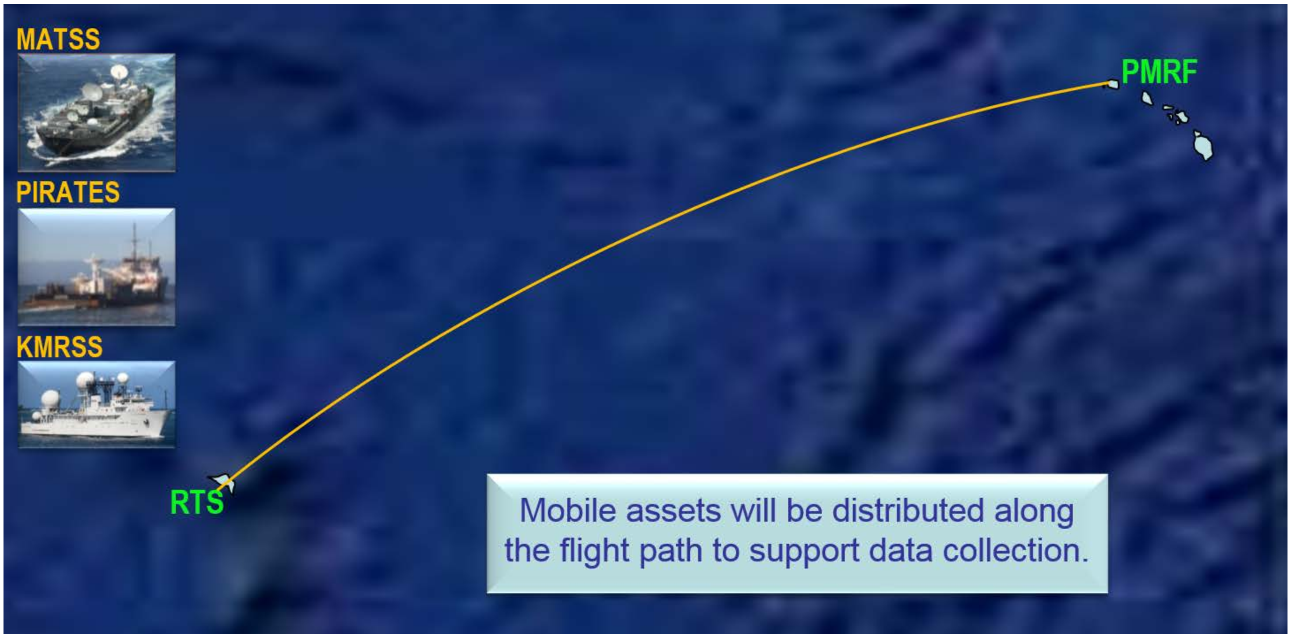


Figure 2-5 Notional FE-1 Flight Path Sensor Coverage

2.5.4.3 Terminal Phase Preparations and Operations

Following launch, the payload would separate from the booster over the Pacific Ocean, and fly at high-speeds in the upper atmosphere towards RTS. If payload onboard computers determine that there is insufficient energy to reach the target area, the payload could be directed to descend in a controlled termination of the test flight into the over-ocean flight corridor broad ocean area (BOA).

The RTS is a tenant activity of the USAG-KA. RTS is operated independently, but relies on base operations and logistic support from USAG-KA.

At USAKA, impact sites are located in deep ocean areas east and west of the Kwajalein Atoll and in the vicinity of Illeginni Islet, within the Mid-Atoll Corridor. Upon reaching the terminal end of the flight, the payload would either impact on the northwestern end of Illeginni Islet (Figure 2-6) or in the deep offshore waters northeast of Kwajalein Atoll or southwest of Illeginni Islet (Figure 2-2) at USAKA. Targeted areas for the payload would be selected to minimize impacts to reefs and identified wildlife habitats. A reef or shallow water impact is not part of the Proposed Action, would be unintentional, and is unlikely.

For the Illeginni Islet vicinity scenario, the proposed impact point for the Navy SSP payload would be in the non-forested area to avoid affecting the bird habitat. A crater would form as a result of this impact and leave debris that would need to be recovered[2]. Post-test debris recovery and cleanup operations on Illeginni Islet would cause some short-term disturbance to small areas of migratory bird habitat and possibly to coral reef habitat. However, because this is one flight test, the overall effects are considered to be minimal. Debris would be recovered and the crater filled for a land impact. Visible debris would be removed following any unintentional shallow water impact.

For the deep water impact zone scenarios, the proposed impact would occur in the deep ocean waters surrounding the Kwajalein Atoll. No residual debris is expected following impact; however, a recovery team

[2] The payload debris would include tungsten for ballast, etc., in accordance with Table 2-2; exact quantities of tungsten are unknown at this time and are not expected before the EA/OEA is completed. In order to provide an appropriate conservative assessment, a quantity of up to 1,000 pounds of tungsten alloy is used for the environmental impact analysis.

would be sent to inspect the impact location as soon as range safety clears the area. The deep water areas surrounding the Kwajalein Atoll are too deep to allow safe recovery of any hardware that might survive the impact with the water and still have sufficient mass to sink. Visible debris still on the surface of the water would be recovered and removed.

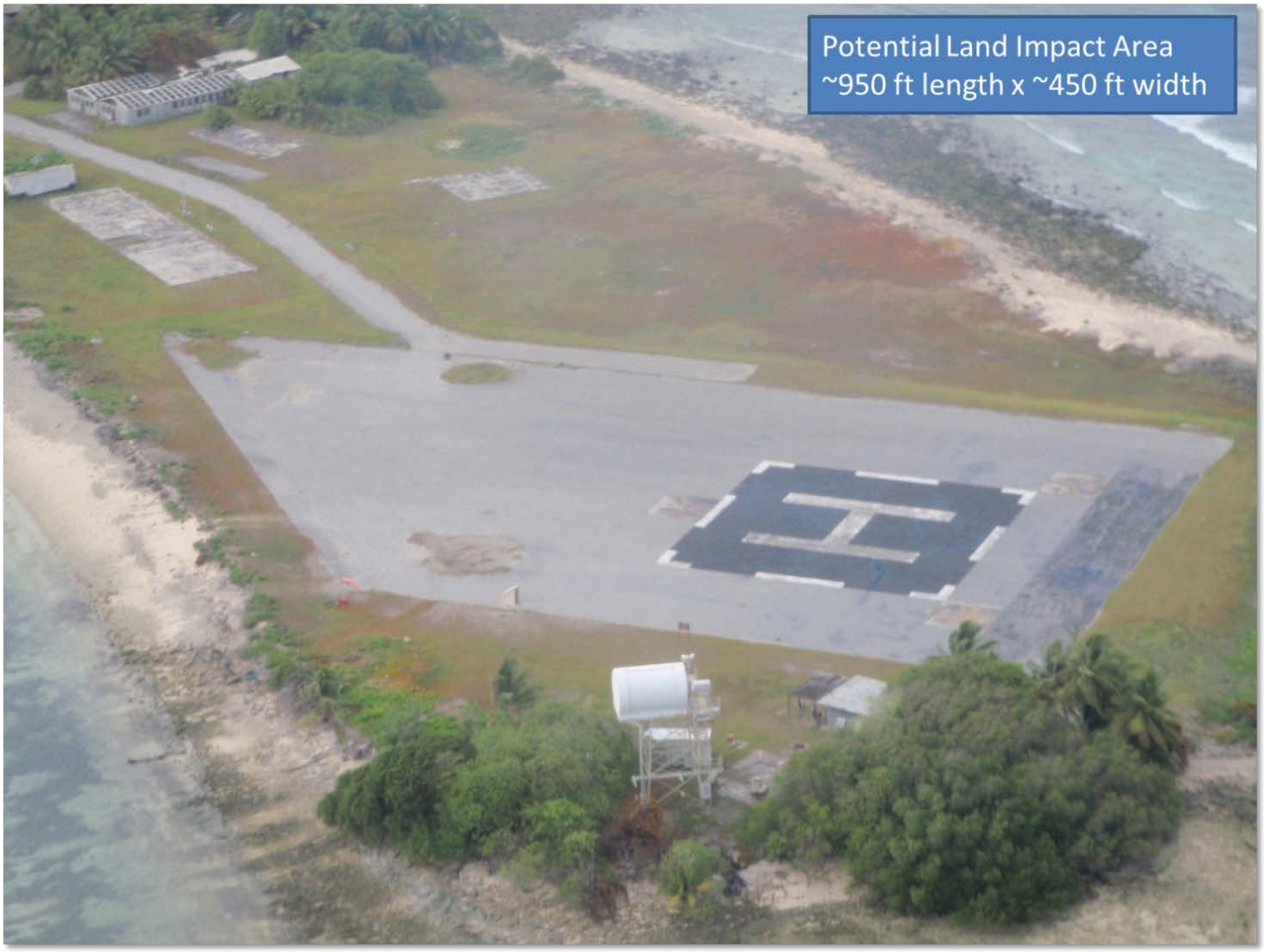


Figure 2-6 Potential Land Impact Area on Illeginni Islet

Vehicle impacts from other tests have occurred within the Kwajalein Atoll lagoon, on and in the vicinity of Illeginni Islet, and in the deep water impact zones near RTS, USAKA. These and other actions within the geographical scope of this EA/OEA have undergone environmental analysis and review, which is provided in Section 1.3, Related Environmental Documentation and the analyses all resulted in FONSIs.

To ensure the safe conduct of flight testing, a Mid-Atoll Corridor Impact Area has been established across the mid-section of the Atoll (Figure 2-2). When a test is to occur in this area, a number of strict precautions are taken to protect personnel. Such precautions may consist of evacuating nonessential personnel and sheltering all other personnel remaining within the Mid-Atoll Corridor. Notices to Airmen (NOTAMs) and Notices to Mariners (NOTMARs) are published and circulated in accordance with established procedures to provide warning to persons, including native Marshallese citizens, concerning any potential hazard areas that should be avoided. For public notification within USAKA before any flight test occurs, standard practice is to distribute an announcement from Kwajalein Island regarding the upcoming mission that is then provided to the public in Marshallese and English on the Roller and in radio announcements. Additionally, notices of upcoming missions are provided by the US Embassy to the Government of the RMI (GRMI) for the GRMI to distribute. A fact sheet describing the project and the environmental controls would be prepared in English and Marshallese and would be provided at locations on Ebeye and Kwajalein Island. Radar and visual sweeps of the hazard area are accomplished immediately prior to test flights to ensure the clearance of non-critical personnel.

In addition to land-based and sensor vessel support, up to 16 rafts with onboard optical and/or acoustical sensors (Figure 2-3) may be placed in the Kwajalein Atoll lagoon near Illeginni Island. Within a day of the flight test, one or two of the range LCU vessels would be used to deploy the rafts. The rafts would be equipped with battery-powered electric motors for propulsion to maintain position in the water. Sensors on the rafts would collect data during the payload’s descent until impact.

During travel to and from impact zones, including Illeginni Islet, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.

Radars would also be placed on Illeginni Islet to gather information on the payload. Up to two radars that fit within a 24-inch by 15-inch by 6-inch cube would be placed within the impact area. These radars are powered by automobile batteries or shore/generator power.

2.5.5 Post-Launch Operations

At the launch location on SNL/KTF, the launch pad area would be checked for safe access after vehicle liftoff. Post-launch activities would include inspection of the launch pad facilities and equipment for damage, as well as general cleanup and performance of maintenance and repairs necessary to accommodate launches for other programs. The expended rocket motors and other vehicle hardware would not be recovered from the ocean following flight.

Within either deep water impact zone, the self-stationing rafts and the large instrumentation raft would be recovered and the data collected for analysis.

Prior to recovery and cleanup actions at the Illeginni Islet impact zone, payload recovery personnel would first survey the impact site for any residual explosive materials. Post-test recovery operations at Illeginni Islet would require the manual cleanup and removal of any debris, including hazardous materials. Site recovery and clean-up would be performed for land or shallow water impact in a manner to minimize further harm to biological resources. Post-survey monitoring would also be conducted to observe any impacts to adult black-naped terns of their nests. Results of the monitoring would be reported to the USAG-KA Environmental Engineer to provide to the USFWS.

When feasible, within 1 day after the land impact test at Illeginni Islet, USAK-KA environmental staff would survey the islet and the near-shore waters for any injured wildlife, damaged coral, or damage to sensitive habitats. For recovery and rehabilitation of any injured migratory birds or sea turtles found at Illeginni, USFWS and NMFS would be notified to advise on best care practices and qualified biologists would be allowed to assist in recovering and rehabilitating any injured sea turtles found. During inspections of the islet and near-shore waters, USAG-KA environmental staff would assess any sea turtle mortality. Any impacts to biological resources would be reported to the Appropriate Agencies, with USFWS and NMFS offered the opportunity to inspect the impact area to provide guidance on mitigations.

Following completion, personnel would recover all visible payload debris. Should an island impact occur, the impact area would be washed down to stabilize the disturbed soil. Following removal of all experiment items and any remaining debris from the target site, the impact crater would be backfilled and, if necessary, repairs made to surrounding structures. Any accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be returned to Kwajalein Island for proper disposal in the US. Following cleanup and repairs to the Illeginni site, soil samples would be collected at various locations around the impact area and tested for tungsten alloy.

Debris from the payload impact on land or in the Atoll lagoon would be recovered. Post-test recovery operations at Illeginni Island require the manual cleanup and removal of any debris, including hazardous materials, followed by filling in larger craters using a backhoe or grader. USAG-KA and RTS personnel are usually involved in these operations. Payload recovery/cleanup operations and removal of surface floating debris in the lagoon and ocean reef flats, within 150 to 300 m (500 to 1,000 ft) of the shoreline, would be conducted similarly to land operations when tide conditions and water depth permit. A backhoe would be used to excavate the crater. Excavated material would be screened for debris and the crater would be back-filled with coral ejected around the rim of the crater. Should the payload impact in the deeper waters of the Atoll lagoon, a dive team from USAG-KA or RTS would be brought in to conduct underwater searches. Also under consideration for underwater debris recovery would be the use of remotely operated vehicles (ROVs). If warranted due to other factors, such as significant currents or mass of the debris to be recovered, the recovery team would consider the use of an ROV instead of divers.

If an inadvertent impact occurs on the reef, reef flat, or in shallow waters less than 3 m (10 ft) deep, an inspection by project personnel would occur within 24 hours. Representatives from the NMFS and USFWS would also be invited to inspect the site as soon as practical after the test. The inspectors would assess any damage to coral and other natural and biological resources and, in coordination with SSP, USAG-KA and RTS representatives, decide on any response measures that may be required.

Recovery operations on the reef flat would be conducted similarly to land operations when tide conditions and water depth permit. Should the payload inadvertently impact in the deeper waters of the Atoll lagoon (up to approximately 55 m [180 ft]), a dive team from USAG-KA or RTS would be brought in to conduct underwater searches. Using a ship for recovery operations, the debris field would be located and certified divers in scuba gear would attempt to recover the debris manually.

In general, payload recovery operations would not be attempted in deeper waters on the ocean side of the Atoll. Searches for debris would be attempted out to depths of up to 55 m [180 ft]). An underwater operation similar to a lagoon recovery would be used if debris were located in this area.

Additionally, the US Navy and USASMDC have performed a bench study to measure the dissolution and potential for migration of the tungsten alloy in Illeginni Islet soils to inform future biological resources analyses of any potential effects (Appendix D).

Following cleanup and repairs to the Illeginni site, soil and groundwater sample would be collected at various locations around the impact area and tested for tungsten alloy.

In accordance with the Final Biological Opinion (Appendix E) provided by NMFS on June 29, 2017, the following reasonable and prudent measure would necessary and appropriate to minimize impacts of the Proposed Action and monitor levels of incidental take. The measures described below are non-discretionary and must be undertaken in order for the Incidental Take Statement to apply. (NMFS, 2017b)

1. The US Navy SSP shall reduce impacts on UES-protected corals, top shell snails, clams and their habitats through the employment of BMP and conservation measures.
2. The US Navy SSP shall record and report all action-related take of UES-consultation species.

The US Navy SSP must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To meet reasonable and prudent measure 1 above, the US Navy SSP shall ensure that their personnel comply fully with the BMP and conservation measures identified in the Biological Assessment (BA) (US Navy and USASMDC, 2017) and below.

    a. The US Navy SSP shall ensure that all relevant personnel associated with this project are fully briefed on the BMP and the requirement to adhere to them for the duration of this project.

    b. In the event the payload impact that affects the reef at Illeginni, the US Navy SSP shall require its personnel to secure or remove from the water any substrate or coral rubble from the ejecta impact zone that may become mobilized by wave action as soon as possible.

        i. Ejecta greater than 6 inches in any dimension shall be removed from the water or positioned such that it would not become mobilized by expected wave action, including replacement in the payload crater

        ii. If possible, coral fragments greater than 6 inches in any dimension shall be positioned on the reef such that they would not become mobilized by expected wave action, and in a manner that would enhance its survival; away from fine sediments with the majority of the living tissue (polyps) facing up.

        iii. UES consultation coral fragments that cannot be secure in-place should be relocated to suitable habitat where it is not likely to become mobilized.

    c. In the event of the payload impact affects the reef at Illeginni, the US Navy SSP shall require its personnel to reduce impacts on top shell snails.

        i. Rescue and reposition any living top shell snails that are buried or trapped by rubble.

        ii. Relocate to suitable habitat, any living top shell snails that are in the path of any heavy equipment that must be used in the marine environment.

    d. In the event the payload land impact affects the reef at Illeginni, the US Navy SSP shall require its personnel to reduce impact on clams.

        i. Rescue and reposition any living clams that are buried or trapped by rubble.

        ii. Relocate to suitable habitat, any living clams that are in the path of any heavy equipment that must be used in the marine environment.

2. To meet reasonable and prudent measure 2 above:

    a. The US Navy SSP shall assign appropriately qualified personnel to record all suspected incidences of take of any UES-consultation species.

    b. The US Navy SSP shall utilize digital photography/videography to record any UES-consultation species found injured or killed in or near the ocean target areas and/or at Illeginni. As practicable: 1) Photograph all damaged corals and/or other UES-consultation species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.

c. In the event the payload impact that affects the reef at Illeginni, the US Navy SSP shall require its personnel to survey the ejecta field for impacted corals, top shell snails, and clams. The personnel shall also be mindful for any other UES-consultation species that may have been affected.

d. Within 60 days of completing post-test clean-up and restoration, provide photographs/videos and records to the USAG-KA environmental office. USAG-KA and NMFS biologists will review the photographs and records to identify the organisms to the lowest taxonomic level accurately possible to assess impacts on consultation species.

e. Within 6 months of completion of the action, USAG-KA will provide a report to NMFS. The report shall identify: 1) The flight test and date; 2) The target area; 3) The results of the pre- and post-flight surveys; 4) The identity and quantity of affected resources (include photographs and videos as applicable); and 5) The disposition of any relocation efforts.

Reinitiation of formal consultation would be required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law, and if:

1. The amount or extent of anticipated incidental take is exceeded;
2. New information reveals that the action may affect UES-protected marine species or critical habitat in a manner or to an extent not considered in the NMFS Final Biological Opinion;
3. The action is subsequently modified in a manner that may affect UES-protected marine species or critical habitat to an extent, or in a manner not considered in the NMFS Final Biological Opinion; or
4. A new species is listed or critical habitat designated that may be affected by the action.

2.6 Alternatives Considered but not Carried Forward for Detailed Analysis

The following alternatives were considered, but not carried forward for detailed analysis in this EA/OEA as they did not meet the purpose and need for the Proposed Action and satisfy the reasonable alternative screening factors presented in Section 2.2.

2.6.1 Johnston Atoll

An alternative would be launching a STARS booster from Johnston Atoll with an impact in USAKA. Johnston Atoll is an unincorporated territory of the US, currently administered by the US Fish and Wildlife Service (USFWS). The Atoll is managed as part of the Pacific Remote Islands Marine National Monument, established in 2009. It had been formerly under control of the US DoD, but was closed in 2004. Johnston Atoll had been the site of various missile launches in the past, but that capability no longer exists. This alternative would not meet the purpose of the Proposed Action because the launch equipment has not been used or maintained since the facility closed in 2004 and therefore would not meet performance requirements. The cost and schedule that would be needed to refurbish or replace the launch facilities would significantly delay the completion of the Proposed Action.

2.6.2 Pacific Spaceport Complex Alaska

An alternative to the flight test between the KTF and USAKA would be to launch the STARS booster from the Pacific Spaceport Complex Alaska on the island of Kodiak, Alaska, with an impact in the BOA north of the PMRF. This alternative would not meet the purpose of the Proposed Action because there is no existing instrumentation in the BOA north of the PMRF to collect data that could verify the payload performance. The cost and schedule that would be needed to develop and test a new BOA instrumentation suite near PMRF would significantly delay the completion of the Proposed Action.

2.6.3 Farallon De Medinilla

Another alternative would be launching a STARS booster from the KTF at PMRF with an impact in the Farallon De Medinilla in the Northern Marianna Islands. This alternative would not meet the purpose of the Proposed Action because there is no existing instrumentation at Farallon De Medinilla to collect data that could verify the payload performance in support of capability needs. The cost and schedule that would be needed to develop and test a new BOA instrumentation suite near Farallon De Medinilla would significantly delay the completion of the Proposed Action.

3 Affected Environment

This chapter presents a description of the environmental resources and baseline conditions that could be affected from implementing the Proposed Action and any of the three impact scenarios.

All potentially relevant environmental resource areas were initially considered for analysis in this EA/OEA. In compliance with NEPA, CEQ, and 32 CFR part 775 guidelines, the discussion of the affected environment (i.e., existing conditions) focuses only on those resource areas potentially subject to impacts. Additionally, the level of detail used in describing a resource is commensurate with the anticipated level of potential environmental impact.

3.1 PMRF/Kauai Test Facility

This section includes air quality, water resources, biological resources, airspace, noise, public health and safety, and hazardous materials and wastes for potential environmental impacts to the PMRF/KTF launch site.

The potential impacts to the following resource areas are considered to be negligible or non-existent so they were not analyzed in detail in this EA/OEA:

Geological Resources: The Navy FE-1 flight test requires no ground-disturbing activities; thus no impacts to geological resources would be expected.

Cultural Resources: The Navy FE-1 flight test requires no ground-disturbing activities; thus no impacts to cultural resources would be expected.

Land Use: The Navy FE-1 flight test represents activities that are consistent with the mission and well within the limits of current operations of both PMRF and KTF. Thus, there would be no adverse effects on land use.

Infrastructure: The Navy FE-1 flight test represents activities that are consistent with the mission and well within the limits of current operations of both PMRF and KTF. Thus, there would be no adverse effects on infrastructure.

Transportation: The Navy FE-1 flight test represents activities that are consistent with the mission and well within the limits of current operations of both PMRF and KTF. Thus, there would be no adverse effects on transportation.

Socioeconomics: There would be little increase in personnel on base; thus no socioeconomic concerns are anticipated. Any increase would be temporary and only for the duration of the Proposed Action.

Environmental Justice: The Navy FE-1 flight test includes a launch trajectory, range safety regulations and procedures, and dispersing of noise over a wide area that precludes disproportionate impacts to minority populations and low-income populations under Executive Order 12898.

Visual Resources: The Navy FE-1 flight test does not require any new construction and the visual aesthetics of PMRF and KTF would not be changed.

Marine Sediments: The Navy FE-1 flight test does not require any new construction and the marine sediments of PMRF and KTF would not be changed.

3.1.1 <u>Air Quality</u>

This discussion of air quality includes criteria pollutants, standards, sources, permitting and greenhouse gases. Air quality in a given location is defined by the concentration of various pollutants in the atmosphere.

A region's air quality is influenced by many factors including the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions.

Most air pollutants originate from human-made sources, including mobile sources (e.g., cars, trucks, buses) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Air pollutants are also released from natural sources such as volcanic eruptions and forest fires.

3.1.1.1 Regulatory Setting

Criteria Pollutants and National Ambient Air Quality Standards

The principal pollutants defining the air quality, called "criteria pollutants," include carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone, suspended particulate matter less than or equal to 10 microns in diameter (PM_{10}), fine particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead (Pb). CO, SO_2, Pb, and some particulates are emitted directly into the atmosphere from emissions sources. Ozone, NO_2, and some particulates are formed through atmospheric chemical reactions that are influenced by weather, ultraviolet light, and other atmospheric processes.

Under the Clean Air Act (CAA), the USEPA has established National Ambient Air Quality Standards (NAAQS) (40 CFR part 50) for these pollutants. NAAQS are classified as primary or secondary. Primary standards protect against adverse health effects; secondary standards protect against welfare effects, such as damage to farm crops and vegetation and damage to buildings. Some pollutants have long-term and short-term standards. Short-term standards are designed to protect against acute, or short-term, health effects, while long-term standards were established to protect against chronic health effects.

Areas that are and have historically been in compliance with the NAAQS are designated as attainment areas. Areas that violate a federal air quality standard are designated as nonattainment areas. Areas that have transitioned from nonattainment to attainment are designated as maintenance areas and are required to adhere to maintenance plans to ensure continued attainment.

The CAA requires states to develop a general plan to attain and maintain the NAAQS in all areas of the country and a specific plan to attain the standards for each area designated nonattainment for a NAAQS. These plans, known as State Implementation Plans (SIPs), are developed by state and local air quality management agencies and submitted to USEPA for approval.

In addition to the NAAQS for criteria pollutants, national standards exist for hazardous air pollutants (HAPs), which are regulated under Section 112(b) of the 1990 CAA Amendments. The *National Emission Standards for Hazardous Air Pollutants* regulate HAP emissions from stationary sources (40 CFR part 61).

Mobile Sources

HAPs emitted from mobile sources are called Mobile Source Air Toxics (MSATs). MSATs are compounds emitted from highway vehicles and non-road equipment that are known or suspected to cause cancer or other serious health and environmental effects. In 2001, USEPA issued its first MSAT Rule, which identified 201 compounds as being HAPs that require regulation. A subset of six of the MSAT compounds was identified as having the greatest influence on health and included benzene, butadiene, formaldehyde, acrolein, acetaldehyde, and diesel particulate matter. More recently, USEPA issued a second MSAT Rule in February 2007, which generally supported the findings in the first rule and provided additional recommendations of compounds having the greatest impact on health. The rule also identified several engine emission certification standards that must be implemented (40 CFR parts 59, 80, 85, and 86; Federal

Register Volume 72, No. 37, pp. 8427–8570, 2007). Unlike the criteria pollutants, there are no NAAQS for benzene and other HAPs. The primary control methodologies for these pollutants for mobile sources involves reducing their content in fuel and altering the engine operating characteristics to reduce the volume of pollutant generated during combustion.

General Conformity

The USEPA General Conformity Rule applies to federal actions occurring in nonattainment or maintenance areas when the total direct and indirect emissions of nonattainment pollutants (or their precursors) exceed specified thresholds. The emissions thresholds that trigger requirements for a conformity analysis are called *de minimis* levels. *De minimis* levels (in tons per year [tpy]) vary by pollutant and also depend on the severity of the nonattainment status for the air quality management area in question.

A conformity applicability analysis is the first step of a conformity evaluation and assesses if a federal action must be supported by a conformity determination. This is typically done by quantifying applicable direct and indirect emissions that are projected to result due to implementation of the federal action. Indirect emissions are those emissions caused by the federal action and originating in the region of influence (ROI), but which can occur at a later time or in a different location from the action itself and are reasonably foreseeable. The federal agency can control and will maintain control over the indirect action due to a continuing program responsibility of the federal agency. Reasonably foreseeable emissions are projected future direct and indirect emissions that are identified at the time the conformity evaluation is performed. The location of such emissions is known and the emissions are quantifiable, as described and documented by the federal agency based on its own information and after reviewing any information presented to the federal agency. If the results of the applicability analysis indicate that the total emissions would not exceed the de minimis emissions thresholds, then the conformity evaluation process is completed. De minimis threshold emissions are presented in Table 3-1.

Permitting

New Source Review (Preconstruction Permit). New major stationary sources and major modifications at existing major stationary sources are required by the CAA to obtain an air pollution permit before commencing construction. This permitting process for major stationary sources is called New Source Review and is required whether the major source or major modification is planned for nonattainment areas or attainment and unclassifiable areas. In general, permits for sources in attainment areas and for other pollutants regulated under the major source program are referred to as Prevention of Significant Deterioration (PSD) permits, while permits for major sources emitting nonattainment pollutants and located in nonattainment areas are referred to as nonattainment new source review permits. In addition, a proposed project may have to meet the requirements of nonattainment new source review for the pollutants for which the area is designated as nonattainment and PSD for the pollutants for which the area is attainment. Additional PSD permitting thresholds apply to increases in stationary source greenhouse gas (GHG) emissions. PSD permitting can also apply to a new major stationary source (or any net emissions increase associated with a modification to an existing major stationary source) that is constructed within 10 km (6.2 miles) of a Class I area, and which would increase the 24-hour average concentration of any regulated pollutant in the Class I area by 1 microgram per cubic meter ($\mu g/m^3$) or more. Navy installations shall comply with applicable permit requirements under the PSD program per 40 CFR section 51.166.

Table 3-1 General Conformity De minimis Levels

Pollutant	*Area Type*	*TPY*
Ozone (VOC or NO_x)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NO_x)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
Carbon monoxide, SO_2 and NO_2	All nonattainment & maintenance	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$ Direct emissions, SO_2, NO_x (unless determined not to be a significant precursor), VOC or ammonia (if determined to be significant precursors)	All nonattainment & maintenance	100
Lead (Pb)	All nonattainment & maintenance	25

Source: US Navy , 2013

<u>Title V (Operating Permit)</u>. The Title V Operating Permit Program consolidates all CAA requirements applicable to the operation of a source, including requirements from the SIP, preconstruction permits, and the air toxics program. It applies to stationary sources of air pollution that exceed the major stationary source emission thresholds, as well as other non-major sources specified in a particular regulation. The program includes a requirement for payment of permit fees to finance the operating permit program whether implemented by USEPA or a state or local regulator. Navy installations subject to Title V permitting shall comply with the requirements of the Title V Operating Permit Program, which are detailed in 40 CFR Part 70 and all specific requirements contained in their individual permits.

Greenhouse Gases

GHGs are gas emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in GHG emissions from human activities. The climate change associated with this global warming is predicted to produce negative economic and social consequences across the globe.

The CEQ released on August 1, 2016, final guidance on when and how Federal agencies should consider GHG emissions and climate change in NEPA analyses (CEQ, 2016). The guidance is primarily focused on projects that have large air quality implications. It also emphasizes a netting approach to GHG analysis. This threshold was carried forward to see if additional quantitative analysis would be required for the Proposed Action. The guidance recommends that agencies consider both the potential effects of a proposed action on climate change, as indicated by its estimated greenhouse gas emissions, and the implications of climate change for the environmental effects of a proposed action. The guidance also emphasizes that agency analyses should be commensurate with projected greenhouse gas emissions and climate impacts, and should employ appropriate quantitative or qualitative analytical methods to ensure useful information is available to inform the public and the decision-making process in distinguishing between alternatives and mitigations. Although not specifically identified in the final guidance, the prior draft guidance recommended that agencies consider 25,000 metric tons per year (27,558 tons per year) of carbon dioxide equivalent (CO_2e) emissions as a reference point below which a quantitative analysis of greenhouse gas is not recommended unless it is easily accomplished based on available tools and data.

The USEPA issued the *Final Mandatory Reporting of Greenhouse Gases Rule* on September 22, 2009. GHGs covered under the *Final Mandatory Reporting of Greenhouse Gases Rule* are carbon dioxide (CO_2), methane, nitrogen oxide (NO_x), hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers. Each GHG is assigned a global warming potential. The global warming potential is the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to CO_2, which has a value of one. The equivalent CO_2 rate is calculated by multiplying the emissions of each GHG by its global warming potential and adding the results together to produce a single, combined emissions rate representing all GHGs. Under the rule, suppliers of fossil fuels or industrial GHGs, manufacturers of mobile sources and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions as CO_2e are required to submit annual reports to USEPA.

Hawai`i's 2007 Greenhouse Gas Emissions Inventory states that in both 1990 and 2007, emissions from transportation and electric power sources accounted for the vast majority (more than 85%) of GHG emissions in Hawai`i. At 91% of the total in 2007, CO_2 is the largest single contributor to GHG emissions from in-state sources. Oahu accounts for 71% of Hawai`i's GHG emissions; Kauai contributes 5% (Hawai'i Department of Business, Economic Development & Tourism, 2008).

The global annual temperature has increased at an average rate of 0.07 degrees (°) Celsius [C] (0.13° Fahrenheit [F]) per decade since 1880 and at an average rate of 0.17°C (0.31°F) per decade since 1970. The warmest global average temperatures on record have all occurred within the past 15 years, with the warmest years being 2010, 2013, 2014, and 2015 (NOAA, 2016). With this in mind, the Navy has established energy targets to reduce GHG by 2020. The targets of significance to this EA/OEA include: (1) by 2020, half of the Navy's energy consumption (ashore and afloat) will come from alternative sources; (2) by 2020, half of Navy installations will be net-zero energy consumers, using solar, wind, ocean, and geothermal power generated on base; (3) by 2015, the Navy will cut in half the amount of petroleum used in Government vehicles through phased adoption of hybrid, electric, and flex fuel vehicles; and (4) effective immediately, Navy contractors will be held contractually accountable for meeting energy efficiency targets.

In an effort to reduce energy consumption, reduce GHGs, reduce dependence on petroleum, and increase the use of renewable energy resources the Navy has implemented a number of renewable energy projects. The Navy has established Fiscal Year 2020 GHG emissions reduction targets of 34% from a FY 2008 baseline for direct GHG emissions and 13.5% for indirect emissions. Examples of Navy-wide GHG reduction projects include energy efficient construction, thermal and photovoltaic solar systems, geothermal power plants, and the generation of electricity with wind energy. The Navy continues to promote and install new renewable energy projects.

3.1.1.2 Region of Influence (ROI)

Air Quality

Air quality in Hawai'i is defined with respect to compliance with primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) established by the USEPA and adopted by the State of Hawai'i. The Clean Air Act (42 USC 7401-7671q), as amended, gives USEPA the responsibility to set safe concentration levels for six criteria pollutants: particulate matter measuring less than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$), sulfur dioxide, carbon monoxide, nitrogen oxides, lead, and 8-hour ozone (measured by its precursors, volatile organic compounds [VOCs] and nitrogen oxides).

For inert pollutants (all pollutants other than ozone and its precursors: VOCs and nitrogen oxides), the ROI is generally limited to an area extending several miles downwind from the source. Consequently, for the air quality analysis, the ROI for project activities is the existing airshed (the geographic area responsible for emitting 75% of the air pollution reaching a body of water) surrounding the various sites, which encompasses the KTF located on PMRF, Kauai, Hawai'i. The ROI for ozone may extend much farther downwind than the ROI for inert pollutants. As the project area has no heavy industry and relatively few automobiles, ozone and its precursors are not of concern. The ROI for ozone depleting gases and greenhouse gas (GHG) emissions is global.

Climate

Weather is an important factor in the disbursement of air pollutants. PMRF is located just south of the Tropic of Cancer and has a mild and semi-tropical climate. Typical temperatures for the area are 80 to 84 degrees Fahrenheit (°F) during the day and 65 to 68°F during the night. The trade winds are from the northeast and are typically light—mean trade winds between 18 to 21 miles per hour. Precipitation in the area averages 41 inches annually. Most of the rain falls during the October through April wet season. Relative humidity is approximately 60% during the day throughout the year.

Regional Air Quality

Air quality data in Hawai'i are collected by the Hawai'i State Department of Health, Clean Air Branch. In 2008, the state maintained 14 air monitoring stations on 3 islands (none on Kauai). Between 2004 and 2008, none of the monitored ambient air concentrations in the State exceeded the annual average Ambient Air Quality Standards (AAQS) (Hawai'i State Department of Health, Clean Air Branch, 2008). Therefore, Hawai'i is in attainment for all NAAQSs.

USEPA's general air conformity rule applies to Federal actions occurring in nonattainment or maintenance areas when the total indirect and direct emissions of the subject air pollutant exceed specific thresholds. An air conformity analysis is not required for the Proposed Action because as of 2010, the State of Hawai'i was in attainment for all NAAQS.

Existing Emission Sources

PMRF and KTF power is supplied by Kauai Island Utility Cooperative (KIUC) during non-testing times. KIUC is in the process of reducing power cost by decreasing use of imported fossil fuels and increasing the amount of energy generated from Kauai's own resources. The KIUC initiative is to generate 50 percent of its electricity from renewable sources by 2023. In 2016, 38 percent of the electricity generated on Kauai came from a mix of solar, hydropower, and biomass sources. On the sunniest days, 60 percent of Kauai's daytime energy needs are met by solar. (KIUC, 2017).

The only major stationary sources of air emissions at PMRF are generators used by and permitted for PMRF/Main Base, KTF, the Advanced Radar Detection Laboratory, and the Aegis Ashore Missile Defense program during testing events and when electrical demand is high (Pacific Missile Range Facility, 2010)

Stationary emission sources at PMRF include three 320-kilowatt (kW) and the two 600-kW generators that are operational in addition to the KIUC power system. These generators are covered under the PMRF Title V Noncovered Source Permit. The Title V permit controls the nitrogen dioxide and sulfur dioxide emissions from each generator by restricting the hours of use and limiting the diesel fuel supplied for the generators to ultra-low sulfur diesel with a sulfur content not to exceed 0.0015% by weight.

Stationary emission sources at KTF include two standby 320-kW diesel engine generators that are permitted for operation by the State of Hawai'i under a Non-covered Source Permit. (Pacific Missile Range Facility, 2010)

Mobile sources from PMRF-associated testing include aircraft, missile launches, diesel-fueled vehicles, and vehicular traffic. Aircraft are operated and supported at PMRF Airfield. Missile launches are a source of mobile emissions at PMRF. Currently, there are as many as 46 missile launches per year from PMRF and KTF, which includes launches of interceptor missiles and target launches. These systems use both solid and liquid propellants. The most common exhaust components for typical missiles include aluminum oxide, carbon dioxide, carbon monoxide, hydrogen, hydrogen chloride, nitrogen, water, ferric chloride, ferric oxide, nitric oxide, chlorine, and sulfur dioxide.

3.1.2 Water Resources

This section describes the existing water resource conditions at the proposed sites. Water resources include those aspects of the natural environment related to the availability and characteristics of water. For the purposes of this document, water resources can be divided into three main sections: surface water, groundwater, and flood hazard areas.

Surface water includes discussions of runoff, changes to surface drainage, and general surface water quality. Surface water resources generally consist of wetlands, lakes, rivers, and streams. Surface water is important for its contributions to the economic, ecological, recreational, and human health of a community or locale. A Total Maximum Daily Load (TMDL) is the maximum amount of a substance that can be assimilated by a water body without causing impairment. A water body can be deemed impaired if water quality analyses conclude that exceedances of water quality standards occur.

Groundwater discussions focus on aquifer characteristics, general groundwater quality and water supply. Groundwater is water that flows or seeps downward and saturates soil or rock, supplying springs and wells.

Wetlands are jointly defined by USEPA and USACE as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Wetlands generally include "swamps, marshes, bogs and similar areas" (40 CFR section 230.3[t] and 33 CFR section 328.3[b]).

Flood hazard area discussions center on floodplains. Floodplains are areas of low-level ground present along rivers, stream channels, large wetlands, or coastal waters. Floodplain ecosystem functions include natural moderation of floods, flood storage and conveyance, groundwater recharge, and nutrient cycling.

Floodplains also help to maintain water quality and are often home to a diverse array of plants and animals. In their natural vegetated state, floodplains slow the rate at which the incoming overland flow reaches the main water body. Floodplain boundaries are most often defined in terms of frequency of inundation, that is, the 100-year and 500-year flood. Floodplain delineation maps are produced by the Federal Emergency Management Agency and provide a basis for comparing the locale of the Proposed Action to the floodplains.

Sediments are the solid fragments of organic and inorganic matter created from weathering rock transported by water, wind, and ice (glaciers) and deposited at the bottom of bodies of water. Components of sediment range in size from boulders, cobble, and gravel to sand (particles 0.05 to 2.0 millimeters [mm] in diameter), silt (0.002 to 0.05 mm), and clay (less than or equal to 0.002 mm). Sediment deposited on the continental shelf is delivered mostly by rivers but also by local and regional currents and wind. Most sediment in nearshore areas and on the continental shelf is aluminum silicate derived from rocks on land that is deposited at rates of greater than ten centimeters per 1,000 years. Sediment may also be produced locally as nonliving particulate organic material ("detritus") that travels to the bottom (Hollister, 1973; Milliman et al., 1972). Some areas of the deep ocean contain an accumulation of the shells of marine microbes composed of silicon and calcium carbonate, termed biogenic ooze (Chester, 2003). Through the downward movement of organic and inorganic particles in the water column, substances that are otherwise scarce in the water column (e.g., metals) are concentrated in bottom sediment (Chapman et al., 2003; Kszos et al., 2003).

Where practicable, water resources are described quantitatively (volume, mineral concentrations, salinity, etc.); otherwise they are described qualitatively (good, poor, etc.) when necessary.

3.1.2.1 Regulatory Setting

Groundwater quality and quantity are regulated under several statutes and regulations, including the Safe Drinking Water Act.

The CWA establishes federal limits, through the National Pollutant Discharge Elimination System (NPDES) program, on the amounts of specific pollutants that can be discharged into surface waters to restore and maintain the chemical, physical, and biological integrity of the water. The NPDES program regulates the discharge of point (i.e., end of pipe) and nonpoint sources (i.e., storm water) of water pollution.

Waters of the United States are defined as (1) traditional navigable waters, (2) wetlands adjacent to navigable waters, (3) nonnavigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow perennially or have continuous flow at least seasonally (e.g., typically 3 months), and (4) wetlands that directly abut such tributaries under Section 404 of the CWA, as amended, and are regulated by USEPA and the USACE. The CWA requires that Hawai'i establish a Section 303(d) list to identify impaired waters and establish TMDLs for the sources causing the impairment.

Section 438 of the Energy Independence and Security Act (42 U.S.C. section 17094) establishes storm water design requirements for development and redevelopment projects. Under these requirements, federal facility projects larger than 465 m^2 (5,000 ft^2) must "maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow."

Wetlands are currently regulated by the USACE under Section 404 of the CWA as a subset of all "Waters of the United States." The term "Waters of the United States" has a broad meaning under the CWA and incorporates deepwater aquatic habitats and special aquatic habitats, including wetlands. Jurisdictional Waters of the United States regulated under the CWA include coastal and inland waters, lakes, rivers, ponds, streams, intermittent streams, and "other" waters that, if degraded or destroyed, could affect interstate commerce. The full regulatory definition of Waters of the United States is provided in the Clean Water Act.

Executive Order 11990, *Protection of Wetlands*, requires that federal agencies adopt a policy to avoid, to the extent possible, long- and short-term adverse impacts associated with destruction and modification of wetlands and to avoid the direct and indirect support of new construction in wetlands whenever there is a practicable alternative.

Section 404 of the CWA authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits for the discharge of dredge or fill into wetlands and other Waters of the United States. Any discharge of dredge or fill into Waters of the United States requires a permit from the USACE.

Section 10 of the Rivers and Harbors Act provides for USACE permit requirements for any in-water construction. USACE and some states require a permit for any in-water construction. Permits are required for construction of piers, wharfs, bulkheads, pilings, marinas, docks, ramps, floats, moorings, and like structures; construction of wires and cables over the water, and pipes, cables, or tunnels under the water; dredging and excavation; any obstruction or alteration of navigable waters; depositing fill and dredged material; filling of wetlands adjacent or contiguous to waters of the US; construction of riprap, revetments, groins, breakwaters, and levees; and transportation of dredged material for dumping into ocean waters.

The National Wild and Scenic Rivers System was created by Congress in 1968 to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The Act is notable for safeguarding the special character of these rivers, while also recognizing the potential for their appropriate use and development. It encourages river management that crosses political boundaries and promotes public participation in developing goals for river protection.

Executive Order 11988, *Floodplain Management*, requires federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development unless it is the only practicable alternative. Flood potential of a site is usually determined by the 100-year floodplain, which is defined as the area that has a 1% chance of inundation by a flood event in a given year. All of PMRF Barking Sands and the Mana Plain up to the foothills are now in the Tsunami Evacuation Zone which is coincident with the Federal Flood Hazard Zone (John Burger personal communication, 20 February 2017).

The Coastal Zone Management Act of 1972 (CZMA) provides assistance to states, in cooperation with federal and local agencies, for developing land and water use programs in coastal zones. Section 307 of the CZMA stipulates that where a federal project initiates reasonably foreseeable effects to any coastal use or resource (land or water use, or natural resource), the action must be consistent to the maximum extent practicable with the enforceable policies of the affected state's federally approved coastal management plan. The Hawai'i Coastal Zone Management Program is the lead agency for coastal management and, along with State and county partners, is responsible for enforcing the State's federally approved coastal management plan. However, Federal lands, which are "lands the use of which is by law subject solely to the discretion of…the Federal Government, its officers, or agents," are statutorily excluded from the State's "coastal zone". If, however, the proposed federal activity affects coastal resources or uses beyond the boundaries of the federal property (i.e., has spillover effects), the CZMA Section 307 federal consistency requirement applies. As a federal agency, the Navy is required to determine whether its proposed activities would affect the coastal zone. This takes the form of either a Negative Determination or a Consistency Determination. Military testing and training at PMRF has been included in a list of US Navy de minimis activities under the

CZMA. The Hawai'i Coastal Zone Management Program determined the listed activities "are expected to have insignificant direct or indirect (cumulative and secondary) coastal effects, and should not be subject to further review by the Hawai`i CZM program." (Mayer, 2009)

The following discussions provide a description of the existing conditions for each of the categories under water quality resources at PMRF. Bathymetry is included in the Geological Resources section.

3.1.2.2 Region of Influence (ROI)

The ROI includes the area within and surrounding the PMRF property boundaries, including KTF and the restrictive easement. The Mana Plain and the Ground Hazard Area are also included.

Surface Water

The surface water within the PMRF boundary is in the canals that drain the agricultural areas east of PMRF. Apart from these drainages, no surface drainage has been established because the rain sinks into the permeable sand. There are numerous drains and several irrigation ponds in the agricultural land.

The waters in the irrigation ponds generally do not meet drinking water standards for chloride salts, but have near neutral to slightly alkaline pH. A surface water quality study for chloride was conducted in the Mana Plain/KTF area. The chloride levels do not indicate residual hydrochloric acid effects of the past launches at KTF (US Army Program Executive Office, 1995). Because the drainage ditches are designed to move water away from the agricultural fields during irrigation and rainfall, and to leach salts from the soil, no residual effects of past launches are expected (US Army Program Executive Office, 1995). The Agribusiness Development Corporation administers the activity on the agricultural aspects of the Mana Plain (John Burger, personal communication, 20 February 2017).

Surface water in the area of the restrictive easement on the Mana Plain is restricted to drains and agricultural irrigation ponds. Within the restrictive easement boundary, the surface water and storm water runoff drain onto former Amfac Sugar-Kauai lands and agricultural ponds below the Mana cliffs. The Mana Plain is drained by canals that flow seaward. Typically, the water from the canals that drain from the sugar cane fields is brackish. (US Army Space and Strategic Defense Command (USASSDC), 1993b)

The waters in the agricultural ponds along the Mana cliffs generally do not meet drinking water standards for chloride salts but are near neutral to slightly alkaline. The highest chloride salt levels, near those of seawater, were observed in water from the Mana Pond Wildlife Sanctuary near the north gate of PMRF. This may be due to the infiltration of brackish to saline groundwater into the pond basin or excessive evaporation to a low surface level. (USASSDC, 1993b)

Water quality along the PMRF shoreline was within Department of Health standards, with the exception of two locations where sugar cane irrigation water, pumped from the sugar cane fields, is discharged to the ocean (Belt Collins Hawai`i, 1994). In these areas, Department of Health water quality criteria are exceeded within 164 ft (50 m) of the shoreline. Mixing processes are sufficient to dilute the drainage water to near background levels within 164 to 328 ft (50 to 993 m) of the shoreline (Belt Collins Hawai`i, 1994). These outfall locations are currently monitored under a National Pollutant Discharge Elimination System Permit that is held by the Agribusiness Development Corporation (US Navy, 2010).

Groundwater

Bedrock, alluvium, and sand dunes make up hydraulically connected aquifers within the ROI. The bedrock (basement volcanics, primarily basalt) is highly permeable, containing brackish water that floats on seawater. (USASSDC, 1993b)

The overlying sediments are saturated, but they are not exploitable as an aquifer because of unfavorable hydraulic characteristics. The groundwater in the sediments originates as seepage from irrigation percolation and rainfall in the basalt aquifer, especially where the sediments are thin near the inland margin of the Mana Plain.

The dune sand aquifer on which PMRF/Main Base lies has a moderate hydraulic conductivity and moderate porosity of about 20%. It consists of a lens of brackish groundwater that floats on seawater and is recharged by rainfall and by seepage from the underlying sediments. The only record of an attempt to exploit this groundwater is of a well drilled for the Navy in 1974, 6.4 km to 8 km (4 to 5 miles) south of KTF. The well was drilled to a depth of 13 m (42 ft), and tested at 1,136 liters per minute (300 gallons per minute). In 1992, the water was too brackish for plants and animals to consume; consequently, the well is not used. (US Army Program Executive Office, 1995)

The nearest fresh groundwater sources are in the Napali formation at the inland edge of the coastal plain along the base of the Mana cliffs. Groundwater in the region is generally considered to be potable at the base of the cliffs, increasing in salinity closer to the coast. (USASSDC, 1993b)

Sampling for perchlorate was initiated at PMRF in 2006. USEPA adopted an oral reference dose for perchlorate in 2009, following a National Academy of Sciences recommendation that it not exceed 15 parts per billion in drinking water. Until USEPA promulgates standards for perchlorate, the DoD has established 15 parts per billion as the current level of concern for managing perchlorate (Office of the Under Secretary of Defense, 2009). This level has also been adopted in the Navy Perchlorate Sampling and Management Policy.

As part of the implementation of the Navy policy, perchlorate sampling has been conducted at two drinking water supply locations. One location is the “Mana well,” which is the former Kekaha Sugar/AMFAC well from which PMRF obtains drinking water, referenced as “BS 335,” and supplies the “north end” of PMRF. It is a hand-dug well, now concrete-lined, approximately 90 ft (27.4 m) deep, and is located at the base of the ridge near the Kamokala Caves. The pumps and electric motors are down in the well. The other location is the water tank at the southern end of the base identified as reference code “BS 820.” Water in the tank comes from the County of Kauai. Perchlorate concentrations at both sites were less than the initial screening level of 4.0 parts per billion. Based on guidance PMRF received from Navy Region Hawai`i, since the two consecutive samples were less than 4 parts per billion, no further analysis was required.

Flood Hazard Areas

The primary flood hazard is from overflow of the ditches that drain the Mana Plain. Extended periods of heavy rainfall have resulted in minor flooding of low-lying areas of PMRF/Main Base. In addition, all of PMRF/Main Base is within the tsunami evacuation area.

3.1.3 Biological Resources at SNL/KTF

Biological resources include living, native, or naturalized plant and animal species and the habitats within which they occur. Plant associations are referred to generally as vegetation, and animal species are referred to generally as wildlife. Habitat can be defined as the resources and conditions present in an area that support a plant or animal. The biological resources at SNL/KTF were recently evaluated for launches in this area in the *Advanced Hypersonic Weapons Program Environmental Assessment* (USASMDC/ARSTRAT, 2011) and STARS system launches have been evaluated at PMRF in the *Hawaii Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement* (HRC, 2008). This EA/OEA summarizes information on plant and animal species and their habitats, with emphasis on special-status species listed by State and Federal agencies.

Within this EA/OEA, biological resources are divided into four major categories: (1) terrestrial vegetation, (2) terrestrial wildlife, (3) marine vegetation, and (4) marine wildlife. Threatened, endangered, and other special status species are discussed in their respective categories. Table 3-2 lists all special status species that are potentially present at or near SNL/KTF.

3.1.3.1 Regulatory Setting at SNL/KTF

For the purposes of this EA/OEA, special-status species at or near SNL/KTF are those species listed as threatened or endangered under the Endangered Species Act (ESA) and species afforded federal protection under the Marine Mammal Protection Act (MMPA) or the Migratory Bird Treaty Act (MBTA).

The purpose of the ESA is to conserve the ecosystems upon which threatened and endangered species depend and to conserve and recover listed species. Section 7 of the ESA requires action proponents to consult with the US Fish and Wildlife Service (USFWS) or National Oceanic and Atmospheric Administration (NOAA) Fisheries to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species, or result in the destruction or adverse modification of designated critical habitat. For all ESA listed species, the ESA defines "harm" as an act which kills or injures wildlife including significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (16 USC, §§ 1531-1544). The ESA defines harassment as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to breeding, feeding, or sheltering.

All marine mammals are protected under the provisions of the MMPA. The MMPA prohibits any person or vessel from "taking" marine mammals in the United States or the high seas without authorization. As defined by the MMPA, level A harassment of cetaceans is any act which has the potential to injure a marine mammal or marine mammal stock in the wild. Level B harassment is defined as any act which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing behavioral pattern disruptions, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering.

Birds, both migratory and most native-resident bird species, are protected under the MBTA, and their conservation by federal agencies is mandated by EO 13186 (Migratory Bird Conservation). Under the MBTA

Table 3-2 Special-status Species Known to Occur or Potentially Occurring at or near SNL/KTF and Critical Habitat Present at PMRF

Common Name	*Scientific Name*	*Federal Listing Status*	*Likelihood of Occurrence at or near KTF*	*Critical Habitat Present?*
Plants				
Lau'ehu	*Panicum niihauense*	E	U	Yes
Ohai	*Sesbania tomentosa*	E	U	Yes
Terrestrial Mammals				
Hawaiian hoary bat	*Lasiurus cinereus spp. Semotus*	E	P	
Marine Mammals				
Minke whale	*Balaenoptera acutorostrata*	-	P	
Sei whale	*B. borealis*	E	U	
Bryde's whale	*B. edeni*	-	P	
Blue whale	*B. musculus*	E	U	

Common Name	*Scientific Name*	*Federal Listing Status*	*Likelihood of Occurrence at or near KTF*	*Critical Habitat Present?*
Fin whale	*B. physalus*	E	U	
Pygmy killer whale	*Feresa attenuata*	-	P	
Short-finned pilot whale	*Globicephala macrorhynchus*	-	P	
Risso's dolphin	*Grampus griseus*	-	P	
Longman's beaked whale	*Indopacetus pacificus*	-	P	
Pygmy sperm whale	*Kogia breviceps*	-	P	
Dwarf sperm whale	*K. sima*	-	P	
Fraser's dolphin	*Lagenodelphis hosei*	-	U	
Humpback whale	*Megaptera novaeangliae*	[1]	L	
Blainville's beaked whale	*Mesoplodon densirostris*	-	P	
Northern elephant seal	*Mirounga angustirostris*		U	
Hawaiian monk seal	*Neomonachus schauinslandi*	E	L	
Killer whale	*Orcinus orca*	-	P	
Melon-headed whale	*Peponocephala electra*	-	P	
Sperm whale	*Physeter macrocephalus*	E	P	
False killer whale	*Pseudorca crassidens*	E, Insular Hawaiian DPS	P	
Pantropical spotted dolphin	*Stenella attenuata*	-	P	
Striped dolphin	*S. coeruleoalba*	-	P	
Spinner dolphin	*S. longirostris*	-	L	
Rough-toothed dolphin	*Steno bredanensis*	-	P	
Bottlenose dolphin	*Tursiops truncatus*	-	P	
Cuvier's beaked whale	*Ziphius cavirostris*	-	P	
Birds				
Koloa maoli (Hawaiian duck)	*Anas wyvilliana*	E	L	
Nene (Hawaiian goose)	*Branta sandvicensis*	E	L	
\`Alae ke\`oke\`o (Hawaiian coot)	*Fulica alai*	E	L	
\`Alae \`ula (Hawaiian common moorhen	*Gallinula chloropus sandvicensis*	E	L	
Ae\`o (Hawaiian black-necked stilt)	*Himantopus mexicanus knudseni*	E	L	
Band-rumped storm-petrel	*Oceanodroma castro*	Proposed E	P	
Short-tailed albatross	*Phoebastria albatrus*	E	U	
\`Ua\`u (Hawaiian petrel)	*Pterodroma phaeopygia sandwichensis*	E	P	
\`A\`o (Newell's Townsend's shearwater)	*Puffinus auricularis newelli*	T	P	
Sea Turtles				
Loggerhead turtle	*Caretta caretta*	E	P	
Green turtle	*Chelonia mydas*	T, Central	L	

Common Name	*Scientific Name*	*Federal Listing Status*	*Likelihood of Occurrence at or near KTF*	*Critical Habitat Present?*
		North Pacific DPS		
Leatherback turtle	*Dermochelys coriacea*	E	P	
Hawksbill turtle	*Enetmochelys imbricata*	E	L	
Olive ridley turtle	*Lepidochelys olivacea*	T	P	

Abbreviations: ESA = Endangered Species Act, E = federal endangered; T = federal threatened; L = Likely; P = Potential; U = Unlikely.
[1] The Hawai'i distinct population segment (DPS) is not listed under the ESA. The eastern north Pacific DPS is listed as endangered. There is some evidence that eastern north Pacific DPS whales may winter in Hawai'i.

it is unlawful by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, [or] possess migratory birds or their nests or eggs at any time, unless permitted by regulation. The 2003 National Defense Authorization Act gave the Secretary of the Interior authority to prescribe regulations to exempt the Armed Forces from the incidental taking of migratory birds during authorized military readiness activities. The final rule authorizing the DoD to take migratory birds in such cases include a requirement that the Armed Forces must confer with the USFWS to develop and implement appropriate conservation measures to minimize or mitigate adverse effects of the proposed action if the action will have a significant negative effect on the sustainability of a population of a migratory bird species.

The Magnuson-Stevens Fishery Conservation and Management Act provides for the conservation and management of the fisheries. Under the Magnuson-Stevens Fishery Conservation and Management Act, essential fish habitat (EFH) consists of the waters and substrate needed by fish to spawn, breed, feed, or grow to maturity.

The Coastal Zone Management Act establishes a federal-state partnership to provide for the comprehensive management of coastal resources. Coastal states and territories develop management programs based on enforceable policies and mechanisms to balance resource protection and coastal development needs. Actions implemented on federal lands must ensure consistency with these plans and programs to the maximum extent practicable.

3.1.3.2 Region of Influence (ROI)

The following discussions provide a description of the existing conditions for each of the categories under biological resources at and near SNL/KTF, which is located on PMRF Main Base, Hawai'i. The ROI is the area within SNL/KTF boundaries and adjacent areas that may be affected by elevated sound levels, deposition of debris, hazardous chemicals, and increased human activity.

3.1.3.3 Vegetation at SNL/KTF

Vegetation includes terrestrial plant communities and constituent plant species. SNL/KTF is located in the northern portion of PMRF main base and is covered primarily with coastal dune vegetation. Naupaka, beach morning glory, and `a`ali`i (*Dodonaea viscosa*) are common species at SNL/KTF (US Navy, 2008). PMRF also has areas of native scrub vegetation and coastal strand. In areas where natural vegetation has been disturbed within SNL/KTF, the habitat is managed by mowing (USASMDC/ARSTRAT, 2011). No threatened or endangered plants have been observed at SNL/KTF (USASMDC/ARSTRAT, 2011). Two ESA listed endangered plants have been observed north of PMRF, lau'ehu (*Panicum nihauense*) and ohai (*Sesbania tomentosa*; USASMDC/ARSTRAT, 2011). Critical habitat has been designated for these species and an area on the northwestern end of PMRF near Polihale Park is a portion of the critical habitat for the endangered ohai and lau`ehu. In January 2002, the USFWS proposed additional critical habitat for the lau'ehu in the southern portion of PMRF (USASMDC/ARSTRAT, 2011). Although lau`ehu does not grow on PMRF/Main Base, the USFWS has determined that land on PMRF adjacent to Polihale State Park and dune areas along the southern portion of the range contain primary constituents necessary for the recovery of lau`ehu because not enough areas exist outside of PMRF (USASMDC/ARSTRAT, 2011)

3.1.3.4 Terrestrial Wildlife at SNL/KTF

Wildlife includes all animal species (i.e., insects and other invertebrates, fish, amphibians, reptiles, birds, and mammals) focusing on the species and habitat features of greatest importance or interest.

Mammals. The Hawaiian hoary bat (*Lasiurus cinereus semotus*) is the only strictly terrestrial special-status mammal species potentially found at SNL/KTF. This federally and Hawaiian state listed endangered species is the only land mammal endemic to Hawai`i. Hawaiian hoary bats generally occur in or near forest habitat, and apparently use native vegetation more frequently than non-native vegetation (USASMDC/ARSTRAT, 2011). Their diet consists of flying insects and Hawaiian hoary bats have been observed to forage over open fields, over open ocean near the mouths of river or stream outlets, and over streams and ponds (USASMDC/ARSTRAT, 2011). The current population size of Hawaiian hoary bats is unknown, but the greatest threats to populations are thought to be habitat loss, use of pesticides, and predation. This species has not been recorded at PMRF for over a decade and the abundance and distribution of this species in the area remains largely unknown (John Burger, personal communication, 20 February 2017). A group of four bats was observed foraging around the sewage treatment ponds, and another separate group of five bats was seen just offshore of northern PMRF (USASMDC/ARSTRAT, 2011).

Hawaiian monk seals (*Monachus schauinslandi*) are found on and near Kauai, especially in shallow waters within 12nm of the PMRF coastline. While these marine mammals do haul out on beaches and rock coastlines, the closest observed Hawaiian monk seal haul out area is approximately 1.6 km (1 mile) south of Launch Pad 42 (USASMDC/ARSTRAT, 2011). While critical habitat has been established for the Hawaiian Monk seal at Kauai and most other Hawaiian Islands, there is no designated critical habitat for this species at PMRF Main Base.

*Birds. Bir*ds on SNL/KTF include both resident and migratory bird species. Resident bird species include the red junglefowl (*Gallus gallus*), ring-necked pheasant (*Phasianus colchicus*), and northern mockingbird (*Mimus polyglottos*) (USASMDC/ARSTRAT, 2011). Migratory seabirds and shorebirds commonly observed at PMRF Main Base include brown boobies (*Sula leucogaster*), sanderlings (*Calidris alba*), wandering tattlers (*Tringa incana*), ruddy turnstones (*Arenaria interpres*), and Pacific golden plovers (*Pluvialis fulva*; USASMDC/ARSTRAT, 2011). Wedge-tailed shearwaters (*Puffinus pacificus*) nest in the Nohili dunes area and near the beach cottages (USASMDC/ARSTRAT, 2011). Laysan albatross also nest maintained disturbed areas at PMRF (USASMDC/ARSTRAT, 2011).

Nine species of ESA listed bird species occur or have the potential to occur at PMRF. While the endangered Hawaiian goose (*Branta sandvicensis*) is found on other areas of PMRF, the SNL/KTF area lacks suitable habitat for this species (USASMDC/ARSTRAT, 2011). Four endangered waterbirds, the Hawaiian coot (*Fulica alai*), Hawaiian black-necked stilt (*Himantopus mexicanus knudseni*), Hawaiian common moorhen (*Gallinula chloropus sandvicensis*), and Hawaiian duck (*Anas wyvilliana*) are potentially present or confirmed within or near the SNL/KTF area (USASMDC/ARSTRAT, 2011). The Hawaiian coot, black-necked stilt, and common moorhen are known to nest on the island of Kauai year-round (USASMDC/ARSTRAT, 2011). In March of 2000, an endangered juvenile short-tailed albatross (*Phoebastria albatrus*) was observed at PMRF, resting in the grass on the mountain side of the PMRF runway (USASMDC/ARSTRAT, 2011). While the band-rumped storm petrel (*Oceanodroma castro*), Hawai'i petrel (*Pterodroma phaeopygia sandwichensis*), and Newell's Townsend's shearwater (*Puffinus auricularis newelli*) are not known to nest or roost at PMRF main base, they are known to fly over or near the area. Newell's shearwater breed only in the southeastern Hawaiian Islands where they nest in burrows on steep forested mountain slopes (Pyle and Pyle, 2009). Adults return to Hawai'i to breed in April and depart in leave in early fall (Pyle and Pyle 2009). In September 2016, PMRF instituted a "Dark Skies" program involving turning off all non-essential lighting on the base and modifying night time operations to prevent disorientation of sea birds during nocturnal flight.

No designated critical habitat for bird species is found at or near SNL/KTF.

Sea Turtles. Although five species of sea turtles potentially inhabit the nearshore and offshore area of Hawai'i, green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles account for nearly all sightings in the area (Hanser et al. 2013). While sea turtle nesting at PMRF has been relatively rare, green sea turtles (*Chelonia mydas*) have regularly nested along the beachfront on PMRF in recent years. In 2015, at least 6 green sea turtle nests hatched successfully between July 18 and September 3, with a total of 468 hatchlings on PMRF (John Burger personal communication, 23 February 2017). No designated critical habitat for sea turtles is found at or near SNL/KTF.

3.1.3.5 Marine Vegetation at SNL/KTF

Common plants found in the rocky intertidal habitats offshore of PMRF include sea lettuce (*Ulva*), Sargasso or kala (*Sargassum*), coralline red algae (*Hydrolithon*), red fleshy algae (*Melanamansia*, *Pterocladiella*, *Jania*), brown algae (*Padina*, *Turbinaria*, *Dictyota*), and fleshy green algae (*Neomeris*, *Halimeda*, and *Caulerpa*; US Navy, 2008). Algal species on the limestone bench fronting Nohili Point preferred by the green turtle include but are not limited to lipuupuu (*Dictyospheria versluysii*), kala-laununui (*Sargassum echinocarpum*), pahalahala (*Ulva fasciatus*), and mane`one`o (*Laurencia nidifica*; US Navy, 2008). The algal and macroinvertebrate survey in Majors Bay noted that four macroalgal and eight macroinvertebrate species were present (US Navy, 2008). No special-status marine vegetation is located near SNL/KTF.

3.1.3.6 Marine Wildlife at SNL/KTF

Offshore areas near PMRF include a narrow fringing reef follows the coastline up to Nohili Point and Barking Sands (US Navy, 2008). Coral density is low in this area and is dominated by lobe coral (*Porites lobata*) and small stands of arborescent (branched or tree shaped) corals (US Navy, 2008). Broad uncolonized pavement (1,772 feet [ft] wide) and colonized pavement (2,297 ft wide) stretch along the coastline seaward of the fringing reef (US Navy, 2008). Uncolonized pavement is flat, low relief, solid carbonate rock often covered by a thin sand veneer. The surface of the pavement often has sparse coverage of macroalgae, hard coral, and other sessile invertebrates that does not obscure the underlying surface. Colonized pavement is flat, low-relief, solid carbonate rock with coverage of macroalgae, hard coral, and other sessile invertebrates that are dense enough to begin to obscure the underlying surface (US Navy, 2008). No designated critical habitat for any marine species is found on or near KTF.

Marine Mammals. Of the 26 species of marine mammals with the potential to occur near PMRF, the Hawaiian monk seal, humpback whale (*Megaptera noveangliae*), and spinner dolphin (*Stenella longirostris*) are the most likely species to be observed within 12 nm of the PMRF coastline. The endangered Hawaiian monk seal is an indigenous mammal that has been observed at PMRF. The primary occurrence of Hawaiian monk seals within the area is expected to be in a continuous band between Nihoa, Kaula, Niihau, and Kauai (US Navy, 2008). This band extends from the shore to around 273 fathoms and is based on the large number of sightings and births recorded in this area (US Navy, 2008). Hawaiian monk seals (*Monachus schauinslandi*) are found on and near Kauai, especially in shallow waters within 12 nm of the PMRF coastline. While critical habitat has been established for the Hawaiian Monk seal at Kauai and most other Hawaiian Islands, there is no designated critical habitat for this species offshore of PMRF Main Base.

Spinner dolphins (*Stenella longirostris*) are the most commonly recorded cetaceans observed within 12 nm of the PMRF coastline. The spinner dolphin inhabits bays and protected waters, often in waters less than 40 ft deep (US Navy, 2008). Spinner dolphins are expected to occur in shallow water resting areas (about 162 ft deep or less) throughout the middle of the day, moving into deep waters offshore during the night to feed (US Navy, 2008).

The humpback whale peak abundance around the Hawaiian Islands is from late February through early April (US Navy, 2011). During the fall-winter period, primary occurrence is expected from the coast to 50 nm offshore, including the areas off PMRF (US Navy, 2008). There is some ambiguity as to which DPS the whales near Hawai'i belong. The Hawai'i DPS of humpback whales is not listed under the ESA. This DPS includes whales which remain near Hawaiian waters throughout the year. There are also humpback whales which winter in Hawaiian waters and migrate north to summer feeding grounds. These whales likely belong to the eastern north Pacific DPS (Muto et al., 2015) which also not listed under the ESA.

NOAA Fisheries maintains jurisdiction over marine mammals in the ROI.

Sea Turtles. Of the five sea turtle species that have the potential to occur near PMRF, Green and hawksbill turtles are the most common sea turtles in offshore waters around the Main Hawaiian Islands, as they prefer reef-type environments that are less than about 55 fathoms in depth (HRC, 2011). Green turtles have been observed offshore of Nohili Ditch, the only area where basking/haul-out activity on PMRF/Main Base is observed (US Navy, 2008). The PMRF Natural Resources Manager monitors sea turtle activity at PMRF. Security patrol reports include a record of the presence and locations of turtles. Any records of green turtle observation are maintained by the PMRF Environmental Office. The USFWS and NOAA Fisheries share federal jurisdiction for sea turtles with the USFWS having lead responsibility on the nesting beaches and NOAA Fisheries, the marine environment.

Fish. Fish are vital components of the marine ecosystem. They have great ecological and economic aspects. To protect this resource, NOAA Fisheries works with the regional fishery management councils to identify the essential habitat for every life stage of each federally managed species using the best available scientific information. Essential fish habitat (EFH) has been described for approximately 1,000 managed species to date. EFH includes all types of aquatic habitat including wetlands, coral reefs, seagrasses, and rivers; all locations where fish spawn, breed, feed, or grow to maturity.

Essential Fish Habitat. The Magnuson-Stevens Fishery Conservation Management Act (MSA) of 1976 mandates identification and conservation of EFH to help maintain productive fisheries and rebuild depleted fish stocks. All federal agencies whose work may affect fish habitats must assess potential project effects on EFH. Under the MSA, EFH is defined as "those waters and substrate necessary to fish for spawning, breeding or growth to maturity." An EFH may include US waters within exclusive economic zones (EEZ; seaward boundary out to a distance of 200 nm) and covers all fish species within in a fishery management unit (50 CFR §600.805). Under the MSA, an adverse effect means any impact that reduces quality and/or quantity of EFH (50 CFR §600.810). Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH (50 CFR §600.810).

The Western Pacific Regional Fishery Management Council (WPRFMC) has authority over the fisheries and EFH designation in and surrounding the State of Hawai`i, the Territory of American Samoa, the Territory of

Guam, the Commonwealth of the Northern Mariana Islands, and the US Pacific Remote Island Areas (Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Wake Island, Palmyra Atoll, and Midway Atoll; Figure 3-1). The flight path for FE-1 crosses over waters designated as EFH near the Hawaiian Islands. Therefore the effects of the Proposed Action on EFH near the Hawaiian Islands are evaluated in this section of the EA/OEA. The effects of the Proposed Action on EFH near Johnson Atoll are discussed in section 3.2.2.

The WPRFMC developed EFH designations for Bottomfish and Seamount Groundfish, Crustaceans, and Precious Corals (approved by the Secretary of Commerce on February 3, 1999; 64 FR 19068) as well as for Coral Reef Ecosystem Management Unit Species (MUS; approved by the Secretary of Commerce on June 14, 2002; 69 FR 8336) (WPRFMC, 2009b). The EFH for these species management units which are summarized here are discussed in detail by WPRFMC in the Fishery Ecosystem Plan for the Hawai'i Archipelago (WPRFMC, 2009a), the Fishery Ecosystem Plan for the Pacific Remote Island Area (WPRFMC, 2009b), and the Fishery Ecosystem Plan for Pacific Pelagic Fisheries of the Western Pacific Region (WPRFMC, 2005). EFH in the Action Area is summarized in Table 3-3 and discussed below.

In addition to EFH, the WPRFMC (2009b) has identified habitat areas of particular concern (HAPCs) within the EFH for certain MUS. The HAPCs are specific areas within EFH that are essential to the life cycle of important coral reef species (WPRFMC, 2009b). These HAPCs must meet one of the following criteria: a) the ecological function provided by the habitat is important; b) the habitat is sensitive to human-induced environmental degradation, c) development activities are, or will be, stressing the habitat type; or d) the habitat type is rare (WPRFMC, 2009b). HAPCs within the Action Area are summarized in Table 3-3 and discussed below.

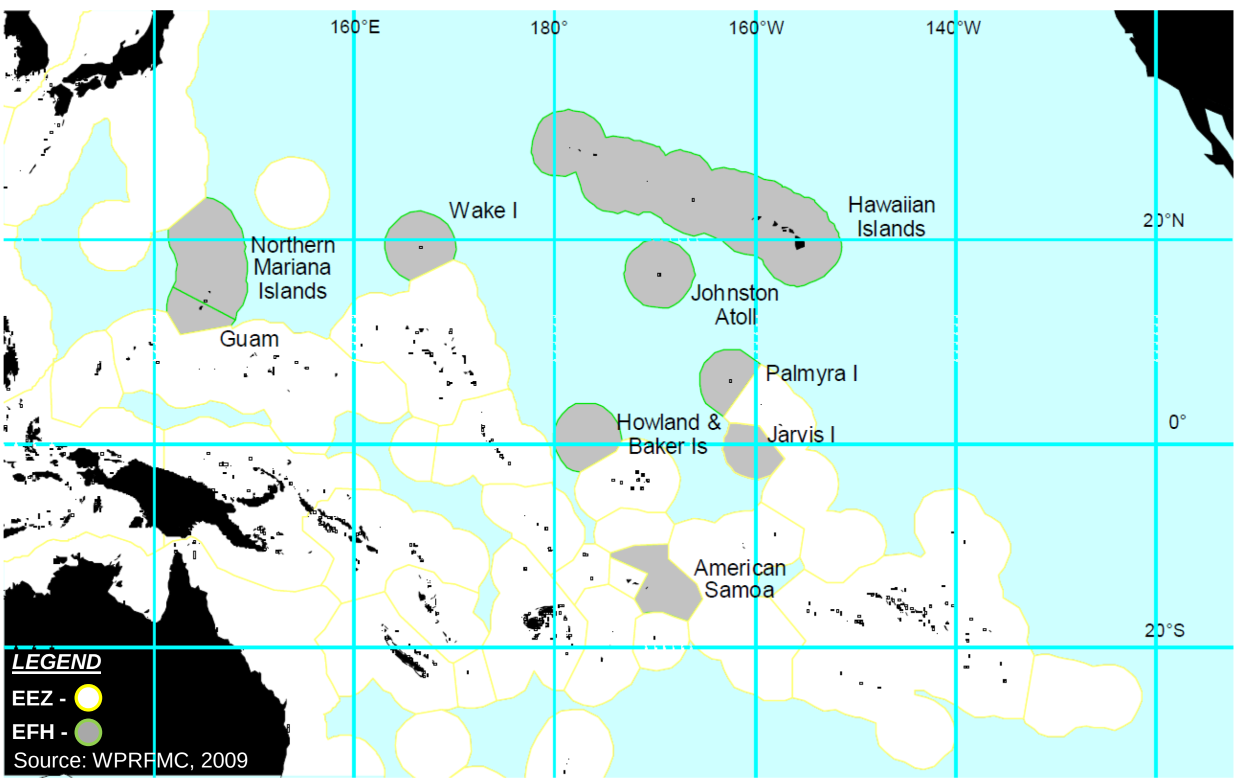


Figure 3-1 Exclusive Economic Zones and Extent of Essential Fish Habitat in the Western Pacific Region

Table 3-3 Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for Hawaiian Archipelago Management Unit Species [1]

Resource	*Species Complex*	*EFH*	*HAPC*
Bottomfish and Seamount Groundfish	Shallow-water species (0–50 fm): uku (*Aprion virescens*), thicklip trevally (*Pseudocaranx dentex*), black trevally (*Caranx lugubris*), amberjack (*Seriola dumerili*), taape (*Lutjanus kasmira*)	Eggs and larvae: the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm). Juvenile/adults: the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	Deep-water species (50–200 fm): ehu (Etelis carbunculus), onaga (*Etelis coruscans*), opakapaka (*Pristipomoides filamentosus*), yellowtail kalekale (*P. auricilla*), , kalekale (*P. sieboldii*), gindai (*P. zonatus*), hapuupuu (*Epinephelus quernus*), lehi (*Aphareus rutilans*)	Eggs and larvae: the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm) Juvenile/adults: the water column and all bottom habitat extending from the shoreline to a depth of 400 meters (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	Seamount groundfish species (50–200 fm): armorhead (*Pseudopentaceros richardsoni*), ratfish/butterfish (Hyperoglyphe japonica), alfonsin (*Beryx splendens*)	Eggs and larvae: the (epipelagic zone) water column down to a depth of 200 m (100 fm) of all EEZ waters bounded by latitude 29°–35° Juvenile/adults: all EEZ waters and bottom habitat bounded by latitude 29°–35° N and longitude 171° E–179° W between 200 and 600 m (100 and 300 fm)	No HAPC designated for seamount groundfish
Crustaceans	Spiny and slipper lobster complex: Hawaiian spiny lobster (*Panulirus marginatus*), spiny lobster (*P. penicillatus,* P. spp.), ridgeback slipper lobster (*Scyllarides haanii*), Chinese slipper lobster (*Parribacus antarticus*) Kona crab: Kona crab (*Ranina ranina*)	Eggs and larvae: the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (75 fm) Juvenile/adults: all of the bottom habitat from the shoreline to a depth of 100 m (50 fm)	All banks with summits less than or equal to 30 m (15 fathoms) from the surface
Crustaceans	Deepwater shrimp (Heterocarpus spp.)	Eggs and larvae: the water column and associated	No HAPC designated for deepwater shrimp.

Resource	*Species Complex*	*EFH*	*HAPC*
		outer reef slopes between 550 and 700 m Juvenile/adults: the outer reef slopes at depths between 300-700 m	
Precious Corals	Deep-water precious corals (150–750 fm): Pink coral (*Corallium secundum*), red coral (*C. regale*), pink coral (*C. laauense*), midway deepsea coral (C. spp. nov.), gold coral (Gerardia sp.), gold coral (*Callogorgia gilberti*), gold coral (Narella spp.), gold coral (Calyptrophora spp.), bamboo coral (*Lepidisis olapa*), bamboo coral (Acanella spp.) Shallow-water precious corals (10-50 fm): black coral (*Antipathes griggi*), black coral (*Antipathis grandis*), black coral (*Myriopathes ulex*)	EFH for Precious Corals is confined to six known precious coral beds located off Keahole Point, Makapuu, Kaena Point, Wespac bed, Brooks Bank, and 180 Fathom Bank EFH has also been designated for three beds known for black corals in the Main Hawaiian Islands between Milolii and South Point on the Big Island, the Auau Channel, and the southern border of Kauai	Includes the Makapuu bed, Wespac bed, Brooks Banks bed For Black Corals, the Auau Channel has been identified as a HAPC
Coral Reef Ecosystems	All Currently Harvested Coral Reef Taxa All Potentially Harvested Coral Reef Taxa	EFH for the Coral Reef Ecosystem Management Unit Species (MUS) includes the water column and all benthic substrate to a depth of 50 fathoms (fm) from the shoreline to the outer limit of the EEZ	Includes all no-take MPAs identified in the CRE-FMP, all Pacific remote islands, as well as numerous existing MPAs, research sites, and coral reef habitats throughout the western Pacific

[1] Source: WPRFMC 2009a, Table 34.

__Bottomfish and Seamount Groundfish.__ Very little is known about the life histories, habitat utilization, diet, or reproductive behavior of most adult and juvenile bottomfish and seamount groundfish species (WPRFMC, 2009a).

Bottomfish MUS in the Western Pacific Region are found concentrated on steep slopes of deepwater banks near the 100-fathom isobath (WPRFMC, 2009a). Adult bottomfish are generally found in habitats with hard substrate with high structural complexity (WPRFMC, 2009a). Due to a lack of data on productivity of bottomfish in different habitats and the fishes utilization of these habitats, the WPRFMC has designated EFH for adult and juvenile bottomfish as the water column and all bottom habitat extending from the shoreline to a depth of 400 m (1,312 ft) encompassing the steep drop-offs and high-relief habitats that are important for bottomfish in the Western Pacific Region (WPRFMC, 2009a).

Eggs and larva of bottomfish MUS are pelagic and therefore subject to ocean currents (WPRFMC, 2009a). Since little is known about the distribution of egg and larval life stages, the WPRFMC has designated EFH for egg and larval bottomfish as the water column extending from the shoreline to the outer boundary of the EEZ to a depth of 400 m (1,312 ft) throughout the Western Pacific Region (WPRFMC, 2009a).

The WPRFMC (2009a) designated EFH for adult seamount groundfish MUS as all waters and bottom habitat bounded by latitude 29°-35° N and longitude 171° E-179° W between 80 and 600 m (262 and 1,969 ft). For seamount groundfish eggs, larvae, and juveniles, designated EFH includes the epipelagic zone (200 m in depth) of all waters bounded by latitude 29°-35° N and longitude 171° E-179° W (WPRFMC 2009a). All escarpments/slopes between 40-280 m throughout the Western Pacific Region are designated as HAPCs for bottomfish (WPRFMC 2009a).

Crustaceans. The WPRFMC (2009a) has designated EFH for two crustacean species assemblages; a spiny lobster, slipper lobster, and kona crab complex and a shrimp complex.

Spiny lobsters of the genus *Panulirus* are found throughout the Western Pacific Region including 13 species distributed in tropical and subtropical Pacific waters, 3 species which are absent from many island nations, and the Hawaiian spiny lobster (*P. marginatus*) which is endemic to Hawai'i and Johnston Atoll (WPRFMC 2009b). The slipper lobsters belong to a closely related family, Scyllaridae (WPRFMC, 2009a).

In Hawai'i, spiny lobsters are typically found in crevices and under rocks in well protected, rocky areas (WPRFMC, 2009a). The EFH for adult and juvenile spiny lobster is designated at the bottom habitat from the shoreline to a depth of 100 m (328 ft) throughout the Western Pacific Region (WPRFMC, 2009a).

Little is known about spiny lobster egg production or larval settlement, however, the WPRFMC (2009b) has designated EFH for spiny lobster larvae as the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (492 ft) throughout the Western Pacific Region (WPRFMC, 2009a).

The EFH for deepwater shrimp eggs and larvae is designated at the water column and associated outer reef slopes between 550 and 700 m (1,640 and 2,267 ft) and the EFH for juveniles and adults is designated as the outer reef slopes at depth between 300 and 700 m (984 and 2,267 ft; WPRFMC, 2009a).

Precious Corals. Precious corals are divided into deep- and shallow-water species complexes (WPRFMC, 2009b). Deep-water species such as pin coral (*Corallium secundum*), gold coral (*Gerardi* sp. and *Parazoanthus* sp.), and bamboo coral (*Lepidistis olapa*), are generally found between 350 and 1,500 m (1,148 and 4,921 ft) deep (WPRFMC, 2009a). Shallow-water species include three species of black coral (*Antipathes griggi*, *A. grandis*, and *Myriopathes ulex*, which occur between 30 and 100 m (98 and 328 ft) deep (WPRFMC, 2009b). These corals are non-reef building and are found on solid substrate in areas with moderate to strong bottom currents which keep the area swept free of accumulated sediments which would prevent settlement of new larvae (WPRFMC, 2009b). In the Hawaiian Islands, large beds of pink, gold, and bamboo corals are found in deep interisland channels in the Hawaiian Islands and the WPRFMC (2009b) has designated six known beds of precious corals as EFH. These beds are found at Keahole Point, Makapuu, Kaena Point, Wespac, Brooks Bank, and 180 Fathom Bank. Black corals are typically found under vertical drop-offs where they host unique communities of marine life including crustaceans, bivalves, and fish (WPRFMC, 2009a). The EFH and HPAC designations for these precious corals are detailed in Table 3-3.

Coral Reef Ecosystems. For coral reef ecosystem MUS, the WPRFMC (2009a) has designated EFH based on habitat, including sand, live coral, seagrass beds, mangrove, and open ocean, for each life history stage where EFH is consistent with the depth of the ecosystem to 91 m (300 ft) and out to the limit of the EEZ. Since little data are available concerning life history, habitat utilization, food habits, and spawning behavior of most coral reef associated species, these species are farther divided into currently harvested coral reef taxa MUS and potentially harvested coral reef taxa MUS (WPRFMC, 2009ba.

Detailed information concerning species assemblages for these MUS and known habitat usage for adults, spawners, juveniles, larvae, and eggs are available in the Fishery Ecosystem Plan for the Hawai'i Archipelago (WPRFMC, 2009a). Currently harvested coral reef taxa MUS include certain species of surgeonfish and unicornfish (Acanthuridae), triggerfish (Balistidae), jacks (Carangidae), reef sharks (Carcharhinidae), soldierfish and squirrelfish (Holocentridae), flagtails (Kuhliidae), rudderfish (Kyphosidae), wrasses (Labridae), goatfish (Mullidae), octopuses (Octopodidae), mullets (Mugilidae), moray eels (Muraenidae), threadfins (Polynemidae), bigeyes (Priacanthidae), parrotfishes (Scaridae), barracudas (Sphyraenidae),), sugeonfishes (Acanthuridae), the Moorish idol (Zanclidae), the dragon moray (Muraenidae), hawkfishes (Cirrhitidae), butterflyfishes (Chaetodontidae), damselfishes (Pomacentridae), and feather-duster worms (Sabellidae ; see WPRFMC 2009a Table 30 for detailed species list). Potentially harvested coral reef taxa MUS include species in over 36 families of ray-finned fish, 5 families of sharks and rays, stony corals, azooxanthellate corals, mushroom corals (Fungiidae), soft corals, anemones, zooanthids, sponges, hydrozoans, lace corals (Stylasteridae), hydroid fans (Solanderidae), bryozoans, tunicates, feather worms (Sabellidae), echinoderms, sea snails (Gastropoda), sea slugs (Opistobranchs), giant clams (Tridacnidae)Trochus, sea slugs (Opistobranchs) black lipped pearl oyster (*Pinctada margaritifera*) and other bivalves, cephalopods, octopuses, lobsters, shrimp, crabs, annelid worms, and algae species (see WPRFMC 2009a Table 32 for details). While the EFH differs slightly for some species assemblages/complexes, taken together, the EFH for all life stages of both currently harvested coral reef taxa MUS and potentially harvested coral reef taxa MUS encompasses the water column and bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 50 fathoms (WPRFMC, 2009a).

Coral. Corals are invertebrates that are related to anemones, jellyfish, and hydras. They are made of invertebrate polyps and can generally be categorized as either hard or soft. Hard corals have calcium carbonate skeletons, grow in colonies, and are reef-building animals that live in symbiosis with phytoplankton called zooxanthellae. Soft corals are flexible, have calcareous particles in their body walls for structural support, can be found in both tropical and cold ocean waters, do not grow in colonies or build reefs, and do not always contain zooxanthellae.

Total coral cover in the Nohili Sector north of PMRF Main Base ranges from 32% to 39% of bottom cover (US Navy, 2008). The most abundant coral species are lobe coral, rose or cauliflower coral (*Pocillopora meandrina*), and ringed rice coral (*Montipora patula*). Along the central portion of PMRF, living coral is sparsely distributed, approximately one half of that found in the Nohili area (US Navy, 2008). The dominant species is lobe coral. Coral cover further south in the Major's Bay Sector is less than 2% (US Navy, 2008). Further offshore, the predominant coral is antler coral (*Pocillopora eydouxi*), which occurs as single large branching colonies (US Navy, 2008). Other corals found in this area are primarily smaller species which have a collective coverage of about 5% of bottom cover: rose or cauliflower coral, lobe coral, corrugated coral (*Pavona varians*), flat lobe coral (*P. duerdeni*), blue rice coral (*Montipora flabellata*), ringed rice coral, Verrill's ringed rice coral *(M. verrilli),* rice coral (*M. capitata*), crust coral (*Leptastrea purpurea*), and mushroom coral (*Fungia scutaria*; US Navy, 2008).

No known special-status coral are found in the ROI near KTF.

Non-coral Invertebrates. Animals that live on the sea floor are called benthos. Most of these animals lack a backbone and are called invertebrates. Typical benthic invertebrates found near PMRF include sea anemones, sponges, corals, sea stars, sea urchins, worms, bivalves, crabs, and many more (US Navy, 2008). Common animals found in rocky intertidal habitats include limpets, periwinkles, littorine snails, rock crabs, gastropods, and rock urchins (USASMDC/ARSTRAT, 2011). Further offshore in coral reef habitats, macroinvertebrates include the rock oyster (*Spondylus tenebrosus*), cone shells (*Conus* spp.), sea urchins

(*Echinometra mathaei*), and sea cucumbers (*Holothuria atra*; US Navy, 2008). No known special-status invertebrates are found in the ROI near KTF.

3.1.4 Airspace

This discussion of airspace includes current uses and controls of the airspace. The Federal Aviation Administration (FAA) manages all airspace within the United States and the US territories. Airspace, which is defined in vertical and horizontal dimensions and also by time, is considered to be a finite resource that must be managed for the benefit of all aviation sectors including commercial, general, and military aviation.

3.1.4.1 Regulatory Setting

Airspace, or that space which lies above a nation and comes under its jurisdiction, is generally viewed as being unlimited. However, it is a finite resource that can be defined vertically and horizontally, as well as temporally, when describing its use for aviation purposes. The time dimension is a very important factor in airspace management and air traffic control.

Under Public Law (PL) 85-725, Federal Aviation Act of 1958, the Federal Aviation Administration (FAA) is charged with the safe and efficient use of our nation's airspace and has established certain criteria and limits to its use. The method used to provide this service is the National Airspace System. This system is "…a common network of US airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information and manpower and material."

Specific aviation and airspace management procedures and policies to be used by the Navy are provided by OPNAVINST 3710.7, *Naval Aviation Training and Operating Procedure Standardization*. Other applicable regulations regarding special use airspace management include FAA Order 7490, "*Policies and Procedures for Air Traffic Environmental Actions*;" FAA Order 7610.4H, "*Special Military Operations*;" and the Memorandum of Understanding Between the Federal Aviation Administration and the Department of the Defense Concerning Special Use Airspace Environmental Actions (January 26, 1998).

3.1.4.2 Region of Influence (ROI)

The affected airspace use environment in the PMRF/KTF ROI is described below in terms of its principal attributes: controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, airports and airfields, and air traffic control. There are no military training routes in the ROI.

The ROI for airspace includes the airspace over and surrounding the islands of Kauai and Niihau. Figure 3-2 shows a view of the airspace within the PMRF/Main Base ROI, including the PMRF Aircraft Operational Areas, the R-3101 Restricted Area, and surrounding airspace off the western and northwestern coast of Kauai.

The affected airspace use environment in the PMRF/KTF ROI is described below in terms of its principal attributes: controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, airports and airfields, and air traffic control. There are no military training routes in the ROI.

Controlled and Uncontrolled Airspace

The airspace outside the special use airspace identified below is essentially international airspace controlled by the Honolulu Control Facility and Oakland Air Route Traffic Control Center (ARTCC). Class D airspace (generally that airspace surrounding those airports that have an operational control tower) surrounds the PMRF/Main Base airfield with a ceiling of 2,500 ft (762 m). It is surrounded to the north, south, and east by

Class D airspace with a floor 700 ft (713 m) above the surface (Figure 3-2). Lihue Airport, located approximately 15 nm (27.8 km) east of PMRF, includes Class D, surface Class E (controlled airspace not in the other classes), and additional Class E airspace with a floor 700 ft (713 m) above the surface. There is no Class B (US terminal control areas) airspace (which usually surrounds the nation's busiest airports) or Class C (operational control tower and radar approach control) airspace in the ROI.

Special Use Airspace

A restricted area is airspace designated under Part 73 within which the flight of aircraft, while not wholly prohibited, is subject to restriction. A warning area is airspace of defined dimensions, extending from 3 nm outward from the coast of the United States that contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both. (14 CFR Title 14 Part 1.1, 2006)

The special use airspace in the ROI (Figure 3-3) consists of Restricted Area R-3101, which lies immediately above PMRF/Main Base and to the west of Kauai, portions of Warning Area W-188 north of Kauai, and Warning Area W-186 southwest of Kauai, all controlled by PMRF. Restricted Area R-3107 over Kaula, a small uninhabited rocky islet 19 nm southwest of Niihau that is used for fixed- and rotary-wing aircraft gunnery practice, and which lies within the W-187 Warning Area, is also special use airspace within the ROI.

Restricted Area R-3107 and Warning Area W-187 are scheduled through the Navy Fleet and Area Control and Surveillance Facility Pearl Harbor (FACSFACPH). PMRF and FACSFACPH each coordinate with the FAA Honolulu Control Facility regarding special use airspace. The Honolulu Control Facility is the location in which the ARTCC, the Honolulu control tower, and the Combined Radar Approach Control are collocated.

Table 3-5 lists the affected Restricted Areas and Warning Areas and their effective altitudes, times used, and their manager or scheduler. There are no Prohibited or Alert special use airspace areas in the PMRF airspace use ROI.

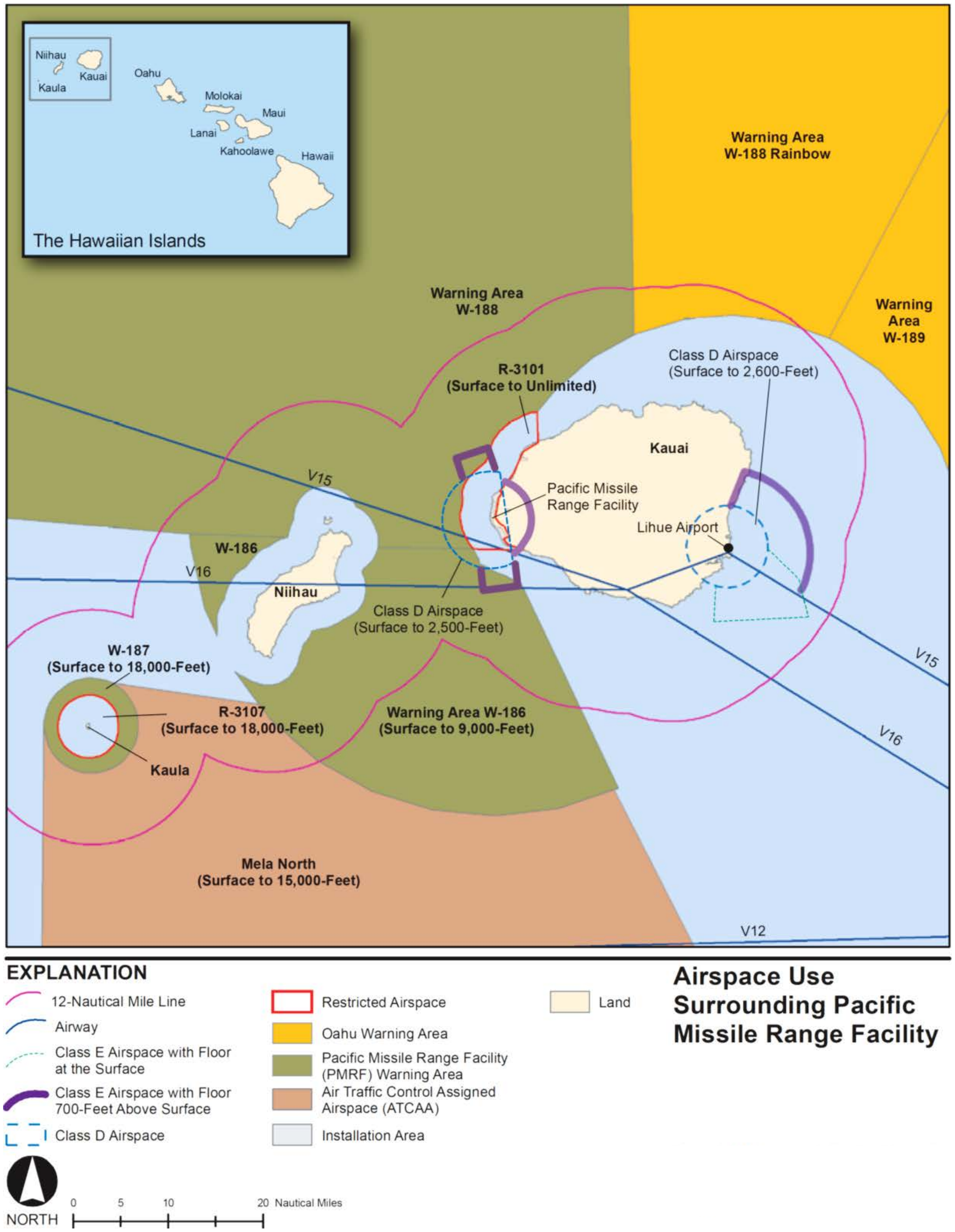


Figure 3-2 Airspace Use Surrounding Pacific Missile Range Facility

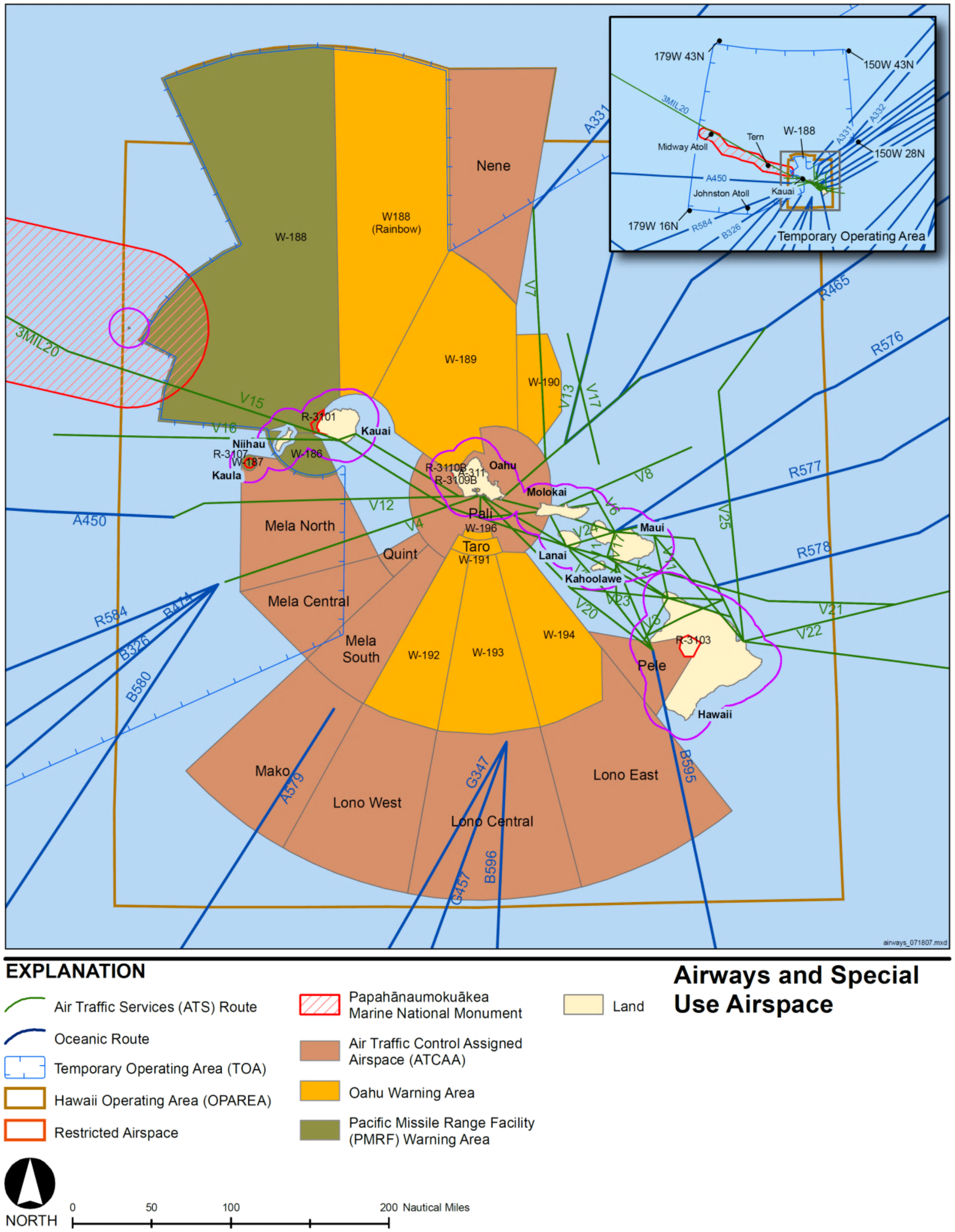


Figure 3-3 Airways and Special Use Airspace

Table 3-4 Special Use Airspace in the PMRF/Main Base Airspace Use Region of Influence (ROI)

Number	Location	Altitude	Time of Use		Controlling Airspace
			Days	Hours	
R-3101	PMRF	To Unlimited	M-F	0600-1800	PMRF
W-186	Southwest of PMRF	To 9,000	Continuous	Continuous	PMRF
W-188	Northwest of PMRF	To Unlimited	Continuous	Continuous	PMRF/HCF

Source: AHW Program EA, 2011. Notes: R=Restricted; W=Warning; PMRF = Pacific Missile Range Facility; HCF = Honolulu Combined Facility, the location in which the Air Route Traffic Control Center (ARTCC), the Honolulu control tower, and the Combined Radar Approach Control are co-located.

Other types of airspace, and special airspace use procedures used by the military to meet its particular needs, include Air Traffic Control Assigned Airspace (ATCAA) and Altitude Reservation (ALTRV) procedures: (1) ATCAA, or airspace of defined vertical and lateral limits, is assigned by air traffic control to provide air traffic segregation between specified activities being conducted within the assigned airspace and other instrument flight rules (IFR) air traffic. ATCAAs are usually established in conjunction with Military Operations Areas, and serve as an extension of Military Operations Area airspace to the higher altitudes required. These airspace areas support high altitude operations such as intercepts, certain flight test operations, and air refueling operations; (2) ALTRV Procedures are used as authorized by the Central Altitude Reservation Function, an air traffic service facility, or appropriate ARTCC, under certain circumstances, for airspace utilization under prescribed conditions. An ALTRV receives special handling from FAA facilities. According to FAA Handbook 7610.4H, Chapter 3, ALTRVs are classified as either moving or stationary, with the latter normally defining the fixed airspace area to be occupied as well as the specific altitude(s) and time period(s) the area will be in use. ALTRVs may encompass certain rocket and missile activities and other special operations as may be authorized by FAA approval procedures.

To ensure safe operations, PMRF requests use of specific areas of airspace from the FAA during missile defense testing. The FAA issues a NOTAM to avoid specific areas of airspace until testing is complete. The NOTAM System is a telecommunication system designed to distribute unanticipated or temporary changes in the National Airspace System or until aeronautical charts and other publications can be amended. This information is distributed in the Notice to Airmen Publication.

To further ensure aircraft safety, if aircraft are seen in an impact area, safety regulations dictate that hazardous activities will be suspended when it is known that any non-participating aircraft has entered any part of the danger zone until the non-participating entrant has left the area or a thorough check of the suspected area has been performed. Models run sequentially or in parallel are designed to compute risks based on estimating both the probabilities and consequences of launch failures as a function of time into the mission. Databases include data on mission profile, launch vehicle specifics, local weather conditions, and the surrounding population distribution. Given a mission profile, the risks would vary in time and space. Therefore, a launch trajectory optimization is performed by the range for each proposed launch, subject to risk minimization and mission objectives constraints. The debris impact probabilities and lethality are then estimated for each launch considering the geographic setting, normal jettisons, failure debris, and demographic data to define destruct lines to confine and/or minimize the potential risk of injury to humans or property damage.

En Route Airways and Jet Routes

Although relatively remote from the majority of jet routes that crisscross the Pacific, the airspace use ROI has two IFR en route low altitude airways used by commercial air traffic that pass through the ROI: V15, which passes east to west through the southernmost part of Warning Area W-188, and V16, which passes east to west through the northern part of Warning Area W-186 and over Niihau (Figure 3-2). An accounting of the number of flights using each airway is not maintained.

The airspace use ROI, located to the west, northwest, and north of Kauai, is far removed from the low altitude airways carrying commercial traffic between Kauai and Oahu and the other Hawaiian islands, all of which lie to the southeast of Kauai. There is a high volume of island helicopter sightseeing flights along the Na Pali coastline and over the Waimea Canyon, inland and to the east of PMRF, particularly out of Port Allen near Hanapepe on Kauai's southern coastline and other tourist and resort towns on the island. However, these do not fly over PMRF or into Restricted Area R-3101 (National Aeronautical Charting Office, 2007).

Airports and Airfields

With the exception of the airfield at PMRF and the Kekaha airstrip approximately 5 km (3 mi) to the southeast of PMRF and 3 km (2 mi) northwest of Kekaha, there are no airfields or airports in the airspace use ROI. Lihue Airport is located 20 nm east of PMRF, outside the ROI. In addition to helicopter and fixed-wing aircraft landings associated with PMRF's mission, the PMRF airfield serves as a training facility for landings and takeoffs. The overall number of air operations was 13,395 for 2004. The 2009 air operations were estimated to be 25,486, an increase of about 90%. (US Department of the Navy, Engineering Field Activity Chesapeake, 2006)

Air Traffic Control

Use of the airspace by the FAA and PMRF is established by a Letter of Agreement between the two agencies. Under this agreement, PMRF is required to notify the FAA by 2:00 p.m. the day before range operations would infringe on the designated airspace. Range Control and the FAA are in direct real-time communication to ensure safety of all aircraft using the airways and jet routes and the special use airspace. Within the special use airspace, military activities in Warning Areas W-186 and W-188 are under PMRF control, and the PMRF Range Control Officer is solely authorized and responsible for administering range safety criteria, the surveillance and clearance of the range, and the issuance of range RED (no firing) and GREEN (clearance to fire) status (Pacific Missile Range Facility, Barking Sands, Hawai`i, 1991). Warning Area W-187 is scheduled through the FACSFACPH.

As Warning Areas are located in international airspace, the procedures of the International Civil Aviation Organization (ICAO), outlined in ICAO Document 444, Rules of the Air and Air Traffic Services, are followed. ICAO Document 444 is the equivalent air traffic control manual to FAA Handbook 7110.65, Air Traffic Control. The FAA acts as the US agent for aeronautical information to the ICAO, and air traffic in the ROI is managed by the Honolulu ARTCCs.

3.1.5 Noise

This discussion of noise includes the types or sources of noise and the associated sensitive receptors in the human environment. Noise in relation to biological resources and wildlife species is discussed in the Biological Resources section.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and are sensed by the human ear. Sound is all around us. The perception and evaluation 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

Noise is defined as unwanted or annoying sound that interferes with or disrupts normal human activities. Although continuous and extended exposure to high noise levels (e.g., through occupational exposure) can cause hearing loss, the principal human response to noise is annoyance. 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. While aircraft are not the only sources of noise in an urban or suburban environment, they are readily identified by their noise output and are given special attention in this EA/OEA.

Basics of Sound and A-weighted Sound Level

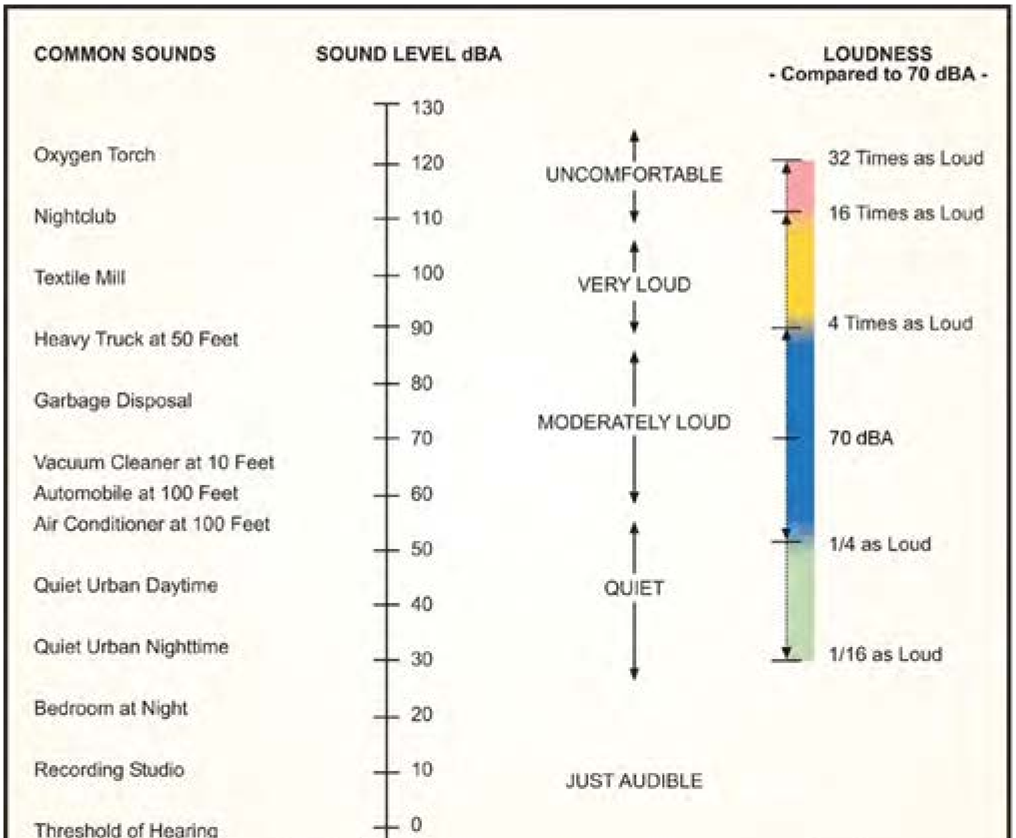
The loudest sounds that can be detected comfortably by the human ear have intensities that are a trillion times higher than those of sounds that can barely be detected. This vast range means that using a linear scale to represent sound intensity is not feasible. The dB is a logarithmic unit used to represent the intensity of a sound, also referred to as the sound level. All sounds have a spectral content, which means their magnitude or level changes with frequency, where frequency is measured in cycles per second or Hz. To mimic the human ear’s non-linear sensitivity and perception of different frequencies of sound, the spectral content is weighted. For example, environmental noise measurements are usually on an “A-weighted” scale that filters out very low and very high frequencies in order to replicate human sensitivity. It is common to add the “A” to the measurement unit in order to identify that the measurement has been made with this filtering process (dBA). In this document, the dB unit refers to A-weighted sound levels. Table 3-5 provides a comparison of how the human ear perceives changes in loudness on the logarithmic scale.

Figure 3-4 provides a chart of A-weighted sound levels from typical noise sources. Some noise sources (e.g., air conditioner, vacuum cleaner) are continuous sounds that maintain a constant sound level for some period of time. Other sources (e.g., automobile, heavy truck) are the maximum sound produced during an event like a vehicle pass-by. Other sounds (e.g., urban daytime, urban nighttime) are averages taken over extended periods of time. A variety of noise metrics have been developed to describe noise over different time periods, as discussed below.

Table 3-5 Subjective Responses to Changes in A-Weighted Decibels

Actual Change	*Change in Perceived Loudness*
3 dB	Barely perceptible
5 dB	Quite noticeable
10 dB	Dramatic – twice or half as loud
20 dB	Striking – fourfold change

Noise levels from aircraft operations that exceed background noise levels at an airfield typically occur beneath main approach and departure corridors, in local air traffic patterns around the airfield, and in areas immediately adjacent to parking ramps and aircraft staging areas. As aircraft in flight gain altitude, their noise contributions drop to lower levels, often becoming indistinguishable from the background noise.



Sources: Derived from Harris (1979) and Federal Interagency Committee on Aviation Noise (1997)

Figure 3-4 A-Weighted Sound Levels from Typical Sources

Noise Metrics

A metric is a system for measuring or quantifying a particular characteristic of a subject. Since noise is a complex physical phenomenon, different noise metrics help to quantify the noise environment. The noise metrics used in this EA/OEA are described in summary format below. While the Day-Night Average Sound Level (DNL) and Community Noise Equivalent Level (CNEL) noise metrics are the most commonly used tools for analyzing noise generated at an airfield, the DoD has been developing additional metrics (and analysis techniques). These supplemental metrics and analysis tools provide more detailed noise exposure information for the decision process and improve the discussion regarding noise exposure. The DoD Noise Working Group product, *Improving Aviation Noise Planning, Analysis and Public Communication with Supplemental Metrics* (DoD Noise Working Group, 2009)was used to determine the appropriate metrics and analysis tools for this EA/OEA.

The DNL metric is the energy-averaged sound level measured over a 24-hour period, with a 10-dB penalty assigned to noise events occurring between 10 p.m. and 7 a.m. (acoustic night). DNL values are average quantities, mathematically representing the continuous sound level that would be present if all of the variations in sound level that occur over a 24-hour period were averaged to have the same total sound energy. The DNL metric quantifies the total sound energy received and is therefore a cumulative measure, but it does not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour day. DNL is the standard noise metric used by the US Department of Housing and Urban Development, FAA, USEPA, and DoD. Studies of community annoyance in response to numerous types of environmental noise show that DNL correlates well with impact assessments; there is a consistent relationship between DNL and the level of annoyance. Most people are exposed to sound levels of 50 to 55 DNL or higher on a daily basis.

Research has indicated that about 87% of the population is not highly annoyed by outdoor sound levels below 65 dB DNL (Federal Interagency Committee on Urban Noise, 1980). Therefore, the 65 dB DNL noise contour is used to help determine compatibility of military aircraft operations with local land use, particularly for land use associated with airfields.

Community Noise Equivalent Level

CNEL is a noise metric adopted as a standard by the state of California. The CNEL metric is similar to the DNL metric and is also an energy-averaged sound level measurement. DNL and CNEL provide average noise levels taking into consideration and applying penalties for annoyance from intrusive events that occur during evening and nighttime hours. Both DNL and CNEL are measures of cumulative noise exposure over a 24-hour period, with adjustments to reflect the added intrusiveness of noise during certain times of the day. However, while DNL considers one adjustment period, CNEL reflects two adjustment periods. DNL includes a single adjustment period for night, in which each aircraft noise event at night (defined as 10 p.m. to 7 a.m.) is counted 10 times. CNEL adds a second adjustment period where each aircraft noise event in the evening (defined as 7 p.m. to 10 p.m.) is counted three times. The nighttime adjustment is equivalent to increasing the noise levels during that time interval by 10 dB. Similarly, the evening adjustment increases the noise levels by approximately 5 dB.

Equivalent Sound Level

A cumulative noise metric useful in describing noise is the Equivalent Sound Level (Leq). Leq is the continuous sound level that would be present if all of the variations in sound level occurring over a specified time period were smoothed out as to contain the same total sound energy. The same calculation for a daily average time period such as DNL or CNEL but without the penalties is a 24 hour equivalent sound level, abbreviated Leq(24). Other typical time periods for Leq are 1 hour and 8 hours.

Sound Exposure Level

The Sound Exposure Level (SEL) metric is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of total sound energy of the entire acoustic event, but it does not directly represent the sound level heard at any given time. During an aircraft flyover, SEL captures the total sound energy from the beginning of the acoustic event to the point when the receiver no longer hears the sound. It then condenses that energy into a 1-second period of time and the metric represents the total sound exposure received. The SEL has proven to be a good metric to compare the relative exposure of transient sounds, such as aircraft overflights, and is the recommended metric for sleep disturbance analysis (DoD Noise Working Group, 2009). In this EA/OEA, SEL is used in aircraft comparison and sleep disturbance analyses.

Maximum Sound Level

The highest A-weighted sound level measured during a single event where the sound level changes value with time (e.g., an aircraft overflight) is called the maximum A-weighted sound level or Lmax. During an aircraft overflight, the noise level starts at the ambient or background noise level, rises to the maximum level as the aircraft flies closest to the observer, and returns to the background level as the aircraft recedes into the distance. Lmax defines the maximum sound level occurring for a fraction of a second. For aircraft noise, the “fraction of a second” over which the maximum level is defined is generally 1/8 second (American National Standards Institute, 1988). For sound from aircraft overflights, the SEL is usually greater than the Lmax because an individual overflight takes seconds and the Lmax occurs instantaneously. In this EA/OEA, Lmax is used in the analysis of aircraft comparison and speech interference.

Number of Events Above a Threshold Level

The Number of Events Above a Threshold Level metric provides the total number of noise events that exceed a selected noise level threshold during a specified period of time (DoD Noise Working Group, 2009). Combined with the selected noise metric, Lmax or SEL, the Number of Events Above metric is symbolized as NAXXmetric (NA = number of events above, XX = dB level, metric = Lmax or SEL). For example, the Lmax and SEL Number of Events Above metrics are symbolized as NA75Lmax and NA75SEL, respectively, with 75 dB as the example dB level. In this EA/OEA, an Lmax threshold is selected to analyze speech interference and an SEL threshold is selected for analysis of sleep disturbance.

Noise Effects

An extensive amount of research has been conducted regarding noise effects including annoyance, speech interference, sleep disturbance, noise-induced hearing impairment, nonauditory health effects, performance effects, noise effects on children, effects on domestic animals and wildlife, property values, structures, terrain, and archaeological sites. These effects are summarized below.

Annoyance

As previously noted, the primary effect of aircraft noise on exposed communities is long-term annoyance, defined by USEPA as any negative subjective reaction on the part of an individual or group. The scientific community has adopted the use of long-term annoyance as a primary indicator of community response and there is a consistent relationship between DNL/CNEL and the level of community annoyance (Federal Interagency Committee on Noise, 1992).

Potential Hearing Loss

People living in high noise environments for an extended period of time (40 years) can be at risk for hearing loss called Noise Induced Permanent Threshold Shift (NIPTS). The NIPTS defines a permanent change in hearing level, or threshold, caused by exposure to noise (United States Environmental Protection Agency, 1982). According to USEPA (1974), changes in hearing level of less than 5 dB are generally not considered noticeable. There is no known evidence that an NIPTS of less than 5 dB is perceptible or has any practical significance for the individual affected. Furthermore, the variability in audiometric testing is generally assumed to be plus or minus 5 dB. The preponderance of available information on hearing loss risk is from the workplace with continuous exposure throughout the day for many years.

Based on a report by Ludlow and Sixsmith (1999), there were no major differences in audiometric test results between military personnel, who as children, had lived in or near installations where fast jet operations were based, and a similar group who had no such exposure as children. Hence, for the purposes of this EA/OEA, the limited data are considered applicable to the general population, including children, and are used to provide a conservative estimate of the risk of potential hearing loss.

DoD policy directive requires that hearing loss risk be estimated for the at-risk population, defined as the population exposed to DNL greater than or equal to 80 dB (Defense, 2009). To assess the potential for NIPTS, the Navy generally uses the 80 dB DNL noise contour (or in California 80 dB CNEL) as a threshold to identify the exposed population who may be at the most risk of possible hearing loss from aircraft noise (USEPA, 1982; DoD Noise Working Group, 2009). However, it should be recognized that characterizing noise exposure in terms of DNL and CNEL overestimates hearing loss risk but suffices when nighttime operations are 5% or less than the total operations. When nighttime operations are greater than 5%, Leq(24) is recommended for calculating potential hearing loss since hearing loss is a physical phenomenon due to the sound level and independent of annoyance. Thus, the additional penalties applied by CNEL for evening and nighttime operations do not accurately portray the NIPTS. This EA/OEA calculates potential hearing loss using Leq(24) to get the accuracy necessary for the larger amount of nighttime and evening operations.

Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance for communities. Speech interference can cause disruption of routine activities, such as enjoyment of radio or television programs, telephone use, or family conversation, giving rise to frustration or irritation. In extreme cases, speech interference may cause fatigue and vocal strain to individuals who try to communicate over the noise. In this EA/OEA, speech interference is measured by the number of daily indoor events (from 7 a.m. to 10 p.m.) that exceed 50 dB Lmax at selected locations. This metric also accounts for noise level reduction provided by buildings with windows open or closed.

Classroom Criteria and Noise Effects on Children

Research suggests that environments with sustained high background noise can have variable effects, including effects on learning and cognitive abilities and various noise-related physiological changes. Research on the impacts of aircraft noise, and noise in general, on the cognitive abilities of school-aged children has received more attention in recent years. Several studies suggest that aircraft noise can affect the academic performance of school children. Physiological effects in children exposed to aircraft noise and the potential for health effects have been the focus of limited investigation (DoD Noise Working Group, 2009).

Analyses for school-aged children are similar to speech interference by using the indoor number of events exceeding 50 dB Lmax, but also has the added restriction of using an outdoor equivalent noise level of 60 dB Leq(9 hr). This represents a level that a person with normal hearing can clearly hear a speaker (teacher) speaking at a level of 50 dB indoors in a classroom setting.

Sleep Disturbance

The disturbance of sleep is a major concern for communities exposed to nighttime aircraft noise. In this EA/OEA, sleep disturbance uses the SEL noise metric and calculates the probability of awakening from single aircraft overflights. These are based upon the particular type of aircraft, flight profile, power setting, speed, and altitude relative to the receptor. The results are then presented as a percent probability of people awakening (United States Environmental Protection Agency, 1974).

Workplace Noise

In 1972, the National Institute for Occupational Safety and Health (NIOSH) published a criteria document with a recommended exposure limit of 85 dBA as an 8-hour time-weighted average. This exposure limit was reevaluated in 1998 when NIOSH made recommendations that went beyond conserving hearing by focusing on the prevention of occupational hearing loss. Following the reevaluation using a new risk assessment technique, NIOSH published another criteria document in 1998, which reaffirmed the 85 dB recommended exposure limit (National Institute for Occupational Health and Safety, 1998).

Nonauditory Health Effects

Studies have been conducted to examine the nonauditory health effects of aircraft noise exposure, focusing primarily on stress response, blood pressure, birth weight, mortality rates, and cardiovascular health. Exposure to noise levels higher than those normally produced by aircraft in the community can elevate blood pressure and also stress hormone levels. However, the response to such loud noise is typically short in duration: after the noise goes away, the physiological effects reverse and levels return to normal. In the case of repeated exposure to aircraft noise, the connection is not as clear. The results of most cited studies are inconclusive, and it cannot be conclusively stated that a causal link exists between aircraft noise exposure and the various type of nonauditory health effects that were studied (DoD Noise Working Group, 2009).

Noise Effects on Children

A review of the scientific literature indicated that there has not been a tremendous amount of research in the area of aircraft noise effects on children. The research reviewed does suggest that environments with sustained high background noise can have variable effects, including effects on learning and cognitive abilities and various noise-related physiological changes. Research on the impacts of aircraft noise, and noise in general, on the cognitive abilities of school-aged children has received more attention in recent years. Several studies suggest that aircraft noise can affect the academic performance of schoolchildren. Physiological effects in children exposed to aircraft noise and the potential for health effects have been the focus of limited investigation (DoD Noise Working Group, 2009).

Noise Modeling

Computer modeling provides a tool to assess potential noise impacts. DNL/CNEL noise contours are generated by a computer model that draws from a library of actual aircraft noise measurements. Noise contours produced by the model allow a comparison of existing conditions and proposed changes or alternative actions, even when the aircraft studied are not currently operating from the installation. For these reasons, on-site noise monitoring is seldom used at military air installations, especially when the aircraft mix and operational tempo are not uniform.

The noise environment for this EA/OEA was modeled using NOISEMAP. NOISEMAP analyzes all the operational data (types of aircraft, number of operations, flight tracks, altitude, speed of aircraft, engine power settings, and engine maintenance run-ups), environmental data (average humidity and temperature), and surface hardness and terrain. The result of the modeling is noise contours; lines connecting points of equal value (e.g., 65 dB CNEL and 70 dB CNEL). Noise zones cover an area between two noise contours and are usually shown in 5-dB increments (e.g., 65–69 dB CNEL, 70–74 dB CNEL, and 75–79 dB CNEL). As stated earlier, since the two home basing alternatives considered are in California, CNEL is the standard used for noise calculations in this EA/OEA.

A newer model, called the Advanced Acoustic Model, has not yet been approved for use by the DoD. Per Chief of Naval Operations Instruction (OPNAVINST) 11010.36C, Air Installations Compatible Use Zones (AICUZ) Program, NOISEMAP is to be used for developing noise contours and is the best noise modeling science available today for fixed-wing aircraft until the Advanced Acoustic Model is approved.

Under the Noise Control Act of 1972, the Occupational Safety and Health Administration (OSHA) established workplace standards for noise. The minimum requirement states that constant noise exposure must not exceed 90 A-weighted decibels (dBA) over an 8-hour period. The highest allowable sound level to which workers can be constantly exposed is 115 dBA and exposure to this level must not exceed 15 minutes within an 8-hour period. The standards limit instantaneous exposure, such as impact noise, to 140 dBA. If noise levels exceed these standards, employers are required to provide hearing protection equipment that will reduce sound levels to acceptable limits.

The joint instruction, OPNAVINST 11010.36C and Marine Corps Order 11010.16, provides guidance administering the AICUZ program which recommends land uses that are compatible with aircraft noise levels. OPNAVINST 3550.1A and Marine Corps Order 3550.11 provide guidance for a similar program, RAICUZ. This program includes range safety and noise analyses, and provides land use recommendations which will be compatible with Range Compatibility Zones and noise levels associated with military range operations.

3.1.5.1 Regulatory Setting

Under the Noise Control Act of 1972, the Occupational Safety and Health Administration (OSHA) established workplace standards for noise. The minimum requirement states that constant noise exposure must not exceed 90 A-weighted decibels (dBA) over an 8-hour period. The highest allowable sound level to which workers can be constantly exposed is 115 dBA and exposure to this level must not exceed 15 minutes within an 8-hour period. The standards limit instantaneous exposure, such as impact noise, to 140 dBA. If noise levels exceed these standards, employers are required to provide hearing protection equipment that will reduce sound levels to acceptable limits.

3.1.5.2 Region of Influence (ROI)

The ROI for noise analysis is the area within and surrounding PMRF/Main Base in which humans and wildlife may suffer annoyance or disturbance from noise sources at KTF. This would include areas on PMRF, KTF, and the town of Kekaha.

Primary sources of noise on PMRF/Main Base include airfield and range operations and missile, rocket, and drone launches. Airfield operations include take-offs and landings of high performance and cargo/passenger aircraft, as well as helicopter operations. Range operations include training and research and development activities support. Ambient noise levels from natural sources include wind, surf, and birds.

Noise generated at the PMRF airfield stem from one active runway, four helicopter operating spots, and maintenance operations. Noise levels produced by airfield operations tend to have a continuous impact on PMRF/Main Base. Existing noise levels near the runway may average as high as 75 A-weighted decibels (dBA). Buildings in this area are insulated to achieve a noise reduction of up to 35 dBA. Noise levels farther away from the runway are more characteristic of a commercial park, with levels not exceeding 65 dBA. Airfield noise zones have been established to safeguard the public and all station personnel from the effects of noise from air operations. The Final Noise and Accident Potential Zone Study for the Pacific Missile Range Facility Barking Sands determined that noise levels around the airfield are low due to the relatively few annual air operations, 13,395 for 2004 (US Navy, 2008). The noise study determined that 1 acre of land was affected by 75-decibel (dB) noise levels and that no housing units or populations are impacted. (US Department of the Navy, Engineering Field Activity Chesapeake, 2006)

Range operations that may impact the sound environment include, but are not limited to, power generation, training and research and development activities support, maintenance operations, and construction or renovation.

The activity with the most noticeable sound events is the launch of missiles, rockets, and drones. These launches result in high-intensity, short-duration sound events. Typical launches at PMRF/Main Base (including KTF launch sites) include the STARS, Terminal High Altitude Area Defense, and Strypi missile launches and have resulted in no public noise complaints. Table 3-6 lists the noise levels monitored for previous STARS launches at PMRF/Main Base.

Table 3-6 Noise Levels Monitored for STARS Launches at PMRF/Main Base

Distance m (ft)	***Measured Average Peak (decibel)***
175.3 (575)	125.3
243.8 (800)	123.0
268.5 (881)	121.8
372.5 (1,222)	118.2
482.8 (1,584)	115.3
3,048 (10,000; approx. 2 miles)	97.1
10,668 (35,000; approx. 6.5 miles)	54.0

Source: US Army Strategic Defense Command, 1992

The nearest on-base housing area is located approximately 8 km (5 mi) south of the northern KTF and PMRF launch areas. The nearest off-base residential area is Kekaha, which is approximately 12.9 km (8 mi) south of the northern KTF and PMRF launch areas.

KTF supports a variety of sounding rocket missions; therefore, occasional rocket, missile, or drone launches produce high-intensity, short-duration sound events. Data collected in the nearest town of Kekaha indicated that levels were no louder than noise generated from passing vehicles on a nearby highway. No noise-sensitive land uses are affected by existing noise levels. (Sandia National Laboratories, 2006)

In addition to the noise from the rocket engine, launch vehicles can also generate sonic booms during flight. A sonic boom is a sound that resembles rolling thunder, and is produced by a shock wave that forms at the nose and at the exhaust plume of a missile that is traveling faster than the speed of sound. Shock waves that form at the nose and at the exhaust plume of a missile travelling faster than the speed of sound produce an audible sonic boom when they reach the ground. The sonic boom occurs some distance downrange of the launch site. The uprange boundary of the sonic boom carpet forms a parabola pointing downrange. Most of the region subjected to any sonic boom from launches at PMRF is the surface of the ocean. Thus, land based population centers are not affected. Under suitable atmospheric conditions and depending on the trajectory of the missile, low level sonic booms may reach the northern portion of Niihau, as is the case for current operations from PMRF. (ACTA, 2009)

Noise impacts on wildlife receptors at the KTF and PMRF/Main Base area are discussed in the Biological Resources section.

3.1.6 Public Health and Safety

This discussion of public health and safety includes consideration for any activities, occurrences, or operations that have the potential to affect the safety, well-being, or health of members of the public. The primary goal is to identify and prevent potential accidents or impacts on the general public.

A safe environment is one in which there is no, or optimally reduced, potential for death, serious bodily injury or illness, or property damage. Human health and safety addresses public safety during construction, demolition, and renovation activities; and during subsequent operations of those facilities. Various stressors in the environment can adversely affect human health and safety. Identification and control or elimination of these stressors can reduce risks to health and safety to acceptable levels or eliminate risk entirely.

Emergency services are organizations which ensure public safety and health by addressing different emergencies. The three main emergency service functions include police, fire and rescue service, and emergency medical service.

The AICUZ Program, which is discussed in Section 3.6, delineates accident potential zones (APZs), which are areas around an airfield where an aircraft mishap is most likely to happen. APZs are not predictors of accidents nor do they reflect accident probability. The DoD defines an APZ as a planning tool for local planning agencies. The APZs follow departure, arrival, and flight pattern tracks from an airfield and are based upon historical accident data. RAICUZ, which is discussed in Section 3.6 addresses range safety.

The US Notice to Mariners provides timely marine safety information for the correction of all US Government navigation charts and publications from a wide variety of sources, both foreign and domestic. To ensure the safety of life at sea, the information published in the Notice to Mariners is designed to provide for the correction of unclassified nautical charts, the unclassified NGA/DLIS Catalog of Hydrographic Products, United States Coast Pilots, NGA List of Lights, USCG Light Lists, and other related nautical publications produced by NGA, NOS and the USCG.

Environmental health and safety risks to children are defined as those that are attributable to products or substances a child is likely to come into contact with or ingest, such as air, food, water, soil, and products that children use or to which they are exposed.

3.1.6.1 Regulatory Setting

Aircraft safety is based on the physical risks associated with aircraft flight. Military aircraft fly in accordance with Federal Aviation Regulations (FAR) Part 91, General Operating and Flight Rules, which govern such things as operating near other aircraft, right-of-way rules, aircraft speed, and minimum safe altitudes. These rules include the use of tactical training and maintenance test flight areas, arrival and departure routes, and airspace restrictions as appropriate to help control air operations. In addition, naval aviators must also adhere to the flight rules, ATC, and safety procedures provided in Navy guidance.

Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks, requires federal agencies to “make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children and shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.”

3.1.6.2 Region on Influence

Health and safety includes consideration of any activities, occurrences, or operations that have the potential to affect one or more of the following:

The well-being, safety, or health of workers—Workers are considered to be persons directly involved with the operation producing the effect or who are physically present at the operational site.

The well-being, safety, or health of members of the public—Members of the public are considered to be persons not physically present at the location of the operation, including workers at nearby locations who are not involved in the operation and the off-base population. Also included within this category are hazards to equipment and structures.

The ROI for potential impacts related to the health and safety of workers includes work areas associated with FE-1 flight test launch operations. The population of concern includes the workers employed at PMRF, including SNL/KTF, but also other personnel directly involved with range operation and training activities currently occurring at PMRF/KTF.

The ROI for potential impact related to public health and safety also includes the areas of Kauai County adjacent to SNL/KTF that could be affected by the proposed launch. These areas include the PMRF overwater training areas. The population of concern consists of visitors to Kauai and permanent residents living in Kauai County.

PMRF takes every reasonable precaution during the planning and execution of the range operations training and test activities to prevent injury to human life or property. In addition to explosive, physical impact, and electromagnetic hazards, potential hazards from chemical contamination, ionizing and non-ionizing radiation, radioactive materials, and lasers are studied by PMRF Range Safety Office to determine safety restrictions.

SNL/KTF Operations

KTF is a launch facility operated by Sandia National Laboratories for the Department of Energy on PMRF/Main Base through Inter-Service Support Agreements (US Department of the Navy, 1998). SNL/KTF notifies PMRF Operations, Security, Fire Department, and Ordnance/Explosive Disposal as required prior to launch and other hazardous operations. (Sandia National Laboratories, 2006)

All hazardous operations at SNL/KTF are performed under strict adherence to existing SOPs. A site SOP provides general requirements and guidance for all range operations at SNL/KTF, including ordnance safety, pre-launch and hazardous operations control, ordnance handling and storage facilities, liquid fuels storage and handling, and launch pad operations.

KTF rocket motors and other ordnance components are stored in explosive storage magazines by PMRF, except when needed by SNL/KTF for processing, assembly, and launch. The movement of explosives and other hazardous materials between PMRF and KSNL/TF is conducted in accordance with PMRF procedures and DoD Explosives Safety Standards.

PMRF provides fire protection and firefighting services to SNL/KTF, and enforces base safety regulations and programs on SNL/KTF.

Range Safety. Range Safety at PMRF is controlled by Range Control, which is responsible for hazard area surveillance and clearance and control of all PMRF operational areas. Range Control maintains real time surveillance, clearance, and safety at all PMRF areas including SNL/KTF. PMRF sets requirements for minimally acceptable risk criteria to occupational and non-occupational personnel, test facilities, and non-military assets during range operations. For all range operations at PMRF, the Range Control Officer requires a safety plan. A Range Safety Operation Plan is generated by PMRF Range Safety personnel prior to range operations.

The PMRF Range Safety Office is responsible for establishing Ground Hazard Areas and Launch Hazard Areas over water beyond which no debris from early flight termination is expected to fall. The Ground and Launch Hazard Areas for missile launches are determined by size and flight characteristics of the missile, as well as individual flight profiles of each flight test. Data processed by ground-based or onboard missile computer systems may be used to recognize malfunctions and terminate missile flight. Before a launch is allowed to proceed, the range is determined cleared using input from ship sensors, visual surveillance from aircraft and range safety boats, radar data, and acoustic information.

All range users must: (1) provide a list of project materials, items, or test conditions that could present hazards to personnel or material through toxicity, combustion, blast, acoustics, fragmentation, electromagnetic radiation, radioactivity, ionization, or other means; (2) describe radiation, toxic, explosive, or ionization problems that could accumulate as a result of their tests; (3) provide aerodynamic and flight control information, and destruct system information and parameters; (4) submit plans, specifications, and procedural or functional steps for events and activities involving explosives to conform to criteria in the PMRF instruction; and (5) provide complete operational specifications of any laser to be used and a detailed description of its planned use. (US Department of the Navy, 1998; 2008)

Missile Flight Analysis. PMRF conducts missile flight safety in accordance with Naval Air Warfare Center Weapons Division Instruction. Missile flight safety includes analysis of missile performance capabilities and limitations, of hazards inherent in missile operations and destruct systems, and of the electronic characteristics of missiles and instrumentation. It also includes computation and review of missile trajectories, launch azimuths, kinetic energy intercept debris impact areas, and hazard area dimensions, review and approval of destruct systems proposals, and preparation of the Range Safety Operation Plan required of all programs at PMRF. These plans are prepared by the PMRF Safety Office for each mission and must be approved by the Commanding Office prior to any launch. Launch is only allowed when the risk levels are less than the acceptable risk criteria in PMRF Instruction 8020.16, which are equivalent to the criteria developed by the Range Commanders Council (RCC) (e.g., RCC 321).

Ground Safety. The Range Control Officer using PMRF assets is solely responsible for determining range status and setting RED (no firing – unsafe condition due to a fouled firing area) and GREEN (range is clear and support units are ready to begin the event) range firing conditions. The Range Safety Approval and the Range Safety Operation Plan documents are required for all weapons systems using PMRF (US Department of the Navy, 1998). PMRF uses RCC 321, Common Risk Criteria for National Test Ranges. RCC 321 sets requirements for minimally acceptable risk criteria to occupational and non-occupational personnel, test facilities, and nonmilitary assets during range operations. Under RCC 321, the general public shall not be exposed to a probability of casualty greater than 1 in 10 million for each individual during any single mission and a total expectation of casualty must be less than 30 in 1 million. (Range Commanders Council, Range Safety Group, 2002)

To ensure the protection of all persons and property, Standard Operating Procedures (SOPs) have been established and implemented for the Ground Hazard Areas. These SOPs include establishing road control points and clearing the area using vehicles and helicopters (if necessary). Road control points are established 3 hours prior to launches. This allows security forces to monitor traffic that passes through the Ground Hazard Areas. At 20 minutes before a launch, the Ground Hazard Area is cleared of the public to ensure that, in the unlikely event of early flight termination, no injuries or damage to persons or property would occur. After the Range Safety Officer declares the area safe, the security force gives the all-clear signal, and the public is allowed to reenter the area. (US Department of the Navy, 1998) No inhabited structures are located within the off-base sections of the Ground Hazard Area. The potential for launch-associated hazards are further minimized through the use of the PMRF Missile Accident Emergency Team. This team is assembled for all launches from PMRF facilities and on-call for all PMRF launches in accordance with PMRF Instruction 5100.1F.

Ordnance Management and Safety. Ordnance safety includes procedures to prevent premature, unintentional, or unauthorized detonation of ordnance. Any program using a new type of ordnance device for which proven safety procedures have not been established requires an Explosive Safety Approval before the ordnance is allowed on PMRF or used on a test range. This approval involves a detailed analysis of the explosives and of the proposed test activities, procedures, and facilities for surveillance and control, an adequacy analysis of movement and control procedures, and a design review of the facilities where the ordnance items will be handled.

Ordnance management procedures are found in PMRFINST 8020.5, Explosive Safety Criteria for Range Users Ordnance Operations. The Range Control Branch of the Range Programs Division is responsible for: (1) providing detailed analysis of all proposals concerning missiles or explosives and their proposed operation on the range; (2) establishing procedures for surveillance and control of traffic within and entering hazard areas; (3) reviewing the design of facilities in which ordnance items are to be handled to ensure that safety protection meets the requirements of Naval Sea System Command Publication (NAVSEAOP) -5, Ammunition and Explosives Ashore; Safety Regulations for Handling, Storing, Production, Renovation, and Shipping, Chapter 4; (4) training, certifying, and providing Launch Control Officers, Safety Monitors, and Ordnance personnel for activities involving explosive ordnance; (5) assuming responsibility for the control of all emergency facilities, equipment, and personnel required in the event of a hazardous situation from a missile inadvertently impacting on a land area; (6) providing positive control of the ordering, receipt, issue, transport, and storage of all ordnance items; and (7) ensuring that only properly certified handling personnel are employed in any handling of ordnance.

Ordnance is either delivered to PMRF/Main Base by aircraft to the on-base airfield or by ship to Nawiliwili Harbor, and then over land by truck transport along Highway 50 to the base. The barges carrying explosives are met at Nawiliwili Harbor by trained ordnance personnel and special vehicles for transit to and delivery at PMRF/Main Base. All ordnance is transported in accordance with US Department of Transportation regulations. The STARS is stored in a specially constructed facility on KTF. No mishaps involving the use or handling of ordnance have occurred at PMRF.

PMRF/Main Base has defined explosive safety-quantity distance (ESQD) arcs. The arcs are generated by launch pads, the Kamokala Magazine ordnance storage area, the Interim Ordnance Handling Pad, and the Missile Assembly/Test Buildings 573, 590, and 685. Only the ESQD arcs generated by the Interim Ordnance Handling Pad and Building 573 are covered by a waiver or exemption. The Sandia Launcher site and Missile Assembly Buildings (647 and 685) can accommodate a 1,250-foot ESQD arc.

Ocean Area Clearance. Range Safety officials manage operational safety for projectiles, targets, missiles, and other hazardous activities into PMRF operational areas. The operational areas consist of two Warning Areas (W-186 and W-188) and one Restricted Area (R-3101) under the local control of PMRF. The Warning Areas are in international waters and are not restricted; however, the surface area of the Warning Areas is listed as “HOT” (actively in use) 24 hours a day. PMRF publishes dedicated warning NOTMARs and NOTAMs 1 week before hazardous operations. In addition, a 24-hour recorded message is updated on the hotline daily by Range Operations to inform the public when and where hazardous operations will take place.

Prior to a hazardous operation proceeding, the range is determined to be cleared using inputs from ship sensors, visual surveillance of the range from aircraft and range safety boats, radar data, and acoustic information from a comprehensive system of sensors and surveillance from shore.

Transportation Safety. PMRF transports ordnance by truck from Nawiliwili Harbor to PMRF along Highway 50. The barges carrying explosives are met at Nawiliwili Harbor by trained ordnance personnel and special vehicles for transit to and delivery at PMRF. All ordnance is transported in accordance with US Department of Transportation regulations. PMRF has established PMRFINST 8023.G, which covers the handling and transportation of ammunition, explosives, and hazardous materials on the facility.

In addition, liquid fuels (e.g., nitrogen tetroxide and unsymmetrical dimethylhydrazine) are transported to KTF. These fuels can be shipped to the site by truck, aircraft or barge, which do not affect transportation routes on the island of Kauai. Transportation of these materials is conducted in accordance with US Department of Transportation regulations and specific safety procedures developed for the location.

Range Control and the FAA are in direct communication in real time to ensure the safety of all aircraft using the airways and the Warning Areas. Within the Special Use Airspace, military activities in Warning Areas W-186 and W-188 are under PMRF control. Warning Areas W-189, W-187, and W-190 are scheduled through the Fleet Area Control and Surveillance Facility.

Because the Warning Areas are located in international airspace, the procedures of the ICAO are followed. The FAA acts as the US agent for aeronautical information to the ICAO, and air traffic in the ROI is managed by the Honolulu Control Facility and Oakland ARTCC.

Fire and Crash Safety. The Navy has developed standards that dictate the amount of fire/crash equipment and staffing that must be present based on the number and types of aircraft stationed on base, and the types and total square footage of base structures and housing. PMRF Crash/Fire is located in the base of the Air Traffic Control Tower, Building 300. Personnel are trained to respond to activities such as aircraft fire fighting and rescue in support of airfield operations, hazardous material incidents, confined space rescue, and hypergolic fuel releases, plus structure and brush fire fighting, fire prevention instruction, and fire inspections.

Ambulance and Class II Emergency Medical Technician services are provided by Emergency Medical Technicians assigned to Crash/Fire. These contractor-operated services are available to military, civil service, and non-government personnel at PMRF, 24 hours a day, 7 days a week. More extensive emergency medical services are available from the West Kauai Medical Center in Waimea, 16 km (10 miles) from the Main Gate at Barking Sands.

3.1.7 Hazardous Materials and Wastes

This section discusses hazardous materials, hazardous waste, toxic substances, and contaminated sites.

In general, hazardous materials and wastes are defined as those substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, would present substantial danger to public health and welfare or to the environment when released into the environment.

As defined by the Department of Transportation, a hazardous material is a material that is capable of posing an unreasonable risk to health, safety, or property when transported in commerce and has been so designated. Hazardous waste is further defined by the USEPA as any solid waste not specifically excluded in 40 CFR 261.2 of the Resource Conservation and Recovery Act regulations, which meets specified concentrations of chemical constituents or has certain toxicity, ignitability, corrosivity, or reactivity characteristics.

3.1.7.1 Regulatory Setting

Hazardous materials are defined by 49 CFR section 171.8 as “hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table, and materials that meet the defining criteria for hazard classes and divisions” in 49 CFR part 173. Transportation of hazardous materials is regulated by the US Department of Transportation regulations.

Hazardous wastes are defined by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments, as: “a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed." Certain types of hazardous wastes are subject to special management provisions intended to ease the management burden and facilitate the recycling of such materials. These are called universal wastes and their associated regulatory requirements are specified in 40 CFR part 273. Four types of waste are currently covered under the universal wastes regulations: hazardous waste batteries, hazardous waste pesticides that are either recalled or collected in waste pesticide collection programs, hazardous waste thermostats, and hazardous waste lamps.

Special hazards are those substances that might pose a risk to human health and are addressed separately from other hazardous substances. Special hazards include asbestos-containing material (ACM), polychlorinated biphenyls (PCBs), and lead-based paint. The USEPA is given authority to regulate special hazard substances by the Toxic Substances Control Act (TSCA). Asbestos is also regulated by USEPA under the Clean Air Act, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The DoD established the Defense Environmental Restoration Program (DERP) to facilitate thorough investigation and cleanup of contaminated sites on military installations (active installations, installations subject to Base Realignment and Closure, and formerly used defense sites). The Installation Restoration Program and the Military Munitions Response Program are components of the DERP. The Installation Restoration Program requires each DoD installation to identify, investigate, and clean up hazardous waste disposal or release sites. The Military Munitions Response Program addresses nonoperational rangelands that are suspected or known to contain unexploded ordnance, discarded military munitions, or munitions constituent contamination. The Environmental Restoration Program is the Navy's initiative to address DERP.

3.1.7.2 Region of Influence (ROI)

The Navy has implemented a strict Hazardous Material Control and Management Program and a Hazardous Waste Minimization Program for all activities. These programs are governed Navy-wide by applicable OPNAV instructions and at the installation by specific instructions issued by the Base Commander. The Navy continuously monitors its operations to find ways to minimize the use of hazardous materials and to reduce the generation of hazardous wastes.

The ROI for hazardous materials and hazardous waste would be limited to areas of PMRF, including KTF, to be used for launch preparation, launch, and post-launch activities and in areas where hazardous materials are stored and handled.

Hazardous Materials

PMRF manages hazardous materials through the Navy's Consolidated Hazardous Materials Reutilization and Inventory Management Program (CHRIMP). CHRIMP mandates procedures to control, track, and reduce the variety and quantities of hazardous materials in use at facilities. The CHRIMP concept established Hazardous Materials Minimization Centers as the inventory controllers for Navy facilities. All departments, tenant commands, and work centers must order hazardous materials from the Hazardous Materials Minimization Centers, where all such transactions are recorded and tracked. The exception to this is KTF, which obtains its hazardous materials through Department of Energy channels. Hazardous materials on PMRF are managed by the operations and maintenance contractor through CHRIMP. Hazardous materials managed through the CHRIMP program other than fuels are stored in Building 338. Typical materials used on PMRF/Main Base and stored at Building 338 include cleaning agents, solvents, and lubricating oils.

PMRF has developed programs to comply with the requirements of the Superfund Amendments and Reauthorization Act Title III and Emergency Planning and Community Right-to-Know Act. This effort has included submission to the State and local emergency planning committees of annual Tier II forms, which are an updated inventory of chemicals or extremely hazardous substances in excess of threshold limits. These chemicals at PMRF include jet fuel, diesel fuel, propane, gasoline, aqueous firefighting foam, chlorine, used oil, paint/oils, and paint.

Hazardous Waste

PMRF/Main Base is a large-quantity hazardous waste generator with a USEPA identification number. Hazardous waste on PMRF is not stored beyond the 90-day collection period. PMRF/Main Base has two storage areas on base for hazardous wastes: Building 392 and Building 419. Building 392 stores all base waste except for OTTO (torpedo) fuel, a liquid monopropellant. Building 419 is the torpedo repair shop. At present, both buildings are not used at their maximum hazardous waste storage capacity.

KTF is a small-quantity hazardous waste generator and has a USEPA identification number. There is one hazardous waste storage area on KTF.

PMRF outlines management and disposal procedures for used oils and fuels in the Hazardous Waste Management Plan. PMRF maintains a Used Oil transporter/Processor Permit through the Hawai'i Department of Health. Additionally, degraded jet fuel is used in crash-fire training events. The majority of wastes are collected and containerized at PMRF/Main Base for direct offsite disposal through the Defense Reutilization and Marketing Office (DRMO) at Pearl Harbor within 90 days. The DRMO provides for the transportation and disposal of the wastes to the final disposal facility.

Pollution Prevention/Recycling/Waste Minimization

PMRF has a pollution prevention plan in place for the Main Base and all sites on Kauai, which follows CHRIMP procedures for controlling, tracking, and reducing hazardous materials use and waste generation. PMRF/Main Base currently has three hazardous waste elimination programs in place. These involve recycling toner cartridges, mercury from mercury lamps, and acid/lead batteries.

Installation Restoration Program

KTF has no Environmental Restoration sites. Three Environmental Restoration sites were identified in 1995 and were given a No Further Action determination by USEPA in 1996 (Sandia National Laboratories, 2006).

Underground and Aboveground Storage Tanks

There is one underground storage tank and one 10,000-gal aboveground fuel tank at KTF. KTF complies with PMRF's management plans for oil and hazardous materials outlined in the PMRF Spill Prevention Control and Countermeasures Plan and the Installation Spill Contingency Plan. (Sandia National Laboratories, 2006)

Asbestos, Lead-Based Paint, and Polychlorinated Biphenyls

PMRF manages asbestos in accordance with the Base Operations Support contractor's asbestos management plan. Prior to any construction projects, areas to be disturbed are surveyed for asbestos, and any asbestos is removed, before disturbance, by a certified asbestos contractor. The handling of hazardous materials and the potential generation and disposal of hazardous wastes follow ongoing, standard, and applicable regulations and procedures at PMRF.

All facilities associated with PMRF follow basic lead management principles and policies. The exception is KTF, which follows Department of Energy plans for the removal of lead-based paint wastes. The transformers on the KTF site have been tested and are free of polychlorinated biphenyls, and there are no asbestos issues at the site (Sandia National Laboratories, 2006).

Liquid Fuels and Other Toxic Fuels

PMRF uses gasoline and diesel fuels to power range trucks and equipment. Aircraft at PMRF use jet fuel and Jet-A. Jet-A is available at the fuel farm near the airfield. Both aircraft fuels are delivered to the flight line in refuelers.

3.2 Over-Ocean Flight Corridor

This section includes air quality and biological resources within the Pacific BOA along the over-ocean flight corridor for the FE-1 flight test.

The potential impacts to the following resource areas are considered to be negligible or non-existent so they were not analyzed in detail in this EA/OEA:

Water Resources: There are no groundwater or surface water resources along the over-ocean flight corridor that would be affected by the FE-1 flight test. There would be no disturbance to ocean waters beyond the settling of the individual booster stages hundreds of kilometers (miles) apart as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). No impacts would occur to water resources within the over-ocean flight corridor from the FE-1 flight test.

Geological Resources: There would be no drilling, mining, or construction in the open ocean and no sediment disturbance beyond the settling of the individual rocket booster stages hundreds of kilometers (miles) apart as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). There would be no impacts to geological resources in the over-ocean flight corridor from the FE-1 flight test.

Cultural Resources: There are no identified cultural resources along the flight path within the over-ocean flight corridor; therefore, there would be no impacts to cultural resources within that area from the FE-1 flight test.

Land Use: The FE-1 flight path would avoid populated land masses with their associated assigned land uses. There would be no changes, and therefore, no impacts, from the FE-1 flight test to land use along the flight path over the over-ocean flight corridor.

Airspace: The over-ocean flight corridor is located over international airspace and, therefore, has no formal airspace restrictions governing it. Over-ocean flight tests must comply with DOD Instruction 4540.01, *Use of International Airspace by US Military Aircraft and for Missile/Projectile Firings*. Commercial and private aircraft would be notified through NOTAMs issued through the FAA in advance of the FE-1 flight test launch at the request of RTS as part of their routine operations. Test flight operations would be conducted in accordance with Western Range procedures and would not expand or alter currently controlled airspace. There would be no impacts to airspace from the FE-1 flight test.

Noise: The FE-1 flight would occur at high altitude where it would be generally undetected by vessels or aircraft at the ocean's surface. Sonic booms are generated following launch and during terminal flight and impact; these areas are not within the over-ocean flight corridor. Therefore, there would be no impacts to noise within the over-ocean flight corridor from the FE-1 flight test.

Infrastructure: No changes would occur to infrastructure in the over-ocean flight corridor from the FE-1 flight test; therefore, there would be no impacts to infrastructure in the over-ocean flight corridor.

Transportation: Transportation services would be unaffected by the FE-1 flight test over the open ocean. The payload flight would occur at high altitude where it would be rgenerally undetected by vessels or aircraft. Public NOTAMs and NOTMARS would be issued along the flight path to ensure the safety of both aircraft and vessels. Components would drop over pre-determined open ocean areas to ensure, along with the public notices, that there would be no vessels or aircraft in the vicinity. There would be no impacts from the FE-1 flight test to transportation along the flight path over the open ocean.

Public Health and Safety: The FE-1 flight would occur at high altitudes where it would be generally undetected by vessels or aircraft. NOTAMs and NOTMARS would be issued along the flight path to ensure the safety of personnel on aircraft and vessels. Components would drop over pre-determined open ocean areas to ensure, along with the public notices, that there would be no vessels or aircraft in the vicinities. Range Safety at PMRF would monitor the flight until takeover by RTS range safety as the payload comes into USAKA. If the FE-1 flight strays outside its designated corridor, it would be considered to be malfunctioning and to constitute an imminent safety hazard. The destruct package, which is installed in all flight vehicles capable of impacting inhabited areas, would be activated. This effectively halts powered flight, causing the remaining hardware to fall into the ocean along a ballistic trajectory. The low potential for a flight failure, combined with the low density of vessels in the open ocean, make any potential impact discountable. There would be no impacts from the FE-1 flight test to public health and safety along the flight path over the over-ocean flight corridor.

Hazardous Materials and Wastes: Each of the three rocket motor boosters would exhaust on-board propellant before dropping into the ocean, while fairings would not carry hazardous materials. *De minimus* residual quantities of other materials may remain on the boosters and fairings; these would be carried to the ocean floor by the sinking components. There would be no impacts to hazardous materials and wastes along the over-ocean flight corridor from the FE-1 flight test.

Socioeconomics: Use of USAKA by the US Army is maintained under the MUORA and Compact of Free Association, with lease payments made to the Marshallese landowners. The current lease is valid through 2066 with an additional option through 2086. Personnel conducting the FE-1 flight test would reside only temporarily at USAKA, and the FE-1 flight test would not employ any Marshallese citizens or contribute to the local Marshallese economy. There is no resident population at Illeginni Islet. Therefore, there would be no impacts to socioeconomics from the FE-1 flight test.

Environmental Justice: USAKA does not include any population centers such that minorities or low income populations would be subject to disproportionate impacts from the FE-1 flight test. Range safety regulations and procedures protective of health and safety would be applied throughout the flight corridor. There would be no disproportionate impacts within the over-ocean flight corridor to minority populations or low-income populations under Executive Order 12898 from the FE-1 flight test.

Visual Resources: The FE-1 flight would occur at high altitude where it would be generally undetected by vessels or aircraft. There would be no changes from the FE-1 flight test to visual resources along the flight path over the over-ocean flight corridor.

Marine Sediments: There would be no marine sediment disturbance beyond the settling of the rocket components as they come to rest on the sea floor after splashing into the ocean along the flight path and slowly sinking thousands of meters (feet). There would be no impacts to marine sediments in the over-ocean flight corridor from the FE-1 flight test.

3.2.1 Air Quality, Greenhouse Gases and Climate Change

3.2.1.1 Regulatory Setting

Because of the potential global effects of testing rockets over the ocean and through the Earth's atmosphere, this EA/OEA considers the environmental effects on the global environment in accordance with the requirements of Executive Order (EO) 12114, *Environmental Effects of Major Federal Actions*, DODD 6050.7, *Environmental Effects Abroad of Major Department of Defense Actions; and* EO 13693, *Planning for Federal Sustainability in the Next Decade*, which outlines policies to ensure that Federal agencies evaluate climate-change risks and vulnerabilities, and to manage the short- and long-term effects of climate change on their operations and mission. This EO specifically requires DoD agencies to measure, report, and reduce their GHG emissions from both their direct and indirect activities (DoD, 2016). This section describes the baseline conditions within the Pacific BOA over-ocean flight corridor (Figure 2-5) that may be affected by the proposed FE-1 flight test.

Air Quality

The stratosphere, which extends from 6 mi (10 km) to approximately 30 mi (50 km) in altitude, contains the Earth's ozone layer (National Oceanic and Atmospheric Administration [NOAA], 2008). The ozone layer plays a vital role in absorbing harmful ultraviolet radiation from the sun. Over the last 20 years, anthropogenic (human-made) gases released into the atmosphere—primarily chlorine related substances—have threatened ozone concentrations in the stratosphere which filter harmful ultraviolet sunlight. Such materials include chlorofluorocarbons (CFCs), which have been widely used in electronics and refrigeration systems, and the lesser-used halons, which are extremely effective fire extinguishing agents. Once released, the motions of the atmosphere mix the gases worldwide until they reach the stratosphere, where ultraviolet radiation releases their chlorine and bromine components.

Through global compliance with the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer and amendments, the worldwide production of CFCs and other ozone-depleting substances has been drastically reduced and banned in many countries. A continuation of these compliance efforts is expected to allow for a slow recovery of the ozone layer (World Meteorological Organization [WMO], 2016).

Atomic chlorine produced from emissions of HCl during high-temperature afterburning reactions in the exhaust plume of solid propellant rocket motors can contribute to overall global chlorine loading, which contributes to long-term ozone depletion. Stratospheric HCl is diffused through the troposphere and dissipates with a half-life of about 2.3 years; however, HCl from rocket emissions could have longer lifetimes because part of the emission occurs at atmospheric levels above the stratosphere. Studies have shown that Al_2O_3, which is emitted from the rocket exhaust as solid particles, could contribute to ozone depletion via activation of chlorine in the atmosphere. Emissions of NO_X produced in the exhaust plume of rockets can also contribute to stratospheric ozone depletion. Table 3-7 presents typical emissions from a single STARS booster launch.

Impacts of the FE-1 flight test launch on global warming and ozone depletion in the atmosphere have also been considered as part of cumulative impacts in Section 5.

Greenhouse Gases

As described in 3.1.1.1, the CEQ final guidance (2016) recommended that agencies use projected GHG emissions as a proxy for assessing potential climate change effects or include a qualitative analysis when quantifications is not reasonably available when preparing NEPA documents. The guidance is primarily focused on projects that have large air quality implications and emphasizes a netting approach to GHG analysis. Although not specifically identified in the final guidance, the prior draft guidance included a reference point of 27,558 tons per year (25,000 metric tons per year) of CO_2 equivalent emissions for discussion and disclosure of such emissions from larger federal actions that may have appreciable GHG emissions (CEQ 2014). This threshold was carried forward to determine if additional quantitative analysis would be required for the FE-1 flight test within this EA/OEA.

In an effort to reduce energy consumption, reduce GHGs, reduce dependence on petroleum, and increase the use of renewable energy resources the Navy has implemented a number of renewable energy projects. The Navy continues to promote and install new renewable energy projects.

Climate Change

Current global climate changes are scientifically attributable to global warming occurring from GHG emissions. The global annual temperature has increased at an average rate of 0.07° Celsius [C] (0.13° Fahrenheit [F]) per decade since 1880 and at an average rate of 0.17°C (0.31°F) per decade since 1970. The warmest global average temperatures on record have all occurred within the past 15 years, with the warmest years being 2010, 2013, 2014, and 2015 (NOAA, 2016). With this in mind, the Navy is poised to support climate-changing initiatives globally, while preserving military operations, sustainability, and readiness by working, where possible, to reduce GHG emissions.

Table 3-7 Total Emissions from a STARS Booster

Emission Component	*First Stage Kg (Lbs)*	*Second Stage Kg (Lbs)*	*Third Stage Kg (Lbs)*
Water (H_2O)	598.16 (1318.70)	252.02 (555.60)	22.62 (49.87)
Carbon Dioxide (CO_2)	211.34 (465.91)	171.46 (378.00)	9.03 (19.91)
Hydrogen (H_2)	219.83 (484.63)	58.87 (129.80)	9.48 (20.91)
Nitrogen (N_2)	894.42 (1971.82)	741.64 (1635.00)	47.37 (104.44)
Hydrogen Chloride (HCl)	1576.55 (3475.64)	62.05 (136.80)	23.56 (162.18)
Aluminum Oxide (AL_2O_3)	3558.80 (7845.67)	1391.92 (3068.60)	155.04 (341.82)
Carbon Monoxide (CO)	2355.86 (5193.70)	1346.74 (2969.00)	92.90 (204.80)
Chlorine (Cl)	19.81 (43.68)	4.03 (8.90)	0.20 (0.45)

Source: STARS EA, 1990

Sea level rise from global warming is primarily ascribed to water flowing into the sea from melting freshwater ice on land and the expansion of sea water as it warms. Tracked by satellites (1993-2016) and as measured along coast lines (1870-2000), according to the US National Aeronautics and Space Administration (NASA, 2016) the current rate of sea level rise is 3.41 millimeters (0.13 inches) per year.

3.2.1.2 Region of Influence (ROI)

Over-Ocean Flight Corridor

Dominant during much of the year, trade winds effectively disperse air emissions along the over-ocean flight corridor. Studies in Pacific locations have shown seasonal variations in the concentrations of man-made emissions, consisting of sulfate, nitrate, and dust. Each spring, large quantities of pollution, aerosols, and mineral dust are carried eastward out of Asia and transported over a broad region of the northern Pacific Ocean. Although an increasing trend in emission levels was occurring from the early 1980s to the mid-1990s, a more recent downward trend was recorded through 2000. Because of the lack of local air pollution sources, the dispersal of emissions by trade winds, and the lack of topographic features that inhibit dispersion, air quality along the Pacific BOA over-ocean flight corridor is considered good. Unlike the continental US, tropospheric ozone is not a concern in this general area. (USAF, 2013)

Changes in sea level have occurred throughout history, with the primary influences being global temperatures; Arctic, Antarctic, and glacial ice masses; and changes in the shape of the oceanic basins and land/sea distribution. Generally, with rising global temperatures, less ice is created or maintained throughout the Earth and sea levels rise. Currently, small islands located within the over-ocean flight corridor may be affected by rising sea levels from global climate change.

3.2.2 Biological Resources in the Over-Ocean Flight Corridor

Biological resources and habitat are defined as in section 3.1.3. Within the over-ocean flight corridor, existing information on biological resources, specifically marine wildlife, was reviewed. Threatened, endangered, and other special status species are discussed in their respective categories. Table 3-8 lists all special status species that are potentially present in the over-ocean flight corridor. Detailed descriptions and analyses for these consultation marine species are included in the Navy SSP FE-1 BA (US Navy and USASMDC, 2017).

3.2.2.1 Regulatory Setting

For the purposes of this EA/OEA, special-status species in the over-ocean flight corridor are those species listed as threatened or endangered under the Endangered Species Act (ESA) and species afforded federal protection under the Marine Mammal Protection Act (MMPA) or the Migratory Bird Treaty Act (MBTA). The purposes of the ESA, MMPA, and MBTA as well as relevant definitions under these acts are as described in section 3.1.3.1.

Table 3-8 Special-Status Species Known to Occur or Potentially Occurring in the BOA of the Over-Ocean Flight Corridor

Common Name	*Scientific Name*	*ESA Listing Status*	*Protection Status*	*Likelihood of Occurrence in the BOA*
Cetaceans				
Minke whale	*Balaenoptera acutorostrata*	-	MMPA	L
Sei whale	*B. borealis*	E	MMPA-Depleted	L
Bryde's whale	*B. edeni*	-	MMPA	L
Blue whale	*B. musculus*	E	MMPA-Depleted	L
Fin whale	*B. physalus*	E	MMPA-Depleted	P
Short-beaked common dolphin	*Delphinus delphis*	-	MMPA	U
Pygmy killer whale	*Feresa attenuata*	-	MMPA	P
Short-finned pilot whale	*Globicephala macrorhynchus*	-	MMPA	L
Risso's dolphin	*Grampus griseus*	-	MMPA	P
Longman's beaked whale	*Indopacetus pacificus*	-	MMPA	P
Pygmy sperm whale	*Kogia breviceps*	-	MMPA	P
Dwarf sperm whale	*K. sima*	-	MMPA	P
Fraser's dolphin	*Lagenodelphis hosei*	-	MMPA	P
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	-	MMPA	P
Humpback whale	*Megaptera novaeangliae*	E	MMPA-Depleted	P
Blainville's beaked whale	*Mesoplodon densirostris*	-	MMPA	P
Killer whale	*Orcinus orca*	-	MMPA	P
Melon-headed whale	*Peponocephala electra*	-	MMPA	L
Sperm whale	*Physeter macrocephalus*	E	MMPA-Depleted	L

Common Name	***Scientific Name***	***ESA Listing Status***	***Protection Status***	***Likelihood of Occurrence in the BOA***
False killer whale	*Pseudorca crassidens*	E, Insular Hawaiian DPS	MMPA-Depleted	P
Pantropical spotted dolphin	*Stenella attenuata*	-	MMPA-Depleted	L
Striped dolphin	*S. coeruleoalba*	-	MMPA	L
Spinner dolphin	*S. longirostris*	-	MMPA-Depleted	P
Rough-toothed dolphin	*Steno bredanensis*	-	MMPA	P
Bottlenose dolphin	*Tursiops truncatus*	-	MMPA-Depleted	P
Cuvier's beaked whale	*Ziphius cavirostris*	-	MMPA	P
Pinnipeds				
Hawaiian monk seal	*Neomonachus schauinslandi*	E	MMPA-Depleted	P
Birds				
\`A\`o (Newell's Townsend's shearwater)	*Puffinus auricularis newelli*	T	ESA	P
Sea Turtles				
Loggerhead turtle	*Caretta caretta*	E	ESA	P
Green turtle	*Chelonia mydas*	E, Central West Pacific DPS	ESA	L
Leatherback turtle	*Dermochelys coriacea*	E	ESA	L
Hawksbill turtle	*Enetmochelys imbricata*	E	ESA	L
Olive ridley turtle	*Lepidochelys olivacea*	T	ESA	P
Fish				
Bigeye thresher shark	*Alopias superciliosus*	C	ESA	L
Oceanic whitetip shark	*Carcharhinus longimanus*	C	ESA	L
Oceanic giant manta ray	*Manta birostris*	C	ESA	P
Pacific bluefin tuna	*Thunnus orientalis*	C	ESA	P

Abbreviations: ESA = Endangered Species Act, C = candidate species for federal ESA listing; E = federal endangered; T = federal threatened; MMPA = Marine Mammal Protection Act; L = Likely; P = Potential; U = Unlikely.

The Magnuson-Stevens Fishery Conservation and Management Act provides for the conservation and management of the fisheries. Under the Magnuson-Stevens Fishery Conservation and Management Act, essential fish habitat (EFH) consists of the waters and substrate needed by fish to spawn, breed, feed, or grow to maturity. The effect area for the Proposed Action includes the waters designated as EFH around Johnson Atoll. EFH in this area is discussed in detail in Section 3.2.2.2

3.2.2.2 Region of Influence (ROI)

The following discussions provide a description of the existing conditions for each of the categories of biological resources in the over-ocean flight corridor. The waters of the over-ocean flight corridor consist of BOAs. The depth within much of the over-ocean flight corridor is over 3,056 m (10,000 ft) and consists of pelagic and benthic areas. Pelagic areas support communities of organisms including both planktonic (drifting) and nektonic (swimming) marine organisms. Benthic communities are made up of marine organisms that live on or near the sea floor such as bottom dwelling fish, shrimp, worms, snails, and sea stars.

The north-central Pacific Ocean contains a number of threatened, endangered, and other protected species, including cetaceans (whales, dolphins, and porpoises), sea turtles, and fish. These species are listed in Table 3-8 for deep ocean areas within the over-ocean flight corridor. Many of these species can be found near the Hawaiian Islands or other islands, but they are sometimes seasonal in occurrence because of unique migration patterns. Some species, particularly the larger cetaceans, can occur hundreds or thousands of miles from land. For most of the over-ocean flight corridor, there are no accurate population estimates or migratory routes for listed marine wildlife species.

No designated critical habitat for any assessed species occurs in the over-ocean flight corridor. Critical habitat for the Hawaiian Monk Seal has been designated around many Hawaiian Islands including the Northwest Hawaiian Islands including most terrestrial habitat 5 m (16 ft) inland and the bottom 10 m (33 ft) of habitat from the shore out to the 200 m (656 ft) depth contour. The ROI for spent motor splashdown does not intersect any designated critical habitat for the Hawaiian Monk Seal (Figure 3-5); therefore, the action would not result in any destruction or adverse modification of critical habitat.

Marine Mammals

Cetaceans and Hawaiian monk seals are the only special-status marine mammals that have been documented in the over-ocean flight corridor. Nine cetacean species are considered likely to occur in the BOA portion of the ROI between the Hawaiian Islands and Kwajalein Atoll: minke whale, sei whale, Bryde's whale, blue whale, short-finned pilot whale, melon headed whale, sperm whale, pantropical spotted dolphin, and striped dolphin (Table 3-8). Fifteen other cetaceans are considered to have the potential to occur in the BOA of the ROI. Some of these species occur only seasonally for breeding or during particular points in the migration patterns. Migratory paths of these species were considered when determining the likelihood of occurrence in the BOA. Six of these cetacean species are listed under the ESA as endangered. All marine mammals discussed in this section are also protected under the MMPA (16 USC, § 1361 et seq.).

Any species listed as threatened or endangered under the ESA is considered a depleted stock by the MMPA. The term depleted is further defined by the MMPA as any case in which a species or population stock is determined to be below its optimum sustainable population. In addition to those species listed as depleted under the MMPA because they are listed as threatened or endangered under the ESA. Three other cetacean species are also listed as depleted under the MMPA even though these species are not ESA listed (Table 3-8).

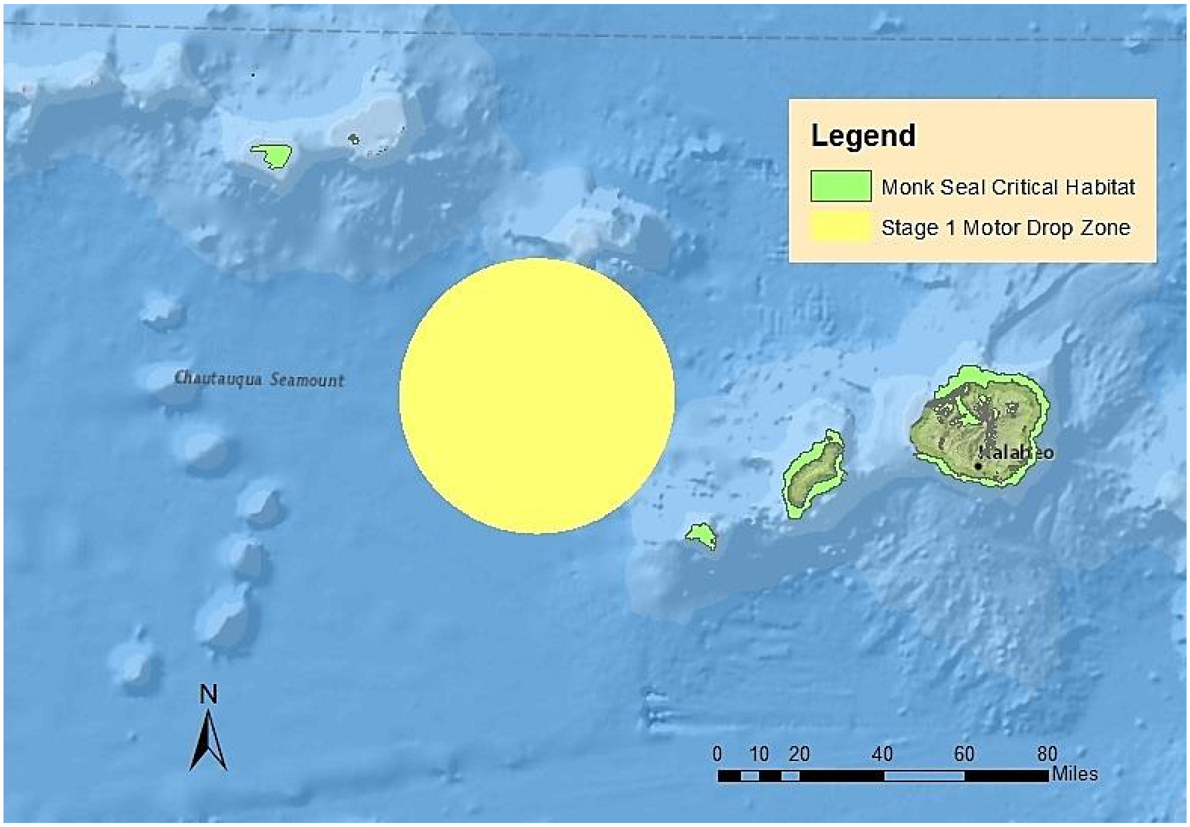


Figure 3-5 Representative Stage 1 Spent Motor Drop Zone and Hawaiian Monk Seal Critical Habitat

Potential threats to cetacean species in the BOA and deep ocean waters near the RMI include ingestion of marine debris, entanglement in fishing nets or other marine debris, collision with vessels, loss of prey species due to new seasonal shifts in prey species or overfishing, excessive noise above baseline levels in a given area, chemical and physical pollution of the marine environment, and changing sea surface temperatures due to global climate change. These threats are not particular to ESA or UES listed species, but the death of an individual is a higher cost to populations with low numbers.

Regarding noise exposure, there are many different sources of noise in the marine environment, both natural and anthropogenic. Biologically produced sounds include whale songs, dolphin clicks, and fish vocalizations. Natural geophysical sources include wind-generated waves, earthquakes, precipitation, wave action, and lightning storms. Anthropogenic sounds are generated by a variety of activities, including commercial shipping, geophysical surveys, oil drilling and production, dredging and construction, sonar, DoD test activities and training maneuvers, and oceanographic research (USAF, 2006).

While measurements for sound pressure levels in air are referenced to (re) 20 micro-Pascals (µPa), underwater sound levels are normalized to 1 µPa at 1 m (3.3 ft) from the source, a standard used in underwater sound measurement. In the BOA, some of the loudest underwater sounds generated are most likely to originate from storms, ships, and some marine mammals. Thunder can have source levels of up to 260 dB (re to 1 µPa). A passing supertanker can generate up to 190 dB (re to 1 µPa) of low frequency sound.

Jurisdiction over marine mammals such as whales, dolphins, porpoises, seals, and sea lions is maintained by NOAA Fisheries.

Birds

While no terrestrial habitat occurs in the BOA portion of the ROI, many pelagic sea birds may use this area for foraging and resting. One species of bird, the Newell's shearwater, is known to use the BOA southwest of Hawai'i for foraging (John Burger personal communication, 9 January 2017). Newell's shearwater breed only in the southeastern Hawaiian Islands where they nest in burrows on steep forested mountain slopes (Pyle and Pyle, 2009). Adults return to Hawai'i to breed in April and depart in leave in early fall (Pyle and Pyle 2009). Little is known about their winter range or about their pelagic foraging distribution. Newell's shearwaters have been primarily recorded in the tropical Pacific between 9-12° N and 160-120° W; however, these birds have been observed and collected at Guam, Saipan, Wake Island, Johnston Atoll, and American Samoa (Pyle and Pyle 2009).

The Newell's shearwater forages in BOA and offshore waters near breeding grounds where it feeds primarily on squid (NMFS, 2016). While little is known about these birds in the BOA, researchers have recorded Newell's shearwaters in low numbers in offshore waters near Hawai'i (Pyle and Pyle, 2009). These researchers observed the highest numbers of shearwaters in the spring and within 370 km (200 nm) of Kauai (Pyle and Pyle 2009). Primary threats to Newell's shearwater are terrestrial in nature and include nest predation by barn owls (*Tyto alba*), introduced terrestrial mammals, and artificially lighting which disorients fledgling birds (NMFS, 2016).

The USFWS maintains jurisdiction over migratory birds in the BOA of the ROI.

Sea Turtles

Five species of sea turtle: green, hawksbill, leatherback, loggerhead, and olive ridley, all of which are listed under the ESA (Table 3-8), occur in the BOA portion of the ROI. Much of the sea turtle research in the BOA has been conducted on the beaches and near shore waters of Hawai`i; thus, much of the data documenting the species' occurrence in the BOA is limited to that region.

Though each of the sea turtle species in the ROI has unique life history characteristics and preferred habitat, many environmental factors are common among all species. Bycatch in commercial fisheries, ship strikes, and marine debris are primary threats to sea turtles in the BOA (Lutcavage et al., 1997). One comprehensive study estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries (Wallace et al., 2010). Precise data are lacking for sea turtle deaths directly caused by ship strikes; however, live and dead turtles are often found with deep cuts and fractures indicative of a collision with a boat hull or propeller (Hazel et al., 2007; Lutcavage et al., 1997). Marine debris can also be a problem for sea turtles through entanglement or ingestion. Sea turtles can mistake debris for prey; one study found 37% of dead leatherbacks to have ingested various types of plastic (Mrosovsky et al., 2009). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown turtles in all life stages.

Aquatic degradation issues, such as poor water quality and invasive species, can alter ecosystems, limit food availability, and decrease survival rates (NMFS, 2016). Environmental degradation can also increase susceptibility to diseases, such as fibropapillomatosis, a debilitating tumor-forming disease that primarily affects green turtles (Santos et al. 2010). Fibropapillomatosis causes tumor-like growths (fibropapillomas), resulting in reduced vision, disorientation, blindness, physical obstruction to swimming and feeding, and increased susceptibility to parasites (NMFS and USFWS, 1998b; Santos et al., 2010).

Global climate change, with predictions of increased ocean and air temperatures and sea level rise, may also negatively impact turtles in all life stages, from egg to adult (Griffin et al., 2007; Poloczanska et al., 2009). Effects include embryo death caused by high nest temperatures, skewed sex ratios due to increased sand temperature, loss of nesting habitat to beach erosion, coastal habitat degradation (e.g., increased water temperature and disease), as well as, alteration of the marine food web, which can decrease the amount of prey species.

Sea turtles' long life expectancy and site fidelity may make them vulnerable to chronic exposure to marine contaminants (Woodrom Rudrud et al., 2007). Sea turtles may also be vulnerable to the bioaccumulation of heavy metals in their tissues (Sakai et al., 2000). At this time, the amount of contaminants in the marine environment has not been measured, and sea turtles have not been tested for heavy metal levels in blood or tissues. Damage to coral reefs can reduce foraging habitat for hawksbill turtles, and damage to seagrass beds and declines in seagrass distribution can reduce near shore foraging habitat for green turtles in the RMI (NMFS and USFWS, 2007c, 1991).

Sea turtle auditory sensitivity is not well studied. The range of maximum sensitivity for sea turtles appears to be 200 to 800 Hz (Lenhardt, 1994; Moein et al., 1994). Hearing below 80 Hz is less sensitive but still potentially usable to the turtle (Lenhardt, 1994). Ridgway et al. (1969) concluded that green turtles have a useful hearing span of 60 to 1,000 Hz, but they hear best from 200 Hz up to 700 Hz, with sensitivity falling off considerably below 400 Hz. Because their anatomy is similar to that of green turtles, other sea turtle species are thought to have the same sensitivity ranges.

The USFWS and NOAA Fisheries share federal jurisdiction for sea turtles with the USFWS having lead responsibility on the nesting beaches and NOAA Fisheries, the marine environment.

Fish

Four species of ESA candidate fish have the potential to occur in the BOA of the ROI (Table 3-8). The bigeye thresher shark, oceanic whitetip shark, oceanic giant manta ray, and Pacific bluefin tuna are primarily open ocean species and have the potential to occur in the BOA.

Due to their differing life histories, these fish species have many species specific threats. All of these species are threatened by overutilization due to targeted fishing as well as capture as bycatch in commercial fisheries.

While little is known about the specific hearing capabilities of fish in the ROI, most fish are able to detect a wide range of sounds from below 50 Hz up to 500-1500 Hz (Popper and Hastings 2009). Potential responses to sound disturbance in fish include temporary behavioral changes, stress, hearing loss (temporary or permanent), tissue damage (such as damage to the swim bladder), or mortality (Popper and Hastings, 2009). In studies of other fish, short duration sounds with peaks less than 176 dB re 1 µPa were found to temporarily alter fish behavior, cause temporary threshold shifts (temporary hearing alteration), but caused no observable physical damage (Popper and Hastings, 2009). It is important to note that the effects of sound on these fishes are largely unknown as are sound effects on the eggs and larvae of these fish. Some researchers suggest that threshold guidelines of a peak exposure of 206 dB for physical injury of fish, a 189 dB sound exposure level for auditory tissue damage, and 150 dB for behavioral effects (Oestman et al., 2009).

Fish are vital components of the marine ecosystem. They have great ecological and economic aspects. To protect this resource, NOAA Fisheries works with the regional fishery management councils to identify the essential habitat for every life stage of each federally managed species using the best available scientific information. Essential fish habitat (EFH) has been described for approximately 1,000 managed species to date. EFH includes all types of aquatic habitat including wetlands, coral reefs, seagrasses, and rivers; all locations where fish spawn, breed, feed, or grow to maturity.

Essential Fish Habitat. The MSA of 1976 mandates identification and conservation of EFH to help maintain productive fisheries and rebuild depleted fish stocks. All federal agencies whose work may affect fish habitats must assess potential project effects on EFH. Under the MSA, EFH is defined as "those waters and substrate necessary to fish for spawning, breeding or growth to maturity." An EFH may include US waters within exclusive economic zones (EEZ; seaward boundary out to a distance of 200 nm) and covers all fish species within in a fishery management unit (50 CFR §600.805). Under the MSA, an adverse effect means any impact that reduces quality and/or quantity of EFH (50 CFR §600.810). Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH (50 CFR §600.810).

The Western Pacific Regional Fishery Management Council (WPRFMC) has authority over the fisheries and EFH designation in and surrounding the State of Hawai`i, the Territory of American Samoa, the Territory of Guam, the Commonwealth of the Northern Mariana Islands, and the US Pacific Remote Island Areas (Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Wake Island, Palmyra Atoll, and Midway Atoll; Figure 3-1). The flight path for FE-1 crosses over waters designated as EFH near the Hawaiian Islands and the over-ocean flight corridor effect area extends into waters designated as EFH at Johnson Atoll (in the Pacific Remote Islands Area). The effects of the Proposed Action on EFH near both the Hawaiian Islands and near Johnson Atoll are evaluated in this section of the EA/OEA.

The WPRFMC developed EFH designations for Bottomfish and Seamount Groundfish, Crustaceans, and Precious Corals (approved by the Secretary of Commerce on February 3, 1999; 64 FR 19068) as well as for Coral Reef Ecosystem Management Unit Species (MUS; approved by the Secretary of Commerce on June 14, 2002; 69 FR 8336) (WPRFMC, 2009b). The EFH for these species management units which are summarized here are discussed in detail by WPRFMC in the Fishery Ecosystem Plan for the Hawai'i Archipelago (WPRFMC, 2009a), the Fishery Ecosystem Plan for the Pacific Remote Island Area (WPRFMC, 2009b), and the Fishery Ecosystem Plan for Pacific Pelagic Fisheries of the Western Pacific Region (WPRFMC, 2005). EFH in the Action Area is summarized in Table 3-9 and discussed below.

In addition to EFH, the WPRFMC (2009b) has identified habitat areas of particular concern (HAPCs) within the EFH for certain MUS. The HAPCs are specific areas within EFH that are essential to the life cycle of important coral reef species (WPRFMC, 2009b). These HAPCs must meet one of the following criteria: a) the ecological function provided by the habitat is important; b) the habitat is sensitive to human-induced environmental degradation, c) development activities are, or will be, stressing the habitat type; or d) the habitat type is rare (WPRFMC, 2009b). HAPCs within the Action Area are summarized in Table 3-9 and discussed below.

Table 3-9 Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for All Western Pacific Archipelagic Management Unit Species (including the Pacific Remote Islands Area)[1]

Resource	***Species Complex***	***EFH***	***HAPC***
Bottomfish and Seamount Groundfish	Shallow-water species (0–50 fm): uku (*Aprion virescens*), thicklip trevally (*Pseudocaranx dentex*), lunartail grouper (*Variola louti*), blacktip grouper (*Epinephelus fasciatus*), ambon emperor (*Lethrinus amboinensis*), redgill emperor (*Lethrinus rubrioperculatus*), giant trevally (*Caranx ignoblis*), black trevally (*Caranx lugubris*), amberjack (*Seriola dumerili*), taape (*Lutjanus kasmira*)	Eggs and larvae: the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm). Juvenile/adults: the water column and all bottom habitat extending from the shoreline to a depth of 400 m (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	Deep-water species (50–200 fm): ehu (Etelis carbunculus), onaga (*Etelis coruscans*), opakapaka (*Pristipomoides filamentosus*), yellowtail kalekale (*P. auricilla*), yelloweye opakapaka (*P. flavipinnis*), kalekale (*P. sieboldii*), gindai (*P. zonatus*), hapuupuu (*Epinephelus quernus*), lehi (*Aphareus rutilans*)	Eggs and larvae: the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m (200 fm) Juvenile/adults: the water column and all bottom habitat extending from the shoreline to a depth of 400 meters (200 fm)	All slopes and escarpments between 40–280 m (20 and 140 fm) Three known areas of juvenile opakapaka habitat: two off Oahu and one off Molokai
Bottomfish and Seamount Groundfish	Seamount groundfish species (50–200 fm): armorhead (*Pseudopentaceros richardsoni*), ratfish/butterfish (Hyperoglyphe japonica), alfonsin (*Beryx splendens*)	Eggs and larvae: the (epipelagic zone) water column down to a depth of 200 m (100 fm) of all EEZ waters bounded by latitude 29°–35° Juvenile/adults: all EEZ waters and bottom habitat bounded by latitude 29°–35° N and longitude 171° E–179° W between 200 and 600 m (100 and 300 fm)	No HAPC designated for seamount groundfish
Crustaceans	Spiny and slipper lobster complex: Hawaiian spiny lobster (*Panulirus marginatus*), spiny lobster (*P. penicillatus,* P. spp.), ridgeback slipper lobster (*Scyllarides haanii*), Chinese slipper lobster (*Parribacus antarticus*) Kona crab: Kona crab (*Ranina ranina*)	Eggs and larvae: the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (75 fm) Juvenile/adults: all of the bottom habitat from the shoreline to a depth of 100 m (50 fm)	All banks with summits less than or equal to 30 m (15 fathoms) from the surface
Crustaceans	Deepwater shrimp (Heterocarpus spp.)	Eggs and larvae: the water column and associated	No HAPC designated for deepwater shrimp.

Resource	Species Complex	EFH	HAPC
		outer reef slopes between 550 and 700 m Juvenile/adults: the outer reef slopes at depths between 300-700 m	
Precious Corals	Deep-water precious corals (150–750 fm): Pink coral (*Corallium secundum*), red coral (*C. regale*), pink coral (*C. laauense*), midway deepsea coral (C. spp. nov.), gold coral (Gerardia sp.), gold coral (*Callogorgia gilberti*), gold coral (Narella spp.), gold coral (Calyptrophora spp.), bamboo coral (*Lepidisis olapa*), bamboo coral (Acanella spp.) Shallow-water precious corals (10-50 fm): black coral (*Antipathes griggi*), black coral (*Antipathis grandis*), black coral (*Myriopathes ulex*)	EFH for Precious Corals is confined to six known precious coral beds located off Keahole Point, Makapuu, Kaena Point, Wespac bed, Brooks Bank, and 180 Fathom Bank EFH has also been designated for three beds known for black corals in the Main Hawaiian Islands between Milolii and South Point on the Big Island, the Auau Channel, and the southern border of Kauai	Includes the Makapuu bed, Wespac bed, Brooks Banks bed For Black Corals, the Auau Channel has been identified as a HAPC
Coral Reef Ecosystems	All Currently Harvested Coral Reef Taxa All Potentially Harvested Coral Reef Taxa	EFH for the Coral Reef Ecosystem Management Unit Species (MUS) includes the water column and all benthic substrate to a depth of 50 fathoms (fm) from the shoreline to the outer limit of the EEZ	Includes all no-take MPAs identified in the CRE-FMP, all Pacific remote islands, as well as numerous existing MPAs, research sites, and coral reef habitats throughout the western Pacific

[1] Source: WPRFMC 2009b, Table 16.

Bottomfish and Seamount Groundfish. Very little is known about the life histories, habitat utilization, diet, or reproductive behavior of most adult and juvenile bottomfish and seamount groundfish species (WPRFMC, 2009b).

Bottomfish MUS in the Western Pacific Region are found concentrated on steep slopes of deepwater banks near the 100-fathom isobath (WPRFMC, 2009b). Adult bottomfish are generally found in habitats with hard substrate with high structural complexity (WPRFMC, 2009b). Due to a lack of data on productivity of bottomfish in different habitats and the fishes utilization of these habitats, the WPRFMC has designated EFH for adult and juvenile bottomfish as the water column and all bottom habitat extending from the shoreline to a depth of 400 m (1,312 ft) encompassing the steep drop-offs and high-relief habitats that are important for bottomfish in the Western Pacific Region (WPRFMC, 2009b).

Eggs and larva of bottomfish MUS are pelagic and therefore subject to ocean currents (WPRFMC, 2009b). Since little is known about the distribution of egg and larval life stages, the WPRFMC has designated EFH for egg and larval bottomfish as the water column extending from the shoreline to the outer boundary of the EEZ to a depth of 400 m (1,312 ft) throughout the Western Pacific Region (WPRFMC, 2009b).

The WPRFMC (2009b) designated EFH for adult seamount groundfish MUS as all waters and bottom habitat bounded by latitude 29°-35° N and longitude 171° E-179° W between 80 and 600 m (262 and 1,969 ft). For seamount groundfish eggs, larvae, and juveniles, designated EFH includes the epipelagic zone (200 m in depth) of all waters bounded by latitude 29°-35° N and longitude 171° E-179° W (WPRFMC 2009b). All escarpments/slopes between 40-280 m throughout the Western Pacific Region are designated as HAPCs for bottomfish (WPRFMC 2009b).

Crustaceans. The WPRFMC (2009b) has designated EFH for two crustacean species assemblages; a spiny lobster, slipper lobster, and kona crab complex and a shrimp complex.

Spiny lobsters of the genus *Panulirus* are found throughout the Western Pacific Region including 13 species distributed in tropical and subtropical Pacific waters, 3 species which are absent from many island nations, and the Hawaiian spiny lobster (*P. marginatus*) which is endemic to Hawai'i and Johnston Atoll (WPRFMC 2009b). The slipper lobsters belong to a closely related family, Scyllaridae (WPRFMC, 2009b).

In the Main Hawaiian Islands, commercial catch landings of spiny lobsters in the EEZ are between 3,175 and 5,443 kg (7,000 and 12,000 lbs) annually while recreational and subsistence catch in these areas remains unknown (WPRFMC, 2009b). In the southwestern Pacific, spiny lobsters are typically found in association with coral reefs where they inhabit the rocky shelters in the windward surf zones of oceanic reefs and move to reef flats at night to forage (WPRFMC, 2009b). The EFH for adult and juvenile spiny lobster is designated at the bottom habitat from the shoreline to a depth of 100 m (328 ft) throughout the Western Pacific Region.

Little is known about spiny lobster egg production or larval settlement, however, the WPRFMC (2009b) has designated FEH for spiny lobster larvae as the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m (492 ft) throughout the Western Pacific Region.

The EFH for deepwater shrimp eggs and larvae is designated at the water column and associated outer reef slopes between 550 and 700 m (1,640 and 2,267 ft) and the EFH for juveniles and adults is designated as the outer reef slopes at depth between 300 and 700 m (984 and 2,267 ft; WPRFMC, 2009b).

Precious Corals. Precious corals are divided into deep- and shallow-water species complexes (WPRFMC, 2009b). Deep-water species such as pin coral (*Corallium secundum*), gold coral (*Gerardi* sp. and *Parazoanthus* sp.), and bamboo coral (*Lepidistis olapa*), are generally found between 350 and 1,500 m (1,148 and 4,921 ft) deep (WPRFMC, 2009b). Shallow-water species include three species of black coral (*Antipathes griggi*, *A. grandis*, and *Myriopathes ulex*, which occur between 30 and 100 m (98 and 328 ft) deep (WPRFMC, 2009b). These corals are non-reef building and are found on solid substrate in areas with moderate to strong bottom currents which keep the area swept free of accumulated sediments which would prevent settlement of new larvae (WPRFMC, 2009b). In the Hawaiian Islands, large beds of precious corals are found in deep interisland channels in the Hawaiian Islands and the WPRFMC (2009b) has designated six known beds of precious corals as EFH. These beds are found at Keahole Point, Makapuu, Kaena Point, Wespac, Brooks Bank, and 180 Fathom Bank.

Coral Reef Ecosystems. For coral reef ecosystem MUS, the WPRFMC (2009b) has designated EFH based on habitat, including sand, live coral, seagrass beds, mangrove, and open ocean, for each life history stage where EFH is consistent with the depth of the ecosystem to 91 m (300 ft) and out to the limit of the EEZ. Since little data are available concerning life history, habitat utilization, food habits, and spawning behavior of most coral reef associated species, these species are farther divided into currently harvested coral reef taxa MUS and potentially harvested coral reef taxa MUS (WPRFMC, 2009b).

Detailed information concerning species assemblages for these MUS and known habitat usage for adults, spawners, juveniles, larvae, and eggs are available in the Fishery Ecosystem Plan for the Pacific Remote Island Area (WPRFMC, 2009b). Currently harvested coral reef taxa MUS include certain species of surgeonfish and unicornfish (Acanthuridae), triggerfish (Balistidae), jacks (Carangidae), reef sharks (Carcharhinidae), soldierfish and squirrelfish (Holocentridae), flagtails (Kuhliidae), rudderfish (Kyphosidae), wrasses (Labridae), goatfish (Mullidae), octopuses (Octopodidae), mullets (Mugilidae), moray eels (Muraenidae), threadfins (Polynemidae), bigeyes (Priacanthidae), rabbitfish (Siganidae), parrotfishes (Scaridae), tuna and mackerel (Scombridae), barracudas (Sphyraenidae), and turban shells (Turbinidae; see WPRFMC 2009b Table 12 for detailed species list). Potentially harvested coral reef taxa MUS include species in over 45 families of ray-finned fish, 4 families of sharks and rays, stony corals, blue corals (*Helipora*), organpipe (Tubipora), azooxanthellate corals, mushroom corals (Fungiidae), polyped corals, firecorals (*Millepora*), soft corals, anemones, zooanthids, sponges, hydrozoans, lace corals (Stylasteridae), bryozoans, tunicates, feather worms (Sabellidae), echinoderms, sea snails (Gastropoda), Trochus, sea slugs (Opistobranchs), black lipped pearl oyster (*Pinctada margaritifera*) and other bivalves, cephalopods, octopuses, lobsters, shrimp, crabs, annelid worms, and algae species (see WPRFMC 2009b Table 14 for details). While the EFH differs slightly for some species assemblages/complexes, taken together, the EFH for all life stages of both currently harvested coral reef taxa MUS and potentially harvested coral reef taxa MUS encompasses the water column and bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 50 fathoms (WPRFMC, 2009b).

Coral. Corals are invertebrates that are related to anemones, jellyfish, and hydras. They are made of invertebrate polyps and can generally be categorized as either hard or soft. Hard corals have calcium carbonate skeletons, grow in colonies, and are reef-building animals that live in symbiosis with phytoplankton called zooxanthellae. Soft corals are flexible, have calcareous particles in their body walls for structural support, can be found in both tropical and cold ocean waters, do not grow in colonies or build reefs, and do not always contain zooxanthellae.

Total coral cover in the Nohili Sector north of PMRF Main Base ranges from 32% to 39% of bottom cover (US Navy, 2008). The most abundant coral species are lobe coral, rose or cauliflower coral (*Pocillopora meandrina*), and ringed rice coral (*Montipora patula*). Along the central portion of PMRF, living coral is sparsely distributed, approximately one half of that found in the Nohili area (US Navy, 2008). The dominant species is lobe coral. Coral cover further south in the Major's Bay Sector is less than 2% (US Navy, 2008). Further offshore, the predominant coral is antler coral (*Pocillopora eydouxi*), which occurs as single large branching colonies (US Navy, 2008). Other corals found in this area are primarily smaller species which have a collective coverage of about 5% of bottom cover: rose or cauliflower coral, lobe coral, corrugated coral (*Pavona varians*), flat lobe coral (*P. duerdeni*), blue rice coral (*Montipora flabellata*), ringed rice coral, Verrill's ringed rice coral *(M. verrilli),* rice coral (*M. capitata*), crust coral (*Leptastrea purpurea*), and mushroom coral (*Fungia scutaria*; US Navy, 2008).

No known special-status coral are found in the ROI near KTF.

Non-coral Invertebrates. Animals that live on the sea floor are called benthos. Most of these animals lack a backbone and are called invertebrates. Typical benthic invertebrates found near PMRF include sea anemones, sponges, corals, sea stars, sea urchins, worms, bivalves, crabs, and many more (US Navy, 2008). Common animals found in rocky intertidal habitats include limpets, periwinkles, littorine snails, rock crabs, gastropods, and rock urchins (USASMDC/ARSTRAT, 2011). Further offshore in coral reef habitats, macroinvertebrates include the rock oyster (*Spondylus tenebrosus*), cone shells (*Conus* spp.), sea urchins

(*Echinometra mathaei*), and sea cucumbers (*Holothuria atra*; US Navy, 2008). No known special-status invertebrates are found in the ROI near KTF.

Coral

Corals are invertebrates that are related to anemones, jellyfish, and hydras. They are made of invertebrate polyps and can generally be categorized as either hard or soft. Hard corals have calcium carbonate skeletons, may live as solitary individuals or in colonies, and many are reef-building animals that live in symbiosis with phytoplankton called zooxanthellae. Soft corals are flexible, have calcareous particles in their body walls for structural support, can be found in both tropical and cold ocean waters, may be solitary or colonial, and do not always contain zooxanthellae.

Special status adult shallow-water reef-associated corals do not occur in the BOA portion of the ROI because their required shallow habitat is absent. At various times of the year the gametes (eggs and sperm) and larvae of reef-associated invertebrates may occur in the BOA. For corals, this is generally July to December and particularly the week following the August and September full moons. The densities of coral larvae are difficult to predict, but studies of coral larvae during peak spawning report 0.1 to 1 planktonic larvae m^3 in waters 5 km away from the reef, and 1.6 m^3 (brooding species) to 16 m^3 (spawning species) in waters directly over the reef during reproduction (Hodgson, 1985). Because of the relatively large distances between reefs and the BOA, larval density in the BOA is likely to be near the lower range. Eggs, larvae, and planulae are not homogenously distributed but sometimes travel in semi-coherent aggregations (slicks) or become concentrated along oceanic fronts (Hughes et al., 2000; Jones et al., 2009). It would be unlikely that these shallow-water reef-associated larvae would occur in spent motor drop zones in the BOA because they are so far up current from sources of larvae.

Non-coral Benthic Invertebrates

Animals that live on the sea floor are called benthos. Most of these animals lack a backbone and are called invertebrates. Typical benthic invertebrates include sea anemones, sponges, corals, sea stars, sea urchins, worms, bivalves, crabs, and many more.

There are two special status mollusk species in the ROI: the commercial top snail and the black-lipped pearl oyster. The commercial top snail (*Tectus niloticus*) is regulated by Marshall Islands Revised Code 1990, Chapter 3. The black-lipped pearl oyster (*Pinctada margaritifera*) is regulated by Marshall Islands Revised Code 1990, Chapter 1, § 5.

Adult shallow-water reef-associated mollusks that require consultation do not occur in the BOA of the ROI because their required shallow habitat is absent. At various times of the year the gametes (eggs and sperm) and larvae of reef-associated invertebrates may occur in the BOA. The densities of mollusk larvae are difficult to predict as there is much variation in life histories both among species and among individuals within a species (Hadfield and Strathmann, 1996). Researchers have found that marine invertebrate species have variation in both timing and duration of breeding seasons with latitude and annual environmental conditions (Hadfield and Strathmann, 1996). Marine invertebrate species may also have variation in the duration of the pelagic larval phase depending on life history characteristics, environmental conditions such as water temperatures, and ultimately, presence of suitable substrate to induce metamorphosis (Hadfield and Strathmann, 1996; Scheltema, 1971. Because of the relatively large distances between reefs and the BOA, overall larval density in the BOA is likely to be much lower. However, eggs and larvae are not homogenously distributed and sometimes travel in semi-coherent aggregations (slicks) or become concentrated along oceanic fronts (Hughes et al., 2000; Jones et al., 2009). It would be unlikely that shallow-water, reef-associated invertebrate larvae would occur in spent motor drop zones because they are so far up current from their sources.

3.3 US Army Kwajalein Atoll (USAKA), Republic of the Marshall Islands

This section includes detailed descriptions of cultural resources, biological resources, noise, public health and safety, and hazardous materials and wastes.

The potential impacts to the following resource areas within this geographical area are considered to be negligible or non-existent so they were not analyzed in detail in this EA/OEA:

Air Quality, Greenhouse Gases, and Climate Change: Because of the relatively small numbers and types of local air-pollution sources, the dispersion caused by trade winds, and the lack of topographic features that inhibit dispersion, air quality at USAKA is considered good. The primary activities at USAKA contributing to air pollution are combustion sources that produce particulates, nitrous oxide, sulfur dioxide, carbon monoxide, and hydrocarbon emissions. (UES§1-5.3, 2016) Most of these sources are located on Kwajalein Island and are regulated under the current version Air Emissions from Major, Synthetic Minor, and Industrial Boiler Stationary Sources Document of Environmental Protection 2013 (Air DEP). There are no ongoing, regulated primary air emission activities at Illeginni Islet or in the BOA proposed impact locations and there would be no change to air emissions on Kwajalein from the Proposed Action.

The developmental payload would not emit HAPs during flight or impact in USAKA and no major stationary emission sources would be involved or affected. Fugitive dust from a land impact would be temporary and quickly dispersed by trade winds. Prior to debris recovery at Illeginni Islet, the area would be wetted with freshwater to minimize fugitive dust. Although global sea level is documented to be rising based on climate change and the islands within USAKA are of low elevations, the subtle effects of rising sea level and climate change would not affect the single flight test within a year after signing of the FONSI, if approved, nor would the FE-1 flight test affect climate change. No impacts to air quality, greenhouse gases, or climate change would be expected from the FE-1 flight test.

Water Resources: Illeginni has no surface water; groundwater is very limited in quantity, and is saline and non-potable. Fresh water used to minimize fugitive dust following impact would not be allowed to flow to the lagoon or ocean and would evaporate in place. In the unlikely event of an accidental release of a hazardous material or petroleum product at the impact site, emergency response personnel would comply with the UES Kwajalein Environmental Emergency Plan (KEEP). No impacts to water resources would be expected.

Geological Resources: There would be no mining or quarrying and little, if any, surface disturbance during the placement of equipment prior to the flight test. While a temporary crater would be created at impact on Illeginni Islet, the crater would be refilled with ejecta and the site topography restored. No impact would occur to geological resources from the FE-1 flight test.

Land Use: No changes to land use would occur from the FE-1 flight test**.** Illeginni Islet has served as the flight termination site for numerous ballistic and target test flights. The FE-1 flight test activities are consistent with the RTS mission and are well within the limits of current operations of RTS and USAG-KA.

Airspace: Illeginni Islet and the two BOA locations are located under international airspace and, therefore, have no formal airspace restrictions governing them. No new special use airspace would be required, expanded, or altered for the FE-1 flight test. Local airport operations would not be affected. Commercial and private aircraft would be notified through FAA NOTAMs in advance of the launch at the request of RTS as part of their routine operations. Flight operations would be conducted in accordance with Western Range and RTS procedures. There would be no impacts to airspace from the FE-1 flight test.

Infrastructure: There would be no changes and, therefore, no impacts to infrastructure at USAKA. The Proposed Action represents activities that are consistent with the mission and well within the limits of current operations of RTS and USAG-KA.

Transportation: Transportation services would be unaffected by the FE-1 flight test at Kwajalein Atoll. Public NOTAMs and NOTMARS would be issued along the flight path, to include Kwajalein Atoll, to protect the safety of aircraft and vessels. The payload would impact at Illeginni Islet where there is no resident population, to ensure, along with the public notices, that there would be no unauthorized vessels or aircraft in the vicinity. Transport of FE-1 flight test materials, equipment and personnel to and from USAKA and the impact site would occur using existing transportation methods. The flight test activities are consistent with the mission and well within the limits of current operations of RTS and USAG-KA. There would be no impacts from the FE-1 flight test to transportation at Kwajalein Atoll.

Socioeconomics: Use of USAKA by the US Army is maintained under the MUORA and Compact of Free Association, with lease payments made to the Marshallese landowners. The current lease is valid through 2066 with an additional option through 2086. Personnel conducting the FE-1 flight test would reside only temporarily at USAKA, and the flight test would not employ any Marshallese citizens or contribute to the local Marshallese economy. There currently is no resident population at Illeginni Islet. Therefore, there would be no impacts to socioeconomics from the FE-1 flight test.

Environmental Justice: Illeginni Islet does not include any population centers; there currently is no resident population at Illeginni Islet. Therefore, there would be no disproportionate impacts from the FE-1 flight test Flight Test to minority populations and low-income populations as defined under Executive Order 12898.

Visual Resources: There would be no changes to and, therefore, no impacts to the visual aesthetics at USAKA from the FE-1 flight test.

Marine Sediments: For a deep water impact, there would be no marine sediment disturbance beyond the settling of the payload as it comes to rest on the sea floor after splashing into the ocean at impact and sinking thousands of meters (feet). For an Illeginni Islet impact, which is the Preferred Alternative, some ejecta may be thrown into shallow waters. There would be no impacts to marine sediments in USAKA from the FE-1 flight test.

3.3.1 Cultural Resources

Cultural resources are material remains of human activity that are significant in the history, prehistory, architecture, or archaeology of the RMI. They include prehistoric resources (produced by preliterate indigenous people) and historic resources (produced since the advent of written records).

3.3.1.1 Regulatory Setting

The UES standards for Cultural Resources (UES§3-7) are derived from the National Historic Preservation Act (NHPA). The Act establishes federal responsibilities and implementing regulations in 36 CFR 800 and in the US Archaeological and Historic Preservation Act (Public Law 93-291). The regulations for promoting cultural preservation that are in the RMI's Historic Preservation Act 1991 (45 Marshall Islands Revised Code, Chapter 2) was considered in developing UES§3-7. (UES§1-5.9)

The Standards for cultural resources are similar, with a few exceptions, to the US statutes and regulations on which they are based. Under the UES, the US Advisory Council on Historic Preservation (ACHP) does not have a formal role but may be used as a resource by the RMI Historic Preservation Officer (RMIHPO). The RMI ACHP reviews documentation of interaction between USAKA and RMIEPA in certain instances and may be called upon to mediate disagreements between the RMIHPO and the Commander, USAG-KA. Under the Standards, the RMIHPO executes the function of the state historic preservation office. All communication between USAG-KA and the RMIHPO is conducted through RMIEPA. The Standards substitute the RMI National Register of Historic Places and its listing criteria for the corresponding US Register and listing criteria.

A programmatic DEP (current version - Cultural Resources DEP 2006) on protecting cultural resources at USAKA addresses the potential effects of routine operations at USAKA on cultural resources and the procedures for identifying potential cultural resources in areas where they are not known. The programmatic DEP also establishes mitigation procedures for all adverse effects on previously unidentified cultural resources. For proposed activities not covered by the programmatic DEP, a specific DEP that discusses the potential for effects on cultural resources is required. The Navy SSP would complete a Notice of Proposed Activity (NPA) and DEP for the FE-1 flight test that addresses all applicable areas of the UES.

3.3.1.2 Region of Influence (ROI)

Illeginni Islet (Preferred Impact Location)

The ROI includes those areas on Illeginni Islet where FE-1 flight test activities would occur. Surface cover from construction of a helipad, roads, and facilities, and operational disturbances encompass almost the entirety of Illeginni Islet. Vegetative cover is moderate in some areas and represents regrowth since the early 1970s construction occurred. (HPP, 2006)

Limited subsurface testing on the Islet found severe disturbance to the original land surface, especially along the lagoon-facing shoreline; most of which was bulldozed at some time in the past. With the construction of the remote launch site on the east side of the Islet and subsequent use of the Illeginni as a target impact site, any buried traditional or prehistoric remains are likely under significant amounts of modern fill. Archaeological surveys conducted in 1988 (Craib, et al., 1989) failed to identify any sites on Illeginni Island. Surveys and subsurface testing in 1994 (Panamerican Consultants, Inc.) identified midden-associated (refuse heap) charcoal along the lagoon shoreline that is most likely a modern intrusion; this site was not recommended as eligible for inclusion in the RMI NRHP. (HPP, 2006) No indigenous cultural materials or evidence of subsurface deposits has been found.

In September 1996, a survey of Cold War-era properties at USAKA was completed; a Cold War Historic Context study that built on the 1996 survey was completed in 2012. Several buildings and structures at USAKA are eligible for listing on the RMI NRHP under a Missile Defense Cold War context. Seven potentially eligible buildings are located on Illeginni Islet, and three of those are considered to be significant. These are primarily missile launch facilities and associated buildings. The buildings and other facilities are primarily located in the central and eastern portions of the Islet. Most of them are no longer used and have been abandoned in place. (Leslie Mead, KRS, personal communication, 2014)

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

There are no cultural resources identified at either of the offshore water impact locations.

3.3.2 Biological Resources at Kwajalein Atoll

Biological resources and habitat are defined at in section 3.1.3. Biological resources at and near Kwajalein Atoll are divided into four major categories: (1) terrestrial vegetation, (2) terrestrial wildlife, and (3) marine wildlife. Threatened, endangered, and other special status species are discussed in their respective categories. For purposes of this assessment, the ROI focused on those areas at Illeginni Islet (Preferred Alternative) or in deep ocean waters near USAKA (Southwest and Northeast Action Alternatives)affected by FE-1 flight test missile component impacts, elevated sound pressure levels, and increased human and/or equipment activity. The following subsections describe biological resources for marine and terrestrial environments within the ROI according to the environmental setting, important habitats, and the species requiring agency consultation or coordination. Table 3-10 lists all special status species requiring consultation under the UES that are potentially present at or near Kwajalein Atoll. All coordination species are listed in Appendix B.

Table 3-10 Special-Status Species Requiring Consultation Known to Occur or Potentially Occurring in ROI at Illeginni and the Offshore Waters of Kwajalein Atoll

Common Name	*Scientific Name*	*ESA Listing Status*	*Protection Status*	*LoO in the Kwajalein Atoll Offshore Waters*	*LoO at or near Illeginni Islet*
Cetaceans					
Minke whale	*Balaenoptera acutorostrata*	-	MMPA	L	P
Sei whale	*B. borealis*	E	MMPA	P	U
Bryde's whale	*B. edeni*	-	MMPA	L	P
Blue whale	*B. musculus*	E	MMPA	P	U
Fin whale	*B. physalus*	E	MMPA	P	U
Short-beaked common dolphin	*Delphinus delphis*	-	MMPA	L	P
Short-finned pilot whale	*Globicephala macrorhynchus*	-	MMPA	L	L
Humpback whale	*Megaptera novaeangliae*	E	MMPA	P	U
Killer whale	*Orcinus orca*	-	MMPA	L	P
Melon-headed whale	*Peponocephala electra*	-	MMPA	L	P
Sperm whale	*Physeter macrocephalus*	E	MMPA	L	L
Pantropical spotted dolphin	*Stenella attenuata*	-	MMPA	L	P
Striped dolphin	*S. coeruleoalba*	-	MMPA	L	P
Spinner dolphin	*S. longirostris*	-	MMPA	L	L
Bottlenose dolphin	*Tursiops truncatus*	-	MMPA	L	P
Sea Turtles					
Green turtle	*Chelonia mydas*	E, T	ESA	L	L
Hawksbill turtle	*Enetmochelys imbricata*	E	ESA	L	P
Fish					
Bigeye thresher shark	*Alopias superciliosus*	C	UES	P	U
Oceanic whitetip shark	*Carcharhinus longimanus*	C	UES	P	U
Humphead wrasse	*Cheilinus undulatus*	-	UES	U	L

Common Name	Scientific Name	ESA Listing Status	Protection Status	LoO in the Kwajalein Atoll Offshore Waters	LoO at or near Illeginni Islet
Reef manta ray	*Manta alfredi*	C	UES	P	P
Oceanic giant manta ray	*M. birostris*	C	UES	P	U
Scalloped hammerhead shark	*Sphyrna lewini*	T	ESA	P	P
Pacific bluefin tuna	*Thunnus orientalis*	C	UES	P	U
Corals					
	Acanthastrea brevis		UES	U	L
	Acropora aculeus		UES	U	L
	A. aspera		UES	U	L
	A. dendrum		UES	U	L
	A. listeri		UES	U	L
	A. microclados		UES	U	L
	A. polystoma		UES	U	L
	A. speciosa	T	ESA	U	P
	A. tenella	T	ESA	U	P
	A. vaughani		UES	U	P
	Alveopora verilliana		UES	U	L
	Cyphastrea agassizi		UES	U	L
	Heliopora coerulea		UES	U	L
	Leptoseris incrustans		UES	U	P
	Montipora caliculata		UES	U	L
	Pavona cactus		UES	U	P
	P. venosa		UES	U	L
	Turbinaria reniformis		UES	U	L
	T. stellulata		UES	U	L
Mollusks					
Black-lipped pearl oyster	*Pinctada margaritifera*		UES	U	P
Giant clam	*Hippopus hippopus*	C	UES	U	L
Top snail	*Tectus niloticus*		UES	U	L
Giant clam	*Tridacna gigas*	C	UES	U	L
Giant clam	*T. squamosa*	C	UES	U	L

Abbreviations: LoO = Likelihood of Occurrence; ESA = Endangered Species Act; C = candidate species for federal ESA listing; C = ESA candidate species; E = federal endangered; T = federal threatened; MMPA = Marine Mammal Protection Act; UES = UES protection (USASMDC/ARSTRAT 2016 Section 3-4.5.1); L = Likely; P = Potential.

3.3.2.1 Regulatory Setting

The Compact of Free Association between the RMI and the US (48 US Code [USC], Section [§] 1921) requires all US Government activities at USAG-KA (formerly known as US Army – Kwajalein Atoll [USAKA]) and all DoD and RTS activities in the RMI to conform to specific compliance requirements, coordination procedures, and environmental standards identified in the *Environmental Standards and Procedures for USAKA Activities in the RMI*, also known as the USAKA Environmental Standards (UES). As specified in Section 2-2 of the UES, these standards also apply to all activities occurring in the territorial waters of the RMI. The proposed Navy developmental payload test, which could affect Illeginni Islet, the deep-water region southwest of Illeginni Islet, or the deep ocean waters northeast of Kwajalein Atoll, must comply with the UES (USASMDC/ARSTRAT 2016).

For the purposes of this EA/OEA, special-status species at or near Kwajalein Atoll are those species protected under the standards identified in the UES. Section 3-4 of the UES contains the standards for managing endangered species and wildlife resources. The standards in this section were derived primarily from 50 Code of Federal Regulations (CFR), Sections (§§) 17, 23, 402, 424, and 450-452, which include provisions of the ESA (16 USC, §§ 1531-1544) and other regulations applicable to biological resources. The Marshall Islands Marine Resources Authority manages marine resources in the RMI, which does not participate in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The UES provides protection for a wide variety of marine mammals, sea turtles, fish, mollusks, coral species, birds, and other terrestrial and marine species, which are listed in Section 3-4 of the UES (USASMDC/ARSTRAT, 2016). This protection applies to all of the following categories of biological resources occurring within the Marshall Islands, including RMI territorial waters:

- Any threatened or endangered species listed under the US ESA
- Any species proposed for designation or candidates for designation to the endangered species list in accordance with the US ESA
- All species designated by the RMI under applicable RMI statutes, such as the RMI Endangered Species Act of 1975, Marine Mammal Protection Act of 1990, Marine Resources (*Trochus*) Act of 1983, and the Marine Resources Authority Act of 1989
- Marine mammals designated under the US Marine Mammal Protection Act of 1972
- Bird species pursuant to the Migratory Bird Conservation Act (MBCA)
- Species protected by the Convention on International Trade in Endangered Species (CITES), or mutually agreed on by USAG-KA, USFWS, NMFS, and the RMI Government as being designated as protected species (USASMDC/ARSTRAT, 2014a).

3.3.2.2 Region of Influence (ROI)

Illeginni Islet (Preferred Impact Location)

Illeginni Islet is 31 acres (12.5 hectares) of land area with several buildings (mostly abandoned), towers, roads, a helipad, and a dredged harbor area. Illeginni Islet also has terrestrial and marine habitats of significant biological importance, as defined in the UES.

Vegetation at Illeginni Islet. Illeginni Islet vegetation is previously disturbed and managed on much of the western end of the island and around buildings/facilities. Native vegetation present on the islet consists of one patch of herbaceous vegetation and three patches of littoral (near shore) forest (Figure 3-6). The forest areas are made up primarily of *Pisonia*, *Intsia*, *Tournefortia*, and *Guettarda* trees. Some littoral shrub land can also be found mostly on the western end of the islet (USAF, 2010; USFWS, 2011). No vegetation species of special status occur on Illeginni Islet.

Terrestrial Wildlife at Illeginni Islet. A number of protected migratory and resident seabirds and shorebirds have been seen breeding, roosting, or foraging on Illeginni Islet (Appendix B, Table B-4). Biological inventories conducted on the islet by the USFWS and NMFS have identified at least 14 bird species, including the black noddy, pacific golden plover, wandering tattler, and ruddy turnstone (Appendix B, Table B-4). Migratory birds protected under the MBCA within USAKA receive protection under the UES. None of these species, however, are currently listed as protected under the US ESA. Surveys have shown shorebirds to use the littoral forest, littoral shrub, and managed vegetation throughout the islet's interior (Figure 3-6). Pooled water on the paved areas attracts both wintering shorebirds and some seabirds (e.g., terns and plovers). White terns have been observed in trees at the northwest corner and southwest quadrant of the islet. The shoreline embankment and exposed inner reef provides a roosting habitat for great crested terns and black-naped terns. Black-naped tern nests with eggs and/or chicks were recorded on Illeginni in 2012 and 2014 and are known to nest in the vicinity of the impact area (Michael Fry, personal communication, 24 April 2017). Concentrations of seabirds have also been seen in the littoral forest on the southeast side of the islet, which supports the second largest nesting colony of black noddies recorded on the USAKA-leased islets; 339 nests were identified in 2008. In general, the nesting season for seabirds and shorebirds at Illeginni and other USAKA islets begins in October and continues through April. Exceptions include white terns, which may nest throughout the year (USAF, 2010; USFWS, 2011) and black-naped terns, which are known to nest in March and October/November but may next throughout the year (Michael Fry, personal communication, 24 April 2017). These migratory and resident bird species are considered coordination species under the UES. There are no known consultation bird species present on Illeginni Islet.

Suitable sea turtle haul-out/nesting habitat exists along the shoreline on the northwestern and eastern sides of Illeginni.

Other terrestrial species observed on Illeginni include brown rats, red and black ants, and skinks. These non-native species were accidentally introduced to the islet some years earlier (USAF, 2010; USFWS, 2011a).

In 1996, three sea turtle nesting pits were found on the northwestern tip of Illeginni Islet. No pits were observed during the 1998, 2000, 2002, 2004, 2006, 2008, or 2010 biological inventories of Illeginni; however, the habitat still appeared suitable for resting and nesting. On a few occasions, adult hawksbill and green sea turtles have been seen in the waters offshore. Within Kwajalein Atoll, nesting for both hawksbill and green sea turtles has been observed to occur throughout the year (USAF, 2010; USFWS, 2011a).

Marine Wildlife at Illeginni Islet. The marine environment surrounding Illeginni Islet supports a diverse community of fish, corals, and other invertebrates. In general, coral cover and invertebrate diversity is moderate to high on the lagoon reef slopes and around the eastern seaward reef crest and slopes as well as off the seaward western side. While portions of the western seaward reef area are pavement and cobble with limited diversity and abundance of marine wildlife, much of the area has reef flats and ridges with dense assemblages of corals and other marine organisms.

Figure 3-6 Illeginni Islet Littoral Forest, Potential Sea Turtle Nesting/Haulout Areas, and Notional Payload Impact Zone

There are many invertebrate and vertebrate species found in the vicinity of Illeginni Islet which require coordination and several that require consultation. Coordination species observed on recent biological inventories are listed in Appendix B (species are listed in Table B-1 for fish, Table B-2 for mollusks, and Table B-3 for hard corals). Consultation species are listed in Table 3-10.

Marine Mammals. Marine mammals do not occur in the shallow waters immediately adjacent to Illeginni Islet where debris from payload impact has the potential to enter the marine environment. Some marine mammals (Table 3-10) may occur in deeper waters near Illeginni Islet in areas subject to increased vessel activity and elevated sound pressure levels. On the ocean side of the atoll, cetaceans have occasionally been seen and heard (underwater clicking sounds such as those known to be produced by sperm whales) in the vicinity of Illeginni Islet. There have been documented occurrences of sperm whales in the Illeginni Islet area for several years. In 2000, a pod of approximately 12 endangered sperm whales was seen a few miles southeast of Illeginni. In 2006, two sperm whales, eight short-finned pilot whales, and a large group of spinner dolphins were sighted near the area. In 2007, three marine hydrophones deployed near Illeginni Islet detected sperm whales during March, May, and September. In April 2009, an estimated four sperm whales were sighted a few miles southeast of Illeginni (Nosal, 2011; USAFGSC and USASMDC/ARSTRAT, 2015; USAF, 2010). NOAA Fisheries maintains jurisdiction over whales, dolphins, and porpoises, seals.

Potential threats to cetaceans near Illeginni Islet and hearing ability of these species are the same as for those species in other portions of the ROI (see section 3.2.2.2).

Sea Turtles. Of the five species of sea turtle discussed in Sections 3.2.2, only the green turtle and hawksbill turtle are known to occur in the waters of the RMI. Green turtles are more common, while hawksbills are considered rare or scarce (Maison et al., 2010). Only green and hawksbill turtles are known to occur in the vicinity of Illeginni Islet. During the 2010 marine inventory at Illeginni, 4 adult green turtles were observed at 3 of 4 survey stations (USFWS and NMFS, 2012). During 2012, marine inventories of Harbors on Kwajalein Atoll Islets, green turtles were only observed in one harbor and this was at Illeginni Islet (USFWS and NMFS 2017). Sea turtles are highly migratory and utilize the waters of more than one country in their lifetimes. The USFWS and NOAA Fisheries share federal jurisdiction for sea turtles with the USFWS having lead responsibility on the nesting beaches and NOAA Fisheries, the marine environment.

In addition to the threats all sea turtles species face throughout their ranges (see discussion in section 3.2.2), sea turtle near Kwajalein Atoll have the potential to be effected by local threats. In the RMI, sea turtles are an important part of Marshallese culture; they are featured in many myths, legends, and traditions, where they are revered as sacred animals. Eating turtle meat and eggs on special occasions remains a prominent part of the culture. Presently, despite national and international protection as endangered species, marine turtles remain prestigious and a highly desired source of food in the RMI (Kabua and Edwards, 2010). Turtles have long been a food source in the RMI, though the level of exploitation is unknown. Direct harvest of eggs and nesting adult females from beaches, as well as direct hunting of turtles in foraging areas, continues in many areas. Anecdotal information from RMI residents suggests a decline in the green turtle population, possibly of up to 50% in the last 10 years (McCoy 2004). The harvest of sea turtles in the RMI is regulated by the RMI Marine Resources Act, which sets minimum size limits for greens (86 centimeter [cm; 34-inch (in)] carapace length) and hawksbills (69 cm [27 in] carapace length) and closed seasons from June 1 to August 31 and December 1 to January 31. Egg collecting and take of turtles while they are onshore is prohibited (Kabua and Edwards, 2010). The Marshall Islands Marine Resources Authority manages marine resources in the RMI, which does not participate in CITES.

Sea turtles' long life expectancy and site fidelity may make them vulnerable to chronic exposure to marine contaminants (Woodrom Rudrud et al., 2007). Sea turtles may also be vulnerable to the bioaccumulation of heavy metals in their tissues (Sakai et al., 2000). At this time, the amount of contaminants in the marine environment at USAG-KA has not been measured, and sea turtles in the RMI have not been tested for heavy metal levels in blood or tissues. Several studies evaluating sources and contaminants in marine waters, sediments, and organisms have been completed at USAKA for the USAG-KA Environmental Cleanup program. Specifically, the Kwajalein Harbor (USAKA/RTS, 2013), Kwajalein Landfill (USAG-KA, 2017), and US Army Public Health Center (USAPHC, 2014) Fish Studies have brought to light sources and releases of contaminants that have made their way into the marine environment. While the purpose of each of these studies was related to issues of release and cleanup, results of several of the studies have indicated there are contaminant concentrations of concern in marine waters, sediments, and organisms at some USAKA sites. Following the USAPHC fish study, it was determined that several lagoon "No Fishing" areas would be established to safeguard the Marshallese and US inhabitants of USAKA because contaminant concentrations in lagoon reef fish are at levels where they may adversely affect public health, the marine environment, and protected beneficial uses of surface water (e.g., fishing). The implications to marine organisms, including sea turtles, are that they also could be affected, particularly by ingestion of fish, algae, and other food sources within the waters at Kwajalein Atoll. Damage to coral reefs can reduce foraging habitat for hawksbill turtles, and damage to seagrass beds and declines in seagrass distribution can reduce near shore foraging habitat for green turtles in the RMI (NMFS and USFWS, 2007c; 1991).

Fish. Many species of reef-associated fish are found in the vicinity of Illeginni Islet. A single consultation species, the humphead wrasse (*Cheilinus undulatus*), has been observed on biological inventories at Illeginni Islet. A second species of fish, *Plectropomus laevis*, has been observed near Illeginni Islet, is a SOSBI species under the UES, and is therefore a coordination species (USASMDC/ARSTRAT, 2016). Both species have been observed at multiple locations throughout USAKA (Table 3-11). One other consultation species, the reef manta ray (*Manta alfredi*), has been observed at two sites near Kwajalein Islet in biennial inventories (Table 3-11). Though this species has not been recorded near Illeginni Islet, it has the potential to occur in this area. Scalloped hammerhead sharks are found in nearshore areas including bays and estuaries, over continental shelves, and around coral reefs (Defenders of Wildlife, 2015). While some reports of scalloped hammerhead sharks in the vicinity of Illeginni Islet are known (M. Molina, Pers. Comm., 2014), this species likely has a sparse and sporadic distribution near Illeginni islet.

Table 3-11 Consultation and Coordination Fish Species Frequency of Occurrence at 2010 Biological Inventory Sites at Illeginni Islet and Throughout Kwajalein Atoll

Scientific Name	*Common Name*	*Listing Status**	*Frequency at Illeginni Islet (n=4 Sites)*	*Frequency Throughout Kwajalein Atoll (n=61 Sites)*
Cheilinus undulatus	Humphead wrasse	UES, SOSBI	0.25	0.18
Manta alfredi	Reef manta ray	ESA Candidate	--	0.03
Plectropomus laevis	Giant coral trout	UES, SOSBI	0.50	0.10

* Sources: USASMDC/ARSTRAT 2014a, USAFGSC and USASMDC/ARSTRAT 2015
Listing Status; ESA: Endangered Species Act, SOSBI: Species of Significant Biological Importance, UES: UES protection (USASMDC/ARSTRAT 2011a Section 3-4.5.1)

In addition to these coordination and consultation species, there have been many other reef-associated fish observed in the vicinity of Illeginni Islet during biological inventories. These fish include many species of squirrelfishes, pipefish, groupers, hawkfish, jacks, and snappers.

The humphead wrasse is found at low densities (1 to 8 per acre) where it occurs, and is generally observed as solitary male/female pairs or in small groups of two to seven individuals (NMFS, 2009). This fish occurs in coral reef regions of the Indo-Pacific in depths from 3-330 ft (1-100 m; WildEarth Guardians, 2012). Both juveniles and adults utilize reef habitats. While juveniles inhabit denser coral reefs closer to shore, adults live in deeper, more open water at the edges of reefs in channels, channel slopes, and lagoon reef slopes (Donaldson and Sadovy, 2001). While there is limited knowledge of their movements, it is believed that adults are largely sedentary over a patch of reef and during certain times of the year they move short distances to congregate at spawning sites (NMFS, 2009).

Threats to special-status fish include overharvest as well as habitat destruction and degradation (NMFS, 2009). The humphead wrasse is especially vulnerable to overharvest by both legal and illegal fishing activities due to their long lifespan, large size, and unique life history of female to male sex change later in life (NMFS, 2009). Another significant threat to the decline of reef-associated fish species is habitat loss and degradation, specifically destruction and degradation of reef habitats, which is common throughout the Indo-Pacific (NMFS, 2009).

No EFH exists near Illeginni Islet.

Coral. The marine environment surrounding Illeginni supports a community of corals that is typical of reef ecosystems in the tropical insular Pacific. Within this community are species of corals that are protected by an assortment of regulatory mechanisms (Table 3-10 and Appendix B, Table B-3). There are 14 species of coral requiring consultation that have been found in the vicinity of Illeginni Islet since 2008 (Appendix B, Table B-3) and an additional 5 consultation species that have the potential to occur in the ROI. These species include 2 coral species listed as ESA- threatened and the remaining 17 species requiring consultation are protected under section 3.4.5.1(a)UES (USASMDC/ARSTRAT, 2016). The 17 species were proposed for listing under the ESA but were found not to warrant protection under that act and for which the RMIEPA has decided that they remain as consultation species. All 19 coral species that require consultation are also listed as vulnerable by the International Union for Conservation of Nature (IUCN) and as Species of Significant Biological Importance (SOSBIs) under the UES (USASMDC/ARSTRAT, 2016). During 2010 biological inventories of USAKA, 109 hard coral species were observed in the vicinity of Illeginni Islet. All of these coral species are listed as SOSBIs under the current edition of the UES (USASMDC/ARSTRAT, 2016) and as such are considered coordination species (Table B-3). The frequency of all hard coral species identified during the 2010 survey as well at their frequencies throughout the atoll are listed in Appendix B (Table B-3), including the consultation species. All consultation and coordination species were observed in surveys of at least one other islet of the 11 islets surveyed and 84% of hard coral species were observed on 4 or more islets (Table B-3).

All hard coral species found at Illeginni Islet are typical of shallow-water tropical Indo-Pacific coral reefs. In general, these corals may occur at depths of 0-100 ft (0-30 m), although some species have more specific depth and subhabitat preferences (USAFGSC and USASMDC/ARSTRAT, 2015; Sakashita and Wolf, 2009). Predators of corals include sea stars, snails, and fishes (e.g., crown of thorns sea stars, parrotfish, and butterfly fish; Boulon et al., 2005; Gochfeld, 2004; Gulko, 1998). The crown of thorns sea stars (*Acanthaster planci*) are the primary predators of most ESA-candidate and SOSBI coral species known at Illeginni Islet (Table 3-10 and Appendix B, Table B-3).

Corals prey on zooplankton, which are small organisms that inhabit the ocean. Corals capture prey in tentacles armed with stinging cells that surround the corals' mouths or by employing a mucus-net to catch suspended prey (Brusca and Brusca, 2003). In addition to capturing prey, corals possess a unique method of acquiring essential nutrients through their relationship with zooxanthellae (a type of algae) that benefits both organisms.

Reproductive strategies in corals are not well defined (Fautin, 2002). Most of the shallow-water species requiring consultation in Table 3-10 reproduce by spawning, typically from July to December. Some species brood live young, and some coral species engage in both spawning and brooding (Fautin, 2002; Gascoigne and Lipcius, 2004). Most corals are capable of asexual reproduction by fragmentation. This is most often seen in branching corals that are more likely to break (Lirman, 2000). Reproductive potential (fecundity) is a function of colony age and size, and many threats to corals reduce reproductive potential by degrees, up to halting reproduction for several years (Boulon et al., 2005; Fautin, 2002; Gascoigne and Lipcius, 2004; Lirman, 2000).

Coral larval duration ranges from a few days to months (reviewed by Jones et al., 2009), but short durations of 3-9 days are much more common (Hughes et al. 2000) (Vermeij, et al. 2010). Accordingly, dispersal ranges a few tens of meters to 2000 km, but local short-distance dispersal on a scale of tens of kilometers (miles) occurs much more frequently than long-distance dispersal (Jones et al., 2009; Mumby and Steneck, 2008). Less frequent long-distance dispersal is more commonly associated with spawning corals, and it is these buoyant eggs and planktonic larvae (typically free-swimming planulae) that are more likely to be found in open ocean areas. Among corals of the Great Barrier Reef, about 130 of approximately 400 species spawn at the peak of summer (November and December) (Hughes et al., 2000). It is a reasonable assumption that this proportion would be spawning species in RMI. Altogether this suggests that gametes and planulae will be found in the open ocean, but this is the smaller fraction of the total pool of gametes, planulae, and larvae.

Coral planulae density in the water directly over the reef is zero except during reproduction when density peaks at 1,600 per 100 m^3 (brooding species) to 16,000 per 100 m^3 (spawning species) (Hodgson, 1985). On the Great Barrier Reef, similar densities of coral larvae directly over the reef rapidly dispersed by 3 to 5 orders of magnitude in waters 5 km (3.1 mi) distant from the reef (Oliver et al., 1992). Eggs, larvae, and planulae are not homogenously distributed but sometimes travel in semi-coherent aggregations (slicks) or become concentrated along oceanic fronts (Hughes et al., 2000; Jones et al., 2009).

There are no known species-specific threats for any particular coral species listed in Table 3-10 or Table B-3, although it is conceivable that some diseases are species specific. Some groups of corals are more or less susceptible to predation and general threats. For example, the predatory crown of thorns sea star (*Acanthaster planci*) feeds preferentially, but not exclusively, on *Acropora* and *Pocillopora* species (Gulko, 1998). A type of "white" disease seems to preferentially affect tabular colonies of *Acropora* (Beger et al., 2008). The aquarium industry has various taxa-specific preferences and, as one of the more profitable industries in the RMI, is a potential contributor to loss of preferred populations (Pinca et al., 2002). Factors that can stress or damage coral reefs are coastal development (Risk, 2009), impacts from inland pollution and erosion (Cortes and Risk, 1985), overexploitation and destructive fishing practices (Jackson et al., 2001; Pandolfi et al., 2003), global climate change and acidification (Hughes et al. 2003), disease (Beger et al., 2008; Galloway et al., 2009), predation (Richmond et al., 2002; Sakashita and Wolf, 2009), harvesting by the aquarium trade (Caribbean Fishery Management Council, 1994; Richmond et al., 2002), boat anchors (Burke and Maidens, 2004), invasive species (Bryant et al., 1998; Galloway et al., 2009; Wilkinson, 2002), ship groundings (Sakashita and Wolf, 2009), oil spills (NOAA, 2001), and possibly human-made noise (Vermeij et al., 2010).

All of the general threats to and characteristics of corals listed above are not known or expected to be different among consultation, coordination, or other coral species in the RMI.

<u>*Non-coral Benthic Invertebrates .*</u> Animals that live on the sea floor are called benthos. Most of these animals lack a backbone and are called invertebrates. Typical benthic invertebrates include sea anemones, sponges, corals, sea stars, sea urchins, worms, bivalves, crabs, and many more. A diverse benthic invertebrate community exists in the shallow waters near Illeginni Islet. Several special-status species have been observed near Illeginni Islet in biennial inventories of the area and are listed in Table 3-10 and Appendix B, Table B-2.

Five species of mollusk requiring consultation have been found at Illeginni, including the top snail (*Trochus niloticus*), the black-lipped pearl oyster (*Pinctada margaritifera*), and three species of giant clam (*Hippopus hippopus*, *Tridacna gigas*, and *Tridacna squamosal*). Two other mollusk species that are listed as SOSBIs and are subsequently coordination species have been observed in the vicinity of Illeginni Islet (Appendix B, Table B-2). *Lambis truncata*, and *Tridacna maxima* are known to occur in shallow water reef habitat throughout Kwajalein Atoll. All consultation and coordination mollusk species are found at multiple islets throughout Kwajalein Atoll (Appendix B, Table B-2) and are found in many shallow-water reef habitats throughout the RMI and the tropical Indo-Pacific.

All members of the family Tridacnidae are native to shallow-water coral reef habitats in the tropical Indo-Pacific. Although some species are occasionally found in the low intertidal zone and can tolerate brief aerial exposure, all members of Tridacnidae are generally found at subtidal depths. Although deep-water mollusks may occur in the ROI, no surveys have been done to determine their presence, abundance, or diversity.

The black-lipped pearl oyster (*Pinctada margaritifera*), a consultation species, is found on reef habitats throughout the tropical Indo-Pacific. It is typically found shallower than 8 m (25 ft) but occurs at least as deep as 15 m (50 ft; Keenan et al., 2006). Although these species are occasionally found in the low intertidal zone and can tolerate brief aerial exposure, they are generally found at subtidal depths. These animals typically spawn bimonthly (Nair, 2004) and pelagic larval duration for this species lasts from 15 to more than 30 days (Thomas et al., 2011).

Spider conchs of the family Strombidae are found on reef habitats throughout the tropical Indo-Pacific. *Lambis spp*. are typically found in waters shallower than 5 m (15 ft). Although some species are occasionally found in the low intertidal zone and can tolerate brief aerial exposure, all members of Strombidae are generally found at subtidal depths. They are oviparous (egg laying) and the free-swimming larvae (veligers) are competent for at least 7 days (Hamel and Mercier, 2006).

Reproduction of mollusks often includes a free-swimming stage (veliger) enabling dispersal over great distances, and genetic similarity across most mollusk species' ranges indicates that long-distance dispersal occurs with regularity. Dispersal on smaller spatial scales of tens of kilometers is much more common (Cowen and Sponaugle, 2009; Mumby and Steneck, 2008).

The densities of mollusk larvae are difficult to predict as there is much variation in life histories both among species and among individuals within a species (Hadfield and Strathmann, 1996). Researchers have found that marine invertebrate species have variation in both timing and duration of breeding seasons with latitude and annual environmental conditions (Hadfield and Strathmann, 1996). Marine invertebrate species may also have variation in the duration of the pelagic larval phase depending on life history characteristics, environmental conditions such as water temperatures, and ultimately, presence of suitable substrate to induce metamorphosis (Hadfield and Strathmann, 1996; Scheltema, 1971. Altogether, this suggests that veligers will be found in the open ocean, but this is the smaller fraction of the total pool of veligers.

All members of the family Tridacnidae and *Pinctada margaritifera* are filter-feeders, preying on plankton, bacteria, and particulate organic matter. Giant clams also host symbiotic zooxanthellae (see Section 2.3.2). Although giant clams are efficient filter feeders, most of their carbohydrate needs are supplied by their photosynthetic symbionts (Klumpp, 1992).

Major threats to mollusk include predation by specialist invertebrates and vertebrates including octopus and triggerfish (family Balistidae) and fishing pressure for food, the aquarium, and curio trades (USAFGSC and USASMDC/ARSTRAT, 2015). This has led to widespread declines of some mollusks near human populations. Fishing pressure has caused many stocks to collapse, and most are greatly reduced from their historical baselines (Munro, 1994; Tardy et al., 2008). However, populations of Tegulidae and other marine mollusks increase rapidly when fishing bans are well enforced (Dumas et al,. 2010). General threats include habitat degradation and land-based anthropogenic pollution, which interferes with reproduction (Spade et al., 2010).

Sponges are ubiquitous on the seafloor at all depths, but are most common on hard bottom or reef substrates. The sponges that inhabit coral reefs range from robust species, capable of surviving wave energy and temperature extremes, to specialized species that are delicate and cryptic. The sponges that inhabit coral reefs of the RMI are generally found throughout the tropical Indo-Pacific region. All artificially planted or cultivated sponges (phylum *Porifera*) within the RMI are afforded protection under the RMI Marine Resources Act (USASMDC/ ARSTRAT, 2016). All artificially planted or cultivated sponges are protected under the UES (USASMDC/ARSTRAT, 2016); however, no cultivated sponges are present in the study area. No sponges are regulated by the CITES and no sponges are protected under the ESA (USAFGSA and

USASMDC/ARSTRAT, 2015). While there are no consultation or coordination sponges in the ROI, the sponges that inhabit the shallow-water coral reefs of the RMI are generally found throughout the Indo-Pacific, although endemism is possible given that at least 50 other organisms are known to be endemic to the RMI (Beger et al. 2008).

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

For biological resources in deep ocean waters near USAKA, the ROI includes a deep ocean waters area northeast of Kwajalein Atoll and one southwest, which can be affected by payload impact, elevated noise levels, and increased human and equipment activity (Figure 2-2). The ROI includes portions of the territorial waters and Exclusive Economic Zone of the RMI near Kwajalein Atoll.

Ocean depths in this region of the RMI generally range between 5,000 and 15,748 ft (1,524 and 4800 m) (Hein et al., 1999). Kwajalein Atoll is near the southern edge of the large North Equatorial Current, which generally flows from the east/northeast to the west/southwest; this Current forms the southern side of a clockwise subtropical gyre. There is a wide variety of pelagic and benthic communities in the deep ocean areas near Kwajalein Atoll. A number of threatened, endangered, and other protected cetacean species can occur here, which are listed in Table 3-10 and in Appendix B along with their likelihood for occurrence. Some of these species occur only seasonally for breeding or because of unique migration patterns.

As described in Section 3.2.2, there are many different sources of noise in the marine environment, both natural and anthropogenic. Within the ROI, some of the loudest underwater sounds generated are most likely to originate from storms, ships, and some marine mammals.

Marine Wildlife in Offshore Waters

Marine Mammals. Jurisdiction over marine mammals is maintained by NOAA Fisheries and the RMI.

Cetaceans are the only special-status marine mammals that have been documented in the deep offshore waters near Kwajalein Atoll (Table 3-10). Eleven cetacean species are considered likely to occur in the deep offshore waters portion of the ROI near Kwajalein Atoll and ten other cetaceans are considered to have the potential to occur in this area. Some of these species occur only seasonally for breeding or during particular points in the migration patterns. Migratory paths of these species were considered when determining the likelihood of occurrence though little is known about the migratory patterns and distributions of some cetacean species. Five of these special-status cetacean species are listed under the ESA as endangered. All marine mammals discussed in this section are also protected under the MMPA (16 USC, § 1361 et seq.) and the UES.

Potential threats to cetacean species and hearing abilities of cetaceans in the deep offshore waters near Kwajalein Atoll are the same as the general cetacean threats outlined for the open ocean area (section 3.2.2).

Sea Turtles. Of the five species of sea turtle species found in the ROI, only the green turtle and hawksbill turtle are known to occur in Kwajalein Atoll offshore waters. Green turtles are more common, while hawksbills are considered rare or scarce (Maison et al., 2010). Sea turtles are highly migratory and utilize the waters of more than one country in their lifetimes. The USFWS and NOAA Fisheries share federal jurisdiction for sea turtles with the USFWS having lead responsibility on the nesting beaches and NOAA Fisheries, the marine environment.

Fish. Six species of special-status fish have the potential to occur in the deep offshore waters of Kwajalein Atoll (Table 3-10). While the bigeye thresher shark, oceanic whitetip shark, and Pacific bluefin tuna are known to occur in the Marshall Islands and have been documented as being caught in local fisheries, little is known about their abundance, distribution, or seasonality in this area. The reef manta ray is not likely to occur in deep offshore waters, however, individuals have been known to migrate further offshore. The oceanic giant manta ray is a more oceanic species and has the potential to occur in these waters. Scalloped hammerhead sharks of the Indo-west Pacific DPS have the potential to occur in the offshore waters of Kwajalein Atoll. The scalloped hammerhead occurs in coastal, warm temperate waters from the surface and intertidal zones to depths of at least 275 m (900 ft). They are highly mobile and partly migratory (Food and Agriculture Organization of the United Nations 2006). Scalloped hammerheads typically remain close to shore during the day and move into deeper waters at night to feed (Bester, 1999). Little is known about the abundance, distribution, or migration patterns of scalloped hammerheads in the ROI.

Coral. Adult shallow-water reef-associated corals (Table 3-10) that require consultation do not occur in the deep-water portions of the ROI because their required shallow habitat is absent. At various times of the year the gametes (eggs and sperm) and larvae of reef-associated invertebrates may occur in deep offshore waters. For corals, this is generally July to December and particularly the week following the August and September full moons. The densities of coral larvae are difficult to predict, but studies of coral larvae during peak spawning report 0.1 to 1 planktonic larvae m^3 in waters 5 km away from the reef, and 1.6 m^3 (brooding species) to 16 m^3 (spawning species) in waters directly over the reef during reproduction (Hodgson, 1985). Larval density in the deep ocean waters near USAG-KA are likely to be near the lower range except during peak spawning when density may approach the upper range. Eggs, larvae, and planulae are not homogenously distributed but sometimes travel in semi-coherent aggregations (slicks) or become concentrated along oceanic fronts (Hughes et al., 2000; Jones et al., 2009).

Non-coral Benthic Invertebrates. There are five mollusk species that require consultation in the ROI: the commercial top snail, the black-lipped pearl oyster, and three species of giant clam (Table 3-10). The commercial top snail (*Tectus niloticus*) is regulated by Marshall Islands Revised Code 1990, Chapter 3. The black-lipped pearl oyster (*Pinctada margaritifera*) is regulated by Marshall Islands Revised Code 1990, Chapter 1, § 5. The giant spider conch and one additional species of giant clam (Appendix B, Table B-2) are coordination species which are also found in the vicinity of Kwajalein Atoll.

Adult shallow-water reef-associated mollusks that require consultation and coordination do not occur in the deep offshore waters of the ROI because their required shallow habitat is absent. At various times of the year the gametes (eggs and sperm) and larvae of reef-associated invertebrates may occur in the BOA or deep ocean waters. The densities of mollusk larvae are difficult to predict as there is much variation in life histories both among species and among individuals within a species (Hadfield and Strathmann, 1996). Researchers have found that marine invertebrate species have variation in both timing and duration of breeding seasons with latitude and annual environmental conditions (Hadfield and Strathmann, 1996). Marine invertebrate species may also have variation in the duration of the pelagic larval phase depending on life history characteristics, environmental conditions such as water temperatures, and ultimately, presence of suitable substrate to induce metamorphosis (Hadfield and Strathmann, 1996; Scheltema, 1971). However, eggs and larvae are not homogenously distributed and sometimes travel in semi-coherent aggregations (slicks) or become concentrated along oceanic fronts (Hughes et al., 2000; Jones et al., 2009). Larval density in the deep ocean waters near USAG-KA is likely to be near the lower end of its range except during peak spawning when density may be higher.

3.3.3 Noise

This discussion of noise includes the types or sources of noise and the associated sensitive receptors in the human environment. Natural sources of noise on Kwajalein Atoll include the constant wave action along shorelines and the occasional thunderstorm. The sound of thunder is one of the loudest sounds expected at the Atoll and can register up to 120 dB. Within the Atoll communities, other noise sources include a limited number of motor vehicles, motorized equipment, and an occasional fixed- or rotary-wing aircraft. Daytime noise levels within the local communities are expected to typically range between 55 and 65 dBA. Ambient noise levels at Kwajalein Island are slightly greater because of higher levels of equipment, vehicle, and aircraft operations; there are several aircraft flights per week there, including military and commercial jet aircraft. (USASMDC, 2014)

Flight test vehicles can generate sonic booms during flight. The sound of a sonic boom resembles rolling thunder, and is produced by a shock wave that forms at the nose and at the exhaust plume of a missile when it travels faster than the speed of sound. These shock waves produce an audible sonic boom when they reach the ground.

3.3.3.1 Regulatory Setting

The UES incorporate provisions and policies for noise management and specify conformance with the US Army's Environmental Noise Management Program and noise monitoring provisions as specified in Army Regulation 200-1 (*Environmental Protection and Enhancement*). As an Army installation, USAG-KA also implements the Army's Hearing Conservation Program as described in Department of the Army Pamphlet 40-501 (*Hearing Conservation Program*). Army standards require hearing protection whenever a person is exposed to steady-state noise greater than 85 dBA, or impulse noise greater than 140 dB, regardless of duration. Army regulations also require personal hearing protection when using noise-hazardous machinery or entering hazardous noise areas.

3.3.3.2 Region of Influence (ROI)

Illeginni Islet (Preferred Impact Location)

During terminal flight and impact at RTS, the Navy SSP payload has the potential to affect land areas with sonic booms. The ROI for noise is focused primarily on those RMI atolls and islands closest to a proposed flight path. For the Illeginni Islet land impact scenario, Kwajalein, Likiep, Ailuk, Taka, and Utirik Atolls, as well as Jemo Island, might be affected. Census records from 2011 indicate 401 residents on Likiep Atoll, 339 on Ailuk Atoll, and 435 on Utirik Atoll; and none were reported on Taka Atoll or on Jemo Island. Kwajalein Atoll has the highest population within the ROI with a total population of approximately 11,408, including US personnel and Marshallese residents. (Secretariat of the Pacific Community, 2011)

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

During terminal flight and impact at RTS, the developmental payload has the potential to affect open ocean areas with sonic booms. Thus, the ROI for noise for a BOA impact is focused primarily on those RMI atolls and islands closest to the proposed flight path. For a BOA impact scenario, Bikar, Taka, and Utirik Atolls might be affected. Census records from 2011 indicate 435 residents on Utirik Atoll and none were reported on Bikar or Taka Atolls or on Jemo Island.

3.3.4 Public Health and Safety

RTS range safety ensures protection to Installation personnel, inhabitants of the Marshall Islands, and ships and aircraft operating in the downrange areas potentially affected by flight tests. Commercial, private, and military air and sea traffic in caution areas designated for specific flight tests or missions, and inhabitants near a flight path, are notified of potentially hazardous operations. A NOTMAR and a NOTAM are transmitted to appropriate authorities to clear traffic from caution areas and to inform the public of impending missions. The warning messages describe the time, the area affected, and safe alternate routes. The GRMI also is informed in advance of rocket launches and reentry payload missions.

3.3.4.1 Regulatory Setting

Specific procedures based on regulations, directives, and flight safety plans are required for all missions at RTS involving aircraft, missile launches, and reentry vehicles. All program operations must first receive approval from the Safety Office at RTS. This is accomplished through presentation of the proposed program to the Safety Office. All safety analyses, SOPs, and other safety documentation applicable to operations affecting the RTS must be provided, along with an overview of mission objectives, support requirements, and schedule. The flight safety plans evaluate risks to inhabitants and property near the flight path, calculate trajectory and debris areas, and specify range clearance and notification procedures. Criteria used at RTS to determine debris hazard risks are in accordance with RCC Standard 321-10, *Common Risk Criteria Standards for National Test Ranges* (Range Commanders Council, 2010).

3.3.4.2 Region of Influence (ROI)

Illeginni Islet (Preferred Impact Location)

The areas of Illeginni Islet where FE-1 flight test activities would occur are the ROI for a land impact scenario. Illeginni is and has been the target impact location for several missile programs, including the MMIII ICBM flights. As part of USAKA, the Islet is not open to the public. A limited number of FE-1 flight test personnel would access the Islet before the flight test to place equipment and after the test to recover the equipment and restore the impact site. There would be no personnel on-island during the impact; project personnel would be located offshore on ships or at other islands at the time of impact.

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

The deep offshore waters to the southwest or northeast of Kwajalein Atoll are the ROI for a FE-1 flight test water impact. These have been previously identified as potential impact locations for several missile programs. Radar and/or visual sweeps of hazard areas are accomplished immediately prior to operations to assist in the clearance of non-mission ships and aircraft. For terminal flight tests, when a point of impact in the Mid-Atoll Corridor Impact Area at RTS (Figure 2-2) is required, additional precautions are taken to protect personnel and the general public, including evacuating nonessential personnel. The FE-1 flight test would not have a Mid-Atoll Corridor impact.

3.3.5 Hazardous Materials and Wastes

Hazardous materials are defined by the UES referencing the US DOT definition: a substance or material that is capable of posing an unreasonable risk to health, safety, or property when transported in commerce and has been so designated. Hazardous waste is defined as any solid waste not specifically excluded which meets specified concentrations of chemical constituents or has certain toxicity, ignitability, corrosivity, or reactivity characteristics.

3.3.5.1 Regulatory Setting

The UES for material and waste management (UES §3-6) are derived from a composite of US statutes and regulations addressing the use and management of hazardous material and solid waste and the RMIEPA regulations. (UES §1-5.8)

The UES for hazardous materials and wastes differ from US standards in that the UES classify all materials as either general-use, hazardous, petroleum products, or prohibited. The objective of the Standards for material and waste management is to identify, classify, and manage in an environmentally responsible way all materials imported or introduced for use at USAKA/RTS. Hazardous materials are subject to requirements for security, storage, and inspection at USAKA. Hazardous wastes must be shipped off the island. Also prohibited are all new uses of PCBs, introduction of new PCBs, and introduction of PCB articles or PCB items.

The USAG-KA base contractor manages hazardous materials and wastes through a Hazardous Materials Management Plan (HMMP, UES §3-6.4.2), which is incorporated into the Kwajalein Environmental Emergency Plan [KEEP]) (UES §3-6.4.1). The import, use, handling, and disposal procedures, records, and reporting outlined in the KEEP apply to all tenant activities at USAKA and the RMI as well as to the Garrison.

3.3.5.2 Region of Influence (ROI)

Illeginni Islet (Preferred Impact Location)

Per the UES requirements, activity-specific Hazardous Materials Procedures are submitted by the project or mission proponents to the Commander, USAG-KA for approval within 15 days of receipt of any hazardous material or before use, whichever comes first. Hazardous materials to be used by organizations on the RTS test range and its facilities are under the direct control of the user organization, which is responsible for ensuring that these materials are stored and used in accordance with UES requirements. The use of all hazardous materials is subject to ongoing inspection by USAG-KA environmental compliance and safety offices to ensure the safe use of all materials. The majority of these materials are stored in satellite supply facilities, are distributed through the base supply system, and are consumed in operational processes.

Pollution prevention, recycling, and waste minimization activities are performed at USAKA in accordance with the UES and established contractor procedures are in place and managed through USAG-KA.

USAG-KA has a contingency plan (the KEEP]; UES§3-6.4.1) for responding to releases of oil, hazardous material, pollutants, and contaminants to the environment similar to the spill prevention, control, and countermeasure (SPCC) plan required in the US. The UES also include a process for evaluating and, when called for, remediating sites contaminated from releases. The process is similar to US CERCLA requirements with full participation by the public and UES Appropriate Agencies.

USAG-KA has removed all remaining hazardous materials and wastes (e.g., asbestos, polychlorinated biphenyls in old light ballasts, and cans of paint) from buildings and facilities on Illeginni (USAF, 2004). Range personnel, generally using the unexploded ordnance (UXO) burn pit on the far west side of the islet, also ensure that any unexploded ordnance or material is consumed with each burn operation. Due to the intermittent nature of flight testing and consequent occupancy of at Illeginni Islet, only small quantities of hazardous wastes are generated and managed on occasion at Illeginni Islet.

Hazardous waste, whether generated by Installation activities or RTS users, is collected at individual work sites in waste containers. Containers are labeled in accordance with the waste which they contain and are dated the day that the first waste is collected in the container.

Containers are kept at the point of generation until full or until a specified time limit is reached. Once full, containers are collected from the generation point within 72 hours and are prepared for transport to the Hazardous Waste Storage Facility (Building 1521) on Kwajalein. Each of the accumulation sites is designed to handle hazardous waste and provide the ability to contain any accidental spills of material, including spills of full containers, until appropriate cleanup can be completed.

Hazardous handling and disposal activities are closely monitored by the USAG-KA Environmental Office in accordance with Standard Practice Instruction 1534 (Management of Materials, Wastes, and Petroleum Products). Waste treatment or disposal is not allowed at the Installation under the UES.

At Illeginni Islet, as a result of previous reentry vehicle tests, residual concentrations of beryllium (Be) and depleted uranium (DU) remain in the soil near the helipad on the west side of the Islet. In 2005, LLNL analyzed over 100 soil samples collected around the helipad to determine concentrations of Be and DU in the soil (Robison et al., 2006). Soil samples were collected again following subsequent flight tests and results were reported in 2010 and 2013 (Robison et al., 2010 and 2013). Table 3-12 summarizes the concentration results from the 2013 sampling event.

Several studies evaluating sources and contaminants in marine waters, sediments, and organisms have been completed at USAKA for the USAG-KA Environmental Cleanup program. Specifically, the Kwajalein Harbor (2013), Kwajalein Landfill (2017), and US Army Public Health Center Fish Studies (2016) have brought to light sources and releases of contaminants that have made their way into the marine environment. While the purpose of each of these studies was related to issues of release and cleanup, results of several of the studies have determined there are contaminant concentrations of concern in marine waters, sediments and organisms at some USAKA sites. Following the USAPHC fish study, it was determined that several lagoon “No Fishing” areas would be established to safeguard the Marshallese and US inhabitants of USAKA because contaminant concentrations in lagoon reef fish are at levels where they may adversely affect public health, the marine environment, and protected beneficial uses of surface water (e.g., fishing). The implications to marine organisms, including sea turtles, are that they also could be affected, particularly by ingestion of fish, algae, and other food sources within the waters at Kwajalein Atoll.”

Table 3-12 Concentrations of Beryllium and Uranium in Soil at Illeginni Islet

Concentration	*Beryllium (µg/g)*	*Uranium (µg/g)*
Low	0.07	3.3
High	6.7	149.7
Mean	2.1	22
Standard Deviation	2.3	35
Standard Error	0.58	8.8

Source: Robison et al., 2013
µg/g = Micrograms per gram

The observed soil concentrations of Be and uranium (U) (as a surrogate for DU) on Illeginni Islet are within compliance with USEPA Region 9 Preliminary Remediation Goals as outlined in the UES. The USEPA and UES guidance for Be in residential soils is 160 micrograms per gram (µg/g). For U as a surrogate for DU, the

USEPA guidance of 230 µg/g and UES guidance of 47 µg/g (based on soluble uranium salts, not relevant to insoluble DU) for residential soils are used for comparison and compliance.

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

As for a land impact, the UES, KEEP, and HMMP specify procedures relative to hazardous materials and waste. Activity-specific Hazardous Materials Procedures would be submitted by the project or mission proponents to the Commander, USAG-KA for approval within 15 days of receipt of any hazardous material or before use, whichever comes first. Hazardous materials would be under the direct control of the user organization to ensure these materials are stored and used in accordance with UES requirements. Identified materials would be expected to be consumed in operational processes associated with the FE-1 flight test.

NASA conducted a thorough study of the seawater quality effects of missile components deposited in ocean waters (1998). NASA concluded that the release of hazardous materials from missiles into seawater would not be significant. The materials will be rapidly diluted and, except in the immediate vicinity of the debris, will not be found at concentrations that produce adverse effects. The payload materials are relatively insoluble and the depth of the Pacific Ocean at either of the proposed BOA impact sites is thousands of feet; where light does not penetrate; levels of oxygen that might interact with materials at the surface are too low for that to occur; and water temperature differences from the upper water layers hamper any mixing between them. Any area on the ocean bottom affected by the slow dissolution of the payload debris will be relatively small, due to the size of the payload debris pieces as compared relative to the volume of surrounding seawater. Therefore, water quality effects from the payload are expected to be minimal. As potential for toxic concentrations is expected to be small and the effects would be very localized, the potential for cumulative impacts is expected to be nil. There are no plans to monitor deep water impacts in the BOA benthic zones of 8,000 ft depth or greater, where no mixing with upper layers of water occurs.

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4 Environmental Consequences

This chapter presents an analysis of the potential direct and indirect effects of each alternative on the affected environment. The following discussion elaborates on the nature of the characteristics that might relate to resources. "Significantly," as used in NEPA, requires considerations of both context and intensity. Context means that the significance of an action must be analyzed in several contexts such as society as a whole (e.g., human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of a proposed action. For instance, in the case of a site-specific action, significance would usually depend on the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant (40 CFR part 1508.27). Intensity refers to the severity or extent of the potential environmental impact, which can be thought of in terms of the potential amount of the likely change. In general, the more sensitive the context, the less intense a potential impact needs to be in order to be considered significant. Likewise, the less sensitive the context, the more intense a potential impact would be expected to be significant.

4.1 Kauai Test Facility, Pacific Missile Range Facility

4.1.1 Air Quality

Effects on air quality are based on estimated direct and indirect emissions associated with the action alternatives. The ROI for assessing air quality impacts is the air basin surrounding PMRF.

Estimated emissions from a proposed federal action are typically compared with the relevant national and state standards to assess the potential for increases in pollutant concentrations.

> Air Quality Potential Impacts:
>
> - **No Action: No Change**
> - **Proposed Action: Minor, short-term Impacts; No Significant Impact**

4.1.1.1 Kauai Test Facility, Pacific Missile Range Facility - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to baseline air quality. Therefore, no impacts to air quality or air resources would occur with implementation of the No Action Alternative.

4.1.1.2 Kauai Test Facility, Pacific Missile Range Facility - Proposed Action

The Proposed Action would launch a developmental payload on a STARS booster missile with impact of the payload on Illeginni Islet at RTS, USAKA. Launches of the STARS have been analyzed in various environmental documents (USASDC, 1992; US Navy, 2008) and have been determined to not have a significant impact on air quality.

The Proposed Action would include one launch of a STARS booster with the developmental payload from KTF. The STARS booster has been previously launched at SNL/KTF, and it is anticipated that the launch of the FE-1 flight test at the same site would have a similar air quality impact as described for the No Action Alternative. The Proposed Action would be similar to previous ballistic missile tests from SNL/KTF, and the potential impacts on air quality would be similar to that described for previous STARS missile launches.

Table 4-1 lists major exhaust components from STARS missiles launched from PMRF. In the stratosphere (6.2 to 31 mi [10 to 50 km] above the Earth's surface), missile launch emissions could potentially affect global warming (the greenhouse gas effect) and contribute to depletion of the stratospheric ozone layer. Of the chemical species that form during launches, the most environmentally significant are hydrochloric acid, aluminum oxide, nitrogen, and carbon dioxide.

Table 4-1 Estimated Emissions from a STARS Missile Launch[1] at SNL/KTF

Emission	*Aluminum Oxide[2]*	*Carbon Monoxide*	*Carbon Dioxide[3]*	*Hydrogen*	*Water*	*Hydrochloric Acid[2]*	*Nitrogen Oxides[2]*	*Lead*	*Others*
Tons per launch	5.628	4.185	0.431	0.318	0.959	1.943	1.855	0.000	0.027

[1] Exhaust products are total for all three stages
[2] Ozone-depleting Substances
[3] Greenhouse Gas

General Conformity

Existing aircraft exercises and support would continue from the PMRF airfield under the No Action Alternative. Approximately 69% of Navy aircraft using the airfield are C-26 “Metroliner” aircraft and the UH-3H “S-61” helicopter. The estimated annual mobile source emission levels, including aerospace ground support activities and engine testing, are:

- 12.9 tons per year (TPY) for carbon monoxide
- 3.6 TPY for volatile organic compounds (VOC)
- 13.8 TPY for nitrogen dioxides
- 1.3 TPY for sulfur dioxide
- 0.8 TPY for particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10})

These emissions are calculated using an air emissions screening computer program developed by the Air Force to calculate air emissions for realignment of aircraft, personnel, and for facility construction (USAF, 2005). Aircraft operating data are derived from 2004 operations at the airfield (US Department of the Navy, Engineering Field Activity Chesapeake, 2006). These emissions are not further evaluated because they are not restricted by the current Title V permit held by PMRF, and because the General Conformity Rule applicability analysis, though a useful tool, is not required for Navy actions in Hawai`i.

Greenhouse Gases

In the stratosphere (6.2 to 31 mi above the Earth’s surface), missile launch emissions could potentially affect global warming (the greenhouse gas effect) and contribute to depletion of the stratospheric ozone layer. The worst case estimated total carbon dioxide emissions from launches into the troposphere for the Proposed Action would be less than 10 TPY (Table 4-1 for emissions per launch). However, because the STARS is relatively small and the launch is a short-term, discrete event, the time between launches of the Proposed Action and other launches scheduled from SNL/KTF would allow the dispersion of greenhouse gases and ozone depleting substances. Therefore, implementation of the FE-1 flight test would not result in significant impacts to air quality.

4.1.2 Water Resources at Kauai Test Facility, Pacific Missile Range Facility

Water Resources Potential Impacts:

- **No Action: No change**
- **Proposed Action: Minor, short-term impact; No Significant Impacts**

Effects on water quality are based on estimated direct and indirect impacts associated with the action alternatives. The ROI for assessing water resources impacts is the area surrounding PMRF.

4.1.2.1 Water Resources at Kauai Test Facility, Pacific Missile Range Facility - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to baseline water resources. Therefore, no significant impacts to water resources would occur with implementation of the No Action Alternative.

4.1.2.2 Water Resources at Kauai Test Facility, Pacific Missile Range Facility - Proposed Action

The Proposed Action is a single launch of a developmental payload on a STARS missile with impact at RTS, USAKA. Launches of the STARS have been analyzed in various environmental documents and have been determined to not have a significant impact on air quality.

Analysis of STARS launch-related impacts is covered in the STARS EIS (US Army Strategic Defense Command, 1992). The EIS evaluated the potential impacts of launch emissions, spills of toxic materials, and early flight termination. The analysis concluded that hydrogen chloride emissions would not significantly affect the chemical composition of surface or groundwater; that there would be no significant increase in aluminum oxide in surface waters due to launches; that sampling of surface waters in the vicinity of the launch site showed that hydrogen chloride, potentially deposited during past launches, has not affected surface water quality on PMRF or adjacent areas; and that contamination from spills of toxic materials would be highly unlikely.

Subsequent sampling and analysis, prior to and following a 26 February 1993 STARS target launch, showed little or no evidence that the launch produced any adverse impact on water, soil, or vegetation (USASSDC, 1993a). Based on the Calendar Year 2005 Annual Site Environmental Report for Tonopah Test Range and Kauai Test Facility (Sandia National Laboratories, 2006), there were no reportable releases at the SNL/KTF under EPCRA or CERCLA in 2005. In addition, there were no compliance issues with respect to any state or federal water pollution regulations in 2005. As reported in the Annual Site Environmental Report, a National Pollutant Discharge Elimination System (NPDES) permit is not required due to the lack of significant storm water runoff discharging into "Waters of the US," as defined in 40 CFR 122.

The results of soil sampling conducted in 1999, 2002, and 2007 are presented in the KTF Report (Sandia National Laboratories, 2008). The results show that most reported values are below the USEPA residential screening levels. Iron and thallium exceed the residential screening level however; they are below the industrial screening level. Arsenic exceeds the USEPA industrial screening level however; the State of Hawai'i has identified action levels based on bioavailable arsenic. As presented in the Hawai'i Department of Health Technical Report (Hawai'i Department of Health, 2006) background concentrations of arsenic in soil in Hawai'i may range up to 20 milligrams per kilogram (mg/kg) [20 parts per million (ppm)] or higher (up to 50 mg/kg (50 ppm) in some cases). In addition, much of the arsenic in pesticide-contaminated soil appears to be tightly bound to soil particles and not available for uptake in the human body. This portion of the arsenic is essentially nontoxic. These two factors led to a need for further guidance, particularly with respect to the use of bioaccessible arsenic data in human health risk assessments and in the development of risk-based, soil action levels.

The highest level found in the KTF report was 56 mg/kg (56 ppm). This would fall into the Hawai'i Department of Health Category 2 Soils (C-2): Bioaccessible Arsenic >19 mg/kg and <95 mg/kg. Long-term exposure to Category 2 (C-2) soils is not considered to pose a significant risk to workers provided that lawns and landscaping are maintained to minimize exposure and control fugitive dust.

Impacts on water resources have not been identified from these constituents at the levels found on PMRF. Sampling for perchlorate was conducted at PMRF in October and November 2006, and the results indicated perchlorate levels were within guidelines. Based on this previous analysis and sampling, the Proposed Action activities do not adversely affect water resources. Therefore, implementation of the Proposed Action would not result in significant impacts to water resources.

The launches of the STARS have been analyzed in various environmental documents (USASDC, 1992; US Navy, 2008) and have been determined to not have a significant impact on water resources.

Therefore, implementation of the Proposed Action would not result in significant impacts to water resources.

4.1.3 Biological Resources at SNL/KTF

Biological Resource Potential Impacts:

- **No Action: No Change**
- **Proposed Action: Short-term Impact; No Significant Impacts**

Potential impacts of construction, building modification, and missile launches on terrestrial biological resources within the PMRF ROI have been addressed in detail in the HSTT EIS/OEIS (US Navy, 2013), t EIS/OEIS (US Navy, 2008), Strategic Target System EIS (USASDC, 1992), the Restrictive Easement EIS (USASSDC, 1993b), the PMRF Enhanced Capability EIS (US Navy, 1998), and the THAAD Pacific Flight Tests EA, (USASDC, 1992; USASSDC, 1993a; US Navy, 1998; USASMDC, 2002). Based on these prior analyses, and the effects of current and past missile launch activities, the potential impacts of all alternatives of the Proposed Action on terrestrial biological resources would be expected to be minimal.

4.1.3.1 Biological Resources at SNL/KTF - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources. Therefore, no significant impacts to biological resources would occur with implementation of the No Action Alternative.

4.1.3.2 Biological Resources at SNL/KTF - Proposed Action

The study area for the analysis of effects to biological resources associated with the Proposed Action includes SNL/KTF for the greatest launch effects. Surrounding terrestrial and marine areas of PMRF may also be affected by hazardous chemicals, increased sound pressure levels, and increased human and vessel activity. In this section the potential for the Proposed Action to adversely impact the biological resources described in section 3.1.3 is analyzed.

Launches of the new booster configurations as part of the Proposed Action testing would be similar to launches of the STARS previously analyzed in the Strategic Target System EIS and the PMRF Enhanced Capability EIS (USASDC, 1992; US Navy, 1998). No new facilities would be required. The launch azimuth and flight termination system would be the same as that of the previously analyzed STARS boosters.

Existing radars and the ground hazard area would also be the same. As a result, impacts on biological resources would be similar to those previously analyzed and are expected to be minimal. Impacts on threatened and endangered species at PMRF are not expected to be different than for any other terrestrial wildlife species. Additionally, installation personnel would continue to manage habitats according to the Installation Natural Resources Management Plan (INRMP), which is designed to protect and benefit threatened and endangered species.

Vegetation at SNL/KTF

No ground clearing or construction is expected for the Proposed Action. The Launch would take place at a previously disturbed, previously used, and previously analyzed location. Vegetation near the launch pad could be impacted by the heat generated at launch, however, vegetation is typically cleared from areas adjacent to the launch site and duration of high temperature is extremely short (a few seconds). Plants also have the potential to be impacted by hydrogen chloride or aluminum oxide emissions at launch. However, analyses of the STARS system (USASDC, 1992) concluded that there is no evidence of any long-term adverse impact on vegetation from heat or chemical emission in two decades of launches on PMRF. Compliance with relevant Navy policies and procedures during these increased training events should continue to minimize the effects on vegetation, as well as limit the potential for introduction of invasive plant species. Equipment imported to the launch site at SNL/KTF from the mainland or other islands would be inspected prior to loading and upon arrival to reduce the risk of introduction or spread of invasive species.

No long term adverse impacts on vegetation are expected. No threatened or endangered plants have been observed on PMRF and critical habitat for the ohai and lau`ehu would not be affected by the action.

Terrestrial Wildlife at SNL/KTF

No ground clearing or construction is expected for the Proposed Action. Wildlife species such as birds may be impacted by elevated sound pressure levels from launch as well as hazardous chemicals, increased human activity, artificial lighting, and direct contact from debris. The launch site at KTF is in an area that has routine human activity, equipment operation, and launch activity.

Elevated Sound Pressure Levels. Impacts on wildlife species can vary from temporary behavioral effects to physical injury or even death. As analyzed for previous STARS launches at PMRF (US Navy, 2008), noise from launches and launch related activity may startle nearby wildlife, causing flushing behavior in birds, but this startle reaction would be of short duration. The brief noise peaks produced by missiles are comparable to levels produced by thunder at close range (120 decibels [dB] to 140 dB peak; US Navy, 2008). Disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause birds and other mobile wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound producing activities have ended. Monitoring of birds in areas similarly exposed to launch noise during the breeding season indicates that adults respond to launch noise by flying away from nests, but returning within 2 to 4 minutes (US Navy, 2008). Terrestrial species at PMRF are already habituated to high levels of noise associated with ongoing activities at this facility.

Hazardous Chemical Emissions. Results of monitoring conducted following a STARS launch from SNL/KTF at PMRF indicated little effect on wildlife due to the low-level, short-term hydrogen chloride air (exhaust) emissions (US Navy, 2008). The program included surveys of representative birds and mammals for both prelaunch and post-launch conditions. Birds flying through an exhaust plume may be exposed to concentrations of hydrogen chloride that could irritate eye and respiratory membranes, however, most birds would not come into contact with the exhaust plume, because of their flight away from the initial launch noise (US Navy, 2008). Deposition of aluminum oxide from missile exhaust onto skin, fur, or feathers of animals would not cause injury because it is inert and not absorbed into the skin (US Navy, 2008). Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions (US Navy, 1998; USASMDC, 2008).

In the unlikely event of an on-pad fire or early flight failure over land of this solid propellant missile, most or all of the fuel would likely burn up before being extinguished. Any remaining fuel would be collected and disposed of as hazardous waste. Soil contamination which could result from such an incident is expected to be localized, along with any impacts on vegetation or wildlife.

Artificial Lighting. Pre-launch activities at KTF include final vehicle and experiment assembly, preflight checks, and demonstration of system performance. None of these activities will take place at night and lights will not be turned on at night for any FE-1 activities during the period of concern for Newell's shearwaters. If program activities are required to occur at night (outside the Newell's shearwater period of concern), the US Navy will coordinate these activities through PMRF to comply with the Dark Skies policy and avoid disorienting Newell's shearwaters with artificial lights. The USFWS has concurred with this determination (Appendix A).

Direct Contact from Debris. No impacts on wildlife due to direct contact from debris are expected during normal flight operations. The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact at PMRF or along the flight corridor. In most cases, an errant missile would be moving at such a high-speed that resulting missile debris would strike the water further downrange (US Navy, 2008). If monk seals or sea turtles were observed in the launch safety zone, the launch would be delayed until the animals leave.

Marine Species at KTF

Marine wildlife species listed in Table 3-2, which include marine mammals and sea turtles, have the potential to be impacted by elevated sound pressure levels, hazardous chemicals, direct contact from debris, and disturbance from increase human or equipment operation. The offshore waters of PMRF is an area that has routine human activity, equipment operation, and launch activity.

Elevated Sound Pressure Levels. Impacts of elevated sound pressure levels on marine wildlife species can vary from temporary behavioral effects to physical injury or even death. As analyzed for previous STARS launches at PMRF (US Navy, 2008), noise from launches and launch related activity may startle nearby wildlife, but this startle reaction would be of short duration. The brief noise peaks produced by missiles are comparable to levels produced by thunder at close range (120 dB to 140 dB peak; US Navy, 2008). The offshore waters where marine wildlife reside would be subject to much lower sound pressure levels as sound pressures attenuate with distance from the launch site. Disturbance to wildlife from launches would be brief and is not expected to have any long-term impacts. Increased human and equipment activity, such as vehicles, helicopters, and landing craft, may cause mobile marine wildlife to temporarily leave the area. It is expected that these individuals would return to the area and to normal activity after the sound producing activities have ended. Standard operating procedures at PMRF incorporate procedures to avoid wildlife that are foraging or resting such as sea turtles, Hawaiian monk seals, or cetaceans. Marine species at PMRF are likely already habituated to high levels of noise associated with ongoing activities at this facility.

Hazardous Chemical Emissions. Within offshore waters, the potential ingestion of contaminants by fish and other marine species would be remote because of atmospheric dispersion of the emission cloud, the diluting effects of the ocean water, and the relatively small area of the Essential Fish Habitat (EFH) that would be affected (US Navy, 2008). Results of monitoring conducted following a STARS launch from KTF at PMRF indicated little effect on wildlife due to the low-level, short-term hydrogen chloride air (exhaust) emissions (US Navy, 2008). The program included surveys of representative birds and mammals for both prelaunch and post-launch conditions. Deposition of aluminum oxide from missile exhaust onto skin, fur, or feathers of animals would not cause injury because it is inert and not absorbed into the skin (US Navy, 2008). Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions (US Navy, 1998; USASMDC, 2004).

In the unlikely event of an early flight failure over offshore waters, scattered pieces of burning propellant could enter coastal water and potentially affect wildlife or EFH closer to shore. Concentrations of toxic materials would be highest in this shallow water and have a greater chance of being ingested by feeding animals (US Navy, 2008). However, the potential for a launch mishap is very low, and in most cases the errant missile would be moving at a rapid rate such that pieces of propellant and other toxic debris would strike the water further downrange. The debris would also be small and widely scattered, which would reduce the possibility of ingestion.

Direct Contact from Debris. No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations. According to analysis contained in the PMRF Enhanced Capability EIS (US Navy, 1998), debris from shore-based missile launch programs is not expected to produce any measurable impacts on offshore benthic (sea floor) resources (US Navy, 2008). The potential impact on EFH from launch activities would mainly be from boosters and missile debris to waters off the coast (US Navy, 2008) in the BOA.

The probability for a launch mishap is very low. However, an early flight termination or mishap would cause missile debris to impact along the flight corridor, potentially in offshore waters (US Navy, 2008). If humpback whales, monk seals, or sea turtles were observed in the offshore launch safety zone, the launch would be delayed (US Navy, 1998). Some fish near the surface could be injured or killed by larger pieces of debris. It is unlikely that the smaller pieces of sinking debris would have sufficient velocity to harm individual marine mammals or fish.

4.1.4 Airspace at SNL/KTF

The analysis of airspace management and use involves consideration of many factors including the types, locations, and frequency of aerial operations, the presence or absence of already designated (controlled) airspace, and the amount of air traffic using or transiting through a given area.

4.1.4.1 Airspace at SNL/KTF - No Action Alternative

Airspace Potential Impacts:

- **No Action: No Change**
- **Proposed Action: No Significant Impact**

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to airspace. Therefore, no significant impacts to airspace would occur with implementation of the No Action Alternative.

4.1.4.2 Airspace at SNL/KTF - Proposed Action (All Alternatives)

The Navy SSP **FE-1** flight test would be similar to previous ballistic missile tests, and the potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described for missile launches in previous environmental documentation (USASDC, 1992; US Navy, 2008) for PMRF and SNL/KTF.

The advanced planning and coordination with the FAA regarding: scheduling of special use airspace, and coordination of the proposed FE-1 flight test relative to en route airways and jet routes, would result in minimal impacts on airspace.

Therefore, implementation of the Proposed Action (All Alternatives) would not result in significant impacts to airspace.

4.1.5 Noise at SNL/KTF

Noise Potential Impacts:

- **No Action: No Change**
- **Proposed Action: No Significant Impact**

Analysis of potential noise impacts includes estimating likely noise levels from the Proposed Action and determining potential effects to sensitive receptor sites.

4.1.5.1 Noise at SNL/KTF - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to baseline noise levels. Therefore, no significant impacts due to the noise environment would occur with implementation of the No Action Alternative.

4.1.5.2 Noise at SNL/KTF - Proposed Action

The study area for the analysis of effects to noise resources associated with the Proposed Action includes KTF and PMRF.

The Proposed Action would include the launch of a STARS booster with the developmental payload from SNL/KTF. The STARS booster has been previously launched at SNL/KTF (USASDC, 1992; US Navy, 2008) , and noise levels would be the same as previous launches. Launching of the Proposed Action would produce similar noise levels to previous STARS launches at SNL/KTF.

Therefore, because five previous STARS analyses concluded with a FONSI, implementation of the FE-1 flight test also would not result in significant impacts to the noise environment.

4.1.6 Public Health and Safety at SNL/KTF

Public Health and Safety Potential Impacts:

- **No Action: No Change**
- **Proposed Action: No Significant Impact**

The safety and environmental health analysis contained in the respective sections addresses issues related to the health and well-being of military personnel and civilians living on or in the vicinity of SNL/KTF and PMRF. Additionally, this section addresses the environmental health and safety risks to children.

4.1.6.1 Public Health and Safety at SNL/KTF - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to public health and safety. Therefore, no significant impacts would occur with implementation of the No Action Alternative.

4.1.6.2 Public Health and Safety at SNL/KTF - Proposed Action (All Alternatives)

The study area for the analysis of effects to noise resources associated with the Proposed Action includes SNL/KTF and PMRF.

The FE-1 flight test would include the launch of a STARS booster with the payload from SNL/KTF. The STARS booster has been previously launched at SNL/KTF. The testing of the developmental payload at the same site would have a similar potential health and safety impact as described for the No Action Alternative. The proposed solid propellants would be similar to past launches and would follow the same health and safety procedures developed under existing plans.

Because the NEPA analyses (USASDC, 1992; US Navy, 2008) of the past STARS booster launches concluded with a FONSI and the conditions at SNL/KTF have not changed, implementation of the Proposed Action would not result in significant impacts to public health and safety.

4.1.7 Hazardous Materials and Wastes at SNL/KTF

Hazardous Material and Waste Potential Impacts:

- **No Action: No Change**
- **Proposed Action: No Significant Impact**

The hazardous materials and wastes analysis contained in the respective sections addresses issues related to the use and management of hazardous materials and wastes as well as the presence and management of specific cleanup sites at KTF.

4.1.7.1 Hazardous Materials and Wastes at SNL/KTF - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change associated with hazardous materials and wastes. Therefore, no significant impacts would occur with implementation of the No Action Alternative.

4.1.7.2 Hazardous Materials and Wastes at SNL/KTF - Proposed Action (All Alternatives)

The study area for the analysis of effects to hazardous materials and wastes associated with the Proposed Action includes SNL/KTF and PMRF.

The flight test would include the STARS booster with the developmental payload launched from KTF. The STARS booster has been previously launched at SNL/KTF, and hazardous materials and wastes would be the same for these launches. The launch of the Proposed Action would be anticipated to use similar hazardous materials and produce similar hazardous waste. This launch is included in the overall number of missile launches proposed in the HRC EIS/OEIS. Hazardous material usage and waste generation would continue to be managed by PMRF under appropriate State and Federal requirements. Because the NEPA analyses (USASDC, 1992; US Navy, 2008), of the past STARS booster launches concluded with a FONSI and the conditions at SNL/KTF have not changed, implementation of the Proposed Action would not result in significant impacts with hazardous materials and wastes.

In accordance with EO 13045, *Protection of Children from Environmental Health and Safety Risks*, the Navy has determined that, since the majority of the FE-1 flight test would be conducted on DoD property and out in the open ocean, the FE-1 flight test has no environmental health and safety risks that may disproportionately affect children.

4.2 Over-Ocean Flight Corridor

4.2.1 Air Quality, Global Atmosphere, and Climate Change in the Over-Ocean Flight Corridor

Air Quality Potential Impacts:

- **No Action: No Change**
- **Proposed Action: No Significant Impact**

Effects on air quality are based on estimated direct and indirect emissions associated with the action alternatives. The ROI for the over-ocean flight corridor is the global upper atmosphere over the Pacific BOA along the flight path from outside the launch area at SNL/KTF to outside the impact area at RTS. During flight, the emissions within the over-ocean flight corridor from the FE-1 flight test have the potential to affect air quality in the global upper atmosphere.

Estimated emissions from a proposed federal action are typically compared with the relevant national and state standards to assess the potential for increases in pollutant concentrations.

4.2.1.1 Air Quality, Global Atmosphere, and Climate Change in the Over-Ocean Flight Corridor - No Action Alternative

Under the No Action Alternative, the FE-1 flight test would not occur and there would be no change to baseline air quality. Therefore, no significant impacts to air quality or air resources would occur with implementation of the No Action Alternative.

4.2.1.2 Air Quality, Greenhouse Gases, and Climate Change in the Over-Ocean Flight Corridor - Proposed Action (All Alternatives)

Air Quality

For all alternatives, the FE-1 vehicle would launch from SNL/KTF and travel along a pre-determined flight corridor over the Pacific BOA before payload descent for impact at RTS.

The FE-1 vehicle would launch from SNL/KTF to RTS with rocket emissions occurring in the over-ocean flight corridor as propellant is burned until exhausted from the rocket motor boosters. The active flight time over the ROI would be measured in minutes. Exhaust emissions would contain both chlorine compounds and free chlorine, produced primarily as hydrogen chloride (HCl) at the nozzle.

Approximately 5.6 tons of Al_2O_3 and 1.9 tons of NO_x (Table 3-7) are released over a period of minutes. The aluminum oxide is emitted as solid particles and can activate chlorine in the atmosphere. Chlorine and HCl would have a tropospheric lifetime long enough to eventually mix with the stratosphere. Both Al_2O_3 and NOx are of concern with respect to stratospheric ozone depletion. NO_x contributes to catalytic gas phase ozone depletion and the exact magnitude of ozone depletion that can result from a buildup of Al_2O_3 over time has not yet been determined quantitatively. However, following the FE-1 flight test, the majority of Al_2O_3would be removed from the stratosphere through dry deposition and precipitation.

The production of NO_x species from solid rocket motors is dominated by high-temperature "afterburning" reactions in the exhaust plume. As the temperature of the exhaust decreases with increasing altitude, less NO_x is formed. On a global scale, the quantity of NO_x emissions from a single STARS vehicle would represent a very small fraction of NO_X species generated. Additionally, diffusion and winds would disperse the NO_x species. No significant effect on ozone levels from NO_x is expected (US Department of the Air Force, 2010).

Emissions of HCl and Al_2O_3 from a single launches of a STARS booster (Table 3-7) would be substantially less than those that were released by a single Space Shuttle launch, and on a global scale the level of emissions would not be statistically significant. Because the emissions of HCl, Al_2O_3, and NO_X from a launch of a STARS booster would be relatively small compared to emissions released on a global scale, the large air volume over which these emissions are spread, and the rapid dispersion of the emissions by stratospheric winds, a single launch of a STARS booster should not have a significant impact on stratospheric ozone. Therefore, impacts from single launch of a STARS vehicle for the FE-1 flight test would not be expected to have a significant impact on the upper atmosphere.

STARS rocket motor emissions from the FE-1 flight test would not have a significant impact on stratospheric ozone depletion. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that even incremental effects on the global atmosphere are not likely.

Impacts of the FE-1 flight test launch on global warming, climate change, and ozone depletion in the atmosphere have also been considered as part of cumulative impacts in Section 4.18.

Greenhouse Gases and Climate Change within Over-Ocean Flight Corridor

CO_2 is the only GHG identified in the Kyoto Protocol or the Hawai'i rule that would be emitted during the FE-1 flight test. Because of the solid propellant used, the launch would release only 0.4 ton of CO_2. This does not include a small number of support ocean vessels, aircraft, and other equipment that would be used along the flight path, at RTS, and around USAKA to support the terminal phase preparations and operations, which would be limited and temporary. The availability of GHG emission factors for vessels and some aircraft is limited. Therefore, GHG emissions from those sources were not quantified in this analysis. The amount of emissions that would be released, however, is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time associated with conducting the FE-1 flight test activities. This limited amount of emissions would not likely contribute to global warming or climate change to any discernible extent.

Therefore, implementation of the FE-1 flight test would not result in significant impacts to greenhouse gases and climate change in the over-ocean flight corridor.

4.2.2 Biological Resources in the Over-Ocean Flight Corridor

Potential impacts of the Action on biological resources in the over-ocean flight corridor are evaluated in this section. The over-ocean flight corridor is in the Pacific BOA between Kauai, Hawai'i and Kwajalein Atoll.

Biological Resource Potential Impacts:

- **No Action: No Change**
- **Proposed Action: No Significant Impact**

4.2.2.1 Biological Resources in the Over-Ocean Flight Corridor - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources. Therefore, no significant impacts to biological resources would occur with implementation of the No Action Alternative.

4.2.2.2 Biological Resources in the Over-Ocean Flight Corridor - Proposed Action

The Proposed Action is evaluated for the potential impacts on marine biological resources in the BOA of the ROI. Potential impacts of the Action in this area include elevated sound pressure levels, direct contact from missile debris, exposure to hazardous chemicals, and increased human and vessel activity. The potential for the Proposed Action to adversely impact biological resources including those special-status species described in section 3.2.2 (Table 3-8) is evaluated in this section. In depth analyses of effects on consultation species have been completed in the FE-1 BA (US Navy and USASMDC, 2017) and have been reviewed by NMFS in a Biological Opinion (NMFS, 2017b; Appendix E). Impacts on threatened and endangered species are not expected to be different than those on non-listed species.

Within the over-ocean flight corridor, the FE-1 flight test flight is not expected to have a discernible or measurable impact on benthic or planktonic organisms because of their abundance, their wide distribution, and the protective influence of the mass of the ocean around them. The potential exists, however, for impacts to larger vertebrates in the open ocean area, particularly those that must come to the surface to breathe (e.g., marine mammals and sea turtles). Potential stressors to such species could occur from exposure to elevated noise (sonic booms), direct contact from falling booster stages and other vehicle components, and exposure to propellants or other contaminants released into the water.

Because of the potential for ESA-listed and other protected marine species to be affected in the open ocean area, the US Navy initiated consultations with NMFS (Pacific Islands Regional Office) in Honolulu, Hawai'i.

4.2.2.2.1 Exposure to Elevated Sound Levels

The Proposed Action has the potential to result in elevated sound pressure levels both in-air and underwater in the BOA. The primary elements of the Proposed Action that would result in elevated sound pressure levels in the BOA are: 1) sonic booms and 2) splashdown of vehicle components.

Sound creates vibrations that travel through air or water. Sound vibrations are characterized by their frequency (generally expressed in Hertz [Hz]) and amplitude or loudness which is quantified here using the logarithmic dB. In water, sound pressure levels (SPL) are typically referenced to a baseline of 1 µPa whereas in-air pressures are typically referenced to 20 µPa. In-air pressure measurements are converted to in-water estimates. Unless noted, all in-water sound pressure levels in the following analyses all dB levels presented below assume dB re 1µPa. For many organisms it can be useful to distinguish between peak exposure levels (dBpeak) and total exposure over time (sound exposure level [SEL]). For some organisms, effects are compared to thresholds based on the root mean square (RMS) sound pressure level which is the quadratic mean sound pressure over the duration of the sound.

Sonic Booms The launch vehicle would fly at speeds sufficient to generate sonic booms from close to launch at PMRF and extending to impact at or near Kwajalein Atoll. Sonic booms create elevated pressure levels both in-air and underwater. The sonic boom generated by the FE-1 test flight has been estimated and is detailed in the FE-1 BA (US Navy and USASMDC, 2017). Numerous assumptions were made for sonic boom calculations and all assumptions were made to err on the side of conservatism, yielding calculated values larger than what will likely occur during the test flight. Table 4-2 shows peak sonic boom sound pressure levels at various stages during the trajectory.

The sonic boom will propagate up-range from the launch site and extend downrange along the entire flight path. The FE-1 sonic boom overpressures in the water at the ocean surface were estimated to be near their maximum level (~145 dB) near the launch site and would only be at this level for a short downrange distance and extending out from the flight path less than 28 km (15 nm). The maximum SPL of the sonic boom over the BOA is 135 dB and the average 130 dB footprint extends out from the flight path no more than 55km (30 nm). The duration of these overpressures is expected to average 270 milliseconds (ms) where SPLs are less than 140 dB, and the overpressure (sound levels) would dissipate with increasing distance and ocean depth.

Table 4-2 Estimated Sonic Boom Peak Sound Pressure Levels in Water for FE-1 Trajectory

Reference	*Intensity (dB re 1 μPa)*	*Location in ROI*
Boost (Maximum)	145	SNL/KTF
Flight (Maximum)	135	BOA
Flight (Average)	130	BOA
Terminal (Maximum)	175	Kwajalein Atoll

Source: Kahle and Bhandari, 2016

For the entire FE-1 flight path, affected areas for sonic boom were calculated at various acoustic intensities (dB re 1 μPa (FE-1 BA, US Navy and USASMDC, 2017). Approximately 1 km^2 (0.4 mi^2) of ocean surface would be exposed to SPLs up to 170 dB, 54 km^2 (21 mi^2) to SPLs up to 160 dB, and 338 km^2 (131 mi^2) to SPLs up to 150 dB. Assuming an "N-Wave" sonic boom, a wide range for frequencies at various pressure levels are expected (see FE-1 BA, US Navy and USASMDC, 2017). As stated above, the model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservatively high estimates of affect area.

Splashdown of Spent Rocket Motors and other Vehicle Components. Elevated sound pressure levels would occur in the ocean as spent rocket motors impact the ocean's surface. Three spent rocket motor drop zones for these components are identified in the BOA of the ROI between 130 and 2,778 km (70 and 1,500 nm) from the launch pad (Figure 2-4). The nose fairing covering the payload is expected to be ejected and to fall into the third stage spent motor drop zone approximately 270 nm from the third stage impact.

Estimates of splashdown forces and associated sound pressure levels for FE-1 spent motors and the nose fairing have been estimated based on the size, shape, weight, trajectory, and impact velocity of the components, are discussed in detail in the FE-1 BA (US Navy and USASMDC, 2017), and are summarized in Table 4-3. Calculations for these estimates were made with numerous assumptions because there are no data available. All assumptions were made to err on the side of conservatism, yielding values larger than what would actually occur. All estimates are presented as in-water (at the surface) SPLs in dB re 1 μPa. The frequency of stage impacts is estimated to range from 100 Hz to 4 kHz (detailed in the FE-1 BA).

The effects of elevated sound levels due to splashdown of spent vehicle components is only expected to occur in the BOA of the action area. While there are no calculated estimates of duration for elevated SPLs associated with vehicle component splashdown, these elevated sound pressure levels are not expected to last more than a few seconds. Using the spherical spreading model for deep ocean waters, the range to threshold and affect area were calculated for the biologically relevant thresholds for special status species in the FE-1 BA (US Navy and USASMDC, 2017).

Effect Thresholds for Wildlife Species

Noise from sonic booms, splashdown of vehicle components could impact the behavior and hearing sensitivity in cetaceans, sea turtles, and fish in the ROI. Loud sounds might cause these organisms to quickly react, altering their normal behavior either briefly or more long term or may even cause physical injury. The extent of the effect depends of the frequency and intensity of the sound as well as on the

Table 4-3 Estimated Stage Impact Contact Areas and Peak Sound Pressure Levels for FE-1 Vehicle Components

Stage	*Contact Area* m^2 (ft^2)	*Peak Sound Pressure Level (dB re 1 µPa)*
Stage 1 Spent Motor	27.73 (81.12)	218
Stage 2 Spent Motor	10.17 (33.38)	205
Stage 3 Spent Motor	5.94 (19.5)	201
Nose Fairing	16.81 (55.14)	196

Source: FE-1 BA (US Navy and USASMDC, 2017)

Table 4-4 Marine Mammal Species Groups for Assessing the Effects of Elevated Sound Pressure Levels

Group	*Common Name*	*Scientific Name*
Low-frequency Cetaceans	Minke whale	*Balaenoptera acutorostrata*
	Sei whale	*B. borealis*
	Bryde's whale	*B. edeni*
	Blue whale	*B. musculus*
	Fin whale	*B. physalus*
	Humpback whale	*Megaptera novaeangliae*
Mid-frequency Cetaceans	Short-beaked common dolphin	*Delphinus delphis*
	Pygmy killer whale	*Feresa attenuata*
	Short-finned pilot whale	*Globicephala macrorhynchus*
	Risso's dolphin	*Grampus griseus*
	Longman's beaked whale	*Indopacetus pacificus*
	Fraser's dolphin	*Lagenodelphis hosei*
	Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
	Blainville's beaked whale	*Mesoplodon densirostris*
	Killer whale	*Orcinus orca*
	Melon-headed whale	*Peponocephala electra*
	Sperm whale	*Physeter macrocephalus*
	False killer whale	*Pseudorca crassidens*
	Pantropical spotted dolphin	*Stenella attenuata*
	Striped dolphin	*S. coeruleoalba*
	Spinner dolphin	*S. longirostris*
	Rough-toothed dolphin	*Steno bredanensis*
	Bottlenose dolphin	*Tursiops truncatus*
	Cuvier's beaked whale	*Ziphius cavirostris*
High-frequency Cetaceans	Pygmy sperm whale	*Kogia breviceps*
	Dwarf sperm whale	*K. sima*
Phocids	Hawaiian monk seal	*Neomonachus schauinslandi*

Source: NOAA 2016

hearing ability of the organism. In general, a SPL that is sufficient to cause physical injury to auditory receptors is a sound that exceeds an organism's permanent threshold shift (PTS) level. Depending on the species, higher SPLs may induce other physical injury or, in extreme cases, even death. The extent of physical injury depends on the SPL as well as the anatomy of each species. A temporary threshold shift

(TTS) is when an organism is exposed to sound pressures below the threshold of physical injury but may result in temporary hearing alteration. Another common effect of elevated sound pressure levels is behavioral modification. Most observations of behavioral responses to anthropogenic sounds have been limited to short-term behavioral responses, which include disturbance to feeding, resting, or social interactions. Such responses as sudden diving, change in swim speed, and change in respiration rate can have an effect on foraging and can decrease the foraging efficiency of various species. A disruption in foraging, or a reaction that forces an animal to expend energy diving or fleeing, may also affect the animal's energy budget (energy income against expenditure), with the outcome of less energy available for important biological functions. Responses can also include changes in the type or timing of an animal's vocalizations and masking of sounds produced from the impacted individual or from other individuals of the same species in the area such that those near the sound source would not hear those calls. Marine mammals have been observed to decrease their vocalizations in response to noise (Aguilar de Soto 2006; IWC 2007), which can have further implications on breeding, feeding, and social interacting.

Interpreting the effects of noise on marine mammals, sea turtles, and fish depends on various parameters, including the sound exposure level and duration, the sound frequency, and the animals hearing ability. As discussed above, SPLs can be expressed in several ways including: (1) peak pressure levels expressed in either psi, or dB re 1 µPa, (2) the average or root-mean-square (RMS) level over the duration of the sound, also expressed in dB re 1 µPa, and (3) sound exposure level (SEL) where the sound pressure is squared and integrated over the duration of the signal and summed for multiple events to result in a cumulative SEL (SEL_{cum}). Because the expected underwater noise levels from sonic booms and component splashdown represent single pulses that are relatively low in acoustic strength and very short in duration (on the order of several seconds, peak pressure levels were used for analysis purposes when available.

Cetaceans. For assessing TTS and PTS effects on cetaceans in the Action Area, this analysis used the revised acoustic threshold criteria from NMFS "Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing" (NOAA, 2016). The current thresholds depend on the hearing ability of marine mammals where cetaceans are separated into low-frequency, mid-frequency, and high-frequency groups (Table 4-4). The revised thresholds (Table 4-5) use both peak sound pressure levels (SPL_{peak}) and accumulated sound exposure levels (SEL_{cum}; NOAA, 2016). Since the revised acoustic threshold criteria used by NMFS (NOAA, 2016) include only thresholds for PTS and TTS and no criteria for behavioral effects, we use the "Criteria and Thresholds for US Navy Acoustic and Explosive Effect Analysis" (Finneran and Jenkins, 2012). The current US Navy standard for analysis for single explosive events is not to use a behavioral disturbance threshold for marine mammals as any behavioral disturbance from this type of event is likely to be limited to a short-lived startle reaction (Finneran and Jenkins, 2012).

Phocids. For phocids, the current thresholds used by NMFS to evaluate the onset of PTS and TTS are ≥ 212 dB and ≥ 218 dB, respectively (NOAA, 2016; Table 5-3). As with other marine mammals, the US Navy does not use any unique behavioral disturbance thresholds for exposure to single explosive events because any behavioral disturbance is likely to be limited to a short-lived startle reaction.

Birds. Hearing range and sensitivity has been determined from many land birds; however, seabird hearing remains largely unknown (US Navy, 2015a). Studies of terrestrial and marine bird hearing have shown greatest hearing sensitivity for these species between 1 and 4 kHz with minimum detectable frequency around 20 Hz and maximum hearing limit of 15 kHz (US Navy, 2015a). While most seabirds

Table 4-5 Acoustic Thresholds for PTS, TTS, and Behavioral Disruption from Single Exposure to Impulsive In-Water Sounds in Marine Mammals (Peak SPL Thresholds in dB re 1 µPa)

Group	*PTS threshold (dB SPL_{peak})*	*TTS Threshold (dB SPL_{peak})*	*Behavioral Disruption[1]*
Low-frequency Cetaceans	219	213	NA
Mid-frequency Cetaceans	230	224	NA
High-frequency Cetaceans	202	196	NA
Phocids	218	212	NA

[1] For single explosive events, behavioral disturbance is likely to be limited to a short-lived startle reaction; therefore, the US Navy does not use any unique behavioral disturbance thresholds for marine mammals exposed to single explosive-like events.

found in the ROI feed by diving, skimming, or grasping prey at the water's surface or within 1-2 m (3-6 ft) of the surface, there is little published literature on the hearing abilities of seabirds underwater (US Navy, 2015a). A bird's response to noise depends on many factors including life-history characteristics of the species, frequency and amplitude of the noise source, distance from the noise source, presence of visual stimuli, and previous exposure to similar sounds (US Navy, 2015a).

If a seabird were exposed to elevated sound pressure levels, it could suffer auditory fatigue (hearing sensitivity over a portion of hearing range) or behavioral disruption (US Navy, 2015a). As with marine organisms, auditory threshold shifts may be either permanent (PTS) or temporary (TTS). Unlike most other species, birds have the ability to regenerate hair cells in the inner ear which allows them to recover from auditory injury better than other species, usually within several weeks (US Navy, 2015a). Some very intense sounds may result in permanent hearing damage in birds. Few studies have examined hearing loss in seabirds; however, the Navy's current standard of analysis uses a PTS threshold of 110 A-weighted decibels (dBA) re 20 µPa for continuous sounds and 140 dB re 20 µPa for blast noise (US Navy, 2015a).

Behavioral response to elevated sound pressure levels in birds include behaviors such as alert behavior, startle response, avoidance behavior, and increased vocalizations (US Navy, 2015a). In some cases, where noises induce behavioral response repeatedly over time, effects to birds may include chronic stress which may compromise the overall heath and reproductive success (US Navy, 2015a). The reported behavioral and physiological response of birds to elevated sounds as in the Proposed Action can fall within the range of normal adaptive responses to stressors such as predation which birds experience on a daily basis (US Navy, 2015a). There is also some evidence that certain birds may become habituated to noises after frequent exposure and cease to respond behaviorally (US Navy, 2015a). While birds may experience behavioral and physiological responses to sounds, for short duration and unrepeated sounds, birds may return to normal almost immediately after exposure and no long term affects are expected. Conservative estimates of sound effects on birds have been presented by the California Department of Transportation (Dooling and Popper, 2007). These estimates based on dBA (A-weighted for human hearing) do not provide accurate estimates of the noise level in the frequency range where birds hear and communicate; however, they can provide an overestimate of effects and therefore very conservative (if unrealistic) thresholds of effect (Dooling and Popper, 2007). A 93 dBA threshold for physiological or behavioral disruption from continuous noise sources has been suggested as a very conservative estimate of effects in birds (Dooling and Popper, 2007). While no data supported thresholds are known for impulsive sounds, the threshold for continuous noise can be used as a very conservative threshold of effects.

Sea Turtles. For sea turtles, we use the criteria and acoustic threshold standards which have been used by the US Navy for explosive sources (Finneran and Jenkins, 2012). These criteria and acoustic thresholds for sea turtles are similar to those proposed for marine mammals and all sea turtles are placed into a single functional hearing group (Finneran and Jenkins, 2012). Sea turtles have a functional hearing range of approximately 100 Hz to 1 kHz with and upper frequency limit of 2 kHz (Finneran and Jenkins, 2012). Physiological effects of elevated sound pressure levels from explosive sources can include not only auditory effects (PTS and TTS) but also mortality and direct (non-auditory) tissue damage known as primary blast injury (Finneran and Jenkins, 2012). In sea turtles, the lungs and auditory system are considered the most likely site of primary blast injury; however the US Navy applies a conservative approach of using the GI tract injury threshold for marine mammals for sea turtles also (Finneran and Jenkins, 2012). Therefore, the threshold for mortality and primary (non-auditory) blast injury for sea turtles is an (unweighted) SPL of 237 dB re 1 µPa (Finneran and Jenkins 2012). Since no data exist to better estimate the auditory effects of explosive sound sources, the US Navy applies the thresholds for TTS and PTS of low-frequency cetaceans to sea turtles as well (Finneran and Jenkins 2012). Therefore, the TTS threshold for sea turtles is a peak SPL of 224 dB re 1 µPa and the PTS threshold is a peak SPL of 230 dB re 1 µPa (Finneran and Jenkins, 2012). As with marine mammals, the behavioral effects of a single explosive event on sea turtles are likely to be limited to a short lived-startle reactions. Even though this is a single event, the US Navy's sea turtle behavioral disturbance threshold after exposure to multiple, successive underwater impulses might be used for a conservative estimate of behavioral effects on sea turtles: SEL (weighted) of 160 dB re 1 µPa2s (Finneran and Jenkins, 2012). This threshold is based on studies that indicate that behavioral disturbance may occur with SPLs of 175 to 179 dB re 1 µPa (which correspond to SELs of 163.6 to 160.4 dB re 1 µPa2s (Finneran and Jenkins, 2012).

Fish. While little is known about the specific hearing capabilities of the most species, most fish are able to detect a wide range of sounds from below 50 Hz up to 500-1500 Hz (Popper and Hastings 2009). While fish would likely be able to detect sounds like a sonic boom, their response to this sound disturbance is unclear. Potential responses to sound disturbance in fish include temporary behavioral changes, stress, hearing loss (temporary or permanent), tissue damage (such as damage to the swim bladder), or mortality (Popper and Hastings 2009).

The effects of elevated sound levels on fish are evaluated using the current conventional threshold levels by the US Navy for assessing the effects of explosives on fish based on NMFS 2015a and Popper et al. 2014. The mortality/mortal injury threshold, peak SPL of 229 dB re 1 µPa, is based on a literature review by Popper et al. (2014). It is important to note that this mortality threshold is based on the distance from the sound source that would be expected to result in only 1% fish mortality. The Northwest Training and Testing Biological Opinion (NMFS, 2015a) does not provide a set threshold for sub-lethal injury effects on fish. The onset of physical injury (non-lethal) is modeled based on the representative weight of the fish species (and age class, if data are available; NMFS, 2015a). Since the authors did not provide these calculations for PTS and other references are not available, we use the TTS threshold as an extremely conservative estimate of the extent of both temporary and permanent non-lethal damage. The threshold criteria for eliciting TTS in fish is 186 dB SEL_{cum} (NMFS, 2015a). The threshold for TTS in fish without a swim bladder and for fish with a swim bladder that is not involved in hearing is likely higher than this value (US Navy, 2015b); however, we use 186 dB SEL_{cum} as a conservative threshold for all fish species. While there are little known data supporting a general threshold for behavioral disturbance in fish and the effects from a single impulsive event are likely to be very fleeting, 150 dBRMS has been used in past analyses and is used here.

Corals and Mollusks. Corals and mollusks can perceive sounds (Fritzsch et al. 2007; Mooney et al. 2010; Vermeij et al. 2010), but much less than other invertebrates more specialized to produce and sense sounds (e.g., crabs and shrimp) (Patek and Caldwell 2005; Waikiki Aquarium and University of Hawai`i-Manoa 2009). Thresholds for damage to auditory sensors are unknown for corals and mollusks. Exposure to intense sound can cause behavioral reactions in some animals, which may include cessation of resting, feeding, social interactions, predator avoidance, and physiological changes to respiration or metabolism. Repeated exposures may cause behavioral acclimation, and chronic exposure to elevated sound levels is likely to impact individuals or populations for other taxa (Vermeij et al. 2010). Acute and temporary acoustic exposures such as those associated with FE-1 flight test impacts are likely to have only temporary consequences, if any, for some of the more specialized invertebrates. These impacts could include temporary disruption of feeding or predator avoidance behaviors (Mooney et al. 2010), but such consequences are likely to be irrelevant for corals and mollusks.

Estimation of Elevated Sound Level Impacts

Elevated sound pressure levels from sonic booms are not expected to impact marine wildlife in the BOA as maximum SPLs for sonic booms in the BOA (145 dB re 1 µPa) do not exceed the PTS, TTS, or behavioral thresholds for cetaceans, pinnipeds, phocids, sea turtles, or fish.

The probability of animals being impacted by elevated sound levels from splashdown of vehicle components in the BOA was calculated for special-status cetacean, phocid, and sea turtle species in the Navy SSP FE-1 BA (US Navy and USASMDC, 2017). Elevated SPLs resulting from vehicle component splashdown exceed PTS for only 3 marine mammal species (pygmy sperm whale, dwarf sperm whale, and Hawaiian monk seal) and exceed TTS for only those 3 species and 6 other cetacean species (minke whale, sei whale, Bryde's whale, blue whale, fin whale, and humpback whale). Based on densities of these marine mammals in the action area, the chance of exposures to SPLs exceeding PTS was between 1 in 1.07×10^6 and 2.62×10^6. The chance of exposure to SPLs exceeding TTS was between 1 in 261,327 and 1 in 2.0×10^9. Based on these exceedingly low probabilities, elevated SPLs from FE-1 vehicle component splashdown is not expected to impact marine mammals in the BOA.

For sea turtles, elevated SPLs resulting from vehicle component splashdown exceed only the behavioral disturbance threshold for these animals and do not exceed the TTS or PTS thresholds. Based on the best available density data for sea turtles, FE-1 BA analyses resulted in estimates for the chances of sea turtle exposure to SPLs exceeding the threshold for behavioral disturbance is 1 in 109. As with marine mammals, the model used for analysis assumed that the turtles did not move or exhibit avoidance behaviors to the approaching components. The estimates for the chances of elevated sound levels affecting individual sea turtles are likely overestimated in these analyses; however, these estimates do provide a conservative estimate of effects. Based on these analyses, elevated SPLs from FE-1 vehicle component splashdown is not expected to adversely impact sea turtles in the BOA.

While specific analyses were not conducted for fish due to lack of density data, elevated sound pressure levels are not likely to significantly impact fish in the BOA. Sound pressures have the potential to exceed the TTS threshold for fish up to 40 m (131 ft) from motor splashdowns and to exceed the behavioral disruption threshold out to 2.5 km (1.4 nm). While PTS threshold levels were not calculated, the TTS threshold was used as a very conservative estimate of physical injury potential. Some fish may be in these areas; however, these SPLS are not likely to adversely impact fish due to the very short in duration (less than 1 second) of the sound pressures and the low abundance and patchy distribution of fish in the BOA. Although loud sounds may cause fish species to quickly react, briefly altering their normal behavior, fish are expected to resume their normal activity within minutes and these sounds would not impact individuals long-term. Elevated SPLs are not expected to adversely impact EFH in the action area.

At certain times of the year the gametes and larvae of some reef-associated fish, coral, and mollusk species may occur as zooplankton within the boundaries of the stage-three drop zones. It is extremely unlikely that these shallow-water reef-associated larvae would occur in the BOA because they are so far up current from sources of larvae. Elevated sound levels are not expected to impact individual larval fish, corals, or mollusks.

For birds, sonic boom SPLs in the BOA do not exceed the PTS threshold. Birds may be exposed to SPLs high enough to elicit behavioral response from sonic booms in the BOA for brief periods (average duration of 270 ms). Sonic boom pressure may exceed 94 dB in-air at the water's surface over an area of 392,581 km^2 (151,576 mi^2) This is an estimate for the entire flight path (from launch at SNL/KTF to impact at Kwajalein Atoll) and due to assumptions made during sonic boom modeling, this is likely a conservative estimate which overestimates the affect area. In the BOA, seabirds are likely to have very low densities and patchy distributions. Some seabirds may be exposed to sonic boom SPLs great enough to elicit behavioral response; however, any response is likely to be very short in duration and limited to behaviors such as startle response. Bird behavior is expected to return to normal after a few minutes.

Elevated SPLs from vehicle component splashdown may exceed the PTS threshold for birds over a total area of 0.54 km^2 (0.21 mi^2) and the behavioral response threshold over 26,861 km^2 (10,371 mi^2). Reliable density data for seabirds in the BOA is not available; however surveys of seabirds in deep ocean areas suggest that seabird density is low and patchy as bird's density and distribution is likely determined by the distribution and abundance of their food supply. Consequently, elevated SPLs in the BOA are not likely to impact seabirds by physical injury. Some seabirds may be impacted by elevated SPLs causing temporary behavioral disruption; however, any behavioral disruption is expected to be limited to minor behavioral modification and bird behavior is expected to return to normal within minutes of exposure.

4.2.2.2.2 Direct Contact

The Proposed Action would result in spent rocket motors and nose fairings splashing down into the BOA. These falling components will directly impact marine habitats and have the potential to directly contact consultation organisms. The force of impact for these vehicle components contacting the ocean surface may result in shock waves radiating out from the point of impact. Shock-wave pressures are discussed in section 4.2.2.2.1 above. The first stage motor is 4.62 m (182 in) long with a diameter of 1.37 m (54 in) with an additional interstage section that is 87.12 cm (34.3 in) long with a diameter of 1.37 m (54 in). The second stage motor is 2.26 m (89 in) long with a diameter of 1.37 m (54 in) and the third stage motor is 1.32 m (52 in) long with a diameter of 1.37 m (54 in). Direct contact areas for these individual components are listed in Table 4-3 and total approximately 61 m^2 (189 ft^2).

If a spent rocket motor or other FE-1 component were to strike a cetacean, sea turtle, or fish near the water surface, the animal would most likely be killed or injured. Based on the above discussed affect areas, and the best available species density information, chances of direct contact to cetaceans and sea turtles in the BOA were calculated in the FE-1 BA (US Navy and USASMDC, 2017). Calculations were based on methodology in the Mariana Islands Training and Testing Activities Final EIS (Appendix G in US Navy 2015a) and the Hawai'i-Southern California Training and Testing EIS (Appendix G in US Navy 2013). Very little information regarding fish densities is available for deep ocean waters; therefore direct contact probability was not calculated for fish species. These analyses assumed that all animals would be at or near the surface 100% of the time and that the animals are stationary. While these assumptions did not account for animals that spend the majority of time underwater or for any animal movement or potential avoidance to proposed activities, these assumptions should have resulted in a conservative estimate of direct contact effect on species.

Based on analyses for marine mammals in the FE-1 BA (US Navy and USASMDC, 2017), the estimated number of animal exposures to direct contact from falling FE-1 components in the BOA is between 1 in 117,000 and 1 in 14,700,000 depending on individual species (Table 4-3). While we have included all possible species in these analyses, it is also important to note that many of these species are extremely unlikely to occur in the BOA or in the deep ocean waters of the Action Area (Table 3-8). Even when totaled across species, the estimated number of marine mammal exposures is only 1 in 20,200. The model does not account for animal movement or avoidance behaviors. Since cetaceans are highly mobile, they may be able to detect and avoid approaching vehicle components to some extent. The exposure estimates were modeled based on conservative assumptions and likely results in an overestimation of probability of effect. For all cetacean species, the chances of animals being physically injured from direct contact from splashdown of vehicle components is considered discountable based on these analyses.

Based on the best available density data for sea turtles, the estimated number of animal exposure to direct contact from falling FE-1 vehicle components in the BOA is 1 in 748,000. As with cetaceans, it is important to note some of the drawbacks of this model that may lead to overestimation of effect. The model is based on the best available density data. Since many density studies of turtles are conducted in nearshore areas, density estimates in deep ocean areas are largely unknown. The model also assumes that the turtles do not move or exhibit avoidance behaviors to the approaching components. Based on these analyses, FE-1 components are not expected to adversely impact sea turtles in the BOA.

Due to density data deficiencies, the number of direct contact exposures for fish was not able to be estimated. The abundance of these organisms in the BOA is expected to be low and their distributions patchy. These are also highly mobile organisms which may be able to detect and avoid falling vehicle components. For these reasons, direct contact from spent rocket motors or other FE-1 vehicle components is not likely to impact fish or EFH in the BOA.

Direct contact from splashdown of rocket components may impact individual larval fish, corals, and mollusks but the effects are considered insignificant. The Proposed Action may injure or kill a small but undeterminable number of fish, coral, and mollusk larvae. However, the impact on larval fish, coral, and mollusks are expected to be extremely small in relation to their total numbers, their distribution, and their life history.

While seabird density data are not available to allow reliable calculation of direct contact effects, the low density and patchy distribution of seabirds make it unlikely that birds would be impacted by direct contact from FE-1 component splashdown in the BOA.

4.2.2.2.3 Exposure to Hazardous Chemicals

The Proposed Action has the potential to introduce hazardous chemicals into the ROI. Splash-down of launch vehicle components has the potential to introduce propellants, hydraulic fluids, battery acids, explosives, and heavy metals into the marine environment of the BOA.

Any substances of which the launch vehicle is constructed or that are contained on the launch vehicle and are not consumed during FE-1 flight or spent motor jettison will fall into the BOA when first , second-, and third-stage launch vehicle motors and nose fairing are released (Tables 2-1 and 2-2) . The launch vehicle includes rocket motors, solid rocket propellant, magnesium-thorium in the booster interstage, asbestos in the second stage, battery electrolytes (lithium-ion and silver-zinc), radio frequency transmitters, and small electro-explosive devices. Though the batteries carried onboard the rocket motors would be discharged by the time they splash down in the ocean, they would still contain small quantities of electrolyte material. These materials, along with residual amounts of propellant, asbestos, and heavy metals contained in the first- and third-stage motors or nose fairing, may contaminate seawater. The release of such contaminants could harm a cetacean or sea turtle that comes in contact with, or ingests, toxic levels of these solutions.

In an evaluation of the effects of rocket systems that are deposited in seawater, the National Aeronautics and Space Administration concluded that the release of hazardous materials carried onboard launch vehicles would not significantly impact marine life. Materials would be rapidly diluted in the seawater and, except for the immediate vicinity of the debris, would not be found at concentrations that produce adverse effects (US Navy 1998).

Overall, larger and heavier vehicle components will sink fairly quickly to the ocean floor. Ocean floor depths in the BOA are so deep that consultation organisms will likely not be in contact with these materials. Any chemicals that do leak into the water column will be quickly diluted by ocean currents and the very large volume of ocean water.

Hazardous chemical release in the BOA is not expected to impact marine biological resources including EFH and seabirds due to the relatively small area affected by the dissolution of chemicals and the minimal amount of residual chemicals the spent boosters contain, components sinking to the ocean bottom where depths reach thousands of feet, the quick dilution and dispersion of any chemicals introduced to the water column, and the low density and patchy distribution of marine mammals, sea turtles, fish, and larval fish, corals and mollusks in the BOA.

4.2.2.2.4 Disturbance from Increased Human Activity and Vessels

The Proposed Action has the potential to increase ocean-going vessel traffic in the ROI. Pre-test activities would include vessel traffic to and from the BOA for onboard sensor placement. Three vessels with sensors are expected to enter the BOA where they would remain through the completion of the test. Since vessel traffic is common in this area and the increase in human activity and vessel traffic in the BOA is expected to be minimal, these activities are not expected to impact marine resources including threatened and endangered species or EFH.

4.3 USAKA, Kwajalein Atoll, Republic of the Marshall Islands

4.3.1 Cultural Resources at Illeginni Islet

Analysis of potential impacts to cultural resources considers both direct and indirect impacts. Direct impacts may be the result of physically altering, damaging, or destroying all or part of a resource, altering characteristics of the surrounding environment that contribute to the importance of the resource, introducing visual, atmospheric, or audible elements that are out of character for the period the resource represents (thereby altering the setting), or neglecting the resource to the extent that it deteriorates or is destroyed.

Cultural Resources Potential Impacts:

- **No Action: No Change**
- **Preferred Impact Location: No Significant Impact**
- **Alternative Impact Locations: No Impacts**

4.3.1.1 Cultural Resources at Illeginni Islet - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to cultural resources. There would be no site preparation or placement of radars or data collection equipment at Illeginni Islet or Gagan Islet. Therefore, no impacts to cultural resources would occur with implementation of the No Action Alternative.

4.3.1.2 Cultural Resources at Illeginni Islet - Proposed Action (All Impact Location Alternatives)

The ROI is the areas on Illeginni Islet where FE-1 flight test activities would occur; there are no identified cultural resources within the deep ocean locations. The preferred site for the developmental payload impact is on the west side of Illeginni Islet. Existing surface cover and site disturbance from construction of a helipad, roads, and facilities, and operations including previous missile flight tests with land impacts encompass almost the entirety of Illeginni Islet. Buildings and other facilities on Illeginni are primarily in the central and eastern portions of the islet.

Illeginni Islet (Preferred Impact Location)

For a land impact, the FE-1 flight test is proposed to occur on the west end of Illeginni Islet. Archaeological surveys have not found indigenous cultural materials or evidence of subsurface deposits on the Islet. The Cold War-era properties potentially eligible for listing on the RMI NRHP are located in the central and eastern portions of the Islet. Because a land impact would not occur in proximity to known or potential cultural resources on Illeginni Islet, implementation of the Proposed Action would not result in significant impacts to cultural resources. Personnel involved in the FE-1 flight test operational activities would be briefed on and would follow UES requirements in handling or avoiding any cultural resources uncovered during operational or monitoring activities.

Offshore Waters – Southwest and Northeast (Alternative Impact Locations)

There are no cultural resources associated with either the southwest or northeast BOA location, and, therefore, no impacts to cultural resources.

There would be no significant impact to cultural resources from the FE-1 flight test at any of the three proposed impact zones.

4.3.2 Biological Resources at Kwajalein Atoll

Potential impacts of the FE-1 flight test on biological resources at the terminal end of the flight at or near Kwajalein Atoll are evaluated in this section. The payload flight would terminate either at Illeginni Islet (preferred impact location) or at one of two deep-water offshore sites (alternative impact locations; southwest or northeast deep water impact zones) near Kwajalein Atoll.

Biological Resources Potential Impacts:

- **No Action: No Change**
- **Preferred Impact Location: No Significant Impact**
- **Alternative Impact Locations: No Significant Impacts**

4.3.2.1 Biological Resources at Kwajalein Atoll - No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to biological resources. Therefore, no impacts would occur to biological resources with implementation of the No Action Alternative.

4.3.2.2 Biological Resources at Kwajalein Atoll (Preferred Impact Location)

The Proposed Action is evaluated for the potential impacts on marine biological resources at Illeginni Islet. Potential impacts of the Action in this area include elevated sound pressure levels, direct contact from payload impact debris, exposure to hazardous chemicals, and increased human and vessel activity. The potential for the Proposed Action to adversely impact biological resources including those special-status species described in section 3.3.2 (Table 3-10 and Appendix B) is evaluated in this section. In depth analyses of effects on consultation species have been completed in the FE-1 BA (US Navy and USASMDC, 2017) and has been reviewed by NMFS in a Biological Opinion (NMFS, 2017b; Appendix E). Impacts on threatened and endangered species are not expected to be different than those on non-listed species.

4.3.2.2.1 Exposure to Elevated Sound Levels

The Proposed Action has the potential to result in elevated sound pressure levels both in-air and underwater. The primary elements of the Proposed Action that would result in elevated sound pressure levels in this area are sonic booms and impact of the developmental payload.

Discussion of potential effects of elevated sound pressure levels on wildlife species as well as on effect thresholds for these species is presented in section 4.2.2.2.1 above.

Sonic Booms

The developmental payload would fly at high-speeds sufficient to generate sonic booms from third stage separation in the BOA and extending to impact at or near Kwajalein Atoll. Sonic booms create elevated pressure levels both in-air and underwater. At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB near (Table 4-2). At the point of impact, the sonic boom footprint would narrow to about 46 km (25 nm) at this peak pressure. For payload impact at Illeginni Islet, elevated SPLs due to the sonic boom would be present in the air over land and would also be present in the surrounding waters. The duration for sonic boom overpressures produced by the payload are expected to average 75 ms where SPLs are greater than 140 dB and 270 ms where SPLs are less than 140 dB.

As detailed in the FE-1 BA (US Navy and USASMDC, 2017; approximately 1 km^2 (0.4 mi^2) of ocean surface would be exposed to SPLs up to 170 dB, 54 km^2 (21 mi^2) to SPLs up to 160 dB, and 338 km^2 (131 mi^2) to SPLs up to 150 dB. As discussed in section 4.2.2.2.1, model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area.

Impact of the Developmental Payload

Impact of the developmental payload at the terminal end of the flight would result in elevated in-air and/or underwater sound levels. Estimates for pressure from impact of vehicles using a similar amount of high explosives as those in the payload resulted in sound pressure levels in-air of 140 dB re 20 µPa at 18 m (59 ft). These levels were used as a bounding case for the current Proposed Action in the FE-1 BA (US Navy and USASMDC, 2017). Using the spherical spreading model, the SL is estimated to be 165 dB in-air and an estimated 191 dB in-water. For payload impact at Illeginni Islet, in-air pressure levels would remain above 140 dB up to 18 m (59 ft) from the impact site and above 93 dB up to 3,981 m (13,061 ft) away. The impact may result in some in-water elevated sound pressure levels in the shallow waters surrounding Illeginni. Using the cylindrical spreading model for shallower waters and an in-water SL of

191 dB, sound pressure levels may be above 160 dB out to 117 m (384 ft) and above 150 dB out to 541 m (1,775 ft).

Estimation of Elevated Sound Level Impacts

Terrestrial Wildlife. A payload impact on Illeginni has the potential to impact nesting, roosting, and foraging bird species. If birds were exposed to elevated sound pressures above PTS threshold levels, physical injury or even death could result. Birds are able to recover from hearing damage better than many other species, and most physical injury would likely be temporary; however, very loud sounds may cause permanent damage. Elevated SPLs from sonic booms would exceed PTS threshold for birds near payload impact where sound pressure levels would be above 140 dB re 20 µPA over only about 0.2 km^2 (0.08 mi^2), an area that is smaller than the potential impact area on Illeginni Islet where birds are unlikely to occur. It is likely that birds would be exposed to SPLs lower than the PTS threshold but high enough to cause behavioral disturbance. While birds might be temporarily startled by these sounds, any behavioral or physiological response is likely to be very brief as the duration of the elevated SPLs from sonic booms are on the order of 270 ms. No adverse impacts to birds on or near Illeginni Islet are expected due to elevated SPLs due to sonic booms.

Elevated sound pressure levels from payload impact would only exceed the PTS threshold for birds out to 18 m (59 ft) the point of impact. The impact area is composed primarily of previously disturbed habitat and mitigation measures to deter bird from nesting and roosting in the impact area would be employed such as visual deterrents (e.g., scarecrows, Mylar flags, helium-filled balloons, or strobe lights). Therefore, birds are not expected to be in this disturbed portion of the Islet that is the impact zone. Birds are expected to be roosting, foraging, or nesting (depending on the season) in the area surrounding the impact zone that may be subject to SPL exceeding bird's behavioral disturbance threshold. While birds are likely to be exposed to SPLs high enough to elicit behavioral response, any response to this short duration sound is likely to limited to temporary startle responses. Bird behavior is expected to return to normal within minutes of impact and no lasting behavioral or physiological responses are expected. Birds may be more sensitive to elevated sound pressure level disturbance at certain nesting cycle stages (US Navy, 2015a). There is evidence that elevated noise levels may be more likely to cause nest abandonment during the incubation stage than during brooding of chicks (US Navy, 2015a). In general, the nesting season for seabirds and shorebirds at Illeginni and other USAKA islets begins in October and continues through April. In 2011, a USFWS and US Geological Survey team (Foster and Work, 2011) evaluated the AHW impact at the helipad on Illeginni Islet with pre- and post-test site visits. Post-test visits revealed that black-naped terns were actively feeding chicks at nests approximately 65 and 100 m (213 and 328 ft) of the impact site (Foster and Work, 2011). White terns were also observed roosting about 140 m (459 ft) from the impact site (Foster and Work, 2011). Even during nesting season, short-duration elevated SPLs from FE-1 activities are not expected to cause birds to abandon nests. Elevated SPLs from payload impact are not expected to adversely impact seabirds at and near Illeginni Islet.

Marine Wildlife. If organisms were exposed to elevated sound pressure levels above thresholds for PTS, physical injury or even death could result. If this were to occur, the animals would be subject to "harm" (as defined by the ESA and MMPA) or Level A Harassment. Exposure to SPLs above thresholds for TTS or behavioral thresholds have the potential to temporarily alter hearing abilities or temporarily alter behavior in consultation organisms but would not result in lasting effects or injury. If a consultation organism was impacted by temporary hearing shift or temporary behavioral modification, this could be considered Level B Harassment (as defined under the ESA and MMPA). The chances that these events would occur as a result of the proposed action were analyzed in the FE-1 BA (US Navy and USASMDC, 2017). Methods for these analyses and acoustic threshold levels for organisms are discussed in Section 4.2.2.2.1 above.

The maximum SPLs for sonic booms at the terminal end of payload flight do not exceed the PTS or TTS thresholds for cetaceans, sea turtles, or fish. There is a potential for behavioral disruption in sea turtles near the payload impact point: however, only 54 km^2 (20.9 mi^2) would be subject to SPLs of 160 dB sonic boom overpressures. For fish, sonic boom SPLs would not exceed the TTS threshold and would exceed behavioral disruption threshold over an area of 338 km^2 (130.5 mi^2) near the payload impact point. An estimated maximum of 21 green turtles and 7 hawksbill turtles may be exposed to SPLs high enough to elicit behavioral response. No lasting effects from any realized behavioral disruption are expected for any of the consultation organisms. Animals may have a startle response from this short duration sound but animals are expected to return to their normal behavior within minutes of exposure. For these reasons, elevated sonic boom SPLs are not expected to adversely impact wildlife near Illeginni Islet.

At Illeginni Islet, payload impact pressure levels would not exceed PTS or TTS thresholds for marine mammals or sea turtles in the waters surrounding Illeginni. The SPLs from payload impact may expose green and hawksbill turtles to SPLs above the behavioral disruption threshold. Based on analyses in the FE-1 BA (US Navy and USASMDC, 2017) the chance of an individual green turtle being in the area with payload impact SPLs high enough to induce behavioral disturbance is 1 in 61. The chance of a hawksbill turtle being subject to SPLs loud enough to induce behavioral disturbance is 1 in 176. As with cetaceans, it is important to note some of the drawbacks of this model that may lead to overestimation of effect. The model is based on the best available density data for turtles in shallow Pacific waters. The model assumes that the turtles do not move or exhibit avoidance behaviors to the approaching components. The estimates for the chances of elevated sound levels affecting individual sea turtles are likely overestimated in these analyses; however, these estimates do provide a conservative estimate of effects. Elevated SPLs from payload impact are not expected to adversely impact marine mammals or sea turtles near Illeginni Islet.

There are no known reliable density estimates for consultation fish species in the shallow waters near Kwajalein Atoll. These fish species likely have very low densities in these areas with patchy distributions. Near Illeginni, the maximum radial distance at which fish might be subject to injury is only 2.2 m (7.2 ft) from payload impact and 541 m (1,775 ft) for behavioral disturbance. Adult fish are not expected to be within 2.2 m (7.2 ft) of payload impact on Illeginni and as stated above, any behavioral disturbance in fish would likely be limited to a brief startle response and behaviors would likely quickly return to normal. Elevated SPLs from payload impact are not expected to adversely impact fish near Illeginni Islet.

Although densities of larval fish, coral, and mollusks have the potential to be higher in the shallow waters surrounding Illeginni Islet, elevated sound pressure levels in the area are not likely to impact larval fish, corals and mollusks. Fish, corals, and mollusks are expected to respond behaviorally to acute sounds, if at all. Any modification of behavior is likely to be temporary and behavior would return to normal after a brief interval. Larval fish, corals, and mollusks, while present in shallow waters near Illeginni Islet are episodic in their presence with peak abundance during spawning season between July and December.

4.3.2.2.2 Direct Contact

The Proposed Action would result in impact of the payload on land. Falling debris would directly impact terrestrial habitats and has the potential to directly contact marine habitats. The force of impact for the payload contacting land may result in ejecta and/or shock waves radiating out from the point of impact. While direct estimates for shock-wave strength and cratering are not available for the FE-1 flight test, cratering and shock waves are expected to be less than those of MMIII re-entry vehicles (RVs). Therefore, MMIII estimates of cratering and shock waves (USAFGSC and USASMDC/ARSTRAT 2015) are used as a maximum bounding case for the Proposed Action. Shock-wave pressures are discussed in section 4.3.2.2.1 Exposure to Elevated Sound Levels.

Analysis was performed using the kinetic energy of previous Minuteman III impacts which is greater than that anticipated for the FE-1 impact. As described in the BA, the kinetic energy of impact of the FE-1 stages is on the order of $4x10^9$ Joules, or 0.96 ton of trinitrotoluene. For a terrestrial impact on Illeginni Islet, the payload would likely form a crater including ejecta spreading out from the crater. The designated impact zone is an area approximately 290 m (950 ft) by 137 m (450 ft) on the northwest end of the Islet, as limited by available land mass. The footprint of a payload impact on land would be roughly elliptical but its size would depend on the precise speed of the payload and its altitude. Since speed, altitude, and size information are not available for a payload impact, we use estimates of re-entry vehicle (RV) cratering from MMIII test flights as a bounding case for potential impacts of the Proposed Action. For MMIII RVs, the ejecta field from crater formation at impact was expected to cover a semicircular area (approximately 120 degrees) extending 60-91 m (200-300 ft) from the impact and the density of ejecta was expected to decrease with distance from the point of impact (USAFGSC and USASMDC/ARSTRAT 2015). Craters from MMIII RVs have been documented to be 6-9 m (20-30 ft) in diameter and 2-3 m (7-10 ft) deep.

The payload is planned to impact on Illeginni Islet within the designated impact zone (Figure 2-6). A shoreline impact has the potential to affect sea turtle nesting habitat. It is possible that a payload impact on the shoreline at Illeginni would affect the near shore marine environment through ejecta from a crater and/or falling fragments.

Estimation of Direct Contact Impacts

Terrestrial Vegetation. Terrestrial vegetation in the payload impact zone at Illeginni is vegetation of previously disturbed habitat and is predominantly managed vegetation. Therefore, no adverse impacts to terrestrial vegetation are expected.

Terrestrial Wildlife.

Birds on Illeginni Islet. Direct contact from the payload or debris/ejecta radiating out from the point of impact has the potential impact birds by injuring or killing birds, or by nest destruction. Fifteen bird species are known to occur on Illeginni Islet. Birds such black noddies, Pacific golden plovers, white terns, sanderlings, and tattlers are known to use the forested area east of the Illeginni impact zone (Foster and Work, 2011; USFWS and NMFS, 2012) and black noddies are known to nest in this area. Several species are also known to use the forested area west of the impact zone. White terns, tattlers, plovers, black-naped terns, and great-crested terns are known to utilize the grassy areas near the helipad but it is unknown if any of these species use the area for nesting (Foster and Work, 2011; USFWS and NMFS, 2012). Black-naped tern nests with eggs and/or chicks were recorded on Illeginni in 2012 and 2014 and are known to nest in the vicinity of the impact area (Michael Fry, personal communication, 24 April 2017). Up to 4 black-naped tern nests have been observed by USFWS on Illeginni at one time and nests normally have one or two viable eggs/chicks (USFWS communication, 27 April 2017). It is likely that pre-flight human activity and equipment operation would disturb any birds using the impact area and may cause nest abandonment if any birds are nesting in the area (discussion in "Disturbance from

Human Activity and Equipment Operation" section below). The impact area is composed primarily of previously disturbed habitat and mitigation measures to deter bird from nesting and roosting in the impact area would be employed such as visual deterrents (e.g., scarecrows, Mylar flags, helium-filled balloons, or strobe lights). Birds are not expected to be in this disturbed portion of the Islet that is the impact zone; however, there is a chance that birds may still be roosting, foraging, or nesting in the area the time of payload impact. Direct contact from payload debris or ejecta may adversely impact birds in the impact zone. The USFWS estimated that a maximum of 12 black naped terns might be adversely affected by a daytime payload impact and a maximum of 16 birds could be injured or killed in the event of a nighttime payload impact (USFWS communication, 27 April 2017). The impact area would be monitored for black-naped tern nesting activity during pre-launch activities. If nests are found, eggs and chicks would be protected with the construction of wooden "A-frame" structures as per USFWS guidance to shade eggs or chicks in the event that adults are flushed from nests and to warn project personnel of the presence of this protected resource (USFWS communication, 27 April 2017). Birds roosting or nesting in the adjacent littoral forest and shrub habitats are not expected to be adversely affected by payload impact.

Sea Turtles and Sea Turtle Nests on Illeginni Islet. Only green sea turtles and hawksbill turtles have been observed near Kwajalein Atoll islets. These two species are known to nest or haul out on some Kwajalein Atoll Islets. If a sea turtle or sea turtle nest were struck by debris or ejecta from payload impact, a sea turtle could be killed or injured or sea turtle eggs could be damaged or destroyed. Turtles may also be subject to behavioral disruption significant enough to preclude females from haul-out and nesting.

In the Marshall Islands, sea turtle nesting generally occurs between May and November and peaks from June to September. Based on available information, NMFS and USFWS (2015) estimated 300 nesting green turtle females in the RMI out of a total of 6,500 nesting females in the Central West Pacific DPS (4.6% of known breeding population). In a 2008 survey of USAG-KA, suitable nesting habitat (relatively open sandy beaches and seaward margins of herbaceous strand above tidal influence) for sea turtles was identified, and these areas were thoroughly surveyed on foot for nesting pits and tracks. Green sea turtles have been observed hauling out and nesting at the northeastern portion of Kwajalein Islet, including the lagoon side at Emon Beach and the sand berm on the ocean side, approximately east of Emon Beach. However, no sea turtles were observed during the 2008 survey. The most significant green turtle nesting assemblage in RMI is in Bikar Atoll, in the northeastern corner of RMI. In May 2009, a hawksbill nested on the lagoon side of Omelek Islet near the harbor area (Malone 2009). The eggs hatched in early July and were inventoried. Thirteen unhatched eggs and 101 hatched eggs were counted. Three sea turtle nests (species unidentified) were found at Kwajalein Islet in September and October 2010, on a beach on the east-facing shore across the street from the high school (Eder 2011). The three nests were excavated after the eggs hatched, and the numbers of hatched and unhatched eggs were estimated as less than 300 eggs.

Successful sea turtle nesting on Eniwetak was confirmed by video recordings of turtle hatchlings entering the ocean at the islet in May 2011 (Aljure 2016). Successful nesting was also observed on Kwajalein Islet in January 2015 when hatchlings were found and returned to the beach or ocean (Aljure 2016). Observations of potential turtle haul-outs within Kwajalein Atoll include, a lagoon-side observation at Legan in May 2013, one at Eniwetak in March 2014, two haul-outs on the ocean-side of Kwajalein Islet in 2014, and two at Eniwetak in December 2014 (Aljure 2016).

Known green and hawksbill sea turtle activity in the vicinity of Illeginni Islet is limited to the following individual sightings:

- An adult green turtle was seen in nearshore waters on the ocean side of Illeginni in 1996 (USFWS and NMFS 2002);
- A hawksbill was observed near shore in the lagoon north of Illeginni in 2002 (USFWS and NMFS 2004);
- An adult hawksbill was observed during a 2004 marine survey of an area extending over the lagoon-facing reef northwest of the harbor to a point across from the northwestern corner of the islet. The survey occurred at depths from 5 to 10 m (16 to 33 ft; USFWS and NMFS 2006). This high-relief habitat supports a complex community of coral, a foraging area for hawksbills;
- An adult turtle of unknown species was documented in the 2006 inventory;
- Four green sea turtles were observed near Illeginni in the 2010 inventory;
- In 2012, 1 green sea turtle was observed off a lagoon patch reef adjacent to Illeginni Islet;
- An adult green sea turtle was observed during the 2014 inventory in a dense area of seagrass (*Halophila minor*) in Illeginni Harbor; and
- Sea turtle nest pits (unidentified species) were last found on Illeginni Islet in 1996, on the northern tip of the islet. No nesting was observed in surveys taken in 1998, 2000, 2002, 2004, 2006, or 2008, although suitable sea turtle nesting habitat was observed (USFWS 2011). Suitable nesting habitat appears northwest and east of the helipad on the lagoon side of Illeginni (USFWS and NMFS 2002).

The reported observations listed above were made during single-day surveys that were part of biennial resource inventories. These surveys were very limited in scope and effort, lasting for only a few hours and usually done by three people. The low number of sightings near Illeginni Islet may be attributed to the low level of effort expended to observe sea turtles there. While avoidance of a shoreline payload impact would be attempted, there is a chance that this would occur or that debris or ejecta from an impact further inland would affect sea turtle nesting habitat near the shoreline as debris and ejecta may extend out 100 m from the point of impact. While Illeginni Islet has shoreline habitat suitable for sea turtle nesting, no sea turtle nests or nesting activity have been observed on Illeginni in over 20 years. The last evidence of sea turtle nesting activity on Illeginni Islet consisted of observations of nest pits in 1996, 21 years ago. Therefore, the US Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-1 activities may but are not likely to adversely affect nesting sea turtles (US Navy and USASMDC, 2017). The USFWS has concurred with this determination (Appendix A).

Mitigation measures would be employed to decrease the chances of there being effects on sea turtles or sea turtle nests. For at least 8 weeks preceding the FE-1 flight test launch, Illeginni Islet would be surveyed bi-weekly by qualified personnel for sea turtles, sea turtle nesting activity, and sea turtle nests and any observation would be reported to the appropriate test personnel and the USAG-KA Environmental Engineer. If possible, personnel would also inspect the area within two days of the launch. Pre-test personnel at Illeginni Islet and in vessels traveling to and from Illeginni Islet would look for and report to the appropriate test personnel and the USAG-KA Environmental Engineer any observations of sea turtles, evidence of sea turtle haul out or nesting, or of sea turtle nests at or near Illeginni Islet. If personnel observe endangered, threatened, or other species requiring consultation moving into the area, work would be delayed until such species leave the area or were out of harm's way. Should any missile components or debris impact areas of sensitive biological resources (i.e., sea turtle nesting habitat or coral reef), a USFWS or NMFS biologist would be allowed to provide guidance and/or assistance in recovery operations to minimize impacts on such resources.

Marine Wildlife

Larval Fish, Corals, and Mollusks. Direct contact or shock waves from splashdown of rocket components may impact individual larval fish, corals or mollusks that may be present as components of drifting plankton. However, the density and distribution of larval organisms is likely to be so variable in space and time that accurate estimates of potential incidental take of larval consultation species would have to include a margin of error of several orders of magnitude.

Studies of coral larvae density during the peak spawning period indicate 1 to 0.1 planktonic larvae m^3 in per 35.31 ft^3) in waters 5 km (2.7 nm) away from the reef (Hodgson 1985). Larval densities are generally higher nearer to the reef and decrease as distance increases. These larval densities depend on conditions including ocean currents and seasonality. Based on analyses in the FE-1 BA (US Navy and USASMDC, 2017), it is possible that a very low number of fish, coral, or mollusk larvae would be within the affected volume of surface water. Therefore, payload impact may adversely impact a very small, but indeterminable, number of larval fish, corals or mollusks.

In general, the consequences of taking individual larvae are considered to be substantially less severe than the consequences of taking individual adults because the baseline mortality rate of larvae is several orders of magnitude higher than for adults; therefore, the odds of individual larvae surviving to reproductive age are substantially lower than the odds of an adult surviving to reproduce again (Gascoigne and Lipcius 2004). Population effects to consultation species are discountable for this reason; because the affected area is trivially small relative to the distribution of these invertebrates; and because the number of larvae potentially affected is likely to be trivially small relative to their population sizes and the effects are considered discountable.

Non-larval Fish, Corals, and Mollusks near Illeginni Islet. Many non-larval reef associated fish, coral, and mollusk species have the potential to occur near Illeginni Islet (Appendix B) including 19 consultation coral species, 3 consultation fish species, and 5 consultation mollusk species. These forms include the relevant coral and mollusk species and adults and juveniles of the relevant fish species. Although coral reefs are not planned or expected to be targeted, a land payload impact on the shoreline of Illeginni could result in ejecta/debris fall, shock waves, and post-test cleanup operations, which may adversely impact at least some of the consultation fish, coral and mollusk species on the adjacent reef. Attempts would be made to avoid payload impact near these sensitive shoreline areas; however, here we present results of FE-1 BA (US Navy and USASMDC, 2017) analyses of this worst case scenario to elucidate the maximum effects of the Proposed Action.

The anticipated worst-case scenario of a payload land impact at Illeginni islet is considered to be a shoreline strike, which would result in debris fall and shock wave effects within an affected area that would extend outward from the point of strike (Figure 4-1). Based on this worst-case scenario, the US Navy and USASMDC (FE-1 BA, US Navy and USASMDC, 2017) estimated a maximum of 100 juvenile and 8 adult humphead wrasses may be found in habitats in both the debris fall and shock wave affect areas. The maximum number of consultation coral colonies that may be present was estimated to be 9,097 colonies and the maximum number of individual consultation mollusks was estimated to be 468. Not every consultation species individual or colony within an affected area of habitat would be equally vulnerable to the effects of debris fall and shock wave impacts (NMFS-PIRO 2014a and 2014b). These effects should be assumed to affect only a proportion of the associated coral colonies, mollusks, and fish that may be present.

Planned land strikes would not be targeted close to the shoreline, and impacts to near shore consultation species would be avoided. As can be seen in Figure 4-1, the entire potential affected reef area is very small in comparison to the total comparable reef area surrounding and connected to Illeginni. Moreover, this area is considered extremely small compared to sum of comparable reef areas under US control per the current military use agreement with the RMI, and miniscule in comparison with comparable reef areas within the entire Atoll. If the reef, reef flat, or shallow waters were inadvertently impacted, an inspection would be performed within 24 hours to assess any damage and determine mitigation measures.

Of the 15 consultation coral species that have the potential to be impacted as adults, all were observed at multiple islets and 80% were observed at more than five islets. Most of the species appeared to be geographically widespread with observed occurrences of four species, *Acropora microclados*, *Heliopora coerulea*, *Pavona venosa*, and *Montipora caliculata*, exceedingly common. The humphead wrasse is common in distribution within USAG-KA. A total of 103 sites were surveyed for protected fish since 2008. *Cheilinus undulatus* has been seen at 10 of the 11 islets.

Since at least some adult consultation corals, mollusks, and fish may be affected by direct contact, the US Navy and USASMDC have concluded that these activities may adversely affect these species (US Navy and USASMDC, 2017) and initiated consultation with NMFS. In their Final Biological Opinion (NMFS, 2017b; Appendix E), NMFS concluded that a total of up to 9,929 colonies of consultation corals, 117 top shell snails, and 12 giant clams could be affected by direct contact, ejecta, and/or shock waves from a FE-1 payload impact near the Illeginni shoreline. The NMFS also concluded that the potential loss of these adult coral and mollusk species is not expected to eliminate them from Illeginni or to appreciably reduce the likelihood of their survival and recovery (NMFS, 2017b; Appendix E).

Cetaceans. Cetaceans would not be affected by direct contact from payload components in the vicinity of Illeginni Islet. All affects from direct contact with payload fragments or ejecta are expected to occur within 91 m (300 ft) of a payload impact. Cetaceans do not occur in these shallow waters.

4.3.2.2.3 Vessel Strike

The Proposed Action has the potential to increase ocean-going vessel traffic in the ROI. Prior to the test flight, radars and test equipment would be placed on Illeginni Islet and would be transported aboard ocean-going vessels. Sensor rafts would also be deployed near the impact site from a LCU vessel. The rafts are self-stationing; therefore, none of the rafts would require an anchoring system. Post-test recovery efforts would also result in increased vessel traffic to the payload impact site. In the event of a payload impact at Illeginni Islet, vessels would be used to transport heavy equipment (such as backhoe or grader) and personnel for manual cleanup of debris, backfilling or any craters, and instrument recovery. BMP would be implemented to ensure disturbed sediment does not wash in nearby waters. Deployed sensor rafts would also be recovered by a LCU vessel. Debris would only be recovered in waters up to approximately 30.5 m (100 ft) deep. Pre- and Post-test, vessel traffic is expected to last approximately 10 weeks total and involve about 8 vessel round-trips.

Figure 4-1 Representative Maximum Direct Contact Affect Areas for a Shoreline Payload Impact at Illeginni Islet, Kwajalein Atoll

Estimation of Vessel Strike Impacts

Terrestrial Wildlife. Seabirds that forage in waters offshore of Illeginni Islet may be exposed to vessels transiting to and from Illeginni Islet. Direct collisions of birds with Navy vessels are unlikely and not expected. Birds are more likely to be visually and behaviorally disturbed by vessels causing birds to either avoid vessels or in some cases to follow vessels. No adverse impacts to birds are expected from vessels transiting to and from Illeginni Islet.

Marine Wildlife. Marine wildlife has the potential to be impacted by vessel strike primarily by being at the surface when a vessel travels through an area or by a deploying raft. Organisms at the surface are at risk of being struck by the vessel or their propellers. Organisms that are not found at the sea surface have the potential of being struck when a vessel drops anchor or if a vessel runs aground. Cetaceans, sea turtles, fish, corals, and mollusks present in the vicinity of Illeginni Islet are not expected to be impacted by vessel strike, as a small number of vessel trips would be required to support pre-flight and post-flight cleanup activities, and there would be only one flight test conducted.

While cetaceans and sea turtles breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels and they may already be used to some vessel traffic in the ROI. Fish species do not need to surface to breathe are not known to frequent the ocean surface, and are highly mobile animals capable of avoiding vessels. Corals and mollusks have the potential to be struck by a dropped anchor or a vessel contacting reef habitats, although this is unlikely, vessel operators would be made aware of sensitive reef habitats in order to avoid these areas. Additionally mitigation measures would be employed to avoid vessel strikes, including vessel operators and other project personnel watching for and avoiding cetaceans and sea turtles by adjusting their speed or waiting until animals have moved away from the area before deploying rafts.Any marine mammal or sea turtle sightings during surveys, overflights, or ship travel would be reported to the USAG-KA Environmental Engineer, the RTS Range Directorate, and the Flight Test Operations Director for consideration in approving the launch.

4.3.2.2.4 Exposure to Hazardous Chemicals

Land impact of the payload would have the potential to introduce propellants, battery acids, explosives, and heavy metals into the terrestrial environment of Illeginni Islet. Pre-test preparatory and post-test cleanup activities may involve heavy equipment and ocean-going vessels, which have the potential to introduce fuels, hydraulic fluids, and battery acids to terrestrial habitats as well as marine habitats. A small number of small radars are considered expendable and may be destroyed during testing. While the debris from these radars is expected to be recovered, battery acids and heavy metals may be introduced into the terrestrial environment and may potentially leech into the marine environment.

Following the impact of the payload, fragmentation of the payload would disperse any of the residual onboard hazardous materials (Table 2-2), such as battery acids, residual explosives, and heavy metals, around the impact point. Onboard the payload there would be up to four lithium ion batteries each weighing between 1.36 and 22.68 kg (3 and 50 lbs) and two radio frequency transmitters. The batteries carried onboard the payload would be discharged by the time the vehicle impacts on land at Illeginni Islet; however a small quantity of electrolyte material (on the order of a couple ounces) may still enter the terrestrial environment. The payload also carries up to 454 kg (1,000 lbs) of tungsten alloy which would enter the terrestrial and possible marine environments upon payload impact. The payload structure itself contains heavy metals including aluminum, titanium, steel, magnesium, tungsten, and other alloys.

With the payload impact on Illeginni, debris including hazardous materials would fall on Illeginni and possibly into nearshore habitats. Debris and ejecta from a land impact would be expected to fall within 100 m (328 ft) of the impact point. Post-flight cleanup of the impact area would include recovery/cleanup off all visible debris including during crater backfill. BMP would be implemented to ensure disturbed sediment does not wash into nearby waters. Searches for debris would be attempted out to water depths of 15 to 30.5 m (50 to 100 ft) if debris enters the marine environment. Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any cetaceans, fish or sea turtles in the area. Any visible battery fragments in the lagoon, in other shallow waters, or on Illeginni would be removed during recovery and cleanup. While every attempt would be made to clean up all visible metal and other fragments, it is likely that some fragments would be too small to be recovered or may be buried by the force of impact. Therefore, it should be considered that a small but unknowable amount of these heavy metals or other substances may remain in the terrestrial or marine environments at Illeginni Islet.

Since up to 454 kg (1,000 lbs) of tungsten alloy would be contained on the payload and be introduced into the terrestrial (and possibly marine) environments upon payload impact, it is possible that a small but unknowable amount of tungsten alloy would remain at Illeginni Islet. While the effects of tungsten alloys in ecosystems is largely unknown, recent studies have concluded that under certain environmental conditions tungsten may dissolve and some forms of tungsten (depending on soil conditions) can move through soil (Dermatas et al., 2004). A 2008 study (Bednar et al.) of geochemical parameters influencing tungsten mobility in soils found that dissolved tungsten reached equilibrium after approximately 48 hours and mobility decreased by approximately one-half within a 4 month period. In the presence of alloying elements such as iron, nickel, and cobalt, tungsten was sorbed to clay soils and mobility was decreased; however, this sorption also depends on soil conditions such as pH and mineral and organic composition (Dermatas et al., 2004). Soils on Illeginni are primarily well-drained and composed of calcareous sand that is poor in organic materials with a few carbonate fragments. Some studies suggest that introduction of tungsten into soil increases soil pH and may impact soil microbial communities (Dermatas et al., 2004; Strigul et al., 2005). There is also some evidence that soluble tungsten may decrease biomass production, and that plants and worms may take up tungsten ions from the soil (Strigul et al., 2005).

The US Navy and USASMDC performed a bench study and computer modeling (LLNL, 2017; Appendix D) to quantify material-specific tungsten alloy dissolution rates in groundwater and seawater and predict the degree of tungsten sorption to the carbonate material of Marshall Islands coralline soils. The bench study dissolution rates were applied to the computer model to determine the residual quantities of tungsten alloy over time. The model results are compared to USEPA guidance (June 2017) for human health-based risks associated with exposure, and conclusions drawn based on the USEPA guidance. Based on a calculated amount of tungsten material from the FE-1 flight test remaining in the soil following cleanup at Illeginni Islet, the bench study and model results indicate levels of tungsten in Illeginni Islet soil and groundwater would be below the USEPA Residential RSLs (LLNL, 2017) for soil and drinking water (although this area is not designated as potable water) from the end of the flight test to 25 years out, the period for which the model was run. Therefore, significant environmental effects from tungsten in soils would not be expected. US Navy SSP would perform pre- and post-flight test sampling at Illeginni Islet to verify model results.

Regarding the long term risk from entering the marine ecosystem, the bench study and model results (LLNL, 2017) indicate very slow dissolution and passivation (i.e., natural chemical encapsulation) of tungsten from FE-1 may occur in sea water. The dissolution rate of the tungsten alloy in seawater peaked within an initial two week leaching period during the study. The average dissolution rate over three months was 2.8 milligrams per square meter per hour (mg/m^2/hr); the highest rate measured over the 13 week study was 7.4 mg/m^2/hr, occurring in the second week, which agreed with the model. The lowest rate was 0.0 mg/m^2/hr occurring in the first week, followed by 0.4 mg/m^2/hr for the 11th and 13th weeks. At a rate of 0.4 mg/m^2/hr, if that rate were fairly constant, it would take approximately 280 years for the maximum 454 kg (1,000 lbs) mass to dissolve in ocean waters. Because the preferred impact location is Illeginni Islet, none or only a small quantity of the payload would occur within the nearshore environment and no significant effects would be expected.

Up to four small units powered by car batteries are considered expendable and would be destroyed by the impact. While the debris from these radars is expected to be recovered, acids and heavy metals may be introduced into the terrestrial environment. Only trace amounts of hazardous chemicals are expected to remain in terrestrial areas. If any hazardous chemicals enter the marine environment they are expected to be diluted and dispersed quickly by currents and wave action.

Prior to use or transport, vessel and heavy equipment operators would inspect and clean equipment for fluid and fuel leaks. Post-flight cleanup activities may include the use of heavy equipment such as a backhoe or grader on Illeginni. This equipment has the potential to introduce fuels, hydraulic fluids, and battery acids into terrestrial habitats. Equipment operation would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life. Any accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be transported to Kwajalein Islet for proper disposal. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA.

Hazardous material releases would comply with the emergency procedures set out in the KEEP and the UES. Following cleanup and repair operations at Illeginni, soil samples would be collected at various locations around the impact area and tested for pertinent contaminants.

Estimation of Exposure to Hazardous Chemicals Impacts

Terrestrial Vegetation. Terrestrial vegetation in the payload impact zone at Illeginni is vegetation of previously disturbed habitat and is predominantly managed vegetation. Exposure to hazardous chemicals may affect terrestrial vegetation; however since these areas are predominantly disturbed areas there is not expected adverse impact on native vegetation.

Terrestrial Wildlife. Hazardous chemicals may but are not likely to adversely impact nesting sea turtles, sea turtle nests, and/or sea turtle nesting habitat. As discussed in section 4.3.2.2.2, debris and ejecta from payload impact has the potential to impact sea turtle nesting habitat. This debris and ejecta has the potential to include hazardous chemicals including heavy metals. If these chemicals were introduced into sea turtle nesting habitat, they have the potential to dissuade females from nesting, harm sea turtle eggs, or affect the health of sea turtle hatchlings. While post-test cleanup would be conducted, there is a chance that fragments or residual chemicals may remain in sea turtle nesting habitat. While Illeginni Islet has shoreline habitat suitable for sea turtle nesting, no sea turtle nests or nesting activity have been observed on Illeginni in over 20 years. The last evidence of sea turtle nesting activity on Illeginni Islet consisted of observations of nest pits in 1996, 21 years ago. Therefore, the US Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-1 activities may but are not likely to adversely affect nesting sea turtles (US Navy and USASMDC, 2017). The USFWS has concurred with this determination (Appendix A).

Hazardous chemicals are not expected to impact birds at Illeginni Islet.

Marine Wildlife. Cetaceans and scalloped hammerhead sharks would not be impacted by hazardous chemicals from payload components in the vicinity of Illeginni Islet. All effects from hazardous chemicals are expected to occur within 91 m (300 ft) of a payload impact or on Illeginni Islet. Cetaceans do not occur in these shallow waters and scalloped hammerhead sharks are not known to occur within 91 m (300 ft) of the Illeginni shoreline.

Chemicals dispersed at Illeginni Islet are not expected to impact fish, corals, or mollusks because most payload fragments and chemicals should be contained within terrestrial environments, all visible debris in terrestrial and shallow water (up to water depths of 15 to 30.5 m) would be recovered, and any soluble chemicals introduced into the marine environment are expected to be quickly dispersed and diluted by ocean currents and wave action.

4.3.2.2.5 Disturbance from Human Activities and Equipment Operation

Both pre-flight preparations and post-flight cleanup activities would result in elevated levels of human activity in terrestrial and marine environments. Elevated levels of human and equipment activity are expected for approximately 10 weeks. Personnel and equipment would be used for preparation of the impact site including placement of radars in both terrestrial an ocean areas. Post-flight cleanup would involve recovery of all debris possible and would include personnel and equipment in both terrestrial and ocean areas. Radars would be retrieved from marine and terrestrial locations and impact craters (if present) would be filled. Approximately 8 round-trips of ocean-going vessels would be used to transport personnel and equipment to Illeginni. It is anticipated that as many as two dozen persons would be active on Illeginni Islet during pre- and post-test activities. These activities would include use of heavy equipment such as a backhoe or grader. In the event of an impact on the Illeginni shoreline, post-flight operations would be conducted similarly to terrestrial operations, when tide conditions and water depth on the adjacent near shore reef permit. A backhoe would be used to excavate the crater, excavated material would be screened for debris, and the crater would usually be backfilled with coral that had been ejected around the wall of the crater. BMP would be implemented to ensure disturbed sediment does not wash into nearby waters. Use of heavy equipment, if necessary, would be coordinated with USFWS/NMFS in order to minimize impacts to sensitive resources.

Estimation of Disturbance from Human Activities and Equipment Operation Impacts

Terrestrial Vegetation. Terrestrial vegetation in the payload impact zone at Illeginni is vegetation of previously disturbed habitat and is predominantly managed vegetation. Exposure to disturbance from human activities and equipment operation may impact terrestrial vegetation; however since these areas are predominantly disturbed areas, there is not expected adverse impact on native vegetation.

Terrestrial Wildlife. Disturbance from human activities and equipment operation has the potential to impact birds, especially nesting seabirds on Illeginni islet. Fifteen bird species are known to occur on Illeginni Islet. Birds such black noddies, Pacific golden plovers, white terns, sanderlings, and tattlers are known to use the forested area east of the Illeginni impact zone (Foster and Work, 2011; USFWS and NMFS, 2012) and black noddies are known to nest in this area. Several species are also known to use the forested area west of the impact zone. White terns, tattlers, plovers, black-naped terns, and great-crested terns are known to utilize the grassy areas near the helipad but it is unknown if any of these species use the area for nesting (Foster and Work, 2011; USFWS and NMFS, 2012). The impact area is composed primarily of previously disturbed habitat and mitigation measures to deter bird from nesting and roosting in the impact area would be employed such as visual deterrents (e.g., scarecrows, Mylar flags, helium-filled balloons, or strobe lights). Visual and physical deterrents such as Mylar flags or tarp coverings would also be attached to heavy equipment when not in use to deter birds from roosting on equipment. While birds are not expected to be in this disturbed portion of the Islet that is the impact zone, pre-flight human activity and equipment operation would disturb any birds using the impact area and may cause nest abandonment if any birds are nesting in the area. Birds roosting, nesting, or foraging adjacent to the impact area may also be disturbed by activities in the impact zone or by transit of personnel and equipment across the Islet to and from the impact zone. The impact area would be monitored for black-naped tern nesting activity during pre-launch activities. If black-naped tern or other seabird nests are found, eggs and chicks would be protected with the construction of wooden “A-frame” structures as per USFWS guidance (USFWS communication, 27 April 2017) to shade eggs or chicks in the event that adults are flushed from nests and to warn project personnel of the presence of this protected resource.

Noise from and presence of helicopters also has the potential to disturb birds at Illeginni Islet. Helicopters may elicit short-term behavioral or physiological responses such as alert response, startle response, or temporary increase in heart rate in birds (US Navy, 2015a). Helicopters typically operate at low altitudes and slow speeds which increase the duration of noise exposures and some studies have suggested that birds respond more to noise from helicopters than from fixed-wing aircraft (US Navy, 2015a). Helicopter flights may disturb roosting, foraging, and nesting birds near the helipad and surrounding habitats. Studies of many bird species have found that many birds may respond by flushing from their nests in response to helicopter landings; however there is also some evidence that birds may become habituated to these types of activities and that birds may return to their nests within 15 minutes after the disturbance ceases (US Navy, 2015a). For the above reasons, disturbance from human activity and equipment operation may impact birds at Illeginni Islet.

Disturbance from human activities and equipment operation may but is not likely to adversely impact nesting sea turtles, sea turtle nests, and/or sea turtle nesting habitat. While personnel would be instructed to avoid suitable sea turtle haul out or nesting habitat, pre-test activities still have the potential to disturb sea turtles that have hauled out or are nesting and to possible cause a nesting attempt to be aborted. As discussed in section 4.3.2.2.2, debris and ejecta from payload impact has the potential to impact sea turtle nesting habitat. While a shoreline impact may be avoided, debris and ejecta has the potential to extend out 100 m (328 ft) from payload impact, which may affect sea turtle nesting habitat. Post-flight cleanup operations include recovery/cleanup of visible payload debris and backfilling of any payload-created crater. BMP would be implemented to ensure disturbed sediment does not wash into nearby waters. During post-flight operations, heavy equipment may be used to recover land-based debris (including hazardous materials), backfill craters, and restore potential sea turtle nesting habitat. It is possible that during these operations, heavy equipment may severely damage or destroy turtle eggs and may physically change the habitat, making it unsuitable for future successful nesting. While Illeginni Islet has shoreline habitat suitable for sea turtle nesting, no sea turtle nests or nesting activity have been observed on Illeginni in over 20 years. The last evidence of sea turtle nesting activity on Illeginni Islet consisted of observations of nest pits in 1996, 21 years ago. Therefore, the US Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-1 activities may but are not likely to adversely affect nesting sea turtles (US Navy and USASMDC, 2017). The USFWS has concurred with this determination (Appendix A).

Marine Wildlife. Acoustic effects associated with post-test operations would be consistent with any other land or sea activity that uses mechanized equipment and the greatest intensity would be centered on the payload impact location. Potential consequences of these acoustic effects include noise avoidance and temporary disruption of feeding or predator avoidance behaviors in sea turtles, some motile invertebrates and small fish (Mooney et al. 2010). Because these acoustic effects are substantially less intense than sonic boom overpressures, the area of potential effect would be substantially smaller (See section 4.3.2.2.1), restricted to relatively poor reef habitats near the shoreline due to the nature of the operations, and is not expected to impact marine wildlife.

Physical contact by humans (e.g., handling, walking on, and kicking with fins) is likely to injure corals and likely to disturb reef-associated fish and mollusks if payload debris extends into the marine environment. Contact by equipment is also likely to injure or kill corals and mollusks and may injure or kill reef-associated fish. An organism's potential to recover from injury is a function of intrinsic and extrinsic factors. The extent of this potential impact would be restricted to the vicinity of the payload land impact site and the access corridor between this site and the adjacent reef.

If divers are required to search for payload debris on the adjacent reef flat, they would be briefed prior to operations about coral fragility and provided guidance on how to carefully retrieve the very small pieces of payload debris that they would be looking for. Although diver recovery operations might cause minor coral colony breakage, it is unlikely that any entire colonies would be killed. Although top snails may be moved out of the way, it is unlikely that a top snail would be killed due to the strong and protective nature of the snail’s thick shell. Sea turtles and humphead wrasses, which are normally patchy in distribution and usually present as solitary individuals or in very low numbers, might be present. However, due to their natural wariness, they are expected to shy well away from the divers and not be killed or injured.

All land-based post-flight activities have the potential to increase turbidity, especially for filter-feeding invertebrates such as the species of corals and mollusks. Potential consequences include decreased feeding efficiency and increased effort expended to clear sediments (Cortes and Risk 1985; Rogers 1990). However, increased turbidity associated with the operations would be temporary and turbidity would likely return to background levels within a few hours of the activity's conclusion.

Marine organisms such as cetaceans, sea turtles, sharks, and manta rays may be disturbed by vessel traffic for delivering personnel and equipment, dive operations for debris recovery, and by deployment of radar rafts. These highly mobile animals may exhibit avoidance behavior by leaving the disturbed area. However, animals are expected to return to normal distributions and behaviors soon after the disturbance has ceased; therefore, impacts are expected to be insignificant.

In shallow waters near Illeginni, corals, mollusks, and reef-associated fish have the potential to be disturbed by shallow water debris recovery and/or backfill operations. Humphead wrasses are highly mobile animals and may exhibit avoidance behavior, temporarily leaving the site of increased human activity. There is no reason to expect that these fish would not return to these areas once the disturbance has ended. Mollusks are immobile and cannot flee from human activity but they may respond to disturbance by closing their shells which would decrease their foraging activity. It is expected that mollusks would resume normal behaviors shortly after cessation of the disturbance activity. Corals may be affected by disturbance from debris recovery and/or backfill operations. However, personnel would be advised to avoid or uses extreme caution if debris is located near corals and reef habitats to avoid damage to these consultation organisms. Divers would be briefed prior to operations about coral fragility and provided guidance on how to avoid or minimize unavoidable contact with fragile marine resources as they carefully retrieve the very small pieces of RV debris that they would be looking for. In the event that payload debris or ejecta impacts reef habitats, there is a chance that recovery operations might cause minor coral colony breakage and therefore a small but unknown number of coral colonies may be affected. This is not expected to greater than or outside of the estimates of effect for direct contact analyzed in section 4.3.2.2.2.

4.3.2.3 Biological Resources in Offshore Waters – Southwest and Northeast of Kwajalein Atoll (Alternative Impact Locations)

Two alternative actions within the Proposed Action include impact of the payload in deep offshore waters near Kwajalein Atoll. The alternative impact locations are evaluated for the potential impacts on marine biological resources in these deep offshore waters near Kwajalein Atoll. Potential impacts of the Action in this area include elevated sound pressure levels, direct contact from payload impact debris, exposure to hazardous chemicals, and increased human and vessel activity. The potential for the Proposed Action to adversely impact biological resources including those special-status species described in section 3.3.2 (Table 3-10 and Appendix B) is evaluated in this section. Impacts on threatened and endangered species are not expected to be different than those on non-listed species.

4.3.2.3.1 Exposure to Elevated Sound Levels

The Proposed Action has the potential to result in elevated sound pressure levels both in-air and underwater. The primary elements of the Proposed Action that would result in elevated sound pressure levels in this area are sonic booms and impact of the developmental payload.

Discussion of potential effects of elevated sound pressure levels on wildlife species as well as on acoustic thresholds for these species is presented in section 4.2.2.2.1.

Sonic Booms. The developmental payload would fly at high-speeds sufficient to generate sonic booms from stage 3 separation in the BOA and extending to impact near Kwajalein Atoll. Sonic booms create elevated pressure levels both in-air and underwater. At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB near impact (Figure 4-1). At the point of impact, the sonic boom footprint would narrow to about 46 km (25 nm) at this peak pressure. For payload impact in deep ocean waters near Kwajalein Atoll, elevated SPLs due to the sonic boom would be present in the air over land and would also be present in the surrounding waters. The duration for sonic boom overpressures produced by the payload are expected to average 75 ms where SPLs are greater than 140 dB and 270 ms where SPLs are less than 140 dB.

As detailed in the FE-1 BA (US Navy and USASMDC, 2017; approximately 1 km^2 (0.4 mi^2) of ocean surface would be exposed to SPLs up to 170 dB, 54 km^2 (21 mi^2) to SPLs up to 160 dB, and 338 km^2 (131 mi^2) to SPLs up to 150 dB. As discussed in section 4.2.2.2.1, model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affect area.

Splashdown of Vehicle Components Elevated sound pressure levels would occur in the ocean as the payload impacts near the ocean's surface. Estimates for pressure from impact of vehicles using a similar amount of high explosives as those in the payload resulted in sound pressure levels in-air of 140 dB at 18 m (59 ft). These levels would be used as a bounding case for the current Proposed Action. Using the spherical spreading model, the SL is estimated to be 165 dB in-air and an estimated 191 dB in-water. For impact in deep ocean areas near Kwajalein Atoll, an in-water SPL of 191 dB would attenuate to 160 dB at 35.5 m (116.5 ft) and to 150 dB at 112 m (367 ft).

Estimation of Elevated Sound Level Impacts

Terrestrial Wildlife. No terrestrial habitat exists in the deep offshore water payload impact zones; however seabirds may forage in these areas and be exposed to elevated SPLs from sonic booms and payload impact. As discussed in for the Preferred Alternative at Illeginni, if birds were exposed to elevated sound pressures above PTS threshold levels, physical injury or even death could result. Birds are able to recover from hearing damage better than many other species, and most physical injury would likely be temporary; however, very loud sounds may cause permanent damage. Elevated SPLs from sonic booms would exceed PTS threshold for birds near payload impact where sound pressure levels would be above 140 dB re 20 µPA over only about 0.2 km^2 (0.08 mi^2). While density of foraging seabirds in these areas is unknown, it is likely densities would be very low. It is possible that birds would be exposed to SPLs lower than the PTS threshold but high enough to cause behavioral disturbance. While birds might be temporarily startled by these sounds, any behavioral or physiological response is likely to be very brief as the duration of the elevated SPLs from sonic booms are on the order of 270 ms. If any behavioral disturbance was realized it would likely be in the form or alert behaviors, minor behavioral changes, or flight response (US Navy, 2015a). No adverse impacts to birds on or near Illeginni Islet are expected due to elevated SPLs due to sonic booms.

Elevated sound pressure levels from payload impact would only exceed the PTS threshold for birds out to 18 m (59 ft) from the point of impact. Due to the likely low density and patchy distribution of seabirds foraging in these areas, birds are not expected to be in this area or be exposed to SPLs loud enough to cause physical damage. While birds may be exposed to SPLs high enough to elicit behavioral response, any response to this short duration sound is likely to limited to temporary startle responses as described above. Bird behavior is expected to return to normal within minutes of impact and no lasting behavioral or physiological responses are expected. Elevated SPLs from payload impact are not expected to adversely impact seabirds in the deep offshore impact zones.

Marine Wildlife. If organisms were exposed to elevated sound pressure levels above thresholds for PTS, physical injury or even death could result. If this were to occur, the animals would be subject to “harm” (as defined by the ESA and MMPA) or Level A Harassment. Exposure to SPLs above thresholds for TTS or behavioral thresholds have the potential to temporarily alter hearing abilities or temporarily alter behavior in consultation organisms but would not result in lasting effects or injury. If a consultation organism was impacted by temporary hearing shift or temporary behavioral modification, this could be considered “harassment” or Level B Harassment (as defined under the ESA and MMPA). The chances that these events would occur as a result of the Preferred Alternative were analyzed in the FE-1 BA (US Navy and USASMDC, 2017). The same method was used to analyze impacts for the alternatives of payload impact in deep ocean waters. Methods for these analyses and acoustic threshold levels for organisms are discussed in Section 4.2.2.2.1 above.

The maximum SPLs for sonic booms at the terminal end of payload flight do not exceed the PTS or TTS thresholds for any cetacean, sea turtle, or fish. There is a potential for behavioral disruption in sea turtles near the payload impact point: however, only 54 km^2 (20.9 mi^2) would be subject to SPLs of 160 dB sonic boom overpressures. For fish, sonic boom SPLs would not exceed the TTS threshold and would exceed behavioral disruption threshold over an area of 338 km^2 (130.5 mi^2) near the payload impact point. Without specific data on sea turtle density in these deep ocean waters, density was estimated to be similar to sea turtle guild density in the BOA. Based on the highest BOA density, the estimated chance of a sea turtle being exposed to SPLs high enough to exceed the behavioral response threshold is 1 in 4.3. If a sea turtle were exposed to SPLs high enough to exceed the behavioral disturbance threshold, no lasting effects from any realized behavioral disruption are expected for any of the consultation organisms. Animals may have a startle response from this short duration sound but animals are expected to return to their normal behavior within minutes of exposure. For these reasons, elevated sonic boom SPLs are not expected to adversely impact wildlife in the deep ocean waters near Kwajalein Atoll.

In deep ocean water areas, payload impact pressure levels would not exceed PTS or TTS thresholds for marine mammals or sea turtles. The SPLs from payload impact may expose green and hawksbill turtles to SPLs above the behavioral disruption threshold. Based on analyses in the FE-1 BA (US Navy and USASMDC, 2017) the chance of an individual sea turtle being in the area with payload impact SPLs high enough to induce behavioral disturbance is 1 in 5,435. The chance of a hawksbill turtle being subject to SPLs loud enough to induce behavioral disturbance is 1 in 176. Though turtle density data in these deep ocean areas near Kwajalein Atoll are unavailable, the model is based on the best available density data for turtles in other deep water areas of the Pacific. The model assumes that the turtles do not move or exhibit avoidance behaviors to the approaching components. The estimates for the chances of elevated sound levels affecting individual sea turtles are likely overestimated in these analyses; however, these estimates do provide a conservative estimate of effects. Elevated SPLs from payload impact are not expected to adversely impact marine mammals or sea turtles near Illeginni Islet.

There are no known reliable density estimates for consultation fish species in the deep ocean waters near Kwajalein Atoll. These fish species likely have very low densities in these areas with patchy distributions. For these alternatives, the maximum radial distance at which fish might be subject to injury is only 2.2 m (7.2 ft) from payload impact and 541 m (1,775 ft) for behavioral disturbance. Adult fish are not likely to be within 2.2 m (7.2 ft) of payload impact on Illeginni and as stated above, any behavioral disturbance in fish would likely be limited to a brief startle response and behaviors would likely quickly return to normal. Elevated SPLs from payload impact are not expected to adversely impact fish in deep ocean waters near Kwajalein Atoll.

Densities of larval fish, coral, and mollusks are expected to be low in the deep ocean waters near Kwajalein Atoll. Therefore, elevated sound pressure levels in the area are not likely to impact larval fish, corals and mollusks.

4.3.2.3.2 Direct Contact

The Alternative Action would result in impact of the payload in one of two deep offshore water locations near Kwajalein Atoll. The payload debris could directly impact aquatic habitats and have the potential to directly contact marine organisms. The location southwest of Kwajalein Atoll would be approximately 244 m (800 ft) by 488 m (1600 ft) with a surface area of 0.1191 km^2 (0.0459 mi^2). The location northeast of Kwajalein Atoll would be approximately 366 m (1200 ft) by 732 m (2400 ft) with a surface area of 0.2679 km^2 (0.1033 mi^2). While the footprint of a payload impact would likely be roughly elliptical, its size would depend on the precise speed of the payload and its altitude. Since speed, altitude, and size information are not available for a payload impact, it is difficult to get an estimate of the area which has the potential for falling debris. For these analyses we use a maximum distance estimated for debris/ejecta for an on-land impact (100 m [328 ft] from impact) for the area exposed to debris in impact zones in deep offshore waters.

Estimation of Direct Contact Impacts

Terrestrial Wildlife. While terrestrial habitat does not occur in the deep offshore impact zones, seabirds may forage in these areas. No reliable density information for seabirds foraging offshore near Kwajalein Atoll is available; however densities are expected to be very low and distributions patchy. Because foraging sea bird densities are likely very low, direct contact from payload debris is not expected to impact birds in the offshore impact zones.

Marine Wildlife. If payload components were to strike a cetacean, sea turtle, or fish near the water surface, the animal would most likely be injured or killed. Reliable density information for cetaceans in the deep ocean waters near Kwajalein Atoll is unavailable. The best available density information is from the Navy's Marine Mammal Density Database which has modeled cetacean density in deep ocean waters between Hawai'i and Kwajalein Atoll (maximum estimates from the BOA, see Navy SSP FE-1 BA [US Navy and USASMDC, 2017] for details). Based on the above discussed affect areas, and the best available species density information, chances of direct contact to cetaceans and sea turtles in the deep offshore waters of Kwajalein Atoll were calculated based on the radial impact scenario in the FE-1 BA (US Navy and USASMDC, 2017). Based on these analyses, the chance of direct contact exposures for cetaceans in the deep waters near Kwajalein Atoll is between 1 in 1,495 and 1 in 191,748 depending on individual species densities. If totaled across species, total number of cetacean exposures has been estimated to be 0.0036 (chances 1 in 278). Assumptions of these analyses are discussed in section 4.2.2.2.2. It is important to note that these estimates are likely overestimates as calculations were based on the maximum possible affect area and assume the entire area would be subject to direct strike rather than subject to payload fragment impact. Based on these calculations, marine mammals are not expected to be impacted by direct contact from payload impact.

The chance of an individual sea turtle being in the area subject to possible direct contact from payload impact has been estimated as 1 in 7,315. These estimates are likely overestimates as calculations were based on the maximum possible affect area and assume the entire area would be subject to direct strike rather than subject to payload fragment impact. Based on these estimates, sea turtles are not likely to be impacted by direct contact from payload impact in deep ocean waters near Kwajalein Atoll. While little data is available for fish densities in the deep offshore waters near Kwajalein Atoll, fish species are not expected to be impacted by direct contact from payload impact.

Direct contact or shock waves from splashdown of payload components may adversely impact individual larval fish, corals or mollusks that may be present as components of drifting plankton. However, estimates of potential impact on larvae would have to include a margin of error of several orders of magnitude. Even if applicable density data existed, the distribution of larval organisms is likely to be so variable in space and time that accurate estimates of potential incidental take of larval consultation species would have to be based on samples taken at the precise time and location of splashdown of either missile parts or RVs. It is possible that a very low number of fish, coral, or mollusk larvae would be within the affected volume of surface water but this is a very small and indeterminable number. In general, the consequences of taking individual larvae are considered to be substantially less severe than the consequences of taking individual adults because the baseline mortality rate of larvae is several orders of magnitude higher than for adults; therefore, the odds of individual larvae surviving to reproductive age are substantially lower than the odds of an adult surviving to reproduce again (Gascoigne and Lipcius 2004). No adverse effects due to direct contact are expected for adult fish, coral, or mollusks in the deep offshore waters near Kwajalein Atoll.

Three times over at least the week prior to the test as as close to launch as safely practicable, overflights of Illeginni would conducted to survey for marine mammals and sea turtles. At least 30 days prior to launch and as close to launch as safely practicable, the beach area would be inspected for active sea turtle nests. Sightings would be reported to the USAG-KA Environmental Engineer, the RTS Range Directorate, and the Flight Test Operations Director for consideration in approving the launch. When feasible, within 1 day after the flight test, the islet and near-shore waters would be surveyed for injured wildlife, damaged coral, or damage to sensitive habitat. Results of the survey would be provided to the USAG-KA Environmental Engineer to forward to the NFMS, USFWS, and the RMIEPA.

4.3.2.3.3 Vessel Strike

The Proposed Alternative Action has the potential to increase ocean-going vessel traffic in the ROI. Pre-test activities would include vessel traffic to and from one of the two deep-water offshore payload impact sites. Prior to the test flight, sensor rafts would be deployed near the impact site from a LCU vessel. The large raft would have running lights and station-keeping ability; visual deterrents (e.g., scarecrows, Mylar flags) would be employed on the raft to discourage birds from resting on the raft. Post-test recovery efforts would also result in increased vessel traffic to the payload impact site for recovery of deployed sensor rafts. Vessel traffic would be elevated in the deep water impact areas for up to 4 weeks.

Estimation of Vessel Strike Impacts

<u>*Terrestrial Wildlife.*</u> Seabirds that forage in deep waters offshore of Kwajalein Atoll may be exposed to vessels transiting to and from the offshore payload impact zones. Direct collisions of birds with Navy vessels are unlikely and not expected. Birds are more likely to be visually and behaviorally disturbed by

vessels causing birds to either avoid vessels or in some cases to follow vessels. No adverse impacts to birds are expected from vessels transiting to and from offshore impact zones.

Marine Wildlife. Marine organisms have the potential to be affected by vessel strike primarily by being at the surface when a vessel travels through an area. Organisms at the surface are at risk of being struck by the vessels or their propellers. Organisms that are not found at the sea surface have the potential of being struck when a vessel drops anchor or if a vessel runs aground.

Cetaceans, sea turtles, fish, corals, and mollusks present in the deep ocean waters near Kwajalein Atoll and/or in the vicinity of Illeginni Islet are not expected to be adversely impacted by vessel strike for the following reasons: 1) A small number of vessel trips would be required to support pre-flight and post-flight cleanup activities and there would be only one flight. 2) While cetaceans and sea turtles breath air, must surface to breathe, and are known to bask at the ocean surface, these are highly mobile animals capable of avoiding vessels and they may already be used to some vessel traffic in the ROI. 3) Fish species do not need to surface to breathe are not known to frequent the ocean surface, and are highly mobile animals capable of avoiding vessels. 4) Corals and mollusks have the potential to be struck by a dropped anchor or a vessel contacting reef habitats, although this is unlikely, vessel operators would be made aware of sensitive reef habitats in order to avoid these areas. 5) Vessel operators would watch for and avoid cetaceans and sea turtles by adjusting their course and speed.

4.3.2.3.4 Exposure to Hazardous Chemicals

Following the impact of the payload, fragmentation of the payload would disperse any of the residual onboard hazardous materials (Table 2-2), such as battery acids, residual explosives, and heavy metals, around the impact point. Onboard the payload there would be up to four lithium ion batteries each weighing between 1.36 and 22.68 kg (3 and 50 lbs) and two radio frequency transmitters. The batteries carried onboard the payload would be discharged by the time the vehicle impacts; however a small quantity of electrolyte material (on the order of a couple ounces) may still enter the marine environment. The payload also carries up to 454 kg (1,000 lbs) of tungsten alloy which would enter the marine environments upon payload impact. The payload structure itself contains heavy metals including aluminum, titanium, steel, magnesium, tungsten, and other alloys.

Debris would be expected to fall within 100 m (328 ft) of the impact point. Post-flight cleanup of the impact area would include recovery/cleanup off all visible floating debris. Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any cetaceans, fish or sea turtles in the area.

Since up to 454 kg (1,000 lbs) of tungsten alloy would be contained on the payload, that amount of tungsten alloy would be introduced into the marine environments upon payload impact. The effects of tungsten alloys in ecosystems are largely unknown. Generally, dispersion of the tungsten alloy is not expected due to its relatively insoluble nature, the depth at which it would come to rest, which would result in low temperatures, low oxygen content, and no sunlight to facilitate chemical interaction. There also is lack of mixing in the deep sea water column; the deep Pacific experiences no deep convection of cooled salty surface water because the surface layer is too fresh and buoyant to sink. The bench study and model results (LLNL, 2017) indicate very slow dissolution and passivation (i.e., natural chemical encapsulation) of tungsten from FE-1 may occur in sea water such that. tungsten concentrations would have little or no impacts on marine organisms.

Post-flight cleanup activities may include the use of vessels for radar placement and retrieval and has the potential to introduce fuels and oils into the marine habitats. Equipment operation would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life. Any accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be transported to Kwajalein Islet for proper disposal. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous material releases would comply with the emergency procedures set out in the KEEP and the UES. Following cleanup and repair operations at Illeginni, soil samples would be collected at various locations around the impact area and tested for pertinent contaminants.

Estimation of Exposure to Hazardous Chemical Impacts

Terrestrial Wildlife. While terrestrial habitat does not occur in the deep water offshore payload impact zones, foraging seabirds may occur in these areas. Foraging seabirds are not expected to be exposed to hazardous chemicals and not impacts from hazardous chemicals on foraging seabirds are expected.

Marine Wildlife. Release of hazardous chemicals into the deep offshore waters near Kwajalein Atoll is not expected to adversely impact cetaceans, sea turtles, fish, corals, mollusk, or larval fish, corals, and mollusks. The area which would be affected by dissolution of chemicals would be relatively small because of the size of the payload components and the amount of residual materials they would contain. Components would likely sink to the ocean floor and since these are deep waters, cetaceans, sea turtles, and fish are not likely to contact them. Any chemicals introduced into the water column would be quickly diluted and dispersed and the low densities and patchy distributions of marine mammals, sea turtles, and larval fish, corals, and mollusks in the area make contact with hazardous chemicals unlikely.

4.3.2.3.5 Disturbance from Human Activities and Equipment Operation

Both pre-flight preparations and post-flight cleanup activities would result in elevated levels of human activity in marine environments. Elevated levels of human activity are expected for a period of up to four weeks. Personnel and equipment would be used for preparation of the impact site including placement of radars in ocean areas. Post-flight cleanup would involve recovery of all debris possible and radars and would include personnel and vessels in ocean areas.

Acoustic effects associated with post-test operations would be consistent with any other sea activity that uses mechanized equipment and the greatest intensity would be centered on the payload impact location. Potential consequences of these acoustic effects include noise avoidance and temporary disruption of feeding or predator avoidance behaviors in sea turtles, some motile invertebrates and small fish (Mooney et al. 2010). Because these acoustic effects are substantially less intense than sonic boom overpressures, the area of potential effect would be substantially smaller (See section 4.3.2.3.1).

Estimation of Disturbance from Human Activities and Equipment Operation Impacts

Terrestrial Wildlife. No terrestrial habitat exists in the offshore payload impact zones; however, foraging seabirds may occur in these areas. While disturbance from human activities and equipment operation has the potential to impact birds, the density of foraging sea birds in this area is likely very low. It is unlikely that human activity and equipment operation would disturb, or subsequently impact, any birds in these offshore payload impact zones.

Marine Wildlife. Marine organisms such as cetaceans, sea turtles, and fish may be disturbed by vessel traffic for delivering personnel and equipment, dive operations for debris recovery, and by deployment of radar rafts. These highly mobile animals may exhibit avoidance behavior by leaving the disturbed area. However, animals are expected to return to normal distributions and behaviors soon after the disturbance has ceased and affects are expected to be insignificant.

Disturbance from human activity and equipment operation is not expected to adversely impact cetaceans, sea turtles, fish, invertebrates or larval fish, coral, or mollusks in the deep ocean waters near Kwajalein Atoll. The duration of disturbance is expected to be short and these widely dispersed, highly mobile species are able to avoid areas of disturbance by leaving the area. It is expected that these species would return to normal behaviors and distributions after cessation of human activities or equipment operation.

4.3.3 Noise within the Kwajalein Atoll

Noise Resources Potential Impacts:

- **No Action: No Change**
- **Preferred Impact Location: No Significant Impact**
- **Alternative Impact Locations: No Significant Impact**

Analysis of potential noise impacts includes estimating likely noise levels from the Proposed Action and determining potential effects to sensitive receptor sites.

4.3.3.1 No Action Alternative

Under the No Action Alternative, the Proposed Action would not occur and there would be no change to noise levels in the ROIs. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.

4.3.3.2 Proposed Action

The ROIs for noise from the FE-1 flight test are Illeginni Islet for a land impact or one of the BOA locations southwest of Illeginni Islet or east of Gagan for a water impact.

Illeginni Islet (Preferred Impact Location)

Terminal flight of the payload over the RMI would create a sonic boom carpet along its flight path. Because of the vehicle’s high altitude during flight, maximum elevated sound pressure levels from sonic booms beneath the flight corridor would be 145 dB re 1 μPa in air) until descent. As the payload nears RTS, the vehicle would fly towards the pre-designated impact site at Illeginni Islet. During vehicle descent, a focused boom would occur over the intended site and the nearby areas of the Atoll.

At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB (Table 4-2). At the point of impact, the sonic boom footprint would narrow. For payload impact at Illeginni Islet, elevated SPLs due to the sonic boom would be present in the air over land and would also be present in the surrounding waters. The duration for sonic boom overpressures produced by the payload are expected to average 75 ms where SPLs are greater than 140 dB and 270 ms where SPLs are less than 140 dB.

Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area.

Within Kwajalein Atoll, Kwajalein and Roi-Namur islets are the only populated islets under USAG-KA management. There are also Marshallese residents located on Ennubirr Islet (southeast of Roi-Namur Islet), Ebeye Islet, Carlos Islet (located a few miles northwest of Kwajalein Islet), and on a few other islets.

While meteorological conditions can influence peak sound pressure levels, noise for these areas is estimated to peak at less than 180 dB near impact (Table 4-2). Because the sonic boom footprints at impact normally do not overlap any RMI communities, there are no residents within 18 mi (29 km) of Illeginni Islet, the sonic boom would be audible only once at any nearby location and last no more than a fraction of a second, and because range evacuation procedures are implemented during such flight tests, no residents or personnel are expected to be subjected to significant noise-related impacts.

The populated islets are located outside the sonic boom footprint and residents at these locations may not hear the noise at all. During the flight test, RTS would verify that no non-mission vessels would be in the area. Depending on a mission vessel's location, on-board personnel may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program.

Noise levels during pre-test and post-flight activities at the pre-determined target site would occur in an unpopulated area without resident receptors. FE-1 flight test personnel and RTS and USAG-KA personnel also may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program.

Offshore Waters – Southwest and Northeast of Kwajalein Atoll (Alternative Impact Locations)

As with an Illeginni impact, for an Offshore Waters impact, because of the vehicle's high altitude during flight, maximum elevated sound pressure levels from sonic booms beneath the flight corridor would be 145 dB re 1 µPa in air until descent. As the payload nears RTS, the vehicle would fly towards the pre-designated impact site. During vehicle descent, a focused boom would occur over the intended site and the nearby areas of the Atoll.

At the terminal end of the flight path, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB (Table 4-2). At the point of impact, the sonic boom footprint would narrow. For payload impact at Illeginni Islet, elevated SPLs due to the sonic boom would be present in the air over the ocean. The duration for sonic boom overpressures produced by the payload are expected to average 75 ms where SPLs are greater than 140 dB and 270 ms where SPLs are less than 140 dB.

Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area.

The populated islets are located outside the sonic boom footprint for an Offshore Waters impact and residents at these locations may not hear the noise at all. Noise from the sonic boom would be audible only once, would last no more than a fraction of a second, and would be well within the Army standard of 140 dB (peak sound pressure level) for impulse noise at the closest populated islets. During the flight test, RTS would verify that no non-mission vessels would be in the area. Depending on a mission vessel's location, on-board personnel may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program.

Noise levels during pre-test and post-flight activities at the pre-determined impact site would occur in mostly in unpopulated areas without resident receptors. FE-1 flight test personnel and RTS and USAG-KA personnel may be required to wear hearing protection in compliance with the Army's Hearing Conservation Program

As a result, noise levels for an Offshore Waters impact are not expected to have a significant impact on the human environment and implementation of the FE-1 flight test would not result in significant impacts from noise.

4.3.4 Public Health and Safety within Kwajalein Atoll

Public Health and Safety Potential Impacts:

- **No Action: No Significant Impact**
- **Preferred Impact Location: No Significant Impact**
- **Alternative Impact Locations: No Significant Impacts**

The public health and safety analysis section address issues related to the health and well-being of military personnel and civilians living on or in the vicinity of USAKA. Specifically, this section provides information on hazards associated with a single FE-1 flight test. Additionally, this section addresses the environmental health and safety risks to children.

4.3.4.1 No Action Alternative

Under the No Action Alternative, the FE-1 flight test would not occur and there would be no change to public health and safety. Therefore, no significant impacts to public health and safety would occur with implementation of the No Action Alternative.

4.3.4.2 Proposed Action

The developmental payload would descend into one of the two Offshore Waters locations or Illeginni Islet. Nominally, the payload would break up on or just before impact. The payload would not have a thrust mechanism and data would be transmitted to range safety personnel to allow a continuing evaluation of the "health" of the FTS and the performance of the payload against the safety criteria. The payload FTS would be designed to cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. This failsafe requires positive action to be taken by range safety personnel to allow the payload to continue flight to the pre-designated impact site. In this manner, the resulting debris would fall short of any protected or inhabited area.

Therefore, the presence of non-mission vessels and aircraft in proximity to the impact zone represents the greatest risk to public health and safety for all the FE-1 flight test alternatives.

Illeginni Islet (Preferred Impact Location)

There are no resident populations in proximity to Illeginni Islet where the payload would impact. A NOTMAR and a NOTAM are transmitted to appropriate authorities to clear commercial, private, and non-mission military vessel and aircraft traffic from caution areas and to inform the public of impending missions. The warning messages describe the time, the area affected, and safe alternate routes. The GRMI also is informed in advance of rocket launches and reentry payload missions. A fact sheet describing the project and the environmental controls would be prepared and would be provided at locations on Ebeye and Kwajalein Island. Radar and visual sweeps of hazard areas would be regularly scheduled and conducted prior to launch to clear any non-mission ships and aircraft.

Offshore Waters – Southwest and Northeast of Kwajalein Atoll (Alternative Impact Locations)

As with the land impact site, there are no resident populations in proximity to either of the Offshore Waters locations where the developmental payload would impact. The same precautions to notify the public and ensure there are no vessels or aircraft in the Illeginni Islet area would be undertaken for either deep offshore water impact zone.

In accordance with EO 13045, Protection of Children from Environmental Health and Safety Risks, since the majority of the FE-1 flight test would be conducted on DoD property and out in the open ocean, this EA/OEA has not identified any environmental health and safety risks that may disproportionately affect children.

Based on the above, implementation of the FE-1 flight test would not result in significant impacts to Public Health and Safety at USAKA.

4.3.5 Hazardous Materials and Wastes within Kwajalein Atoll

The hazardous materials and wastes analysis addresses issues related to the use and management of hazardous materials and wastes as well as the management of specific cleanup at within the ROIs at USAKA.

4.3.5.1 Hazardous Materials and Wastes within Kwajalein Atoll - No Action Alternative

Under the No Action Alternative, the FE-1 flight test would not occur and there would be no change associated with hazardous materials and wastes at Kwajalein Atoll. Therefore, no significant impacts would occur to hazardous materials and waste with implementation of the No Action Alternative.

4.3.5.2 Hazardous Materials and Wastes within Kwajalein Atoll - Proposed Action

The payload would descend into Illeginni Islet or one of the two offshore waters locations. The payload would break up on or just before impact.

Illeginni Islet (Preferred Impact Location)

As shown in Table 2-2, hazardous materials used in the developmental payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, DU, Be, or radioactive materials would be carried on the developmental payload. Each battery would be environmentally qualified, including safeguards for containing accidental hazardous battery casing leak or electrical anode or cathode shorting. All explosive devices would be handled in accordance with DoD 6055.09-STD. Specific restoration actions and debris recovery, if necessary, would be determined on a case-by case basis in compliance with the UES and in coordination with the USAG-KA Environmental Office. At the conclusion of launch activities, LLNL, RTS, Navy Project, and USAG-KA personnel would remediate the impact site, all visible debris would be removed, and all equipment and materials would be recovered from Illeginni Islet. Any hazardous waste resulting from FE-1 flight test activities on Illeginni Islet would be disposed of in accordance with the UES.

Offshore Waters – Southwest and Northeast of Kwajalein Atoll (Alternative Impact Locations)

The payload would breakup prior to or upon impact with the water and recovery would not be attempted. All parts would be expected to sink to the sea floor. If there were any floating debris, it would be recovered and brought onboard a vessel for appropriate handling and disposal in accordance with the UES.

The UES, KEEP, and HMMP specified procedures for hazardous materials and waste would be followed. Activity-specific Hazardous Materials Procedures would be submitted by the project or mission proponents to the Commander, USAG-KA for approval within 15 days of receipt of any hazardous material or before use, whichever comes first. Hazardous materials would be under the direct control of the user organization to ensure these materials are stored and used in accordance with UES requirements. Identified hazardous materials would be expected to be consumed in operational processes associated with the FE-1 flight test. Disposal of wastes resulting from the FE-1 flight test also would be in accordance with the UES.

Therefore, implementation of the Proposed Action would not result in significant impacts to hazardous materials and wastes.

4.4 Summary of Potential Impacts to Resources and Impact Avoidance and Impact Avoidance and Minimization

A summary of the potential impacts associated with each of the action alternatives and the No Action Alternative and impact avoidance and minimization measures are presented in Tables 4-6 and 4-7, respectively.

Table 4-6 Potential Impacts Associated with the No Action Alternative and the Proposed Action

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
PMRF	**Air Quality**	There would be no change to baseline air quality and, therefore, no significant impacts to air quality or air resources would occur with implementation of the No Action Alternative.	STARS launches have been determined to not have a significant impact on air quality. Existing aircraft exercises and support from the PMRF airfield are not restricted by the current Title V permit held by PMRF. A General Conformity Rule applicability analysis is not required for Navy actions in Hawai`i. The STARS is relatively small and the launch is a short-term, discrete event; the time between launches of the Proposed Action and other launches scheduled from SNL/KTF would allow the dispersion of greenhouse gases and ozone depleting substances. A single launch for the FE-1 flight test would have a similar air quality impact as described for the No Action Alternative.
	Water Resources	There would be no change to baseline water resources, and therefore, no significant impacts to water resources from implementation of the No Action Alternative.	Sampling and analyses of soil and water prior to and following previous STARS launches did not indicate impacts. Perchlorate analytical results indicated levels were within guidelines. The Proposed Action would not result in significant impacts to water resources.
	Biological Resources	There would be no change to biological resources, and therefore, no significant impacts to biological resources from implementation of the	Based on prior analyses, and the effects of current and past missile launch activities, the potential impacts of the Proposed Action on terrestrial biological resources are expected to be minimal. No ground clearing or construction is expected and no long term adverse impacts on vegetation are expected. No threatened or endangered plants have been observed on PMRF and critical habitat for the ohai and lau`ehu would not

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
		No Action Alternative.	be affected by the action. The launch site at KTF is in an area that has routine human activity, equipment operation, and launch activity. Terrestrial species at PMRF are already habituated to high levels of noise associated with ongoing activities at this facility. Because aluminum oxide and hydrogen chloride do not bioaccumulate, no indirect effects on the food chain are anticipated from these exhaust emissions. Marine species at PMRF are likely already habituated to high levels of noise associated with ongoing activities at this facility. No impacts on marine wildlife due to direct contact from debris are expected during normal flight operations.
	Airspace	There would be no change to airspace use or control, and therefore, no impacts to airspace from implementation of the No Action Alternative.	The Navy SSP FE-1 flight test would be similar to previous ballistic missile tests, and the potential impacts on controlled and uncontrolled airspace, special use airspace, en route airways and jet routes, and airports and airfields would be similar to that described for missile launches in previous environmental documentation for PMRF and SNL/KTF. The advanced planning and coordination with the FAA regarding: scheduling of special use airspace, and coordination of the proposed FE-1 flight test relative to en route airways and jet routes, would result in minimal impacts on airspace. Therefore, implementation of the Proposed Action would not result in significant impacts to airspace.
	Noise	There would be no change to noise sources, and therefore, no impacts from noise resulting from implementation of the No Action Alternative.	Launch of missiles is a routine activity from SNL/KTF. The STARS booster has been previously launched at SNL/KTF, and noise levels for the FE-1 flight test would be the same as for previous STARS launches, and would not result in significant impacts to the noise environment.
	Public Health and Safety	With only one less launch from SNL/KTF, there would be no significant change to public health and safety. No significant impacts to public health and safety would result from the	The STARS booster has been previously launched at SNL/KTF. Flight testing the payload from the same site would have a similar potential health and safety impact as described for the No Action Alternative. The proposed solid propellants would be similar to past launches and would follow the same health and safety procedures developed under existing plans. Implementation of the Proposed Action would not result in

Location	Resource Area	No Action Alternative	Navy SSP FE-1 Proposed Action
		No Action Alternative.	significant impacts to public health and safety.
	Hazardous Materials and Wastes	There would be no change to hazardous materials and wastes, and, therefore, no significant impacts from hazardous materials and wastes that would result from implementation of the No Action Alternative.	The FE-1 flight test launch would use similar hazardous materials and produce similar hazardous waste as previous STARS launches. The FE-1 launch is included in the overall number of missile launches proposed in the HRC EIS/OEIS. Hazardous material usage and waste generation would continue to be managed by PMRF under appropriate State and Federal requirements. Therefore, implementation of the Proposed Action would not result in significant impacts from hazardous materials and wastes.
Over-Ocean Flight Corridor	**Air Quality**	Under the No Action Alternative, the FE-1 flight test would not occur and there would be no change to baseline air quality in the over-ocean flight corridor. No significant impacts to air quality or air resources would occur with implementation of the No Action Alternative	Under the Proposed Action, following the FE-1 flight test, the majority of Al_2O_3 would be removed from the stratosphere through dry deposition and precipitation. Emissions from a STARS vehicle launch would be relatively small compared to all emissions released on a global scale. The large air volume over which the STARS emissions are spread, and the rapid dispersion of the STARS emissions by stratospheric winds would reduce potential impacts. Ozone-depleting gas emissions from the single flight test would represent such a minute increase that even incremental effects on the global atmosphere are not likely. The Proposed Action would not have a significant impact on stratospheric ozone or on the upper atmosphere The amount of GHG emissions that would be released from activities associated with a single FE-1 flight test is assumed to be negligible based on the small number of vessels and aircraft utilized and the short period of time for conducting the single FE-1 flight test activities. This limited amount of emissions would not likely contribute to global warming and climate change to any discernible extent. Implementation of the Proposed Action would not result in significant impacts to Air Quality or GHG Emissions.
	Biological Resources	There would be no change to biological resources, and therefore, no significant impacts to biological resources from implementation of the	*Marine Wildlife*: Noise: Sonic booms overpressures would not exceed PTS, TTS, or behavioral disturbance thresholds for organisms in the BOA and therefore no adverse impacts from sonic booms are expected. Splashdown pressures would exceed PTS thresholds for high frequency cetaceans and seabirds. These pressures would also exceed TTS thresholds for high and low frequency

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
		No Action Alternative.	cetaceans, Hawaiian monk seals, birds, and fish. These organisms may also be exposed to SPLS high enough to cause behavioral disturbance. While effects of elevated SPLs are possible, based on species abundance and distribution in the BOA, the chances of this occurring are likely very low. Any effects of elevated SPLs are likely to be temporary, behavioral modifications with no lasting effects. Therefore no significant impacts from elevated SPLs are expected. Direct Contact: The chances of and FE-1 component directly contacting a marine mammal are very low (1 in 20,200 total for all species). The chances of direct contact with a sea turtle are also extremely low (1 in 710,000). Direct contact would not be expected to adversely impact cetaceans, sea turtles, birds, fish or EFH in the BOA. Hazardous Chemicals: the release of hazardous materials carried onboard a launch vehicle would not significantly impact marine life. Hazardous materials would be rapidly diluted in the seawater and. larger and heavier vehicle components would sink fairly quickly to the ocean floor to depths where consultation organisms would likely not be in contact with these materials. Increased Human and Vessel Activity: Vessel traffic is common in this area and the increase in human activity and vessel traffic in the BOA would be expected to be minimal; these activities would not be expected to impact marine resources including threatened and endangered species or EFH.
USAKA, RMI	**Cultural Resources**	There would be no changes and therefore, no impacts to cultural resources from implementation of the No Action Alternative.	For a land impact, the FE-1 flight test would occur on the west end of Illeginni Islet. Archaeological surveys have not found indigenous cultural materials or evidence of subsurface deposits on the Islet. The Cold War-era properties potentially eligible for listing on the RMI NRHP are located in the central and eastern portions of the Islet. Because a land impact would not occur in proximity to known or potential cultural resources on Illeginni Islet, implementation of the Preferred Alternative would not result in significant impacts. There are no cultural resources associated with either the southwest or northeast BOA location.
Illeginni Islet	**Biological Resources**	There would be no change to biological resources under the No Action Alternative. Therefore, no impacts	*Terrestrial Veget*ation: Terrestrial vegetation in the payload impact zone at Illeginni is vegetation of previously disturbed habitat and is predominantly managed vegetation. Therefore, no adverse impacts to terrestrial vegetation are expected. Terrestrial Wildlife:

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
		would occur to biological resources with implementation of the No Action Alternative	Noise: It is likely that birds would be exposed to SPLs high enough to cause behavioral disturbance. While birds might be temporarily startled by these sounds, any behavioral or physiological response is likely to be very brief and no adverse impacts to birds on or near Illeginni Islet are expected due to elevated SPLs. Direct Contact: While direct contact from payload debris may impact any birds in the impact zone, very few birds are expected to be within this area. Birds roosting or nesting in the adjacent littoral forest and shrub habitats are not expected to be adversely impacted by payload impact While Illeginni Islet has shoreline habitat suitable for sea turtle nesting, no sea turtle nests or nesting activity have been observed on Illeginni in over 20 years. The last evidence of sea turtle nesting activity on Illeginni Islet consisted of observations of nest pits in 1996, 21 years ago. Therefore, the US Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-1 activities may but are not likely to adversely affect nesting sea turtles (US Navy and USASMDC, 2017). The USFWS has concurred with this determination (Appendix A).Vessel Strike: Direct collisions of birds with Navy vessels are unlikely and not expected. No adverse impacts to birds are expected from vessels transiting to and from Illeginni Islet. Exposure to Hazardous Chemicals: Hazardous chemicals are not expected to impact birds at Illeginni Islet. Hazardous chemicals may adversely impact nesting sea turtles, sea turtle nests, and/or sea turtle nesting habitat. Payload debris and ejecta have the potential to include hazardous chemicals including heavy metals. If these chemicals were introduced into sea turtle nesting habitat, they have the potential to dissuade females from nesting, harm sea turtle eggs, or affect the health of sea turtle hatchlings. While Illeginni Islet has shoreline habitat suitable for sea turtle nesting, no sea turtle nests or nesting activity have been observed on Illeginni in over 20 years. The last evidence of sea turtle nesting activity on Illeginni Islet consisted of observations of nest pits in 1996, 21 years ago. Therefore, the US Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-1 activities may but are not likely to adversely affect nesting sea turtles (US Navy and USASMDC, 2017). The USFWS has concurred with this determination (Appendix A).Human Disturbance: Disturbance from human activities and equipment operation has the potential to impact birds, especially nesting seabirds on Illeginni islet; however any disturbance is not expected to have a significant, long term impact. Disturbance from human activities and equipment operation may but is not likely to

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
			adversely impact nesting sea turtles, sea turtle nests, and/or sea turtle nesting habitat While Illeginni Islet has shoreline habitat suitable for sea turtle nesting, no sea turtle nests or nesting activity have been observed on Illeginni in over 20 years. The last evidence of sea turtle nesting activity on Illeginni Islet consisted of observations of nest pits in 1996, 21 years ago. Therefore, the US Navy and USASMDC have concluded that the probability of sea turtle nesting in the area is so low as to be discountable and that FE-1 activities may but are not likely to adversely affect nesting sea turtles (US Navy and USASMDC, 2017). The USFWS has concurred with this determination (Appendix A). Marine Wildlife: Noise: The maximum SPLs for sonic booms and payload impact at the terminal end of payload flight do not exceed the PTS or TTS thresholds for cetaceans or, sea turtles, or fish. Payload impact would result in SPLs above the injury threshold for fish but only out to 2.2 m from impact; therefore injury to fish is unlikely. There is a potential for behavioral disruption in sea turtles and fish near the payload impact point. While there is a chance that up to 2 green sea turtles and 7 hawksbill turtle may be exposed to SPLs high enough to elicit behavioral response, any response is expected to be temporary and turtles would be expected to return to normal behavior within minutes. Any behavioral disturbance in fish would likely be limited to a brief startle response and behaviors would quickly return to normal. Therefore, no lasting adverse impacts are expected from elevated SPLs. Direct Contact: Payload impact is not expected to adversely affect cetaceans or sea turtles in the water through direct contact. Payload impact may adversely impact a very small, but indeterminable, number of larval fish, corals or mollusks. The number of larvae potentially affected is likely to be trivially small relative to their population sizes and the effects are considered discountable. Based on analyses of a worst-case scenario of a shoreline impact, direct contact from payload debris may also affect up to 9,097 coral colonies, 468 individual mollusks, and 100 juvenile and 8 adult humphead wrasses. The NMFS has been provided these analyses in a BA and they found that a total of up to 9,929 colonies of consultation corals, 117 top shell snails, and 12 giant clams could be affected by direct contact, ejecta, and/or shock waves from a FE-1 payload impact near the Illeginni shoreline. The NMFS also concluded that the potential loss of these adult coral and mollusk species is not expected to eliminate them from Illeginni or to appreciable reduce the likelihood of their survival and recovery (NMFS, 2017b; Appendix E). Vessel Strike: Marine wildlife has the potential to be impacted

Location	Resource Area	No Action Alternative	Navy SSP FE-1 Proposed Action
			by vessel strike primarily by being at the surface when a vessel travels through an area. Due to species characteristics, abundance, and distribution, and mitigation measures, no adverse impacts due to vessel strike are expected. Hazardous Chemicals: Post-flight cleanup of the impact area would include recovery/cleanup off all visible floating debris. Considering the small quantities of hazardous materials contained in the batteries, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, the battery materials released during payload impact should be of little consequence to any cetaceans, fish or sea turtles in the area. Hazardous chemicals have the potential to impact sea turtle nests and nesting. The USFWS has been provided a BA and the findings of their Final Biological Opinion are included in the Final EA/OEA. Human Disturbance: Cetaceans, sea turtles in the water, and most fish are unlikely to be adversely impacted by increased human activity or equipment operation at Illeginni Islet. In shallow waters near Illeginni, corals, mollusks, and reef-associated fish have the potential to be disturbed by shallow water debris recovery and/or backfill operations. The NMFS has been provided a BA and the findings of their Final Biological Opinion are included in Appendix E.
	Noise	There would be no change to noise levels in the ROIs. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.	While meteorological conditions can influence peak sound pressure levels, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB. At the point of impact, the sonic boom footprint would narrow and duration for sonic boom overpressures are expected to average 75 to 270 ms. Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area. Mission vessel personnel may be required to use hearing protection. Noise levels during pre-test and post-flight activities at the pre-determined target site would occur in an unpopulated area without resident receptors. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.
	Public Health and Safety	There would be no change to public health and safety under the No Action Alternative.	In case of an anomaly, the payload FTS would cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. For impact, there are no resident populations in proximity to Illeginni Islet. NOTAMs and NOTMARs would be issued to clear traffic from caution areas prior to the test. There would be no significant impacts

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
			to public health and safety from the Proposed Action.
	Hazardous Materials and Wastes	Under the No Action Alternative, there would be no change to hazardous materials and waste at Illeginni Islet.	Hazardous materials used in the payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, DU, Be, or radioactive materials would be carried on the payload. Flight test personnel would remediate the impact site, all visible debris would be removed, and all equipment and materials would be recovered from Illeginni Islet. Any hazardous waste resulting from FE-1 flight test activities on Illeginni Islet would be disposed of in accordance with the UES. No significant impacts would occur from the Proposed Action.
USAKA, RMI **Offshore Waters**	**Cultural Resources**	There are no known cultural resources within either of the BOA deep water impact locations.	There are no known cultural resources within either of the BOA deep water impact locations. No impacts would occur to Cultural Resources from the either Alternative Action location.
	Biological Resources		Terrestrial Wildlife: While no terrestrial habitat exists in the offshore waters, seabirds may forage in these areas. Based on likely seabird density and distribution in these areas, it is unlikely that seabirds would be exposed to SPLs high enough to cause injury or behavioral disturbance, direct contact, hazardous chemicals, vessel traffic, or human disturbance. Therefore seabirds are unlikely to be adversely impacted. Marine Wildlife: Noise: The maximum SPLs for sonic booms and payload impact at the terminal end of payload flight do not exceed the PTS or TTS thresholds for cetaceans or sea turtles. Payload impact would result in SPLs above the injury threshold for fish but only out to 2.2 m from impact; therefore injury to fish is unlikely. There is a potential for behavioral disruption in sea turtles and fish near the payload impact point. While there is a 1 in 4.3 chance that a sea turtle would be exposed to SPLs high enough to elicit behavioral response, any response is expected to be temporary and turtles would be expected to return to normal behavior within minutes. Any behavioral disturbance in fish would likely be limited to a brief startle response and behaviors would quickly return to normal. Therefore, no lasting adverse impacts are expected from elevated SPLs. Direct Contact: The total chance (all species combined) of a cetacean being directly contacted by payload impact in deep ocean waters is 1 in 278. There is a 1 in 7,315 chance that a sea turtle would be impacted by direct contact. Based on these chances, it is unlikely that a cetacean or sea turtle would be significantly impacted by direct contact from payload impact. Direct contact may adversely impact a very small, but

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
			indeterminable, number of larval fish, corals or mollusks. The number of larvae potentially affected is likely to be trivially small relative to their population sizes and the effects are considered discountable. Vessel Strike: Marine wildlife has the potential to be impacted by vessel strike primarily by being at the surface when a vessel travels through an area. Due to species characteristics, abundance, and distribution, and mitigation measures, no adverse impacts due to vessel strike are expected. Hazardous Chemicals: Post-flight cleanup of the impact area would include recovery/cleanup off all visible floating debris. Considering the small quantities of hazardous materials contained in the payload and the dilution and mixing capabilities of the ocean and lagoon waters, the materials released during payload impact should be of little consequence to any cetaceans, fish or sea turtles in the area. Human Disturbance: Cetaceans, sea turtles in the water, and fish are unlikely to be adversely impacted by increased human activity or equipment operation at Illeginni Islet.
Offshore Waters	**Noise**	There would be no change to the noise environment and, therefore, no impacts from noise.	While meteorological conditions can influence peak sound pressure levels, the sonic boom generated by the approaching payload is estimated to peak at less than 180 dB. At the point of impact, the sonic boom footprint would narrow and duration for sonic boom overpressures are expected to average 75 to 270 ms. Approximately 1 km^2 (0.4 mi^2) would be exposed to SPLs up to 170 dB. Noise model assumptions for estimating sonic boom overpressures likely lead to conservatively high estimates of sonic boom pressures and, therefore, conservative estimates of affected area. Mission vessel personnel may be required to use hearing protection. Noise levels during pre-test and post-flight activities at the pre-determined target site would occur in an unpopulated area without resident receptors. Therefore, no significant impacts would occur from noise with implementation of the No Action Alternative.
	Public Health and Safety	There would be no change to the Public Health and Safety and, therefore, no resulting impacts.	In case of an anomaly, the payload FTS would cut the nose section from the rest of the vehicle as a failsafe operation to ensure the safety of the Marshall Islands. For impact, there are no resident populations in proximity to either Offshore Waters location. NOTAMs and NOTMARs would be issued to clear traffic from caution areas prior to the test. There would be no significant impacts to public health and safety from the Proposed Action.

Location	*Resource Area*	*No Action Alternative*	*Navy SSP FE-1 Proposed Action*
	Hazardous Materials and Wastes	There would be no change to the Hazardous Materials and Wastes, and, therefore, no impacts would occur.	Hazardous materials used in the payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, DU, Be, or radioactive materials would be carried on the payload. Any hazardous waste resulting from FE-1 flight test activities from vessels or equipment would be disposed of in accordance with the UES. No significant impacts would occur from the Proposed Action.

1 **Table 4-7 Impact Avoidance and Minimization Measures**

Location	*Measure*	*Anticipated Benefit*	*Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*	*Estimated Completion Date*
PMRF	**FE-1 (Proposed Action)**					
	Transportation, handling, and storage of rocket motors and other ordnance would occur in accordance with DoD, Navy, and US DOT policies and regulations	Safeguard the materials from fire or other mishap	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DoD, Navy, and US DOT policies and regulations	Navy SSP, USAF	Within 1 year after the FONSI is signed
	Shipments would be inspected for species of plants and animals alien to the environment at Hawai'i	Prevent the introduction of alien species of plants and animals at Hawai'i and the RMI	Determine the rate of successful prevention, identifying the need for treatment applications, as necessary	Recordkeeping of all inspections and outcomes	Navy SSP	Within 1 year after the FONSI is signed
	Sandia personnel at KTF would conduct range responsibilities	Ensure appropriate launch preparation, including explosive safety, support to PMRF range safety and inter-range coordination	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DoD, Navy, and other applicable policies and regulations	Sandia	Within 1 year after the FONSI is signed
	Publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NOTMARs) prior to launch	Provide safety and warning to personnel, including private citizens and commercial entities, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DoD, Navy, and DOE policies and regulations	Navy SSP, Sandia	Within 1 year after the FONSI is signed
	Check launch pad area for safe access after vehicle liftoff	Ensure worker safety for post-launch inspection, clean-up, and maintenance	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with DoD, Navy, and DOE policies and regulations	Sandia	Within 1 year after the FONSI is signed

Over-Ocean Flight Corridor	**FE-1 (Proposed Action)**					
	Payload's flight path would avoid flying over the Northwestern Hawaiian Islands	Avoid impacts to protected species and habitats	Determine that actual flight path complies	Recordkeeping and reporting in accordance with DoD, Navy, and DOE range and flight safety policies and regulations, USFWS regulations, and the ESA and MMPA	Navy SSP, Sandia	Within 1 year after the FONSI is signed
	During travel in the BOA, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes. Vessel operators would adjust speed based on expected animal locations, densities, and or lighting and turbidity conditions when possible.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to SMDC, who would then inform NMFS and USFWS.	Recordkeeping and reporting to the appropriate authorities	Navy SSP, RTS	Within 1 year after the FONSI is signed
	Computer-monitored destruct lines, based on no-impact lines, are pre-programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols and US range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with DoD, Navy, and DOE range and flight safety policies and regulations	Navy SSP, Sandia	Within 1 year after the FONSI is signed
	FE-1 (Preferred Impact Location)					
USAKA, RMI Illeginni Islet	Computer-monitored destruct lines, based on no-impact lines, are pre-programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DoD, Navy, and RTS range and flight safety	Navy SSP, RTS	Within 1 year after the FONSI is signed

		and US range operation standards and practices		policies and regulations		
	Pre-flight monitoring by qualified personnel would be conducted on Illeginni Islet for sea turtles or sea turtle nests. On-site personnel would report any observations of sea turtles or sea turtle nests on Illeginni to appropriate test and USAG-KA personnel to provide to NMFS.	Avoid impacts to sea turtles and sea turtle nests	Determine the rate of successful compliance and incident prevention or occurrence	For at least 8 weeks preceding the FE-1 launch, Illeginni Islet would be surveyed by pre-test personnel for sea turtles, sea turtle nesting activity, and sea turtle nests on a bi-weekly basis. If possible, personnel would inspect the area within two days of the launch. If sea turtles or sea turtle nests are observed near the impact area, observations would be reported to appropriate test and USAG-KA personnel for consideration in approval of the launch and to NMFS. Recordkeeping and reporting in accordance with UES, DoD, Navy, and USFWS regulations	RTS/USAG-KA, Navy SSP	Within 1 year after the FONSI is signed
	RTS would conduct range responsibilities	Ensure appropriate launch preparation, including explosive safety, support to Navy	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, and RTS applicable policies and	RTS	Within 1 year after the FONSI is signed

		SSP and inter-range coordination		regulations		
	During travel to and from impact zones, including Illeginni Islet, and during raft deployment, ship personnel would monitor for marine mammals and sea turtles to avoid potential vessel strikes. Vessel operators would adjust speed or raft deployment based on expected animal locations, densities, and or lighting and turbidity conditions.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to the USAG-KA Environmental Office and SMDC, who would then inform NMFS and USFWS. USAG-KA aircraft pilots otherwise flying in the vicinity of the impact and test support areas would also similarly report any opportunistic sightings of dead or injured marine mammals or sea turtles.	If personnel observe sea turtles or marine mammals in potential impact zones, sightings would be reported to appropriate test and USAG-KA personnel for consideration in launch planning, recordkeeping and reporting in accordance with UES, DOD, Navy, and RTS policies and regulations.	Navy SSP, RTS	Within 1 year after the FONSI is signed
	Vessel and equipment operations would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm terrestrial or marine life. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous material	Avoid introduction of hazardous chemicals into terrestrial and marine environments.	Determine the rate of successful compliance and incident prevention	Vessel and heavy equipment operators would inspect and clean equipment for fuel or fluid leaks prior to use or transport, recordkeeping of all incidents and outcomes	Navy SSP, RTS	Within 1 year after the FONSI is signed

	releases would comply with the emergency procedures set out in the KEEP and the UES.					
	All equipment and packages shipped to USAG-KA would undergo inspection prior to shipment.	Prevent the introduction of alien species of plants and animals to Kwajalein Atoll	Determine the rate of successful prevention, identifying the need for treatment applications, as necessary	Recordkeeping of all inspections and outcomes	Navy SSP	Within 1 year after the FONSI is signed
	Sensor rafts would not be located in waters less than 3 m (10 ft) deep.	To avoid impacts on coral heads off Illeginni Islet	Determine the rate of successful compliance and incident prevention	Recordkeeping of deployments and outcomes	Navy SSP, LLNL	Within 1 year after the FONSI is signed
	Publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NOTMARs) prior to launch	Provide safety and warning to personnel, including private citizens and commercial entities, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, and RTS policies and regulations	Navy SSP, RTS	Within 1 year after the FONSI is signed
	FTS on the payload would include a failsafe operation	Further ensure the safety of the Marshall Islands and avoid debris falling on inhabited areas or any protected area, ensure compliance with Space System Software Safety Engineering protocols and US range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, and RTS policies and regulations	Navy SSP, Sandia, RTS	Within 1 year after the FONSI is signed
	Payload impact would be in the non-forested area, place scarecrows, Mylar flags, helium-filled	Avoid affecting the bird habitat	Determine the rate of successful compliance and incident prevention or	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS,	Navy SSP, RTS	Within 1 year after the FONSI is signed

	balloons, and strobe lights or tarp coverings on or near equipment and the impact area		occurrence	USFWS, and RMIEPA policies and regulations		
	The impact area would be searched for seabird nests, including eggs and chicks, prior to pre-flight activity. Any discovered seabird nest would be covered with an A-frame structure to protect eggs or chicks and to warn project personnel	Avoid impacts to seabirds, especially black-naped terns	Post-test monitoring to observe impacts to seabirds, especially black-napped terns, their nests, eggs, or chicks	Results of monitoring would be reported to USAG-KA Environmental and to USFWS		
	Debris recovery and site cleanup would be performed for land or shallow water impacts.	To minimize long-term risks to terrestrial and marine life	Comparison of recovered debris to known materials in the payload	All visible project-related debris would be recovered during post-flight operations, including debris in shallow lagoon or shallow ocean waters by range divers. In all cases, recovery and cleanup would be conducted in a manner to minimize further impacts on biological resources Protected marine species including invertebrates would be avoided or effects to them would be minimized, which may include movement of these organisms out	RTS, Navy SSP	Within 1 year after the FONSI is signed

				of the area likely to be affected.		
	Should any missile components or debris impact areas of sensitive biological resources (i.e., sea turtle nesting habitat or coral reef), a USFWS or NMFS biologist would be allowed to provide guidance and/or assistance in recovery operations to minimize impacts on such resources	Minimize impacts on terrestrial and marine biological resources	Determine whether components or debris impact sensitive resources, determine if a USFWS or NMFS biologist was contacted and allowed to provide guidance	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies and regulations	Navy SSP	Within 1 year after the FONSI is signed
	Should personnel observe endangered, threatened, or other species requiring consultation moving into the area, work would be delayed until such species leave the area or were out of harm's way.	Avoid impacts to terrestrial and marine wildlife	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting with UES, DoD, Navy, RTS, USFWS, and RMIEPA policies and regulations	Navy SSP	Within 1 year after the FONSI is signed
	Evacuation of nonessential personnel and sheltering all other personnel remaining within the Mid-Atoll Corridor; publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NOTMARs); perform radar and visual sweeps of the hazard area immediately prior to test flights	Provide safety and warning to personnel, including native Marshallese citizens, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, and RTS policies and regulations	Navy SSP, RTS	Within 1 year after the FONSI is signed
	Ordnance personnel	Ensure post-test	Determine the rate of	Recordkeeping in	RTS	Within 1 year after

	survey of impact site, removal of residual explosive materials, manual cleanup and removal of debris including hazardous materials, backfill impact crater, dive team or ROV survey and debris recovery for deeper water lagoon impact	personnel safety, avoid impacts to terrestrial and marine vegetation and wildlife	successful compliance and incident prevention with appropriate disposition of recovered materials	accordance with UES, DoD, Navy, and RTS policies and regulations		the FONSI is signed
	Inspect reef, reef flat, or shallow waters within 24 hours if inadvertently impacted, assess damage, decide on any mitigation measures	Avoid or minimize impacts to marine vegetation and wildlife	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS and RMIEPA policies and regulations	RTS, Navy SSP, possibly NMFS/USFWS	Within 1 year after the FONSI is signed
	Ensure that all relevant personnel associated with this project are fully briefed on the BMP and the requirement to adhere to them for the duration of this project.	Ensure awareness of and application of BMP for the duration of the FE-1 flight test	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP	Within 1 year after the FONSI is signed
	In the event the payload land impact affects the reef at Illeginni, personnel shall secure or remove from the water any substrate or coral rubble from the ejecta impact zone that may become mobilized by wave action as soon as possible. Ejecta greater than six inches in any dimension shall be removed from the water or positioned	Avoid impacts to marine wildlife, determine impacts to reef and disposition of ejecta	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed

	such that it would not become mobilized by expected wave action, including replacement in the payload crater. If possible, coral fragments greater than six inches in any dimension shall be positioned on the reef such that they would not become mobilized by expected wave action, and in a manner that would enhance its survival; away from fine sediments with the majority of the living tissue (polyps) facing up. UES consultation coral fragments that cannot be secured in-place should be relocated to suitable habitat where it is not likely to become mobilized.					
	In the event the payload land impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to reduce impacts on top shell snails. Rescue and reposition any living top shell snails that are buried or trapped by rubble. Relocate to suitable	Avoid impacts to marine wildlife	Post-test monitoring to observe impacts to reef and top shell snails, and determine disposition of ejecta	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed

	habitat, any living top shell snails that are in the path of any heavy equipment that must be used in the marine environment.					
	In the event the payload land impact affects the reef at Illeginni, personnel shall be required to reduce impacts on clams. Rescue and reposition any living clams that are buried or trapped by rubble. Relocate to suitable habitat, any living clams that are in the path of any heavy equipment that must be used in the marine environment.	Avoid impacts to marine wildlife	Post-test monitoring to observe impacts to reef and living clams, and determine disposition of ejecta	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed
	Appropriately qualified personnel shall be assigned to record all suspected incidences of take of any UES-consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Identification or refutation of all suspected incidences of take	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed
	Digital photography shall be utilized to record any UES- consultation species found injured or killed in or near the ocean target areas and/or at Illeginni. As practicable: 1) Photograph all damaged corals and/or other UES-consultation	Ensure accuracy of data collection and applicability to incidences of take	Photodocumentation prepared as per NMFS guidance	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed

	species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.					
	In the event the payload land impact affects the reef at Illeginni, personnel shall be required to reduce impacts on clams. Rescue and reposition any living clams that are buried or trapped by rubble. Relocate to suitable habitat, any living clams that are in the path of any heavy equipment that must be used in the marine environment.	Avoid impacts to marine wildlife	Post-test monitoring to observe impacts to reef and living clams, and determine disposition of ejecta	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed
	Appropriately qualified personnel shall be assigned to record all suspected incidences of take of any UES-consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Identification or refutation of all suspected incidences of take	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed
	Digital photography shall be utilized to record any UES- consultation species found injured or killed in or near the ocean target areas and/or at Illeginni. As practicable: 1) Photograph all	Ensure accuracy of data collection and applicability to incidences of take	Photodocumentation prepared as per NMFS guidance	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed

	damaged corals and/or other UES-consultation species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.					
	In the event the payload impact affects the reef at Illeginni, personnel shall survey the ejecta field for impacted corals, top shell snails, and clams. Also be mindful for any other UES- consultation species that may have been affected.	Avoid impacts to marine wildlife; ensure accuracy of data collection and applicability to incidences of take	Post-test monitoring to observe impacts to reef and identified organisms, including UES consultation species	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 60 days of completing post-test clean-up and restoration
	Within 60 days of completing post-test clean-up and restoration, provide photographs and records to the USAG-KA Environmental Office. USAG-KA and NMFS biologists will review the photographs and records to identify the organisms to the lowest taxonomic level accurately possible to assess impacts on consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Submittal of photographs and records within 60 days of completing post-test clean-up and restoration	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 60 days of completing post-test clean-up and restoration
	Within 6 months of completion of the action, US Navy SPP shall provide a report to USAG-KA to	Ensure compliance with UES and NMFS Biological Opinion Terms and Conditions	Submittal of report within 6 months of completing the action	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS,	US Navy SSP, USAG-KA	Within 6 months of completion of the action

	forward to NMFS. The report shall identify: 1) The flight test and date; 2) The target area; 3) The results of the pre- and post-flight surveys; 4) The identity and quantity of affected resources (include photographs and videos as applicable); and 5) The disposition of any relocation efforts.			USFWS and NMFS policies, regulations, and guidance		
	Prepare a project specific NPA and DEP	Ensure UES compliance	Complete the NPA and DEP prior to occurrence of the Proposed Action	Final DEP authorized with UES Appropriate Agencies' signatures prior to occurrence of the Proposed Action	Navy SSP	Within 1 year after the FONSI is signed
USAKA, RMI Southwest or Northeast Offshore Waters	**FE-1 (Alternative Impact Locations)**					
	Computer-monitored destruct lines, based on no-impact lines, are pre-programmed into flight safety software	Avoid debris falling on inhabited areas, ensure compliance with Space System Software Safety Engineering protocols and US range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DoD, Navy, and RTS range and flight safety policies and regulations	Navy SSP, RTS	Within 1 year after the FONSI is signed
	Raft would have running lights and station-keeping; no intentional ocean dumping should the instrumentation raft be inadvertently struck during the conduct of the mission; possible use of scarecrows, Mylar flags, helium-filled balloons, and strobe lights.	Maritime safety; compliance with international policy; visual deterrents to avoid inadvertent impacts to birds that might be on the raft	Determine the rate of successful compliance and incident prevention or occurrence	Recordkeeping and reporting in accordance with UES, DoD, Navy, and RTS range and flight safety policies and regulations	Navy SSP, RTS, LLNL	Within 1 year after the FONSI is signed; reporting on bird impacts before the end of the year in which the FE-1 flight test occurs

	FTS on the payload would include a failsafe operation to further ensure the safety of the Marshall Islands	Further ensure the safety of the Marshall Islands and avoid debris falling on inhabited areas or into any protected area, ensure compliance with Space System Software Safety Engineering protocols and US range operation standards and practices	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, and RTS policies and regulations	Navy SSP, RTS	Within 1 year after the FONSI is signed
	Visible debris on the water surface would be recovered and removed	Avoid physical impacts to marine life	Collection of any visible debris on the water surface or documentation of the lack of visible debris	All visible project-related debris on the water surface would be recovered during post-flight operations. In all cases, recovery and cleanup would be conducted in a manner to minimize further impacts on biological resources. Recordkeeping and reporting in accordance with UES, DoD, Navy, and RTS, policies and regulations	RTS/USAG-KA, Navy SSP	Within 1 year after the FONSI is signed
	Evacuation of nonessential personnel and sheltering all other personnel remaining within the Mid-Atoll Corridor; publication and circulation of Notices to Airmen (NOTAMs) and Notices to Mariners (NOTMARs); a fact sheet	Provide safety and warning to personnel, including native Marshallese citizens, concerning any potential hazard areas that should be avoided; ensure the clearance of non-critical personnel, vessels or aircraft in the vicinity	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, and RTS policies and regulations	Navy SSP, RTS	Within 1 year after the FONSI is signed

	describing the project and the environmental controls would be prepared and would be provided at locations on Ebeye and Kwajalein Island; perform radar and visual sweeps of the hazard area immediately prior to test flights.					
	Ordnance personnel survey of impact site, removal of residual explosive materials, manual cleanup and removal of surface floating debris including hazardous materials	Ensure post-test personnel safety, avoid impacts to marine vegetation and wildlife	Determine the rate of successful compliance and incident prevention with appropriate disposition of recovered materials	Recordkeeping in accordance with UES< DoD, Navy, and RTS policies and regulations	RTS	Within 1 year after the FONSI is signed
	Prepare a project specific NPA and DEP	Ensure UES compliance	Complete the NPA and DEP prior to occurrence of the Proposed Action	Final DEP authorized with UES Appropriate Agencies' signatures prior to occurrence of the Proposed Action	Navy SSP	Within 1 year after the FONSI is signed
	During travel to and from impact zones, ship personnel would monitor for marine mammals and sea turtles to avoid potential ship strikes. Vessel operators would adjust speed based on expected animal locations, densities, and or lighting and turbidity conditions.	Avoid impact on marine mammals and sea turtles.	Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel would be reported to the USAG-KA Environmental Office and SMDC, who would then inform NMFS and USFWS. USAG-KA aircraft pilots otherwise flying in the vicinity of the impact and test support areas would also similarly	If personnel observe sea turtles or marine mammals in potential impact zones, sightings would be reported to appropriate test and USAG-KA personnel for consideration in launch planning.	Navy SSP, RTS	Within 1 year after the FONSI is signed; reporting on marine mammal or sea turtle impacts before the end of the year in which the FE-1 flight test occurs

			report any opportunistic sightings of dead or injured marine mammals or sea turtles.			
	Vessel and equipment operations would not involve any intentional discharges of fuel, toxic wastes, or plastics and other solid wastes that could harm marine life. Hazardous materials would be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous material releases would comply with the emergency procedures set out in the KEEP and the UES.	Avoid introduction of hazardous chemicals into marine environments.	Determine the rate of successful compliance and incident prevention	Vessel and heavy equipment operators would inspect and clean equipment for fuel or fluid leaks prior to use or transport, recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, and RMIEPA policies and regulations	Navy SSP	Within 1 year of completion of the FONSI
	Should personnel observe endangered, threatened, or other species requiring consultation moving into the area, work would be delayed until such species leave the area or were out of harm's way.	Avoid impacts to terrestrial and marine wildlife.	Determine the rate of successful compliance and incident prevention	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, NMFS, USFWS, and RMIEPA policies and regulations	Navy SSP, RTS	Within 1 year after the FONSI is signed; reporting on any impacts before the end of the year in which the FE-1 flight test occurs
	Ensure that all relevant personnel associated with this project are fully briefed on the BMP and the requirement to adhere to them for the	Ensure awareness of and application of BMP for the duration of the FE-1 flight test	Determine the rate of successful compliance and incident prevention	Recordkeeping in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP	Within 1 year after the FONSI is signed

	duration of this project.					
	Appropriately qualified personnel shall be assigned to record all suspected incidences of take of any UES-consultation species.	Ensure accuracy of data collection and applicability to incidences of take	Identification or refutation of all suspected incidences of take	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed
	Digital photography shall be utilized to record any UES- consultation species found injured or killed in or near the ocean target areas and/or at Illeginni. As practicable: 1) Photograph all damaged corals and/or other UES-consultation species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.	Ensure accuracy of data collection and applicability to incidences of take	Photodocumentation prepared as per NMFS guidance	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 1 year after the FONSI is signed
	Within 60 days of completing post-test clean-up and restoration, provide photographs and records to the USAG-KA Environmental Office. USAG-KA and NMFS biologists will review the photographs and records to identify the organisms to the lowest taxonomic level accurately possible	Ensure accuracy of data collection and applicability to incidences of take	Submittal of photographs and records within 60 days of completing post-test clean-up and restoration	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 60 days of completing post-test clean-up and restoration

	to assess impacts on consultation species.					
	Within 6 months of completion of the action, US Navy SPP shall provide a report to USAG-KA to forward to NMFS. The report shall identify: 1) The flight test and date; 2) The target area; 3) The results of the pre- and post-flight surveys; 4) The identity and quantity of affected resources (include photographs and videos as applicable); and 5) The disposition of any relocation efforts.	Ensure compliance with UES and NMFS Biological Opinion Terms and Conditions	Submittal of report within 6 months of completing the action	Recordkeeping and reporting in accordance with UES, DoD, Navy, RTS, USFWS and NMFS policies, regulations, and guidance	US Navy SSP, USAG-KA	Within 6 months of completion of the action
	Perform a bench study to develop measurements of dissolution and potential migration of the tungsten alloy in Illeginni Islet soils	Inform future biological resources analyses of potential effects	Completion of the study and determination of findings	Report of study and findings made available to DOD partners, USEPA, NMFS, USFWS, and the RMIEPA	Navy SSP, LLNL	Final Report to be completed before EA/OEA finalized

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5 Cumulative Impacts

This section 1) defines cumulative impacts, 2) describes past, present, and reasonably foreseeable future actions relevant to cumulative impacts, 3) analyzes the incremental interaction the proposed action may have with other actions, and 4) evaluates cumulative impacts potentially resulting from these interactions.

5.1 Definition of Cumulative Impacts

The approach taken in the analysis of cumulative impacts follows the objectives of NEPA, CEQ regulations, and CEQ guidance. Cumulative impacts are defined in 40 CFR section 1508.7.

The impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

To determine the scope of environmental impact statements, agencies shall consider cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.

In addition, CEQ and USEPA have published guidance addressing implementation of cumulative impact analyses—Guidance on the Consideration of Past Actions in Cumulative Effects Analysis (CEQ 2005) and Consideration of Cumulative Impacts in USEPA Review of NEPA Documents (USEPA, 1999). CEQ guidance entitled Considering Cumulative Impacts Under NEPA (1997) states that cumulative impact analyses should:

"…determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative impacts of other past, present, and future actions...identify significant cumulative impacts…[and]…focus on truly meaningful impacts."

Cumulative impacts are most likely to arise when a relationship or synergism exists between a proposed action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or in close proximity to the proposed action would be expected to have more potential for a relationship than those more geographically separated. Similarly, relatively concurrent actions would tend to offer a higher potential for cumulative impacts. To identify cumulative impacts, the analysis needs to address the following three fundamental questions.

- Does a relationship exist such that affected resource areas of the proposed action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?
- If one or more of the affected resource areas of the proposed action and another action could be expected to interact, would the proposed action affect or be affected by impacts of the other action?
- If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the proposed action is considered alone?

5.2 Scope of Cumulative Impacts Analysis

The scope of the cumulative impacts analysis involves both the geographic extent of the effects and the time frame in which the effects could be expected to occur. For this EA/OEA, the study area delimits the geographic extent of the cumulative impacts analysis. In general, the study area would include those areas previously identified in Chapter 4 for the respective resource areas. The time frame for cumulative impacts centers on the timing of the proposed action.

Another factor influencing the scope of cumulative impacts analysis involves identifying other actions to consider. Beyond determining that the geographic scope and time frame for the actions interrelate to the proposed action, the analysis employs the measure of "reasonably foreseeable" to include or exclude other actions. For the purposes of this analysis, public documents prepared by federal, state, and local government agencies form the primary sources of information regarding reasonably foreseeable actions. Documents used to identify other actions include notices of intent for EISs and EAs, management plans, land use plans, and other planning related studies.

5.3 Past, Present, and Reasonably Foreseeable Actions

This section will focus on past, present, and reasonably foreseeable future projects at and near SNL/KTF, the over-ocean flight corridor, and RTS, Kwajalein Atoll. In determining which projects to include in the cumulative impacts analysis, a preliminary determination was made regarding the past, present, or reasonably foreseeable action. Specifically, using the first fundamental question included in Section 5.1, it was determined if a relationship exists such that the affected resource areas of the Proposed Action (included in this EA/OEA) might interact with the affected resource area of a past, present, or reasonably foreseeable action. If no such potential relationship exists, the project was not carried forward into the cumulative impacts analysis. In accordance with CEQ guidance (CEQ 2005), these actions considered but excluded from further cumulative effects analysis normally are not catalogued here as the intent is to focus the analysis on the meaningful actions relevant to inform decision-making. However, in response to a comment on the Draft FE-1 EA/OEA by the RMIEPA, projects preliminarily reviewed but not carried forward for analysis are described briefly in section 5.3.1.1 for informational purposes. Projects included in this cumulative impacts analysis are listed in Table 5-1 and briefly described in the following subsections.

5.3.1 Past Actions

There have been less than 10 STARS launches in the last 25 years from KTF. The most recent STARS launch was in 2011. Other past actions have included testing and training for Navy and other government agencies. Actions have included RDT&E activities in the HRC, Major Exercises, and maintenance of the technical and logistical facilities that support these activities and exercises.

MMIII ICBM missile RVs have routinely impacted at KMISS and Illeginni Islet in the past. An EA with a FONSI was completed for MMIII modifications in 2004, and a Supplemental EA is in process for additional missile configuration updates (2017).Both Be and DU remain in the soil at Illeginni Islet from MMIII land impacts.

The Advanced Hypersonic Weapon program had a single payload that previously impacted at Illeginni Islet following a launch using a STARS booster from SNL/KTF.

Kwajalein Echo Pier repairs improved the ability to receive and ship goods and mission-related items at USAKA.

The KMISS refurbishment replaced cabling and hydrophones to re-establish the accuracy required for ICBM testing and improve data collection for other programs that may have impacts within the KMISS area.

5.3.2 Past Actions Not Carried Forward for Analysis

A MMIII Extended Range flight test occurred in 2013. The single flight test from Vandenberg AFB to a BOA in the Republic of Palau was evaluated in a MM III Supplemental Environmental Assessment, which resulted in a FONSI. Personnel and equipment for the flight test were moved through USAKA; however, the flight test was conducted between Vandenberg Air Force Base in California and a BOA in the Republic of Palau. There were no effects to USAKA, Illeginni Islet or the Offshore Waters locations from this activity and it was not carried forward for cumulative analysis.

The North Pacific Target Launch EA (2001) evaluated use of Strategic Target System launch vehicles from Kodiak Launch Complex [Pacific Spaceport Complex Alaska] in Alaska or from KTF to a BOA impact site in either USAKA or off of the Baja California in Mexico. Nine flight tests were planned through 2008, however, not all of the flights were successful or had launches utilizing USAKA. All target launches occurred from Kodiak Launch Complex and ultimately none involved intercept launches from RTS. The trajectories for actual flights did not overlapped the Over-Ocean Flight Corridor between KTF and RTS, and there were no impacts or intercepts within USAKA. There was no impact to resources at USAKA, Illeginni Islet or the Offshore Waters locations from this activity and it was not carried forward for cumulative analysis.

Integrated Flight Tests at USAKA and Wake Island were conducted by the US Missile Defense Agency in 2012 and 2013. Personnel and equipment were situated on several islands at USAKA. Placement of a radar and launch of air-breathing targets for these flight tests occurred at Illeginni Islet. Target intercepts occurred over BOAs north/northwest of Kwajalein Atoll and east/southeast of Wake Island. There was no significant impact to resources at USAKA, Illeginni Islet or the Offshore Waters locations from this activity and it was not carried forward for cumulative analysis.

Kwajalein Echo Pier repairs improved the ability to receive and ship goods and mission-related items at USAKA. This provided increased efficiencies in moving goods to and from the island of Kwajalein. Biological resources on and near the pier were managed in coordination and consultation with NMFS and USFWS. There were no effects to Illeginni Islet or the Offshore Waters locations from this activity and it was not carried forward for cumulative analysis.

A USAPHC Fish Study was completed in 2014 for the USAG-KA Cleanup Program (USAPHC, 2014). The study identified, “Unacceptable cancer risk for Marshallese adults [from consumption of fish] at Illeginni [harbor] is attributable to the pesticide, chlordane.” Chlordane is a pesticide used to treat wood and wood structures for control of pests, particularly termites, and is not associated with previous missile flight tests impacting at Illeginni. Although Be and DU are known to exist in soil at Illeginni from MMIII RV impacts, they are at levels below USEPA Residential RSLs and they were not identified as a contaminant in fish harvested at Illeginni for the study. Therefore, the fish study was not carried forward for cumulative impacts analysis with FE-1.

A second Advanced Hypersonic Weapon flight test failed upon launch from Kodiak Launch Complex; the booster landed in a BOA of the North Pacific Ocean between Alaska and Hawai’i. There were no effects to USAKA, Illeginni Islet or the Offshore Waters locations from this activity and it was not carried forward for cumulative analysis.

5.3.3 Present and Reasonably Foreseeable Actions

MMIII ICBM missile RVs are planned to impact at KMISS; land impacts are no longer proposed for that program.

The actions associated with testing and training for Navy and other government agencies are still occurring and are expected to occur well into the future. The actions that include RDT&E activities in the HRC, Major Exercises, and maintenance of the technical and logistical facilities that support these activities and exercises are also still occurring and are expected to continue.

Table 5-1 NEPA Analyses Performed for Actions Considered in Cumulative Action Evaluation

Location	*Action*	*Level of NEPA Analysis Completed*
PMRF	**Past Actions**	
	Strategic Target System Launches	EIS/ROD
	Navy Testing and Training	EIS/OEIS/ROD
	Present and Reasonably Foreseeable Future Actions	
	Navy Testing and Training	EIS/OEIS/ROD
Over-Ocean Flight Corridor	**Past Actions**	
	Minuteman III Flight Testing	EA/FONSI
	Advanced Hypersonic Weapon Flight Testing	EA/FONSI
	Present and Reasonably Foreseeable Future Actions	
	Minuteman III Flight Testing	(S)EA/FONSI
USAKA, RMI Illeginni Islet	**Past Actions**	
	Minuteman III RV Impacts	EA/FONSI
	Present and Reasonably Foreseeable Future Actions	
	US Navy SSP FE-2 and FE-3 (potentially	EA/FONSI (Expected)
USAKA, RMI Offshore	**Past Actions**	
	Minuteman III RV Impacts at KMISS	EA/FONSI
	Present and Reasonably Foreseeable Future Actions	
	Minuteman III RV Impacts at KMISS	EA/FONSI
	US Navy SSP FE-2 and FE-3 (potentially)	EA/FONSI (Expected)

5.4 Cumulative Impact Analysis

Where feasible, the cumulative impacts were assessed using quantifiable data; however, for many of the resources included for analysis, quantifiable data are not available and a qualitative analysis was undertaken. In addition, where an analysis of potential environmental effects for future actions has not been completed, assumptions were made regarding cumulative impacts related to this EA/OEA where possible. The analytical methodology presented in Chapter 4, which was used to determine potential impacts to the various resources analyzed in this document, was also used to determine cumulative impacts.

5.4.1 PMRF

5.4.1.1 Description of Geographic Study Area

There has been no significant change in resources at PMRF as a result of past and present actions. No changes are anticipated in the future.

5.4.1.2 Relevant Past, Present, and Future Actions

The launching of missiles both from PMRF and ships offshore would continue as part of the RDT&E and training mission of PMRF.

5.4.1.3 Cumulative Impact Analysis

No past, present, or reasonably foreseeable actions has been identified that might interact with the affected resource areas of the Proposed Action and result in significant impacts.

5.4.2 Over-Ocean Flight Corridor

5.4.2.1 Description of Geographic Study Area

The Over-Ocean Flight Corridor between KTF and RTS is the geographic study area for cumulative impacts from FE-1 and other relevant past, present, and future actions. There has been no known significant change in air quality or biological resources within the Over-Ocean Flight Corridor.

5.4.2.2 Relevant Past, Present, and Future Actions

MMIII ICBM missile testing between Vandenberg AFB, California, and RTS has occurred and will continue to occur on an annual basis. Up to four MM III missile flight tests would be conducted annually through 2030, and four Fuze Modernization flight tests would occur over a four-year period. EAs with FONSIs were prepared for the MMIII missile testing in 2001 and 2004. An additional Supplemental Environmental Assessment is in process for the modification and fuze modernization flight tests through 2030. The trajectory for these flights partially overlaps the Over-Ocean Flight Corridor between KTF and RTS.

In November 2011, the USASMDC/ARSTRAT performed a test flight of the Advanced Hypersonic Weapon (AHW) concept. The test vehicle was launched from the KTF to RTS. The flight path for this flight test was the same as the Over-Ocean Flight Corridor between KTF and RTS for FE-1.

A second US Navy SSP Flight Experiment (FE-2) and possibly a third (FE-3) are being considered as future actions. During the original preparation of the Draft FE-1 EA/OEA, additional flights were not considered as a reasonable future activity. After the public release of the Draft EA/OEA, the DoD and the US Navy SSP made the decision to investigate the possibility of one other flight, or possibly two. Details are not completely firm, but the second flight would probably be substantively similar to FE-1. With regard to a possible third flight, discussions are at least two years in the future and no specifics are currently available. The flight path for FE-2 is anticipated to use the same Over-Ocean Flight Corridor between KTF and RTS as FE-1.

5.4.2.3 Cumulative Impact Analysis

Although there have been several missile flight tests within the same or part of the same Over-Ocean Flight Corridor as FE-1, the majority of these flight test used the STARS boosters or a launch vehicle of comparable size. As shown in section 4.2.1.2, the STARS booster is relatively small and on a global scale the level of emissions from each STARS booster would not be statistically significant. Because the emissions of HCl, Al2O3, and NOX from each launch of a STARS booster would be relatively small, the air volume over which these emissions are spread is large, the emissions are rapidly dispersed by stratospheric winds, and the length of time between discreet launches is measured in months or years, these missile flight tests within the Over-Ocean Flight Corridor would not have a significant cumulative impact. Therefore, cumulative impacts from the FE-1 flight test and the other evaluated flight tests would not be expected to have a significant impact on the upper atmosphere or stratospheric ozone depletion.

Impacts to biological resources within the Over-Ocean Flight Corridor for the referenced missile flight tests were not identified as being significant. The potential for impacts from noise or direct contact from boosters or other missile components was extremely low given the size of the area, the size of missile components, and the low densities of marine mammals across the corridor.

No past, present, or reasonably foreseeable actions have been identified in the Over-Ocean Flight Corridor that might interact with the affected resource areas of the FE-1 Proposed Action and result in significant cumulative impacts.

5.4.3 USAKA, RMI

5.4.3.1 Illeginni Islet

5.4.3.1.1 Description of Geographic Study Area

The northwest end of Illeginni Islet is the geographic study area for cumulative impacts from FE-1 and other relevant past, present, and future actions. There has been no significant change in cultural resources, biological resources, noise, public health and safety, and hazardous materials and wastes at Illeginni Islet. Although there are Be and DU in the soil at Illeginni Islet from past MMIII RV impacts, analytical results indicate the levels are below USEPA residential regulatory limits. (Robison et al., 2013) The USAPHC Fish Study (2014) noted that "unacceptable cancer risk for Marshallese adults at Illeginni [harbor] is attributable to the pesticide, chlordane." Chlordane is a pesticide used to treat wood and wood structures for control of pests, particularly termites, and is not associated with previous missile flight tests impacting at Illeginni.

5.4.3.1.2 Relevant Past, Present, and Future Actions

MMIII ICBM missile testing between Vandenberg AFB, California, and RTS has occurred and will continue to occur on an annual basis. Up to four MMIII missile flight tests would be conducted annually through 2030, and four Fuze Modernization flight tests would occur over a four-year period. In 2016, USAFGSC determined that land impacts at Illeginni Islet would no longer occur. EAs with FONSIs were prepared for the MMIII missile testing in 2001 and 2004. An additional Supplemental Environmental Assessment is in process for the modification and fuze modernization flight tests through 2030. Past RV impacts occurred on Illeginni Islet; future RV impacts would only occur at KMISS. For past flight tests, the impact crater was screened for debris and all other visible debris from around the impact was manually recovered and disposed of in accordance with the UES.

As noted in the section 5.4.2.2, a second US Navy SSP Flight Experiment (FE-2) and possibly a third (FE-3) are being considered as future actions. A second flight would probably be substantively similar to FE-1. Discussions are at least two years in the future regarding a third flight test and no specifics are currently available. The Preferred Alternative impact at Illeginni Islet is anticipated to be the same for FE-2 as for FE-1.

5.4.3.1.3 Cumulative Impact Analysis

MMIII ICBM missile testing from Vandenberg AFB, California, to Illeginni Islet has occurred in the past. Be and DU from past MMIII RV impacts remain in the soil at Illeginni Islet; analytical results indicate the levels are below USEPA residential regulatory limits (Robison et al., 2013). No future MMIII impacts are planned for Illeginni Islet. MMIII flight test have been and will continue to be conducted in accordance with biological opinions from NMFS and USFWS, in addition to program specific DEPs and the UES.

The AHW flight was conducted in accordance with the Illeginni Impacts DEP and the UES. Payload impacts were less than those of the MMIII RVs (USASMDC, 2011). There was no significant impact to resources at Illeginni Islet from the AHW flight test.

For FE-1, a 2008 study of geochemical parameters influencing tungsten mobility in soils (Bednar et al., 2008) found that dissolved tungsten reached equilibrium in soil after approximately 48 hours and mobility decreased by approximately one-half within a 4 month period. The "long term known impact or potential risk" (RMIEPA, 2017) is not conclusively identified in peer reviewed literature. For the US Navy SSP flight test impacts, the bench study and model results indicate levels of tungsten in Illeginni Islet soil would be below the USEPA Residential RSLs (LLNL, 2017) for soil and drinking water (although this area is not designated as potable drinking water) from the end of the flight test to 25 years out, the period for which the model was run.

For potential cumulative effects of tungsten in the soil from a second US Navy SSP flight test, the US Navy anticipates remediation activities could be required after the second flight. The accumulation of tungsten following the two flight test could potentially approach or exceed USEPA Residential RSLs. Sampling and analyses of tungsten and other alloy metals in soil at Illeginni will be conducted prior to and after FE-1 and after the FE-2 flight test. If analyses of FE-2 post-flight test soil samples indicated tungsten levels above RSLs, phytoremediation, using plants to draw up metals from the soil, would be considered, as suggested for consideration by the USEPA. In particular, some ryegrass species can take up tungsten in direct relation to the amount of material in soil (Strigul et al., 2005), i.e., the more material left in the soil, the more is taken up into the plants (Markum and Pessarakli, 2010). Application of this methodology as phytoremediation at Illeginni Islet would introduce an exotic species to the Atoll and present a poor growth environment for ryegrass (i.e., calcareous sand with low organic content and high soluble salt content, heavy rainfall, and high temperatures, at which ryegrass becomes dormant). Any type of remediation would only occur after field-portable elemental analysis such as laser-induced breakdown spectroscopy, or other in-situ detection systems, to determine the level of tungsten remaining in the soil and a need for additional cleanup to bring the concentration of tungsten in soil below the USEPA Residential RSLs. If phytoremediation were employed, following an initial growth period, the plants would be removed and laboratory analyzed to determine their effectiveness. Any plant remains would then be appropriately disposed of as hazardous waste IAW with the UES.

No past, present, or reasonably foreseeable actions have been identified at Illeginni Islet that might interact with the affected resource areas of the FE-1 Proposed Action and result in significant cumulative impacts.

5.4.3.2 Offshore Waters – Southwest and Northeast

5.4.3.2.1 Description of Geographic Study Area

The Offshore Waters impact alternatives are in deep ocean regions southwest of Illeginni Islet and within the KMISS area southeast of Gagan Islet. MMIII ICBM missile testing between Vandenberg AFB, California, and RTS, has occurred.

5.4.3.2.2 Relevant Past, Present, and Future Actions

MMIII ICBM missile testing between Vandenberg AFB, California, and KMISS have occurred and will continue to occur annually. KMISS is the selected site for all future impacts for MMIII.

The KMISS refurbishment replaced failing cabling and hydrophones to re-establish the accuracy required for ICBM testing and improve data collection for programs that may have impacts within the KMISS area. At depth, the ocean bottom consists of soft silt sediment which, when disturbed, tends to rapidly settle from the water column due to a high composition of sand. Biological resource impacts were managed through consultation and coordination with NMFS and USFWS. Although one alternative impact location for the FE-1 flight test is within the KMISS, the Preferred Alternative is to impact on land.

US Navy SSP FE-2 would most likely also consider the Offshore Waters for potential payload impact. As with FE-1, the Preferred Alternative would be a land impact at Illeginni Islet, although this has yet to be determined.

5.4.3.2.3 Cumulative Impact Analysis

The KMISS refurbishment improved data collection for programs that may have impacts within the KMISS area. Although this contributes to the success of missile flight testing, the environmental impact of cable and hydrophone replacements in deep waters would not contribute to cumulative impacts from two US Navy SSP flight experiments. Biological resource impacts from the refurbishment were managed through consultation and coordination with NMFS and USFWS. The bench study and model results (LLNL, 2017) indicate very slow dissolution and passivation (i.e., natural chemical encapsulation) of tungsten from FE-1 may occur in sea water. Although one alternative impact location for the FE-1 flight test is within the KMISS, the Preferred Alternative is to impact on land.

While the effects of tungsten alloys in ecosystems are largely unknown, as noted in the USEPA Technical Fact Sheet for tungsten (2014), with no known studies of marine ecosystems, there are some studies that indicate tungsten exposure may have health impacts. According to the USEPA Technical Fact Sheet, direct occupational exposure is the most common scenario (but which does not apply to the FE-1 flight test conditions) and, “may cause eye and skin irritation, cough, nausea, diffuse interstitial pulmonary fibrosis and changes in blood.” However, the Fact Sheet also states, “Tungsten has not been classified for carcinogenic effects by the Department of Health and Human Services, the International Agency for Research on Cancer or the [US]EPA.”

No past, present, or reasonably foreseeable actions have been identified in the KMISS or southwest BOA that might interact with the affected resource areas of the FE-1 Proposed Action and result in significant cumulative impacts.

6 Other Considerations Required by NEPA

6.1 Consistency with Other Federal, State, and Local Laws, Plans, Policies, and Regulations

In accordance with 40 CFR section 1502.16(c), analysis of environmental consequences shall include discussion of possible conflicts between the Proposed Action and the objectives of federal, regional, state and local land use plans, policies, and controls. Table 6-1 identifies the principal federal and state laws and regulations that are applicable to the Proposed Action, and describes briefly how compliance with these laws and regulations would be accomplished.

6.2 Coastal Zone Management

The federal Coastal Zone Management Act (CZMA) of 1972 establishes a federal-state partnership to provide for the comprehensive management of coastal resources. Coastal states and territories develop site-specific coastal management programs based on enforceable policies and mechanisms to balance resource protection and coastal development needs. The Hawai'i Coastal Zone Management Program lays out the policy to guide the use, protection, and development of land and ocean resources within the state's coastal zone. Under the Act, federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination or a Negative Determination. In other words, any federal agency proposing to conduct or support an activity within or outside the coastal zone that will affect any land or water use or natural resource of the coastal zone is required to do so in a manner consistent with the CZMA or applicable state coastal zone program to the maximum extent practicable. However, Federal lands, which are "lands the use of which is by law subject solely to the discretion of…the Federal Government, its officers, or agents," are statutorily excluded from the State's "coastal zone". If, however, the proposed federal activity affects coastal resources or uses beyond the boundaries of the federal property (i.e., has spillover effects), the CZMA Section 307 federal consistency requirement applies. As a federal agency, the Navy is required to determine whether its proposed activities would affect the coastal zone. This takes the form of either a Negative Determination or a Consistency Determination.

Military testing and training at PMRF has been included in a list of US Navy de minimis activities under the CZMA. The Hawai'i Coastal Zone Management Program determined the listed activities "are expected to have insignificant direct or indirect (cumulative and secondary) coastal effects, and should not be subject to further review by the Hawai`i CZM program." (Mayer, 2009).

6.3 Relationship between Short-Term Use of the Environment and Long-Term Productivity

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one development site reduces future flexibility in pursuing other options, or that using a parcel of land or other resources often eliminates the possibility of other uses at that site.

Operations would not significantly impact the long-term natural resource productivity in any of the Proposed Action areas. The Proposed Action would not result in any impacts that would significantly reduce environmental productivity or permanently narrow the range of beneficial uses of the environment.

Table 6-1 Principal Federal and State Laws Applicable to the Proposed Action

Federal, State, Local, and Regional Land Use Plans, Policies, and Controls	***Status of Compliance***
National Environmental Policy Act (NEPA) (42 U.S.C. section 4321 et seq.); CEQ NEPA implementing regulations (40 CFR parts 1500-1508; Navy procedures for Implementing NEPA ((32 CFR part 775 and OPNAVINST 5090.1D)	Compliant
Clean Air Act (42 U.S.C. section 7401 et seq.)	Compliant
Clean Water Act (33 U.S.C. section 1251 et seq.)	Compliant
Coastal Zone Management Act (16 U.S.C. section 1451 et seq.)	Compliant
National Historic Preservation Act (Section 106, 16 U.S.C. section 470 et seq.)	Compliant
Endangered Species Act (16 U.S.C. section 1531 et seq.)	Compliant
Marine Mammal Protection Act (16 U.S.C. section 1361 et seq.)	Compliant
Migratory Bird Treaty Act (16 U.S.C. sections 703-712)	Compliant
Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (16 U.S.C. section 1801 et seq.)	Compliant
US Public Law 108-188, Compact of Free Association Amendments Act of 2003	Compliant
Executive Order 11988, Floodplain Management	Compliant
Executive Order 12088, Federal Compliance with Pollution Control Standards	Compliant
Executive Order 12114, Environmental Effects Abroad of Major Federal Actions	Compliant
Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations	Compliant
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	Compliant
Executive Order 13089, Coral Reef Protection	Compliant
Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management	Compliant
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	Compliant
Executive Order 13696, Planning for Federal Sustainability in the Next Decade	Compliant

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8 List of Preparers

This EA/OEA was prepared collaboratively between the US Government and contractor preparers.

US Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT)

Thomas M. Craven (DCSEN-Environmental)
M.S. Biology
B.S. Biology and Mathematics
Years of Experience: 44
Section(s) person is responsible for: Program Management

Joel Shady (Strategic System Directorate)
B.S. Electrical and Computer Engineering
Years of Experience: 31
Section(s) person is responsible for: Program Description

Contractors

Lynne Morris (Intrepid, Inc.)
B.S.B.A. Management Information Systems
Years of Experience: 26
Section(s) person is responsible for: Program Description

Shari Clayton Hendrix, PG (TN, WA) (Teledyne Brown Engineering, Inc.)
M.S. Environmental Management
B.S. Geography and Geology
Years of Experience: 24
Section(s) person is responsible for: Over-Ocean Flight Corridor-All resources excluding biological resources; US Army Kwajalein Atoll, Republic of the Marshall Islands-All resources excluding biological resources

Karen Hoksbergen (Teledyne Brown Engineering, Inc.)
M.S. Biology
B.S. Wildlife and Biology
Years of Experience: 15
Section(s) person is responsible for: All biological resources

Michael Molina (Teledyne Brown Engineering, Inc.)
M.S. Marine Biology
B.S. Biology
Years of Experience: 36
Section(s) person is responsible for: Review of All biological resources

Rickie D. Moon (Teledyne Brown Engineering, Inc.)
M.S. Environmental Management
B.S. Chemistry and Mathematics
Years of Experience: 31
Section(s) person is responsible for: SNL/KTF, PMRF-All resources excluding biological resources

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9 Distribution List

This EA/OEA was distributed to the following agencies/people.

Federal Agencies

Dan A. Polhemus, PhD
US Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
P.O. Box 50088
Honolulu, Hawaii 96850

Steven P. Kolinski, PhD
National Marine Fisheries Service
Pacific Islands Regional Office
Habitat Conservation Division
1845 Wasp Boulevard, Building 176
Honolulu, Hawaii 96818

US Army Corps of Engineers
Honolulu District
CEPOH-PP-E/Ms. Helene Takemoto
Building 252
Fort Shafter, Hawaii 96858-5440

Mr. Norwood Scott
US Environmental Protection Agency
Region IX
Pacific Islands Office
75 Hawthorne Street (LND-3-2)
San Francisco, California 94105

Other Organizations

Ms. Moriana Phillip
General Manager
Republic of the Marshall Islands
Environmental Protection Authority
P.O. Box 1322
Majuro, Marshall Islands 96960-1322

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10 Persons Contacted List

The following agencies/people were contacted during the development of this EA/OEA:

USFWS - Dan A. Polhemus, PhD

NMFS - Steven P. Kolinski, PhD

USEPA - Mr. Norwood Scott

USACE - Ms. Helene Takemoto

RMIEPA - Ms. Moriana Phillip

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Appendix A

Agency Correspondence

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DEPARTMENT OF THE NAVY
DIRECTOR STRATEGIC SYSTEMS PROGRAMS
1250 10TH STREET SE, SUITE 3600
WASHINGTON NAVY YARD, DC 20374-5127

IN REPLY REFER TO

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From: Director, Strategic Systems Programs
To: Department of Energy, National Nuclear Security Administration, Sandia Field Office, Manager, Environmental Team

Subj: COOPERATING AGENCY FOR ENVIRONMENTAL ASSESSMENT/OVERSEAS ENVIRONMENTAL ASSESSMENT SUPPORTING FLIGHT EXPERIMENT MISSILE TESTING AT PACIFIC MISSILE RANGE FACILITY

Encl: (1) Flight Experiment-1 Navy Project Stick Chart

1. Strategic Systems Programs (SSP) is preparing an Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) to evaluate potential environmental impacts from the proposed testing of the Flight Experiment-1 (FE-1) missile. SSP's FE-1 Program is currently supported by the Department of Energy (DOE)/National Nuclear Security Administration (NNSA), Sandia National Laboratory (SNL), Sandia Field Office (SFO), as well as the U.S. Army Space and Missile Defense Command (SMDC). DOE/NNSA SFO provides technology development support for the program and launch facilities for the proposed FE-1 flight test at DOE/NNSA's Kauai Test Facility (KTF). Accordingly, per 40 CFR Part 1501 and Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, SSP requests DOE/NNSA SFO participate as a Cooperating Agency for the development of the FE-1 EA/OEA. SMDC has elected to participate informally in the environmental planning process.

2. The proposed action consists of a flight test of the Intermediate Range Conventional Prompt Global Strike FE-1 launch vehicle. The FE-1 launch vehicle consists of a 3-stage Strategic Target System III booster system and an Intermediate Range Glide Body. The proposed FE-1 test flight would originate from KTF located on Pacific Missile Range Facility, Barking

Sands, Kauai, Hawaii, with impact at one of three locations within the Reagan Test Site at U.S. Army Kwajalein Atoll in the Republic of the Marshall Islands. The flight test is scheduled for 2017.

3. SSP will take the following actions to support interagency cooperation with DOE/NNSA SFO:

a. Request your review of draft EA/OEAs and related National Environmental Policy Act (NEPA) documentation such as the Finding of No Significant Impact and biological consultation documents.

b. Invite you to FE-1 environmental planning meetings and confer with your staff on regulatory agency consultations, including consultations that directly affect KTF.

c. Include information within environmental documents that DOE/NNSA SFO may need to meet its environmental responsibilities such as mitigation, permits and consultations for SNL/KTF facilities and properties that will support the FE-1 flight test.

d. No direct writing or analysis by DOE/NNSA SFO will be required.

4. As a Cooperating Agency, SSP requests DOE/NNSA SFO support SSP in the following:

a. Provide reviews and comments throughout the EA/OEA process, to include working drafts of the EA and other ancillary documents such as biological consultation documents.

b. Participate in meetings to discuss EA/OEA related issues.

c. Respond to SSP requests for information.

d. Assist SSP in determining appropriate avoidance, minimization and mitigation measures to incorporate into environmental documentation and permit applications.

e. Adhere to the overall schedule as set forth by SSP. Enclosure (1) provides the current FE-1 Navy Project Stick Chart identifying project milestones.

f. Provide a formal, written response to this request, agreeing to the support listed in subparagraphs 4.a. through 4.f.

5. The Navy views its relationship with DOE/NNSA SFO as important to the successful completion of the NEPA process for the FE-1 EA/OEA. It is the Navy's goal to complete the NEPA process as expeditiously as possible, and the Navy believes that establishing a formal Cooperating Agency relationship with DOE/NNSA SFO will help attain this goal. In the event that DOE/NNSA SFO elects not to participate as a Cooperating Agency, the Navy welcomes DOE/NNSA SFO's informal participation in the environmental planning process.

6. The SSP technical Point Of Contact (POC) for this action is Mr. Fred Chamberlain, (202) 433-7141, SP20161@ssp.navy.mil. SSP legal POCs are Mr. Jeremy Cohn, (202) 433-9773, Jeremy.Cohn@ssp.navy.mil and Mr. Paul Atelsek, (202) 433-9770, Paul.Atelsek@ssp.navy.mil.

John C Schaefer Jr. for
M.F. MAGLICH
By direction

Copy to:
Commander, U.S. Pacific Fleet
Commander, Navy Region Southwest
Commander, Navy Region Hawaii
Commander, Joint Region Marianas

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND/
ARMY FORCES STRATEGIC COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

March 1, 2017

Dan A. Polhemus, PhD
U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
P.O. Box 50088
Honolulu, Hawaii 96850

Dear Dr. Polhemus:

The U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) is assisting the U.S. Navy Strategic Systems Programs (SSP), the action proponent, in evaluating the effects of a single flight test of the Flight Experiment-1 (FE-1). We have prepared a Biological Assessment (BA) to initiate formal consultation under section 3-4.5 of the U.S. Army Kwajalein Atoll Environmental Standards (UES), section 7(a)(2) of the U.S. Endangered Species Act (ESA), and in connection with section 101 of the Marine Mammal Protection Act (MMPA). There is no affected critical habitat for any of the protected species in the proposed Action Area.

As described in the enclosed BA, UES, ESA, and MMPA protected species occur or have the potential to occur in the action area. Based on analyses of all of the potential stressors resulting from the proposed action, we have concluded that the proposed action may affect and is likely to adversely affect some of these species. These include 2 species of nesting sea turtles, *Chelonia mydas* and *Eretmochelys imbricata*; one fish species, *Cheilinus undulatus*; one mollusk species, *Trochus niloticus*; and 14 coral species, *Acanthastrea brevis*, *Acropora aculeus*, *A. aspera*, *A. dendrum*, *A. listeri*, *A. microclados*, *A. polystoma*, *Alveopora verilliana*, *Cyphastrea agassizi*, *Heliopora coerulea*, *Montipora caliculata*, *Pavona venosa*, *Turbinaria reniformis*, and T. *stellulata*.

We have concluded that the proposed action may affect but is not likely to adversely affect 25 cetacean species, Hawaiian monk seals (*Neomonarhus schauinslandi*), Newell's shearwaters (*Puffinus auricularis newelli*), 3 sea turtle species, 6 fish species, 5 coral species, the mollusk species *Pinctada margaritifera*, and larval fish, coral, and mollusks. These species include the cetacean species *Balaenoptera acutorostrata*, *B. borealis*, *B. edeni*, *B. musculus*, *B. physalus*, *Delphinus delphis*, *Feresa attenuata*, *Globicephala macrorhynchus*, *Grampus griseus*, *Indopacetus pacificus*, *Kogia breviceps*, *K. sima*, *Lagenodelphis hosei*, *Megaptera novaeangliae*, *Mesoplodon densirostris*, *Orcinus orca*, *Peponocephala electra*, *Physeter macrocephalus*, *Pseudorca crassidens*, *Stenella attenuata*, *S. coeruleoalba*, *S. longirostris*, *Steno bredanensis*, *Tursiops truncatus*, and *Ziphius cavirostris*; the turtle species *Caretta caretta*, *Dermochelys coriacea*, and *Lepidochelys olivacea*; the fish species *Alopias superciliosus*, *Carcharhinus longimanus*, *Manta alfredi*, *M. birostris*, *Sphyrna lewini*, and *Thunnus orientalis*; and the coral species *Acropora speciosa*, *A. tenella*, *A. vaughani*, *Leptoseris incrustans*, and *Pavona cactus*.

Because of these potential effects to UES, ESA, and MMPA protected species, the USASMDC/ARSTRAT and U.S. Navy would like to initiate formal consultation with the U.S. Fish and Wildlife Service under section 3-4.5 of the UES for potential effects in the Republic of the Marshall Islands to nesting sea turtles, *Chelonia mydas* and *Eretmochelys imbricata*. USASMDC/ARSTRAT and U.S. Navy would like to initiate informal consultation with the U.S. Fish and Wildlife Service under section 7(a)(2) of the U.S. ESA for potential effects to at-sea Newell's shearwaters, *Puffinus auricularis newelli*.

I am providing copies of this letter and the BA to Ms. Moriana Phillip, Republic of the Marshall Islands Environmental Protection Authority; Steve Kolinski, National Marine Fisheries Service; Helene Takemoto, U.S. Army Corps of Engineers; and Norwood Scott, U.S. Environmental Protection Agency.

Please contact Thomas Craven, USASMDC/ARSTRAT, Environmental Division, regarding this consultation request at (256) 955-1533 or at thomas.m.craven2.civ@mail.mil.

Sincerely,

Weldon Hill
Deputy Chief of Staff, Engineer
U.S. Army Space and Missile Defense
Command/ Army Forces Strategic Command

Enclosure

Department of Energy
National Nuclear Security Administration
Sandia Field Office
P.O. Box 5400
Albuquerque, NM 87185

APR 27 2017

Director
Strategic Systems Programs
Department of the Navy
1250 10th Street SE, Suite 3600
Washington Naval Yard, DC 20374-5127

Subject: Department of Energy/National Nuclear Security Administration (DOE/NNSA) Sandia Field Office Participation as a Cooperating Agency

Reference: Director/SSP to DOE/NNSA SFO letter (Ser: SP20161/062316000) dated July 26, 2016; Subject: *Cooperating Agency for Environmental Assessment/Overseas Environmental Assessment Supporting Flight Experiment Missile Testing at Pacific Missile Range Facility*

Dear Sir or Ma'am:

This letter is in response to your Referenced request regarding our participation as a cooperating agency for testing at the Pacific Missile Range Facility, specifically at the DOE/NNSA Kauai Test Facility. The DOE/NNSA agrees to cooperate in the preparation of this Environmental Assessment.

Following 10 CFR 1021, *DOE National Environmental Policy Act Implementing Procedures*, the Sandia Field Office contributed by reviewing draft Environmental Assessments/Overseas Environmental Assessments and National Environmental Policy Act-related documentation, and will review consultations directly affecting the Kauai Test Facility.

If you have questions, please contact Susan Lacy, Environmental Team Lead, at (505) 845-5542.

Sincerely,

James W. Todd
Assistant Manager for Engineering

cc:
Fred Chamberlain, DoN/SSP, SP20161@ssp.navy.mil
Paul Atelsek, DoN/SSP, Paul.Atelsek@ssp.navy.mil
Jeremy Cohn, DoN/SSP, Jeremy.Cohn@ssp.navy.mil
731129

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND/
ARMY FORCES STRATEGIC COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

May 4, 2017

SMDC-ENE

Ms. Moriana Phillip
General Manager
Republic of the Marshall Islands
Environmental Protection Authority
P.O. Box 1322
Majuro, Marshall Islands 96960-1322

Dear Ms. Phillip:

Two copies of the Draft Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) for Flight Experiment 1 (FE-1) and the Draft Finding of No Significant Impact (FONSI) are enclosed for placement in a convenient, accessible place in your office that will allow public review. **Please provide a space in your office for these documents which would allow the public to review the documents.**

A Notice of Availability for the Draft DEP will be published in the Marshall Islands Journal on May 19, 2017 and in the Kwajalein Hourglass on May 20, 2017. Responses are requested by **June 19, 2017**.

Comments on the Draft DEP may be submitted through a website:
https://tbe.com/Flight_Experiment_1_Documents_for_Public_Review

Or written comments may be directed to:

Strategic Systems Program
ATTN: Mr. Fred Chamberlain
1250 10th Street, SE
Washington Navy Yard, DC 20374-5127

Mailed comments must be postmarked no later than June 19, 2017.

Thank you for your assistance in this matter.

Sincerely,

David C. Hasley
UES Co-Chairperson

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND/
ARMY FORÇES STRATEGIC COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

May 4, 2017

SMDC-ENE

Mr. Kawa Jatios
Republic of the Marshall Islands
Environmental Protection Authority
Ebeye Office
Ebeye, MH 96960

Dear Mr. Jatios:

The Draft Environmental Assessment (EA)/Overseas Environmental Assessment(OEA) for Flight Experiment 1 (FE-1) and the Draft Finding of No Significant Impact (FONSI) are enclosed for your review, as required by the National Environmental Policy Act (42 U.S.C. 4321 et seq.) in accordance with 32 CFR 651.

To fulfill its mission to prove various aspects of their system's capabilities, the U.S. Navy Strategic Systems Programs (SSP) plans to conduct a single FE-1 flight test into the Ronald Reagan Ballistic Missile Defense Test Range (RTS), USAKA, within a year of a FONSI from the completed EA/OEA.

Please provide any comments to Ms. Phillip at RMI EPA Majuro for her incorporation into the RMI EPA response back to SMDC. Responses are requested by **June 19, 2017**.

The technical point of contact is Mr. Thomas M. Craven, commercial (256) 955-1533, or thomas.m.craven2.civ@mail.mil.

Sincerely,

David C. Hasley
UES Co-Chairperson

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND/
ARMY FORCES STRATEGIC COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

4 May 2017

SMDC-ENE

To Whom It May Concern

SUBJECT: Draft Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) for Flight Experiment 1 (FE-1) and Draft Finding of No Significant Impact (FONSI)

Dear Sir or Madam:

Please provide a convenient, accessible location in your facility for the public review of the enclosed documents. The enclosed Draft Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) for Flight Experiment 1 (FE-1) and Draft Finding of No Significant Impact (FONSI) should be made available for public review between May 19 and June 19, 2017. A Notice of Availability for these documents will be published in the Marshall Islands Journal on May 19, 2017; the Kwajalein Hourglass on May 20, 2017; and The Garden Island on May 19 through 21, 2017.

Comments on the Draft EA/OEA and FONSI may be submitted through a website: https://tbe.com/Flight_Experiment_1_Documents_for_Public_Review

Or written comments may be directed to:

Strategic Systems Program
ATTN: Mr. Fred Chamberlain
1250 10th Street, SE
Washington Navy Yard, DC 20374-5127

Mailed comments must be postmarked no later than June 19, 2017.

Thank you for your assistance in this matter.

Sincerely,

David C. Hasley
US Army Kwajalein Atoll Environmental Standards
Co-Chairperson

Enclosure

From:	Craven, Thomas M CIV USARMY SMDC (US)
To:	RMIEPA UES; Kolinski, Steven P CIV (US); Dan Polhemus; Takemoto, Helene CIV USARMY CEPOH (US); Scott, Norwood
Cc:	Elizabeth Harding; Hasley, David C CIV USARMY SMDC (US); Chamberlain, Fred L CIV USN DIRSSP (US); Montgomery, Anthony; Michael Fry
Subject:	Draft Environmental Assessment/Overseas Environmental Assessment and Draft Finding of No Significant Impact for Flight Experiment 1 (FE-1)
Date:	Tuesday, May 09, 2017 11:16:57 PM
Attachments:	Draft EA OEA USFWS letter 4 May 2017.pdf Draft EA OEA RMIEPA letter 4 May 2017.pdf Draft EA OEA USACOE Memo 4 May 2017.pdf Draft EA OEA NMFS letter 4 May 2017.pdf Draft EA OEA USEPA letter 4 May 2017.pdf Blank Comments Form-Draft FE-1 EA_OEA_2017_04_19.docx Draft US Navy SSP FE-1 EA-OEA_2017_04_19_Public Review.pdf

BLUF: COMMENTS ARE DUE JUNE 19, 2017

Iakwe UES team,

The Draft Environmental Assessment (EA)/Overseas Environmental Assessment (OEA) for Flight Experiment 1 (FE-i) and the Draft Finding of No Significant Impact (FONSI) are attached for your review, as required by the National Environmental Policy Act (42 U.S.C. 4321 et seq.) in accordance with 32 CFR 651.

To fulfill its mission to prove various aspects of their system's capabilities, the U.S. Navy Strategic Systems Programs (SSP) plans to conduct a single FE-1 flight test into the Ronald Reagan Ballistic Missile Defense Test Range (RTS), USAKA, within a year of a FONSI from the completed EA/OEA.

Comments should be sent to Mr. Tom Craven, U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT), at thomas.m.craven2.civ@mail.mil with Mr. Fred Chamberlain, U.S. Navy SSP, copied at Fred.Chamberlain@ssp.navy.mil. Comments are due by June 19, 2017. Please use the attached comment form to record your comments.

A Notice of Availability for these documents will be published in the Marshall Islands Journal on May 19, 2017; the Kwajalein Hourglass on May 20, 2017; and The Garden Island on May 19 through 21, 2017. The public comment period for the Draft EA/OEA and the Draft Finding of No Significant Impact will start on 19 May and runs through 19 June.

Interested parties can review the draft FONSI and the draft EA on the internet at https://tbe.com/Flight_Experiment_1_Documents_for_Public_Review

In the Republic of the Marshall Islands, the documents will be available at the following four public information repositories:

1. Grace Sherwood Library
Kwajalein Island
US Army Garrison - Kwajalein Atoll

2. Roi-Namur Library
Roi-Namur Island
US Army Garrison - Kwajalein Atoll

3. Republic of the Marshall Islands
Environmental Protection Authority
Majuro, RMI

4. Republic of the Marshall Islands
Environmental Protection Authority
Ebeye, RMI

In Hawaii, the documents will be available at the following two public information repositories:

1. Lihue Regional Library
4344 Hardy Street
Lihue, HI 96766

2. Waimea Public Library
P.O. Box 397
Waimea, HI 96766

Adiitionally, the document will be placed at:

Defense Technical Information Center
8725 John J. Kingman Road
Suite 0944
Ft. Belvoir, VA 22060-6218

The technical point of contact is Mr. Thomas M. Craven, commercial (256) 955-1533, or thomas.m.craven2.civ@mail.mil

COMMENTS ARE DUE BY JUNE 19, 2017.

Kommol tata,

Tom Craven
Environmental Division
Deputy Chief of Staff, Engineer
US Army Space and Missile Defense Command/Army Force Strategic Command
(256) 955-1533
DSN 645-1533

REPUBLIC OF THE MARSHALL ISLANDS
ENVIRONMENTAL PROTECTION AUTHORITY
P.O. Box 1322

Majuro, Marshall Islands 96960

Phone: (692) 625-3035/5203 * Fax: (692) 625-5202 * Email: rmiepa@ntamar.net

19 June 2017

Mr. Thomas Craven
US Army Space and Missile Defense Command/Army Strategic Forces Command
Huntsville, AL
USA
thomas.m.craven2.civ@mail.mil
copy to Mr. Fred Chamberlain
US Navy SSP – fred.chamberlain@ssp.navy.mil

Mr. Craven,

Enclosed are comments regarding the Draft Environmental Assessment/Overseas Environmental Assessment for the Flight Experiment 1 and Draft Finding of No Significant Impact, as forwarded in a May 4 2017 Letter from Mr. David C Halsey, UES Co-Chair.

Accessibility of EA

The EA and it's appendixes is over 200 pages in length. RMI EPA calls attention to CEQ regulations establishing a target size for EISs as "normally not to exceed 150 pages in length and for proposals of unusual scope or complexity 300 pages (40 CFR 1502.7) as well as 1981 CEQ guidance opinion stating that an Environmental Assessment should not exceed 10-15 pages in length (referenced in CEQ's "40 Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations"). On length alone, the EA appears to read more like a "mini EIS" which resolves impacts, rather than a proper assessment which only identifies them, and the overall scale and complexity of the document does not lead us to consider it as a concise public document (particularly for many Marshallese who are unfamiliar with highly technical English language terminology). RMI EPA would understand an EA to be a concise document which would briefly provide sufficient evidence and analysis to determine if an EIS is necessary, and just long enough to allow decision-makers to evaluate impacts and alternatives.

RMI EPA encourages tiered approaches (supported by CEQ regulation 40 CFR 1508.28) which provides a process for analysis of broad conceptual proposals followed by narrower site-specific analysis incorporating earlier work by reference. Such a process would allow for environmental decision-making to be integrated much earlier into agency planning, instead of as a procedural undertaking, well after de-facto program decisions have already been made. Such an approach could reduce, rather than expand, the overall burden and technical complexity of such documents, while also allowing for a more targeted and earlier consideration of environmental issues.

Cumulative Impacts

RMI EPA recalls its comments on the Coordinating Draft Supplemental Environmental Assessment for Minuteman III Modification and Fuze Modernization, and requests clarification regarding the analysis in that document, other related assessments, and the present document, including regarding cumulative impacts.

The Cumulative Impact Analysis in Section 5.4 references the MMIII testing impacts, but appears to have a conclusory and repeated statement regarding the lack of cumulative impacts, which lacks a detailed presentation of substantive analysis, or needed clarification between the current EA and the 2016 Minuteman III/Fuze Supplemental EA. RMI EPA would consider cumulative impacts to be those that are incremental impacts, when added to other past, present and reasonably foreseeable future actions. The CEQ has stated that "evidence is increasing that the most devastating environmental effects may result not from the direct effects of a particular action, but from the combination of individually minor effects of multiple actions over time." (CEQ "Considering Cumulative Effects Under the National Environmental Policy Act" 1997 pg 1). Such effects should be specifically identified and evaluated.

RMI EPA considers the cumulative environmental impacts to be potentially or generally within the entire mid-atoll corridor area (USAKA), not necessarily only limited to discrete locations. Moreover, RMI EPA considers the cumulative impacts to include all related actions. Here RMI notes separate analysis (only some of which are cited in the EA) including the Final Supplemental Environmental Assessment for Minuteman III Extended Range Flight Testing (August 2013), Coordinating Draft Supplamental Environmental Assessment for Minuteman III Modification and Fuze Modernization (2016), the 2004 Minuteman III Modification Environmental Assessment, the 2012 Environmental Assessment for Integrated Flight Tests at USAKA which includes THAAD, Patriot and Aegis missile/vehicle tests, the 2001 North Pacific Target Launch Environmental Assessment, the 2011 Advanced Hypersonic Weapon Program Environmental Assessment, and the 2014 Advanced Hypersonic Weapon Flight Test 2 Hypersonic Technology Test Environmental Assessment.

While the range of different testing programs – and different DoD agencies involved – may be clear and distinct within the US government, it is less clear to RMI other than a strong concern that the cumulative impact of these multiple and related actions are adequately identified and considered, in a comprehensive manner.

In it's 2016 Minuteman III comments, RMI EPA raised this same issue addressed herein, regarding the fragmentation or piecemeal approach towards environmental impacts of multiple testing programs (and their respective environmental assessments). In it's 2016 comments, RMI EPA presumed that that environmental assessment would be the only NEPA-level document produced through the 2030 analytical timeframe for missile testing or other related security actions or projects, and that EA would summarize the full extent of projected and cumulative impacts. RMI EPA again would see a single, combined analysis is needed for proposed actions that are similar, cumulative and/or connected (common timing and geography). Actions that are interdependent could still exist without each other. The 2016 MMIII EA, for example, addresses potential cumulative impacts for biological resources from both MMIII tests "and other flight tests." It would be useful to clarify this issue in respect to the current Environmental Assessment.

RMI EPA notes the present section 5 regarding the explanation of cumulative impacts, and the reference in the 5.1 Table spreadsheet to Minuteman III RV Impacts at KMISS and Minuteman III RV Impacts as well as the Hypersonic Weapon Program, all of which appear to be missile testing programs, but is not able to clear connect these references to the subsequent Section 5.4.3 Cumulative Impact Analysis for USAKA RMI. Here the reader is not told what data the conclusion was based on, or why objective data cannot be provided. RMI EPA requests clarification regarding a more specific explanation of the questions and criteria provided in Section 5.1 "Definition of Cumulative Impacts" and the one sentence generalized conclusions presented in Section 5.4 "Cumulative Impact Analysis."

No Action Alternatives Analysis

RMI EPA notes that the EA describes the "no action alternative" as one which "would not meet the purpose and need for the proposed action" but that "it provides the baseline for measuring the environmental consequences" (page 2-3) . In most, if not nearly all instances, the "no action alternative" in environmental assessments does not meet the immediate purpose and need to the proposed action. The purpose of the EA, and NEPA itself, is for agency decision-makers to take a "hard look" at impacts and alternatives. It is not appropriate to disregard reasonable alternatives merely because they do not offer a complete solution. While there is a rule of reason applied, the description of the "no action" alternative appears to be cursory, procedural or self-serving, rather than an integral part of reasoned decision-making of alternatives as far as environmental aspects are concerned, including alternatives not necessarily within the scope of the agency. No other alternatives in the EA have any environmental information, and RMI EPA requests clarification within the EA on the degree of consideration of the "no action" alternative.

Public participation and information

RMI EPA notes the Marshallese translation of the 1993 SEIS summary. This approach was useful as many Marshallese have a limited exposure to written english, in particular the complex technical and legal terminology within the 200 page EA, and the lack of Marshallese translation is a practical barrier in the ability to provide public review and comment. RMI EPA recommends that further direct public engagement, such as a public meeting or other alternatives, including any summary or written material with Marshallese translation, and/or advertisements or notices in Marshallese language, regarding the EA, would greatly improve public participation, understanding and dialogue.

In this regard, RMI EPA suggests that Notices to Mariners, which include intended warning to Marshallese citizens, and the referenced fact sheet on Ebeye and Kwajalein (describing the project and environmental controls), also be prepared in Marshallese language (referenced on page 2-11).

Cultural Resources

Regarding section 3.3.1.1 (Cultural Resources Regulatory Setting). Although RMI EPA and HPO agree with the "no effect" finding, we express continued disagreement regarding the purported lack of application of the US National Historic Preservation Act and exclusion of US ACHP regarding US National Historic Landmark consultations (referencing Sections 402, 106 and 110(f) of the NHPA). This was also expressed during the approval of the Cultural Resources DEP. RMI notes recent US ACHP training sessions provided for RMI regarding application of the NHPA.

Hazardous Materials

Regarding offshore waters impact areas (page 3-73), the EA references a 1998 NASA study of seawater quality effects of missile components deposited in ocean waters, with a conclusion that release of hazardous materials from missiles into seawaters would not be significant (rapidly diluted and, except in immediate vicinity, not at concentrations that produce adverse effects). The EA notes that payload is "generally insoluable" and would be at "thousands" of feet of depth in these areas, with water quality effects "expected to be minimal, with potential for toxic concentrations "expected to be small" with localized effects and "the potential for cumulative impacts is expected to be nil."

The discussion of tungsten alloy release (1,000 pounds in the payload) reveal a bench study planned whose results would not likely be available before the proposed action but will inform future analysis as a mitigation measure, and that some recent analysis could indicate the ability of tungsten to dissolve in the soil. The EA concludes that only trace amounts will remain in terrestrial areas and that "if any hazardous chemicals enter the marine environment they are expected to be diluted and dispersed quickly by currents and wave action." (page 4-33) Further, deep ocean analysis (page 4-41) states that the 1,000 pounds of tungsten alloy would be introduced into the marine environment and that "the effects of tungsten alloys in ecosystems are largely unknown" (with no known studies on marine ecosystems), that this would sink to the ocean floor and be dispersed by "wave action and ocean currents such that tungsten concentrations would have little or no impacts on marine organisms." (page 4-41) with the final conclusion that "components would likely sink to the ocean floor" and that marine organisms "are not likely to contact them" with any chemicals in the water column to be quickly diluted among low densities of organisms (page 4-42).

RMI EPA requests further clarification; on one hand, the EA states that very little to no information is known or available as to ecosystem impact of tungsten (in particular in marine ecosystems), and on the other hand, the EA concludes there is no significant impact, and it is unclear if these are more speculative statements or scientific assessments. It would be important to understand, in detail, the scientific analysis and methodology applied to reach this conclusion, and to distinguish firm scientific conclusions from more speculative assessments. RMI EPA does not have extensive experience addressing tungsten alloy, but a cursory examination of background literature reveals that it is considered somewhat toxic to animals, and thus RMI EPA has some caution.

RMI EPA understands the EA to state that unless there is surface impact (which would be collected in some form), that deep water splashdown of the vehicle/payload would result in 1,000 pounds of tungsten going to the deep ocean floor for an indefinite basis, or being dispersed by ocean current or wave action. RMI EPA requests clarification on several points in the EA. What is the long-term known impact or potential risk over a significant period of time (eg until 2080) of this quantity either remaining on the ocean floor or entering the marine ecosystem through wave action and currents? What is the known direction or dispersal of these currents or wave patterns? What is the basis or methodology for the use of the term "likely" and how (in a quantifiable sense) is this likely or unlikely? What would be the relationship between contact with marine organisms and wider food chain impacts, including fish tissue, and what would be the projected impact to human health and safety for fish consumption? RMI EPA notes the 2014 draft Southern USAG-KA Fish Study undertaken by the US Army Public Health Command, in particular it's conclusion to determine possible on land sources of contamination stemming from Illeginni activities and suggests that, as this is a visible public issue, it would be appropriate for the EA to take into account this study and address the relationship, if any, between the EA's proposed action/alternative and existing fish tissue contamination at Illeginni. What are cumulative impacts, if any, from other payload contaminants from other missile tests at USAKA, including be and DU, within Illeginni, or even if not in the immediate geographic proximity?

Finally, RMI EPA welcomes the planned bench study on tungsten alloy and it's environmental impact for use in future analysis, but would not consider this a mitigation measure; rather, such a study would be normally considered part of the necessary analysis under NEPA to identify potential environmental impacts and take these into account in decision-making as part of

NEPA's standard, and thus would be applied in some measure prior to any FONSI or proceeding of project action. General statements about possible effects and some risk do not constitute a "hard look" absent a justification regarding why more definative information cannot be provided (particularly as the bench study appears to provide such information, albeit not in the proponent's desired timeframe).

Consistency with Other Federal Laws

Section 6.1, Consistency with Other Federal, State, and Local Laws, Plans, Policies and Regulations, and Table 6.1, which identifies the principle federal and state laws and regulations that are applicable to the proposed action, should also reference the US Public Law 108-188, Compact of Free Association Amendments Act of 2003.

Thank you for the opportunity to provide comments

Sincerely,

Ms. Moriana Phillip
General Manager
Marshall Islands Environmental Protection Authority
Majuro, Republic of the Marshall Islands

DEPARTMENT OF THE ARMY
U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND/
ARMY FORCES STRATEGIC COMMAND
POST OFFICE BOX 1500
HUNTSVILLE, ALABAMA 35807-3801

REPLY TO
ATTENTION OF

June 30, 2017

SMDC-ENE

Mary Abrams
U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
300 Ala Moana Blvd., Room 3-122
Honolulu, Hawaii 96850

Dear Ms. Abrams:

On March 2, 2017, the U.S. Navy Strategic Systems Programs (SSP) as action proponent and assisted by the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTART), submitted a Biological Assessment (BA) for Flight Experiment 1 (FE-1) to the U.S. Fish and Wildlife Service. Three species, which are protected under section 3-4.5 of the U.S. Army Kwajalein Atoll Environmental Standards (UES) or section 7(a)(2) of the U.S. Endangered Species Act (ESA), occur or have the potential to occur in the action area and are under the jurisdiction of the U.S. Fish and Wildlife Service. In the BA, we concluded that the proposed action may affect and is likely to adversely affect 2 species of nesting sea turtles, *Chelonia mydas* and *Eretmochelys imbricata*. We also concluded in the BA that the proposed action may affect but is not likely to adversely affect Newell's shearwaters, *Puffinus auricularis newelli*.

Because of the potential effects to these species, the USASMDC/ARSTRAT and U.S. Navy SSP requested initiation of formal consultation with the U.S. Fish and Wildlife Service for nesting sea turtles (*Chelonia mydas* and *Eretmochelys imbricata*). The US Navy SSP and USASMDC/ARSTRAT also requested to initiate informal consultation with the U.S. Fish and Wildlife Service under section 7(a)(2) of the U.S. ESA for potential effects to at-sea Newell's shearwaters, *Puffinus auricularis newelli*.

Based on conversations with U.S. Fish and Wildlife Service personnel during the BA review, and in light of new information, we have reexamined the effects of the action on nesting sea turtles. After reconsidering the mitigation measures outlined in the BA, the location of the affect area being clear of the shoreline, and information regarding sea turtle nesting at Illeginni, we have revised our effect determination for nesting sea turtles. While Illeginni Islet has shoreline habitat suitable for sea turtle nesting, no sea turtle nests or nesting activity have been observed on Illeginni in over 20 years. The last evidence of sea turtle nesting activity on Illeginni Islet consisted of observation of nest pits (unidentified species) in 1996, 21 years ago. Therefore, we conclude that the probability of sea turtle nesting in the area is so low as to be discountable. After revaluating the stressors of the action in light of the remote probability of green or hawksbill sea turtles nesting in the area, we now conclude that *Chelonia mydas* and

Eretmochelys imbricata may be but are not likely to be adversely affected by the proposed action.

We would also like to provide you with additional information about FE-1 launch activities at the Pacific Missile Range Facility (PMRF). In 2011, USASMDC/ARSTRAT conducted a similar mission using the same missile from Pad 42 during the Newell's shearwater fledging season. The USFWS issued a biological opinion for that mission. The pad was lit, using the green lighting system, for more than a week prior to the night launch and there were no fall out events at the pad. In the FE-1 BA, we deferred to the 2014 Programmatic Biological Opinion (BO) for PMRF for FE-1 launch activities at Kauai Test Facility (KTF), which is currently under a reinitiated consultation. However, in order to support a not likely to adversely affect determination for our entire action, we provide additional details as they relate to the launch activities and the Newell's shearwaters.

Pre-launch activities, which will occur at or near pad 42 at KTF, include final vehicle and experiment assembly, preflight checks, and demonstration of system performance at KTF. These activities will not occur at night. The program will not turn on the Pad 42 lights at night for any program activities during the Newell's shearwater period of concern (i.e., 10 days prior to the new moon through 8 days after). If program activities are required to occur at night outside the period of concern and if for safety reasons pad lights are required, the program will coordinate these activities through PMRF in order to comply with the Dark Skies policy. Because of these practices, we believe shearwaters are not likely to be disoriented by artificial lighting from FE-1 activities.

Based on the above information and information contained in the FE-1 BA, we have determined that the FE-1 flight test may affect but is not likely to adversely affect Newell's shearwaters (*Puffinus auricularis newelli*) at KTF in addition to the broad ocean area already analyzed in the FE-1BA.

The U.S. Navy SSP and USASMDC/ARSTRAT request your review of our revised conclusion of a may affect but not likely to adversely affect determination for *Chelonia mydas* and *Eretmochelys imbricata.* Based on our conclusion that the action is not likely to adversely affect *Chelonia mydas*, *Eretmochelys imbricata,* and *Puffinus auricularis newelli*; USASMDC/ARSTRAT and U.S. Navy SSP requests your concurrence for our may affect but not likely to adversely affect determination for these species.

Please contact Thomas Craven, USASMDC/ARSTRAT, Environmental Division, regarding this consultation request at (256) 955-1533 or at thomas.m.craven2.civ@mail.mil.

Sincerely,

Weldon Hill
Deputy Chief of Staff, Engineer
U.S. Army Space and Missile Defense
Command/Army Forces Strategic Command

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawaii 96850

In Reply Refer To:
01EPIF00-2017-I-0317

JUL 13 2017

Mr. Weldon Hill
Deputy Chief of Staff, Engineer
U.S. Army Space and Missile Defense Command
Army Forces Strategic Command
P.O. Box 1500
Huntsville, Alabama 35807-3801

Subject: Informal Consultation for the Proposed U.S. Navy Strategic Systems Programs, Flight Experiment-1 on Green and Hawksbill sea turtles and Newell's Shearwater

Dear Mr. Hill:

The U.S. Fish and Wildlife Service (Service) received your letter dated June 30, 2017, withdrawing your March 1, 2017, request for formal consultation for nesting Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricata*) sea turtles and informal consultation for Newell's shearwaters (*Puffinus auricularius newelli*). In this same letter you are also resubmitting your request for informal consultation for nesting Green and Hawksbill sea turtles and Newell's Shearwater. You are requesting concurrence with your determination that the proposed U.S. Department of the Navy (Navy) Strategic Systems Programs (SSP) Flight Experiment -1 (FE-1) at U.S. Garrison - Kwajalein Atoll (USAG-KA), may affect, but is not likely to adversely affect the federally endangered Green and Hawksbill sea turtles and Newell's Shearwater. The U.S. Navy assisted by the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) is proposing to conduct the FE-1, including pre-launch and launch activities at the Kauai Test Facility (KTF) located on the Pacific Missile Range Facility (PMRF) on the island of Kauai in Hawaii.

Your concurrence request addresses the anticipated impacts to nesting Green and Hawksbill sea turtles and Newell's Shearwater from the FE-1 at USAG-KA and KTF and does not address impacts to Newell's shearwater resulting from other operations and activities at PMRF. Formal consultation for PMRF Base-wide Infrastructure, Operations, and Maintenance (PMRF Base-wide) and its effects on the Newell's shearwater was reinitiated in April 2015 (Service file number: 01EPIF00-2015-F-0227). The scope of the proposed action under the PMRF Base-wide consultation includes all current and ongoing base infrastructure, operations, and maintenance activities at all terrestrial PMRF sites, including activities of tenant and customer Department of Defense commands and other Federal agencies. This includes the management and operation for missile assembly and launch operations and associated support activities, administration, and services at KTF. Completion of the PMRF Base-wide consultation has been delayed.

The findings and recommendations in this consultation are based on (1) your letter and Biological Assessment received on March 2, 2017; (2) our meeting via telephone between Service staff and USASMDC/ARSTRAT staff on June 19, 2017 during pre-consultation; (3) your June 30, 2017 letter received on July 3, 2017; and (4) other information available to us in our databases and records. A complete administrative record is on file in our office. This response is in accordance with Section 3-4.5 (Procedures for Consultation on Endangered Resources) of the U.S. Army Kwajalein Atoll Environmental Standards (UES) (11^{th} edition) and section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*).

Project Description

The Navy assisted by the USASMDC/ARSTRAT proposes to conduct a single flight test to prove various aspects of the Navy FE-1 system's capabilities including flight testing of a developmental payload. The purpose of the Proposed Actions is to collect data on a developmental payload by testing range performance and to demonstrate capabilities as a prospective means to strike capabilities. The developmental payload will be launched from KTF located on the PMRF in Hawaii and would travel across a broad ocean area of the Pacific Ocean towards the Ronald Regan Ballistic Missile Defense Test Site (RTS) at the USAG-KA, in the Republic of the Marshall Islands (RMI). Pre-launch activities include final vehicle and experiment assembly, pre-flight checks, and demonstration of system performance at or near Pad 42 at KTF.

The preferred terminal end of the missile flight test will be at Illeginni Islet in Kwajalein Atoll. This zone is approximately 290 m (950 ft.) by 137 m (450 ft.) on the non-forested, northwest end of the islet. Upon reaching the terminal end of the flight, the payload will impact the Islet creating a crater and leave debris containing less than 454kg (1,000lbs) of tungsten. Post-flight operations include the manual clean-up of payload debris, use of heavy equipment for cleanup and repairs, and retrieval of sensors. All waste materials will be returned to Kwajalein Island for proper disposal in the US.

Conservation Measures

The following measures identified in your Biological Assessment and June 30, 2017 letter will be implemented at the project site to avoid and minimize effects to Green and Hawksbill sea turtles and Newell's shearwaters. The following avoidance and minimization measures are considered part of the project description:

- If personnel observe sea turtles in or near potential impact zones, sightings will be reported to appropriate test and USAG-KA personnel for consideration in launch planning.
- Vessel and equipment operations will not involve any intentional discharges of fuel, toxic waters, or plastics and other solid wastes that could harm terrestrial or marine life.
- Hazardous materials will be handled in adherence to the hazardous materials and waste management systems of USAG-KA. Hazardous waste incidents will comply with the emergency procedures set out in the Kwajalein Environmental Emergency Plan (KEEP) and the UES.
- All equipment and packages shipped to USAG-KA will undergo inspection prior to shipment to prevent the introduction of alien species into Kwajalein Atoll.

- Pre-flight monitoring by qualified personnel will be conducted on Illeginni Islet for sea turtles or sea turtle nests. For at least 8 weeks preceding the FE-1 launch, Illeginni Islet will be surveyed by pre-test personnel for sea turtles, sea turtle nesting activity, and sea turtle nests on a bi-weekly basis. If possible personnel will inspect the area within two days of the launch. If sea turtles or sea turtle nests are observed near the impact area, observations will be reported to appropriate test and USAG-KA personnel for consideration in approval of the launch and to NMFS and the Service.
- Personnel will report any observations of sea turtles or sea turtle nests on Illeginni to appropriate test and USAG-KA personnel to provide to NMFS and USFWS.
- Debris recovery and site cleanup will be performed on land. Recovery and cleanup will be conducted in a manner to minimize further impacts on biological resources.
- At Illeginni Islet, should any missile components or debris impact areas of sensitive biological resources, a Service or NMFS biologist will be allowed to provide guidance and or/or assistance in recovery operations to minimize impacts on such resources.
- Although unlikely, any dead or injured marine mammals or sea turtles sighted by post-flight personnel will be reported to the USAG-KA Environmental Office and SMDC, who will then inform NMFS and the Service. USAG-KA aircraft pilots otherwise flying in the vicinity of the impact and test support areas will also similarly report any opportunistic sightings of dead or injured marine mammals or sea turtles.
- As soon as practical following payload impact at Illeginni Islet, qualified biologists will be allowed to assist in recovering and rehabilitating any injured sea turtles found.
- During post-test recovery and cleanup, should personnel observe endangered, threatened, or other species requiring consultation moving into the area, work will be delayed until such species were out of harm's way or leave the area.
- To minimize impacts during post-flight operations, the Service and NMFS will be allowed to provide guidance and/or assistance during recovery and cleanup at Illeginni Islet. In all cases, recovery and cleanup operations will be conducted in a manner to minimize further harm to biological resources.
- Pre-launch activities at or near Pad 42 KTF will not occur at night.
- No lights at Pad 42 will be turned on at night for any program activities 10 days prior to the new moon through 8 days after the new moon. If program activities are required to occur at night outside of the above period and if for safety reasons pad lights are required, the program will coordinate these activities through PMRF and comply with the Dark Skies policy.

In addition to the above conservation measures, the Service acknowledges that if program activities occur at night outside of the period identified above, USASMDC/ARSTRAT estimates that the number of nights that lighting will be turned on is not likely to exceed a total of 2 nights (discussed in the June 19, 2017 pre-consultation meeting). We also understand that the PMRF Dark Skies policy (PACMISRANFAC NOTICE 10570) provides guidance for measures to be implemented to reduce/eliminate risk to the Newell's shearwater during the fledgling season, September 15th through December 15th. The policy document states that portable light carts used for Force Protection should be equipped with two green and two white lights; only the green lights are used during lower Force Protection Conditions (FPCON) status, while white lights are available for higher FPCON status. It also states that lamps should be oriented in the full cut off position and facing directly downward. Based on email communication between the Navy and the Service in November 2016 regarding this policy, the Service acknowledges that the Navy no longer uses green lights at PMRF.

Summary

After reviewing the new information provided and in our files, we have concluded that the location of the target site is clear of the shoreline, however, payload impact debris and ejecta could impact adjacent sandy shoreline. While Illeginni Islet has shoreline habitat that a sea turtle could successfully lay a nest, a significant portion of the habitat is submerged or inundated during high tide events; thus drowning any sea turtle nests that may be present. In addition, any turtle nesting or terrestrial activity sign that could identify any nesting or terrestrial behaviors would be washed away if they are below the high tide line.

Adult Newell's shearwaters do not nest at PMRF, but do use the area to transit between their ocean foraging areas and their high elevation, montane nesting sites. Fledgling Newell's shearwaters fly through the PMRF sites on their first trip to the sea. The proposed project may impact Newell's shearwaters, especially fledgling seabirds, by causing seabirds to fall to the ground or collide with utility wires, poles, trees, or buildings as a result of being disorientated by upward projecting nighttime lighting. By incorporating the above avoidance and minimization measures for Newell's shearwaters, seabird disorientation to shielded nighttime lighting is not probable.

Based on the proposed action, minimization measures being implemented, and the reasoning provided in your June 30, 2017 letter, it is not probable the proposed action will impact sea turtle(s) or Newell's shearwater(s). Therefore, the Service has determined any effects are discountable and not likely to adversely affect the Green and Hawksbill sea turtles and their nests and Newell's shearwaters. Therefore, the Service concurs with your determination that the proposed test flight may effect, but is not likely to adversely affect the Green and Hawksbill sea turtles or their nests and Newell's shearwaters.

Unless the project description changes, or new information reveals that the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to Section 7 of the ESA is necessary.

We appreciate your efforts to conserve threatened and endangered species. If you have questions regarding this letter, please contact Fish and Wildlife Biologists Joy Browning (Joy_Browning@fws.gov or 808-792-9400) or Adam Griesemer (Adam_Griesemer@fws.gov or (808) 822-2175). In future communications regarding this project please include this reference number: 01EPIF00-2017-I-0317.

Sincerely,

Aaron Nadig
Island Team Manager
Oahu, Kauai, Northwestern Hawaiian
Islands and American Samoa

Appendix B

Biological Resources at Kwajalein Atoll

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Table B-1. Fish Species Requiring Consultation (Bold) and Coordination that may Occur near Kwajalein Atoll.				
Scientific Name	***Common Name***	***Listing Status****	***LoO in deep offshore waters near Kwajalein Atoll*****	***LoO near Illeginni Islet***
Alopias superciliosus	**Bigeye thresher shark**	**ESA-Candidate**	**P**	**U**
Carcharhinus longimanus	**Oceanic whitetip shark**	**ESA-Candidate**	**P**	**U**
Cheilinus undulatus	**Humphead wrasse**	**ESA-Candidate, SOSBI**	**U**	**L**
Manta alfredi	**Reef manta ray**	**ESA-Candidate**	**P**	**P**
M. birostris	**Oceanic giant manta ray**	**ESA-Candidate**	**P**	**U**
Sphyrna lewini	**Scalloped hammerhead**	**ESA- Threatened (Indo-West Pacific Distinct Population Segment)**	**U**	**P**
Plectropomus laevis	Giant coral trout	UES, SOSBI	U	L
Thunnus orientalis	**Pacific bluefin tuna**	**ESA-Candidate**	**P**	**U**

Sources: USASMDC/ARSTARAT 2014, USAFGSC and USASMDC/ARSTRAT 2015
* Listing Status; ESA: Endangered Species Act, SOSBI: Species of Significant Biological Importance, UES: UES protection (USASMDC/ARSTRAT 2011a Section3-4.5.1)
**LoO – Likelihood of Occurrence; L-Likely; P – Potential; U – Unlikely

Table B-2. Mollusk Species Requiring Consultation (Bold) and Coordination Found at Illeginni Islet during the 2008 and 2010 Biological Inventories of USAKA.				
Scientific Name	***Common Name***	***Listing Status***	***Frequency of Occurrence at Illeginni (n=5)***	***Frequency of Occurrence Throughout USAKA (n=66)***
Class Gastropoda				
Family Trochidae				
Trochus niloticus*	**Top shell snail**	**UES**	**1.0**	**0.63**
Family Strombidae				
Lambis truncata	Giant spider conch	UES	0.20	0.45
Class Bivalvia				
Family Pteriidae				
Pinctada margaritifera	**Black-lipped pearl oyster**	**UES**	**0.20**	**0.10**
Family Tridacnidae				
Tridacna gigas	Giant clam	UES	0.20	0.12
T. maxima	Giant clam	UES	1.0	0.69
T. squamosa	Giant clam	UES	0.20	0.23

Sources: USFWS 2011; USFWS and NMFS 2012.
* Synonymous with *Trochus maximus, Tectus niloticus,* and *Tectus maximus*.
** UES: UES protection (USASMDC/ARSTRAT 2014, Section3-4.5.1)

Table B-3. Hard Coral Species Requiring Consultation (Bold) and Coordination Observed at Illeginni Islet in 2010 with Frequency of Occurrence at Survey Sites Compared with Atoll-Wide Frequencies.

Scientific Name	Illeginni Frequency (n=4 Sites)	Atoll-Wide Frequency (n=52 Sites)	Number of Islets Observed On (n=11)
Acroporidae			
Acropora abrotanoides	0.50	0.48	9
A. aculeus	**0.25**	**0.06**	**4**
A. austera	0.75	0.67	11
A. aspera*	-	**0.23**	**5**
A. cytherea	0.50	0.52	8
A. dendrum	**0.25**	**0.15**	**7**
A. digitifera	0.75	0.88	11
A. gemmifera	1.00	0.77	11
A. granulosa	0.25	0.44	9
A. humilis	1.00	0.83	11
A. hyacinthus	0.50	0.33	7
A. latistella	1.00	0.63	10
A. listeria	-	**0.06**	**3**
A. microclados	**1.00**	**0.71**	**10**
A. monticulosa	0.75	0.44	10
A. nasuta	1.00	0.87	11
A. palifera	1.00	0.52	10
A. polystoma*	-	**0.02**	**1**
A. robusta	0.50	0.40	7
A. secale	0.25	0.42	10
A. speciosa**	-	-	-
A. tenella	**0.25**	**0.08**	**2**
A. tenuis	1.00	0.75	11
A. valida	0.75	0.63	11
A. vaughani	**0.25**	**0.19**	**7**
Astreopora gracilis	0.25	0.10	6
A. myriophthalma	1.00	0.77	11
A. randalli	0.50	0.12	4
Montipora aequituberculata	1.00	0.77	11
M. caliculata	**0.75**	**0.38**	**9**
M. digitata	0.25	0.29	4
M. floweri	0.25	0.13	7
M. grisea	0.25	0.27	8
M. hoffmeisteri	0.50	0.27	8
M. peltiformis	0.25	0.06	4
M. tuberculosa	0.50	0.54	10
M. verrucosa	0.25	0.27	9
Agariciidae			
Gardineroseris planulata	0.75	0.33	9
Leptoseris incrustans*	-	**0.08**	**3**
Pachyseris speciosa	0.25	0.04	3
Pavona cactus*	-	**0.31**	**6**
Pavona decussata	**1.00**	**0.08**	**5**
P. maldivensis	0.50	0.31	10
P. varians	1.00	0.90	11
P. venosa	0.25	0.38	10
Astrocoeniidae			
Stylocoeniella armata	0.25	0.08	5
Turbinaria reniformis	**0.75**	**0.15**	**5**
T. stellulata	**0.50**	**0.08**	**5**

Table B-3. Hard Coral Species Requiring Consultation (Bold) and Coordination Observed at Illeginni Islet in 2010 with Frequency of Occurrence at Survey Sites Compared with Atoll-Wide Frequencies.			
Scientific Name	**Illeginni Frequency (n=4 Sites)**	**Atoll-Wide Frequency (n=52 Sites)**	**Number of Islets Observed On (n=11)**
Euphyllidae			
Plerogyra sinuosa	0.50	0.08	3
Faviidae			
Cyphastrea agassizi	**0.50**	**0.08**	**4**
Echinopora pacificus	0.25	0.25	7
Favia favus	0.25	0.08	4
F. matthaii	1.00	0.69	10
F. pallida	1.00	0.67	11
F. rotumana	0.50	0.04	3
F. speciosa	0.50	0.31	8
F. veroni	0.25	0.25	8
Favites halicora	0.25	0.50	11
F. pentagona	0.25	0.08	5
Goniastrea edwardsi	1.00	0.69	11
G. pectinata	0.50	0.63	10
G. reniformis	0.25	0.54	10
Leptastrea pruinosa	1.00	0.37	10
L. purpurea	1.00	0.75	11
L. transversa	0.75	0.52	11
Montastrea curta	0.75	0.40	9
Oulophyllia crispa	0.50	0.12	5
Platygyra daedalea	0.75	0.35	9
P. pini	0.75	0.25	9
P. ryukyuensis	0.50	0.04	3
P. sinensis	1.00	0.69	11
Fungiidae			
Ctenactis echinata	0.50	0.15	6
Fungia fungites	1.00	0.75	11
F. granulosa	0.50	0.25	8
F. horrida	0.25	0.12	6
F. paumotensis	0.75	0.56	11
F. repanda	0.50	0.50	11
F. scutaria	0.75	0.50	11
Halomitra pileus	0.50	0.40	10
H. limax	0.75	0.50	11
Helioporidae			
Heliopora coerulea	**1.00**	**0.42**	**11**
Merulinidae			
Hydnophora exesa	0.25	0.10	6
H. microconis	0.50	0.50	10
Merulina ampliata	0.75	0.42	10
Millepora exaesa	1.00	0.92	11
M. platyphylla	0.75	0.33	9
M. tenella	1.00	0.37	9
Mussidae			
Acanthastrea brevis	**0.50**	**0.08**	**5**
A. echinata	0.75	0.13	6
Lobophyllia hemprichii	1.00	0.60	11
L. robusta	0.50	0.25	6
Symphyllia recta	0.75	0.17	6
Oculinidae			

Table B-3. Hard Coral Species Requiring Consultation (Bold) and Coordination Observed at Illeginni Islet in 2010 with Frequency of Occurrence at Survey Sites Compared with Atoll-Wide Frequencies.

Scientific Name	Illeginni Frequency (n=4 Sites)	Atoll-Wide Frequency (n=52 Sites)	Number of Islets Observed On (n=11)
Galaxea horrescens	0.25	0.15	6
Pectiniidae			
Echinophyllia aspera	0.25	0.13	5
Pocilloporidae			
Pocillopora damicornis	0.25	0.73	11
P. eydouxi	1.00	0.96	11
P. meandrina	1.00	0.90	11
P. verrucosa	1.00	0.85	11
P. woodjonesi	0.25	0.15	5
Seriatophora histrix	0.25	0.29	8
Stylophora pistillata	0.75	0.27	9
Poritidae			
Alveopora verrillana	0.50	0.06	3
Goniopora lobata	0.25	0.08	4
G. minor	0.25	0.29	10
G. norfolkensis	0.50	0.04	2
G. pandoraensis	0.25	0.10	4
G. tenuidens	0.50	0.02	2
Porites cylindrica	0.50	0.42	10
P. lobata	1.00	0.75	11
P. lutea	1.00	0.98	11
P. rus	1.00	0.69	11
P. solida	0.25	0.02	2
Siderastreidae			
Coscinaria columna	0.25	0.10	6
Psammocora haimeana	0.50	0.44	10
P. nierstraszi	0.50	0.27	8
Average Frequency/Number	0.60	0.39	8.07

Source: USFWS and NMFS 2012

* Acropora aspera, A. listeria, A. polystoma, Leptoseris incrustans, and Pavona cactus were not observed during surveys of Illeginni Islet during 2010, however, these consultation species have been observed on other surveys or have the potential to occur at Illeginni Islet.

Table B-4. Number of Birds Observed on Illeginni Islet during the 1998, 2000, 2002, 2004, 2006, 2008, and 2010 Biological Inventories

Common Name	Scientific Name	Year						
		'98	'00	'02	'04	'06	'08	'10
Great frigatebird	*Fregata minor*	-	-	-	-	1	-	-
Pacific reef heron	*Egretta sacra*	11	7	3	6	3	3	2
Pacific golden plover	*Pluvialis fulva*	59	39	24	27	41	55	15
Wandering tattler	*Heteroscelus incanus*	6	13	5	7	11	18	7
Gray-tailed tattler	*Heteroscelus brevipes*	-	-	-	-	-	-	1
Tattler spp.	*Heteroscelus* spp.	-	4	1	-	-	-	-
Whimbrel	*Numenius phaeopus*	3	3	4	2	-	4	9
Bristle-thighed curlew	*Numenius tahitiensis*	-	2	-	-	1	2	-
Godwit Sp.	*Limosa*	2	-	-	-	-	-	-
Ruddy turnstone	*Arenaria interpres*	27	3	9	19	57	49	75
Black-naped tern	*Sterna sumatrana*	8	29	24	11	13	31	1
Great crested tern	*Sterna bergii*	5	3	2	1	10	4	3
Brown noddy	*Anous stolidus*	2	4	186	1	36	15	39
Black noddy, adults (nests)	*Anous tenuirostris minutus*	90	292	135	326 (130)	378	- (339)	108 (30)
White tern	*Gygis alba*	14	15	4	5	26	14	-

Source: USFWS and NMFS, 2012

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Appendix C

Comments and Responses on Draft EA/OEA

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COMMENT FORM

COMMENT INCORPORATOR: Teledyne Brown Engineering, Inc.	**DATE: 6/8/2017**
COMMENTOR: Tony Montgomery	**ORGANIZATION OF COMMENTOR: USFWS**
TITLE OF DOCUMENT Draft Environmental Assessment/Overseas Environmental Assessment for Flight Experiment 1 (FE-1)	**DATE OF DOCUMENT: 19 April 2017**

ITEM NO.	PAGE NO.	SECT. NO.	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES *(Exact wording of suggested change)*	INCOR-PORATED? *(Yes/No)*	HOW COMMENT WAS INCORPORATED *(If not incorporated, why?)*
Tony Montgomery, USFWS								
1	3-22	3.1.3 .4?	7			The species of precious corals are incorrect. The black coral formally known as *Antipathes dichotoma* in Hawaii has been redescribed to Antipathes griggi (Opresko 2009). The black coral formally known as *Antipathes ulex* has been moved to a new genus of *Myriopathes* (Opresko 2001). This should also be corrected in the preceding Table 3-3 as well.	Yes	Revised species names in section 3.1.3.5 Marine Wildlife at SNL/KTF.
2	3-22	3.1.3 .4?	18			This section appears to apply to the SNL/KTF. However, the various sections seem to flip between biological descriptions of Hawaii and the Pacific Islands Remote areas which have different communities and fall under different MUS under the WPRFMC. It is not clear if the remote islands are included in the SNL/KTF ROI. The back and forth and inconsistency between these sections is confusing and seems to reference groups of animals not found in Hawaii, so it is hard to tell if this is referencing the ROI that includes areas outside Hawaii or if the sections are referencing inappropriate information. The two literature references of WPRFMC 2009a and WPRFMC 2009b also may be referenced incorrectly. A general review of all the marine resource description under the SNL/KTF section may be warranted to make sure the descriptions are clear and accurate.	Yes	Separated the Hawai'i Archipelago and Pacific Remote Island Area EFHs for clarity and accuracy. Changes made in section specified here and also in section 3.2.2.2 (Over-ocean Flight Corridor).
3	3-69	3.3.2 .2	1			Coral section: Some discussion should include benthic communities in offshore waters. The presence of corals in deep water is largely contingent on bottom substratum. If hard bottom exists with some degree of rugosity or relief, it is likely deep water coral communities exist. Some of these species can be slow growing and be extraordinarily old. The discussion should reference any information that supports a determination of bottom type and bathymetry in the alternative areas. While none of the species are considered consultation species, some may be coordination species (Scleractinians and Antipatharians).	Yes	Additional discussion of coral benthic communities in the deep-water ROI near Kwajalein Atoll added to the referenced section.
4	3-69	3.3.2 .2	12			See comment above. These communities may contain unique invertebrate communities as well. While none are considered consultation species or coordination species, a description should	Yes	Additional discussion of non- coral benthic invertebrate communities in the deep-water ROI near Kwajalein

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						be included.		Atoll added to the referenced section.
5		4.1.3.2				May need to be updated based on the USFWS consultation for Newell's shearwater.	Yes	Revised referenced section to include USFWS Letter of Concurrence with our determination of "may affect but is not likely to adversely affect" Newell's shearwater.
6		4.1.3.2				May need to be updated based on the USFWS consultation for nesting sea turtles.	Yes	Revised referenced section to include USFWS Letter of Concurrence with our determination of "may affect but is not likely to adversely affect" nesting sea turtles.
Steve Kolinski, NMFS								
1	3-21		24			put *Panulirus* in italics	Yes	Italicized in section 3.1.3.5 Marine Wildlife at SNL/KTF
2	3-22		12			The euphotic zone goes to about 80 m depth, so the shallow water black coral species (range 30 to 100 m) may or may not be living below the euphotic zone, in contrast to the general statement that they "live below the euphotic zone".	Yes	Removed statement that these corals live below the euphotic zone in section 3.1.3.5 Marine Wildlife at SNL/KTF
3			15			Precious corals are found in many places in the Hawaiian islands outside of deep interisland channels. We see them quite often in coastal habitats including under ledges in relatively shallow water. This contrast with the statement made that they are found only in deep interisland channels in the Hawaiian Islands. Large beds have been located in deep interisland channels.	Yes	Revised to reflect comment in section 3.1.3.5 Marine Wildlife at SNL/KTF.
4			19			Not quite sure what "love coral" is?	Yes	Changed "love coral" to "live coral" in section 3.1.3.5 Marine Wildlife at SNL/KTF.
5	3-23		18			Didn't see KTF in acronym list, may want to add.	Yes	"KTF – Kauai Test Facility" added to Acronym list.
6	3-53		39			The statement, "the amount of contaminants in the marine environment at USAG-KA has not been measured" is true and will probably be true into eternity given the enormity of such a task, but it's not really the pertinent baseline upon which to evaluate potential contaminants in turtles at USAKA. There have been multiple studies of contaminant levels in marine waters, sediments and organisms at USAKA sites. The results, to date, are concerning in terms of marine organisms and human consumption of marine organisms. At least some of those studies should be discussed and referenced here.	Yes	The referenced phrase is in 3.2.2.2 ROI Over-Ocean Flight Corridor section; therefore, "at USAG-KA" was removed from the sentence. See response to comment number 16 for information added to section 3.3.2.2 ROI Illeginni Islet regarding, "the amount of contaminants in the marine environment at USAG-KA has not been measured".
7	3-54		30			Some hard coral species are solitary, i.e. not colonial as indicated (i.e. Fungidae). Also, there are hard coral species that do not live in symbiotic relationships with zooxanthellae (such as Tubastrea), in	Yes	Revised to address comment in section 3.2.2.2 ROI Over-Ocean Flight Corridor.

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						contrast to what is presented.		
8			32			Most soft corals are colonial, in contrast to what is presented.	Yes	Revised to address comment in section 3.2.2.2 ROI Over-Ocean Flight Corridor.
9	3-55		12-22			There is actually an older but fairly interesting and relevant literature related to mollusk dispersal and larval longevity. Check out Hadfield, M.G. and M.F. Strathmann. 1996. Variability, flexibility and plasticity in life histories of marine invertebrates. *Oceanologica Acta,* 19, 3-4, 323-334. In particular, follow through with review of some of the references in this paper, in particular Scheltema and also Thorson. This will likely be much more relevant than repeating what has been put forward for corals. See also page 3-67 line 12.	Yes	Thank you for the reference. Information from Hadfield and Strathmann has been incorporated in section 3.2.2.2 ROI Over-Ocean Flight Corridor and 3.3.2.2 ROI Illeginni Islet.
10	3-61		2			The UES no longer requires protection for species specifically because they are petitioned under the US ESA, in contrast to what is presented.	Yes	Revised to address comment in section 3.3.2.1 Regulatory Setting.
11	3-62		14			The characterization that abundance and diversity of marine wildlife is low of the seaward western side of Illeginni Islet is grossly in error. There is a single section on the western side that is mainly pavement and cobble, but the majority of the region is extremely dense with corals (see recent NMFS reports on site specific MMIII impact area. The western impact region had more species and, for most species, greater densities than that on the eastern lagoon side). The reef flat transitions into large complex ridges with extremely diverse and abundant resource communities which continue down the ocean slope environment. This mischaracterization of the western side of Illeginni appears to persist from a previous biennial inventory report where the author put forward impressions that were personal as opposed to observational; they were not well supported by data, as is illustrated in the NMFS MMIII impact area report.	Yes	Revised to address comment in section 3.3.2.2 ROI Illeginni Islet.
12			15			The suggestion of degradation relative to analogous areas at other USAKA islets is unfounded and not supported by observational data. This statement should be removed.	Yes	Revised to address comment in section 3.3.2.2 ROI Illeginni Islet.
13			16			Metal fragments are present in one are, but do not widely cover the benthic substrate on this side of the islet.	Yes	Revised to address comment in section 3.3.2.2 ROI Illeginni Islet.
14			17			Coral diversity is not limited, and suspended sediment is no different than that which is commonly experienced at similar tides at other islet.	Yes	Revised to address comment in section 3.3.2.2 ROI Illeginni Islet.
15			19			Successful coral recruitment is not reduced, as evidenced by size measurements of corals (USFWS 2011, NMFS 2017) and the extensive coverage of coral in most areas on this side of the islet. Recommend referring to NMFS 2017.Biological assessment of	Yes	Revised to address comment in section 3.3.2.2 ROI Illeginni Islet.

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						coral reef resources at risk when targeting Illeginni Islet using missile reentry vehicles, USAKA, RMI, for appropriate site descriptions of potential impact area and associated communities.		
16	3-63		42-43			The statement, "the amount of contaminants in the marine environment at USAG-KA has not been measured" is true and will probably be true into eternity given the enormity of such a task, but it's not really the pertinent baseline upon which to evaluate potential contaminants in turtles at USAKA. There have been multiple studies of contaminant levels in marine waters, sediments and organisms at USAKA sites. The results, to date, are concerning in terms of marine organisms and human consumption of marine organisms. At least some of those studies should be discussed and referenced here.	Yes	The following has been added to the EA/OEA at section 3.3.3.2 ROI Illeginni Islet, immediately following the referenced sentence: "Several studies evaluating sources and contaminants in marine waters, sediments, and organisms have been completed at USAKA for the USAG-KA Environmental Cleanup program. Specifically, the Kwajalein Polychlorinated Biphenyl, Kwajalein Harbor, Kwajalein Landfill, and US Army Public Health Center Fish Studies have brought to light sources and releases of contaminants that have made their way into the marine environment. While the purpose of each of these studies was related to issues of release and cleanup, results of several of the studies have determined there are contaminant concentrations of concern in marine waters, sediments and organisms at some USAKA sites. Following the USAPHC fish study, it was determined that several lagoon "No Fishing" areas would be established to safeguard the Marshallese and US inhabitants of USAKA because contaminant concentrations in lagoon reef fish are at levels where they may adversely affect public health, the marine environment, and protected beneficial uses of surface water (e.g., fishing). The implications to marine organisms, including sea turtles, are that they also could be affected, particularly by ingestion of fish, algae, and other food sources within the waters at Kwajalein Atoll."

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								Additional details of the studies are added in Section 5 Cumulative Impacts Analysis.
17	3-64		12			References should be provided to support the “known” reports of scalloped hammerhead sharks in the vicinity of Illeginni Islet.	Yes	M. Molina Personal communication 2014 added to section 3.3.2.2 ROI Illeginni Islet
18	3-65		6			17 corals are protected by “RMI statutes”? Please clarify which statutes (are they new?).	Yes	The 17 consultation coral species are protected under UES section 3-4.5.1(a). These are species that were proposed for listing under the U.S. Endangered Species Act but were found not to warrant protection under that act and for which the RMIEPA has decided that they remain as consultation species. Reference was updated in section 3.3.2.2 ROI Illeginni Islet.
19	3-66		35			Update the bivalves to include the giant clam Hippopus hippopus (which would make 4 mollusk species in line 33), which was recently found in high numbers within the potential FE-1 reef impact area (see recent NMFS report), as well as in Illeginni lagoon.	Yes	Updated with NMFS 2017 report and relevant inventories in section 3.3.2.2 ROI Illeginni Islet.
20	3-67		32			If all sponges within the RMI are afforded protection under the RMI Marine Resources Act as stated, then all sponges, not just those artificially planted and cultivated, are protected under the UES consultation procedures. At last check, only sponges artificially planted or cultivated were protected by RMI law. This needs to be clarified here (has RMI law changed?).	Yes	Revised to clarify in section 3.3.2.2 ROI Illeginni Islet.
21	3-68		41			This sentence should be rephrased, as the U.S. has no statutory authority to designate EFH in waters off Kwajalein Atoll.	Yes	Removed from section 3.3.2.2 ROI Illeginni Islet
22	3-69		16			Four species of giant clam, not three.	Yes	Revised section 3.3.2.2 ROI Illeginni Islet to reflect that 3 species of giant clams are now U.S. ESA candidate species and thus are considered consultation species under the UES. These are *Hippopus hippopus*, *Tridacna squamosal*, and *T. gigas*. The remaining giant clam species found at USAKA, *T. maxima*, is a coordination species.
23	3-73		1		3-11	It’s not clear to me how the SE for Uranium could be larger than the SD, since SE is SD/(sq. root of sample size)? Also, lower and upper range values of all collected samples should be included in a	Yes	Corrected numbers, added rows for low and high range values to Table 3-10

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						separate row to allow more direct comparison with associated text.		
24	4-25		20			Actually, turtle density data are available near Illeginni Islet. The 2010 inventory lists numbers of turtles observed by survey station. In addition, the 2014 inventory lists number of turtles observed in the harbor, which are likely to experience higher densities at times due to the presence of dense sea grass beds.	Yes	Changed wording in section 4.3.2.2.1 Exposure to Elevated Sound Levels and updated turtle occurrence information throughout the document as well.
Norwood Scott, USEPA								
1	4-32		20-38			"While the effects of tungsten alloys in ecosystems is largely unknown, recent studies have concluded that under certain environmental conditions tungsten may dissolve and some forms of tungsten (depending on soil conditions) can move through soil… As a mitigation measure, the US Navy and USASMDC have begun a bench study to measure the dissolution and migration of the tungsten alloy used in this study in Illeginni Islet soils. While the results of the bench study will likely not be available before the Proposed Action takes place, this study will inform future biological resource analyses of the effects of a tungsten alloy in soils such as those found at Illeginni Islet." EPA is concerned that up to 1,000 lbs. of tungsten alloy may be dispersed on Illeginni and the effects on the environment are not fully known. EPA recommends completing the bench study and installing groundwater monitoring wells prior to considering a land impact.	Yes	We note that 1,000 lbs is the upper boundary under consideration and not the designated payload weight. The bench study results are in and are included in the EA/OEA at sections 4.3.2.2.4 Exposure to Hazardous Chemicals and 5.4 Cumulative Impacts Analysis, and as an Appendix. Additional information regarding the fate and transport of tungsten will also be included in the EA/OEA, as applicable. US Navy SSP is considering groundwater monitoring well installation and pre- and post-flight test groundwater sampling at Illeginni Islet in addition to pre- and post-flight test soil sampling. This information is added to the EA/OEA in sections 4.3.2.2.4 Exposure to Hazardous Chemicals and 5.4 Cumulative Impacts Analysis.
2	N/A					EPA recommends including analysis regarding the kinetic energy produced from up to 1,000 lbs. of tungsten alloy colliding into Illeginni at hypersonic speed. The reader may better understand the potential impacts if it is compared to tons of TNT, as an equivalent.	Yes	Analysis was performed using the kinetic energy of previous Minuteman III impacts which is greater than that anticipated for the FE-1 impact. As described in the Biological Assessment the kinetic energy of impact of the FE-1 stages is on the order of $4x10^9$ Joules, or 0.96 ton of TNT. This will be added to the EA/OEA at section 4.3.2.2.2 Direct Contact .
3	4-32		20-38			The proposed benchmark study mitigation measure may need to be expanded, depending on the impacts from a land strike. Another	Yes	The referenced paper was obtained and reviewed. According to the

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						possible mitigation measure might include the development of a phytoremediation-based technology for the cleanup of tungsten contaminated sites. This is further discussed in the cited paper titled, "Effects of Tungsten on Environmental Systems." https://www.ncbi.nlm.nih.gov/pubmed/16168748		authors, "Plants [i.e., ryegrass] and worms take up tungsten ions from soil in significant amounts while an enrichment of tungsten in the plant rhizosphere is observed. These results provide an indication that tungsten compounds may be introduced into the food chain and suggest the possibility of development of phytoremediation-based technologies for the cleanup of tungsten contaminated sites." Although this study indicates there is potential for the use of ryegrass to uptake tungsten residuals in soil, application of this methodology as phytoremediation at Illeginni Islet would introduce an exotic species to the Atoll and present a poor growth environment for ryegrass (i.e., calcareous sand with low organic content and high soluble salt content, heavy rainfall, high temperatures at which ryegrass becomes dormant). Additionally, the bench study results indicate residual tungsten levels in soil and drinking water (although this is not an area designated for potable drinking water), from the end of the flight test out to 25 years afterward, would be below US EPA Residential Risk-Based Screening Levels (RSLs). Therefore, remediation of residual tungsten in Illeginni soils would not be necessary. Bench study and modeling results are added to the EA/OEA in sections 4.3.2.2.4 Exposure to Hazardous Chemicals and 5.4 Cumulative Impacts Analysis.
Moriana Phillip, RMIEPA								
1						Accessibility of EA – The EA and it's (sic) appendixes is over 200 pages in length. RMI EPA calls attention to CEQ regulations establishing a target size for EISs as "normally not to exceed 150 pages in length and for proposals of unusual scope or complexity 300 pages (40 CFR 1502.7) as well as 1981 CEQ guidance	No	When the CEQ guidance on Environmental Assessment was written 36 years ago, environmental regulations were not as complex and involved as they are now. For

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						opinion stating that an Environmental Assessment should not exceed 10-15 pages in length (referenced in CEQ's "40 Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations"). On length alone, the EA appears to read like a "mini EIS", which resolves impacts, rather than a proper assessment which only identifies them, and the overall scale and complexity of the document does not lead us to consider it as a concise public document (particularly for many Marshallese who are unfamiliar with highly technical English language terminology). RMI EPA would understand an EA to be a concise document which would briefly provide sufficient evidence and analysis to determine if an EIS is necessary, and just long enough to allow decision-makers to evaluate impacts and alternatives. RMI EPA encourages tiered approaches (supported by CEQ regulation 40 CFR 1508.28) which provides (sic) a process for analysis of broad conceptual proposals followed by narrower site-specific analysis incorporating earlier work by reference. Such a process would allow for environmental decision-making to be integrated much earlier into agency planning, instead of as a procedural undertaking, well after de-facto program decisions have already been made. Such an approach could reduce, rather than expand, the overall burden and technical complexity of such documents, while also allowing for a more targeted and earlier consideration of environmental issues.		example, when the 1981 guidance was developed, the National Marine Fisheries Service had 18 listings of threatened and endangered species for which consultation was required. Today they have 168 listings. This is an increase of 930% and the pace of listing is increasing. Between 2000 and 2009, 2 listings per year were added. Between 2010 and 2013, 6 per year were added. Between 2014 and 2017, 31 per year were added. While the EA is over 200 pages, this is due primarily to the diverse marine and terrestrial resources of the Pacific Ocean areas of the project, which requires extensive analysis of biological resources. Additionally, because there are differing and multiple resource components to be analyzed at the launch, over ocean flight path, and three potential impact areas, the document is necessarily more complex than, for example, construction of a small office building with a parking lot at a federal facility. We agree that under 40 CFR 1508, an EA serves to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement"; however, an additional phrase follows in §1508.9 "or a finding of no significant impact". It is the combination of those phrases that guides the analyses level of this document. The US Navy SSP appreciates the encouragement of the use of tiered approaches. Even though 40 CFR 1508.28 provides the sequence of analysis under which tiering is appropriate, the US NAVY SSP FE-1 does not meet the circumstances for

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								application of the tiering model as delineated in that CFR. US Navy SSP has been directed by DoD to perform the FE-1 flight test; there was no US Navy program, plan, or policy (tiering sequence a) and no previous US Navy EIS (tiering sequence b) from which this action has been sequentially downselected. Additionally, because numerous missile test and payload activities of somewhat similar or overlapping scope have been planned at USAKA and Illeginni Islet, and were analyzed under EAs with resulting FONSIs, the use of an EA without tiering also is appropriate for this proposed project. CEQ recommendations do provide substantial guidance on preparing documents to satisfy NEPA requirements, mostly for EISs. However, they do not provide comprehensive regulation on the preparation of EAs. In accordance with the CEQ Forty Most Asked Questions guidance, a practical or feasible and common sense approach is encouraged, which was utilized for this assessment.
2						<u>Cumulative Impacts</u> – RMI EPA recalls its comments on the Coordinating Draft Supplemental Environmental Assessment for Minuteman III Modification and Fuze Modernization, and requests clarification regarding the analysis in that document, other related assessments, and the present document, including regarding cumulative impacts. The Cumulative Impact Analysis in Section 5.4 references the MMIII testing impacts, but appears to have a conclusory and repeated statement regarding the lack of cumulative impacts, which lacks a detailed presentation of substantive analysis, or needed clarification between the current EA and the 2016 Minuteman III/Fuze Supplemental EA. RMI EPA would consider cumulative impacts to be those that are incremental impacts, when	Yes	In response to the RMI EPA comments and in an effort to provide clarification in that section of the document, more details and analyses have been included in the final EA/OEA section 5 Cumulative Impacts, particularly sections 5.3 Past, Present, and Reasonably Foreseeable Actions, and 5.4 Cumulative Impact Analysis. As of September 2016, the US Air Force made the decision to no longer have MMIII land impacts at Illeginni

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						added to other past, present and reasonably foreseeable future actions. The CEQ has stated that “evidence is increasing that the most devastating environmental effects may result not from the direct effects of a particular action, but from the combination of individually minor effects of multiple actions over time.” (CEQ “Considering Cumulative Effects Under the National Environmental Policy Act” 1997 pg 1). Such effects should be specifically identified and evaluated. RMI EPA considers the cumulative environmental impacts to be potentially or generally within the entire mid-atoll corridor area (USAKA), not necessarily only limited to discrete locations. Moreover, RMI EPA considers the cumulative impacts to include all related actions. Here RMI note separate analysis (only some of which are cited in the EA) including the Final Supplemental Environmental Assessment for Minuteman III Extended Range Flight Testing (August 2013), coordinating Draft Supplemental Environmental Assessment for Minuteman III Modification and Fuze Modernization (2016), the 2004 Minuteman III Modification Environmental Assessment, the 2012 Environmental Assessment for Integrated Flight Tests at USAKA which includes THAAD, Patriot and Aegis missile/vehicle tests, the 2001 North Pacific Target Launch Environmental Assessment, the 2011 Advanced Hypersonic Weapon Program Environmental Assessment, and the 2014 Advanced Hypersonic Weapon Flight Test 2 Hypersonic Technology Test Environmental Assessment. While the range of different testing programs – and different DoD agencies involved – may be clear and distinct within the US government, it is less clear to RMI other than a strong concern that the cumulative impact of the multiple and related actions are adequately identified and considered, in a comprehensive manner. In it’s (sic) 2016 Minuteman III comments, RMI EPA raised this same issue addressed herein, regarding the fragmentation or piecemeal approach toward environmental impacts of multiple testing programs (and their respective environmental assessment). In it’s (sic) 2016 comments, RMI EPA presumed that that environmental assessment would be the only NEPA-level document produced through the 2030 analytical timeframe for missile testing or other related security actions or projects, and that EA would summarize the full extent of projected and cumulative impacts. RMI EPA again would see a single, combined analysis is needed for proposed actions that are similar, cumulative and/or connected (common timing and geography). Actions that are interdependent could still exist without each other. The 2016 MMIII		Islet. This will be reflected in the Draft MMIII Supplemental EA when it is released for public review and is presented in the Final DEP for the Minuteman III Program, which has been reviewed and approved by the RMI EPA. An additional Navy SSP flight test as a reasonably foreseeable future activity is added to sections 5.3 and 5.4 of Section 5 Cumulative Impacts. During the original preparation of the draft EA/OEA, a second flight was not considered as a reasonable future activity. After the release of the Draft EA/OEA, the DoD and the US Navy have made the decision to investigate the possibility of another flight. Details are not completely firm, but the second flight will probably be substantively similar to FE-1. With regard to a possible third flight, discussions are at least two years in the future and no specifics are currently available. With regard to cumulative effects of tungsten in the soil, the US Navy anticipates remediation activities could be required after the second flight, because the accumulation of tungsten could potentially approach or exceed USEPA Regional Screening Levels (RSLs). Remediation activities could include phytoremediation, as suggested for consideration by the USEPA, following field-portable elemental analysis such as laser-induced breakdown spectroscopy, or other in-situ detection systems, to determine the level of tungsten remaining in the soil. This information also is added to section 5 Cumulative Impacts in the EA/OEA.

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						EA, for example, addresses potential cumulative impacts for biological resources from both MMIII tests "and other flight tests." It would be useful to clarify this issue in respect to the current Environmental Assessment. RMI EPA notes the present section 5 regarding the explanation of cumulative impacts, and the reference in the 5.1 Table spreadsheet to Minuteman III RV Impacts at KMISS and Minuteman III RV Impacts as well as the Hypersonic Weapon Program, all of which appear to be missile testing programs, but is not able to clear connect these references to the subsequent Section 5.4.3 Cumulative Impact Analysis for USAKA RMI. Here the reader is not told what data the conclusion was based on, or why objective data cannot be provided. RMI EPA requests clarification regarding a more specific explanation of the questions and criteria provided in Section 5.1 "Definition of Cumulative Impacts" and the one sentence generalized conclusions presented in Section 5.4 "Cumulative Impact Analysis."		As noted in the RMI EPA comments, although the range of testing programs generally appears to be quite similar (e.g., missile flight testing with impacts within USAKA), there are different Agencies/Services working on different programs comprised of different mechanical and chemical methodologies and components, that necessitate different timing in order to have access to RTS resources, and the resulting effects of which are different. The preparation of an overarching EIS for activities at USAG-KA would appear to be a worthwhile effort but is outside the purview of the US Navy SSP. The purpose of Table 5-1 in the EA/OEA is to show the projects for which potential cumulative impacts are considered and to provide the level of NEPA analysis performed for each of those projects. Additional details have been added to the section 5 Cumulative Impacts text and to Table 5-1 for clarification in the final FE-1 EA/OEA.
3						<u>No Action Alternatives Analysis</u> – RMI EPA notes that the EA describes the "no action alternative" as one which "would not meet the purpose and need for the proposed action" but that "it provides the baseline for measuring the environmental consequences" (page 2-3). In most, if not nearly all instances, the "no action alternative" in environmental assessments does not meet the immediate purpose and need to the proposed action. The purpose of the EA, and NEPA itself, is for agency decision-makers to take a "hard look" at impacts and alternatives. It is not appropriate to disregard reasonable alternatives merely because they do not offer a complete solution. While there is a rule of reason applied, the description of the "no action" alternative appears to be cursory, procedural or self-serving, rather than an integral part of reasoned	No	US Navy SSP has been directed by DoD to perform the FE-1 flight test. The flight test must meet certain mission and project objectives to provide the data desired by DoD. In accordance with Chief of Naval Operations Instruction (OPNAVINST) 5090.1D, *Environmental Readiness Program*, the no action alternative is an alternative that must be analyzed. The no action alternative can either be stop all activities or continue the *status*

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						decision-making of alternatives as far as environmental aspects are concerned, including alternatives not necessarily within the scope of the agency. No other alternatives in the EA have any environmental information and RMI EPA requests clarification within the EA on the degree of consideration of the "no action" alternative.		*quo* without implementing the Proposed Action. In the FE-1 EA/OEA the no action is the continuation of the *status quo* as described in Chapter 3.0, Affected Environment. Environmental information on the alternative target areas is included in detail in the EA/OEA. As to the Alternatives Considered But Not Carried Forward in Section 2.6, because they do not meet the criteria of the mission and project objectives set forth by DoD, there was no requirement to include further analysis to increase the page count of the EA/OEA.
4						<u>Public participation and information</u> – RMI EPA notes the Marshallese translation of the 2993 (*sic*) SEIS summary. This approach was useful as many Marshallese have a limited exposure to written english (sic), in particular the complex technical and legal terminology within the 200 page EA, and the lack of Marshallese translation is a practical barrier in the ability to provide public review and comment. RMI EPA recommends that further direct public engagement, such as a public meeting or other alternatives, including any summary or written material with Marshallese translation, and/or advertisements or notices in Marshallese language, regarding the EA, would greatly improve public participation, understanding and dialogue. In this regard, RMI EPA suggests that Notices to Mariners, which include intended warning to Marshallese citizens, and the referenced fact sheet on Ebeye and Kwajalein (describing the project and environmental controls), also be prepared in Marshallese language (referenced on page 2-11)	No and Yes	We note that the DEP and EA/OEA NOAs requesting public comment on those documents are published in Marshallese in both the Marshall Islands Journal and The Kwajalein Hourglass. For public notification within USAKA before any flight test occurs, standard practice is to distribute an announcement from Kwajalein Island regarding the upcoming mission that is then provided to the public in Marshallese and English on the Roller and in radio announcements. Additionally, notices of upcoming missions are provided by the US Embassy to the Government of the RMI (GRMI) for the GRMI to distribute as they see fit, in English and/or Marshallese. We agree that direct public involvement is useful for large projects; public involvement will be considered for any such future actions.

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								Sentences have been added to the EA clarifying that the FE-1 Fact Sheet also will be available in Marshallese. Publication of the NOTMARs in Marshallese is not within the authority of the US Navy SSP, RTS, SMDC, or USAG-KA. NOTMAR information detailing planned USAKA activities is provided by RTS or other range personnel to the NOTMAR publishing agency, the National Geospatial-Intelligence Agency (NGA). NGA only publishes NOTMARs in English.
5						<u>Cultural Resources</u> – Regarding section 3.3.1.1 (Cultural Resources Regulatory Setting). Although RMI EPA and HPO agree with the "no effect" finding, we express continued disagreement regarding the purported lack of application of the US National Historic Preservation Act and exclusion of US ACHP regarding US National Historic Landmark consultations (referencing Sections 402, 106 and 110(f) of the NHPA). This was also expressed during the approval of the Cultural Resources DEP. RMI notes recent US ACHP training sessions provided for RMI regarding application of the NHPA	No	We continue to use and adhere to the Cultural Resources guidance put forth in the government to government agreement, the USAKA Environmental Standards, also known as the UES.
6						<u>Hazardous Materials</u> – Regarding offshore water impact areas (page 3-73), the EA references a 1998 NASA study of seawater quality effects of missile components deposited in ocean waters, with a conclusion that release of hazardous materials from missiles into seawaters would not be significant (rapidly diluted and, except in immediate vicinity, not at concentrations that produce adverse effects). The EA notes that payload is "generally insoluable" and would be a "thousands" of feet of depth in these areas, with water quality effects "expected to be minimal, with potential for toxic concentrations "expected to be small" with localized effects and "the potential for cumulative impacts is expected to be nil." The discussion of tungsten alloy release (1,000 pounds in the payload) reveal a bench study planned whose results would not likely be available before the proposed action but will inform future analysis as a mitigation measure, and that some recent analysis could indicate the ability of tungsten to dissolve in the soil. The EA concludes that only trace amounts will remain in terrestrial areas and that "if any hazardous chemicals enter the marine environment they are expected to be diluted and dispersed quickly by currents and wave action." (page 4-33) Further, deep ocean analysis (page	Yes	Note that the hazardous materials identified as being "used in the [FE-1] developmental payload would be limited to batteries, small electro-explosive devices, and a tungsten alloy. No solid or liquid propellants, DU, Be, or radioactive materials would be carried on the developmental payload." The 1998 NASA study applies to the effects of missile components in seawater in general, and the bench study is specific to the alloy being employed in the FE-1 payload. The bench study results quantify the expected amount of tungsten alloy that would dissolve in groundwater and seawater and applies those dissolution rates to a model to determine the expected residual quantities over time. The modeled

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						4-41) states that the 1,000 pounds of tungsten alloy would be introduced into the marine environment and that "the effects of tungsten alloys in ecosystems are largely unknown" (with no known studies on marine ecosystems), that this would sink to the ocean floor and be dispersed by "wave action and ocean currents such that tungsten concentrations would have little or no impacts on marine organisms." (page 4-41) with the final conclusion that "components would likely sink to the ocean floor" and that marine organisms "are not likely to contact them" with any chemicals in the water column to be quickly diluted among low densities of organisms (page 4-42). RMEI EPA requests further clarification; on one hand, the EA states that very little to no information is known or available as to ecosystem impact of tungsten (in particular in marine ecosystems), and on the other hand, the EA concludes there is no significant impact, and it is unclear if these are more speculative statements or scientific assessments. It would be important to understand, in detail, the scientific analysis and methodology applied to reach this conclusion, and to distinguish firm scientific conclusions from more speculative assessments. RMI EPA does not have extensive experience addressing tungsten alloy, but a cursory examination of background literature reveals that it is considered somewhat toxic to animals, and thus RMI EPA has some caution. RMI EPA understands the EA to state that unless there is surface impact (which would be collected in some form), that deep water splashdown of the vehicle/payload would result in 1,000 pounds of tungsten going to the deep ocean floor for an indefinite basis, or being dispersed by ocean current or wave action. RMI EPA requests clarification on several points in the EA. What is the long-term known impact or potential risk over a significant period of time (eg until 2080) of this quantity either remaining on the ocean floor or entering the marine ecosystem through wave action and currents? What is the know direction or dispersal of these currents or wave patterns? What is the basis or methodology for the use of the term "likely" and how (in a quantifiable sense) is this likely or unlikely? What would be the relationship between contact with marine organisms and wider food chain impacts, including fish tissue, and what would be the projected impact to human health and safety for fish consumption? RMI EPA notes the 2014 draft Southern USAG-KA Fish Study undertaken by the US Army Public Health Command, in particular it's (sic) conclusion to determine possible on land sources of contamination stemming from Illeginni activities and suggest that, as this is a visible public issue, it would be appropriate for the EA to take into account this study and		residual quantities can then be compared to USEPA guidance (June 2017) for human health-based risks associated with exposure, and conclusions drawn based on the USEPA guidance. The USEPA Fact Sheet for tungsten (2014) notes that tungsten has, "Low solubility in water and high sorption (soil/water distribution) coefficients at low to neutral pH levels." It also states, "Currently, little information is available about the fate and transport of tungsten in the environment and its effects on human health. Research about tungsten is ongoing and includes health effects and risks…." Tungsten alloys also may behave differently than tungsten itself; however, the Fact Sheet states, "Tungsten compounds are expected to exist as ions or insoluble solids in the environment." The bench study was undertaken to provide the dissolution rate of the specific alloy used in the FE-1 flight test in Illeginni groundwater, coastal seawater, and Illeginni soil. Additionally a model was developed to predict amounts of tungsten that could be in soils and lysimeter waters on Illeginni. The bench study is near completion, the results are included in the final EA/OEA, and the sections referenced in the comment have been clarified in accordance with those results. Also, the methodology and details of the bench study are appended to the final EA/OEA. Within the EA/OEA, a discussion of fate, transport, and effects of tungsten in seawater, groundwater, and on land are added

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						address the relationship, if any, between the EA's proposed action/alternative and existing fish tissue contamination at Illeginni. What are cumulative impacts, if any, from other payload contaminants from other missile tests at USAKA, including be (sic) and DU, within Illeginni, or even if not in the immediate geographic proximity? Finally, RMI EPA welcomes the planned bench study on tungsten alloy and it's (sic) environmental impact for use in future analysis, but would not consider this a mitigation measure; rather such a study would be normally considered part of the necessary analysis under NEPA to identify potential environmental impacts and take these into account in decision-making as part of NEPA's standard, and thus would be applied in some measure prior to any FONSI or proceeding of project action. General statements about possible effects and some risk do not constitute a "hard look" absent a justification regarding why more definitive information cannot be provided (particularly as the bench study appears to provide such information, albeit not in the proponent's desired timeframe).		based on the model developed for tungsten. Model results indicate levels of tungsten from Illeginni Islet would be below the USEPA Residential Risk-Based Screening Levels (RSLs)(June 2017) for soil and drinking water (although this area is not designated as potable drinking water) from the end of the flight test to 25 years out (the period for which the model was run). The quantity of tungsten alloy that could be deposited in the deep ocean is **up to** 1,000 pounds (453.6 kg). This is an exaggerated amount to provide a "worst case", conservative basis for developing potential effects. The preferred impact location is on land, in which case, there would be **no** tungsten alloy deposited in the deep ocean near Kwajalein Atoll. Regarding the long term risk from being on the ocean floor or entering marine ecosystem, the bench testing shows the dissolution rate of the tungsten alloy in seawater peaked within an initial two week leaching period. The average dissolution rate over three months was 2.8 $mg/m^2/hr$; the highest rate measured over the 13 week study was 7.4 $mg/m^2/hr$, occurring in the 2nd week, which agreed with the model. The lowest rate was 0.0 $mg/m^2/hr$ occurring in the first week, followed by 0.4 $mg/m^2/hr$ for the 11th and 13th weeks. At a rate of 0.4 $mg/m^2/hr$, if that rate were fairly constant, it would take approximately 280 years for the maximum 1,000 lbs

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								mass to dissolve in ocean waters. These findings support the NASA study findings (1998) cited in the EA/OEA, "The payload materials are relatively insoluble and the depth of the Pacific Ocean at either of the proposed BOA impact sites is thousands of feet; where light does not penetrate; levels of oxygen that might interact with materials at the surface are too low for that to occur; and water temperature differences from the upper water layers hamper any mixing between them." According to the USAPHC fish study (2016), "Unacceptable cancer risk for Marshallese adults at Illeginni [harbor] is attributable to the pesticide, chlordane." Chlordane is a pesticide used to treat wood and wood structures for control of pests, particularly termites, and is not associated with previous missile flight tests impacting at Illeginni. Although beryllium and depleted uranium are known to exist in soil at Illeginni, they are at levels below residential RSLs and they were not identified as a contaminant in fish harvested at Illeginni for the study. This information is added to the EA/OEA in section 5.4 Cumulative Impacts Analysis. The Preferred Action is for a land impact at Illeginni Islet; however, if one of the other two impact locations were used for the flight test, ocean currents could dilute and disperse the more soluble hazardous materials from the FE-1 payload. Kwajalein Atoll is near the southern edge of the large North Equatorial Current, which generally flows from the east/northeast to the

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								west/southwest; this Current forms the southern side of a clockwise subtropical gyre. General, dispersion of the tungsten alloy is not expected due to its relatively insoluble nature, the depth at which it would come to rest, which would result in low temperatures, low oxygen content, and no sunlight to facilitate chemical interaction. There also is lack of mixing in the deep sea water column; the deep Pacific experiences no deep convection of cooled salty surface water because the surface layer is too fresh and buoyant to sink. This information was added to the EA/OEA at sections 3.3.5.2 ROI Offshore Waters and 4.3.2.3.4 Exposure to Hazardous Chemicals. We note that an ocean impact for the FE-1 flight test is not the preferred alternative; for the preferred land impact there would be no deposition of payload in deep waters. Sampling and analyses of tungsten and other alloy metals in soil at Illeginni will be conducted prior to and after the FE-1 flight test. If analyses of post-flight test samples indicated tungsten levels above RSLs, phytoremediation, using plants to draw up metals from the soil, would be considered. In particular, some ryegrass species can take up tungsten in direct relation to the amount of material in soil, i.e., the more material left in the soil, the more is taken up into the plants. If phytoremediation were employed, following an initial growth period, the plants would be appropriately disposed of as hazardous waste IAW with the UES

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								following remediation. This information is added to the EA/OEA in sections 4.3.2.2.4 Exposure to Hazardous Chemicals and 5.4 Cumulative Impacts. Impacts from tungsten are deduced based on the chemical characteristics of tungsten and the proposed locations at which the payload would come to rest. Additional details have been added to the EA/OEA at sections 3.3.5.2 ROI Offshore Waters, 4.3.2.3.4 Exposure to Hazardous Chemicals, and 5.4 Cumulative Impacts Analysis to clarify the conclusions. While the effects of tungsten alloys in ecosystems are largely unknown, as noted in the USEPA Fact Sheet for tungsten (2014), with no known studies of marine ecosystems, there are some studies that indicate tungsten exposure may have health impacts. According to the USEPA Fact Sheet, direct occupational exposure is the most common scenario (but which does not apply to the FE-1 flight test conditions) and, "may cause eye and skin irritation, cough, nausea, diffuse interstitial pulmonary fibrosis and changes in blood." However, the Fact Sheet also states, "Tungsten has not been classified for carcinogenic effects by the Department of Health and Human Services, the International Agency for Research on Cancer or the [US] EPA." This information is added to the EA/OEA at sections 3.3.5.2 ROI Offshore Waters, 4.3.2.3.4 Exposure to Hazardous Chemicals, and 5.4 Cumulative Impacts Analysis.

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								A 2008 study of geochemical parameters influencing tungsten mobility in soils found that dissolved tungsten reached equilibrium after approximately 48 hours and mobility decreased by approximately one-half within a 4 month period. The "long term known impact or potential risk" is not conclusively identified in peer reviewed literature. For the FE-1 flight test impacts, the model results indicate levels of tungsten from Illeginni Islet would be below the USEPA Residential Risk-Based Screening Levels (RSLs)(June 2017) for soil and drinking water (although this area is not designated as potable drinking water) from the end of the flight test to 25 years out (the period for which the model was run)." This information is added to the EA/OEA at sections 3.3.5.2 ROI Offshore Waters, 4.3.2.3.4 Exposure to Hazardous Chemicals, and 5.4 Cumulative Impacts Analysis. Use of the terms likely and unlikely are intended to provide an approach at making the EA/OEA more readable to the average public reviewer. There is no identified relationship between contact of the FE-1 payload with marine organisms and wider food chain impacts, including fish tissue, projected impact to human health and safety for fish consumption. The preferred alternative for the FE-1 flight test is a land impact at Illeginni. The 2014 fish study conclusion to determine possible on land sources of contamination from Illeginni activities refers to chlordane, a pesticide used to treat wood and wood structures, which

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								is not associated with missile flight testing impacts at Illeginni. Additional information to address Cumulative Impacts from FE-1, other projects, and the human health/fish study results, including other missile tests at USAKA, including Be and DU, or activities not in the immediate vicinity of the FE-1 flight test activities is added to the EA/OEA at section 5.4 Cumulative Impacts Analysis. The use of "mitigation measure" to describe the bench study will be removed from throughout EA/OEA. The bench study results have been added to the EA/OEA text at sections 4.3.2.2.4 Exposure to Hazardous Chemicals and 5.4 Cumulative Impacts Analysis, and to Table 4-7 Impact Avoidance and Minimization Measures; the bench test and model methodology are added as an Appendix.
7		6.1			6.1	Consistency with Other Federal Laws – Section 6.1, Consistency with Other Federal State, and Local Laws, Plans, Policies and Regulations, and Table 6.1, which identifies the principle federal and state laws and regulations that are applicable to the proposed action, should also reference the US Public Law 108-188, Compact of Free Association Amendments Act of 2003.	Yes	US Public Law 108-188, Compact of Free Association Amendments Act of 2003 has been added to Table 6.1 Principal Federal and State Laws Applicable to the Proposed Action.
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Appendix D

Tungsten Alloy Bench Study and Model Results Report

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Leaching Study on Tungsten-Nickel-Iron Alloy in a Coralline Soil Environment

Introduction:

There is a paucity of experimental data available on the dissolution kinetics of Tungsten (W) bearing materials released into the environment. Initially thought to be environmentally inert, W was used by the U.S. Army as a substitute for lead (Pb) based munitions between the mid-1990s and 2009. Recent reports of Tungsten contamination of groundwater and soil at several military sites across the U.S. suggest that Tungsten is more environmentally reactive than first thought. Moreover, it has been shown that that different soil types and pH conditions can strongly influence the migration behavior of W in the environment. Tungsten contaminated media is now a growing concern to the U.S. Environmental Protection Agency (USEPA) and the U.S. Department of Defense (DoD). Despite the efforts of several agencies, studies on the fate and transport of W have failed to produce definitive outcomes that support a regulatory framework to provide standards for protection of the environment and human health, and for cleanup of contaminated sites. Consequently, model predictions formulated under this Environmental Assessment (EA) are based on material-specific dissolution rate-constant data derived from laboratory leaching experiments conducted at the Lawrence Livermore National Laboratory (LLNL) under environmental conditions that closely mimic those found in coralline soils in the Marshall Islands. This work sets a strong foundation for developing a scientifically credible and defensible EA for use of W alloy compounds in flight test experiments conducted at Illeginni Islet at Kwajalein Atoll.

***Benchtop Testing, Materials and Methods**:*

Tungsten alloy coupons (i.e., samples) to be used in leaching experiments were selected from LLNL's collection of used tungsten parts from previous Navy experiments. The leaching experiments were each conducted in large capacity glass column reservoirs loaded with approximately 750-gram (dry-soil equivalent) of coral soil, and connected to a high-performance liquid chromatography (HPLC) pump and a water reservoir (Fig 1). Two different leaching agents were used. The primary experiment for estimating dissolution rate constants for model predictions was based on water within the soil (i.e., soil-water) on Bikini Island collected by Terry Hamilton, LLNL, using a plate lysimeter inserted into the soil about 1 meter below ground surface. Sea water was also included as a leaching agent for comparison. Each investigative column for the soil-water and sea water experiments contained approximately 478 grams of W alloy coupons of various shapes and sizes evenly distributed throughout the column of soil. A parallel set of control experiments was conducted using inert Teflon™ coupons of the same shape and size as that of the W alloy. All the column experiments were conducted under natural pH (pH ~8.9, EPA SW-846 Method 9045) and oxidative conditions with continuous circulation of water through the column reservoirs. No biofouling agent was used. The dry-soil sample was collected from Illeginni Islet at Kwajalein Atoll. The coral soil was dried and size-fractionated (<4.75 mm > 500 µm) before use to reduce the risk of any fines clogging up the columns, provide for a more reproducible means of loading the columns with soil, and reduce the tendency of channel flow for circulating water.

The metal alloy was composed mostly of Tungsten (W, 97%) with lesser amount of Nickel (Ni, 2.1%) and Iron (Fe, 0.9%). In this initial phase of the experiment, the concentrations of all 3 elements were measured in the reservoir water at selected time intervals for both dissolved and particulate metals. The chemical analyses were performed by Inductively Coupled Plasma- Mass Spectrometry at EMSL

Analytical, Inc. using EPA Method 200.8. The ICP-MS Detection limits for W, Fe, and Ni were 0.5, 0.5 and 0.005 mg L^{-1}, respectively.

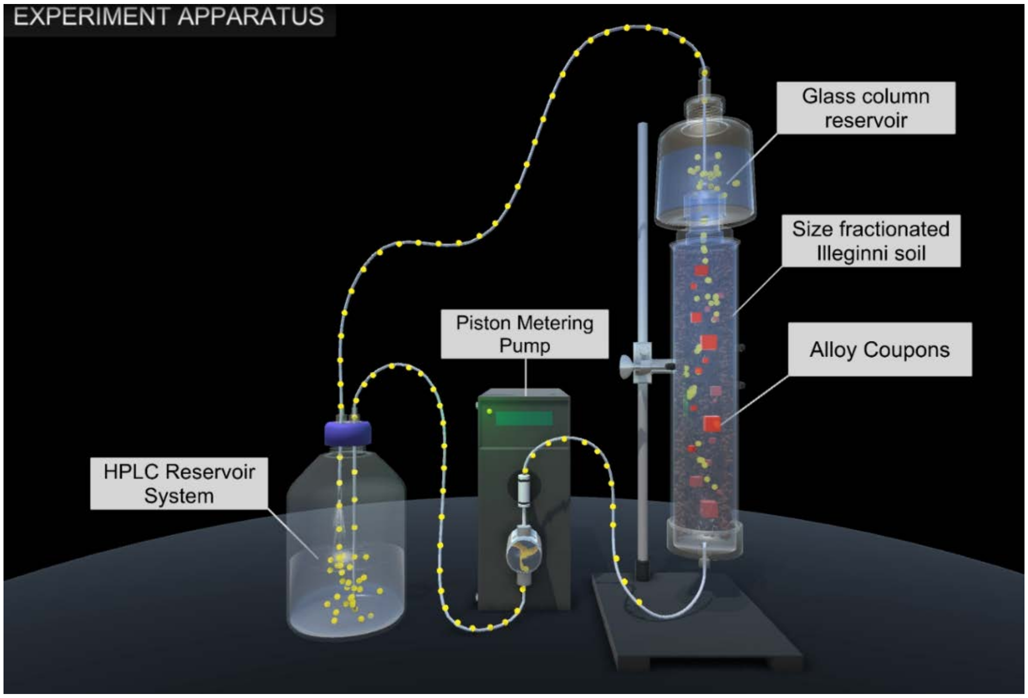

Figure 1: Experimental Design of the Alloy Leaching Experiments.

Benchtop Testing, Discussion of Results:

Beginning in January 2017, the HPLC pumps were started on the columns and water was circulated through the closed-loop systems continuously. On a regular frequency, small water samples were pulled from the HPLC reservoir. Two types of water samples were sent off for testing: (1) an unfiltered sample that was representative of the total concentration of metal particulate in the system reservoir; and (2) a sample that was passed through a 0.45 µm filter, which was representative of the total dissolved fraction of metal particulate in the system reservoir. Initial samples were pulled after days 1, 3, 10 and 14. After day 14, samples were pulled every 2 weeks through day 84. Following day 84, and up through the end of the experiment, samples were pulled weekly order to increase the number of data points. While the actual ratio of tungsten alloy to soil in the columns is drastically higher than is expected in real world conditions (~100,000x higher), the leaching study was intended to experimentally determine the tungsten dissolution rate in both lysimeter and sea water. The results from these column experiments for the three metals present in the alloy coupons (W, Ni, and Fe) are shown below in Tables 1 (total) and 2 (dissolved) and Figures 2 (total) and 3 (dissolved). The experimentally determined (surface area normalized) rate constant also is shown for tungsten. As expected, the circulation of water through the columns produced an initial spike in tungsten dissolution during the first 10 days, followed by a period of steady dissolution and finally a drop in dissolution rate around day 56. The results from these column experiments were used as calibration data for the modeling effort described in the following section.

Table 1: Experimental Results of Dissolution of W-Ni-Fe (total) in Lysimeter and Sea Water

		Column 1: Alloy in Lysimeter Water				Column 2: Alloy in Sea Water			
		W		Fe	Ni	W		Fe	Ni
		Concentration	Dissolution Rate	Concentration	Concentration	Concentration	Dissolution Rate	Concentration	Concentration
Date	Day	mg/L	$mg/m^2/hr$	mg/L	mg/L	mg/L	$mg/m^2/hr$	mg/L	mg/L
30-Jan	1	0.0	0.0	ND	0.0	0.0	0.0	ND	ND
1-Feb	3	5.2	10.0	ND	0.0	3.3	6.4	ND	0.4
8-Feb	10	12.9	7.5	ND	0.0	14.0	8.1	ND	1.7
12-Feb	14	8.4	3.5	ND	0.0	9.5	3.9	ND	2.6
26-Feb	28	12.7	2.6	ND	0.1	21.5	4.5	ND	5.5
12-Mar	42	18.8	2.6	ND	0.1	35.3	4.9	ND	8.0
26-Mar	56	23.8	2.5	ND	0.4	44.8	4.6	ND	9.5
9-Apr	70	11.6	1.0	ND	0.2	49.7	4.1	ND	11.9
23-Apr	84	12.0	0.8	ND	0.2	54.6	3.8	ND	13.4
30-Apr	91	14.2	0.9	ND	0.3	31.9	2.0	ND	14.0
7-May	98	31.9	1.9	ND	0.3	7.0	0.4	ND	12.5
14-May	105	21.9	1.2	ND	0.3	13.8	0.8	ND	12.8
21-May	112	52.8	2.7	ND	0.3	7.8	0.4	ND	13.0

Table 2: Experimental Results of Dissolution of W-Ni-Fe (dissolved) in Lysimeter and Sea Water

		Column 1: Alloy in Lysimeter Water				Column 2: Alloy in Sea Water			
		W		Fe	Ni	W		Fe	Ni
		Concentration	Dissolution Rate	Concentration	Concentration	Concentration	Dissolution Rate	Concentration	Concentration
Date	Day	mg/L	$mg/m^2/hr$	mg/L	mg/L	mg/L	$mg/m^2/hr$	mg/L	mg/L
30-Jan	1	0.0	0.0	ND	0.0	0.0	0.0	ND	ND
1-Feb	3	5.0	9.6	ND	0.0	3.8	7.4	ND	0.4
8-Feb	10	13.6	7.9	ND	0.0	6.4	3.7	ND	1.3
12-Feb	14	9.9	4.1	ND	0.0	8.9	3.7	ND	2.0
26-Feb	28	4.4	0.9	ND	0.1	20.5	4.2	ND	4.7
12-Mar	42	14.4	2.0	ND	0.1	32.8	4.5	ND	7.0
26-Mar	56	9.4	1.0	ND	0.1	42.1	4.4	ND	8.4
9-Apr	70	13.1	1.1	ND	0.2	49.0	4.1	ND	10.4
23-Apr	84	11.0	0.8	ND	0.2	36.9	2.5	ND	11.5
30-Apr	91	11.5	0.7	ND	0.2	14.4	0.9	ND	13.9
7-May	98	24.1	1.4	ND	0.3	6.4	0.4	ND	12.8
14-May	105	5.6	0.3	ND	0.3	11.4	0.6	ND	12.9
21-May	112	6.7	0.3	ND	0.3	6.8	0.4	ND	13.0

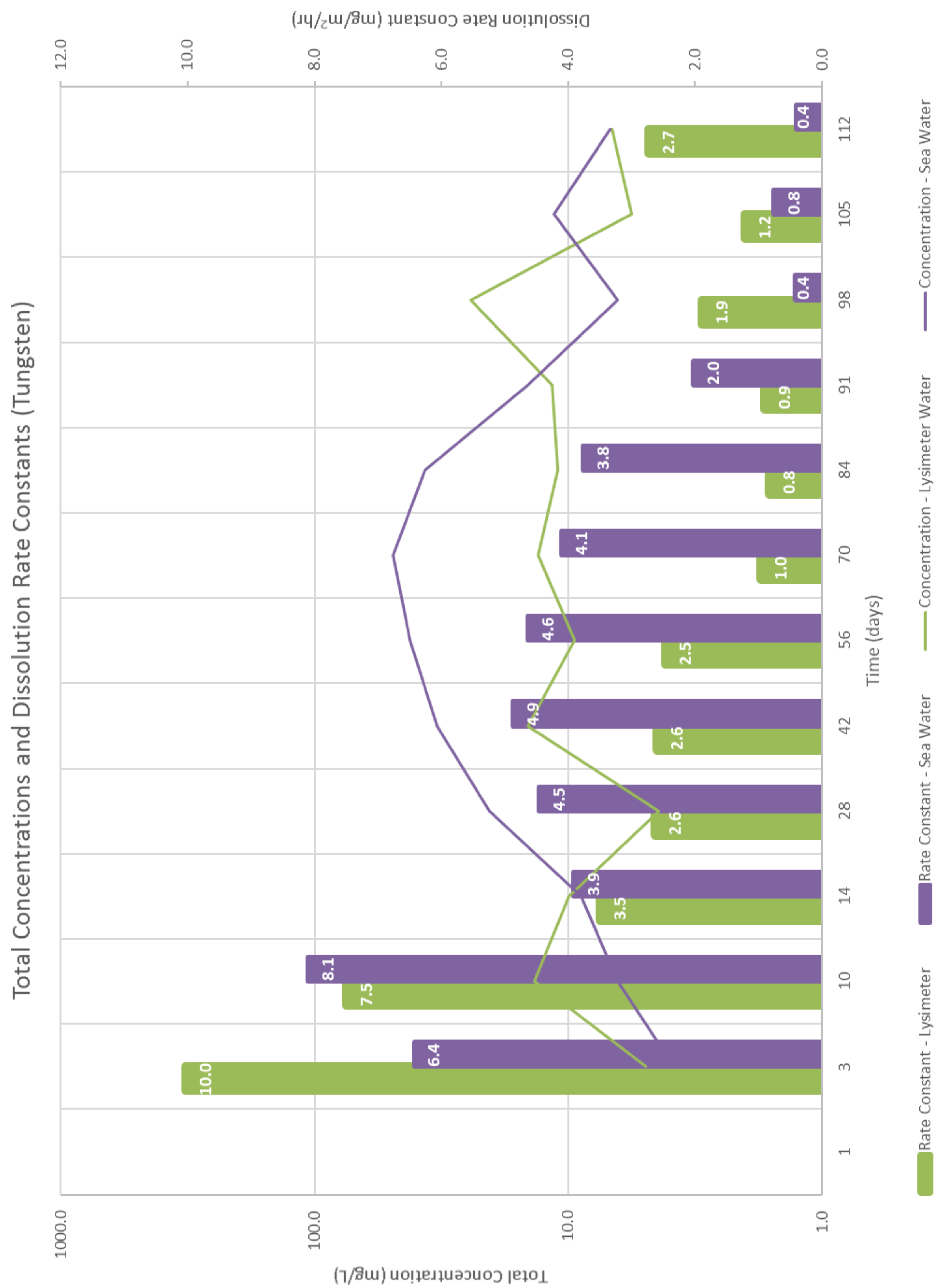

Figure 2: Dissolution of W-Ni-Fe (total) in Lysimeter and Sea Water

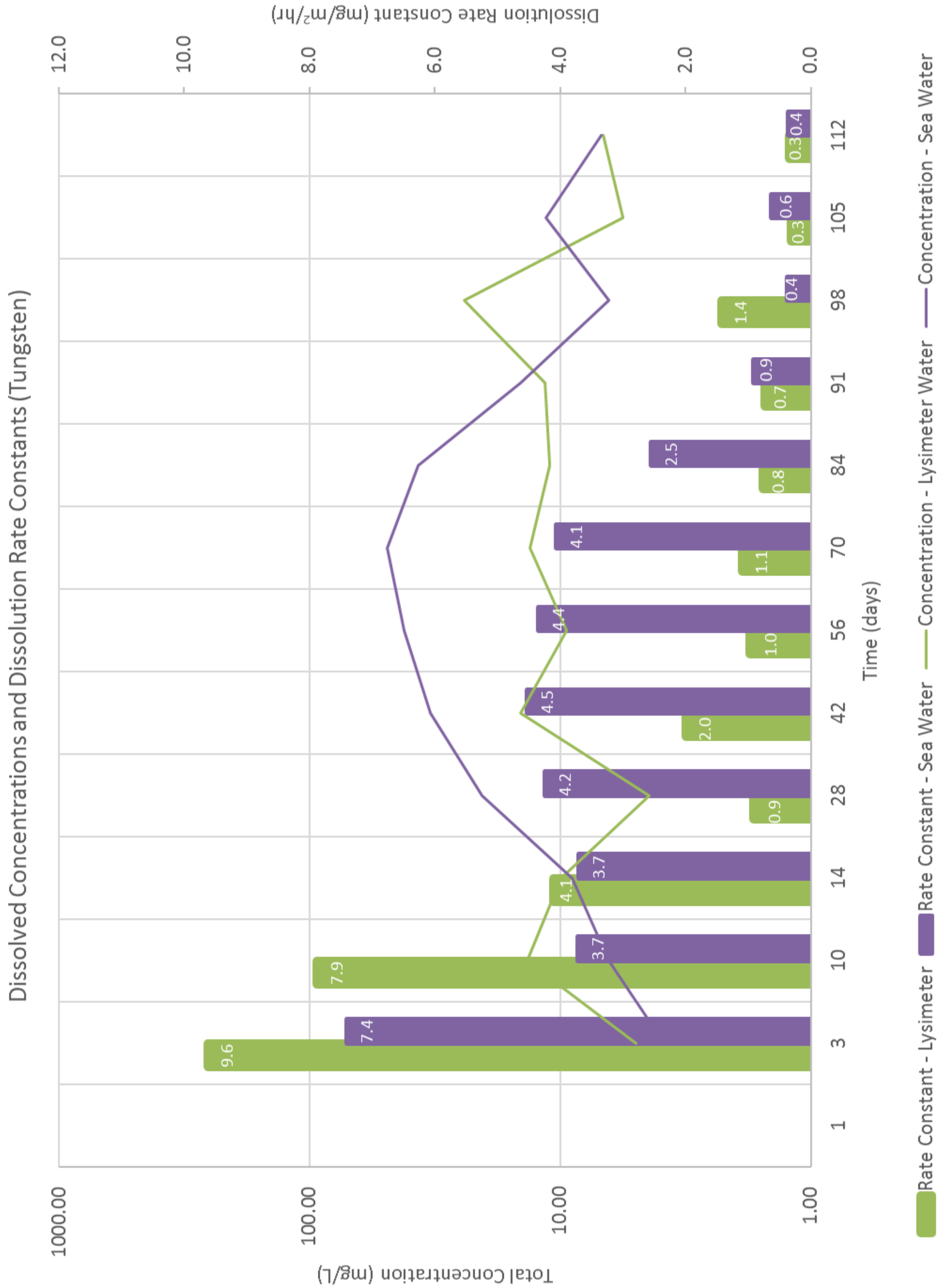

Figure 3: Dissolution of W-Ni-Fe (dissolved) in Lysimeter and Sea Water

Computer Modeling, Tungsten Concentrations in Soil:

As a first order check of expected tungsten contamination to the soil, the average tungsten concentration in soil was estimated from the total mass of tungsten and the estimated area of tungsten dispersion. Approximately 91 kg of tungsten is expected in an area with a diameter of 45.7 meters. The total depth of deposition was estimated at 4.25 meters. Based on a soil bulk density of 2.0 g/cm^3, the average concentration of tungsten in the soil is estimated to be 6.5 mg/kg. This concentration is below the USEPA Regional Screening Levels (RSL) of 63 mg/kg for residential areas and well below the RSL of 930 mg/kg for industrial areas. In reality, tungsten deposition is likely to be heterogeneous and this was reflected by use of varying sizes of tungsten coupons in the leaching experiments. Nevertheless, our model results, based on the tungsten mass and the estimated volume of tungsten deposition, indicate that tungsten concentrations in soil will be below the USEPA residential screening levels and no further modeling was performed.

Computer Modeling, Tungsten Concentration in Water:

The tungsten concentration in water was estimated from a combination of experimental observation (column experiments) discussed above and modeling results. Column experiments quantified the rates of tungsten dissolution and degree of tungsten sorption to carbonate material, which were then used to calibrate the CrunchFlow model. The calibrated dissolution rate and sorption affinity were then used in a simple one-dimensional model of the area of tungsten deposition to estimate tungsten concentrations in the freshwater zone just below the zone of tungsten deposition in soil. All computer modeling was performed using the CrunchFlow reactive transport computer code. (STEEFEL et al., 2015)

Tungsten in column experiments

To quantify the rate of tungsten dissolution and the sorption affinity of tungsten to the carbonate rock, the CrunchFlow code simulated the experimental conditions of the column experiments. The model accounted for the concentration and surface area of the tungsten in the column, the volume of fluid in both the column and the reservoir, and the fluid flow rate. To simulate the observed concentration of tungsten in the reservoir, both the sorption affinity of tungsten and the tungsten dissolution rate were adjusted manually until an adequate fit to the data was achieved. Based on the column experiment containing tungsten in the presence of lysimeter water (Figure 4), the tungsten sorption affinity was estimated to be 0.1 mL/g, often referred to as the “Kd”. The tungsten Kd is simply a ratio of tungsten in the solid phase (mg/g) divided by the tungsten in the aqueous phase (mg/mL). The low value of 0.1 mL/g indicates that tungsten has a very low affinity for carbonate soil under lysimeter water solution conditions (e.g. circumneutral pH). The tungsten dissolution rate was estimated to be between 1.0 and 2.6 mg/m^2/hr. These values are somewhat lower than those estimated from literature data (28 to 139 mg/m^2/hr). (BEDNAR et al., 2008; DERMATAS et al., 2004; JOHNSON, 1969) The lower rates may reflect the passivation (i.e., natural chemical encapsulation) of the tungsten surfaces in our long-term column experiments compared to the short-term experiments reported in the literature. They more likely reflect the fact that the tungsten material used here is an alloy whose dissolution rate may be somewhat different from a pure tungsten metal. Interestingly, the observed nickel concentration in the reservoir could be simulated using the same tungsten dissolution rate constant, the known Ni concentration in the tungsten alloy (2.1 % by mass) and a sorption affinity of 11 mL/g. The simultaneous fit and alignment of both the tungsten and nickel data provides additional evidence for the effectiveness of our simulated tungsten alloy dissolution rates.

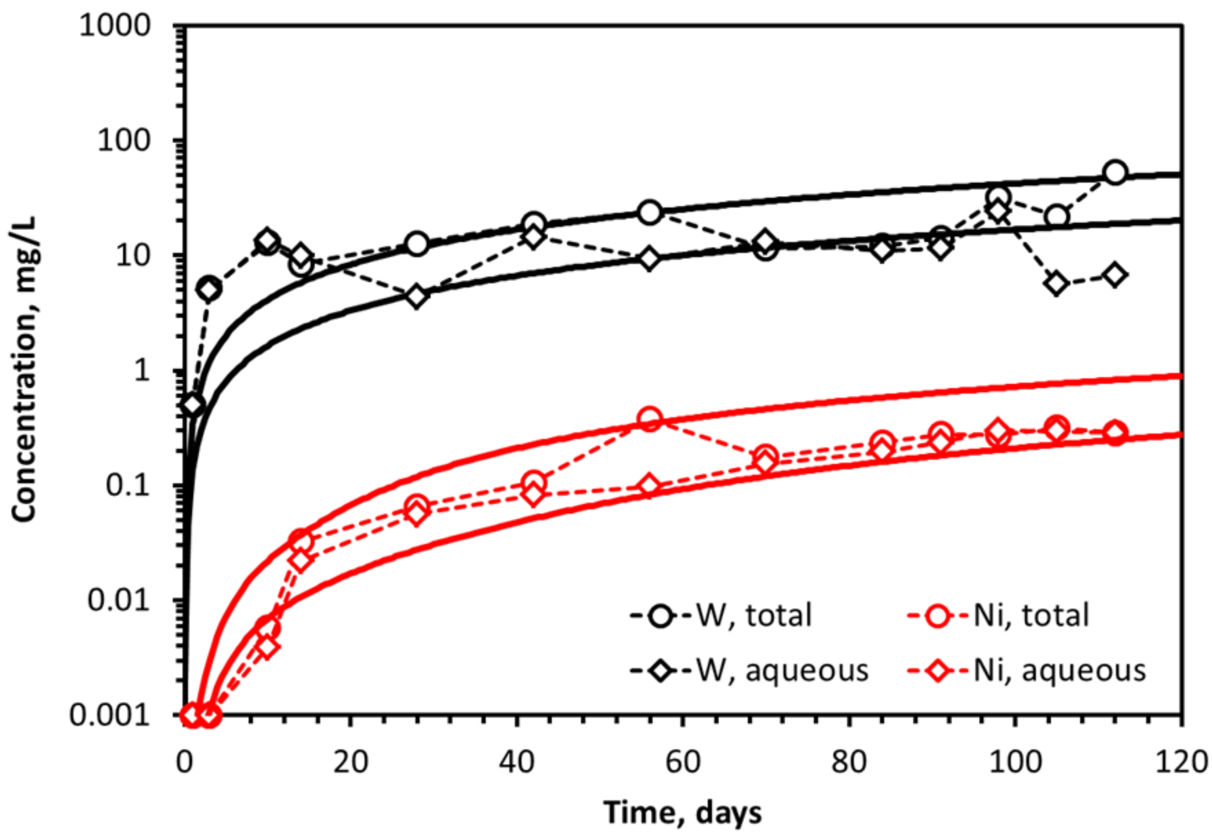

Figure 4: Tungsten and nickel concentrations in column experiment containing tungsten coupons in the presence of lysimeter water. Model fits are shown as solid lines.

Tungsten concentrations in the field

To estimate the tungsten aqueous concentration in the freshwater lens below the zone of tungsten deposition in soil: 1) the tungsten alloy dissolution rate and tungsten affinity for carbonate soil was taken from the calibrated column experiments, 2) the mass, surface area, and distribution of tungsten was estimated from the known characteristics of the tungsten debris, and 3) the rainfall/precipitation rates were estimated from available rainfall data for the Marshall Islands (2.5 m/yr). (PROGRAM, 2011) This information was used to develop a simple one-dimensional computer model of tungsten concentrations in the area of tungsten deposition. Computer simulations were run such that the aqueous tungsten concentration just below the zone of tungsten deposition was monitored (this is the location of highest expected tungsten concentration).

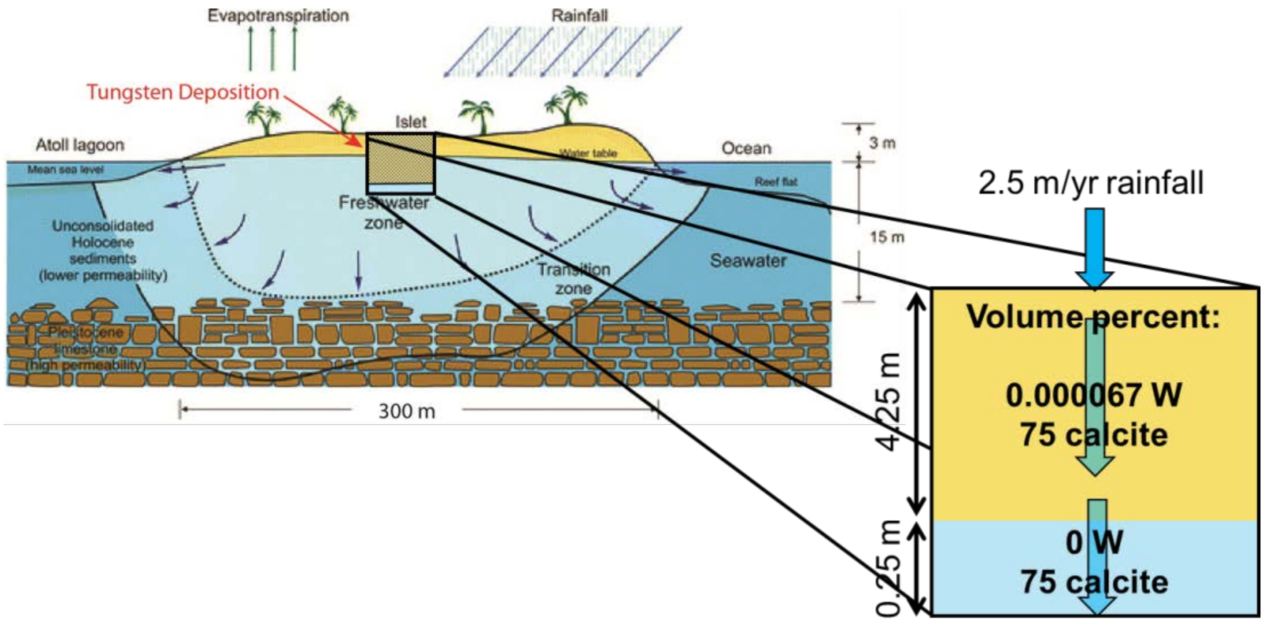

Figure 5: Conceptual model of tungsten dispersion characteristics

Conclusions:

Following calibration of the CrunchFlow Simulation using experimental data gathered in the benchtop experiments, it was determined that a dissolution rate between 1.0 and 2.6 mg/m^2/hr, provided the best fit between experimental results and the model. The resulting estimated aqueous tungsten concentration, based on dissolution rates of 1.0 to 2.6 mg/m^2/hr, are shown in Figure 6. Shortly after tungsten is deposited in the carbonate soil and rainfall begins the dissolution process, aqueous tungsten concentrations increase; with regular precipitation (assumed at 2.5 m/yr) the concentrations reach a steady state in less than 1 year and remain constant for the following 25 years, the period for which the model was run. The steady state concentration is primarily controlled by the rate of tungsten alloy dissolution and the rate of precipitation on the island. Based on the model parameters used here, we estimate that aqueous tungsten concentrations will be between 0.006 mg/L (at a dissolution rate of 1.0 mg/m^2/hr) and 0.015 mg/L (at a dissolution rate of 2.6 mg/m^2/hr). These results both fall below the EPA Residential Regional Screening Level of 0.016 mg/L.

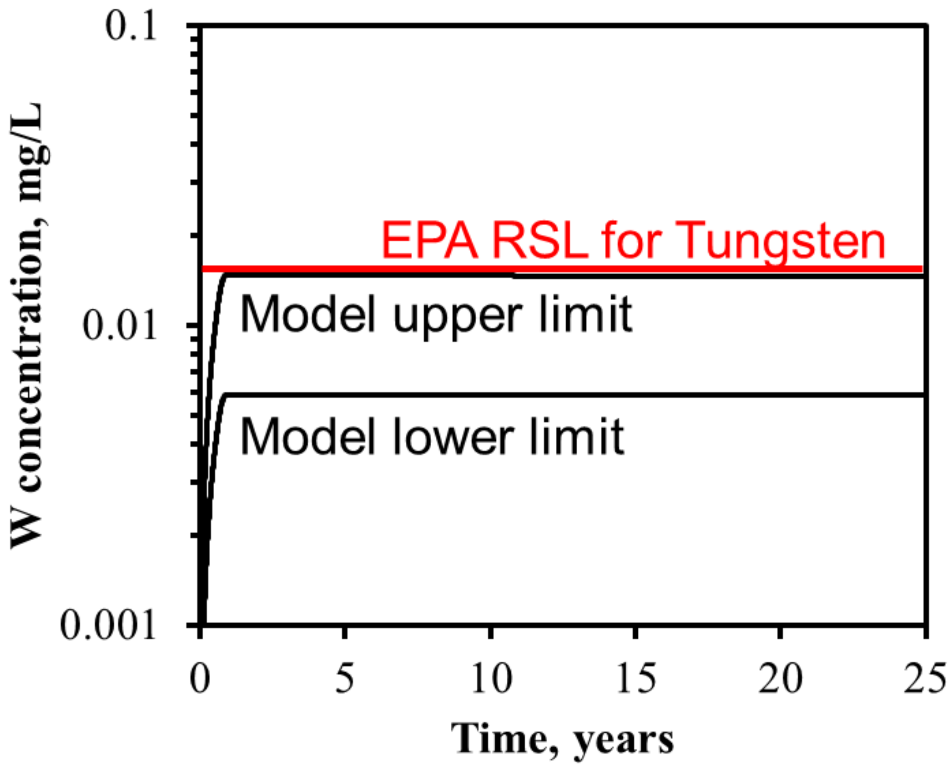

Figure 6: Simulated tungsten aqueous concentrations below the zone of tungsten deposition as a function of time. Model lower limit based on a dissolution rate of 1.0 mg/m²/hr and model upper limit based on a dissolution rate of 2.6 mg/m²/hr.

References:

Bednar, A. J., Jones, W. T., Boyd, R. E., Ringelberg, D. B., and Larson, S. L., 2008. Geochemical Parameters Influencing Tungsten Mobility in Soils All rights reserved. No part of this periodical may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. *Journal of Environmental Quality* **37**, 229-233.

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Appendix E

Formal Consultation Under the Environmental Standards for United States Army Kwajalein Atoll Activities in the Republic of the Marshall Islands Biological Opinion

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg 176
Honolulu, Hawaii 96818
(808) 725-5000 • Fax: (808) 725-5215

JUN 2 9 2017

Mr. Weldon Hill
Deputy Chief of Staff, Engineer
U.S. Army Space and Missile Defense Command/
Army Forces Strategic Command
Post Office Box 1500
Huntsville, Alabama 35807-3801

Re: Formal Consultation under the Environmental Standards for United States Army Kwajalein Atoll Activities in the Republic of the Marshall Islands Biological Opinion; and Informal Consultation under Section 7 of the Endangered Species Act for the Flight Experiment-1 Project, at Pacific Missile Range Facility Barking Sands, Kauai, Hawaii and the Ronald W. Reagan Test Site, U.S. Army Kwajalein Atoll, Republic of Marshall Islands.

Dear Mr. Hill:

Thank you for your letter of March 2, 2017, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to the Environmental Standards and Procedures for U.S. Army Garrison – Kwajalein Atoll Activities (UES) in the Republic of Marshall Islands, and section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Flight Experiment-1 project.

We concurred with your effect determination that the proposed action is not likely to adversely affect North Pacific loggerhead sea turtle Distinct Population Segment (DPS), Central North Pacific green Sea Turtle DPS, Central Western Pacific DPS, leatherback sea turtle, hawksbill sea turtle, Olive Ridley sea turtle, Hawaiian monk seal, minke whale, sei whale, Bryde's whale, blue whale, fin whale, common dolphin, pygmy killer whale, short-finned pilot whale, Risso's dolphin, Longman's beaked whale aka -tropical bottlenose whale, pygmy sperm whale, dwarf sperm whale, Fraser's dolphin, humpback whale, Blainville's beaked whale, killer whale, Melon-headed whale, sperm whale, false killer whale, spotted dolphin, striped dolphin, spinner dolphin, rough-toothed dolphin, Pacific bottlenose dolphin, Cuvier's beaked whale, bigeye thresher shark, humphead wrasse, reef manta ray, scalloped hammerhead shark, Pacific bluefin tuna, cceanic white-tip shark, black-lip pearl oyster, *Acropora speciosa*, *Acropora tenella*, *Acropora vaughani*, and *Pavona cactus*.

After reviewing the current status of UES-protected marine species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our

Opinion that the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command's implementation of the FE-1 experimental flight test at the Ronald W. Reagan Test Site at U.S. Army Kwajalein Atoll, Republic of Marshall Islands is not likely to jeopardize the continued existence of *Acanthastrea brevis*, *Acropora aculeus*, *A. aspera*, *A. dendrum*, *A. listeria*, *A. microclados*, *A. polystoma*, *Alveopora verriliiiana*, *Cyphastrea agassizi*, *Heliopora coerulea*, *Leptoseris incrustans*, *Montipora caliculata*, *Pavona venosa*, *Turbinaria reniformis*, *T. stellulata*, top shell snail, and two species of giant clams (*Hippopus hippopus* and *Tridacna squamosa*).

As required by the UES, NMFS is providing an incidental take statement (ITS) with the opinion. The ITS describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this program. The ITS also sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of the listed species considered in this opinion.

Consultation must be reinitiated if: 1) take occurs; 2) new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; 3) the identified action is subsequently modified in a manner causing effects to listed species or designated critical habitat not previously considered; or 4) a new species is listed or critical habitat designated that may be affected by the identified action.

If you have further questions please contact Dawn Golden on my staff at (808) 725-5144 or dawn.golden@noaa.gov. Thank you for working with NMFS to protect our nation's living marine resources.

Sincerely,

Michael D. Tosatto
Regional Administrator, Pacific Islands Region

Enclosure – Biological Opinion

cc: Steve Kolinski, PIRO HCD
Thomas Craven, USASMDC/ARSTRAT

Formal Consultation under the Environmental Standards for United States Army Kwajalein Atoll Activities in the Republic of the Marshall Islands

Biological Opinion

And
Informal Consultation under Section 7 of the Endangered Species Act

Action Agencies:	Department of the Navy, Strategic Systems Programs (SSP) Department of the Army, U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) – Huntsville AL
	Activity: Single Flight Experiment-1 (FE-1)
Consulting Agency:	National Marine Fisheries Service, Pacific Islands Region
NMFS File No. (PCTS):	PIR-2017-10125
PIRO Reference No.:	I-PI-17-1504-AG
Approved By:	______________________________
	Michael D. Tosatto Regional Administrator, Pacific Islands Region
Date Issued:	______________________________

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Acronyms

ARSTRAT	Army Forces Strategic Command, US Army
BA	Biological Assessment
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DPS	Distinct Population Segment
DQA	Data Quality Act
ESA	Endangered Species Act
FR	Federal Register
ft	Foot or Feet
kg	Kilogram
km	Kilometer
m	Meter
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NLAA	Not Likely to Adversely Affect
nm	Nautical Miles
NMFS	National Marine Fisheries Service (aka NOAA Fisheries)
NOAA	National Oceanic and Atmospheric Administration
PIRO	Pacific Islands Regional Office
RMI	Republic of the Marshall Islands
ROV	Remotely Operated Vehicle
RTS	Ronald Reagan Ballistic Missile Test Site (aka Reagan Test Site)
SMDC	Space and Missile Defense Command, US Army
SSP	Strategic Systems Programs
UES	USAG-KA Environmental Standards
US	United States
USAF	U.S. Air Force
USAKA	U.S. Army Kwajalein Atoll
USAG-KA	US Army Garrison - Kwajalein Atoll
FWS	US Fish and Wildlife Service

1 Introduction

As described in more detail in the description of the proposed action below, the proposed action involves launching a test missile from the Kauai Test Facility located on the Pacific Missile Range (PMRF) in Hawaii which would travel across a broad ocean area (BOA) of the Pacific Ocean towards the Ronald Reagan Ballistic Missile Defense Test Site (Reagan Test Site [RTS] at the US Army Kwajalein Atoll (USAKA), in the Republic of the Marshall Islands (RMI). The terminal end of the missile flight test would be at Illeginni Islet in Kwajalein Atoll. (Figure 1).

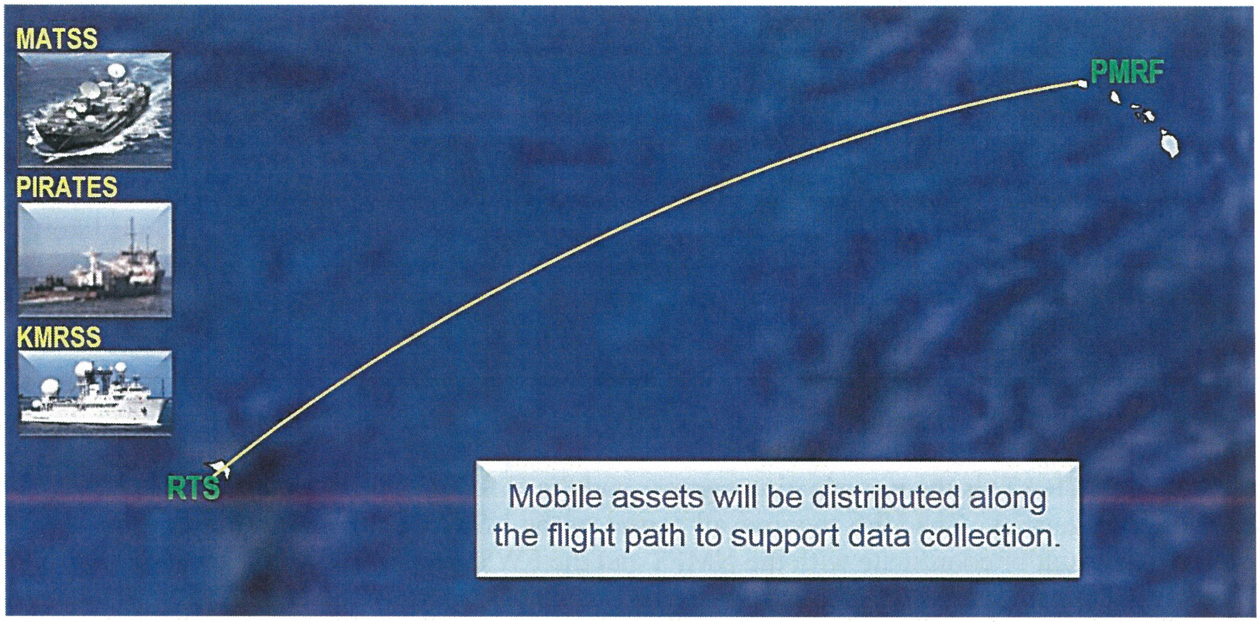

Figure 1. Flight Experiment 1 (FE-1) Representative Flight Path.

The Endangered Species Act (ESA) would apply for the portions of the action that would take place in and over United States (US) territory and international waters, but not for the portions of the action that would take place within the RMI. The Government of the RMI has agreed to allow the US Government to use certain areas of Kwajalein Atoll (collectively referred to as US Army Kwajalein Atoll or USAG-KA). "USAG-KA" is defined as "…the [USAG-KA]-controlled islands and the Mid-Atoll Corridor, as well as all USAG-KA-controlled activities within the [RMI], including the territorial waters of the RMI". The USAG-KA controls 11 islets around the atoll. The relationship between the US Government and the Government of the RMI is governed by the Compact of Free Association (Compact), as Amended in 2003 (48 USC 1681). Section 161 of the Compact obligates the US to apply the National Environmental Policy Act of 1969 (NEPA) to its actions in the RMI as if the RMI were a part of the US. However, the ESA does not apply within the RMI. Instead, the Compact specifically requires the US Government to develop and apply environmental standards that are substantially similar to several US environmental laws, including the ESA and the Marine Mammal Protection Act (MMPA). The standards and procedures described in the Environmental Standards and Procedures for USAG-KA Activities in the RMI (aka USAKA Environmental Standards or UES, 14th Edition) were developed to satisfy that requirement. Therefore, the US Government must apply the UES to its activities within the RMI. Because the ESA and UES both apply to this action, this biological opinion was written in a manner that considers and complies with each of those standards, as applicable.

Section 7(a) (2) of the Endangered Species Act (ESA) of 1973, as amended (ESA; 16 U.S.C. 1536(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" an ESA-listed species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS; for marine species or their designated critical habitat) or the U.S. Fish and Wildlife Service (FWS; for terrestrial and freshwater species or their designated critical habitat). Federal agencies are exempt from this formal consultation requirement if they have concluded that an action "may affect, but is not likely to adversely affect" ESA-listed species or their designated critical habitat, and NMFS or the FWS concur with that conclusion (50 CFR 402.14 (b)).

If an action is likely to adversely affect a listed species, the appropriate agency (either NMFS or FWS) must provide a Biological Opinion (Opinion) to determine if the proposed action is likely to jeopardize the continued existence of listed species (50 CFR 402.02). "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.

The US Army Space and Missile Defense Command/Army Forces Strategic Command (SMDC/ARSTRAT) is the participating agency, and the U.S. Navy SSP, and DOE are cooperating agencies. The UES requires all parties of the US Government involved in this project to consult or coordinate with the NMFS and the FWS to conserve species and habitats of special concern at USAKA. We will address the USASMDC/ARSTRAT exclusively in this document as the participating agency. Section 3.4 of the UES establishes the standards and procedures to be followed "...to ensure that actions taken at USAG-KA will not jeopardize the continued existence of these species or result in destroying or adversely changing the habitats on which they depend." Section 3.4 is derived primarily from the regulations implementing the ESA, other US regulations, and wildlife protection statutes of the RMI. As such, the list of UES consultation species includes all species present in the RMI that are listed under the ESA (including those that are candidates or are proposed for listing), all marine mammals protected under the MMPA, and all species and critical habitats as designated under RMI law. However, no critical habitat has yet been designated in the RMI.

Under the UES, "the final biological opinion shall contain the consulting agency's opinion on whether or not the action is likely to jeopardize the continued existence of a species or to eliminate a species at USAG-KA, or to eliminate, destroy, or adversely modify critical habitats in the RMI" (UES at 3-4.5.3(e)). Although the UES does not specifically define jeopardy, the Compact clearly intends that the UES provide substantially similar environmental protections as the ESA. We interpret this to include adoption of the ESA definition of jeopardy, as described above, and this review relies upon the ESA definition of jeopardy to reach its final conclusions. This document represents our Opinion of the effects on marine species protected under the ESA and the UES that may result from the FE-1 flight test at the Reagan Test Site (RTS) at Kwajalein Atoll. This Opinion is based on the review of: the USASMDC/ARSTRAT March 2, 2017, Biological Assessment (BA) for the proposed action (SSP 2017); recovery plans for U.S. Pacific populations of ESA-listed marine mammals and sea turtles; published and unpublished scientific information on the biology and ecology of ESA-listed marine species, UES-consultation marine species, and other marine species of concern in the action area; monitoring reports and research in the region; biological opinions on similar actions; and relevant scientific and gray literature (see Literature Cited).

2 Consultation History

On January 11, 2005, the FWS issued a no-jeopardy Opinion regarding effects on nesting green sea turtles at Illeginni Islet for the U.S. Air Force's (USAF) Minuteman III testing. The FWS Opinion included an incidental take statement for the annual loss of no more than three green sea turtle nests, or injury or loss of up to 300 hatchlings, per year as a result of RV impacts at Illeginni Islet. This conclusion was issued for the USAF's Minuteman III testing and not part of this action. On May 16, 2005, we issued a letter of concurrence (LOC) with the USAF's "not likely to adversely affect" determination for sea turtles and marine mammals under our jurisdiction. It is important to note that sea turtles are under the jurisdiction of the FWS while in terrestrial habitats, whereas they are under our jurisdiction when in marine habitats. Therefore, any impacts on hauled-out or nesting adult turtles, eggs in nests, or hatchlings before they reach the water, were considered in the 2005 FWS Opinion, not in our LOC.

On March 2, 2017, we received from USASMDC/ARSTRAT, on behalf of the US Navy SSP, a consultation request and BA for the proposed action, stating that they had determined that the FE-1 flight test may affect 59 marine ESA and/or UES consultation species (Tables 1 and 2), and requested consultation for those species.

On April 18, 2017 the USASMDC/ARSTRAT responded with answers to questions that were sent on April 3, 2017, regarding the action. We sent more questions to USASMDC/ARSTRAT regarding the action on May 1, 2017. On May 12, 2017, NMFS staff and USASMDC/ARSTRAT staff met to go over details of the action and to discuss the timeline of the Opinion.

On May 30, 2017 USASMDC/ARSTRAT sent us an email asking NMFS to include three species of giant clams that have been found in the action area after we let them know that they were likely to become candidate species before the consultation ended.

On May 31, 2017, USASMDC/ARSTRAT responded to our questions from May 1, 2017.

Table 1. Marine consultation species likely to be adversely affected by the proposed action

Scientific Name	Species	ESA	MMPA	CITES	RMI
		Fish			
Cheilinus undulatus	Humphead Wrasse			X	X
		Corals			
Acanthastrea brevis	No Common Name			X	X
Acropora aculeus	No Common Name			X	X
A. aspera	No Common Name			X	X
A. dendrum	No Common Name			X	X
A. listeri	No Common Name			X	X
A. microclados	No Common Name			X	X
A. polystoma	No Common Name			X	X
Alveopora verriliiiana	No Common Name			X	X
Cyphastrea agassizi	No Common Name			X	X
Heliopora coerulea	No Common Name			X	X
Leptoseris incrustans	No Common Name			X	X
Montipora caliculata	No Common Name			X	X
Pavona venosa	No Common Name			X	X
Turbinaria reniformis	No Common Name			X	X
T. stellulata	No Common Name			X	X
		Mollusks			
Tectus niloticus	Top Shell Snail				X
Hippopus hippopus	Giant clam				X
Tridacna squamosa	Giant clam				X

In the BA, USASMDC/ARSTRAT further determined that the proposed action was likely to adversely affect the 17 marine UES consultation species listed in Table 1, and that the proposed action was not likely to adversely affect (NLAA) 41 consultation species (Table 2). Formal consultation was initiated on May 12, 2017, resulting in this Opinion.

Table 2. Marine consultation species not likely to be adversely affected by the proposed action

Scientific Name	Species	ESA	MMPA	CITES	RMI
		Sea Turtles			
Caretta caretta	North Pacific Loggerhead Sea Turtle Distinct Population Segment (DPS)	Endangered		X	X
Chelonia mydas	Central North Pacific Green Sea Turtle DPS	Threatened		X	X
	Central Western Pacific DPS	Endangered		X	X
Dermochelys coriacea	Leatherback Sea Turtle	Endangered		X	X
Eretmochelys imbricata	Hawksbill Sea Turtle	Endangered		X	X
Lepidochelys olivacea	Olive Ridley Sea Turtle	Threatened		X	X
		Marine Mammals			
Neomonachus schauinslandi	Hawaiian monk seal	Endangered	X	X	
Balaenoptera acutorostrata	Minke Whale		X		
B. borealis	Sei Whale	Endangered	X	X	
B. edeni	Bryde's Whale		X	X	
B. musculus	Blue Whale	Endangered	X	X	X
B. physalus	Fin Whale	Endangered	X	X	
Delphinus delphis	Common Dolphin		X		X
Feresa attenuata	Pygmy Killer Whale		X		
Globicephala macrorynchus	Short-finned Pilot Whale		X		
Grampus griseus	Risso's Dolphin		X		
Indopacetus pacificus	Longman's Beaked Whale aka -Tropical Bottlenose Whale		X		
Kogia breviceps	Pygmy Sperm Whale		X		
K. sima	Dwarf Sperm Whale		X		
Lagenodelphis hosei	Fraser's Dolphin		X		
Megaptera novaeangliae	Humpback Whale	Endangered	X	X	
Mesoplodon densirostris	Blainville's Beaked Whale		X		
Orcinus orca	Killer Whale		X		
Peponocephala electra	Melon-Headed Whale		X		
Physeter macrocephalus	Sperm Whale	Endangered	X	X	X
Pseudorca crassidens	False Killer Whale		X		X
Stenella attenuata	Spotted Dolphin		X		X
S. coeruleoalba	Striped Dolphin		X		X
S. longirostris	Spinner Dolphin		X		X
Steno bredanensis	Rough-toothed Dolphin		X		
Tursiops truncatus	Bottlenose Dolphin, Pacific		X		
Ziphius cavirostris	Cuvier's Beaked Whale		X		
		Fish			
Alopias superciliosus	Bigeye Thresher Shark				X
Cheilinus undulates	Humphead wrasse				X
Manta alfredi	Reef manta ray				X
Sphyrna lewini	Scalloped Hammerhead Shark	Threatened			X
Thunnus orientalis	Pacific bluefin tuna				X
Carcharhinus longimanus	Oceanic white-tip shark				
		Corals			
Acropora speciosa	No Common Name				X
A. tenella	No Common Name				X
A. vaughani	No Common Name				X
Pavona cactus	No Common Name				X
		Mollusks			
Pinctada margaritifera	Black-Lip Pearl Oyster				X

3 Description of the Proposed Action and Action Area

The proposed action is described in detail in the USASMDC/ARSTRAT BA. The purpose of the Proposed Action is to collect data on a developmental payload by testing missile range performance and to demonstrate capabilities as a prospective means to strike capabilities. Specifically, the FE-1 experiment would develop, integrate, and flight test the developmental payload concept to demonstrate the maturity of key technologies. These technologies include precision navigation, guidance and control, and enabling capabilities. The developmental payload would be launched from Kauai Test Facility located on the PMRF in Hawaii and would travel across a broad ocean area (BOA) of the Pacific Ocean towards the RTS at the USAG-KA, formerly known as US Army Kwajalein Atoll (USAKA), in the RMI. The terminal end of the missile flight test would be at Illeginni Islet in Kwajalein Atoll.

The Proposed Action consists of pre-flight preparations in the BOA and at USAG-KA, the FE-1 flight test across the BOA with three motor splash downs (figure 4), payload impact, and post-flight impact data collection, debris recovery, and clean-up operations at USAG-KA. The Proposed Action would occur within a year, if a Finding of No Significant Impact (FONSI), can be reached and approved. The following subsections include descriptions of the launch vehicle, pre-flight operations, flight, terminal phase operations, and post-flight operations.

Launch Vehicle Description

The Navy Strategic Systems Program FE-1 program launch vehicle consists of a 3-stage Strategic Target System (STARS) booster (Figure 2) and the developmental payload. The STARS booster vehicle is composed of three motor stages and control electronics. Figure 2 shows a typical STARS vehicle and Table 3 outlines the launch vehicle characteristics. The first stage motor is 4.62 m (182 inches [in]) long with a diameter of 1.37 m (54 in). The second stage motor is 1.32 m (52 in) long with a diameter of 1.37 m (54 in) and the third stage motor is 1.32 (52 in) long with a diameter of 1.37 m (54 in). The amount of propellant in the three boosters of a STARS vehicle totals approximately 13,608 kilograms (kg; 30,000 pounds [lbs]) and the vehicle generates approximately 34,019 kg (75,000 lbs) of thrust (USASMDC/ARSTRAT 2011). The amount of propellant and the Environmental impacts of STARS launches was analyzed in 2008 in the Hawaii Range Complex (HRC) EIS/OEIS (US Navy 2008). Since environmental impacts of STARS launches at PMRF have been analyzed as a part of activities at PMRF, we do not further analyze vehicle launch in this document.

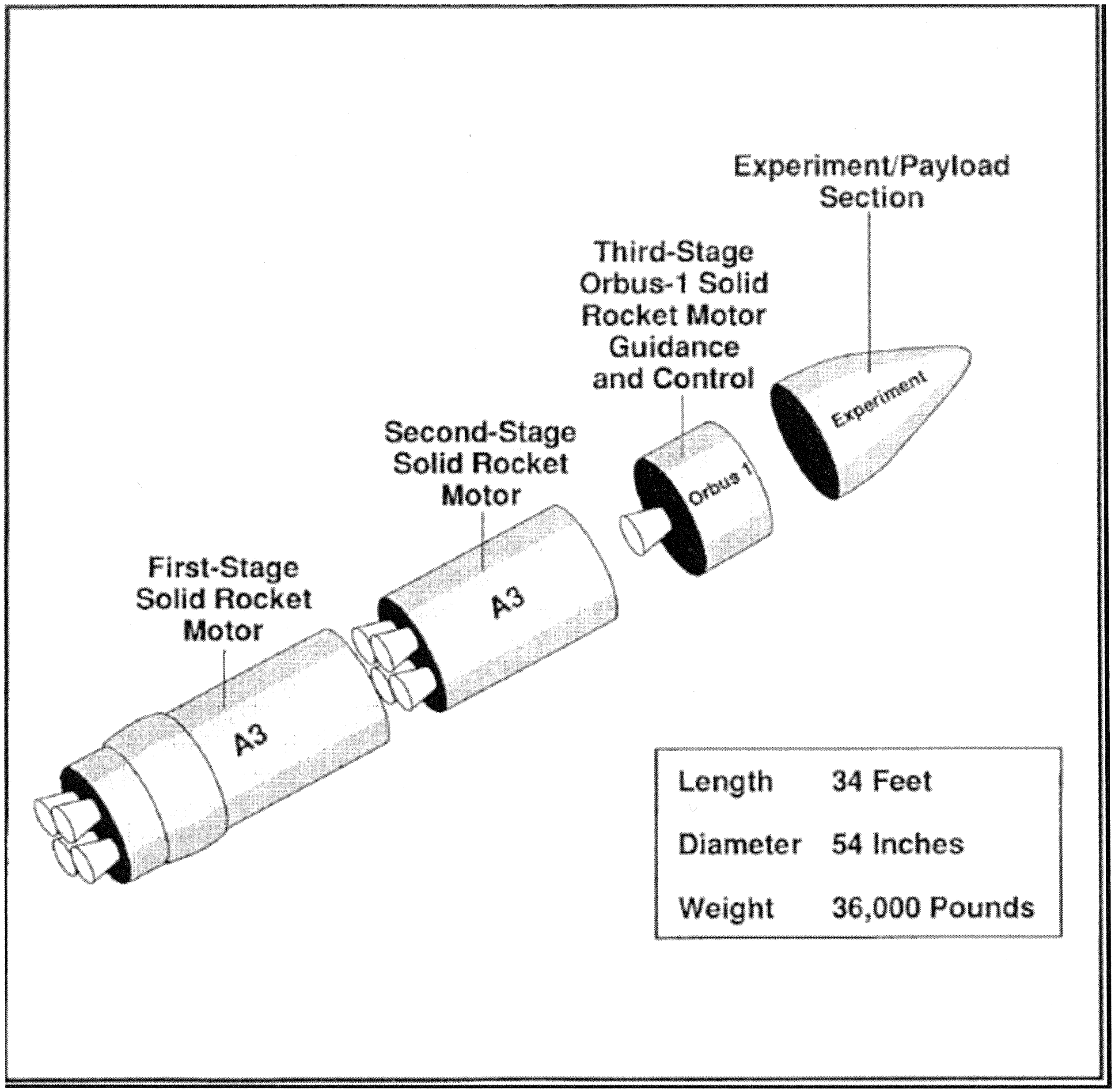

Figure 2. Typical Strategic System (STARS) Vehicle

Table 3. Launch Vehicle Characteristics

Major components	Rocket motors, propellant, magnesium thorium (booster interstage)[1], nitrogen gas, halon, asbestos (contained in second stage), battery electrolytes (lithium-
Communications	Various 5- to 20-watt radio frequency transmitters; one maximum 400-watt radio frequency transponder
Power	Up to nine lithium ion polymer and silver zinc batteries, each weighing between 3 and 40 pounds
Propulsion/Propellan	Solid Rocket propellant
Other	Small Class C (1.4) electro-explosive devices , ~3 lbs of pressurized nitrogen gas

1 The skin of the STARS first/second interstage structure was manufactured from a magnesium-thorium alloy (HK31A-H24). This is a surplus Polaris A3R asset that has been adapted to STARS and it contains less than 3% (<80 micro curies [μCi]) thorium. The interstagealloys are commercially available products containing magnesium-thorium alloy and are exempted from controls by the Nuclear Regulatory Commission (10 CFR 40.13) and the Radiological Procedures Protection Manual (RPPM) since there is no physical, chemical or metallurgical processing performed on the items.

Table 3 details the launch vehicle characteristics and Table 4 describes the payload system characteristics. Up to 454 kg or (1,000 lbs) of tungsten will be contained in the payload. A nose fairing covers the payload until separation from the third stage motor. This nose fairing is approximately 3.12 m (100 in) long composed with a diameter of 1.37 m (54 in) and then tapering to a 10.16 cm (4 in) diameter at the nose. The nose fairing is a single piece but there are two clamshell extensions on the bottom 61 cm (24 in) in length that separate into two symmetric halves.

Table 4. Payload System Characteristics

Structure	Aluminum, steel, titanium, magnesium and other alloys, copper, fiber glass, chromate coated hardware, tungsten, plastic, teflon, quartz, RTV
Communications	Two less-than-20-watt radio frequency transmitters
Power	Up to three lithium ion polymer batteries, each weighing between 3 and 50
Propulsion/Propellant	None
Other	Class C (1.4) electro-explosive devices for safety and payload subsystems

Launch: The FE-1 missile will be launched from land at PMRF and enter an over-ocean flight phase within seconds after the launch.

Over-Ocean Flight: During the planned FE-1 flight over the BOA, the first-stage motor will burn out and separate from the second stage. Further into flight, the second-stage and third-stage motors would also burn out and separate. Jettison of the fairing and payload separation from the fairing would occur inside the atmosphere. Splashdown of all three spent motor stages and the fairing would occur at different points in the open ocean between 130 and 2,778 km (70 and 1,500 nm) from the launch pad. Figure 3 depicts the drop zones for the rocket motors. The nose fairing is expected to splashdown in motor drop zone 2. Following separation from the launch vehicle, the payload would use autonomous flight control to fly at high-speeds in the upper atmosphere towards RTS. If the payload's onboard computers determine that there is insufficient energy to reach the target area, the payload will be directed to descend in a controlled termination of the flight into the BOA.

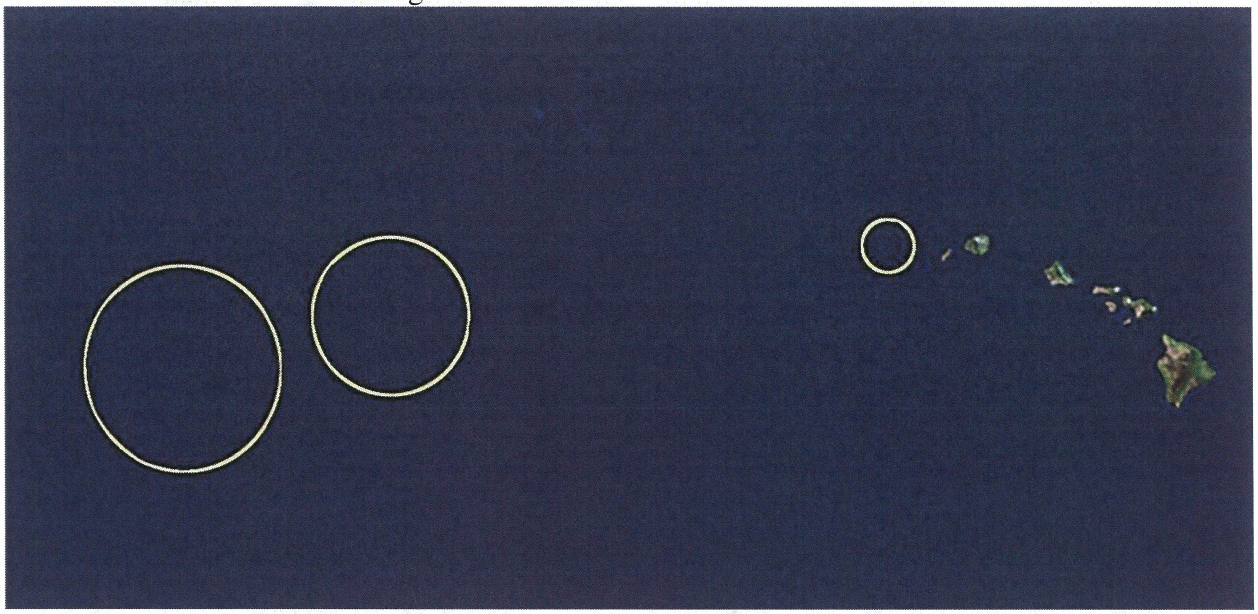
Figure 3. Representative Drop Zones (yellow circles) for spent motors and nose fairing assembly.

Upon reaching the terminal end of the flight, the payload would impact on the non-forested northwestern end of Illeginni Islet (Figure 4 and Figure 5). A crater would form as a result of this impact and leave debris containing less than 454 kg (1,000 lbs) of tungsten. Targeted areas for the payload will be selected to minimize impacts to reefs and identified wildlife habitats. A coral reef or shallow water impact at Illeginni is not part of the proposed action, would be unintentional, and is unlikely (SSP 2017).

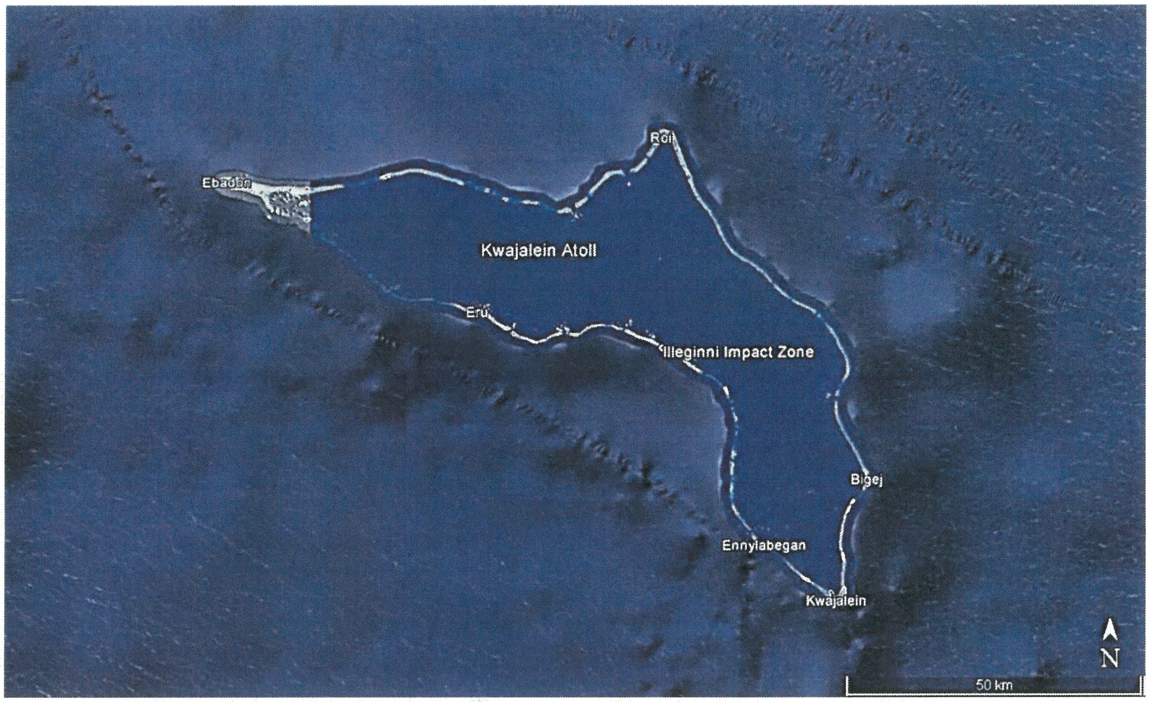

Figure 4. Notional Impact Area at Illeginni Islet, Kwajalein Atoll.

Figure 5. Potential Land Impact Area on Illeginni Islet, Kwajalein Atoll.

Sensor Coverage in the BOA: The flight path would essentially be the same as that analyzed in the Final Environmental Impact Statement for the Strategic Target System (USASDC 1992) and the HRC EIS/OEIS (US Navy 2008). A series of sensors would overlap coverage of the flight from launch at KTF until impact at USAG-KA. The sensors would include:

- Ground-based optics and radars at PMRF
- Sea-based sensors on the Mobile Aerial Target Support System (MATSS) out of PMRF, the Kwajalein Mobile Range Safety System (KMRSS) on board the US Motor Vessel (USMV) Worthy, and the Raytheon Portable Instrumented Range
- Augmentation Telemetry Equipment System (PIRATES); and
- The C-26 Safety Relay aircraft for "off-axis" range safety and support (at certain times the aircraft would not use PMRF airfield in order to be compliant with Dark Skies Initiative).

Sensor Coverage at USAG-KA: Radars would be placed on Illeginni Islet to gather information on the payload. Up to four radar units which are less than 0.4 m^3 (14 ft^3) would be placed within the impact area and may be destroyed by payload impact. These radars are powered by automobile batteries or on-shore generator power.

In addition to land-based radars and sensor vessel support, up to 16 self-stationing rafts with onboard optical and/or acoustical sensors (Figure **6**) may be placed in nearshore ocean waters near Illeginni Islet. Before the flight test, one or two of the range landing craft utility (LCU) vessels would be used to deploy the rafts. The rafts would be equipped with battery-powered electric motors for propulsion to maintain position in the water. Sensors on the rafts would collect data during the experiment's descent until impact.

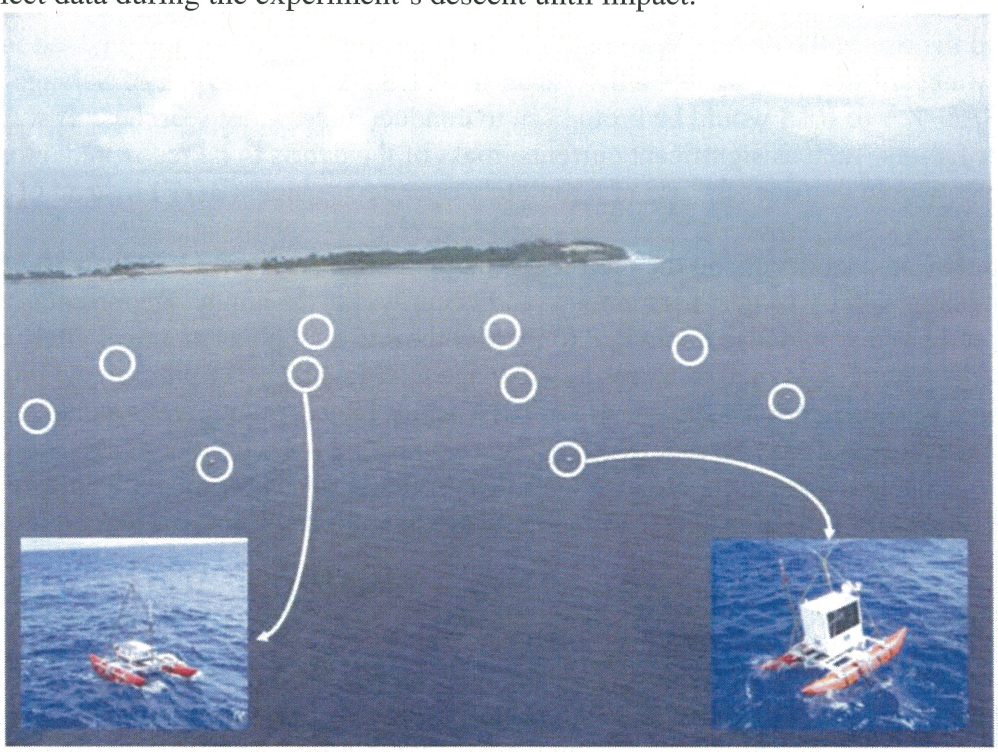

Figure 6. Notional Locations of Precision Scoring Augmentation Rafts.

Post-flight operations may include manual cleanup of payload debris, use of heavy equipment for cleanup and repairs, retrieval of sensors, and use of remotely operated vehicles (ROVs) for underwater debris retrieval as described below.

Post-flight debris deposited on Illeginni Islet or in the adjacent ocean or lagoon would be recovered. Prior to recovery and cleanup actions at the impact site, unexploded ordnance personnel would first survey the impact site for any residual explosive materials. For a land impact at Illeginni Islet, the impact areas would be washed down if necessary to stabilize the soil. Post-flight recovery operations at Illeginni Islet will involve manual cleanup and removal of all visible experiment debris, including hazardous materials, followed by filling in larger craters with ejecta using a backhoe or grader. Repairs will be made to the impact area if necessary. USAG-KA and RTS personnel are usually involved in these operations. Any accidental spills from support equipment operations would be contained and cleaned up. All waste materials would be returned to Kwajalein Island for proper disposal in the US. Following cleanup and repairs to the Illeginni site, soil samples would be collected at various locations around the impact area and tested for pertinent contaminants. Recovery and cleanup operations on Illeginni Islet could possibly cause some short-term disturbance to migratory bird habitat, potential sea turtle nesting habitat, and nearshore coral reef habitat.

While a shallow water impact is not planned or expected, any payload impact debris found in the shallow waters near Illeginni Islet would be removed while attempting to not further disturb or damage corals or other marine organisms. Payload recovery/cleanup operations in the lagoon and ocean reef flats, within 500 to 1,000 ft of the shoreline, are conducted similarly to land operations when tide conditions and water depth permit. A backhoe is used to excavate the crater. Excavated material is screened for debris and the crater is usually back-filled with ejecta from around the rim of the crater. While not planned or expected, should the payload impact in the deeper waters of the atoll lagoon, a dive team from US Navy Supervisor of Salvage and Diving, USAG-KA or RTS would be brought in to conduct underwater searches. If warranted due to other factors, such as significant currents, mass of the debris to be recovered, etc., the recovery team would consider the use of a remotely operated vehicle (ROV) instead of divers.

If an inadvertent impact occurs on the reef, reef flat, or in shallow waters less than 30.5 m (100 ft) deep, an inspection by project personnel would occur within 24 hours. Representatives from the NMFS and FWS would also be invited to inspect the site as soon as practical after the test. The inspectors would be invited to assess any damage to coral and other natural and biological resources and, in coordination withSSP, USAG-KA and RTS representatives, decide on any mitigation measures that may be required. In general, payload recovery operations would not be attempted in deeper waters on the ocean side of the Atoll. Searches for debris would be attempted out to depths of up to 180 ft. An underwater operation similar to a lagoon recovery would be used if debris were located in this area.

3.1 Interrelated/Interdependent Actions

Military training and testing at Kwajalein Atoll has been ongoing since World War II. Testing of missile programs at Kwajalein began in 1959 for the Nike Zeus missile program. The

Minuteman (MM) I program began in 1962, MMII began in 1965, and MMIII began in 1970. In addition to the MM program, anti-ballistic missile, and other missile development and testing take place at the RTS, along with other military training and testing activities, and commercial missile launches. If it were not for these numerous activities, it is doubtful that the facilities at USAG-KA and RTS would be required. Therefore actions to develop and maintain USAG-KA and RTS facilities and infrastructure, and to support the various missions, are interrelated and/or interdependent with the training and testing activities that occur at the USAG-KA and RTS. However, much of the infrastructure and facilities are designed to support numerous programs and missions, with few being project-specific. Therefore, support activities that are solely attributable to the FE-1 testing program constitute a small portion of the total that occur at USAG-KA and RTS in support of the site's numerous missions. Further, per the Document of Environmental Protection (DEP) procedures outlined in the UES, any USAG-KA and RTS actions that may affect the USAG-KA environment require structured environmental review, with coordination and/or consultation as appropriate. Based on this, we expect that interrelated or interdependent actions that may be solely attributable to the FE-1 test would be virtually inseparable from the routine activities at USAG-KA and RTS, and any impacts those actions may have would be considered through the DEP procedures outlined in the UES.

3.2 Action Area

As described above, the action area for this consultation begins after the launch immediately offshore from PMRF, Kauai, where the sonic boom of the accelerating missiles would reach the ocean surface. The action area extends from there, across the Pacific Ocean along a relatively narrow band of ocean area directly under the flight path of the missile, where the sonic boom and spent missile components are expected to impact the surface (Figures 1 & 3). The action area also includes the area of and around Kwajalein Atoll, RMI where the payload would impact the target areas (Figure 5), as well as the areas immediately around support vessels and sensor rafts used to monitor the payload impacts, and the down-current extent of any plumes that may result from discharges of wastes or toxic chemicals such as fuels and/or lubricants associated with the machinery used for this activity.

4 Species and Critical Habitats Not Likely to be Adversely Affected

As explained above in Section 1, USASMDC/ARSTRAT determined that the proposed action was not likely to adversely affect (NLAA) the 43 consultation species listed in Table 2, and would have no effect on critical habitats designated under the ESA and/or the UES. With the exception that we have determined that the proposed action may affect, but is NLAA critical habitat that has been designated under the ESA for Hawaiian monk seals, this section serves as our concurrence under section 7 of the ESA of 1973, as amended (16 U.S.C. §1531 *et seq.*), and under section 3-4.5.3(d) of the UES, 14^{th} Edition, with USASMDC/ARSTRAT's determination.

The UES does not specifically define the procedure to make a NLAA determination. However, the Compact clearly intends that the UES provide substantially similar environmental protections as the ESA. We interpret this to include adoption of the ESA NLAA determination process. In order to determine that a proposed action is not likely to adversely affect listed species, under the ESA, we must find that the effects of the proposed action are expected to be insignificant, discountable, or beneficial as defined in the joint FWS-NMFS Endangered Species Consultation Handbook. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those that are extremely unlikely to occur; and beneficial effects are positive effects without any adverse effects (FWS & NMFS 1998). As described in Section 2, test flights have 3 distinct phases: Launch; Over-Ocean Flight; and Terminal Flight and Impact in the RMI. Each phase has potential stressors, listed below, that are based on what the missile is doing, and on activities done to support the test.

<u>Over-Ocean Flight</u>: The potential stressors during over-ocean flight are:
a. Exposure to elevated noise levels;
b. Impact by falling missile components; and
c. Exposure to hazardous materials.

<u>Terminal Flight and RV Impact in the RMI</u>: The potential stressors during terminal flight, payload impact, and preparation and restoration work at Kwajalein Atoll are:
a. Exposure to elevated noise levels;
b. Impact by falling missile components;
c. Exposure to hazardous materials;
d. Disturbance from human activity and equipment operation; and
e. Collision with vessels.

Each of these stressors are addressed below to determine whether or not individuals of any of the ESA-listed and UES-protected marine species considered in this consultation are likely to be adversely affected by that stressor. The species that may be exposed to stressors during each phase, and their likely response to exposure are based on the biological and/or ecological characteristics of each species. Any incidence where a stressor has more than a discountable risk of causing an adverse effect on any individual of the ESA- and/or UES-protected species will result in that stressor and those species being considered in the following biological opinion.

<u>a. Exposure to elevated noise levels</u>: While in flight between PMRF and Kwajalein Atoll, the missile and the payload would travel at velocities that cause sonic booms. High-intensity in-water noise would be created when large missile components, such as spent rocket motors' impact the ocean's surface (splash-down). The impact from the payload hitting the ground will also create a sound to land and water that could transfer to water causing impulsive sound sources. High intensity impulsive noises can adversely affect marine life. The USASMDC/ARSTRAT will also create sounds from vessels and human activity in and near water during placement and retrieval of sensors and other data collecting instruments, and retrieval of debris from the impact. Effects vary with the frequency, intensity, and duration of the sound source, and the body structure and hearing characteristics of the affected animal. Effects may include: non-auditory physical injury; temporary or permanent hearing damage expressed as temporary threshold shift (TTS) and permanent threshold shift (PTS) respectively;

and behavioral impacts such as temporarily masked communications or acoustic environmental cues and modified behaviors.

Sound is a mechanical disturbance consisting of minute vibrations that travel through a medium, such as air, ground, or water, and is generally characterized by several variables. Frequency describes the sound's pitch and is measured in hertz (Hz) or cycles per second. Sound level describes the sound's loudness. Loudness can be measured and quantified in several ways, but the logarithmic decibel (dB) is the most commonly used unit of measure, and sound pressure level (SPL) is a common and convenient term used to describe intensity. Sound exposure level (SEL) is a term that is used to describe the amount of sound energy a receiver is exposed to over time. The dB scale is exponential. For example, 10 dB yields a sound level 10 times more intense than 1 dB, while a 20 dB level equates to 100 times more intense, and a 30 dB level is 1,000 times more intense. Sound levels are compared to a reference sound pressure, based on the medium, and the unit of measure is the micro-Pascal (μPa). In water, sound pressure is typically referenced to a baseline of 1 μPa (re 1 μPa), vice the 20 μPa baseline used for in-air measurements. As a rule of thumb, 26 dB must be added to an in-air measurement to convert to an appropriate in-water value for an identical acoustic source (Bradley and Stern 2008). Root mean square (RMS) is the quadratic mean sound pressure over the duration of a single impulse. RMS is used to account for both positive and negative values so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units rather than by peak pressures. For brevity, all further references to sound level assume dB_{rms} re 1 μPa, unless specified differently.

Transmission loss (attenuation of sound intensity over distance) varies according to several factors in water, such as water depth, bottom type, sea surface condition, salinity, and the amount of suspended solids in the water. Sound energy dissipates through mechanisms such as spreading, scattering, and absorption (Bradley and Stern 2008). Spreading refers to the apparent decrease in sound energy at any given point on the wave front because the sound energy is spread across an increasing area as the wave front radiates outward from the source. In unbounded homogenous water, sound spreads out spherically, losing as much as 7 dB with each doubling of range. Toward the other end of the spectrum, sound may expand cylindrically when vertically bounded such as by the surface and substrate, losing only about 3 dB with each doubling of range. Scattering refers to the sound energy that leaves the wave front when it "bounces" off of an irregular surface or particles in the water. Absorption refers to the energy that is lost through conversion to heat due to friction. Irregular substrates, rough surface waters, and particulates and bubbles in the water column increase scattering and absorption loss. Shallow nearshore water around Illeginni where the payload may impact, is vertically bounded by the seafloor and the surface, but is considered a poor environment for acoustic propagation because sound dissipates rapidly due to intense scattering and absorption. The unbounded deep open ocean waters where the motors would impact is considered a good acoustic environment where spherical spreading would predominate in the near field.

In the absence of location-specific transmission loss data, equations such as RL = SL – #Log(R) (RL = received level (dB); SL = source level (dB); # = spreading coefficient; and R = range in meters (m)) are used to estimate RL at a given range (isopleth). Spherical spreading loss is estimated with spreading coefficient of 20, while cylindrical spreading loss is estimated with spreading coefficient of 10. Spreading loss in near shore waters is typically somewhere between the two, with absorption and scattering increasing the loss. $RL = SL - 20_{Log}(R)$ was used here to estimate ranges in deep open ocean water, and $RL = SL - 15_{Log}(R)$ was used to estimate ranges in the lagoon and reef flat areas around Illeginni.

The sound pressures associated with non-auditory injury are very high and are generally associated with a shock wave that is generally not found in sounds that are created by a splashdown. The Navy identified a threshold for non-auditory injury based on gastrointestinal bursting at 237 dB re: 1 μPa (Finneran and Jenkins 2012). The sounds estimated from the splashdowns and sonic booms are clearly below those thresholds and are not likely to cause non-auditory injury to marine mammals, sea turtles, elasmobranchs, and large fishes.

Table 5. Estimated thresholds for TTS and behavioral changes for hearing groups (NMFS [2016], Finneran and Jenkins [2012], Popper et al. [2014]).

Hearing Group	**TTS peak pressure threshold (SPL_{peak})**	**Weighted TTS onset threshold (SEL_{CUM})**	**Estimated threshold for behavioral changes**
Low-frequency cetaceans (humpback whale and other baleen whales)	213 dB	179 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
Mid-frequency cetaceans (dolphins, pilot whales and other toothed whales)	224 dB	178 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
High-frequency cetaceans (Kogia, true porpoises)	196 dB	153 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
Phocid pinnipeds (Hawaiian monk seals and other true seals)	212 dB	181 dB	Continuous = 120 dB_{RMS} Non-continuous = 160 dB (re: 1 μPa)
Sea turtles	224 dB	200 dB	160 dB
Sharks, rays, and fish	229 dB*	186 dB*	150 dB

* - SPL for lethal and sublethal damage to fish with swim bladders exposed to not specific to hearing.

The threshold for the onset of behavioral disturbance for all marine mammals from a single exposure to impulsive in-water sounds is ≥ 160 dB. Ongoing research suggests that these thresholds are both conservative and simplistic (detailed in Southall *et al.* 2007 and NOAA 2013). The draft revised thresholds for marine mammals uses two metrics: 1) exposure to peak sound pressure levels (SPL_{peak}) and 2) exposure to accumulated sound exposure levels (SEL_{cum}). The thresholds for single exposures to impulsive in-water sounds are listed in Table 5 for the onset of injury and temporary hearing impacts (NOAA 2016). Corals and mollusks can react to exposure to intense sound and could be affected by concussive forces if exposed to very intense sound sources such as an underwater detonation.

Sonic booms: A sonic boom is a thunder-like noise caused by the shock wave generated by an object moving at supersonic speed. As objects travel through the air, the air molecules are pushed aside with great force and this forms a shock wave much like a boat creates a bow wave (NASA 2014). Exposure to sonic booms would have insignificant effects on any of the species considered in this consultation. The FE-1 vehicle may generate sonic booms from shortly after launch to impact at or near Illeginni. Sound attenuates with distance from the source due to spreading and other factors. The higher the missile climbs, the quieter the sonic boom would be at the Earth's surface. Similarly, the greater the distance either side of the centerline of the flight path, the quieter the sonic boom. Therefore, the sound intensity would be loudest directly below the missile when the component is closest to the surface. Additionally, Laney and Cavanagh (2000) report that sound waves arriving at the air/water interface at an angle less steep than 13.3° from of the vertical will not normally propagate into water. This means that within the footprint of the sonic boom, only those marine animals within 13.3° of directly below the source could be expected to hear the sonic boom. Sounds originating in air, even intense ones like sonic booms transfer poorly into water, and most of its energy would refract at the surface or absorb in waves or natural surface disturbance at the surface. Once in the water, the sounds of a sonic boom would attenuate with distance. For this project, Kahle et al. (2017) estimated sound transfer from air to water using a model absent all atmospheric variables that would increase refraction, absorption, and dissipation. The loudest sounds were assumed to be near launch (145 dB re: 1 μPa) and at impact site (175 dB). Considering the short (few seconds) duration of the exposure, as noted below,neither are loud or long enough to cause TTS in animals of any of the hearing groups.

Using a model absent most variables that would reduce spreading, (Kahle et al. 2017) predicted the sonic boom footprint of sounds ≥ 160 dB to cover at most a 20.9 square mile radius, and 130.5 square mile radius for sounds ≥ 150 dB. The duration of a sonic boom at any given point within the footprint would be about 0.27 seconds.

In summary, at its loudest (175 dB), an in-water sonic boom exceeds no thresholds for injury to any of the species considered in this consultation, and it is well below the new proposed threshold for the onset of temporary hearing impacts for all hearing groups. Large areas were estimated to be affected by sounds high enough to cause behavioral responses for turtles and fish. However, the models did not account for refraction at the surface, wind or other atmospheric factors like wind and moisture that would dissipate the spreading; it will actually be a much smaller area, as would the corresponding estimate of animals affected by the sonic boom. Those factors would also significantly reduce the intensity of the noise in the water column where most of the UES consultation species spend the majority of their time. Nonetheless, the USASMDC/ARSTRAT estimated that they could affect animals in those respective areas of effect if they were near the surface. All animals in the action area could be exposed to the sonic boom at the impact site for no more than 0.3 seconds. We believe that, at most, an exposed individual may experience temporary behavioral disturbance in the form of slight changes in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure. Therefore, the exposure is expected to have insignificant effects.

Exposure to splash-down noise would be discountable for any of the species considered in this consultation. Three spent rocket motors and a nose fairing will fall into the ocean during the flight. The motors are the only components of sufficient size and velocity to create significant noise levels on splash-down. The noise generated by the splash-down will be heard by every hearing group, some even up to a few miles away. The USASMDC/ARSTRAT predicted the impulsive noises created by the splash based on the size of the components, listed in Table 6.

Table 6. Stage Impact Contact Areas and Peak Sound Pressure Levels for FE-1 Vehicle Components (Kahle et al. 2017).

Stage	Contact Area m^2 (ft^2)	Peak Sound Pressure Level (dB re 1 μPa)
Stage 1 Spent Motor	27.73 (81.12)	218
Stage 2 Spent Motor	10.17 (33.38)	205
Nose Fairing	16.81 (55.14)	196
Stage 3 Spent Motor	5.94 (19.5)	201

Of the three motors, the first stage is the largest and the one expected to make the most noise on impact; a brief (less than one second) impulse of 218 dB @ 1m (Kahle et al. 2017). All four objects would fall into deep open ocean waters. The first would splash-down shortly after takeoff near Kaula Rock in the Hawaiian Islands. The remaining objects would splash-down in tropical waters closer to the target site at Illeginni Islet than Hawaii but still in deep ocean waters. Cetaceans, sea turtles, adult scalloped hammerhead sharks, oceanic white tip sharks, bigeye thresher sharks, rays, and pelagic fish may be affected by this stressor. Hawaiian monk seals may be affected by this stressor near the launch.

As sounds dissipate with distance, they get less intense and are less capable of producing injury and behavioral responses. Assuming spherical spreading, the range to the hearing groups' TTS isopleths around each splash-down are listed in Table 7. Since exposure to sounds that could cause TTS would be harmful, we evaluated the probability of an exposure to UES consultation species. The best information available to describe the abundance and distribution of open ocean species considered in this consultation, supports the understanding that these animals are widely scattered, and their densities are very low in the open ocean areas where the motors would splash-down. We know of no information to suggest that the splash-down zones are in areas of any significance that would cause any congregations of these species.

Because the area of influence for TTS is within feet of their impact with the surface, the splash-downs will create an acoustic area of effect little or no greater than that of direct contact. As such, the probability of exposure is the same as a direct contact. The USASMDC/ARSTRAT compared marine mammal density information from Hawaii, and sea turtle density information from Guam, against the expected range of effect around falling missile components to estimate the probability of effect. Their modeling suggests that the probability of exposing marine mammals to a TTS-level exposure for a test flight would be between 1 in 261,327 chance for the most common and sensitive species (Hanser et al. 2013). This is likely an overestimate, since those calculations did not include weighting factors used in our evaluations, which reduces the zone of influence. Based on the low annual number of splash-downs, their wide spacing, their small area of effect (< 100 m), and the expected low densities of the consultation species in the affected areas, we believe that the risk of exposure to splash-down acoustic effects in the open ocean is discountable for all of the species considered in this consultation.

Table 7. Estimated distances from source noise to TTS thresholds

Hearing Group	**TTS peak pressure threshold (SPL_{peak})**	**Isopleths to TTS threshold from:**			
		218 dB	**205 dB**	**201 dB**	**196 dB**
Low-frequency cetaceans (humpback whale and other baleen whales)	213 dB	1.8 m (5.9 feet)	0.4 m	0 m	0 m
Mid-frequency cetaceans (dolphins, pilot whales and other toothed whales)	224 dB	0 m	0 m	0 m	0 m
High-frequency cetaceans (Kogia, true porpoises)	196 dB	0.2 m (0.65 feet)	0 m	0 m	0 m
Phocid pinnipeds (Hawaiian monk seals and other true seals)	212 dB	1 m (3.28 feet)	0.2 m	0 m	0 m
Sea turtles	224 dB	0 m	0 m	0 m	0 m
Sharks, rays, and fish	229 dB*	0 m	0 m	0 m	0 m

In each hearing group, the individuals affected would have to be within six feet of the source to experience TTS. The sounds produced by splashdowns will be louder or equal to the 160 dB behavior response thresholds for all hearing groups, up to ½ mile away from the source for some species, and some species should be able to detect sounds (below behavior thresholds) for a few more miles. The sounds will be a short impulse, which will dissipate within seconds of impact. We believe that, at most, an exposed individual may experience temporary behavioral disturbance in the form of slight changes in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure.

The USASMDC/ARSTRAT will use vessels of varying size to install and retrieve equipment in water to gather data and remove debris. Large vessels can create sounds ranging from 170-190 dB (re: 1 μPa). Smaller vessels like skiffs with outboards range from 150-170 dB. Vessels are generally moving and the sound sources are considered non-impulsive and mobile. Human activity in water during retrieval of instruments, debris, and ejecta are not louder than those sources. Air bubbles from SCUBA are among the higher noise sources considered, and were reported by Radford et al. (2005) with mean levels of 161 dB and mean peak levels of 177 dB at 1 meter. We consider this source a non-impulsive, mobile, intermittent noise source. Because of the mobile nature of vessels and the intermittent nature of SCUBA bubbles, animals of all hearing groups are not likely to be exposed to the source long enough or continuously enough to experience TTS from vessels and SCUBA air bubbles. Furthermore, behavioral disturbances are likely brief because the mobile and temporary nature of the sources, and the noises will likely have an immeasurable effect on an individual's behavior during and after exposure.

For payload impacts in the ocean south of Illeginni, sea turtles, scalloped hammerhead sharks, oceanic white tip sharks, bigeye thresher sharks, manta rays, and humphead wrasse along the outer edge of the fringing reef may be exposed to a brief pulse of sound from air or underground. The USASMDC/ARSTRAT recorded similar payload strikes at Illeginni that produced sounds at a level of 140 dB re: 20 μPa 18 m from the source. Using backtracking, the measurements corresponds to a source level of 165 dB, and loosely corresponds to underwater sounds at 191 dB. This is likely an overestimate, because the model did not account for sound refraction, absorption, and other dissipation which happens in natural environments. By the time the sound reaches water, it will likely be less than 191 dB. The sound at payload impact will be too low to cause TTS. At most, we expect that an exposed individual may experience a temporary behavioral disturbance, in the form of slight change in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure. Therefore, the exposure is expected to have insignificant effects. Being much less acoustically sensitive, any exposed corals or mollusks that may be on the outer reef edge are expected to be unaffected by payload impact noise. Based on the best available information, exposure to splash-down noise is expected to have insignificant effects for all species considered in this consultation.

b. Impact by falling missile components: It is discountable that any of the species considered in this consultation would be hit by falling missile components, or to be close enough to an impact site to be significantly affected by concussive forces. It is also discountable that the humphead wrasse or any of the species identified in Table 2 would be hit by payload or ejecta, or be significantly affected by concussive forces during the single planned payload strike on Illeginni Islet. However, the payload strike on Illeginni Islet may adversely affect the species identified in Table 1, other than the humphead wrasse. Therefore, the potential effects of this stressor on those species are considered below in the effects of the action section (Section 4).

Direct Contact

The Proposed Action will result in spent rocket motors and nose fairings splashing down into the BOA as well as impact of the payload on land at Illeginni Islet. These falling components will directly contact aquatic and/or terrestrial habitats and have the potential to directly contact consultation species. Payload component contact with the land may result in cratering and ejecta radiating out from the point of impact. While direct estimates for cratering and ejecta field size are not available for the proposed payload, cratering and ejecta are expected to be less than those of MMIII reentry vehicles (RVs). Therefore, MMII estimates of cratering and shock waves (USAFGSC and USASMDC/ARSTRAT 2015) are used as a maximum bounding case for the Proposed Action.

Three spent rocket motors, and various smaller/lighter missile components would fall into the ocean during the flight. To be struck by a missile component, an animal would have to be at, or very close to the surface, and directly under the component when it hits. USASMDC/ARSTRAT (2017) reports that the first stage motor is about 15 ft (4.6m) long, 4.5 ft (1.37 m) in diameter, and is the largest component. The second stage motor is 7.4 ft (2.26m) long with a diameter of 4.5 ft (1.37m) and the third stage motor is 4.3 ft (1.32m) long with a diameter of 4.5 ft (1.37 m). Direct contact areas for these individual components are listed in Table 6 and total approximately 61 m^2 (189 ft^2).

If a spent rocket motor or other FE-1 component were to strike a cetacean, sea turtle, or fish near the water surface, the animal would most likely be killed or injured. Based on the above discussed affected areas, and the best available species density information, chances of direct contact to cetaceans and sea turtles in the BOA were calculated. Calculations are based on methodology in the Mariana Islands Training and Testing Activities Final EIS (Appendix G in US Navy 2015a) and the Hawaii-Southern California Training and Testing EIS (Appendix G in US Navy 2013).

A probability of direct contact and total number of exposures were calculated for each marine mammal species and for a sea turtle guild for each FE-1 component based on component characteristics and animal density in the Action Area (SSP 2017). The probability analysis is based on probability theory and modified Venn diagrams with rectangular "footprint" areas for the individual animals and the component impact footprints within the Action Area. Sea turtles were combined into a "sea turtle guild" for analyses due to the lack of species specific occurrence data (Hanser et al. 2013). This sea turtle guild is composed of primarily green and hawksbill turtles as they account for nearly all sightings; however, in theory, the guild also encompasses leatherback, olive ridley, and loggerhead turtles (Hanser et al. 2013; SSP 2017). These analyses assume that all animals would be at or near the surface 100 percent of the time and that the animals are stationary. While these assumptions do not account for animals that spend the majority of time underwater or for any animal movement or potential avoidance to proposed activities, these assumptions should lead to a conservative estimate of direct contact effect on listed species.

Their modeling suggests that the probability of exposing marine mammals to direct impact or injurious concussive force for a test flight would be between 1 in 117,000 and 1 in 14,700,000 depending on the species (Table 8). The probability of exposing sea turtles is 1 in 710,000 (SSP 2017). No density information is available for scalloped hammerhead sharks, bigeye thresher sharks, oceanic white tip sharks, bluefin tuna, humphead wrasse, and the reef or giant manta ray but their densities are believed to be low. Based on that and the expectation that they would be well below the surface most of the time, we believe that the probability of their exposure to direct impact or injurious concussive force would be as low or lower than those described above. While larval stages of fish, corals, and mollusks may also be found in the BOA we believe that the densities are low and will also be at depths greater than where significant impacts are expected to occur and therefore the probability that any will be impacted is extremely low. The corals considered in this consultation are restricted to shallow nearshore waters well away from missile components falling into the ocean. Therefore, that stressor would have no effect on them. Based on the best available information, we believe that it is discountable that any of the species considered in this consultation would be exposed to missile components falling into the ocean.

Table 8. Probability of Direct Contact from FE-1 Vehicle Components and Estimated Number of Marine Mammal and Sea Turtle Exposures in the BOA.[1]

Species/ Group	Average Probability of Impacting One Animal Across Scenarios based on Animal and Component Size				Average Number of Exposures Across Scenarios (number of animals)				Estimated Total Number of Exposures
	1st Stage Motor	2nd Stage Motor	Nose Fairing	3rd Stage Motor	1st Stage Motor	2nd Stage Motor	Nose Fairing	3rd Stage Motor	
Marine Mammals									
Balaenoptera acutorostrata	4.03E-08	1.86E-09	3.05E-09	7.29E-10	1.56E-06	6.31E-07	1.03E-06	5.35E-07	3.76E-06
B. borealis	6.22E-08	3.28E-09	4.97E-09	1.41E-09	9.10E-08	4.21E-08	6.37E-08	3.45E-08	2.31E-07
B. edeni	5.78E-08	2.99E-09	4.58E-09	1.27E-09	6.30E-08	3.84E-08	5.87E-08	2.40E-08	1.84E-07
B. musculus	1.11E-07	6.81E-09	9.43E-09	3.24E-09	5.06E-08	2.73E-08	3.77E-08	3.41E-07	4.57E-07
B. physalus	8.68E-08	5.03E-09	7.20E-09	2.30E-09	4.77E-08	2.42E-08	3.46E-08	1.39E-07	2.46E-07
Delphinus delphis [2]	2.28E-08	8.42E-10	1.58E-09	2.78E-10	0	0	0	0	0
Feresa attenuata	2.26E-08	8.30E-10	1.56E-09	2.73E-10	9.09E-07	2.92E-07	5.50E-07	1.88E-08	1.77E-06
Globicephala macrorhynchus	2.92E-08	1.20E-09	2.11E-09	4.32E-10	2.41E-06	2.92E-07	5.13E-07	1.43E-07	3.36E-06
Grampus griseus	4.82E-08	2.36E-09	3.73E-09	9.63E-10	2.07E-06	8.88E-07	1.40E-06	1.26E-06	5.63E-06
Indopacetus pacificus	3.78E-08	1.71E-09	2.83E-09	6.58E-10	1.07E-06	4.24E-07	7.03E-07	8.51E-08	2.28E-06
Kogia breviceps	2.46E-08	9.40E-10	1.73E-09	3.20E-10	6.55E-07	2.19E-07	4.02E-07	1.19E-07	1.40E-06
K. sima	2.28E-08	8.42E-10	1.58E-09	2.78E-10	1.49E-06	4.81E-07	9.02E-07	2.55E-07	3.13E-06
Lagenodelphis hosei	2.28E-08	8.42E-10	1.58E-09	2.78E-10	4.38E-06	1.42E-06	2.65E-06	7.78E-08	8.53E-06
Megaptera novaeangliae	6.22E-08	3.28E-09	4.97E-09	1.41E-09	2.71E-06	6.58E-07	9.95E-07	1.76E-08	4.38E-06
Mesoplodon densirostris	3.04E-08	1.27E-09	2.21E-09	4.62E-10	2.39E-07	1.36E-07	2.36E-07	7.91E-08	6.91E-07
Orcinus orca	4.03E-08	1.86E-09	3.05E-09	7.29E-10	2.21E-08	8.95E-09	1.47E-08	2.25E-08	6.82E-08
Peponocephala electra	2.28E-08	8.42E-10	1.58E-09	2.78E-10	4.17E-07	1.35E-07	2.53E-07	5.37E-08	8.59E-07
Physeter macrocephalus	5.64E-08	2.90E-09	4.46E-09	1.22E-09	7.96E-07	3.22E-07	4.96E-07	2.02E-07	1.82E-06
Pseudorca crassidens	3.04E-08	1.27E-09	2.21E-09	4.62E-10	2.16E-07	1.06E-07	1.85E-07	7.01E-08	5.77E-07
Stenella attenuata	2.13E-08	7.58E-10	1.45E-09	2.44E-10	1.18E-06	2.57E-07	4.91E-07	1.46E-07	2.07E-06
S. coeruleoalba	2.28E-08	8.42E-10	1.58E-09	2.78E-10	7.48E-07	3.46E-07	6.48E-07	2.29E-07	1.97E-06
S. longirostris	2.13E-08	7.58E-10	1.45E-09	2.44E-10	4.78E-07	3.00E-07	5.74E-07	2.27E-07	1.58E-06
Steno bredanensis	2.26E-08	8.30E-10	1.56E-09	2.73E-10	9.51E-07	7.05E-08	1.33E-07	3.16E-08	1.19E-06
Tursiops truncatus	2.58E-08	1.00E-09	1.82E-09	3.46E-10	7.09E-07	4.66E-08	8.44E-08	2.11E-08	8.61E-07
Ziphius cavirostris	3.28E-08	1.41E-09	2.41E-09	5.24E-10	9.01E-08	7.01E-07	1.20E-06	4.17E-07	2.41E-06
Neomonachus schauinslandi	2.19E-08	7.93E-10	1.50E-09	2.58E-10	6.02E-09	3.45E-11	6.55E-11	0	6.12E-09
Total Marine Mammal Exposures					**2.34E-05**	**7.86E-06**	**1.37E-05**	**4.55E-06**	**4.94E-05**
Sea Turtles									
Sea Turtle Guild [2]	1.70E-08	6.31E-10	1.18E-09	2.10E-10	6.70E-07	2.17E-07	1.16E-07	3.34E-07	1.41E-06

[1] Animal densities used for analyses are presented in table 5-9 of the SSP 2017 BA. The first stage motor would splashdown in motor drop zone 1, the second stage motor and nose fairings in motor drop zone 2, and the third stage motor in motor drop zone 3.

[2] Sea turtles were combined into a "sea turtle guild" in the Marine Mammal Density Database due to the lack of species specific occurrence data (Hanser et al. 2013). This sea turtle guild is composed of primarily green and hawksbill turtles as they account for nearly all sightings in the study area; however, in theory, the guild also encompasses leatherback, olive ridley, and loggerhead turtles (Hanser et al. 2013).

Of the species identified in Table 2, only green and hawksbill sea turtles may occur close enough to the potential impact site to be affected by these stressors. Therefore we believe that, with the exception of green and hawksbill sea turtles, it is discountable that any of those species would be exposed to the payload impact on Illeginni Islet. Although green and hawksbill sea turtles may occur around Illeginni Islet, they do so infrequently and in low numbers, and typically in waters closer to the reef edge, which is over 500 feet from shore, where they spend the majority of their time under water. Therefore, we consider it unlikely that either turtle species would be close enough to shore to be within the range of shock wave effects, and that any exposure to ejecta would be in the form of relatively slow moving material sinking to the bottom near the animal. In the unlikely event of a turtle being within the ejecta zone during the impact, at most, an exposed animal may experience temporary behavioral disturbance in the form of slight changes in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure. Therefore, the exposure is expected to have insignificant effects.

The USASMDC/ARSTRAT estimated that juvenile humphead wrasse on the lagoon side, and adults on the ocean side might be within the range of the shockwave associated with the impact of the payload with land and/or the ejecta, and therefore may be adversely affected by the payload. This estimate was based on a NMFS Preliminary Estimate Report based on surveys made at numerous sites around USAG-KA, but not of the potentially impacted sites (NMFS 2014a). However, since that report was issued, our divers made surveys in the potentially affected areas. No adult or juvenile humphead wrasse were observed in either area, and neither were the deep branching corals, bushy algae, or sea grass beds that are typical juvenile humphead wrasse shelter habitat (Kolinski pers. comm. 2015). The adults that were observed at Illeginni in the previous surveys were in seaward reef habitats at depths exceeding 15 ft (5 m) (NMFS 2014a). Therefore, we believe that it is discountable that juvenile humphead wrasse are in the Illeginni action area, and that at most, any adults present in the action area during a land impact may experience temporary behavioral disturbance in the form of slight changes in swimming direction or speed, feeding, or socializing, that would have no measurable effect on the animal's fitness, and would return to normal within moments of the exposure. Therefore, the exposure is expected to have insignificant effects.

Non-larval Fish, Corals, and Mollusks near Illeginni Islet. Non-larval forms of 19 coral species, three fish species, and three mollusk species have the potential to occur on the reefs and waters in the vicinity of Illeginni Islet. These forms include the relevant coral and mollusk species and adults and juveniles of the relevant fish species. Although coral reefs are not planned or expected to be targeted, a land payload impact on the shoreline of Illeginni could result in ejecta/debris fall, shock waves, and post-test cleanup operations, which may affect and will likely adversely affect at least some of the consultation fish, coral and mollusk species on the adjacent reef. The analysis of these potential affects are analyzed below in section 6.

<u>c. Exposure to hazardous materials</u>: For all of the species considered in this consultation, exposure to action-related hazardous materials is expected to have insignificant effects. During over-ocean flight, any substances of which the launch vehicle is constructed or that are contained on the launch vehicle and are not consumed during FE-1 flight or spent motor jettison will fall into the BOA when first-, second-, and third-stage launch vehicle motors and nose fairing are

released. The launch vehicle includes rocket motors, solid rocket propellant, magnesium thorium in the booster interstage, asbestos in the second stage, battery electrolytes (lithium-ion and silver-zinc), radio frequency transmitters, and small electro-explosive devices. Though the batteries carried onboard the rocket motors would be discharged by the time they splash down in the ocean, they would still contain small quantities of electrolyte material. The amount of other toxic substances, such as battery acid, hydraulic fluids, explosive residues and heavy metals is small (SSP 2017). The affected areas would be very small locations within the drop zones, and the hazardous materials within the missile component debris would sink quickly to the seafloor at depths of multiple thousands of feet; well away from protected marine species. Materials leaked at the surface and in the water column as the debris sinks would be quickly diluted by the enormous relative volume of sea water, aided by the debris' movement through the water column and by ocean currents, thus never accumulating to levels expected to elicit a detectable response should a protected species be exposed to the material in the upper reaches of the water column. On the seafloor, the materials would leak or leach into the water and be rapidly diluted by ocean currents, or leach into bottom sediments. However, it is discountable that any of the consultation species would encounter the diluted materials near the seafloor, or in the bottom sediments.

Pre-test preparatory and post-test cleanup activities may involve heavy equipment and ocean-going vessels, which have the potential to introduce fuels, hydraulic fluids, and battery acids to terrestrial habitats as well as marine habitats. Any accidental spills from support equipment operations would be contained and quickly cleaned up. All waste materials would be transported to Kwajalein Islet for proper disposal in the US.

With the payload impact on Illeginni, debris including hazardous materials would fall on Illeginni and possibly into nearshore habitats. The payload carries up to 1,000 lbs of tungsten alloy which will enter the terrestrial and possible marine environments upon impact. The payload structure itself contains heavy metals including aluminum, titanium, steel, magnesium, tungsten, and other alloys. Debris and ejecta from a land impact would be expected to fall within 91 m (300 ft) of the impact point. Post-flight cleanup of the impact area will include recovery/cleanup of all visible debris including during crater backfill. Searches for debris would be attempted out to water depths of 15 to 30.5 m (50 to 100 ft) if debris enters the marine environment. Considering the quantities of hazardous materials, the planned land impact, and the dilution and mixing capabilities of the ocean and lagoon waters, we believe that any effects from chemicals will be insignificant to protected species in the area.

<u>d. Disturbance from human activities and equipment operation</u>: Many of the activities done to complete pre-flight preparations and post-flight restoration work at Kwajalein Atoll, would take place in marine waters inhabited by protected marine species covered by this consultation. Those activities may affect any of the species considered in this consultation should those species encounter or be directly impacted by ongoing activities. However, none of the planned activities would intentionally contact marine substrates or consultation species, except those activities taken to restore in-water areas that may be impacted by the payload at Illeginni Islet. Impact restoration actions that may be taken in marine waters around Illeginni Islet may adversely affect species identified in Table 1 (with the exception of the humphead wrasse for the reasons presented above), but not any of the species identified in Table 2. The sessile species in Table 2 (4 corals and black-lip pearl oyster) are not likely to occur in the area where they could be affected. Similarly, the motile species in Table 2, either do not occur in the area that may be

impacted (marine mammals and three oceanic turtles), or they are expected to temporarily leave the area with no measurable effect on their fitness (green and hawksbill turtles, manta rays, oceanic white tip sharks, bigeye thresher sharks, and scalloped hammerhead sharks). The potential effects of in-water restoration activities on the corals and top shell snails in Table 1 will be considered later in the Effects of the Action Section.

For all other operations (vessel movement, dive operations, deployment and recovery of the LIDSS rafts, etc.) the most likely reaction to exposure to the activities, would be a short-term avoidance behavior, where motile species such as marine mammals, sea turtles, and fish temporarily leave the immediate area with no measurable effect on their fitness, then return to normal behaviors within minutes of cessation of the activity. Sessile organisms such as mollusks may temporarily close their shells or adhere more tightly to the substrate, also returning to normal behaviors within minutes of cessation of the activity. Corals are not expected to have any measurable reaction to short-term non-contact activities. Planned protective measures would reduce the potential for this interaction by watching for and avoiding protected species during the execution of pre-flight preparations and post-flight restoration work. Based on the best available information, project-related disturbance may infrequently cause an insignificant level of behavioral disturbance for the species identified in Table 2**Error! Reference source not found.**, but may adversely affect the species identified in Table 1, except humphead wrasse.

e. Collision with vessels: The Proposed Action has the potential to increase ocean vessel traffic in the action area during both pre-flight preparations and post-flight activities, however it is discountable that any of the species considered in this consultation would experience a collision with a project-related vessel. As part of FE-1 flight test monitoring and data collection, sea based sensors will be deployed along the flight path on vessels in the BOA. These three vessels (Figure 1) will travel from PMRF or USAG-KA to locations along the flight path. Pre-flight activities at or near USAG-KA will include vessel traffic to and from Illeginni Islet. Prior to launch, radars will be placed on Illeginni Islet and would be transported aboard ocean going vessels. Sensor rafts will also be deployed near the impact site from a LCU vessel. Approximately four vessel round trips to Illeginni will be conducted for pre-flight and four for post-flight activities.

Post-flight, payload debris recovery and clean-up will take place at Illeginni Islet. These post-test cleanup and recovery efforts will result in increased vessel traffic to and from Illeginni Islet. Vessels will be used to transport heavy equipment (such as backhoe or grader) and personnel for manual cleanup of debris, backfilling or any craters, and instrument recovery. Deployed sensor rafts (Figure 6) will also be recovered by a LCU vessel. In the event of an unintended shallow water impact or debris entering the shallow water environments from a land impact near the shoreline, debris would be recovered. Smaller boats will transport divers, and ROVs if needed, to and from Illeginni to locate and recover this debris in waters up to approximately 30.5 m (100 ft) deep on the ocean side of Illeginni and within 152 to 305 m (500 to 1,000 ft) of the islet's shoreline on the lagoon side.

Sea turtles and cetaceans must surface to breathe air. They also rest or bask at the surface. Therefore, when at or near the surface, turtles and cetaceans are at risk of being struck by vessels or their propellers as the vessels transit. Corals could also be impacted if a vessel runs aground or drops anchors on the reef. Conversely, scalloped hammerhead sharks, bigeye thresher sharks, oceanic white tip sharks, manta rays, and humphead wrasse respire with gills and as such do not need to surface to breathe and are only infrequently near the surface. They are also agile and capable of avoiding oncoming vessels.

The conservation measures that are part of this action include requirements for vessel operators to watch for and avoid marine protected species, including adjusting their speed based on animal density and visibility conditions. Additionally, no action-related anchoring is planned and vessel operators are well trained to avoid running aground. Therefore, based on the best available information we consider the risk of collisions between project-related vessels and any of the consultation species identified in Tables 1 and 2 to be discountable.

Critical habitat: Critical habitat for the Hawaiian Monk Seal has been designated in the main Hawaiian Islands and the Northwestern Hawaiian Islands. Critical habitat was designated for this species in 1986 with revisions in 1988 and 2015 (Federal Register 80: 50925[August 21, 2015]). In the revised rule, critical habitat includes terrestrial areas used for pupping, nursing, and haul-out as well as marine habitat within 10 m (33 ft) of the seafloor out to the 200 m (656 ft) depth contour (Federal Register 80: 50925[August 21, 2015]). No Hawaiian monk seal critical habitat was designated immediately adjacent to the Pacific Missile Range Facility on Kauai, Hawaii.

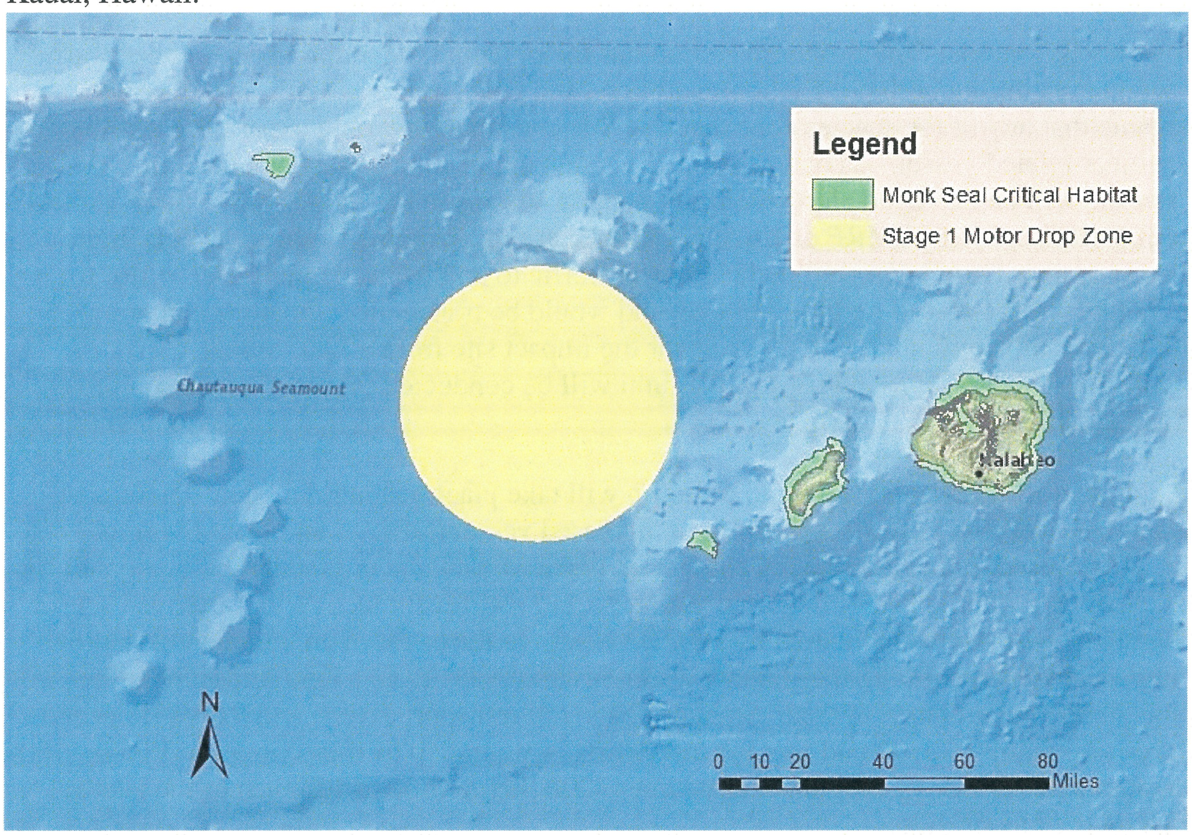

Figure 7. Representative Stage 1 Spent Motor Drop Zone and Hawaiian Monk Seal Critical Habitat.

The flight path of the FE-1 flight test crosses designated critical habitat for Hawaiian monk seals in the Main Hawaiian Islands. The spent stage one motor drop zone in the BOA is the closest potential action which could affect Hawaiian monk seal critical habitat (Figure 7). The stage one potential action which could affect Hawaiian monk seal critical habitat (Figure 7). The stage one motor drop zone is at least 26 km (16 mi) from critical habitat at Kaula Island, 48 km (30 mi) from critical habitat at Niihau, and 70 km (43 mi) from critical habitat at Nihoa.

There is no designated critical habitat within the RMI. Therefore, the proposed action may affect the designated critical habitat identified above, but would have no effect on critical habitat in the RMI.

Hazardous materials within the missile, including unburnt propellant, may affect water quality in the immediate area around the splash-down of each stage of the missile. However, as described above, hazardous materials within missile debris would sink quickly to the seafloor, likely to depths of multiple thousands of feet. Any hazardous materials leaked at the surface and in the water column as the debris sinks would be quickly diluted by the enormous relative volume of sea water, aided by the debris' movement through the water column and by ocean currents. The leaching rate of unburned solid propellant in ocean water is very low. That material would sink to the deep seafloor where it would be quickly diluted by ocean currents as it slowly dissolves over years. The concentrations of hazardous material are expected to remain below levels that would elicit a detectable response in the turtles or their prey should they be exposed to the material in the water column. Therefore, based on the best available information, potential launch failures are expected to have insignificant effects on monk seal designated critical habitat.

Designated critical habitat for Hawaiian monk seals is outside the area of effect for the FE-1 flight test. The stage one motor drop zone is at least 26 km (16 mi) from critical habitat at Kaula Island, 48 km (30 mi) from critical habitat at Niihau, and 70 km (43 mi) from critical habitat at Nihoa. Therefore, it is discountable that the FE-1 flight test would affect designated critical habitat for Hawaiian monk seals.

Considering the information presented above, and in the best scientific information available about the biology and expected behaviors of the marine species considered in this consultation, we agree that exposure to the proposed action would have insignificant effects, or the likelihood of exposure would be discountable for the consultation species identified in Table 2 and the humphead wrasse. Further, we have determined that the proposed action would have discountable or insignificant effects on designated critical habitat for the Hawaiian monk seal.

Therefore, we concur with your determination that conducting the proposed FE-1 flight test is NLAA the consultation species identified in Table 2, and would have no effect on designated critical habitat in the RMI. We have also determined that the proposed FE-1 flight test is NLAA humphead wrasse, and ESA-designated critical habitat. Those species and critical habitat will not be considered further in this consultation.

5 Status of the Species

This section presents biological or ecological information for the UES consultation species that the proposed action is likely to adversely affect. As stated above in Section 1, USASMDC/ARSTRAT determined that the proposed action was likely to adversely affect the 19 marine UES consultation species listed in Table 1. However, as described above in Section 3, along with the species identified in Table 2, we have determined that the proposed action is not likely to adversely affect humphead wrasse. Therefore, the humphead wrasse and the species listed in Table 2 will be not be considered further in this consultation,

As described above in the introduction, the jeopardy analyses in this Opinion considers the risk of reducing appreciably the likelihood of survival and recovery of UES-protected marine species within USAG-KA. As such, subsections 4.1 through 4.18 provide species-specific descriptions of distribution and abundance, life history characteristics (especially those affecting vulnerability to the proposed action), threats to the species, and other relevant information as they pertain to these animals within USAG-KA. Factors affecting these species within the action area are described in more detail in the Environmental Baseline (Section 5).

5.1 *Acanthastrea brevis* (Coral)

A. brevis is broadly distributed across the Indo-Pacific region, occurring in 46 of 133 ecoregions defined by Veron (2014). As a candidate species for listing under the ESA, *A. brevis* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.1.1 Distribution and Abundance

The reported range of *A. brevis* is from the Red Sea and eastern Africa to Madagascar, through the Indo-Pacific region, and eastward to the central Pacific Ocean out to American Samoa. It ranges as far north as Luzon Island in the Philippines and the Northern Mariana Islands, to the south down to New Guinea and possibly Northern Australia. *A. brevis* is reported as uncommon (Veron 2014). Within the area potentially impacted at Illeginni, *A. brevis* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies per square meter (colonies/m^2). It has been observed at Illeginni, five other of the 11 USAG-KA islands, and at 23 of 35 sites within the mid-atoll corridor (NMFS 2014). In a recent survey conducted at the Minuteman III impact area *A. brevis* was not observed in the study area (NMFS 2017a).

5.1.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. brevis is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed Grottoli et al. 2006).

A. brevis colonies are typically submassive clumps that are attached to hard substrate. It occurs in reef habitats, at depths down to about 66 ft (20 m). The reproductive characteristics of *A.*

brevis are undetermined, but both of its congeners that have been studied are hermaphroditic broadcast spawners; releasing gametes of both sexes (Brainard *et al.* 2011).

5.1.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures caused by anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. brevis* to these threats. However, the genus *Acanthastrea* is reported as highly susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). The susceptibility of *Acanthastrea spp.* to acidification is unknown. However, in most corals studied, acidification impairs growth, as well as impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles for some species (Anthony *et al.* 2008). The susceptibility and impacts of disease and predation on the genus *Acanthastrea* are not known. The effects of land-based toxins and nutrients on *A. brevis* are largely unknown, but may pose significant threats to this species at local scales. One of its congeners, *A. echinata* is reported to have one of the lowest sediment rejection rates of studied corals, but was able to clear most sediment within 24 hours without regard to particle size. Collection and trade are not considered threats to this genus (Brainard *et al.* 2011). As described above, *A. brevis* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.1.4 Conservation of the Species

A. brevis is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.2 *Acropora aculeus* (Coral)

A. aculeus is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. aculeus* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.2.1 Distribution and Abundance

The reported range of *A. aculeus* is from the entire east coast of Africa and Madagascar, across the Indian Ocean, through Indonesia and French Polynesia to Pitcairn Island in the southeastern Pacific Ocean, and from Japan, down through the Marianas, south along the Northeastern and Northwestern coasts of Australia (Veron 2014). *A. aculeus* is reported as usually common in the central Indo-Pacific, and uncommon elsewhere (Veron 2014). Within the area potentially impacted at Illeginni, *A. aculeus* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, at three more of the 11 USAG-KA islands, and at three of 35 sites within the mid-atoll corridor (NMFS 2014). In a recent survey conducted at the Minuteman III impact area *A. aculeus* was not observed in the study area (NMFS 2017a).

5.2.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. aculeus is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover *et al.* 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed Grottoli *et al.* 2006).

A. aculeus typically forms flat-topped, clumping, or tabular corymbose colonies formed by horizontal branches. Colonies are attached to hard substrate, and are particularly abundant in shallow lagoons and protected waters, at depths from low tide down to about 66 ft (20 m). *A. aculeus* is a hermaphroditic spawner that participates in mass broadcast spawning. (Brainard *et al.* 2011).

5.2.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures caused by anthropogenic climate change. *A. aculeus* has moderately high susceptibility to thermal stress induced "bleaching" where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). Acidification experiments have demonstrated negative effects on *Acropora* calcification, productivity, and impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles (Anthony *et al.* 2008). The susceptibility and impacts of disease on *A. aculeus* are not known, but its genus is considered moderately to highly susceptible to disease. The crown of thorns seastar (*Acanthaster planci*) preferentially preys on members of the genus *Acropera*, and the dead areas of the coral are rapidly overgrown by algae. Land-based toxins and nutrients are reported to have deleterious effects on *A. aculeus* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. aculeus* is likely included in this trade (Brainard *et al.* 2011). As described above, *A. aculeus* is highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.2.4 Conservation of the Species

A. aculeus is listed in CITES Appendix II, has been retained as a consultation species under the UES.

5.3 *Acropora aspera* (Coral)

A. aspera is a broadly distributed Indo-Pacific staghorn coral. As a candidate species for listing under the ESA, *A. aculeus* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.3.1 Distribution and Abundance

A. aspera is distributed in tropical waters from central east Africa and northern Madagascar to the Arabian Gulf and Oman, across the Indian Ocean and the Indo-Pacific region, past Samoa to Jarvis Island in the east-central Pacific Ocean, and from central Japan, south along the Northeastern and Northwestern coasts of Australia (Veron 2014). *A. aspera* has been reported as sometimes common, but is classified as vulnerable and decreasing on the International Union for Conservation of Nature Red List. Within the area potentially impacted at Illeginni, *A. aspera* is estimated to be aggregated in shallow inshore habitats with aggregation areas no greater than 40 m^2, and at a density of up to 5.08 colonies/m^2. It has been observed at five of the 11 USAG-KA islands and at one of 35 sites within the mid-atoll corridor (NMFS 2014a).

5.3.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. aspera is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed Grottoli *et al.* 2006).

A. aspera is a branching coral that occurs in water depths from low-tide down to at least 33 ft (10 m). It has multiple growth forms, which are influenced by exposure to wave energy. Colonies on exposed forereefs may have short and stout branches, while colonies in deeper protected waters may develop tree-like branches. It can be found attached to hard substrate as well as loose colonies on unconsolidated sediment. *A. aspera* reproduces both sexually and asexually. It is a hermaphroditic spawner; releasing gametes of both sexes. It also reproduces through fragmentation, where broken pieces continue to grow to form new colonies (Brainard *et al.* 2011).

5.3.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures caused by anthropogenic climate change. *A. aspera* is highly susceptible to thermal stress induced "bleaching" where the coral expels its zooxanthellae and was identified as one of the most susceptible species on the Great Barrier Reef (Done *et al.* 2003). The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). Increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates. It can increase the susceptibility to thermal stress, and tends to decrease growth and calcification rates (Anthony *et al.* 2008). The susceptibility and impacts of disease on *A. aspera* are not known, but its genus is considered moderately susceptible to disease. The crown of thorns seastar (*Acanthaster planci*) preferentially preys on *A. aspera*, and the dead areas of the coral are rapidly overgrown by algae (Sonoda and Paul 1993). Land-based toxins and nutrients are reported to have deleterious effects on *A. aspera* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. aspera* is likely included in this trade (Brainard *et al.* 2011). As described above, *A. aspera* is highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.3.4 Conservation of the Species

A. aspera is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.4 *Acropora dendrum (Coral)*

A. dendrum is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. dendrum* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.4.1 Distribution and Abundance

The reported range of *A. dendrum* is from the southern tip of Sri Lanka, through the Indo-Pacific region, and eastward to the Tuamotus in the southeastern Pacific Ocean. It ranges as far north as central Japan, to the south through the Philippine Islands, down across the northern coast of Australia to the Coral Sea. *A. dendrum* is reported as uncommon to rare (Veron 2014). Within the area potentially impacted at Illeginni, *A. dendrum* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, at six more of the 11 USAG-KA islands, and at five of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *A. dendrum* was not observed in the study area (NMFS 2017a).

5.4.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. dendrum is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed Grottoli et al. 2006).

A. dendrum colonies are typically corymbose plates that are attached to hard substrate, with widely-spaced tapering branches. It occurs in upper reef slope environments at depths down between 16 and 66 ft (5 to 20 m). *A. dendrum* is a hermaphroditic spawner; releasing gametes of both sexes. It also reproduces through fragmentation, where broken pieces continue to grow to form new colonies (Brainard *et al.* 2011).

5.4.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. dendrum* to these threats. However, the genus *Acropora* is ranked as one of the most severely susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). Acidification experiments have demonstrated negative effects on *Acropora* calcification, productivity, and impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles (Anthony *et al.* 2008). The susceptibility and impacts of disease on *A. dendrum* are not known, but its genus is considered moderate to highly susceptible to disease. The crown of thorns seastar (*Acanthaster planci*) and corallivorous snails preferentially prey on *Acropora spp.*, and the dead areas of the coral are rapidly overgrown by algae. Land-based toxins and nutrients are reported to have deleterious effects on *Acropora spp.* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. dendrum* is likely included in this trade (Brainard *et al.* 2011). As described above, *A. dendrum* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.4.4 Conservation of the Species

A. dendrum is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.5 *Acropora listeri* (Coral)

A. listeri is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. listeri* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.5.1 Distribution and Abundance

The reported range of *A. listeri* is from the Red Sea, central east Africa and northern Madagascar, Diego Garcia, and southern Sri Lanka in the Indian Ocean, through the central Indo-Pacific region, past Samoa and eastward to the Tuamotus in the southeastern Pacific Ocean. It ranges as far north as central Japan, to the south through the Philippines, down across the northern coast of Australia to the Coral Sea. *A. listeri* is reported as uncommon (Veron 2014). Within the area potentially impacted at Illeginni, *A. listeri* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at four of the 11 USAG-KA islands and at two of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *A. listeri* was not observed in the study area (NMFS 2017a).

5.5.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. listeri is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed (Grottoli et al. 2006).

A. listeri colonies are typically clumps or corymbose plates that are attached to hard substrate, with thick branches of irregular length. It occurs in highly active shallow subtidal reef environments at depths down to about 49 ft (15 m). *A. listeri* is a hermaphroditic spawner; releasing gametes of both sexes. It also reproduces through fragmentation, where broken pieces continue to grow to form new colonies (Brainard *et al.* 2011).

5.5.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. listeri* to these threats. However, the genus *Acropora* is ranked as one of the most severely susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). Acidification experiments have demonstrated negative effects on *Acropora* calcification, productivity, and impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles (Anthony *et al.* 2008). The susceptibility and impacts of disease on *A. listeri* are not known, but its genus is considered moderate to highly susceptible to disease. The crown of thorns seastar (*Acanthaster planci*) and corallivorous snails preferentially prey on *Acropora spp.*, and the dead areas of the coral are rapidly overgrown by algae. Land-based toxins and nutrients are reported to have deleterious effects on *Acropora spp.* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. listeri* is likely included in this trade (Brainard *et al.* 2011). As described above, *A. listeri* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.5.4 Conservation of the Species

A. listeri is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.6 *Acropora microclados* (Coral)

A. microclados is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. microclados* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.6.1 Distribution and Abundance

The reported range of *A. microclados* is from the Red Sea and northern Madagascar, the Chagos Archipelago in the central Indian Ocean, through the Indo-Pacific region, and eastward to the central Pacific Ocean out to Pitcairn Island. It ranges as far north as the Ryukyu Islands of Japan, and to the south down along the eastern and western coasts of Australia. *A. microclados* is reported as uncommon to common (Veron 2014). Within the area potentially impacted at Illeginni, *A. microclados* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, all of the other USAG-KA islands, and at 34 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *A. microclados* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.6.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. microclados is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. Scleractinian corals act as plants during the day and as animals at night, or in some combination of the two. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. Corals also feed by consuming prey that is captured by the nematocysts (Brainard *et al.* 2011).

A. microclados colonies are typically corymbose plates that are attached to hard substrate, with short, uniform, evenly spaced tapered branchlets. It occurs on upper reef slopes and subtidal reef edges at depths of 16 to 66 ft (5 to 20 m). Like other corals, *A. microclados* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. *A. microclados* is a hermaphroditic spawner; releasing gametes of both sexes. It also reproduces through fragmentation, where broken pieces continue to grow to form new colonies (Brainard *et al.* 2011).

5.6.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is a potential effect of anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. microclados* to these threats. However, the genus *Acropora* is ranked as one of the more susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). Acidification experiments have demonstrated negative effects on *Acropora* calcification, productivity, and impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles (Brainard *et al.* 2011). The susceptibility and impacts of disease on *A. microclados* are not well understood, but subacute dark spots disease has been reported in this species, and its genus is considered moderate to highly susceptible to disease. The crown of thorns seastar (*Acanthaster planci*) and corallivorous snails preferentially prey on *Acropora spp.*, and the dead areas of the coral are rapidly overgrown by algae. Land-based toxins and nutrients are reported to have deleterious effects on *Acropora spp.* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. microclados* is likely included in this trade (Brainard *et al.* 2011). As described above, *A. microclados* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects on a global level.

5.6.4 Conservation of the Species

A. microclados is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.7 Acropora polystoma (Coral)

A. polystoma is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. polystoma* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.7.1 Distribution and Abundance

The reported range of *A. polystoma* is from the Red Sea to central Africa and Madagascar, and the Chagos Archipelago in the central Indian Ocean, through the Indo-Pacific region, eastward to the Tuamotus in the southeastern Pacific Ocean. It ranges as far north as the south of Taiwan, through the South China Sea and the Philippines, and to the south down along the northern coast of Australia and the Coral Sea. *A. ploystoma* is reported as uncommon to common (Veron 2014). Within the area potentially impacted at Illeginni, *A. ploystoma* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, all of the other USAG-KA islands, and at 34 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *A. polystoma* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.7.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. polystoma is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed Grottoli et al. 2006).

A. polystoma colonies are typically clumps or corymbose plates that are attached to hard substrate, with tapered branches of similar length. It occurs in highly active intertidal to shallow subtidal reef tops and edges with strong wave action and/or high currents, at depths down to about 33 ft (10 m). *A. polystoma* is a hermaphroditic spawner; releasing gametes of both sexes. It also reproduces through fragmentation, where broken pieces continue to grow to form new colonies (Brainard *et al.* 2011).

5.7.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. polystoma* to these threats. However, the genus *Acropora* is ranked as one of the most severely susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). Acidification experiments have demonstrated negative effects on *Acropora* calcification, productivity, and impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles (Anthony *et al.* 2008). The genus *Acropora* is considered moderate to highly susceptible to disease, and *A. polystoma* has been reported to experience severe white-band/white plague disease. The crown of thorns seastar (*Acanthaster planci*) and corallivorous snails preferentially prey on *Acropora spp.*, and the dead areas of the coral are rapidly overgrown by algae. Land-based toxins and nutrients are reported to have deleterious effects on *Acropora spp.* depending on the substance, concentration, and duration of exposure. The genus *Acropora* has been heavily involved in international trade, and *A. polystoma* is likely included in this trade (Brainard *et al.* 2011). As described above, *A. polystoma* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.7.4 Conservation of the Species

A. polystoma is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.8 Alveopora verrilliana (Coral)

A. verrilliana is broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *A. verrilliana* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.8.1 Distribution and Abundance

The reported range of *A. verrilliana* is from the eastern Madagascar and Diego Garcia in the Indian Ocean, through the Indo-Pacific region, and eastward to the Tuamotus and French Polynesia in the southeastern Pacific Ocean. It ranges as far north as the Ryuku Islands of Japan, down to the south, about midway along the east and west coasts of Australia. *A. verrilliana* is reported as rare to uncommon (Veron 2014). Within the area potentially impacted at Illeginni, *A. verrilliana* is estimated to occur in small aggregations on submerged hard pavement reef areas, at a density of up to 0.16 colonies/m^2. It has been observed at Illeginni, at three more of the 11 USAG-KA islands, and at 10 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *A. verrilliana* was not observed in the study area (NMFS 2017a).

5.8.2 Life History Characteristics Affecting Vulnerability to Proposed Action

A. verrilliana is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed (Grottoli et al. 2006).

A. verrilliana colonies are attached to hard substrate and typically composed of clumps of short irregularly divided knob-like branches with corallites that have palisades of conspicuous vertical spines. It is typically reported in shallow reef habitats, at depths down to about 10 to 131 ft (3 to 40 m), but has also been reported on steep slopes at 66 to 262 ft (20 to 80 m) in the Red Sea. *A. verrilliana* is a hermaphroditic broadcast spawner; releasing gametes of both sexes (Brainard *et al.* 2011).

5.8.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. Little specific information is available to describe the susceptibility of *A. verrilliana* to these threats. However, the genus *Alveopora* is reported as highly susceptible to bleaching, where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). The susceptibility of the genus *Alveopora* to acidification is unknown. However, in most corals studied, acidification impaired growth, as well as impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles for some species (Anthony *et al.* 2008). The susceptibility and impacts of disease and predation on the genus *Alveopora* are not known. The effects of land-based toxins and nutrients on the genus *Alveopora* are largely unknown, but may pose significant threats to this species at local scales. Collection and trade are not considered threats to this genus (Brainard *et al.* 2011). As described above, *A. verrilliana* is likely highly susceptible to effects attributed to anthropogenic climate change, and is likely being adversely affected by those effects across its range.

5.8.4 Conservation of the Species

A. verrilliana is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.9 *Cyphastrea agassizi* (Coral)

C. agassizi is found primarily in the Indo-Pacific. As a candidate species for listing under the ESA, *C. agassizi* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.9.1 Distribution and Abundance

The reported range of *C. agassizi* is from Indonesia to the Hawaiian Islands in the central Pacific Ocean, and from southern Japan and the Northern Mariana Islands, south to Northeastern Australia. *C. agassizi* is reported as uncommon (Veron 2014). Within the area potentially impacted at Illeginni, *C. agassizi* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, at six more of the 11 USAG-KA islands, and at 14 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *C. agassizi* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.9.2 Life History Characteristics Affecting Vulnerability to Proposed Action

C. agassizi is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. Scleractinian corals act as plants during the day and as animals at night, or in some combination of the two. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. Corals also feed by consuming prey that is captured by the nematocysts (Brainard *et al.* 2011).

C. agassizi typically forms deeply grooved massive colonies attached to hard substrate. It occurs in shallow reef environments of back- and fore-slopes, lagoons and outer reef channels at depths of about 7 to 66 ft (2 to 20 m). Like other corals, *C. agassizi* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. The reproductive characteristics of *C. agassizi* are undetermined, but its congeners include a mix of hermaphroditic spawners and brooders (Brainard *et al.* 2011).

5.9.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is a potential effect of anthropogenic climate change. *Cyphastrea* are considered generally resistant to bleaching, but elevated temperatures may still cause mortality within this genus (Brainard *et al.* 2011). The effects of increased ocean acidity are unknown for this genus, but in general, increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for many corals. It also can induce bleaching more so than thermal stress, and tends to decrease growth and calcification rates. The specific susceptibility and impacts of disease on *C. agassizi* are not known, but some of its congeners have been infected with various "band" diseases. As such, it appears that *C. agassizi* is susceptible (Brainard *et al.* 2011). The susceptibility of *C. agassizi* to predation is unknown. The effects of land-based pollution on *C. agassizi* are largely unknown, but it may pose significant threats at local scales. This coral light to moderately exploited in trade at the genus level (Brainard *et al.* 2011). As described above, the genus *Cyphastrea* is considered generally resistant to bleaching, but mortality due to elevated temperatures, which may be attributable to anthropogenic climate change, may still occur. As such, this species may be currently adversely affected by those effects on a global level.

5.9.4 Conservation of the Species

C. agassizi is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.10 *Heliopora coerulea* (Coral)

H. coerulea is a very broadly distributed Indo-Pacific coral. It is considered the oldest living coral species. *H. coerulea* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.10.1 Distribution and Abundance

The reported range of *H. coerulea* is from southern east Africa to the Red Sea, across the Indian Ocean to American Samoa in central Pacific Ocean, and from Japan, south to Australia (Brainard *et al.* 2011). Colonies of *H. coerulea* are often patchy in their distribution, but can dominate large areas. Within the area potentially impacted at Illeginni, *H. coerulea* is estimated to be scattered across submerged hard pavement reef areas, including intertidal and/or inshore rocky areas, at a density of up to 0.53 colonies/m^2. It has been observed at Illeginni, at all of the other USAG-KA islands, and at 32 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *H. coerulea* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.10.2 Life History Characteristics Affecting Vulnerability to Proposed Action

H. coerulea is a non-scleractinian stony coral. Stony corals are sessile, colonial, marine invertebrates. Unlike the calcium carbonate skeleton of scleractinian corals, the skeleton of *H. coerulea* consists of aragonite, and it is blue instead of white. As with scleractinian corals, the individual unit of a coral colony is called a polyp, which is typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense, but instead of living in "cups on the surface of the coral, *H. coerulea* polyps live in tubes within the skeleton. Each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue called the coenenchyme. As with other corals, *H. coerulea* acts as a plant during the day and as an animal at night, or in some combination of the two. The soft tissue harbors mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. Corals also feed by consuming prey that is captured by the nematocysts (Brainard *et al.* 2011).

H. coerulea is a massive coral that typically forms castellate blades. It occurs in water depths from the intertidal zone down to about 197 ft (60 m). It is most abundant from the shallow reef crest down to forereef slopes at 33 ft (10 m), but is still common down to 60 ft (20 m). Like other corals, *H. coerulea* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. *H. coerulea* colonies have separate sexes. Fertilization and early development of eggs begins internally, but the planula larvae are brooded externally under the polyp tentacles. Larvae are considered benthic, as they normally distribute themselves by crawling away vice drifting in the plankton (Brainard *et al.* 2011).

5.10.3 Threats to the Species

Brainard *et al.* (2011) suggest that *H. coerulea* is a hardy species. They report that it is one of the most resistant corals to the effects of thermal stress and bleaching, and although there is no specific research to address the effects of acidification on this species, it seems to have survived the rapid acidification of the oceans during the Paleocene-Eocene Thermal Maximum acidification. They also report that disease does not appear to pose a substantial threat, and that adult colonies are avoided by most predators of coral. However, the externally brooded larvae are heavily preyed upon by several species of butterflyfish. Although *H. coerulea* tends to prefer clear water with low rates of sedimentation, Brainard *et al.* (2011) report that sediment appears to pose no significant threat to the species. Land-based sources of pollution may pose significant threats at local scales. Collection and trade appear to be the biggest threat to this species. *H. coerulea* has been reported as one of the top 10 species involved in international trade. Its morphology and natural color make it highly desirable (Brainard *et al.* 2011). As described above, *H. coerulea* does not appear to be particularly susceptible to effects attributed to anthropogenic climate change, but it is likely being adversely affected by international trade.

5.10.4 Conservation of the Species

H. coerulea is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.11 *Leptoseris incrustans* (Coral)

L. incrustans is broadly distributed across the Indo-Pacific region. *L. incrustans* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.11.1 Distribution and Abundance

The reported range of *L. incrustans* includes the western Red Sea, central east Africa and Madagascar, and Diego Garcia in the central Indian Ocean; the Indo-Pacific region from the Ryukyu Islands, through the Philippines and Indonesia, to the northern coast of Australia; and eastward around New Guinea to most of the central Pacific, to include the Marianas, Hawaii, French Polynesia to Pitcairn's Island, Samoa, and most of the islands between. *L. incrustans* has been reported as uncommon (Veron 2014). Within the area potentially impacted at Illeginni, *L. incrustans* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at six of the 11 USAG-KA islands, and at 25 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *L. incrustans* was not observed in the study area (NMFS 2017a).

5.11.2 Life History Characteristics Affecting Vulnerability to Proposed Action

L. incrustans is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. Scleractinian corals act as plants during the day and as animals at night, or in some combination of the two. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. Corals also feed by consuming prey that is captured by the nematocysts (Brainard *et al.* 2011).

L. incrustans typically forms encrusting colonies attached to hard substrate. It occurs in shallow reef environments at depths of about 7 to 66 ft (2 to 20 m), as well as in the mesophotic zone between 160 and 260 ft (50 and 80 m). Like other corals, *L. incrustans* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. The reproductive characteristics of *L. incrustans* are undetermined, but one of its congeners is gonochoric (separate sexes) (Brainard *et al.* 2011).

5.11.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is a potential effect of anthropogenic climate change. The genus *Leptoseris* is listed as having no bleaching response (Brainard *et al.* 2011). The effects of increased ocean acidity are unknown for this genus, but in general, increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for many corals, and it tends to decrease growth and calcification rates. The susceptibility and impacts of disease and predation on *L. incrustans* are not known. The effects of land-based pollution on the genus *Leptoseris* are largely unknown, but it may pose significant threats at local scales. Collection and trade are not considered a significant threat to this species (Brainard *et al.* 2011). Although this genus is considered resistant to bleaching, anthropogenic climate change may still adversely affect *L. incrustans* on a global level.

5.11.4 Conservation of the Species

L. incrustans is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.12 *Montipora caliculata* (Coral)

M. caliculata is broadly distributed across the Indo-Pacific region. It became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.12.1 Distribution and Abundance

The reported range of *M. caliculata* includes the eastern Red Sea, central east Africa and Madagascar, and Diego Garcia in the central Indian Ocean; the Indo-Pacific region from the Ryukyu Islands, through the Philippines and Indonesia, to the north and northeastern coasts of Australia; and eastward around New Guinea to most of the central Pacific, to include the Marianas, the Marshalls, Samoa, French Polynesia and Pitcairn Island, and most of the islands between. *M. caliculata* has been reported as uncommon to common (Veron 2014). Within the area potentially impacted at Illeginni, *M. caliculata* is estimated to be scattered across submerged hard pavement reef areas, including intertidal and/or inshore rocky areas, at a density of up to 0.14 colonies/m^2. It has been observed at Illeginni, at all but one of the other USAG-KA islands, and at 31 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *M. caliculata* was not observed in the study area (NMFS 2017a).

5.12.2 Life History Characteristics Affecting Vulnerability to Proposed Action

M. caliculata is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed (Grottoli et al. 2006).

M. caliculata typically forms massive colonies attached to hard substrate. It occurs in most shallow reef environments at depths down to about 66 ft (20 m). The reproductive characteristics of *M. caliculata* are undetermined, but of the 35 of its congeners that have been studied, all are hermaphroditic broadcast spawners (Brainard *et al.* 2011).

5.12.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. The genus *Montipora* is considered to have a relatively high bleaching response to thermal stress, but *M. caliculata* is considered to have a moderate response (Brainard *et al.* 2011). The effects of increased ocean acidity are unknown for *M. caliculata*. However, a congener demonstrated a significant reduction in growth rate during experimental exposure to anticipated acidification levels. In general, increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for many corals, and it tends to decrease growth and calcification rates (Anthony *et al.* 2008). The specific susceptibility and impacts of disease and predation on *M. caliculata* are not known, but the genus *Montipora* is considered moderately susceptible to diseases such as black band disease and white syndrome, and the genus is a preferred prey of the crown of thorns seastar (*Acanthaster planci*). The effects of land-based pollution on *M. caliculata* are largely unknown, but the genus is considered "sediment intolerant" with substantial variation in sediment intolerance among species. Land-based pollution may pose significant threats at local scales. The genus *Montipora* is also heavily exploited in the international aquarium trade (Brainard *et al.* 2011). As described above, the genus *Montipora* is susceptible to effects of thermal stress, which may be attributable to anthropogenic climate change. As such, this species is likely being adversely affected by those effects across its range.

5.12.4 Conservation of the Species

M. caliculata is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.13 *Pavona venosa* (Coral)

P. venosa is a broadly distributed Indo-Pacific. It became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.13.1 Distribution and Abundance

The reported range of *P. venosa* extends down the eastern shore of the Saudi Arabian, into the Red Sea, down to central Africa and Madagascar, across the Indian Ocean to include the Chagos Archipelago and Sri Lanka, through the Indo-Pacific region, eastward to the Tuamotus in the southeastern Pacific Ocean. It ranges as far north as the Ryukyu Islands, through the South China Sea and the Philippines, and to the south down along the east and west coasts of Australia and the Coral Sea. *P. venosa* has been reported as common. Within the area potentially impacted at Illeginni, *P. venosa* is estimated to be scattered across submerged hard pavement reef areas, mostly below the intertidal zone and very shallow water habitats, at a density of up to 0.08 colonies/m^2. It has been observed at Illeginni, all of the other USAG-KA islands, and at 16 of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *P. venosa* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.13.2 Life History Characteristics Affecting Vulnerability to Proposed Action

P. venosa is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed (Grottoli et al. 2006).

P. venosa typically forms massive to encrusting colonies attached to hard substrate. It occurs in shallow reef environments at depths of about 7 to 66 ft (2 to 20 m). The reproductive characteristics of *P. venosa* are unknown, but six of its congeners are gonochoric (separate sexes) spawners; releasing gametes of both sexes that become fertilized in the water (Brainard *et al.* 2011).

5.13.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. *P. venosa* has moderate to high susceptibility to thermal stress induced "bleaching" where the coral expels its zooxanthellae. The physiological stress and reduced nutrition from bleaching are likely to have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). In general, increased ocean acidity is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for many corals. It can increase the susceptibility to thermal stress, and tends to decrease growth and calcification rates (Anthony *et al.* 2008). No studies have examined the direct impacts of ocean acidification on *P. venosa*, but some evidence suggests that the genus *Pavona* has some degree of tolerance to acidification (Brainard *et al.* 2011). The specific susceptibility and impacts of disease on *P. venosa* are not known, but susceptibility is considered to be low (Brainard *et al.* 2011). There are a medium number of reports of acuter white disease for the genus *Pavona*. The susceptibility of *P. venosa* to predation is considered to be low, but there is no specific information. Members of the genus *Pavona* have varied susceptibility to predation by the crown of thorns seastar (*Acanthaster planci*). There is no specific information about the effects of land-based pollution on *P. venosa*, but it may pose significant threats at local scales. International trade includes the genus *Pavona*, but at relatively low levels (Brainard *et al.* 2011). As described above, *P. venosa* is susceptible to effects of thermal stress, which may be attributable to anthropogenic climate change. As such, this species is likely being adversely affected by those effects across its range.

5.13.4 Conservation of the Species

P. venosa is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.14 *Turbinaria reniformis* (Coral)

T. reniformis is very broadly distributed across the Indo-Pacific region. *T. reniformis* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.14.1 Distribution and Abundance

The reported range of *T. reniformis* includes the Persian Gulf, the Red Sea, and most of the Indian Ocean basin, through the Indo-Pacific region, and eastward to the central Pacific Ocean out to Samoa and the Cook Islands. It ranges as far north as central Japan, down through the Philippines, around New Guinea, and down along the east and west coasts of Australia, and also down the Marianas, the Marshalls, and east to the Line Islands. It has been reported as common (Veron 2014). Within the area potentially impacted at Illeginni, *T. reniformis* is estimated to occur in small aggregations on submerged hard pavement reef areas, at a density of up to 0.16 colonies/m^2. It has been observed at Illeginni, at five more of the 11 USAG-KA islands, and at nine of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *T. reniformis* was observed in the study area and the density estimates are slightly less than what was predicted (NMFS 2017a).

5.14.2 Life History Characteristics Affecting Vulnerability to Proposed Action

T. reniformis is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. Scleractinian corals act as plants during the day and as animals at night, or in some combination of the two. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. Corals also feed by consuming prey that is captured by the nematocysts (Brainard *et al.* 2011).

T. reniformis colonies are attached to hard substrate and typically form large lettuce-like assemblages of plates. The plates tend to be very convoluted in shallow active water, whereas they are broad and flat in deeper calmer waters. It has been reported from the surface down to over 130 ft (0 to 40 m), commonly on forereef slopes at 33 ft (10 m) and deeper, but it prefers turbid shallow protected waters where it forms massive and extensive stands. Like other corals, *T. reniformis* feeds on tiny free-floating prey that is captured by the tentacles of the individual coral polyps that comprise the colony. *T. reniformis* is a gonochoric (separate sexes) spawner; releasing gametes of one sex or the other that become fertilized in the water (Brainard *et al.* 2011).

5.14.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is a potential effect of anthropogenic climate change. Susceptibility of *Turbinaria spp.* to thermal stress induced bleaching (where the coral expels its zooxanthellae) varies regionally, and among species, but ranges between low to moderate. The physiological stress and reduced nutrition from bleaching may have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony. However, *T. reniformis* has shown the potential to reduce bleaching impacts through increased heterotrophic feeding rates (Brainard *et al.* 2011). The susceptibility of *T. reniformis* to acidification appears to be lower than that of other genera of scleractinian corals tested. However, in most corals studied, acidification impaired growth, as well as impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles for some species (Brainard *et al.* 2011). Susceptibility and impacts of disease on *T. reniformis* are not known, but both white syndrome disease and black lesions have affected members of this genus. Adult colonies of *Turbinaria spp.* are rarely eaten by the crown of thorns seastar (*Acanthaster planci*), but the gastropod nudibranch (*Phestilla sibogae*) both feeds upon, and infects *Turbinaria spp.* with disease. *T. reniformis* appears to tolerate high turbidity and sedimentation, as well as low-salinity events, but land-based toxins and nutrients may have deleterious effects on a regional scale, depending on the substance, concentration, and duration of exposure. The genus *Turbinaria* has been heavily exploited in international trade, and *T. reniformis* is likely included in this trade (Brainard *et al.* 2011). As described above, *T. reniformis* may be susceptible to some effects attributed to anthropogenic climate change, and as such could be currently adversely affected by those effects on a global level.

5.14.4 Conservation of the Species

T. reniformis is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.15 Turbinaria stellulata (Coral)

T. stellulata is very broadly distributed across the Indo-Pacific region. As a candidate species for listing under the ESA, *T. stellulata* became a consultation species under UES section 3-4.5.1 (a), and retained that status, per the wishes of the RMI Government, after we determined that listing under the ESA was not warranted.

5.15.1 Distribution and Abundance

The reported range of *T. stellulata* includes the Red Sea and most of the Indian Ocean basin, through the Indo-Pacific region, and eastward to the central Pacific Ocean out to Samoa and the Cook Islands. It ranges as far north as central Japan, down through the Philippines, around New Guinea, and down along the east and west coasts of Australia, and also down the Marianas, the Marshalls, and east to the Line Islands. It has been reported as common (Veron 2014). Within the area potentially impacted at Illeginni, *T. stellulata* is estimated to occur in small aggregations on submerged hard pavement reef areas, at a density of up to 0.16 colonies/m^2. It has been observed at Illeginni, at five more of the 11 USAG-KA islands, and at nine of 35 sites within the mid-atoll corridor (NMFS 2014a). In a recent survey conducted at the Minuteman III impact area *T. stellulata* was not observed in the study area (NMFS 2017a).

5.15.2 Life History Characteristics Affecting Vulnerability to Proposed Action

T. stellulata is a scleractinian (stony) coral. Stony corals are sessile, colonial, marine invertebrates. A living colony consists of a thin layer of live tissue over-lying an accumulated calcium carbonate skeleton. The individual unit of a coral colony is called a polyp. Polyps are typically cylindrical in shape, with a central mouth that is surrounded by numerous small tentacles armed with stinging cells (nematocysts) that are used for prey capture and defense. Individual polyps secrete a cup-like skeleton (corallite) over the skeletons of its predecessors, and each polyp is connected to adjacent polyps by a thin layer of interconnecting tissue. The soft tissue of stony corals harbor mutualistic intracellular symbiotic dinoflagellates called zooxanthellae, which are photosynthetic. The zooxanthellae allow scleractinian corals to gain most of their food through photosynthesis during the day, switching to more capture of microscopic prey with nematocysts on their tentacles at night. Corals also absorb significant amounts of microorganic compounds and free nutrients (Bythell, 1990; Grover et al. 2008). However, the dominant feeding mode varies among species and some species can shift among them as needed (Grottoli et al. 2006).

T. stellulata is typically an encrusting coral, found attached to hard substrate, but sometimes forms massive dome-shaped colonies. Its depth range is unknown, but it is generally found in clear (low turbidity) water. The reproductive characteristics of *T. stellulata* are unknown, but three of its congeners are gonochoric (separate sexes) spawners; releasing gametes of one sex or the other that become fertilized in the water (Brainard *et al.* 2011).

5.15.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, predation, pollution, and exploitation. Increased exposure to thermal stress is occurring as part of the rising ocean temperatures being caused by anthropogenic climate change. Susceptibility of *Turbinaria spp.* to thermal stress induced bleaching (where the coral expels its zooxanthellae) varies regionally, and among species, but ranges between low to moderate. The physiological stress and reduced nutrition from bleaching may have synergistic effects of lowered fecundity and increased susceptibility to disease. Bleaching can also result in mortality of the affected colony (Brainard *et al.* 2011). The susceptibility of *Turbinaria spp.* to acidification appears to be lower than that of other genera of scleractinian corals tested. However, in most corals studied, acidification impaired growth, as well as impaired fertilization, larval settlement, and zooxanthellae acquisition rates in juveniles for some species, and can induce bleaching more so than thermal stress (Anthony *et al.* 2008). Susceptibility and impacts of disease on *T. stellulata* are not known, but both white syndrome disease and black lesions have affected other members of this genus. *Turbinaria spp.* are rarely eaten by the crown of thorns seastar (*Acanthaster planci*), but the gastropod nudibranch (*Phestilla sibogae*) both feeds upon, and infects *Turbinaria spp.* with disease. *T. stellulata* appears to tolerate low-salinity events, but it is also intolerant of high-turbidity, and land-based toxins and nutrients may have deleterious effects on a regional scale, depending on the substance, concentration, and duration of exposure. Although the genus *Turbinaria* has been heavily involved in international trade, *T. stellulata* is likely less impacted by this trade due to its relatively unattractive morphology (Brainard *et al.* 2011). As described above, *T. stellulata* may be susceptible to some effects attributed to anthropogenic climate change, and as such could be currently adversely affected by those effects across its range.

5.15.4 Conservation of the Species

T. stellulata is listed in CITES Appendix II, and has been retained as a consultation species under the UES.

5.16 *Tectus niloticus* (Top Shell Snail)

The top shell snail is also sometime referred to as *Trochus niloticus*. It is a broadly distributed marine gastropod, and is a consultation species under UES section 3-4.5.1 (a).

5.16.1 Distribution and Abundance

The top shell snail is distributed in sub-tropical to tropical waters of the Indo-Pacific region. They are indigenous to Yap, Palau, and Helen Reef in Micronesia, but have been introduced to nearly every island group across the Indo-Pacific region (Smith 1987). Larvae recruit to shallow intertidal zones, typically along exposed (seaward) shores. Individuals migrate into deeper water as they grow (Heslinga *et al.* 1984) with maximum reported depth being 24 m (Smith 1987). Data are insufficient to determine current population levels and trends across its range, including in the RMI. Within the area potentially impacted at Illeginni, the top shell snail is estimated to be scattered across submerged hard pavement reef areas, including intertidal and/or inshore rocky areas, at a density of up to 0.09 individuals/m^2. It has been observed at Illeginni, at all of the other USAG-KA islands, and at 12 of 35 sites within the mid-atoll corridor (NMFS 2014a).

5.16.2 Life History Characteristics Affecting Vulnerability to Proposed Action

The top shell is a nocturnal, herbivorous, marine gastropod mollusk. It is normally found on the reef surface in the intertidal and subtidal zones. The life span is between 15 and 20 years, with sexual maturity occurring at about 2 years. It is a hardy species that is commonly relocated between island groups with high success. Dobson (2001), reports that top shell snails can survive out of the water for up to 36 hours when kept cool and damp. After being relocated on a new reef area and left undisturbed for a brief period, top shell snails typically resume normal behaviors with no measurable effects assuming the relocation site supports adequate forage and shelter.

5.16.3 Threats to the Species

The top shell is highly susceptible to over-exploitation. It is an edible species whose shells are also commercially important in the mother of pearl button industry (Heslinga *et al.* 1984). They are slow moving and are easily spotted by reef-walkers and snorkelers. Unregulated or poorly regulated harvesting has led to their depletion across their range. Although top shell snails are probably beginning to be affected by impacts associated with anthropogenic climate change (described in more detail in the Environmental Baseline section below), no significant climate change-related impacts to its populations have been observed to date.

5.16.4 Conservation of the Species

The top shell is afforded protection at USAG-KA as a consultation species under the UES (USAG-KA 2014).

5.17 *Hippopus hippopus* (giant clam)

H. hippopus is broadly distributed across the Indo-Pacific region. It is a candidate species for listing under the ESA, *H. hippopus* became a consultation species under UES section 3-4.5.1 (a).

5.17.1 Distribution and Abundance

H. hippopus are reported to be found in the eastern Indian Ocean at Myanmar and east to the Fiji and Tonga Islands, in the north as far as southern Japan and then south to the Great Barrier Reef, New Caledonia and western Australia. Within the area potentially impacted at Illeginni, *H. hippopus* was found throughout the lagoon area but was rare on the ocean side in a recent survey conducted at the impact area. It has been observed at Illeginni, and at eight more of the 11 USAG-KA islands, and at nine of 35 sites within the mid-atoll corridor (NMFS 2017b).

5.17.2 Life History Characteristics Affecting Vulnerability to Proposed Action

H. hippopus is a giant clam which is markedly stenothermal (i.e., they are able to tolerate only a small range of temperature) and thus restricted to warm waters. Giant clams are typically found living on sand or attached to coral rock and rubble by byssal threads (Soo and Todd 2014), but they can be found in a wide variety of habitats, including live coral, dead coral rubble, boulders, sandy substrates, seagrass beds, macroalgae zones, etc. (Gilbert et al. 2006; Hernawan 2010).

The exact lifespan of tridacnines has not been determined; although it is estimated to vary widely between 8 to several hundred years (Soo and Todd 2014). Little information exists on the size at maturity for giant clams, but size and age at maturity vary by species and geographical location (Ellis 1997). In general, giant clams appear to have relatively late sexual maturity, a sessile, exposed adult phase and broadcast spawning reproductive strategy, all of which can make giant clams vulnerable to depletion and exploitation (Neo *et al.* 2015). All giant clam species are classified as protandrous functional hermaphrodites, meaning they mature first as males and develop later to function as both male and female (Chambers 2007); but otherwise, giant clams follow the typical bivalve mollusk life cycle. At around 5 to 7 years of age (Kinch and Teitelbaum 2010), giant clams reproduce via broadcast spawning, in which several million sperm and eggs are released into the water column where fertilization takes place. Giant clam spawning can be seasonal; for example, in the Central Pacific, giant clams can spawn year round but are likely to have better gonad maturation around the new or full moon (Kinch and Teitelbaum 2010). In the Southern Pacific, giant clam spawning patterns are seasonal and clams are likely to spawn in spring and throughout the austral summer months (Kinch and Teitelbaum

2010). Once fertilized, the eggs hatch into free-swimming trochophore larvae for around 8 to 15 days (according to the species and location) before settling on the substrate (Soo and Todd 2014; Kinch and Teitelbaum 2010). During the pediveliger larvae stage (the stage when the larvae is able to crawl using its foot), the larvae crawl on the substrate in search of suitable sites for settlement and metamorphose into early juveniles (or spats) within 2 weeks of spawning (Soo and Todd 2014).

According to Munro (1993), giant clams are facultative planktotrophs, in that they are essentially planktotrophic (i.e., they feed on plankton) but they can acquire all of the nutrition required for maintenance from their symbiotic algae, *Symbodinium.*

5.17.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, pollution, and exploitation. The harvest of giant clams is for both subsistence purposes (e.g., giant clam adductor, gonad, muscle, and mantle tissues are all used for food products and local consumption), as well as commercial purposes for global international trade (e.g., giant clam shells are used for a number of items, including jewelry, ornaments, soap dishes). The extent of each of these threats is largely unknown. Blidberg *et al.* (2000) studied the effect of increasing water temperature on *T. gigas, T. derasa,* and *H. hippopus* at a laboratory in the Philippines. *H. hippopus* experienced increased respiration and production of oxygen in elevated temperatures and was therefore more sensitive to higher temperature than the two other species tested. After 24 hours at ambient temperature plus 3°C, however, no bleaching was observed for any of the species. The susceptibility and impacts of disease on *H hippopus* are not known, but incidences of mortality from rickettsiales-like organisms in cultured clams in the western Pacific, one in the Philippines and one in Kosrae have been documented (Norton et al. 1993).

5.17.4 Conservation of the Species

H hippopus is listed in CITES Appendix II, is an ESA candidate species and is therefore a consultation species under the UES.

5.18 *Tridacna squamosa (giant clam)*

T. squamosa is broadly distributed across the Indo-Pacific region. It is a candidate species for listing under the ESA, therefore *T. squamosa* is a consultation species under UES section 3-4.5.1 (a).

5.18.1 Distribution and Abundance

T. squamosa has a widespread distribution across the Indo-Pacific. Its range extends from the Red Sea and East African coast across the Indo-Pacific to the Pitcairn Islands. It has also been introduced in Hawaii (CITES 2004a). The species' range also extends north to southern Japan, and south to Australia and the Great Barrier Reef (bin Othman *et al.* 2010). This range description reflects the recent range extension of *T. squamosa* to French Polynesia as a result of observations by Gilbert *et al.* (2007). Within the area potentially impacted at Illeginni, *T. squamosa* was observed in the lagoon area but not on the ocean side in a recent survey conducted at the impact area. It has been observed at Illeginni, at five more of the 11 USAG-KA islands, and at 24 of 35 sites within the mid-atoll corridor (NMFS 2017b).

5.18.2 Life History Characteristics Affecting Vulnerability to Proposed Action

T. squamosa is a giant clam which are markedly stenothermal (i.e., they are able to tolerate only a small range of temperature) and thus restricted to warm waters. *T. squamosa* is usually recorded on reefs or sand; it is found attached by its byssus to the surface of coral reefs, usually in moderately protected localities such as reef moats in littoral and shallow water to a depth of 20 m (Kinch and Teitelbaum 2010). This species tends to prefer fairly sheltered lagoon environments next to high islands; however, *T. squamosa* appears to be excluded by *T. maxima* in the closed atoll lagoons of Polynesia (Munro 1992). Neo *et al.* (2009) found that *T. squamosa* larvae, like many reef invertebrates, prefer substrate with crustose coralline algae. *Tridacna squamosa* is also commonly found amongst branching corals (staghorn, *Acropora* spp.; CITES 2004a)

The exact lifespan of tridacnines has not been determined; although it is estimated to vary widely between 8 to several hundred years (Soo and Todd 2014). Little information exists on the size at maturity for giant clams, but size and age at maturity vary by species and geographical location (Ellis 1997). In general, giant clams appear to have relatively late sexual maturity, a sessile, exposed adult phase and broadcast spawning reproductive strategy, all of which can make giant clams vulnerable to depletion and exploitation (Neo *et al.* 2015). All giant clam species are classified as protandrous functional hermaphrodites, meaning they mature first as males and develop later to function as both male and female (Chambers 2007); but otherwise, giant clams follow the typical bivalve mollusk life cycle. *T. squamosa* reaches sexual maturity at sizes of 6 to 16 cm, which equates to a first year of maturity at approximately four years old (CITES 2004a). Giant clam spawning can be seasonal; for example, in the Central Pacific, giant clams can spawn year round but are likely to have better gonad maturation around the new or full moon (Kinch and Teitelbaum 2010). In the Southern Pacific, giant clam spawning patterns are seasonal and clams are likely to spawn in spring and throughout the austral summer months (Kinch and Teitelbaum 2010). Once fertilized, the eggs hatch into free-swimming trochophore larvae for around 8 to 15 days (according to the species and location) before settling on the substrate (Soo and Todd 2014; Kinch and Teitelbaum 2010). During the pediveliger larvae stage (the stage when the larvae is able to crawl using its foot), the larvae crawl on the substrate in search of suitable sites for settlement and metamorphose into early juveniles (or spats) within two weeks of spawning (Soo and Todd 2014).

According to Munro (1992), giant clams are facultative planktotrophs, in that they are essentially planktotrophic (i.e., they feed on plankton) but they can acquire all of the nutrition required for maintenance from their symbiotic algae, *Symbodinium.*

5.18.3 Threats to the Species

Current threats include: thermal stress, acidification, disease, pollution, and exploitation. The harvest of giant clams is for both subsistence purposes (e.g., giant clam adductor, gonad, muscle, and mantle tissues are all used for food products and local consumption), as well as commercial purposes for global international trade (e.g., giant clam shells are used for a number of items, including jewelry, ornaments, soap dishes). The extent of each of these threats is largely unknown. Blidberg *et al.* (2000) studied the effect of increasing water temperature on *T. gigas,* *T. derasa,* and *H. hippopus* at a laboratory in the Philippines. *H. hippopus* experienced increased respiration and production of oxygen in elevated temperatures and was therefore more sensitive to higher temperature than the two other species tested. After 24 hours at ambient temperature plus 3°C, however, no bleaching was observed for any of the species. In a lab experiment, short-term temperature increases of 3 °C resulted in *T. squamosa* maintaining a high photosynthetic rate but displaying increased respiratory demands (Elfwing *et al.* 2001). Watson *et al.* (2012) showed that a combination of increased ocean CO_2 and temperature are likely to reduce the survival of *T. squamosa*. Specifically, in a lab experiment, *T. squamosa* juvenile survival rates decreased by up to 80 percent with increasing pCO_2 and decreased with increasing seawater temperature for a range of temperatures and pCO_2 combinations that mimic those expected in the next 50 to 100 years. The susceptibility and impacts of disease on *T. squamosa* are not known, but incidences of mortality from rickettsiales-like organisms in cultured clams in the western Pacific, one in the Philippines and one in Kosrae have been documented (Norton et al. 1993).

5.18.4 Conservation of the Species

T. squamosa is listed in CITES Appendix II, is an ESA candidate species and is therefore a consultation species under the UES.

6 Environmental Baseline

The UES does not specifically describe the environmental baseline for a biological opinion. However, under the ESA, the environmental baseline includes: past and present impacts of all State, Federal, or private actions and activities in the action area; the anticipated impacts of all proposed Federal projects in the action area that have already undergone Section 7 consultation; and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The Consultation Handbook further clarifies that the environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystem, within the action area (FWS & NMFS 1998). The purpose of describing the environmental baseline in this manner within a biological opinion is to provide the context for the effects of the proposed action on the listed species. We apply the ESA standards consistent with the intent of the UES agreement in our effects analysis. As described in Sections 2 and 3 above, the action area where the proposed action may adversely affect consultation species consists of the marine waters adjacent to Illeginni Islet at Kwajalein Atoll, RMI (

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Figure 8. Illeginni Islet

The Marshall Islands consist of 29 atolls and 5 islands aligned in two roughly parallel northwest-southeast chains: the northeastern Ratak Chain and the southwestern Ralik Chain. The total land area is about 70 square miles, and the total lagoon area is about 4,500 square miles. Kwajalein Atoll is located near the center of the island group, about 8 degrees above the equator, and is one of the largest coral reef atolls in the world. The past and present impacts of human and natural factors leading to the status of UES-protected species within the action area include coastal development, armed conflict, direct take, fishing interactions, vessel strikes and groundings, marine debris, and climate change.

Kwajalein Atoll was the site of heavy fighting during World War II (1940s), when the US took it from the Japanese. Many of the islets have been heavily modified by dredge and fill construction operations by both the Japanese and US forces. More recently, the RMI has provided eleven islets around the rim of Kwajalein Atoll for the use by the US Government as part of the RTS. Hundreds of US personnel live on some of the islets, and Marshallese workers commute daily between the US occupied islets and the ones the Marshallese live on. Vessel traffic occurs regularly between the islets, and to and from the atoll. This includes fishing boats, personnel ferries, military service craft, visiting military ships, and cargo vessels that supply the peoples of Kwajalein Atoll. For more than 18 years, the USAG-KA has participated in testing hypersonic vehicles from ICBM and other flight tests launched from Vandenberg AFB and other locations. Vehicle impacts from such tests have occurred and continue to occur on and in the vicinity of Illeginni Islet and in adjacent ocean waters. In the Opinion on the Minuteman III operations through the year 2030 it was estimated that 49,645 colonies of the 15 species of UES corals and 117 top shell snails may be killed (NMFS 2015). These estimates are likely higher than what the total impacts will be due to the unlikely event of a shoreline impact and the data the estimates were based on. The estimates were based on surveys that have been conducted throughout the area but not in the impact zone. A survey was completed after these estimates were made and some of the corals that were predicted to be in the area were not observed and others were observed at densities lower than what had been estimated (NMFS 2017a). Additional surveys could show that they are indeed in the area but not at higher levels than estimated.

Direct take through harvest continues in the RMI for several of the UES consultation species. For example, sea turtles, black lip pearl oysters, and top shell snails (all of which are UES consultation species) are considered a food source or of economic value by many RMI nationals. The harvest of these and other UES-protected marine species is believed to continue on most of the inhabited islands and islets of the RMI, with the possible exception of the USAG-KA-controlled islets, where access is limited and the UES prohibits those activities. However, the level of exploitation is unknown, and no concerted research or management effort has been made to conserve these species in the RMI. No information is currently available to quantify the level of impact direct take is having on consultation species in the Marshall Islands.

Despite the development, wartime impacts, and human utilization of marine resources mentioned above, the atoll's position at the center of the Pacific Ocean is far from highly industrialized areas, and its human population remains relatively low. Consequently, the water quality level of the lagoon and the surrounding ocean is very high, and the health of the reef communities, along with the overall marine environment of Kwajalein Atoll, borders on pristine.

Climate change may be affecting marine ecosystems at Kwajalein Atoll. Climate refers to average weather conditions within a certain range of variability. The term climate change refers to distinct long-term changes in measures of climate, such as temperature, rainfall, snow, or wind patterns lasting for decades or longer. Climate change may result from: natural factors, such as changes in the Sun's energy or slow changes in the Earth's orbit around the sun; natural processes within the climate system (e.g., changes in ocean circulation); and human activities that change the atmosphere's makeup (e.g., burning fossil fuels) and the land surface (e.g., cutting down forests, planting trees, building developments in cities and suburbs, etc.), also known as anthropogenic climate change (U.S. Environmental Protection Agency). The global mean temperature has risen 0.76°C over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (Solomon *et al.* 2007). Sea level rose approximately 17 cm during the 20th century (Solomon *et al.* 2007) and further increases are expected. Climate change is a global phenomenon so resultant impacts have likely been occurring in the action area. However, scientific data describing impacts in the action area are lacking, and no climate change-related impacts on UES-protected species within the action area have been reported to date.

Climate change-induced elevated water temperatures, altered oceanic chemistry, and rising sea level may be contributing to changes to coral reef ecosystems, and is likely beginning to affect corals and mollusks found in the action area. Globally, climate change is adversely affecting many species of corals. Increasing thermal stress due to rising water temperatures has already had significant effects on most coral reefs around the world. It has been linked to widespread and accelerated bleaching and mass mortalities of corals around the world over the past 25 years (Brainard *et al.* 2011). As the atmospheric concentration of CO_2 has increased, there has been a corresponding reduction in the pH of ocean waters (acidification). As ocean acidity increases, the calcium carbonate saturation state of the water decreases. Increased ocean acidity has the potential to lower the calcium carbonate saturation state enough to slow calcification in most corals and may increase bioerosion of coral reefs. It is thought to adversely affect fertilization, larval settlement, and zooxanthellae acquisition rates for corals, and can induce bleaching more so than thermal stress, and tends to decrease growth and calcification rates (Brainard *et al.* 2011). By the middle of this century, ocean acidity could lower calcium carbonate saturation to the point where the reefs may begin to dissolve (Brainard *et al.* 2011).

Changes in ocean temperature and chemistry, and rising sea level may be affecting the black-lip pearl oyster in the action area, but no specific information is currently available to assess the impacts. Because this species depends on an exoskeleton that is comprised primarily of calcium carbonate, we expect that minimally, increased acidity could have effects that parallel those described for corals above, with the exception of impacts related to zooxanthellae.

Attempting to determine whether recent biological trends are causally related to anthropogenic climate change is complicated because non-climatic influences dominate local, short-term biological changes. However, the meta-analyses of 334 species and the global analyses of 1,570 species show highly significant, nonrandom patterns of change in accord with observed climate warming in the twentieth century. In other words, it appears that these trends are being influenced by climate change-related phenomena, rather than being explained by natural variability or other factors (Parmesan and Yohe 2003). However, the implications of these changes are not clear in terms of population level impacts, and data specific to the action area are lacking. Over the long-term, climate change-related impacts could influence the biological trajectories of UES-protected species on a century scale (Parmesan and Yohe 2003). However, due to a lack of scientific data, the specific effects climate change could have on these species in the future are not predictable or quantifiable to any degree that would allow for more detailed analysis in this consultation (Hawkes *et al.* 2009).

7 Effects of the Action

In this section of a biological opinion, we assess the probable effects of the proposed action on UES-protected species. Effects of the Action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that would be added to the environmental baseline. Direct effects are caused by exposure to the action related stressors that occur at the time of the action. Indirect effects are those that are likely to occur later in time (50 CFR 402.02). The effects of the action are considered within the context of the Status of the Species, together with the Environmental Baseline and Cumulative Effects sections of this Opinion to determine if the proposed action can be expected to have direct or indirect effects on UES-protected species that appreciably reduce their likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (50 CFR 402.02), otherwise known as the jeopardy determination. Since no critical habitat has been designated in the RMI, impacts on critical habitat are not considered in this Opinion.

Approach. We determine the effects of the action using a sequence of steps. The first step identifies potential stressors associated with the proposed action with regard to listed species. We may determine that some potential stressors result in insignificant, discountable, or beneficial effects to listed species, in which case these potential stressors are considered not likely to adversely affect protected species, and subsequently are considered no further in this Opinion. Those stressors that are expected to result in significant negative (i.e., adverse) effects to listed species are analyzed via the second, third, and fourth steps described below.

The second step identifies the magnitude of the stressors (e.g., how many individuals of a particular species would be exposed to the stressors; *exposure analysis*). In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to a proposed action's effects, and the populations or subpopulations those individuals represent.

The third step describes how the exposed individuals are likely to respond to the stressors (*response analysis*). In this step, we determine if the stressors are likely to result in any adverse effects on exposed individuals.

The final step in determining the effects of the action is to establish the risks those responses pose to listed resources (*risk analysis*). The risk analysis is different for listed species and designated critical habitat. However, as mentioned above, the action area includes no designated critical habitat, thus it is not considered in this Opinion. Our jeopardy determinations must be based on an action's effects on the continued existence of UES-protected species within USAG-KA. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (probability of extinction or probability of persistence) of listed species depends on the viability of their populations.

7.1 Stressors

As described above in Section 3, we believe that the proposed action would cause five stressors that may affect the consultation species considered in this consultation: exposure to elevated noise levels; impact by falling missile components; exposure to hazardous materials; disturbance from human activity and equipment operation; and collision with vessels. Of those stressors, impact by falling missile components, specifically for the payload that would target Illeginni Islet, is the only stressor that is likely to adversely affect consultation species. The remaining stressors are expected to have insignificant effects and/or exposure is discountable (extremely unlikely to occur), and those stressors are discussed no further in this Opinion. Similarly, Section 3 described why all of the species identified in Table 2, and the humphead wrasse from Table 1, are unlikely to be adversely affected, and therefore considered no further in this Opinion. In summary, the 15 coral species, top shell snail, and two giant clams identified in Table 1 may be hit by the falling payload or by ejecta, or be significantly affected by concussive forces during the single planned payload on Illeginni Islet.

Note: Within the 15 coral species that may be adversely affected by the proposed action, the effects are expected to be practically identical. Addressing the species individually would significantly increase the length of this Opinion with no discernible improvement in the evaluation. Therefore, all 15 corals are referred to together as "corals", unless an individual species needs to be identified due to some unique sensitivity or response. The same is true for the two clam species.

7.2 Exposure to Impact by Falling Missile Components

This section analyzes the proposed action's potential for exposing UES-consultation corals and top shell snails to being hit by the FE-I flight test payload or ejecta thereof planned to strike on Illeginni Islet. This analysis is based on the distribution and density report completed for the MM III proposed action, the follow-up survey post action, and on personal communication with the survey team (NMFS 2014b, NMFS 2017a, Kolinski Pers. Comm. 2015), and on the description of the effects of the FE-1 flight test impact (SSP 2017). We believe that the distribution and density report likely over-estimates the number of coral and mollusk species that may be within the action area at Illeginni, but that it represents the best available information to make those estimates.

The quantitative estimates of species distribution and abundance within the potentially affected areas at Illeginni are based on surveys of 136 sites around the 11 USAG-KA islets, including four sites around Illeginni (NMFS 2014b). Species observed to occur on reef flat, crest, and gently sloping substrates around USAG-KA islets at depths less than or equal to 35 feet water depth were considered as potentially being present within the MMIII impact area and hence the FE-1 impact area. Because the available survey information also includes the observed distribution and abundance of the affected consultation species in numerous habitat types around the 11 USAG-KA islets and at 35 survey sites throughout the mid-atoll corridor (MAC), we believe that the existing information also serves as a reasonable foundation to estimate the distribution and abundance of these organisms throughout USAG-KA. As previously mentioned, one survey conducted in the impact area of MMIII found some of these corals to be there in lower densities than previously estimated or not in the area in the ground they covered (NMFS 2017a). The MMIII estimates are still the best estimates at this time because these corals could still be in the area and densities may change with additional surveys but they are not expected to be any higher than what was estimated for MMIII (S. Kolinski, NMFS-PIRO, Pers. Comm., 2017).

As described above in Sections 2 and 3, there is a chance that the FE-1 flight test payload could strike the water's edge along the lagoon or ocean shore at Illeginni. Empirical observations of historical reentry vehicle impacts from MMIII tests in very shallow waters found that most debris was contained within the crater and ejecta were concentrated within 1.5 to 3 m (5 to 10 ft) of the crater rim (USAFGSC and USASMDC/ARSTRAT 2015). As with MMIII reentry vehicles, we estimate that the payload land impact may produce ejecta and debris concentrated near the impact site and extending outward to 91 m (300 ft). Empirical evidence from MMIII tests corroborates predictions of the propagation of shock waves associated with impact were approximately 37.5 m (123 ft) through the adjacent reef from the point of impact on the shoreline (USAFGSC and USASMDC/ARSTRAT 2015). The USASMDC/ARSTRAT estimates that an area equal to 15,557 yd^2 (13,008 m^2) could be affected by ejecta impact along either shore

(Figure 9**Error! Reference source not found.**). Coral, and mollusk mortality or injury could occur from impact by shock/vibration. These reef impacts were based on observations of damaged corals, which can be affected by ground borne vibration.

Habitat suitability for consultation species is lowest along the water's edge and with the exception of sandy patches, typically increases with distance from shore. Based on the professional judgement of the NMFS survey divers, up to 80% of the area potentially affected by ejecta, 12,445 yd^2 (10,406 m^2), is suitable habitat for the consultation species (Kolinski 2014 in USASMDC/ARSTRAT 2015). Similarly, approximately 9,756 m^2 (0.004 mi^2; 75%) of the ocean-side affected area is considered to be potentially viable habitat for consultation fish, coral and mollusk species (S. Kolinski, NMFS-PIRO, Pers. Comm., 2014). Since the debris fall affect area is larger than the shock wave affect area, we calculated the effects of the action based on the debris fall/ejecta area. Although the exact shape of the affected area is impossible to pre-determine, the seaward portion of such an area is conceptually illustrated as a rough semi-circle on the lagoon and ocean sides of Illeginni with a radius of 300ft (Figure 9**Error! Reference source not found.**).

Figure 9. Representative Maximum Direct Contact Affect Areas for a Shoreline Payload Impact at Illeginni Islet, Kwajalein Atoll.

It is reasonable to assume that the effects of debris fall and shock waves would not occur evenly across an entire area of potentially viable habitat. Thus, the actual habitat area that would be affected is considered to be a proportion of the total estimated viable habitat. Since there are no data available to identify this unknown proportion or the actual amount of viable habitat that would be affected by debris fall or shock waves, these analyses should be regarded as an overestimate and those of maximum effect.

The effects of ejecta impact would not occur evenly across the affected area. Chunks of ejecta would be scattered across the area; impacting a small proportion of the suitable habitat. Also, the area within the shockwave range of effect would be completely contained within the area at risk for ejecta impacts. To account for the unevenness of impact across the area, and to avoid double counting potential exposures, the USASMDC/ARSTRAT estimates that 50% of the 12,445 yd^2 (10,406 m^2) potentially affected suitable habitat would be affected by the combination of ejecta and/or shock waves would equal 6,223 yd^2 (5,203 m^2). The 99% upper confidence level of the bootstrap mean densities for the potentially affected consultation species in the area was multiplied by the areal extent of potentially affected suitable habitat to estimate the number of coral colonies and top shell snails that may be adversely affected by ejecta and/or shockwave effects by a payload land impact at Illeginni Islet (Table 9).

Table 9. Marine UES consultation species likely to be adversely affected by ejecta and/or shockwaves by payload shoreline strike.

Scientific Name	Species	Colonies or Individuals Affected
	Corals	
Acanthastrea brevis	No Common Name	416
Acropora aculeus	No Common Name	416
A. aspera	No Common Name	203
A. dendrum	No Common Name	416
A. listeri	No Common Name	416
A. microclados	No Common Name	416
A. polystoma	No Common Name	416
Alveopora verriliiiana	No Common Name	832
Cyphastrea agassizi	No Common Name	416
Heliopora coerulea	No Common Name	2,758
Leptoseris incrustans	No Common Name	416
Montipora caliculata	No Common Name	728
Pavona venosa	No Common Name	416
Turbinaria reniformis	No Common Name	832
T. stellulata	No Common Name	832
	Mollusks	
Tectus niloticus	Top Shell Snail	468
Hippopus hippopus	Giant clam	40
Tridacna squamosa	Giant clam	6

7.3 Response to Falling Missile Components

This section analyzes the responses of UES-consultation corals, top shell snails, and giant clams that may be exposed to being hit by the FE-1 payload and/or ejecta.

The FE-1 payload would be traveling at hypersonic velocity when it impacts the islet. The kinetic energy released into the substrate would be similar to the detonation of high explosives. The payload will effectively "explode", with some of its mass reduced to very fine particles ("aerosolized") and the remainder reduced to an undescribed range of fragment sizes. The substrate at the impact site would be blasted into a range of fragment sizes ranging from powder to larger rocks toward the outer edges of the crater. Some debris and substrate rubble would remain in the crater. The remainder would be thrown from the crater (ejecta). Initially, some of the ejecta would be moving at high velocity (bullet speeds). Some ejecta would move laterally, some would travel upward then fall back down close to the impact area. The resulting crater would be up to 30 ft (9 m) across and 10 ft (3 m) deep. The substrate immediately around the crater would be covered by larger chunks of ejecta from the outer edges of the crater as well as finer material that was thrown more vertically before falling back down. The movement of ejecta away from the crater would act to spread it out (scatter) over an increasing area, with decreasing available material being scattered over an increasing area. The velocity of the ejecta would also diminish with distance.

The intensity of the payload impact, and the uniformity of exposure to ejecta and the shockwave would decrease with distance from the point of impact. Any corals and top shell snails directly beneath the payload, or within the crater radius are expected to be instantly killed, with very little left of the organisms that would be recognizable. Beyond the crater, corals and top shell snails would be exposed to ejecta and the ground borne shockwave. Corals and top shell snails immediately beyond the crater would likely experience mortality from impact by high-velocity ejecta, from burial under mobilized crater material, or from exposure to the ground borne shockwave.

The response of corals to ejecta and the ground borne shockwave would depend largely on the scale and intensity of the exposure. Impact by high-velocity dense ejecta (rock or metal), could fracture the hard structure of corals and would likely injure or destroy soft tissues. Fracturing would depend largely on the size and intensity of the impact and on morphology of the impacted coral. Plate-forming and branching corals are more easily broken than large massive or encrusting forms. Fractures due to payload impact are expected to range from pulverization of colonies in and close to the crater, to cracks and/or loss of branches in colonies toward the outer edge of effect. Additionally, exposure to the ground based shockwave could also fracture or dislodge coral colonies out to about 123 ft from the payload impact. Because the coral skeletons are hard rock-like structures that are rigidly fixed to the hard substrate through which the shock wave would travel, much of the available energy in the substrate can be transferred directly into the coral's skeletal structure. If the shockwave is intense enough, the coral's structure may crack or fracture and/or it may become unattached from the substrate. At close ranges, impact by lower velocity and/or lower density ejecta could affect the soft tissues of corals, ranging from burial to scouring away all or most of the living polyps and interconnecting soft tissues from a colony. At greater ranges, localized damage of a small part of a colony is possible.

Pulverization of a colony's structure, deep burial, or loss of a large proportion of a colony's soft tissue would likely result in the mortality of the colony. Partial fracturing of a coral skeleton and/or dislodgement of a coral from the substrate due to ejecta impact or from exposure to the ground based shock wave would injure the soft tissues at and around the break. Re-growth of soft tissues has energetic costs that could slow other growth and reproduction. Exposed areas of coral skeleton are prone to bioerosion and overgrowth by algae and certain sponges. Large areas of damaged or dead tissue could result in the introduction of algae that may prevent the regeneration of healthy coral tissue, or that may overcome the whole colony. Damaged and stressed tissues may also be more susceptible to infection by coral diseases that may hinder or prevent healing to the point that the colony dies.

Fragmentation is a form of asexual reproduction in some branching corals, resulting in the development of new, but genetically identical colonies. Bothwell (1981) reports that several *Acropora* species successfully colonize through fragmentation and translocation of fragments by storm-driven waves. However, not all coral fragments, or dislodged colonies would be expected to survive. Survival would depend largely on where a fragment falls and how it is oriented after it settles to substrate. A fragment or colony is likely to die if the living tissue is on the underside of the fragment or if the fragment settles into fine sediments. Additionally, in areas that experience regular high surf, such as the ocean side reef at Illeginni, loose coral fragments and colonies could repeatedly become mobilized by the waves. This reduces the likelihood of their survival, and potentially injures additional coral colonies should the fragments be cast against them.

Based on the available information, we believe that the numbers of coral colonies, identified above in Table 9, represent a conservative yet reasonable estimate of the corals that may be adversely affected by the proposed action. Further, this Opinion conservatively assumes that mortality would result for all exposed coral colonies. This approach is being taken to ensure a precautionary assessment is made of the jeopardy risk for the affected species.

In the case of the top shell snail, the effects of exposure to ejecta and shockwave is expected to quickly diminish to insignificance with distance from the payload impact site. Impact by high-velocity dense ejecta (rock or metal) immediately around the crater could penetrate or fracture an exposed snail's shell, either killing the animal directly, or leaving it vulnerable to predation. Conversely, with movement away from the payload impact site, ejecta would become slower, and the ejecta would have to penetrate increasing water depth to impact the snails. Considering the conical shape and thickness of a top shell snail's shell, most ejecta that may strike one that is under water and at any distance from the payload impact site is likely to be deflected without imparting a significant proportion of its kinetic energy to the shell or the animal within.

Top shell snails immediately around the payload crater may also be buried by ejecta. The potential for burial, and the depth of the material under which a snail may be buried would likely decrease quickly with distance from the payload impact site. Mortality could result if the snail is crushed, smothered, or permanently pinned beneath rubble. Non-lethal effects could include energetic costs and/or foraging impacts.

Exposure to intense ground borne shockwaves could injure the soft tissues of top shell snails. Mortality of the snail is possible if the injury is significant enough. The range to the onset of significant injuries for top shell snails exposed to a ground based payload impact shockwave is unknown, but it is likely much less than that estimated for corals (123 ft). Top shell snails are not rigidly attached to the substrate as are corals. Instead, they adhere to the reef using a muscular foot. Whereas rigidly attached corals would be directly linked to the substrate such that the energy could readily travel into and along its skeletal structure, the muscular foot of the snail acts to isolate the snail's shell from the vibration, and to reduce the transfer of the energy to other soft tissues and organs. Non-lethal effects could include bruising of the foot and other tissues, which may have energetic costs and/or may have reproductive impacts.

As stated above at 6.2, habitat suitability for the consultation species is lowest along the water's edge and typically increases with distance from shore. Therefore, top shell snail density would be lowest in the area immediately adjacent to the payload impact site, where ejecta effects and shockwave would be greatest. Conversely, in the areas where top shell snail density would be highest, ejecta would be slower, and it would have to penetrate several feet of water to impact the snails. Based on this, on the robust nature of snails (see Section 3), and the characteristics of its shell, most ejecta that may strike top shell snails is likely to be deflected without imparting any significant proportion of its kinetic energy to the shell or the animal within. In this situation, ejecta impact would result in little more than inducing the affected snail to briefly adhere more tightly to the substrate before resuming normal behaviors. The range to adverse effects from burial and shockwaves would likely be similarly restricted to the area along the water's edge. Therefore, we expect that fewer than 117 (25%) of the 468 top shell snails that may be exposed to the combined effects of a payload land strike (Table 9, above), would be adversely affected by the exposure.

In the case of the clams, the effects of exposure to ejecta and shockwave is expected to quickly diminish to insignificance with distance from the payload impact site. Impact by high-velocity dense ejecta (rock or metal) immediately around the crater could penetrate or fracture an exposed clam shell, or damage soft tissue that is exposed possibly killing the animal. Conversely, with movement away from the payload impact site, ejecta would become slower, and the ejecta would have to penetrate increasing water depth to impact the clams. Considering the thickness of a clam shell, most ejecta that may strike one that is under water and at any distance from the payload impact site is likely to be deflected without imparting a significant proportion of its kinetic energy to the shell or the animal within unless it is able to lodge itself in the shell opening.

Clams immediately around the payload crater may also be buried by ejecta. The potential for burial, and the depth of the material under which a clam may be buried would likely decrease quickly with distance from the payload impact site. Mortality could result if the clam is crushed, smothered, or permanently pinned beneath rubble. Non-lethal effects could include foraging impacts if the clam is unable to filter feed due to debris.

Exposure to intense ground borne shockwaves could injure the soft tissues of clams. Mortality is possible if the injury is significant enough. The range to the onset of significant injuries for clams exposed to a ground based payload impact shockwave is unknown. Clams can be buried in substrate or attached to corals which means they would be directly linked to the substrate such that the energy could readily travel into the shell and affect the soft tissue and organs. Non-lethal effects could include bruising of the tissues, which may have energetic costs and/or may have reproductive impacts.

As stated above at 6.2, habitat suitability for the consultation species is lowest along the water's edge and typically increases with distance from shore. Therefore, clam density would be lowest in the area immediately adjacent to the payload impact site, where ejecta effects and shockwave would be greatest. Conversely, in the areas where clam density would be highest, ejecta would be slower, and it would have to penetrate several feet of water to impact the clams. Based on this, on the robust nature of clams (see Section 3), and the characteristics of its shell, most ejecta that may strike clams is likely to be deflected without imparting any significant proportion of its kinetic energy to the shell or the animal within. In this situation, ejecta impact would result in little more than inducing the affected clam to close before resuming normal behaviors. The range to adverse effects from burial and shockwaves would likely be similarly restricted to the area along the water's edge. Therefore, we expect that fewer than 12 (25%) of the 46 clams that may be exposed to the combined effects of a payload land strike (Table 9**Error! Reference source not found.**, above), would be adversely affected by the exposure.

7.4 Risk

This section analyzes the risk posed by the proposed action for populations of UES-protected marine species at USAG-KA due to exposure to direct impact and removal from the water as described above. Because this Opinion assumes mortality for all exposed individuals, regardless of the stressor, the risk assessment below focuses on the species impacts from the direct impact.

7.4.1 Risk for coral populations due to expected levels of action-related mortality

As described in the exposure analyses above, up to 9,929 colonies of 15 UES-consultation coral species (Table 9) could experience mortality from the payload strike on Illeginni Islet. This would be due to the combined exposure to direct payload impact, ejecta, and ground based shockwave. The US Navy plans just one FE-1 flight test so this represents the maximum possible impact associated with this action.

Based on the best information available, we believe that these corals are all widely distributed around the atoll, and that the potentially impacted area represents a very small fraction (not currently quantifiable) of coral-occupied habitat at Illeginni, and likely below 1% of coral-occupied habitat at USAG-KA. As described above at 6.2, we further believe that the distribution and abundance of these coral species in similar habitat areas outside of the potentially impacted zones would be similar to their estimated distribution and abundance within the impacted zones, and as such, these 9,929 colonies likely represent a tiny fraction of their species found at Illeginni and across USAG-KA. Therefore, based on the best available information, we consider the risk negligible that project-related effects from direct payload impact, ejecta, and ground based shockwave would eliminate any of these species at USAG-KA, or appreciably reduce the likelihood of their survival and recovery at USAG-KA and across their global range.

7.4.2 Risk for top shell snails due to expected levels of action-related mortality

As described in the exposure and response analyses above, we expect up to 117 top shell snails could experience mortality as the result of a single direct payload impact, ejecta, and ground based shockwave. We believe that top shell snails are widely distributed at all of the USAG-KA islets around the atoll, and that the potentially impacted area represents a very small fraction (not currently quantifiable) of top shell snail-occupied habitat at Illeginni, and likely below 1% of top shell snail-occupied habitat at USAG-KA. As described above at 6.2, we further believe that the distribution and abundance of these mollusks in similar habitat areas outside of the potentially impacted zones would be similar to their estimated distribution and abundance within the impacted zones, and as such, these 117 top shell snails likely represent a tiny fraction of their species found at Illeginni and across USAG-KA, and their loss would be virtually indistinguishable from natural mortality levels in the region. Therefore, based on the best available information, we consider the risk negligible that the effects of direct payload impact, ejecta, and ground based shockwave would eliminate this species at USAG-KA, or appreciably reduce the likelihood of its survival and recovery at USAG-KA and across their global range.

7.4.3 Risk for clams due to expected levels of action-related mortality

As described in the exposure and response analyses above, we expect up to 10 *H. hippopus* and two *T. squamosa* clams could experience mortality as the result of a single direct payload impact, ejecta, and ground based shockwave. We believe that both species of clams are widely distributed at all of the USAG-KA islets around the atoll, and that the potentially impacted area represents a very small fraction (not currently quantifiable) of clam-occupied habitat at Illeginni, and likely below 1% of clam-occupied habitat at USAG-KA. As described above at 6.2, we further believe that the distribution and abundance of these mollusks in similar habitat areas outside of the potentially impacted zones would be similar to their estimated distribution and abundance within the impacted zones, and as such, these 12 clams likely represent a tiny fraction of their species found at Illeginni and across USAG-KA, and their loss would be virtually indistinguishable from natural mortality levels in the region. Therefore, based on the best available information, we consider the risk negligible that the effects of direct payload impact, ejecta, and ground based shockwave would eliminate this species at USAG-KA, or appreciably reduce the likelihood of its survival and recovery at USAG-KA and across their global range.

8 Cumulative Effects

The UES does not specifically describe "cumulative effects" for a biological opinion. However, Section 161 of the Compact provides that for U.S. Government activities requiring the preparation of an environmental impact statement (EIS) under NEPA, the U.S. Government shall comply with environmental standards that protect public health and safety and the environment that are comparable to the U.S. environmental statutes, including the Endangered Species Act. Although not all USAG-KA actions that require formal consultation also require the preparation of an EIS, such as this action, we analyze cumulative effects in all USAG-KA consultations as that term is defined in the ESA implementing regulations. Cumulative effects are limited to the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion (50 CFR 402.02). Cumulative effects, as defined in the ESA, do not include the continuation of actions described under the Environmental Baseline, and future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

The impacts of RMI coastal development, fisheries interactions, vessel groundings, direct take, marine debris, and global climate change (as described in the Environmental Baseline section) are not only expected to continue, they are likely to intensify over time. The intensification of those impacts is expected to cause cumulative effects on UES-protected marine species at USAG-KA. Continued growth of the human population at Kwajalein Atoll would likely result in increased coastal development, fishing pressure, vessel traffic, and pollution of the marine environment.

Anthropogenic release of CO_2 and other greenhouse gases is considered the largest contributor to global climate change, and it is expected that the release of those gases is not only likely to continue, but the rate of their release is expected to increase during the next century (Brainard *et al.* 2011). Therefore, global climate change is expected to continue to impact UES-protected marine species and their habitats, especially on those species that are dependent on shallow coastal reefs and shorelines, such corals and marine mollusks.

There is uncertainty associated with the analysis of potential impacts of climate change on species and ecosystems (Barnett 2001). Effects of climate change will not be globally uniform (Walther *et al.* 2002) and information regarding the magnitude of future climate change is speculative and fraught with uncertainties (Nicholls and Mimura 1998). In particular, there is no comprehensive assessment of the potential impacts of climate change within the action area or specific to UES-protected marine species. In addition to the uncertainty of the rate, magnitude, and distribution of future climate change and its associated impacts on temporal and spatial scales, the adaptability of species and ecosystems are also unknown. Impact assessment models that include adaptation often base assumptions (about when, how, and to what conditions adaptations might occur) on theoretical principles, inference from observed observations, and arbitrary selection, speculation, or hypothesis (see review in Smit *et al.* 2000). Impacts of climate change and hence its 'seriousness' can be modified by adaptations of various kinds (Tol *et al.* 1998). Ecological systems evolve in an ongoing fashion in response to stimuli of all kinds, including climatic stimuli (Smit *et al.* 2000).

The effects of global climate change, the most significant of which for corals are the combined direct and indirect effects of rising sea surface temperatures and ocean acidification, are currently affecting corals on a global scale, particularly in parts of the Caribbean. The return frequency of thermal stress-induced bleaching events has exceeded the ability of many reefs and coral species to recover there. Brainard *et al.* (2011) report that those effects likely represent the greatest risk of extinction to ESA-candidate corals over the next century. Field observation and models both predict increasing frequency and severity of bleaching events, causing greater coral mortality and allowing less time to recover between events. However, predicting how global climate change may impact particular species remains poorly understood, especially in understudied areas such as USAG-KA.

The effects of global climate change could act synergistically on corals affected by the proposed action. The ability of impacted corals to respond to the effects of the proposed action could be reduced due to the effects of elevated temperatures and increased ocean acidity, and the longer it takes for impacted corals to recover from the effects of the proposed action, the more likely it becomes that the effects of climate change would synergistically impact those corals. However, the degree to which those synergistic impacts may affect corals over the time required for them to recover from project impacts is unknown.

The effects of global climate change could also act synergistically on top shell snails affected by the proposed action. However, no specific information is currently available to assess the impacts. Changes in ocean temperature and chemistry, and rising sea level may be affecting this species because it depends on an exoskeleton that is comprised primarily of calcium carbonate. We expect that minimally, increased acidity could have effects that parallel those described for corals above, with the exception of impacts related to zooxanthellae.

Given the small area and low numbers of individuals expected to be adversely affected by the proposed action, the possible synergistic impacts of climate change combined with the effects of the proposed action are not expected to be significant for the corals and mollusk considered in this Opinion.

9 Integration and Synthesis of Effects

The purpose of this Opinion is to determine if the proposed action is likely to jeopardize the continued existence of UES-protected marine species at USAG-KA (USAG-KA 2017). "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a UES-protected marine species at USAG-KA by reducing the reproduction, numbers, or distribution of that species. This Opinion considers the Effects of the Action within the context of the Status of the Species, the Environmental Baseline, and Cumulative Effects as described in Section 6 under "Approach".

We determine if reduction in fitness to individuals of marine consultation species that may result from the proposed action are sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the risk of reducing the likelihood of survival and recovery of UES-protected species). In order to make that determination, we use the population's base condition (established in the Status of Listed Species and Environmental Baseline sections of this Opinion), considered together with Cumulative Effects, as the context for the overall effects of the action on the affected populations at USAG-KA. The following discussion summarizes the probable risks the proposed action poses to the corals, top shell snails, and giant clams identified in Section 4.

9.1 Corals

As described in the Effects of the Action section, a total of up to 9,929 colonies of UES-consultation corals (15 species) could be killed through some combination of exposure to direct payload impact, ejecta, and ground based shock wave.

As discussed in the Status of Listed Species, abundance and trend data are lacking for these corals at USAG-KA. However, they are all widely distributed around the atoll, with three of the 15 corals being known to occur at all USAG-KA islets. Seven others are known to occur on at least half of the USAG-KA islets. Of the remaining five, one has been found on five of the islets, and three are known on four islets, and one is known from two islets that are on opposite ends of the atoll. All 15 species have also been observed at survey sites in the MAC, with three found at over 30 of the 35 sites, eight have been observed at four to 25 sites, and four at three or less sites. It is important to recognize that survey data for USAG-KA is far from complete. Only a small portion of the total reef area around the USAG-KA islets and MAC has been surveyed, and surveys to specifically identify and quantify these species are yet to be done. A recent survey was completed at Ilegini Islet in the MM III reef impact area, which is also the area that has been analyzed for impacts from the FE-1 payload and the results suggest that the estimate for corals in the area may be lower than what has been estimated (NMFS 2017a).

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of fisheries interactions, direct take, and climate change are expected to continue and likely worsen in the future for these corals. However, the impact and time scale of these effects on the trajectory of the affected coral populations at USAG-KA, and across Oceania is currently uncertain, and those impacts are expected to occur on a time scale against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in the mortality of up to 9,929 coral colonies at Illeginni Islet. These coral colonies represent a small fraction of the total number of their species found at Illeginni, and even less around USAG-KA. The potential loss of these coral colonies is not expected to significantly impact reproduction or to impede the recovery of their species across USAG-KA and the mid-atoll corridor. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to eliminate any of the 15 UES consultation corals considered in this Opinion from Illeginni, or appreciably reduce the likelihood of their survival and recovery across USAG-KA including the mid-atoll corridor.

9.2 Top Shell Snail

As described in the Effects of the Action section, a total of up to 117 top shell snails could be killed through some combination of exposure to direct payload impact, ejecta, and ground based shock wave.

As discussed in the Status of Listed Species, top shell snails have been reported at all of the 11 USAG-KA islets as well as at 12 of 35 survey sites in the mid-atoll corridor. It is important to recognize that survey data for USAG-KA is far from complete. Only a small portion of the total reef area around the USAG-KA islets has been surveyed, and surveys to specifically identify and quantify this species are yet to be done. As such, it is possible that the distribution and abundance of top shell snails at USAG-KA is higher than the current information can confirm. As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, direct take, and climate change are expected to continue and likely worsen in the future for this species. However, the impact and time scale of these effects on the trajectory of the affected top shell snail populations at USAG-KA is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in death of up to 117 top shell snails at Illeginni. The affected snails would represent a small fraction of the total number of top shell snails found at Illeginni, and an even smaller proportion of the population across USAG-KA. The potential loss of 117 top shell snails across the area is not expected to significantly impact reproduction or to impede the recovery of this species across USAG-KA and the mid-atoll corridor. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to eliminate top shell snails at Illeginni, or appreciably reduce the likelihood of their survival and recovery across USAG-KA including the mid-atoll corridor.

9.3 Giant Clams

As described in the Effects of the Action section, a total of up to 12 giant clams could be killed through some combination of exposure to direct payload impact, ejecta, and ground based shock wave.

As discussed in the Status of Listed Species, the two clam species have been reported at most of the of the 11 USAG-KA islets, (9 for H. hippopus and 6 for T. squamosa) as well as at 9 and 24 respectively of 35 survey sites in the mid-atoll corridor. It is important to recognize that survey data for USAG-KA is far from complete. Only a small portion of the total reef area around the USAG-KA islets has been surveyed, and surveys to specifically identify and quantify this species are yet to be done.

As discussed more fully in the Environmental Baseline and Cumulative Effects sections, the effects of coastal development, direct take, and climate change are expected to continue and likely worsen in the future for this species. However, the impact and time scale of these effects on the trajectory of the affected giant clam populations at USAG-KA is currently uncertain, and those impacts are expected to occur on a time scale, against which the impacts of the proposed action would be indistinguishable.

The proposed action is anticipated to result in death of up to 12 giant clams at Illeginni. The affected clams would represent a small fraction of the total number of clams found at Illeginni, and an even smaller proportion of the population across USAG-KA. The potential loss of 12 giant clams across the area is not expected to significantly impact reproduction or to impede the recovery of this species across USAG-KA and the mid-atoll corridor. Therefore, when taken in context with the status of the species, the environmental baseline, cumulative impacts and effects, the proposed action is not likely to eliminate giant clams at Illeginni, or appreciably reduce the likelihood of their survival and recovery across USAG-KA including the mid-atoll corridor.

10 Conclusion

After reviewing the current status of UES-protected marine species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our Opinion that the USASMDC/ARSTRAT's implementation of the FE-1 experimental flight test at the Reagan Test Site, USAG-KA, RMI is not likely to jeopardize the continued existence of any of the UES-protected corals considered in this Opinion, the top shell snail, or two species of giant clams. As described above in Section 3, no critical habitat has been designated or proposed for designation for any UES-protected marine species in the action area or elsewhere in the RMI. Therefore, the proposed action would have no effect on designated or proposed critical habitat.

11 Incidental Take Statement

The UES does not specifically describe "take" for a biological opinion. However, under the ESA "take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the reasonable and prudent measures and terms and conditions of the Incidental Take Statement (ITS). Although the ESA does not specifically apply to actions taken at USAG-KA, under section 161 of the Compact and the UES, the ESA provides the basis for determining the level of incidental take, so the ESA definitions will be used for this Opinion.

11.1 Anticipated Amount or Extent of Incidental Take

Based on the analysis in the accompanying Opinion we conclude that the FE-1 flight test at the USAG-KA RTS, would result in the take of 15 species of UES consultation corals, top shell snails, and two clam species. As described above in the exposure and response analyses, we expect that up to 9929 colonies of UES consultation corals (as quantified in Table 10) could experience complete mortality, up to 117 top shell snails may be killed by the proposed action, and up to 12 clams could be killed by the proposed action.

Table 10. Expected Take of Marine UES consultation species due to FE-1 flight test

Scientific Name	Species	Colonies or Individuals Taken
	Corals	
Acanthastrea brevis	No Common Name	416
Acropora aculeus	No Common Name	416
A. aspera	No Common Name	203
A. dendrum	No Common Name	416
A. listeri	No Common Name	416
A. microclados	No Common Name	416
A. polystoma	No Common Name	416
Alveopora verriliiiana	No Common Name	832
Cyphastrea agassizi	No Common Name	416
Heliopora coerulea	No Common Name	2758
Leptoseris incrustans	No Common Name	416
Montipora caliculata	No Common Name	728
Pavona venosa	No Common Name	416
Turbinaria reniformis	No Common Name	832
T. stellulata	No Common Name	832
	Mollusks	
Tectus niloticus	Top Shell Snail	117
Hipoppus hippopus	Giant clam	10
Tridacna squamosa	Giant clam	2

11.2 Effect or Impact of the Take

In the accompanying Opinion, we determined that this level of anticipated take is not likely to result in the jeopardy of any of the UES consultation species expected to be taken by the proposed action.

11.3 Reasonable and Prudent Measures

We believe the following reasonable and prudent measures, as implemented by the terms and conditions, are necessary and appropriate to minimize impacts of the proposed action and monitor levels of incidental take. The measures described below are non-discretionary and must be undertaken in order for the ITS to apply.

1. The USASMDC/ARSTRAT shall reduce impacts on UES-protected corals, top shell snails, clams and their habitats through the employment of best management practices and conservation measures.
2. The USASMDC/ARSTRAT shall record and report all action-related take of UES-consultation species.

11.4 Terms and Conditions

The USASMDC/ARSTRAT must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To meet reasonable and prudent measure 1 above, the USASMDC/ARSTRAT shall ensure that their personnel comply fully with the best management practices and conservation measures identified in the BA and below.
    a. The USASMDC/ARSTRAT shall ensure that all relevant personnel associated with this project are fully briefed on the best management practices and the requirement to adhere to them for the duration of this project.
    b. In the event the payload land impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to secure or remove from the water any substrate or coral rubble from the ejecta impact zone that may become mobilized by wave action as soon as possible.
        i. Ejecta greater than six inches in any dimension shall be removed from the water or positioned such that it would not become mobilized by expected wave action, including replacement in the payload crater.
        ii. If possible, coral fragments greater than six inches in any dimension shall be positioned on the reef such that they would not become mobilized by expected wave action, and in a manner that would enhance its survival; away from fine sediments with the majority of the living tissue (polyps) facing up.
        iii. UES consultation coral fragments that cannot be secured in-place should be relocated to suitable habitat where it is not likely to become mobilized.
    c. In the event the payload land impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to reduce impacts on top shell snails.

        i. Rescue and reposition any living top shell snails that are buried or trapped by rubble.
        ii. Relocate to suitable habitat, any living top shell snails that are in the path of any heavy equipment that must be used in the marine environment.
    d. In the event the payload land impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to reduce impacts on clams.
        i. Rescue and reposition any living clams that are buried or trapped by rubble.
        ii. Relocate to suitable habitat, any living clams that are in the path of any heavy equipment that must be used in the marine environment.

2. To meet reasonable and prudent measure 2 above:
    a. The USASMDC/ARSTRAT shall assign appropriately qualified personnel to record all suspected incidences of take of any UES-consultation species.
    b. The USASMDC/ARSTRAT shall utilize digital photography to record any UES-consultation species found injured or killed in or near the ocean target areas and/or at Illeginni. As practicable: 1) Photograph all damaged corals and/or other UES-consultation species that may be observed injured or dead; 2) Include a scaling device (such as a ruler) in photographs to aid in the determination of size; and 3) Record the location of the photograph.
    c. In the event the payload impact affects the reef at Illeginni, the USASMDC/ARSTRAT shall require its personnel to survey the ejecta field for impacted corals, top shell snails, and clams. Also be mindful for any other UES-consultation species that may have been affected.
    d. Within 60 days of completing post-test clean-up and restoration, provide photographs and records to the USAG-KA environmental office. USAG-KA and our biologists will review the photographs and records to identify the organisms to the lowest taxonomic level accurately possible to assess impacts on consultation species.
    e. Within 6 months of completion of the action, USAG-KA will provide a report to us. The report shall identify: 1) The flight test and date; 2) The target area; 3) The results of the pre- and post-flight surveys; 4) The identity and quantity of affected resources (include photographs and videos as applicable); and 5) The disposition of any relocation efforts.

12 Conservation Recommendations

The following conservation recommendations are discretionary agency activities provided to minimize or avoid adverse effects of a proposed action on UES-protected marine species or critical habitat, to help implement recovery plans, or develop information.

1. We recommend that the USASMDC/ARSTRAT continue to work with NMFS staff to conduct additional marine surveys around Illeginni Islet to develop a comprehensive understanding of the distribution and abundance of species that are there.
2. We recommend that the USASMDC/ARSTRAT continue to work with NMFS staff to conduct marine surveys at additional sites around all of the USAG-KA islets and in the

mid-atoll corridor to develop a more comprehensive understanding of the distribution and abundance of species and habitats at USAG-KA.

3. We recommend that the USAG-KA develop capacity and procedures for responding to marine mammal and turtle strandings.
    a. Acquire required permits and training to perform necropsies and/or to take and transport tissue samples.
    b. Develop professional relations with qualified federal agencies and universities to capitalize on samples and information gained at USAG-KA.
    c. Develop mechanisms to collect and disseminate the information.

Reinitiation Notice

This concludes formal consultation on the implementation of the FE-1 flight test program at the USAG-KA RTS, RMI. Reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law, and if:

1. The amount or extent of anticipated incidental take is exceeded;
2. New information reveals that the action may affect UES-protected marine species or critical habitat in a manner or to an extent not considered in this Opinion;
3. The action is subsequently modified in a manner that may affect UES-protected marine species or critical habitat to an extent, or in a manner not considered in this Opinion; or
4. A new species is listed or critical habitat designated that may be affected by the action.

13 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Supplement has undergone pre-dissemination review.

13.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the SSP, and USASMDC/ARSTRAT, . Other interested users could include the citizens of RMI, USFWS, and NOAA, . Individual copies of this Opinion were provided to the USASMDC/ARSTRATand will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

13.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

13.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and reviewed in accordance with Pacific Islands Region ESA quality control and assurance processes.

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