Nationwide Public Safety Broadband Network Draft Programmatic Environmental Impact Statement for the Non-Contiguous United States

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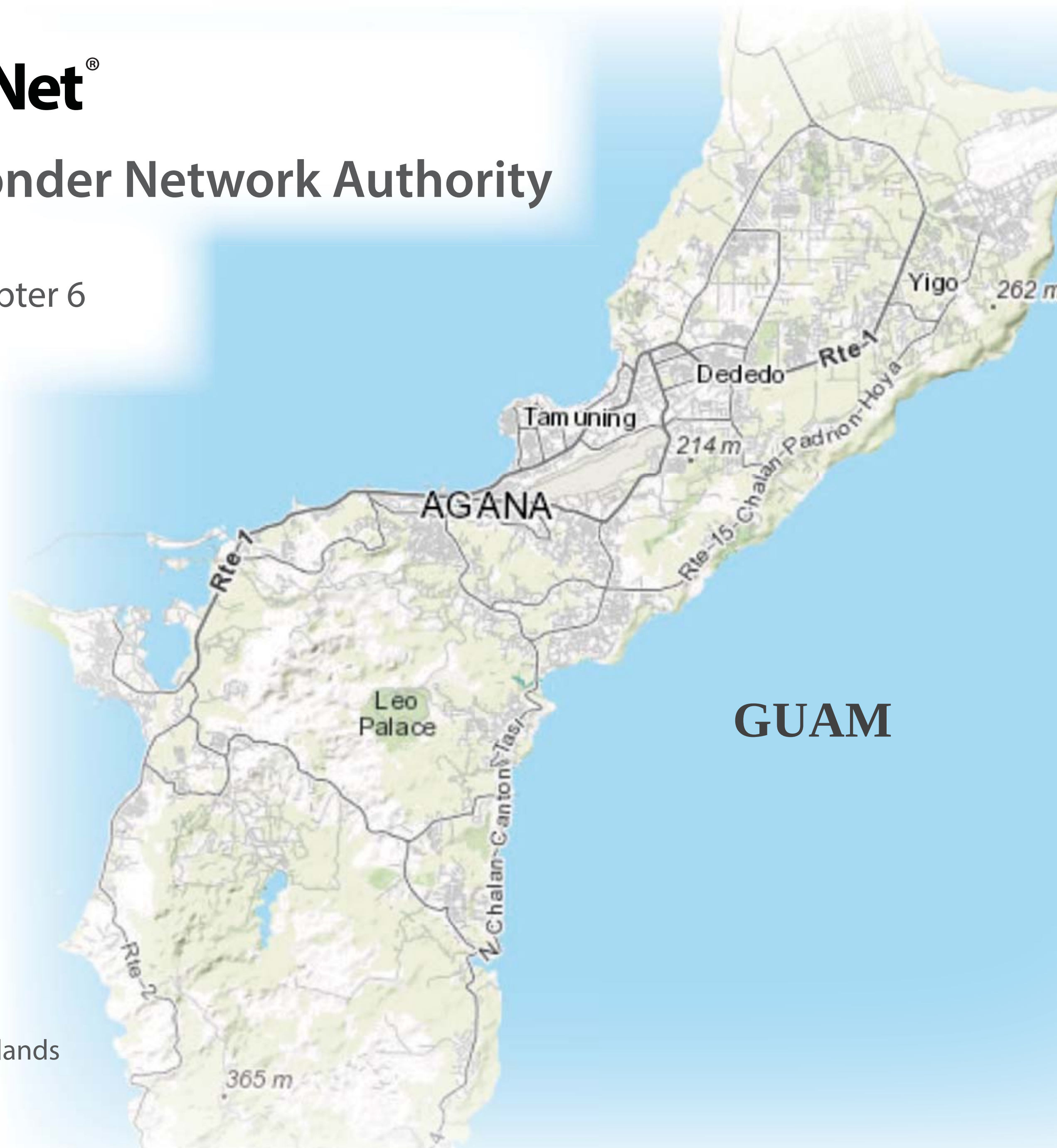
First Responder Network Authority

Volume 4 - Chapter 6



Alaska
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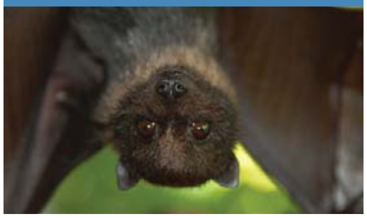

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First Responder Network Authority

Nationwide Public Safety Broadband Network
Draft Programmatic Environmental Impact Statement
for the Non-Contiguous United States

Volume 4

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Cooperating Agencies
Federal Communications Commission
General Services Administration
U.S. Department of Agriculture—Rural Utilities Service
U.S. Department of Agriculture—U.S. Forest Service
U.S. Department of Agriculture—Natural Resource Conservation Service
U.S. Department of Defense—Department of the Air Force
U.S. Department of Energy
U.S. Department of Homeland Security

March 2016

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Map Service. 2015. *OpenStreetMap*. ArcGIS Map Image Layer by Esri. Sourced from: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community.

NOAA (National Oceanic and Atmospheric Administration). 2016. *Polar bear (Ursus maritimus)*. Uncredited Marine Mammal Commission Photograph. Accessed: January 2016. Retrieved from: http://search.noaa.gov/search/images?utf8=%E2%9C%93&sc=0&query=Polar+bear+%28Ursus+maritimus%29&m=&affiliate=noaa.gov&commit=Search

NPS (National Park Service). 2016. *Fruit Bat [White-necked Flying Fox (Pteropus tonganus)]*. Uncredited NPS Photograph. Accessed: January 2016. Retrieved from: http://www.nps.gov/npsa/learn/education/fruit-bats-are-our-friends.htm

USFWS (U.S. Fish and Wildlife Service). 2013a. *Mariana Fruit Bat Pteropus mariannus / Fanihi*. Uncredited USFWS Photograph. Accessed: January 2016. Retrieved from: http://www.fws.gov/refuge/guam/wildlife_and_habitat/mariana_fruit_bat.html

_____. 2013b. *Nēnē Branta sandvicensis / Hawaiian Goose*. Photograph by Laura Beauregard, USFWS. Accessed: January 2016. Retrieved from: http://www.fws.gov/refuge/Hakalau_Forest/wildlife_and_habitat/nene.html

_____. 2015. *Rota blue damselfly (Ischura luta)*. Photograph by A. Asquith, USFWS. Accessed: January 2016. Retrieved from: https://www.fws.gov/news/ShowNews.cfm?ID=4DA36523-E516-A820-414BB2B0165E7461

_____. 2016. *West Indian Manatee.* Photograph by Keith Ramos, USFWS. Accessed: January 2016. Retrieved from: http://www.fws.gov/southeast/wildlife/mammal/manatee/

USFWS Alaska (Alaska Region U.S. Fish and Wildlife Service). 2004. *Walrus Cows and Yearlings on Ice*. Photograph by Joel Garlich-Miller, USFWS. Accessed: January 2016. Retrieved from: https://www.flickr.com/photos/usfws_alaska/5390772958/

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ACRONYMS AND ABBREVIATIONS

°F	degree Fahrenheit
°N	degrees north
$\mu g/m^3$	microgram(s) per cubic meter
µPa	micro Pascal
%	percent
A	attained
AAC	Alaska Administrative Code
AAFIS	Alaska Public Safety Identification System
AAQS	Ambient Air Quality Standards
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey (U.S. Census Bureau)
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AGL	above ground level
AIRFA	American Indian Religious Freedom Act
AJRCCM	American Journal of Respiratory and Critical Care Medicine
AKNHP	Alaska National Heritage Program
AKOSH	Alaska Occupational Safety and Health
AKWAS	Alaska Warning System
ALMR	Alaska Land Mobile Radio
ANFIRS	Alaska Fire Incident Reporting System
ANSCA	Alaska Native Claims Settlement Act
ANSI	American National Standards Institute
APE	Area of Potential Effect
APLIC	Avian Power Line Interaction Committee
APSIN	Alaska Public Safety Information Network
AQCR	air quality control region
ARFF	Aircraft Rescue and Firefighting
ARMS	Alaska Records Management System
ARPA	Archaeological Resources Protection Act of 1979
AS	Alaska Statute
A.S.A.C.	American Samoa Administrative Code
ASCA	American Samoa Code Annotated
ASCMP	American Samoa Coastal Management Program
ASDMWR	American Samoa Department of Marine and Wildlife Resources
ASEPA	American Samoa Environmental Protection Agency
ASHPO	American Samoa Historic Preservation Office
ASPA	American Samoa Power Authority
ATO	Air Traffic Organization
ATWC	Alaska Tsunami Warning Center
AURORA	Alaska Uniform Response Online Reporting Access
BACT	best available control technology
BCE	before Common Era
BCR	Bird Conservation Regions
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BLS	U.S. Bureau of Labor Statistics
BMP	best management practice
BRFSS	Behavioral Risk Factor Surveillance System
BSAI	Bering Sea/Aleutian Island
BWG	BioInitiative Working Group
CAA	Clean Air Act
CAB	Clean Air Branch
CARB	California Air Resources Board
CBIA	Coastal Barrier Improvement Act of 1990
CBRA	Coastal Barrier Resources Act of 1982
CCP	Comprehensive Conservation Plan
CDC	Center for Disease Control
CDLNR	Commonwealth Department of Lands and Natural Resources
CE	Common Era
CELCP	Coastal and Estuarine Land Conservation Program
CEPD	Caribbean Environmental Protection Division
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFMC	Caribbean Fisheries Management Council
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CHC	Commonwealth Health Center
CIA	Central Intelligence Agency
CMIP3	Coupled Model Intercomparison Project phase 3
CNMI	Commonwealth of Northern Mariana Islands
CNMIAC	Commonwealth of Northern Mariana Islands Administrative Code
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalents
COMAR	Committee on Man and Radiation
CPA	Commonwealth Ports Authority

CRMP	Coastal Resources Management Program
CSP	Central South Pacific
CUC	Commonwealth Utilities Corporation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
DACA	Deployable Airborne Communications Architecture
DAR	Division of Aquatic Resources (Hawaii)
DAWR	Division of Aquatic and Wildlife Resources (Guam)
dB	decibel(s)
dBA	A-weighted decibel(s)
DBCP	1,2-dibromo-3-chloropropane
dBZ	Z-weighted decibel(s)
DCP	1,2-dichloropropane
DEC	Department of Environmental Conservation
DHHL	Department of Hawaiian Homelands
DLNR	Department of Land and Natural Resources (Hawaii)
DMA	Disaster Mitigation Act of 2000
DNER	Department of Natural and Environmental Resources of Puerto Rico
DOA	Department of Agriculture
DOD	Department of Defense
DOE	U.S. Department of Energy
DOH	Department of Health
DOH-CAB	Hawaii Department of Health, Clean Air Branch
DOT	U.S. Department of Transportation
DPNR	Department of Planning and Natural Resources (U.S. Virgin Islands)
DPS	Department of Public Safety
EA	Environmental Assessment
EAS	Emergency Alert System
EBS	Emergency Broadcast System
EDB	ethylene dibromide
EFH	essential fish habitat
EMS	emergency medical services
ENSO	El Niño/Southern Oscillation
EO	Executive Order
EPCRA	Emergency Planning and Community Right-to-Know Act
ERP	effective radiated power
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index
FAA	Federal Aviation Administration
FAD	Fish Aggregating Device
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FirstNet	First Responder Network Authority
FMP	Fishery Management Plan
FPPA	Farmland Protection Policy Act of 1981
FR	Federal Register
ft	feet
g/hp-hr	grams per horsepower-hour
g/mi	grams per mile
GAP	Gap Analysis Program
GCA	Guam Code Annotated
GDA	Guam Department of Agriculture
GEPA	Guam Environmental Protection Agency
GHG	greenhouse gas
GIS	geographic information system
GMP	General Management Plan
GOA	Gulf of Alaska
GRHP	Guam Register of Historic Places
GWP	global warming potential
H_2S	hydrogen sulfide
HDOH	Hawaii Department of Health
HEI	Health Effects Institute
HHCA	Hawaiian Homes Commission Act of 1920
HIANG	Hawaii Air National Guard
HIARNG	Hawaii Army National Guard
HIHWNMS	Hawaiian Islands Humpback Whale National Marine Sanctuary
HIOSH	Hawaii Occupational Safety and Health Division
hp	horsepower
HRD	(Guam) Historic Resources Division
HRHP	Hawaii Register of Historic Places
HRS	Hawaii Administrative Rules, Revised Statute
HTA	Hawai'i Tourism Authority
HUC	hydrologic unit code
I/M	Inspection/Maintenance
IARC	International Agency for Research on Cancer
IBA	Important Bird Area
IEEE	Institute of Electrical and Electronics Engineers
IFC	International Finance Corporation
in	inches
IPCC	Intergovernmental Panel on Climate Change
IR	ionizing radiation
ITCZ	Intertropical Convergence Zone
IUCN	International Union for Conservation of Nature
kg/gal	kilograms per gallon
KIRC	Kaho'olawe Island Reserve Commission
LAER	lowest achievable emission rate
lb/day	pounds per day
lb/hp-hr	pounds per horsepower-hour

LBJ	Lyndon B. Johnson
Ldn	day-night average sound level
Leq	equivalent noise levels
LNG	liquefied natural gas
LTE	Long Term Evolution
$\mu g/m^3$	microgram(s) per cubic meter
μPa	micro Pascal
m/s	meter per second
MBTA	Migratory Bird Treaty Act
mg/m^3	Milligram(s) per cubic meter
mgd	million gallons per day
MHz	megahertz
MLRA	Major Land Resource Area
mm/s	millimeters per second
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement
MPA	Marine Protected Area
mph	miles per hour
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MTR	Military Training Route
MUID	Map Unit Identification Data
MW	megawatt
mW/cm^2	milliwatts per centimeter squared
N	north; not attained
N_2O	nitrous oxide
NA	not applicable; not assessed
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NANSR	Nonattainment New Source Review
NAWAS	National Warning System
NCA	National Climate Assessment
NCD	non-communicable disease
NCDC	National Climatic Data Center
NCN	no common name
NCRP	National Council on Radiation Protection and Measurements
ND	no data
NE	northeast
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFIP	National Flood Insurance Program
NFIRS	National Fire Incident Reporting System
NHPA	National Historic Preservation Act
NIR	non-ionizing radiation
NMFS	National Marine Fisheries Service
NMHC	non-methane hydrocarbon compounds
NMOG	non-methane organic compounds
NNE	north-northeast
NOAA	National Oceanic and Atmospheric Administration
NOx	nitrogen oxides
NP	National Park
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NPSBN	nationwide public safety broadband network
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NTIA	National Telecommunications and Information Administration
NVSR	National Vital Statistics Report
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
NWWS	National Weather Wire Satellite System
OHA	Office of History and Archaeology
OIA	Office of Insular Affairs (USDI)
OSHA	Occupational Safety and Health Administration
PA	Programmatic Agreement
PAG	Port Authority of Guam
PAHO	Pan American Health Organization
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PDO	Pacific Decadal Oscillation
PEIS	Programmatic Environmental Impact Statement
PL	Public Law
PM	particulate matter
PM_{10}	particulate matter up to 10 micrometers in diameter
$PM_{2.5}$	particulate matter up to 2.5 micrometers in diameter
POPs	points of presence
ppm	parts per million
PRDNER	Puerto Rico Department of Natural and Environmental Resources
PREQB	Puerto Rico Environmental Quality Board
PR OSHA	The Puerto Rico Occupational Safety and Health Administration
PRASA	Puerto Rico Aqueduct and Sew Authority
PREPA	Puerto Rico Electric Power Authority
PRSHPO	Puerto Rico State Historic Preservation Office
PSD	Prevention of Significant Deterioration
PUAG	Public Utility Agency of Guam
PV	photovoltaic
RAN	radio access network
RCP	Representative Concentration Pathway
RCRA	Resource Conservation and Recovery Act

RF	radio frequency
RIN	Regulation Identification Number
rms	root mean square
ROW	right-of-way
SAAQS	State Air Quality Standards
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SARA	Superfund Amendments and Reauthorization Act of 1986
SCD	State Civil Defense
SE	Standard of Error
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SLR	sea level rise
SMA	Special Management Area
SMS	Scenery Management System
SO_2	sulfur dioxide
SOx	sulfur oxides
SPCZ	South Pacific Convergence Zone
SPOC	Single Point of Contact
SRES	Special Report on Emission Scenarios
SSA	sole source aquifer
STATSGO2	State Soil Geographic [Database]
SW	southwest
TAAQS	Territory Ambient Air Quality Standards
TCP	traditional cultural property
TEMCO	Territorial Emergency Management Coordinating Office
TMDL	Total Maximum Daily Load
TOC	total organic compound
tpy	tons per year
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
U.S.	United States
UAMES	University of Alaska Museum Earth Sciences
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Climate Change Research Program
USGS	U.S. Geological Survey
USVIDOH	U.S. Virgin Islands Department of Health
USVIPD	U.S. Virgin Islands Police Department
UVA	University of Virginia
VIC	Virgin Islands Code
VIPA	Virgin Islands Port Authority
VISHPO	Virgin Islands State Historic Preservation Office
VOC	volatile organic compound
vog	volcanic smog
VRM	Visual Resource Management
W	watt(s)
W/m^2	watts per meters squared
WAPA	Water and Power Authority
WHO	World Health Organization
WIMARCS	West Indies Marine Animal Research and Conservation Science
WNP	Western North Pacific
WNW	west-northwest
WPC	watts per channel
WPRFMC	Western Pacific Regional Fishery Management Council

6. GUAM

This chapter provides details about the existing environment of Guam and potential impacts related to the Proposed Action.

Guam is believed to have been inhabited since 2,000 B.C., and the indigenous culture is referred to as Chamorro. In 1521, Portuguese explorer Ferdinand Magellan made contact with the island, and the Spanish established the first European colony on the island in 1668. Spain maintained control until the Spanish-American War in 1898, when the United States gained possession. Guam became a U.S. territory in 1949.

General facts about Guam are provided below:

- Area: 209 square miles (*AIA Guam and Micronesia 2012*)
- Capital: Hagåtña
- Municipalities: 19 (U.S. Census Bureau 2010)
- Population: 159,358 people (U.S. Census Bureau 2010)
- Most Populated Cites: Dededo, Yigo, Tamuning, and Hagåtña
- Main Rivers: Talofofo River, Ylig River, Pago River
- Bordering Waterbodies: Pacific Ocean
- Notable Mountain Ranges and Summits: Mount Alifan, Mount Bolanos, Mount Jumullong Manglo, Mount Lamlam
- Highest Point: Mt. Lamlam (1,338 feet) (WA 2015)

Guam is located in the Pacific Ocean in the Western North Pacific region. The territory is the largest and southernmost island of the Mariana Islands chain; it is an independent territory from the other nearby islands. The United States (U.S.) Census Bureau treats Guam as a single territory and county and recognizes 19 municipalities as legal subdivisions of Guam (see Figure 6-1).

Currently, 49.3 percent of residents identify themselves as Native Hawaiian or Other Pacific Islander (including 37.3 percent who identify themselves as Chamorro or Guamanian[1]); 32.2 percent identify themselves as Asian; and just over 7 percent identified as white (*U.S. Census Bureau 2010*; see Section 6.1.10.3, Minority and Income Status).

[1] Guamanians are the native peoples of Guam.

Hagåtña is the capital of Guam and is located within the central portion of the island. Guam is an unincorporated territory of the United States that is organized into three branches: executive, legislative, and judicial. The legislative branch consists of a unicameral legislature[2] with 15 members who are elected for 2-year terms and are empowered and responsible for creating laws; the judicial branch interprets how these laws should be applied, and consists of the Superior Court of Guam and the Supreme Court of Guam; the executive branch is managed by the governor and lieutenant governor of Guam who are tasked with the implementation of Guam's laws through its departments, bureaus, committees and agencies that make up the government of Guam (*GEDA Undated*). Guam's Environmental Protection Agency and Department of Agriculture are the territory's environmental agencies.

Due to Guam's geographic location, there is little seasonal variation in weather, which translates to a minor seasonal temperature range. The air temperatures in Guam are tropical marine, and range from 70 °F to 85°F with an average temperature of 81.5°F and an average relative humidity of 80.5 percent. The summer season occurs from March through August, and the winter season occurs from December through February (see Section 6.1.14.5, Existing Climate and Meteorology). Severe weather data recorded over the last 18 years (1996 to 2014) for Guam include flooding, thunderstorm, tornado/funnel cloud, hurricane, and high wind (50-plus miles per hour)—typically from tropical cyclones (*NOAA 2015*).

Guam has a complex geography made up of mountainous regions and forests. Approximately 20 percent of Guam has been designated as local or federal conservation lands. Guam is prone to natural catastrophes like earthquakes, typhoons, and other tropical cyclones (*USEPA 2013*). Guam is said to have the highest frequency of natural disasters among all the states and territories in America (*GlobalSecurity.org 2015*). All of these factors add an extra level of challenge in ensuring that adequate communication systems are in place.

The Guam Homeland Security Office of Civil Defense is responsible for coordinating and facilitating the response agencies of Guam (government, military, and federal liaison) regarding the mitigation, preparation, response, and recovery from all natural and manmade disasters in the territory (*GHS/OCD 2015*). In addition to the Guam Police Department and Fire Department, the Guam National Guard plays a major role in public safety in Guam and assists during national disasters (*GlobalSecurity.org 2015*).

Guam's economy consists of four principal activities: tourism, U.S. military spending, and exports of fish and handicrafts (*Guam Attorney General 2015*). Guam is lightly industrialized. According to the U.S. Census Bureau, in 2010 (the most recent year for which data were available) the unemployment rate was 8.2 percent, compared to the national average of 7.9 percent (see Section 6.1.9.4, Real Estates, Tax Revenues, Property Values, and Local Economic Activity). Guam has four airports and one deep water port. The Jose D. Leon Guerrero Commercial Port of Guam is the primary seaport in Micronesia and is an important hub linking the Western Pacific Islands with the rest of the world.

[2] Unicameral legislature is a legislature consisting of one chamber (a single house, for example).

This chapter contains a discussion of the Affected Environment (see Section 6.1) and Environmental Consequences (see Section 6.2) for each of the 15 resources:

- Infrastructure
- Soils
- Geology
- Water Resources
- Wetlands
- Biological Resources
  - Terrestrial Vegetation
  - Wildlife
  - Fisheries and Aquatic Habitats
  - Threatened and Endangered Species and Species of Conservation Concern
- Land Use, Airspace, and Recreation
- Visual Resources
- Socioeconomics
- Environmental Justice
- Cultural Resources
- Air Quality
- Noise
- Climate Change
- Human Health and Safety

Source: Map Service 2015

Figure 6-1: Guam Geography

6.1. AFFECTED ENVIRONMENT

This section provides a description of those portions of the environment that could be affected by the Proposed Action in Guam. This information is used in the assessment of potential impacts from the Proposed Action as described in 6.2, Environmental Consequences; the level of detail in the description of each resource in this section corresponds to the magnitude of the potential direct, indirect, or cumulative impacts of the Proposed Action. The information presented was derived from government data or reports and scientific literature. This section describes the current conditions and characteristics of 15 distinct resources:

- Section 6.1.1, Infrastructure: existing transportation, public safety services and infrastructure, communication services, and other utilities and related emergency operational planning;
- Section 6.1.2, Soils: existing soil resources, features, and characteristics;
- Section 6.1.3, Geology: geologic features and characteristics that would be potentially sensitive to impacts from construction and operation of the Proposed Action, as well as geologic hazards that could potentially affect the Proposed Action;
- Section 6.1.4, Water Resources: surface water, floodplains, nearshore marine waters, and groundwater;
- Section 6.1.5, Wetlands: wetland resources, features, and characteristics;
- Section 6.1.6, Biological Resources: terrestrial vegetation, wildlife, fisheries and aquatic habitats, and threatened and endangered species and species of conservation concern;
- Section 6.1.7, Land Use, Airspace, and Recreation: overview of land use, airspace, and recreational facilities and activities;
- Section 6.1.8, Visual Resources: natural and human-made features, landforms, structures, and other objects;
- Section 6.1.9, Socioeconomics: demographic, cultural, and economic conditions;
- Section 6.1.10, Environmental Justice: demographic data on minority or low-income groups;
- Section 6.1.11, Cultural Resources: known historic properties, traditional cultural properties, and places of cultural or religious significance;
- Section 6.1.12, Air Quality: existing air quality conditions;
- Section 6.1.13, Noise: existing noise conditions;
- Section 6.1.14, Climate Change: setting and context of global climate change effects in Guam; and historical and existing climate parameters including temperature, precipitation, and severe weather; and
- Section 6.1.15, Human Health and Safety: health profile of the population of Guam, including basic population health indicators and a discussion of any key community health and safety issues identified.

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6.1.1. Infrastructure

6.1.1.1. Introduction

This section discusses existing infrastructure in Guam. Information presented in this section focuses on existing transportation, public safety services and infrastructure, communication services, and other utilities and related emergency operational planning that could be augmented, supplemented, or otherwise affected by deployment and operation of the Proposed Action.

Infrastructure consists of the systems and physical structures that enable a population in a specified area to function. Infrastructure includes a broad array of facilities such as utility systems, streets and highways, railroads, airports, buildings and structures, ports, harbors, and other manmade facilities. Individuals, businesses, government entities, and virtually all relationships between these groups depend on infrastructure for their most basic needs, as well as for critical and advanced needs (e.g., emergency response, health care, and telecommunications).

Infrastructure is entirely manmade with a high correlation between the type and extent of infrastructure and the degree to which an area is characterized as "developed." Public safety infrastructure is any infrastructure utilized by a public safety entity[1] as defined in the Middle Class Tax Relief and Job Creation Act of 2012 (*Pub. L. No. 112-96, Title VI, 126 Stat. 156* (*codified at 47 USC 1401 et seq.*), including infrastructure associated with police, EMS, and fire services. This infrastructure includes fire and rescue departments, law enforcement precincts, medical centers and hospitals, transportation assets, government facilities, schools, and libraries that can be used as evacuation centers. First responder personnel include dispatch, fire and rescue, law enforcement, and medical professionals throughout the territory.

Utilities typically consist of the power, water, sewer, transit, and telecommunications systems that are essential to support daily operations. Changes in land use, population density, and development usually generate changes in the demand for and supply of utilities.

6.1.1.2. Specific Regulatory Considerations

Guam Homeland Security Office of Civil Defense is responsible for the facilitation of all government of Guam, military, and federal liaison response agencies in the mitigation, preparation, response, and recovery from all natural and manmade disasters in the territory (*GHS OCD 2015*). In the event of an emergency, the Federal Emergency Management Agency (FEMA) provides assistance for the territory and the Government of Guam (*FEMA 2015*).

Guam Homeland Security Office of Civil Defense developed the Guam Emergency Response Plan in order to ensure the effective response and recovery from emergencies and disasters. This plan outlines how best to utilize the Government of Guam's limited resources in order to mitigate, prepare for, respond to, and recover from natural and man-made disasters (*GHS OCD 2005*). Guam government agencies with regulatory or administrative authority over other territory infrastructure are identified in the sections below.

[1] The term "public safety entity" means an entity that provides public safety services (47 USC § 1401(26)).

6.1.1.3. Transportation

Railroads, Roads and Highways

There are no railroads in Guam. There are 34 highways and roadways in Guam totaling approximately 531 miles, 419 miles of which are paved (*vBulletin Solutions, Inc. 2015*). Figure 6.1.1-1 shows the location of roads and highways in Guam. The Guam Department of Public Works maintains the highway system in Guam (*vBulletin Solutions, Inc. 2015*).

Ports

The Port Authority of Guam (PAG) is a government agency responsible for the maintenance and operation of port facilities at Apra Harbor (*DOI 1999*). The Jose D. Leon Guerrero Commercial Port of Guam ("the Port") is currently owned, operated, and managed by the PAG. As shown in Figure 6.1.1-1, the Port is located on 62 acres of land on and adjacent to Cabras Island in Piti. Facilities and resources controlled by the PAG include, "over 1,000 acres in the Apra Harbor area including the Commercial Port with six waterfront berths (F1-F6), two fuel piers, a 500-foot long wharf, marine industrial terminal (oil tank farm and cement silos), fishing facilities, seaplane ramp and a privately-managed marina and harbor of refuge" (*Parsons Brinkerhoff 2013*).

The port is an important transportation hub linking the Western Pacific islands with the expanding Far East market, the United States (U.S.) and the rest of the world. An estimated 90 percent of the day-to-day goods and supplies consumed by its constituencies pass through Guam's Commercial Port. In addition, it is the primary seaport in Micronesia and serves as a transshipment hub for the entire Western Pacific Region. Sheltered within the inner reaches of the Outer Apra Harbor, the Commercial Port is Guam's only deepwater port and provides the people of Guam with ocean commerce, shipping, recreational, and commercial boating, as well as sea vessel navigation. It is also the 16th commercial strategic seaport in the U.S. and the only commercial port on the island, offering facilities and services to ships of all registries (*Parsons Brinkerhoff 2013*).

Airports

Guam has two airports in (see Figure 6.1.1-2) (*Megginson Technologies Ltd. 2015*):

- Andersen Air Force Base Airport – Andersen, Mariana Island
- Antonio B. Won Pat International Airport – Tamuning

Source: NGA 2015; USDA 2010

Figure 6.1.1–1: Guam Ports and Major Roads

Source: Vidiani.com 2011

Figure 6.1.1-2: Guam Airports

6.1.1.4. Public Safety Services

This section provides a description of baseline public safety infrastructure conditions as it relates to police services, fire services, emergency medical services (EMS) and hospitals in Guam.

Police

The Guam Police Department is responsible for crime prevention, law enforcement, and all other police-related services in Guam. The Guam police department staff is made up of 313 uniformed officers, 6 detention officers, and 63 civilian officers (*The Transition Team 2011*). The precincts are divided into two districts. District I includes Yigo, Dededo, and Tumon/Tamuning precincts, and District II includes Hagatna, Agat, and Talofofo precincts. The police headquarters is based in Tiyan Barrigada, Guam (*GPD 2010*).

In addition to the Guam Police Department, the Guam National Guard also plays a major role in public safety in Guam. The Guam National Guard is responsible for supporting the territory during times of natural disaster and war and is made up of the Guam Air National Guard and the Guam Army National Guard. A Guam Air National Guard station is located at the Andersen Air Force Base in Barrigada, Guam (*Air National Guard 2015*). The Guam Army National Guard is headquartered at Ft. Juan Muna in Barrigada, Guam and maintains two armories in two separate communities in the territory. The Guam National Guard has been providing natural disaster recovery response for over two decades on the island (*GlobalSecurity.org 2015*).

The United States Coast Guard Sector Guam is one of the primary agencies responsible for emergencies at sea in the Northern Mariana Islands, Guam, Republic of Palau, and the Federated States of Micronesia. They are responsible for security at ports, waterways and the coast, as well as law enforcement and marine protection (*USDHS USCG 2014*). Naval Base Guam also falls under the Joint Region Marianas and is available to Guam in time of emergency (*Military INSTALLATIONS 2015*).

Fire Services

The Guam Fire Department consists of three units including the Fire Suppression Unit, the Rescue Unit, and the EMS Unit. There are 12 fire stations distributed throughout Guam, one rescue base located in Agat, and the E911 Integrated Emergency Communications Center located in Agana Heights (*Guam Fire Department 2007*). The Fire Department is made up of one fire chief, one assistant fire chief, two fire battalion chiefs, 40 fire captains, 72 fire lieutenants, 59 firefighter Is, 72 firefighter IIs, and 27 fire recruits (*Guam Fire Department 2013a*). In 2010 Guam Fire Department had a total of six fire trucks located at five stations (*USDN 2010*).

EMS and Hospital Services

The EMS and Rescue Units within the Guam Fire Department are responsible for EMS, ambulance services, and rescue operations in Guam (*Guam Fire Department 2007*). There are 23 Emergency Medical Dispatchers in Guam (*Guam Fire Department 2013a*). During the 2012 to 2013 fiscal year, the EMS Unit had eight full-time ambulances and five on standby (*Guam Fire Department 2013*b).

The Guam Memorial Hospital, located in Tamuning, is the only civilian hospital in Guam and serves a population of over 159,000 citizens. The Guam Memorial Hospital received its accreditation from The Joint Commission in 2010. It consists of 158 acute care beds and 40 licensed long-term care beds, which are located at the Skilled Nursing Facility in Barrigada Heights. The Guam Memorial Hospital is required by law to serve the citizens of Guam and the people of the Federated States of Micronesia (*DOI 2014*).

6.1.1.5. Communications

Over the years, numerous lives have been lost as a result of the lack of interoperability in public safety telecommunications in America. The Final Report of the Public Safety Wireless Advisory Committee identified three main issues in public safety communications: 1) congested radio frequencies; 2) the inability of public safety officials to communicate with each other due to incompatible equipment, multiple frequency bands, and lack of standardization in repeater spacing and transmission formats; and, 3) the lack of cutting edge communications technologies (*Public Safety Wireless Advisory Committee 1996*). Large-scale emergency situations like Hurricane Sandy and the September 11 attacks further exposed vulnerabilities in the public safety communications systems, especially as it related to inadequate infrastructure. During Hurricane Sandy, resilient infrastructure to withstand weather related risks was not available, which led to devastating power outages, fuel shortages, and significant road and transit complications (*HSRTF 2013*). Likewise, based on the September 11 attacks, the National Task Force on Interoperability concluded that more effective infrastructure capable of supporting interoperable radio communications could have resulted in the preservation of numerous lives (*NTFI 2005*). Additionally, the National Task Force on Interoperability asserts that during major emergencies it is often extremely difficult for first responders to communicate across jurisdictions given the reliance on multiple separate and incompatible communications systems (*NFTI 2005*).

Guam has a complex geography, made up of mountainous regions and forests, and is geographically removed from the Continental U.S. (*Guampedia 201*4). It is the southernmost and most populated of the Mariana Islands. Guam is prone to natural catastrophes like earthquakes, typhoons, and tropical cyclones (*USEPA 2013*). Guam is said to have the highest frequency of natural disasters amongst all of the states and territories in America (*GlobalSecurity.org 201*5). All of these factors add an extra level of challenge in ensuring that adequate communication systems are in place.

The following communication methods are used by various public safety services in the territory of Guam:

- *E911 Communications Bureau*: Established in order to ensure that the people of Guam have access to all emergency services. The Communications Bureau is also responsible for dispatching public safety services and gathering, prioritizing and disseminating emergency related information to appropriate units and agencies (*Guam Fire Department 2007*).

- *Government of Guam Interoperable Communications Working Group:* A group established by Executive Order No. 2014-10, which was formed in order to ensure that residents of Guam receive reliable emergency response communications (*GPD & ICWG 2015*).
- *Land Mobile Radio System*: An island-wide wireless communications system utilized by 18 Government of Guam agencies, 10 federal agencies and the Guam Hotel and Restaurant Association Security Council (*GPD & ICWG 2015*).
- *Federal Emergency Management Agency Integrated Public Alert and Warning System*: A national public alert warning system implemented by the Federal Emergency Management Agency, National Oceanic and Atmospheric Administration national Weather Service, Federal Communications Commission, and Department of Homeland Security Science and Technology Directorate in order to provide emergency alert information prior to, during and after emergencies and disasters. Station KTWG was chosen as the primary entry point station in Guam responsible for disseminating information (*FEMA 2013*).
- *National Incident Management System:* Provides a template for departments, agencies and nongovernmental organizations so that they will have the capacity to properly protect against, recover from and mitigate the effects of largescale incidents (*GHS OCD 2015*).

6.1.1.6. Other Utilities

Energy

The Guam Power Authority, an autonomous agency of the Government of Guam, has the responsibility to provide electricity throughout the island. Guam does not produce or consume natural gas or coal and has no petroleum production or refineries within the territory. There are no conventional energy resources in Guam, so the territory relies on the importation of petroleum products to meet the majority of its energy needs. Petroleum products are shipped to Apra Harbor, the location of Guam's only deepwater port. Approximately 7,000 barrels per day of petroleum products were imported in Guam in 2010 (3,000 barrels/day of jet fuel, 3,000 barrels/day of motor gasoline, and 1,000 barrel/day of distillate fuel imports (*EIA 2015*).

In 2012, Guam had a total installed electrical capacity of 1 million kilowatts. The net electricity generation total in 2012 was 2 billion kilowatt hours, all of which was generated from petroleum. Total fossil fuel emissions in Guam totaled two million metric tons in 2012, and total energy consumption in 2011 totaled 199 million British thermal units (*EIA 2015*).

In order to develop its local economy, one of Guam's major goals is to reduce its reliance on imported petroleum resources and to adopt more sustainable energy strategies by utilizing local resources. Guam intends to reduce fossil fuel consumption within the territory by 20 percent of 2010 levels by 2020. One of the primary goals of the Guam Renewable Energy Portfolio is to ensure that 5 percent of net electricity sales come from renewable energy resources by 2015, and 25 percent by 2035. There are very few renewable energy resources available on the island aside from a few solar photovoltaic units, solar thermal units, and wind generators. Guam Power Authority's first commercial wind and solar projects were approved by the Public Utility Commission in 2011 and totaled 35 megawatts (*EIA 2015*).

Wastewater

The Public Utility Agency of Guam (PUAG) and the Guam Waterworks Authority are the two agencies responsible for wastewater collection and treatment in the territory. Guam Waterworks Authority operates seven wastewater treatment plants in Guam (*USEPA 2013*).

Water Supply

PUAG provides approximately 74 percent of the water produced on Guam, and the Air Force and Navy installations produce the remainder (*DOI 1999*). The major sources of water are groundwater and surface water from the Ugum River. The majority of the water that PUAG supplies comes from the Northern Lens aquifer. The Northern Lens aquifer is also connected to approximately 94 active wells, and approximately 26 million gallons of water are pumped from it each day. After the execution of the $12 million Ugum River project, an additional 2 million gallons of water per day were added to Guam's potable water supply (*DOI 1999*). Fena Lake is a surface reservoir located in the southern part of the island that is the primary water supply for the Navy.

Storm Water

Northern Guam has a relatively flat topography; during heavy rain events, precipitation flows from swales into retention basins (sinks) and then percolates into the ground. Conversely, southern Guam contains many mountainous regions and storm water in this portion of the territory is often accommodated by the rivers located in the upland areas of the mountains. In the more rural areas of Guam there are a series of grass strips located along the roadways that collect storm water runoff. The more urban areas of Guam are made up of a system of storm drains, outlets, sinks, and infiltration basins located along roadways that are owned and maintained by the Guam Department of Public Works (*Parsons Transportation Group 2010*).

6.1.2. Soils

6.1.2.1. Introduction

This section discusses the existing soil resources in Guam. Information is presented regarding soil features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

The Soil Science Society of America defines soil as:

> "(i) The unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants.
>
> (ii) The unconsolidated mineral or organic matter on the surface of the Earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics." *(NRCS 2015*)

Five primary factors account for soil development patterns. A combination of the following variables contributes to the soil type in a particular area (*Anderson et al. 2001*):

- *Parent Material:* The original geologic source material from the soil formed affects soil aspects, including color, texture, and ability to hold water.
- *Climate:* Chemical changes in parent material occur slowly in low temperatures. However, hot temperatures evaporate moisture, which also facilitates chemical reactions within soils. The highest degree of reaction within soils occurs in temperate, moist climates.
- *Topography:* Steeper slopes produce increased runoff, and, therefore, downslope movement of soils. Slope orientation also dictates the microclimate to which soils are exposed, because different slope faces receive more sunlight than others.

6.1.2.2. Specific Regulatory Considerations

Local or territory-level permits are required in Guam to reduce soil erosion and sedimentation associated with ground disturbance activities. In Guam, all projects that involve construction, clearing, and/or earth moving activities require a permit per the Soil Erosion and Sediment Control Regulations.[1] There are no other Guam-specific regulatory considerations that pertain to the Proposed Action outside of those discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and Appendix C, *Environmental Laws and Regulations*.

[1] See Section 6.2.2 for specific information related to best management practices that would be implemented to reduce or avoid potential impacts to soil resources.

6.1.2.3. Environmental Setting

Soil formation occurs due to complex and multiple interactions among geologic material, climate, topography, biological processes (such as vegetation growth and interactions with other organisms), and time. The soil resources present in Guam were identified, evaluated, and described using information gathered from and characteristics as defined by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) State Soil Geographic (STATSGO2) Soil Association Map Units (*STATSGO2 Database 2015*) database, the Soil Survey of Guam (*Soil Conservation Service 1985*), and the NRCS's Major Land Resources Areas (MLRAs) soil descriptions[2] (*NRCS 2006*).

Guam is located in the Pacific Basin land resource region, along with American Samoa and the Northern Mariana Islands. Within this region in Guam, the two major land resource areas consist of the High Limestone Plateaus of the Mariana Islands and the Volcanic Highlands of the Mariana Islands (see Figure 6.1.2-1).

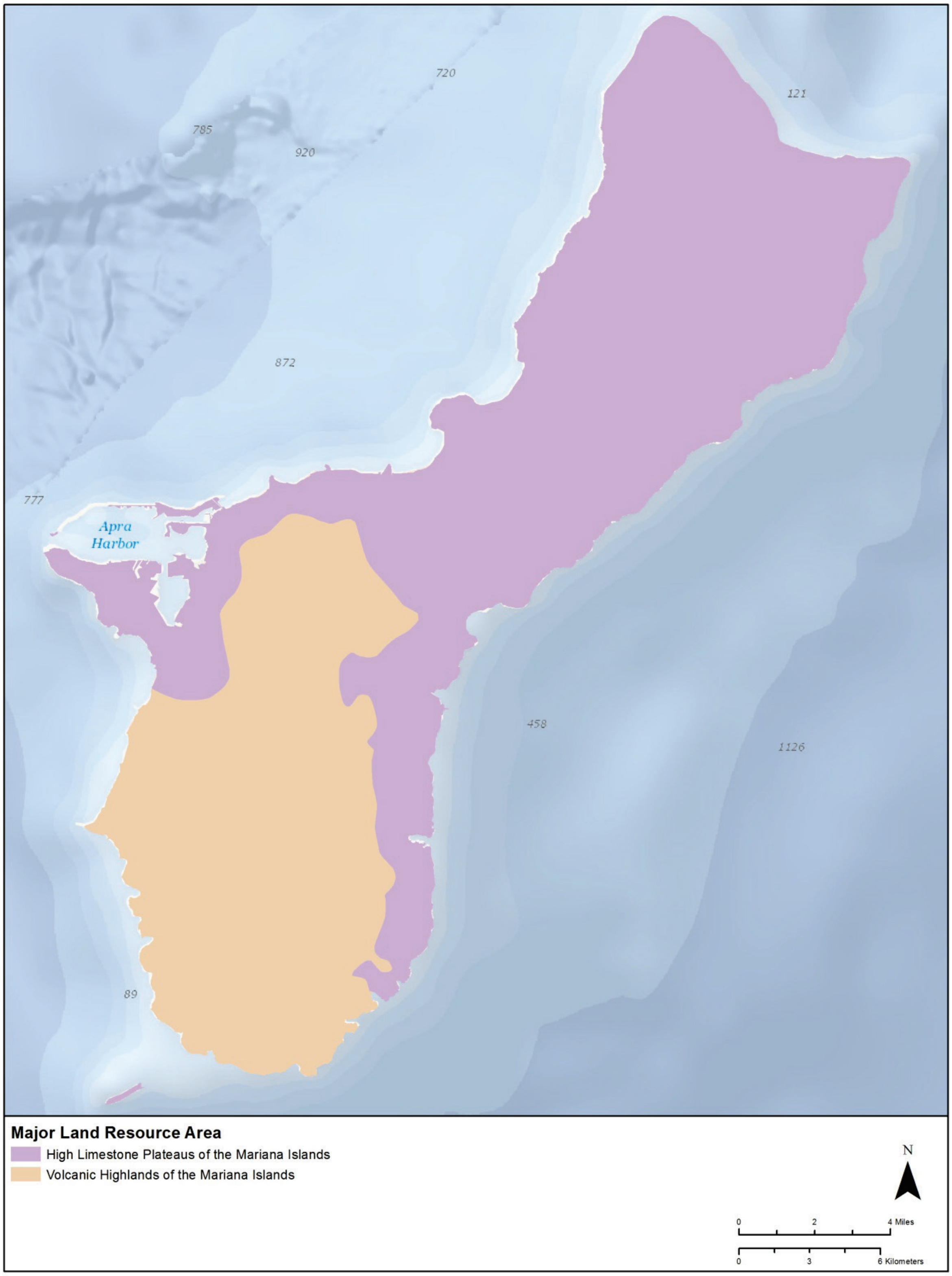
High Limestone Plateaus of the Mariana Islands

The High Limestone Plateaus of the Mariana Islands major land resource area encompasses the northern portion of Guam. The physiography of this area consists of steep cliffs and complex slopes in volcanic bedrock, as well as some gently sloping limestone plateaus. Coastline physiography ranges from cliffs to beaches and reef flats. Dominant soils in this major land resource area consist of highly weathered clays and are moderately well drained (*NRCS 2006*).

Volcanic Highlands of the Mariana Islands

The Volcanic Highlands of the Mariana Islands are located in the southern portion of Guam and make up a little over a third of the territory's land area. The inland areas of southern Guam consist of steep mountains dissected by streams and some rivers. Coastal areas in this major land resource area also consist of cliffs, beaches, and reef flats. Dominant soils are fine textured and range from well drained to somewhat poorly drained, and are shallow to deep (*NRCS 2006*).

[2] The NRCS categorizes soil resources into land resource units based on significant geographic differences in soils, climate, water resources, or land use. These land resource units are typically coextensive with general soil map units at the territory level. Geographically associated land resource units are further grouped into major land resource areas, which are then grouped into land resource regions. These large areas are important for territory-wide agricultural planning as well as interstate, regional, and national planning.



Source: NRCS 2006

Figure 6.1.2-1: Major Land Resource Areas of Guam

6.1.2.4. Soil Associations Map Units Characteristics

The STATSGO2 soil database identified eight soil associations or groupings of Map Unit Identification Data (MUID) in Guam.[3] Table 6.1.2-1 provides a summary of the major physical-chemical characteristics of the various soil types (soil series) found in Guam that make up the MUIDs, and Figure 6.1.2-2 (located after the table) depicts the distribution of the MUIDs. An MUID, or soils association, is made up of a landscape that has a distinctive proportional pattern of soil types, as shown in the map and table below. MUIDs normally consist of one or more major soil types. Each of the soil types that make up a given MUID are shown in the legend of the map and are listed in the table. A summary of the major soil characteristics relevant to the types of activities expected to be associated with the Proposed Action is presented in the table below.

Slope and Runoff and Erosion Potential

Slopes on Guam range from 0 to 99 percent (flat to very steep). The characteristic clay loam soils along with steep slopes tend to result in a moderate to high potential for runoff and erosion in the Akina, Agfayan, Pulantat, and Ritidian soil types, as indicated in Table 6.1.2-1. Generally, runoff and erosion diminish soil fertility as the topsoil is eroded away; this often leads to increased sedimentation in nearby surface waterbodies and can be exacerbated by ground disturbance activities. In addition, areas with very steep slopes with high potential for runoff and erosion are not well suited as construction locations. As explained in Section 6.1.2.3, Environmental Setting, both the High Limestone Plateaus of the Mariana Islands and the Volcanic Highlands of the Mariana Islands are characterized as having areas with relatively steep slopes.

Drainage Class and Permeability

With the exception of the Inarajan, Inarjan Variant, Ylig, and Chacha soil types found on valley bottoms, coastal plains, or basins, soils on the Guam MUID are characterized as well drained. Permeability ranges from slow to moderately rapid (see Table 6.1.2-1).

[3] Soil suborders were identified and described in the Alaska, Hawaii, and Puerto Rico Soils sections. Soil associations were used in the other Soils sections (including this one) as data at the suborder level would not provide meaningful detail for the smaller territories.

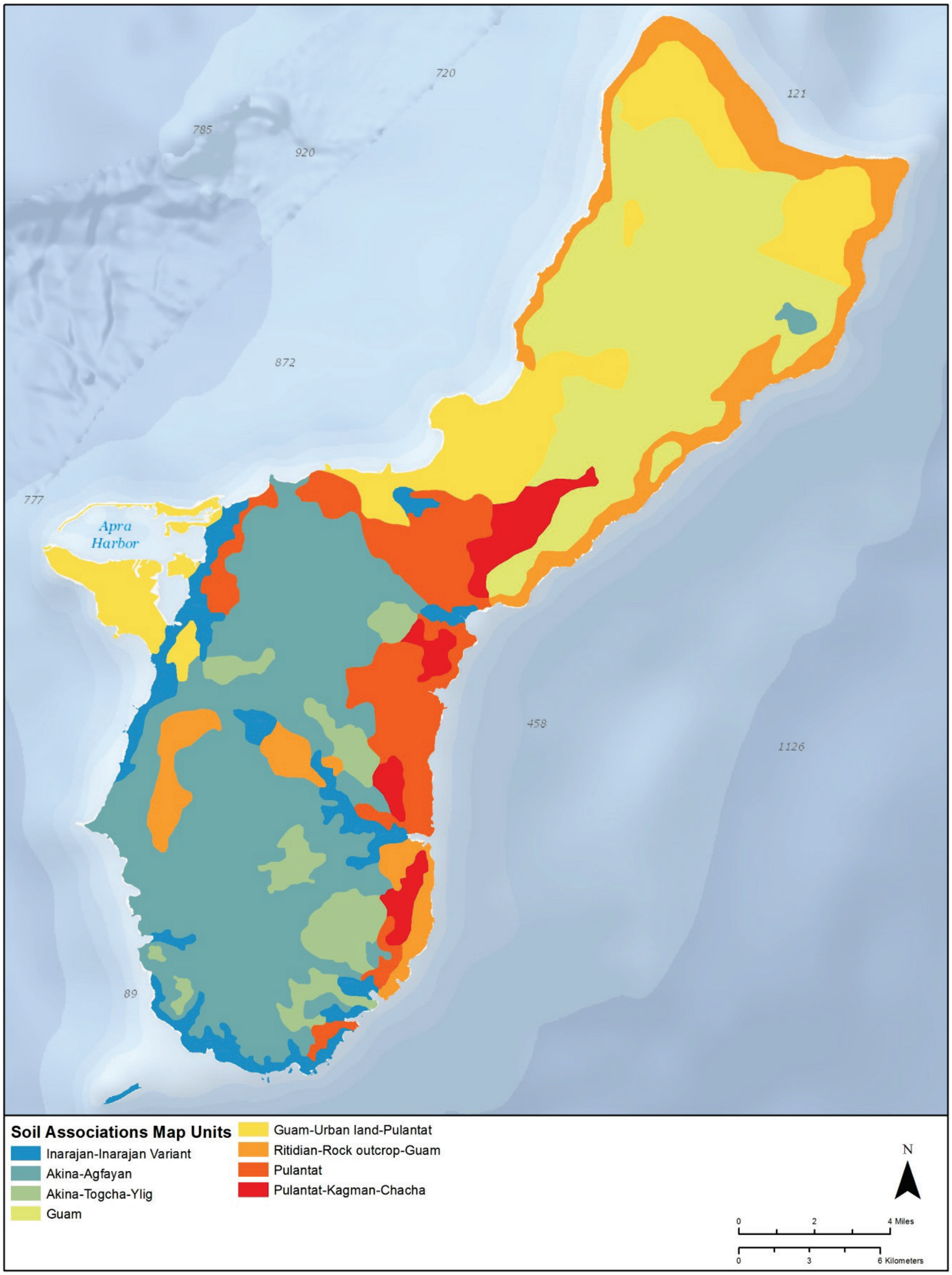
Table 6.1.2-1: Major Characteristics of MUIDs and Soil Types Found in Guam

MUID	Soil Type	Ecological Site Description	Soil Texture	Slope (%)	Runoff Potential	Erosion Potential	Drainage Class	Permeability[a]	Hydric Soil[b]	Depth to Bedrock (inches)	Compaction and Rutting Potential	Prime Farmland[c]
Inarjan - Inarjan Variant	Inarajan	Found on broad valley bottoms and coastal plains; most areas are farmed in dry season, some areas used for wildlife habitat and watershed conservation; areas not under cultivation are in water-tolerant forest and grasslands.	Clay	0 - 4	Low	Slight	Somewhat poorly drained	Slow	Some[d]	Over 60; some areas as shallow as 40 over limestone	Moderate to high	No
	Inarajan Variant	Found on coastal plains along western coast; well suited for wetland wildlife habitat.	Clay	0 - 3	Low	Slight	Somewhat poorly drained	Moderately slow	Some[d]	Over 60	Moderate to high	No
Akina - Agfayan	Akina	Found on gently sloping to very steep volcanic uplands; well suited for wildlife habitat and watershed; vegetation in most areas is savannah; some areas are farmed with watermelon, cucumber, and cantaloupe.	Silty clay	0 - 99	Moderate to high	Slight to severe	Well drained	Slow	No	20 - 40	Moderate	No
	Agfayan	Found on sloping to very steep uplands; commonly used for wildlife habitat and watershed; vegetation is mainly savannah dominated by swordgrass; in some places this soil is forested	Clay	7 - 99	High	Severe	Well drained	Moderately slow	No	4 - 15	Moderate	No
Akina - Togcha - Ylig	Akina	Found on gently sloping to very steep volcanic uplands; well suited for wildlife habitat and watershed; vegetation in most areas is savannah; some areas are farmed with watermelon, cucumber, and cantaloupe.	Silty clay	0 - 99	Moderate to high	Slight to severe	Well drained	Slow	No	20 - 40	Moderate	No
	Togcha	Found on rolling volcanic uplands; many areas are farmed, other areas are in savannah and are used for watershed and wildlife habitat.	Silty clay	3 - 15	Low to moderate	Moderate	Well drained	Moderate	No	Over 60	Moderate	Some, 3 to 7 percent slopes
	Ylig[e]	Found in seep areas on concave hillsides and in drainageways; used for watershed and wildlife habitat; vegetation is mostly water-tolerant forest and grass species; some areas farmed in dry season.	Clay loam	0 - 15	Moderate	Moderate	Somewhat poorly drained	Moderately slow	Yes	Over 60	Moderate to high	No
Guam	Guam	Found on sloping to strongly sloping limestone plateaus; commonly used for urban development, row crops, and as watershed conservation and wildlife habitat; areas not urbanized or cultivated are in forest.	Clay loam	0 - 15	Low	Slight to moderate	Well drained	Moderately rapid	No	2 - 10	Moderate	Some, 0 to 7 percent slopes
Guam - Urban Land - Pulantat	Guam	Found on sloping to strongly sloping limestone plateaus; commonly used for urban development, row crops, and as watershed conservation and wildlife habitat; areas not urbanized or cultivated are in forest.	Clay loam	0 - 15	Low	Slight to moderate	Well drained	Moderately rapid	No	2 - 10	Moderate	Some, 0 to 7 percent slopes
	Urban Land	Consists of areas covered by roads, buildings, parking lots, airfields, and other impervious surfaces.	—	0 - 3	Low	Slight	—	Slow	No	—	—	No
	Pulantat	Found on upland plateaus and hills; most areas are in forest and are used as wildlife habitat and as watershed; a few areas are farmed and some areas are urbanized.	Clay	3 - 60	Moderate to high	Moderate	Well drained	Slow	No	10 - 20	Moderate	No
Ritidian - Rock Outcrop - Guam	Ritidian	Found on limestone plateaus and escarpments; used for wildlife habitat and as watershed; vegetation is native forest.	Clay	3 - 99	Moderate to high	Moderate to Severe	Well drained	Moderately Rapid	No	2 – 10	Moderate	No
	Guam	Found on sloping to strongly sloping limestone plateaus; commonly used for urban development, row crops, and as watershed conservation and wildlife habitat; areas not urbanized or cultivated are in forest.	Clay loam	0 - 15	Low	Slight to moderate	Well drained	Moderately rapid	No	2 - 10	Moderate	Some, 0 to 7 percent slopes
Pulantat	Pulantat	Found on upland plateaus and hills; most areas are in forest and are used as wildlife habitat and as watershed; a few areas are farmed and some areas are urbanized.	Clay	3 - 60	Moderate to high	Moderate	Well drained	Slow	No	10 - 20	Moderate	No

MUID	Soil Type	Ecological Site Description	Soil Texture	Slope (%)	Runoff Potential	Erosion Potential	Drainage Class	Permeability[a]	Hydric Soil[b]	Depth to Bedrock (inches)	Compaction and Rutting Potential	Prime Farmland[c]
Pulantat - Kagman - Chacha	Pulantat	Found on upland plateaus and hills; most areas are in forest and are used as wildlife habitat and as watershed; a few areas are farmed and some areas are urbanized.	Clay	3 - 60	Moderate to high	Moderate	Well drained	Slow	No	10 - 20	Moderate	No
	Kagman	Found on uplifted limestone plateaus; most areas are forested, some areas are grazed or used for vegetable cropping, some areas urbanized.	Clay	0 - 15	Moderate	Moderate	Well drain	Moderately slow	No	60 – over 80	Moderate	Some, 0 to 7 percent slopes
	Chacha	Found in concave, basin positions on limestone plateaus; vegetation consists of mainly row crops such as beans, cucumbers, or melons, or fallow in grasses and forbs; some areas are forested.	Clay	0 - 7	Very low	Low	Somewhat poorly drained	Slow	No	Over 60	Moderate to high	No

Sources: Soil Conservation Service 1985; STATSGO2 Database 2015

[a] Permeability refers to the ability and pace of the soil to allow water to pass through it.
[b] Hydric soils are explained in the text above.
[c] Prime farmland is land that possesses the required characteristics for producing food, feed, fiber, and oilseed crops. None of the soil types qualify as prime farmland in their entirety, but some of the components of the soil types indicated meet the requirements of prime farmland when irrigated. Prime farmland is further discussed in Section 6.1.7, Land Use, Airspace, and Recreation.
[d] Includes some hydric inclusions depending on their location in the landscape.
[e] In general, Ylig soils and those above in this table are found on bottom lands; the rest below are on limestone bluffs.



Source: STATSGO2 Database 2015

Figure 6.1.2-2: Soil Associations Map of Guam

Hydric Soils

Hydric soils are formed under wet conditions, such as in low-lying areas prone to flooding or ponding, or areas with poorly drained soil types. In order for hydric soils to develop, these areas must be wet long enough during the growing season to develop anaerobic conditions that support the growth of water-tolerant vegetation, such as the vegetation found in certain wetland environments. The Ylig soil type mentioned above is classified as a hydric soil. Hydric inclusions occur in the Inarjan and Inarjan Variant soils depending on location in the landscape.

Soil Depth to Bedrock

Depth to bedrock for half of all the mapped soil types is less than 5 feet. Depth to bedrock for the rest of the soils is greater than 5 feet.

Compaction and Rutting Potential

Compaction and rutting[4] potential for soils found on Guam are is generally moderate given the soil textures and drainage classes of the soils present. Clay, clay loam, and silty clay soils tend to have moderate resistance to compaction and rutting, particularly when well drained. Of the soils present on Guam, the Inarajan, Inarjan Variant, Ylig, and Chacha likely have the greatest potential for compaction and rutting because these soil types are somewhat poorly drained and are found on valley bottoms, coastal plains, or basins in wet areas. Wet soils tend to have a lower resistance to compaction and rutting than dry soils.

[4] A soil rut is a sunken track or groove made by vehicle or equipment activity.

6.1.3. Geology

6.1.3.1. Introduction

This section discusses the geologic resources and hazards in Guam. Information is presented regarding geologic features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action, as well as geologic hazards that could potentially affect the Proposed Action.

The United States (U.S.) Geological Survey (USGS) is the primary government organization responsible for the nation's geological resources. The USGS defines geology as an interdisciplinary science with a focus on the following aspects of earth sciences: geologic hazards and disasters, climate variability and change, energy and mineral resources, ecosystem and human health, and groundwater availability. Several of these elements are discussed in other sections of this Draft Programmatic Environmental Impact Statement, including climate change (Section 6.1.14, Climate Change), biological resources (Section 6.1.6, Biological Resources), human health (Section 6.1.15, Human Health and Safety), and groundwater (Section 6.1.4, Water Resources).

6.1.3.2. Specific Regulatory Considerations

There are no Guam-specific regulatory considerations that pertain to geologic resources outside of those discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and Appendix C, *Environmental Laws and Regulations*.

6.1.3.3. Environmental Setting

General Geologic Resources

Guam, as well as the islands that make up the Northern Mariana Islands, is a volcanic island formed as a result of magma released as the Pacific Plate slid beneath the Philippine Sea Plate (*Mueller et al. 2012; Tarbuck and Lutgens 1996*).[1] Therefore, volcanic rocks form the geologic and structural base of Guam (*Gingerich 2003*). Later in geologic time, limestone rocks were deposited over much of what is now the island of Guam.[2] Figure 6.1.3-1 shows the various upper-most rock unit ages present in Guam either at the surface or beneath overlying soils and sediment; Table 6.1.3-1 describes the geologic formations and rock types associated with each of these unit ages.

[1] The Pacific and Philippine Sea Plates are tectonic plates located within portions of the Pacific Ocean and Philippine Sea, respectively. Tectonic plates are the solid pieces of rock (or earth) that collide, move apart, or slide past each other over geologic time. The Pacific plate is moving westward at a rate of about 3 inches per year (*Mueller et al. 2012*). See Section 7.1.3, Geology, for a description of the geologic setting in the Northern Mariana Islands.

[2] Limestone is a sedimentary rock that consists of calcium carbonate and can be deposited either by direct precipitation out of sea water, or by biochemical processes such as coral reefs that secrete calcium carbonate as part of their structure.

Source: Water and Environmental Research Institute of the Western Pacific and Island Research and Education Initiative Undated

Figure 6.1.3-1: Geologic Rock Unit Ages in Guam

Table 6.1.3-1: Geologic Rock Unit Ages in Guam

Name[a]	Dominant Formation Name(s)	General Rock Type
Eocene	Facpi formation	Volcanic
Eocene and Oligocene	Alutom formation	Volcanic
Oligocene	Alutom formation	Volcanic
Miocene	Umatac formation	Volcanic and limestone
Miocene and Pliocene	Bonya Limestone, Alifan Limestone, and Janum Formation	Limestone
Pliocene and Pleistocene	Mariana Limestone	Limestone
Quaternary	NA	Beach deposits, reef limestone, sand and gravel

Source: Water and Environmental Research Institute of the Western Pacific and Island Research and Education Initiative Undated; Gingerich 2003

NA = not applicable
[a] Rock unit names correspond to the names in Figure 6.1.3-1 and are listed from oldest (top) to youngest (bottom).

As shown in the table and figure above, and as described in Section 6.1.2, Soils, the northern portion of Guam consists primarily of younger limestone rocks near the surface, whereas the southern portion is dominated by older volcanic rocks. The general topography and physiographic[3] characteristics of the northern limestone areas consist of gently sloping limestone plateaus with coastline areas ranging from cliffs to beaches and reefs (*NRCS 2006*). The southern volcanic portion consists of steep mountains dissected by streams and some rivers (*NRCS 2006*).[4]

Mineral and Fossil Fuel Resources

A survey analysis conducted by the South Pacific Applied Geoscience Commission in 1984 and 1985 revealed manganese nodules[5] and cobalt-rich iron/manganese deposits surrounding Guam offshore *(SOPAC 1996)*. Although no known exploration or excavation of these minerals has commenced to date, there is ongoing discussion about the management of deep sea mining and mineral resources throughout the islands of Micronesia *(SOPAC 1996)*. The European Union is collaborating with the Secretariat of the Pacific Community to support a Deep Sea Minerals Project *(SPC-EU 2013)*. The project aims to help prepare and equip Pacific Island countries to manage deep sea mineral resources while protecting the environment and preserving island culture. Informational development workshops have been held throughout the region, the seventh and most recent of which was held in Fiji in August 2015 *(SPC-EU 2013)*.

In addition, Guam produces crushed stone, and it was reported that the production value significantly increased in 2010 and 2011; however, the production data are not published by USGS since they are proprietary (*USGS 2015a*).

[3] Physiography refers to the description of the Earth's landforms and surface features.
[4] Section 6.1.2, Soils, provides an explanation of the topography and physiographic characteristics and corresponding soil characteristics in Guam as they relate to the territory's land resource area.
[5] Manganese nodules are nodular concretions of manganese and iron oxides that occur on the ocean floor as a result of direct precipitation of minerals from seawater (*Hein et al. 2005*).

Guam does not produce or consume natural gas or coal, and all of the petroleum that Guam consumes is imported and routed through its only port at Apra *(EIA 2014)*. Guam's petroleum product imports total approximately 7,000 barrels per day *(EIA 2014)*. Electricity on the island is generated with petroleum products. Approximately half of the petroleum consumed annually is residual fuel oil, while the other half is a combination of motor gasoline, jet fuel, diesel fuel, and propane *(EIA 2014)*. See Section 6.1.1, Infrastructure, for additional information related to energy use and sources in Guam.

Paleontological Resources[6]

Few paleontological studies of Guam, or the surrounding Pacific islands as a whole, have been widely circulated. Despite volcanic activity and some potential for lava-flow preservation, paleontological resources are susceptible to serious storm damage (*NPS Undated*). Therefore, the likelihood of successful archeological and paleontological searches and discoveries is reduced. However, there was a distinct finding that received attention from the scientific community in 2002. A large number of fossil decapods[7] were found on t Guam within Pleistocene deposits (see Figure 6.1.3-1), including several discoveries of novel decapod crustacean species *(Schweitzer et al. 2002*). Earlier research efforts have identified fossilized algae, corals, and mollusks in numerous locations on Guam within various limestone formations (*Johnson 1964; Schlanger 1964*).

6.1.3.4. Geologic Hazards

Geologic hazards exist in many areas in Guam, including seismic activity, landslides, and land subsidence.

Seismic and Volcanic Activity

As mentioned above, Guam is situated near the Pacific Plate - Philippine Sea Plate boundary, and the movement and friction along the plate boundary is primarily responsible for the frequent earthquake activity (*Mueller et al. 2012*). In April and May of 1997, for example, two earthquakes of magnitudes 6.2 and 6.0, respectively, caused damage in Guam (*Earthquake Engineering Research Institute 1997*).[8] Additionally, an earthquake with a magnitude of 8.1 occurred in August of 1993 and caused significant damage to structures and injuries to people (*Earthquake Engineering Research Institute 1993*). According to USGS, the entire island of Guam has a high seismic hazard risk (*Mueller et al. 2012*).[9] Information related to real-time, historical, and significant earthquakes can be obtained via the USGS Earthquake Hazards Program website (*USGS 2015b*).

[6] Paleontological resources, or fossils, are the physical remains of plants and animals that have mineralized into or left impressions in solid rock or sediment.

[7] Decapods are types of crustaceans. Common crustacean examples include crayfish, crabs, and lobsters.

[8] Earthquakes with magnitudes of 3 or less are generally not felt. Magnitudes greater than 6 can cause widespread damage (*USGS 2012*).

[9] Data from USGS showing the levels of horizontal ground shaking that have a 10 percent probability of exceedance in 50 years indicate high seismic hazards throughout the entire island of Guam. See *Mueller et al. 2012* for additional information related to seismic hazard prediction models for Guam.

Earthquakes can lead to abrupt disturbances of the ocean floor and ocean water that can cause tsunamis. Tsunamis are large ocean waves that form as a result of water displacement (*USGS 1997*). The source of a tsunami in Guam can originate from anywhere in the Pacific Ocean, or locally as a result of earthquakes on or near the island (*USGS 1997*). For example, the August 1993 earthquake mentioned above triggered a tsunami that caused widespread damage (*Lander and Whiteside 2002*). Besides the 1993 event, Guam has had only two other recorded tsunamis that caused damage at more than one location (in 1849 and 1892). An estimated additional two to six locally generated tsunamis have been observed in the past 200 years, although those could not be confirmed as true tsunamis (*Lander and Whiteside 2002*).

Unlike many of the Northern Mariana Islands to the north, Guam is not currently volcanically active.[10]

Landslides

The term "landslide" refers to processes that lead to the downhill movement of earth materials due to gravity and other forces (*USGS 2004*). In Guam, excessive rainfall and seismic activity can trigger landslides, especially near areas that have steep slopes with loose or unconsolidated material. According to Guam's Hazard Mitigation Plan, all slopes in Guam with an angle of 30 percent or more are classified as having a moderate to high landslide potential. Slopes less than 5 percent are considered to have a low potential for landslides (*Guam.gov 2011*). Only flat areas along the eastern coast and around Apra Harbor (east-central Guam) have a low potential for landslides (*Guam.gov 2011*).

Land Subsidence

Land subsidence is the downward settling or sudden sinking of the Earth's surface (*USGS 2013*). The main causes of land subsidence may include groundwater level declines, drainage of organic soils, underground mining, excessive wetting of soils, natural compaction, sinkholes, and thawing permafrost (*USGS 2013*). As is the case with karst topography[11], land subsidence can also occur in areas with an abundance of underlying soluble rocks and minerals, such as limestone, gypsum, or salt, which have the potential to dissolve in water and wash out from the area (*USGS 2013*). As mentioned above, the northern portion of Guam consists almost entirely of limestone rocks. As a result, this region consists almost entirely of karst terrain and is characterized as having numerous sinkholes. Karst terrain in southern Guam is found in some of the limestone units, including near the southeastern coast (*Guam.gov 2011*).

[10] See Section 7.1.3, Geology, for a discussion of volcanic activity on the Northern Mariana Islands.

[11] "Karst is a terrain with distinctive landforms and hydrology created from the dissolution of soluble rocks, principally limestone and dolomite. Karst terrain is characterized by springs, caves, sinkholes, and a unique hydrogeology." (*USGS Undated*)

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6.1.4. Water Resources

6.1.4.1. Introduction

This section discusses water resources in Guam, including surface water, floodplains, nearshore marine waters, and groundwater. Information is presented regarding features and characteristics of these waters that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Water resources are defined as all surface water bodies and groundwater systems including streams, rivers, lakes, canals, ditches, estuarine waters, floodplains, aquifers, and other aquatic habitats (wetlands are discussed separately in Section 6.1.5, Wetlands). These resources can be grouped into watersheds, areas of land whose flowing water resources (including runoff from rainfall) drain to a common outlet such as a river or ocean. The value and use of water resources are influenced by the quantity and quality of water available for use and the demand for available water. Water resources are used for drinking, irrigation, industry, recreation, and as habitat for wildlife. Some water resources that are particularly pristine, sensitive, or of great economic value enjoy special protections under federal and state laws. An adequate supply of water is essential for human health, economic wellbeing, and the maintenance of natural infrastructure and ecological services (*USGS 2014*).

6.1.4.2. Specific Regulatory Considerations

Water quality is federally regulated pursuant to the Clean Water Act (CWA) (see Section 1.8.7, Clean Water Act), which is administered in Guam by the Guam Environmental Protection Agency.

The Sole Source Aquifer (SSA) protection program, authorized under the Safe Drinking Water Act (*42 United States Code Section 300f* et seq.) is designed to protect drinking water in areas with few or no alternatives to the groundwater resource and where, if contamination occurred, using an alternative source of drinking water would be extremely expensive. The U.S. Environmental Protection Agency defines an SSA as one that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. Any potential effects to SSAs or other critical aquifers, or that adversely affect any surface water supplies, would be controlled through these requirements.

The National Flood Insurance Program (NFIP) is a federal program managed by the Federal Emergency Management Administration (FEMA) that allows property owners in participating communities to purchase flood insurance with rates established through the National Flood Insurance Rate Maps. In Alaska, the Department of Community and Economic Development has been designated as the State Coordinating Agency responsible for administering the program. Implemented regulations include the Floodplain/Wetlands Environmental Review Requirements (*10 Code of Federal Regulations 1022.12*) and *Executive Orders 11988* and *13960* (see Sections 1.8.10, Executive Order 11988 – Floodplain Management, and 1.8.14, Executive

Order 13690 – Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input, respectively).

Guam implements the Coastal Zone Management Act (see Section 1.8.8) through its Guam Coastal Management Program, which was approved in 1979 and is overseen by the Guam Bureau of Statistics and Plans. The Coastal Management Program guides the use, protection, and development of land and land resources within Guam's coastal zone, which, because Guam is a small island, includes its entire land area. Additionally, Guam's coastal areas are managed under the territory's Seashore Protection Act (*21 Guam Code Annotated Chapter 63)*.

6.1.4.3. Environmental Setting

This section describes surface water, floodplain, nearshore marine, and groundwater features in Guam.

Inland Surface Water Characteristics

Surface waters in Guam include rivers, streams, lakes, and reservoirs (see Table 6.1.4-1). The amount of water in any surface water system is dependent upon quantity and timing of precipitation, storage in the watershed, soil permeability, climate and evaporation rates, and watershed land cover. Streams are present only in southern Guam, where low-permeability volcanic rocks slow the infiltration of rainwater and allow groundwater to discharge to streams (*Ward et al. 1965*). Because virtually all rainwater infiltrates the porous limestone substrate in northern Guam, water does not move across the surface in streams (*USGS 2003*).

Table 6.1.4-1: Total Surface Waters for Guam

Waters	Size	Units
Rivers and streams	228.7	miles
Bays and estuaries	915.0	square miles
Coastal shoreline	116.5	miles

Source: USEPA 2010

Stream hydrology in southern Guam is made up of rainfall and overland flow as well as groundwater; perennial and intermittent[1] streams also occur in southern Guam. Hydrologic data are available on streams where discharge and flow are measured with installed gages. Gaged streams in southern Guam receive about 25 to 50 percent of their flow from groundwater (*USGS 2003*).

[1] Perennial streams are those which normally have surface flow year-round in all or part of their course. Non-perennial streams are normally dry during part of the year.

Most streams originate in southern Guam's interior and drain to the coast (*Ward et al. 1965*). Watersheds in Guam are illustrated on Figure 6.1.4-1. There is one reservoir in Guam, the Fena Valley Reservoir, located in southern Guam and constructed in order to provide a water source to the U.S. Naval Base Guam and nearby residences (*USGS 2015*). Surface water supplies are generally used in the southern portion of Guam and supply about 20 percent of the drinking water for the island (*USGS 2003*).

Figure 6.1.4-2 depicts the spatial distribution of perennial and non-perennial streams in Guam. There are a total of 228.7 miles of rivers and streams in Guam (*USEPA 2010*).

Water quality of surface waters in Guam is regulated according to the CWA. The territory's inland waters are assigned to a set of water quality criteria depending on the beneficial uses that are to be protected. General designations of these areas include the following:

- Aesthetic enjoyment
- Aquatic life
- Consumption
- Drinking water (with and without treatment)
- Contact recreation (limited and whole body)

The territory's CWA 303(d) and 305(b) integrated water quality report (*USEPA 2010*) describes water quality conditions for waters in Guam. The report describes that a total of 84.7 miles of Guam's 228.7 miles of surface waters (37 percent) were assessed for water quality conditions in 2010. Of these 84.7 miles, 29.0 miles were found to be impaired. Total Maximum Daily Loads (TMDLs) are a regulatory tool used for impaired waterbodies, and describe a maximum amount of a pollutant that a waterbody can receive while still meeting water quality standards. TMDLs must be developed for all waterbodies on a state or territory's 303(d) list. TMDLs have been developed for 21.6 miles of these impaired waters, leaving TMDLs needed on 7.4 miles of impaired streams. Turbidity is the parameter for which standards are most often not met, followed by e coli bacteria and dissolved oxygen (*USEPA 2010*).

There are no wild and scenic rivers designated on Guam (*National Wild and Scenic Rivers Program 2015*).

Source: USDA Geospatial Data Gateway 2015

Figure 6.1.4-1: Spatial Distribution of Guam Watersheds

Source: USDA Service Center 2015

Figure 6.1.4-2: Spatial Distribution of Guam Surface Waters

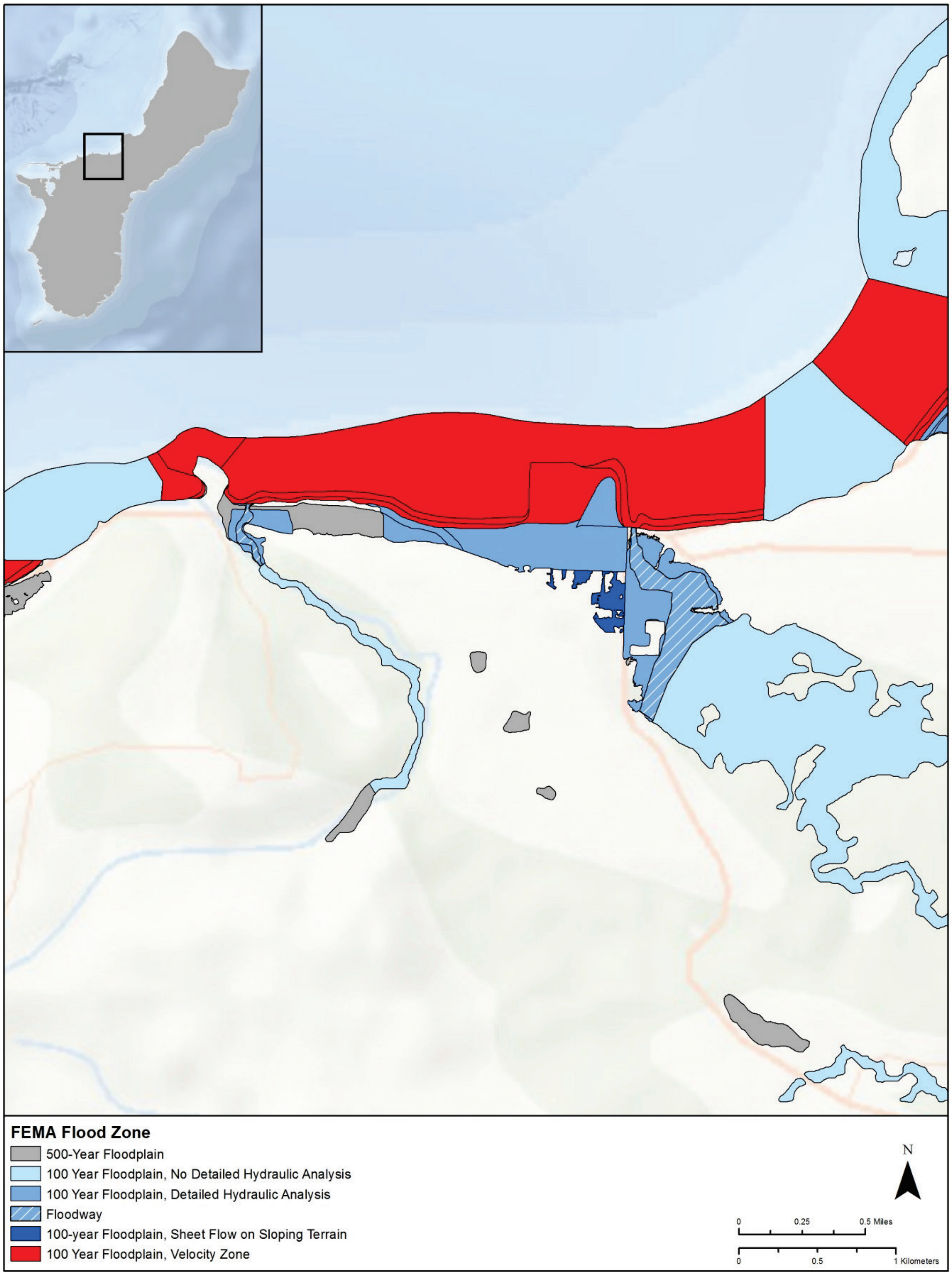
Floodplain Characteristics

Floodplains are lowland and flat areas adjoining inland and coastal waters. These areas are often prone to flooding, depending on streamflow amounts and timings. The FEMA maps 100-year floodplains on its NFIP Rate Maps, and defines 100-year floodplains as areas that have a 1 percent chance of being flooded in a given year. Regulations for 100-year floodplains include requirements for new development and substantial redevelopments of existing property to have certain flood resistant qualities. Flood insurance may also be required. Additionally, any fill of the floodplain by new development is limited so as to not increase flood elevations elsewhere in the floodplain. The 500-year recurrence interval flood is also included on FEMA NFIP floodplain maps; however, these events are rare and the 500-year floodplain is generally not regulated.

The low-permeability geology of southern Guam creates proportionally more overland flow, such that heavy rainfall, resulting from both typhoons and local storms, can cause intense flooding in southern Guam. As there are very few streams and a highly porous limestone layer in northern Guam, delineated floodplains in northern Guam are limited to primarily 500-year floodplains associated with disconnected low-lying areas that experience ponding.

FEMA NFIP floodplain maps are available for most of the United States. Often floodplain data are not available in areas where floodplain maps were not created because the areas are not flood prone (sometimes called map “panels not printed”). Guam’s NFIP maps are viewable online on FEMA’s Map Service Center (*FEMA 2015*), which allows the user to navigate to any location of the United States and, where data are available, zoom into any area to view flood zones. An example of flood data for Guam is provided in Figure 6.1.4-3. The land area shown in this figure is southwest of the Guam International Airport near Agana. The figure shows coastal areas, inland stream areas, and inland reservoirs of low accumulation areas prone to flooding. Interested parties are directed to FEMA’s Map Service Center[2] (*FEMA 2015*) to obtain more information on the location and extent of floodplains in Guam.

[2] https://msc.fema.gov/portal



Source: FEMA 2015

Figure 6.1.4-3: Example Floodplain Map for Guam Floodplains

Nearshore Marine Characteristics

The island of Guam contains approximately 116.5 miles of shoreline and 915 square miles of bays and harbors (*USEPA 2010*). Nearshore waters include estuaries,[3] bays and harbors, and recreational shorelines. Fresh water from streams, estuaries, and surface water runoff flows into nearshore marine waters. Land development and water use affect the way this water travels across the landscape, impacting both the quantity and quality of water reaching the coastal zone.

Shoreline waters are assessed for compliance with standards established for consumption and whole body contact recreation. Of the island's 116.5 miles of coastline, 16.1 miles were assessed for water quality conditions. All of the assessed coastlines were found to have water quality impairments; a TMDL has been developed for 5.8 miles of those. Impairment in these waterbodies is primarily due to pathogens, with some areas cited for polychlorinated biphenyls in fish tissue (*USEPA 2010*).

Bays and estuaries were assessed for compliance with standards established for aquatic life, consumption, and whole body contact recreation (*USEPA 2010*). Of the island's 915 square miles of bays and estuaries, 35.1 square miles were assessed for water quality conditions. Of those, 14.8 square miles were found to be impaired, none of which have had a TMDL developed (*USEPA 2010*).

Impairment in these waterbodies was primarily due to polychlorinated biphenyls in fish tissue, with a smaller portion of the impairment due to toxic organics and inorganics, metals, and pesticides (*USEPA 2010*).

Groundwater Characteristics

Groundwater is the water found underground in the cracks and spaces in soil, sand, and rock. It is stored in and moves slowly through geologic formations of soil, sand, and rocks called aquifers. Groundwater occurrence and quantities are generally dictated by geology. Groundwater supplies about 80 percent of drinking water in Guam, mostly from wells in the northern part of the island. Guam is formed from volcanic rock, which is overlain by limestone over about 60 percent of the island, mostly in the north (*Ward et al. 1965*). Groundwater resources are differentiated by whether or not they are overlain by limestone and are discussed as the northern (limestone) and southern (volcanic) areas (*USGS 2003*).

Guam's groundwater systems can be described as freshwater-lens and high-level groundwater types. Freshwater-lens systems are systems where freshwater floats on saltwater separated by a transition zone of brackish water, found in areas where groundwater is not held up by impermeable barriers. Groundwater flows generally from the interior of the island toward the coast. The major fresh groundwater systems are freshwater-lens systems, although minor perched[4] systems can occur above the lowest water table (*USGS 2003*). Northern Guam's limestone rocks house a freshwater-lens aquifer. This freshwater-lens system is recharged by

[3] Estuaries are defined as coastal areas where salt water from the sea mixes with rivers and streams, and may be called bays, harbors, inlets, lagoons, or estuaries.
[4] Perched groundwater is an aquifer that occurs above the regional water table, separated by an impermeable or relatively impermeable layer of rock or sediment.

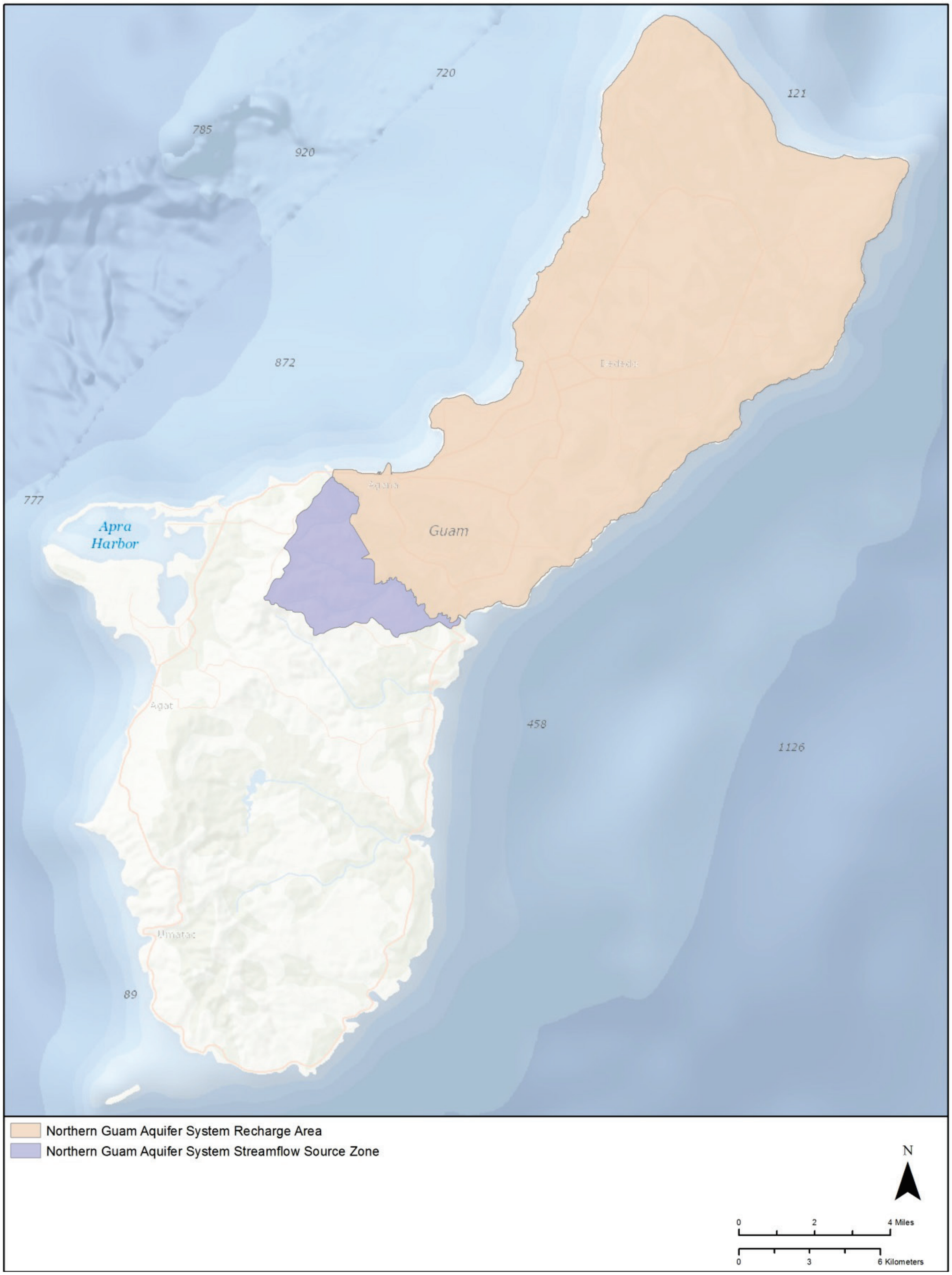
direct infiltration of rainfall and by inflow from perched groundwater systems. Limestone in this area is highly permeable, such that rapid infiltration of rainfall occurs, and little water is left for overland flow. Perched groundwater is found in areas where low permeability rocks impede movement of groundwater down to the basal system (*USGS 2003*).

High-level groundwater is generally found primarily in southern Guam where volcanic rock influences where water is present and where it can move. Southern Guam's geology is primarily low-permeability volcanic rocks, thus less rainfall infiltrates and less groundwater resources are available, resulting in minor perched aquifer systems, which are generally unavailable via well drilling (*Ward et al. 1965*). In southern Guam, groundwater often discharges to stream valleys above sea level where the ground surface intersects the water table, constituting about 25 to 50 percent of streamflow in these areas (*USGS 2003*).

Groundwater withdrawal intensified during World War II, reducing freshwater-lens system and creating widespread intrusion of salt water into the aquifer (*Ward et al. 1965*). Additional factors that may contribute to saltwater intrusion include excessive rates of groundwater withdrawal from a single well, a cluster of wells too closely spaced, wells that are drilled too deeply into the freshwater lens, or higher permeability geologic units that allow increased mixing of freshwater with the underlying saltwater.

As discussed in Section 6.1.4.2, the SSA[5] protection program protects groundwater in areas with no drinking water source that could physically, legally, and economically supply all those who depend on the aquifer for drinking water. This designation requires the USEPA to review certain proposed projects within the designated area, and all proposed projects receiving federal funds are subject to review to ensure they do not danger the water source. The northern portion of Guam is covered by two SSA areas: the Northern Guam Aquifer System Recharge Area SSA and the Northern Guam Aquifer System Streamflow Source Zone SSA (*USEPA 2014*; see Figure 6.1.4-4).

[5] The U.S. Environmental Protection Agency defines an SSA as one that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer.



Source: USEPA 2009

Figure 6.1.4-4: Spatial Distribution of Guam Aquifers

6.1.5. Wetlands

6.1.5.1. Introduction

This section discusses wetland resources on Guam. Information is presented regarding wetland features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Wetlands are a subset of Waters of the United States (U.S.), defined for regulatory purposes by the U.S. Environmental Protection Agency under the Clean Water Act (CWA) as those areas that are inundated or saturated by surface or groundwater 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 (*USEPA 2004*). Similarly, the U.S. Fish and Wildlife Service (USFWS) classification system (*Cowardin et al. 1979)* defines wetlands as "…lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water…" (*Cowardin et al. 1979).*Wetlands can be vegetated or non-vegetated, but where vegetation is present, the plants are adapted for life in saturated or flooded soil. Examples of wetlands include marshes, bogs, ponds, intertidal areas, and estuaries.[1]

In contrast to wetlands, deepwater habitats (referred to as waters) are defined as any "permanently flooded lands lying below the deepwater boundary of wetlands" (*Cowardin et al. 1979)*. Waters are typically non-vegetated, have a bed and bank, and include intermittent, ephemeral, or perennial streams[2], rivers, or standing water (e.g., lakes). Waters are not included in this wetlands section, as they are discussed in Section 6.1.4, Water Resources.

The Environmental Protection Agency estimates that "more than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half of such species use wetlands at some point in their lives" (*USEPA 1995*). In addition to providing habitat for many plants and animals, wetlands also provide benefits to human communities. Wetlands store water during flood events, improve water quality by filtering polluted runoff, help control erosion by slowing water velocity and filtering sediments, serve as points of groundwater recharge, and help maintain base flow in streams and rivers. Additionally, wetlands provide recreation opportunities for people, such as hiking, bird watching, and photography.

6.1.5.2. Specific Regulatory Considerations

Under Section 404 of the CWA (Section 404), activities that adversely affect Waters of the U.S., including wetlands, must be authorized through a Section 404 permit issued by the U.S. Army Corps of Engineers, and adverse impacts must be mitigated to the extent practicable. Locally, the Guam Environmental Protection Agency (Guam EPA) requires the completion of an

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[1] Estuaries are found where salt water from the sea mixes with rivers and streams.

[2] Intermittent streams carry water part of the year (generally winter and spring), ephemeral streams carry water only as a result of precipitation (any time of year), and perennial streams are those convey water year round under normal precipitation conditions (*NCDEQ Undated*).

Samoa Department of Commerce (*American Samoa DOC 2015*). The PNRS process considers public health, safety, and environmental impacts (including impacts to wetlands) as part of the review process for proposed development projects. The American Samoa Environmental Protection Agency is part of the PNRS, providing review of environmental impacts. The American Samoa Coastal Management Program (ASCMP) promotes the management of natural resources in coastal areas, including wetlands, through environmental review of land use activities, land use planning, restoration activities, and education and outreach. The ASCMP manages the Community Based Wetlands Management Program, a grassroots resource management approach whereby villages can participate in managing their local wetlands (*American Samoa DOC 2015*).

The following government agencies are also involved in local wetland management and regulation in American Samoa: National Parks Service; Consolidated Farm Service Agency; Natural Resource Conservation Service; National Oceanic and Atmospheric Administration; U.S. Fish and Wildlife Service; U.S. Environmental Protection Agency; State Department of Marine and Wildlife Resources; Department of Parks and Recreation; Department of Public Works; Economic Development Planning Office; village leaders and councils; and the Zoning Board (*USGS 1996*). Additional guidance on compliance with American Samoa government environmental regulations can be found at the American Samoa Environmental Protection Agency website[3] (*American Samoa EPA 2015*).

Several large portions of American Samoa are protected; the primary protected areas include the National Park of American Samoa, National Marine Sanctuary of American Samoa (formerly Fagatele Bay National Marine Sanctuary), and the Rose Atoll National Monument.

5.1.5.3. Environmental Setting

As mentioned above, wetlands are recognized as important for maintaining watershed and environmental health due to their potential to perform various ecological, hydrologic, biogeochemical, and social functions, although not all wetlands perform these functions equally. Typical wetland functions include bank stabilization, flood mitigation, maintenance of water quality, maintenance of fish and wildlife habitat, sediment retention, groundwater discharge and recharge, and maintenance of nutrient retention and export. Their capacity or degree to which they perform individual functions depends on the wetland characteristics including soil type, substrate, type and percent cover of vegetation, water source, landscape position, location within a watershed, and location relative to populated areas (*USGS 1997*). As part of CWA Section 404 permitting, a wetland functional assessment is typically used to place wetlands into one of three categories, with Category 1 wetlands being the highest quality and/or functioning wetlands (and/or rare types); Category 2 wetlands being of moderate to high quality and/or function; and Category 3 wetlands being lower quality and/or functioning wetlands (and/or more common types). While a formal assessment of wetland functions and categorization is beyond the scope

[3] http://www.epa.as.gov/

> cliff-bound seaward coast fringed by coral reefs characterize a broad, gently undulating limestone plateau in the northern half. Volcanic formations and perennial streams with fringing reefs make up the southern half.
>
> It is within the northern plateau that the largest source of fresh groundwater on the island can be found. That "water table" lies beneath the highly permeable limestone plateau and consists of a … lens system of freshwater floating upon a seawater base. The lens is charged by rainwater percolating through the limestone catchment, and surfaces at coastal regions near sea level forming freshwater caves, springs and seeps. Small lakes, marshes or even short streams may be fed by this lens.
>
> Grassy flats in the central area are important for the recharge of the central aquifer which is a much smaller lens, yet the lens least affected by saltwater intrusion. Some water from this aquifer reaches the surface at Agana Springs and disperses into the Agana Swamp.
>
> The south contains two basic volcanic formations, the Alutom formation and the Umatac formation. There are approximately 40 rivers and streams that form a surface drainage pattern that meanders through ravine forests, floodplains, and wetlands."[4,5] (*Siha 1991, p 4*).

For specific information about Guam's soils, see Section 6.1.2, Soils. The water resources on Guam are discussed in more detail in Section 6.1.4, Water Resources.

Wetlands were assessed using the USFWS National Wetland Inventory (NWI) (*USFWS 2015*), which maps and classifies wetlands using the NWI classification system (*Cowardin et al. 1979*). NWI for Guam was mapped using aerial imagery from 1975 at a scale of 1 to 24,000. NWI mapping is created exclusively using geographic information system-based methods, with limited ground truthing as required by the Federal Geographic Data Committee standards[6]. For Guam, NWI mapping field checks were completed in 1983 (*USFWS Undated*). For the purpose of this Draft Programmatic Environmental Impact Statement, the NWI mapping is the best available territory-wide wetland mapping, and is considered to be of sufficient accuracy to assess wetland locations and type. The NWI mapping includes both wetlands and waters, of which only wetlands are included in this section. For the purpose of this assessment, all areas that are classified by the NWI (per *Cowardin et al. 1979*) as either palustrine,[7] marine intertidal,[8] and estuarine intertidal[9] were included as wetlands. The remaining classifications were unvegetated

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[4] Perennial streams are streams that normally have surface flow year-round in all or part of their course; a lens is a layer of freshwater that floats on top of saltwater; an aquifer is an underground layer of water.

[5] See Figure 6.1.5-3 for a map of Guam wetlands types.

[6] Federal Geographic Data Committee standards web site: http://www.fgdc.gov/standards

[7] Palustrine wetlands: Includes all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand.

[8] Marine intertidal: Areas of open ocean associated with high energy coastline where the substrate is exposed and flooded by tides (*Cowardin et al. 1979*).

[9] Estuarine intertidal: Coastal areas usually semi-enclosed by land but have open partially-obstructed access to open ocean. Water is partially diluted by freshwater runoff.

waters and were not included in this assessment: marine subtidal, estuarine subtidal, lacustrine (lake-based), and riverine (river-based) (*Cowardin et al. 1979*). These waters areas are assessed in Section 6.1.4, Water Resources.

6.1.5.4. Wetland Characteristics

Wetlands on Guam include swamps, marshes, mangroves, natural ponds, springs, and estuaries. A total of approximately 3,843 acres of wetlands are mapped for Guam (*USFWS 2015a)*, which represents 2.8 percent of the total area of the territory, lower than the approximately 5.5 percent of total area comprised of wetlands in the contiguous U.S. as of 2009 (*Dahl 2011*) (see Table 6.1.5-1). The large majority of Guam's wetlands are classified as palustrine (freshwater) (3,585 acres), followed by estuarine intertidal (201- acres), and marine intertidal (56- acres) (see Figure 6.1.5-1). See Figure 6.1.5-2 for an example of a palustrine emergent wetland on Guam. Nearly all of the estuarine and palustrine wetlands are vegetated, with estuarine emergent, estuarine forested, and palustrine scrub/shrub wetlands being the least common vegetated wetland types on the island. Specifically, of the estuarine vegetated wetlands, the vast majority is estuarine scrub/shrub wetlands (which include mangrove forests); estuarine emergent and estuarine forested wetlands are far less common. For the palustrine vegetated wetlands, the vast majority are palustrine forested; palustrine emergent wetlands are also common but present at about half the acreage of palustrine forested. Palustrine scrub/shrub wetlands are the least common palustrine wetland type (Table 6.1.5-1; *USFWS 2015a*). On Guam, swamps and marshes are classified as either palustrine or estuarine, depending on the degree of salt water present. Swamp vegetation is typically scrub-shrub or forested, while marsh vegetation is typically emergent.

Figure 6.1.5-3 depicts the spatial distribution of wetland types on Guam (*USFWS 2015a)*. Most of the wetlands are found on the southern portion of the island, attributed to the high permeability of the limestone in the northern portion of the island, which limits development of wetland hydrology (*USFWS Undated*).

Along with the wetlands mapped as part of the NWI (*USFWS 2015a*), Siha *(1991)* lists the following specific wetland areas on Guam; these areas are included as part of the NWI mapping presented in Figure 6.1.5-3, but are not specifically called out on the figure: Agana swamp, Sasa mangroves and marsh, Atantano River valley and mangroves, naval station marshes (five sites), Namo River floodplain, Umatic marsh, Geus River estuary, Achang Bay mangroves, Ajayan estuary, Agfayan estuary, Inarajan River estuary, Talofofo River valley, Pago River estuary, and Fena Reservoir (fringe).

Table 6.1.5-1: Acreages, Types, and Descriptions of Wetlands in Guam

System[a]	Subclass[a]	Veg/Non-Veg	Class[a]	Code[a]	Acres	Physical Description	Hydrology	Vegetation
Marine	Intertidal	NA	All M2 classes	All M2 codes	56.2	Areas of open ocean associated with high energy coastline where the substrate is exposed and flooded by tides	Substrate exposed and flooded by tides; Includes the splash zone	Typically unvegetated, or with some intertidal vegetation; includes seagrasses, algae, and corals
				Total Marine Intertidal	**56.2**			
Estuarine	Intertidal	Non-Vegetated	Aquatic bed; unconsolidated bottom; unconsolidated shore; rocky shore	E2AB, E2UB, E2US, E2RS	11.1	Coastal areas usually semi-enclosed by land but have open partially-obstructed access to open ocean; water is partially diluted by freshwater runoff	Substrate exposed and flooded by tides; Includes the splash zone	NA
		Vegetated	Emergent; scrub/shrub; forested	E2EM, E2SS, E2FO	190.3			Swamps or marshes with herbaceous emergent, scrub/shrub, or forested vegetation; includes mangrove trees (e.g., *Bruguiera gymnorhiza* and *Rhizophora mucronata,)* pandanus trees, reeds (e.g., *Phragmites karka)*, sedges, and grasses
				Total Estuarine Intertidal	**201.4**			
Palustrine	NA	Non-Vegetated	Unconsolidated shore	PUS	2.3	Unvegetated freshwater wetlands that 1) lack active wave-formed or bedrock shorelines (e.g., lakes), and 2) are <20 acres and 3) are <6 feet deep at low water; substrate includes rock, sand, other fine materials, or vegetation growing below the water surface; Includes ponds	Water <6 feet deep; hydrologic regime ranges from permanently flooded to seasonally/ intermittently flooded, to saturated	NA
			Open water	PUB	29.4			NA
			Aquatic beds	PAB	0.4			Vegetation, algae, or moss growing below the water surface
				Total Palustrine Non-Vegetated	**32.1**			
		Vegetated	Emergent	PEM	1,397.8	Vegetated freshwater wetlands that 1) lack active wave-formed or bedrock shorelines (e.g., lakes), and 2) are dominated by vegetation, regardless of size; includes bogs, fens, marshes, swamps, and prairies	Hydrologic regime ranges from permanently flooded to seasonally/ intermittently flooded, to saturated	Marshes with herbaceous vegetation growing above the water surface; includes *Eleocharis ochrostachys* (spikerush), lily pads, reeds, sedges, and grasses
			Scrub/shrub	PSS	45.8			Swamps with scrub/shrub vegetation; trees and other woody species such as nypa and hibiscus
			Forested	PFO	2109.3			Swamps with forested vegetation; pandanus trees, and other woody species
				Total Palustrine Vegetated	**3,552.9**			
				Total Palustrine	**3,585.0**			
				Total Wetlands	**3,842.7**			

Source: USFWS 2015; Cowardin et al. 1979; Siha 1991; USFS 2006

NA= Not applicable

[a] System, subclass, class, and code are based on NWI Classification (*Cowardin et al. 1979*) as follows:

Marine intertidal: M2: marine intertidal;

- Marine intertidal: M2: marine intertidal;
- Estuarine intertidal: E2AB: estuarine intertidal aquatic bed; E2UB: estuarine intertidal unconsolidated bottom; E2US: estuarine intertidal unconsolidated shore; E2RS: estuarine intertidal rocky shore;
- Palustrine
  - Non-vegetated: PUS: palustrine unconsolidated shore; PUB: palustrine unconsolidated bottom; PAB: palustrine aquatic bed;
  - Vegetated: PEM: palustrine emergent; PSS: palustrine scrub-shrub; PFO: palustrine forested

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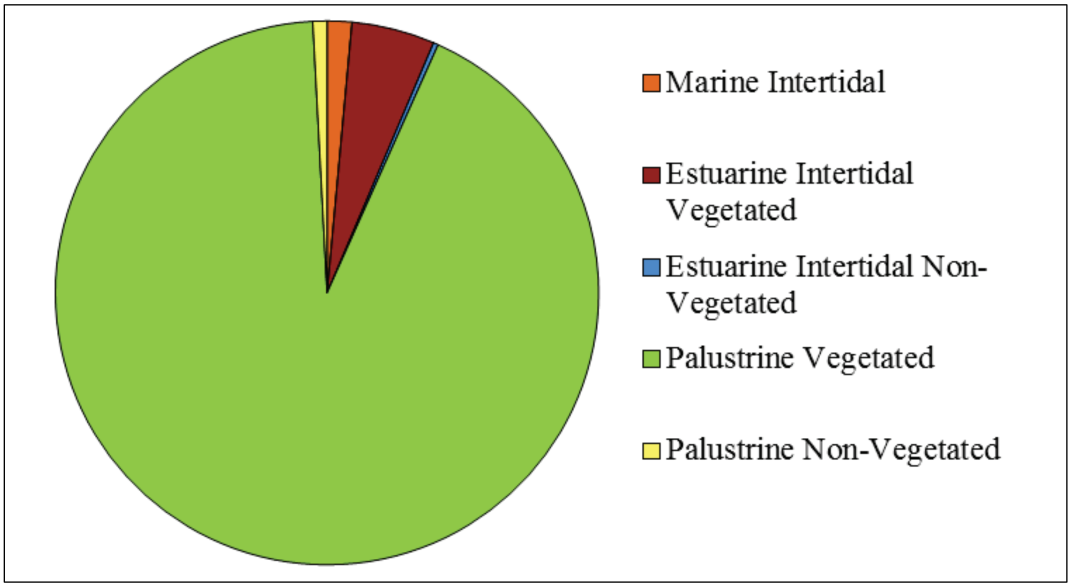

Source: USFWS 2015

Figure 6.1.5-1: Guam Wetland Types

Photo taken on Guam. Source: NOAA 2015a

Figure 6.1.5-2: Marine Intertidal Wetland on Guam

Source: USFWS 2015

Figure 6.1.5-3: Spatial Distribution of Guam Wetland Types

Siha (*1991*) provides a detailed discussion of several functions provided by Guam's wetlands, and these include:

- Filtration of sediment away from coral reefs;
- Provision of shoreline protection during storm events;
- Protection of inland and coastal shoreline areas from erosion;
- Flood reduction;
- Improved water quality;
- Support of plant and animal life;
- Provision of recreational opportunities and visual benefits;
- Facilitation of groundwater discharge;
- Reduce nutrient load in runoff; and
- Limitation of the type, amount, and nature of algae growth.

Current stressors to Guam wetlands include grazing and trampling by feral ungulates (e.g., introduced pigs and deer), human disturbance, invasive plant species, sedimentation, and erosion (*Joint Guam Program Office 2010*). Certain wetland types may be more sensitive to stressors than others, or may be more difficult to restore or rehabilitate structure and function after disturbance. For example, vegetated wetlands would be more difficult to restore than non-vegetated wetlands, with forested wetlands being the most difficult to restore given the time required for trees to grow, followed by scrub/shrub and emergent wetlands. For this same reason, wetlands that support coral reefs would also be more difficult to restore.

The National Oceanic and Atmospheric Administration has developed a national set of Environmental Sensitivity Index (ESI) maps that includes Guam. The ESI maps present coastal area resources that may be at risk in the event of an oil spill. These maps provide a sensitivity index for areas considered to be "sensitive shorelines", including coastal wetlands, wetlands providing habitat for sensitive or special status plant and wildlife species, and coral reefs (*NOAA 2015b)*. The ESI maps could therefore be used as a tool to determine potentially sensitive wetland habitats in coastal areas.[10]

No wetlands were identified by the NWI within the USFWS Guam National Wildlife Refuge at the northern tip of the island; however, wetlands may be present in the refuge that are not mapped by the NWI.

[10] ESI maps and downloadable data can be found at http://response.restoration.noaa.gov/maps-and-spatial-data/environmental-sensitivity-index-esi-maps.html

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6.1.6. Biological Resources

6.1.6.1. Introduction

Biological resources include 1) terrestrial vegetation, 2) wildlife, 3) fisheries and aquatic habitats, and 4) threatened and endangered species and communities and species of conservation concern. Wildlife habitat and associated biological ecosystems are also important components of biological resources.

This section discusses existing biological resources in Guam:

- Terrestrial vegetation, including vegetation types, vegetation communities of conservation concern, and invasive species.
- Wildlife, including wildlife habitat and seasonal characteristics. Species included in this section are terrestrial invertebrates; amphibians and reptiles; terrestrial mammals (game and non-game); marine mammals; and birds occurring in Guam and in Guam's offshore environment. Wildlife species and their habitat in Guam are generally discussed along with select principal species or those of particular interest.
- Fisheries and aquatic habitats, including fisheries features and characteristics. Species included in this section include freshwater and marine species of fish and shellfish occurring in Guam and in Guam's offshore environment.
- Threatened and endangered species and species of conservation concern. This analysis considers plant and animal species that are federally listed as threatened, endangered, candidate, proposed, or species of concern; species that are state-listed as endangered; and/or species that receive specific protection defined in federal or state legislation. This analysis considers species that are known to occur in Guam for all or part of their life cycle.

6.1.6.2. Specific Regulatory Considerations

Given the expected nature and extent of the Proposed Action, it is likely that a wide range of biological resources could be impacted to varying degrees. Therefore, there are many federal, state/territory, and local laws and regulations as well as executive orders considered as part of this analysis. Each biological resource below contains a brief discussion of laws and regulations specific to its resource. Appendix C, *Environmental Laws and Regulations*, provides a comprehensive list of all applicable laws and regulations that were considered as part of the Proposed Action.

6.1.6.3. Terrestrial Vegetation

Introduction

This section discusses terrestrial vegetation resources in Guam. Information is presented regarding vegetation types and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Specific Regulatory Considerations

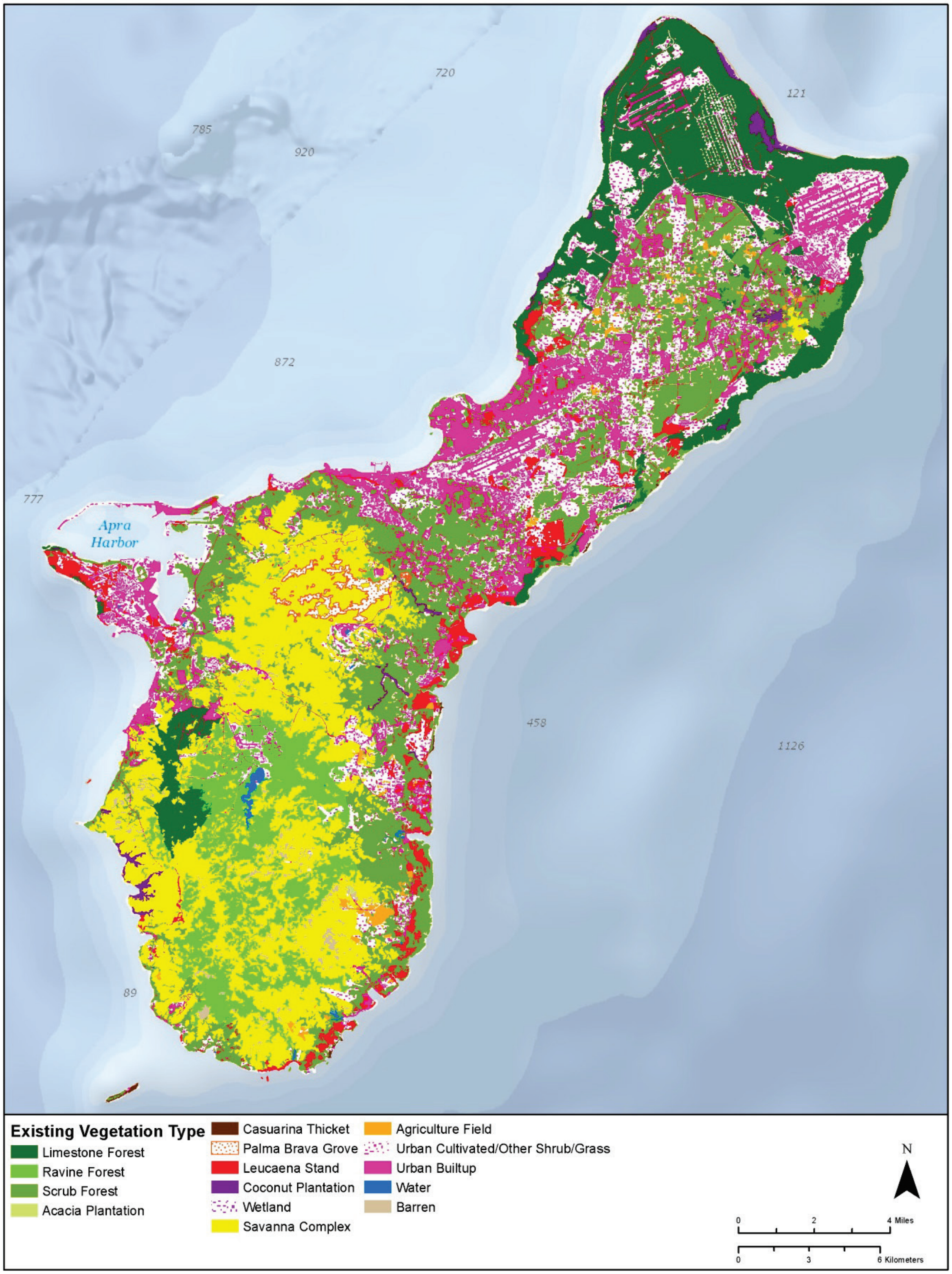
Related to terrestrial vegetation, and as addressed in Appendix C, *Environmental Laws and Regulations, Executive Order (EO) 13112* "directs federal agencies to prevent the introduction of invasive plant and other species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species can cause."

Environmental Setting

The vegetation types present in the Guam were identified, evaluated, and described using information gathered from the Pacific Islands Imagery Consortium of Vegetation Mapping and Monitoring (*USFS 2006*). This consortium consists of federal, state/territory, and local governments and agencies and is led by the United States (U.S.) Department of Agriculture Forest Service. Supplemental vegetation mapping information and class descriptions were obtained and summarized from *Liu and Fischer 2006*, a document authored by the Forest Service. In addition, vegetation communities of conservation concern were identified and described using information provided by the U.S. Fish and Wildlife Service (*USFWS 2012, 2015*) and the Guam Department of Agriculture Division of Aquatic and Wildlife Resources (*Guam DOA DAWR 2015*). Finally, invasive plant species are summarized in this section based on information from the Global Invasive Species Database and the Draft Comprehensive Wildlife Conservation Strategy for Guam.

Vegetation Types

Based on the vegetation data provided by the Forest Service, 15 different vegetation types or land cover classes were identified in Guam. Figure 6.1.6.3-1 depicts the distribution of these vegetation types or land cover classes in the territory, and Table 6.1.6.3-1 provides a description of each type and their typical vegetation characteristics.



Source: USFS 2006

Figure 6.1.6.3-1: Vegetation Types and Land Cover Classes in Guam

Table 6.1.6.3-1: Vegetation Types/ Land Cover Classes in Guam

Vegetation Type or Land Cover Class Name	General Description	Vegetation Characteristics
Limestone Forest	Primarily moist, broadleaved evergreen forest on elevated limestone plateaus and cliffs	Forest varies from tall trees to a dense scrub on edges and faces of cliffs; dominated by dugdug or wild breadfruit (*Artocarpus mariannensis*), screw pine (*Pandanus amaryllifolius*), and other species
Ravine Forest	Moist, broadleaved evergreen and mixed forest containing palm (*Arecaceae* family), screw pine (*Pandanus amaryllifolius*), and pago (hibiscus) vegetation	Mixed forest with various palm and other trees, scrub species, and grass; coconuts are occasional to locally common
Scrub Forest	Also called secondary forest; contains various introduced species and secondary growth resulting from human disturbance; in some areas these trees are thick enough to be considered as forests	Trees, shrubs, and other plants; provides habitat for important wildlife species; commonly includes breadfruit (*Artocarpus mariannensis*), coconut groves and some very large areas of Tanantangan (*Leucaena leucocephala*) thickets
Acacia Plantation (*Acacia confuse*)	Introduced species planted by Guam Forestry on Savanna areas to present soil erosion	Small stands on flat areas with gentle slopes along grassland areas
Casuarina Thicket (*Casuarina equisetifolia*)	Grows well on the savanna but is scattered; occurs on limestone and lowland habitat	Small, fast growing tree; provides habitat for native bird species; also commonly called ironwood or Australian iine
Palma Brava Grove (*Heterospathe elata*)	Consists of groves of forest in ravines and slopes of central Guam	Naturalized species with aggressive behavior, spreading in ravines and slopes
Leucaena/Tanantangan (*Leucaena leucocephala*) Stand	Occurs on limestone and lowland habitat; dominated by non-native tangantangan (*Leucaena leucocephala*) tree	Small, fast growing tree; provides habitat for native bird species but out-competes many native plants
Coconut Plantation	Consists of areas with coconut palms (Arecaceae family) for commercial purposes; most plantations have been abandoned since World War II	Includes coconut palms (Arecaceae family)
Wetland[a]	Consists of plants specialized for growing in standing water or soils that are wet for most of the year	Grasses, sedges, herbs, or woody species
Savanna Complex	Occurs on limestone and volcanic soils, mainly in open fields	Grassy and low/short herbaceous plants;[b] intermixed with erosion scars with shrubs and tangled ferns; dominated by swordgrass (*Miscanthus floridulus*)
Agriculture Field	Cultivated lands, very limited existence	Various vegetables and other crops including tomatoes, green onions, eggplant, and cucumbers
Urban Cultivated/Other Shrub/Grass	Vegetation around urban areas, usually maintained	Various grasses, trees, and shrubs including those found at golf courses, lawns, and soccer and baseball fields
Urban Buildup	Towns, villages, buildings, roads and other inhabited areas	NA

Vegetation Type or Land Cover Class Name	General Description	Vegetation Characteristics
Water	Water of all types	NA
Barren	Bare land with no or minimum vegetation coverage.	NA

Source: Liu and Fischer 2006; USFWS 2006

NA = not applicable
[a] See Section 6.1.5, Wetlands, for a discussion on wetlands.
[b] Herbaceous plants do not have woody stems.

As shown in Figure 6.1.6.3-1, the majority of the northern portion of Guam consists of Limestone Forest and Scrub Forest vegetation. Much of this northern portion is also classified as Urban Built-up land. The southern portion of Guam primarily consists of Savannah Complex, Ravine Forest, and Scrub Forest. In general, native vegetation in Guam has been affected in recent years due to various anthropogenic and natural factors such as the introduction and spreading of invasive species, poor land management practices, overexploitation, and typhoons (*Guam DOA DAWR 2015*).

Vegetation Communities of Conservation Concern

Some vegetation communities or types have become of conservation concern because of declining abundance, sensitivity to disturbance, and/or due to the reliance of certain species on the habitat they create. In Guam, the tree fern (*Cyathea lunulata*), *Seriantes nelsonii* (no common name), and *Heritiera longipetiolata* (no common name) are currently the only federally listed endangered plant species under the Endangered Species Act of 1973 (see Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern; *USFWS 2012; 2015*). In addition, 13 candidate plant species have been recently formally proposed to be listed as threatened or endangered. Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, provides a listing of these species.

As further discussed and shown in Section 6.1.6.4, Wildlife, approximately 20 percent of Guam has been designated as local or federal conservation lands. Formally protected areas that contain important terrestrial vegetation for wildlife habitat and conservation activities include the Anao, Bolanos, and Cotal Conservation Areas. These three areas total 4,077 acres in size (*Guam DOA DAWR 2015*).

The Anao Conservation Area consists of 764 acres located in northeastern Guam. The majority of vegetation cover in this area includes Limestone Forest and Scrub Forest, representing 78.6 and 14.7 percent of its total land area, respectively. The Limestone Forest provides important habitat for fruit bats (*Guam DOA DAWR 2015*).

The Bolanos Conservation Area is 2,854 acres in size and is managed for hunting and outdoor recreation. Historically, the vegetation cover in this area consisted primarily of Ravine Forest. However, agricultural burning and browsing have changed this; vegetation cover now consists of Ravine Forest (50.2 percent) and Savanna Complex (47.1 percent; *Guam DOA DAWR 2015*).

The Cotal Conservation Area is 662 acres in extent and is predominately covered by Savanna Complex (73.8 percent) and Scrub Forest (24.7 percent). Recent activities have begun to restore native vegetation and wildlife habitat to this area; however, grass fires have made reforestation difficult (*Guam DOA DAWR 2015*).

Invasive Species

EO 13112 defines an invasive species as a species not native to an area whose introduction causes or is likely to cause harm to the economy or the environment, or harms animal or human health. As mentioned above, the EO "directs federal agencies to prevent the introduction of invasive species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species can cause."

According the Global Invasive Species Database,[1] there are 83 invasive plant species identified in Guam (*Global Invasive Species Database Undated*). The Draft Comprehensive Wildlife Conservation Strategy for Guam (*DOA DAWR 2015*) highlights specific concerns related to several of these invasive plants:

- Tangantangan (*Leucaena leucocephala*) – used by the U.S. military to reseed the island's barren landscape after World War II; out-competes many native plants and has played a role in changing soil composition;
- Chain-of-love vine (*Antigonon leptopus*) – smothering vine that blocks sunlight and competes with native plants for water;
- Dodder (*Cuscuta campestris*) – extremely aggressive smothering vine that also blocks sunlight and competes with native plants for water;
- Agalondi (*Vitex parviflora*) – now one of the most dominant trees on Guam, crowds out native plants and prevents native forest growth;
- Palma brava (*Heterospathe elata*) – has taken over numerous ravines and valleys after land disturbance from brush fires.

[1] The Global Invasive Species Database is managed by the Invasive Species Specialist Group of the International Union for Conservation of Nature Species Survival Commission. It is supported through partnership with the National Biological Information Infrastructure, Manaaki Whenua-Landcare Research, and the University of Auckland.

6.1.6.4. Wildlife

Introduction

This section discusses the existing wildlife resources in Guam. Information is presented regarding wildlife habitat and sensitive characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Species included in this section are reptiles and amphibians, terrestrial invertebrates, terrestrial mammals, marine mammals, and birds occurring in Guam and in Guam's offshore environment. Wildlife species and their habitat are generally discussed in this section. Species reviewed in this section, although not inclusive, represent the major taxonomic groups including reptiles and amphibians, terrestrial invertebrates, terrestrial mammals, marine mammals, and birds occurring in Guam and in Guam's offshore environment. Descriptions of the terrestrial invertebrate and vertebrate species of Guam and their associated habitats can be found in Guam's Comprehensive Wildlife Conservation Strategy (CWCS) (*Guam DAWR 2006*). For more information about water and wetlands, see Sections 6.1.4 Water Resources and 6.1.5 Wetlands. For more information on threatened and endangered species of wildlife, see Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Specific Regulatory Considerations

The Guam Department of Agriculture (DOA) is responsible for the control and regulation of fish and game in and about Guam and the administration of laws pertaining to them. Within the DOA the Division of Aquatic and Wildlife Resources (DAWR) is the equivalent of a state fish and game agency, with the responsibility to monitor and manage game populations. Game is defined "all native or introduced species of wild birds or wild animals" (*Guam DAWR 2006*). The DOA is also given regulatory power over endangered species (*Title 5 Guam Code Annotated, Chapter 63, §63205*). It has the authority to promulgate a list of endangered species to be adopted through the Administration Adjudication Act and approved by the Guam legislature. The DOA, in cooperation with the Department of Parks and Recreation and other agencies of the Government of Guam, also has the authority to control and manage conservation reserves on Guam (*Title 5 GCA, Chapter 63, §63401*).

Pursuant to Section 6 of the Endangered Species Act, a cooperative agreement exists between the Guam DOA and the U.S. Fish and Wildlife Service (USFWS). This agreement obligates the DOA to enforce federal laws such as the Migratory Bird Treaty Act (MBTA) of 1918 and the Marine Mammal Protection Act of 1972.

The USFWS's Pacific Islands Fish and Wildlife Office is responsible for the management of endangered and threatened species, habitat conservation, and invasive species, as well as management of the Guam National Wildlife Refuge (NWR). The National Oceanographic and Atmospheric Administration's (NOAA) National Marine Fisheries Service and USFWS have shared jurisdiction for recovery and conservation of sea turtles listed under the Endangered Species Act. A Memorandum of Understanding outlines National Marine Fisheries Service as the lead for conservation and recovery of sea turtles in the marine environment, and USFWS has the lead for the conservation and recovery of sea turtles on nesting beaches (*NOAA 2015*).

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA) affords specific legal protection to bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*). Under this Act, it is a violation to "…take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner any bald eagle commonly known as the American eagle or any golden eagle, alive or dead, or any part, nest, or egg thereof…." (*16 United States Code [USC] § 668*). The BGEPA defines "take" as pursuing, shooting, shooting at, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing (*16 USC § 668c*). "Disturb" is defined in regulation *50 CFR 22.3* as the following:

> "...[T]o agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." (*50 CFR 22.3*)

In fall 2009, USFWS implemented two rules (*50 CFR 22.26 and 22.27*) authorizing limited legal take of bald and golden eagles "when the take is associated with, but not the purpose of an otherwise lawful activity, and cannot practicably be avoided" (*USFWS 2011*).

Migratory Bird Treaty Act

A migratory bird is any individual species or family of birds that crosses international borders at some point during their annual life cycle to live or reproduce. The MBTA implements four treaties that prohibit take, possession, transportation, and importation of all migratory, native birds (plus their eggs and active nests) occurring in the wild in the U.S., except for house sparrow, European starling, rock pigeon, any recently listed unprotected species in the *Federal Register* (*70 Federal Register 12710*), and non-migratory upland game birds, except when specifically authorized by the USFWS. The MBTA provides that it is unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird or any part, nest, or egg or any such bird unless authorized under a permit issued by the Secretary of the Interior. Some regulatory exceptions apply. "Take" is defined in regulations as: "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect" (*16 USC § 1532(19)*). In total, more than 1,000 bird species are protected by the MBTA, 58 of which can be legally hunted with a permit as game birds. The MBTA addresses take of individual birds, not population-level impacts, habitat protection, or harassment. Failure to comply with the MBTA can result in criminal penalties. As authorized by the MBTA, the USFWS issues permits to qualified applicants for the following types of activities: falconry, raptor propagation, scientific collecting, special purposes (rehabilitation, educational, migratory game bird propagation, and salvage), take of depredating birds,[1] taxidermy, and waterfowl sale and disposal.

Marine Mammal Protection Act

The Marine Mammal Protection Act prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.[2] The act defines "take" to mean "to hunt, harass, capture, or kill" any marine mammal or attempt to do so. Exceptions to the moratorium can be made through permitting actions for take incidental to commercial fishing and other non-fishing activities; for scientific research; and for public display at licensed institutions such as aquaria and science centers.

Other federal regulations pertaining to wildlife resources are discussed in Chapter 1, Introduction, and Appendix C, *Environmental Laws and Regulations*.

The DAWR distributes hunting regulations that control the taking of various wildlife species. Guidance on compliance with Guam government wildlife regulations can be found at the DAWR website.[3]

Terrestrial Habitats and Wildlife (Invertebrates, Mammals, Reptiles and Amphibians)

Habitats

Guam's Comprehensive Wildlife Conservation Strategy (*Guam DAWR 2006*) describes key terrestrial habitats and is summarized below.

Limestone Forest

Limestone forest is composed of dense canopies of a mature growth trees up to 100 feet high. The understory vegetation varies from open to dense areas of native trees and plants. The structure of the forest is changing as a result of grazing by introduced species, such as the Philippine deer (*Rusa marianna*) and feral pigs. Limestone forests are found on the northern limestone plateau and on large limestone outcroppings in southern Guam. The mature tree habitat and understory of the limestone forest is utilized by almost all of Guam's wildlife species.

[1] A bird that causes resource damage, economic loss, or a threat to health and human safety.
[2] U.S. persons and U.S. vessels within and outside the territorial limits of the U.S. The National Oceanic and Atmospheric Administration has consistently interpreted the Marine Mammal Protection Act as applicable to U.S. vessels and citizens throughout the high seas, including exclusive economic zones, as reflected in congressional and other correspondence and international agreements that rely upon jurisdiction over U.S. vessels and citizens in foreign exclusive economic zones (*16 USC §§ 1361-1423h*).
[3] http://wildlife.guam.gov/law-regulation/

Scrub Forest or Secondary Growth Forest

The canopy of scrub forest is shorter than limestone or ravine forest, reaching only 30 feet. Additionally, this habitat type is more brushy and dense than the other forest types. The presence of introduced ungulates,[4] invasive plants, land clearing activities, and natural events such as typhoons prevent this habitat type from fully developing into limestone forest habitat. This habitat type is prevalent on the Tarague Plateau and Northwest Field region of Guam.

Open Field or Large Mowed Area

Open fields are the result of human disturbance including agricultural fields, runways, communication stations, and parks. These habitats are typically composed of grass species surrounded by scrub forest. Fields provide important habitat for many migratory birds including plovers, sandpipers, and other bird species.

Coconut Grove

Coconut groves are the result of abandoned coconut plantations and are common along sandy coastal areas. The understory contains a variety of native and non-native shrubs and young coconut palms, with mature palm trees reaching 50 to 80 feet high. Coconut palms are susceptible to typhoons, termites, and uprooting by feral pigs. Some of the native species of birds using this habitat include the Micronesian kingfisher (*Todiramphus cinnamominus*), rails, and fantails (e.g., Guam rail [*Hypotaenidia owstoni*] and rufous fantail [*Rhipidura rufifrons*]).

Ravine Forest

Ravine forests occur in river valleys and depressions in southern Guam. Guam's ravine forests are highly degraded and contain many non-native species. Though historically abundant, this habitat has been reduced and degraded by damage from introduced ungulates, invasive plants, and forest fires. Little native ravine forest remains on Guam; however, restoration programs are currently being implemented.

Broken Forest or Mixed Woodland

A mixed woodland is a fragmented limestone or ravine forest, which includes small, interspersed open or scrub fields typically as a result of human disturbance. It contains both native and naturalized vegetation with a low, open canopy. Damage and disturbance caused by introduced ungulate species has degraded this habitat type, lowering its quality.

Savanna or Grassland

Savanna grasslands are found in southern Guam and are characterized by rolling hills of dense, tall, sharp swordgrass (*Miscanthus* spp.). Fires commonly occur, suppressing tree growth and contributing to the spread of the fire-resistant grassland species. This habitat type is particularly important for the endangered island swiftlet (*Aerodramus bartschi*).

[4] Ungulate is a classification of mammals having hooves, such as deer or pigs.

Beach Strand and Strand Forest

Beach strand habitat occurs on coasts and beaches, and is composed of open sand, barren outcrops, and sparse vegetation. Vegetation here is usually less than 10 feet tall. Beach strands are typically adjacent to scrub and limestone forests. Nesting seabirds, sea turtles, and lizards frequently utilize this habitat type, as well as many invertebrate species. As a part of beach strand habitat, strand forest occurs along beaches and other coastal areas. It has a mixture of trees with pronounced groups based on the distance from the shoreline. This type of forest is degraded from disturbance by humans and feral animals and is susceptible to insect infestations and typhoon damage.

Shoreline

Shorelines along the coasts of Guam, Cocos Island, and other islets are mostly bare sand with limestone outcroppings, coral fragments, and sparse grass vegetation. Shorelines, much like beach strands, are important for nesting seabirds, sea turtles, lizards, and many invertebrate species.

Limestone Caves

Most of Guam's limestone caves (karst caves) are located in the northern portion of the island, with a few in southern Guam. The caves are created when groundwater dissolves cavities in limestone rock. Bats and island swiftlets use limestone caves for roost sites. Roost caves are especially susceptible to disturbance and invasive species.

Freshwater Environment

Marshes, swamps, and manmade reservoirs on Guam provide freshwater habitat for wildlife. Guam has more freshwater wetland habitat than any other island in the Mariana Archipelago. The wetlands occur in central and southern Guam, where limestone and clay layers restrict surface water infiltration. Freshwater swamps are categorized by their woody vegetation, while marshes have stands of grasses. The Mariana common moorhen (*Gallinula chloropus guami*) occurs in both manmade reservoirs and freshwater marshes around the island.

Wildlife

Guam's CWCS (*Guam DAWR 2006*) identified 20 terrestrial species (2 mammal species, 13 birds, 5 lizards) and 14 marine mammals along with 2 sea turtles as priority species for conservation concern.

Terrestrial Invertebrates

The status of terrestrial vertebrates as a whole is largely undetermined with an estimated 4,000 insect species yet to be identified and cataloged (*Guam DAWR 2006*). Ants, mosquitos, and spiders are reported as the most numerous terrestrial invertebrate species in southern Guam (*U.S. Bureau of Reclamation 1985*). Other common invertebrates include butterflies, earwigs, termites, flies, millipedes, and dragonflies (*U.S. Bureau of Reclamation 1985*). Several snails and butterfly species are of particular concern as a result of habitat loss and degradation. The endemic Guam tree snail (*Partula radiolata*), the humped tree snail (*Partula gibba*), and the fragile tree snail (*Samoana fragilis*) have been recently proposed for federal listing along with the Mariana eight-spot butterfly (*Hypolimnas octocula mariannensis*) and the Mariana wandering butterfly (*Vagrans egistina*) (*USFWS 2015*).

Amphibians and Reptiles

Historically, Guam did not have any known native species of amphibians, and introduced populations quickly spread to cover much of the island. At least nine species of frogs and toads are known to inhabit the Mariana Islands Archipelago: cane toad (*Rhinella marina*), the coqui frog (*Eleutherodactylus coqui*), the greenhouse frog (*Eleutherodactylus planirostris*), Eastern dwarf tree frog (*Litoria fallax*), the marbled pygmy frog (*Microhyla pulchra*), grass frog (*Fejervarya limnocharis*), crab eating frog (*Fejervarya cancrivora*), Gunther's frog (*Hylarana guentheri*), and the spot-legged tree frog (*Polypedates megacephalus*) (*Kerr 2013*). Several of these amphibian species have detrimental effects on Guam (*Guam DAWR 2006*). Therefore, Guam provides colonization and reproductive success to opportunistic species of amphibians and reptiles currently inhabiting the island. Today, the leading negative impact to Guam's biodiversity is the accidental transport of amphibians and reptiles (*Wiles 2000*).

There are six native terrestrial reptiles, five skink species and one gecko species, the Micronesian gecko (*Perochirus ateles*), that are still found in the wild (*Guam DAWR 2006*). Skink species include the snake-eyed skink (*Cryptoblepharus poecilopleurus*), tide-pool skink (*Emoia atrocostata*), azure-tailed skink (*Emoia cyanura*), Slevin's skink (*Emoia slevini*), and the moth skink (*Lipinia noctua*). All of these species are listed as threatened or endangered and further discussed in Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Three species of sea turtles have been recorded inhabiting the waters off Guam. Nests of the green sea turtle (*Chelonia mydas*) and the hawksbill sea turtle (*Eretmochelys imbricata*) have been found on Guam (*Eldredge 2003*). Leatherback sea turtles (*Dermochelys coriacea*) are extremely rare around Guam with the last sighting recorded in 1985 (*Cummings 2002; GNWR 2009*). These species are further discussed in Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Terrestrial Mammals

The Marianas fruit bat (*Pteropus mariannus*) is the only extant bat on Guam and is federally listed as endangered under the Endangered Species Act. This species is further discussed in Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern. Along with the Marianas fruit bat, the Pacific sheath-tailed bat (*Emballonura semicaudata*) and little Marianas fruit bat (*Pteropus tokudae*) were also native terrestrial mammals of Guam. However, both populations have greatly declined in recent years to the point where the Pacific sheath-tailed bat is now extirpated (locally extinct) in Guam, and the little Marianas fruit bat, which historically coexisted with the Marianas fruit bat, is now extinct (*USDA 2009*). The leading causes of these extinctions and possible risks to the extant Marianas fruit bat include natural disturbances, environmental changes, and other chance events which are detrimental to small vulnerable populations (*USFWS 2012*).

Introduced mammals include pigs, water buffalo (*Bubalus bubalis*), and Philippine deer, all brought by Spanish colonizers in the late 1600s (*GNWR 2009*). They have become an important part of the culture for the native Chamorro people of Guam. A variety of habitats provide for these animals including native forest, wetlands, shoreline, grasslands, and a mosaic of other habitat types (*Stone 1970*). Feral pigs are omnivorous and feed on native sea turtles, sea birds, and reptiles (*GNWR 2009*). Pigs and deer are valued for hunting and food (*GNWR 2009*).

Other terrestrial non-native species reported in the Guam NWR include feral cats and dogs, shrew, the black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), and house mouse (*Mus musculus*) (*GNWR 2009*). Rodents are predators of nesting birds, land invertebrates, and plants as well as a reservoir of disease and disperser of invasive plant seeds (*Amori and Clout 2003*).

Habitats and Marine Mammals

Recent surveys by NOAA indicate that 14 species of marine mammals have been reported in Guam's waters; these include dugongs (*Dugong dugon*), three species of baleen whales, and 10 species of toothed whales (*Guam DAWR 2006*). Species that have been reported from Guam are listed in Appendix 5 of the Guam CWCS (*Guam DAWR 2006*).

Marine ecosystems such as coral reefs, seagrass beds, mangrove forests, and lagoon zones provide important habitat for marine mammals of Guam and are summarized below.

Coral Reefs

Guam's coral reefs almost completely surround the island and include the common fringing reefs which grow near and around the island; patch reefs which tend to be small isolated reefs that occur between fringing reefs and barrier reefs; and the deeper barrier reefs that also parallel the coastline (*Coral Reef Alliance 2014*). Fringing reefs are the predominant reef type extending around Guam (*Coral Reef Alliance 2014*). The width of the shallow (0 to 6 feet) reef flat platform varies from tens of feet to over a half mile in Pago Bay (*Randall and Eldredge 1976*). The condition of Guam's coral reefs varies considerably, depending on a variety of factors including geology, human population density, degree of coastal development, levels and types of marine resource uses, oceanic circulation patterns, and frequency of natural disturbances (e.g., storms and earthquakes) (*NOAA-CRIS 2015*).

Seagrass Beds

The Guam CWCS describes the seagrass bed habitat type and its importance for marine wildlife:

> "Sea grass beds cover approximately 917 acres of reef flats in numerous coastal bays around Guam… These sea grass beds range in size from small beds a few meters in diameter to continuous beds nearly 250 acres in size. The largest of these sea grass beds are found along the reef flats in the southern part of the island including Cocos Lagoon and within the Achang Reef Flat Preserve. These sea grass beds are used as foraging grounds by green sea turtles. Other substantial sea grass resources are located in East Agana Bay, Pago Bay, Piti Bomb Holes Marine Preserve, and Agat areas… Sea grass resources in Guam are threatened by land-based sources of pollution and recreational misuse and overuse including personal watercraft and trampling by divers." (*Guam DAWR 2006*)

Mangroves

Brackish estuarine wetlands occur where saltwater and freshwater converge, typically where river deltas reach the coast; stands of mangrove trees establish themselves here, and their root systems stabilize the substrate, providing a secure habitat for fish and wildlife. In Guam, large groups of mangroves occur in the eastern part of Apra Harbor, Merizo, and Inarajan (*Guam DAWR 2006*). This habitat type's tidal variations and higher salt concentrations create a unique habitat for migratory birds, invertebrates, and a variety of other aquatic and terrestrial wildlife.

Lagoon Zones

The Guam CWCS describes the lagoon zone habitat type and its importance for marine wildlife:

> "Lagoon zones are areas enclosed by the low tide line of the inner edge of barrier reef flat. Guam has two areas that can be considered true lagoon zones: Apra Harbor and Cocos Lagoon in Merizo. The depth in these areas ranges from less than three feet to over 100 feet. Apra Harbor has sandy and muddy bottom in between scattered patch reefs and shoals. These patch reefs and shoals boast some of the highest coral cover in Guam with many areas exceeding 100% coral cover. They also support diverse macroalgae and sponge communities. Cocos Lagoon is generally shallower than Apra Harbor and has a predominantly sand bottom with numerous small patch reefs scattered throughout… The lagoon is also home to soft coral stands that provide unique habitat found in few locations in Guam's waters. These lagoons are utilized by a wide variety of reef fish species as well as both green and hawksbill sea turtles." (*Guam DAWR 2006*)

Habitats and Birds

Over 100 species of birds are documented in Guam including 87 migrants, 20 resident landbirds, 27 seabirds, 68 waterbirds, and 4 breeding endemic birds (*BirdLife International 2015a*). Fourteen bird species are globally threatened and discussed in Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

The Guam CWCS (*Guam DAWR 2006*) states that "Only three of 12 native forest bird species continue to persist in the wild on Guam, they include the Mariana crow (*Corvus kubaryi*), Micronesian starling (*Aplonis opaca guami*) and the island swiftlet. Additionally, two wetland species of birds: the Mariana common moorhen and the yellow bittern (*Ixobrychus sinensis*) also continue to persist in the wild." Both are discussed in Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Three Important Bird Areas (IBAs) are located on Guam. These include Cocos Island, Guam National Wildlife Refuge, and Mahlac Caves (*Birdlife International 2015a*). Virtually all of the seabirds nesting around Guam are found on Cocos Island, 1 mile off the southern tip of Guam. Some example species which frequent the IBAs on Guam include common white terns (*Gygis alba*), brown noddies (*Anous stolidus*), and black noddies (*Anous minutus*). The Guam National Wildlife Refuge IBA contains several portions of the larger Guam National Wildlife Refuge, including the USFWS-owned Ritidian Point and much of the U.S. Air Force Overlay Refuge. The IBA includes known populations of the Mariana crow and a snake-free enclosure with Guam rails. Micronesian starlings were also observed in the IBA in 2005 (*Guam DAWR 2006*). Additionally, the refuge is known to hold important habitat for the Guam subspecies of the Micronesian kingfisher. Recovery plans for the kingfisher include reintroduction of the bird from captive breeding programs (*69 Federal Register 23211, 2004; Birdlife International 2015b*). The Mahlac caves are composed of limestone substrate with multiple entrances and ceiling cavities that provide the island swiftlets with suitable nesting habitat (*USFWS 1992, Birdlife International 2015a*).

Important Habitat Areas

Approximately 20 percent of Guam has been designated as local or federal conservation lands (Figure 6.1.6.4-1). The Government of Guam has identified three areas for conservation: Anao, Bolanos, and Cotal Conservation areas. The Bolanos Conservation area is managed by DAWR for hunting and outdoor recreation.

In addition to locally managed conservation lands, the federal government has identified conservation areas on Guam including the Guam NWR.

Over 10 percent of Guam's coastline has been set aside as marine preserves: Tumon Bay, Piti Bomb Holes, Sasa Bay, Achang Reef Flat, and Pati Point (Figure 6.1.6.4-1). The largest of the preserves, Pati Point Marine Preserve, protects important green sea turtle nesting areas (*Guam DAWR 2006*). Sasa Bay Marine Preserve serves as foraging ground for green and hawksbill sea turtles.

Source: USGS GAP 2012

Figure 6.1.6.4-1: Location of Conservation Lands and Marine Preserves on Gaum

The Manell-Geus watershed on the southern tip of Guam has been selected as the next Habitat Focus Area under NOAA's Habitat Blueprint (*NOAA 2015*). The area is important habitat for both green and hawksbill sea turtles and contains the largest aggregations of sea turtles observed on Guam (*NOAA 2015*).

Threats and Stressors

Some of the major threats to native species include introduced and invasive plants and animals, loss and/or degradation of key habitat types, and climate change. The Guam CWCS (Guam DAWR 2006) summarized the following threats to wildlife resources:

> "Guam's native flora and fauna have been impacted by various threats, such as the introduction of invasive species, poor land management practices, and overexploitation. These anthropogenic threats are exacerbated by the frequency with which the island is impacted by typhoons. In the last decade, Guam has been hit directly by four storms with sustained winds greater than 150 miles per hour and suffered high wave and winds from large systems passing near Guam." (*Guam DAWR 2006*)

Marine mammals are threatened by loss of near shore habitat and feeding grounds due to land-based sources of pollution and overfishing. They are also threatened by marine debris, getting caught as by-catch in nets and on longlines, oil spills, overzealous tour operators, disturbance, underwater noise, etc.

Invasive species introductions, both intentional and accidental, have greatly affected Guam's native ecology. Guam's native terrestrial fauna have evolved in the absence of predators. As mentioned in previous sections, the native wildlife populations are vulnerable to introduced predators such as brown treesnakes (*Boiga irregularis*), rats, feral cats, amphibians, and ants. Introduction of the brown treesnake has resulted in the loss of many of Guam's native species of birds and lizards, and may be preventing the recovery of the Mariana fruit bat (Guam DAWR 2006).

Natural forces such as hurricanes and storm disturbances pose threats to small island populations.

6.1.6.5. Fisheries and Aquatic Habitats

Introduction

This section discusses fisheries resources of Guam. Information is presented regarding fisheries features and characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

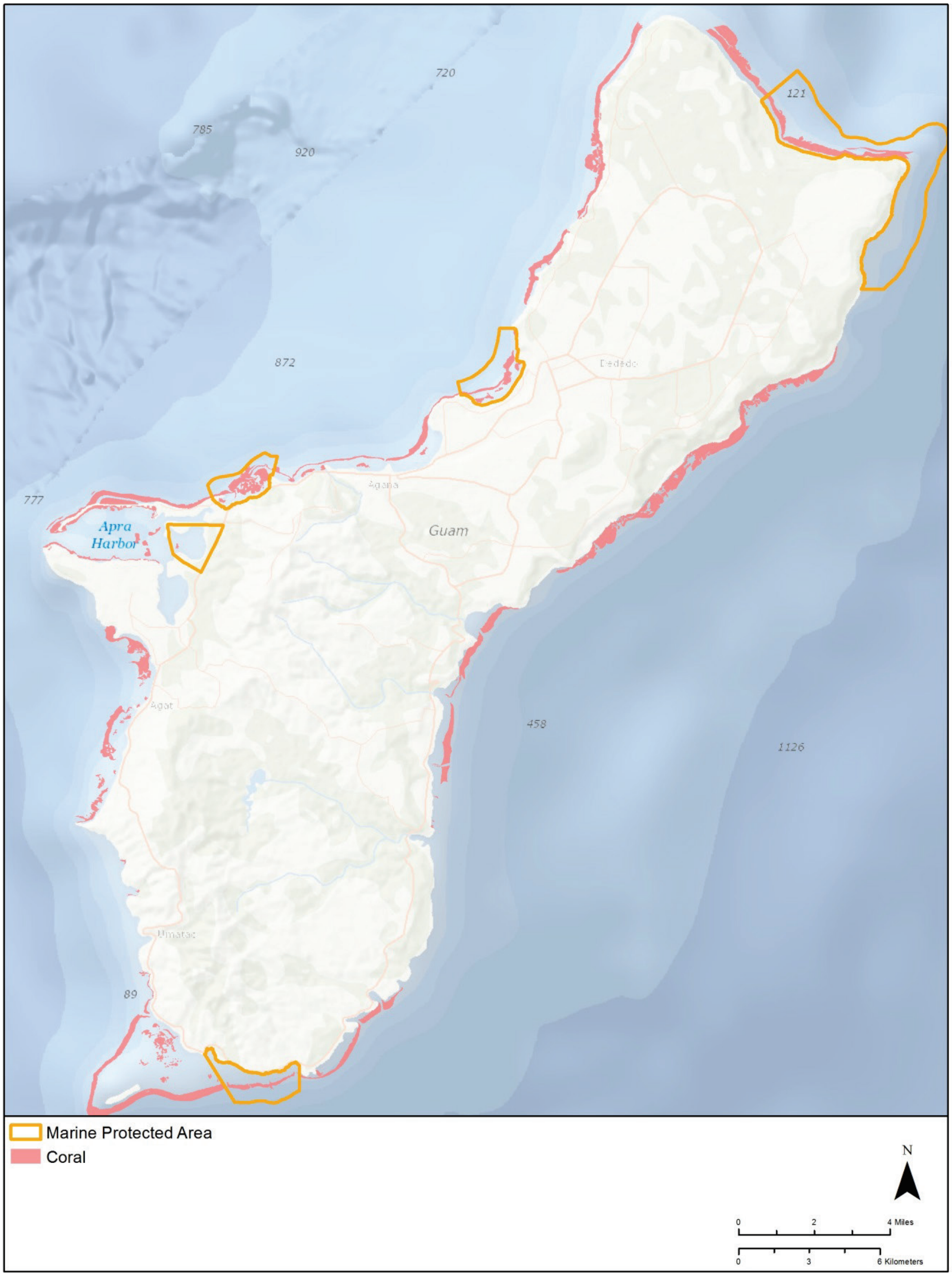
Species included in this section include freshwater and marine species of fish and shellfish occurring in Guam and in Guam's offshore environment. Fish species and habitat in Guam are generally discussed in this section. For more information about water, see Section 6.1.4, Water Resources. Fisheries are defined as the human activities involved in harvesting fish or shellfish, or a group of fish species that share the same habitat (*NOAA 2015a*). The types of fisheries in Guam include commercial,[1] subsistence,[2] and recreational.[3] For more information on subsistence use and threatened and endangered species of fish, see Section 6.1.9, Socioeconomics, and Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, respectively.

Specific Regulatory Considerations

The Western Pacific Regional Fishery Management Council (WPRFMC) has authority over the fisheries based in, and surrounding, the Territory of Guam within its Exclusive Economic Zone[4] (*WPRFMC 2009*). The Territory of Guam manages marine resources within waters 0 to 3 miles from their shoreline. As part of a shift away from species-based management toward ecosystem-based management, the WPRFMC produced a Fishery Ecosystem Plan for the Mariana Archipelago (Guam and the Mariana Islands), which outlines ecosystem approaches to management of the fisheries. The Guam Department of Agriculture Division of Aquatic and Wildlife Resources is responsible for the implementation of fisheries management on Guam (*WPRFMC 2009*). Fishing permits are not required on Guam, but restrictions do apply in protected areas such as Marine Preserves and the United States (U.S.) Fish and Wildlife managed Guam National Wildlife Refuge (Figure 6.1.6.5-1).

Guidance on compliance with Guam fisheries management and regulations can be found on the Guam Department of Agriculture Division of Aquatic and Wildlife Resources website[5] (*Guam DOA 2015*).

[1] The whole process of catching and marketing fish and shellfish for sale (*NOAA 2015a*)
[2] The catch is shared and consumed directly by the families and kin of the fishermen, rather than being sold (*NOAA 2015a*).
[3] The catch is for personal use, pleasure, or competition (*NOAA 2015a*).
[4] The U.S. Exclusive Economic Zone is a 200-mile ocean boundary around the coastline of U.S. states and territories in which the United States asserts exclusive commercial fishing rights.
[5] http://dawr.guam.gov/guams-water-resources/



Source: NOAA and USDOI 2014; Anderson 2004

Figure 6.1.6.5-1: Marine Protected Areas and Coral around Guam

Environmental Setting

The wetlands in Guam include marsh lands, mangrove swamps consisting of black and red mangroves, and non-descriptive inland areas saturated with water (*Liu and Fischer 2006*). The wetland scientist Sesonyan Siha thoroughly described the aquatic habitats of Guam and the species that utilize them in his report, *The Wetlands of Guam: A Guidebook for Decision Makers* (*Siha 1991*).

Coastal Saltwater Marshes

Siha (*1991*) describes the coastal and saltwater marsh environments on Guam:

> "Saltwater aquatic: These wetlands are routinely flooded by saltwater. Vegetation such as sea grasses and algae can be found in certain areas. Others support corals while still others are intertidal reefs and unconsolidated shore. A highly productive ecosystem, this area provides a feeding ground for juvenile fish. Shallow waters are home to such species as hawksbill and green turtles (*Eretmochelys imbricate* and *Chelonia mydas*), fish and shellfish.
>
> Coastal marsh: Predominantly herbaceous vegetation, sedges and grasses grow here under the influence of brackish (salty) water. Reed marshes are included in this category. Often located at the mouth of a river where outlet meets ocean water (transitional)."

Mangrove Swamp

Estuaries that are dominated by mangrove species with extensively intertwining prop root systems are called mangrove swamps (*Siha 1991*). These areas have brackish water and support other woody species; they may also have a distinctive odor at low tide (*Siha 1991*). Mudflats in and around mangrove swamps are frequented by mud crabs that burrow in the substrate, and the prop root system of mangrove trees provide habitat for many mollusk species (*Siha 1991*).

Freshwater Environment

Siha (*1991*) describes the freshwater environment on Guam:

> "Freshwater aquatic: Fringe areas of stagnant ponds, slow-moving streams or lakes that support wetland species. Permanently flooded by freshwater, these areas usually contain floating plant species without well-developed structural support. Includes reservoirs as well and can provide food for waterbirds.
>
> Marsh land: Also called grassy marsh, sedge marsh, reed marsh. Little open water choked with reeds and sedges. Places where the water table is at or near the surface permanently and which supports an herbaceous type of vegetation usually in pure stands. These can also contain masses of floating vegetation, and shrub vegetation. Found in lowland and upland, they can occur in savannah wetlands that probably came about as a result

> of massive disturbances that altered soil characteristics. These areas are important waterbird habitat."

Some common species in Guam's freshwater environments include the native freshwater eel, introduced tilapia, catfish, gobies, flagtails, and freshwater shrimp (*Siha 1991*).

Coral Reefs and Marine Environment

Live coral reefs surround approximately 50 percent of Guam's 153 kilometer shoreline (*WPRFMC 2009*). They vary in width from narrow benches (10 to 20 feet) to broad reef flats (*Joint Guam Program Office 2010*), but most of the reefs are fringing reefs up to 600 meters wide (*WPRFMC 2009*). Most of the reefs are located in territorial waters (0 to 3 nautical miles), while reefs located at the offshore banks are in federal waters. Guam has approximately 14.2 square miles of coral reefs, 0.55 square miles of seagrass beds, 1.43 square miles of estuarine systems, and 21.73 square miles of marine bays (*Joint Guam Program Office 2010*).

Marine invertebrate groups important to ecosystem function and energy transfer through the food web are corals, sponges, star fishes, anemones, crustaceans,[6] and mollusks (*WPRFMC 2009*). On Guam, notable invertebrates from the groups listed above are spiny and slipper lobsters (families Palinuridae and Scyllaridae), sea cucumbers (family Holothuroidea), sea urchins (family Echinoidea), red reef crab (*Atergatis subdentatus*), seven-eleven crab (*Carpilius maculatus*), giant clams (*Tridacna gigas*), and trochus (*Trochus* spp., an introduced species of sea snail). Coral reefs occur where water is shallow, consistently clear, fully saline, relatively clean, and has a stable bottom (*NOAA and SFWR 1994*). Unlike continental North America with its continental shelf ecosystems, Pacific islands are primarily volcanic peaks with steep offshore drop-offs and limited shelf ecosystems (*WPRFMC 2009*).

Fisheries Characteristics

Commercial

Commercial fishing is not allowed in freshwater environments on Guam. The enforcement of commercial fishing regulations in the marine environment is relatively lax except in Marine Preserves where there are closed areas as well as gear and species restrictions. Catch quantities have been declining over recent decades; a recent study estimated that fishery catches on Guam have declined up to 86 percent since 1950 (*Joint Guam Program Office 2010*).

[6] A group of freshwater and saltwater invertebrates with jointed legs and a hard shell of chitin; includes shrimps, crabs, lobsters, and crayfish (*NOAA 2006*)

The *Joint Guam Program Office* (*2010*) states that "reef-related fishing methods currently used on Guam include hook and line, cast net, spear fishing with snorkel and SCUBA, gill net, surround net, trolling, drag net, hooks and gaffs, jigging, spincasting, and bottom fishing." Two fishing methods have been banned on Guam and the Northern Mariana Islands: the use of SCUBA and artificial light for night spear fishing and the use of monofilament gill nets (*Joint Guam Program Office 2010*).

Some commonly targeted commercial species include trochus, sea cucumbers, spiny and slipper lobster, humphead parrotfish (*Bolbometopon muricatum*), groupers (family Epinephelinae), snappers (family Lutjanidae), and tuna (subgroup of family Scombridae) (*NOAA and SFWR 1994*).

Subsistence

It is estimated that around 35 to 40 percent of local residents fish weekly (*GNWR 2009*). In the Guam National Wildlife Refuge alone, an estimated 100 visits per week were for fishing purposes (*GNWR 2009*). Fishing methods used in the refuge are primarily hook and line, throw netting, spear fishing, simple collection (e.g., octopus), cast nets, and surround nets (*GNWR 2009*).

Some commonly fished subsistence species include the giant clam, spiny and slipper lobster, coconut crab (*Birgus latro*), bigeye scad (*Selar crumenophthalmus*), rudderfish (family Kyphosidae), unicornfish (*Naso* spp.), parrotfish (family Scaridae), emperors (family Lethrinidae), goatfish (family Mullidae), rabbitfish (*Siganus* spp.), and tuna (*NOAA and SFWR 1994*).

Recreational

No fishing license is required for recreational fishing on Guam and regulations are fairly lax, with exceptions in Marine Preserves. Boat-based trolling and bottom fishing are common in waters offshore of Guam (*GNWR 2009*).

Commonly targeted sport fish species include Indo-Pacific blue marlin (*Makaira nigricans*), Indo-Pacific sailfish (*Istiophorus platypterus*), shortbill spearfish (*Tetrapturus angustirostris*), broadbill swordfish (*Xiphias gladius*), mahi-mahi (*Coryphaena hippurus*), unicornfish, parrotfish, jacks, trevally (*Caranx* spp.), wahoo (*Acanthocybium solandri*), and tuna (*NOAA and SFWR 1994*).

Areas of Importance

Essential fish habitat (EFH) is determined by National Oceanic and Atmospheric Administration (NOAA) through the Magnuson-Stevens Fishery Conservation and Management Act. EFH are those waters and substrates necessary to fish for spawning, breeding, feeding, or growing to maturity (*NOAA 2007*) as determined by regional fishery management councils. EFH has been identified in Guam for bottomfish, Seamount Groundfish, Precious Corals and Pelagic[7] management unit species. Except for several of the major commercial species, very little is known about the life histories, distribution, habitat utilization patterns, food habits, or spawning behavior of most adult bottomfish and seamount groundfish species (*WPRFMC 2009*).

The WPRFMC further describes Guam's EFH in its Fishery Ecosystem Plan (*WPRFMC 2009*):

> "The following EFH designations were developed by the Council and approved by the Secretary of Commerce. EFH designations for Bottomfish and Seamount Groundfish, Crustaceans, Precious Corals and Pelagic MUS [management unit species] were approved by the Secretary on February 3, 1999 (64 FR 19068). EFH designations for Coral Reef Ecosystem MUS were approved by the Secretary on June 14, 2002 (69 FR 8336).
>
> To reduce the complexity and the number of EFH identifications required for individual species and life stages, the Council has designated EFH for bottomfish, crustacean, precious coral, and coral reef taxa assemblages pursuant to Section 600.805(b) of 62 FR 66551. The designation of these assemblages is based on the ecological relationships among species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual MUS throughout the Western Pacific Region."

Given the uncertainty concerning the life histories and habitat requirements of the EFH-designated species assemblages, the Council delineated EFH based upon water column depth preference and all bottom habitat extending from the shoreline to a depth of 400 meters (200 fathoms) encompassing the steep drop-offs and high-relief habitats that are important for bottomfish throughout the Western Pacific Region (*WPRFMC 2009*). As a result of these multi-species EFH designations, the entire coastline of Guam and nearshore waters are designated as EFH.

There are five marine preserves on Guam: Tumon Bay, Piti Bomb Holes, Sasa Bay, Achang Reef Flat, and Pati Point (Figure 6.1.6.5-1) (*Joint Guam Program Office 2010*). Commercial, subsistence, and recreational fishing activities are variably restricted in the preserves (*Guam DOA 2000*). The preserves were established by the government to help declining reef fish populations; however, fishing restrictions were not fully enforced until 2001 (*Joint Guam Program Office 2010*).

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[7] Inhabiting the water column as opposed to being associated with the sea floor; generally occurring anywhere from the surface to 1,000 meters

The reef flats in Tumon, Hagåtña, Agat, and Asan Bays as well as on the shore side of Cocos Island Lagoon are popular subsistence and recreational fishing areas; these reefs are extremely valuable in terms of marine life, aesthetics, food supply, recreation, and protection of Guam's highly erodible shorelines from storm waves, currents, and tsunamis (*Joint Guam Program Office 2010*).

The largest lake on Guam, Fena Lake, is a popular site for sportfishing (*Siha 1991*). Agaña Spring is another important freshwater fish habitat (*Siha 1991*).

The Guam National Wildlife Refuge is located on the northern tip of the island. It includes 371 acres of coral reef, which are relatively pristine and have higher species diversity than other reefs around Guam (*GNWR 2009*). The Marianas Trench Marine National Monument is located just offshore of Guam by approximately 75 miles. This trench is the deepest spot in the world and exhibits a diversity of marine life, much of which has yet to be studied.

Threats and Stressors

The *Joint Guam Program Office* (*2010*) describes basic stressors to Guam's fisheries:

> "Examples of stressors include overfishing, increased pollutants released directly to the marine environment or indirectly from land, point and non-point source discharges of stormwater and wastewater treatment plant outfalls, invasive species, recreational activities, diseases, coral bleaching, and storms. Other anthropogenic sources of stress on the marine environment include deliberate damage to marine resources by the human population on Guam, including military personnel; examples include destructive fishing methods such as dynamite fishing and deliberate collection of corals and live rock for aquarium use… Sedimentation, algal overgrowth due to decreased fish stocks, and low recruitment rates of both corals and fish continue to be important issues that must also be addressed." [8]

Overfishing occurs when fish are harvested at a rate faster than they can reproduce, a potentially devastating problem for fisheries worldwide (*Monterey Bay Aquarium 2015*). The Mariana Islands Archipelago Fishery Ecosystem Plan, mandated by the Magnuson-Stevens Act, strives to "achieve long-term sustainable yields from domestic fisheries while preventing overfishing" (*WPRFMC 2009*). Typically, overfishing begins when fishermen target the largest fish in the population for the greatest economic value. When the largest fish become depleted, the next largest fish size is targeted and the overfishing sequence continues until only the smallest size classes remain in the population. Larger fish are generally the ones that reproduce; therefore, when larger fish are removed the population cannot sustain itself. Some examples of fish and shellfish in Guam that are at risk of overfishing include trochus (*Trochus* spp.), coconut crab, humphead parrotfish, and the gray reef shark (*Carcharhinus amblyrhynchos*) (*NOAA and SFWR 1994*).

[8] An invasive species is an introduced species that out-competes native species for space and resources (*NOAA 2006*).

One of the WPRFMC's primary management objectives for the Mariana Islands Archipelago is "to minimize fishery bycatch and waste to the extent practicable" (*WPRFMC 2009*). *NOAA* (*2011*) describes the effects and importance of managing non-target species bycatch:[9]

> "Bycatch costs fishermen time and money, harms endangered and threatened species, affects marine and coastal ecosystems, and makes it more difficult for scientists to measure the effect of fishing on the stock's population, and for managers to set sustainable levels for fishing. Preventing and reducing bycatch is an important part of ensuring sustainable living marine resources and coastal communities. The 2006 reauthorization of the Magnuson Stevens Act, the nation's principal law for living marine resources, made bycatch reduction a priority, leading NOAA to establish a bycatch reduction program to develop technological devices and other conservation engineering solutions."

There are other naturally occurring threats to fish habitat, such as crown-of-thorns starfish outbreaks, which can drastically reduce coral cover; an incident occurred in the early 1970s where coral cover was reduced from 50 to 60 percent cover to less than 1 percent cover (*Joint Guam Program Office 2010*).

[9] Unintentional capture/injury/entanglement of unwanted species during commercial fishing (e.g., a shark captured in a seine net targeting salmon)

6.1.6.6. Threatened and Endangered Species and Species of Conservation Concern

Introduction

The threatened and endangered species analysis in this Draft Programmatic Environmental Impact Statement considers plant and animal species that are federally listed as threatened (likely to become endangered), endangered (at risk for extinction), candidate,[1] proposed,[2] or species of concern (species in need of conservation); and species that are territory-listed as critically endangered (high risk of extinction), endangered, threatened, or vulnerable (e.g., threatened). This analysis considers species that are known to occur in Guam for all or part of their life cycle.[3]

Specific Regulatory Considerations

Federal Regulations

<u>Endangered Species Act</u>

The Endangered Species Act (ESA) is administered by the United States (U.S.) Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). With some exceptions, Section 9 of the ESA prohibits unauthorized take[4] of any fish or wildlife species listed as endangered or threatened under the ESA. Subject to specified terms and conditions, Section 10 of the ESA allows for the incidental take of listed species by non-federal entities otherwise prohibited by Section 9. Pursuant to Section 10, an Incidental Take Permit[5] is issued through adoption of an USFWS-approved Habitat Conservation Plan[6] that demonstrates that take has been avoided, minimized, and mitigated (reduced severity) to the maximum extent practicable.

Section 7(a)(2) of the ESA states that each federal agency shall ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of designated critical habitat. A federal action "means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas" (*50 Code of Federal Regulations 402.2*).

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[1] Candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act.

[2] Proposed species are those that have been proposed in a Federal Register (FR) after the completion of a status review and consideration of other protective conservation measures.

[3] Life cycle is defined as the continuous sequence of development of an organism.

[4] Take is defined differently by various federal and state regulations, but the most commonly accepted definition is that of the U.S. Endangered Species Act (ESA). This act defines take as "to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in any such conduct." The act further defines "harm" as "significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering," and "harass" as "actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering."

[5] An Incidental take permit is issued under Section 10 of the ESA to private parties undertaking otherwise lawful projects that might result in the take of an endangered or threatened species (*USFWS 2015a*).

[6] A plan that outlines mitigation measures to enhance, maintain, and protect habitats of a particular species. The Plan is developed to help reduce impacts.

Actions of federal agencies that do not jeopardize the continued existence of listed species or result in destruction or adverse modification of their designated critical habitat, but that could result in a take, must be addressed by consulting with applicable resource agencies under Section 7. The Proposed Action is subject to the ESA because it is a proposed federal undertaking.

Territory Regulations

Chapter 63, Article 2 of Title 5 of the Guam Code contains the Endangered Species Act of Guam, which establishes the territory's legal framework related to endangered species and provides the regulations related to those species protected under the law within the territory, including prohibiting take, import, and export of such species. Under the act, the Guam Department of Agriculture is responsible for determining and maintaining a list of threatened and endangered species in Guam. The Guam Department of Agriculture most recently codified its list of species of concern in Endangered Species Regulation Number 9 (*GDA 2009*). Conservation needs and management strategies for these species are considered in Guam's Comprehensive Wildlife Conservation Strategy, which is currently being updated (*GDA 2006*).

Species Overview

Federally and Territory-listed and Candidate Species

There are 32 federally and/or territory-listed plant and animal species in Guam, including 3 plants, 5 birds, 7 mammals, 10 reptiles, 1 fish, and 6 invertebrates. There are 15 federal candidate species including 13 plants and 2 invertebrates. Table 6.1.6.6-1 lists the federally and state-listed species and candidate species and summarizes their habitat and nesting preferences, geographic distribution, population status, and occurrence in Guam.

Critical Habitat

Two species in Guam have critical habitat that has been designated by the USFWS: Mariana fruit bat (*Pteropus m. mariannus*), and Mariana crow (*Corvus kubaryi*).

Mariana fruit bat critical habitat occurs on the northern coastline of Guam at Ritidian Point. Critical habitat for this species includes undisturbed wet forests that contain specific tree species used for foraging, roosting, and breeding as well as limestone cliffs between 260 and 590 feet tall (*USFWS 2004*). Threats for this species include habitat degradation due to the conversion of forests to pastures for agriculture use (e.g., large sugar plantations and free-range livestock pastures), invasive species, and an overall increase in human populations (*Cotter 2005*).

Critical habitat for the Mariana crow also occurs on the northern coastline of Guam at Ritidian Point. Critical habitat for this species contains unfragmented and undisturbed wet forests with dense tree cover, standing dead trees, and specific tree species used for breeding and foraging. Forest that has been designated as critical habitat for this species is over 950 feet from the nearest road and 203 feet from the nearest forest edge and at least 30 acres in size (*USFWS 2004*). Threats for this species include habitat loss, persecution, and predation by invasive species, in particular the brown tree snake (*Boiga irregularis*) (*IUCN 2013*).

Table 6.1.6.6-1: Federal- and Territory-listed Threatened and Endangered and Candidate Species Known to Occur in Guam

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Plants (16)						
Tree Fern (*Cyathea lunulata*)	TE	Terrestrial	Savanna and narrow ravines	Guam and other Micronesian islands and Polynesia	Unknown	Y
No common name (*Serianthes nelsonii*)	FE, TE	Terrestrial	Limestone forests	Guam and Rota of the Mariana Islands	Decreasing	Y
No common name (*Heritiera longipetiolata*)	TE	Terrestrial	Moist forest on limestone cliffs and coastal windblown sites	Guam, Northern Mariana Islands	Decreasing	Y
Fadang (Cycas micronesica)	FC	Terrestrial	Closed forest on coral limestone or coral sand, or occasionally on volcanic soils	Micronesia, the Marianas Group including Guam, and the western Caroline Islands	Decreasing	Y
No common name (*Maesa walkeri*)	FC	Terrestrial	Forest edge and open, sunny sites on limestone	Guam and the Northern Mariana Islands	Unknown	Y
No common name (*Nervilia jacksoniae*)	FC	Terrestrial	Forests below 1,200 feet	Guam and Rota of the Northern Mariana Islands	Unknown	Y
Wild Onion (*Bulbophyllum guamense*)	FC	Terrestrial	Limestone forests at elevations above 900 feet	Guam and the Northern Mariana Islands	Unknown	Y
No common name (*Dendrobium guamense*)	FC	Terrestrial	Epiphytic species (i.e., a plant that grow upon or attaches to another living plant) that is associated with numerous tree species, including some plantation trees (betelnut and coconut). Often found in coastal forests within 300 feet of the coast.	Guam and Northern Mariana Islands	Unknown	Y

Common Name and Scientific Name	**Listing Status[a]**	**Type of Habitat (Terrestrial, Marine, or Freshwater)**	**General Habitat Description**	**Geographic Range**	**Population Status (Stable, Declining, Increasing, Unknown)**	**Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)**
Berenghenas Halomtano (*Solanum guamense*)	FC	Terrestrial	Rock substrates along the coast	Guam and Northern Mariana Islands	Unknown	Y
No common name (*Tabernaemontana rotensis*)	FC	Terrestrial	Raised limestone terraces on extinct volcanic peaks and slopes with limited areas of volcanic soils protruding through the limestone	Guam and Rota of the Northern Mariana Islands	Decreasing	Y
No common name (*Tuberolabium guamense*)	FC	Terrestrial	Epiphytic species that grow on trees in lowland forests	Guam and Rota of the Northern Mariana Islands	Unknown	Y
No common name (*Eugenia bryanii*)	FC	Terrestrial	Open forest and edge habitat	Endemic (i.e., occurs only in a specific area) to Guam	Unknown	Y
Paudedo (*Hedyotis megalantha*)	FC	Terrestrial	Savanna	Endemic to Guam	Unknown	Y
No common name (*Phyllanthus saffordii*)	FC	Terrestrial	Savanna	Endemic to Guam	Unknown	Y
Aplokhating-palaoan (*Psychotria malaspinae*)	FC	Terrestrial	Forest	Endemic to Guam	Unknown	Y
No common name (*Tinospora homosepala*)	FC	Terrestrial	Coastal limestone forest	Endemic to Guam	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Birds (5)						
Guam Rail (*Gallirallus owstoni*)	FE, TE	Terrestrial	Medium sized landbird that occurs in a wide variety of habitats in Guam including forest, savanna, scrub, secondary grassland, fern thickets and agricultural areas. Nests on the ground year round.	Cocos Island and Guam and Rota of the Mariana Islands	Decreasing	Y
Mariana Common Moorhen (*Gallinula chloropus guami*)	FE, TE	Terrestrial	Medium-sized waterbird that inhabits freshwater wetlands, both still and moving, sheltered by woodland, bushes or tall emergent vegetation. Nesting occurs year round.	Guam and Northern Mariana Islands	Unknown	Y
Mariana Gray Swiftlet (*Aerodramus bartschi*)	FE, TE	Terrestrial	Small bird that forages over coastal and interior forest and grassland, roosts and breeds in caves. Nests multiple times per year.	Guam and Northern Mariana Islands	Increasing	Y
Mariana Crow (*Corvus kubaryi*) (CH)	FE, TE	Terrestrial	Medium-bodied bird that inhabits mature and second-growth limestone forest and also forages in coastal vegetation. Peak nesting period occurs from August through February but is highly variable year to year.	Guam and the Northern Mariana Island of Rota	Decreasing	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Micronesian Starling (*Aplonis opaca guami*)	TE	Terrestrial	Small bird that inhabits a variety of forest types and nests in natural tree cavities and in cavities on limestone cliffs. Nesting period is variable and poorly documented but most commonly occurs from October through March.	Guam, Rota, Tinian and Saipan	Unknown	Y
Mammals (7)						
Mariana Fruit Bat (*Pteropus m. mariannus*) CH	FT, TE	Terrestrial	Medium-sized bat that primarily forages and roosts in native limestone forest, occasionally in coconut groves and strand vegetation. Breeds at any time during the year.	Guam and the Central Northern Mariana Islands	Decreasing	Y
Blue Whale (*Balaenoptera musculus*)	FE	Marine	The species feeds on small, planktonic, shrimp-like krill (*Euphausia pacifica* and *Thysanoessa spinifera*) near the ocean's surface.	Worldwide distribution, broken into regional groups. North Pacific group ranges from Kamchatka to southern Japan in the west and from the Gulf of Alaska and California south to Costa Rica.	Unknown	M

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Humpback Whale (*Megaptera novaeangliae*) (Western North Pacific DPS)	FT	Marine	Breeds in tropical waters and migrates to temperate and subpolar waters for feeding.	Worldwide distribution. Western North Pacific DPS ranges winters near Japan and probably migrates to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall.	Increasing	M
Fin Whale (*Balaenoptera physalus*)	FE	Marine	Generally concentrated along frontal boundaries (or mixing zones) between coastal and oceanic waters near 660-foot depth. Feeds on fish.	Worldwide (offshore and outside of temperate waters). Migrates to tropics in winter and northern latitudes in summer.	Unknown	M
Sei Whale (*Balaenoptera borealis*)	FE	Marine	Distribution in open ocean highly variable and related to ocean currents. Strongly associated with ocean fronts and eddies; rare in semi-enclosed seas or gulfs. Feeds on copepods (small crustaceans) and euphausiids (shrimp-like crustaceans).	Offshore occurring in the North Atlantic, North Pacific, and Southern Hemisphere; an occasional visitor to the Mediterranean Sea. Generally migrate toward the lower latitudes during the winter and higher latitudes during the summer.	Unknown	M
Sperm Whale (*Physeter microcephalus*)	FE	Marine	Occurs offshore in submarine canyons at the edge of the continental shelf or in waters deeper than 660 feet.	Worldwide distribution. No obvious seasonal migration in tropical locales.	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Dugong (*Dugong dugon*)	FE	Marine	Shallow, tropical marine coastal water mainly confined to sea grass beds, which occur in calm and shallow coastal areas, such as embayment and lagoons.	Discontinuously found in coastal waters of east Africa from the Red Sea to northernmost South Africa, northeastern India, along the Malay peninsula, around the northern coast of Australia to New Guinea, and many of the island groups of the South Pacific.	Unknown	Y
Reptile (10)						
Snake-eyed Skink (*Cryptoblepharus poecilopleurus*)	TE	Terrestrial	Prefers rock walls or lava overlooking or adjacent to beach, occurs commonly in casuarina groves.	Islands of the western Pacific Ocean and Indian Ocean. Introduced and established on Guam and the Mariana Islands.	Unknown	Y
Tide-pool Skink (*Emoia atrocostata*)	TE	Terrestrial	Intertidal and adjacent strand vegetation (narrow bands of marine vegetation)	Native to Ryukyu Islands, Taiwan, southeastern Asia, Australia and many Pacific islands, including the Mariana islands of Guam and Cocos and Rota.	Unknown	Y
Azure-tailed Skink (*Emoia cyanura*)	TE	Terrestrial	Strand and back strand vegetation, edges between forest and disturbed ground	Native to Melanesia through Polynesia. Found in Guam and Cocos in the Mariana Islands.	Unknown	Y
Slevin's Skink (*Emoia slevini*)	TE	Terrestrial	Inhabits the forest floor, field edges	Endemic to the Mariana Islands of Cocos, Guam, Rota, Tinian, Sarigan, Guguan, Alamagan, Asuncion, and Maug.	Decreasing	Y

Common Name and Scientific Name	**Listing Status[a]**	**Type of Habitat (Terrestrial, Marine, or Freshwater)**	**General Habitat Description**	**Geographic Range**	**Population Status (Stable, Declining, Increasing, Unknown)**	**Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)**
Moth Skink (*Lipinia noctua*)	TE	Terrestrial	Ground dwelling, and low in trees	Native to northern New Guinea, Melanesia and Micronesia, including the Mariana Island of Guam	Unknown	Y
Green Turtle (*Chelonia mydas*)	FT, TT	Marine	Shallow coastal (i.e., neritic) areas rich in sea grass/marine algae	Circumglobal (global) distribution, throughout coastal waters of western Pacific islands	Decreasing	Y
Hawksbill Turtle (*Eretmochelys imbricata*)	FE, TE	Marine	Shallow coastal (e.g., neritic) areas rich in sea grass/marine algae	Circumglobal distribution throughout temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. Forage throughout western Pacific region but tends to nest only in remote areas.	Decreasing	Y
Loggerhead Turtle (*Caretta caretta*)	FT	Marine	Shallow Coastal (e.g., neritic) areas rich in sea grass/marine algae	Circumglobal distribution throughout temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans.	Decreasing	M
Leatherback Turtle (*Dermochelys coriácea*)	FE	Marine	Shallow Coastal (e.g., neritic)areas rich in sea grass/marine algae	Found from tropical to sub-polar oceans worldwide. Western Pacific leatherbacks migrate between nesting beaches in the western Pacific (primarily Papua Barat, Indonesia, Papua New Guinea, and the Solomon Islands) to foraging grounds in the eastern North Pacific.	Decreasing	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Olive Ridley Turtle (*Lepidochelys olivacea*)	FT	Marine	Mainly open ocean, but has been known to inhabit coastal areas, including bays and estuaries.	Globally distributed in the tropical regions of the South Atlantic, Pacific, and Indian Oceans	Decreasing	Y
Fish (1)						
Scalloped Hammerhead Shark, Indo-West Pacific DPS (*Sphyrna lewini*)	FT	Marine	Coastal pelagic (e.g., open ocean) over continental and insular shelves adjacent to deeper water.	From Japan and China to New Caledonia, including throughout the Philippines, Indonesia, and Australia	Unknown	Y
Invertebrates (8)						
Mariana Eight Spot Butterfly (*Hypolimnas octocula mariannensis*)	FC	Terrestrial	Open forest; *Elatostema calcareum* and *Procris pedunculata* are host plants (plants that provide resources to the species).	Guam and Saipan of the Northern Mariana Islands	Decreasing	Y
Mariana Wandering Butterfly (*Vagrans egistina*)	FC	Terrestrial	Open forest; *Maytenus thompsonii* is the host plant.	Guam, Rota, Saipan, and Tinian	Unknown	Y
Humped Tree Snail (*Partula gibba*)	FE	Terrestrial	Forest	Guam, Northern Mariana Islands	Decreasing	Y
Guam Tree Snail (*Partula radiolata*)	FE	Terrestrial	Forest	Endemic to Guam	Decreasing	Y
Fragile Tree Snail (*Samoana fragilis*)	FE	Terrestrial	Forest	One population on Rota supports about 100 individuals. It may be extinct on Guam.	Decreasing	Y
Coral—no common name (*Acropora globiceps*)	FT	Marine	Upper reef slopes and reef flats	Likely distributed from the oceanic west Pacific to the central Pacific as far east as the Pitcairn Islands	Unknown	Y

Common Name and Scientific Name	Listing Status[a]	Type of Habitat (Terrestrial, Marine, or Freshwater)	General Habitat Description	Geographic Range	Population Status (Stable, Declining, Increasing, Unknown)	Occurrence in Guam (B=Breeding, Y= Year Round Resident, W=Wintering, M-Migratory)
Coral—no common name (*Acropora retusa*)	FT	Marine	Upper reef slopes and tidal pools	Likely distributed in the western Indian Ocean, the east coast of India, and from Vietnam east to the Pitcairn Islands.	Unknown	Y
Coral—no common name (*Seriatopora aculeata*)	FT	Marine	Shallow reef environments	Likely distributed mostly within the Coral Triangle area (ocean and coastal waters in Southeast Asia), as well as adjacent areas in the western Pacific from Mariana Islands down to New Caledonia.	Unknown	Y

Sources: GDA 2009; IUCN 2015; NMFS 2015; USFWS 2015b; and official species accounts or recovery plans published by USFWS or NMFS

Note: Species considered by USFWS to be extinct or extirpated from the wild were excluded from this table. DPS = Distinct Population Segment
[a] Listing Status: FE = Federally Endangered, FT = Federally Threatened, FC = Federal Candidate for listing, TE = Territory Endangered, TT =Territory Threatened, CH = Federally designated critical habitat has been designated for this species

6.1.7. Land Use, Airspace, and Recreation

6.1.7.1. Introduction

This section provides a broad overview of land use, airspace, and recreational facilities and activities in Guam. This includes regulations, conditions, and activities that could potentially be affected by deployment and operation of the Proposed Action. The following summarizes major land uses, recreational venues, and airspace considerations, and characterizes existing, baseline conditions for use in evaluating the potential environmental consequences resulting from implementing the Proposed Action or Alternatives.

Land Use and Recreation

Land use is defined as "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change, or maintain it" (*Di Gregorio and Jansen 1998*). A land use designation can include one or more pieces of land, and multiple land uses may occur on the same piece of land. Land use also includes the physical cover, observed on the ground or remote sensing and mapping, on the earth's surface; land cover includes vegetation and manmade development (*USGS 2012b*).

Recreational uses are activities in which residents and visitors participate. They include outdoor activities, such as hiking, fishing, boating, athletic events (e.g., golf and boating), and other attractions (e.g., historic monuments and cultural sites) or indoor activities, such as museums and historic sites. Recreational resources can include trails, beaches, caves, lakes, forests, beaches, recreational facilities, museums, historic sites, and other outdoor areas. Recreational resources are typically managed by state, county, or local governments.

Land uses are typically defined and managed by local governments, and the categories of land use can vary considerably from jurisdiction to jurisdiction. As a result, this Draft Programmatic Environmental Impact Statement refers to "land use/land cover," as defined in the National Land Cover Database (*USGS 2001*), a standardized set of 21 categories defined by the U.S. Geological Survey that incorporates both land use and land cover characteristics. Where appropriate, or important to convey local conditions, more general land use categories such as "forest," "agricultural," and "developed" are also used. Descriptions of land ownership are presented in four main categories: private, federal, state, and tribal, although other geographically-specific terms (such as "municipal") are used where appropriate. Descriptions of recreational opportunities are presented in a regional fashion, highlighting areas of recreational significance within 12 identified regions.

Airspace

Airspace is generally defined as the space lying above the earth, above a certain area of land or water, or above a nation and the territories that it controls, including territorial waters (*Merriam Webster Dictionary 2015*). Airspace is a finite resource that can be defined vertically and horizontally, as well as temporally, when discussing it in relation to aircraft activities. Airspace management addresses how and in what airspace aircraft fly. Air flight safety considers aircraft flight risks, such as aircraft mishaps and bird/animal-aircraft strikes. The Federal Aviation Administration (FAA) is charged with the safe and efficient use of the nation's airspace and has established criteria and limits to its use.

The FAA operates a network of airport towers, air route traffic control centers, and flight service stations. The FAA also develops air traffic rules, assigns use of airspace, and controls air traffic in U.S. airspace. "The Air Traffic Organization (ATO) is the operational arm of the FAA responsible for providing safe and efficient air navigation services to approximately 30.2 million square miles of airspace. This represents more than 17 percent of the world's airspace and includes all of the U.S. and large portions of the Atlantic and Pacific Oceans and the Gulf of Mexico" (*FAA 2014*). The ATO is comprised of Service Units (organizations) that support the operational requirements.

The FAA Air Traffic Services Unit (the Unit) manages the National Airspace System and international airspace assigned to U.S. control and is responsible for ensuring efficient use, security, and safety of the nation's airspace. FAA field and regional offices (e.g., Aircraft Certification Offices, Airports Regional Offices, Flight Standards District Offices, Regional Offices & Aeronautical Center, etc.) assist in regulating civil aviation to promote safety, and develop and carry out programs that control aircraft noise and other environmental effects (e.g., air pollutants) attributed from civil aviation (*FAA 2015c*). The FAA works with state aviation officials and airport planners, military airspace managers, and other organizations in deciding how best to use airspace.

6.1.7.2. Specific Regulatory Considerations

Land Use

Land use in Guam is guided by the *Section 1, Chapter II, Title LXV* of Guam's government code (Comprehensive Planning). The code identifies "a pressing need to establish policies which reflect the people's aspirations with respect to the future development of Guam – policies which evolve from sound strategic planning initiatives; policies that take into account all diverse elements of community needs and desires…" The intent of the legislation includes establishing the following:

> "...[A] process and mechanism through which duly adopted policies of Guam are linked with all elements of governmental and non-governmental development planning and implementation activity, the island having experienced the ill-effects of fragmented and disjointed development efforts resulting from the absence of both an integrated planning process and a Comprehensive Development Plan that contain rational parameters for Guam's growth…" (*Public Law 20-147, 20th Guam Legislature*)

The Bureau of Statistics and Plans classifies land in Guam, and evaluates requests for amendment to existing classifications, into 1 of 11 categories, such as residential, commercial, mixed use, or industrial (*Guam Bureau of Statistics and Plans 2009*).

Under *Public Law 20-147*, local plans and zoning must be generally consistent with the North and Central Guam Land Use Plan and land classification system (*Bureau of Statistics and Plans 2009*). Thus, for example, a local comprehensive plan may not encourage a residential area on land designated as conservation by the North and Central Guam Land Use Plan.

Whereas the North and Central Guam Land Use Plan indicates the overall intent of Guam's land use policy, the territory's zoning code (*21 Guam Code Annotated 61*) codifies that intent with specific requirements such as a list of permitted land uses, maximum residential density (e.g., number of dwelling units per acre), and maximum building height. The zoning code does not include regulations specific to telecommunication equipment.

The Chamorro Land Trust Act "was enacted in February 1975 to protect and ensure [that] trust lands are…awarded to native Chamorro[1] through residential, agricultural and commercial leases for one dollar ($1.00) a year, for 99 years" (*Chamorro Land Trust Commission 2011*). The Chamorro Land Trust Commission manages the acquisition and sale of land in Guam in accordance with the Chamorro Land Trust Act (*21 Guam Code Annotated §75101-75117*) and subsequent federal and territorial laws, such as the federal Guam Excess Lands Act, (P.L. 103-339) of 1994, which directs the U.S. General Services Administration to transfer specific parcels totaling approximately 3,213 acres to the Government of Guam. As of 2011, the Chamorro Land Trust Commission had awarded approximately 3,942 acres of land to native Chamorro lessees (*Chamorro Land Trust Commission 2011*).

There are no incorporated cities in Guam.

Airspace

The FAA has jurisdiction over air traffic in the United States (U.S.), and must be contacted for proposed construction or alteration of objects within navigable airspace that meet the following criteria (*14 Code of Federal Regulations 77, commonly known as Part 77 regulations*):

- Any construction or alteration that is more than 200 feet above ground level at the structure's proposed location (including buildings, wind turbines, communications towers, etc.); or
- Construction or alteration that exceeds certain imaginary surfaces extending outward and upward from an airport, seaplane base, or heliport. Imaginary surfaces are three-dimensional shapes surrounding aviation facilities within which development is limited or prohibited in order to ensure safe aviation and minimize the potential effects of crashes.

[1] The Chamorro people are the indigenous people of the Mariana Islands, including Guam and the Northern Mariana Islands.

FAA review of proposed construction or alteration within the spaces listed above could result in denial of permission for construction/alteration, or approval of construction/alteration with or without additional marking /or lighting (*FAA 2015d*). Section 6.1.8, Visual Resources, discusses FAA lighting regulations. Certain airspace in the U.S. reserved or intended for military use is managed jointly by the FAA and the Department of Defense. Aside from Part 77 airspace, there is no restricted airspace and no Military Training Routes over Guam.

Recreation

Guam contains a variety of recreational lands, ranging from historic/cultural areas to National Wildlife Refuges. Each of these facilities is administered according to the applicable federal, territory, or local law, along with management documents prepared for that facility. For example, the National Park Service prepares a Superintendent's Compendium document for each of its units, enumerating park-specific restrictions, closures, permit requirements, and other regulations (*NPS 2015*).

6.1.7.3. Land Use and Ownership

Land Use/Land Cover

Land use/land cover refers to the use of land, as visible from the air (or satellites). Figure 6.1.7-1 and Table 6.1.7-1 show the distribution of land use/land cover in Guam. As shown in Table 6.1.7-1, evergreen forest and grassland/herbaceous account for 65 percent of land cover in Guam. Developed open space covers approximately 11 percent of the territory. Scrub/Shrub—which includes shrubs and smaller trees (*MRLC 2014*)—accounts for 9 percent of land cover. Impervious surface covers approximately 10 percent of Guam.

Source: USGS 2001

Figure 6.1.7-1: Land Use/Land Cover in Guam

Table 6.1.7-1: Land Use/Land Cover in Guam

Land Use/Land Cover	Acres[a]	Percent of Total[b]
Bare Land	2,685	2%
Cultivated	584	<1%
Developed Open Space[c]	14,541	11%
Wetlands	4,034	3%
Evergreen Forest	60,916	45%
Grassland[d]	26,586	20%
Impervious Surface	13,004	10%
Palustrine Aquatic Bed	2	<1%
Pasture/Hay	28	<1%
Scrub/Shrub	11,561	9%
Unconsolidated Shore	126	<1%
Water	362	<1%
Total	**134,429**	**100%**

Source: NOAA 2011

[a] Totals may not match due to rounding.
[b] Percent of the island's total land area within each land use/land cover.
[c] "Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses" (*MRLC 2014*).
[d] These areas may be used for grazing, but are not subject to active management, such as tilling (*MRLC 2014*).

Land Ownership

Table 6.1.7-2 lists major land owners in Guam. Ownership information is not readily available for approximately 65 percent of Guam. This land is assumed to be privately owned, although this assumption has not been verified.

Table 6.1.7-2: Major Land Owners in Guam

Land Ownership	Acres	Percent of Total[a]
Federal	42,824	32%
Territorial	3,988	3%
Chamorro (native) interests	20	<1%
Private	158	<1%
Other (assumed to be privately owned)[b]	87,513	65%
Total	**46,991**	**100%**

Source: USGS 2012a

[a] Percentage of territory held by each ownership type. This does not include Marine Protected Areas, which are offshore.
[b] *USGS 2012a* data does not specify ownership data for the entire territory and no other data are readily available.

Based on land whose ownership is specified in the *USGS 2012a* dataset (summarized in Table 6.1.7-2), the federal government owns approximately 32 percent of land in the territory; the territorial government owns approximately 3 percent of land, while Chamorro (native) interests and private entities each own less than 1 percent of land.

Most of the federal land in Guam is for military use. The largest concentrations of federal land ownership are at the northern tip of the island (Andersen Air Force Base) and on the southwest coast (U.S. Naval Base Guam and Ordnance Annex). Major federal lands in Guam also include the National Park System's War in the Pacific National Historical Park and the Guam National Wildlife Refuge (*USGS 2012a*).

Territorial government land includes two conservation areas (Anao and Balanos Conservation Areas) and several Marine Protected Areas (Achang Reef Flat Reserve, Tumon Bay Marine Preserve, Piti Bomb Holes, and Sasa Bay Marine Preserve) (*USGS 2012a*). The Marine Protected Areas are offshore, and are thus not included in the total acreage in Table 6.1.7-2.

The Masso River Reservoir Area Natural Reserve is owned by Chamorro groups (Guam's native population).

6.1.7.4. Airspace

Guam International is the only civilian airport in Guam (*FAA 2015a*). It is served by commercial airlines, including overseas (international or mainland U.S.) flights and interisland commercial airlines. Guam International airport served more than 1.4 million passengers in 2014 (*FAA 2015b*). There is also one private heliport located in Agana.

Anderson Air Force Base, the sole military-only airfield in Guam, is one of the most strategically important U.S. airbases in the Pacific region. It "serves as a staging base for activities in Asia and the South Pacific" (*DOD 2015*), and has also supported U.S. military operations in the Middle East (*USAF 2015*).

As described in Section 6.1.7.2, Specific Regulatory Considerations, airspace immediately surrounding airports is subject to Part 77 regulations, which generally govern the placement, height, and use of structures near airports and their runway approaches.

6.1.7.5. Recreation

Figure 6.1.7-2 shows federal, territorial, and locally owned or managed land in Guam that is intended or generally available for public recreation. Such land generally includes public parks and recreation facilities (including large athletic fields at public schools), forests, wildlife refuges, and other lands the public might reasonably expect to be able to use for recreation (*USGS 2012a*).

Table 6.1.7-3 summarizes the acreage of recreation land by type. As shown in that table, the Guam National Wildlife Refuge accounts for approximately 94 percent of recreational lands. Territorial habitat management areas, such as the Anao and Bolanos Conservation Areas and the Masso River Reservoir Area Natural Reserve, are coterminous with the wildlife refuge (*USGS 2012a*). Historic/cultural areas, such as the War in the Pacific National Historical Park, account for approximately 4 percent of recreational lands in Guam.

Source: USGS 2012a

Figure 6.1.7-2: Recreational Areas

Table 6.1.7-3: Acreage of Recreational Lands in Guam, by Type

Recreational Land Type	Guam Total Acres	Guam Total Percent of Total[a]
Historic / Cultural Area	1,497	5%
Marine Protected Area	361	1%
National Wildlife Refuge	29,464	94%
Total	**31,322**	**100%**

Source: USGS 2012a

[a] Percent of the territory's total recreational land area within each recreational land type.

Guam offers a wide variety of offshore recreation, particularly diving and snorkeling to observe Guam's "highly diverse assemblage of coral and marine fish species" (*USFWS 2009*). Section 6.1.6, Biological Resources, summarizes offshore ecological communities, including fisheries. Notable restrictions on ocean use include the following:

- Sasa Bay Preserve. This territorial marine preserve includes more than 775 acres of ocean and is designated a No Take area;
- Pati Point Preserve: This territorial marine preserve includes more than 4,900 acres of ocean where commercial fishing is restricted and recreational fishing is prohibited; and
- Restricted fishing areas: More than 9,000 acres of ocean, primarily in coastal areas, where fishing is restricted, in addition to general federal or territorial fishing regulations.

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6.1.8. Visual Resources

6.1.8.1. Introduction

Visual resources refer collectively to the natural and manmade features, landforms, structures, and other objects visible from a single location or a broader landscape. Visual resources influence the human experience of a landscape. Various aspects combine to create visual resources, such as color, contrast, texture, line, and form. Features (e.g., mountain ranges, city skylines, ocean views, unique geological formations, rivers) and constructed landmarks (e.g., bridges, memorials, cultural resources, or statues) are considered visual resources. For some, cityscapes are valued visual resources, whereas others prefer natural areas. While many aspects of visual resources are subjective, evaluating potential impacts on the character and continuity of the landscape is a consideration when evaluating proposed actions for National Environmental Policy Act and National Historic Preservation Act compliance. A general definition of visual resources used by the Bureau of Land Management is "the visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features)" (*BLM 1984*). This section provides a broad overview of visual resources in Guam. This includes regulations, conditions, and activities that could potentially be affected by deployment and operation of the Proposed Action.

6.1.8.2. Specific Regulatory Considerations

Federal Lands

As described in Section 6.1.7, Land Use, Airspace, and Recreation, the major federal landholders in Guam are the Department of Defense (DOD), National Park Service (NPS), and United States (U.S.) Fish and Wildlife Service (USFWS). Section 6.1.7 lists federal and territory lands (other than DOD lands) that are managed or available for recreation (see Figure 6.1.7-2, Recreational Areas). These recreational areas are also generally managed to address visual resources, except for offshore marine protected areas and management areas. DOD facilities are not evaluated here because any deployment on DOD lands will have to comply with DOD requirements associated with visual concerns. As DOD facilities are not open to the public, the likelihood of a visual impact beyond the perimeter of the facility is unlikely.

While agency-specific guidelines for complying with the National Environmental Policy Act typically require consideration of visual impacts, there is no overall federal regulation or methodology specifying how such impacts should be evaluated.

The most comprehensive federal agency visual impact methodologies are the Forest Service's Scenery Management System and the Bureau of Land Management's Visual Resource Management System. Neither of these agencies manages land in Guam; however, in practice, many Environmental Impact Statement documents use methodologies similar to the Forest Service and Bureau of Land Management.

There are no agency-specific methodologies for evaluating visual impacts on NPS or USFWS lands, although relevant NPS guidance is described below.

National Park Service

An NPS-authored guidance document for evaluating visual impacts associated with renewable energy projects (such as wind turbines) does provide an indication of the agency's approach to visual impact assessment. For NPS, visual impact assessment revolves primarily around the following concepts:

- Visual contrast: "the change in what is seen by the viewer" as a result of a new project such as a wind turbine (*Sullivan and Meyer 2014*); and
- Visual impact: "both the change to the visual qualities of the landscape resulting from the introduction of visual contrasts [i.e., a new wind turbine]…and the human response to that change" (*Sullivan and Meyer 2014*).

Visual impact assessments are incorporated into Environmental Impact Statements for units of the National Park System.

Federal Aviation Administration

Federal Aviation Administration (FAA) regulations in *14 Code of Federal Regulations 77* (commonly known as Part 77 regulations) require distinctive paint and lighting for structures with the potential to affect aerial navigation. Recommendations on marking and lighting structures may vary depending on terrain features, weather patterns, and geographic location. Guidance for implementing Part 77 regulations include (but are not limited to) the following (all citations from *FAA 2015*):

- Flashing or steady red lights (nighttime only) on structures up to 200 feet above ground level (AGL);
- Medium-intensity flashing white lights (daytime and twilight with automatically selected reduced intensity for nighttime) for structures greater than 200 feet AGL (other lighting and marking methods may be omitted for structures that do not exceed 700 feet AGL);
- Aviation orange and white paint for daytime marking on structures exceeding 700 feet AGL;
- High-intensity flashing white lights (daytime only with automatically selected reduced intensities for twilight and nighttime) for structures exceeding 700 feet AGL (other lighting and marking methods may be omitted if this system is used);
- Dual lighting including red lights for nighttime and high- or medium-intensity flashing white lights for daytime and twilight;
- Temporary high- or medium-intensity flashing white lights, as recommended in the determination, operated 24 hours a day during construction until all permanent lights are in operation;
- Red obstruction lights with painting or a medium intensity dual system for structures 200 feet or more AGL in urban areas where there are numerous other white lights; and
- Steady red lighting for transmission wires (referred to in *FAA 2015* as "catenary wires" between transmission towers) near aviation facilities, canyons, and other areas.

In addition, USFWS has drafted revised guidelines related to communication towers, designed to protect migratory birds (*USFWS 2013*).[1] Regarding visual conditions, the USFWS guidelines recommend that, for new structures tall enough to require lighting under FAA Part 77 guidance

> "…the minimum amount of pilot warning and obstruction avoidance lighting required by the FAA should be used. Unless otherwise required by the FAA, only white strobe or red strobe lights (red preferable), or red flashing incandescent lights should be used at night, and these should be the minimum number, minimum intensity,…and minimum number of flashes per minute (i.e., longest duration between flashes/"dark phase") allowable by the FAA. The use of solid (non-flashing) warning lights at night should be avoided." (*USFWS 2013*):

Territorial Lands

Regulations associated with the territory's marine protected areas and other territorial lands do not address visual impacts, nor does the territory's zoning code or other regulations.

6.1.8.3. Existing Visual Resources

Large portions of Guam, particularly the beaches, coastal, and natural areas in less-developed portions of the island, are quite scenic (*Guam Visitors Bureau 2015*). This section focuses on scenic resources that have been defined through the regulations and guidance described in Section 6.1.8.2, Specific Regulatory Considerations.

Federal Lands

Scenic resources on the federal lands in Guam are identified and managed by the host agency (in this case, the NPS or USFWS) and codified in each agency's management document. For units of the National Park System (i.e., national parks, national monuments, etc.), the NPS uses a General Management Plan (GMP) to identify and manage all resources and impacts, including visual resources. A GMP typically divides a National Park System unit into management zones or areas, each of which has a defined purpose, along with a list of appropriate activities and management strategies.

The legislation establishing the War in the Pacific National Historical Park (*Public Law 95-348*) describes the park's purpose as "to conserve and interpret outstanding natural, scenic, and historic values and objects on the island of Guam for the benefit and enjoyment of present and future generations." These scenic values (which include scenery related to the events of World War II, as well as other scenic resources), include marine and terrestrial biology, vegetation, and native Chamorro culture (*NPS 1983*).

[1] See Chapter 11, BMPs and Mitigation Measures, for additional information regarding USFWS and FAA guidelines.

While management prescriptions do not focus on visual resources, the GMP for the War in the Pacific National Historical Park generally emphasizes the importance of preserving visual cues that help visitors understand the events of the World War II battles on Guam, as well as other non-military aspects of the island.

Territorial Lands

Guam's local regulations do not specifically address visual impacts.

6.1.9. Socioeconomics

6.1.9.1. Introduction

The National Environmental Policy Act of 1969 (NEPA; see Section 1.8, Overview of Relevant Federal Laws and Executive Orders) requires consideration of socioeconomics in NEPA analysis. Specifically, Section 102(A) of NEPA requires federal agencies to ensure "the integrated use of the natural and social sciences…in planning and in decision making" (*42 U.S.C. 4332(A)*). Socioeconomics refers to a broad, social-science-based approach to understanding a region's social and economic conditions. It typically includes population, demographic descriptors, cultural conditions, economic activity indicators, housing characteristics, property values, and public revenues and expenditures. When applicable, it includes qualitative factors such as community cohesion. Socioeconomics provides important context for analysis of FirstNet projects that could affect a region's socioeconomic conditions.

The choice of socioeconomic topics and depth of their treatment depends on the relevance of potential topics to the types of federal actions under consideration. FirstNet's mission is to provide a nationwide public safety broadband network (NPSBN) and interoperable emergency communications coverage. Relevant socioeconomic topics include population density and growth, economic activity, housing, property values, and territory and local taxes.

Environmental justice is a related topic that specifically addresses the presence of minority populations (defined by race and Hispanic ethnicity) and low-income populations, to give special attention to potential impacts on those populations per *Executive Order 12898* (see Section 1.8, Overview of Relevant Federal Laws and Executive Orders). Certain demographic information—including race, ethnicity, age, income, and poverty status—is also relevant to evaluating potential environmental justice issues, as discussed in the Environmental Justice sections 6.1.10 and 6.2.10 (in the Affected Environment and Environmental Consequences sections, respectively).

This PEIS also addresses the following topics, sometimes included within socioeconomics, in separate sections: land use, airspace, and recreation (Sections 6.1.7 and 6.2.7), infrastructure (Sections 6.1.1 and 6.2.1), and visual resources (Sections 6.1.8 and 6.2.8).

The financial arrangements for deployment and operation of the FirstNet network have socioeconomic implications. Section 1.1, Overview and Background, frames some of the public expenditure and public revenue considerations specific to FirstNet. This socioeconomics section provides some additional broad context, including data and discussion of territory and local government revenue sources that FirstNet could affect.

Wherever possible, this section draws on nationwide datasets from federal sources such as the United States Census Bureau (U.S. Census Bureau) and U.S. Bureau of Labor Statistics (BLS). This ensures consistency of data and analyses across the states and territories examined in this PEIS. In all cases, this section uses the most recent data available for each geographical location at the time of writing. At the county, territory, state, region, and United States levels, the data is typically for 2013 or 2014. For smaller geographic areas, this section uses data from the U.S. Census Bureau's American Community Survey (ACS). The ACS is the U.S. Census Bureau's flagship demographic estimates program for years other than the decennial census years. This PEIS uses the 2009-2013 ACS, which is based on surveys (population samples) taken across that 5-year period; thus, it is not appropriate to attribute its data values to a specific year. It is a valuable source because it provides the most accurate and consistent socioeconomic data across the nation at the sub-county level. Where available, information is presented at the national and territory levels.

This section discusses the existing socioeconomic conditions of Guam that could potentially be affected by deployment and operation of the Proposed Action, including the following subjects: regulatory considerations specific to socioeconomics in the territory, communities and populations, economic activity, housing, property values, and taxes.

6.1.9.2. Specific Regulatory Considerations

Subsistence

In December, 2008, the Guam Legislature passed Public Law 29-127 granting Chamorros (Guam's indigenous peoples) rights to subsistence fishing and harvesting. Because draft rules and regulations to implement the law have not yet been approved by the attorney general, the law has yet to be implemented (*Hernandez 2015*). Research for this section did not identify any readily available subsistence data or information for this Draft Programmatic Environmental Impact Assessment; however, the existence of Public Law 20-127 indicates that subsistence fishing and harvesting does occur.

Other Regulatory Considerations

Research for this section did not identify any other specific territory, local, or tribal laws or regulations relevant to socioeconomics for this Draft Programmatic Environmental Impact Assessment.

6.1.9.3. Communities and Populations

The geographic area of Guam consists of the main island plus 20 separate islands and 1 islet group (see Section 6.0, Guam):

- Agrigan Island
- Alutom Island
- Alupat Island
- Anae Island
- Asgadao Island
- Asgon Rock
- Babe Island
- Bangi Island
- Cabras Island
- Camel Rock
- Cocos Island
- Dry Dock Island
- Facpi Island
- Fofos Island
- Guijen Rock
- Lalas Rock
- Neye Island
- Orote Island
- Pelagi Islets
- Tangon Rock
- Yona Island

For the purposes of data presentation, the U.S. Census Bureau treats Guam as a single territory and county. The U.S. Census Bureau also recognizes 19 municipalities as legal subdivisions of Guam. Table 6.1.9-1 presents population information for Guam.

Table 6.1.9-1: National and Territory Population, Population Density, and Growth Rates

	2000	2010	2010 Population Density (persons/square mile)	Annual Growth Rate[a]
United States	281,421,906	308,745,538	87	0.1%
Guam	154,805	159,358	760	<0.1%

Source: U.S. Census Bureau 2000, 2010

[a] Calculated as the total change, divided by the number of years between 2000 and 2010.

The population density of Guam in 2010 (760 persons per square mile) is substantially higher than the national average (87 persons per square mile). The U.S. Census Bureau classifies 94 percent of Guam's population as urban,[1] compared to 81 percent for the nation as a whole (*U.S. Census Bureau 2015*). As illustrated in Table 6.1.9-1, population growth in Guam since 2000 has occurred at a lower rate (less than 1 percent) than in the nation as a whole (1 percent).

Table 6.1.9-2 shows population projections for Guam and the United States through 2040. Over this period of time, Guam's population is expected to grow at a rate higher than for the nation as a whole.

Table 6.1.9-2: Population Projections

	2010	2020	2030	2040	Annual Growth Rate
Guam	154,805	180,000	200,000	215,000	1.3%
United States	308,745,538	335,605,444	360,978,449	382,152,234	0.8%

Source: UVA 2015

The environmental justice analysis in Section 6.2.10 provides detailed race and ethnicity information for Guam and its census block groups.

6.1.9.4. Real Estate, Tax Revenues, Property Values, and Local Economic Activity

Economic Activity

Guam's economy consists of four principle activities: tourism, U.S. military spending, and exports of fish and handicrafts (*Guam Attorney General 2015*).

Tourism in particular "accounts for up to 60 percent of the government's annual revenues and provides more than 20,000…jobs" (*Joint Guam Program Office 2010*). Guam received 1.334 million visitors in 2013 with wildlife viewing and observation as a primary tourist activity, especially within the Guam National Wildlife Refuge. The highly diverse marine environment in Guam also attracts ecotourists such as divers, snorkelers, and underwater photographers; an estimated 300,000 dives occur in Guam each year, of which two-thirds are tourists (*GNWR 2009*). Guam's coral "reefs and the protection that they provide make Guam a popular tourist destination for Asian travelers" (*Joint Guam Program Office 2010*). The northern portion of Guam (where the Guam National Wildlife Refuge is located) functions as a valuable marine mammal and aquatic life habitat and includes several well-known dive locations, including Pati Point, The Pinnacle, Northern Caves, and Double Reef (*GNWR 2009).*

[1] Urban is defined as "densely developed residential, commercial, and other non-residential areas".

Table 6.1.9-3 summarizes household income in Guam in 2010, the most recent year for which data were available. Unemployment in Guam was 8.2 percent, compared to the national average of 7.9 percent. Per capita income in Guam was lower than the United States as a whole, although median household income was higher (*U.S. Census Bureau 2010*).

Table 6.1.9-3: Select Economic Indicators, 2010

	Per Capita Personal Income	Median Household Income	Unemployment Rate (Annual Average)
United States	$21,587	$41,994	7.9%
Guam	$16,549	$48,274	8.2%

Source: U.S. Census Bureau 2010, U.S. Department of Labor 2015

Housing

Table 6.1.9-4 provides information on housing units, occupancy, and tenure (owner versus renter), while Table 6.1.9-5 provides information on median housing values. The vacancy rate in Guam was approximately 17 percent in 2010. The median value of a single family home in Guam was $216,145, higher than the U.S. average.

Table 6.1.9-4: Housing Units, Occupancy, and Tenure, 2010

	United States		Guam	
	Number	Percent	Number	Percent
Total:	131,704,730	100%	50,567	100%
Occupied	116,716,292	89%	42,026	83%
Owner-occupied	75,986,074	58%	21,140	42%
Renter-occupied	40,730,218	31%	20,886	41%
Vacant	14,988,438	11%	8,541	17%

Source: U.S. Census Bureau 2010

Table 6.1.9-5: Housing Costs

	Median Home Value (Owner-Occupied)	Median Monthly Contract Rent (Renter-Occupied)
United States	$179,900	$713
Guam	$216,145	$879

Source: U.S. Census Bureau 2010

Property Values and Tax Revenues

In 2013, Guam's Department of Revenue and Taxation collected $18,686,459 in real property taxes and assessed $21,568,272 (*Guam Department of Revenue and Taxation 2013*). Table 6.1.9-6 illustrates the median value of owner-occupied, single family homes in 2010 as well as their distribution across a range of prices.

Table 6.1.9-6: Median Value of Owner-Occupied Single Family Homes, 2010

	Less than $50,000	$50,000 to $99,999	$100,000 to $149,999	$150,000 to $199,999	$200,000 to $299,999	$300,000 to $499,999	$500,000 or more
Guam	3%	6%	12%	23%	32%	17%	7%

Source: U.S. Census Bureau 2010

Changes in land value depend on factors such as the parcel size, proximity to public services, the parcel's current value and land use, and the value of nearby land parcels. Potential future buyers of land may also make decisions based on intended future use of land, as expressed in comprehensive land use plans or other local planning documents.

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6.1.10. Environmental Justice

6.1.10.1. Introduction

This section presents select demographic data relevant to the assessment of environmental justice. The United States (U.S.) Environmental Protection Agency (USEPA) defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies" (*USEPA 2014*). Environmental justice issues arise when minority or low-income groups experience disproportionately adverse health or environmental effects. The Council on Environmental Quality's (CEQ) document titled *Environmental Justice: Guidance Under the National Environmental Policy Act* clarifies that environmental effects include ecological, cultural, human health, economic, and social impacts (*CEQ 1997*).

Potential environmental justice issues associated with the Proposed Action are most likely to occur within the confines of a particular place and at a local level. Therefore, the information in this section is presented at the U.S. Census block group level, the smallest geographic unit for which demographic data are readily available. The U.S. Census Bureau describes block groups as statistical divisions of census tracts, generally containing between 600 and 3,000 people, and typically covering a contiguous area. Block Groups do not cross state, county, or census tract boundaries, but may cross the boundaries of other geographic entities (*U.S. Census Bureau 2012*).

6.1.10.2. Specific Regulatory Considerations

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, is the basis for environmental justice analysis and is discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders.

The analysis of the potential impacts of the Proposed Action on environmental justice issues follows guidelines described in the *Environmental Justice: Guidance Under the National Environmental Policy Act* (*CEQ 1997*). The analysis method has three steps: 1) describe the geographic distribution of low-income and minority populations in the affected area; 2) assess whether the potential impacts of construction and operation would produce impacts that are high and adverse; and 3) if impacts are high and adverse, determine whether these impacts disproportionately affect minority and low income populations (*CEQ 1997*).

A description of the geographic distribution of minority and low-income groups in Guam was based on U.S. Census Bureau demographic data. The following definitions provided by the *Environmental Justice: Guidance Under the National Environmental Policy Act* (*CEQ 1997*) were used to identify minority and low-income population groups:

- Minority populations consist of individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic; and
- Low-income populations consist of individuals living in poverty, as defined by the U.S. Census Bureau.

Since publication of the *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ 1997), the U.S. Census Bureau has changed how it defines race and ethnicity. Ethnicity (Hispanic or not Hispanic) is now counted separately from race. As a result, this Draft Programmatic Environmental Impact Statement (PEIS) considers both race and ethnicity separately for the purpose of evaluating minority status.

In 2014, the USEPA issued the *Policy on Environmental Justice for Working with Federally Recognized Tribes and Indigenous Peoples*, which establishes principles to ensure that achieving environmental justice is part of the USEPA's work with federally recognized tribes and Indigenous Peoples in all areas of the U.S. and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands, and others living in Indian country. The policy, which is based on Executive Order 12898 as well as USEPA strategic plan and policy documents, contains 17 principles pertaining to the policy's four focus areas. These four areas are:

- Direct implementation of federal environmental programs in Indian country and throughout the U.S.;
- Work with federally recognized tribes/tribal governments on environmental justice;
- Work with Indigenous Peoples (state-recognized tribes, tribal members, etc.) on environmental justice; and
- Coordinate and collaborate with federal agencies and others on environmental justice issues of tribes, Indigenous Peoples, and others living in Indian country.

The policy includes accountability for the implementation of the policy, a definitions section, and an appendix that contains a list of implementation tools available.

Research for this section did not identify any Guam-specific territorial, local, or tribal laws or regulations relevant to environmental justice for this Draft PEIS.

6.1.10.3. Minority and Income Status

Table 6.1.10-1 shows the race and ethnicity of Guam residents. Respondents to the U.S. Census in Guam may identify themselves as white, Black or African American, Asian, Native Hawaiian and Other Pacific Islander, American Indian or Alaska Native, Hispanic, some other race alone,[1] or a combination of these primary races. In Guam, 49.3 percent of residents identify themselves as Native Hawaiian or Other Pacific Islander (including 37.3 percent who identify themselves as Chamorro or Guamanian), and 32.2 percent identify themselves as Asian, compared to 0.2 percent and 4.9 percent, respectively, in the nation as a whole. Individuals identifying as white comprise just over 7 percent of Guam's population, compared to 74 percent of the nation *(U.S. Census Bureau 2010)*.

For Guam and other island territories, the 2010 U.S. Census included ethnicity—being of Hispanic origin—along with race (race and ethnicity are separate categories for the census in U.S. states). As shown in Table 6.1.10-1, less than 1 percent of Guam residents identify themselves as being Hispanic, compared to over 16 percent for the entire U.S.

Appendix E, *Environmental Justice Demographic Data*, provides demographic data characteristics for all block groups in Guam, including race, ethnicity, poverty status, and income. These data form the basis for the analysis of environmental consequences in Section 6.2.10, Environmental Justice.

Table 6.1.10-1: Race and Ethnicity, Guam, 2010

	Guam[a]		United States[a]	
Race	**Number**	**Percent**	**Number**	**Percent**
White	11,321	7.1%	223,553,265	72.4%
Black/African American	1,540	1%	38,929,319	12.6%
American Indian/Alaska Native	0	0%	2,932,248	0.9%
Asian	51,381	32.2%	14,674,252	4.8%
Native Hawaiian/Pacific Islander	78,582	49.3%	540,013	0.2%
Chamorro[b]	59,381	37.3%	88,310	<0.1%
Some other race alone	404	1.1%	19,107,368	6.2%
Multiple Races	14,929	9.4%	9,009,073	2.9%
Hispanic or Latino[c]	1,201	0.8%	50,477,594	16.3%
Total	**159,358**		**308,745,538**	

Source: U.S. Census Bureau 2010

[a] Because 2010 was the most recent data available for Guam, U.S. 2010 data are used here for comparison.
[b] In U.S. Census data, Chamorro is a subset of Native Hawaiian/Pacific Islander, and is thus not included in the totals at the bottom of the table. This sub-population is called out here due to its prominence in Guam.
[c] For the U.S. as a whole, ethnicity (Hispanic/Latino or not Hispanic/Latino) is counted separately from race (White, Black, etc.); however, no such distinction was made for Guam. As a result, the population total for Guam *does* include individuals who identified themselves as Hispanic or Latino, while the population total for the U.S. *does not* include individuals who identified themselves as Hispanic or Latino.

[1] This definition includes all respondents who did not identify themselves as either White, Black or African American, American Indian or Alaska Native, Asian, or Native Hawaiian or Other Pacific Islander race categories, or as an individual of multiple races.

6.1.10.4. Identification of Potential for Environmental Justice Impacts

Environmental justice impacts of the Proposed Action would most likely occur at a local level. For example, if adverse impacts from dust and noise exposure from construction of a communication tower, changes in property values, or adverse effects from operation of communications equipment occur disproportionately in a specific environmental justice community, then these could constitute an environmental justice impact. Therefore, the environmental justice screening analysis in this Draft PEIS uses the smallest geographic unit for which socioeconomic data are readily available, the Census Block Group. The U.S. Census Bureau defines this unit as follows:

> "Block groups are statistical divisions of census tracts, [and] are generally defined to contain between 600 and 3,000 people …A block group usually covers a contiguous area…block groups never cross state, county, or census tract boundaries but may cross the boundaries of any other geographic entity." (*U.S. Census Bureau 2012*)

In dense urban areas, a block group may only encompass a few city blocks. In rural areas, a block group may cover many square miles.

Because the specific location and deployment options of the Proposed Action have not been determined, this Draft PEIS identifies locations in Guam where potential environmental justice impacts could be either more or less likely to occur. If the potential exists for environmental justice impacts from one or more aspects of the Proposed Action (such as noise, air quality, or visual impacts), additional analyses to identify environmental justice communities and assess specific impacts on those communities could be necessary as part of implementation.

The remainder of this section describes the methodology for making that determination.

The CEQ provides some basic guidance on the choice of metrics for classifying minority populations (i.e., environmental justice communities):

> "Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis." (*CEQ 1997*)

The CEQ also states that "low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the U.S. Census Bureau's Current Population Reports, Series P-60 on Income and Poverty" (*CEQ 1997*). Poverty thresholds are specific income levels that take into account factors such as family size. The federal government defines these levels annually for the nation. The U.S. Census Bureau defines a "poverty area" as an area (in this case, a block group) where more than 20 percent of the population is at or under the poverty level (*Bishaw 2014*).

Beyond this guidance, many aspects of environmental justice impacts are discretionary and are matters of precedent and best practice within particular agencies and among socioeconomic analysts. The CEQ also does not define "meaningfully greater," nor does it define the "appropriate unit of geographic analysis" (per the quote above).

For the purpose of evaluating potential environmental justice impacts, the Draft PEIS uses Guam's total population as the comparison group (the "general population or other appropriate unit" described in the quote above), hereafter called the reference population. The Draft PEIS also defines a low-income household as one whose income is less than or equal to two times the federal poverty level. This approach aligns with the USEPA's approach to defining "low income" in its recently released EJSCREEN mapping tool (*USEPA 2015*).

The Draft PEIS evaluates the potential for environmental justice impacts along a spectrum, from low to high potential. The location along this spectrum is determined by the presence of one or more cases where the racial, ethnic, or low income characteristics of the block group's population is "meaningfully greater" than the reference population's characteristics. The Draft PEIS defines "meaningfully greater" as meeting or exceeding one or more of the following thresholds:

1. An overall racial (non-white) or ethnic (Hispanic or Latino) minority population whose share of the block group's population is at least 20 percentage points greater than the reference population's minority percentage. This is the U.S. Department of Housing and Urban Development's definition of a "minority neighborhood" (*HUD Undated*).[2]
2. One or more individual racial or ethnic minority populations whose share of the block group's population is at least 20 percentage points greater than the reference population's comparable minority percentage.
3. An overall racial or ethnic minority population whose share of the block group's population is at least 120 percent of the reference population's minority population.
4. The share of low-income residents (those with a household income equal to or less than two times the federal poverty level) in the block group is at least 120 percent of the reference population's low income level. For example, if 25 percent of the reference population is low income, the threshold applied to each block group is 30 percent.

Approximately 93 percent of Guam's population identifies itself as a racial minority (i.e., a race other than White or Caucasian), including 49 percent of the population that identifies itself themselves as Native Hawaiian or Other Pacific Islander). The same is true in a large proportion of Guam's block groups. Accordingly, the 50 percent threshold recommended by CEQ guidelines has not been applied to Guam. Instead, the analysis of minority populations is based on the thresholds described above.

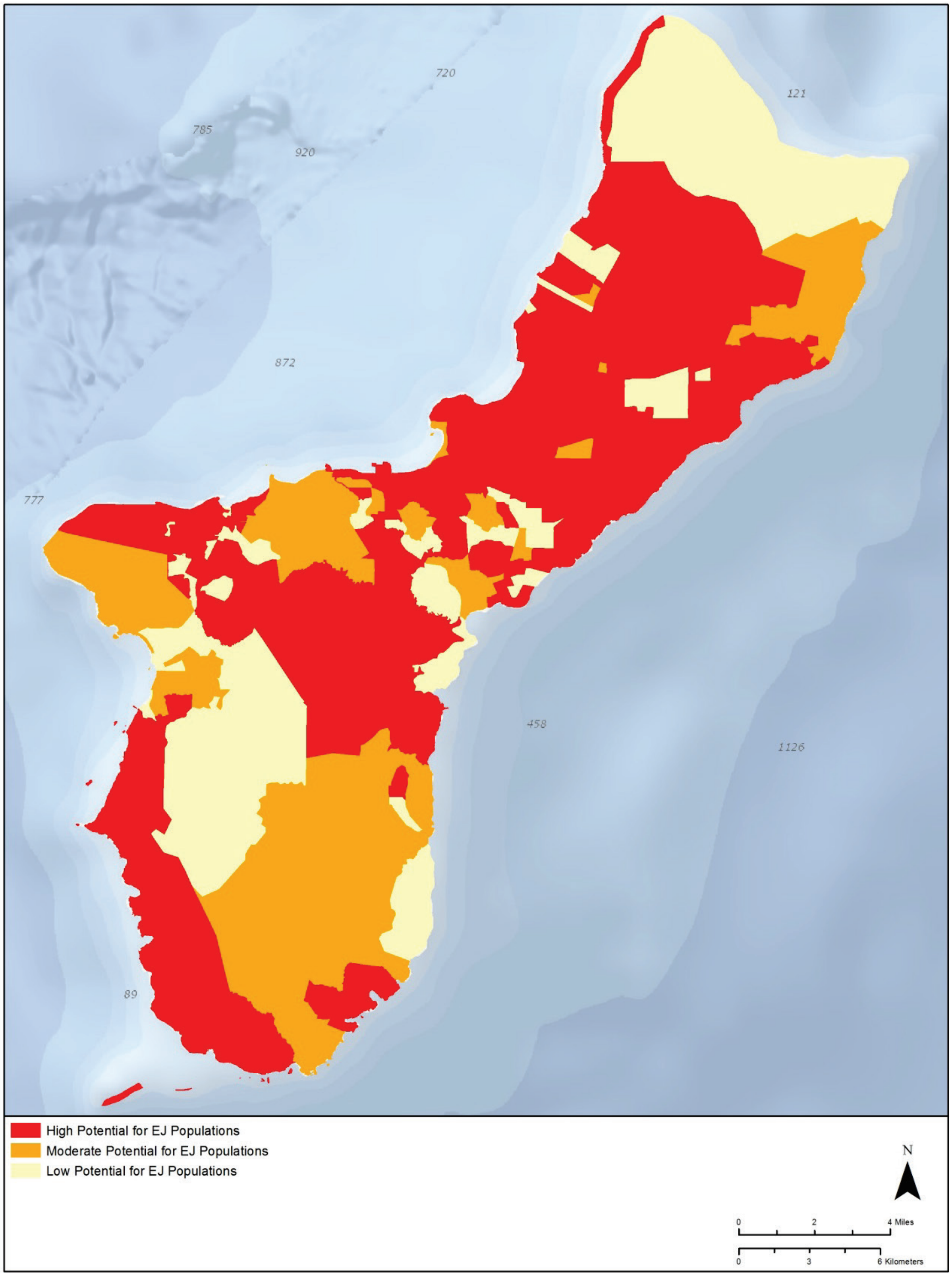
[2] Race (White, Black/African American, Asian, etc.) and ethnicity (Hispanic/Latino or not Hispanic/Latino) are separate categories, and are therefore considered separately.

The following combinations of the threshold characteristics listed above define three degrees of likelihood that a block group contains a potential environmental justice community:

- High Potential for Environmental Justice Communities
  - Greater than 20 percent of the block group's total population living in poverty; or
  - At least one minority population whose percentage of the block group's total population is at least 20 percentage points higher than that minority's share of the reference population; or
  - The combined minority share of the block group's overall population is at least 120 percent of the reference population's combined minority share.
- Moderate Potential for Environmental Justice Communities
  - Does not meet any of the above thresholds; and
  - At least one minority's share of the block group's overall population is at least 120 percent of that minority's share of the reference population; or
  - The low-income share of the block group's population is at least 120 percent below the 200 percent poverty level.
- Low Potential for Environmental Justice Communities
  - Does not meet any of the above thresholds

This Draft PEIS applies this methodology to all block groups in the territory.

Figure 6.1.10-1 displays the results of the screening analysis and shows the potential presence of environmental justice communities. A substantial portion of Guam's block groups has a high potential for environmental justice communities, and therefore a high potential for impacts to those communities. These high-potential areas include Guam's outlying islands, most of the central portion of the main island (including the urban area in and around Tamuning), and portions of the southwestern and northwestern coastlines. Moderate-potential block groups are found in the northeastern and southeastern area of the main island, as well as the area near Naval Base Guam, southwest of Tamuning). Low-potential block groups are found along the northern coast and south-central portion of the main island.



Source: U.S. Census Bureau 2010

Figure 6.1.10-1: Potential for Environmental Justice Populations

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6.1.11. Cultural Resources

6.1.11.1. Introduction

This section discusses cultural resources that are known to exist in Guam. For the purposes of this Draft Programmatic Environmental Impact Statement (PEIS), cultural resources are defined as natural or manmade structures, objects, features, and locations with scientific, historic, and cultural value, including those with traditional religious or cultural importance, as well as any prehistoric or historic district, site, or building included in, or eligible for inclusion in, the National Register of Historic Places (NRHP).

This definition is consistent with how cultural resources are defined in:

- The statutory language and implementing regulations for Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), formerly *16 United States Code (USC) 470a(d)(6)(A)* (now *54 USC 306131(b)*) and *36 Code of Federal Regulations (CFR) 800.16(l)(1)*;
- The statutory language and implementing regulations for the Archaeological Resources Protection Act of 1979, *16 USC 470cc(c)* (now *54 USC 3203*) and *43 CFR 7.3(a)*;
- The statutory language and implementing regulations for the Native American Graves Protection and Repatriation Act, *25 USC 3001(3)(D)* and *43 CFR 10.2(d)*; and
- National Park Service's guidance for evaluating and documenting traditional cultural properties (TCPs)[1] (*NPS 1998*).

Information is presented regarding cultural resources that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

6.1.11.2. Specific Regulatory Considerations

The Proposed Action is considered an undertaking as defined in *36 CFR 800*, the regulation implementing Section 106 of the NHPA. The intent of Section 106, as set forth in its attending regulations, is for federal agencies to take into account the effects of a proposed undertaking on historic properties,[2] which can include TCPs, and to consult with the Advisory Council on Historic Preservation, federally recognized American Indian tribes[3] and Native Hawaiian

[1] TCPs are defined as a place "eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (*NPS 1998*).

[2] A historic property is defined as any "prehistoric or historic district, site, building, structure, or object included on, or eligible for inclusion on the National Register [of Historic Places (NRHP)], including artifacts, records, and material remains related to the district, site, building, structure, or object" (*54 USC 300308*).

[3] NHPA defines "Indian tribe" as "an Indian tribe, band, nation, or other organized group or community, including a Native village, Regional Corporation or Village Corporation, as those terms are defined in section 3 of the Alaska Native Claims Settlement Act (*43 USC 1602*), which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians" (*54 USC 300309*).

organizations,[4] State Historic Preservation Offices, local governments, applicants for federal assistance, permits, licenses, and other approvals, as well as any other interested parties with a demonstrated interest in the proposed undertaking and its potential effects on historic properties.

The Guam Historic Resources Division (HRD) of the Department of Parks and Recreation is the Guam Historic Preservation Office and is responsible for the preservation and protection of cultural resources and consultation with the Advisory Council on Historic Preservation, federal and territory agencies, and territory residents regarding proposed undertakings under Section 106 and various other federal and territory laws and regulations in Guam.

In addition to Section 106 and the various federal laws and regulations discussed in Section 1.8, Overview of Relevant Federal Laws and Executive Orders, and Appendix C, *Environmental Laws and Regulations*, Guam has several territory-specific laws, regulations, executive orders, and general guidance to protect and consider potential effects to cultural resources as part of any proposed federal or territory projects.

Title 21, Chapter 76 of the Guam Code Annotated (*21 GCA 76*) established the "historical objects and sites law" in Guam. This law directed the Guam Department of Parks and Recreation to establish and implement a historic preservation program, which would later be administered by HRD, and establish procedures for other territory agencies to follow when considering their own projects, plans, and programs. Among other things, the law also called for the designation of historic sites, landmarks, districts, and zones as part of the Guam Register of Historic Places (GRHP), and establishment of standards, permit programs, and review procedures and authority for cultural resources survey, excavation, and handling of human remains.

To further supplement and clarify roles, responsibilities, and procedures under *21 GCA 76*, Guam has adopted *Executive Order 89-9* regarding procedures for preserving historic sites and *Executive Order 89-24* regarding policies for disposition of archaeologically recovered human remains, established formal rules and regulations for the GRHP, and amended the guidelines for archaeological burials.

Based on the federal and territory laws and regulations discussed above, the Proposed Action requires FirstNet to seek the review, consultation, and concurrence of the Guam HRD prior to deployment.

Federal agencies are required to consult with American Indian tribes and Native Hawaiian organizations as part of Section 106 and as part of other federal historic preservation laws. Although Section 106 and other federal policies and historic preservation laws require federal agencies to consult with American Indian tribes and Native Hawaiian organizations, consultation

[4] NHPA defines a Native Hawaiian organization as any organization which "serves and represents the interests of Native Hawaiians; has as a primary and stated purpose the provision of services to Native Hawaiians; and has demonstrated expertise in aspects of historic preservation that are culturally significant to Native Hawaiians. In this division, the term 'Native Hawaiian organization" includes the Office of Hawaiian Affairs of Hawaii and Hui Malama I Na Kupuna O Hawai'i Nei, an organization incorporated under the laws of the State of Hawaii" (54 *USC 300314*). NHPA defines Native Hawaiian as "any individual who is a descendant of the aboriginal people who, prior to 1778, occupied and exercised sovereignty in the area that now constitutes Hawaii" (54 *USC 300313*).

with Pacific Islanders is not required. However, many agencies, such as FirstNet, consult with Pacific Islanders consistent with the intentions of these policies and laws to maintain open, collaborative relationships with native peoples throughout their projects and programs.

In accordance with the Council on Environmental Quality's guidance, entitled *NEPA and NHPA: A Handbook for Integrating NEPA and Section 106*, the NHPA Section 106 process is proceeding on a parallel path to the National Environmental Policy Act (NEPA) process. FirstNet has begun consultation with affected Pacific Islander groups as part of the NHPA and NEPA processes, and these consultations have informed the development of the cultural resources sections of this Draft PEIS.

6.1.11.3. Cultural Setting

As discussed above, cultural resources is a general term that can include a wide range of resources. Section 106 review commonly focuses on the identification of historic properties; however, historic properties are only a subset of cultural resources, and are but one aspect of the "human environment" defined by the NEPA regulations. The human environment, under NEPA, includes the natural and the physical (e.g., structures) environment, and the association of people to those environments. Therefore, a NEPA review must consider the cultural context in which the project effects would occur. The intent of this section is to describe the affected environment within this cultural context.

Cultural Context

The Guam HRD has divided the cultural history of Guam into generalized sequences or time periods (*Guam HRD 2006*). Analysis of material culture in combination with ethnographic[5] data, oral tradition, and historical documentation form the framework within which these generalized sequences or temporal periods have been developed. The generalized temporal periods for Guam include the Prehistoric Period, Spanish Period, First American Period, World War II—Japanese Military Occupation Period, and Post-War Second American Period.

Prehistoric Period (ca. 1687 BCE [Before Common Era] to 1668 CE [Common Era])

Prehistoric sites are the physical evidence of human activity that occurred prior to European contact. Based on current knowledge, humans began to inhabit Guam at approximately 1687 BCE (*Guam HRD 2006*). At the time of European contact, Guam was inhabited by a group of people that came to be known as the Chamorro. Though Ferdinand Magellan visited the island in 1521 and the Spanish crown formally claimed the island in 1565, there was little European impact upon traditional Chamorro life until the establishment of a Jesuit mission on Guam in 1668 (*CNMI DHP 2011*). For this reason, the Prehistoric Period is considered to continue on through 1668. The Prehistoric Period is subdivided into two periods, the Pre-Latte Period and the Latte Period, differentiated by settlement patterns, subsistence adaptations, and the advent of the latte architectural form.

[5] Ethnographic refers to the systematic study of people and cultures, generally designed to explore culture from the point of view of the subject of the study.

Pre-Latte Period (ca. 1687 BCE to 800 CE)

Sites representing the Pre-Latte Period are fairly rare and often poorly preserved. Most sites from this period are found within coastal beach environments and to a lesser extent at inland locations such as rock shelters and caves. Evidence indicates that populations living on Guam during this period lived along the coastlines, favoring coastal lagoons that offered easy access to marine resources (*Tomonari-Tuggle et al. 2007*). Such sites appear to have been intensively used. Archaeological excavations have identified postholes, hearths, and substantial amounts of habitation debris demonstrating the occurrence of cooking, food storage, and tool making activities at sites from this period. Large amounts of shellfish and reef fish remains identified at sites from this period indicate that subsistence practices focused on harvesting the marine resources of nearshore reefs; however, it is evident that populations also depended upon bird hunting and plant collection *(Reinman 1977*; *Kurashina and Clayshulte 1983; Tomonari-Tuggle et al. 2007*). The manufacture of tools, implements, and ornaments from stone, bone, and shell was also an important aspect of the Period (*Haun et al. 1999*).

Latte Period (800 CE to 1668 CE)

Archaeological evidence indicates that around 800 CE major changes in settlement patterning and subsistence adaptations took place in addition to the introduction of a new architectural form, the *latte*. Latte are large limestone or basalt pillars topped with a capstone (*Morgan 1988*). The pillars were constructed in two parallel rows of even numbered uprights forming a "set." Clusters of "sets" have been most commonly identified along the coastline of Guam indicating the locations of hamlets or villages. Archaeological deposits identified at Latte Period village sites indicate that subsistence practices focused heavily upon marine resources such as fish and shellfish and to a lesser extent on terrestrial-based species such as birds, fruit bats, lizards, turtles, and land snails. These sites are commonly found to contain large basalt grinding stones and rock-filled ovens, which suggest an increased consumption of rice and tubers such as taro or yams (*Bulgrin 2006; Butler 1990*). Latte Period sites—consisting of pottery fragments well inland from coastal communities—corroborate notations by the Spanish clergy that Chamorro farmers were working individual inland plots. During this period, burials tended to be associated with larger latte sets and were placed beneath or adjacent to latte structures (*Driver 1993*).

Other site types of the Latte Period include latte stone quarries, water wells, tool manufacture areas, rock shelters, cave sites, and rock art locations. As populations increased from the Pre-Latte Period into the Latte Period, settlement expanded into areas outside of coastal environments.

Spanish Period (1668 to 1898)

Ferdinand Magellan visited Guam in 1521 and the Spanish crown formally claimed the island in 1565; however, there was little European impact upon traditional Chamorro life until the establishment of a Jesuit mission on Guam in 1668 (*CNMI DHP 2011*). The Spanish introduced cattle, pigs, sheep, corn, iron, and glass to the island. Staple crops consisted of breadfruit, yams, taro, bananas, sugarcane, and rice, while marine resources remained the staple food source.

Early colonization efforts by the Spanish resulted in open revolt (*Rogers 1995*). Conflicts persisted until 1694 when the Spanish forcefully relocated all Chamorro on the Mariana Islands to villages on Guam, Saipan, and Rota (*Coomans 1997*). This 4-year-long consolidation program was referred to by the Spanish as the *reducción* (*Rogers 1995*). By 1700, all Chamorro settlements were restricted to Guam, Saipan, and Rota. Disease and warfare with the Spanish decimated the Chamorro population from an estimated 20,000 to 40,000 in 1668 to 1,600 by 1693 (*Tomonari-Tuggle et al. 2007*).

Between 1815 and 1820, after severe storms had devastated the Caroline Islands, Carolinian refugees began arriving on the Mariana Islands (*Driver and Brunal-Perry 1995*). During this time, the Carolinians formed trade networks with the Spanish on Guam, and by the 1880s more Carolinians immigrated to the Mariana Islands and settled on Saipan and Tinian where they assisted in rounding up feral cattle for sale to Guam, as well as assisted in inter-island transportation for the Spanish government.

Sites associated with the Spanish Period are uncommon in Guam and consist of the ruins of mission villages, fortifications, bridges, shipwrecks, and scattered buildings and artifact deposits.

First American Period (1898 to 1941)

Guam was ceded to the United States (U.S.) government by Spain in 1898. During this period, Guam served as a refueling station for naval ships as well as a strategic naval radio station and later as a landing location for Pan-American trans-Pacific clipper aircraft. However, the U.S. did very little in the way of military defense of the island due to an agreement established with other colonial powers in the region after World War I.

World War II—Japanese Military Occupation Period (1941 to 1944)

A few hours after the December 7, 1941 attack on Pearl Harbor, Japanese planes from Saipan attacked Guam. The Japanese aerial assault initially focused on the Pan American building and the Standard Oil fuel tank in Sumay and subsequently on military targets at the Piti navy yard, the Libugon radio towers, and vessels in and around Apra Harbor (*Rogers 1995*). Two days later, the Japanese launched a marine invasion that was met with little resistance. The Japanese Navy took over control of the island and its economy (*Higuchi 2008*). Americans on the island were deported to Japan as prisoners of war in January of 1942, and in 1944 the Japanese began fortifying the island in readiness against U.S. invasion forces (*Denfield 1997*). The local populations were subjected to forced labor and ultimately placed into internment camps once combat began (*Tomonari-Tuggle et al. 2007*).

The U.S. initiated air raids on Japanese-controlled Guam in 1944. The Chamorro were forced by the Japanese to construct air raid shelters consisting of dugouts topped with coconut logs as well as tunnels dug into cliffs and hillsides (*Rogers 1995*). U.S. ground forces landed at Asan Beach on July 21, 1944, and by July 27 the U.S. had claimed Guam once again with all organized resistance ceasing by August 10 (*Tomonari-Tuggle et al. 2007*). Once the island was recaptured, there was a massive build-up of U.S. forces along with the construction of many new facilities to support air attacks on, and prepare for the invasion of, Japan.

Japanese sites associated with the defense of the islands include airfields, reinforced gun positions, troop barracks, anti-aircraft and coastal defense guns, man-made tunnels, improved caves, surface scatters of equipment and ordinance, mass graves, and off-shore wrecks. U.S. sites associated with invasion and post-invasion use of Guam consist of airfields, roadways, hospitals, ammunition storage areas, Quonset hut foundations, equipment dumps, artifact scatters, and buried ordinance.

Post-War—Second American Period (1944 to Present)

After the war, some of the military infrastructure was abandoned; however, a number of facilities continued to be used and others added in support of military needs that arose during the Cold War, Korean War, and Vietnam War (*Rogers 1995*). A civilian government was established under the U.S. Navy Administration in 1946. In 1950, Guam officially became a U.S. territory and Guamanians were granted U.S. citizenship. Since the 1960s, tourism has been the primary economic foundation of Guam. U.S. military presence on the island also continues to provide a large boost to the Guam economy through federal subsidies, civilian employment, and the expenditure of military personnel.

Sites from this period consist largely of early post-war architectural structures such as churches, commercial buildings, government buildings, and residences as well as infrastructure related to tourism such as resorts and golf courses.

Archaeological and Historic Resources

The above sections provide a basis for understanding the identification and evaluation of cultural resources as it relates to the cultural context of Guam and the type of cultural resources that could exist within a project area of potential effect. Although site-specific information regarding cultural resources would need to be collected to define the affected environment of an individual project, the types of cultural resources that are currently listed on the GRHP and NRHP across Guam can provide an understanding of the types and range of potential archaeological and historic resources that should be considered and could be affected by the Proposed Action.

Table 6.1.11-1 provides a list of cultural resources that have been evaluated and designated significant to be listed on the GRHP and NRHP. There are currently 169 cultural resources listed on the GRHP and 146 cultural resources listed on the NRHP in Guam; of these, 127 cultural resources are listed on both. The cultural resources consist of archaeological sites and features; historic buildings and bridges; military sites, features, and objects; cemeteries; historic districts; water features (e.g., dams); and cultural landscapes. Figure 6.1.11-1 shows the locations of the cultural resources listed in Table 6.1.11-1.

Table 6.1.11-1: Cultural Resources Listed on the GRHP and NRHP

Historic Property	Village	Property Type	GRHP Listed	NRHP Listed
Agana Cliffline Fortifications	Agana	Site	X	X
Agana Fortification	Agana	Site	X	X
Agana Historic District	Agana	District	X	X
Agana Japanese Fortifications	Agana	Building/Structure/Site	X	X
Agana Spanish Bridge	Agana	Structure	X	X
Agana-Hagatna Pillbox	Agana	Structure	X	X
Ayulang Pillbox	Agana	Site		X
Cormoran Monument	Agana	Structure	X	
Dr. Mesa House	Agana	Structure	X	X
Dulce Nombre de Maria Agana Cathedral-Basilica	Agana	Structure	X	
Fort Santa Agueda	Agana	Structure	X	X
Garrido House	Agana	Structure	X	
Guam Congress Building	Agana	Structure	X	X
Guam Institute	Agana	Structure	X	X
Japanese Caves	Agana	Site	X	
Marine Drive Monument	Agana	Structure	X	
Plaza de Espana	Agana	Site	X	X
Shimizu House	Agana	Structure	X	
Spanish Dikes	Agana	Structure	X	X
Toves House	Agana	Structure	X	X
U.S. Naval Cemetery Fortification	Agana	Site	X	X
Ungacta House	Agana	Structure	X	X
War in the Pacific National Park	Agana	District		X
Agat Invasion Beach	Agat	Site	X	X
Agat WWII Amtrac	Agat	Structure		X
Cable Station Ruins	Agat	Structure	X	X
Fena Massacre Site	Agat	Site	X	
Hill 40	Agat	Site	X	X
Mount Alifan Battle Site	Agat	Site	X	
Sumay Cemetery	Agat	Site	X	X
Taelayag Spanish Bridge	Agat	Structure	X	X
Taleyfac Spanish Bridge	Agat	Structure	X	X
Umang Dam	Agat	Structure	X	X
Asan Invasion Beach	Asan	Site	X	X
Asan Ridge Battle Area	Asan	Site	X	X
Fonte Plateau	Asan	Site	X	
Fonte River Dam	Asan	Structure		X
Matgue River Valley Battle Area	Asan	Site	X	X
Memorial Beach Park	Asan	Site	X	X
Canada Water Wells	Barrigada	Structure	X	X
Guzman Water Catchment	Barrigada	Structure	X	X
Pago Pillbox I	Chalan Pago	Structure	X	X
Pago Pillbox II	Chalan Pago	Structure	X	X
Falcona Beach	Dededo	Site	X	
Haputo Beach Site	Dededo	Site	X	X
Hilaan Complex	Dededo	Site	X	

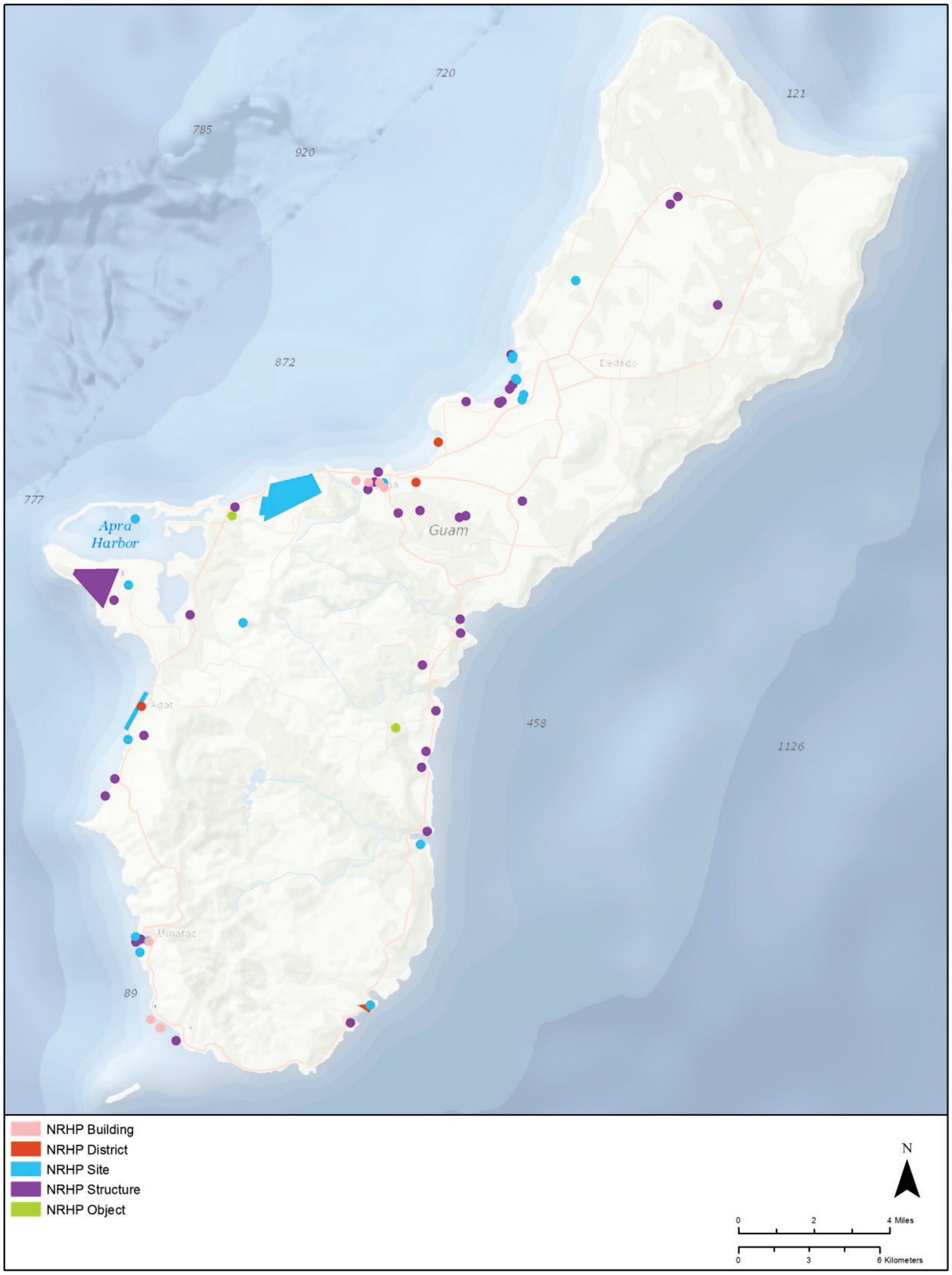
Historic Property	Village	Property Type	GRHP Listed	NRHP Listed
Ritidian Site	Dededo	Site	X	
South Finegayan Latte Stone Park	Dededo	Site	X	X
Uruno Beach Site	Dededo	Site	X	X
Uruno Site	Dededo	Site	X	X
Aga Tongan	Inarajan	Site	X	X
Asiga Beach	Inarajan	Site	X	
Gadao's Cave	Inarajan	Site	X	X
Halaiha Point	Inarajan	Site	X	
Inalahan Pillbox	Inarajan	Site		X
Inarajan Baptist Church	Inarajan	Structure	X	
Inarajan Falls Site	Inarajan	Site	X	
Inarajan Pillbox/Fortification	Inarajan	Site	X	X
Inarajan Ridge	Inarajan	Site	X	X
Inarajan Village Architectural Historic District	Inarajan	District	X	X
Kitsugawa Maru	Inarajan	Site	X	
Malolos Site	Inarajan	Site	X	X
Nomna Bay Site	Inarajan	Site	X	X
North Inarajan Site	Inarajan	Site	X	X
Paulino Outdoor Oven	Inarajan	Structure		X
St. Joseph's Catholic Church	Inarajan	Structure	X	
Talofofo River Valley Site	Inarajan	Site	X	X
West Atate	Inarajan	Site	X	X
Mochom	Mangilao	Site	X	X
South Mochom	Mangilao	Site	X	
Taogam Archaeological Settlement	Mangilao	Site	X	X
Asmaile Point	Merizo	Site	X	X
Faha Massacre Site	Merizo	Site	X	X
Malesso Japanese Rice Mill	Merizo	Structure		X
Malessu' Pillbox	Merizo	Structure		X
Merizo Bell Tower	Merizo	Structure	X	X
Merizo Conbento	Merizo	Structure	X	X
Merizo Pillbox	Merizo	Structure	X	X
Merlyn G. Cook School	Merizo	Structure	X	X
Tinta Massacre Site	Merizo	Site	X	X
Fort San Luis	Naval Station	Site	X	
Fort Santiago, Spanish Steps, Spanish Well, and Orote Archaeology Site	Naval Station	Site	X	X
Ha. 62-76 Japanese Midget Attack Submarine	Naval Station	Structure	X	X
Orote Air Field	Naval Station	Structure	X	X
Pan American Hotel	Naval Station	Site	X	
Tokai Maru	Naval Station	Site	X	X
Last Japanese High Command Post	Nimitz Hill	Site	X	
War Crimes Trial Site	Nimitz Hill	Site	X	
Atantano Shrine	Piti	Structure	X	X
Mabini Prisoner of War Camp Site	Piti	Site	X	

Historic Property	Village	Property Type	GRHP Listed	NRHP Listed
Piti Coastal Defense Guns	Piti	Object	X	X
Quan Outdoor Oven	Piti	Structure		X
Bona Site	Santa Rita	Site	X	X
East Bona Site	Santa Rita	Site	X	
Mount Tenjo Fortifications	Santa Rita	Site	X	X
Orote Historic Complex	Santa Rita	Site	X	X
Orote Point Complex	Santa Rita	Site/Structure	X	X
SMS Cormoran	Santa Rita	Site	X	X
Talisay Site – Latte’ Saddok Talisai	Santa Rita	Site		X
West Bona Site	Santa Rita	Site	X	X
Sinajana Japanese WWII Cave Fortification	Sinajana	Site	X	
Won Pat Outdoor Oven	Sinajana	Structure		X
Talofofo Bay Fortification	Talofofo	Structure	X	X
Adjoulan Point Pillbox	Talofofo	Structure	X	X
Aratama Maru	Talofofo	Site	X	X
Asquiroga Cave	Talofofo	Site	X	X
Garapan Mount Pillbox	Talofofo	Site		X
Mahlac Pictograph Cave	Talofofo	Site		X
Mana Pillbox	Talofofo	Structure	X	X
Matala Point Pillbox	Talofofo	Site	X	X
South Talofofo Site	Talofofo	Site	X	X
Talofofo Site	Talofofo	Site	X	
Tokcha’ Point Pillbox	Talofofo	Structure	X	X
Yokoi's Cave	Talofofo	Site	X	X
Dungca's Beach Defense Guns	Tamuning	District	X	X
Faifai Beach Site	Tamuning	Site	X	X
Oka Fortification	Tamuning	Site	X	X
As Sombrero Pillbox I	Tumon	Site	X	X
As Sombrero Pillbox II	Tumon	Structure	X	X
As Sombrero Pillbox III	Tumon	Structure	X	X
Gognga Beach Gun Emplacement	Tumon	Structure	X	X
Gognga Beach Gun Mount	Tumon	Site	X	X
Gognga Beach Mount Pillbox	Tumon	Site	X	X
Naton Headland Caves	Tumon	Site	X	X
Naton Headland Fortification I	Tumon	Site	X	X
Naton Headland Fortification II	Tumon	Site	X	X
San Vitores Beach Fortification	Tumon	Site	X	X
San Vitores Martyrdom Site	Tumon	Site	X	X
Tumon Cliffline Fortification I	Tumon	Site	X	X
Tumon Cliffline Fortification II	Tumon	Site	X	X
Tumon Cliffline Fortification III	Tumon	Site	X	X
Tumon Fortification I	Tumon	Site	X	X

Historic Property	Village	Property Type	GRHP Listed	NRHP Listed
Tumon Pillbox I	Tumon	Structure	X	X
Tumon Pillbox II	Tumon	Structure	X	X
Tumon Pillbox III	Tumon	Structure	X	X
Ypao Beach Archaeological Site	Tumon	Site	X	X
Ypao Pillbox I	Tumon	Structure	X	X
Ypao Pillbox II	Tumon	Structure	X	X
Ypao Pillbox III	Tumon	Structure	X	X
Abong Beach	Umatac	Site	X	
Achugao Bay Site	Umatac	Site	X	X
Agaga Beach	Umatac	Site	X	X
Cetti Bay	Umatac	Site	X	X
Creto Site	Umatac	Site	X	X
Fort Nuestra Señora de la Soledad	Umatac	Site	X	X
Fort San Jose	Umatac	Site	X	X
Fort Santo Angel	Umatac	Structure	X	X
Fouha Bay	Umatac	Site	X	X
Francisco Q. Sanchez Elem. School	Umatac	Structure	X	X
Machadgan Point	Umatac	Site	X	X
Magellan Monument	Umatac	Structure	X	
North Cetti Bay	Umatac	Site	X	
San Dionisio Catholic Church	Umatac	Structure	X	
San Dionisio Church Ruins	Umatac	Site	X	X
Sella Bay	Umatac	Site	X	X
Sella Bay Spanish Bridge	Umatac	Structure	X	
Sella Bay Spanish Oven	Umatac	Structure	X	X
Toguan Bay	Umatac	Site	X	
Umatac Outdoor Library	Umatac	Structure	X	X
Umatac Pillbox	Umatac	Site	X	X
Umatac Ridge	Umatac	Site	X	
Guam’s Outdoor Ovens (Hotno)	Various	Structure		X
Japanese Coastal Defense Fortifications on Guam	Various	Building/Structure/Site		X
Anao Site	Yigo	Site	X	
Cruz Water Catchment	Yigo	Structure	X	X
Hanum Site	Yigo	Site	X	X
Inapsan	Yigo	Structure/Object	X	X
Jinapsan Outdoor Oven	Yigo	Structure	X	
Jinapsan Site	Yigo	Site	X	X
Lujuna	Yigo	Site	X	
Mataguac Hill Command Post	Yigo	Structure	X	X
Pagat Site	Yigo	Site	X	X
Pajon Point	Yigo	Site	X	
Pati Point	Yigo	Site	X	
Talagi Pictograph Cave	Yigo	Site		X
Tarague Beach District	Yigo	District	X	
Torre Water Catchment	Yigo	Structure	X	X
Baza Outdoor Oven	Yona	Structure		X

Historic Property	Village	Property Type	GRHP Listed	NRHP Listed
Ilik River Fortification I	Yona	Site		X
Ilik River Fortification II	Yona	Structure		X
Light Model Tank No. 95	Yona	Object	X	X
Manenggon Concentration Camp	Yona	Site	X	
South Pulantat B	Yona	Site	X	X
South Pulantat Site	Yona	Site	X	X
Talofofo Pillbox	Yona	Structure	X	X
Ylig River	Yona	Site	X	
Ylig River Fortification I	Yona	Site	X	X
Ylig River Fortification II	Yona	Site	X	X

Source: Guam HRD 2015; Stutts 2014



Sources: Stutts 2014

Notes: Spatial data for cultural resources only listed on the GRHP were not available and are not presented here. Some of the cultural resources listed in Table 6.1.11-1 have sensitive locations (e.g., archaeological sites) and are not shown here.

Figure 6.1.11-1: Cultural Resources Listed on the GRHP and NRHP

In addition to those listed on the GRHP and NRHP, other known and unknown cultural resources exist across Guam that have yet to be identified or evaluated for their significance. Cultural resources survey would need to be conducted to identify specific cultural resources of an individual project; however, through previous surveys and a general understanding of the cultural context, archaeological sites and historic resources are more typically found in certain locations given their size, type, and function.

Archaeological site potential is largely based on an area's habitation suitability, proximity to natural resources, and/or locational prominence/importance. For instance, habitation sites, both prehistoric and historic, are typically found in naturally protected, upland landforms close to a significant and consistent fresh water source and within proximity to food resources. However, habitation sites can vary based on seasonal considerations or be temporal based on their use as specific resource extraction locations, recognizing that environmental conditions may have changed over time. Proximity to resources can vary according to a combination of environmental conditions such as the size and nature of the water source (perennial versus intermittent) and/or extent and location of food sources. Topographic prominence is also often indicative of archaeological potential. Topographically prominent locations were likely desirable locations as they provided vantage points for observation, which would be useful for tracking wildlife or recognizing potential threats to the habitation site. The presence of an extractive resource can also raise the potential for archaeological sites in a given location. Large outcrops of preferred stone resources, for example, are often the location of quarry sites; in another example, wood or other structural building resources would be expected in heavily forested areas. Likewise, topographic prominence could be an important component of ceremonial or spiritual sites or cultural landscapes.

In Guam, archaeological sites dating to the Pre-Latte Period are generally small and located along flat, elevated coastal areas (generally on low terraces above beaches), especially near coastal lagoons with easy access to marine resources (*Tomonari-Tuggle et al. 2007*). These locations seem to have been favored by the early inhabitants due to the great quantity of shellfish and reef fish. Although few inland sites have been identified, evidence shows that early inhabitants used a mixture of fishing, hunting, and collecting activities for subsistence. During the Latte Period, sites are typically found in relatively sheltered areas, with reef and beach access to fish accomplished through the use of canoes. However, increased populations later in this period pushed settlements into areas outside coastal environments and into inland and upland areas (*Reinman 1977; Kurashina and Clayshulte 1983; Tomonari-Tuggle et al. 2007*).

Following contact with Europeans and extending into historic periods, agriculture was a fundamental aspect of the economy of Guam *(Bowers 1950*). As such, in addition to traditional coastal locations, archaeological sites and historic structures from these periods can additionally be found inland, where large, flat agricultural areas exist, and around the established towns and populated areas. Military sites and remnants are scattered across the island. For instance, Japanese military sites can be found in cliff sides and on top of topographically prominent locations overlooking beaches to provide for their strategic placement. Concentrated military structures are focused in the primary facility locations used by the Japanese and U.S. militaries during the 1900s (*U.S. Department of Navy 2015*).

Traditional Cultural Properties and Cultural Resources of Traditional Religious or Cultural Importance

Traditional cultural properties and other cultural resources of traditional religious or cultural importance can include a wide range of tangible and intangible resources (e.g., archaeological sites and funerary objects, ceremonial places, traditional wildlife and plant gathering areas, and cultural landscapes). Section 106 consultation would provide the means of identifying the affected environment of these types of resources for an individual project (*NPS 1998*). Since Pacific Islanders are not formally recognized the same was as an American Indian tribe or Native Hawaiian organization under Section 106, the public scoping and comment processes are some ways for FirstNet to learn of concerns from other distinct cultural groups regarding traditional cultural properties.

It is often difficult, if not impossible, to place strict boundaries on locations of traditional significance. Another complicating factor is that even when boundaries might be defined, members of cultural groups may not be willing to disclose such information to those outside of their communities for a number of reasons. Therefore, cultural sensitivity is needed to ensure protection of these important places (*ACHP 2008*). Types of traditional resources may include, but are not limited to, archaeological sites, burial sites, ceremonial sites, traditional hunting, fish ponds, plant gathering areas, trails, certain prominent geological features that may have spiritual significance (i.e., cultural landscapes), and viewsheds to and/or from sacred locations (*NPS 1998*).

Whereas traditional cultural properties are historic properties (they are eligible for listing in the NRHP), other cultural resources of traditional religious or cultural importance need to be considered as they are important to a community's practices and beliefs and are necessary for maintaining the community's cultural identity. FirstNet plans to work with the HRD and interested Pacific Islander groups as part of the NHPA and NEPA processes, and these consultations will inform the development of the cultural resources sections of the Final PEIS. Although specific locations of traditional cultural properties and other cultural resources of traditional religious or cultural importance in Guam are not currently known, FirstNet will maintain open, collaborative relationships with Pacific Islander groups throughout the NHPA consultation and NEPA public comment processes for all cultural groups.

6.1.12. Air Quality

6.1.12.1. Introduction

This section discusses the existing air quality conditions in Guam. Information is presented regarding air quality characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action. Air quality in a geographic area is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography[1] of the area, and the prevailing weather and climate conditions. The levels of pollutants and pollutant concentrations in the atmosphere are typically expressed in units of parts per million (ppm)[2] or micrograms per cubic meter ($\mu g/m^3$) determined over various periods of time. The U.S. Environmental Protection Agency (USEPA) designates areas within the United States as attainment,[3] nonattainment,[4] maintenance,[5] or unclassifiable[6] depending on the concentration of air pollution relative to ambient air quality standards.

6.1.12.2. Specific Regulatory Considerations

Air quality and emissions of atmospheric pollutants are regulated under the Clean Air Act (CAA). The CAA establishes limits on how much air pollution can exist in an area at any given time, based on local climatological factors. These limits are known as the national ambient air quality standards (NAAQS). The USEPA has established NAAQS for six common pollutants, known as criteria pollutants. These include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM), and sulfur dioxide (SO_2) (*USEPA 2013*). Local air quality protection and permitting in Guam is jointly the responsibility of the Guam Environmental Protection Agency (GEPA) and USEPA Region 9 (*USEPA 2014c* and *USEPA 2014b*). Guam enforces the federal NAAQS as well as several Territory Ambient Air Quality Standards (TAAQS). For each pollutant, the most stringent standard in Guam must be adhered to (throughout this section, the term AAQS [ambient air quality standards] is used to refer to the most stringent standard, inclusive of NAAQS and TAAQS). Table 6.1.12-1 summarizes the NAAQS and TAAQS in Guam.

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[1] The unique features and shapes of the land (e.g., valleys and mountains)

[2] Equivalent to 1 milligram per liter

[3] Attainment areas: Any area that meets the national primary or secondary ambient air quality standard for the pollutant (*USEPA 2015d*)

[4] Nonattainment areas: Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant (*USEPA 2015d*)

[5] Maintenance areas: An area that was previously nonattainment, but has met the national primary or secondary ambient air quality standards for the pollutant, and has been designated as attainment (*40 Code of Federal Regulations 93.152*)

[6] Unclassifiable areas: Any area that cannot be classified on the basis of available information as meeting the national primary or secondary air quality standard for a pollutant (*USEPA 2015d*)

Table 6.1.12-1: Ambient Air Quality Standards in Guam

Pollutant	Averaging Period	NAAQS (Primary Standard)[a]	NAAQS (Secondary Standard)[b]	TAAQS
Carbon monoxide	8-hour	9 ppm (10 mg/m^3)	None	Same as NAAQS
	1-hour	35 ppm (40 mg/m^3)	None	Same as NAAQS
Lead	3-month average	0.15 µg/m^3 (rolling 3-month)	Same as primary	1.5 µg/m^3 (calendar quarter)
Nitrogen dioxide	Annual	0.053 ppm (100 µg/m^3)	Same as primary	Same as NAAQS
	1-hour	0.1 ppm (188 µg/m^3)	None	None
Ozone	8-hour	0.075 ppm	Same as primary	None
	1-hour	None (revoked)[c]	None	0.12 ppm (235 µg/m^3)
Particulate matter: PM_{10}	Annual	None (revoked)[c]	None	50 µg/m^3
	24-hour	150 µg/m^3	Same as primary	Same as NAAQS
Particulate matter: $PM_{2.5}$	Annual	12 µg/m^3	15 µg/m^3	None
	24-hour	35 µg/m^3	Same as primary	None
Sulfur dioxide	Annual	None (revoked)[c]	None	0.03 ppm (80 µg/m^3)
	24-hour	None (revoked)[c]	None	0.14 ppm (365 µg/m^3)
	3-hour	None	0.5 ppm (1,300 µg/m^3)	Same as NAAQS
	1-hour	0.075 ppm (196 µg/m^3)	None	None

Source: USEPA 2014a and 22 Guam Administrative Rules and Regulations 1302.

µg/m^3= microgram(s) per cubic meter; mg/m^3 = milligram(s) per cubic meter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter; ppm = parts per million
[a] Primary standards are set to protect public health.
[b] Secondary standards are set to protect public welfare, including visibility and crops.
[c] Revoked means the previous pollutant standard has been retracted and no longer valid.

States and territories must establish enforceable plans, known as State Implementation Plans (SIPs), to achieve their AAQS. Regions that are not in compliance with AAQS (i.e., exceed the AAQS limits) are known as nonattainment areas. Regions that have previously exceeded the AAQS and subsequently improved air quality to become in compliance are re-designated as maintenance areas. Those that are in compliance are known as attainment areas. Those without sufficient data are designated unclassifiable and generally have the same obligations as attainment areas. Regions can be classified as in attainment for some criteria pollutants and nonattainment for others. SIPs must describe how the state or territory will maintain compliance in attainment and maintenance areas and will improve air quality in nonattainment areas (*USEPA 2013*).

In addition to regulating ambient air quality, the CAA also establishes limits on the level of air pollution that can be emitted from both stationary (e.g., manufacturing facility) and non-stationary (e.g., motor vehicle) emission sources. For stationary sources, states and territories may implement more stringent standards than those set by the USEPA. For mobile sources, states or territories must adopt standards set by either USEPA or California (*USEPA 2013*).

The key permitting programs for major stationary sources are Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NANSR). The PSD program ensures that clean air (in attainment, maintenance and unclassifiable areas) is not degraded by new or modified major sources.

To obtain a PSD permit, proposed sources must:

- Be designed with best available control technology giving consideration to cost and other factors;
- Show that the added emissions will not cause or contribute to an air pollution increase in excess of the allowable increment, any NAAQS, or any other applicable CAA emissions standard; and
- Show that the added emissions will not have an adverse impact on air-quality related values in a Class I area[7] such as a national park or wilderness area (*USEPA 2013*).

The NANSR program ensures that proposed major stationary sources will not further degrade air quality in locations where AAQS are not being met (i.e., nonattainment areas). To obtain an NANSR permit, proposed sources must:

- Be designed for the lowest achievable emission rate ; and
- Obtain emission offsets (certified reductions in air pollution from existing facilities in the region) to provide a net air quality benefit (*USEPA 2013*).

Stationary sources may also be subject to federal air quality regulations under the New Source Performance Standards or National Emission Standards for Hazardous Air Pollutants.

Air pollution from mobile sources is managed primarily through vehicle and fuel standards. Vehicle standards set limits for fuel efficiency and are the basis for state and territory vehicle emissions inspection programs. Fuel standards regulate the amount of sulfur in gasoline and diesel fuels.

Other regulatory programs that may potentially be involved with deployment and operation of the Proposed Action include visibility protection and conformity. Haze[8] is one of the most basic forms of air pollution and it degrades visibility in many U.S. cities and scenic areas (*USEPA 2015c*). National parks and scenic areas are protected from air pollution associated with both new and existing sources of air emissions due to visibility concerns from haze. Protection from new sources of air pollution occurs through the PSD program discussed above. Protection from existing sources occurs through the USEPA's 1999 Regional Haze Rule, which set goals of preventing future and remedying existing impairment in Class I Areas. States and territories are required to adopt progress goals every 10 years, with the ultimate goal of achieving natural background conditions, or conditions which existed before manmade pollution, by 2064 (*USEPA 2010*).

[7] Class I areas are national parks and wilderness areas in attainment or unclassifiable areas that exceed 5000 acres in size and were in existence on August 7, 1977.

[8] Haze is caused when sunlight encounters tiny pollution particles in the air. Some light is absorbed by particles; other light is scattered away before it reaches an observer. More pollutants mean more absorption and scattering of light, which reduce the clarity and color of what we see. Some types of particles such as sulfates, scatter more light, particularly during humid conditions.

Federal departments and agencies are prohibited from taking actions in nonattainment and maintenance areas without first demonstrating that the actions would conform to the state or territory's SIP. The CAA conformity requirements ensure that federal activities will not: 1) cause or contribute to new air quality violations; 2) worsen existing violations; or 3) delay attainment of AAQS. The transportation conformity requirements apply to projects funded by or requiring approval from the Federal Highway Administration or those related to a project funded under the Federal Transit Act, and thus would not apply to the Proposed Action. The general conformity requirements apply to other federal actions and may apply to the Proposed Action (*USEPA 2013*).

6.1.12.3. Ambient Air Quality

One of the key indicators of current ambient air quality in a state or territory is the compliance status of each region compared to the AAQS (refer to Table 6.1.12-1 above). Compliance is typically evaluated by county or, in some cases, large cities. Based on the limited geographic size of Guam, the entire territory is generally evaluated as a single air quality control region (AQCR): Guam AQCR 246 *(40 Code of Federal Regulations [CFR] Part 81, Appendix A)*. However, small portions of the island are designated as nonattainment for the annual and 24-hour SO_2 AAQS. The current nonattainment areas within Guam are listed in Table 6.1.12-2. Maps showing nonattainment areas in Guam were not publicly available.

Table 6.1.12-2: Nonattainment Areas in Guam

Pollutant (standard)	Area	Nonattainment Classification	Nonattainment Date	Reclassification Date	2010 Population
Areas in Nonattainment Status					
Sulfur dioxide (1971 24-hour)	Piti Power Plant	NA	Nov 1990	NA	1,000
	Tanguisson Power Plant	NA	Nov 1990	NA	1,000

Source: USEPA 2015a and USEPA 2015b

NA = not applicable

As discussed in Section 6.1.12.2, Specific Regulatory Considerations, the two primary permitting programs for proposed new or modified major stationary sources are PSD and NANSR. In Guam, the PSD program (*40 CFR Part 52.21)* is implemented by USEPA Region 9. GEPA implements the NANSR and the minor source construction and operating permit programs (*USEPA 2014b*). The type of permit required in Guam is primarily based on: 1) the location of the proposed stationary source (attainment vs. nonattainment area); 2) the type of proposed stationary source; and 3) the potential amount of air pollutants that could be emitted per year from the proposed source. Emissions thresholds for new stationary sources are as follows: PSD review is triggered if facility-wide potential emissions of any criteria pollutant exceed 250 tons per year (tpy); NANSR review is triggered if facility-wide potential emissions of SO_2 exceed 100 tpy. For modified stationary sources, the PSD thresholds vary by pollutant; the NANSR threshold for SO_2 is 40 tpy (*40 CFR 51.166*). Minor source permitting thresholds also vary by pollutant.

As mentioned above, the entirety of Guam is evaluated as one AQCR. In implementing the federal PSD program, USEPA Region 9 ensures that air quality throughout the territory is not degraded by proposed major sources, specifically ensuring that a proposed major source would not cause ambient air concentrations to increase by more than allowable thresholds listed in Table 6.1.12-3.

Table 6.1.12-3: PSD Allowable Increase Increments

Pollutant	Averaging Period	PSD Increment (μg/m^3)	
		Class I Area[a]	Class II Area[b]
Nitrogen dioxide	Annual	2.5	25
Particulate matter: PM_{10}	Annual	4	17
	24-hour	8	30
Particulate matter: $PM_{2.5}$	Annual	1	4
	24-hour	2	9
Sulfur dioxide	Annual	2	20
	24-hour	5	91
	3-hour	25	512

Source: 40 CFR 51.166(c).

μg/m^3 = micrograms per cubic meter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; PM_{10} = particulate matter up to 10 micrometers in diameter
[a] Class I areas are national parks and wilderness areas in attainment or unclassifiable areas that exceed 5000 acres in size and were in existence on August 7, 1977.
[b] Class II areas are all other attainment or unclassifiable areas outside Class I areas.

Note that thresholds are lower for Class I Areas, which receive greater protection. However, there are no designated Class I Areas in Guam; therefore, the entire territory is evaluated according to the Class II Area increments.

As discussed in Section 6.1.12.2, Specific Regulatory Considerations, the USEPA protects visibility in Class I Areas through both the PSD program and the federal 1999 Regional Haze Rule. Because there are no Class I Areas in Guam and its remote location prevents air emissions from impacting Class I Areas in other states and territories (the closest territory to Guam is the Northern Mariana Islands, which has no Class I Areas), the Regional Haze Rule is not currently applicable in Guam (*USEPA 2010* and *USEPA 2012b*).

While PSD and visibility programs are critical to air quality in attainment/unclassifiable and Class I Areas, respectively, conformity requirements are a key concern in nonattainment and maintenance areas. As discussed in Section 6.1.12.2, Specific Regulatory Considerations, above, general conformity (rather than transportation conformity) may apply to the Proposed Action overall.

The emissions threshold for a general conformity demonstration in Guam is provided in Table 6.1.12-4. If annual source emissions are below the specified threshold level, no conformity determination is required. If the emissions exceed the threshold, a conformity determination must be undertaken to demonstrate how the action will conform to the SIP. However, notwithstanding this emission threshold, certain federal actions are exempt from general conformity requirements. If applicable, the demonstration process includes public notification and response and may require extensive analysis.

Table 6.1.12-4: General Conformity Emissions Threshold in Guam[a]

Pollutant	Region Status	Other Criteria	Emission Threshold (tpy)
Sulfur dioxide	Nonattainment	All nonattainment areas	100

Source: 40 CFR 93.153

tpy = tons per year
[a] Only those pollutant/attainment status combinations that are applicable to Guam are shown in this table. Other emissions thresholds can be found at *40 CFR 93.153*.

In most U.S. states and territories, mobile source air pollution is managed primarily through vehicle maintenance and fuel standards. Guam does not currently implement a regular inspection and maintenance program for vehicles. Nonetheless, the GEPA does conduct periodic inspections and testing to identify vehicle emission problems. This inspection program aims to eliminate or reduce excessive pollution from gas and diesel engines. Currently GEPA tests for opacity of emissions only, which can be used as an indicator for sulfur and particulate emissions (*GEPA 2015*).

Guam is currently exempt from the federal USEPA standards requiring ultra-low sulfur diesel fuel based on its small size and remote location (*USEPA 2012a*). However, Guam has implemented local regulations prohibiting higher-sulfur fuel on the island. Specifically, *10 Guam Code Annotated. 49119* requires that all diesel imported for sale or distribution in Guam must meet the USEPA's ultra-low sulfur diesel standards (*59 Federal Register 48968 [Sep 1993]* and *Guam Office of the Attorney General 2013*). Similarly, Guam is exempt from diesel engine standards for other off-road engines and aircraft, among others (*USEPA 2012a*).

6.1.13. Noise

6.1.13.1. Introduction

This section discusses noise conditions in Guam. Information is presented regarding noise characteristics that would be potentially sensitive to impacts from deployment and operation of the Proposed Action.

Noise is a form of sound caused by pressure variations that the human ear can detect and is often defined as unwanted sound (*USEPA 2012*). Noise is one of the most common environmental issues that can interfere with normal human activities and otherwise diminish the quality of the human environment. Typical sources of noise that result in this type of interference in both urban and suburban surroundings include interstate and local roadway traffic, rail traffic, industrial activities, aircraft, and neighborhood sources like lawn mowers, leaf blowers, etc.

The effects of noise can be classified into three categories:

- Noise events that result in annoyance and nuisance;
- Interference with speech, sleep, and learning; and,
- Physiological effects such as hearing loss and anxiety.

6.1.13.2. Specific Regulatory Considerations

In 1974, the United States Environmental Protection Agency determined that an exterior day-night average sound level (L_{dn}) of 55 A-weighted decibels (dBA) would not adversely affect public health and welfare by interfering with speech or other activities (*USEPA 1974*).

There are no numerical noise limits under Guam's Environmental Protection Agency authority (*Yevette Cruz [Guam EPA Deputy Administrator], Personal Communication with Franklin Bourdeau [former ERM Staff Engineer], March 19, 2015).*).

Per the Occupational Safety and Health Act of 1970, employees should not be exposed to more than 85 decibels (dB) for an 8-hour day, and if the noise level exceeds the 85 dB threshold, protective measures must be installed to reduce noise exposure (*29 Code of Federal Regulations 1910.95(c)(1)*).

6.1.13.3. Environmental Setting

Noise is generally defined as unwanted sound. Sound can be perceived as pleasant or annoying, and as loudness/intensity, in terms of dB. Sound measurement is refined by using a dBA scale that emphasizes the range between 1,000 and 8,000 cycles per second, which are the sound frequencies most audible to the human ear. The perceived increase in loudness of a sound does not correspond directly to numerical increase in dBA values. Typically, an increase of less than 3 dBA is barely noticeable, an increase of 5 dBA is noticeable, an increase of 10 dBA is perceived as a doubling in apparent loudness, and an increase of 20 dBA is perceived as a four-fold increase in apparent loudness. Table 6.1.13-1 shows typical noise levels generated by common indoor and outdoor activities, and provides possible human effects.

Table 6.1.13-1: Typical Noise Levels and Possible Human Effects

Common Noises[a]	Noise Level (dBA)	Effect
Rocket launching pad (no ear protection)	180	Irreversible hearing loss
Carrier deck jet operation	140	Painfully loud
Air raid siren		
Thunderclap	130	Painfully loud
Jet takeoff (200 feet)	120	Maximum vocal effort
Auto horn (3 feet)		
Pile driver	110	Extremely loud
Loud concert		
Garbage truck	100	Very loud
Firecrackers		
Heavy truck (50 feet)	90	Very Annoying
City traffic		Hearing damage (8 hours of exposure)
Alarm clock (2 feet)	80	Annoying
Hair dryer		
Noisy restaurant	70	Telephone use difficult
Freeway traffic		
Business office		
Air conditioning unit	60	Intrusive
Conversational speech		
Light auto traffic (100 feet)	50	Quiet
Living room	40	Quiet
Bedroom		
Quiet office		
Library/soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	Very quiet
Pin dropping	10	Just audible
Threshold of hearing	0	Hearing begins

Source: WSDOT 2015

dBA = A-weighted decibel
[a] No common 10 dBA source(s) was available, but expected noise effects for this decibel value were included.

In Guam, just like in any state or territory, noise can be generated from a variety of sources such as industries, roadway vehicle traffic, aircraft, hunting, construction activities, and public gatherings, to name just a few.

In the absence of measured data, typical sound level by outdoor land use category is presented in Table 6.1.13-2. In Guam, evergreen forest and grassland/herbaceous accounts for 65 percent of land cover, and developed open space covers approximately 11 percent of the territory (see Section 6.1.7.3, Land Use and Ownership). Ambient day-night noise levels in major cities such as Dededo, Yigo, Tamuning, and Mangilao as well as areas with dense traffic or some commerce or industry are expected to range from 55 to 65 dBA. Ambient day-night noise levels in rural and suburban Guam towns (e.g., Piti, Umatac, etc.) with infrequent traffic are expected to range from 40 to 45 dBA.

The Guam National Wildlife Refuge accounts for approximately 94 percent of recreational lands in the territory (see Section 6.1.7.5, Recreation). Ambient day-night noise levels in the most sensitive areas in American Samoa, such as the Guam National Wildlife Refuge or the War in the Pacific National Historic Park, are expected to be 35 dBA or less.

Table 6.1.13-2: Typical Outdoor Sound Levels by Land Use Category

Land Use Category	L_d (dBA)[a]	L_n (dBA)[b]	L_{dn} (dBA)[c]
Wilderness areas	35	25	35
Rural and outer suburban areas with negligible traffic	40	30	40
General suburban areas with infrequent traffic	45	35	45
General suburban areas with medium density traffic or suburban areas with some commerce or industry	50	40	50
Urban areas with dense traffic or some commerce or industry	55	45	55
City or commercial areas or residences bordering industrial areas or very dense traffic	60	50	60
Predominantly industrial areas or extremely dense traffic	65	55	65

Source: Cavanaugh and Tocci 1998; Bies and Hansen 2009

dBA = A-weighted decibel
[a] L_d, or daytime L_{eq}, is the average equivalent sound level for daytime (7 a.m. to 10 p.m.).
[b] L_n, or nighttime L_{eq}, is the average equivalent sound level for nighttime (10 p.m. to 7 a.m.).
[c] L_{dn}, or day-night average sound level, is the average equivalent A-weighted sound level during a 24-hour time period with a 10-dB weighting applied to equivalent sound level during the nighttime hours of 10 p.m. to 7 a.m.

$$L_{dn} = 10log_{10}(\frac{15}{24}10^{L_d/10} + \frac{9}{24}10^{(L_n+10)/10})$$

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6.1.14. Climate Change

6.1.14.1. Introduction

This section discusses the setting and context of global climate change effects in Guam. Information is presented regarding the historical and existing climate parameters including temperature, precipitation, and severe weather.

Climate change, according to the Intergovernmental Panel on Climate Change (IPCC), is defined as "…a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or human activity." (*IPCC 2007*)

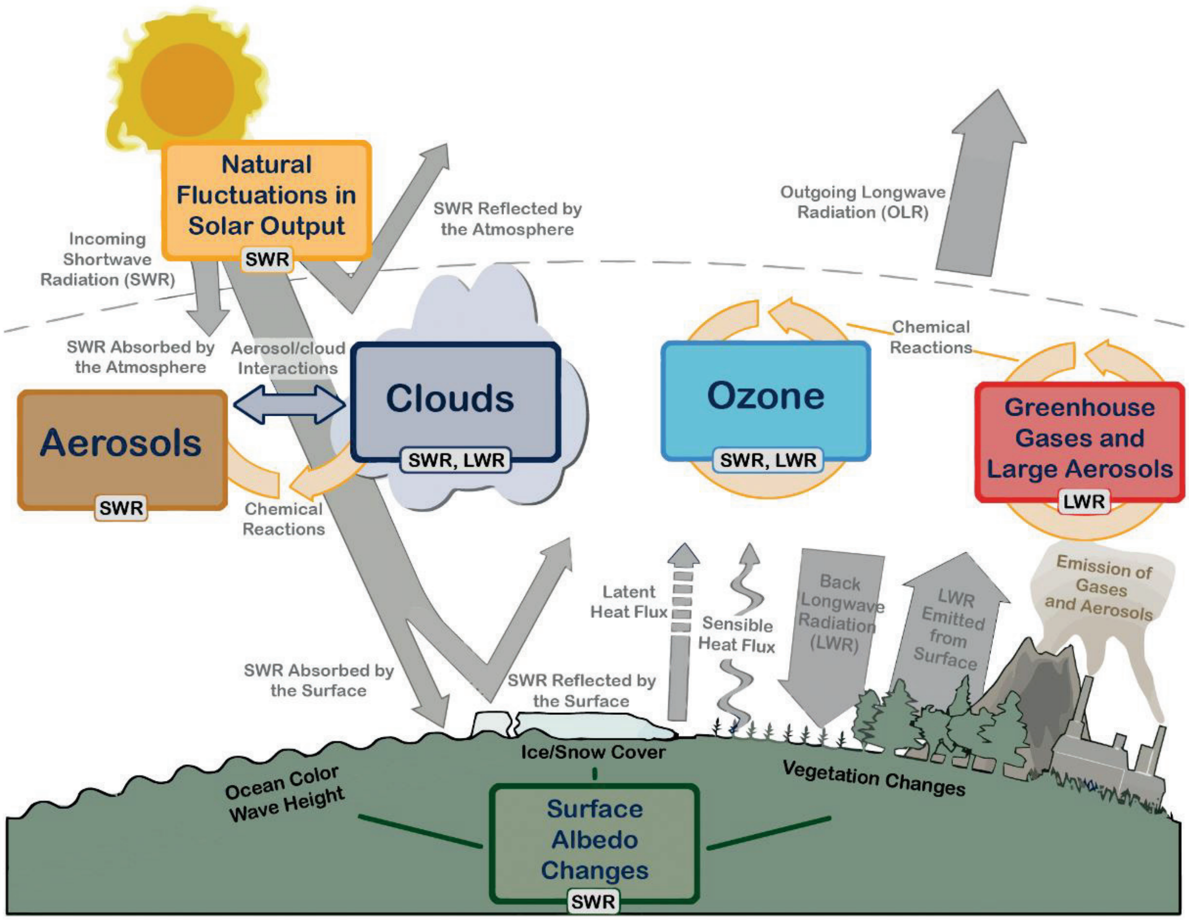
Accelerated rates of climate change are linked to an increase in atmospheric concentrations of greenhouse gas (GHG) caused by emissions from human activities such as burning fossil fuels to generate electricity (*USEPA 2012*). The IPCC is now 95 percent certain that humans are the main cause of current global warming (*IPCC 2013a*). Human activities result in emissions of four main GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halocarbons (a group of gases containing fluorine, chlorine, or bromine) (*IPCC 2007*). The common unit of measurement for GHGs is metric tons of CO_2-equivalent, which equalizes for the different global warming potential of each type of GHG.

The IPCC reports that "global concentrations of these four GHGs have increased significantly since 1750" and that "atmospheric concentrations of CO_2 increased from 80 parts per million (ppm) of carbon in 1750 to 379 ppm of carbon in 2005." (*IPCC 2007*) The atmospheric concentration of CH_4 and N_2O have increased from pre-industrial values of about 715 and 270 parts per billion to 1774 and 319 parts per billion, respectively, in 2005 (*IPCC 2007*). In addition, the IPCC reports that human activities are causing an increase in various hydrocarbons from near-zero pre-industrial concentrations (*IPCC 2007*).

Both the GHG emissions effects of the Proposed Action and Alternatives, as well as the relationships of climate change effects to the Proposed Action and Alternatives, are considered in this Draft Programmatic Environmental Impact Statement (see Section 6.2, Environmental Consequences). Existing climate conditions in the Proposed Action area are described first by state/territory and sub-region, where appropriate, and then by future projected climate scenarios.

6.1.14.2. Context

Output from the sun powers the Earth's climate through solar radiation. The sun's energy in the form of light (including visible light or sunlight), which is electromagnetic radiation, and heat is reflected, transmitted or absorbed into the Earth's atmosphere. For the Earth's temperature and longer term climate to remain relatively constant, the incoming radiation from the sun must balance with outgoing radiation into space. Most of the outgoing radiation leaving the Earth's surface is longwave radiation, which is also referred to as infrared radiation (*IPCC 2013a*). Some of the infrared radiation that is emitted from the Earth's surface is absorbed by certain gases in the atmosphere, which also emit longwave radiation into all directions. The radiation downward back into the surface adds and traps heat into the earth's surface, creating the greenhouse gas effect. This effect is illustrated in Figure 6.1.14-1 below.



Source: IPCC 2013a

Figure 6.1.14-1: The Greenhouse Gas Effect

Gases including CO_2, methane CH_4, N_2O, water vapor, and ozone naturally occur in the atmosphere in addition to manufactured pollutants such as hydrofluorocarbons and chlorofluorocarbons. These gases have the ability to emit radiation and can trap outbound radiation within the Earth's atmosphere (*IPCC 2013a*). These gases are collectively called GHGs due to their ability to contribute to the greenhouse gas effect (*IPCC 2013a*). Some GHGs, such as CO_2, CH_4, N_2O, and water vapor, have been continuously released throughout Earth's geologic history through natural processes. Natural sinks[1] that absorb CO_2, such as vegetation and forests, counterbalance this cycle.

[1] Carbon sinks occur when natural processes absorb more CO_2 than they release. Examples of natural processes that serve as carbon sinks include forests, soils, oceans, and vegetation.

Since the industrial revolution, increasing GHG emissions from human activities (referred to as anthropogenic emissions and contrasting with emissions arising from natural processes) have increased the levels of GHGs in the atmosphere. Anthropogenic emissions enhance the greenhouse gas effect and result in a greater amount of heat that is trapped in the atmosphere (*IPCC 2013a*). Human activities that emit GHGs include the combustion of fossil fuel, industrial processes, land use changes, deforestation, and agricultural production.

The Fifth Assessment Report by the IPCC concludes that total radiative forcing, which is the difference between the visible light absorbed by Earth and the energy reflected, is positive. This leads to an increase in energy in the climate system (*IPCC 2013b*). The largest contributor to radiative forcing is caused by the increase of CO_2 in the atmosphere since 1750 (*IPCC 2013b*). Furthermore, according to climate models, continued GHG emission will cause further warming and changes in the climate system (*IPCC 2013b).*

6.1.14.3. Specific Regulatory Considerations

In 2007, the United States (U.S.) Supreme Court in *Massachusetts v EPA, 549 U.S. 497 (2007)* ruled that GHGs are air pollutants and can be regulated under the Clean Air Act. Since this ruling, there have been state and federal programs and initiatives that have been proposed and implemented that address GHG emissions in the U.S. The programs that are relevant to the Proposed Action are described below.

Revised Draft CEQ Guidance

The Council on Environmental Quality (CEQ) published revised draft guidance for GHG emissions and climate change impacts in December 2014. This guidance is applicable to all federal agency actions and is meant to facilitate compliance within legal requirements of the National Environmental Policy Act. The CEQ guidance describes how federal agency actions should evaluate GHG and climate change effects in their National Environmental Policy Act reviews. CEQ defines GHGs to include CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, which is in accordance with section 19 (i) of Executive Order 13514. The CEQ guidance proposes that agencies should consider that a proposed action and its reasonable alternatives contribute, specifically, "(1) the potential effects of a proposed action on climate change as indicated by its GHG emissions; and (2) the implications of climate change for the environmental effects of a proposed action." For GHG emissions, the guidance provides a reference point of 25,000 metric tons (tonnes) per year or more where a quantitative analysis would be warranted. CEQ recommends agencies evaluate project emissions and changes in carbon sequestration and storage, when appropriate, in assessing a proposed action's potential climate change impacts. The analysis should assess direct and indirect climate change effects of a proposed project including connected actions, the cumulative impacts of its proposed action, and reasonable alternatives. CEQ advises that climate change effects on the environmental consequences of a proposed action should be described based on available studies, observations, interpretive assessments, predictive modeling, scenarios, and other empirical evidence. The temporal bounds should be limited by the expected lifetime of the proposed project. Mitigation and adaptation measures should be considered in the analysis for effects that occur immediately and in the future.

Territory Regulations

There are no territory regulations or guidelines on GHGs and climate change in Guam.

6.1.14.4. Historical Climate

Guam is located in the Western North Pacific (WNP) region. An increasing trend has been observed in maximum and minimum temperatures in the past 60 years (*Keener et al. 2013*). The region is cooler on average during the El Niño phase of El Niño/Southern Oscillation (ENSO) and warmer during the La Niña events (*Keener et al. 2013*). ENSO is a naturally occurring phenomenon that involves fluctuating ocean temperatures in the equatorial Pacific, and influences North America as it is a dominant force causing variations in regional climate patterns (*NC State Undated_b*). ENSO cycles typically only last 6 to 18 months (*NC State Undated_a*). Additionally, oscillations in regional sea level variations are associated with the ENSO (*Keener et al. 2012*). Historically, energetic[2] ENSO events can cause sea levels to rise 6 to 12 inches above mean conditions (*Keener et al. 2012*). The Third National Climate Assessment published in 2014 concludes that average sea surface temperature in the Pacific has been observed rising as much as 3.6 degrees Fahrenheit (°F) since the 1950s (*USGCRP 2014*).

There has been an observed increasing trend in precipitation for the WNP region (*Keener et al., 2013*). Additionally, fewer extreme rainfall events have been observed in the WNP since the 1950s (*Keener et al. 2013*). The WNP region is the most active tropical cycle basin with an average of 25 to 26 cyclones reaching tropical storm strength or higher (*Keener et al. 2012*). The occurrence of typhoons has increased in the period covering 1990 to 2010 compared to a baseline of 1970 to 1990 (*Keener et al. 2013*).

The historical annual average temperature in Guam from 1980 to 2010 is 81.5°F and precipitation is 97.6 inches (*NOAA 2012).*

6.1.14.5. Existing Climate and Meteorology

Guam has a landmass of 209 square miles and it lies between latitude 13.2 degrees north and 13.7 degrees north and longitude 144.6 degrees east and 145 degrees east (*AIA Guam and Micronesia 2012*). Guam is located within the Western North Pacific Ocean region, and is the largest and southern-most island of the Mariana Islands.

The weather in Guam is influenced by the North Pacific High/Trade Winds and the Intertropical Convergence Zone. The North Pacific High/Trade Winds are most active between the months of December to June, a period which brings episodic winds to Guam (*Keener et al. 2013*). The Intertropical Convergence Zone is a stormy low-pressure system that arises due to differential heat absorption between Asia and the ocean and its position varies seasonally. From May to October, it moves through the WNP sub-region, which defines the region's rainy season

[2] Energetic refers to strength and amplification in oscillations.

(*Keener et al. 2013*). Because Guam is located within the northern portion of the WNP and is in close proximity to the North Pacific High/Trade Winds, it experiences a longer dry season than other islands located in Micronesia (*Keener et al. 2013*).

Because Guam has a small landmass, the climate and meteorological information included here applies to the entire island. General meteorological conditions for Guam, including temperature, precipitation, wind direction, and wind speed were extracted from historic climate information issued by the National Oceanic and Atmospheric Administration (NOAA); National Environmental Satellite, Data and Information Service; National Climatic Data Center (NCDC) Comparative Climatic Data for the U.S. through 2012; and a NOAA National Environmental Satellite, Data and Information Service Technical Report in 2013.

Due to Guam's geographic location, there is little seasonal variation in weather, which translates to a minor seasonal temperature range. The air temperatures in Guam are tropical marine, and range from 70°F to 85°F with an average temperature of 81.5°F and an average relative humidity of 80.5 percent. The summer season occurs from March through August and the winter season occurs from December through February. Guam's dry season occurs from December through June, and its rainy season occurs from May through October (*CIA 2015*). On average, Guam receives between 80 to 110 inches of rain annually (*Villaverde 1995*). Typical wind direction is northerly to northeasterly. Annual average meteorological data for Guam are shown in Table 6.1.14-1.

Table 6.1.14-1: Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for Guam

Parameter	Annual Average
Temperature (°F)	81.5
Relative Humidity (%)	80.5
Precipitation: Rain (in)	97.6
Precipitation: snow/sleet (in)	0
Wind speed (mph)	20.8
Max (gust) wind speed (mph)	133.1
Wind direction	NNE

Source: NOAA 2012

°F = degree Fahrenheit; % = percent; in = inches; mph = miles per hour; NNE = north-northeast

Severe weather data recorded over the last 18 years (1996 to 2014) for Guam include flooding, thunderstorm (marine thunderstorm, thunderstorm wind, lightning, and heavy rain), tornado/funnel cloud, hurricane, and high wind (50-plus miles per hour [mph]). Occurrence of such events during that time period is listed in Table 6.1.14-2. Flooding is the most common severe weather phenomenon within the island.

Table 6.1.14-2: Severe Weather Data for Guam (1996-2014)

Number of Recorded Occurrences	Flooding[a]	Thunderstorm[b]	Tornado / Funnel Cloud	Hurricane/ Typhoon	High Wind (50+ mph)
Guam	71	19	27	7	8

Source: NOAA 2015

mph = miles per hour
[a] Includes NCDC Event Type: Coastal Flood, Flash Flood, and Flood
[b] Includes NCDC Event Type: Marine Thunderstorm Wind, Thunderstorm Wind, Lightning, and Heavy Rain

6.1.15. Human Health and Safety

6.1.15.1. Introduction

This section provides a health profile of the population of Guam where potential worker and community health and safety effects related to the deployment and operation of the Proposed Action could occur. The health profile includes a summary of basic population health indicators and a discussion of any key community health and safety issues, with a focus on those health issues that may be potentially sensitive to impacts from the Proposed Action.

This health profile is based on a review of various secondary data sources, including the Centers for Disease Control and Prevention, the Guam Department of Health, and the United States (U.S.) Environmental Protection Agency (USEPA).

The existing environment for health and safety is defined by occupational and environmental hazards likely to be encountered during the deployment, operation, and maintenance of towers, antennas, cables, utilities, and other equipment and infrastructure at existing and potential FirstNet telecommunication sites. There are two human populations of interest within the existing environment of health and safety, 1) telecommunication occupational workers and 2) the general public near telecommunication sites. Each of these populations could experience different degrees of exposure to hazards as a result of their relative access to FirstNet telecommunication sites and their function throughout the implementation of the FirstNet telecommunication network infrastructure.

The health and safety issues reviewed in this section include occupational safety for telecommunications workers, contaminated sites, and natural disaster sites. This section does not evaluate the health and safety risks associated with radio frequency radiation or vehicular traffic and transportation of hazardous materials and wastes. Radio frequency is evaluated in Section 2.4, Radio Frequency Emissions. Vehicle traffic and the transportation of hazardous materials and wastes are evaluated in Section 6.1.1, Infrastructure.

6.1.15.2. Specific Regulatory Considerations

The Occupational Safety and Health Administration is the primary regulatory agency in charge of the enforcement of worker safety and health regulations in Guam, primarily the Occupational Safety and Health Act of 1970. This Act sets and enforces protective standards and regulations to assure safe and healthful working conditions for all workers in both the private and public sectors. For regulations specific to radio frequency exposure, U.S. Federal Communications Commission standards apply, as it has jurisdiction in all 50 states, the District of Columbia, and U.S. territories such as Guam (*OSHA 2015*).

Although the Occupational Safety and Health Administration is the primary regulatory agency in charge of these regulations, other regulations could play a role in if the project activities would include handling of hazardous waste.

The following four laws are overseen by the USEPA and regulate aspects of worker health in conjunction with the Occupational Safety and Health Administration:

- The main objective of the Resource Conservation and Recovery Act of 1976 is to "protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner" (*USEPA 2013a*);
- The Comprehensive Environmental Response, Compensation, and Liability Act or Superfund law was designed to help clean up hazardous waste sites and releases of pollutants or contaminants that may negatively affect public health (*USEPA 2015b*);
- The Toxic Substances Control Act regulates the introduction of new or existing chemicals that present a risk to human health or the environment (*USEPA 2015c*);
- The Emergency Planning and Community Right-to-Know Act of 1986 was designed to assist communities in planning for emergencies related to hazardous waste. The law also requires industry to inform federal, state/territory, and local governments on the storage use and releases of hazardous chemicals (*USEPA 2015a*).

Other regulatory considerations that are applicable to worker and community health and safety are outlined in Section 2.4, Radio Frequency Emissions; Section 6.1.1, Infrastructure; Section 6.1.4, Water Resources; Section 6.1.10, Environmental Justice; Section 6.1.12, Air Quality; and Section 6.1.13, Noise.

6.1.15.3. Health Overview

Several measures of general health status, such as life expectancy (how long an individual from a certain population is expected to live), mortality rates, and disease prevalence are common indicators of the overall health status of a population. Table 6.1.15-1 summarizes some of the key health indicators for Guam compared to the averages for the U.S.

Table 6.1.15-1: Key Health Indicators for Guam

Health Outcome Indicator (data year)	Guam	United States
Age-adjusted death rate, per 100,000 population (2013)	767.6	731.9
Life expectancy (2010)	Male: 77.0 years Female: 82.1 years	Male: 76.2 years Female: 81.0 years
Leading causes of death, % of total deaths (2013)	32.4% - heart disease 18.6% - cancer 8.1% - cerebrovascular diseases 4.7% - accidents 4.4% - diabetes	23.5% - heart disease 22.5% - cancer 5.7% - chronic lower respiratory diseases 5.0% - accidents 5.0% - cerebrovascular
Infant mortality rate, per 1,000 live births (2013)	9.44	5.96

Source: CDC 2013a; World Bank 2013; WHO 2011.

Guam shows poorer health status than the overall U.S. on several important health measures, but better health status on others. However, due to its relatively small population, Guam's death rates are likely to show much more year-to-year variation than the contiguous U.S. In 2013, Guam had a higher all-cause death rate and a considerably higher infant mortality rate than the U.S.; however, life expectancy at birth in 2010 was higher in Guam than in the U.S. With regards to causes of death, the data show that the two leading causes of death in Guam (heart disease and cancer) are the same as in the U.S.; however a larger share of deaths in Guam are made up of heart disease, and a smaller percentage by cancer. Guam also differs in its considerably higher rate of cerebrovascular death, and the fact that diabetes is among its five leading causes of death (4.4 percent of deaths compared with 2.9 percent in the U.S.). However, Guam has some of the lowest death rates from all causes across the U.S. and its territories, and has met the U.S. Department of Health and Human Services "Healthy People 2020"[1] targets for the rates of death from to cancer, colorectal cancer, lung cancer, and chronic obstructive pulmonary diseases (*Office on Women's Health 2014*).

6.1.15.4. Summary of Key Health and Safety Conditions for Guam

The following summarizes key health and safety conditions in Guam, with a focus on those conditions that could potentially be impacted by the activities and infrastructure associated with the Proposed Action, or potentially increase health risk to the Proposed Action workforce.

Mental health and substance use—Guam ranks amongst the highest in the U.S. in deaths from suicide, with approximately one suicide every two weeks. Suicide rates are highest in young males (*Peace Guam 2015b*). The high suicide rate has been attributed to a multitude of factors including socioeconomic conditions such as high unemployment rates, peer group approval, cultural changes and suicide "contagion"[2] (*Booth 2010*). Additionally, the use of alcohol was linked to 25 percent of all suicide deaths from 2008 to 2011. Other drugs were linked to 7 percent of all suicide deaths (*Guam State Epidemiological Outcomes Workgroup 2015*). Suicide is often linked with other issues such as isolation and inadequate access to mental health services (*CDC 2015a*).

Illicit drug use has risen steadily in Guam. Drug-related charges have increased with a total of 101 cases reported in 2011. In particular, methamphetamine has been the leading street drug linked with arrests and convictions (*NDIC 2003*).

In addition to drug use, alcohol abuse is a significant public health concern in Guam. The estimated prevalence of adults who reported binge drinking during the preceding month in 2010 was 17.7 percent compared to the U.S. at 15.1 percent. The State Epidemiological Outcomes Workgroup reported that heavy drinking[3] and binge drinking[4] are both significantly higher among adults in Guam. Heavy drinking is a particularly serious issue among males in Guam

[1] "Healthy People" is a program of nationwide health-promotion and disease-prevention goals set by the U.S. Department of Health and Human Services.

[2] Suicide contagion is direct or indirect exposure to suicide or suicidal behaviors within one's family, peer group or media reports that can result in an increase in suicide or suicidal behaviors, especially in adolescents and young adults (*HHS 2015*).

[3] More than two drinks per day for adult men and more than one drink per day for adult women (*CDC 2013c*).

[4] More than five drinks on one occasion for adult men and more than four drinks on one occasion for adult women (*CDC 2013c*).

with 10.7 percent reporting drinking compared to 5.6 percent among men in the U.S. Binge drinking among males in Guam is 65 percent higher than that of males in the U.S. (34.5 percent vs. 20.9 percent) (*Peace Guam 2015a*). In 2009, alcohol was involved in 33 percent of all traffic deaths (*Guam State Epidemiological Outcomes Workgroup 2015*).

Infectious diseases—Dengue fever is also an ongoing concern in Guam, though official statistics are not available (*CDC 2014*). As of March 2015, no cases of chikungunya had been reported in Guam (*CDC 2015b*), but public health officials are remaining vigilant due to a local abundance of *Aedes albopictus* mosquito species, which are one of the vector species[5] for the disease (*Marianas Variety 2013b*).

Chronic diseases affected by air pollution—Common mobile source air emissions of health concern include nitrogen dioxide and particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$). Fossil fuel combustion associated with traffic and the use of heavy machinery and generators is the primary source of $PM_{2.5}$ and nitrogen oxides that could be generated by the Proposed Action. Baseline levels of air pollutants in Guam are addressed in Section 6.1.12, Air Quality. The focus of this section is on vulnerable groups that may be particularly sensitive to even short-term increases in $PM_{2.5}$ or nitrogen oxides.

Research to date has not revealed the existence of "No Observed Adverse Effects Level" thresholds for $PM_{2.5}$ or nitrogen oxides below which no health effects would be expected for sensitive populations (*HEI 2010; USEPA 2009; Kelly and Fussell 2011; Levy et al. 2002; Nishimura et al. 2013; Patel & Miller 2009; O'Neill et al. 2005, 2007; Sarnat and Holguin 2007*). Sensitive populations for exposure to $PM_{2.5}$ and nitrogen dioxide are:

- Those with chronic respiratory diseases (asthma and chronic obstructive pulmonary disease), particularly children and the elderly;
- Those with acute respiratory infections, particularly children and the elderly;
- Those with chronic heart diseases; and
- Diabetics.

Compared to the overall U.S., the population in Guam has better health status with regards to prevalence of asthma and respiratory illness-related deaths. Table 6.1.15-2 provides a summary of the prevalence of health conditions that can be exacerbated by air pollution, in Guam and the U.S.

[5] A vector is an organism that carries and transmits an infectious pathogen to another living organism.

Table 6.1.15-2: Health Conditions Affected by Air Pollution

Chronic Condition	Guam	United States
Adult asthma prevalence[a] (2013)	5.4%	9.0%
Chronic lower respiratory diseases, percentage of all deaths (2013)	3.1%	5.6%
Influenza and pneumonia, percentage of all deaths (2013)	1.9%	2.2%
Heart disease, percentage of all deaths (2013)	32.4%	23.5%
Diabetes prevalence[b] (2013)	14.1%	9.8%

Sources: CDC 2013a; CDC 2013b

[a] Defined as ever having been told by a doctor that you currently have asthma.
[b] Defined as ever having been told by a doctor that you have diabetes.

Smoking is the primary behavioral health risk behavior for chronic illnesses that are affected by air pollution. According to the 2013 Behavioral Risk Factor Surveillance System Guam has a significantly higher smoking rate than the U.S. at 26.5 percent compared to 18.1 percent (*CDC 2013b*). Approximately one in four adults is a smoker in Guam. Demographically, smoking is highest among the indigenous group Chamorros, followed by other Guam residents; furthermore, these groups suffer from the highest rates of lung and oral cancers (most cases are caused by tobacco) (*Guam State Epidemiological Outcomes Workgroup 2015*).

Occupational injuries and fatalities—In 2013, the incidence rate of nonfatal occupational injuries and illnesses in Guam for all industries was 3.7 compared to 3.5 in the U.S. (*BLS 2013b*).[6] The total fatal occupational injuries in Guam in 2013 amounted to three cases (*BLS 2013a*).

Hazardous waste/contaminated areas—Existing environmental contaminants in soil or water at a development site could potentially result in a worker or community health concern if such contaminants were not adequately managed during development. Health effects from environmental contaminants can range from experiences of physical irritation/nuisance to acute illness to chronic disease outcomes. Existing areas of contamination can come from both existing industrial facilities and legacy contaminated sites.

Guam is lightly industrialized. According to the USEPA's Toxic Release Inventory (TRI), as of 2013 Guam ranks 23 out of 56 states/territories nationwide[7] and has 12 TRI facilities with a total of 517,157 pounds of disposal or other releases. The TRI database is a measure of the industrial nature of an area and the over-all chemical use, and can be used to track trends in releases over time. The "releases" do not necessarily equate to chemical exposure by humans or necessarily constitute to quantifiable health risks because the releases include all wastes generated by a facility – the majority of which are disposed of via managed, regulated processes that minimize human exposure and related health risks (e.g., in properly permitted landfills or through recycling facilities).

[6] Incidence rates are based on the number of injuries and illnesses per 10,000 full-time workers.
[7] Rank 1 represents the highest volume of releases.

The electric utilities sector is the highest contributor of on-site releases in Guam. Furthermore, Guam Power Authority is the highest contributor of on-site disposal with sulfuric acid being its primary chemical release representing 82.4 percent of total air releases in Guam (*USEPA 2013b*). According to the USEPA, Guam has two listed active Superfund sites. TRI facilities are shown on Figure 6.1.15-1 below.

Source: USEPA 2013c

Figure 6.1.15-1: Location of TRI Facilities in Guam

Affected environment discussions for radio frequency, traffic, noise/vibration, and public safety services, all of which have the potential to influence community and worker health, are covered in Section 2.4, Radio Frequency Emissions; Section 6.1.1.3, Transportation; Section 6.1.13, Noise; and Section 6.1.1.4, Public Safety Services, respectively, in this Draft Programmatic Environmental Impact Statement.

6.2. ENVIRONMENTAL CONSEQUENCES

This section describes the potential direct and indirect environmental impacts that could be caused by the deployment, operation, and maintenance of the Proposed Action and discusses best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts. Cumulative environmental impacts of the Proposed Action and other past, present, and reasonably foreseeable projects are described separately in Chapter 10, Cumulative Effects. In each of the resource area-specific sections that follow, a table is presented outlining each of the potential types of effects that could impact the given resource.

The levels of impacts for each resource area are defined as follows:

- *Potentially significant,* where there is substantial evidence that an effect may be significant;
- *Less than significant with best management practices (BMPs) and mitigation measures incorporated,* where the use of mitigation measures reduce an effect from a *potentially significant* impact to a *less than significant* impact;
- *Less than significant,* where the activity creates impacts but no significant impacts; or
- *No impact,* which applies where a project does not create an impact.

Characteristics of each type of effect, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact for each type of project activity associated with the Proposed Action. Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to the resources are presented as a range of possible impacts. BMPs and mitigation measures are described in Chapter 11.

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6.2.1. Infrastructure

6.2.1.1. Introduction

This section describes potential impacts to infrastructure including transportation, communications and other utilities in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.1.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on infrastructure, which includes public safety telecommunications systems, transportation safety and capacity, utility services, access to emergency services and commercial communications systems, were evaluated using the significance criteria presented in Table 6.2.1-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts infrastructure addressed in this section are presented as a range of possible impacts.

Table 6.2.1-1: Impact Significance Rating Criteria for Infrastructure

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Transportation system capacity and safety	Magnitude or Intensity	Creation of substantial traffic congestion/delay and/or a substantial increase in transportation incidents (e.g., crashes, derailments)	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Minimal change in traffic congestion/delay and/or transportation incidents (e.g., crashes, derailments)	No effect on traffic congestion or delay, or transportation incidents
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or multiple isolated locations.	NA
	Duration or Frequency	Permanent: persisting indefinitely		Short-term effects would be noticeable for up to the entire construction phase or a portion of the operational phase	NA
Strain on capacity of local health, public safety, and emergency response services	Magnitude or Intensity	Impacted individuals or communities cannot access health care and/or emergency health services or access is delayed due to the Proposed Action activities.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Minor delays to access to care and emergency services that do not impact health outcomes	No impacts on access to care or emergency services
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to state/territory).		Impacts only at a local/neighborhood level	NA
	Duration or Frequency	Duration is constant during the construction and deployment phase.		Rare event during construction and deployment phase	NA

<table>
<tr><th rowspan="2">Type of Effect</th><th rowspan="2">Effect Characteristics</th><th colspan="4">Impact Level</th></tr>
<tr><th>Potentially Significant</th><th>Less than Significant with BMPs and Mitigation Measures Incorporated</th><th>Less than Significant</th><th>No Impact</th></tr>
<tr><td rowspan="3">Modifies existing public safety response telecommunication practices, physical infrastructure, or level of service in a manner that directly affects public safety communication capabilities and response times</td><td>Magnitude or Intensity</td><td>Substantial adverse changes in public safety response times and the ability to communicate effectively with and between public safety entities</td><td rowspan="3">Effect that is potentially significant, but with BMPs and mitigation measures is less than significant</td><td>Minimal change in the ability to communicate with and between public safety entities</td><td>No perceptible change in existing response times or the ability to communicate with and between public safety entities</td></tr>
<tr><td>Geographic Extent</td><td>Local/city, county/region, or state/territory</td><td>Local/city, county/region, or state/territory</td><td>Local/city, county/region, or state/territory</td></tr>
<tr><td>Duration or Frequency</td><td>Permanent or perpetual change in emergency response times and level of service</td><td>Change in communication and/or the level of service is perceptible but reasonable to maintaining effectiveness and quality of service</td><td>NA</td></tr>
<tr><td rowspan="3">Effects to commercial telecommunication systems, communications, or level of service</td><td>Magnitude or Intensity</td><td>Substantial adverse changes in level of service and communications capabilities</td><td rowspan="3">Effect that is potentially significant, but with BMPs and mitigation measures is less than significant</td><td>Minor changes in level of service and communications while transitioning to the new system</td><td>No perceptible effect to level of service or communications while transitioning to the new system</td></tr>
<tr><td>Geographic Extent</td><td>Local/city, county/region, or state/territory</td><td>Local/city, county/region, or state/territory</td><td>Local/city, county/region, or state/territory</td></tr>
<tr><td>Duration or Frequency</td><td>Persistent, long-term, or permanent effects to communications and level of service</td><td>Minimal effects to level of service or communications lasting no more than a short period (minutes to hours) during the construction and deployment phase</td><td>NA</td></tr>
</table>

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Effects to utilities, including electric power transmission facilities and water and sewer facilities	Magnitude or Intensity	Substantial disruptions in the delivery of electric power or to physical infrastructure that results in disruptions, including frequent power outages or drops in voltage in the electrical power supply system ("brownouts"). Disruption in water delivery or sewer capacity, or damage to or interference with physical plant facilities that impact delivery of water or sewer systems.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Minor disruptions to the delivery of electric power, water, and sewer services or minor modifications to physical infrastructure that result in minor disruptions to delivery of power, water, and sewer services	There would be no perceptible impacts to delivery of other utilities and no service disruptions
	Geographic Extent	Local/city, county/region, or state/territory		Local/city, county/region, or state/territory	Local/city, county/region, or state/territory
	Duration or Frequency	Effects to other utilities would be seen throughout the entire construction phase.		Effects to other utilities would be of short duration (minutes to hours) and would occur sporadically during the entire construction phase	NA

NA = not applicable

6.2.1.3. Description of Environmental Concerns

Transportation System Capacity and Safety

Deployment and operation of the Proposed Action could potentially impact transportation system safety and capacity in Guam. The transport of heavy equipment required to support any clearance, drilling, and construction activities needed for network deployment could potentially have an impact on traffic congestion and transportation safety. Deployment activities including plowing, directional boring, and trenching necessary for the installation of fiber optic cable along the road and within the public road right-of-way (ROW) also have the potential to create temporary traffic congestion. The presence of deployable technologies such as Cell on Wheels, Cell on Light Truck, System on Wheels, and Deployable Aerial Communications Architecture could potentially impact air and land-based traffic congestion and safety. However, potential impacts would likely be *less than significant* given that deployable technologies would typically be stationed in the more rural areas of Guam where there is less transportation system infrastructure that would be disrupted and where less permanent fixed infrastructure is likely to be erected.

Submarine deployment activities have the potential to increase boat traffic and congestion on a short-term basis. Submarine deployment activities likely to create potential impacts include the installation of sealed cables in limited nearshore waters and inland waterbodies and the construction of landings and facilities onshore to accept cables.

Each of the potential impacts to transportation capacity and safety discussed above would likely be short term, would be regionally based around the ongoing phase of construction, and would return to normal conditions after a few months or less.

Strain on Capacity of Local Health, Public Safety, and Emergency Response Services

Deployment activities involving plowing, directional boring, or trenching along the road during the installation of fiber optic cable, or construction of wireless towers or other structures could have the potential to temporarily create minor road blockages or cause radio interference during the transition to the new system. Deployable technologies with cellular base stations and generators that could require connection to utility power cables could have the potential to create temporary power outages or utility service interruptions. While the potential impacts are not certain, these potential impacts would be localized, short-term, and temporary, and the Proposed Action would likely improve overall access to health care and emergency health services during the operations phase. Deployable Technologies in particular would help to provide coverage in areas of Guam where fixed infrastructure cannot be erected due to a variety of factors. Guam is said to have the highest frequency of natural disasters among the states and territories in the United States (*GlobalSecurity.org 2015*). With successful completion of the Proposed Action, FirstNet would have established a nationwide broadband network allowing public safety officers and emergency responders to communicate with each other across agencies and jurisdictions, thus improving current conditions for first responders and impacted individuals in emergency situations.

Public Safety Communication Capabilities and Response Times

Currently, the Government of Guam Land Mobile Radio System is the primary public safety interoperable communications system in Guam and provides federal, territory, and local communications capabilities to emergency first responders. Other communication methods used by various public safety services in Guam are through E911 Communications Bureau, Government of Guam Interoperable Communications Working Group, and Federal Emergency Management Agency Integrated Public Alert and Warning System. Guam operates one of the more advanced telecommunications systems in the Pacific region given the strong military presence in the territory. It is made up of approximately nine submarine cable networks. However, an undersea cable break to Guam in July 2015 demonstrated the vulnerability of the submarine cables and their importance to local communications and the economy. The cable break resulted in significant disruptions to Guam's banking systems, health-care consultations, business and consumer activities, and public safety and security systems. The cable break also highlighted the need to ensure hardened systems to prevent natural disaster interruption and theft (*Pacific Daily News 2015*). Digital Subscriber Line and modems are the primary broadband technologies utilized in the territory, while more advanced High Speed Packet Access and Long-Term Evolution technologies continue to be developed in Guam (*Paul Budde Communication 2015*). Guam does not have a current mobile communications vehicle, nor does it have effective mobile and alternate dispatching capabilities, which makes the territory more vulnerable in times of emergency (*USDOC & USDHS 2008*). The Proposed Action is needed to address existing deficiencies in public safety communications interoperability, durability, and resiliency that have been highlighted in recent years for the ways in which they have hindered response activities in high profile natural and man-made disasters.

As stated in Chapter 2, Description of the Proposed Action and Alternatives, FirstNet proposes to implement a nationwide public safety broadband network (NPSBN) that would involve high-speed fourth generation Long Term Evolution technology(as defined in Section 2.1.1, Characteristics of the NPSBN), a core network, and a radio access network. A wide range of new telecommunications infrastructure and deployable technologies would likely be implemented as a part of the core network, including fiber optic cable, towers, data centers, microwave technology, and others. The radio access network is necessary for the connection of user devices and includes infrastructure related to the radio base station, such as communication towers, cell site equipment, antennas, deployable mobile hotspots, and backhaul equipment required to enable wireless communications with devices using the public safety broadband spectrum.

The NPSBN intends to provide a backbone to allow for improved communications by carrying high-speed data, location information, images, and, eventually, streaming video. This capability could increase situational awareness during an emergency, thereby improving the ability of the public safety community to effectively engage and respond. The NPSBN is also intended to have a higher level of redundancy and resiliency than current commercial networks to support the public safety community effectively. The backhaul, or intermediate links that carry user traffic, including voice, data and video, and signaling from radio base stations to the core network, would likely be accomplished through fiber optic and microwave technology, with an emphasis on redundancy that is intended to allow the network to continue to function in events of extreme demand. The NPSBN would also include, by statute, a variety of characteristics, one of which being substantial rural coverage. Guam has a complex geography made up of numerous mountainous regions and forests, and many communities within the territory are severely lacking in existing rural coverage. Implementation of the FirstNet public safety telecommunications infrastructure is intended to significantly improve public safety communications capabilities and response times in both urban and rural areas of Guam during operations.

Effects to Commercial Telecommunication Systems, Communications, or Level of Service

The capacity of local health, public safety, and emergency response services would experience negligible impacts during deployment or operation phases. During deployment and system optimization, existing services would likely remain operational in a redundant manner ensuring continued operations and availability of services to the public. The only potential impact would be extremely rare – and that is if emergency response services were using transportation infrastructure to respond to an emergency at the exact time that deployment activities were taking place. This type of impact would be isolated at the local or neighborhood level, and the likelihood of such an impact would be extremely low. Once operational, the new network would provide beneficial impacts to the capacity of local health, public safety, and emergency response services through enhanced communications infrastructure, thereby increasing capacity for and enhancing the ability of first responders, local health officials, and public safety officials to communicate during emergency response situations. Based on the impact significance criteria presented in Table 6.2.1-1, such potential negative and positive impacts would be *less than significant*.

Effects to Utilities

Potential impacts to utilities, including electric power transmission facilities, could occur throughout the deployment/construction phase but would return to their original state during the operational phase. During deployment activities, to the extent practicable or feasible, FirstNet would work to implement wired projects using existing public road ROWs. These ROWs include existing utility corridors and other easements. As part of the Proposed Action, FirstNet could also install of new fiber on existing poles in an effort to improve disaster resistance and resiliency. Pole replacement could be necessary as a part of project activities. Deployable technologies that contain generators could be connected to power utility cables, which could potentially result in temporary power outages. It is unlikely that these project activities would increase the load on the existing electrical utilities; however, the implementation of BMPs and mitigation measures (as discussed in Chapter 11, BMPs and Mitigation Measures) such as organizing scheduled coordination with other service providers while working within utility corridors and easements, would help avoid or minimize the potential for overloading or interrupting the service. Once deployment activities have terminated, if there was any change in service or added burden to the system, electrical utilities would likely return to their original state.

Deployment of new submarine cable would involve the installation of specially sealed cables in nearshore waters and inland waterbodies. However, it is not likely that these project activities would impact offshore utilities.

6.2.1.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to public safety telecommunications systems, commercial communications, transportation capacity and safety, and utilities; and others would not. In addition, and as explained in this section, various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to public safety telecommunications infrastructure, commercial communications, transportation capacity and safety, access to emergency services, and utilities under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to infrastructure resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes or disruption of transportation, telecommunications, or utility services.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to infrastructure resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact infrastructure resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to telecommunications infrastructure as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of excavation, trenching, construction, or maintenance within public road ROWs and utility corridors, collocation of network equipment on existing structures, transport or positioning of deployable technologies, construction of access roads, and installation of new fiber optic cables, poles, towers or ancillary structures. Potential impacts that could possibly result due to the deployment activities of the Preferred Alternative could include increased traffic congestion, current telecommunication system interruption, increased emergency response times, and utility interruptions. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to telecommunications infrastructure, commercial communications systems, transportation capacity and safety, utilities, and access to emergency facilities include the following:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Deployment activities involving plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence,[1] huts, or other associated facilities or hand-holes along the utility corridor or within the public road ROW could potentially result in minor, temporary disruptions to some utility services. Construction along a utility corridor could require that certain utilities are shut down during construction. Temporary traffic congestion and limited access to emergency services could occur as a result of construction and the presence of heavy machinery and vehicles near public road ROWs. Public safety and commercial telecommunications systems could also be temporarily disturbed during construction due to potential short-term radio interference; however during operation the buried fiber optic plant would likely improve coverage and telecommunications capabilities, as discussed below.
  - New Build–Aerial Fiber Optic Plant: Construction of new fiber optic cable involving installation of new poles and hanging cables on disturbed and undisturbed ROWs or easements could potentially impact some utility services. The presence of heavy equipment and vehicles during construction along ROWs could limit access to emergency services and result in increased traffic congestion. Depending on the availability of ROWs, the installation of new poles could involve the construction of access roads, which also has the potential to impact traffic flow. Temporary disruptions to public safety telecommunications systems and current commercial communications systems could also occur as a result of the installation of new poles and hanging cables. As a large portion of Guam has a complex geography, made up of mountainous regions and forests, public safety and commercial communication systems are likely to improve during operations given the new source of aerial coverage that the NPSBN intends to provide. These positive operational impacts are discussed below.

[1] Points of presence are connections or access points between two different networks, or different components of one network.

- Collocation on Existing Aerial Fiber Optic Plant: Replacement of poles, installation of new fiber on existing poles, and structural hardening could cause some disruptions to current telecommunications infrastructure. These activities also have the potential to temporarily disrupt current commercial communications systems. If construction is required within utility corridors, current utility systems could be affected. The transport of heavy equipment use associated with these activities could result in increased traffic congestion and could potentially impact traffic safety conditions and limited access to emergency services. The collocation on existing aerial fiber optic plant would provide a new level of resiliency to current public safety telecommunications capabilities. Furthermore, pole replacement as a part of deployment activities could help to accommodate loads from new users. These positive impacts are discussed below.
- New Build–Submarine Fiber Optic Plant: The installation of cables in limited nearshore or inland bodies of water would not impact land transportation systems, public safety telecommunications systems, commercial communications system, or land-based utility systems because there would be little to no terrestrial ground disturbance associated with this activity. Temporary impacts to telecommunications infrastructure could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cables.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require minimal construction, there would likely be no impact to infrastructure because there would be no disturbance to existing infrastructure. Fiber installation activities could require additional installation of equipment to enhance the digital signals travelling through the fiber, which could interfere with the existing telecommunication services. Installation of transmission equipment such as small boxes or huts is typically installed in the ROW of the utility corridor. Construction activities involving excavation could potentially impact utility services. Depending on the availability of a public ROW, construction of a new access road could be necessary, which has the potential to impact transportation capacity and safety. However, these potential impacts are expected to be minor and temporary.

• Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads might result in temporary or unintended impacts to current public safety telecommunications systems, commercial communications systems, or utility service during installation or interconnection activities. Generally, however, these deployment activities would be independent and would not be expected to interfere with other existing towers and structures. Transport of heavy equipment during these activities, construction that occurs within the public road ROW, and construction of new access roads could result in

temporary impacts to transportation capacity and safety and could limit access to emergency services.

  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, installation of power units, and structural hardening on existing towers and structures. These activities are not likely to impact transportation system capacity and safety or access to emergency services; however, there is a possibility that these activities could result in interruptions to the existing public safety telecommunications infrastructure, current communications systems, and electric power utilities. Collocation on existing wireless towers, structures, or buildings would improve disaster resistance and resiliency and increase the capacity of the system to accommodate the load from new users. These positive impacts are discussed below.

- Deployable Technologies
  - Deployable technologies including Cell on Wheels, Cell on Light Truck, and System on Wheels are comprised of cellular base stations (sometimes with expandable antenna masts) and generators that connect to utility power cables. Connecting the generators to utility power cables has the potential to disrupt electric power utility systems or cause power outages; however, this is expected to be temporary and minor. Some staging or landing areas (depending on the type of technology) could require minor construction and maintenance within public road ROWs and utility corridors, heavy equipment movement, minor excavation and paving near public roads, which have the potential to impact transportation capacity and safety as these activities could increase transportation congestion and delays. Implementation of deployable technologies would help to provide coverage in rural and urban areas of Guam where permanent, fixed infrastructure cannot be erected due to a variety of factors. Positive impacts associated with operation of the Proposed Action are discussed below.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of permanent equipment on existing structures and the use of portable devices that use satellite technology have the potential to temporarily interfere with existing public safety telecommunications systems and current commercial communications systems. Given that construction activities would occur on existing structures, transportation capacity and safety and access to emergency services would not be impacted.

In general, the above-mentioned activities could potentially involve trenching or directional boring, construction of access roads, huts, and installation of equipment such as antennas or microwave dishes and specially sealed cables in nearshore waters and inland waterbodies, and heavy equipment movement. Potential impacts to telecommunications infrastructure associated with deployment of this infrastructure could include increased traffic congestion, interruptions to existing telecommunication systems, increased emergency response times, reductions in emergency levels of service, and utility interruptions. These potential impacts would generally be minor and temporary, and associated BMPs and mitigation measures to help avoid or reduce these impacts are described further in Chapter 11.

Potential Transportation System Capacity and Safety Impacts

Based on the analysis of the deployment activities described above, potential impacts to transportation system capacity and safety as a result of transport of heavy equipment, road blockages, and excavation activities are anticipated to be *less than significant* (see Table 6.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Impacts to the Accessibility of Local Health, Public Safety, and Emergency Response Services

Based on the analysis of proposed activities described above, potential impacts to local health, public safety, and emergency response times are considered to be *less than significant* (see Table 6.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with infrastructure.

Potential Public Safety Telecommunication and Infrastructure Impacts

Based on the analysis of proposed activities described above, potential impacts to public safety telecommunications are considered to be *less than significant* (see Table 6.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Commercial Telecommunication System Level of Service Impacts

Based on the analysis of the proposed activities described above, potential impacts to the current commercial telecommunication system level of service are anticipated to be *less than significant* (see Table 6.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Utility Service Impacts

Based on the analysis of the proposed activities described above, potential impacts to utility services are anticipated to be *less than significant* (see Table 6.2.1-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned deployment impacts. It is anticipated that there would be no negative impacts to telecommunications infrastructure associated with routine inspections of the Preferred Alternative, assuming that the same access roads and utility ROWs used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if further construction related activities are required along public road and utility ROWs, increased traffic congestion, current telecommunication system interruption, and utility interruptions could result as explained above, although these potential impacts would be expected to be minor and temporary.

Numerous beneficial impacts would be associated with operation of the NPSBN. The new system is intended to result in substantial improvements in public safety response times and the ability to communicate effectively with and between public safety entities, and would also likely result in substantial improvements in level of service and communications capabilities. Operation of the NPSBN is intended to involve high-speed data capabilities, location information, images, and eventually streaming video, which would likely significantly improve communications and the ability of the public safety community to effectively engage and respond. The NPSBN is also intended to have a higher level of redundancy and resiliency than current commercial networks to support the public safety community effectively, even in events of extreme demand. This improvement in the level of resiliency and redundancy is intended to increase the reliability of systems, communications, and level of service, and also minimize disruptions and misinformation resulting from limited or disrupted service. Finally, the NPSBN would likely improve the much needed coverage in both rural and remote areas as well as the urban areas of Guam.

6.2.1.5. Alternatives Impact Assessment

The following section assesses potential impacts to public safety telecommunications infrastructure associated with the Deployable Technologies Alternative and the No Action Alternative.[2]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking

[2] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to Guam's infrastructure as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts to telecommunications systems, commercial communications systems, and utilities if deployment occurs within public road and utility ROWs. Some staging or landing areas (depending on the type of technology) could require heavy equipment movement, excavation, or paving, which have the potential to impact transportation systems. The presence and transport of these mobile communication units could potentially increase traffic congestion and delays and, increase transportation-related incidents, and limit access to emergency services. However, implementation of deployable technologies would result in positive impacts during operation, as discussed below.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be no negative impacts to the existing telecommunications infrastructure associated with routine inspections of the Preferred Alternative, assuming that the same access roads and utility ROWs used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or utility ROWs, or if additional maintenance-related construction activities occur within public road and utility ROWs, *less than significant* impacts to transportation systems, utility services, emergency-level of service, emergency response times, and access to emergency facilities could occur.

As with operations associated with the Preferred Alternative, it is likely that the operation of the Deployable Technologies Alternative would result in improvements to public safety response times and the ability to communicate effectively with and between public safety entities, and would also likely result in improvements in level of service and communications capabilities, but all these improvements would likely be temporary as opposed to the permanent beneficial impacts of the Preferred Alternative. Generally, these units would be deployed at times of an incident to the affected area for either planned or unplanned incidents or events. Many of the urban and rural areas in Guam are lacking public safety telecommunications infrastructure and coverage given the complex geography, made up of mountainous regions and forests. As explained above, under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure, which would likely temporarily improve coverage throughout Guam.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no negative impacts to telecommunications infrastructure as a result of construction and operation of the Proposed Action; however, none of the beneficial impacts associated with improved response times, redundancy, and resiliency of the system creating a more reliable emergency communication system would be realized. Environmental conditions would therefore be the same as those described in Section 6.1.1, Infrastructure.

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6.2.2. Soils

6.2.2.1. Introduction

This section describes potential impacts to soil resources in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are discussed in Chapter 11, BMPs and Mitigation Measures.

6.2.2.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on soil resources were evaluated using the significance criteria presented in Table 6.2.2-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each potential impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to soil resources addressed in this section are presented as a range of possible impacts.

Table 6.2.2-1: Impact Significance Rating Criteria for Soils

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Soil erosion	Magnitude or Intensity	Severe, widespread, and observable erosion in comparison to baseline, high likelihood of encountering erosion-prone soils; High likelihood of encountering prime or unique farmland	Effect that is *potentially significant*, but with mitigation is *less than significant*	Perceptible erosion in comparison to baseline conditions; low likelihood of encountering erosion-prone soil types; low likelihood of encountering prime or unique farmland	No perceptible change in baseline conditions; *no impacts* to prime or unique farmland
	Geographic Extent	State or territory		Region or county	NA
	Duration or Frequency	Chronic or long-term erosion not likely to be reversed over several years		Isolated, temporary, or short-term erosion that that is reversed over few months or less	NA
Topsoil mixing	Magnitude or Intensity	Clear and widespread mixing of the topsoil and subsoil layers	Effect that is *potentially significant*, but with mitigation is *less than significant*	Minimal mixing of the topsoil and subsoil layers has occurred	No perceptible evidence that the topsoil and subsoil layers have been mixed
	Geographic Extent	State or territory		Region or county	NA
	Duration or Frequency	NA		NA	NA
Soil compaction and rutting	Magnitude or Intensity	Severe and widespread, observable compaction and rutting in comparison to baseline	Effect that is *potentially significant*, but with mitigation is *less than significant*	Perceptible compaction and rutting in comparison to baseline conditions	No perceptible change in baseline conditions
	Geographic Extent	State or territory		Region or county	NA
	Duration or Frequency	Chronic or long-term compaction and rutting not likely to be reversed over several years		Isolated, temporary, or short term compaction and rutting that is reversed over a few months or less	No perceptible change in baseline conditions

NA = not applicable

6.2.2.3. Description of Environmental Concerns

Soil Erosion

One of the primary environmental concerns during construction activities is soil erosion and sedimentation. Increased sedimentation in waterways, for example, could alter natural sediment transport processes which can impair water and habitat quality and potentially affect aquatic plants and animals. Potential impacts to soils from erosion could occur in areas where the slopes are steep and where the erosion potential is moderate to severe as indicated by soil type. Areas exist in Guam that have steep slopes (i.e., greater than 20 percent) and where the erosion potential is moderate to severe, particularly in the Akina-Agfayan soil association, or Map Unit Identification Data (MUID[1]); the Akina-Togcha-Ylig MUID; and in the Ritidian-Rock Outcrop-Guam MUID (see Section 6.1.2, Soils).

According to Natural Resources Conservation Service data, prime farmland only exists within three soil types when irrigated on Guam: the Guam, Kagman, and Togcha soil types.[2] Therefore, the likelihood of the Proposed Action impacting these soils is minimal. FirstNet and/or their partners would work to avoid deployment/construction activities, as practicable or feasible, in areas with severe erosion potential and steep slopes (up to 99 percent). However, given that steep slopes are present throughout portions of Guam, some limited amount of infrastructure could be built or deployed in these areas, in which case BMPs and mitigation measures (see Chapter 11) could help avoid or minimize the potential impacts. In addition, it is anticipated that any soil erosion would likely be isolated within those locations and would be short-term with stability achieved after a few months or less.

Topsoil Mixing

The potential for the loss of topsoil (i.e., organic and mineral topsoil layers) by mixing would be present during construction of the proposed facilities/infrastructure and during trenching, grading, and/or foundation excavation activities. Although there are only three prime farmland soil types identified in Guam, topsoil mixing could result in the loss of soil productivity and fertility, as well as the loss of viable seeds and/or root mass present in surficial soil layers in prime farmland and in non-prime farmland areas. It is possible that minimal topsoil mixing as a result of construction could potentially be perceptible at some buildout locations if BMPs and mitigation measures are not followed (see Chapter 11). However, it is anticipated that topsoil mixing would likely be minimal and isolated within those locations.

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[1] As explained in Section 6.1.2, Soils, a landscape that has a distinctive proportional pattern of soil types make up a soil association or MUID, and normally consists of one or more major soil series. A map and descriptions of the MUIDs for Guam is included in Section 6.1.2.

[2] Within these soil types, prime farmland is found in some locations with 0 to 7 percent slopes. See Section 6.1.7, Land Use, Airspace, and Recreation, for additional information related to prime farmland.

Soil Compaction and Rutting

The movement of heavy equipment required to support any clearance, drilling, and construction activities, as well as installation of equipment or modification of structures needed to support network deployment, could potentially impact soil resources by causing the compaction and rutting of susceptible soils. Soils with the highest potential for compaction or rutting resulting from heavy equipment passage were identified by using the Soil Survey of Guam (see Section 6.1.2, Soils). Of the soil types identified on Guam, somewhat poorly drained and hydric soils (Inarajan, Inarajan Variant, Ylig, and Chacha soil types) have the highest potential for compaction and rutting. These soils are found on valley bottoms, coastal plains, or basins in wet areas. In general, wet soils tend to have a lower resistance to compaction and rutting than dry soils. It is anticipated that soil compaction and rutting as a result of deployment of the Proposed Action would likely not be perceptible over a widespread area since the Inarajan, Inarajan Variant, Ylig, and Chacha soil types (with high potential for compaction and rutting) are present in only 4 of the soil types present on Guam. In addition, compaction would not likely be widespread within those locations and deployment activities would likely be temporary.[3] Implementation of BMPs and mitigation measures would further decrease the potential for impacts.

6.2.2.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to soil resources and others would not. In addition, and as explained in this section, various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have no *impacts* to soil resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit

[3] Although deployable technologies could be in place for a period of several years, potential impacts are still expected to range from *no impact* (if placed on a previously paved surface) to *less than significant*. See below.

points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to soil resources because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to soil resources because there would be no ground disturbance.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact soil resources because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle is very unlikely to impact soil resources, it is anticipated that this activity would have *no impact* on soil resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to soil resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including soil erosion, topsoil mixing, and soil compaction and rutting. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to soil resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence[4], huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to soil resources. Soil disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of points of presence, huts, or other associated facilities or hand-holes to access fiber could result in soil erosion, topsoil mixing, soil compaction and rutting.
  - New Build – Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the installation of new poles could result in soil erosion and topsoil mixing. The use of heavy equipment during the installation of new poles and hanging of cables could result in soil compaction and rutting.

[4] Points of presence are connections or access points between two different networks, or different components of one network.

  - Collocation on Existing Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in soil compaction and rutting.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water would not impact soil resources because there would be no ground disturbance associated with this activity (see Section 6.2.4, Water Resources, for a discussion of potential impacts to water resources). However, impacts to soil resources could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Soil erosion and topsoil mixing could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Soil compaction and rutting could potentially occur due to heavy equipment use during these activities.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to soils. If installation of transmission equipment required grading or other ground disturbance to install small boxes, hunts, or access roads, there could potentially be impacts to soils. Such ground disturbance could result in soil erosion and topsoil mixing. Heavy equipment use could result in soil compaction and rutting.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to soil resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in soil erosion or topsoil mixing, and heavy equipment use during these activities could result in soil compaction and rutting.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to soils because there would be no ground disturbance associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact soil resources if this activity would not require ground disturbance. However, if structural hardening and physical security measures require ground disturbance, such as grading or excavation activities, impacts to soil resources could occur, including soul erosion and topsoil mixing, as well as soil compaction and rutting associated with heavy equipment use.

- Deployable Technologies
  - Where deployable technologies, both land-based and aerial, would be located on existing paved surfaces and the acceptable load on those paved surfaces is not exceeded, it is anticipated that there would be *no impacts* to soil resources because there would be no ground disturbance. However, implementation of deployable technologies could result in potential impacts to soil resources if deployment of land-based deployables occurs in unpaved areas, or if the implementation results in minor construction or paving of previously unpaved surfaces. In addition, potential impacts to soils could occur on paved surfaces if the acceptable load of the surface is exceeded. Some staging areas could require land/vegetation clearing, minor excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities could result in soil compaction and rutting. In addition, implementation of and activities associated with deployable technologies themselves could also result in soil compaction and rutting if deployed in unpaved areas.

In general, the abovementioned activities could potentially involve land/vegetation clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to soil resources associated with deployment of this infrastructure could include soil erosion, topsoil mixing, and/or soil compaction and rutting. These potential impacts are described further below, and BMPs and mitigation measures to help avoid or reduce these potential impacts are discussed in Chapter 11.

Potential Soil Erosion Impacts

Based on the analysis of the deployment activities described above to soil resources, potential impacts as a result of erosion are anticipated to be *less than significant*. See Chapter 11 for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential soil erosion impacts.

Potential Topsoil Mixing Impacts

Based on the analysis of proposed activities described above, the minimal mixing of the topsoil with the subsoil layers could result in potentially *less than significant* impacts. See Chapter 11 for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential soil erosion impacts.

Potential Soil Compaction and Rutting Impacts

Based on the analysis of the proposed activities described above to soil resources, potential impacts to soil resources as a result of soil compaction and rutting are anticipated to be *less than significant*. See Chapter 11 for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential soil erosion impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *no impacts* to soil resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, *less than significant* soil compaction and rutting impacts could potentially result as explained above.

6.2.2.5. Alternatives Impact Assessment

The following section assesses potential impacts to soils associated with the Deployable Technologies Alternative and the No Action alternative.[5]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts to soil resources as a result of implementation of this alternative are described below.

Potential Deployment Impacts

As explained above, implementation of land-based deployable technologies could result in *less than significant* impacts to soil resources if deployment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, potential impacts to soils could occur on paved surfaces if the acceptable load of the surface is exceeded. Some staging areas could require land/vegetation clearing, excavation, and paving. These activities could result in soil erosion and topsoil mixing. Heavy equipment use associated with these activities could result in soil compaction and rutting. In addition, implementation of and activities associated with deployable technologies themselves could also result in soil compaction and rutting if deployed in unpaved areas.

[5] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to soil resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, or if the acceptable load of the surface is exceeded, *less than significant* soil compaction and rutting impacts could potentially result as previously explained above. Finally, if deployable technologies are parked and operated with air conditioning for extended periods of time, the condensation water from the air conditioner could result in soil erosion as it runs onto the ground. However, it is anticipated that the soil erosion would not result in perceptible changes to baseline conditions.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to soil resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.2, Soils.

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6.2.3. Geology

6.2.3.1. Introduction

This section describes potential impacts to geologic resources in Guam associated with deployment and operation of the Proposed Action as well as the geologic hazards that could potentially affect the Proposed Action. Best management practices (BMPs) and mitigation measures that would help avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.3.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on geologic resources and the potential impacts to the Proposed Action from geologic hazards were evaluated using the significance criteria presented in Table 6.2.3-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to geologic resources addressed in this section are presented as a range of possible impacts.

Table 6.2.3-1: Impact Significance Rating Criteria for Geology

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Surface geology, bedrock, topography, physiography, and geomorphology impacts	Magnitude or Intensity	Substantial and measurable degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphological processes	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Minor degradation or alteration of surface geology, bedrock, topography that does not result in measurable changes in physiographic characteristics or geomorphological processes	No degradation or alteration of surface geology, bedrock, topography, physiographic characteristics, or geomorphologic processes
	Geographic Extent	State or territory		State or territory	NA
	Duration or Frequency	Permanent or long-term changes to characteristics and processes		Temporary degradation or alteration of resources that is limited to the construction and deployment phase	NA
Mineral and fossil fuel resource impacts	Magnitude or Intensity	Severe, widespread, observable impacts to mineral and/or fossil fuel resources	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Limited impacts to mineral and/or fossil resources	No perceptible change in mineral and/or fossil fuel resources
	Geographic Extent	Regions of mineral or fossil fuel extraction areas are highly prevalent within the state or territory.		Mineral or fossil fuel extraction areas occur within the state or territory, but may be avoidable.	Mineral or fossil fuel extraction areas do not occur within the state or territory.
	Duration or Frequency	Long-term or permanent degradation or depletion of mineral and fossil fuel resources		Temporary degradation or depletion of mineral and fossil fuel resources	NA
Paleontological resources impacts	Magnitude or Intensity	Severe, widespread, observable impacts to paleontological resources	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than*	Limited impacts to paleontological and/or fossil resources	No perceptible change in baseline conditions

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Geographic Extent	Areas with known paleontological resources are highly prevalent within the state or territory.		Areas with known paleontological resources occur within the state or territory, but may be avoidable.	Areas with known paleontological resources do not occur within the state or territory.
	Duration or Frequency	NA		NA	NA
Seismic hazards	Magnitude or Intensity	High likelihood that a project activity could be located within a high-risk earthquake hazard zone or active fault	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Low likelihood that a project activity could be located within an earthquake hazard zone or active fault	No likelihood of a project activity being located in an earthquake hazard zone or active fault
	Geographic Extent	Hazard zones or active faults are highly prevalent within the state or territory.		Earthquake hazard zones or active faults occur within the state or territory, but may be avoidable.	Earthquake hazard zones or active faults do not occur within the state or territory
	Duration or Frequency	NA		NA	NA
Volcanic activity	Magnitude or Intensity	High likelihood that a project activity could be located near a volcano lava or mud flow area of influence	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Low likelihood that a project activity could be located near a volcanic ash area of influence	No likelihood of a project activity located within a volcano hazard zone
	Geographic Extent	Volcano lava flow areas of influence are highly prevalent within the state or territory.		Volcano ash areas of influence occur within the state or territory, but may be avoidable.	Volcano hazard zones do not occur within the state or territory.
	Duration or Frequency	NA		NA	NA
Landslides	Magnitude or Intensity	High likelihood that a project activity could be located within a landslide area	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Low likelihood that a project activity could be located within a landslide area	No likelihood of a project activity located within a landslide hazard area
	Geographic Extent	Landslide areas are highly prevalent within the state or territory.		Landslide areas occur within the state or territory, but may be avoidable.	Landslide hazard areas do not occur within the state or territory.

Type of Effect	Effect Characteristic	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
	Duration or Frequency	NA		NA	NA
Land subsidence	Magnitude or Intensity	High likelihood that a project activity could be located within an area with a hazard for subsidence (e.g., karst terrain, lava tubes, etc.)	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Low likelihood that a project activity could be located within an area with a hazard for subsidence (e.g., karst terrain, lava tubes, etc.)	Project activity located outside an area with a hazard for subsidence (e.g., karst terrain, lava tubes, etc.)
	Geographic Extent	Areas with a high hazard for subsidence (e.g., karst terrain, lava tubes, etc.) are highly prevalent within the state or territory.		Areas with a high hazard for subsidence (e.g., karst terrain, lava tubes, etc.) occur within the state or territory, but may be avoidable.	Areas with a high hazard for subsidence (e.g., karst terrain, lava tubes, etc.) do not occur within the state or territory.
	Duration or Frequency	NA		NA	NA

NA = not applicable

6.2.3.3. Description of Environmental Concerns

Terms and concepts discussed in this section are further discussed and defined in the Affected Environment section (Section 6.1.3, Geology).

Potential Effects from the Proposed Action

Potential Surface Geology, Bedrock, Topography, Physiography, and Geomorphology Impacts

The potential for impacts to surface geology, bedrock, topography, physiography, and geomorphology could be present during deployment or construction of the proposed facilities/infrastructure, particularly during trenching, grading, and/or foundation excavation activities. For example, as discussed in and shown graphically in Section 6.1.2, Soils, there are numerous areas in Guam where shallow soils are present and bedrock is likely at or near the surface including, but not limited to, the Agfyan and Pulantat soils in the southern portion of the territory, as well as the Guam soils in the northern portion. Such shallow bedrock could be susceptible to potential impacts from rock ripping.[1] However, rock ripping would likely only occur in discrete locations where necessary and would not result in large-scale changes to Guam's geologic, topographic, or physiographic characteristics. In addition, to the extent practicable or feasible FirstNet and/or their partners would work to avoid areas that commonly undergo significant geomorphological changes, such as active stream and river channels. Temporary degradation or alteration of surface geology, bedrock, topography, physiography, and geomorphology would primarily be limited to the construction/deployment phases and would be limited and localized in extent. Therefore, it is anticipated that potential impacts to surface geology, bedrock, topography, physiography, and geomorphology as a result of the anticipated project activities would be minor and would not result in measureable changes. Implementation of BMPs and mitigation measures would help further reduce potential impacts.[2]

Potential Mineral and Fossil Fuel Resource Impacts

In general, potential impacts to mineral and fossil fuel resources as a result of the Proposed Action would be more likely in states or territories with numerous extraction areas. However, Guam does not produce natural gas, coal, or petroleum, and has limited mineral resources (*USGS 2015; EIA 2014).*[3] Because of this, no impacts to fossil fuel resources could occur as a result of the Proposed Action. Any potential impacts would only be to mineral resources and are likely to be minor and temporary, and further reduced with implementation of BMPs and mitigation measures, as discussed in Chapter 11, BMPs and Mitigation Measures.

[1] Rock ripping refers to the breakup and removal of rock material with heavy equipment such as an excavator.
[2] See Chapter 11 for a discussion of specific required BMPs and mitigation measures.
[3] See Section 6.1.3, Geology, for a discussion of mineral and fossil fuel resources.

Paleontological Resources[4] Impacts

The potential for impacts to paleontological resources could be present during deployment or construction of the proposed facilities/infrastructure, particularly during trenching, grading, and/or foundation excavation activities. As discussed in detail in Section 6.1.3, Geology, few paleontological studies of Guam have been widely circulated, but fossils do exist in various limestone formations including fossilized algae, corals, and mollusks. It is anticipated that impacts to specific areas with significant paleontological resources would be avoided, minimized, or mitigated, and any potential impacts would likely be limited and localized. Implementation of the BMPs and mitigation measures as discussed in Chapter 11, BMPs and Mitigation Measures, would help further reduce impacts.

Potential Effects to the Proposed Action

Seismic Hazards

As discussed in Section 6.1.3, Geology, Guam is located near the Pacific Plate - Philippine Sea Plate boundary, and the movement and friction along the plate boundary is primarily responsible for frequent earthquake activity in the territory. According to the U.S. Geological Survey, the entire island of Guam has a high seismic hazard risk (*Mueller et al. 2012*). The Proposed Action is unlikely to affect seismic activity, but rather seismic hazards could have the potential to impact the Proposed Action. As discussed in Chapter 1, Introduction, the FirstNet network would be "hardened" from the physical layer, user access, and cyber security perspectives to be more resilient to potential impacts than typical telecommunications infrastructure. However, some potential impacts to the Proposed Action infrastructure could occur during significant earthquake events, and it is recommended that FirstNet and/or its partners attempt, as feasible or practicable, to design the network to reasonably withstand the seismic activity typical in Guam, thereby limiting potential impacts. In addition, implementation of the BMPs and mitigation measures as discussed in Chapter 11, BMPs and Mitigation Measures, would help further reduce potential impacts.

Volcanic Activity

As discussed in Section 6.1.3, Geology, there are no active volcanoes in Guam. Therefore, based on the significance criteria presented in Table 6.2.3-1, there would be *no impacts* to the Proposed Action as a result of volcanic activity.

Landslides

In general, the Proposed Action is unlikely to affect landslide activity, but rather landslides in Guam have the potential to impact the Proposed Action. As discussed in Section 6.1.3, Geology, excessive rainfall and seismic activity can trigger local landslides, especially near areas with steep slopes and loose or unconsolidated material. As discussed in Section 6.1.2, Soils, slopes in Guam range from 0 to 99 percent, with steepest areas located in the Akina and Agfayan soils

[4] Paleontological resources, or fossils, are the physical remains of plants and animals that have mineralized into or left impressions in solid rock or sediment.

areas located in southern Guam and Ritidian soils areas located primarily in the coastal areas in northern Guam.[5]

To the extent practicable or feasible, FirstNet and/or their partners would work to avoid developing and deploying telecommunications infrastructure in areas that are highly susceptible to landslides. Although some localized, limited impacts could occur as a result of landslides, widespread impacts are unlikely. Implementation of the BMPs and mitigation measures as discussed in Chapter 11, BMPs and Mitigation Measures, would help further reduce potential impacts.

Land Subsidence

As discussed in Section 6.1.3, Geology, the northern portion of Guam possesses karst terrain and has numerous sinkholes. To the extent practicable or feasible, FirstNet and/or their partners would work to avoid areas with a high hazard for subsidence during deployment and operation of the Proposed Action. Implementation of the BMPs and mitigation measures discussed in Chapter 11 would help avoid or further minimize potential impacts to the Proposed Action as a result of land subsidence.

6.2.3.4. Potential Impacts of and to the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities as well as potential geologic hazards to the Preferred Alternative.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to geologic resources and others would not. In addition, and as explained in this section, various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions. Additionally, geologic hazards such as earthquakes, landslides, and land subsidence that have the potential to impact the deployment of the Preferred Alternative are discussed below.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to geologic resources under the conditions described below:

[5] See Section 6.1.2, Soils, for descriptions and locations of these soil types.

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to geologic resources because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to geologic resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact geologic resources, it is anticipated that this activity would have *no impact* to geologic resources.

Activities and Geologic Hazards with the Potential to Have Impacts

Potential deployment-related impacts to geologic resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities including potential impacts to surface geology, bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. In addition, geologic hazards including seismic activity, landslides, and land subsidence have the potential to impact deployment of the Preferred Alternative. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to geologic resources, or potential impacts from geologic hazards, include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence[6], huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to geologic resources. Ground disturbance and heavy equipment use associated with plowing, trenching, directional boring, excavation activities, rock ripping, and landscape grading associated with construction of points of presence, huts, or other associated facilities or hand-holes to access fiber could result in limited potential impacts to bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. Depending on its location, this development scenario could also

[6] Points of presence are connections or access points between two different networks, or different components of one network.

be potentially impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.

- New Build – Aerial Fiber Optic Plant: Depending on its location and deployment methods used, excavation and excavated material placement, trenching, grading, and rock ripping during the installation of new poles or construction of points of presence, huts, or other facilities could result in limited and localized potential impacts to bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. This development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence, if it occurs in areas of high susceptibility.
- Collocation on Existing Aerial Fiber Optic Plant: Depending on its location, excavation, grading, and rock ripping during the replacement of poles and structural hardening could result in localized potential impacts to bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. This development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence, depending on deployment location and its susceptibility to those hazards.
- New Build – Submarine Fiber Optic Plant: The installation of cables in near-shore or inland bodies of water would not impact geologic resources. However, potential impacts to geologic resources could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Grading, foundation excavation, rock ripping, or other ground disturbance activities could result in limited potential impacts to bedrock, topography, physiography, and geomorphology; potential mineral impacts; and potential paleontological impacts. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to geologic resources. If installation of transmission equipment required grading, foundation excavation or other ground disturbance activities including rock ripping to install small boxes, hunts, or access roads, there could potentially be temporary impacts to geologic resources. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to geologic resources. Excavation activities, landscape grading, rock

ripping, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in potential localized impacts to bedrock, topography, physiography, and geomorphology; potential mineral and fossil fuel impacts; and potential paleontological impacts. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.

  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to geologic resources because there would be no ground disturbance associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact geologic resources if this activity would not require ground disturbance. However, if structural hardening required ground disturbance, such as grading, excavation activities, or rock ripping, potential impacts to geological resources could occur. Deployment of this development scenario could also potentially be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility.

- Deployable Technologies
  - Where deployable technologies (both land-based and aerial) would be located or deployed on existing paved surfaces, it is anticipated that there would be no impacts to geologic resources because there would be no new ground disturbance. However, implementation of deployable technologies could result in potential impacts to geologic resources. These potential impacts could occur if deployment of land-based or aerial deployables occurs in unpaved areas, or if the implementation results in minor construction, paving of previously unpaved surfaces, grading, excavation, or rock ripping (e.g., for staging or launching/landing areas).
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact geologic resources because those activities would not require ground disturbance nor any impact to the built or natural environment. However, where equipment is permanently installed in locations that are susceptible to specific geologic hazards, such as earthquakes, it is possible that they could be affected by that hazard.

In general, the abovementioned activities could potentially involve excavation, rock ripping, trenching or directional boring, and landscape grading. Potential impacts to geologic resources associated with deployment of this infrastructure could include localized and/or limited impacts to bedrock, topography, physiography, and geomorphology; mineral; and paleontological resources. Additionally, deployment of the abovementioned scenarios could be impacted by geologic hazards including seismic activity, landslides, and/or land subsidence if it occurs in areas of high susceptibility. These potential impacts are described further below. BMPs and mitigation measures to help avoid or reduce these potential impacts are discussed in Chapter 11, BMPs and Mitigation Measures.

Potential Impacts from the Preferred Alternative

Potential Surface Geology, Bedrock, Topography, Physiography, and Geomorphology Impacts

Based on the analysis of the deployment activities described above to bedrock, topography, physiography, and geomorphology, potential impacts are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential impacts to these resources.

Potential Mineral and Fossil Fuel Resource Impacts

Based on the analysis of proposed activities described above to geologic resources, potential mineral and fossil fuel resource impacts could result in potentially *less than significant* impacts; however, there would be no impacts to fossil fuel resources since Guam does not produce or have any proven recoverable reserves of petroleum, natural gas, or coal. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential impacts to mineral resources.

Potential Paleontological Resources Impacts

Based on the analysis of the proposed activities described above to geological resources, potential paleontological resources impacts are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential impacts to paleontological resources.

Potential Impacts to the Preferred Alternative

Potential Seismic Hazard Impacts

Based on the analysis of the proposed activities described above, impacts to the deployment of the Preferred Alternative as a result of seismic hazards are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with seismic hazards.

Potential Volcanic Activity Impacts

Based on the analysis of the proposed activities described above, potential impacts to the deployment of the Preferred Alternative as a result of volcanic activity are anticipated to have *no impacts*.

Potential Landslide Impacts

Based on the analysis of the proposed activities described above, potential impacts to the deployment of the Preferred Alternative as a result of landslides are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with landslide hazards.

Potential Land Subsidence Impacts

Based on the analysis of the proposed activities described above, potential impacts to the deployment of the Preferred Alternative as a result of land subsidence are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with land subsidence.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *no impacts* to geologic resources associated with routine inspections of the Preferred Alternative.

The operation of the Preferred Alternative could be affected by to geologic hazards including seismic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be *less than significant*, and even further reduced if BMPs and mitigation measures discussed in Chapter 11, BMPs and Mitigation Measures are implemented.

6.2.3.5. Alternatives Impact Assessment

The following section assesses potential impacts to geologic resources associated with the Deployable Technologies Alternative and the No Action alternative.[7]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater

[7] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts to geologic resources as a result of implementation of this alternative are described below.

Potential Deployment Impacts

As explained above, if deployment occurs on unpaved areas and/or if implementation results in paving of unpaved surfaces or if grading, excavation, or rock ripping is required for staging or launching/landing areas, implementation of deployable technologies (i.e., System on Wheels, Cell on Wheels, Cell on Light Truck, Unmanned Aerial Vehicle) would likely result in *less than significant* impacts to geologic resources. It is anticipated that the same BMPs and mitigation measures discussed for the Preferred Alternative would apply to the Deployable Technologies Alternative, to the extent practicable or feasible.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to geologic resources associated with routine inspections of the Deployable Technologies.

As with the Preferred Alternative, the operation of the Deployable Technologies Alternative could be affected due to geologic hazards including seismic activity, landslides, and land subsidence. However, potential impacts would be anticipated to be *less than significant*, especially given the BMPs and mitigation measures discussed in Chapter 11, BMPs and Mitigation Measures. It is anticipated that the same BMPs and mitigation measures discussed for the Preferred Alternative would apply to the Deployable Technologies Alternative, to the extent practicable or feasible.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to geologic resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.3, Geology.

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6.2.4. Water Resources

6.2.4.1. Introduction

This section describes potential impacts to water resources in Guam associated with deployment and operation of the Proposed Action and alternatives. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.4.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on water resources were evaluated using the significance criteria presented in Table 6.2.4-1. As described in Section 6.2, Environmental Consequences, the categories of potential impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to water resources addressed in this section are presented as a range of possible impacts.

Table 6.2.4-1: Impact Significance Rating Criteria for Water Resources

Type of Effect	**Effect Characteristics**	**Impact Level**			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Water Quality (groundwater and surface water) - sedimentation, pollutants, water temperature	Magnitude or Intensity	Groundwater contamination creating a drinking quality violation, or otherwise substantially degrade groundwater quality or aquifer; local construction sediment water quality violation, or otherwise substantially degrade water quality; water degradation poses a threat to the human environment, biodiversity, or ecological integrity. Violation of various regulations including: Clean Water Act, Safe Drinking Water Act	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Potential impacts to water quality, but potential effects to water quality would be below regulatory limits and would naturally balance back to baseline conditions	No changes to water quality, sedimentation, water temperature, or the presence of water pollutants
	Geographic Extent/Context	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level[a]	NA
	Duration or Frequency	Chronic and long term changes not likely to be reversed over several years or seasons		The impact is temporary, lasting no more than 6 months.	NA

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Floodplain degradation	Magnitude or Intensity	The use of floodplain fill, substantial increases in impervious surfaces, or placement of structures within a 500-year flood area that will impede or redirect flood flows or impact floodplain hydrology. High likelihood of encountering a 500-year floodplain within a state or territory.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Activities occur inside the 500-year floodplain, but do not use fill, do not substantially increase impervious surfaces or place structures that would impede or redirect flood flows or impact floodplain hydrology, and do not occur during flood events. There is a low likelihood of encountering a 500-year floodplain within a state or territory.	Activities occur outside of floodplains and therefore do not increase fill or impervious surfaces, nor do they impact flood flows or hydrology within a floodplain.
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Chronic and long-term changes not likely to be reversed over several years or seasons.		The impact is temporary, lasting no more than 1 season or water year, or occurring only during an emergency.	NA
Drainage pattern alteration	Magnitude or Intensity	Alteration of the course of a stream of a river, including stream geomorphological conditions, or a substantial and measurable increase in the rate or amount of surface water or changes to the hydrologic regime	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Any alterations to the drainage pattern are minor and mimic natural processes or variations.	Activities do not impact drainage patterns
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA

Type of Effect	**Effect Characteristics**	**Impact Level**			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent.		The impact is temporary, lasting no more than 6 months.	NA
Flow alteration	Magnitude or Intensity	Consumptive use of surface water flows or diversion of surface water flows such that there is a measurable reduction in discharge	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Minor or no consumptive use with negligible impact on discharge	Activities do not impact discharge or stage of waterbody.
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Impact occurs in perennial streams, and is ongoing and permanent.		Impact is temporary, not lasting more than 6 months.	NA
Changes in groundwater or aquifer characteristics	Magnitude or Intensity	Substantial and measurable changes in groundwater or aquifer characteristics, including volume, timing, duration, and frequency of groundwater flow, and other changes to the groundwater hydrologic regime.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Any potential impacts to groundwater or aquifers are temporary, lasting no more than a few days, with no residual impacts.	Activities do not impact groundwater or aquifers
	Geographic Extent	Watershed level, and/or within multiple watersheds		Watershed or subwatershed level	NA
	Duration or Frequency	Impact is ongoing and permanent.		Potential impact is temporary, not lasting more than 6 months.	NA

Note: Because public safety infrastructure is considered a critical facility, Proposed Action activities should avoid the 500-year floodplain wherever practicable per the Executive Orders on Floodplain Management (*Executive Orders 11988 and 13690*).
NA = not applicable
[a] Definitions of U.S. Geological Survey (USGS) watershed and subwatershed: USGS watershed refers to the USGS 10 digit hydrologic unit code (HUC10), which averages approximately 230 square miles, depending on the region. USGS subwatershed refers to the USGS 12 digit hydrologic unit code (HUC12), which averages approximately 40 square miles, depending on the region. See *USGS and NRCS 2013* for an explanation of HUC codes.

6.2.4.3. Description of Environmental Concerns

Water Quality – Potential Impacts Associated with Sedimentation, Pollutants, or Water Temperature

One of the primary environmental concerns during deployment activities is minimizing potential impacts to water quality. Potential impacts to water quality could result from sedimentation or pollutants due to ground disturbance, disruption of streamside soils or vegetation, or spills of fluids from motorized equipment. Potential impacts to water quality due to deployment activities would be influenced by the timing of deployment, weather conditions, local topography, and the erosion and infiltration potential of soils.

Potential sedimentation impacts to streams or lakes, the near-shore ocean floor, or floodplains could be caused by ground disturbing activities such as trenching, pole installation, or road work. As streams occur only in southern Guam (see the Inland Surface Water Characteristics subsection of Section 6.1.4.3, Environmental Setting), potential impacts to water resources in northern Guam apply only to marine bodies and groundwater.

Increased sedimentation in waterways could impair water and habitat quality and potentially affect aquatic plants and animals. Turbidity is the parameter for which surface water quality standards are most often not met in Guam (*USEPA 2014*). Potential impacts to water quality from erosion and sedimentation are most likely in areas where:

- Ground disturbance occurs in or near waterbodies or floodplains;
- Riparian vegetation is cleared or disturbed; and/or
- Steep slopes with moderate to severe erosion potential are disturbed (see Section 6.1.2, Soils, and Section 6.1.3, Geology).

Other potential sources of sedimentation impacts include vehicle travel on dirt or gravel roads, or off-road construction activity in southern Guam and outside of the dry season. BMPs and mitigation measures would be implemented during deployment to adjust to local conditions and minimize soil erosion and storm water runoff.

During the dry season, the amount of sediment introduced to streams during vehicular travel, ground disturbance, or road work would be similar to natural erosion processes because there would be little or no flowing water on road surfaces or across disturbed areas.

Potential inputs of pollutants could occur if chemicals or petroleum products are spilled from equipment due to malfunction or refueling errors. Accidental spills of chemicals or petroleum products from motorized equipment during deployment could expose surface water resources to hazardous materials. Spills could also infiltrate the groundwater aquifer in areas with porous geology if the spills are not contained. Northern Guam's porous limestone geology is vulnerable to infiltration of spills into groundwater. Southern Guam's less-permeable volcanic geology would generally be anticipated to prevent spills from reaching groundwater. Any spills from vehicles or machinery used during deployment tend to be associated with refueling activities, and as such, would likely be a few gallons or less in volume and could easily be contained and cleaned.

Most wood poles used for utility or telephone lines are treated with a preservative called pentachlorophenol (PCP) to lessen wood rot and extend the life of the poles. Once constructed, new treated poles could potentially impact surface water (or groundwater) by leaching PCP. Because of the demonstrated tendency for PCP to adsorb to soils, the moderately rapid degradation of the compound in the environment, and the localized nature of the compound, it is unlikely that surface water (or groundwater) contamination would result from installation of the new wood poles. In addition, concentrations of PCP released during placement or replacement of poles are not expected to exceed United States (U.S.) Environmental Protection Agency levels of concern for human health.

Water temperature could potentially be impacted by reduced stream shading in any areas where riparian vegetation is cleared.

To the extent practicable or feasible, FirstNet and/or their partners would work to avoid stream crossings. Given that streams do not occur in northern Guam, and many streams on southern Guam are dry for a portion of the year, it could be possible to limit required stream crossings to times when streams are dry or have minimal flow. When crossing streams that are flowing is required, potential impacts could be reduced by scheduling stream crossings for times of the year when stream flow is lowest. Further, to the extent practicable or feasible, limiting deployment in areas with severe erosion potential due to sensitivity and constructability limitations associated with steep slopes (up to 90 percent) could also reduce potential water quality impacts (see Section 6.2.2, Soils, and Section 6.2.3, Geology). However, because steep slopes are present throughout much of Guam, some limited amount of infrastructure could be built in these areas, in which case BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help avoid or minimize the potential impacts. If appropriate BMPs and mitigation measures are implemented, soil erosion could likely be isolated within those locations and could be short-term with stability achieved after a few months or less.

Sedimentation, whether due to storm water runoff or other deployment activity, could likely return to current levels once deployment is complete and if vegetation is re-established in disturbed areas. Additionally, creation of turbidity from installation of submarine infrastructure deployed in near-shore or inland bodies of water would be temporary and would likely return to background levels after deployment activities subside.

Floodplain Degradation

Floodplains can be degraded by construction of additional impervious surfaces or reduced ability to store floodwaters due to floodplain fill. Additionally, construction of structures in floodplains that cannot withstand flooding can cause residual effects for downstream areas where flood debris is transported. Soil compaction and removal of vegetation in the floodplain could contribute to erosion within the floodplain, lessen dissipation of water energy during floods, and impede floodplain permeability. In areas that are not permanently disturbed, these potential impacts could be reduced if these areas are restored by establishing new vegetation.

Potential impacts to floodplains apply to southern Guam, where intense flooding occurs due to climate and geology; floodplains, and likewise the risk of potential impacts to floodplains, are very limited in northern Guam (see the Floodplain Characteristics subsection of Section 6.1.4.3, Environmental Setting).

To the extent practicable or feasible, FirstNet and/or their partners would work to avoid deployment activities in floodplains, particularly in the floodway. The employment of BMPs and mitigation measures as described below could also help avoid or minimize potential impacts in floodplain areas.

Drainage Pattern Alteration

Drainage patterns could be altered if Proposed Action activities involved alteration of a stream or a river course. This could be due to changes in stream geomorphological conditions, and/or a substantial or measureable increase in the amount of surface water or changes to the hydrologic regime of a surface waterbody. If in-stream construction activities such as trenching or road building were to involve rerouting of surface waters, this could result in drainage pattern alterations. Where surface disturbance associated with trenching and road building could be conducted when streams do not have flow, potential impacts are not anticipated to occur and surface waters would not need to be re-routed. When construction activities would cross perennial streams or during times that intermittent streams have flow, potential impacts to drainage patterns would be temporary and streams would be returned to their natural course after construction is complete.

Flow Alteration

Stream flow could be altered if Proposed Action activities involved withdrawal of surface water or diversion of surface water flows such that there is a measurable reduction in stream discharge. Withdrawal of surface water (for water trucks used in dust suppression for air quality mitigation) would be unlikely to result in a significant quantity of water being withdrawn, and therefore would not be likely to impact to stream flow patterns.

Changes in Groundwater or Aquifer Characteristics

Groundwater or aquifer characteristics could potentially be impacted if Proposed Action activities involved contamination of groundwater with petroleum, lubricants, or other fluids from heavy equipment. As discussed above, any concentrations of PCP released to groundwater during placement or replacement of poles are not expected to exceed U.S. Environmental Protection Agency levels of concern for human health, and are likewise not anticipated to impact wildlife. Trenching for installation of Proposed Action features and pole placement could be deep enough to interact with shallow groundwater, but would not impact groundwater quality or aquifer characteristics, and any accidental spills of chemicals would likely be contained before they would reach groundwater; therefore, impacts to groundwater are not anticipated.

6.2.4.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to water resources and others would not. In addition, and as explained in this section, the various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to water resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to water resources because the activities that would be conducted at these small entry and exit points are likely to be located in areas away from waterbodies, and are not likely to produce perceptible surface disturbances.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts to water resources because there would be no ground disturbance.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to water resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including in-stream construction work, resulting primarily in sediments entering streams, but also potentially to near-shore or inland waters, as well as the potential for other impacts to water quality and floodplains. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to water resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence (POPs)[1], huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to water resources. Ground disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of POPs, huts, or other associated facilities or hand-holes to access fiber could result in stream sedimentation, construction of impervious surfaces and structures in floodplains, stream channel alteration, and accidental spills of fuels or lubricants to waterbodies. New Build – Buried Fiber Optic Plant projects could present a higher risk to water resources because of their relatively high degree of soil disturbance compared to the other types of projects.
  - New Build – Aerial Fiber Optic Plant: Soil exposure from installation of new poles or construction of new roads, POPs, huts, or other facilities near waterbodies could result in ground disturbance, resulting in sediment deposition and increased turbidity in nearby waterbodies. The use of heavy equipment during the installation of new poles and cables could result in potential soil disturbance and the resulting potential sedimentation impacts to streams, disturbance of riparian vegetation, leaching of PCPs, and accidental spills of fuels or lubricants to waterbodies.
  - Collocation on Existing Aerial Fiber Optic Plant: Lighting up of dark fiber would have *no impacts* to water resources. If required, and if done in existing huts or on existing poles with no ground disturbance, installation of new associated equipment would have *no impacts* to water resources. Ground disturbance during the replacement of poles and structural hardening could result in potential soil erosion and sedimentation impacts to streams, particularly where this work would be done in proximity to waterbodies. Collocation on Existing Aerial Fiber Optic Plant projects could present a lower risk to water resources because of their relatively low degree of soil disturbance compared to the other types of projects.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in near-shore and inland bodies of water would potentially impact water quality due to disruption of sediments on the floor of the waterbody. Impacts to water resources could also potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Sediments entering limited near-shore or inland waterbodies could potentially occur as result of grading, foundation excavation, or other ground disturbance activities. Construction of facilities in floodplains could potentially impact floodplain functionality and drainage patterns.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to water resources. If installation of

[1] POPs are connections or access points between two different networks, or different components of one network.

transmission equipment required grading or other ground disturbance to install small boxes, huts, or access roads, there could potentially be impacts to water resources. The extent of these potential impacts would depend upon the proximity of the disturbance to waterbodies and floodplains.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to water resources. Ground disturbance and vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads completed in or near streams could result in sediments entering streams and physical disturbance of streams if crossings are required. Additionally, use of heavy equipment around streams could result in the accidental spill of fuel or other liquids from equipment that could potentially impact water quality. New Wireless Communication Tower projects could present a higher risk to water resources than some of the lower risk wired projects because of their relatively high degree of soil disturbance compared to the other projects.
  - Co-location on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to water resources because there would be no ground disturbance or in-water construction associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact water resources if this activity would not require ground disturbance or in-water construction. However, if the on-site delivery of additional power units, structural hardening, and physical security measures required travel through streams or ground disturbance, such as grading or excavation activities near streams, potential impacts to water resources could occur, including stream sedimentation and physical disturbance associated with heavy equipment use.
- Deployable Technologies
  - Where deployable technologies would be implemented on existing paved surfaces, away from streams, and outside of floodplains, it is anticipated that there would be *no impacts* to water resources because there would be no ground disturbance use of motorized equipment near streams. However, implementation of deployable technologies could result in potential impacts to water resources. These potential impacts could occur if deployment involves movement of equipment through streams, involves riparian or floodplain areas, or if the implementation results in minor construction, paving of previously unpaved surfaces in floodplains, or fuels leaking into surface or groundwater. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, minor excavation, and paving. These activities could result in erosion and sedimentation into streams. Heavy equipment use associated with these

activities could result in stream sedimentation and physical disturbance of waterbodies if the equipment is used in or near streams. In addition, implementation of deployable technologies themselves could result in ground disturbance and related sediment input to waterbodies deployed in unpaved areas near streams.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact water resources because those activities would not require ground disturbance, construction in floodplains, or use of motorized equipment near streams.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide, public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact water resources, it is anticipated that this activity would have *no impact* to those resources.

In general, the abovementioned activities could potentially involve land/vegetation clearing, ground disturbance, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to water resources associated with deployment of this infrastructure could include soil erosion and the resulting sediments entering waterbodies; construction of structures and impervious surfaces near waterbodies and in floodplains; in-water construction related to trenching, road building, and construction of marine infrastructure; and spills of fuels, lubricants, or other materials from construction and maintenance equipment to waterbodies. These potential impacts and associated BMPs and mitigation measures to help mitigate or reduce these impacts are described further in Chapter 11.

Potential Water Quality Impacts

Based on the analysis of the deployment activities described above to water resources, potential impacts to water quality are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts to water resources.

Potential Floodplain Degradation Impacts

Based on the analysis of proposed activities described above, the development of Proposed Action facilities in floodplains could result in potentially *less than significant* impacts (see Table 6.2.4-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts to water resources.

Potential Drainage Pattern Alteration Impacts, BMPs, and Mitigation Measures

Based on the analysis of the proposed activities described above to water resources, impacts to water resources as a result of drainage pattern alteration are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts to water resources.

Potential Flow Alteration Impacts

Based on the analysis of the proposed activities described above, *no impacts* to water resources as a result of drainage pattern alteration would occur as a result of the Proposed Action because activities would not impact the discharge or stage of waterbodies.

Potential Groundwater or Aquifer Impacts

Based on the analysis of the proposed activities described above, potential impacts to water resources as a result of groundwater or aquifer impacts are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts to water resources.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned construction impacts. It is anticipated that there would be *no impacts* to water resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections, and assuming that all refueling and vehicle maintenance BMPs and mitigation measures are followed. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and near waterbodies, the resulting ground disturbance could increase sedimentation in waterbodies, potentially impacting water quality. It is assumed that routine maintenance would not include operation of vehicles or equipment in waterbodies.

6.2.4.5. Alternatives Impact Assessment

The following section assesses potential impacts to water resources associated with the Deployable Technologies Alternative and the No Action alternative.[2]

[2] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to water resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts to water resources if deployment of ground-based equipment occurs in unpaved areas, or if the implementation results in paving of previously unpaved surfaces. In addition, potential impacts to water resources could occur if equipment maintenance and refueling standards are not followed, resulting in spills of petroleum products or other chemicals to surface waters. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, minor excavation, and paving. These activities could result in soil erosion and related sediments entering to streams, drainage pattern alteration through the creation of cleared or impervious surfaces, and/or floodplain degradation if these activities occur in floodplains. Deployment and heavy equipment use associated with these activities could result in ground disturbance and sedimentation.

Potential Operation Impacts

As explained above, operation activities would consist of implementation and running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to water resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and near waterbodies, the resulting ground disturbance could increase sedimentation in waterbodies, potentially impacting water quality. It is assumed that routine maintenance would not include operation of vehicles or equipment in waterbodies. Site maintenance, including mowing or herbicides, may result in *less than significant* effects to water quality, depending on the location and amount of herbicides used. In addition, the presence of new access roads could increase the overall amount of impervious surface in the area, and increase runoff effects on water resources, as explained above. Finally, if ground-based deployable technologies are parked and operated with air conditioning for extended periods of time, the condensation water from the air conditioner could result in soil erosion that could potentially impact waterbodies if the deployables are located adjacent to waterbodies. It is anticipated that operation impacts on water quality would be *less than significant* due to the small scale of expected FirstNet activities in any one location.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to water resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.4, Water Resources.

6.2.5. Wetlands

6.2.5.1. Introduction

This section describes potential impacts to wetland resources in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.5.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on wetland resources were evaluated using the significance criteria presented in Table 6.2.5-1. As described in Section 6.2, Environmental Consequences, the categories of potential impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each potential impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

As discussed in Section 6.1.5, Wetlands, wetlands are recognized as important for maintenance of watershed and environmental health due to their potential to perform various ecological, hydrologic, biogeochemical, and social functions, although not all wetlands perform these functions equally. Typical wetland functions in Guam include shoreline and stream bank stabilization, flood mitigation, maintenance of water quality, maintenance of fish and wildlife habitat, sediment retention, groundwater discharge and recharge, and maintenance of nutrient retention and export. Their capacity or degree to which they perform individual functions depends on the wetland characteristics including soil type, substrate, type and percent cover of vegetation, water source, landscape position, location within a watershed, and location relative to populated areas (*USGS 1997*).

As part of mitigation planning (to avoid, minimize, and/or compensate for unavoidable impacts to wetlands) associated with Clean Water Act (CWA) Section 404 permitting, a wetland functional assessment is typically used to categorize wetlands into one of three categories, as defined by United States Army Corps of Engineers (USACE) (*USACE 2014*). Category 1 wetlands are the highest quality or functioning wetlands (or rare/unique); Category 2 wetlands are moderate to high functioning (or rare/unique); and Category 3 wetlands are lesser quality or lower functioning (or less rare/unique). Although these categories are useful for determining the significance of project-specific impacts to wetlands, given the programmatic nature of this environmental analysis, the magnitude of potential wetland impacts are discussed more broadly as part of the significance criteria presented in Table 6.2.5-1.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to wetland resources addressed in this section are presented as a range of possible impacts.

Table 6.2.5-1: Impact Significance Rating Criteria for Wetlands

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Direct wetland loss (fill or conversion to non-wetland)	Magnitude[a] or Intensity	Substantial loss of high-quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.); Violations of Section 404 of the Clean Water Act	Effect that is *potentially significant*, but with mitigation is *less than significant*	Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity)	No direct loss of wetlands
	Geographic Extent	USGS watershed level (e.g., HUC10),[d] and/or within multiple watersheds		USGS watershed (HUC10)[d] or subwatershed (HUC12)[d] level	NA
	Duration or Frequency	Long-term or permanent loss, degradation, or conversion to non-wetland		Periodic and/or temporary loss reversed over one to two growing seasons with or without active restoration	NA

Type of Effect	Effect Characteristics	Impact Level: Potentially Significant	Less than significant with BMPs and Mitigation Measures Incorporated	Less than Significant	No Impact
Other direct effects: vegetation clearing; ground disturbance; direct hydrologic changes (flooding or draining); direct soil changes; water quality degradation (spills or sedimentation)	Magnitude or Intensity	Substantial and measurable changes to hydrological regime of high-quality wetlands impacting salinity, pollutants, nutrients, biodiversity (diversity of species present), ecological condition, or water quality; Introduction and establishment of invasive plant or animal species to high-quality wetlands	Effect that is *potentially significant*, but with mitigation is *less than significant*	Impacts to lower quality wetlands affecting the hydrological regime including salinity, pollutants, nutrients, biodiversity (diversity of species present), ecological condition, or water quality; Introduction and establishment of invasive plant or animal species to high-quality wetlands	No direct impacts to wetlands affecting vegetation, hydrology, soils, or water quality
	Geographic Extent	USGS watershed level (e.g., HUC10),[d] and/or within multiple watersheds		USGS watershed (HUC10)[d] or subwatershed (HUC12)[d] level	NA
	Duration or Frequency	Long-term or permanent alteration that is not restored within two growing seasons, or ever		Periodic and/or temporary loss reversed over one to two growing seasons with or without active restoration	NA

<table>
<tr><th rowspan="2">Type of Effect</th><th rowspan="2">Effect Characteristics</th><th colspan="4">Impact Level</th></tr>
<tr><th>Potentially Significant</th><th>Less than significant with BMPs and Mitigation Measures Incorporated</th><th>Less than Significant</th><th>No Impact</th></tr>
<tr><td rowspan="3">Indirect effects:[b] change in function(s);[c] change in wetland type</td><td>Magnitude or Intensity</td><td>Changes to the functions or type of high-quality wetlands (e.g., those that provide critical habitat for sensitive or listed species, are rare or a high-quality example of a wetland type, are not fragmented, support a wide variety of species, etc.)</td><td rowspan="3">Effect that is potentially significant, but with mitigation is less than significant</td><td>Impacts to lower quality wetlands (e.g., not rare or unique, that have low productivity and species diversity, and those that are already impaired or impacted by human activity)</td><td>No changes in wetland function or type</td></tr>
<tr><td>Geographic Extent</td><td>USGS watershed level (e.g., HUC10),[d] and/or within multiple watersheds</td><td>USGS watershed (HUC10)[d] or subwatershed (HUC12)[d] level</td><td>NA</td></tr>
<tr><td>Duration or Frequency</td><td>Long-term or permanent change in function or type that is not restored within two growing seasons, or ever</td><td>Periodic and/or temporary loss reversed over one to two growing seasons with or without active restoration</td><td>NA</td></tr>
</table>

NA= not applicable
[a] Magnitude is defined based on the type of wetland impacted, high or low quality.
[b] Indirect effects are those resulting from direct effects, but they occur elsewhere in space and/or time.
[c] Wetland functions include hydrologic, ecological, geomorphic, and social functions typically assessed for wetlands as part of USACE compensatory mitigation planning. Typical functions assessed may include flood attenuation, bank stabilization, water quality, organic matter input/transport, nutrient processing, wildlife habitat, threatened and endangered species habitat, biodiversity, recreational/social value.
[d] Definitions of USGS watershed and subwatershed: *USGS Watershed* refers to the USGS 10 digit hydrologic unit code (HUC10), which averages approximately 230 square miles, depending on the region. *USGS Subwatershed* refers to the USGS 12 digit hydrologic unit code (HUC12), which averages approximately 40 square miles, depending on the region. See *USGS and NRCS (2013)* for an explanation of HUC codes.

6.2.5.3. Description of Environmental Concerns

Table 6.2.5-1 presents three types of potential effects to wetlands that were evaluated: direct wetland loss, other direct effects, and indirect effects. *Direct wetland loss* includes the actual loss of wetland habitat due to fill or conversion to a non-wetland habitat, such as a dryer habitat (upland area), or a wetter habitat (e.g., lake or stream). *Other direct effects* includes any direct effects that cause impacts such that the area remains a wetland and is not lost or converted, but the impacts cause a change in the type of wetland or a decrease in wetland function. *Indirect effects* are effects that occur secondarily as a result of direct effects and, like direct effects, cause a change in the type of wetland or a decrease in wetland function.

Wetland Loss

Wetland loss is a primary environmental concern for wetlands during construction. Direct wetland loss can be caused by the placement of fill into wetlands, thereby converting the wetland to a developed area. Wetlands can also be lost due to impacts to hydrology that cause a wetland to convert to a non-wetlands either by draining (converting a wetland to an upland area), or by inundation (converting a wetland to a waterbody such as a lake). Hydrologic changes can occur due to several activities, including draining or damming of a wetland, or placing fill outside of, but up or down flow of the wetland's primary hydrologic source (in turn causing drying or inundation of the wetland, respectively); replacing native soil with soil having different drainage rates; compacting or rutting soil; or increasing non-permeable surfaces. All of these activities can in turn alter wetland drainage patterns. Potential impacts to soils that could indirectly cause changes to hydrology are discussed in greater detail in Section 6.2.2, Soils. Potential impacts to water resources that could directly or indirectly impact wetland hydrology are discussed in Section 6.2.4, Water Resources.

To the extent practicable or feasible, FirstNet and/or their partners would avoid filling wetlands or altering the hydrologic regime so that wetlands would not be lost or converted to non-wetlands. Loss of high- and low-quality wetlands would be l*ess than significant* given the small amount of land disturbance associated with the project locations (generally less than an acre) and the short time-frame of deployment activities. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. Potential wetlands impacts can be further reduced by implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

Other Direct Effects

For the purpose of this assessment, direct effects are defined as any effect that occurs in the same time and place as the impact, resulting from activities including vegetation clearing, ground disturbance, hydrologic alteration such as flooding or draining, changes to soils, or water quality degradation. Short of causing wetland loss, these construction and/or operation activities could potentially cause direct effects to wetlands, such as a change in the type of wetland (e.g., vegetation type), or a decrease or loss of one or all wetland functions performed by a given wetland. These activities can alter the wetland type by shifting vegetation structure, such as changing from a forested to a woody shrub or herbaceous vegetation type, due to vegetation clearing, or changes in hydrology or soil drainage. Some or all wetland functions in a given wetland can be lost or decreased due to the activities described above.

Effects to high- and low-quality wetlands would be *less than significant* given the small amount of land disturbance associated with the project locations (generally less than an acre), the short timeframe of deployment activities, and the application of federal, Commonwealth, or locally required wetlands regulations. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed. Potential wetlands impacts can be further reduced by implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

Indirect Effects

Indirect effects can result from the same activities that cause direct effects, but the effect occurs secondarily (e.g., in a different time or location) to the direct effects. In the same ways as direct effects, indirect effects can result in a change in wetland type or decrease in wetland function. In the case of wetlands, indirect effects can be the result of direct hydrologic alterations. For example, changes in hydrology caused by direct effects (e.g., fill placement) can result in a cascade of indirect effects, including changes in vegetation structure, changes in the type of wildlife habitat that is supported by the wetland, and changes to the functions that the wetland provides, including bank stability, filtering of pollutants for maintenance of water quality, and mitigation of flood flows. Indirect effects can also occur due to other activities such as vegetation clearing and ground disturbance, resulting in changes in wildlife habitat, weed infestation, and changes in wetland function, as described previously.

It is anticipated that indirect effects to high- and low-quality wetlands would be *less than significant* due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, Commonwealth, or locally required wetlands regulations. Implementation of BMPs and mitigation measures (see Chapter 11) could further reduce these potential impacts.

As with the direct effects category described above, the indirect effects category includes only effects that do not cause wetland loss or conversion to non-wetland, which are covered in the wetland loss category above.

6.2.5.4. Potential Impacts of the Preferred Alternative

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wetland resources. In addition, and as explained in this section, the same type of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to wetland resources under the conditions described below:[1]

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to wetlands resources because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to wetlands resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact wetland resources because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide, public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wetlands resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to wetland resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of project construction activities. The following types of infrastructure development or deployment activities could cause wetland loss, conversion of wetlands to non-wetlands, or direct or indirect effects to wetlands as a result of wetland fill, vegetation clearing, landscape grading, soil compaction, and other various ground disturbance activities. Potential wetland impacts associated with each infrastructure development type are discussed below.

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of points of presence,[2] huts, or other associated facilities or hand-holes to

[1] A determination of *no impact* from these activities assumes that no heavy construction equipment would be required for deployment, or if heavy construction equipment were required, it would be deployed on a paved or non-paved gravel surface.

access fiber could result in potential impacts to wetlands from both construction equipment and the activity itself.

- New Build – Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the installation of new poles could result in wetland loss, conversion, or direct or indirect effects. The use of heavy equipment during the installation of new poles and hanging of cables could result in direct or indirect effects to wetlands.
- Collocation on Existing Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening could result in wetland fill, conversion, or direct or indirect effects to wetlands.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water could potentially impact wetland resources if the water body was a flooded wetland. In addition, potential wetland impacts could occur as a result of the construction of landings and/or facilities on shore to accept submarine cable.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance, there would be *no impacts* to wetlands. However, if installation of transmission equipment required vegetation clearing, grading, or other ground disturbance to install small boxes, hunts, or access roads, wetland loss, conversion, or direct or indirect effects to wetlands could potentially occur.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to wetland resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads could result in wetland loss, conversion, or direct or indirect effects to wetlands.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower or structure, which would have *no impacts* to wetlands because there would be no ground disturbance associated with this activity. The potential addition of power units, structural hardening, and physical security measures would also have *no impacts* on wetland resources if this activity would not require ground disturbance. However, if the onsite delivery of additional power units, structural hardening, and physical security measures required ground disturbance, such as grading or excavation activities, direct or indirect effects to wetlands could occur.

[2] Points of presence are connections or access points between two different networks, or different components of one network.

- Deployable Technologies
  - Implementation of deployable aerial communications architecture (such as drones, balloons, or piloted aircraft) would not likely result in any potential impacts to wetlands, as there would not be any ground disturbance. Implementation of ground-based Cell on Wheels, Cell on Light Truck, and System on Wheels would not result in potential impacts to wetland resources if deployment occurs on paved or non-paved gravel surfaces. However, implementation of the three land-based deployable technologies (Cell on Wheels, Cell on Light Truck, and System on Wheels) could result in potential impacts to wetland resources. These potential impacts could occur if deployment occurs in undeveloped areas, requiring minor construction, grading, filling, or paving of a surface to place a deployable technology. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, excavation, and paving.

Potential Wetland Impacts

Based on the analysis of the deployment activities described above to wetland resources, potential impacts as a result of Preferred Alternative activities are anticipated to be *less than significant*.

Wetlands comprise less than 3 percent of the area on Guam (*USFWS 2015*), and are therefore considered a rare, highly valued habitat type to be preserved (*GCMP 2008; Government of Guam 1978*). *The Guam Coastal and Estuarine Land Conservation Program Plan* developed by the Guam Coastal Management Program (*GCMP 2008)* includes wetland areas as one class of areas to be protected. In addition to their general uniqueness, most wetlands on Guam are considered high-quality habitats due to their provision of one or more important hydrologic, geomorphic, ecological, or social functions. For example, when the government of Guam designated wetlands as Areas of Particular Concern in 1978, they cited the following reasons for designation related to wetland functions and values to Guam: "high biological productivity and significant resource value…", provision of "critical habitat for maintenance of native plant and animal life", their ability to "act as floodplains during periods of excessive water flow and a source of fresh water for domestic and agricultural purposes…", and the fact that "mangrove wetlands act as a shoreline stabilization mechanism and prevent shoreline erosion and stormwave damage…" (*Government of Guam 1978*).

Additional functions specific to Guam wetlands include maintenance of groundwater quality to protect drinking water resources; maintenance of surface water quality; coastal or inland waterbody bank stabilization; habitat for endemic,[3] threatened, endangered, or other species of concern; high-quality general wildlife habitat; community water storage, flood mitigation, and/or coastal storm protection (*Siha 1991*). Loss of wetlands or direct or indirect potential impacts resulting in a decrease in any of these functions would be less than significant given the small amount of land disturbance associated with the project locations (generally less than an acre) and the short timeframe of deployment activities. Additionally, all site-specific locations will be subject to an environmental review to help ensure environmental concerns are addressed.

[3] Endemic species are only found in one area or region.

Potential wetlands impacts can be further reduced by implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

In addition to a low relative abundance of wetlands in general, certain Guam wetland types are also regionally rare or unique, including freshwater ponds, estuarine intertidal, and marine intertidal wetlands, or any type of wetland located on the northern half of the islands where wetland habitat is rare in general (*USFWS 2015*) and would be considered high quality based on this characteristic alone. Relative abundance of wetland types on Guam are presented in Section 6.1.5.4, Wetland Characteristics. Other characteristics and/or wetland types other than those listed here can certainly be associated with high-quality wetlands. As described in Section 6.2.5.2, Impact Assessment Methodology and Significance Criteria, the quality or uniqueness of wetlands potentially impacted by deployment activities would require a formal assessment on a case by case basis as part of Proposed Action permitting.

To minimize potential impacts to wetlands, BMPs and mitigation measures would be implemented in compliance with any issued federal, territory, and local permits. For example, loss of jurisdictional wetlands[4] resulting from the placement of dredged or fill material would require a CWA Section 404 permit, issued by the USACE and reviewed by the United States Environmental Protection Agency.

See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with wetlands.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *no impacts* to wetland resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If heavy equipment is used as part of routine maintenance, if inspections occur off of established access roads or corridors, or if routine maintenance and application of herbicides is used to control vegetation, potential wetland impacts could be *less than significant* as explained above.

6.2.5.5. Alternatives Impact Assessment

The following section assesses potential impacts to wetlands associated with the Deployable Technologies Alternative and the No Action alternative.[5]

[4] Jurisdictional wetlands are wetlands that are found to be "waters of the U.S." per definitions presented in the CWA, and are thus under the jurisdiction of the USACE.
[5] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet aerial and land-based of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wetland resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

Implementation of the three land-based deployable technologies (Cell on Wheels, Cell on Light Truck, and System on Wheels) could result in *less than significant* impacts. Some staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. These activities could result in wetland loss, conversion, or direct or indirect effects to wetlands. Heavy equipment use associated with these activities could result in soil compaction, resulting in direct or indirect potential impacts to wetlands. However, it is anticipated that impacts to wetlands would be *less than significant* due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, Commonwealth, or locally required wetlands regulations. Implementation of BMPs and mitigation measures (see Chapter 11) could further reduce these potential impacts.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there could be *less than significant* potential impacts to wetland resources associated with routine inspections and maintenance of the Preferred Alternative.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to wetland resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.5, Wetlands.

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6.2.6. Biological Resources

6.2.6.1. Introduction

This section describes potential impacts to biological resources in Guam associated with deployment and operation of the Proposed Action, and discusses best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts. These are the resources covered in this section:

- Terrestrial vegetation, including vegetation loss, fragmentation, and invasive species;
- Wildlife, including amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates occurring in both onshore and offshore environments;
- Fisheries and aquatic habitats, including both marine and freshwater species and habitats; and
- Threatened and endangered species and species of conservation concern, including federal-, state-, or agency-listed plant and animal species and designated critical habitat.

6.2.6.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on terrestrial vegetation, wildlife, and fisheries and aquatic habitat were evaluated using the significance criteria presented in Table 6.2.6.2-1 for direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; indirect injury/mortality; effects to migration or migratory patterns; reproductive effects; and invasive species effects. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*.

The potential impacts of the Proposed Action on threatened and endangered species and species of conservation concern were evaluated using the significance criteria presented in Table 6.2.6.6-1 in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern. The categories of impacts are defined as: *may affect, likely to adversely affect; may affect, not likely to adversely affect;* and *no effect*. These impact categories are comparable to those defined in the *Endangered Species Consultation Handbook* (*USFWS and NMFS 1998*).

Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact. Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to biological resources addressed in this section are presented as a range of possible impacts.

Table 6.2.6.2-1: Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigations Measures Incorporated**	**Less than Significant**	**No Impact**
Direct Injury/Mortality	Magnitude or Intensity	Population-level or sub-population[a] injury/mortality effects observed for at least one species depending on the distribution and the management of said species. Events that may impact endemics[b] or concentrations during breeding or migratory periods. Violation of various regulations including: MMPA, MBTA, and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant.*	Individual mortality observed but not sufficient to affect population or sub-population survival.	No direct individual injury or mortality would be observed.
	Geographic Extent	Regional effects observed within each respective state or territory for at least one species. Anthropogenic[c] disturbances that lead to exclusion from nutritional or habitat resources, or direct injury or mortality of endemics or a significant portion of the population or sub-population located in a small area during a specific season.		Effects realized at one location when population is widely distributed and not concentrated in affected area.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within 1 to 3 years.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigations Measures Incorporated**	**Less than Significant**	**No Impact**
Vegetation and Habitat Loss, Alteration, or Fragmentation	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species or vegetation cover type, depending on the distribution and the management of said species. Impacts to terrestrial, aquatic, or riparian habitat or other sensitive natural community vital for feeding, spawning/breeding, foraging, migratory rest stops, refugia,[d] or cover from weather or predators. including: MMPA, MBTA, and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant.*	Habitat alteration in locations not designated as vital or critical for any period. Temporary losses to individual plants within cover types, or small habitat alterations take place in important habitat that is widely distributed and there are no cover type losses or cumulative effects from additional projects.	Sufficient habitat would remain functional to maintain viability of all species. No damage or loss of terrestrial, aquatic, or riparian habitat from the Proposed Action would occur.
	Geographic Extent	Regional effects observed within each respective state or territory for at least one species. Anthropogenic disturbances that lead to the loss or alteration of nutritional or habitat resources for endemics or a significant portion of the population or subpopulation located in a small area during a specific season.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within 1 to 3 years.	NA

Type of Effect	**Effect Characteristics**	**Impact Level**			
		Potentially Significant	**Less than Significant with BMPs and Mitigations Measures Incorporated**	**Less than Significant**	**No Impact**
Indirect Injury/Mortality	Magnitude or Intensity	Population-level or sub-population effects observed for at least one species depending on the distribution and the management of said species. Exclusion from resources necessary for the survival of one or more species and one or more life stages. Anthropogenic disturbances that lead to mortality, disorientation or the avoidance or exclusion from nutritional or habitat resources for endemics or a significant portion of the population or sub-population located in a small area during a specific season. Violation of various regulations including: MMPA, MBTA, and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant*	Individual injury/mortality observed but not sufficient to affect population or sub-population survival. Partial exclusion from resources in locations not designated as vital or critical for any given species or life stage, or exclusion from resources that takes place in important habitat that is widely distributed. Anthropogenic disturbances are measurable but minimal as determined by individual behavior and propagation, and the potential for habituation or adaptability is high given time.	No stress or avoidance of feeding or important habitat areas. No reduced population resulting from habitat abandonment.
	Geographic Extent	Regional or site specific effects observed within each respective state or territory for at least one species; Behavioral reactions to anthropogenic disturbances depend on the context, the time of year age, previous experience and activity. Anthropogenic disturbances that lead to startle responses of large groupings of individuals during haulouts[e], resulting in injury or mortality.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several years for at least one species.		Temporary, isolated, or short-term effects that are reversed within 1 to 3 years.	NA

<table>
<tr><th rowspan="2">Type of Effect</th><th rowspan="2">Effect Characteristics</th><th colspan="4">Impact Level</th></tr>
<tr><th>Potentially Significant</th><th>Less than Significant with BMPs and Mitigations Measures Incorporated</th><th>Less than Significant</th><th>No Impact</th></tr>
<tr><td rowspan="3">Effects to Migration or Migratory Patterns</td><td>Magnitude or Intensity</td><td>Population-level or sub-population effects observed for at least one species depending on the distribution and the management of said species. Temporary or long-term loss of migratory pattern/path or rest stops due to anthropogenic activities. Violation of various regulations including: MMPA, MBTA, and BGEPA.</td><td rowspan="3">Effect that is potentially significant, but with BMPs and mitigation is less than significant.</td><td>Temporary loss of migratory rest stops due to anthropogenic activities takes place in important habitat that is widely distributed, and there are no cumulative effects from additional projects.</td><td>No alteration of migratory pathways and no stress or avoidance of migratory paths/patterns due to Proposed Action activities.</td></tr>
<tr><td>Geographic Extent</td><td>Regional effects observed within each respective state or territory for at least one species. Anthropogenic disturbances that lead to exclusion from nutritional or habitat resources during migration, or lead to changes of migratory routes for endemics or a significant portion of the population or sub-population located in a small area during a specific season.</td><td>Effects realized at one location when population is widely distributed, and not concentrated in affected area.</td><td>NA</td></tr>
<tr><td>Duration or Frequency</td><td>Chronic and long-term effects not likely to be reversed over several years for at least one species.</td><td>Temporary, isolated, or short-term effects that are reversed within 1 to 3 years.</td><td>NA</td></tr>
</table>

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigations Measures Incorporated**	**Less than Significant**	**No Impact**
Reproductive Effects	Magnitude or Intensity	Population or sub-population level effects in reproduction and productivity over several breeding/spawning seasons for at least one species depending on the distribution and the management of said species. Violation of various regulations including: MMPA, MBTA, and BGEPA.	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant.*	Effects to productivity are at the individual rather than population level. Effects are within annual variances and not sufficient to affect population or sub-population survival.	No reduced breeding or spawning success.
	Geographic Extent	Regional effects observed within each respective state or territory for at least one species. Anthropogenic disturbances that lead to exclusion from prey or habitat resources required for breeding/spawning, or anthropogenic disturbances that lead to stress, abandonment, and loss of productivity for endemics or a significant portion of the population or sub-population located in a small area during the breeding/spawning season.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term effects not likely to be reversed over several breeding/spawning seasons for at least one species.		Temporary, isolated, or short-term effects that are reversed within one breeding season.	NA

Type of Effect	Effect Characteristics	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigations Measures Incorporated**	**Less than Significant**	**No Impact**
Invasive Species Effects	Magnitude or Intensity	Extensive increase in invasive species populations over several seasons.	Effect that is *potentially significant*, but with BMPs and mitigation is *less than significant.*	Mortality observed in individual native species with no measurable increase in invasive species populations.	No loss of forage and cover due to the invasion of exotic or invasive plants introduced to Proposed Action sites from machinery or human activity.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one location.	NA
	Duration or Frequency	Chronic and long-term changes not likely to be reversed over several years or seasons.		Periodic, temporary, or short-term changes that are reversed over one or two seasons.	NA

BMPs = best management practices; BGEPA = Bald and Golden Eagle Protection Act; MBTA = Migratory Bird Treaty Act; MMPA = Marine Mammal Protection Act; NA = not applicable; RF = Radio Frequency
[a] Interbreeding organisms occupying a certain space; the number of people or other living creatures in a designated area.
[b] Species that are only found in one area or region.
[c] Changes caused by humans.
[d] Areas of stable environmental conditions that protect wildlife and organisms from environmental change.
[e] Haulouts refers to periods are when seals and walrus come ashore (either land or ice) to rest, molt or breed.

6.2.6.3. *Terrestrial Vegetation*

Introduction

This section describes potential impacts to terrestrial vegetation resources in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are discussed in Chapter 11, BMPs and Mitigation Measures.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on terrestrial vegetation resources were evaluated using the significance criteria presented in Table 6.2.6.2-1 for vegetation and habitat loss, alteration, or fragmentation, and invasive species effects.[1] As described in Section 6.2, Environmental Consequences, the categories of potential impacts are defined as *potentially significant, less than significant with BMPs and mitigation measures incorporated, less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to terrestrial vegetation resources addressed in this section are presented as a range of possible impacts.

Description of Environmental Concerns

Terms and concepts discussed in this section are further discussed and defined in the Affected Environment section (Section 6.1.6.3, Terrestrial Vegetation).

Vegetation and Habitat Loss, Alteration, or Fragmentation[2]

With any construction project requiring ground disturbance, one of the main concerns during construction activities includes vegetation clearing. Not only could vegetation loss potentially result in wildlife habitat loss or fragmentation, as described in Section 6.2.6.4, Wildlife, it could also lead to accelerated erosion and increased sedimentation in waterways.[3] As explained in Section 6.2.2, Soils, soil erosion could alter natural sediment transport processes in streams and other surface waterbodies, which can impair water and habitat quality and potentially affect aquatic plants and animals. Soil associations in Guam that have moderate to severe erosion

[1] Although direct and indirect injury/mortality, effects to migration or migratory patterns, and reproductive effects are types of effects presented in Table 6.2.6.2-1 that are applicable to other biological resources, these effects do not apply to terrestrial vegetation and are therefore not included in this section. For discussions of Wildlife, Fisheries and Aquatic Habitats, and Threatened and Endangered Species and Species of Conservation Concern, see Sections 6.2.6.4, 6.2.6.5, and 6.2.6.6, respectively. A discussion of potential wetland impacts is included in Section 6.2.5, Wetlands.

[2] Vegetation and habitat loss, alteration, or fragmentation effects related to wildlife are presented in Section 6.2.6.4, Wildlife.

[3] Keeping soil vegetated is often the most effective way to prevent erosion.

potential include the Akina-Agfayan, Akina-Togcha-Ylig, and the Ritidian-Rock Outcrop-Guam soils (see Section 6.2.2, Soils, for descriptions of these soil types).

As described and shown graphically in Section 6.1.6.3, Terrestrial Vegetation, the majority of the northern portion of Guam consists of Limestone Forest and Scrub Forest vegetation. Much of this northern portion is also classified as Urban Built-up land. The southern portion of Guam primarily consists of Savannah Complex, Ravine Forest, and Scrub Forest. Potential impacts to terrestrial vegetation in Guam could occur in areas where construction activities require vegetation cutting, clearing, and/or removal. It is anticipated that for most types of facilities or infrastructure development scenarios, vegetation loss would likely be isolated within construction locations and/or would be short-term with stability achieved within several years, depending on the vegetation cover present in the area.[4] As discussed in Chapter 11, BMPs and mitigation measures would help avoid or minimize potential vegetation loss associated with ground disturbance activities.

Invasive Species Effects

Once a landscape has been cleared of vegetative cover and soil is disturbed, the re-establishment of native vegetation could be delayed or prevented if undesirable noxious weeds and/or invasive plants become established (*USFS Undated*). As discussed in Section 6.1.6.3, Terrestrial Vegetation, some invasive plants in Guam, such as the chain of love (*Antigonon leptopus*), dodder (*Cuscuta campestris*), and others, thrive in disturbed soil environments (*Guam DOA DAWR 2015*). Once established, these invasive plants can displace native plants preferred by native animals. In addition, construction equipment or vehicles traveling from areas infested with invasive or noxious plants to areas free of those plants could disperse them if proper care is not taken or if BMPs and mitigation measures are not followed if they are deemed not practicable or feasible (see Chapter 11, BMPs and Mitigation Measures).

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to terrestrial vegetation resources and others would not. In addition, and as explained in this section, various types of Proposed Action infrastructure could result in a range of *no impact* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

[4] Clearing of trees forested and woodland areas (see Section 6.1.6.3, Terrestrial Vegetation, for an explanation of these vegetation types) could result in potential longer-term impacts given the length of time needed for these vegetation communities to mature to pre-disturbance conditions. Therefore, the duration of the potential impact would depend in part on the type of vegetation to be cleared. Grasses, for example, take less time to mature and become re-established than a stand of large trees.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to terrestrial vegetation resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to terrestrial vegetation resources because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to terrestrial vegetation resources because there would be no ground disturbance
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact terrestrial vegetation resources because those activities would not require ground disturbance or vegetation clearing.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact vegetation, it is anticipated that this activity would have *no impact* to terrestrial vegetation resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to terrestrial vegetation resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground disturbance activities, including vegetation and habitat loss, alteration, or fragmentation, and invasive species effects. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to terrestrial vegetation resources include the following activities:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence,[5] huts, or other associated facilities or hand-holes to access fiber would require ground disturbance that would likely

[5] Points of presence are connections or access points between two different networks, or different components of one network.

result in vegetation loss.[6] In addition, ground disturbance and heavy equipment use associated with excavation activities and landscape grading for constructing points of presence, huts, or other associated facilities or hand-holes to access fiber could also result in vegetation clearing or loss. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs[7] and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.

- New Build–Aerial Fiber Optic Plant: Topsoil removal, soil excavation, and excavated material placement during the installation of new poles could result in ground disturbance and vegetation loss. Additionally, forested areas would likely need to be permanently converted to and maintained as shrub/grassland in the permanent right-of-way. In some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.
- Collocation on Existing Aerial Fiber Optic Plant: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would result in *no impact* to terrestrial vegetation because there would be no ground disturbance or vegetation clearing associated with this activity. The potential addition of power units, structural hardening, and physical security measures would not impact vegetation if these activities would not require ground disturbance or vegetation clearing. However, topsoil removal, soil excavation, and excavated material placement during the replacement of poles and structural hardening (should that be required) could result in ground disturbance and vegetation loss. However, it is anticipated that in most cases there would generally be less soil disturbance compared to a new build project. If that is the case, there would likely be correspondingly fewer potential impacts to terrestrial vegetation. In some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.
- New Build–Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water would have *no impact* terrestrial vegetation because there would be no ground disturbance associated with this activity (see Section 6.2.6.5, Fisheries and Aquatic Habitats, for a discussion of potential impacts to aquatic habitat).

[6] See Section 2.1.2, Proposed Action Infrastructure, for a description of the types of infrastructure to be potentially implemented and explanations of specific techniques and terms.
[7] BMPs and mitigation measures to minimize potential impacts to terrestrial vegetation resources are listed in Chapter 11, BMPs and Mitigation Measures.

However, potential impacts to vegetation could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable. Soil disturbance and vegetation loss could occur as a result of grading, foundation excavation, or other ground disturbance activities. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.

  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance or vegetation clearing, there would be *no impacts* to terrestrial vegetation. However, if installation of transmission equipment would require vegetation clearing, landscape grading, or other ground disturbance to install small boxes, huts, or access roads, there would be potential impacts to terrestrial vegetation. In some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to terrestrial vegetation resources. Excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads would likely result in vegetation loss. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to terrestrial vegetation. However, if the onsite delivery of additional power units, structural hardening, and physical security measures required ground disturbance or resulted in vegetation loss, such as grading or excavation activities, potential impacts to vegetation resources would occur. It is anticipated that in most cases there would generally be less soil disturbance compared to a new build project. If that is the case, there would likely be correspondingly fewer potential impacts to terrestrial vegetation. Furthermore, in some build-out locations,

short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.

- Deployable Technologies:
  - Where deployable technologies would be located on existing paved surfaces, it is anticipated that there would be *no impacts* to terrestrial vegetation resources because there would be no new ground disturbance or vegetation clearing required. However, implementation of deployable technologies could result in potential impacts to terrestrial vegetation if deployment of land-based or aerial deployables occurs in unpaved areas and results in vegetation loss. Some staging areas could require land clearing, excavation, and paving, which would result in vegetation loss. Furthermore, in some build-out locations, short-term and localized potential impacts to terrestrial vegetation could occur as a result of invasive or noxious weed establishment if local conditions and ground disturbance creates an environment conducive to their spreading. However, BMPs and mitigation measures to promptly and properly revegetate disturbed areas would help further reduce these potential impacts.

In general, the abovementioned activities could potentially involve land clearing, topsoil removal, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, and heavy equipment movement. Potential impacts to terrestrial vegetation resources associated with deployment of this infrastructure could include vegetation loss and invasive species effects. These potential impacts are described further below, and BMPs and mitigation measures to help mitigate or reduce these potential impacts are described discussed in Chapter 11, BMPs and Mitigation Measures.

Potential Vegetation Loss Impacts

Based on the analysis of the deployment activities described above related to terrestrial vegetation resources, potential impacts as a result of vegetation loss are anticipated to be *less than significant* (see Table 6.2.6.2-1).[8] As mentioned previously, even if certain forested areas would be impacted that require more than several years to become re-established or would be permanently converted to a different cover type, the magnitude/intensity and geographic extent of the vegetation loss is anticipated to be *less than significant*, and further reduced with the implementation of required BMPs and mitigation measures. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential vegetation loss impacts.

[8] Potential impacts to wildlife as a result of vegetation and habitat loss, alteration, or fragmentation as well as a listing of applicable BMPs and mitigation measures are discussed in Section 6.2.6.4, Wildlife, and Chapter 11, respectively.

Potential Invasive Species Impacts

Based on the analysis of proposed activities described above, invasive species effects could result in potentially *less than significant* impacts since it is anticipated that the proposed activities would not lead to measureable increases in invasive species populations, would be localized to individual build-out locations, and would result in changes that could be reversed over one or two growing seasons or less (see Table 6.2.6.2-1). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential vegetation loss impacts.

Potential Operation Impacts

As explained above, implementation of land-based deployable technologies could result in *no impacts* if the deployment occurs on paved or previously disturbed surfaces and *less than significant* impacts to terrestrial vegetation resources if deployment occurs in unpaved areas and results in vegetation loss, or if the implementation results in paving of previously unpaved vegetated surfaces. Potential impacts to vegetation could also occur if ground disturbance of the deployable vehicle(s) creates an environment conducive to invasive plant species and they become established, however, those potential impacts, as explained above, would also be *less than significant*. In addition, some staging or landing areas (depending on the type of technology) could require land clearing, minimal excavation, and paving, which could result in *less than significant* vegetation loss. BMPs and mitigation measures could help to minimize the spread of noxious and invasive weeds.

Alternatives Impact Assessment

The following section assesses potential impacts to terrestrial vegetation associated with the Deployable Technologies Alternative and the No Action Alternative.[9]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts to terrestrial vegetation resources as a result of implementation of this alternative are described below.

[9] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Potential Deployment Impacts

As explained above, implementation of land-based deployable technologies could result in *no impacts* if the deployment occurs on paved or previously disturbed surfaces and *less than significant* impacts to terrestrial vegetation resources if deployment occurs in unpaved areas and results in vegetation loss, or if the implementation results in paving of previously unpaved vegetated surfaces. Potential impacts to vegetation could also occur if ground disturbance of the deployable vehicle(s) creates an environment conducive to invasive plant species and they become established; however, those potential impacts, as explained above, would also be *less than significant*. In addition, some staging or landing areas (depending on the type of technology) could require land clearing, minimal excavation, and paving, which could result in less than significant vegetation loss. BMPs and mitigation measures could help to minimize the spread of noxious and invasive weeds. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential vegetation loss and/or invasive species impacts.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, there would be *no impacts* anticipated to terrestrial vegetation associated with routine inspections of the Deployable Technologies Alternative, assuming that the same access roads used for deployment are also used for inspections. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors and results in ground disturbance or land clearing, vegetation loss and/or invasive species effects could result in *less than significant* impacts as previously explained above. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential vegetation loss and/or invasive species impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to terrestrial vegetation resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.6.3, Terrestrial Vegetation.

6.2.6.4. Wildlife

Introduction

This section describes potential impacts to wildlife resources in Guam associated with deployment and operation of the Proposed Action and alternatives. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures. Potential impacts to amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates occurring in Guam and Guam's offshore environments are discussed in this section.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on wildlife resources were evaluated using the significance criteria presented in Table 6.2.6.2-1. As described in Section 6.2, Environmental Consequences, the categories of potential impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to wildlife resources addressed in this section are presented as a range of possible impacts.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism from interactions associated with the Proposed Action. In general, the most common direct injuries from development projects are entanglement, vehicle strike, problems associated with accidental ingestion, and injuries incurred by sensitive animals, like marine mammals, from disturbance events. Direct injury/mortality environmental concerns pertaining to Guam's amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates are described below.

<u>Amphibians and Reptiles</u>

As discussed in the Section 6.1.6.4, Wildlife, Guam does not have any native species of amphibians, but has five species with current breeding populations. Direct mortality to amphibians and reptiles could occur in construction zones either by excavation activities or by vehicle strikes; however, these events are expected to be temporary and isolated, affecting only individual animals. Environmental consequences pertaining to Guam's protected reptiles (including skinks and sea turtles) are discussed in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Terrestrial Mammals

Bat species are the only native mammals to Guam and are described in the Section 6.1.6.4, Wildlife. The Marianas fruit bat (*Pteropus mariannus*) is the only extant[1] bat on Guam and is federally listed as endangered under the Endangered Species Act. Environmental consequences for this species are further discussed in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Vehicle strikes are sources of direct mortality or injury to terrestrial mammals in Guam. Individual injury or mortality as a result of vehicle strikes associated with the Proposed Action could occur; however, these events are expected to be temporary and isolated, affecting only individual mammals.

Potential impacts of fences or other barriers on wildlife could be a source of mortality or injury to terrestrial mammals. Bats frequently incur injuries from collisions or entanglements in fences (*Amesbury 2007*). Fences or other barriers can also effectively corral wildlife on roadways where vehicular traffic increases strike mortality. Entanglement resulting from wildlife attempting to traverse under or over the barrier is also of concern, as animals can get appendages caught. Potential impacts of fences or other barriers would likely be isolated, individual events.

Marine Mammals

Underwater sound sources, if intense enough, could cause injury or death to marine mammals in the vicinity of the activity. However, given the limited amount of near-shore deployment activities, it is unlikely this would result in population-level impacts and would be isolated, individual events. BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to minimize potential impacts from underwater noise.

Direct mortality and injury to marine mammals as a result of vessel strikes could occur but are not likely to be widespread or affect populations of species as a whole. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts. Mitigation measures that are the result of consultations with the National Marine Fisheries Service would be followed, as required.

Birds

Mortalities from collisions or electrocutions with manmade cables and wires are environmental concerns for avian species, with some species covered under the Migratory Bird Treaty Act. Generally, collision events occur to “poor” fliers (such as ducks), heavy birds (such as swans and cranes), and birds that fly in flocks. Species susceptible to electrocution are birds of prey and

[1] Extant refers to a species still in existence.

thermal soarers[2] like great frigatebirds (*Fregata minor*) that typically have large wing spans. Avian mortalities or injuries can also result from vehicle strikes, although they typically occur as isolated events.

Direct mortality and injury to birds of Guam are not likely to be widespread or affect populations of species as a whole and could be further reduced by implementing BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures). Mitigation measures that are a result of consultations with the U.S. Fish and Wildlife Service regarding potential impacts to migratory birds will be implemented, as required.

Terrestrial Invertebrates

Direct injury or mortality events to terrestrial invertebrates would be similar to those described above for amphibians and reptiles (i.e., vehicle strikes). The overall abundance of terrestrial invertebrate populations of Guam is not expected to be affected by direct mortality or injury events. Several invertebrate species are of particular concern as a result of habitat loss and degradation. Environmental consequences for these species are discussed in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Vegetation and Habitat Loss, Alteration, or Fragmentation

Potential habitat impacts are primarily physical perturbations that result in alterations in the amount or quality of a habitat. As with all of the effects categories, the magnitude of the potential impact depends on the duration, location, and spatial scale of the system and associated activities. Habitat fragmentation is the breaking down of continuous and connected habitat, and impeding access to resources and mates.

Additionally, habitat loss can occur through exclusion, directly or indirectly, preventing an animal from accessing an optimal habitat (e.g., breeding, forage, or refuge), either by physically preventing use of a habitat or by causing an animal to avoid a habitat, either temporarily or long-term. It is expected that activities associated with the Proposed Action would cause isolated, temporary exclusion effects only in very special circumstances.

Potential effects of vegetation and habitat loss, alteration, or fragmentation are described for Guam's wildlife species below.

Amphibians and Reptiles

In general, amphibian species utilize aquatic habitats for some part of their life cycle. Amphibian species have a complex life cycle (i.e., having both larval and adult stages) and require aquatic habitats, such as vernal pools,[3] temporary ponds, and even streams for mating, egg laying, and larval growth. Aquatic habitats are naturally dynamic, often filling and drying

[2] Soarers are birds that fly to a considerable altitude and maintain elevation without moving their wings by using ascending air currents. This is done because soaring is much more energy efficient than flapping their wings, and soarers generally hunt from the air and so spend a lot of time waiting for prey.

[3] Vernal pools are form in basin depressions and are ponded only during the wetter part of the year, also known as ephemeral pools (*USEPA 2015*).

on an annual basis. Amphibians associated with these habitat types are specifically adapted to such processes.

Filling or draining of wetland breeding habitat and alterations to ground or surface water flow associated with the Proposed Action could have effects on Guam's amphibian and reptile populations although the Proposed Action is likely to only affect a small number of the overall population. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to minimize the potential impacts.

The activities associated with the Proposed Action (see below) would cause disturbance and result in temporary displacement of amphibians and reptiles. Some limited amount of infrastructure may be built in these sensitive areas that could permanently displace small numbers of individuals. Implementation of BMPs and mitigation measures could further help minimize potential impacts.

Terrestrial Mammals

The loss of suitable habitat is a major cause for declines in bat populations (*Guam DAWR 2015*). Natural roost sites, such as karst in Guam, are critical limiting factors for bats (*Guam DAWR 2015*). Removal or loss of forest also decreases foraging and cover habitat for frugivorous bats.[4]

Human presence and activity can alarm fruit bats, particularly if frequent, because bats associate humans with being hunted. Entire colonies can abandon roosts for less suitable habitat, and be exposed to unfamiliar territory and predators. Mariana fruit bats are very sensitive to roost disturbance and often become agitated and frightened after detecting the human scent (*NRCS 2009*).

Habitat loss, fragmentation, or alteration effects would likely be temporary and/or isolated. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts.

Marine Mammals

The waters of the South Pacific serve as primary habitat for a range of critical activities including feeding, mating, and calving. Some marine mammals occupy a relatively well-defined habitat year-round or have a narrow feeding niche that restricts them to a particular kind of habitat (e.g., dugongs need access to aquatic vegetation and warm water). Environmental consequences to protected marine mammals are discussed in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Whales, dolphins, and dugongs may be temporarily excluded from a resource if they avoid it due to the increased noise associated with human activity. Depending on the duration of the activity, marine mammals could be excluded from their environment temporarily or could abandon the habitat entirely (*Richardson et al. 1995*). However, the degree to which habitat exclusion affects whales depends on many factors. Marine mammals are mobile and generally use open water

[4] Frugivorous animals are those that eat primarily fruit.

habitat; therefore, it is expected that sea-based activities from the Proposed Action, which would be limited to small boats in near-shore and inland waters, would not affect the ability of marine mammals to access important resources.

Birds

The removal and loss of vegetation can affect avian species directly by loss of nesting, foraging, and cover habitat. Displacement of migratory birds is of particular concern in Guam because the islands are important stopovers for resting and replenishing energy stores as well as wintering habitats. For example, the bristle-thighed curlew (*Numenius tahitiensis*), Pacific golden-plover (*Pluvialis fulva*), and wandering tattler (*Tringa incana*) spend the nonbreeding season on the islands within the Central Pacific Flyway (*PWNET 2015*).

Noise disturbance and human activity, as discussed previously, could directly restrict birds from using their preferred resources. Greater human activity of longer duration could increase the likelihood that birds would avoid the area, possibly being excluded from essential resources.

The degree to which habitat exclusion affects birds depends on many factors. The potential impact to passerine[5] species from disturbance or displacement from construction activities is likely to be short-term with minor effects from exclusion. Exclusion from resources concentrated in a small migratory stop area during peak migration could have potential impacts to species that migrate in large flocks and concentrate at stop overs (e.g., shorebirds). However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of birds. Potential impacts to birds could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

Terrestrial Invertebrates

Terrestrial invertebrates could be displaced or disturbed by activity associated with the Proposed Action on the island. Proposed Action activities that could affect terrestrial invertebrates are expected to be temporary and isolated, affecting only small numbers of terrestrial invertebrates. Potential impacts could be further reduced by the implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures). Several snails and butterfly species are of particular concern as a result of habitat loss and degradation and have been proposed for listing. The endemic[6] Guam tree snail (*Partula radiolata*), the humped tree snail (*Partula gibba*), and the fragile tree snail (*Samoana fragilis*) have been recently proposed for federal listing along with the Mariana eight-spot butterfly (*Hypolimnas octocula mariannensis*) and the Mariana wandering butterfly (*Vagrans egistina*) (*USFWS 2015*). Environmental consequences for these species are discussed in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

[5] Passerines are an order of "perching" birds that have four toes, three facing forward and one backward, which allows the bird to easily cling to both horizontal and nearly vertical perches.
[6] Endemic species are species that are only found in one area or region.

Indirect Injury/Mortality

"Indirect effects" are effects that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (*40 Code of Federal Regulations 1508.8[b]*). Indirect injury/mortality can include stress related to disturbance and disruption of life history patterns (such as migration and breeding) important for survival. A short-term stress response to an acute, temporary stressor initiates a "fight or flight" response that diverts energy (which would otherwise be used for reproduction and growth) to the immediate survival of the animal (*Reeder and Kramer 2005*). Most organisms are well adapted and recover quickly from these types of stressors. A chronic stress response to a persistent stressor; however, can be detrimental to the organism and result in cell death, compromised immune system, muscle wasting, reproductive suppression, and memory impairment (*Reeder and Kramer 2005*). Potential indirect injury/mortality impacts vary depending on the species, time of year, and duration of deployment. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

<u>Amphibians and Reptiles</u>

In general, amphibian species utilize aquatic habitats for some part of their life cycle. Amphibian species have a complex life cycle (i.e., having both larval and adult stages) and require aquatic habitats, such as vernal pools, temporary ponds, and even streams for mating, oviposition, and larval growth. Aquatic habitats are naturally dynamic, often filling and drying on an annual basis. Amphibians associated with these habitat types are specifically adapted to such processes. Changes in water quality and quantity and loss of wetlands and vernal pools, especially during the breeding seasons, reduce the number and density of breeding sites, leading to lower productivity and diminishing the capacity to maintain local and regional species populations (*Semlitsch 2000*). However, changes in water quality or quantity are expected to be temporary and isolated, affecting only a limited number of amphibians.

Reptiles are generally more hardy animals than amphibians, occupy more diverse habitats, and can tolerate longer periods without food and water. However, reptiles are still susceptible to stress from changes in their environment (*ScienceNordic 2012*).

<u>Terrestrial Mammals</u>

Stress from repeated disturbances during critical time periods (e.g., maternity and weaning periods, inactivity) can reduce the overall fitness and productivity of young and adult terrestrial mammals. For example, bats are particularly vulnerable to disturbance during periods of torpor (when arousal affects their ability to conserve energy) and during the breeding season (when they are gathered in maternity colonies where disturbance may cause a decline in breeding success) (*Gannon et al. 2005*). Bats in poor body condition are more susceptible to disease (*Gannon et al. 2005*). Potential indirect injury or mortality to bat species as a result of the Proposed Action is discussed in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Marine Mammals

As discussed above, Guam's waters are primary habitat for feeding, calving, and mating marine mammals. Repeated disturbance, especially near calving or foraging areas, can cause behavioral changes such as alteration or cessation of feeding, nursing, or resting. These behavioral changes can increase an animal's energy expenditure or result in chronic levels of stress, which could have a negative effect on health (*Parsons 2012*). Additional behavioral changes observed in cetacean species in response to disturbance include changes in surfacing, acoustic, and swimming behavior and changes in direction, group size, and coordination, all of which can result in additional energetic cost (*Parsons 2012*). However, deployment activities would only take place in near-shore environments and are expected to be temporary and isolated, likely affecting only individual marine mammals.

Indirect effects from displacement or habitat damage could include lowered fitness as a result of increased energetic challenges, either as added travelling costs or reduced foraging opportunities. However, deployment activities would only take place in near-shore environments and are expected to be temporary and isolated, likely affecting only individual marine mammals. Indirect effects as a result of displacement and disturbance could be further minimized through the use of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

Birds

Nest abandonment and increased predation are two consequences resulting from human-induced disturbance during the breeding/nesting season. Disturbance during migration has been shown to negatively affect grazing geese, shorebirds, and lowland and upland waders (*Hockin et al. 1992*). Most waterfowl and shorebirds take to flight when disturbed; displacing them from preferred feeding or roosting areas (*Tuite et al. 1983, Bell and Austin 1985; Cryer et al. 1987*) or leading them to abandon areas completely (*Bell and Austin 1985; Korschgen et al. 1985; Burger 1986*). A shift from preferred to less preferred feeding areas is likely to affect feeding efficiency (*Burger 1988*).

Repeated disturbance, especially during the breeding and nesting season, can cause stress to individuals lowering fitness and productivity. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of birds. Potential impacts to birds could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

Terrestrial Invertebrates

Terrestrial invertebrates could experience chronic stress either by changes in habitat composition or competition for resources, resulting in lower productivity. However, the overall abundance of terrestrial invertebrate populations in Guam is not expected to be affected by indirect mortality or injury events.

Effects to Migration or Migratory Patterns

Migration is the regular movement of animals from one region to another and back again. Migratory patterns vary by species and sometimes within the same species. Potential effects to migration patterns of Guam's amphibians and reptiles, terrestrial mammals, marine mammals, birds, and terrestrial invertebrates are described below.

Amphibians and Reptiles

Sea turtles are long-distance migrators, swimming long distances to their nesting home range of the tropic and subtropic regions. The leatherback turtle is the record holder, traveling an astounding 10,000 miles or more each year in search of jellyfish, crossing the entire Pacific Ocean from Asia to the West Coast of the U.S. to forage (*Oceanic Society 2015*). Potential effects to migratory patterns of protected species are described in Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Species that use streams as dispersal or migratory corridors could potentially be impacted if these waterways are restricted or altered. However, restrictions or alterations of waterways are not expected to affect widely distributed populations as a whole. Other amphibian species in Guam that concentrate in smaller areas and are not widely distributed could potentially be impacted at the population level depending on the amount of resource altered. However, as deployment activities would be limited and temporary, it is likely that only individual amphibians would be impacted, rather than entire populations. BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts.

Terrestrial Mammals

Guam's terrestrial mammals do not have long-distance migratory patterns though some may exhibit short-distance dispersals. Potential impacts can vary depending on the species, time of year of construction/operation, and duration; however, as deployment activities are expected to be temporary and isolated, it is likely the short-distance dispersal of individual terrestrial mammals would be potentially impacted by the Proposed Action. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts. It is likely that the limited number of permanent structures such as towers or access roads would also have a minimal impact on migratory patterns.

Marine Mammals

Most species of large whales in the Southern Hemisphere migrate from the Pacific islands to the Antarctic Ocean each summer to feed and then return each winter to the Pacific islands to breed (*NZDC 2007*). Noise associated with the installation of cables in the near/offshore waters of the islands could potentially impact marine mammal migration patterns, though any potential impacts are likely to be short-term provided the noise sources are not wide ranging and below

Level A and B sound exposure thresholds.[7] Behavioral changes observed in cetacean species in response to disturbance include changes surfacing, acoustic, and swimming behavior and changes in direction, group size, and coordination, all of which can result in additional energetic cost (*Parsons 2012*). It is clear that behavioral responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. Additionally, as marine mammals have the capacity to divert from sound sources during migration, it is unlikely the Proposed Action would result in migratory impacts. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts.

<u>Birds</u>

Because many bird species have extremely long migrations, protection efforts for critical sites along migratory routes must be coordinated over vast distances often involving many different countries. Guam is located along the Central Pacific Flyway between North American breeding sites and South Pacific wintering grounds. This flyway is crucial for the bristle-thighed curlew (*Numenius tahitiensis*), Pacific golden-plover (*Pluvialis fulva*), and wandering tattler (*Tringa incana*) which spend the nonbreeding season on the islands within this flyway (*PWNET 2015*). Many migratory routes are passed from one generation to the next. Potential impacts can vary (e.g., mortality of individuals or abandonment of stopover sites by whole flocks) depending on the species, time of year of construction/operation, and duration. It is unlikely that the limited amount of infrastructure and the temporary nature of the deployment activities would result in impacts to large populations of migratory birds, but more likely that individual birds could be impacted. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts to migratory pathways.

<u>Terrestrial Invertebrates</u>

Very little is known about migratory behavior in Guam's terrestrial invertebrates. It is expected that the majority of terrestrial invertebrates are localized in their movements during their short life spans and as a result, no o migratory effects to Guam's common terrestrial invertebrates are expected as a result of the Proposed Action.

Reproductive Effects

Reproductive effects are considered those that either directly or indirectly reduce an animal's ability to produce offspring or reduce the rates of growth, maturation, and survival of offspring, which can affect the overall population of individuals.

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[7] Level A (minimum exposure criterion for injury at the level at which a single exposure is estimated to cause onset of permanent hearing loss): 190 decibels (dB) referenced to 1 micro Pascal (µPa) (root mean square [rms]) for seals and 180 dB referenced to 1 µPa (rms) for whales, dolphins, and porpoises. Level B (defined as the onset of significant behavioral disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing): 160 dB referenced to 1 µPa (rms) (*Southall et al. 2007*).

Amphibians and Reptiles

Reproductive effects to sub-populations of amphibians and reptiles could occur through the loss of habitat if deployment activities occur near breeding wetlands, alter water quality through sediment infiltration, or obstruction of natural water flow to pools. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.

Terrestrial Mammals

Disturbance during critical life phases (maternity and weaning periods) could affect reproductive success of bats in Guam, and could result in the abandonment of offspring, leading to reduced survival. It is, however, unlikely that the limited amount of infrastructure and the temporary nature of the deployment activities would impact the life phases of large numbers of bats. It is more likely that individual bats could be affected. Additionally, implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could reduce potential impacts.

Marine Mammals

Restricted access to important calving and nursing grounds has the potential to negatively affect body condition and reproductive success of many marine mammals. As described above, behavioral changes associated with disturbance could also affect mother-infant bonding, reducing survival success of offspring (*Parsons 2012*). Disturbances that could impair socialization (e.g., noise or displacement) can influence reproduction rates through reduced mating opportunities (*Lusseau and Bejder 2007*). As deployment activities are expected to take place only in limited near-shore environments and for a short duration, it is unlikely that marine mammals would experience reproductive impacts. Additionally, implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce any reproductive impacts.

Birds

Potential impacts due to Proposed Action deployment and operations could include abandonment of the area and nests due to disturbance. Disturbance (visual and noise) could displace birds into less suitable habitat and thus reduce survival and reproduction. The loss of cays[8] could result in seabird displacement into marginal habitats, increased predation risks, and/or nest abandonment and chick mortality (*Nytch et al. 2015*). Avian tolerance levels to disturbance can be species-specific. Activities related to the Proposed Action, such as aerial deployment or construction activities, could result in flushing birds from nesting areas; however, the temporary nature of the deployment activities would minimize these impacts. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further help to avoid or minimize potential impacts.

[8] Cays are small, low-elevation, sandy islands on the surface of a coral reef

Terrestrial Invertebrates

Guam's terrestrial invertebrate species are highly diverse and prevalent. Currently, little is known on the status of species populations. It is expected that the majority of terrestrial invertebrates are widespread in Guam and as a result, no population-level reproductive effects to terrestrial invertebrates are expected as a result of the Proposed Action.

Invasive Species Effects

The introduction of non-native species is often the result of human activity. Invasive (non-native) species can have a dramatic effect on natural resources and native populations. Guam's wildlife populations have been affected by invasive species (*USFWS 2012*).

Non-native species that are introduced into an ecosystem, in which they did not evolve, often increase rapidly in number. Native species evolve together as a community and function within an ecosystem governed by many checks and balances. Balance evolves within the system that limits the population growth of any one species; for example predators, herbivores, diseases, parasites, and other organisms compete for the same resources under limiting environmental factors. A non-native species, when introduced into an ecosystem in which it did not evolve naturally, is often times not bound by those limits; its numbers can sometimes dramatically increase and have potential severe impacts on the native community and ecosystem. Invasive species are often times very capable of out-competing native species for food and habitats and sometimes may even be attributed to the extinction of native species or potentially impact the species richness in an ecosystem (*USFWS 2012*).

Potential invasive species effects to Guam's wildlife are described below.

Amphibians and Reptiles

The introduction of invasive species such as the brown tree snake (*Boiga irregularis*) can result in intense predation on bats, birds, amphibians, and reptiles (*USDA 2015*). Feral cats have also been known to selectively prey on native skink populations in Guam (*Lardner et al. 2013*). The limited deployment of infrastructure and the short duration of construction activities are unlikely to result in new species being released. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce potential impacts.

Terrestrial Mammals

Of the extinctions on islands in modern history, rats are estimated to have caused 50 to 81 percent of mammal extinctions (*Ceballos and Brown 1995*). Rats are a serious problem throughout the Pacific (*Buden 2000*; *Guam DAWR 2015*). Invasive species related extinctions occur not only via direct predation, but also by eliminating common prey species used by other mammals. For example, besides eating seeds and small vertebrates, rats prey heavily on insects. This, in turn, can seriously reduce native populations of animals that depend on a diet of insects for survival, such as bats. Introduction of the brown tree snake has resulted in the loss of many of Guam's native species, and may be preventing the recovery of the Mariana fruit bat

(*Guam DAWR 2015*). Other introduced species such as Philippine deer (*Rusa marianna*) and feral pig have been implicated in destruction and degradation of key forest habitats for Guam's bat populations (*Guam DAWR 2015*).

As the limited deployment of infrastructure and the short duration of construction activities are unlikely to result in any of the above named species being introduced or further exacerbated, it is unlikely that the Proposed Action would impact terrestrial mammals through the introduction of invasive species. Invasive species effects to terrestrial mammals could be further minimized following the BMPs and mitigation measures described in Chapter 11, BMPs and Mitigation Measures.

Marine Mammals

Invasive species are detrimental to native communities and ecosystem in that they compete for the same natural resources and life requirements (food, space, and shelter) as native species effectively displacing native fauna and flora communities. Displacement radically alters the nature of the habitats, resulting in the degradation of local ecologies, disrupting food chains, and finally causing the extinction of native species (*USFWS 2012*). Disruptions of food chains can potentially impact higher trophic (i.e., feeding) level species like marine mammals that are specialized feeders. However, the short duration of construction activities in limited near-shore locations are unlikely to result in the introduction or further exacerbation of invasive species to marine environments. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures) could further reduce the likelihood of effects to the marine ecosystem from invasive species.

Birds

Guam's bird communities are vulnerable to introduced predators such as brown tree snakes, rats, and feral cats. For example, high densities of feral cats in the Munitions Storage Area, AAFB have hampered reintroduction efforts of the Guam rail (*Gallirallus owstoni*) (*Guam DAWR 2015*). Seabird populations are particularly susceptible to invasive predators because of their unique life histories. Seabirds are long-lived and many species do not typically reproduce until attaining at least 2 to 3 years of age. Clutch sizes are typically small and young undergo long fledgling periods. These life history variables manifest in low annual productivity. Seabirds typically nest on the ground or in burrows or crevices, are absent for long periods on forage bouts (e.g., albatross and frigatebirds). Absence for long periods leaves the eggs and young vulnerable to predation (*Moors and Atkinson 1984; Major et al. 2006*).

As the Proposed Action only involves temporary limited near-shore deployment activities, it is unlikely invasive species would be released by the construction activities that could threaten seabird populations. Additionally, due to the temporary and limited nature of terrestrial deployment activities, it is also unlikely that invasive species would be introduced or further exacerbated as a result of construction of the Proposed Action. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures), would further reduce potential impacts associated with invasive species.

Terrestrial Invertebrates

Terrestrial invertebrate populations are susceptible to invasive plant species that could change or alter the community composition of specific plants on which they depend. Effects from invasive plant species to terrestrial invertebrates would be similar to those described for habitat loss and degradation. Introduced snails have been a major factor in the reduction of Guam's native snail populations, along with predation by flatworms (*Guam DAWR 2015*). Introduced snails complete directly for food and habitat with native species. As the Proposed Action involves temporary and limited deployment actions, it is unlikely that construction activities would result in population-level impacts as a result of the introduction or further exacerbation of invasive species. Implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures), would further reduce potential impacts associated with invasive species.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to wildlife resources and others would not. In addition, and as explained in this section, various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions. The wildlife that would be affected would depend on the ecoregion, the species' phenology,[9] and the nature and extent of the habitats affected.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are expected to have *no impacts* to wildlife resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to wildlife because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes. Additionally noise generated to install fiber would be infrequent and of short duration and unlikely to produce measureable changes in wildlife behavior.

[9] Phenology is the seasonal changes in plant and animal life cycles, such as emergence of insects or migration of birds.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have no impacts to wildlife because there would be no ground disturbance.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact wildlife because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact wildlife resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to wildlife resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur, including direct injury/mortality; vegetation and habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; reproductive effects; and invasive species effects. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to wildlife resources include the following:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of points of presence (POPs),[10] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to wildlife resources. Land/vegetation clearing and excavation activities, associated with construction of POPs, huts, or other associated facilities could result in direct injury/mortalities of wildlife that are not mobile enough to avoid construction activities (e.g., reptiles, small mammals, and young), that utilize burrows (e.g., ground squirrels), or that are defending nest sites (such as ground-nesting birds). Disturbance, including noise, associated with the above activities could result in habitat loss, effects. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

[10] POPs are connections or access points between two different networks, or different components of one network.

- New Build–Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components on public right-of-ways (ROWs) or private easements as well as the construction of access roads, POPs, huts, or facilitates to house outside plant equipment could result in potential impacts to wildlife resources. Potential impacts could vary depending on the number or individual poles installed, but could include direct injury/mortality as described above; habitat loss, alteration, or fragmentation; effects to migratory patterns; indirect injury/mortality; and invasive species effects. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
- Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, habitat loss or alteration, effects to migratory patterns, indirect injury/mortality, and invasive species effects. Noise disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in migratory effects, indirect injury/mortality, and habitat loss if roost sites are abandoned. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
- New Build–Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water and construction of landings and/or facilities on the shore to accept submarine cables could potentially impact wildlife, marine mammals in particular (see Section 6.2.4, Water Resources, for a discussion of potential impacts to water resources and Section 6.2.6.6, Threatened and Endangered Species and Species of Conservation Concern, for potential impacts to listed wildlife).[11] Effects could include direct injury/mortality; habitat loss, alteration, or fragmentation. If activities occurred during critical time periods, effects to migratory patterns as well as reproductive effects and indirect injury/mortality could occur. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts, there would be no impacts to wildlife because no new infrastructure would be created and no disturbance to wildlife would incur. However, if installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of wildlife as described for other New Build

[11] Listed wildlife is any animal listed as threatened or endangered by federal or territory agencies.

activities. Habitat loss, alteration and fragmentation; effects to migration or migratory patterns, indirect injury/mortality, and invasive species effects could occur as a result of construction and resulting disturbance. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to wildlife resources. Land/vegetation clearing, excavation activities, landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, habitat loss, alteration or fragmentation, and effects to migratory patterns. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, which would not result in impacts to wildlife if no additional disturbance is required to install the hardware on the tower. The potential addition of power units, structural hardening, tower replacement, and physical security measures such as lighting could potentially impact wildlife resources resulting in direct injury/mortality from disturbance activities that could occur during the installation of new equipment. However, deployment activities are expected to be temporary and isolated, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures). Refer to Section 2.4, Radio Frequency Emissions, for information on radio frequency concerns.
- Deployable Technologies
  - In general, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas. This could lead to vegetation and habitat loss, alteration, or fragmentation. Implementation of deployable technologies themselves, including Cell on Wheels, Cell on Light Truck, or System on Wheels, could result in direct injury/mortalities to wildlife on roadways as well as bird strike hazards to low flying species. If off-road deployment is required, the action would potentially impact habitat and result in indirect injury/mortality. If external generators are used, noise disturbance could potentially impact migratory patterns of wildlife. Refer to Section 2.4, Radio Frequency Emissions, for information on radio frequency concerns. Although unlikely, deployment of drones,

balloons, blimps, or piloted aircraft could potentially impact wildlife by direct or indirect injury/mortality from entanglement, collision, or ingestion and potential effects to migratory patterns and reproductive effects from disturbance and/or displacement. The magnitude of these effects depends on the timing and frequency of deployments. However, deployment activities are expected to be temporary, likely affecting only a small number of wildlife. Potential impacts to wildlife could be further reduced by implementation of BMPs and mitigation measures (described in Chapter 11, BMPs and Mitigation Measures).

In general, the abovementioned activities could potentially involve land/vegetation clearing; excavation and trenching; construction of access roads; installation or restructuring of towers and poles; installation of underwater cables in limited near-shore or inland bodies of water; installation of security/safety lighting and fencing; and deployment of aerial platforms. Potential impacts to wildlife resources associated with deployment of this infrastructure could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and effects of invasive species depending on the ecoregion, the species' phenology, and the nature and extent of the habitats affected. These potential impacts are described further below.

Given the scope of the Proposed Action, while geographically enormous (in all 50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive and would likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity and location would be determined based on location-specific conditions and the results of site-specific environmental reviews. These potential impacts associated with the Preferred Alternative, based on the deployment activity and the limited duration of construction activities, are described further below. BMPs and mitigation measures to help mitigate or reduce these potential impacts are described in Chapter 11, BMPs and Mitigation Measures.

Potential Impacts to Amphibians and Reptiles

Based on the analysis of the deployment activities described above to wildlife resources, potential impacts to Guam's amphibians and reptiles are anticipated to be *less than significant* due to the localized and short-term nature of the deployment activity. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Terrestrial Mammals

Based on the analysis of proposed activities described above to wildlife resources, potential impacts to Guam's terrestrial mammals are anticipated to be *less than significant* as deployment activities would be temporary and short in duration. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Marine Mammals

Based on the analysis of proposed activities described above to wildlife resources, potential impacts to Guam's marine mammals are anticipated to be *less than significant* as deployment activities would be temporary, short in duration, take place in near-shore and inland waters and not the open ocean, and avoid important habitats. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Birds

Based on the analysis of proposed activities described above to wildlife resources, potential impacts to Guam's birds are anticipated to be *less than significant* as deployment activities would be temporary and short in duration. BMPs and mitigation measures could be required, as practicable or feasible, to further reduce potential impacts to migratory birds. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with wildlife.

Potential Impacts to Terrestrial Invertebrates

Potential impacts to Guam's terrestrial invertebrates are expected to be *less than significant*. Some limited and localized impacts could result from Preferred Alternative effects such as habitat loss or invasive species. However, deployment activities are expected to be temporary, likely affecting only a small number of wildlife. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with wildlife.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. The wildlife that would be affected would depend on the ecoregion, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that there would be *less than significant* impacts to wildlife resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Site maintenance would be infrequent, including mowing or the limited use of herbicides. This could result in *less than significant* effects to wildlife including direct injury/mortality to less mobile wildlife, as well as injury/mortality from exposure to contaminants from accidental spills from maintenance equipment or release of pesticides. Light, odors, and noise associated with maintenance activities can delay or discourage bats from emergence, or potentially, cause site abandonment, but the infrequent and limited nature of the activity would also result in *less than significant* effects.

During operations, direct injury/mortality of wildlife could occur from collisions and/or entanglements with transmission lines, towers, and aerial platforms. As stated above, these impacts would likely be limited to individual wildlife species, and unlikely to cause population-level impacts.

Wildlife resources could be affected by the reduction in habitat quality associated with habitat fragmentation from the presence of access roads, transmission corridors, and support facilities. As stated above, these impacts would likely result in potential impacts to individuals rather than population-level impacts.

In addition, the presence of new access roads and transmission line ROWs could increase human use of the surrounding areas, which could increase disturbance to wildlife resulting in effects to migratory pathways, indirect injury/mortalities, reproductive effects, as well as the potential introduction and spread of invasive species as explained above. As stated above, these impacts would likely result in potential impacts to individuals rather than population-level impacts.

While these impacts could occur, they are expected to be limited in magnitude and extent, primarily affecting individuals in isolated occurrences. As such, potential operational impacts to Guam's wildlife resources are expected to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with wildlife.

Alternatives Impact Assessment

The following section assesses potential impacts to wildlife resources associated with the Deployable Technologies Alternative and the No Action Alternative.[12]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to wildlife resources as a result of implementation of this alternative could be as described below.

[12] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Potential Deployment Impacts

Activities associated with the set up and operation of deployable technologies for short time periods could result in *less than significant* impacts from direct and indirect injury or mortality events, changes in migratory patterns, disturbance, or displacement. Similar to potential impacts from the deployable elements of the Preferred Alternative, potential impacts under the Deployable Technologies Alternative could include potential noise or visual disturbances from aerial deployable equipment as well as bird strike hazards to low flying species; potential direct injury/mortalities to wildlife on roadways; potential habitat impacts and indirect injury/mortality from off-road deployment; and potential impacts to migratory wildlife patterns due to noise from external generators. Greater frequency and duration of deployments could change the magnitude of potential impacts depending on species, life history, and region of the territory. However, deployment activities are expected to be temporary, likely affecting only a small number of wildlife. Potential impacts associated with the Deployable Technologies Alternative could be further reduced if the BMPs and mitigation measures described in Chapter 11 are implemented.

Potential Operational Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *less than significant* impacts to wildlife resources associated with routine operations, management, and monitoring. To further reduce potential impacts, the BMPs and mitigation measures described in Chapter 11 could be implemented. The potential impacts can vary greatly among species and geographic region and depend on the length and type of operation; potential impacts could result in indirect injury mortality or reproductive effects.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to wildlife resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.6.4, Wildlife.

6.2.6.5. Fisheries and Aquatic Habitats

Introduction

This section describes potential impacts to fisheries resources in Guam associated with deployment and operation of the Proposed Action and alternatives. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on fisheries resources were evaluated using the significance criteria presented in Table 6.2.6-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to fisheries resources addressed in this section are presented as a range of possible impacts.

Description of Environmental Concerns

Direct Injury/Mortality

Direct injury/mortality effects are physical injuries, extreme physiological stress, or death of an individual organism that could result from interactions associated with the Proposed Action. The most common direct injuries from equipment deployment and operation events are entanglement, habitat degradation, accidental ingestion of marine debris, and disturbance incurred by sensitive tropical fishes. However, given that the Proposed Action is only envisioned to be deployed in limited near-shore and inland waters, it is unlikely to impact large populations of fish and any potential impacts would likely be localized, isolated, short-term, and limited to individual or small numbers of fish.

Indirect injury/mortality environmental concerns pertaining to Guam's fisheries are described below.

Coral Reefs and Seagrasses, Habitat Loss, Degradation, or Fragmentation

Guam provides highly productive coral reef habitats, submerged vegetation (i.e., algae), rivers, and complex benthic substrates[1] that harbor many diverse freshwater and marine fishes, invertebrates, mollusks, and other aquatic fauna (*Burdick et al. 2008*). Guam's corals and live rock are protected by local law (*5 Guam Code Annotated Chapter 63*) and are considered high priority areas for conservation, management, and research. Guam's reefs host over 5,000 known marine organisms, including over 1,000 species of reef dependent marine fish (*Porter et al. 2005*). Many environmental concerns arise with the clearing of land-based habitat, and it is possible that the Proposed Action could potentially impact fishery habitat as a result of sediment runoff and erosion reaching nearby waterways if BMPs and mitigation measures are not followed. However, as the proposed deployment activities are only envisioned to be performed in limited near-shore and inland waters, it is unlikely that deployment will result in impacts to coral reefs or seagrasses. Implementation of BMPS and mitigation measures could further reduce potential impacts. Coral reefs provide habitat, spawning, and nursery grounds for half of all federally managed fisheries as well many subsistence, recreational, and aquaculture fish species important to Guam (*GAWR 2000; NOAA 2015*). Global concerns affecting corals include disease, ocean acidification affecting coral calcium carbonate skeletons, coral bleaching,[2] and increasing amounts of carbon dioxide in ocean water because of human development. Although it is unlikely the Proposed Action could contribute to these impacts, it is worth noting that the combination of these threats could inadvertently lead to high mortality of diverse resident and migratory fish found in and around Guam.

The major cause of fish habitat decline in Guam is due to coastal development and the associated degradation associated with pollutant runoff, marine debris, sedimentation, and land-based habitat clearing. Therefore, pollution management measures are recommended prior to the start of Proposed Action activities to minimize the effects of anthropogenic disturbance on coral reef ecosystems. Habitat loss occurring through direct or indirect exclusion, either by physically preventing organisms from using a habitat or by causing fish to avoid a habitat, could potentially lead to temporary or long-term effects. Habitat exclusion could lead to the prevention of fish and invertebrates (e.g., shellfish, sea cucumbers) from accessing an optimal habitat for breeding, spawning, feeding, or cover. Documented causes of pollutants in Guam include microbial organisms, petroleum hydrocarbons, excess nitrogen, heavy metals (i.e., zinc, copper, nickel), and turbidity (*Burdick et al. 2008*). Currently, the Guam Environmental Protection Agency in coordination with the National Pollutant Discharge Elimination System upholds management of pollution by run-off and coastal discharge (*Porter et al. 2005*). However, as the Proposed Action is only envisioned to be deployed in limited near-shore and inland waters, it is unlikely to impact large populations of fish and any potential impacts would likely be limited to individual or small numbers of fish. The wetlands in Guam include mangrove swamps consisting of black and red mangroves, marsh lands, and non-descriptive inland areas saturated with water (*Liu and Fischer*

[1] Material such as sand and cobble that is associated with or occurs on the bottom of a body of water (*NOAA 2006*).
[2] The stress response of corals releasing the photosynthetic plankton, known as Zooxanthellae, leading to coral bleaching.

2006). Mangrove wetland systems protect coastal waters and marine organisms by collecting and filtering rainwater runoff, as well as capturing sediment from eroding soil, which typically contains excess nutrients. These systems serve as important habitats for breeding, rearing, and feeding grounds for fisheries. Deployment activity in or near wetland areas, such as draining or filling wetlands with dirt, pilings, or concrete, could result in damage to specialized roots, habitat removal, and fragmentation, all of which degrade wetlands and decrease their quality as fish habitat. However, to the extent practicable or feasible, FirstNet and/or their partners would work to avoid filling wetlands or altering the hydrologic regime so that wetlands would not be lost or converted to non-wetlands.[3] Implementation of buffer zones and other BMPs and mitigation measures to avoid wetland degradation during equipment placement and operation is discussed in Chapter 11, BMPs and Mitigation Measures.

Guam has established five marine protected areas, national wildlife refuges, and ecological research areas that should be avoided to the extent practicable because these areas provide critical habitat, essential fish habitat (EFH), and niche specific ranges occupied by freshwater and marine fishes (*DAWR 2000*).

Disturbance to sea floor habitats could cause fishery-related stresses such as direct injury or mortality, loss of refuge or cover habitat, increase of suspended sediment, and disturbance or mortality of fish prey (e.g., algae, invertebrates). Land-based sediment and erosion can cause mortality in fish given the water clarity required by coral reef systems (*Rogers 1990*). Installation and operation on or near Guam's sea floor and limited near-shore and inland waters can alter productivity and reduce survivorship by increased sedimentation and turbidity reaching nearby waterways. Fragmentation from construction and development can present major environmental concerns including the loss of resident fish species and range reductions (*Pacific Fishery Management Council 2015*). These potential impacts could also extend to many invertebrate and fish assemblages associated with habitat. Actions that can alter habitat or create physical barriers during equipment placement and operation should be avoided to the extent practicable to minimize the prevention of fish and invertebrates from reaching suitable habitat.

Indirect Injury/Mortality

Indirect injury to aquatic habitat (e.g., coral reefs and seagrasses) that inadvertently affect fisheries include, changes in water quality, pH, and increased water turbidity (*USGS 2014*) Indirect injuries to individuals could be caused by underwater sound, poor water quality or changes in food availability. Underwater sound, such as noise by motor boats laying cable or heavy equipment near the shoreline, during operation and deployment of equipment can physically damage aquatic organisms or disrupt movement and migration patterns (*USDOT 2011*). BMPs and mitigation measures to reduce the effects of underwater noise can be found in Chapter 11, BMPs and Mitigation Measures. Indirect mortality and exclusion from resources could also result from degraded water quality or perturbation of physical habitat features.

[3] See Section 3.2.5, Wetlands, for more information related to potential impacts to wetlands.

However, as deployment activities would likely be temporary and of short duration, it is anticipated that any impacts would be limited to individual fish and aquatic organisms.

Potential indirect fisheries impacts associated with construction noise, installation, and increased human activity could include abandoned reproductive efforts, displacement, and avoidance of work areas, though these potential impacts would likely be temporary. Both direct and indirect potential impacts on fish and other marine life are expected to be short in duration and infrequent (limited to the period of activities). Mortality and injury of individual fish and aquatic organisms directly or indirectly linked to Proposed Action activities would likely be infrequent and could be further minimized by maintaining access to habitats and avoiding critical, species-specific time periods (e.g., spawning and migration).

Effects to Migration or Migratory Patterns

Many statutes and regulations have been implemented in Guam to minimize project activities on specific migratory and anadromous[4] fish-bearing waterbodies and are discussed in Affected Environment Section 6.1.6.3. Anadromous fish are born in freshwater, migrate to the ocean to grow as adults, and then return to freshwater to spawn. Blocked passages of inland streams used by anadromous fish during migration have significant effect on migratory patterns. In marine systems, highly migratory species are characterized as having vast geographical distributions with single stocks utilizing both national and international waters for feeding or reproduction (*Pacific Fishery Management Council 2015*). Highly migratory, non-anadromous fish species of Guam include four tuna species (yellowfin, bigeye, albacore, skipjack), three billfish species (blue marlin, striped marlin and swordfish), and two other species (dolphinfish and wahoo) (*Western Pacific Regional Fishery Management Council Undated_a*). It is possible that the Proposed Action could potentially impact migration or migratory patterns as a result of construction or if the duration of operation caused a deterrence of suitable habitat by fish, invertebrates, crustaceans, etc. However, it is anticipated that any interruption of migratory patterns would be minimal or not likely to occur within the Proposed Action area. Areas used by migratory fish tend to be isolated within migration pathways, spawning grounds, rearing sites, and nursery areas for use by resident and anadromous fish. Proposed Action related noise could mask communications by aquatic species and displace them entirely. Researchers have found that when fish are exposed to high noise levels, communication and auditory sensitivity were found to decline (*Ladich 2013, Codarin et al. 2009*). If continuous high levels of ambient noise persist in an area (e.g., from existing pedestrian traffic, highway noise, and other human activities in the area), the additional noise from installation, deployment, and operation could be negligible and species could acclimate. Otherwise, some species could become temporarily or permanently displaced due to noise. Physical noise displacement from the Proposed Action could cause fish and marine organisms to use an excess expenditure of energy to avoid the noise source or search for more suitable habitat. This, in turn, depletes energy reserves normally used for growth, migration, and/or reproduction.

[4] Anadromous fish are born in freshwater, migrate to the ocean to grow as adults, and then return to freshwater to spawn (NOAA 2006).

It is possible that the Proposed Action could potentially impact migratory patterns due to noise, but it is likely that such impacts would be very localized (associated with limited near-shore and inland water deployment) and of a short duration. Therefore, it is anticipated that migratory patterns would be subject to minimal noise disturbance during construction and operation. Additionally, to further reduce potential impacts, suitable habitat availability in the vicinity of the Proposed Action could be considered to accommodate these species to the extent practicable. For specific noise BMPs and mitigation measures, see Chapter 11, BMPs and Mitigation Measures.

Fish produce sounds through three ways: drumming of the swim bladder with the sonic muscle, striking or rubbing together teeth or skeletal parts, and hydrodynamic sound production when fish quickly change speed and direction. The majority of sounds produced by fishes are of low frequency, typically less than 1000 Hz.

Reproductive Effects

The Magnuson-Stevens Fishery Conservation and Management Act (*16 USC 1801 et seq.*) established a management system for fishery resources in the United States. Identification of EFH includes "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (*NOAA 2007*). The Western Pacific Regional Fishery Management Council has also identified habitat areas of particular concern of corals generally found supporting reproductive life stages of marine fish and aquatic invertebrates (*Western Pacific Regional Fishery Management Council Undated_b*).

Potential impacts to functional development of life stages (i.e., eggs and larvae) could be reduced by minimizing physical barriers. One example of temporary or long-term barriers is the underwater housing of cables that could potentially preventing the success of fish egg fertilization or invertebrate passage during construction or operation, although unlikely due to the small size of underwater conduit that contain telecommunication cable. Reproductive effects to fish and shellfish species are most prevalent through the direct loss of spawning habitat, slow recovery rates of habitat features, and the mortality of eggs and juveniles. However, the Proposed Action anticipates only minor disruption of the reproduction of fisheries and disturbance of their resources as individual projects will be small scale (generally less than an acre of disturbance) and deployment will be short term.

During construction, activities such as minor removal of aquatic and terrestrial vegetation, in-stream trenching, and equipment installation could potentially result in the modification of aquatic habitats and thereby adversely affect fish reproduction. Other risks of vegetation clearing and soil compaction could potentially lead to an increase of runoff into coastal habitats (*Thrush et al. 2004*). Potential impacts could include increased sedimentation and turbidity (see Section 6.2.2, Soils), increased temperature, decreased dissolved oxygen concentrations, releases of existing chemical and nutrient pollutants from disturbed sediments, and introduction of chemical contaminants, such as fuel and lubricants, due to spills (see Section 6.2.4, Water Resources). However, due to the scale of the individual projects (generally less than an acre of disturbance) and the short duration of deployment activities (in some cases, as little as a few hours at one location) it is unlikely that deployment activities will result in more than minor impacts to fish from removal of vegetation or increased sedimentation. Additionally all federal, commonwealth, and local regulatory requirements will be adhered to regarding erosion and sediment control. BMPs and mitigation measures could be implemented to further prevent sedimentation and other discussed hazards from reaching nearby surface waters (see Chapter 11, BMPs and Mitigation Measures). Measures such as time or area restrictions, avoidance of certain habitats, and mitigation could minimize adverse effects on reproductive habitat.

Invasive Species Effects

The introduction of nonnative species affects the structure and function of aquatic systems relied upon by fish. Invasive species can diminish the health of native fish communities through predation, disease introduction, habitat alteration, and competition for resources (e.g., food and space) (*USFWS 2012*). For example, many non-indigenous freshwater fish have been introduced to Guam and expensive eradication efforts have been made to reduce the number of fish inhabiting habitat outside historic ranges. However, most introductions have been associated with aquaculture, ornamental fish trade, biological control methods, and research incidentals (*Nico and Walsh 2011*).

It is possible that the Proposed Action could potentially impact native species if previously deployed equipment is not cleaned and sterilized to prevent the spread of invasive algae, fish species, or other aquatic organisms. However, it is anticipated that the small scale of the individual projects (generally less than an acre) and the short duration of deployment activities would be unlikely to result in the spread of invasive species. Additionally, implementation of BMPs and mitigation measures (and recommended sanitation procedures) could further prevent the spread of invasive species and the alteration of fishery habitat.

Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative would result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to fisheries resources and others would not. In addition, and as explained in this section, the various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2 Proposed Action Infrastructure, the following are likely to have *no impacts* to fisheries resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to fisheries resources since the activities that would be conducted at these small entry and exit points are not likely to produce perceptible changes and are likely not located in fish habitat. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce these potential impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to fishery resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact fisheries resources because those activities would not require ground or waters disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact fisheries resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential construction/deployment-related impacts to fisheries resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of ground or water disturbing activities, including plowing, trenching, boring, and filling in fish habitat. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to fisheries resources include the following:

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, excavating, filling, directional boring and the construction of points of presence,[5] including huts or other associated facilities or hand-holes to access fiber, could result in potential impacts to fisheries and fish habitat. Although potential impacts are usually temporary, buried fiber optic installation methods could potentially result in high-risk situations to fisheries resources by sedimentation from on-shore activities. Furthermore, these risks include the removal of productive habitat, blocked passage of streams used by anadromous fish during reproduction periods, and the introduction of excess sediment and turbidity into waterways during construction/deployment. Ground and water disturbance associated with vibratory plowing activities and excavation activities could also result in fish habitat loss and mortality of individuals due to ground-born sound transmissions. Sound pressure waves pass through various media (soil, water, air) and can propagate long distances with little attenuation, especially when travelling through water (*Dahl et al. 2007*). Aquatic organisms' sensitivity to sound and vibrations varies greatly by species, with sharks and bony fish being particularly sensitive (*University of Maryland 2000*), thus sound and pressure waves can change fish behavior (*Popper and Hastings 2009*). Egg viability and embryoic development of aquatic species can be affected when exposed low frequency vibrations (*VanDerwalker 1964; Vandenberg et al. 2012*). It is anticipated that these potential impacts will be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms.
  - New Build–Aerial Fiber Optic Plant: Ground and water disturbance and heavy equipment use associated with construction activities as well as land/vegetation clearing, and excavation activities associated with pole construction could result in fish habitat loss if activities occur near/in lakes, streams, rivers, coastlines, or wetlands. Noise and sedimentation associated with construction activities could stress fish, therefore potentially impacting their longevity and/or migratory patterns. It is anticipated that these potential impacts will be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms.
  - Collocation on Existing Aerial Fiber Optic Plant: Installation of cables using existing poles and structural hardening or reinforcement of equipment to improve disaster resistance and resiliency would have few potential impacts on fisheries habitat compared to new build construction, although some fish habitat loss could occur if activities were near/in lakes, streams, rivers, coastlines, or wetlands. It is anticipated that these potential impacts will be minimal due to the small footprint of deployment activities (generally

[5] Points of presence are connections or access points between two different networks, or different components of one network.

less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce these potential impacts. Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: The use of existing fiber optic cables would have lower risk and reduced potential impacts on fisheries resources compared to a new system installation; however, if upgrades are necessary or new equipment or cable is installed, there could be potential impacts to fisheries resources. Ground, water, and sea floor disturbance and heavy equipment use associated with construction activities as well as land/vegetation clearing, erosion, sedimentation, noise, and excavation activities associated with construction could result in fish habitat loss and disruption of migratory patterns, especially if activities occur near/in lakes, streams, rivers, coastlines, or wetlands.

- New Build–Submarine Fiber Optic Plant: The installation and construction of sealed cables in limited near-shore or inland bodies of water and the construction of landings/facilities to accept a cable buried close to the shoreline could potentially impact fisheries resources. Although sensitive or vulnerable areas vary along Guam's shores, changes to aquatic communities that occupy the shoreline could disrupt fish development, sessile[6] invertebrates, alter community structure, and potentially change the fishery dynamics within the aquatic habitat (*NOAA 2008*). It is anticipated that these potential impacts will be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion control mechanisms. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce these potential impacts).
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground or water disturbance, there would be *no impacts* to fisheries. Ground and water disturbance during the installation of equipment to enhance the signals traveling through the fiber may involve the installation of concrete pads and potential construction of an access road, potentially leading to runoff, erosion, and sediment reaching nearby fishery habitats. These construction activities, which may include land/vegetation clearing and excavation, could potentially result in the loss of fishery habitat. If an access road is constructed, additional potential impacts to fish habitat resulting from stream crossing methods, culvert installations, and road runoff could be considered. It is anticipated that these potential impacts will be minimal due to the small footprint of deployment activities (generally less than an acre), the short duration of those activities, and the application of federal, commonwealth, or locally required sediment and erosion

[6] Unable to move, attached to the substrate (*NOAA 2006*).

control mechanisms. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce these potential impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads constructed near aquatic habitats could potentially result in potential impacts to fish habitat and other fisheries resources (i.e., construction noise disturbance, light pollution, and spills from generator fluids). It is anticipated that these potential impacts will be minimal due to the small footprint of deployment activities (generally less than an acre) and the short duration of those activities. Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce these potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower and would result in less potential impact to fisheries than the construction of new wireless communication towers. However, if the onsite delivery of additional power units, structural hardening, and physical security measures were required, potential temporary impacts and disturbance to fishery habitat could potentially lead to species deterrence and loss of suitable habitat.
- Deployable Technologies
  - Where deployable technologies (i.e., Cell on Wheels, Cell on Light Truck, System on Wheels, or aerial deployables such as piloted aircraft, balloons, or drones) would be implemented on existing paved and unpaved road surfaces, it is anticipated that there would be no impacts to fisheries resources because there would be no new ground or water disturbance. However, implementation of deployable technologies could result in potential impacts to fisheries resources if deployment occurs in off-road areas. Some construction of staging or landing areas (depending on the type of technology) may require land/vegetation clearing, excavation, and paving. Although unlikely, these activities could result in loss of fish habitat (e.g., wetlands, streams, or vegetation used as cover in these areas). In addition, implementation of aerial deployable technologies could result in direct injury or death to fish or damage to fish habitat if a piece of equipment were to fall into an aquatic habitat. To retrieve a fallen piece of equipment, additional fish habitat damage could occur. It is anticipated that these potential impacts will be minimal due to the small footprint of deployment activities (generally less than an acre) and the short duration of those activities (as short as a few hours in some cases). Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce these potential impacts.

In general, the abovementioned activities could potentially involve ground, waters, and near-shore sea floor disturbance by heavy equipment use associated with the construction activities, land/vegetation clearing, and excavation activities associated with construction. Potential impacts to fisheries resources associated with deployment of this infrastructure could include direct injury/mortality, habitat loss, indirect injury/mortality, effects to migration, reproductive effects, and introductions of invasive species. These potential impacts and associated BMPs and mitigation measures to help mitigate or reduce these potential impacts are described in Chapter 11, BMPs and Mitigation Measures.

Given the scope of the project, while geographically enormous (50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive (generally less than an acre) and will likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity, and where the deployment will take place, will be determined based on location-specific conditions and the results of site-specific environmental reviews. These potential impacts associated with the Proposed Action, based on the deployment activity and the limited duration of construction activities, are described further below.

Potential Direct Injury/Mortality Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential impacts as a result of direct injury/mortality are anticipated to be *less than significant*. It is anticipated that for most types of facilities or infrastructure development scenarios, loss of terrestrial vegetation would likely be isolated within construction locations and/or would be short-term with stability achieved within several years, depending on the vegetation cover present in the area. In addition, since the proposed deployment activities are only envisioned to be performed in limited near-shore and inland waters, it is unlikely that deployment will result in impacts to aquatic habitats. Implementation of BMPS and mitigation measures could further reduce potential impacts. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Habitat Loss Impacts

Based on the analysis of the potential deployment effects to fisheries resources described above, potential impacts as a result of habitat loss are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Indirect Injury/Mortality Impacts

Based on the analysis of the potential deployment effects to fisheries resources described above, potential impacts as a result of indirect injury/mortality are anticipated to be *less than significant* since deployment activities would likely be temporary, of short duration, and any impacts would likely be limited to individual fish and aquatic organisms. See Chapter 11, BMPs and Mitigation

Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Migration Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential migration impacts are anticipated to be *less than significant* since such impacts are anticipated to be localized, short term, and limited to near-shore and inland environments. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Reproductive Effects Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential impacts as a result of reproductive effects are anticipated to be *less than significant*. It is anticipated that project activities would result in only minor disruption to fisheries reproduction at the individual level, not the population level. Potential impacts to reproduction would also likely be short term and localized. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Invasive Species Impacts

Based on the analysis of the deployment activities described above to fisheries resources, potential invasive species impacts are anticipated to be *less than significant*. It is anticipated that the small scale of the individual projects (generally less than an acre) and the short duration of deployment activities would be unlikely to result in the spread of invasive species. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with fisheries and aquatic habitats.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would likely result in potential impacts similar to the abovementioned potential deployment/construction impacts. It is anticipated that there would be few potential impacts to fisheries resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Although unlikely, herbicides and the potential release of other contaminants by runoff could present potential impacts to fish and their habitats. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, additional potential fish impacts could occur (e.g., stream bank erosion, sedimentation of streams). However, these impacts would likely be localized, limited to individual species, and unlikely to cause population-level impacts.

Alternatives Impact Assessment

The following section assesses potential impacts to fisheries associated with the Deployable Technologies Alternative and the No Action Alternative.[7]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to fisheries resources as a result of implementation of this alternative could be as described below.

<u>Potential Deployment Impacts</u>

The implementation of deployable technologies is not anticipated to cause significant potential impacts to fisheries resources. Deployment and operation of cellular masts and antenna generated signals are anticipated to have minimal disturbance to fish. However, greater frequency and duration of deployments could change the magnitude of potential impacts depending on species, life history, and region of the territory.

The main potential impact on fisheries would be the placement of deployable infrastructure near waterbodies. Generator stations that power this infrastructure are designed to be self-contained within a trailer. This would require fuel storage to be kept onsite with associated protection plans to prevent spills and contamination to fishery dependent waterways.

Tidal regimes, which may differ between the north and south coasts, should be taken into account when deploying equipment near coastal locations. This would prevent loss of equipment and marine debris in nearby coastal fish habitat.

Guam is located in the active region of the western Pacific Ocean that experiences frequent trade wind conditions, ocean swells, and tropical storms. Routine maintenance checks of equipment operation sites could prevent potential impact by equipment weathering, such as corrosion of metal, rust, and growth removal to reduce potential impacts on water quality and prevent coastal source pollution. Stability in the construction of equipment to withstand natural environmental

[7] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

factors, (e.g., storms, hurricanes, and typhoons) could prevent the irritation or damage to the digestive systems of fish (*NOAA 2011*).

Potential Operation Impacts

As explained above, operation activities would consist of running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *no impacts* to fisheries resources associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. If routine maintenance or inspections occur off of established access roads or corridors, or if the acceptable load capacity of the roads is exceeded, sediment laden run-off and increased stream bank erosion could occur. The utilization of buffer zones, temporary or permanent native seeding on disturbed ground, ground cover, plastic sheeting and matting would minimize sedimentation of aquatic systems. In addition, Stormwater Pollution Prevention Plans as required by the Clean Water Act should be implemented at Proposed Action sites where more than 1 acre of ground would be disturbed (*USEPA 2007*).

Coastal development can cause potential impacts to aquatic organisms by underwater sound, poor water quality or changes in food availability. Underwater sound during equipment operation, depending on magnitude and frequency, can physically damage fish or disrupt movement and migration patterns (*Popper and Hastings 2009, USDOT 2011*).

To minimize disturbance for the duration of operation, which could potentially last up to 2 years, it is recommended that deployment activities avoid productive habitats, such as coastal wetlands, inland waterways, EFH, seagrasses, and reefs to the extent practicable. Adverse effects on these productive habitats could include many potential direct and indirect impacts in the form of physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, individuals, fisheries, benthic organisms, prey species, and their habitat, and many other ecosystem components. However, it is anticipated that these potential impacts would be minimal due to the small footprint of deployment activities (generally less than an acre) and the short duration of those activities (as short as a few hours in some cases). Implementing BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce these potential impacts.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to fisheries resources as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.6.5, Fisheries and Aquatic Habitats.

6.2.6.6. Threatened and Endangered Species and Species of Conservation Concern

Introduction

This section describes potential impacts to federal- or territory-listed plant and animal species[1] (hereafter collectively referred to as listed species) and designated critical habitat associated with deployment and operation of the Proposed Action and alternatives, and discusses best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts.

Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on listed species were evaluated using the significance criteria presented in Table 6.2.6.6-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as: *may affect, likely to adversely affect; may affect, not likely to adversely affect;* and *no effect*. These impact categories are comparable to those defined in the *Endangered Species Consultation Handbook* and are described in general terms below (*USFWS and NMFS 1998*):

- "*No effect*" means that no listed resources would be exposed to the action and its environmental consequences.
- "*May affect, not likely to adversely affect*" means that all effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact and include those effects that are undetectable, not measurable, or cannot be evaluated. Discountable effects are those extremely unlikely to occur.
- "*May affect, likely to adversely affect*" means that listed resources are likely to be exposed to the action or its environmental consequences and would respond in a negative manner to the exposure.

Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

[1] Includes terrestrial, freshwater, and marine plant and animal species that are federally listed as threatened, endangered, candidate, proposed, or species of concern; species that are territory-listed as critically endangered, endangered, threatened, or vulnerable; and/or species that receive specific protection defined in federal or territorial legislation.

Table 6.2.6.6-1: Impact Significance Rating Criteria for Listed Species and Critical Habitats

Type of Effect	Effect Characteristic	Impact Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
Direct and Indirect Injury/Mortality of a Listed Species	Magnitude or Intensity	According to the U.S. Endangered Species Act, this impact threshold applies at the individual level so therefore applies to any mortality of a listed species and any impact that has more than a negligible potential to result in unpermitted take of an individual of a listed species. Excludes permitted take.	Does not apply in the case of mortality (any mortality unless related to authorized take falls under *likely to adversely affect* category); Applies to a negligible injury that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect; Includes permitted take	No measurable effects on listed species
	Geographic Extent	Any geographic extent of mortality or any extent of injury that could result in take of a listed species	Any geographic extent that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect; Typically applies to one or very few locations	No measurable effects on listed species
	Duration or Frequency	Any duration or frequency that could result in take of a listed species	Any duration or frequency that does not meet the threshold of take due to its low level of effect and/or ability to fully mitigate the effect; Typically applies to infrequent, temporary, and short-term effects	No measurable effects on listed species
Indirect Effects from Disturbance or Displacement Resulting in Reproductive Effects	Magnitude or Intensity	Any reduction in breeding success or survivorship of offspring of a listed species	Changes in breeding behavior (e.g., minor change in breeding timing or location) that are not expected to result in reduced reproductive success or survivorship of offspring	No measurable effects on listed species
	Geographic Extent	Reduced breeding success or survivorship of offspring of a listed species at any geographic extent	Changes in breeding behavior at any geographic extent that are not expected to result in reduced reproductive success or survivorship of offspring of listed species; Typically applies to one or very few locations	No measurable effects on listed species
	Duration or Frequency	Any duration or frequency that could result in reduced breeding success or survivorship of offspring of a listed species	Infrequent, temporary, or short-term changes in breeding behavior that do not reduce breeding success or survivorship of offspring of a listed species within a breeding season	No measurable effects on listed species

Type of Effect	Effect Characteristic	Impact Level		
		May Affect, Likely to Adversely Affect	**May Affect, Not Likely to Adversely Affect**	**No Effect**
Indirect Effects From Disturbance or Displacement Resulting in Behavioral Changes	Magnitude or Intensity	Disruption of normal behavior patterns (e.g., breeding, feeding, or sheltering) that could result in take of a listed species	Minor behavioral changes that would not result in take of a listed species	No measurable effects on listed species
	Geographic Extent	Any geographic extent that could result in take of a listed species	Changes in behavior at any geographic scale that are not expected to result in take of a listed species; Typically applies to one or very few locations	No measurable effects on listed species
	Duration or Frequency	Any duration or frequency that could result in take of a listed species	Infrequent, temporary, or short-term changes that are not expected to result in take of a listed species	No measurable effects on listed species
Direct or indirect effects on habitats (including designated critical habitats) that affect population size and long-term viability for listed species	Magnitude or Intensity	Effects to any of the essential features of listed species habitat that would diminish the value of the habitat for the survival and recovery of the listed species	Effects to listed species habitat that would not diminish the functions or values of the habitat for the species for which the habitat was designated	No measurable effects on listed species habitat
	Geographic Extent	Effects to listed species habitat at any geographic extent that would diminish the value of the habitat for listed species; Note that the *likely to adversely affect* threshold for geographic extent depends on the nature of the effect; Some effects could occur at a large scale but still not appreciably diminish the habitat function or value for a listed species; Other effects could occur at a very small geographic scale but have a large adverse effect on habitat value for a listed species	Effects realized at any geographic extent that would not diminish the functions and values of the habitat for the listed species; Typically applies to one or few locations within a habitat known to be used by listed species	No measurable effects on listed species habitat
	Duration or Frequency	Any duration or frequency that could result in reduction in habitat function or value for a listed species	Any duration or frequency that would not diminish the functions and values of the habitat for which the habitat was designated; Typically applies to Infrequent, temporary, or short-term changes	No measurable effects on listed species habitat

As discussed in Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern, numerous listed species occur in Guam. Listed species are protected under federal and territory regulations and, in most cases, a permit or other authorization is required for take[2] of a listed species. There are 32 federally and/or territorial-listed plant and animal species in Guam, including 3 plants, 5 birds, 7 mammals, 10 reptiles, 1 fish, and 6 invertebrates. There are 15 federal candidate species including 13 plants and 2 invertebrates. Federally listed species are under the jurisdiction of the United States (U.S.) Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) and territory-listed species are under the jurisdiction of the Guam Department of Agriculture. Two species in Guam have critical habitat that has been designated by the USFWS: Mariana fruit bat (*Pteropus m. mariannus*), and Mariana crow (*Corvus kubaryi*) (*USFWS 2015; USFWS 2004*). Table 6.2.6.6-2 provides key information about the federal and territorial-listed species and designated key habitats, summarized by taxonomic group.[3]

As summarized in Table 6.2.6.6-2, most of the federally listed species fall under the endangered[4] and candidate[5] categories. Most of the federally endangered species are whales and birds. Most of the territory endangered species are reptiles and birds. Of the 47 federally and territory-listed species, 20 are marine and 27 are terrestrial.

[2] Take is defined differently by various federal and territorial regulations but the most commonly accepted definition is that of the U.S. Endangered Species Act (ESA). This act defines take as "to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in any such conduct." The act further defines "harm" as "significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering," and "harass" as "actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering."

[3] A taxonomic group is a group of biological organisms that have shared characteristics.

[4] According to the ESA, the term "endangered species" means any species that is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary of the Interior to constitute a pest whose protection under the provisions of the ESA would present an overwhelming and overriding risk to man.

[5] According to the ESA, the term "candidate species" means a species officially nominated for listing as threatened or endangered.

Table 6.2.6.6-2: Summary of Information on Federally and Territory-Listed Species in Guam

Taxonomic Group (Total Number of Species)	Listing Status and Number of Species in Each Listing Category[a]					
	Federally Endangered	**Federally Threatened**	**Federal Candidate**	**Territory Endangered**	**Territory Threatened**	**Key Habitat**
Plants (16)	1	0	13	3	0	Forest, savanna, or rock substrates
Marine Mammals (6)	5	1	0	0	0	5 species are whales that occur in the open marine environment and 1 species is a dugong that occurs in coastal habitats, particularly seagrass.
Terrestrial Mammals (1)	0	1	0	1	0	Fruit bat that occurs primarily in limestone forest and less frequently in coconut plantations
Birds (5)	4	0	0	5	0	3 of 5 species occur in forested habitats and 2 occur in wetlands.
Reptiles (10)	2	3	0	6	1	5 species are sea turtles that occur in marine and coastal habitats and 5 species are skinks that occur in coastal or forest habitats.
Fish (1)	0	1	0	0	0	Marine: coastal pelagic (i.e., open ocean)
Invertebrates (8 includes 2 insects, 3 snails, and 3 corals)	3	3	2	0	0	Insects (butterflies) and snails occur in forest and the corals occupy reefs in marine waters.
TOTAL (47)	**15**	**9**	**15**	**15**	**1**	

Sources: USFWS 2015; NMFS 2015

[a] Eight species in Guam are both federally and territory-listed so the number of species summarized for the listing categories is greater (55) than the total number of listed species (47).

Listed species would be subject to the same potential impacts described for vegetation, wildlife, and fish (Section 6.2.6.3, Terrestrial Vegetation, Section 6.2.6.4, Wildlife, and Section 6.2.6.5, Fisheries and Aquatic Habitats). However, the magnitude of such impacts on listed species have the potential to be greater because of the reduced population size and/or limited geographic distribution of listed species and the importance of habitats known to support listed species for the maintenance of listed species populations. Further, all of the bird populations on Guam have been severely diminished by the presence of non-native mammals including rats and snakes that prey on bird eggs, young, and even adults (*Rodda and Savidge 2007*). Thus, listed bird species are particularly vulnerable to impacts because they are also faced with a substantial, ongoing threat from predation.[6] Potential impacts to endangered species would be more significant in terms of magnitude than impacts to species in the threatened or candidate categories.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to listed species discussed in this section are presented as a range of possible impacts to the major taxonomic groups that encompass the listed species in Guam (i.e., plants, terrestrial mammals, marine mammals, marine reptiles, birds, fish, and invertebrates).

Description of Environmental Concerns

The following types of direct and indirect effects were considered in evaluating the potential impact of the Proposed Action and alternatives on listed species (see Table 3.2.6.6-1 for further details):

- Direct injury or mortality—includes the taking (removal or loss) of a listed species (individual or population) due to physical injuries, extreme stress, or death of an individual from interactions associated with the Proposed Action;
- Indirect effects from disturbance or displacement—includes changes in an individual or population's habitat use or life history pattern due to disturbance from increased noise and vibration, human activity, visual disturbance, and associated transportation activity; increased competition for resources or habitat due to displacement of individuals from the affected area into the territory of other animals; or other indirect effects that ultimately cause mortality, decreased fitness, or reduced breeding in the future population; and
- Direct or indirect effects on habitats for listed species that affect population size and long-term viability for listed species—direct habitat effects are primarily physical disturbances that result in alterations in the amount or quality of a habitat. Indirect habitat loss can occur through preventing an animal from accessing an optimal habitat (e.g., breeding, forage, or refuge), either by physically preventing use of a habitat or by causing an animal to avoid a habitat, either temporarily or long-term.

Any of the listed species with individuals, populations, or habitat in the vicinity of activities related to the Proposed Action could be subject to one or more of the above potential impacts from the Proposed Action; however, implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would completely avoid potential impacts on some species and reduce potential impacts on others. The nature and extent of potential impacts to listed species would vary depending on many factors, including but not limited to, the species, the location and extent of the Proposed Action activity, the time of year, and the duration of deployment.

[6] Predation is the relationship between two organisms of unlike species in which one of them acts as the predator that captures and feeds on the other organism that serves as the prey.

The following sections define and describe each of these potential impacts according to the taxonomic groups encompassing the listed species in Guam.

Plants

Sixteen federally and territory-listed plant species occur in Guam, five of which are only found in Guam and the others are more broadly distributed on other regional island chains (e.g., the Mariana Islands). The 16 species occur in a variety of habitats that encompass multiple forest types, savanna, and rock substrates. Potential impacts of Proposed Action activities on listed plants include direct mortality or injury, habitat loss, and habitat disturbance/degradation. The primary means of avoiding or minimizing potential impacts on listed plant species is to conduct expert and/or agency consultation to gather specific information on the location and distribution of the species prior to construction to ensure that the locations of listed plant species and their habitats are avoided to the maximum extent practicable. Where avoidance is not possible, consultation with USFWS and/or Guam Department of Agriculture would be conducted to identify suitable minimization and mitigation measures to ensure that the Proposed Action would not result in adverse effects to listed plants.

Terrestrial Mammals

One terrestrial mammal species in Guam, the Mariana fruit bat, occurs primarily in undisturbed limestone forests; critical habitat has been designated for the Mariana fruit bat on the northern coastline of Guam at Ritidian Point (see Figure 6.2.6.6-1). Critical habitat for this species includes undisturbed wet forests that contain specific tree species used for foraging, roosting, and breeding as well as limestone cliffs between 260 and 590 feet tall (*USFWS 2004*).

The Mariana fruit bat is highly mobile so would likely move away from any Proposed Action activity, avoiding direct injury or mortality. As such, potential impacts to this species from the Proposed Action would likely be limited to disturbance, displacement, and/or habitat loss. If it would occur, the most significant of these potential impacts would be habitat loss involving loss of maternity roosts[7] because suitable roost sites are often limited and are critical for successful rearing of young (*Bat Conservation Trust 2015*). For this bat species, roosts occur on steep cliffsides where human disturbance is minimal.

[7] Maternity roosts are locations where bats congregate to birth and rear young. Maternity roosts are often located in trees, under manmade structures (e.g., bridges, rooftops, etc.), or in caves.

Source: USFWS 2004

Figure 6.2.6.6-1: Location of Designated Critical Habitat for Mariana Fruit Bat

In general, displacement of individuals into other available and suitable habitats could result in increased energy expenditure and competition for resources in the newly occupied area but these potential impacts would not be expected to cause mortality or have other adverse effects at the population level because bats do not exhibit high site fidelity[8] and they frequently shift habitats based on availability of preferred food resources or roost sites. Breeding occurs throughout the year depending on food availability and climatic conditions, so avoidance of the breeding period could not be guaranteed. However, potential impacts from the Proposed Action on this species would largely be avoidable through informed siting of Proposed Action features[9] away from undisturbed forest and known or potential cliffside roost sites. Any Proposed Action activities that could affect this species or its habitats would be preceded by consultation with USFWS and Guam Department of Agriculture to ensure potential impacts to the species are avoided or minimized to the maximum extent possible.

Marine Mammals

Five federally listed whale species occur in the offshore marine waters of Guam (*NMFS 2015*). FirstNet is unlikely to impact whales because deployment activities would only take place in nearshore or inland waters. Such activities would be conducted using small- to medium-sized vessels that are highly maneuverable and could, therefore, easily avoid interactions with any whales that could incidentally occur in nearshore waters.

A potential impact to listed whale species is disturbance from underwater noise. Noise associated with the installation of cables in the near/offshore waters of Guam could impact whale behavior; however, the marine activities related to the Proposed Action are very limited in nature and would be located in nearshore environments where whales are not expected to occur, so risks to whales from marine noise are expected to be low. Whales could be temporarily excluded from a resource if they avoid it due to the increased presence of boats and associated noise. Greater human activity of longer duration would increase the likelihood that listed whale species would avoid affected areas, possibly being excluded from essential resources. The degree to which habitat exclusion could affect any of the listed whale species depends on many factors, including the context and duration of the noise exposure and the individual's experience, life stage, and conditioning. However, as stated above, the potential impacts associated with the Proposed Action are unlikely to impact whales; the likelihood of impacts could be further reduced with implementation of appropriate BMPs and mitigation measures if deemed necessary and defined through consultation with the appropriate resource agency. Potential impacts from the Proposed Action would likely be short-term, not wide ranging, and below sound exposure impact thresholds[10] and thus would not adversely affect listed whale species.

[8] The tendency of an animal to return to a previously occupied location.

[9] In this section, informed siting of Proposed Action features refers to the act of locating activities or features in areas that do not support listed species or their known habitats.

[10] Sound exposure impact thresholds developed by *Southall et al. (2007*) define specific sound levels above which measurable transient effects (Level B) or permanent effects (Level A) could occur on the hearing of marine mammal species. Level A and B thresholds have been established for seals (all species considered as one group) and for whales, dolphins, and porpoises (all species considered as one group) (*Southall et al. 2007*).

The other listed species of marine mammal in Guam, the dugong, inhabits calm and shallow coastal waters, primarily those with seagrass beds (*IUCN 2015*). Dugongs are highly dependent on the presence of healthy seagrass, which comprises most of their diet; a dugong's reproductive success is directly related to the availability of its seagrass food (*Marsh et al. 2002*). When dugongs do not have enough seagrass to eat, they delay breeding, so any loss or disturbance of seagrass habitat could adversely affect this species (*Marsh et al. 2002*). Seagrasses are very susceptible to changes in water quality conditions, such as increased turbidity, so changes in water quality could potentially indirectly affect dugongs through impacts on their food source. Additionally, dugongs are slow moving and not highly maneuverable, making them subject to vessel strike. Dugong sensitivity to underwater noise is unknown (*Marsh et al. 2002*). As such, the potential impacts of the Proposed Action activities on would be primarily related to habitat loss or degradation and vessel strike; however, the marine activities related to the Proposed Action are very limited in nature, so risks to dugongs from vessel strike and marine noise are expected to be low. Implementation of BMPs and mitigation measures involving avoidance of seagrass habitats and use of marine observers on vessels, if deemed necessary by the appropriate resource agency, would substantially reduce the potential impacts of the Proposed Action to this species.

Marine Reptiles

Five species of sea turtles occur in Guam. Of the five species of sea turtles known to occur in Guam waters, three are incidental and occur infrequently but two occur more regularly and nest on Guam beaches (*USFWS 2015*). Nesting sites sea turtles are well known and could thus be easily avoided through informed siting of Proposed Action activities. As such, potential impacts to listed turtle species as a result of the Proposed Action would likely be limited to vessel strike during marine vessel-based deployment or maintenance activities; however, the marine activities related to the Proposed Action are very limited in nature so risks to listed turtle species from vessel strike and marine noise are expected to be low. Marine-based activities related to the Proposed Action could displace individual turtles from the area around the work zones; however, this displacement would be temporary and would not significantly alter migratory routes or foraging behavior of individuals over the long term. Avoiding seagrass habitats, which marine turtles use for foraging, would minimize the potential impacts to foraging turtles.

Any lighting erected or used along the coast for Proposed Action Activities could disrupt movement patterns and breeding behavior of sea turtles in the vicinity of the lit area. Artificial lighting placed at project locations, either during deployment or operation, could discourage females from nesting and disorient hatchlings, attracting them towards land rather than the ocean, which makes them vulnerable to predation and other sources of mortality (*Sea Turtle Conservancy 2015*). Minimization of coastal lighting, particularly within 500 feet of known nesting beaches, and use of turtle safe lighting instead of normal lights (low-pressure sodium-vapor lighting or red lights that emit a very narrow portion of the visible light spectrum) would minimize the potential impacts to nesting turtles and hatchlings (*Sea Turtle Conservancy 2015*).

Birds

Of the five listed species of birds that occur in Guam,two occur in wetlands, two in forests, and one in limestone caves Critical habitat for one species, the Mariana crow, has been designated on the northern coastline of Guam at Ritidian Point (*USFWS 2004*) (see Figure 6.2.6.6-1). The most significant potential direct impacts to listed bird species from the Proposed Action could be injury or death of individuals from habitat loss or deployment of equipment (e.g., antennas, cables, towers, communication lines). Such potential impacts would be unlikely given that birds are highly mobile and would disperse from Proposed Action activities. Young birds or eggs would be most susceptible to direct or indirect mortality due to their immobility or limited mobility, but BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would significantly reduce the likelihood of such impacts.

The more likely direct and indirect effects of the Proposed Action on listed birds would include potential habitat loss and disturbance and stress caused by noise, human activity (e.g., equipment deployment and human presence), and habitat degradation, which could result in nest abandonment if conducted during the breeding season.

The five species of listed birds in Guam are all highly susceptible to human disturbance and habitat alteration, particularly during the summer breeding season. Disturbance from human activity (addressed above), noise, vibration, and habitat degradation could cause abandonment of nesting sites, resulting in adverse reproductive effects. If the disturbance occurs late in the breeding season, individuals may not reattempt to nest following disturbance, resulting in the loss of a full breeding year for the affected species in a given area. If the disturbance occurs early in the breeding season, individuals could reattempt to nest if suitable habitat exists and it is not already occupied by other individuals. If the new habitat is suboptimal, reduced adult and immature bird survivorship, reduced reproductive rates, or reduced offspring survivorship could occur. Single disturbance events would have lower potential impacts on listed birds than repeated disturbances that are unpredictable in terms of the timing, type, or magnitude of the disturbance. Greater human activity of longer duration would increase the likelihood that birds would avoid the affected area, possibly resulting in permanent displacement or exclusion from essential resources.

The five species of listed birds in Guam each have very specific nesting requirements. As such, loss of nesting habitat and disturbance of breeding birds could be avoided through implementation of informed siting of Proposed Action activities outside of known or potential breeding areas during and immediately after the breeding season (generally April through August).

Mortality or injury from collisions or electrocutions with manmade cables and wires are of concern for avian species. Birds that are at greatest risk of collision events include those that are not highly maneuverable (such as ducks), heavy birds (such as swans and cranes), and birds that fly in flocks (APLIC 2012). Certain bird species and species groups are more susceptible to electrocution than others based on their size and behavior that increases their risk of exposure to energized and/or grounded hardware. For example, the large wingspans of raptors such as bald eagles, red-tailed hawks (*Buteo jamaicensis*), osprey (*Pandion haliaetus*), and great horned owls

(*Bubo virginianus*) enable them to simultaneously touch energized and/or grounded hardware parts. Tall birds such as herons and egrets are also at risk of electrocution where vertical spacing between lines is less than their height (*APLIC 2012; Brown et al. 1987*).

All of the listed bird species in Guam are highly maneuverable and are small to medium-bodied birds so they are not particularly susceptible to collision or electrocution with Proposed Action features. Implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, would significantly reduce the likelihood of collision or electrocution by these or other bird species.

Fish

The federally listed shark species known to occur in Guam waters, the scalloped hammerhead shark, uses coastal and open ocean marine habitats, often exhibiting high site fidelity to core use areas and regularly congregating in large groups during migration. The primary risks to this species associated with the Proposed Action would be direct mortality or injury from interaction with vessels or equipment operating in marine waters, general disturbance of benthic[11] habitat associated with dropping cables or other communications equipment, and displacement from core use areas and stress or injury caused by underwater noise or vibration related to in-water (marine) Proposed Action activities. However, the marine activities related to the Proposed Action are very limited in nature so risks to the shark from vessel strike and marine noise are expected to be low.

Pups would be more susceptible to direct mortality or injury than adults because they are comparatively slow moving and highly bottom-oriented where they feed on bottom reef fish and crustaceans (*Baum et al. 2007*).

Sharks have a narrow hearing range but are sensitive to very low frequency sounds such as those generated by boat engines (*Chapuis 2015*). This type of sound can cause injury to an affected individuals' inner ear or other organs, which could render them unable to navigate and/or hunt for food effectively (*Chapuis 2015*). Proposed Action activities in marine environments would create underwater noise, although the duration and magnitude of the noise is expected to be minimal because of the very limited nature of the marine activities. Targeted BMPs and mitigation measures, as defined through consultation with NMFS, would reduce the potential for and magnitude of potential adverse impacts on the scalloped hammerhead shark.

Invertebrates

There are eight invertebrate species known in Guam, including two butterflies, 3 tree snails, and three coral species. The butterflies and tree snails are all strongly associated with forest habitats, so potential impacts of Proposed Action activities on these species could occur if forest habitat that supports these species is removed or degraded. The primary means of avoiding or minimizing potential impacts on these species is to conduct expert and/or agency consultation to gather specific information on the location and distribution of the species prior to construction to

[11] Anything associated with or occurring on the bottom of a body of water.

ensure that the locations of listed species and their habitats and/or key habitat features (e.g., host plants) are avoided to the maximum extent practicable. Where avoidance of potential impacts is not possible, consultation with USFWS and/or Guam Department of Agriculture would be needed to identify suitable minimization and mitigation measures to ensure that the Proposed Action would not result in adverse effects to these species.

The three listed coral species in Guam are distributed throughout nearshore and offshore reef habitats in the region (*NMFS 2015*). Corals are sensitive to changes in water quality, including increases in turbidity which causes sedimentation and reduced light infiltration (*Erftemeijer et al. 2012*). Sedimentation can smother adult corals and impede settlement of coral larvae while reduced light infiltration can limit the photosynthetic activity of algal symbionts,[12] all of which can result in decreased recruitment[13] and survivorship of corals (*Erftemeijer et al. 2012*). Proposed Action activities that occur in marine environments, even though they would be minimal, could cause direct loss of corals if bottom disturbing activities (e.g., dropping cables) occurred in reef habitats. Potential indirect impacts to corals also could occur from increased turbidity and sedimentation as a result of bottom disturbing activities related to the Proposed Action. Siting of Proposed Action activities to avoid reef environments and their immediate vicinity would avoid potential direct impacts to listed coral species and limit the potential for increased turbidity[14] to reach coral reefs.

Potential Impacts of the Preferred Alternative

This section assesses potential impacts associated with implementation of the Preferred Alternative, including construction/deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to listed species and critical habitats and others would not. These potential impacts would vary considerably by species and would be significantly influenced by deployment scenario, potential impact area, species presence, and site-specific conditions. The species that would be affected would depend on the potential impact area, the species' phenology,[15] and the nature and extent of the habitats affected. As explained in this section, various types of Proposed Action infrastructure could result in a range of *no effect* to *may affect, but not likely to adversely affect* depending on the deployment scenario or site-specific conditions.

[12] Symbionts are either of two organisms that live in symbiosis (mutually beneficial relationship) with one another. Algae species are symbionts with corals.
[13] Recruitment is the number of new individuals reaching reproductive age in a given population over a given time interval (typically measured over a year).
[14] Turbidity is a measure of the clarify of a liquid. When many fine particles are suspended in water, the turbidity is high,
[15] Phenology is the seasonal changes in plant and animal life cycles, such as insect emergence or bird migration.

Activities Likely to Have No Effect

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no effect* to listed species under the conditions described below:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Disturbance, including noise, associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. Although threatened and endangered species and their habitat could be impacted, it is anticipated that effects to threatened and endangered species would be temporary, infrequent, and likely not conducted in locations designated as vital or critical for any period.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would have *no effect* to listed species because there would be no ground disturbance and very limited human activity.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact threatened and endangered because those activities would not require ground disturbance.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would not result in ground or human disturbance in listed species habitats, it is anticipated that this activity would have *no effect* on listed species.

The above activities are expected to have no effect to listed species because they involve collocation or shared use of existing facilities or do not require new ground disturbance or substantial construction activity. Should the above defined conditions not be met and activities require land disturbance, substantial construction activity, or implementation of physical security measures such as lighting, potential impacts to listed species would be similar to those described for new build activities below, although they would likely be lesser in magnitude due to the smaller scale of the activities required for collocation compared to new build scenarios.

Activities with the Potential to Affect

The infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and *may affect, but not likely to adversely affect* listed species include: 1) New Build Scenarios (Buried Fiber Optic Plant, Aerial Fiber Optic Plant, Submarine Fiber Optic Plant, or Installation of Optical Transmission or Centralized Transmission Equipment); 2) New Wireless Communication Towers, Collocation on Existing Aerial Fiber Optic Plant, or Collocation on Existing Wireless Tower, Structure, or Building; and 3) Deployable Technologies.

The actions related to these components that could cause impacts to listed species include 1) land/vegetation clearing; 2) excavation and trenching; 3) construction of access roads; 4) installation or restructuring of towers, poles, or underwater cables; 5) installation of security/safety lighting and fencing; and 6) deployment of aerial platforms. Potential impacts to listed species associated with deployment of this infrastructure and related actions are further described below and in the previous taxa-specific descriptions (see Description of Environmental Concerns section above).

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Plowing, trenching, or directional boring and the construction of points of presence (POPs),[16] huts, or other associated facilities or hand-holes to access fiber could result in potential impacts to listed species. Land/vegetation clearing and excavation activities associated with construction of POPs, huts, or other associated facilities could result in temporary or permanent habitat loss and direct injury/mortalities of species that are not mobile enough to avoid construction activities (e.g., slow moving species such as snails and young). Disturbance and habitat degradation from noise and human activity associated with the above activities could result in displacement of individuals, changes in use of important migration pathways or breeding/rearing sites, indirect injury/mortality, and reproductive effects if BMPs and mitigation measures, as defined through consultation with the appropriate resource agency, are not implemented. In-water activities, although they will be minimal and limited to nearshore and inland waters, could cause vessel strike and/or auditory and potential disturbance impacts on listed fish, sea turtles, and/or marine mammals.
  - New Build–Aerial Fiber Optic Plant: The installation of new poles and hanging cable and associated security, safety, or public lighting components as well as the construction of access roads, POPs, huts, or facilities to house outside plant equipment could result in potential impacts to listed species. Potential impacts would vary depending on the number and location of individual poles or other facilities installed, but would primarily occur to terrestrial species as a result of habitat loss or degradation and/or disturbance from construction noise and human activity. Loss of fish habitat or stress on listed fish species could occur if new equipment were installed near or in streams, rivers, coastlines,

[16] POPs are connections or access points between two different networks, or different components of one network.

or wetlands, though freshwater and marine activities related to the Proposed Action are very limited in nature, so risks to listed species are expected to be low. Sea turtles could be adversely impacted by any lighting that is used or installed at or in the vicinity within 500 feet of turtle nesting beaches.

- Collocation on Existing Aerial Fiber Optic Plant: Land clearing and excavation during replacement of poles and structural hardening could result in direct injury/mortality, reproductive effects, behavioral changes, and loss/degradation of designated critical habitat to threatened and endangered species. Noise disturbance from heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in reproductive effects or behavior changes.
- New Build–Submarine Fiber Optic Plant: The installation of cables in limited nearshore marine or inland freshwater environments and construction of landings and/or facilities on the shore to accept submarine cables could potentially impact listed species, particularly fish, marine mammals, and sea turtles. Effects could include direct or indirect injury/mortality; habitat loss or alteration; and disturbance/displacement from underwater noise and vibration. If activities occurred during critical time periods, effects to migratory patterns or reproduction could occur. However, the marine activities related to the Proposed Action are very limited in nature so risks to listed freshwater and marine species are expected to be low.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment occurs in existing boxes or huts, there would be *no effect* to listed species because there would be no ground disturbance and very limited human activity. However, if installation of transmission equipment required construction of access roads, trenching, and/or land clearing, such disturbance could result in direct injury/mortality of threatened and endangered species as described for other New Build activities. Reproductive effects, behavioral changes, and loss/degradation of designated critical habitat could also occur as a result of construction and resulting disturbance.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in potential impacts to terrestrial listed species. Land/vegetation clearing, excavation activities landscape grading, and other disturbance activities during the installation of new wireless towers and associated structures or access roads could result in direct injury/mortality, habitat loss, alteration or fragmentation, and effects to migratory or habitat use patterns. Security lighting could diminish habitat quality for listed species, particularly birds and sea turtles.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower or structure which would not result in impacts to threatened and endangered species. However, if replacement towers or structural hardening are required, impacts would be similar to new wireless construction. Hazards related security/safety lighting and fencing may produce direct injury/mortality, reproductive effects, and behavioral changes. For a discussion of radio frequency emissions and potential impacts, refer to Chapter 2.4, Radio Frequency Emissions.

- Deployable Technologies
  - Implementation of deployable technologies including Cell on Wheels, Cell on Light Truck, or System on Wheels could result in direct injury/mortalities to terrestrial listed species on roadways. Construction of staging areas could cause potential aquatic habitat impacts if they were constructed near or in lakes, streams, rivers, coastlines, or wetlands. Implementation of Deployable Airborne Communications Architecture is not anticipated to impact threatened and endangered species or their habitat.

Potential Impacts to Listed Species

FirstNet is committed to avoidance of impacts to listed species and their known habitats to the maximum extent practicable. The key time to implement avoidance actions is during siting and deployment, prior to and during Preferred Alternative activities. To facilitate this commitment to impact avoidance, pre-siting or pre-deployment desktop reviews and expert and/or agency consultation to gather information on the location and distribution of listed species and their habitats in the vicinity of Proposed Action activities would be conducted for all proposed activities to ensure that informed siting and/or timing of Preferred Alternative activities would enable avoidance of impacts to listed species and their habitats to the maximum extent practicable.

For activities that could potentially affect listed species, FirstNet would enter into informal or formal consultation, as appropriate, with USFWS and/or NMFS, as well as Guam Department of Agriculture for territory-listed species. These consultations would identify measures to be implemented to ensure potential impacts to listed species would not rise to the level of take or, should take be unavoidable, that it would be fully authorized through receipt of an Incidental Take Permit from USFWS or NMFS for federally listed species or authorization from Guam Department of Agriculture for territory species. FirstNet is committed to perform all required monitoring or mitigation activities associated with any federally or territorially-listed species.

In summary, with effective implementation of BMPs and mitigation measures, as needed and defined through consultation with the appropriate resource agencies, the Preferred Alternative *may affect, but not likely to adversely affect* listed species. Site-specific analysis would likely be required to determine the potential impacts on listed species at specific proposed activity locations, once those locations are determined. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential impacts to these resources.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement conducted as part of ongoing system maintenance would result in potential impacts that are similar to the abovementioned deployment impacts. The species that would be affected and the nature and magnitude of potential impacts would depend on many factors, including but not limited to the impact location related to listed species use areas, the species' phenology, and the nature and extent of the habitats affected.

It is anticipated that potential impacts to listed species *may affect, but not likely to adversely affect* with BMPs and mitigation measures (as defined through consultation with the appropriate resource agency) to listed species associated with routine inspections of the Preferred Alternative, assuming that the same access routes used for deployment are also used for inspections. This is because routine inspections would be short-term in nature, would not involve any new potential habitat impacts, and would not result in significant disturbance or displacement. Site maintenance activities, including mowing and application of herbicides *may affect, but not likely to adversely affect* listed species, as the activity would be infrequent and done in compliance with BMPS and mitigation measures (as defined through consultation with the appropriate resource agency).

During operations, direct injury/mortality of listed bird species could occur from collisions and/or entanglements with communication lines, towers, and aerial platforms. In addition, the presence of new access roads and communication line rights-of-way could increase human use of the surrounding areas, which could increase disturbance to or hunting or fishing of listed species or degradation of listed species habitats. If external generators were used, noise disturbance could potentially impact habitat use patterns or displacement of terrestrial listed species.

Deployable Aerial Communications Architecture, including deployment of drones, weather balloons, blimps, aerostats, and piloted aircraft could potentially impact listed bird and bat species by direct or indirect injury/mortality and disturbance and/or displacement. The magnitude of these effects would depend on the location, timing, and frequency of deployments in relation to listed bird use areas. Other listed species would not be affected by deployable aerial communications equipment because, based on their habitat requirements, the likelihood of their interaction with aerial equipment is very low to nil. Aerial equipment could fall, resulting in injury or death of a listed species individual and/or habitat disturbance. If aerial equipment were to fly at low levels over marine mammal haulout sites or seabird nest locations, mass flight response could occur resulting in trampling death of individuals and/or abandonment of haulout or nest sites.

Such potential impacts *may affect, but not likely to adversely affect* listed species provided that any necessary federal and/or territorial authorizations regarding listed species are obtained. Implementation, as practicable or feasible, of operational BMPs and mitigation measures, as defined through consultation with appropriate resource agencies, would further reduce the potential for impacts to listed species.

Table 6.2.6.6-3 summarizes the impact significance determinations for each taxonomic group as a result of deployment and operations of the Preferred Alternative. Potential impacts to listed species were considered significant (i.e., adverse effect) if listed species or their habitats could be adversely affected over relatively large areas; a large proportion of a listed species' population within a region could be adversely affected; or if disturbances related to the Preferred Alternative could cause significant reductions in population size or distribution of a listed species. The duration of an impact also affected its significance level: temporary impacts (e.g., noise associated with construction) were considered less significant than permanent impacts (e.g., land conversion). The impact ratings assume full and successful implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency. Additional BMPs and mitigation measures, as defined in Chapter 11, may be implemented as appropriate to further minimize potential impacts.

Table 6.2.6.6-3: Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative

Taxa	Impact Determination	Rationale for Determination
Plants	*May affect, not likely to adversely affect*	The listed plant species in Guam occur in a variety of habitats so the primary means of avoiding or minimizing potential impacts on listed plant species is to conduct expert and/or agency consultation to obtain more precise location and distribution information for the species than is publicly available and to conduct preconstruction surveys if warranted based on the agency consultation. This would avoid or minimize the potential for impacts to listed plant species.
Terrestrial Mammals	*May affect, not likely to adversely affect*	The listed bat species occurs in undisturbed forests and on steep cliffs and critical habitat has been designated for the species on the northern coastline of Guam at Ritidian Point. Bats are highly mobile and individuals would likely move away from any Proposed Action avoiding direct injury and mortality. Informed siting of Proposed Action features outside of critical habitat and other known or potential forest and cliffside habitats that could be suitable for this species would limit the potential for impacts to the species.
Marine Mammals	*May affect, not likely to adversely affect*	The marine-based activities of the Preferred Alternative are not extensive and they are limited to nearshore and inland waters. They would be of short duration and spatial extent and would avoid key listed species habitats and activity periods.
Birds	*May affect, not likely to adversely affect*	The five listed bird species occur in wetland, forest, and cave habitats and critical habitat for one species has been designated on the northern coastline of Guam at Ritidian Point. The time period of greatest potential impact to listed birds is during the breeding season. Each of the listed species has very specific nesting requirements so avoidance of designated critical habitat and avoidance of other suitable nesting habitat or limiting activities to outside the bird breeding season would limit the potential for impacts on listed bird species.
Reptiles	*May affect, not likely to adversely affect*	Marine activities related to the Proposed Action are very limited in nature so risks to listed turtle species from vessel strike and marine noise are expected to be low.

Taxa	Impact Determination	Rationale for Determination
Fish	*May affect, not likely to adversely affect*	The one listed fish species is a shark that occupies coastal and open ocean marine habitats. The marine-based activities of the Preferred Alternative are not extensive. They would be of short duration and spatial extent and they would avoid key listed species habitats and activity periods.
Invertebrates	*May affect, not likely to adversely affect*	The eight listed invertebrate species include 2 butterflies, 3 tree snails, and 3 coral species. The butterflies and tree snails are all strongly associated with forest habitats so avoidance of impacts to known or suitable forest habitats for these species would limit the potential impacts on these species. Corals are restricted to marine habitats and marine activities related to the Proposed Action are very limited in nature so risks, such as direct disturbance and changes in water quality, are expected to be low.

Alternatives Impact Assessment

This section assesses potential impacts to listed species associated with the Deployable Technologies Alternative and the No Action Alternative.[17]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative (including land based and aerial technologies) would be the same as the deployable technologies implemented as part of the Preferred Alternative, but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. These increases could increase the magnitude of potential impacts to listed species compared with the Preferred Alternative, as further described below.

<u>Potential Deployment Impacts</u>

As explained above, implementation of deployable technologies could result in minor potential impacts from direct and indirect injury or mortality events, habitat loss, disturbance, or displacement. Greater frequency and duration of deployments could increase the magnitude of these potential impacts depending on the location of the deployments in relation to listed species use areas. However, even with the increased potential impact magnitude, impacts would not adversely affect listed species or designated critical habitats with implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource

[17] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

agency.Additional BMPs and mitigation measures, as defined in Chapter 11, may be implemented as appropriate to further minimize potential impacts.

Potential Operation Impacts

As explained above, operation activities would consist of implementation and running the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, potential impacts associated with routine operations, management, and monitoring would vary among species, season, and geographic region but *may affect, but not likely to adversely affect* any listed species or designated critical habitat with implementation of BMPs and mitigation measures, as developed through consultation with the appropriate resource agency. Such consultation would facilitate avoidance of known listed species use areas to the maximum extent possible. If complete avoidance of listed species use areas would be impossible, consultation with USFWS, NMFS, and Guam Department of Agriculture, as applicable, would identify appropriate impact minimization and mitigation actions that would reduce the potential impacts. As such, the Deployable Technologies Alternative *may affect, but is unlikely to adversely affect* listed species.

The same BMPs and mitigation measures implemented for deployment and operation of the deployable technologies component of the Preferred Alternative would be applied to this alternative.

Table 6.2.6.6-4 summarizes the impact significance determinations for each taxonomic group under the Deployable Technologies Alternative. Deployment and operation of the Deployable Technologies Alternative *may affect, but not likely to adversely affect* any listed species with implementation of BMPs and mitigation measures, as defined through consultation with the appropriate resource agency. Additional BMPs and mitigation measures, as defined in Chapter 11, may be implemented as appropriate to further minimize potential impacts. *No effects* would occur to listed marine mammals, reptiles, or fish as a result of this alternative because of the lack of activities within the aquatic habitats of these species.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure, satellites and other technologies. As a result, there would be *no effects* to listed species as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.6.6, Threatened and Endangered Species and Species of Conservation Concern.

Table 6.2.6.6-4: Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative

Taxa	Impact Determination	Rationale for Determination
Plants	*May affect, not likely to adversely affect*	The listed plant species in Guam occur in a variety of habitats so the primary means of avoiding or minimizing potential impacts on listed plant species is to conduct expert and/or agency consultation to obtain more precise location and distribution information for the species than is publicly available and to conduct preconstruction surveys if warranted based on the agency consultation. This would avoid or minimize the potential for impacts to listed plant species.
Terrestrial Mammals	*May affect, not likely to adversely affect*	The listed bat species is highly mobile and would likely move away from any Deployable Technologies Alternative activities. Further, potential habitat impacts associated with this alternative are expected to be minimal due to the lack of new construction so any potential disturbance impacts to listed bat species would be minor and short term.
Marine Mammals	*No effect*	Deployment and operation of the Deployable Technologies Alternative would not occur in marine waters or coastal habitats and thus would have no effect on listed marine species.
Birds	*May affect, not likely to adversely affect*	Potential impacts to listed bird species are expected to be minimal because potential habitat impacts associated with this alternative are expected to be minimal due to the lack of new construction. Potential disturbance-related impacts could occur or birds could collide with deployable equipment if located near bird use areas. Avoidance of known use areas and the bird breeding season to the extent possible would minimize the potential impacts to listed bird species.
Reptiles	*No effect*	Deployment and operation of the Deployable Technologies Alternative would not occur in marine waters or coastal habitats and thus would have no effect on listed marine turtle species.
Fish	*No effect*	Deployment and operation of deployable technologies would not occur in marine waters or coastal habitats and thus would have no effect on listed fish species.
Invertebrates	*May affect, not likely to adversely affect*	Potential impacts to terrestrial listed invertebrate species are expected to be minimal because potential habitat impacts associated with this alternative are expected to be very minor due to the lack of new construction. Coral species would not be potentially impacted by this alternative because deployment and operation of deployable technologies would not occur in marine waters.

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6.2.7. Land Use, Airspace, and Recreation

6.2.7.1. Introduction

This section describes potential impacts to land use, airspace, and recreation in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.7.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on land use, airspace, and recreation were evaluated using the significance criteria presented in Table 6.2.7-1. As described in Section 6.2, Environmental Consequences, the categories of potential impacts are defined as *potentially significant*, *less than significant with mitigation incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to land use, airspace, and recreation addressed in this section are presented as a range of possible impacts.

Table 6.2.7-1: Impact Significance Rating Criteria for Land Use, Airspace, and Recreation

Type of Effect	Effect Characteristic	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Direct land use change (site of FirstNet facility installation or deployable base)	Magnitude or Intensity	Change in designated/permitted land use that conflicts with existing permitted uses, and/or would require a change in zoning.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Change in existing land use that is within permitted (by-right) uses.	No change in land use
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one location.	No measurable effects
	Duration or Frequency	Permanent: Land use altered indefinitely		Short-Term: Land use altered for as long as the entire deployment phase or a portion of the operations phase.	No measurable effect
Indirect land use change (site of FirstNet facility installation or deployable base)	Magnitude or Intensity	New land use directly conflicts with surrounding land use pattern, and/or causes substantial restriction of land use options for surrounding land uses.	Adverse effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	New land use differs from, but is not inconsistent with surrounding land use pattern; minimal restriction of land use options for surrounding land uses	No measurable effects
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one location	No measurable effects
	Duration or Frequency	Permanent: Land use altered indefinitely		Short-Term: Land use altered for as long as the entire deployment phase or a portion of the operations phase.	No measurable effect

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Use of airspace (at and near site of FirstNet facility installation or deployable base)	Magnitude or Intensity	Complete change in flight patterns and/or use of airspace	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Alteration to air space usage is minimal	No measurable effects
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one location.	No measurable effects
	Duration or Frequency	Permanent: Airspace altered indefinitely		Short-Term: Airspace altered for as long as the entire deployment phase or a portion of the operations phase.	No measurable effect
Loss of access to public or private recreation land	Magnitude or Intensity	Total loss of access to recreation land	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Minor restricted access to recreation land	No measurable effects
	Geographic Extent	Most or all recreational land/sites in a state or territory		One (or a small number of) recreational site	No measurable effects
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire deployment phase or a portion of the operations phase	No measurable effect
Loss of enjoyment of public or private recreation land (due to visual, noise, or other impacts that make recreational activity less desirable)	Magnitude or Intensity	Total loss of enjoyment, resulting in avoidance of activity at one or more sites	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Small reductions in visitation or duration of recreational activity	No measurable effects
	Geographic Extent	Most or all recreational land/sites in a state or territory		One (or a small number of) recreational site	No measurable effects
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire deployment phase or a portion of the operations phase	No measurable effect

6.2.7.3. Description of Environmental Concerns

Direct and Indirect Land Use Change

Deployment and operation of new aboveground facilities associated with the Proposed Action, such as new towers, antennas, or other structures, could result in direct changes to land use where such deployment occurs on land not already used for telecommunications, industrial, or public utility activity.

As discussed in Section 6.2.9, Socioeconomics, the presence of permanent aboveground facilities could lead to reduced property values due to diminishment of aesthetic characteristics and the potential for perceived health impacts. Purchases of land for FirstNet buildout (as also discussed in Section 6.2.9) could also affect localized real estate market values. Such potential real estate impacts could indirectly impact the intensity or type of land use in residential or commercial neighborhoods near new FirstNet aboveground facilities.

Given the constrained nature of real estate in Guam and the territory's high property values (see Section 6.1.9.4, Real Estate, Tax Revenues, Property Values, and Local Economic Activity), such effects would likely be milder than in less land-constrained parts of the nation (i.e., residents are more likely to tolerate disturbances because their ability to relocate is more limited).

The location of new telecommunications equipment, particularly larger aboveground facilities such as antennas or towers with aerial fiber optic plant, would be affected by zoning plans as described in the North and Central Guam Land Use Plan, as discussed in Section 6.1.7.2, Specific Regulatory Considerations. FirstNet and/or their partners will consider existing zoning, likely giving preference to areas where appropriate zoning already exists to facilitate deployment. FirstNet and/or their partners may need to obtain zoning variances or other special permits to construct such facilities in some areas.

Use of Airspace

Deployment and operation of new aboveground facilities associated with the Proposed Action, particularly taller structures such as new towers and antennas, could add new obstructions to existing airspace. Use of Deployable Airborne Communications Architecture (DACA) would add the presence of new air traffic and/or aerial navigation hazards. Given the requirements of Federal Aviation Administration (FAA) Part 77 regulations (see Section 6.1.7.2, Specific Regulatory Considerations), such taller structures are unlikely to be built near airports. There is one civilian airport in Guam, and one military airfield; there is no restricted airspace within Guam.

Access to and Enjoyment of Recreation Land

Deployment of the Proposed Action could temporarily block or hinder access to recreation lands in Guam in cases where deployment activity occurs in the vicinity of the entrances to parks or other such lands. Access could also be affected in cases where construction vehicles must use or cross the access roads for recreation lands. Operation of the Proposed Action would not involve any routine or frequent closures of roads or trails; therefore, the Proposed Action is unlikely to prevent or hinder access to recreation lands.

As discussed above under Direct and Indirect Land Use Change and in Section 6.2.8, Visual Resources, the presence of new aboveground facilities or deployment activity could be perceived as a negative visual impact. Such negative perceptions are more likely to be experienced near areas in Guam that are managed for recreational uses and/or visual resources and/or preservation of natural environmental conditions, (see Section 6.1.7.5, Recreation, and Figure 6.1.7-2). Guam residents and visitors value these lands' scenic beauty and environmental quality. Placement of new aboveground facilities within sight of such lands could create a perceived diminution of those aesthetic and environmental values in the eyes of Guam residents and visitors, thus reducing the enjoyment they derive from living near or visiting recreation lands and facilities.

6.2.7.4. Potential Impacts of the Preferred Alternative

The following section assesses potential land use, airspace, and recreation impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. As explained in this section, various types of Proposed Action infrastructure could result in a range of *no impact* to *less than significant* impacts, depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

The following types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative are likely to have *no impacts* to land use, airspace, or recreation in Guam:

- Wired Projects
  - Use of Existing Conduit–New Buried Fiber Optic Plant: Installation of a new buried fiber optic plant within an existing conduit would have *no impact* on the use of airspace and would have no direct effects on land use or land ownership in Guam. Visible evidence of deployment is unlikely to affect land use or ownership decisions. In general, such effects would be temporary, with blockages of recreation access lasting only as long as deployment. If the deployment activities take place on non-paved roads, the visual evidence of deployment would diminish as affected areas revegetate.
  - Collocation on Existing Aerial Fiber Optic Plant: This activity would involve no new towers or other structures, and thus would not directly affect land use, land ownership, or use of airspace in Guam. While the addition of new aerial fiber optic plant to an existing aerial fiber optic transmission system would likely be visible, the change associated with this option is so small as to be essentially imperceptible, and thus would not affect land uses or the enjoyment of recreation lands. While deployment (specifically, the stringing

of new aerial fiber optic plant) could cause temporary blockage of recreation lands' access roads or trails, such activity would likely be so spread out and of such short duration as to be imperceptible to the vast majority of potential users.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: The use of existing fiber optic plant would involve no new aboveground facilities, and no substantial new trenching. As a result, there would be no perceptible change in land use, land ownership, or use of airspace in Guam from this option. While deployment activity (particularly if a small amount of new buried fiber optic plant must be installed) could be visible, and could theoretically cause temporary blockage of recreation lands' access roads or trails, such activity would likely be so spread out and of such short duration as to be imperceptible to the vast majority of potential users. If deployment activities take place on non-paved surfaces, the visual evidence of deployment would be temporary and diminish as affected areas revegetate.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: This activity would involve no new towers or other structures, and thus would not directly affect land use, land ownership, or use of airspace in Guam. While the addition of new satellite-enabled equipment to existing towers, structures, or buildings would likely be visible, the change associated with this option would be so small as to be essentially imperceptible, and thus would not affect land uses or the enjoyment of recreation lands. Deployment is unlikely to cause blockage of access routes for recreation lands due to the lack of substantial construction activity.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide, public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact land use, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to land use, airspace, and recreation include the following:

- Wired Projects:
  - New Build–Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would have *no impact* on the use of airspace in Guam. Depending on the specific location, minor construction could be visible from existing residences, businesses or recreation areas until revegetation was complete. Deployment could also temporarily block access to recreation areas. As discussed in Section 6.2.7.3, Description of Environmental Concerns, visible evidence of deployment could indirectly affect land use or ownership decisions because the visible presence of infrastructure may be unappealing to home owners and buyers; however, once the area over the buried

conduit has revegetated, there would likely be little visual evidence remaining. Similarly, the visible presence of infrastructure may diminish the enjoyment of recreation facilities and activities during deployment until revegetation has occurred—particularly in more rural recreation sites where the evidence of human activity is expected to be minimal. In general, such effects would be temporary, with blockages of recreation access lasting only as long as deployment; the visual evidence of deployment would diminish as affected areas revegetate. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could further reduce the potential impact of this scenario.

- New Build–Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on existing or new poles) could involve the permanent placement of new poles. New-Build-Aerial Fiber Optic Plan would have *no impact* on airspace as utility poles are in average 40 feet in height and do not intrude into useable airspace. Depending on the existing ownership and land use, this scenario could constitute a potential permanent impact on land use and ownership (if an easement is required for new pole placement). In addition, new poles could potentially constitute a discernable change in visual conditions (see Section 6.2.8, Visual Resources), and thus could indirectly affect land use, land ownership, and/or enjoyment of recreation (as described under the New Build–Buried Fiber Optic Plant option). As discussed for other scenarios, deployment of this scenario could result in temporary blockages of access routes to recreational lands. As it is likely that deployment of new wires on either new or existing poles would take place in established rights of way, and it is unlikely this activity would be noticeable beyond the short time it would take to install the new poles or place the new wire on existing poles. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize potential impacts.
- New Build–Submarine Fiber Optic Plant: Installation of a new submarine fiber optic plant in nearshore or inland waters would have *no impact* on the use of airspace. Depending on the existing ownership and use of affected land (including land required for and immediately adjacent to the submarine plant's onshore landing site), this scenario could constitute a small but potentially permanent impact on land use and ownership. While onshore landing sites would be visible (see Section 6.2.8, Visual Resources), it is unlikely that they would constitute a change in visual conditions sufficient to indirectly affect use or ownership of land not directly affected by this scenario. Depending on the specific location of these landing sites, the change in visual conditions caused by the presence of onshore landing sites could decrease the enjoyment of nearby recreational facilities—particularly if new submarine cables and onshore landing sites are installed near one of Guam's many scenic beaches or shorelines. Offshore deployment of this scenario could limit access to nearshore recreation areas in the immediate vicinity of a new submarine fiber optic plant. Such effects would be more noticeable in nearshore areas or inland bodies of water designated or managed for recreational activity. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.

   - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment would have *no impact* on the use of airspace in Guam. Depending on their specific location, access roads associated with deployment of this scenario could temporarily affect land use or access to recreation in cases where access roads cross private property. The presence of deployment activity near recreational lands could temporarily diminish the enjoyment of recreation activities; however, as the deployment would be short-term (lasting several hours to several weeks), it is unlikely to cause any permanent impact. BMPs and mitigation measures (see Chapter 11) could further help to avoid or minimize potential impacts. While new transmission equipment in this scenario could be visible from private property and recreation areas in Guam, it is unlikely that their presence would noticeably affect land use or the enjoyment of recreational lands.
- Wireless Projects
   - New Wireless Communication Towers: Installation of new wireless communication towers would involve the permanent placement of new structures. Depending on the existing ownership and use of affected land (including land immediately adjacent to the towers), this scenario could constitute a potential permanent impact on land use and ownership. In addition, new structures could potentially constitute a discernable change in visual conditions (see Section 6.2.8, Visual Resources), and thus could indirectly affect land use, land ownership, and/or enjoyment of recreation. Depending on their specific height and proximity to one of Guam's airports, new structures could constitute a new obstruction to be managed by aviators. As discussed for other scenarios, deployment could result in temporary blockages of access routes to recreational lands. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize potential impacts.
   - Collocation on Existing Wireless Tower, Structure, or Building : There would be *no impacts* to existing and surrounding land uses. The potential addition of power units, structural hardening, and physical security measures would not impact existing or surrounding land uses. Installation of antennas or microwaves to existing towers may cause temporary, localized restricted access to recreation lands or activities during installation, which may cause small reductions in visitation for the duration of installation. Collocation of mounting or installing equipment (such as antennas or microwave dishes) on an existing tower, structural hardening, and physical security measures could result in impacts if located near airports.
- Deployable Technologies (all options)
   - The deployment of land-based deployable technologies (e.g., mobilizing vehicles) would have no direct effect on land use or ownership, and would have no permanent effects on the use of airspace or access to or enjoyment of recreation lands and activities in Guam. Implementation of DACA could result in temporary and intermittent potential impacts to airspace. Deployment of tethered systems (such as balloons or blimps) could pose an obstruction hazard if deployed above 200 feet and near airports. Potential impacts to airspace (such as special use airspace and military training routes) may be possible

depending on the planned use of drones, piloted aircraft, untethered balloons, and blimps (e.g., frequency of deployment, altitudes, proximity to airports and airspaces classes/types, length of deployment, etc.). Coordination with the FAA would be required to determine the actual impact and the required certifications. It is expected that FirstNet would attempt to avoid changes to airspace and the flight profiles (boundaries, flight altitudes, operating hours, etc.).

Potential Direct and Indirect Land Use and Land Ownership Impacts

Potential direct land use and land ownership impacts for the New Build–Aerial Fiber Optic Plant and Construction of New Wireless Communication Towers option would be *less than significant*. These options would require permanent dedication of land to new towers or other aboveground structures; however, new aboveground facilities would likely be constructed in locations where such structures are consistent with local land use regulations. Additionally, once deployment locations are known, the location would be subject to an environmental review to help ensure environmental concerns are identified. New communication tower projects would also be required to comply with all relevant federal, territorial, and local regulations.

Potential indirect land use and land ownership impacts associated with these two scenarios, along with for the New Build–Buried Fiber Optic Plant, New Build–Submarine Fiber Optic Plant, Installation of Optical Transmission or Centralized Transmission Equipment, and Deployable Technologies options would generally be *less than significant*. These options would result in temporary disruption associated with deployment, as well as the potential indirect land use and land ownership impacts associated with changing visual conditions (see Section 6.2.7.3, Description of Environmental Concerns); however, these activities would generally be consistent with local land use regulations, and would not result in widespread changes in land use or land ownership patterns.

See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential impacts associated with land use and land ownership.

Potential Airspace Impacts

The Construction of New Wireless Communication Towers could permanently affect the use of airspace by potentially creating new aerial navigation hazards, although restricted airspace would likely be avoided. New towers would be required to comply with all relevant federal, territorial, and local regulations regarding siting, lighting, and engineering. The DACA option would add the presence of new manned and unmanned air traffic and/or aerial navigation hazards (in the case of tethered balloons) in Guam; however, it is likely that only the piloted aircraft option would enter controlled airspace. Because DACA would primarily be used to address wide-scale loss of coverage after a major catastrophic event, such disruptions could be long-term in nature (up to 2 years depending on the emergency).

These effects would be *less than significant,* although BMPs and mitigation measures (see Chapter 11) could further minimize their potential impacts.

To minimize these effects, FirstNet and/or their partners would likely give preference to development options that do not involve new towers or other tall aboveground structures. For cases where new towers or tall aboveground structures are the preferred option, FirstNet and/or their partners would require, as practicable or feasible, implementation of BMPs and mitigation measures (see Chapter 11).

Other build options would have no airspace impacts because they would not involve aboveground facilities that would intrude into airspace.

Potential Recreational Access and Enjoyment Impacts

None of the FirstNet scenarios would permanently affect access to recreational lands. Deployment of the New Build–Buried Fiber Optic Plant, New Build–Aerial Fiber Optic Plant, New Build–Submarine Fiber Optic Plant, Installation of Optical Transmission or Centralized Transmission Equipment, and New Wireless Communication Towers options could result in temporary blockages of access routes to recreational lands. These blockages would not continue beyond deployment activity. Due to the temporary nature of these deployment scenarios, potential impacts would be *less than significant*, although BMPs and mitigation measures (see Chapter 11) could further minimize their potential impacts.

Potential impacts during deployment of the New Build–Aerial Fiber Optic Plant and New Wireless Communication Towers options could permanently change visual conditions in the vicinity of Guam's recreation lands. Because such changes could be perceived as adverse, and because adverse perceptions could affect the ability to enjoy recreational activities, deployment of these options could therefore have to some degree a permanent negative effect on the enjoyment of recreational lands. However, it is anticipated that only minimal or small reductions in visitation or duration of recreational activities would result (as opposed to total loss of enjoyment), if any at all. In addition, the geographic extent of this potential impact would likely be limited to a small number of recreational sites. For these reasons, potential impacts during deployment would be *less than significant.*

All the development scenarios listed in this subsection, as well as Deployable Technologies, could cause temporary changes to the visual environment due to the presence of vehicles, deployment activities, and construction "scars" where subsurface infrastructure is deployed. Such potential impacts would occur during deployment and until vegetation is able to reclaim affected areas. Accordingly, due to the temporary nature of the deployment activities, these effects would be *less than significant* and further reduced by implementation of BMPs and mitigation measures.

See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with recreation.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. There would be *no impacts* to land use, land ownership, use of airspace, access to recreation, or enjoyment of recreation lands associated with routine inspections of the Wired or Wireless options within the Preferred Alternative. However, as discussed above, there would be *less than significant* impacts for wireless projects that deployed new towers or aboveground structures. These impacts could be further minimized by implementation of the BMPs and mitigation measures detailed in Chapter 11.

Operation of the Deployable Technologies options of the Preferred Alternative would result in the temporary presence of deployable vehicles and equipment (including airborne equipment), potentially for up to 2 years in some cases. The degree of change in the visual environment (see Section 6.2.8, Visual Resources)—and therefore the potential indirect impact on a landowner's ability to use or sell of their land as desired—would be highly dependent on the specific deployment location and length of deployment. Nighttime lighting in isolated rural areas or if sited near a national park would be *less than significant with BMPs and mitigation measures incorporated* during operations. Additionally, FirstNet would work closely with the National Park Service to address any concerns they might have if a tower needed to be placed in an area that might affect the nighttime sky at a National Park Service unit. The use of DACA would temporarily add new air traffic or aerial navigation hazards, as discussed above. The magnitude of these effects would depend on the specific location of airborne resources along with the duration of their use. However, as operation of all of the Deployable Technology options are to address emergency situations on a temporary basis, the potential impacts are *less than significant.* BMPs and mitigation measures (see Chapter 11) could further help to avoid or minimize potential impacts.

6.2.7.5. Alternatives Impact Assessment

The following section assesses potential impacts to land use, airspace, and recreation associated with the Deployable Technologies Alternative and the No Action Alternative.[1]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable

[1] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to land use, airspace, and recreation as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* impacts to land use if deployment occurs in areas with compatible land uses. While a single deployable technology may have an imperceptible impact, multiple technologies operating in close proximity for longer periods could impact existing and surrounding land uses. There could be impacts to recreation activities during the deployment of technologies if such deployment were to occur within or near designated recreation areas. Enjoyment of activities dependent upon the visibility of wildlife or scenic vistas may be affected. Also, implementation of deployable technologies could result in *less than significant* impacts to airspace if deployment does trigger any obstruction criterion or result in changes to flight patterns and airspace restrictions.

Potential Operation Impacts

Operation of deployable technologies would result in land use, land ownership, airspace, and recreation (access and enjoyment) similar in type to those described for the Preferred Alternative. The frequency and extent of those potential impacts would be greater than for the Proposed Action because under this Alternative, deployable technologies would be the only options available. As a result, this alternative would require a larger number of terrestrial and airborne deployable vehicles and a larger number of deployment locations in Guam—all of which would potentially affect a larger number of properties and/or areas of airspace. It is anticipated that there would be *no impacts* to land use, recreational resources, or airspace associated with routine inspections assuming the same access roads used for deployment are also used for inspections. Overall these potential impacts would be *less than significant* due to the minimal footprint associated with the land-based deployable (generally the size of a utility truck). Aerial deployables (piloted aircraft, balloons, and drones) would likely use existing airports and facilities for launching and recovery. To further minimize these effects, FirstNet and/or their partners would require, as practicable or feasible, implementation of BMPs and mitigation measures similar to those described for the Preferred Alternative (see Chapter 11).

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated deployment or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to land use, airspace, and recreation as a result of deployment and operation of the Proposed Action. Land use, airspace, and recreation conditions would therefore be the same as those described in Section 6.1.7, Land Use, Airspace, and Recreation.

6.2.8. Visual Resources

6.2.8.1. Introduction

This section describes potential impacts to visual resources in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize potential negative impacts, and/or that would preserve or enhance potential positive impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.8.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on visual resources were evaluated using the significance criteria presented in Table 6.2.8-1. As described in Section 6.2, Environmental Consequences, the categories of potential impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each potential impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to visual resources addressed in this section are presented as a range of possible impacts.

Table 6.2.8-1: Impact Significance Rating Criteria for Visual Resources

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Adverse change in aesthetic character	Magnitude or Intensity	Fundamental and irreversibly negative change in aesthetic character	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Intermittently noticeable negative change in aesthetic character.	No visible effects
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or several locations, but not widespread.	NA
	Duration or Frequency	Persisting more than 1 year		Persisting 1 month or less	NA
Nighttime lighting	Magnitude or Intensity	Lighting dramatically alters night-sky conditions.	Adverse effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Lighting alters night-sky conditions to a degree that is noticeable.	Lighting does not noticeably alter night-sky conditions.
	Geographic Extent	Regional impacts observed throughout the state or territory.		Effects realized at one or several locations, but not widespread.	NA
	Duration or Frequency	Persisting more than 1 year		Persisting 1 month or less	NA

NA = not applicable

6.2.8.3. Description of Environmental Concerns

Opinions of and reactions to changes in visual resources are inherently subjective, and are based on each observer's personal feelings about what they are seeing. This Draft Programmatic Environmental Impact Statement focuses on cases where changes in the aesthetic environment would occur in or affect lands in Guam where visual or scenic resources are the subject of adopted regulations, or places where observers are likely to expect higher scenic quality. These lands are discussed in Section 6.1.8, Visual Resources.

Aesthetic Character

Construction and operation of new aboveground facilities, such as new towers, antennae, or other structures, could add new permanent elements to the visual landscape (what observers can readily see from a given vantage point), while construction of options other than aboveground facilities could create temporary changes to the landscape—such as construction scars or the presence of construction equipment.

Applicable federal and territory policies and regulations would affect the type and location of new Proposed Action facilities on lands where visual resources are managed through specific policies (such as units of the National Park System) or laws (such as zoning ordinances). Observers are more likely to perceive Proposed Action facilities adversely in or near public or recreational areas, such as local parks, historic neighborhoods and landmarks, including national wildlife refuges and the War in the Pacific National Historical Park. Other areas where higher scenic values or the absence of new structures may be preferred include relatively undeveloped parts of Guam, areas of historical importance, beaches, or forests. While such preferences are not necessarily codified in law or regulation, observers tend to prefer higher levels of scenic quality in such areas.

Proposed Action facilities (especially new towers) that extend above the horizon are also likely to be perceived more negatively than options that remain at or near ground level. In addition, as discussed in Section 6.1.8.2, Specific Regulatory Considerations, the Federal Aviation Administration (FAA) may require certain aboveground structures to be painted white and orange, and in some cases to include daytime lighting (*FAA 2015*). Even for structures that do not extend above the horizon, this paint scheme is likely to contrast with the predominant background, and could thus be perceived as a negative effect.

Finally, as discussed in Section 6.2.9.3, Description of Environmental Concerns, potential real estate purchasers (individuals who wish to purchase a home or property, investors, developers, etc.) and renters could see the presence of aboveground facilities as a negative aesthetic element—a perception that could affect property values. Economists and appraisers have studied this issue and use a statistical analysis methodology known as hedonic pricing (looking at the impact of external factors effecting price), or hedonic modelling, to assess how different attributes of properties such as distance from a tower affect property value (*Bond et al. 2013*). Essentially, analysts compare the value of multiple properties while statistically controlling differences in property attributes, in order to isolate the effect of a specific attribute such as proximity of a communications tower.

A recent literature review examined such studies in the United States, Germany, and New Zealand (*Bond et al. 2013*). These studies all focused on residential properties. One study identified a positive effect on price in one neighborhood due to the presence of a wireless communications tower. Most studies identified negative effects on price. Generally, these negative effects were small: an approximately 2 percent decrease in property price. In one case, the average reduction in price was 15 percent. In all cases, the effects declined rapidly with distance, with some cases showing no effect beyond 100 meters (328 feet) and one case showing effects up to about 300 meters (984 feet).

Nighttime Lighting

As discussed in Section 6.1.8.2, Specific Regulatory Considerations, the FAA requires lighting for a wide variety of aboveground structures, including communication towers over 199 feet above ground level (*FAA 2015*). Additionally, structures and facilities associated with the Proposed Action could include ground-level security and safety lighting, although such lighting is not specifically required by the FAA regulations. Although likely minimal, such lighting would not only constitute a new light source, but could also increase the overall diffusion of artificial light into the sky (commonly referred to as sky glow).

Aside from federal and territory lands where visual resources are managed according to established policies or laws, new nighttime light sources are most likely to be perceived negatively in less developed areas of Guam (areas away from population centers such as Hagåtña). In such cases, the new light source may not be able to blend with existing light sources, and would thus potentially be perceived as more distinct.

Nighttime sky glow depends on topography and weather conditions, as well as the number, type, and location of artificial lights. In general, sky glow is associated with larger concentrations of artificial lights (such as a city or neighborhood), rather than a single light source.

6.2.8.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. Potential visual impacts of each of the Preferred Alternative options are discussed as a territory-wide system—i.e., the potential collective visual impact of a series of new fiber optic towers, or the potential collective visual impact of a territory-wide system of new wireless receivers installed on existing structures, etc. While this approach could overestimate potential impacts, this is preferable to underestimating potential impacts, as could be the case if the options were evaluated on a structure-by-structure basis.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. As explained in this section, various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant with BMPs and mitigation measures incorporated*, depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

The following types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative are likely to have *no impacts* to visual resources:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of a new buried fiber optic plant within an existing conduit would create visible evidence of construction limited to minor “scars” in the earth at the entry and exit points of the existing conduit, and the presence of construction equipment. These impacts would be minor, temporary, and last only until the area was revegetated. This option would involve no new nighttime lighting.
  - Collocation on Existing Aerial Fiber Optic Plant: While the addition of new aerial fiber optic plant to an existing aerial fiber optic transmission system would likely be visible, the change associated with this option is so small as to be essentially imperceptible. This option would involve no new nighttime lighting, and pole replacement would be limited.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up dark fiber would not have any impacts to visual resources because there would be no ground disturbance. This option would involve no new nighttime lighting.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: While new satellite-compatible infrastructure on existing towers, structures, or buildings (where antennae are already placed) would likely be visible, the change associated with this option is so small as to be essentially imperceptible. This option would involve no new nighttime lighting.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact visual resources, it is anticipated that this activity would have *no impact* on those resources.

Activities with the Potential to Have Impacts

Given the scope of the Proposed Action, while geographically enormous (in all 50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive and would likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity, and where the deployment would take place, would be determined based on location-specific conditions and the results of site-specific environmental reviews.

Potential deployment-related impacts to visual resources as a result of implementation of the Preferred Alternative would generally consist of the presence of new aboveground structures (where appropriate), as well as visual evidence of construction and the presence of construction equipment. Potential impacts associated with the Preferred Alternative, based on the deployment activity and the limited duration of construction activities, are described further below. The remainder of this section provides summary impact discussions for each development scenario or deployment activity.

The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to visual resources include the following:

- Wired Projects:
  - New Build – Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would create visible evidence of construction, including a "scar" in the earth where the new fiber optic plant was installed, and the presence of construction equipment used for this installation. These "scars" would likely be temporary and last only until the area was revegetated. BMPs and mitigation measures could help to avoid or minimize the potential impacts. This option would involve no new nighttime lighting.
  - New Build – Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on existing and/or new poles) could have a discernable change on aesthetic conditions. This option could add new elements (poles) to the visual environment, and would result in the temporary visible evidence of construction activity and equipment. As it is likely that any new pole placement would take place in established rights-of-way, any potential visual impacts associated with this activity would be temporary and generally unnoticed. BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - New Build – Submarine Fiber Optic Plant: Installation of a new submarine fiber optic plant in nearshore or inland waters would affect visual resources in the vicinity of the onshore landings and any equipment boxes or huts associated with such a cable. Such facilities would represent a change in the visual condition of the shoreline, would create a temporary construction "scar" for the onshore portion of the fiber optic plant, and would involve the presence of construction equipment used for installation. The construction-related aspects of this activity would be temporary while any equipment boxes or huts would be permanent, although generally small in size. BMPs and mitigation measures could help to further avoid or minimize the potential impacts. This option would involve no new nighttime lighting.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment could add a new element to the visual environment, in the form of a small box or hut. The construction aspects of this activity would be temporary and localized while the new boxes or huts would be permanent, although generally small

in size. BMPs and mitigation measures could help to further avoid or minimize the potential impacts. This option would likely involve no new nighttime lighting.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless communication towers would have a discernable change on aesthetic conditions. This option would add new elements (towers) to the visual environment and would result in visible evidence of construction activity and equipment. Depending on specific design, the FAA could require high-visibility paint schemes and/or lighting on the new towers required for this option. BMPs and mitigation measures could help to avoid or minimize potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: While new wireless elements added to existing towers, structures, or buildings (where antennae are already placed) would likely be visible, the change associated with this option is so small as to be essentially imperceptible. However, if the on-site delivery of additional power units, structural hardening, or physical security measures required ground disturbance or removal of vegetation, impacts to the aesthetic character of scenic resources or viewsheds could occur.
- Deployable Technologies (all options)
  - Implementation of deployable technologies could result in potential impacts to visual resources if long-term deployment occurs in scenic areas, or if the implementation requires minor construction of staging or landing areas, or results in vegetation removal, areas of surface disturbance, or additional nighttime lighting.

Potential Aesthetic Character Impacts

Potential visual impacts for Construction of New Wireless Communication Towers and other build options are expected to be *less than significant*. FirstNet and/or their partners would require, as practicable or feasible, implementation of the BMPs and mitigation measures listed in Chapter 11 to further minimize potential visual impacts. BMPs and mitigation measures are particularly important if these project types are implemented in more than a few locations—and/or in locations that affect lands where visual resources are regulated—because these options would permanently change views for a variety of observers. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with visual resources.

Potential Nighttime Lighting Impacts

Depending on specific design, Construction of New Wireless Communication Towers or Installation of Optical Transmission or Centralized Transmission Equipment options could introduce new artificial lighting, due to FAA regulations or other security concerns. New lighting associated with FirstNet structures could contribute incrementally to sky glow. As a result of the temporary nature of deployment, these effects would be *less than significant.* See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with visual resources.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. Wired or wireless options within the Preferred Alternative would have *no impacts* to visual resources beyond those discussed under Potential Deployment Impacts, above. Nighttime lighting in isolated rural areas or if sited near a national park would be l*ess than significant with BMPs and mitigation measures incorporated* during operations. Additionally, FirstNet would work closely with the National Park Service to address any concerns they might have if a tower needed to be placed in an area that might affect the nighttime sky at a National Park Service unit.

Operation of the Deployable Technologies option of the Preferred Alternative would create no permanent changes to the aesthetic environment. Use of these technologies would result in the temporary presence of deployable vehicles and equipment, which would represent a change in existing conditions. The degree of change in the visual environment would be highly dependent on the specific vehicle parking location. Although the FAA would not likely require nighttime lighting for ground-based deployable technologies, some ground-based deployable technologies could include their own safety lighting, which would be visible in the vicinity of the deployable unit. The FAA would likely require nighttime lighting for airborne deployable technologies, such as balloons, blimps, drones, and piloted aircraft.

6.2.8.5. Alternatives Impact Assessment

The following section assesses potential impacts to socioeconomic resources associated with the Deployable Technologies Alternative and the No Action Alternative.[1]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to

[1] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

visual resources as a result of implementation of this alternative could be as described below. To minimize these effects, FirstNet and/or their partners would implement, as practicable or feasible, the BMPs and mitigation measures for the Proposed Action, described in Chapter 11.

Potential Deployment Impacts

Deployment (i.e., purchase, staffing, and mobilization) of deployable technologies would generally result in *less than significant* impacts to visual resources—including aesthetic conditions and nighttime lighting due to the temporary nature of deployment.

Potential Operation Impacts

The potential visual impacts—including aesthetic conditions and nighttime lighting—of the operation of deployable technologies would be *less than significant*. These potential impacts would be similar to the potential impacts described for the Deployable Technologies option of the Preferred Alternative, above, only likely with greater numbers of deployable units.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to visual resources as a result of construction and operation of the Proposed Action. Visual conditions would therefore be the same as those described in Section 6.1.8, Visual Resources.

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6.2.9. Socioeconomics

6.2.9.1. Introduction

This section describes potential impacts to socioeconomics in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize potential negative impacts, and/or would preserve or enhance potential positive impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.9.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on socioeconomic resources were evaluated using the significance criteria presented in Table 6.2.9-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to socioeconomic resources addressed in this section are presented as a range of possible impacts.

Table 6.2.9-1: Impact Significance Rating Criteria for Socioeconomics

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures incorporated**	**Less than Significant**	**No Impact**
Impacts to real estate	Magnitude or Intensity	Change in property values and/or rental fees, constituting a significant market shift	Effect that is *potentially significant*, but with mitigation is *less than significant*	Indiscernible impact to property values and/or rental fees	No perceptible change in baseline conditions.
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action.		Persists for as long as the entire construction phase or a portion of the operations phase	NA
Economic benefits or adverse impacts related to changes in tax revenues, wages, or direct spending (could be positive or negative)	Magnitude or Intensity	Economic change that constitutes a market shift	Adverse effect that is *potentially significant*, but with mitigation is *less than significant*	Discernible but not substantial economic change	No perceptible change in baseline conditions.
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized in one city or town	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	NA
Employment	Magnitude or Intensity	High level of job loss or creation	Effect that is *potentially significant*, but with mitigation is *less than significant*	Low level of job creation	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized in one city or town	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions
Increased pressure on existing public services	Magnitude or Intensity	Access to or quality of public services severely constrained, potentially threatening public safety	Effect that is *potentially significant*, but with mitigation is *less than significant*	Access to or quality of public services constrained to a minimally perceptible degree	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures incorporated**	**Less than Significant**	**No Impact**
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions
Diminished social cohesion / disruption related to influx	Magnitude or Intensity	Impacted individuals and communities cannot adapt to social disruption/ diminished social cohesion, or are not able to adapt fully, even with additional support	Effect that is *potentially significant*, but with mitigation is *less than significant*	Impacted individuals and communities are able to adapt to social disruption and/or diminished social cohesion without support	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions
Reduced opportunities for subsistence practices	Magnitude or Intensity	Impacted individuals and communities cannot adapt to reduced subsistence opportunities, or are not able to adapt fully, even with additional support	Effect that is *potentially significant*, but with mitigation is *less than significant*	Impacted individuals and communities are able to adapt to s reduced subsistence opportunities without support	No perceptible change in baseline conditions
	Geographic Extent	Regional impacts observed throughout the state or territory		Effects realized at one location	NA
	Duration or Frequency	Persists during or beyond the life of the Proposed Action		Persists for as long as the entire construction phase or a portion of the operations phase	No perceptible change in baseline conditions

NA = not applicable

6.2.9.3. Description of Environmental Concerns

Real Estate

Construction and operation of new aboveground facilities, such as new towers, antennae, or other structures, could affect real estate values. Potential real estate purchasers (individuals who wish to purchase a home or property, investors, developers, etc.) and renters could see the presence of aboveground facilities as a negative aesthetic element, especially in a highly scenic territory such as Guam (potential visual impacts are discussed in Section 6.2.8, Visual Resources). Purchasers and renters may also believe (regardless of factual information) that the presence of wireless facilities is a negative health impact (potential health impacts are discussed in Section 6.2.15, Human Health and Safety). Such negative perceptions of the Proposed Action could cause purchasers and renters offer lower payments for affected properties than might otherwise be expected.

Should new land be required for FirstNet buildout (as opposed to installing additional equipment at existing telecommunications sites), such purchases could affect overall real estate markets by reducing the supply of available land, particularly given that less than half of the island is available for private development (*Government of Guam 2009*). Housing vacancy rates in Guam are higher than the United States as a whole (see Section 6.1.9, Socioeconomics). As a result, FirstNet effects on real estate markets could be stronger than in less land-constrained parts of the nation (i.e., those seeking to purchase or rent a new home would have greater choice in where to purchase). Improvements in telecommunications coverage for first responders in Guam's less developed areas could result in increased property value in those areas due to that increased connectivity. Overall effects on real estate would be limited to areas near FirstNet new-build projects rather than the territory as a whole.

Economic Effects (Positive and Negative)

FirstNet deployment and operation could affect the territory's economy through changes in tax revenue, wages, and spending associated with FirstNet. Such effects could be direct, indirect, or induced. Direct effects could include (but are not limited to) taxes generated by FirstNet facilities, wages paid directly to FirstNet employees (deployment or operations), and FirstNet spending on raw materials. Indirect effects could include, for example, wages paid and materials purchased by FirstNet contractors and subcontractors. Induced effects are those that are not directly related to FirstNet, but that would not occur "but for" FirstNet, such as increased spending at restaurants near construction sites.

New projects such as FirstNet are typically associated with potential positive economic impacts. Potential negative impacts could occur if the presence of the Proposed Action were to prevent or diminish other existing or likely future economic activity, resulting in reduced taxes, wages, or spending. The same potential visual impacts that could affect real estate in Guam (see above), could also negatively affect tourist activity in Guam, which is based at least in part on the territory's visual characteristics.

Employment

FirstNet deployment and operations could create direct, indirect, and induced employment, through new jobs associated with FirstNet (direct), its contractors and subcontractors (indirect), and other businesses that serve FirstNet employees, contractors, or subcontractors (induced). As is the case for economic effects (discussed above), such potential impacts are typically positive, but could potentially be negative if FirstNet deployment or operation results in negative economic impacts.

The use of Guam-resident employees for FirstNet projects in Guam is an important consideration. Residents are more likely to spend their wages in the territory, driving economic activity (discussed above) while reducing potential negative impacts on social cohesion in Guam, where approximate 37 percent identify as native Chamorro (see below, as well as Section 6.1.9 Socioeconomics).

Increased Pressure on Public Services

The use of public services, such as first responders (police, fire, emergency medical services, etc.), public utilities, and public schools, is typically tied to Proposed Action-related changes in residential population and employment. Increased population and/or employment typically results in increased demand for services. Increased demand for services could be offset by increased tax revenue (see Economic Effects subsection, above, as well as Section 6.2.1, Infrastructure).

Diminished Social Cohesion and/or Disruption due to Influx

Construction projects such as FirstNet could result in the influx of construction and operations workers into the Proposed Action area. Social tension between existing residents and newly arrived workers could result from a variety of sources, such as dissatisfaction among existing residents who did not receive Proposed Action-related jobs, cultural differences between existing residents and new workers, and inappropriate or illegal behavior by incoming workers (e.g., alcohol and drug abuse, or solicitation of prostitution), many of whom are men without families, or whose families have not relocated with them. While Guam's distance from the mainland United States (and other nations) reduces the possibility of such influx, it does not eliminate this concern, particularly given the need to increase skills among the local workforce (*Maloney 2010*).

Reduced Opportunities for Subsistence Practices

FirstNet's physical footprint and deployment activities could infringe on terrestrial or marine subsistence activities, and/or could diminish the availability of subsistence species. The cultural aspects of subsistence practices in Guam are discussed in Section 6.1.11, Cultural Resources.

6.2.9.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. As explained in this section, the various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following is likely to have *no impacts* to socioeconomics:

- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact socioeconomic resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to socioeconomic resources as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of new employment and/or economic activity, as well as potential effects on real estate, public services, subsistence, and social cohesion. The remainder of this section provides summary potential impact discussions for each development scenario or deployment activity.

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety). There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but would be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Installation of a new buried fiber optic plant within an existing conduit would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety). There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but would be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures)

could help to avoid or minimize potential impacts. The effects described above would be similar to but less than the New Build – Buried Fiber Optic Plant option, because the Use of Existing Conduit – New Buried Fiber Optic Plant option would involve less ground disturbance, and therefore less labor and use of equipment.

- New Build – Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on elevated structures) could potentially have a discernable change for factors that affect perceived property values (aesthetics, health, and safety). To the degree that such changes reduce property values, these effects could also reduce tax revenues, a negative economic effect. BMPs and mitigation measures (see below) could further minimize potential impacts. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment, although there could be a potential increased demand for emergency services. The influx of new workers could affect the social cohesion of a given area, but would be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
- Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant with existing fiber optic plant would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: The use of existing fiber optic plant would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be some potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The effects described above would be similar to but less than those described for the Collocation on Existing Aerial Fiber Optic Plant option, and substantially less than the new build options.
- New Build – Submarine Fiber Optic Plant: Installation of a new submarine fiber optic plant would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety). There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. BMPs and mitigation

measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.

- Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment could potentially have a discernable change in factors that affect perceived property values—particularly aesthetics due to new access roads. To the degree that such changes reduce property values, these effects could also reduce tax revenues, a negative economic effect. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The effects described above would be similar to but less than those described for the New Build – Buried Fiber Optic Plant, because the Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable option would involve less ground disturbance, and therefore less labor and use of equipment.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless communication towers could potentially have a discernable change for factors that affect perceived property values (aesthetics, health, and safety). To the degree that such changes reduce property values, these effects could also reduce tax revenues, a negative economic effect. There could be potentially discernable benefits to the economy (income and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. In addition, and depending on location, installation of new wireless communication towers could affect terrestrial subsistence resources given FirstNet's physical footprint and deployment activities, either through diminishment of habitat or through the interruption of migratory pathways. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building. The collocation of new wireless facilities on existing facilities would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be some potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The effects described above would be similar to but less than those described for the Collocation on Existing Aerial Fiber Optic Plant option, and substantially less than the new build options.

- Deployable Technologies (all options)
  - The use of deployable technologies, including some limited construction associated with implementation, such as land clearing or paving for parking or staging areas, would create no permanent changes to factors that affect perceived property values (aesthetics, health, and safety). There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts.
- Satellite and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of new satellite-compatible infrastructure would create no permanent change in factors affecting perceived property values (aesthetics, health, and safety) or subsistence resources. There could be potentially discernable benefits to the economy (increased property, income, and sales tax revenues) and employment. The influx of new workers could affect the social cohesion of a given area, but could be dependent on whether the workers are residents of Guam or not. The effects described above would be similar to but less than those described for the Collocation on Existing Aerial Fiber Optic Plant option, and substantially less than the new build options. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to further minimize potential impacts. The use of satellite-compatible devices (e.g., mobile phones) absent the installation of new equipment would have *no impacts*.

Potential Real Estate Impacts

Potential real estate impacts for the New Build – Aerial Fiber Optic Plant and Construction of New Wireless Communication Towers option and the Installation of Optical Transmission or Centralized Transmission Equipment option would be less than significant. These options could permanently change views from private property and/or introduce new wireless infrastructure that property buyers or renters could perceive as having impacts; however, these potential impacts would be temporary and only as long as the construction period lasted. Economists and appraisers have studied this issue and use a statistical analysis methodology known as hedonic pricing (looking at the impact of external factors effecting price), or hedonic modelling, to assess how different attributes of properties such as distance from a tower affect property value (Bond et al. 2013). Essentially, analysts compare the value of multiple properties while statistically controlling for differences in property attributes, in order to isolate the effect of a specific attribute such as, proximity of a communications tower.

A recent literature review examined such studies in the United States, Germany, and New Zealand (*Bond et al. 2013*). These studies all focused on residential properties. One study identified a positive effect on price in one neighborhood due to the presence of a wireless communications tower. Most studies identified negative effects on price. Generally, these negative effects were small: an approximately two percent decrease in property price. In one case, the average reduction in price was 15 percent. In all cases, the effects declined rapidly with distance, with some cases showing no effect beyond 100 meters (328 feet) and one case showing effects up to about 300 meters (984 feet).

See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential real estate impacts.

Potential Economic Impacts

To the degree that the New Build – Aerial Fiber Optic Plant and Construction of New Wireless Communication Towers or Installation of Optical Transmission or Centralized Transmission Equipment options reduce property values and, although anticipated to be minor, these options could also reduce tax revenues. Other options would not reduce property values, and would therefore not affect tax revenues. Additionally, construction activity associated with FirstNet deployment would create additional wages, spending, and/or tax revenues. To further minimize these effects, FirstNet and/or their partners would require, as practicable or feasible, implementation of the BMPs and mitigation measures described in Chapter 11, BMPs and Mitigation Measures.

Overall, the potential economic impacts from Preferred Alternative development options would be positive and *less than significant*. BMPs and mitigation measures described in Chapter 11, BMPs and Mitigation Measures would maintain or enhance these positive economic impacts.

Potential Employment Impacts

The potential employment impacts from Preferred Alternative development options would be positive and *less than significant*. Construction activity associated with FirstNet deployment could create additional jobs (through new jobs directly associated with FirstNet, its contractors and subcontractors, and other business that serve FirstNet employees, contractors, or subcontractors). See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to enhance these benefits.

Potential Public Services Impacts

Potential impacts on demand for public services would be *less than significant*. As mentioned above, the use of public services is typically tied to changes in residential population and employment. Increases in population and/or employment typically results in increased demand for services, however, this demand is anticipated to be minimal. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further minimize potential public services impacts.

Potential Social Cohesion Impacts

Potential social cohesion impacts, due to the potential influx of workers into the project area, are anticipated to be *less than significant* for Preferred Alternative development options, primarily due to the limited amount of construction activities in any one area. To further minimize potential social cohesion impacts, FirstNet and/or their partners would, as practicable or feasible, likely give preference to hiring workers who are residents of Guam, and ideally of the island on which construction activities would take place (see Chapter 11, BMPs and Mitigation Measures).

Potential Subsistence Impacts

There could be a potential to cause minor damage, remove access to, or cause the relocation of plant and animal species important for subsistence activities. However, given the limited amount of construction anticipated in any one area, it is anticipated that this potential impact would be minimal. Therefore, potential subsistence impacts are anticipated to be *less than significant* for the Preferred Alternative.

These minimal potential impacts could be further reduced by implementing the BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential impacts to subsistence harvesting (see Chapter 11, BMPs and Mitigation Measures).

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. There would be *less than significant* impacts to real estate public services, social cohesion, and subsistence resources, and minimal, positive, *less than significant* impacts to economic activity and employment associated with routine inspections of the Preferred Alternative.

6.2.9.5. Alternatives Impact Assessment

The following section assesses potential impacts to socioeconomic resources associated with the Deployable Technologies Alternative and the No Action alternative.[1]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable

[1] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to socioeconomic resources as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

Deployment (i.e., purchase and staffing) of deployable technologies would result in *no impacts* to real estate, public services, social cohesion, and subsistence, as well as *less than significant positive impacts* on economic activity and employment due to the employees who operate deployable equipment, the wages paid to them, and the expenditures on equipment, fuel, and other items.

Potential Operation Impacts

Operation of deployable technologies would result in *no impacts* to public services or social cohesion, and *less than significant* impacts to real estate and subsistence resources if deployment locations are in areas where subsistence resources are present, and if the same deployment locations are used repeatedly and frequently. Implementation of deployable technologies could have *less than significant* positive impacts on economic activity and employment due to the employees who operate deployable equipment, the wages paid to them, and the expenditures on equipment, fuel, and other items.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to socioeconomic resources as a result of construction and operation of the Proposed Action. Socioeconomic conditions would therefore be the same as those described in Section 6.1.9, Socioeconomics.

6.2.10. Environmental Justice

6.2.10.1. Introduction

This section describes the potential impacts to environmental justice in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would help avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.10.2. Impact Assessment Methodology and Significance Criteria

Construction and operation of the Proposed Action in Guam could generate a potential environmental justice impact if high and adverse health and/or environmental impacts resulting from any phase of the Proposed Action's deployment or operation were to disproportionately affect a minority or low-income group (see below). If the impacts on the general population are not significant (in other words, are not high and adverse), there can be no disproportionate impacts on minority and low-income populations. For impacts determined to be significant, disproportionality would be determined based on the minority and low-income status of the population in the affected area. The significance of potential impacts of the Proposed Action on environmental justice was evaluated using the significance criteria presented in Table 6.2.10-1. As described in Section 6.2, Environmental Consequences, the categories of potential impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various areas, the potential impacts to environmental justice addressed in this section are presented as a range of possible impacts.

Table 6.2.10-1: Impact Significance Rating Criteria for Environmental Justice

<table>
<tr><th rowspan="2">Type of Effect</th><th rowspan="2">Effect Characteristic</th><th colspan="4">Impact Level</th></tr>
<tr><th>Potentially Significant</th><th>Less than Significant with BMPs and Mitigation Measures Incorporated</th><th>Less than Significant</th><th>No Impact</th></tr>
<tr><td rowspan="3">Effects associated with other resource areas (e.g., cultural resources) that have environmental justice implications due to the affected parties (as defined by EO 12898)</td><td>Magnitude or Intensity</td><td>Direct and disproportionate effects on environmental justice communities (as defined by EO 12898) that cannot be fully mitigated</td><td rowspan="3">Effect that is potentially significant, but with mitigation is less than significant</td><td>Direct effects on environmental justice communities (as defined by EO 12898) that do not require mitigation</td><td>No perceptible change in baseline conditions</td></tr>
<tr><td>Geographic Extent</td><td>Regional impacts observed throughout the state or territory</td><td>Effects realized at one location</td><td>NA</td></tr>
<tr><td>Duration or Frequency</td><td>Persists during or beyond the life of the Proposed Action</td><td>Persists for as long as the entire construction phase or a portion of the operations phase</td><td>NA</td></tr>
</table>

EO = Executive Order; NA = not applicable

6.2.10.3. Description of Environmental Concerns

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the location of the facility/infrastructure and the specific deployment requirements, some activities could result in potential impacts to environmental justice communities and others would not. As explained in this section, the various types of Proposed Action infrastructure could result in impacts ranging from *no impact* to *less than significant,* depending on the deployment scenario or site-specific conditions[1]. Section 6.1.10.4, Identification of Potential for Environmental Justice Impacts, shows areas in Guam with high, moderate, and low potential for environmental justice impacts.

6.2.10.4. Potential Impacts of Preferred Alternative

The following section assesses potential environmental justice impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

The determination of potential environmental justice impacts is dependent on both the specific location of deployment and operation as well as the magnitude of impacts to other resources and the types of resources affected. Environmental justice impacts are more likely to occur as a result of significant impacts to soils, water resources, land use, visual resources, socioeconomics, cultural resources, air quality, noise, and human health and safety, to the extent those impacts occur.

Activities Likely to Have No Impacts

The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and that are likely to have *no impact* on environmental justice include the following:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be *no impacts* to environmental justice communities because the activities that would be conducted at these small entry and exit points are not likely to produce perceptible surface disturbances. Additionally, installation of a new buried fiber optic plant within an existing conduit could lead to minor positive economic and employment benefits.

[1] Since potential environmental justice impacts occur at the site-specific level, analyses of individual proposed projects would be required to determine potential impacts to specific environmental justice communities. BMPs and mitigation measures may be required to address potential impacts to environmental justice communities at the site-specific level.

  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: The use of existing fiber optic plant would involve minimal aboveground activity in Guam. While some socioeconomic impacts could occur (see Section 6.2.9, Socioeconomics), it is unlikely that any of these impacts would rise to the level of "high and adverse" necessary to create environmental justice effects.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of new satellite-compatible infrastructure could lead to economic benefits, and would create no permanent negative changes in factors that affect environmental justice (such as income, economic conditions, population distribution, and subsistence, among others). The use of satellite-compatible devices (e.g., mobile phones) absent the installation of new equipment would have *no impacts*. BMPs and mitigation measures could help to avoid or minimize the potential impacts.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact environmental justice resources, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Given the scope of the project, while geographically enormous (in total 50 states, 5 territories, and the District of Columbia), the actual deployment in any one location is unlikely to be extensive and will likely involve a variety of deployment options (including an emphasis on collocations on existing facilities). The specific deployment activity and where the deployment will take place will be determined based on location-specific conditions and the results of site-specific environmental reviews.

Except for the four infrastructure development activities described above, all development scenarios and deployment activities have at least some potential to create environmental justice impacts. Taking into account the limited duration of construction activities, the types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential environmental justice impacts are discussed below. In general, as described in Section 6.2.10.2, Impact Assessment Methodology and Significance Criteria, environmental justice impacts could occur as a result of other impacts (such as to air, water, or socioeconomics, etc.); the Potential for environmental justice impacts shown in Figure 6.1.10-1 (in the Affected Environment section) indicates the degree to which such resource-specific impacts could disproportionately and adversely affect environmental justice communities. These potential impacts associated with the Proposed Action, based on the deployment activity and the limited duration of construction activities, are described further below.

- Wired Projects:
  - New Build – Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources. BMPs and mitigation measures would help to avoid or minimize these potential impacts.
  - New Build – Aerial Fiber Optic Plant: The installation of a new aerial fiber optic plant (i.e., new wires on elevated structures) could lead to economic and employment benefits, but could have adverse effects on land, air, community cohesion (due to worker influx), and other resources. BMPs and mitigation measures would help to avoid or minimize these potential impacts.
  - Collocation on Existing Aerial Fiber Optic Plant: Collocation of new aerial fiber optic plant with existing fiber optic plant could lead to economic and employment benefits, although these would be less than the New Build – Aerial Fiber Optic Plant option. While this option could affect land, air, and water resources, such potential impacts are less likely than under the New Build – Aerial Fiber Optic Plant option because the Use of Existing Aerial Fiber Optic Plant option would involve less ground disturbance. BMPs and mitigation measures would help to further avoid or minimize these potential impacts.
  - New Build – Submarine Fiber Optic Plant: Installation of a new submarine fiber optic cable in limited near-shore or inland bodies or water could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources. BMPs and mitigation measures would help to avoid or minimize these potential impacts.
  - Installation of Optical Transmission or Centralized Transmission Equipment: Installation of new transmission equipment could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources, due in part to the need to create access roads. BMPs and mitigation measures would help to avoid or minimize these potential impacts. The effects described above would be similar to but less than those described for the New Build – Buried Fiber Optic Plant, because the Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable option would involve less ground disturbance, and therefore less labor and use of equipment.
- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless communication towers could lead to economic and employment benefits, but could have adverse effects on land, air, water, community cohesion (due to worker influx), and other resources. In addition, and depending on location, installation of new wireless communication towers could result in limited and isolated impacts to some terrestrial subsistence resources, either through diminishment of habitat or through the interruption of migratory pathways. However, given the relatively small footprint of this project type, potential impacts, if

any, would likely be localized (not widespread) and only persist during the construction phase, or a limited portion of the operations phase. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) would help to avoid or minimize these potential impacts.

  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would include mounting or installing equipment (such as antennas) on an existing facility. This activity would be small in scale, temporary, and highly unlikely to produce adverse human health or environmental impacts on the surrounding community. Thus, it would not impact environmental justice communities. If collocation requires construction for additional power units, structural hardening, and physical security measures, the construction activity could temporarily generate noise and dust and disrupt traffic. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

- Deployable Technologies (all options)
  - Deployable Technologies: Cell on Wheels, Cell on Light Truck, System on Wheels, and aerial deployable technologies require storage, staging, and (for aerial deployables) launch and landing areas. To the extent such areas require new construction, noise and dust could be generated temporarily, and traffic could be disrupted. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

As described in this Draft Programmatic Environmental Impact Statement, none of the development scenarios or deployment activities would result in significant impacts after mitigation. As a result, there would be no disproportionately high and adverse effects to environmental justice communities in Guam from any development scenario or deployment activity if BMPs and mitigation measures are followed.

Potential Environmental Justice Impacts

Potential environmental justice impacts from all development scenarios and activities (except for the Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable or Deployment of Satellites options, which would have *no impacts*) would be *less than significant.* In general, the impacts from the abovementioned activities would be short-term and could potentially involve objectionable dust, noise, traffic, or other localized impacts due to construction activities. In some cases, these effects and aesthetic effects could potentially impact property values, particularly for new towers. Since environmental justice impacts occur at the site-specific level, analyses of individual proposed projects would likely be required to determine potential impacts to specific environmental justice communities. BMPs and mitigation measures may be required to address potential impacts to environmental justice communities at the site-specific level. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with environmental justice.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative, which would consist of routine maintenance and inspection of the facilities, are anticipated to have *less than significant* impacts if the same roads are used to perform inspections and maintenance activities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the deployment impacts described above.

6.2.10.5. Alternatives Impact Assessment

This section discusses potential environmental justice impacts associated with the Deployable Technologies Alternative and the No Action Alternative.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. In general, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas. However, these construction activities would be minimal in comparison to the combination of project types associated with the Preferred Alternative as described above. . The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative, but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration.

The potential for environmental justice impacts shown in Figure 6.1.10-1 is applicable to this alternative.

Potential Deployment Impacts

As explained above, deployable technologies such as Cell on Wheels, Cell on Light Truck, and System on Wheels, along with aerial deployable technologies, could require storage, staging, and launch/landing areas. To the extent such areas require new construction, noise and dust could be generated temporarily, and traffic could be disrupted. These impacts are expected to be less than significant. If these effects occur disproportionately in environmental justice communities, they would be considered environmental justice impacts.

Potential Operation Impacts

Operation of deployable technologies would result in effects similar in type to, but more frequent than, those described for the Preferred Alternative. As a result, this alternative would result in *less than significant* disproportionate impacts to environmental justice communities due to the impacts to air, water, land, and subsistence resources associated with the operation of deployable vehicles for up to 2 years at a time. The BMPs and mitigation measures described for the

Preferred Alternative would help to minimize these impacts. Implementation of deployable technologies could have *less than significant* positive impacts on environmental justice communities due to the employees who operate deployable equipment, the wages paid to them, and the expenditures on equipment, fuel, and other items (see Section 6.2.9, Socioeconomics).

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be *no impacts* associated with construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. There would be no environmental justice impacts associated with the No Action Alternative.

6.2.11. Cultural Resources

6.2.11.1. Introduction

This section describes potential impacts to cultural resources in Guam associated with deployment and operation of the Proposed Action and alternatives. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.11.2. Impact Assessment Methodology and Significance Criteria

The impacts of the Proposed Action on cultural resources were evaluated using the significance criteria presented in Table 6.2.11-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as an *adverse effect; mitigated adverse effect; effect, but not adverse;* and *no effect*. These impact categories are comparable to those defined in *36 Code of Federal Regulations (CFR) 800*, *Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation* (*NPS 1983*), and the United States (U.S.) National Park Service's *National Register Bulletin: How to Apply the National Register Criteria for Evaluation* (*NPS 2002*). Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to cultural resources addressed in this section are presented as a range of possible impacts.

Table 6.2.11-1: Impact Significance Rating Criteria for Cultural Resources

Type of Effect	Effect Characteristic	Impact Level			
		Adverse Effect	**Mitigated Adverse Effect[a]**	**Effect, but not Adverse**	**No Effect**
Direct effects to historic properties[b]	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	*Adverse effect* that has been procedurally mitigated through Section 106 process	Effects to a non-contributing portion of a single or many historic properties	No direct effects to historic properties
	Geographic Extent	Direct effects APE		Direct effects APE	Direct effects APE
	Duration or Frequency	Permanent direct effects to a contributing portion of a single or many historic properties		Permanent direct effects to a non-contributing portion of a single or many historic properties	No direct effects to historic properties
Indirect effects to historic properties (i.e., visual, noise, vibration, atmospheric)	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	*Adverse effect* that has been procedurally mitigated through Section 106 process	Effects to a contributing or non-contributing portion of a single or many historic properties	No indirect effects to historic properties
	Geographic Extent	Indirect effects APE		Indirect effects APE	Indirect effects APE
	Duration or Frequency	Long-term or permanent indirect effects to a single or many historic properties		Infrequent, temporary, or short-term, indirect effects to a single or many historic properties	No indirect effects to historic properties
Loss of access to historic properties	Magnitude or Intensity	Effects to a contributing portion of a single or many historic properties	*Adverse effect* that has been procedurally mitigated through Section 106 process	Effects to a non-contributing portion of a single or many historic properties	No segregation or loss of access to historic properties
	Geographic Extent	Any area surrounding historic properties that would cause segregation or loss of access to a single or many historic properties		Any area surrounding historic properties that could cause segregation or loss of access to a single or many historic properties	No segregation or loss of access to historic properties
	Duration or Frequency	Long-term or permanent segregation or loss of access to a single or many historic properties		Infrequent, temporary, or short-term changes in access to a single or many historic properties	No segregation or loss of access to historic properties

APE = Area of Potential Effect

Notes:

[a] Whereas BMPs and mitigation measures for other resources discussed in this Draft Programmatic Environmental Impact Statement may be developed to achieve an impact that is *less than significant with BMPs and mitigation measures incorporated*, historic properties are considered to be "non-renewable resources" given their very nature. As such, any and all unavoidable adverse effects to historic properties, per Section 106 of the National Historic Preservation Act (as codified in *Title 36 of the CFR Parts 800.6*), would require FirstNet to consult with the State Historic Preservation Office/Tribal Historic Preservation Office and other consulting parties, including Indian tribes and Native Hawaiian organizations, to develop appropriate BMPs and mitigation measures.

[b] Per the National Historic Preservation Act, a historic property is defined as any district, archaeological site, building, structure, or object that is either listed or eligible for listing in the National Register of Historic Places (NRHP). Cultural resources present within a project's APE are not historic properties if they do not meet the eligibility requirements for listing in the NRHP. Sites of religious and/or cultural significance refer to areas of concern to Indian tribes and other consulting parties that, in consultation with the respective party or parties, may or may not be eligible for listing in the NRHP. These sites may also be considered traditional cultural property (TCPs). Therefore, by definition, these significance criteria only apply to cultural resources that are historic properties, significant sites of religious and/or cultural significance, or TCPs. For the purposes of brevity, the term "historic property" is used here to refer to either historic properties, significant sites of religious and/or cultural significance, or TCPs.

Specific Regulatory Considerations

As discussed in Section 6.1.11, Cultural Resources, the Proposed Action is considered an undertaking as defined in *36 CFR 800*, the regulation implementing Section 106 of the National Historic Preservation Act. The intent of Section 106, as set forth in its attending regulations, is for federal agencies to take into account the effects of a proposed undertaking on historic properties, which can include traditional cultural properties (TCPs), and to consult with the Advisory Council on Historic Preservation (ACHP); State Historic Preservation Offices (SHPOs); federally recognized American Indian tribes and Native Hawaiian organizations; local governments; applicants for federal assistance, permits, licenses, and other approvals; and any other interested parties with a demonstrated interest in the proposed undertaking and its potential effects on historic properties.

Section 106 establishes a process for the following:

- Identifying historic properties that may be affected by a proposed undertaking;
- Assessing the undertaking's effects on those resources; and
- Engaging in consultation that seeks ways to avoid, minimize, or mitigate adverse effects on properties that are either listed on, or considered eligible for listing on, the National Register of Historic Places (NRHP).

The area in which effects on resources are evaluated is known as the Area of Potential Effect (APE). The APE is defined as, "… the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of the undertaking and may be different for different kinds of effects caused by the undertaking" (*36 CFR § 800.16(d)*).

The APE would include potential effects areas for both direct and indirect effects. Direct effects physically alter the historic property in some way, and indirect effects are further removed in time or space and diminish some aspect of the historic property, but may not physically alter it. Direct and indirect effects are discussed in further detail below. Although an APE has not been identified for the Proposed Action due to the nature of this programmatic evaluation, an APE would need to be established to evaluate the potential site-specific effects to cultural resources for any individual project.

To be eligible for listing in the NRHP, a cultural resource must meet at least one of the four criteria for eligibility. The major criteria (*36 CFR 60.4(a–d)*) used to evaluate the significance of a cultural resource are as follows:

a) It is associated with events that have made a significant contribution to the broad patterns of history;

b) It is associated with the lives of past significant persons;

c) It embodies the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d) It has yielded or may be likely to yield information important in history or prehistory.

Properties also need to exhibit integrity of location, materials, setting, design, association, workmanship, and feeling and commonly be at least 50 years old. However, under Criteria Consideration G, a property achieving significance within the past 50 years is eligible if it is of exceptional importance.

As discussed in Section 6.1.11, Cultural Resources, historic properties can also include properties of traditional religious and cultural significance to various populations; these properties are commonly referred to as TCPs. TCP is defined in National Register Bulletin 38 as a place "eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (*NPS 1998*). Because the cultural practices or beliefs that give a TCP its significance are typically still observed in some form at the time the property is evaluated, it is sometimes perceived that the intangible practices or beliefs themselves, not the tangible property, constitute the subject of evaluation. There is naturally a dynamic relationship between tangible and intangible. The beliefs or practices associated with a TCP are of central importance in defining its significance. However, it should be clearly recognized at the outset that the NRHP does not include intangible resources themselves. The entity evaluated must be a tangible property—i.e., a district, site, building, structure, or object. Notably, a property must meet several preconditions in order to meet the federal definition of TCP as articulated in National Register Bulletin 38. These conditions include the ongoing use of a property in spiritual practice or other traditional activities (*NPS 1998*). It is difficult to identify properties of traditional cultural significance because they are often kept secret due to sensitivity around use and location by the effected communities and the National Register discourages nominations of purely natural features "without sound documentation of their historical or cultural significance" (*NPS 1998*). It is through consultation with affected groups themselves that historic properties of religious and cultural significance can be properly identified and evaluated (*ACHP 2008*).

Local, state/territory, tribal, and federal agencies would be consulted as appropriate in findings and determinations made during the Section 106 process, as specified in *36 CFR 800*. This includes any SHPO/Tribal Historic Preservation Office whose state/territory would physically include any portion of the APE. In addition to the SHPO, the lead federal agencies have an obligation, as appropriate, to work with state/territory and local governments as well as private organizations, applicants, or individuals with a demonstrated interest from initiation to completion of the review under Section 106 of the National Historic Preservation Act. Once the lead federal agency has identified the appropriate SHPO, *36 CFR 800.3(f)(2)* requires the federal agencies to identify American Indian tribes or Native Hawaiian organizations that may attach religious and cultural significance to historic properties within the APE and invite them to be consulting parties.

In consultation with the SHPO and other effected parties, FirstNet would apply the criteria of adverse effects to historic properties within the APE to evaluate the potential effect of the Proposed Action on the identified historic properties, as codified in *36 CFR 800.5*.

An *adverse effect* is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association, as discussed above. Adverse effects may include reasonably foreseeable indirect effects that occur later in time, are farther removed, or are cumulative.

FirstNet would confer with consulting parties to determine the undertaking's effects on historic properties, to resolve adverse effects, and to develop BMPs and mitigation measures as necessary. As presented in Table 6.2.11-1, effects determinations have the following three possible outcomes:

1. Finding of *no effect* to historic properties – The Proposed Action does not have the potential to cause effects on historic properties that may be present.
2. Finding of *effect, but not adverse effect* – The historic property would be affected; however, the effects of an undertaking do not meet the criteria of adverse effect, or measures have been taken to avoid or minimize adverse effects.
3. Finding of *adverse effect/mitigated adverse effect* – The undertaking may affect the integrity, which would alter, directly or indirectly, any of the characteristics of a historic property that qualify it for inclusion in the NRHP. If an *adverse effect* is found, the federal lead agency shall consult further to resolve the adverse effect.

Except as described later, if an historic property could be affected, FirstNet would follow the provisions of *36 CFR 800.5* to determine whether the effects were adverse. If an effect were adverse, FirstNet would consult with the parties identified above to identify practicable and feasible ways to avoid, minimize, or mitigate any potential effects of the Proposed Action pursuant to *36 CFR 800.6*. Additionally, the ACHP would be notified of the adverse effects and invited to participate in the resolution of adverse effects process. If adverse effects are unavoidable, then the following are potential BMPs and mitigation measures that could be taken to resolve adverse effects:

- Minimization, which would reduce the effects on the resource through partial avoidance, but would not completely eliminate the effects; and
- Mitigation, which would offset that effect through some of the following means:
  - Protection of a similar resource nearby;
  - Detailed documentation of the resource through data recovery (e.g., excavations, in the case of archaeological sites, or Historic American Buildings Survey/Historic American Engineering Record documentation, in the case of historic structures);
  - Contributions to the preservation of cultural heritage in the affected community;

- Interpretative exhibits highlighting information gained about cultural resources through the Proposed Action; or
- Some combination of these strategies.

If adverse effects are unavoidable, FirstNet would be required to develop appropriate BMPs and mitigation measures, in consultation with some combination of the ACHP, SHPO, a Tribal Historic Preservation Office, and other interested parties, and execute a Memorandum of Agreement (MOA) or Programmatic Agreement (PA), depending on the size and length of the individual project or program and the number of parties involved.

The MOA or PA would establish a process for ongoing consultation, review, and compliance with federal and territorial historic preservation laws, and describe the actions that would be taken by the parties to meet their cultural resources compliance responsibilities. The MOA or PA would ensure the resolution of adverse effects and that consultation and BMPs and mitigation procedures are followed. The MOA or PA would also include an Unanticipated Discovery Plan, which would detail the procedures taken if unanticipated cultural materials or human remains were encountered during the deployment phase of the Proposed Action. The MOA or PA would be used as a tool to ensure that Section 106 and other applicable state/territory and federal cultural resource laws and regulations, such as the Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, are complied with and implemented accordingly.

Additionally, FirstNet is permitted under a 2015 Program Comment approved by the ACHP—that renewed and amended an existing 2009 Program Comment—to use its alternative procedures to comply with Section 106 for any potential effects resulting from any proposed construction and modification undertakings that would be subject to review by the Federal Communications Commission under either an existing 2001 or 2004 nationwide PA for telecommunications and collocations. This permits FirstNet to avoid duplicative reviews and complying separately with Section 106 in evaluating any proposed undertaking, when it has already undergone or will undergo, or is exempt from, a review by the Federal Communications Commission under either the 2001 or 2004 PA (*ACHP 2015*).

6.2.11.3. Description of Environmental Concerns

Direct Effects to Historic Properties

The primary cultural resource concern during deployment and operation activities is physical damage to and/or destruction of historic properties. Direct effects typically occur to historic properties located within or in close proximity to deployment areas. Impacts caused by deployment or operation are restricted to any historic properties, known or unidentified, within the area of physical disturbance.

Any deployment-related ground disturbing activities, such as grading, excavation, vegetation clearing, or even merely driving equipment off-road has the potential to damage, disturb, or remove known or previously unidentified cultural resources, particularly archaeological sites. Since archaeological sites and the scientific data that can be gathered from them are based on their undisturbed context, the integrity and undisturbed nature of an archaeological site is of utmost importance. Ground-disturbing activities are likely to occur during deployment of Proposed Action facilities and associated infrastructure, both on land and in water, and in the future during operation phase maintenance that could involve unanticipated find events.

An influx of non-local workers into an area could subject known historic properties to an increase in visitors who may not be aware of a resource's local, regional, or national cultural value. Resources could be damaged due to intentional or unintentional looting or vandalism. If previously unidentified cultural resources are identified during deployment or operation, individual project-related personnel collecting artifacts as souvenirs could also impact resources.

Based on the impact significance criteria presented in Table 6.2.11-1, physical damage to and/or destruction of historic properties could be adverse if FirstNet's deployment locations or activities would cause permanent direct effects to a contributing portion of a single or multiple historic properties. As discussed in the affected environment Section 6.1.11, Cultural Resources, known and unidentified cultural resources can occur throughout Guam. Although parts of the territory have been systematically surveyed, not all areas or cultural resources have been evaluated for their eligibility, and historic properties have been listed on the Guam and National Registers of Historic Places, there is the potential for unidentified cultural resources to exist and/or known historic properties to be adversely effected by the Proposed Action. Because prehistoric sites in Guam are known to occur near coastal areas where populated areas and infrastructure are prevalent, historic properties, such as Pre-Latte and Latte Period archaeological sites or near-shore shipwrecks, would be most susceptible to near-coastal adverse effects. Additionally, prehistoric and historic period archaeological sites and historic structures are commonly located in more level, inland areas where individual project activities could occur. Topographically prominent locations suited for telecommunication infrastructure could also be located near or on sites of religious and/or cultural significance and historic Japanese military sites or within cultural landscapes.

Prior to deployment, FirstNet would identify and evaluate cultural resources through systematic survey and apply the criteria of adverse effects to historic properties within the individual project APE to determine the potential effect of the Proposed Action on any identified historic properties. To the extent practicable, FirstNet does not expect to raze any historic structures or adversely affect any known historic properties as part of siting the Proposed Action. If the proposed deployment activities would have the potential to adversely affect historic properties, FirstNet would apply BMPs and mitigation measures and/or consult with appropriate federal, territorial, tribal, and other interested parties to apply appropriate mitigation measures to resolve adverse effects. If after initial surveys unanticipated cultural resources were identified during deployment or operation, procedures established within the MOA or PA would be followed to appropriately consult, evaluate, and resolve potential adverse effects to any historic properties. If unmarked human burial remains are encountered, then work in the area of the find must cease immediately and the Guam Historic Resources Division must be contacted before further ground-disturbing activity could occur at the discovery site.

Indirect Effects to Historic Properties

Indirect effects to historic properties could include changes to the views to and from a resource (viewshed impacts); increased noise levels at a resource; vibration; and/or visual or atmospheric effects due to dust, emissions, or pollutants. These types of indirect effects may not only affect a historic property's sense of setting, feeling, or association, but could also indirectly affect the physical characteristics of a historic property.

Indirect effects are typically caused by spatially removed activities due to visual, auditory, vibratory, or atmospheric impacts that occur beyond the physical area of disturbance, but are typically restricted to the immediate area around the emitting source, especially in the case of noise, vibration, dust, or emissions. The size of the area impacted by the indirect effects is determined by a combination of variables including the frequency, duration, intensity, and magnitude of the impacts.

Proposed Action activities that could result in these types of impacts include deployment-related ground disturbance; vegetation clearance; increased noise, vibration, dust, pollutants, and emissions associated with vehicle traffic; and placement of individual project components within viewsheds. The accumulation of dust due to vehicular traffic or deployment activities on historic properties could impact their cultural value to a site user, although they would tend to be minor or limited in extent. The accumulation of other pollutants could have a similar effect as dust and could contribute to physical damage to historic properties from chemical reactions between pollutant and resource materials, although the effects would generally be required to be long-term to cause significant damage.

Historic structures and prehistoric ruins or sensitive features are prone to vibration-related impacts. Vibrations are measured in terms of peak particle velocity. The Swiss Association of Standardization Vibration Damage Criteria states that structures highly sensitive to vibration will sustain damage if continuous vibration activities generate peak particle velocity in the underlying soil of 3.048 millimeters per second (mm/s) or higher (*Jones & Stokes 2004*). A British Museum study found that continuous vibrations of 2.5 mm/s or 5.0 mm/s from intermittent vibrations will damage historic buildings (*Higgitt 2010*). The use of heavy equipment during deployment and increased vehicular traffic along established or new access roads during deployment and operation-phase activities could generate localized vibrations sufficient to damage historic properties. The Proposed Action, however, would likely not possess the amount or frequency of vehicular traffic needed to cause significant effects.

Based on the impact significance criteria presented in Table 6.2.11-1, indirect effects to historic properties could be adverse if FirstNet's deployment or operation activities would cause permanent indirect effects to a contributing portion of a single or many historic properties. As discussed in the affected environment Section 6.1.11, Cultural Resources, known and previously unidentified cultural resources can occur throughout Guam. Although parts of the island have been systematically surveyed, not all areas or cultural resources have been evaluated for their eligibility, and historic properties have been listed on the Guam and National Registers of Historic Places, the potential remains for unidentified cultural resources to exist and/or known historic properties to be adversely effected by the Proposed Action. Additionally, in the case of

TCPs and cultural resources of religious and/or cultural significance, sites may be difficult to identify, boundaries may not be able to be defined, and the affected cultural groups may not be willing to share information about the sites. Historic properties such as those related to natural features, such as many of the beach sites, cemeteries, or even traditional hunting, fishing, or plant gathering sites, could be adversely affected by effects from views, noise, or emissions. Topographically prominent locations suited for telecommunication infrastructure could also be located within the viewshed of TCPs or other sites of religious and/or cultural significance. Historic properties containing structural components (i.e., Fort Soledad or Plaza de España) or sensitive or fragile features, such as any of the 10 pictograph cave sites, could be susceptible to damage due to vibrations.

As discussed above, FirstNet would identify, evaluate, and apply the criteria of adverse effects to historic properties within the individual project APE to determine the potential effect of the Proposed Action on any identified historic properties. To the extent practicable, FirstNet does not expect to adversely affect any known historic properties as part of siting the Proposed Action. If the proposed deployment activities would have the potential to adversely affect historic properties, FirstNet would apply BMPs and mitigation measures and/or consult with appropriate federal, territorial, tribal, and other interested parties to apply appropriate mitigation measures to resolve adverse effects.

Loss of Access to Historic Properties

The goal of historic preservation is not only to preserve and protect historic properties, but also to provide access to cultural resources, especially to those who value them. This is fundamental to all historic properties, primarily to historic properties that are considered TCPs and other sites of religious and/or cultural significance (*NPS 1998*). Effects would be considered adverse if long-term or permanent segregation or loss of access was caused by individual project activities to a single or many historic properties.

Historic resources, especially TCPs, hunting, fishing, or plant gathering sites, graves or cemeteries, and areas of particular religious or traditional importance, can lose their integrity, and thus their potential eligibility for the NRHP when they become degraded as a result of natural or human disturbance processes. Additionally, loss of integrity can occur when the groups, such as the Pacific Islanders, who value these places, can no longer access them, thus losing their ability to use the sites in a traditional way and the cultural connection to the site or place over time.

The cause of the loss of access can be direct or indirect. A historic property such as a cemetery or religious place—Atantano Shrine, for example—could be physically segregated, excluding public use of the place. However, limitations on access could also be indirect, whereas the use associated with the cultural landscape or traditional gathering area is affected be visual or audible effects long-term or permanently so as practitioners cannot perform traditional uses. Many TCPs are used for practical purposes by those who value them and the resources gathered are vital to continuing cultural and traditional practices.

As discussed above, FirstNet would consult with the appropriate territory agencies and interested Chamorro groups and individuals to identify, evaluate, and apply the criteria of adverse effects to historic properties within the project APE to determine the potential effect of the Proposed Action on any identified historic properties. To the extent practicable, FirstNet does not expect to adversely affect access to any known historic properties as part of siting the Proposed Action. If the proposed deployment or operation activities would have the potential to adversely affect historic properties, FirstNet would apply BMPs and mitigation measures and/or consult with appropriate federal, territorial, tribal, and other interested parties to apply appropriate mitigation measures to resolve adverse effects.

6.2.11.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to cultural resources and others would not. In addition, and as explained in this section, the same type of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Effects

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no effects* to cultural resources under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Disturbance associated with the installation of fiber optic cable in existing conduit would be limited to entry and exit points of the existing conduit in previously disturbed areas. It is anticipated that there would be no direct or indirect effects to cultural resources because the activities that would be conducted at these small entry and exit points are within previously disturbed areas and any indirect effect or effects to access would be short-term.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no effects* to cultural resources because there would be no ground disturbance.
- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: The installation of new satellite-compatible infrastructure on existing towers, structures, or buildings (where antennae are already

placed) would likely be visible. It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would not impact cultural resources because those activities would not require ground disturbance or create new perceptible visual effects. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.

- Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle is very unlikely to impact cultural resources, it is anticipated that this activity would have *no effect* on cultural resources.

Activities with the Potential to Have Effects

Potential deployment-related impacts to cultural resources as a result of implementation of the Preferred Alternative would encompass a range of effects that could occur as a result of ground disturbance activities, vehicular traffic, the presence of new aboveground structures or components, visual evidence of construction, and the presence of construction equipment. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential effects to cultural resources include the following:

- Wired Projects
  - New Build – Buried Fiber Optic Plant: Plowing (including vibratory plowing), trenching, or directional boring and the construction of points of presence,[1] huts, or other associated facilities or hand-holes to access fiber could result in potential direct and indirect effects or access effects to cultural resources. Soil disturbance and heavy equipment use associated with plowing, trenching, or directional boring as well as land/vegetation clearing, excavation activities, and landscape grading associated with construction of points of presence, huts, or other associated facilities or hand-holes to access fiber could result in direct and indirect effects or access effects to cultural resources. Installation of a new buried fiber optic plant would create visible evidence of construction, including a narrow, impermanent "scar" in the earth where the new fiber optic plant was installed, and the presence of construction equipment used for this installation. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize the potential impacts.
  - New Build – Aerial Fiber Optic Plant: Soil excavation and excavated material placement during the installation of new poles could result in potential direct and indirect effects or access effects to cultural resources. The use of heavy equipment during the installation of new poles and hanging of cables could also result in potential direct and indirect effects to cultural resources or access effects to cultural resources. The installation of a new aerial fiber optic plant (i.e., new wires on new transmission towers) would have a

[1] Points of presence are connections or access points between two different networks, or different components of one network.

discernable change on visual conditions. Except if replacing existing infrastructure, this option would add new elements (towers) to a viewshed, and would result in visible evidence of construction activity and equipment. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.

  - Collocation on Existing Aerial Fiber Optic Plant: Soil excavation and excavated material placement during the replacement of poles and structural hardening could result in direct and indirect effects to cultural resources, although any effects to access would be short-term. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in direct and indirect effects to cultural resources.
  - New Build – Submarine Fiber Optic Plant: The installation of cables in bodies of water could have direct and indirect impacts to submerged cultural resources. Direct and indirect effects as well as access effects to cultural resources could potentially occur as result of the construction of landings and/or facilities on shore to accept submarine cable or the impact of cable placement on submerged resources. Direct and indirect effects to terrestrial cultural resources could potentially occur as result of grading, foundation excavation, or other ground disturbance activities as well as heavy equipment use during these activities. Installation of new associated huts or equipment, however, would create aboveground features and the presence of construction equipment and create visible aboveground components. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize the potential impacts.
  - Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment would occur in existing boxes or huts and require no ground disturbance (collocations), there would be *no effects* to cultural resources. However, if installation of transmission equipment required grading or other ground disturbance to install small boxes, hunts, or access roads, there could potentially be direct and indirect impacts to cultural resources, although access effects would be short-term. Heavy equipment use associated with these activities as well as with installing new fiber on existing poles could result in direct and indirect effects to cultural resources. Installation of new transmission equipment would add a new element to the viewshed, in the form of a small box or hut. BMPs and mitigation measures (see below) could help to avoid or minimize the potential impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in direct and indirect effects or access effects to cultural resources. Land/vegetation clearing, excavation activities, landscape grading, and other ground disturbance activities during the installation of new wireless towers and associated structures or access roads and heavy equipment use could result in direct and indirect effects. Installation of new wireless communication towers would add new elements (towers) to the viewshed and

would result in visible evidence of construction activity and equipment. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. Although the change associated with this option is small, it could cause cumulative visual effects to historic properties within its viewshed. If the onsite delivery of additional power units, structural hardening, and physical security measures required ground disturbance, such as grading or excavation activities, direct and indirect effects to cultural resources could occur, although access effects would be short-term. The use of heavy equipment could also have direct and indirect effects. BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) could help to avoid or minimize potential impacts.

- Deployable Technologies
  - Implementation of deployable technologies could result in potential direct and indirect effects to cultural resources if deployment of land-based deployables occurs in unpaved areas, or if the implementation results in minor construction or paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, minor excavation, and paving. These activities could result in direct and indirect effect to cultural resources, although access effects would be unlikely. Heavy equipment use associated with these activities and implementation of deployable technologies themselves could result in direct and indirect effects if deployed in unpaved areas. It is anticipated that there would be *no effects* to access or the viewshed during deployment of the deployable technologies.

In general, the abovementioned activities could potentially involve land/vegetation clearing, excavation, excavated material placement, trenching or directional boring, construction of access roads and other impervious surfaces, landscape grading, heavy equipment movement, and installation of aboveground components. Potential effects to cultural resources associated with deployment of this infrastructure could include direct and indirect effects or access effects to cultural resources. These effects and associated BMPs and mitigation measures to help mitigate or reduce these impacts are described further below.

Direct Effects to Historic Properties

Based on the analysis of the deployment activities described above to cultural resources, impacts as a result of direct effects are anticipated to be *effect, but not adverse*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential impacts to these resources.

FirstNet is committed to avoidance of direct effects to historic properties to the maximum extent practicable. The key time to implement avoidance actions is during siting and deployment, prior to and during Preferred Alternative activities. To facilitate this commitment to effect avoidance, pre-siting or pre-deployment surveys for cultural resources would be conducted for all proposed activities not covered by the Program Comment to ensure that informed siting of Preferred Alternative activities would enable avoidance of adverse effects to historic properties to the maximum extent practicable.

Further, the establishment of an unanticipated discovery plan during deployment and operation would be implemented to ensure that procedures are followed if unanticipated cultural materials or human remains were encountered during the deployment and operation of the Preferred Alternative, and that BMPs and mitigation measures are fully and effectively implemented and unanticipated effects to historic properties are not occurring. For activities that could adversely affect historic properties, FirstNet would enter into formal consultation with federal, territorial tribal, and other interested parties to execute a MOA or PA to establish a process for ongoing consultation, review, and compliance with federal and territorial historic preservation laws, and describe the actions that would be taken by the parties in order to meet their cultural resources compliance responsibilities. The MOA or PA would ensure the resolution of adverse effects and that consultation and mitigation procedures are followed. The MOA or PA would be used as a tool to ensure that Section 106 and other applicable territorial and federal cultural resource laws and regulations, such as Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, American Indian Religious Freedom Act, and territorial laws, are complied with and implemented accordingly.

Potential Indirect Effects to Historic Properties

Based on the analysis of the deployment activities described above to cultural resources, indirect effects are anticipated to be *effect, but not adverse*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential impacts to these resources.

Potential Loss of Access to Historic Properties

Based on the analysis of the deployment activities described above to cultural resources, impacts as a result of effects to access are anticipated to be *effect, but not adverse*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential impacts to these resources.

Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in impacts similar to the abovementioned deployment impacts. It is anticipated that there would be *no effects* to historic properties associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections and the activities are infrequent and temporary. If usage of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, direct and indirect effects or temporary access effects could result as explained above.

6.2.11.5. Alternatives Impact Assessment

The following section assesses potential impacts to historic properties associated with the Deployable Technologies Alternative and the No Action alternative.[2]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of land-based and aerial mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential effects to historic properties as a result of implementation of this alternative are described below.

Deployment Impacts

As explained above, implementation of land-based deployable technologies could result in *effects, but not adverse* to historic properties if deployment of land-based deployables occurs in unpaved areas or if the implementation results in paving of previously unpaved surfaces. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, excavation, and paving. These activities could result in direct and indirect effect to cultural resources, although access effects would be unlikely. Heavy equipment use associated with these activities and implementation of deployable technologies themselves could result in direct and indirect effects if deployed in unpaved areas. It is anticipated that there would be *no effects* to access or the viewshed during deployment of the deployable technologies.

Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the deployment impacts, it is anticipated that there would be *effects, but not adverse* to historic properties associated with implementation/running of the deployable technology because effects to access or the viewshed could occur, depending on the length of deployment. Assuming that the same access roads used for deployment are also used for inspections, it is anticipated that there would be *no effects* to historic properties due to inspections. If usage of heavy equipment as part of

[2] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

routine maintenance or inspections occurs off of established access roads or corridors, *effects, but not adverse* to historic properties could result as previously explained above.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated deployment or operation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no effects* to historic properties as a result of deployment and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.11, Cultural Resources.

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6.2.12. Air Quality

6.2.12.1. Introduction

This section describes potential impacts to air quality in Guam associated with deployment and operation of the Proposed Action and alternatives. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are discussed in Chapter 11, BMPs and Mitigation Measure.

6.2.12.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on air quality were evaluated using the significance criteria presented in Table 6.2.12-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of the potential air quality impact, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to air quality addressed in this section are presented as a range of possible impacts.

Table 6.2.12-1: Impact Significance Rating Criteria for Air Quality

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Increased air emissions	Magnitude or Intensity	Emissions would prevent progress toward meeting one or more NAAQS in nonattainment areas. Emissions in attainment or maintenance areas would cause an exceedance for any NAAQS. Emissions exceed one or more major source permitting thresholds. Projects do not conform to SIP.	Effect that is *potentially significant*, but with mitigation is *less than significant*	Negligible emissions would occur for any pollutant within an attainment area, but would not cause a NAAQS exceedance and would not trigger major source permitting.	Emission increases would be infrequent or absent, mostly immeasurable. Projects conform to SIP.
	Geographic Extent	NA		NA	NA
	Duration or Frequency	Permanent or long-term		Short-term	Temporary

NAAQS = National Ambient Air Quality Standards; NA = not applicable; SIP = State (or Territory) Implementation Plan

6.2.12.3. Description of Environmental Concerns

Increased air emissions could result in potentially negative impacts to human health, wildlife, vegetation, and visibility. Emissions could result from stationary or mobile equipment that is powered by fossil fuels such as excavators, backhoes, frontend loaders, graders, pavers, dump trucks, etc. required to support any clearance, drilling, and construction activities associated with network deployment. In addition, the use of power generators, first responder on-road vehicles (large towable trailers, commercial trucks, standard sport utility vehicles), and aerial platforms (unmanned aircraft such as drones and piloted aircraft such as airplanes, balloons, and blimps) associated with the implementation of deployable technologies could also increase air emissions, both from fossil fuel combustion and, in some cases, from stirring up dust on unpaved roads. Helicopters, if needed, would likely only be used during deployment of one of the above technologies to potentially move people or equipment to remote areas. As the use of helicopters would be infrequent, if at all, potential impacts associated with the use of helicopters are not evaluated here.

Potential impacts from increased air emissions could occur in any location; however, the most affected areas are nonattainment areas (where air quality is not meeting local standards), maintenance areas (where air quality has improved but historically did not meet local standards), and designated Class I Areas (areas of special national or cultural significance including certain national parks, wilderness areas, and national monuments). Nonattainment and maintenance areas are sensitive to increased air pollution because of their existing air quality concerns; Class I Areas are sensitive because of the expectation for pristine air quality and visibility in these areas (see Section 6.1.12, Air Quality).

There are no Class I Areas in Guam. However, because Guam contains nonattainment areas (Piti Power Plant and Tanguisson Power Plant), and some amount of infrastructure could be built in these areas, BMPs and mitigation measures (see Chapter 11)would help avoid or minimize potential air quality impacts. In addition, it is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months (typically less than a year, and could be as short as a few hours or days for some activities such as pole construction).

6.2.12.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities. Estimated emissions associated with the Proposed Action are compared to the permitting thresholds for new major stationary sources in order to evaluate the significance of potential air quality impacts. Because the air emissions associated with most of the construction/deployment activities (excluding use of mobile power generators for deployment technologies if on-site for 12 consecutive months or more) are solely from mobile construction equipment/vehicles, these non-stationary sources or activities would not be subject to territory air quality requirements that would require consultation or permitting actions. Emissions from the non-stationary sources (and sources not covered by a New Source Review permit) are subject to the general conformity requirements, if such emissions are generated in areas designated as nonattainment or maintenance for any criteria pollutant or its pre-cursor. The major stationary source permitting thresholds are lower for modifications (rather than new sources); however, these thresholds are based on an increase in emissions compared to the existing source. It is anticipated that any modifications associated with the Proposed Action (e.g., replacement of an existing diesel generator) would involve equipment of the same size with emissions performance equal to or better than the existing equipment. Therefore, only new emission sources are quantitatively evaluated to determine significance. Additionally, lead emissions were not quantified in the following assessment because all fuels are anticipated to be unleaded and no measurable amount of lead emissions are expected as a result of the Proposed Action.

As noted in Section 6.1.12, Air Quality, two areas of Guam (Piti Power Plant and Tanguisson Power Plant) are designated as nonattainment areas for sulfur dioxide (SO_2); the applicable threshold is 100 tons per year (tpy) for SO_2 and 250 tpy for each of the other criteria pollutants emitted by a stationary source. Additionally, general conformity thresholds exist because of the SO_2 nonattainment status for Piti Power Plant and Tanguisson Power Plant. This threshold is 100 tpy, the same as the major source permitting threshold for SO_2.

Furthermore, within the United States and its territories, there are no air quality permitting programs, and thus no thresholds, for mobile sources such as construction equipment/activities, motor vehicles, small boats, airplanes, and drones.[1] As noted in Section 6.1.12, Air Quality, emissions from each of these mobile sources are regulated through fuel standards and inspection/maintenance programs. The proposed BMPs and mitigation measures (see Chapter 11) would help avoid or minimize potential air quality impacts associated with these mobile emission sources. Nonetheless, to provide additional context, emissions from construction equipment/activities and motor vehicles are estimated below and compared to the 250- and 100-tpy major source permitting and general conformity thresholds, although these thresholds would not apply to such emissions for permitting purposes.

Finally, the following analyses consider pollutant emission rates only. Changes to ambient air pollutant concentrations through air dispersion modeling (which accounts for emission rates, source parameters, meteorological conditions, building wake effects, and terrain effects) and associated potential impacts relative to local ambient air quality standards are not evaluated. More detailed project information would be needed to model potential air emission impacts relative to local ambient air quality standards.

[1] The Clean Air Act (CAA), as amended through the 1990 Clean Air Act Amendments, defines "stationary source" in *Title III, General Provisions*, Section 302, Definitions, paragraph (z) [*CAA §302(z)*] such that any source of air emissions resulting directly from a non-road engine is not regulated as a stationary source under the CAA and are therefore, exempt from federal stationary source permitting requirements. The definition of a non-road engine in Title II, *Emission Standards for Moving Sources*, Section 216, Definitions, of the CAA is codified in *40 CFR Part 89.2* and *40 CFR Part 90.3*. As defined in these parts, internal combustion engines that are mobile (i.e., portable or transportable) engines are considered non-road engines. Therefore, internal combustion engines such as portable generators, air compressors, welders, etc. that do not stay at any single site at a building, structure, facility, or installation for 12 consecutive months or more, are considered non-road engines.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to air quality and others would not. In addition, and as explained in this section, various types of Proposed Action infrastructure could result in a range of potential impacts (*no impacts* to *less than significant*) depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to air quality under the conditions described below:

- Wired Projects:
  - Use of Existing Conduit-New Buried Fiber Optic Plant: Although existing conduits would be used, these projects could involve construction equipment for cable pulling, blowing. However due to the temporary and intermittent need for such machinery, there would be no perceptible increase in air emissions.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to air quality because it would not create any sources of airborne emissions. It is expected that no heavy equipment would be used and that transportation activities would be temporary, producing a negligible quantity of air pollution.
- Satellites and Other Technologies:
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact air quality resources, unless this decision changes, it is anticipated that this activity would have *no impact*.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to air quality as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur as a result of fossil fuel combustion associated with on-road and off-road engines, and as a result of motor vehicles or heavy equipment stirring up dust on unpaved roads. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following activities.

Wired Projects

For buried wired projects, construction activities could include plowing (including vibratory plowing), trenching, or directional boring, depending on the nature of the terrain, geology, and environmental conditions. These activities could result in potential impacts to air quality as a result of associated fuel-burning equipment (combustion emissions) and ground disturbance (fugitive dust). This section excludes air emissions associated with trenching and horizontal boring activities as these are expected to be lower or similar to plowing activities (i.e., only one of the three options would likely occur at a particular location depending on the nature of the terrain, geology, and environmental conditions). For aerial wired projects, construction activities could include new wiring and poles that require use of auger trucks, boom trucks, and bucket lifts, as well as excavation and grading for new or modified rights-of-way or easements.

Additional activities associated with installation of new, or modifications to existing, wired systems (buried and aerial) and the construction of points of presence,[2] huts, or other associated facilities could result in air emissions from cable blowing, pulling, and vault placement. In other cases, new structures could be required without the need for new or modified wired systems. The deployment of marine vessels to lay submarine cable is unlikely; however, small work boats (with engines similar to recreational vehicle engines) may be required to transport and lay small wired cable in limited near-shore or inland bodies of water, but emissions from these small marine sources are expected to be negligible and were not quantified. Associated combustion emissions estimates for the anticipated fuel-burning equipment are presented in Table 6.2.12-2 through Table 6.2.12-4.

Furthermore, deployment of wired projects could potentially impact air quality as a result of associated excavation/filling and grading/earth moving activities. Associated fugitive dust emissions estimates are presented in Table 6.2.12-5.

[2] Points of presence are connections or access points between two different networks, or different components of one network.

Table 6.2.12-2: Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions (tons/month)[d,e,f]					
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
Vibratory Plow	0.329	0.110	0.015	0.002	0.001	0.0004
Backhoe	0.328	0.108	0.015	0.001	0.001	0.0004
Dozer	0.330	0.114	0.015	0.002	0.002	0.0004
Flat-bed Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Pick-up Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Trench Roller	0.330	0.112	0.015	0.002	0.002	0.0004
Air Compressor	0.329	0.110	0.015	0.002	0.001	0.0004
Cable Puller/Blower	0.327	0.103	0.015	0.001	0.001	0.0004
Concrete Mixer	0.328	0.105	0.015	0.001	0.001	0.0004
Grader	0.330	0.115	0.015	0.002	0.002	0.0004
Roller	0.330	0.112	0.015	0.002	0.002	0.0004
Total	**3.63**	**1.24**	**0.166**	**0.018**	**0.017**	**0.004**

NOx = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; SO_2 = sulfur dioxide

[a] Deployment activities are assumed to include plowing, wire installation, and construction of points of presence and fiber huts.

[b] Emissions are based on one unit of typical equipment. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.

[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.

[d] Emissions are estimated using methodology from *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition, Equations 1 to 7, NR-009d, July 2010* (*USEPA 2010a*). Typical equation values were obtained from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling, EPA-420-R-10-016, NR-005d, July 2010* (*USEPA 2010b*).

[e] Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. If construction lasts for 4 months, estimated air pollutant emissions would be expected to be four times as large as the values listed here.

[f] Fuel is assumed to be ultra-low sulfur diesel with a maximum sulfur content of 15 parts per million.

Table 6.2.12-3: Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions (tons/month)[d,e,f]					
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
Grader	0.330	0.115	0.015	0.002	0.002	0.0004
Suction Excavator	0.331	0.117	0.015	0.002	0.002	0.0004
Auger Truck	0.328	0.107	0.015	0.001	0.001	0.0004
Boom Truck	0.330	0.112	0.015	0.002	0.002	0.0004
Cable Puller/ Blower	0.327	0.103	0.015	0.001	0.001	0.0004
Bucket Lift	0.327	0.104	0.015	0.001	0.001	0.0004
Flat-bed Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Total	**2.31**	**0.781**	**0.106**	**0.011**	**0.011**	**0.003**

NOx = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; SO_2 = sulfur dioxide

[a] Deployment activities are assumed to include excavation, grading, and pole delivery and installation.

[b] Emissions are based on one unit of typical equipment. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.

[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.

[d] Emissions are estimated using methodology from *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition, Equations 1 to 7, NR-009d, July 2010* (*USEPA 2010a*). Typical equation values were obtained from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling, EPA-420-R-10-016, NR-005d, July 2010* (*USEPA 2010b*).

[e] Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. If construction lasts for 4 months, estimated air pollutant emissions would be expected to be four times as large as the values listed here.

[f] Fuel is assumed to be ultra-low sulfur diesel with a maximum sulfur content of 15 parts per million.

Table 6.2.12-4: Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation

Emission Source[a,b]	Estimated Emissions (tons/month)[c,d,e]					
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
Concrete Mixer	0.328	0.105	0.015	0.001	0.001	0.0004
Flat-bed Truck	0.333	0.124	0.016	0.002	0.002	0.0004
Grader	0.330	0.115	0.015	0.002	0.002	0.0004
Paver	0.330	0.113	0.015	0.002	0.002	0.0004
Roller	0.330	0.112	0.015	0.002	0.002	0.0004
Truck-mounted Crane	0.330	0.112	0.015	0.002	0.002	0.0004
Total	**1.98**	**0.681**	**0.091**	**0.010**	**0.010**	**0.002**

NOx = nitrogen oxides; CO = carbon monoxide; VOC = volatile organic compound; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; SO_2 = sulfur dioxide

[a] Emissions are based on one unit of typical equipment. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.

[b] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.

[c] Emissions are estimated using methodology from *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition, Equations 1 to 7, NR-009d, July 2010* (*USEPA 2010a*). Typical equation values were obtained from *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling, EPA-420-R-10-016, NR-005d, July 2010* (*USEPA 2010b*).

[d] Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. If construction lasts for 4 months, estimated air pollutant emissions would be expected to be four times as large as the values listed here.

[e] Fuel is assumed to be ultra-low sulfur diesel with a maximum sulfur content of 15 parts per million.

Table 6.2.12-5: Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/Earth Moving Activities

Emission Source	Estimated Level of Activity	Estimated Emissions (tons/month)[a,b,c]		
		PM	PM_{10}	$PM_{2.5}$
Excavation and Filling	100,000 tons of material transferred [d]	0.278	0.132	0.020
Grading and Earth Moving	1,200 vehicle miles traveled per month [e]	1.34	0.459	0.042
Total		**1.62**	**0.591**	**0.062**

PM = particulate matter; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter

[a] Emissions are estimated using methodology from *AP-42*, *Compilation of Air Pollutant Emission Factors (USEPA 1998* and *USEPA 2006).*

[b] Excavation and filling emissions are based on *Section 13.2.4, Aggregate Handling and Storage Piles - Equation (1)* (*USEPA 2006*). Mean wind speed is assumed to be 9.3 meters per second (20.8 miles per hour) based on National Oceanic and Atmospheric Administration data for Guam (refer to Chapter 6.1.14, Climate Change). Moisture content is assumed to be the median value (2.525%) listed in AP-42. Control efficiency is assumed to be zero (worst-case scenario).

[c] Grading and earth moving emissions are based on *Section 11.9, Western Surface Coal Mining - Table 11.9-1* (*USEPA 1998*). Mean speed for construction vehicles is assumed to be 5 miles per hour. Emissions (tons) per month assume 240 hours (24 days, 10 hours/day) of construction activity per month. Emission estimates could be scaled proportionally based on the number of months required for grading and earth moving activities.

[d] Excavation and filling emissions assume 100,000 tons of material transferred per month. Emissions estimates could be scaled proportionally based on actual monthly estimates for material transfer (e.g., if monthly material transfer is to be 200,000 tons, associated PM emissions would be 0.480 ton).

[e] Vehicle miles traveled is based on average speed (5 miles per hour) and operating time per month (240 hours) (see note c above). Emission estimates cannot be directly scaled based on an increase/decrease in vehicle miles traveled – refer to equations in *AP-42,* Table 11.9-1 (*USEPA 1998*).

Wired project deployment would also involve other on-road vehicle use, including employee transportation to and from work sites. However, these ancillary activities would be temporary and would produce a negligible quantity of air pollution. Therefore, emissions associated with these ancillary activities were not quantified.

Potential air quality impacts associated with each type of wired project are discussed below:

- New Build–Buried Fiber Optic Plant: These projects could involve plowing (including vibratory plowing), trenching, or directional boring (depending on the nature of the terrain, geology, and environmental conditions), as well as the construction of points of presence, huts, or other associated facilities or hand-holes to access fiber. The associated fuel-burning emissions are estimated in Table 6.2.12-2; the associated dust emissions are estimated in Table 6.2.12-5. For example, monthly nitrogen oxides (NOx) emissions are the highest of all criteria pollutant emissions, at approximately 3.6 tons (based on the assumptions noted with each table); annual NOx emissions, if construction lasted for at least 1 year, would be approximately 44 tons. The annual estimate for each criteria pollutant is less than the major source permitting threshold of 250 tons. Additionally, SO_2 emissions would be expected to be less than 0.05 tpy, much less than the 100-tpy general conformity threshold. Even if additional equipment, beyond the equipment assumed in these calculations was needed, it is still unlikely that emissions would reach the major source or general conformity thresholds.

- New Build–Aerial Fiber Optic Plant: These projects would not require plowing, trenching, or directional boring. However, they could require construction of new wiring and poles, as well as excavation and grading for new or modified right-of-ways or easements. The associated fuel-burning emissions are estimated in Table 6.2.12-3; the associated dust emissions are estimated in Table 6.2.12-5. These emissions are smaller in magnitude than the total emissions associated with New Build–Buried Fiber Optic Plant projects. Even if additional equipment, beyond the equipment assumed in these calculations, was needed, it is still unlikely that emissions would reach the major source or general conformity thresholds.
- Collocation on Existing Aerial Fiber Optic Plant: These projects could require replacement of existing wiring and poles. These emissions are expected to be smaller in magnitude than the total emissions associated with New Build–Aerial Fiber Optic Plant projects.
- New Build–Submarine Fiber Optic Plant: The deployment of large marine vessels to lay submarine cable is unlikely; however, small work boats (with engines similar to recreational vehicle engines) may be required to transport and lay small wired cables in limited near-shore or inland bodies of water, but emissions from these small marine sources would be negligible.
- Installation of Optical Transmission or Centralized Transmission Equipment: These projects could involve installation of boxes, huts, or other structures. Equipment delivery could require large trucks/trailers and installation could require cranes or skylifts. These projects could also require excavation and grading for new equipment and/or access roads. Therefore, emissions could include the sum of the emission estimates in Tables 6.2.12-4 and 6.2.12-5. Assuming at least 1 year of activity, these emissions are also below the 250- and 100-tpy thresholds.

Wireless Projects

Wireless projects would involve similar, but fewer, air emission sources than the previously discussed wired projects. Emissions associated with installation of towers and other structures are comparable to the estimates in Table 6.2.12-4. Potential air quality impacts associated with each type of wireless project are discussed below:

- New Wireless Communication Towers: These projects could involve installation of new wireless towers and associated structures (backup power generators and equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads). Installation emissions are expected to correspond to those listed in Table 6.2.12-4 (emissions associated with backup power generators are discussed in the Potential Operation Impacts section below). For example, monthly NOx emissions are the highest of all criteria pollutant emissions, at approximately 1.98 tons (based on the assumptions noted in Table 6.2.12-4); total NOx and SO_2 emissions for one tower, if construction lasted for a maximum of four months, would be approximately 8 and 0.024 tons, respectively. Additionally, emissions of CO, PM_{10}, and $PM_{2.5}$ would be expected to be approximately 2.7, 0.04, and 0.04 tons, respectively, each less than the 100-tpy general conformity threshold. The annual estimate for each criteria pollutant is less than the major source permitting threshold of 250 tons for one tower and the annual SO_2 estimate is much less than the general conformity threshold of 100 tons for one tower installation. Based on the assumptions stated in Table 6.2.12-4, at least 32 such simultaneous tower installations would be needed for any criteria pollutant (NOx) to trigger the major source permitting threshold of 250 tons. Similarly, at least 4,167 such towers would be needed for any criteria pollutant (SO_2) to trigger the general conformity threshold of 100 tpy. Even if additional equipment, beyond the equipment assumed in these calculations, was needed, it is still unlikely that emissions would reach the major source permitting threshold or general conformity threshold. As noted in Section 6.2.12.4, Potential Impacts of the Preferred Alternative, the mobile sources (non-road engines) are not subject to major source permitting requirements; only general conformity requirements could apply during deployment, and only if a project is located in a nonattainment or maintenance area in Guam.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. Delivery and installation of equipment could require trucks and cranes that would generate air emissions. Additionally, these projects could require some work on structure foundations and thus concrete mixing equipment. Because these projects would not involve installation of new wireless towers and associated structures, air emissions are expected to be smaller in magnitude than the total emissions associated with New Wireless Communication Towers projects.

Deployable Technologies

Deployable technologies could potentially impact air quality because of their use of fuel-burning equipment, including first responder on-road vehicles, mobile power generators (diesel power generators are assumed as most likely fossil fuel technology; although gasoline-fueled and hydrogen-fueled generators could be an option), and aerial vehicles such as drones, airplanes, and blimps. In addition, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas.

During deployment, on-road vehicles could include light-duty trucks for Cell on Light Truck projects or heavy-duty trucks for Cell on Wheels and System on Wheels projects. Vehicle emissions are estimated in Tables 6.2.12-6 and 6.2.12-7; diesel generator emissions are discussed in the Potential Operation Impacts section. This deployment phase is expected to occur over a few days. Potential air quality impacts of the long-term implementation of the deployment technologies at deployment locations (some months to a year or more) are discussed in the Potential Operation Impacts section. Potential air quality impacts associated with each type of deployable technology project are discussed below.

Table 6.2.12-6: Combustion Emission Estimates from Heavy-Duty Vehicles

Pollutant	Emission Factor[a,b]	Estimated Emissions[c]	
	g/hp-hr	lb/day	tons/year
NOx [b]	2.28	22.1	0.022
CO	15.5	150	0.150
$PM/PM_{10}/PM_{2.5}$	0.1	0.970	0.001
VOC [b]	0.12	1.16	0.001

g/hp-hr = grams per horsepower-hour; lb/day = pounds per day; NOx = nitrogen oxides; CO = carbon monoxide; PM = particulate matter; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; VOC = volatile organic compound

[a] Emission factors taken from 40 Code of Federal Regulations 86.004-11(a)(1) (*Emission Standards for 2004 and Later Model Year Diesel Heavy-Duty Engines and Vehicle)*. Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assume to be the same. SO_2 emission factors were not provided for heavy-duty trucks but these are expected to be negligible due to the likely use of fuels with low sulfur content.

[b] NMHC/NOx (non-methane hydrocarbon compounds/nitrogen oxides) emission factor was split 5%/95% for VOC (assumed equal to NMHC) and NOx, respectively (based on California guidance [*CARB 2008*]).

[c] Emissions are estimated assuming one vehicle operates 8 hours per day, 2 days per year (one day for driving to location, one day for departing from location). Vehicle engine size was assumed to be 550 horsepower (typical tractor trailer engine specifications [*Caterpillar 2006*]). Driving emissions are larger than idling emissions; therefore, all operation was assumed to be driving at full capacity.

Table 6.2.12-7: Combustion Emission Estimates from Light-Duty Trucks

Pollutant	Emission Factor[a]	Estimated Emissions[b]	
	g/mi	lb/day	tons/year
NOx	0.9	0.794	0.001
CO	7.3	6.44	0.006
$PM/PM_{10}/PM_{2.5}$	0.12	0.106	0.0001
VOC[c]	0.28	0.247	0.0002

g/mi = grams per mile; lb/day = pounds per day; NOx = nitrogen oxides; CO = carbon monoxide; PM = particulate matter; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; VOC = volatile organic compound

[a] Emission factors taken from *40 Code of Federal Regulations 86.1811-04*, Table S04-1 (*Emission Standards for Light-Duty Vehicles, Light-Duty Trucks and Medium-Duty Passenger Vehicle*s); emission limits were used as worst-case emission factors. Bin 11 vehicles were selected as worst-case scenario. Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assume to be the same. SO_2 emission factors were not provided for light-duty trucks but these are expected to be negligible due to the likely use of fuels with low sulfur content.

[b] Emissions are estimated assuming one vehicle operates 8 hours per day, 2 days per year (one day for driving to location, one day for departing from location). Driving emissions are larger than idling emissions; therefore, all operation was assumed to be driving, with an average speed of 50 miles per hour.

[c] VOC emission factor assumed equal to non-methane organic compounds emission factor.

- Cell on Wheels: These projects could include a heavy-duty vehicle (large trailer) and mobile diesel generator. During deployment, the vehicle engines would power the vehicle while in motion on roadways (the power generators are assumed to be off while the vehicle is in motion). Associated combustion emission estimates during the short-term deployment period (i.e., a few days) are presented in Table 6.2.12-6. If deployment (i.e., mobilization, setting up, and demobilization) lasted for 2 days per year (assume 8 hours per day), NOx emissions (as the worst-case pollutant) from a single Cell on Wheels/heavy-duty vehicle would be approximately 0.022 ton. Additionally, annual CO, PM_{10}, and $PM_{2.5}$ emissions per unit of heavy-duty vehicle would be approximately 0.15, 0.001, and 0.001 ton, respectively. Based on the assumptions stated in Table 6.2.12-6, the project would need to involve over 11,300 Cell on Wheels systems deploying for 2 days per year, for NOx emissions to exceed the 250-tpy major source permitting threshold. Should these amounts of equipment be required during deployment (which is very unlikely), emissions could exceed the regulatory thresholds. As noted in Section 6.2.12.4, Potential Impacts of the Preferred Alternative, the mobile heavy-duty vehicles are not subject to major source permitting requirements. Therefore, only general conformity requirements could apply during deployment and only if a project is located in a nonattainment or maintenance area in Guam. Sulfur dioxide (SOx) is designated as a nonattainment pollutant in Guam. SOx emissions were not quantified but are expected to be negligible due to the likely use of fuels with low sulfur content. Therefore, SOx emissions from Cell on Wheels projects are not expected to trigger general conformity in Guam.

- Cell on Light Truck: These projects could include a light-duty truck and diesel power generator. Associated combustion emission estimates during the short-term deployment period (i.e., a few days) are presented in Table 6.2.12-7. If deployment (i.e., mobilization, setting up, and demobilization) lasted for 2 days per year (assume 8 hours per day), NOx emissions (as the worst-case pollutant) would be less than 0.001 ton from the mobile light-duty vehicle. Annual CO, PM_{10}, and $PM_{2.5}$ emissions would be approximately 0.006, 0.0001, and 0.0001 ton, respectively. Based on the assumptions stated in Table 6.2.12-7, the project would need to involve approximately 315,000 Cell on Light Truck systems deploying for 2 days per year for NOx emissions to exceed the 250-tpy major source permitting threshold Should these amounts of equipment be required during deployment (which is very unlikely), emissions could exceed the regulatory thresholds. As noted in Section 6.2.12.4, Potential Impacts of the Preferred Alternative, the mobile light-duty vehicles are not subject to major source permitting requirements; only general conformity requirements could apply during deployment and only if a project is located in a nonattainment or maintenance area in Guam. SOx emissions were not quantified but are expected to be negligible due to the likely use of fuels with low sulfur content. Therefore, SOx emissions from Cell on Wheels projects are not expected to trigger general conformity in Guam.
- System on Wheels: These projects could include a heavy-duty vehicle (large trailer) and diesel power generator. Therefore, potential air quality impacts are expected to be similar to those for Cell on Wheels projects.
- Deployable Aerial Communications Architecture: These projects could involve mobilizing and demobilizing aerial vehicles including, but not limited to, unmanned aircraft such as drones and piloted aircraft such as airplanes, balloons, and blimps. As indicated above, the deployment phase is only expected to occur over a few days. Potential air quality impacts of the long-term implementation of the Deployable Aerial Communications Architecture at the deployment location (some months to a year or more) are discussed in the Potential Operation Impacts section. These projects could involve fossil fuel combustion (e.g., drone, airplane, and blimp engines), but the associated combustion emissions would not be comparable to stationary source permitting thresholds. More detailed project information would be needed to model potential air emission impacts relative to local ambient air quality standards. However, most of the aerial vehicle emissions would occur at or above a few thousand feet above ground and are expected to dissipate before reaching ground level.

Satellites and Other Technologies

- Satellite-Enabled Devices and Equipment: Although it is expected that existing structures would be used, these projects could involve delivery and installation of equipment. The associated emissions can be estimated from the values in Table 6.2.12-4, although less equipment would likely be required, so emission estimates would likely be less than those values.

In general, the abovementioned activities could potentially involve fuel-burning construction equipment, dust from unpaved roads, first responder on-road vehicles, aerial platforms, and fossil fuel power generators. Increased air emissions associated with deployment of this infrastructure could potentially impact the surrounding community. However, increases in air emissions are not expected to exceed applicable major source permitting thresholds for the projects and potential air quality impacts are expected to be *less than significant* and could be further minimized with BMPs and mitigation measures incorporated. In addition, it is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months (typically less than a year and could be as short as a few hours or days for some activities). BMPs and mitigation measures to help reduce these potential impacts are described in Chapter 11.

Potential Impacts for Increased Air Emissions

Based on the analysis of the deployment activities described above, impacts as a result of increased air emissions are anticipated to be *less than significant* and can be further minimized with BMPs and mitigation measures incorporated for the deployment scenarios. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize the potential air quality impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *less than significant* impacts to air quality associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections (i.e., air emissions would be infrequent and/or immeasurable). If use of heavy equipment or vehicles, outside of established access roads or corridors, occurs as part of routine maintenance or inspections, potential air quality impacts could result as explained above.

Operation activities associated with the Preferred Alternative could also involve the short-term (e.g., few weeks per year) operation of a fossil fuel-powered backup generator for wireless projects (e.g., to power a deployed antenna during upset conditions when commercial power is interrupted and during normal routine maintenance) as well as long-term (e.g., some months up to a year or more) operation of power generators (embedded in on-road vehicles) for land-based deployable technologies while stationed on-site. The types of infrastructure operation scenarios or activities that could be part of the Preferred Alternative and result in potential impacts to air quality include the following activities.

Wireless Projects

- New Wireless Communication Towers: Operation of these projects could involve the use of backup power generators, including those that operate by burning fossil fuels. Diesel-fueled backup power generators were assumed for this analysis; however, gasoline and hydrogen-fueled generators could be an option. The backup power generators would only operate during upset conditions when commercial power is interrupted and during normal routine maintenance (assumed a maximum of 500 hours per year for both upset conditions and normal routine maintenance). The diesel-fueled backup power generator emissions are provided in Table 6.2.12-8. Based on the assumptions stated in the table, these projects would need to involve at least 480 diesel generators rated at 67 horsepower and running 500 hours per year, for any pollutant emissions (NOx) to exceed the 250-tpy major source permitting threshold. At least 2,942 such generators would be needed to trigger general conformity requirements for SO_2. Should these amounts of equipment be required (which is very unlikely), emissions could exceed the corresponding regulatory thresholds for major source permitting or general conformity.
- Collocation on Existing Wireless Tower, Structure, or Building: Operation of these projects would likely not involve the use of additional backup power generators during operations unless the existing backup generator power rating is not large enough for the collocation project. If additional backup power generator is required at the existing site, the potential operation impacts for these projects are expected to be similar to those associated with the New Wireless Communication Towers project (see Table 6.2.12-8).

Table 6.2.12-8: Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers

Pollutant	Emission Factor[a]	Estimated Emissions[b]	
	lb/hp-hr	lb/year	tons/year
NOx	0.031	1,039	0.52
CO	0.00668	224	0.11
SOx	0.00205	68.7	0.034
$PM/PM_{10}/PM_{2.5}$	0.00220	73.7	0.037
VOC [c]	0.00251	84.2	0.042

lb/hp-hr = pounds per horsepower-hour; lb/year = pounds per day; NOx = nitrogen oxides; CO = carbon monoxide; SOx = sulfur oxides; PM = particulate matter; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; VOC = volatile organic compound

[a] Emission factors taken from *AP-42, Compilation of Air Pollutant Emission Factors*, Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*). Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assume to be the same.

[b] Emissions are estimated assuming one, 67-horsepower diesel engine operates for 500 hours per year when commercial power is interrupted and during normal routine maintenance. Estimates can be directly scaled based on actual equipment size and operating schedule.

[c] VOC emissions are assumed equal to total organic compound emissions.

Deployable Technologies

Operation of land-based deployable technologies while stationed on-site could involve the use of power generators embedded on heavy-duty vehicles (Cell on Wheels and System on Wheels) and/or light-duty trucks (Cell on Light Truck). During operations, the generators would power the cell unit while the vehicle is on-site and stationary (vehicle engines would likely be turned off on-site). Associated combustion emission estimates during the long-term operation period (i.e., some months up to a year or more) are presented in Table 6.2.12-9. If operation of the land-based deployment technologies lasted for 363 days per year (assumes 24-hour continuous operation excluding 2 days a year for mobilization, setting up, and demobilization as discussed in the Potential Deployment Impacts section), NOx emissions (as the worst-case pollutant) from a single power generator embedded in each land-based deployment technology (Cell on Wheels, Cell on Light Truck, or System on Wheels) would be approximately 4.32 tons. Additionally, annual SOx, CO, PM_{10}, and $PM_{2.5}$ emissions per unit of heavy-duty vehicle would be approximately 0.29, 0.93, 0.31, and 0.31 ton, respectively. The Proposed Action would need to involve at least 58 land-based deployable technology systems operating continuously and simultaneously for 363 days per year, for NOx emissions to exceed the 250-tpy major source permitting threshold. At least 345 such systems would be needed to trigger general conformity requirements for SOx. Should these amounts of equipment be required during operations (which is very unlikely), emissions could exceed the regulatory thresholds.

Table 6.2.12-9: Combustion Emission Estimates from Diesel Generators on On-Road Vehicles Stationed On-Site

Pollutant	Emission Factor[a]	Estimated Emissions[b]	
	lb/hp-hr	lb/day	tons/year
NOx	0.031	23.8	4.32
CO	0.00668	5.1	0.93
SOx	0.00205	1.6	0.29
$PM/PM_{10}/PM_{2.5}$	0.00220	1.7	0.31
VOC[c]	0.00251	1.9	0.35

lb/hp-hr = pounds per horsepower-hour; lb/day = pounds per day; NOx = nitrogen oxides; CO = carbon monoxide; SOx = sulfur oxides; PM = particulate matter; PM_{10} = particulate matter up to 10 micrometers in diameter; $PM_{2.5}$ = particulate matter up to 2.5 micrometers in diameter; VOC = volatile organic compound; VOC = volatile organic compound

[a] Emission factors taken from AP-42, *Compilation of Air Pollutant Emission Factors*, Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*). Emission factors for PM, PM_{10}, and $PM_{2.5}$ were assume to be the same.

[b] Emissions are estimated assuming one, 32-horsepower diesel engine operates continuously (24 hours per day), 363 days per year (all year except for two travel days – see previous two tables). Estimates can be directly scaled based on actual equipment size and operating schedule.

[c] VOC emissions are assumed equal to total organic compound emissions.

Operation of aerial vehicles such as drones, airplanes, balloons, and blimps could involve fossil fuel combustion (e.g., from their engines), but the associated combustion emissions would not be comparable to stationary source permitting thresholds. Helicopters are not expected to be used for operations activities. More detailed information on the Proposed Action would be needed to model potential air emission impacts relative to local ambient air quality standards. However, most of the aerial vehicle emissions would occur at or above a few thousand feet above ground and are expected to dissipate before reaching ground level.

In general, the abovementioned activities could potentially involve dust from unpaved roads and combustion emissions from first responder on-road vehicles, aerial platforms, and fossil fuel power generators. Increased air emissions associated with operation of this infrastructure could potentially impact the surrounding community. However, increases in air emissions are not expected to exceed applicable major source permitting thresholds for most deployment scenarios and potential air quality impacts are expected to be *less than significant* and can be further minimized with BMPs and mitigation measures incorporated.

Based on the analysis of the operation activities described above, potential impacts as a result of increased air emissions are anticipated to be *less than significant* and can be further minimized with BMPs and mitigation measures incorporated. To minimize the effects of the Preferred Alternative on air quality, FirstNet and/or their partners would require, as practicable or feasible, implementation of the same BMPs and mitigation measures as those required for potential deployment impacts (see Chapter 11).

6.2.12.5. Alternatives Impact Assessment

The following section assesses potential impacts to air quality associated with the Deployable Technologies Alternative and the No Action Alternative.[3]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative option, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts to air quality as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could involve use of fossil fuel-powered generators, first responder on-road vehicles, and/or aerial platforms. Some staging or landing areas (depending on the type of technology) could require excavation and grading. In the event that a limited number of equipment units are needed (consistent with the assumptions described above for the potential deployment impacts), these projects are expected to be *less than significant* and can be further minimized with BMPs and mitigation measures incorporated. However, should greater numbers of equipment or larger equipment be needed, potential impacts could become significant. These impacts would still be reduced through implementation of the BMPs and mitigation measures described in Chapter 11.

[3] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be *less than significant* impacts to air quality associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections; use of fossil fuel-powered generators would result in *less than significant* impacts and can be further minimized with BMPs and mitigation measures incorporated. If greater numbers of equipment or larger equipment are needed, potential impacts could become significant. Potential impacts could be reduced through implementation of BMPs and mitigation measures as described in Chapter 11. If use of heavy equipment or vehicles outside of established access roads or corridors occurs as part of routine maintenance or inspections, additional potential air quality impacts could result as explained above. This alternative could also involve deploying aerial vehicles including, but not limited to, drones, blimps, and piloted aircraft, which could involve fossil fuel combustion. More information would be required regarding the number, type, and flight duration of the vehicles deployed to determine emissions from these technologies. However, most of the aerial vehicle emissions would occur at or above a few thousand feet above ground and are expected to dissipate before reaching ground level.

No Action Alternative

Under the No Action Alternative, the nationwide public safety broadband network would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to air quality because there would be no deployment and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.12, Air Quality.

6.2.13. Noise

6.2.13.1. Introduction

This section describes potential impacts from noise in Guam associated with deployment and operation of the Proposed Action and alternatives. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures. Unless otherwise stated, all references to noise in this section are airborne noise, specifically potential airborne noise impacts on humans. Potential airborne noise impacts on wildlife and underwater noise impact on marine mammals and fish are discussed in Section 6.2.6, Biological Resources.

6.2.13.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on noise were evaluated using the significance criteria presented in Table 6.2.13-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant, less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of the potential noise impact, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts to noise addressed in this section are presented as a range of possible impacts.

Table 6.2.13-1: Impact Significance Rating Criteria for Noise

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Increased noise levels	Magnitude or Intensity	Noise levels would exceed typical noise levels from construction equipment and generators. Noise levels at noise sensitive receptors (such as residences, hotels/motels/inns, hospitals, and recreational areas) would exceed 55 dBA or specific state/ territory noise limits. Noise levels plus baseline noise levels would exceed 10 dBA increase from baseline noise levels (i.e., louder).	Effect that is *potentially significant*, but with mitigation and/or BMPs is *less than significant*	Noise levels resulting from project activities would exceed natural sounds, but would not exceed typical noise levels from construction equipment or generators.	Natural sounds would prevail. Noise generated by the action (whether it be construction or operation) would be infrequent or absent, mostly immeasurable.
	Geographic Extent	Island or local		Island or local	Island or local
	Duration or Frequency	Permanent or long-term		Short-term	Temporary

dBA = A-weighted decibel(s)

6.2.13.3. Description of Environmental Concerns

Potential impacts to the community from increased noise levels could occur in a range of areas:

- Wilderness areas or pristine environments (including wildlife refuges, historic sites, ecological preserve areas, etc.) where natural quiet is expected;
- Rural and outer suburban areas with negligible traffic;
- General suburban areas with infrequent traffic, general suburban areas with medium density traffic; and
- Suburban areas with some commerce or industry.

These areas are most sensitive to increased noise levels because of their low to medium baseline day-night average noise levels, which typically range from 35 to 50 A-weighted decibels (dBA) (see Table 6.1.13-1). Urban areas are less susceptible to increased noise levels because of their higher average ambient noise levels.

Increased noise levels could result in community annoyance by interfering with speech and other human-related activities. Noise emissions associated with network deployment could potentially impact sensitive receptors (residences, hotels/motels/inns, hospitals, places of worship, schools, and recreational areas). The use of the following land-based and aerial deployable technologies could potentially impact such sensitive receptors:

- Wired and wireless technologies using heavy equipment such as excavators, backhoes, trenchers, graders, pavers, rollers, dump trucks, cranes, etc. required to support any construction/deployment activities;
- Land-based deployable technologies using power generators and first responder on-road vehicles (heavy –duty and light duty trucks or vans); and
- Aerial deployable technologies, such as unmanned aircraft (e.g., drones) and piloted aircraft (e.g., airplanes, balloons, and blimps). Helicopters, if needed, would likely only be used during deployment to potentially move people or equipment to remote areas. As the use of helicopters would be infrequent, if at all, potential impacts associated with the use of helicopters are not evaluated here.

Because sensitive areas such as pristine environments (e.g., Guam National Wildlife Refuge and War in the Pacific National Historic Park), rural areas, and suburban areas are present in Guam, infrastructure could be built near these areas, in which case BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) would help avoid or minimize the potential impacts. In addition, it is anticipated that any potential noise increase due to deployment would likely be isolated within those locations and would be short-term with pre-existing noise levels generally achieved after some months (typically less than a year and could be as short as a few hours or days for some activities such as pole construction).

6.2.13.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to noise and others would not. In addition, and as explained in this section, various types of Proposed Action infrastructure could result in a range of *no impact* to *less than significant* depending on the deployment scenario or site-specific conditions.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to noise under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Although existing conduits would be used, these projects could involve equipment used for cable pulling and blowing. Noise associated with this equipment would be infrequent and of a short duration and is not expected to produce perceptible impacts.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to noise. It is expected that no heavy equipment would be used and no new structure would be installed or erected as most activities would be conducted in existing huts.
- Satellites and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact noise resources, it is anticipated that this activity would have no impact to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to noise as a result of implementation of the Preferred Alternative would encompass a range of potential impacts that could occur from on-road and off-road engines of heavy equipment during ground disturbance and installation activities. The types of infrastructure development scenarios or deployment activities that could be part of the Preferred Alternative and result in potential impacts to noise include the following:

Wired Projects

For buried wired projects, construction activities could include plowing (including vibratory plowing), trenching, or directional boring, depending on the nature of the terrain, geology, and environmental conditions. These activities could result in potential impacts to noise as a result of heavy equipment use during earth-work and material handling activities. Additional activities associated with buried wired projects include the installation of new or modified wired systems and the construction points of presence[1], huts, or other associated facilities could result in noise increases. Limiting distances for maximum noise levels associated with these buried wired project-related activities under hard[2] and soft[3] ground conditions are presented in Table 6.2.13-2.

For aerial wired projects, construction activities could include new wiring and poles that require use of auger trucks, boom trucks, and bucket lifts, as well as excavation and grading for new or modified right-of-ways or easements. Similar to buried wired projects, additional activities associated with aerial wired projects include the installation of new or modifications to existing wired systems and the construction points of presence, huts, or other associated facilities could result in noise increases. Limiting distances for maximum noise levels associated with these aerial wired project-related activities under hard and soft ground conditions are presented in Table 6.2.13-3.

In other cases, new buildings or structures could be required without the need for new or modified wired systems. In such cases, construction activities associated with the installation of transmission equipment would be required. Limiting distances[4] for maximum noise levels associated with transmission equipment installation under hard and soft ground conditions are presented in Table 6.2.13-4.

[1] Points of presence are connections or access points between two different networks, or different components of one network.

[2] A hard site exists where noise travels away from the source over a generally flat, hard surface such as water, concrete, hard-packed soil, or other ground surfaces having a low porosity. These are examples of reflective ground, where the ground does not provide any attenuation. The standard attenuation rate for hard site conditions is 6 dBA per doubling of distance for point source noise (e.g., power generators, most construction activities, etc.) and 3 dBA per doubling of distance for line sources (e.g., highway traffic, conveyor belt, etc.) (*WSDOT 2015)*.

[3] A soft site exist where noise travels away from the source over porous ground or normal unpacked earth capable of absorbing noise energy such as grass, trees, or other ground surfaces suitable for the growth of vegetation, such as farmland. An absorptive ground results in an additional 1.5 dBA reduction per doubling of distance at it spreads from the source. Added to the standard reduction rate for soft site conditions, point source noise attenuates at a rate of 7.5 dBA per doubling of distance, and line source noise decreases at a rate of 4.5 dBA per doubling of distance (*WSDOT 2015*).

[4] Limiting distances are distances beyond which an adverse effect would not occur.

Table 6.2.13-2: Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Vibratory Plow[d]	80.0	889	500
Backhoe	78.0	706	416
Dozer	82.0	1,119	601
Flat-bed Truck	74.0	446	288
Pick-up Truck	75.0	500	315
Trench Roller[e]	80.0	889	500
Air Compressor	78.0	706	416
Cable Puller/Blower[f]	80.0	889	500
Concrete Mixer	79.0	792	456
Grader	89.0	2,506	1,145
Roller	80.0	889	500
Warning Horn	83.0	1,256	659
Total	**92.6**	**3,788**	**1,594**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[d] Lmax data for slurry trenching machine were assumed for vibratory plow.
[e] Lmax data for roller were assumed for trench roller.
[f] Lmax data for ventilation fan were assumed for cable puller/blower.

Table 6.2.13-3: Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Grader	89.0	2,506	1,145
Suction Excavator	81.0	998	548
Auger Truck[d]	84.0	1,409	723
Boom Truck[e]	81.0	998	548
Cable Puller/Blower[f]	80.0	889	500
Bucket Lift[e]	81.0	998	548
Flat-bed Truck	74.0	446	288
Warning Horn	83.0	1,256	659
Total	**92.4**	**3,717**	**1,570**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[d] Lmax data for auger drill rig were assumed for auger truck.
[e] Lmax data for truck mounted crane were assumed for boom truck and bucket lift.
[f] Lmax data for ventilation fan were assumed for cable blower.

Table 6.2.13-4: Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Concrete Mixer	79.0	792	456
Flat-bed Truck	74.0	446	288
Grader	89.0	2,506	1,145
Paver	77.0	629	379
Roller	80.0	889	500
Truck Mounted Crane	81.0	998	548
Warning Horn	83.0	1,256	659
Total	**91.4**	**3,296**	**1,426**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.

Wired project deployment would also involve other on-road vehicle use, including worker transportation to and from work sites. However, these ancillary activities would be temporary and would produce negligible noise pollution. Potential noise impacts associated with each type of wired project are discussed below:

- New Build – Buried Fiber Optic Plant: These projects could result in increased noise levels due to use of heavy equipment for plowing (including vibratory plowing), trenching, or directional boring, as well as the construction of points of presence, huts, or other associated facilities or hand-holes to access fiber. The limiting distances for maximum noise levels associated with new buried wired activities are presented in Table 6.2.13-2. The table excludes noise associated with trenching and horizontal boring activities as these are expected to be lower or similar to plowing activities (i.e., only one of the three options could occur at a particular location depending on the nature of the terrain, geology, and environmental conditions). As indicated in Table 6.2.13-2, a maximum noise level of 93 dBA at 50 feet could be expected from New Build – Buried Fiber Optic Plant projects and residences or other sensitive receptors within 3,788 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,594 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. Without BMPs and mitigation measures and/or if a wired project is situated in an area with low background sound levels such as wilderness area, pristine environments, rural areas, or suburban areas with infrequent traffic (see Table 6.1.13-1), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels) and residences and other sensitive receptors within these limiting distances could experience potential negative noise impacts. To minimize the potential short-term noise impacts to residences and other sensitive receptors within these limiting distances, BMPs and mitigation measures should be implemented for New Build – Buried Fiber Optic Plant projects and other similar wired projects.
- New Build – Aerial Fiber Optic Plant: These projects would not require plowing, trenching, or directional boring. However, they could require construction of new wiring and poles, as well as excavation and grading for new or modified right-of-ways or easements. The limiting distances for maximum noise levels associated with new buried wired activities are presented in Table 6.2.13-3. As indicated in the table, a maximum noise level of 92 dBA at 50 feet could be expected from New Build – Aerial Fiber Optic Plant projects and residences or other sensitive receptors within 3,717 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,570 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. These noise increases are similar but slightly smaller in magnitude than those associated with the New Build - Buried Fiber Optic Plant projects.

- Collocation on Existing Aerial Fiber Optic Plant: These projects would not require plowing, trenching, or directional boring. However, they could require replacement of existing wiring and poles (i.e., equipment installation). The maximum noise increases for these projects would be smaller in magnitude than those associated with the New Build - Aerial Fiber Optic Plant projects.
- New Build – Submarine Fiber Optic Plant: The installation of cables in limited near-shore or inland bodies of water could potentially impact aquatic and/marine resources (fish and marine mammals) due to increased underwater noise from small marine vessels (similar to recreational vessels). Potential impacts to airborne noise could potentially occur as a result of the construction of landings and/or facilities on shore to accept submarine cable. Increased airborne and underwater noise is expected to result in similar potential noise impacts to the other New Build projects. Additional information on potential underwater noise impacts on marine mammals and fish is discussed in Section 6.2.6, Biological Resources.
- Installation of Optical Transmission or Centralized Transmission Equipment: These projects could involve installation of boxes, huts, or other structures. Equipment delivery could require large trucks/trailers and installation could require cranes or skylifts. These projects could also require excavation and grading for new equipment and/or access roads. The limiting distances for maximum noise levels associated with installation of transmission equipment are presented in Table 6.2.13-4. As indicated in the table, a maximum noise level of 92 dBA at 50 feet could be expected from these projects and residences or other sensitive receptors within 3,656 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,549 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. These noise increases are similar to those for the New Build –Aerial Fiber Optic Plant projects.

Wireless Projects

Wireless projects would involve similar, but fewer, noise sources than the previously discussed wired projects. Noise increases associated with installation of towers and other structures are comparable to the estimates in Table 6.2.13-4. Potential noise impacts associated with each type of wireless project are discussed below:

- New Wireless Communication Towers: These projects could involve installation of new wireless towers and associated structures (power generator and equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads). Installation noise levels are expected to correspond to those listed in Table 6.2.13-4. Therefore, a maximum noise level of 91 dBA at 50 feet could be expected from these projects and residences or other sensitive receptors within 3,296 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 1,426 feet of these sources could be exposed to noise in excess of the 55 dBA criterion.

Without BMPs and mitigation measures and/or if a wireless project is situated in an area with low background sound levels such as wilderness area, pristine environments, rural areas, or suburban areas with infrequent traffic (see Table 6.1.13-1), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels) and residences and other sensitive receptors within these limiting distances could experience potential negative noise impacts. BMPs and mitigation measures could be implemented for New Wireless Communication Towers projects and other similar wireless projects to further reduce potential impacts.

- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower. Delivery and installation of equipment could require trucks and cranes that would generate noise. Additionally, these projects could require some work on structure foundations and thus concrete mixing equipment. Because these projects would not involve installation of new wireless towers and associated structures, expected maximum noise increases and limiting distances to the 55 dBA criterion would be smaller in magnitude than those for the New Wireless Communication Towers project. Table 6.2.13-5 shows that a maximum noise level of 86 dBA at 50 feet could be expected from these projects and residences or other sensitive receptors within 1,844 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 896 feet of these sources could be exposed to noise in excess of the 55 dBA criterion.

Table 6.2.13-5: Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Concrete Mixer	79.0	792	456
Flat-bed Truck	74.0	446	288
Truck Mounted Crane	81.0	998	548
Warning Horn	83.0	1,256	659
Total	**86.3**	**1,844**	**896**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely than more than one piece of each equipment type would be used at the same time. It is also unlikely that all individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.

Deployable Technologies

Implementation of deployable technologies could result in potential impacts to noise from use of power generators and first responder on-road vehicles and aerial platforms. On-road vehicles could include light-duty trucks for Cell on Light Truck projects or heavy-duty trucks for Cell on Wheels and System on Wheels projects. Aerial platforms could include drones, airplanes, balloons, and blimps. In addition, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas. Noise levels associated with deployable technologies during deployment (including mobilization to the destination site, setting up, and demobilization) are estimated in Table 6.2.13-6.

Table 6.2.13-6: Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-term

Noise Source[a,b,c]	Actual Measured Average Lmax at 50 Feet (dBA)[a,b]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[d]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[d]
Cell on Wheels or System on Wheels			
Heavy-duty Vehicle or Large Trailer (1 Unit)[e]	76.0	561	346
Heavy-duty Vehicle or Large Trailer (2 Units)[e]	79.0	793	456
Heavy-duty Vehicle or Large Trailer (3 Units)[e]	80.8	792	537
Heavy-duty Vehicle or Large Trailer (4 Units)[e]	82.0	1,122	602
Heavy-duty Vehicle or Large Trailer (5 Units)[e]	83.0	1,254	659
Cell on Light Truck			
Light-duty Truck (1 Unit)[f]	75.0	500	315
Light-duty Truck (2 Units)[f]	78.0	707	416
Light-duty Truck (3 Units)[f]	79.8	866	490
Light-duty Truck (4 Units)[f]	81.0	1,000	549
Light-duty Truck (5 Units)[f]	82.0	1,118	601
Deployable Aerial Communication Architecture			
Unmanned Aircraft - Drone Takeoff or Landing (1 Unit)[g, h]	82.0	1,125	603
Unmanned Aircraft - Drone Take-off or Landing (2 Units)[g, h]	85.1	1,591	796
Unmanned Aircraft - Drone Take-off or Landing (3 Units)[g, h]	86.8	1,948	936
Unmanned Aircraft - Drone Take-off or Landing (4 Units)[g, h]	88.1	2,249	1,051
Unmanned Aircraft - Drone Take-off or Landing (5 Units)[g, h]	89.0	2,515	1,149
Piloted Aircraft - Plane Flyover (1 Unit)[i]	114.0	44,668	11,476
Piloted Aircraft - Plane Flyover (2 Units)[i]	117.0	63,171	15,143

Noise Source[a,b,c]	Actual Measured Average Lmax at 50 Feet (dBA)[a,b]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[d]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[d]
Piloted Aircraft - Plane Flyover (3 Units)[i]	118.8	77,368	17,809
Piloted Aircraft - Plane Flyover (4 Units)[i]	120.0	89,337	19,981
Piloted Aircraft - Plane Flyover (5 Units)[i]	121.0	99,881	21,847
Piloted Aircraft - Blimps (1 Unit)[j]	85.6	1,687	835
Piloted Aircraft - and Blimps (2 Units)[j]	88.6	2,386	1,101
Piloted Aircraft - Blimps (3 Units)[j]	90.3	2,922	1,295
Piloted Aircraft - Blimps (4 Units)[j]	91.6	3,374	1,453
Piloted Aircraft - Blimps (5 Units)[j]	92.6	3,772	1,589

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel; NA = not applicable
[a] Source of Lmax data for Cell on Wheels, Cell on Light Truck, and System on Wheels: *WSDOT 2015*
[b] Source of Lmax data for Deployable Aerial Communication Architecture: Hodgson et al 2013 and *WSDOT 2015*
[c] Maximum noise levels for deployable technologies are based on operating one to five units of vehicle type, depending on the size of the coverage area.
[d] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.
[e] Lmax data for dump truck were assumed for heavy-duty vehicle (large trailer).
[f] Lmax data for pick-up truck were assumed for light-duty truck.
[g] Lmax data for drone take-off were based on noise levels of a ScanEagle Unmanned Aerial Vehicle (85 to 90 dBA) at 6 meters (20 feet) (*Hodgson et al. 2013*). The 90 dBA maximum level at 20 feet was assumed for this analysis. The noise level at 20 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.
[h] Lmax data for drone landing were assumed to equal to that for drone take-off.
[i] Lmax data for airplane flyover (120 dBA) at 1,000 feet were taken from *Purdue University 2015*. The noise level at 1,000 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.
[j] Lmax data for blimps were based on noise levels of a Goodyear blimp with two 210-horsepower engines with a total of 110 dBA just outside of a gondola (assume 3 feet away) (*Goodyear Blimp 2015*). A gondola is a passenger compartment suspended beneath a balloon or airship. The 110 dBA maximum level at 3 feet was assumed for this analysis. The noise level at 3 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.

This deployment phase is expected to occur over a few days. Potential noise impacts of the long-term implementation of this technology at the deployment location (some months to a year or more) are discussed in the operation impact section. Potential noise impacts associated with each type of deployable technology project are discussed below.

- Cell on Wheels: These projects could include noise sources such as a heavy-duty vehicle (with large trailer) and power generators. During deployment, the vehicle engines would power the vehicle while in motion on roadways (the power generators are assumed to be off while the vehicle is in motion). The limiting distances for maximum noise levels associated with Cell on Wheels projects during the short-term deployment period (i.e., a few days) are presented in Table 6.2.13-6. As indicated in the table, a maximum noise level of 76 dBA at 50 feet could be expected per unit of heavy-duty vehicle and residences or other sensitive receptors within 561 feet of each heavy-duty vehicle could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 346 feet of each heavy-duty vehicle could be exposed to noise in excess of the 55 dBA criterion. Without BMPs and mitigation measures and/or if a deployable technologies project is situated in an area with low background sound levels such as wilderness area, pristine environments, rural areas, or suburban areas with infrequent traffic (see Table 6.1.13-3), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels) and residences and other sensitive receptors within these limiting distances could experience potential negative noise impacts. The expected maximum noise levels and limiting distances to the 55 dBA criterion during the short-term deployment period (i.e., a few days) is dependent on the type of deployed technology and the number of deployed units per affected area. For example, if Cell on Wheels technology were to be deployed in Guam (approximately 212 square miles) and assuming the Cell on Wheel technology can provide 10-mile diameter coverage; it would require two heavy-duty vehicle or large trailer to cover the entire territory. The maximum noise level associated with this land-based deployment technology (i.e., two heavy-duty vehicles) in Guam would be approximately 79 dBA at 50 feet. Assuming mostly soft ground conditions in the territory (particularly the rural areas with farmland, grasses, trees, etc.), Guam residences or other sensitive receptors within 456 feet of the heavy-duty vehicles could be exposed to noise in excess of the 55 dBA criterion. To minimize the potential noise impacts to residences and other sensitive receptors within these limiting distances, BMPs and mitigation measures could be implemented for Cell on Wheels projects and other similar deployable technology projects.

- Cell on Light Truck: These projects could include a light-duty truck and power generator. As indicated above, generator noise is discussed in the operation impact section. The expected maximum noise levels and limiting distances to the 55 dBA criterion during the short-term deployment period (i.e., a few days) is dependent on the type of deployed technology and the number of deployed units per affected area (Table 6.2.13-6). For example, if Cell on Light Truck technology were to be deployed in Guam (approximately 212 square miles) and assuming the Cell on Light Truck technology can provide 2-mile diameter coverage, it would require approximately nine light-duty trucks to cover the entire territory. The maximum noise level associated with this land-based deployment technology (i.e., nine light-duty trucks) in Guam is approximately 85 dBA at 50 feet. Assuming mostly soft ground conditions in the island (particularly the rural areas with farmland, grasses, trees, etc.), Guam residences or other sensitive receptors within 760 feet of the light-duty trucks could be exposed to noise in excess of the 55 dBA criterion.
- System on Wheels: These projects could include a heavy-duty vehicle (large trailer) and power generator (i.e., same noise sources as Cell on Wheels technology). As indicated above, the generator noise is discussed in the operation impact section. Therefore, expected maximum noise levels and limiting distances to the 55 dBA criterion would be similar to those for the Cell on Wheels projects (Table 6.2.13-6).
- Deployable Aerial Communications Architecture: These projects could involve mobilizing and demobilizing aerial vehicles, including, but not limited to, drones, airplanes, balloons, and blimps. As indicated above, the deployment phase is only expected to occur over a few days. Potential noise impacts of the long-term implementation of the Deployable Aerial Communications Architecture at the deployment location are discussed in the operation

impact section. The aerial vehicles typically generate loud noises during take-off and landing operations. During the short-term deployment period (i.e., a few days), the maximum noise levels for a single aerial vehicle take-off or landing is expected to range from 82 dBA at 50 feet for a drone to 114 dBA at 50 feet for an airplane. As such, residences or other sensitive receptors within 1,125 to 44,668 feet (0.21 to 8.5 miles) of these aerial vehicles could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 603 to 11,476 feet (0.11 to 2.2 miles) of these aerial vehicles could be exposed to noise in excess of the 55 dBA criterion (Table 6.2.13-6). It is unlikely that take-off or landing of, aerial vehicles would occur concurrently at the same location; however, if this were to occur, total noise increases and limiting distances to the 55 dBA criterion would increase as well (Table 6.2.13-6). For overflight operations, most of the noise would occur at a few thousand feet above ground level and could be perceived by sensitive receptors on the ground but for a short-term/intermittent period.

The short-term and intermittent noise increases associated with the aerial vehicles take-off and landings would be higher than those for the Cell on Wheels, Cell on Light Truck, and System on Wheels projects. The expected maximum noise levels and limiting distances for the 55 dBA criterion during the short-term deployment period (i.e., few days) is dependent on the type of deployed aerial technology and the number of deployed units per affected area. For example, if an unmanned aircraft such as a drone were to be deployed in or near Guam National Wildlife Refuge (approximately 37 square miles) and assuming the drone can provide 15-mile diameter coverage, it would require approximately only one drone to cover the entire national wildlife refuge.

The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., the one drone taking off or landing) in or near Guam National Wildlife Refuge would be approximately 82 dBA at 50 feet. Because the ground conditions at national wildlife refuges and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 603 feet (0.11 mile) of the drone take-offs and landings could be exposed to noise in excess of the 55 dBA criterion. If piloted aircraft are used, the corresponding noise levels would be higher and sensitive receptors at larger distances from the source (piloted aircraft) would be exposed to noise above 55 dBA. For example, if a piloted aircraft such as a two-engine airplane were to be deployed in or near Guam National Wildlife Refuge (37 square miles) and assuming the two-engine airplane can also provide 15-mile diameter coverage, it would require only a single two-engine airplane to cover the entire wildlife refuge. The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., the single two-engine airplane taking off or landing) in or near Guam National Wildlife Refuge would be approximately 114 dBA at 50 feet. Because the ground conditions at national wildlife refuges and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 11,476 feet (2.2 miles) of the single two-engine airplane take-off or landing could be exposed to noise in excess of the 55 dBA criterion.

Satellites and Other Technologies

- Satellite-Enabled Devices and Equipment: Although it is expected that existing structures would be used, these projects could involve delivery and installation of equipment. The associated noise increases can be estimated from the values in Table 6.2.13-4 above, although less equipment would likely be required, so noise increases and limiting distances to the 55 dBA criterion under hard and soft ground conditions would likely be less than those values.

Increased Noise Levels during Deployment

In general, the abovementioned activities could potentially involve heavy equipment movement associated with ground disturbance, equipment delivery, and installation, as well as operation of power generators, and first responder on-road vehicles, and aerial platforms. Increased noise levels associated with deployment of this infrastructure could potentially impact the surrounding community. BMPs and mitigation measures could help reduce these potential impacts during deployment activities. Based on the analysis of the deployment activities described above, potential impacts as a result of increased noise levels are anticipated to be *less than significant* since these potential impacts would generally be temporary and limited to areas near deployment locations. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential noise impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be minimal potential impacts to noise associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections (i.e., noise from pick-up truck driven by inspector would be infrequent and/or immeasurable). If use of heavy equipment as part of routine maintenance or inspections occurs off of established access roads or corridors, potential noise impacts could result as explained above.

Operation activities associated with the Preferred Alternative could also involve prolonged operation of a fossil fuel-powered generator (e.g., to power a deployed antenna), aerial vehicles (drones, airplanes, balloons, and blimps) and other support equipment such as ventilation fans associated with heating, ventilation, and air cooling at fiber huts or central offices. Helicopters are not expected to be used for operations activities. Such operation would result in increased noise levels over extended periods. The types of infrastructure operation scenarios or activities that could be part of the Preferred Alternative and result in potential impacts to noise include the following:

Wireless Projects

- New Wireless Communication Towers: Operation of these projects could involve the use of power generators and ventilation fans at fiber huts or central offices. Table 6.2.13-7 indicates a maximum noise level of 83 dBA at 50 feet could be expected from extended use of power generators and ventilation fans and as such, residences or other sensitive receptors within 1,274 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 667 feet of these sources could be exposed to noise in excess of the 55 dBA criterion. Without BMPs and mitigation measures and/or if a wireless project is situated in an area with low background sound levels such as wilderness areas, pristine environments, rural areas, or suburban areas with minimum traffic (see Table 6.1.13-3), the predicted maximum noise levels could substantially increase above background levels (i.e., 10 dBA or more above background levels) and residences and other sensitive receptors within these limiting distances could experience potential negative noise impacts. To minimize the potential long-term noise impacts to residences and other sensitive receptors within these limiting distances, BMPs and mitigation measures should be implemented, as practicable or feasible, for New Wireless Communication Towers projects and other similar wireless projects.
- Collocation on Existing Wireless Tower, Structure, or Building: In the event that additional onsite backup power is required, for reasons of FirstNet's requirements for resiliency and redundancy, operation of these projects could involve the use of power generators (Table 6.2.13-7). If additional power generators are required, the potential operation noise impacts for these projects are expected to be similar but slightly less than to those associated with the New Wireless Communication Towers project. If additional power generators are not required, the potential operation noise impact for these projects would be negligible.

Table 6.2.13-7: Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices

Noise Source[a,b]	Actual Measured Average Lmax at 50 Feet (dBA)[a]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[c]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[c]
Power Generator	81.0	998	548
Ventilation Fan	79.0	792	456
Total	**83.1**	**1,274**	**667**

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel
[a] Source: *WSDOT 2015*
[b] Maximum noise levels are based on operating one unit of typical equipment. It is not likely that more than one piece of each equipment type would be used at the same time. It is also unlikely that individual units of each equipment type listed in the table would be used concurrently; therefore, maximum noise levels and associated limiting distances presented in the table are conservative.
[c] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.

Deployable Technologies

Operation of land-based deployable technologies while stationed on-site could involve the use of power generators embedded on heavy-duty vehicles (Cell on Wheels and System on Wheels) and/or light-duty trucks (Cell on Light Truck) (Table 6.2.13-8). As indicated in the table, a maximum noise level of approximately 61 dBA at 50 feet could be expected per unit of power generator, and residences or other sensitive receptors within 103 feet of these sources could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 89 feet of each power generator could be exposed to noise in excess of the 55 dBA criterion.

The expected maximum noise levels and limiting distances to the 55 dBA criterion during the long-term deployment period (i.e., some months to a year or more) is dependent on the type of deployed land-based technology and the number of deployed units per affected area. As an example, if Cell on Wheels technology were to be deployed in the Guam territory (approximately 212 square miles) and assuming the Cell on Wheel technology can provide 10 mile diameter coverage, it would require approximately two power generators (embedded in heavy-duty vehicles or large trailers) to cover the entire territory. The maximum noise level associated with this land-based deployment technology (i.e., two power generators) in Guam would be approximately 64 dBA at 50 feet. Assuming mostly soft ground conditions in the territory (particularly the rural areas with farmland, grasses, trees, etc.), Guam residences or other sensitive receptors within 117 feet of the power generators could be exposed to noise in excess of the 55 dBA criterion.

These projects could involve aerial vehicles, including, but not limited to, drones, airplanes, balloons, and blimps. Aerial vehicle take-off and landing operations typically generate loud noises. The magnitude of noise generated by these aerial vehicles would be similar to those described in the short-term deployment phase but would occur over a longer period (i.e., some months to a year or more). During the long-term deployment period, the maximum noise level is expected to range from approximately 82 dBA at 50 feet for a drone take-off or landing to 114 dBA at 50 feet for an airplane. As such, residences or other sensitive receptors within 1,125 and 44,668 feet (0.21 to 8.5 miles) of each aerial vehicle take-off or landing could be exposed to noise in excess of the 55 dBA criterion under hard ground conditions. Similarly, under soft ground conditions, residences or other sensitive receptors within 603 to 11,476 feet (0.11 to 2.2 miles) of each aerial vehicle operation could be exposed to noise in excess of the 55 dBA criterion (Table 6.2.13-8). It is unlikely that take-off and landing of aerial vehicles would occur concurrently at the same location; however, if this were to occur, total noise increases and limiting distances to the 55 dBA criterion would increase as well (Table 6.2.13-8). For overflight operations, most of the aerial vehicle noise would occur at a few thousand feet above ground level and could be perceived by sensitive receptors on the ground but for a short-term/intermittent period. The short-term and intermittent noise increases associated with the aerial vehicle take-off and landing would be higher than those for the land-based deployment technologies.

Table 6.2.13-8: Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-term

Noise Source[a,b,c]	Actual Measured Average Lmax at 50 Feet (dBA)[a,b]	Threshold Distance to 55 dBA Noise Criterion Under Hard Ground Conditions (Feet)[d]	Threshold Distance to 55 dBA Noise Criterion Under Soft Ground Conditions (Feet)[d]
Cell on Wheels, Cell on Light Truck, or System on Wheels			
Power Generator (1 Unit)	61.3	103	89
Power Generator (2 Units)	64.3	145	117
Power Generator (3 Units)	66.0	178	138
Power Generator (4 Units)	67.3	205	155
Power Generator (5 Units)	68.2	230	169
Deployable Aerial Communication Architecture			
Unmanned Aircraft - Drone Takeoff or Landing (1 Unit)[e,f]	82.0	1,125	603
Unmanned Aircraft - Drone Takeoff or Landing (2 Units)[e,f]	85.1	1,591	796
Unmanned Aircraft - Drone Takeoff or Landing (3 Units)[e,f]	86.8	1,948	936
Unmanned Aircraft - Drone Takeoff or Landing (4 Units)[e,f]	88.1	2,249	1,051
Unmanned Aircraft - Drone Takeoff or Landing (5 Units)[e,f]	89.0	2,515	1,149
Piloted Aircraft - Plane Flyover (1 Unit)[g]	114.0	44,668	11,476
Piloted Aircraft - Plane Flyover (2 Units)[g]	117.0	63,171	15,143
Piloted Aircraft - Plane Flyover (3 Units)[g]	118.8	77,368	17,809
Piloted Aircraft - Plane Flyover (4 Units)[g]	120.0	89,337	19,981
Piloted Aircraft - Plane Flyover (5 Units)[g]	121.0	99,881	21,847
Piloted Aircraft - Blimps (1 Unit)[h]	85.6	1,687	835
Piloted Aircraft - Blimps (2 Units)[h]	88.6	2,386	1,101
Piloted Aircraft - Blimps (3 Units)[h]	90.3	2,922	1,295
Piloted Aircraft - Blimps (4 Units)[h]	91.6	3,374	1,453
Piloted Aircraft - Blimps (5 Units)[h]	92.6	3,772	1,589

Lmax = maximum value of a noise level that occurs during a single event; dBA = A-weighted decibel; NA = not applicable

[a] Source of Lmax data for Cell on Wheels, Cell on Light Truck, and System on Wheels: *WSDOT 2015*

[b] Source of Lmax data for Deployable Aerial Communication Architecture: *Hodgson et al. 2013* and *WSDOT 2015*

[c] Maximum noise levels for deployable technologies are based on operating one to five units of vehicle type, depending on the size of the coverage area.

[d] Threshold distances to 55 dBA noise criterion were calculated in accordance with the equation and methodology (accounting for hard and soft ground conditions) described in *WSDOT 2015*. The calculations do not include the effects, if any, of atmospheric absorption, screening obstacles/barriers (e.g., earthen berm, buildings), or foliage that could reduce sound levels and limiting distances further.

[e] Lmax data for drone take-off were based on noise levels of a ScanEagle Unmanned Aerial Vehicle (85 to 90 dBA) at 6 meters (20 feet) (*Hodgson et al. 2013*). The 90 dBA maximum level at 20 feet was assumed for this analysis. The noise level at 20 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.

[f] Lmax data for drone landing were assumed to equal to that for drone take-off.

[g] Lmax data for airplane flyover (120 dBA) at 1,000 feet were taken from *Purdue University 2015*. The noise level at 1,000 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.

[h] Lmax data for blimps were based on noise levels of a Goodyear blimp with two 210-horsepower engines with a total of 110 dBA just outside of a gondola (assume 3 feet away) (*Goodyear Blimp 2015*). A gondola is a passenger compartment suspended beneath a balloon or airship. The 110 dBA maximum level at 3 feet was assumed for this analysis. The noise level at 3 feet was converted using typical logarithmic equations to reference noise levels at 50 feet.

The expected maximum noise levels and limiting distances to the 55 dBA criterion during the long-term deployment period (i.e., some months to a year or more) is dependent on the type of deployed aerial technology and the number of deployed units per affected area. For example, if an unmanned aircraft such as a drone were to be deployed in or near Guam National Wildlife Refuge (approximately 37 square miles) and assuming the drone can provide 15-mile diameter coverage, it would require only one drone to cover the entire national wildlife refuge. The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., one drone taking off or landing) in or near Guam National Wildlife Refuge would be approximately 82 dBA at 50 feet. Because the ground conditions at national wildlife refuge and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 603 feet (0.11 mile) of the single drone could be exposed to noise in excess of the 55 dBA criterion. Should piloted aircraft be used, the corresponding noise levels would be higher and sensitive receptors at larger distances from the source (piloted aircraft) would be exposed to noise above 55 dBA. For example, if a piloted aircraft such as a two-engine airplane were to be deployed in or near Guam National Wildlife Refuge (37 square miles) and assuming the two-engine airplane can also provide 15-mile diameter coverage, it would require only a single two-engine airplane to cover the entire national wildlife refuge. The maximum noise level associated with this Deployable Aerial Communication Architecture (i.e., the single two-engine airplane taking off or landing) in or near Guam National Wildlife Refuge would be approximately 114 dBA at 50 feet. Because the ground conditions at national wildlife refuges and wilderness areas are typically soft (grasses, trees, etc.), sensitive receptors within 11,476 feet (2.2 miles) of the single two-engine airplane take-off or landing could be exposed to noise in excess of the 55 dBA criterion.

Increased Noise Levels during Operation

In general, the abovementioned activities could potentially generate noise from extended use of power generators, and aerial vehicles. Increased noise levels associated with operation of this infrastructure could potentially impact the surrounding community. BMPs and mitigation measures could help reduce these potential impacts during operation activities.

Based on the analysis of the operation activities described above, impacts as a result of increased noise levels are anticipated to be *less than significant with BMPs and mitigation measures incorporated*. To minimize the effects of the Preferred Alternative on noise during operation activities, FirstNet and/or their partners would require, as practicable or feasible, implementation of BMPs and mitigation measures described in Chapter 11.

6.2.13.5. Alternatives Impact Assessment

The following section assesses potential impacts to noise associated with the Deployable Technologies Alternative and the No Action alternative.[5]

[5] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts from noise as a result of implementation of this alternative could be as described below.

Potential Deployment Impacts

As explained above, implementation of deployable technologies could result in *less than significant* potential impacts to noise if deployment requires use of heavy equipment, power generators, first responder on-road vehicles, and/or aerial platforms. Some staging or landing areas (depending on the type of technology) could require land/vegetation clearing, minimal excavation, and paving. In comparison to the Deployable Technologies Alternative implemented as part of the Preferred Alternative (Table 6.2.13-6), these activities would likely be implemented in greater number over a larger geographic extent, and used in greater frequency and duration. Therefore, the maximum noise increases and limiting distances to sensitive receptors for this alternative are expected to be greater in magnitude than those listed in Table 6.2.13-6. These activities would result in increased noise levels as well, but again these potential impacts are expected to be *less than significant.*

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that potential noise impacts associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections, and the use of power generators, aerial vehicles, and ventilation fans on fiber huts or central offices are expected to be *less than significant*. If use of heavy equipment or vehicles outside of established access roads or corridors occurs as part of routine maintenance or inspections, potential noise impact could result as explained above.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to noise as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in Section 6.1.13, Noise.

6.2.14. Climate Change

6.2.14.1. Introduction

This section presents future climate change projections for temperature, precipitation, and sea-level rise (SLR). It also describes potential greenhouse gas (GHG) emissions arising from deployment and operation of the Proposed Action and alternatives, the effects of climate change in Guam on the Proposed Action and alternatives. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.14.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of climate change on the Proposed Action were evaluated using the significance criteria presented in Table 6.2.14-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of the potential climate change effects, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various landscapes, the potential impacts of climate change on the Proposed Action and the potential GHG emissions arising from the Proposed Action are addressed in this section as a range of possible impacts.

Table 6.2.14-1: Impact Significance Rating Criteria for Climate Change

Type of Effect	Effect Characteristic	Impact Level			
		Potentially Significant	**Less than Significant with BMPs and Mitigation Measures Incorporated**	**Less than Significant**	**No Impact**
Contribution to climate change through GHG emissions	Magnitude or Intensity	Exceedance of 25,000[a] metric tons of CO_2e/year, and global level effects observed.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Only slight change observed.	There would be no increase in GHG emissions or related changes to the climate as a result of the Proposed Action activities.
	Geographic Extent	NA		NA	NA
	Duration or Frequency	NA		NA	NA
Effect of climate change on Proposed Action-related impacts	Magnitude or Intensity	Local impacts from global climate change effects are observed in air temperature rise, precipitation increases (severe storm events), and/or sea level.	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	Only slight change observed.	There would be no measurable changes in global average temperature, precipitation events including severe storms, or sea-level rise.
	Geographic Extent	Local impacts from global climate change effects are observed.		Local impacts from global climate change effects are observed.	NA
	Duration or Frequency	Long-term changes; changes cannot be reversed in a short term		Long-term changes; changes cannot be reversed in a short term	NA

GHG = greenhouse gas; CO_2e = carbon dioxide equivalents; NA = not applicable

[a] Twenty-five thousand (25,000) metric tons per annum is the threshold set by Draft Council on Environmental Quality Guidance for a quantitative analysis.

6.2.14.3. Global Climate Change Effects

Global climate change due to increasing GHG emissions is projected to produce a range of effects including changes in temperature and precipitation on a seasonal and annual basis, and in sea level compared to historical trends. Additional effects could include intensity and frequency of weather events such as storms, tornados, and droughts. Climate change projections are developed by simulating different future emission scenarios with a variety of models that are calibrated using historical trends plus the influence of varying radiative forcing[1] index due to increase in concentration of GHGs in the atmosphere. Global circulation models are frequently used to make global high level projections of temperature, precipitation, and other parameters. These models can be downscaled to produce regional climate models. Downscaling refers to disaggregating and refining future predictions from global to regional levels.

As part of this Draft Programmatic Environmental Impact Statement, an analysis was conducted to evaluate potential effects of overall climate change in Guam. The potential climate change impacts on the effects of the Proposed Action are evaluated in Section 6.2.14.6, Potential Impacts of the Preferred Alternative. The analysis identified relevant and credible sources for climate change projections in the region potentially affected by the Proposed Action. The projections analyzed were downscaled from global general circulation models. Due to the broad geography of the Proposed Action, four studies were reviewed as part of this analysis:

- *Fifth Assessment Report, International Panel on Climate Change*: the fifth assessment report provides global and regional climate change projections and sector specific climate risks.
- *Third National Climate Assessment, United States Global Change Research Program*: The third National Climate Assessment (NCA) provided downscaled climate change projections and impacts covering the U.S. and its territories.
- *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment Part 8 – Climate of the Pacific Islands, US National Oceanic and Atmospheric Administration*: The regional climate trends report for Hawaii and the Pacific Islands is a key input into the NCA. It provides climate change projections for temperature, precipitation, and SLR for Pacific Islands using 15 coupled atmosphere-ocean general circulation models. These models were downscaled to a resolution of approximately190 miles latitude and 60 to110 miles longitude for multi-model mean maps (*Keener et al. 2013*).
- *Climate Change and Pacific Islands: Indicators and Impacts, Pacific Island Regional Climate Assessment*: This report served as the primary basis for the Regional Climate Trends and Scenarios for the NCA. The report provides climate change projections for temperature, precipitation, extreme heat, and SLR for Hawaii and the Pacific Islands.

Further information on the models used in this Draft Programmatic Environmental Impact Statement can be found in Appendix F, *Climate Change Sources and Models*.

[1] Radiative forcing is the difference between the radiation absorbed by Earth and the energy reflected back to space.

The projections prepared and presented in the NCA are the most recent, and relevant to the U.S. and its territories. Since the Proposed Action has an undetermined timeline, outputs have been provided for: 2030, 2055, and 2090. The NCA provides climate projections using A2 (high emission) and B1 (low emissions) scenarios which cover a significant range of potential future human impacts on the climate system. Additionally, many available literature sources use these two scenarios to evaluate potential impacts as well as mitigation and adaptation measures. Climate change projections have been presented for the A2 and B1 emissions scenarios. However, this analysis took a precautionary approach by using and discussing the worst case scenario (high emission A2) to ensure future potential impacts and outcomes are not underestimated. Guam has a small landmass, therefore most climate models and projections apply to the entire Western North Pacific region.

6.2.14.4. Global and Regional Climate Change Projections

Temperature and Precipitation

Average annual temperature in Guam is expected to increase across all models and in both high (A2) and low (B1) emission scenarios compared to the baseline of 1971 – 2000 (*Keener et al. 2012*). Table 6.2.14-2 below illustrates the temperature projections for three time periods 2030, 2055, and 2090 throughout the end of the century. Models also illustrate with high confidence that the intensity and frequency of days with extreme heat in the Western North Pacific region will increase throughout the end of the century (*Keener et al. 2012*). Additionally, sea temperature in the Pacific is expected to increase by 1.1 degrees Fahrenheit (°F) by 2030, 1.8°F by 2055, and 2.5°F by 2090 compared to 1990 levels under high emission scenario (*USGCRP 2014*).

Table 6.2.14-2: Projected Average Annual Temperature Changes

Scenario	Timeline	Temperature (°F)
A2	2030	1.1 to 1.3
	2055	1.9 to 2.5
	2090	2.7 to 5.1
B1	2030	1.1 to 1.3
	2055	1.9 to 2.5
	2090	2.7 to 5.1

Source: Keener et al. 2012

Previous Coupled Model Intercomparison Project phase 3 (CMIP3) models from the IPCC's Fourth Assessment Report published in 2007 indicate increases in precipitation along the equator and decreases over much of the subtropics through the end of the century (*Keener et al. 2013*). Seasonal precipitation in the tropical Pacific is strongly impacted by the El Niño/Southern Oscillation, which suggests long-term changes in the atmospheric circulation and Pacific basin scale sea surface temperature gradient. Simulations of the Pacific basin scale behavior suggest an average weakening of the zone sea surface temperature gradient and associated weakening of atmospheric circulation (*Keener et al. 2013*). This results in a trend toward more El Niño like events in the tropical Pacific (*Keener et al. 2013*).

Global Sea Level Rise

Global sea level is expected to rise throughout the century. The National Oceanic and Atmospheric Administration's report on global sea level scenarios supporting the NCA concludes with high confidence (greater than 9 in 10 chance) that the global mean sea level will rise at least 8 inches and no more than 6.6 feet by 2100 (*Parris et al. 2012*). SLR is primarily attributed to ocean thermal expansion and ice sheet loss. However, recent studies by The National Research Council based on satellite measurements indicate that the ice sheet loss has greater contribution to global SLR than thermal expansion in the period from 1993 to 2008 (*Parris et al. 2012*). Global SLR projections use four scenarios:

- High, which should be considered for situations with low tolerance for risk;
- Intermediate high, which is based on an average of the high-end global SLR projections;
- Intermediate low, which is based on the upper global SLR projections using B1 emissions scenarios from IPCC's Fourth Assessment Report; and
- Lowest scenarios, which are based on linear extrapolation of historical SLR from tide gauge records since1900. This scenario should be considered where there is great tolerance for risk (*Parris et al. 2012*).

Global SLR projections are highly uncertain. There is low confidence in the future prediction of wind patterns and their influence on regional sea level (*Keener et al. 2012*). It is uncertain how the tropical Pacific atmospheric circulation will respond to future projected global climate change (*Keener et al. 2012*). However, many models have concluded that there will be a trend toward more El Niño background state (*Keener et al. 2012*). Table 6.2.14-3 below illustrates projected global SRL using the four scenarios relative to mean sea level in 1992.

Table 6.2.14-3: Projected Global Sea Level Rise Relative to 1992

Scenario	Sea Level Rise (SLR) by 2100 (feet)[a]
Highest	6.6
Intermediate high	3.9
Intermediate low	1.6
Lowest	0.7

Source: Parris et al. 2012

[a] Relative to mean sea level in 1992

6.2.14.5. Description of Environmental Concerns

Greenhouse Gas Emissions

Since the industrial revolution, increasing GHG emissions from human activities (referred to as anthropogenic emissions and contrasting with emissions arising from natural processes) have increased the levels of GHGs in the atmosphere. Anthropogenic emissions enhance the greenhouse gas effect and result in a greater amount of heat that is trapped in the atmosphere (*IPCC 2013*). Human activities that emit GHGs include the combustion of fossil fuel, industrial processes, land use changes, deforestation, and agricultural production GHG emissions cumulatively contribute to climate change globally. There is no causal connection between GHG emissions arising from the deployment of the Proposed Action and the potential local impacts from global climate change.

Climate Change

Climate changes due to increasing global GHG emissions are projected to produce a range of effects, including changes in temperature, precipitation, and sea level as well as changes in frequency and intensity of weather events when compared to historical trends. These climate change effects can exacerbate, lessen, or have a positive effect on the potential impacts on environmental resources from operations associated with the Proposed Action, as identified in Section 6.2, Environmental Consequences.

Climate change projections have been presented for the A2 (high emissions) and B1 (low emission) scenarios. However, this analysis took a precautionary approach by using and discussing the worst case scenario (high emission A2) to ensure future potential impacts and outcomes are not underestimated. Guam has a small landmass; therefore, most climate models and projections apply to the entire Western North Pacific region,[2] which includes Guam. In an A2 scenario, temperature in the Western North Pacific region is expected to increase by 5.1 °F by the end of the century compared to a baseline of 1971 to 2000 (*Keener et al.* 2012). Additionally, models illustrate that the intensity and frequency of extreme heat will increase through the end of the century (*Keener et al*. 2012) Precipitation is projected to increase along the equator through the end of the century compared to the baseline of 1971 to 2000 (*Keener et al. 2012*). Furthermore, more El Niño like events could be expected in the tropical Pacific (*Keener et al. 2013*).

As a result of these changes, potential impacts on water resources in the Pacific Islands would vary due to island size and relative isolation. Availability of freshwater supplies in many Pacific Islands could potentially be impacted by climate change due to warmer and drier conditions as temperatures increase. Additionally, sea-level rise could increase the salinity of groundwater resources (*Keener et al. 2012*). Rising sea levels would increase likelihood of coastal flooding and erosion (*Keener et al. 2012*).

Transportation infrastructure would be impacted by storm surges or sea-level rise, which could lead to increased cost to repair or replaced infrastructure that could be impacted by climate change effects (*Keener et al. 2012*). Sea level rise would likely increase vulnerability of coastal structures and properties; however impacts would vary with location depending on regional sea level variability coupled with an increasing global average sea level. Increasing mean global sea levels would have an impact on extreme events in the Pacific Island region. (*Keener et al. 2012*) A study conducted by *Hunter (2012)* that focused on Australian sea-level stations estimated that a 4-inch increase in sea level corresponded to an average of a threefold increase in the frequency of extreme weather events (*Keener et al. 2012*).

[2] The Western North Pacific region is defined in *Keener et al. 2013* and includes the Northern Mariana Islands, Republic of Palau, Guam, Federated States of Micronesia, and Republic of the Marshall Islands.

Climate change could have potential impacts on human health by increasing incidences of various infectious diseases such as dengue[3] (*Keener et al. 2012*). Increased flooding from sea-level rise could overflow sewer systems and therefore potentially impact public sanitation (*Keener et al. 2012*)

An increase in temperature could increase stress in vegetation and wildlife species potentially impacted by the Proposed Action. Additionally, drier conditions could increase soil contraction, potentially impacting foundations of infrastructure. Changes in precipitation and increases in extreme weather events could exacerbate impacts due to soil erosion and top soil mixing. Foundations for infrastructure and infrastructure near coastal areas could be particularly vulnerable to increased soil erosion. Additionally, precipitation increase, particularly in storm events, could exacerbate potential impacts from flooding, particularly infrastructure near coastal areas and in flood zones. Furthermore, changes in temperature and precipitation and increases in extreme weather could increase stress on wetlands and biodiversity.

6.2.14.6. Potential Impacts of the Preferred Alternative

The following sections assess potential impacts associated with implementation of the Preferred Alternative, including deployment and operational activities. Potential climate change impacts associated with the Proposed Action include potential impacts from the Proposed Action on climate change, in terms of an increase in GHG emissions, as well as the opposite: climate change effects on the Proposed Action.

GHG emissions would arise from combustion of fossil fuel in stationary or mobile equipment, clearing of vegetation, use of generators, and changes in land use during construction and operation. The types of stationary and mobile equipment that would be used include excavators, backhoes, frontend loaders, graders, pavers, and dump trucks. Additionally, combustion of fuel used in power generators, first responder on-road vehicles, and aerial platforms such as drones and piloted aircraft would contribute to GHG emissions. GHGs are characterized in terms of their global warming potential (GWP). The GWP is a measure of how much energy the emission of 1 tonne[4] of gas will absorb over a period of time, relative to the emission of 1 tonne of carbon dioxide (CO_2). This metric is normalized in terms of carbon dioxide equivalents (CO_2e) and expressed with a time horizon. The most commonly used time horizon is 100 years, where 1 unit of CO_2 will have a 100-year GWP of 1; an equivalent amount of methane will have a 100-year GWP of 25, and an equivalent amount of nitrous oxide will have a 100-year GWP of 298. GHG emissions would be emitted locally but have a global effect as explained in Section

[3] Studies show a correlation between climate and diseases with various transmission with the strongest link shown between climate and mosquito-borne diseases (*Morin and Comrie 2013*). The Fifth Assessment report by the Intergovernmental Panel on Climate Change summarizes the link between temperature and infectious diseases. The influence of temperature on malaria is vector specific (*IPCC 2014*). Temperature affects mosquito vector development rates, mortality, and behavior and controls viral replication *(Morin and Comrie 2013*). New studies show that increasing temperatures studied over a long period of time (30 years) correspond to increased transmission of malaria *(IPCC 2014*). This indicates that even modest warming may drive up increases of malaria transmission. Studies have established transmission of dengue with seasons; the highest cases of dengue fever were recorded during the wet season in Trinidad (*IPCC 2014*). Precipitation provides suitable habitat for mosquitos particularly to create and maintain breeding sites (*Morin and Comrie 2013*).

[4] One tonne is a unit of measure in the International System of Units that is equivalent to 1 metric ton and equivalent to 1.1023 U.S. tons, which are also known as short tons.

6.1.14.2, Context. The GWP values are revised from time to time and should be updated accordingly based on the Intergovernmental Panel on Climate Change Assessment Reports. Current values derive from the Fourth Assessment Report (*IPCC 2007*).

GHG emissions associated with the Proposed Action are estimated and compared against a threshold limit of 25,000 metric tons per year as defined by the Council on Environmental Quality (CEQ) Revised Draft GHG and Climate Change Guidance (*CEQ 2014*). GHG emissions arise from combustion of fossil fuel in stationary or mobile equipment, use of generators, clearing of vegetation and changes in land use during construction and operation. GHG emissions from loss of vegetation and soil disturbance are expected to be minimal and therefore will not be estimated in this analysis[5]. As described in Section 6.1.14.3, Specific Regulatory Considerations, the Revised Draft CEQ Guidance requires that projects provide a quantitative analysis for emissions greater than 25,000 metric tons of CO_2e annually.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the facility infrastructure and specific deployment requirements, climate change effects would result in potential impacts from some activities in the Preferred Alternative in terms of GHG emissions. Climate change effects from deployment of the Preferred Alternative could range from *less than significant* to *no impacts* depending on the project types deployed.

In addition to potential effects from the Proposed Action on climate change, potential climate change effects on the Proposed Action were assessed. If deployment activities occur in the next 10 years, as is anticipated, climate conditions in that period would not differ much from current conditions even in the worst case emission scenario. Therefore, climate change effects on the various deployment activities would likely be minimal and are expected to have *no impacts*.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, climate change effects are likely to have *no impacts* to the following facilities under the conditions described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: Existing conduits would be used in the installation of new fiber optic cable, which could require construction equipment for cable blowing or pulling. The emissions associated with the use of existing conduit would arise from use of similar equipment as those listed in Table 6.2.14-4 below. The short duration and intermittent use of heavy equipment would not produce perceptible changes to climate change.

[5] Emissions from vegetation loss are not significant in the evaluation of the Proposed Action. The greatest source of GHG emissions comes from loss of forest. Approximately 230 hectares of forest would need to be cleared to generate 25,000 metric tons.

- Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: These projects involve lighting up dark fiber and installation of new equipment in existing huts. The use of heavy construction equipment is not expected, and movement of equipment by light truck or cars would produce a minimal amount of GHGs in the context of this Proposed Action. Therefore, no significant GHG emissions are expected to arise from these activities. As mentioned above, GHG emissions from ground disturbance and vegetation loss are expected to be minimal. Emissions from construction of new huts and/or installation of additional cable to reach the final destination are discussed below.

Table 6.2.14-4: GHG Emission Estimates from Buried Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions[d,e,f]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Vibratory Plow, Backhoe, Dozer, Flat-bed Truck, Pick-up Truck, Trench Roller, Air Compressor, Cable Blower, Concrete Mixer, Grader, Roller	1,403	1,273

CO_2e = carbon dioxide equivalent

[a] Deployment activities are assumed to include excavation, grading, and pole delivery and installation.
[b] Emissions are based on one unit of typical equipment. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.
[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.
[d] Emissions are estimated using methodology from *USEPA 2010a*. Typical equation values were obtained from *USEPA 2010b*.
[e] Emissions (tons) assume 240 hours (24 days, 10 hours/day) of construction activity per month. Construction was assumed to last for 3 months in a year. If construction lasts for more than 3 months, emissions would be greater than the values listed here.
[f] Fuel is assumed to be ultra-low sulfur diesel.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: These projects would include installing permanent equipment on existing structures. GHG emissions would arise from fuel combustion from delivery and installation of equipment, however the use of satellite enabled devices and equipment would not create any perceptible changes in GHG emissions.
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. Therefore it is anticipated that there would be no GHG emissions or any climate change effects on the project because of these activities.

Activities with the Potential to Have Impacts

Potential climate change impacts associated with deployment activities as a result of implementation of the Preferred Alternative include increased GHG emissions. However, it may be unlikely that the deployment of any or combination of any or all projects described below would likely emit 25,000 metric tons due to the small geographic are of Guam. GHG emissions would arise from the combustion of fuel used by equipment during construction and changes in land use. Land use emissions occur as a result of soil disturbance and loss of vegetation. GHG emissions from loss of vegetation and soil disturbance are expected to be minimal and therefore are not estimated. The types of deployment activities that would create GHG emissions are discussed below.

Wired Projects

GHG emissions would arise from combustion of fuel from the equipment used for plowing, trenching (including vibratory plowing), or directional boring during construction for buried wired projects. The worst-case emissions are expected to result from plowing techniques. For aerial wired projects, construction activities could include new wiring and poles that require use of auger trucks, boom truck, and bucket lifts, as well as excavation and grading equipment that use fossil fuels. Other activities associated with installation of new or modification of existing wired systems and associated infrastructure, including points of presence[6] (POPs) and huts, could result in GHG emissions during cable blowing, pulling, and vault placement. For some deployment activities, new structures could be required without the need for new or modified wired systems. GHG emissions from fuel combustion due to construction of deployment of wired projects have been estimated and are presented in Tables 6.2.14-4 and 6.2.14-5. Emission calculations assume that all construction equipment use diesel fuel and would have the same emissions. Therefore, each table shows a summation of the estimated emissions for the construction equipment required for each deployment activity.

Table 6.2.14-5: GHG Emission Estimates from New Aerial Wired Project Deployment[a]

Emission Source[b,c]	Estimated Emissions[c,d,e,f]	
	CO_2e (tons/year)	**CO_2e (metric tons/year)**
Grader, Suction Excavator, Auger Truck, Boom Truck, Cable Blower, Bucket Lift, Flat-bed Truck	893	810

CO2e = carbon dioxide equivalent
[a] Deployment activities are assumed to include excavation, grading, and pole delivery and installation.
[b] Emissions are based on one unit of typical equipment. One unit consists of one each of the equipment listed in the table, operating simultaneously. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.
[c] Each equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.
[d] Emissions are estimated using methodology from *USEPA 2010a*. Typical equation values were obtained from *USEPA 2010b*.
[e] Emissions (tons) assume 240 hours (24 days, 10 hours/day) of construction activity per month. Construction was assumed to last for 3 months in a year. If construction lasts for more than 3 months, emissions would be greater than the values listed here.
[f] Fuel is assumed to be ultra-low sulfur diesel.

[6] Points of presence are connections or access points between two different networks, or different components of one network.

Potential GHG impacts associated with each type of wired project are discussed below:

- New Build –Buried Fiber Optic Plant: This activity would include plowing (including vibratory plowing), trenching, and directional boring, and could involve construction of POPs, huts, or other facilities to house outside plant equipment or hand holes to access fiber. The emissions associated from fuel use from these activities are estimated in Table 6.2.14-4. These annual CO_2e emissions resulting from deployment of buried fiber for one unit of equipment, operating for a total of 3 months within a given year, are equivalent to 1,403 tons (1,273 metric tons), which is less than the 25,000 metric ton threshold. It would require 20 or more buried fiber optic cable projects to be deployed simultaneously for 1 year or more for the threshold to be met and/or exceeded, which is unlikely due to the small geographic area of Guam.
- New Build Aerial Fiber Optic Plant: These projects would require construction equipment for installing or replacing new poles and hanging cables as well as excavation and grading for new or modified right-of-ways or easements. It could also include construction of POPs, huts, or other facilities to house outside plant equipment. The GHG emissions from burning fuel for one unit of equipment, operating for a total of 3 months within a given year, are estimated in Table 6.2.14-5. The total emissions are estimated at 893 tons (810 metric tons) per year, which is less than the 25,000 metric ton threshold. It would require 31 or more aerial fiber optic plant projects to be deployed simultaneously for 1 year or more to meet and/or exceed the threshold for quantification, which is unlikely due to the small geographic area of Guam.
- Collocation on Existing Aerial Fiber Optic Plant: These projects would require equipment for replacement of existing wiring and poles. GHG emissions associated with these projects would arise from use of less equipment than those listed in Table 6.2.14-5. As a result, these emissions have not been estimated separately but are expected to be fewer than the total emissions from New Build Aerial Fiber Optic Plant projects, analyzed above.
- New Build – Submarine Fiber Optic Plant: The deployment of marine vessels that are capable of laying underwater cables that would be required for these types of projects is unlikely. However, small work boats (with engines similar to recreational vehicle engines) may be required to transport and lay small wired cable. The emissions from these small marine sources would be negligible.
- Installation of Optical Transmission or Centralized Transmission Equipment: The construction of small boxes or huts or other structures would require construction equipment and additional cranes or sky lifts for installation. GHG emissions for one unit of equipment, operating for a total of 3 months within a given year, correspond to those emissions from Table 5.2.14-6. These emissions are estimated at 766 tons (695 metric tons). For the threshold for quantification to be met and/or exceeded, it would require36 or more optical transmission or centralized transmission equipment projects to be deployed simultaneously for 1 year or more, which is unlikely.

Table 6.2.14-6: GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation[a]

Emission Source[b,c]	Estimated Emissions (tons/month)[c,d,e]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Concrete Mixer, Flat-bed Truck, Grader, Paver, Roller, Truck-mounted Crane	766	695

CO_2e = carbon dioxide equivalent
[a] Emissions are based on one unit of typical equipment. One unit consists of one each of the equipment listed in the table, operating simultaneously. If additional equipment is required, equipment-specific emission estimates should be multiplied by the number of equipment units.
[b] Equipment is assumed to have a maximum rated capacity of 300 horsepower and to be 10 years old (equipment age). If new equipment is used, emissions would be lower.
[c] Emissions are estimated using methodology from Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition, Equations 1 to 7, NR-009d, July 2010 (*USEPA 2010a*. Typical equation values were obtained from *USEPA 2010b*.
[d] Emissions (tons) assume 240 hours (24 days, 10 hours/day) of construction activity per month. Construction was assumed to last for 3 months in a year. If construction lasts for more than 3 months, emissions would be greater than the values listed here.
[e] Fuel is assumed to be ultra-low sulfur diesel.

Wireless Projects

Wireless projects would involve similar but fewer GHG emissions than wired projects. Emissions associated with installation of structures are similar to those found in Table 6.2.14-6 above. GHG emissions associated with each type of wireless project are discussed below:

- New Wireless Communication Towers: These projects would involve installation of new towers as well as associated structure including generators, equipment sheds, fencing, security lighting, aviation lights, and electrical feeds. Emissions from installation of new towers are estimated in Table 6.2.14-6. The annual emissions from these tower structure delivery and installation projects, assuming one unit of equipment operating for a total of 3 months within a given year, are estimated at 766 (695 metric tons) per year. For the threshold for quantification to be met and/or exceeded, 36 or more new towers deployed simultaneously would be required, which is unlikely due to the small geographic area of Guam.
- Collocation on Existing Wireless Tower, Structure, or Building: Collocation would require mounting and installation of equipment on an existing tower. GHG emissions could arise from combustion of fuel from trucks required for the delivery and installation of equipment and from the equipment used for excavation and grading. GHG emissions for these projects are expected to be fewer than the total emissions associated with New Wireless Communication Towers projects (which are estimated in Table 6.2.14-6) because there would be no new towers.

Deployable Technologies

GHG emissions would arise from use of Deployable Technologies from combustion of fuel from on-road vehicles and mobile power generators. It is assumed that diesel generators are the most likely fuel technology although gasoline and hydrogen-fueled generators could be an option. On road vehicles could include light-duty trucks for Cell on Light Truck projects or heavy-duty trucks for Cell on Wheels and System on Wheels. Emissions from diesel-power generators are estimated in Table 6.2.14-7.

Table 6.2.14-7: GHG Emissions Estimates from Heavy and Light Duty Vehicles[a]

Vehicle Type	Emission Factors[b,c]			Emissions	
	CO_2	CH_4	N_2O	Ton CO_2e/year	Metric tons CO_2e/year
	kg/gal	g/mi	g/mi		
Light Truck	10.21	0.0009	0.0014	1.80	1.63
Heavy Duty Vehicles	10.21	0.0051	0.0048	1.80	1.63

CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; kg/gal = kilograms per gallon; g/mi = grams per mile
[a] Emissions are estimated assuming one vehicle operates 8 hours per day, 2 days per year (one day for driving to location, one day for departing from location). Driving emissions are larger than idling emissions; therefore, all operation was assumed to be driving, with an average speed of 50 miles per hour
[b] Emission factors taken from Climate Registry (*2015*), *Default Emission Factors 2014* Table 13.1 and 13.4.
[c] Fuel efficiency for light and heavy trucks taken from *Understanding Tractor-Trailer Performance* (*Caterpillar 2006*).

GHG emissions associated with each type of deployable technology are discussed below:

- Cell on Wheels: These projects consist of a cellular base station on a trailer, which is a heavy-duty vehicle. The generators would power the cell unit while the vehicle is on-site and stationary and the vehicle engines would power the vehicle when it is traveling to and from the site. The GHG emissions from the use of heavy-duty vehicles are presented in Table 6.2.14-7. This estimation assumed that one vehicle operates for 2 days a year twice a year, traveling to and from the site for deployment (operating emissions are calculated separately, below). In order for the threshold for quantification to be met and/or exceeded, 15,338 trucks or more would have to be deployed within a given year, an unlikely event.
- Cell on Light Truck: GHG emissions would arise from the combustion of fuel from light-duty truck and diesel generator for powering the cellular base station. Similar to Cell on Wheels, the generators would power the cell unit while the vehicle is onsite and stationary; however, the vehicle engines would power the vehicle while traveling to the site. The GHG emissions from use of a light-duty truck are presented in Table 6.2.14-7. This estimation assumed that one vehicle operates for 2 days a year twice a year, traveling to and from the site for deployment (operating emissions are calculated separately, below). In order for the threshold for quantification to be met and/or exceeded, 15,338 trucks or more would have to be deployed simultaneously, which is an unlikely event.
- System on Wheels: These projects include a full base station and controller on a large towable trailer or truck. These trailer or trucks are similar to the heavy duty vehicle and diesel-power generator associated with the Cell on Wheels technology. As such, GHG emissions from these projects are expected to be similar to those for Cell on Wheels and are listed in Table 6.2.14-7. This estimation assumed that one vehicle operates for 2 days a year

twice a year, again for deployment only. In order for the threshold for quantification to be met and/or exceeded, 15,338 trucks or more would have to be deployed simultaneously, which is an unlikely event.

- Deployable Aerial Communication Architecture: These projects consist of deploying, but not operating, aerial vehicles such as drones, balloons, blimps, and piloted aircraft to staging areas. GHG emissions would arise from fuel combustion from this staging activity. These emissions have not been estimated but would likely be less than those used in installation and delivery of tower, structure, and transmission equipment (which are estimated in Table 6.2.14-6).

It is likely that the Preferred Alternative would use one or more or a combination of the above mentioned activities. Although each individual project might not meet the GHG emissions threshold for quantification in accordance to CEQ, it is possible that a combination of these activities could result in emissions that meet or exceed the requirement for a qualitative assessment. For example, if a combination of new build buried fiber optic plant, new build aerial fiber optic, new build submarine fiber optic and the installation of optical transmission equipment occurred simultaneously, the threshold for quantification would be exceeded if nine sets of these operating units were deployed in a given year. The use of BMPs and mitigation measures help reduce these emissions. Operational emissions are described further below.

GHG Emissions during Deployment

Based on the analysis of deployment activities described above, GHG emissions are anticipated to be *less than significant* based on a reasonable assumption that the number of simultaneously deployed units would be less than the number required to reach the quantification threshold of 25,000 metric tons per project. It is unlikely that more units would be used or that a combination of projects would be deployed in sufficient numbers to exceed the threshold. In addition, BMPs and mitigation measures presented in Chapter 11, BMPs and Mitigation Measures, would further reduce potential GHG impacts.

Potential Operation Impacts

GHG Emissions

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in similar potential impacts to the abovementioned potential deployment impacts. There would be GHG emissions from combustion of trucks and other equipment used for routine inspection of the Preferred Alternative. However, these emissions would be far fewer than those associated with deployment activities. It is anticipated that there would be no GHG emissions associated with soil disturbance and vegetation loss from routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are used for inspection.

Operational activities associated with the Preferred Alternative could involve operation of fossil fuel power generators in Wireless Projects and Deployable Technologies. This analysis assumed that these power generators would use diesel fuel; however, gasoline- and hydrogen-fueled generators could be options. Power generators would be used as backup generators and operated while onsite for wireless projects during upset conditions where commercial power is interrupted and during routine maintenance; as a result, they would be expected to operate for only a short period of time. For deployable technologies, power generators would be utilized as the primary power source. The deployable technologies would operate onsite for as long as needed. The types of deployment activities that GHG emissions would arise from include the following:

- Wireless Projects
  - New Wireless Communication Towers: GHG emissions would arise from use of power generators including those that operate by combustion of fossil fuels. Backup power generators would only operate for a short period of time during upset conditions when commercial power supply has been interrupted or during routine maintenance. This analysis assumed a maximum of 500 hours per year for both upset conditions and routine maintenance. These emissions have been estimated and are presented in Table 6.2.14-8 below. The annual emissions for backup power generators are 19.3 tons (17.5 metric tons) of CO_2e for one unit, which is less than the 25,000 metric tons threshold. For the threshold to be met and/or exceeded, 1,429 or more units of the above mentioned equipment, operating simultaneously, would be needed, which is unlikely.
  - Collocation on Existing Wireless Tower, Structure or Building: These projects could involve the use of backup power generators such as diesel-power generators. The emissions from combustion of fuel for power generators are comparable to New Wireless Communication towers and are presented in Table 6.2.14-8 below.

Table 6.2.14-8: GHG Emissions from Back-up Diesel Power Generators for Wireless Projects

Emission Source	Estimated Emissions[a,b]	
	CO_2e (tons/year)	**CO_2e (metric tons/year)**
Diesel Generators	19.3	17.5

CO_2e = carbon dioxide equivalent
[a] Emission factors taken from *AP-42, Compilation of Air Pollutant Emission Factors*, Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*)
[b] Emissions are estimated assuming one, 67-horsepower diesel engine operates for 500 hours per year when commercial power is interrupted and during normal routine maintenance. Estimates can be directly scaled based on actual equipment size and operating schedule.

- Deployable Technologies
  - Operation of land-based deployable technologies would involve use of power generators such as diesel-power generators to power the cell unit. This analysis assumed power generators operating continuously for 24 hours a day and for 363 days a year (deployment to and from the site would require 2 additional days, as discussed above). The emissions from combustion of fuel for power generators are presented in Table 6.2.14-9 below. The annual emissions for power generators for deployable technologies

are 160 tons (145 metric tons) of CO_2e for one unit, which is less than the 25,000 metric tons threshold. It would require 173 or more units of the above mentioned equipment operating simultaneously for the threshold to be met and/or exceeded, which is unlikely due to the small geographic area of Guam. These projects may also consist of deploying aerial vehicles including, but not limited to, drones, balloons, blimps, and piloted aircraft, which could involve fossil fuel combustion. These emissions would not be similar to any of the other technologies presented here. More information would be required regarding the number, type, and flight duration of the vehicles deployed to determine emissions from these technologies.

Table 6.2.14-9: GHG Emissions from Power Generators for Deployable Technologies

Emission Source	Estimated Emissions[a,b]	
	CO_2e (tons/year)	CO_2e (metric tons/year)
Diesel Generators	160	145

CO_2e = carbon dioxide equivalent
[a] Emission factors taken from AP-42, *Compilation of Air Pollutant Emission Factors,* Section 3.3, Gasoline and Diesel Industrial Engines, Table 3.3-1 (diesel engines) (*USEPA 1996*).
[b] Emissions are estimated assuming one, 32-horsepower diesel engine operates continuously (24 hours per day), 363 days per year (all year except for two travel days – see Tables 6.2.14-7 and 6.2.14-8). Estimates can be directly scaled based on actual equipment size and operating schedule.

Based on the analysis of operations activities described above, GHG emissions are anticipated to be *less than significant*. It is likely that emissions could be *potentially significant* only if 1,429 or more backup generators for wireless projects or 173 or more deployable units are used at the same time, an unlikely event. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to avoid or minimize potential impacts associated with GHG emissions.

Potential Climate Change Impacts on the Preferred Alternative

Climate change effects such as changes in temperature, precipitation, and sea-level rise during operations could potentially impact the infrastructure of the Preferred Alternative. Section 6.2.14.4, Global and Regional Climate Change Projections, presents climate change effects projected for Guam through the end of the 21st century. The potential impacts on the Preferred Alternative from climate change effects include the following:

- Projections indicate increasing average annual temperatures through the end of the century. These increases could lead to potential impacts associated with heat stress and wildfire risk, particularly for aboveground infrastructure. These would include towers, antennas, POPs, huts, poles, and microwave dishes.
- Precipitation is also expected to increase along the equator. Potential impacts could include increased periods of soil saturation. Additionally, any heavy precipitation events could result in flooding, increased runoff, and erosion. These effects could potentially impact the stability of aboveground infrastructure such as towers, antennas, POPs, huts, poles, and microwave dishes.

- Projections indicate that the global mean sea level would rise through the end of the century. Sea level rise increases the likelihood for coastal flooding and erosion. Sea level rise, soil and coastal erosion, and flooding could pose potential significant impacts to infrastructure near or on the coast such as huts for buried aerial fiber optic or submarine fiber optic. Additionally, other aboveground infrastructure such as antennas, POPs, and poles could potentially be impacted during extreme events.

Adaptation to Climate Change Effects during Operation

Based on the analysis of the operational activities described above, climate change effects on the Preferred Alternative could be *potentially significant* to *less than significant with BMPs and mitigation measures incorporated* because climate change effects such as changes in temperature, precipitation, and sea-level rise during operations could potentially impact the infrastructure of the Preferred Alternative. Mitigation measures could minimize or reduce the severity or magnitude of a potential impact resulting from the Project, while adaptation refers to anticipating adverse effects of climate change and taking appropriate action to prevent and minimize the damage climate change effects could cause. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to minimize climate change effects on the Preferred Alternative.

6.2.14.7. Alternatives Impact Assessment

The following section assesses potential impacts of climate change on the Deployable Technologies Alternative and the No Action Alternative.[7]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Therefore, potential impacts of climate change on the implementation of this alternative are described below. As with the Preferred Alternative, the effects of this alternative on climate change (in terms of GHG emissions) were examined as well as the other way around, in other words, the effects of climate change on the alternative.

Potential Deployment Impacts

The potential impacts on climate change from this alternative were assessed in terms of its potential to generate GHG emissions. As explained above, implementation of deployable technologies could involve use of fossil-fuel-powered vehicles, powered generators, and/or aerial

[7] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

platforms. There could be some emissions and soil and vegetation loss as a result of excavation and grading for staging and/or landing areas depending on the type of technology. GHG emissions are expected to be *less than significant* if 15,338 units or fewer of either light trucks or heavy-duty trucks were deployed, or if a combination of the light trucks or heavy duty trucks amounting to 15,338 units or fewer were deployed simultaneously, which is unlikely; these potential impacts would be further reduced by implementation of BMP and mitigation measures. In addition, GHG emissions would arise from fuel combustion from staging of aerial vehicles. These emissions have not been estimated; more information would be required regarding the number, type, and staging locations of the vehicles deployed to determine emissions from these technologies.

In addition to potential impacts on climate change from this alternative, the potential impacts from climate change on this alternative were assessed. Climate change effects on this alternative during deployment would be similar to such effects on the Preferred Alternative. If deployment activities occur in the next 10 years, as is anticipated, climate conditions in that period would not differ much from current conditions even in the worst case emission scenario. Therefore, climate change effects on the various deployment activities would likely have little to *no impact*. See the section below for more discussion on potential climate change effects during operation.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology and routine maintenance and inspections. As with the Preferred Alternative, it is anticipated that there would be few GHG emissions associated with routine inspections of the Preferred Alternative, assuming that the same access roads used for deployment are also used for inspections. Emissions would arise from use of power generators as the main power source. Emissions from the use of one fossil-fuel-powered generator would not be significant. It would require more than 173 power generators working simultaneously, for GHG emissions to be *potentially significant*. These potential impacts could still be reduced through implementation of BMP and mitigation measures. These projects may also consist of deploying aerial vehicles including, but not limited to, drones, balloons, blimps, and piloted aircraft, which could involve fossil fuel combustion. These emissions would not be similar to any of the other technologies presented here. More information would be required regarding the number, type, and flight duration of the vehicles deployed to determine emissions from these technologies.

Climate change effects on this alternative would have the most noticeable impacts over a long period of time. Climate change effects such as temperature, precipitation changes, and extreme weather during operations would be expected but could have little to *no impact* on the deployed technology if the technologies are deployed within a short period of time (less than a decade). If there are no permanent structures, particularly near coastal areas, there would be little to *no impacts* as a result of sea-level rise. However, if these technologies are deployed continuously (at the required location) for a time period greater than a decade, climate change effects on infrastructure could be similar to the Proposed Action, as explained above.

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be no GHG impacts from the No Action Alternative. However, GHG emissions would be emitted from the current technologies used in Guam for first responders. Climate change effects such as changes in temperature and precipitation, extreme weather and sea-level rise would still occur globally and regionally but have *no impact* in the No Action alternative since there would be no associated infrastructure.

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6.2.15. Human Health and Safety

6.2.15.1. Introduction

This section describes potential impacts to human health and safety in Guam associated with deployment and operation of the Proposed Action. Best management practices (BMPs) and mitigation measures that would avoid or minimize those potential impacts are addressed in Chapter 11, BMPs and Mitigation Measures.

6.2.15.2. Impact Assessment Methodology and Significance Criteria

The potential impacts of the Proposed Action on human health and safety were evaluated using the significance criteria presented in Table 6.2.15-1. As described in Section 6.2, Environmental Consequences, the categories of impacts are defined as *potentially significant*, *less than significant with BMPs and mitigation measures incorporated*, *less than significant*, or *no impact*. Characteristics of each impact type, including magnitude or intensity, geographic extent, and duration or frequency, were used to determine the impact significance rating associated with each potential impact.

Given the nature of this programmatic evaluation, and because the Proposed Action could potentially cover a wide variety of actions that would take place in various geographic and social settings, the potential impacts to health and safety addressed in this section are presented as a range of possible impacts. Potential impacts to human health and safety are assessed for both the workers and/or the general public, where applicable.

Environmental Consequences assessments for traffic, noise, water quality, and air quality, all of which have the potential to influence community and worker health, are covered in this Programmatic Environmental Impact Statement (see Section 6.2.1, Infrastructure; Section 6.2.13, Noise; Section 6.2.4, Water Resources; and Section 6.2.12, Air Quality; respectively). Applicable information from those assessments is referenced in this section if the potential impacts to those resources could result in impacts to community and/or worker health.

Other areas that directly or indirectly relate to health and safety but are not included in this section given the discussion in the respective resource sections include: radio frequency emissions (see Section 2.4, Radio Frequency Emissions); access to health and emergency services (see Section 6.2.1, Infrastructure); environmental justice issues that could result in decreased health (see Section 6.2.10, Environmental Justice); community cohesion and sense of safety (see Section 6.2.9, Socioeconomics).

Table 6.2.15-1: Impact Significance Rating Criteria for Human Health and Safety

Type of Effect	Effect Characteristic	Impact Level: Potentially Significant	Impact Level: Less than Significant with BMPs and Mitigation Measures Incorporated	Impact Level: Less than Significant	Impact Level: No Impact
Decrease in human health and safety (resulting from potential exposure to hazardous materials [including emissions, spills, and potential exposures via disturbance of historical contaminated sites]; accidents and injuries; exposure to noise; unsafe working conditions, and other recognized workplace safety hazards; and transmission of infectious diseases)	Magnitude or Intensity	Exposure to concentrations of chemicals above regulatory limits, or USEPA chemical screening levels protective of the general public; a net increase in the amount of hazardous or toxic materials or wastes generated, handled, stored, used, or disposed of, resulting in unacceptable risk, exceedance of available waste disposal capacity; and probable regulatory violations; site contamination conditions could preclude development of sites for the proposed use; exposure to recognized workplace safety hazards; violations of various regulations including: OSHA, RCRA, CERCLA, TSCA, EPCRA	Effect that is *potentially significant*, but with BMPs and mitigation measures is *less than significant*	No exposure to chemicals above health-protective screening levels; Hazardous or toxic materials or wastes could be safely and adequately managed in accordance with all applicable regulations and policies, with limited exposures or risks; No exposure to unsafe working conditions or other workplace safety hazards	No exposure to chemicals, unsafe working conditions, or other workplace safety hazards
	Geographic Extent	Regional impacts observed ("regional" assumed to be at least a county or county-equivalent geographical extent, could extend to territory)		Impacts only at a local/neighborhood level	NA
	Duration or Frequency	Occasional frequency during the life of the Proposed Action		Rare event	NA

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; EPCRA = Emergency Planning and Community Right-to-Know Act; NA = not applicable; OSHA = Occupational Safety and Health Administration; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substances Control Act

6.2.15.3. Description of Environmental Concerns

Exposure to Hazardous Materials

Health effects from human exposure to contaminants can range from experiences of physical irritation/nuisance to acute illness, to chronic disease outcomes, depending on the type of contaminant and level of exposure. The following are potential pathways for human exposure to contaminants in Guam associated with the Proposed Action.

Existing Contaminants in Soil or Water

The construction of the proposed facilities/infrastructure, trenching, and/or foundation excavation could expose soil containing contaminants from either existing industrial facilities or from legacy industrial activities. The disturbed soil could pose a health risk to workers and communities if there is direct contact with the soil or surface water runoff containing soil chemicals from the construction site. As outlined in the Affected Environment Health and Safety Section 6.1.15, Guam has 12 active Superfund sites that have ongoing cleanup action around soil and ground water contamination, including dioxin and polychlorinated biphenyls, both known carcinogens; volatile organic compounds such as trichloroethylene, toluene, and tetrachloroethane, which can cause acute and chronic health effects; and heavy metals (*USEPA 1995, 2013*). Other existing sources of soil and water contamination that could potentially pose a risk to workers and communities include pesticides used primarily in agricultural areas on the island. The implementation, as practicable or feasible, of water quality and soil erosion BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures) would help ensure contaminated soil and water are safely and adequately managed in accordance with all applicable regulations and policies, and exposure risks are minimized.

Potential Spills of Pollutants into Surface Water

Section 6.2.4.3, Description of Environmental Concerns, discusses the potential for water quality impacts that could occur from petroleum products accidentally spilled during refueling, or from potential pentachlorophenol associated with treated utility poles leaching into surface water, although concentrations of pentachlorophenol released during placement or replacement of poles are not expected to exceed United States (U.S.) Environmental Protection Agency levels of concern for human health (see Section 6.2.4.3, Description of Environmental Concerns). Health risks posed to workers and community members who could potentially come into contact with these chemicals range from acute to chronic illnesses, including increased risk of cancer (*USEPA 2000*).

The source of all freshwater on Guam is rainwater. In the northern half of the island, water used for human consumption is sourced from ground water wells that tap the upper part of a groundwater lens. The ground water supplies 80 percent of the potable water for the island. In southern Guam, the primary water source is surface water from rainwater that runs off the volcanic rocks exposed over much of the area (*Gingerich 2003*).

Therefore, surface water contamination could potentially impact catchment potable water systems, particularly in southern Guam. FirstNet will attempt, the extent that is practicable or feasible, to avoid buildout/deployment locations in or adjacent to waterbodies or that involve in-stream construction. In the event of a larger spill that goes unnoticed, shallow groundwater wells in northern Guam used for potable water could also potentially be impacted. The implementation of spill management BMPs and mitigation measures outlined in Section 6.2.4, Water Resources, could help to further ensure contaminated soil and water are safely and adequately managed in accordance with all applicable regulations and policies, and exposure risks are minimized.

Air Emissions from Mobile Sources

Section 6.2.12, Air Quality, discusses the potential impacts to air quality associated with the Proposed Action, which include emissions from stationary and mobile sources during deployment. Emissions could result from stationary or mobile equipment that is powered by fossil fuels, such as excavators or backhoes, required to support any clearance, drilling, and construction activities associated with network deployment. In addition, the use of power generators, first responder on-road vehicles (large towable trailers, commercial trucks, standard sport utility vehicles), and aerial platforms (aircraft such as drones and piloted aircraft) associated with the implementation of deployable technologies could also increase air emissions, both from fossil fuel combustion and, in some cases, from stirring up dust on unpaved roads. The emissions of health concern to both workers and communities are primarily particulate matter up to 2.5 micrometers in diameter ($PM_{2.5}$) and nitrogen dioxide (NO_2).

There is a substantial body of scientific literature linking both short-term and long-term adverse health impacts to various types of air pollution (*HEI 2010; Sarnat and Holguin 2007; Nishimura et al. 2013; Patel and Miller 2009; USEPA 2009; Levy et al. 2002*). NO_2 has been linked to short-term respiratory and cardiovascular effects (*USEPA 2008*). $PM_{2.5}$ has been linked to both short-term and long-term health effects. Specific health effects for $PM_{2.5}$ exposures include adverse cardiovascular effects, increase in cardiovascular and respiratory mortality, and adverse respiratory effects, including lung cancer (*USEPA 2009*). Both emissions are produced by fossil fuel combustion associated with vehicle, heavy machinery, and generator use.

Research to date has not revealed the existence of concentration thresholds for $PM_{2.5}$ and nitrogen oxides below which no health effects would be expected for sensitive populations.[1] Because a no-effect level has not been defined, the increase in emissions from deployment activities could potentially increase the risk of short-term and long-term effects to sensitive populations within the workforce or nearby communities (*HEI 2010; USEPA 2009, 2013; Kelly and Fussell 2011; Levy et al. 2002; Nishimura et al. 2013; Patel and Miller 2009; O'Neill et al. 2005, 2007; Sarnat and Holguin 2007*). Sensitive populations for exposure to $PM_{2.5}$ and NO_2 are listed below:

- Those with chronic respiratory diseases (asthma and chronic obstructive pulmonary disease), particularly children and the elderly;

[1] If health-based air quality standards are being met, the health of the general population is unlikely to be adversely affected.

- Those with acute respiratory infections, particularly children and the elderly;
- Those with chronic heart diseases; and
- Diabetics.

With regards to sensitive populations in Guam, adult asthma prevalence, and the percentages of deaths attributable to chronic lower respiratory disease, influenza and pneumonia are lower than in the overall United States; however, deaths attributable to heart disease and the rate of diabetes prevalence is higher in Guam (*CDC 2013a; 2013b*). Overall, the percentage of Guam population that could be considered sensitive is likely comparable to the national percentage.

It is important to note that there are multiple causes of the diseases associated with particulate exposures. Although it is possible that some cases of cardiovascular problems, respiratory problems, and lung cancer could be related to, result from, or be worsened by, $PM_{2.5}$, most cases of these health problems are associated with other causes such as smoking.

According to Section 6.2.12, Air Quality, potential impacts to air quality associated with the Preferred Alternative activities could range from *no impacts* to *less than significant* depending on the deployment or operation scenario, or the site-specific conditions. It is anticipated that any air pollution increase due to deployment would likely be short-term with pre-existing air quality levels generally achieved after some months (typically less than a year). The implementation of appropriate air quality BMPs and mitigation measures outlined in Section 11.12, Air Quality, and below, would further help reduce human exposure to air contaminants and minimize the potential risk of health effects.

Accidents and Injuries

Workplace and Construction Site Accidents and Injuries

The Preferred Alternative construction activities, including excavation, drilling, buried, or aerial installations and transportation to and from work sites could increase the risk of accidents and injuries to both workers and communities. For communities, inadequate safety signage at construction and other work sites, as well as poor public awareness regarding construction risks, can increase the risk of injuries and accidents for community members living or working in proximity to those sites. For the workforce, workplace hazards such as work at heights and work involving the use of heavy machinery increase the risk of slips, trips, falls, and other accidents. The U.S. Occupational Safety and Health Administration (OSHA) maintains authority over all federal and private sector workplaces in Guam; therefore, although accidents and injuries are considered an employee workplace hazard, FirstNet and/or their partners could implement appropriate measures, such as Job Hazard Analyses, to assure a safe and healthful workplace in compliance with OSHA standards.

Road Traffic Accidents and Injuries

In addition to worksite accidents and injuries, temporary traffic congestion on public roads as discussed in Section 6.2.1, Infrastructure, during deployment could increase the risk of road traffic-related accidents and injuries for both workers and community members.

Those most at risk for traffic-related accidents are often local citizens whose daily activities occur at the same time or in the same vicinity as the Proposed Action activities. The degree of health risk to the local communities and workers relates to the forms of local community traffic that exist on the same roads used by the Proposed Action (e.g., mixed-use traffic involving pedestrian, motorcycle, animals, etc.), the integrity of local road infrastructure, and driver behavior. Key risk factors for road traffic accidents that should be taken into consideration and mitigated in the deployment and operation phases of the Proposed Action include: alcohol and drug-impaired driving, speeding, low levels of seat belt usage, and helmet usage (for motorcyclists) (*Government of Guam's Office of Highway Safety 2014*).

Adherence to OSHA workplace standards, the implementation of the appropriate traffic congestion BMPs and mitigation measures in Section 11.1, Infrastructure, and implementation of human health and safety BMPs and mitigation measures outlined in Section 11.15 could reduce the risk of road traffic-related accidents and injuries to both communities and workers.

Potential Noise-Related Health Impacts

Noise is measured in A-weighted decibels (dBA). Human exposure to long-term noise levels above 80 dBA is associated with an increased risk of hearing loss, and lower levels of noise exposure may be associated with non-auditory health effects, including sleep disturbance, increase in blood pressure, and increase in stress (*Evans et al. 2001; Babisch 2011; WHO 1999*). Sources of noise during deployment above ambient background noise and threshold distances are discussed in Section 6.2.13, Noise.

Worker health effects managed by OSHA are designed to prevent hearing impairment. If worker noise exposure is equal to or greater than 85 dBA for an 8 hour exposure, a hearing conservation program must be implemented (*OSHA 2015*). During deployment, construction activities that involve the use of heavy machinery could exceed 85 dBA (refer to Section 6.2.13, Noise).

For communities, a 5 dBA increase in noise above the ambient background is used to assess whether an impact is considered to be potentially significant (*IFC 2007; USDOT 2005; WHO 1999*). "Significant" in this context means the level of sound that a community is likely to perceive as an annoyance (*USDOT 2005*). The minimum increase in sound levels that most people can perceive is 3 dBA (*Bies and Hansen 1996*), which equates to a doubling of the sound power (sound is measured on a logarithmic scale). Use of a 5 dBA increase to assess whether a community might perceive a noise annoyance may not be accurate if noise levels in the community are already relatively high (e.g., above 65 dBA) (*USDOT 2005)*. In general, the "noisier" existing conditions are, the less additional noise is tolerated by the community (*USDOT 2006*). Higher noise levels and larger increases above existing noise levels are associated with increasing levels of stress responses. Noise-related disturbance and stress are subjective factors, and therefore there is no defined threshold at which a noise disturbance is considered to result in stress levels representing a measurable health effect. Best practice guidance suggests assessment of community noise based on perception rather than measured health outcomes (*USDOT 2005*), and on examining increases above baseline conditions (*IFC 2007*).

Providing further complication, the potential impacts of increased sound depend not just on the numerical increase in sound levels, but also on the intensity of the sound, the duration of the sound, and the sound setting (*WHO 1999*). Unexpected, short duration, high intensity sounds can have a worse effect than relatively steady sounds. Research suggests that humans appear to have capacity for adaptive response to typical sound levels in their environment; once adaptation has occurred, sleep patterns are not affected (*Stansfeld and Matheson 2003*).

Adherence to OSHA workplace standards, the implementation of the appropriate noise and human health and safety BMPs and mitigation measures outlined in Chapter 11 could minimize the risk of human exposure to noise levels above health-protective levels.

Communicable Diseases

Communicable, or infectious, diseases are illnesses that result typically from infection by biologic agents (most commonly viruses, bacteria, and parasites) in a human or animal host. In Guam, the mosquito-borne dengue is an ongoing public health concern, although official statistics on prevalence are not available (*CDC 2014*). Guam is also on alert for mosquito-borne chikungunya due to a local abundance of *Aedes albopictus* mosquito species, which are one of the vector species[2] for the disease (*Marianas Variety 2013*). As of March 2015 no cases of chikungunya had been reported in Guam (*CDC 2015*). Community members and workers are both at risk for infection, particularly during the rainy season when the disease-vector mosquitos are more prevalent. Construction activities considered under the Preferred Alternative that include land clearing and excavation could inadvertently create new bodies of standing water that can become mosquito vector-breeding sites, which could increase the risk of transmission of mosquito-borne illnesses to workers and community members.

With the implementation of the appropriate soil erosion control and human health and safety BMPs and mitigation measures in in Chapter 11, the risk for transmission of communicable diseases would be significantly minimized.

6.2.15.4. Potential Impacts of the Preferred Alternative

The following section assesses potential impacts associated with implementation of the Preferred Alternative, including deployment and operation activities.

Potential Deployment Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, implementation of the Preferred Alternative could result in the deployment of various types of facilities or infrastructure. Depending on the physical nature and location of the facility/infrastructure and the specific deployment requirements, some activities would result in potential impacts to human health and safety and others would not. In addition, and as explained in this section, the various types of Proposed Action infrastructure could result in a range of *no impacts* to *less than significant* impacts depending on the deployment scenario or site-specific conditions.

[2] A vector is an organism that carries and transmits an infectious pathogen to another living organism.

Activities Likely to Have No Impacts

Of the types of facilities or infrastructure development scenarios described in Section 2.1.2, Proposed Action Infrastructure, the following are likely to have *no impacts* to human health and safety under the condition described below:

- Wired Projects
  - Use of Existing Conduit – New Buried Fiber Optic Plant: The pulling or blowing of fiber optic cable would be performed through existing conduit. Use of mechanical equipment would be limited to pulley systems and blowers. Hazardous materials needed for this work would include fiber optic cable lubricants or mechanical oil/grease, although these materials are expected to be used infrequently and in small quantities. These activities are not likely to result in serious injury, chemical exposure, or surface disturbances since work would be limited to existing entry and exist points, would be temporary, and intermittent. It is anticipated there would be *no impacts* to human health and safety.
  - Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable: Lighting up of dark fiber would have *no impacts* to health resources because there would be no ground disturbance or heavy equipment used to accomplish the task.
- Satellite and Other Technologies
  - Deployment of Satellites: FirstNet does not anticipate launching satellites as part of the deployment of the nationwide public safety broadband network (NPSBN); however, it could include equipment on satellites that are already being launched for other purposes. As adding equipment to an existing launch vehicle would be very unlikely to impact health and safety, it is anticipated that this activity would have *no impact* to those resources.

Activities with the Potential to Have Impacts

Potential deployment-related impacts to human health and safety as a result of the Preferred Alternative implementation would encompass a range of potential impacts that could occur as a result of exposure to hazardous materials in the air, water, or soil; potential workplace or road traffic accidents that result in injury; potential health effects from exposure to noise, and increased infectious diseases transmission. The remainder of this section provides summary impact discussions for each development scenario or deployment activity.

- Wired Projects
  - New Build–Buried Fiber Optic Plant: Installation of a new buried fiber optic plant (i.e., new underground conduit) would include plowing, trenching, or directional boring and the construction of points of presence,[3] huts, or other associated facilities or hand-holes to access fiber could result in: disturbed soil and the potential for exposure to legacy contaminants in the ground, and the possibility for spills, and soil and water contamination that could affect human health. Additionally, the use of heavy machinery

[3] Points of presence are connections or access points between two different networks, or different components of one network.

and other vehicles around the construction area and on access roads would potentially impact human health through increases in air emissions and noise, as well as increased risk of workplace and road traffic accidents. Land clearing and any open areas that could cause rainwater to collect could increase the risk of transmission of mosquito-borne infections, in particular during the rainy season. Given that Guam is an endemic[4] area for dengue (mosquito-borne disease), transmission to workers is a concern even if Proposed Action activities such as land clearing do not increase mosquito propagation at the site. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.

- New Build–Aerial Fiber Optic Plant: The build of an aerial fiber optic plant would require less soil disturbance and therefore the potential for exposure to legacy contaminants would be less than for a buried fiber optic plant. The use of heavy machinery still presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health, as well as possible workplace and road traffic accidents that could result in injury. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.
- Collocation on Existing Aerial Fiber Optic Plant: Collocation of an existing aerial fiber optic plant is not expected to cause a sufficient level of soil disturbance that would result in the potential for exposure to legacy contaminants in the ground. The use of heavy machinery, while expected to be less than for new build, still presents the possibility for spills, soil and water contamination, and air and noise emissions that could potentially impact human health, as well as possible workplace and road traffic accidents that could result in injury. BMPs and mitigation measures (see Chapter 11) could help avoid or minimize the potential impacts.
- New Build – Submarine Fiber Optic Plant: The build of a submarine fiber optic plant would require less soil disturbance and therefore the potential for exposure to legacy contaminants would be less than for a buried fiber optic plant. The use of heavy machinery still presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health, as well as possible workplace and road traffic accidents that could result in injury. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.
- Installation of Optical Transmission or Centralized Transmission Equipment: If installation of transmission equipment requires grading or other ground disturbance to install small boxes, huts, or access roads, there could be soil disturbance and the potential for exposure to legacy contaminants in the ground, and the possibility for spills, and soil and water contamination that could affect human health. Additionally, the use of heavy machinery and other vehicles around the construction area and on access roads would potentially impact human health through increases in air emissions, noise, and increased short-term risk of workplace and road traffic accidents. Land clearing and any open areas

[4] Disease or condition regularly found among particular people or in a certain area.

where rainwater collects could increase the risk of transmission of mosquito-borne infections, in particular during the rainy season. Given that Guam is an endemic area for dengue (mosquito-borne disease), transmission to workers is a concern even if Proposed Action activities such as land clearing do not increase mosquito propagation at the site. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.

- Wireless Projects
  - New Wireless Communication Towers: Installation of new wireless towers and associated structures (generators, equipment sheds, fencing, security and aviation lighting, electrical feeds, and concrete foundations and pads) or access roads could result in soil disturbance and potential for exposure to legacy contaminants in the ground. The use of heavy machinery and generators presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Land/vegetation clearing, excavation activities, landscape grading could increase the risk of transmission of mosquito-borne infections. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.
  - Collocation on Existing Wireless Tower, Structure, or Building: Collocation would involve mounting or installing equipment (such as antennas or microwave dishes) on an existing tower which would not result in soil disturbance, however the use of heavy machinery and generators presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Given no land clearing would be expected, the risk of transmission of mosquito-borne infections would be less although still a possibility for workers given the endemicity of dengue and presence of chikungunya vector mosquitos in Guam. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.
- Deployable Technologies
  - Cell on Wheels, Cell on Light Truck, System on Wheels, Deployable Aerial Communications Architecture: The use of deployable technologies could result in soil disturbance if land-based deployables occur in unpaved areas, or if the implementation results in minor construction or paving of previously unpaved surfaces. The use of heavy machinery presents the possibility for spills and soil and water contamination, and air and noise emissions that could potentially impact human health; and vehicles and heavy equipment present the risk of workplace and road traffic accidents that could result in injury. Use of aerial vehicles would not involve telecommunication site work. Prior to deployment, and when not in use, the aerial vehicles could require preventive maintenance. Workers responsible for these activities may handle hazardous materials

not limited to fuel, solvents, and adhesives. BMPs and mitigation measures (see Chapter 11) could help to avoid or minimize the potential impacts.

- Satellites and Other Technologies
  - Satellite-Enabled Devices and Equipment: It is anticipated that the installation of permanent equipment on existing structures and the use of portable devices that use satellite technology would have *no impact* on impact soil, water, air or noise resources (refer to Sections 3.2.2 Soils, 3.2.4 Water Resources, 3.2.12 Air Quality, and 3.2.13 Noise), therefore the only potential human health and safety impacts considered are those associated with worksite or traffic-related congestion, which are anticipated to be minor and insignificant. Any use of satellite-enabled devices and equipment would be within current regulated ranges/standards. For a discussion of radio frequency emissions, refer to Section 2.4, Radio Frequency Emissions.

In general, the abovementioned activities could potentially involve trenching and/or foundation excavation, which could expose soil containing contaminants either from existing industrial facilities or from legacy industrial activities and could potentially affect human health. In addition, the possibility for spills that result in soil and water contamination exists and could also potentially affect human health. The use of heavy machinery and other vehicles around construction areas and on access roads could potentially impact human health through increases in air emissions and noise, as well as increased risk of workplace and road traffic accidents that could result in injury. Potential human health and safety impacts are described further below, and BMPs and mitigation measures to help avoid or reduce these potential impacts are discussed in Chapter 11.

Potential Exposure to Hazardous Materials Impacts

Based on the analysis of deployment activities, and assuming the adherence to OSHA workplace standards, potential health effects as a result of exposure to environmental hazardous materials are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential human health and safety impacts.

Potential Accident and Injury Impacts

Based on the analysis of deployment activities, and assuming the adherence to OSHA workplace health and safety standards, the risk of construction site, road, and other accidents and injuries to workers and communities is considered *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential human health and safety impacts.

Potential Noise Related Health Impacts

Based on the analysis of deployment activities, and assuming the adherence to OSHA workplace health and safety standards, potential health effects as a result of exposure to noise are anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential human health and safety impacts.

Potential Communicable Disease Impacts

Based on the analysis of deployment activities, the risk of transmission of infectious diseases for the workforce and community members is anticipated to be *less than significant*. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential human health and safety impacts.

Potential Operation Impacts

As described in Section 2.1.2, Proposed Action Infrastructure, operation activities associated with the Preferred Alternative would consist of routine maintenance and inspection of the facilities. Any major infrastructure replacement as part of ongoing system maintenance would result in potential impacts similar to the abovementioned potential deployment impacts. It is anticipated that there would be *less than significant* impacts associated with human exposure to environmental hazardous materials and impacts to human health and safety associated with the risk of road traffic, workplace accidents and injuries, noise exposure, and risk of infectious disease transmission. See Chapter 11, BMPs and Mitigation Measures, for a listing of BMPs and mitigation measures that FirstNet and/or their partners would require, as practicable or feasible, to further avoid or minimize potential human health and safety impacts.

6.2.15.5. Alternatives Impact Assessment

The following section assesses potential impacts to soils associated with the Deployable Technologies Alternative and the No Action Alternative.[5]

Deployable Technologies Alternative

Under the Deployable Technologies Alternative, a nationwide fleet of mobile land-based and aerial communications systems would provide temporary coverage in areas not covered by the existing, usable infrastructure. There would be no collocation of equipment and no new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Some limited construction could be associated with implementation such as land clearing or paving for parking or staging areas. The specific infrastructure associated with the Deployable Technologies Alternative would be the same as the deployable technologies implemented as part of the Preferred Alternative but would likely be implemented in greater numbers, over a larger geographic extent, and used with greater frequency and duration. Potential impacts to health and safety resources as a result of implementation of this alternative are described below.

[5] As mentioned above and in Section 2.1.2, Proposed Action Infrastructure, the Preferred Alternative includes implementation of deployable technologies.

Potential Deployment Impacts

As explained above, implementation of land-based deployable technologies could result in *less than significant* impacts to health and safety resources if deployment occurs within public roads and some staging and land/vegetation clearing, excavation, or paving are required. These activities could result in the potential of on-site or road traffic related accidents involving workers and community members; disturbed soil and the potential for exposure to legacy contaminants in the ground; and air and noise emissions that could potentially impact human health; however, it is anticipated that the activities associated with the Deployables Alternative would have *less than significant* potential impacts because they would not result in exposure to chemicals, including hazardous or toxic materials, above health screening levels and those materials would be handled and disposed of in accordance with prevailing laws and regulations. If land clearing is required, depending on the area and time of year (rainy season), the risk of transmission of mosquito-borne infections could be a concern for workers given that dengue is endemic, and chikungunya-vector mosquitos are present in Guam.

Potential Operation Impacts

As explained above, operation activities would consist of implementation/running of the deployable technology, and routine maintenance and inspections. It is anticipated that potential health impacts associated with human exposure to environmental hazardous materials in air, water, or soil, the risk of road traffic, workplace accidents and injuries, noise, and risk of infectious disease transmission would be *less than significant* because of the small scale of likely FirstNet activities. These potential impacts could be further reduced by implementation, as practicable or feasible, of BMPs and mitigation measures (see Chapter 11, BMPs and Mitigation Measures).

No Action Alternative

Under the No Action Alternative, the NPSBN would not be deployed; therefore, there would be no associated construction or installation of wired, wireless, deployable infrastructure or satellites and other technologies. As a result, there would be *no impacts* to human health and safety as a result of construction and operation of the Proposed Action. Environmental conditions would therefore be the same as those described in the Affected Environment Section 6.1.15, Human Health and Safety.

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6.3. References

6.3.1. Introduction

AIA Guam and Micronesia. 2012. *A Chapter of the American Institute of Architects (Regional Facts)*. Accessed: September 28, 2015. Retrieved from: http://www.aiaguam.org/regional-facts/

GEDA (Guam Economic Development Authority). Undated. *Government*. Accessed: September 28, 2015. Retrieved from: http://www.investguam.com/guam/government/

GHS/OCD (Guam Homeland Security Office of Civil Defense). 2005. *Guam Emergency Response Plan*. February 24, 2005.

GlobalSecurity.org. 2015. *Guam Army National Guard.* Accessed: August 4, 2015. Retrieved from: http://www.globalsecurity.org/

Guam Attorney General. 2015. *What You Should Know About Guam.* Accessed: June 22, 2015. Retrieved from: http://web.archive.org/web/20150523103157/http://www.guamattorneygeneral.com/what-you-should-know-about-guam/ (updated January 2016)

Map Service. 2015. *National Geographic World Map.* ArcGIS Map Image Layer by Esri. Sourced from: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp. Last updated March 1, 2015. Accessed: August 2015. Retrieved from: http://www.arcgis.com/home/item.html?id=b9b1b422198944fbbd5250b3241691b6

NOAA (National Oceanic and Atmospheric Administration). 2015. *National Climatic Data Center (NCDC) Storm Events Database for Guam*. Accessed: June 5, 2015. Retrieved from: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=98%2CGUAM

U.S. Census Bureau. 2010. *2010 Guam Summary File*. Accessed: November 23, 2015. Retrieved from: http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml

USEPA (U.S. Environmental Protection Agency). 2013. *Wastewater Collection and Treatment Inspection for the Guam Waterworks Authority.* January 2013.

USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.* March 1998. Accessed: July 2015. Retrieved from: https://www.fws.gov/ENDANGERED/esa-library/pdf/esa_section7_handbook.pdfWA (World Atlas). 2015. *World Map / Oceana / Guam.* Accessed: November 23, 2015. Retrieved from: http://www.worldatlas.com/webimage/countrys/oceania/gu.htm

6.3.2. Affected Environment

Infrastructure

Air National Guard. 2015. *Andersen Air Force Base.* Accessed: August 3, 2015. Retrieved from: https://www.goang.com/Careers/Explore/GU/Andersen-Air-Force-Base

DOI (U.S. Department of the Interior). 1999. "Chapter 4: Guam." In U.S. Department of the Interior – Office of Insular Affairs. *A Report on the State of the Islands 1999*. Accessed: August 4, 2015. Retrieved from: https://www.doi.gov/sites/doi.gov/files/migrated/oia/reports/upload/islands.pdf (updated January 2016)

_____. 2014. *Guam Memorial Hospital Authority*. December 2014.

EIA (U.S. Energy Information Administration). 2015. *Guam Territory Profile and Energy Estimates.* Accessed: August 4, 2015. Retrieved from: http://www.eia.gov/state/analysis.cfm?sid=GQ

FEMA (Federal Emergency Management Agency). 2013. *Guam, American Samoa, the Commonwealth of the Mariana Islands (CNMI)*. Accessed: August 4, 2015. Retrieved from: http://www.doi.gov/oia/igia/2013/upload/25-Homeland-Security-DHS-FEMA-Region-9-Pacific-Territories.pdf

_____. 2015. *Federal Aid Programs for the Territory of Guam Declaration*. Accessed: August 31, 2015. Retrieved from: http://www.fema.gov/news-release/2015/06/05/federal-aid-programs-territory-guam-declaration

GHS OCD (Guam Homeland Security Office of Civil Defense). 2005. *Guam Emergency Response Plan*. February 24, 2005.

_____. 2015. *Guam Homeland Security Mission.* August 13, 2015.

GlobalSecurity.org. 2015. *Guam Army National Guard.* Accessed: August 4, 2015. Retrieved from: http://www.globalsecurity.org/

GPD & ICWG (Guam Police Department and Government of Guam Interoperable Communications Working Group). 2015. *Consulting Services for the Government of Guam Interoperable Communications Land Mobile Radio (LMR) System.* February 13, 2015.

GPD (Guam Police Department). 2010. *A Citizen-Centric Report for Guam Police Department.* November 1, 2010.

Guam Fire Department. 2007. *Guahan Fire Department.* Accessed: August 3, 2015. Retrieved from: http://www.gfd.guam.gov/

_____. 2013a. *Guam Fire Department Citizen Centric Report.* September 2013.

_____. 2013b. *Guam Fire Department A Report to Our Citizens 2012-2013.* Accessed: August 4, 2015. Retrieved from: http://www.opaguam.org/sites/default/files/gfd_ccr13.pdf (updated January 2016) f

Guampedia. 2014. *Geography of Guam*. Accessed: August 4, 2015. Retrieved from: http://www.guampedia.com/geography-of-guam/

HSRTF (Hurricane Sandy Rebuilding Task Force). 2013. *Hurricane Sandy Rebuilding Strategy.* August 2013.

Megginson Technologies Ltd. 2015. *List of Guamanian Airports*. Accessed: September 16, 2015. Retrieved from: http://ourairports.com/countries/GU/airports.html

Military INSTALLATIONS. 2015. J*oint Region Marianas – Naval Base Guam, Guam*. Accessed: September 1, 2015. Retrieved from: http://www.militaryinstallations.dod.mil/MOS/f?p=132:CONTENT:0::NO::P4_INST_ID%2CP4_INST_TYPE:3025%2CINSTALLATION

NGA (National Geospatial-Intelligence Agency). 2015. *World Port Index*. Publication 150, 24th Edition. Springfield, VA: National Geospatial-Intelligence Agency. Available in PDF, online database, and Shape file formats. Accessed: August 2015. Retrieved from: http://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_pageLabel=msi_portal_page_62&pubCode=0015

NTFI (National Task Force of Interoperability). 2005. *Working Together to Bridge the Communications Gap to Save Lives – A Guide for Public Official.* February 2005.

Parsons Brinkerhoff. 2013. *Jose D. Leon Guerrero Commercial Port of Guam Master Plan Update 2013 Report.* November 2013.

Parsons Transportation Group. 2010. *Storm Water Implementation Plan for the Guam Road Network.* March 2010.

Public Safety Wireless Advisory Committee. 1996. *Final Report of the Public Safety Wireless Advisory Committee.* September 11, 1996.

Transition Team, The. 2011. *Public Safety Committee Report on Public Safety.* Accessed: August 3, 2015. Retrieved from: http://archive.guampdn.com/assets/pdf/M016986824.PDF

USDA (U.S. Department of Agriculture, Service Center Agencies). 2010. *Processed TIGER 2010 Primary and Secondary Roads—Guam*. Vector dataset.

USDHS USCG (U.S. Department of Homeland Security United States Coast Guard). 2014. *USCG Sector Guam*. Accessed: September 1, 2015. Retrieved from: http://www.uscg.mil/d14/sectGuam/

USDN (U.S. Department of the Navy). 2010. *U.S. Naval Base Guam Firefighters Receive Three New Vehicles.* Accessed: August 3, 2015. Retrieved from: http://www.navy.mil/submit/display.asp?story_id=56420

USEPA (U.S. Environmental Protection Agency). 2013. *Wastewater Collection and Treatment Inspection for the Guam Waterworks Authority.* January 2013.

vBulletin Solutions, Inc. 2015. *Guam Roads and Highways.* Accessed: August 4, 2015. Retrieved from: http://www.skyscrapercity.com/showthread.php?t=1554196

Vidiani.com. 2011. *Detailed Political and Relief Map of Guam with Roads, Cities and Airports*. Accessed: August 4, 2015. Retrieved from: http://www.vidiani.com/detailed-political-and-relief-map-of-guam-with-roads-cities-and-airports/

Soils

Anderson, J.L., J.C. Bell, T.H. Cooper, D.F. Grigal. 2001. *Soils and Landscapes of Minnesota*. University of Minnesota Extension Tillage Program. Accessed: July 2015. Retrieved from: http://www.extension.umn.edu/agriculture/tillage/soils-and-landscapes-of-minnesota/

NRCS (Natural Resources Conservation Service). 2006. *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.* U.S. Department of Agriculture Handbook 296.

_____. 2015. *What is Soil?* Accessed: June 2015. Retrieved from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054280

Soil Conservation Service. 1985. *Soil Survey of Territory of Guam.* U.S. Department of Agriculture in cooperation with Guam Department of Commerce and University of Guam.

STATSGO2 Database (State Soil Geographic Database). 2015. *Digital General Soil Map of the United States*. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Accessed: March 11, 2015. Retrieved from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

Geology

Earthquake Engineering Research Institute. 1993. *EERI Dispatches Team to Investigate M 8.1 Quake near Guam*. September, 27(9). Accessed: September 22, 2015. Retrieved from: https://www.eeri.org/lfe/pdf/guam_1993_newsletter.pdf

_____. 1997. *Guam Shaken Twice in Two Weeks – Bridge and Two Schools Closed Due to Damage*. June, 31(6). Accessed: September 22, 2015. Retrieved from: https://www.eeri.org/lfe/pdf/guam_1997_series_eeri_preliminary_report.pdf

EIA (U.S. Energy Information Administration). 2015. *Guam Territory Profile and Energy Estimates*. Accessed: September 4, 2015. Retrieved from: http://www.eia.gov/state/analysis.cfm?sid=GQ

Gingerich, Stephen B. 2003. *Hydrologic Resources of Guam*. U.S. Geological Survey Water-Resources Investigations Report 03-4126. Accessed: September 22, 2015. Retrieved from: http://pubs.usgs.gov/wri/wri034126/pdf/wrir03-4126.pdf

Guam.gov. 2011. 2011 *Guam Hazard Mitigation Plan – Final Plan April 2011*. Accessed: September 22, 2015. Retrieved from: http://documents.guam.gov/wp-content/uploads/Final-Plan_2011-Guam-HMP.pdf

Hein, James, Brandie R. McIntyre, and David Z. Piper. 2005. *Marine Mineral Resources of Pacific Islands – A Review of the Exclusive Economic Zones of Islands of U.S. Affiliation, Excluding the State of Hawaii*. U.S. Geological Survey Circular 1286. Accessed: September 10, 2015. Retrieved from: http://pubs.usgs.gov/circ/2005/1286/c1286.pdf

Johnson, J. Harlan. 1964. *Fossil and Recent Calcareous Algae From Guam*. USGS Geological Survey Professional Paper 403-G. Accessed: September 22, 2015. Retrieved from: http://pubs.usgs.gov/pp/0403g/report.pdf

Lander, James F. and Lowell S. Whiteside. 2002. *The Tsunami History of Guam: 1849-1993*. Science of Tsunami Hazards, 20(3).

Mueller, Charles S., Kathleen M. Haller, Nicholas Luco, Mark D. Petersen, and Arthur D. Frankel. 2012. *Seismic Hazard Assessment for Guam and the Northern Mariana Islands*. USGS Open-File Report 2012-1015. Accessed: September 21, 2015. Retrieved from: http://pubs.usgs.gov/of/2012/1015/

NPS (National Park Service). Undated. *Map Unit Properties Table: War in the Pacific National Historic Park*. Accessed: October 14, 2015. Retrieved from: https://www.nature.nps.gov/geology/inventory/publications/reports/wapa_gri_rpt_table_print.pdf

NRCS (Natural Resources Conservation Service). 2006. *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.* U.S. Department of Agriculture Handbook 296.

Schlanger, Seymour O. 1964. *Petrology of the Limestones of Guam*. USGS Geological Survey Professional Paper 403-D. Accessed: September 22, 2015. Retrieved from: http://pubs.usgs.gov/pp/0403d/report.pdf

Schweitzer, Carrie E., Philip R. Scott-Smith, and Peter K.L. Ng. 2002. *New Occurrences of Fossil Decapod Crustacean (Thalassinidea, Brachyura) from Late Pleistocene Deposits of Guam, United States Territory*. Bulletin of the Mizunami Fossil Museum, 29: 45-49. Accessed: September 4, 2015. Retrieved from: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CDQQFjADahUKEwjZ-b2ViN7HAhUErIAKHY3pDfo&url=http%3A%2F%2Fwww.city.mizunami.lg.jp%2Fdocs%2F2014092922841%2Ffiles%2F2014092922841_29_02.pdf&usg=AFQjCNGFAW6j46dmJqFr6RqIKxhe6uQSBA&sig2=if4-P_78207PaeJOy4xLFw

SOPAC (South Pacific Applied Geoscience Commission). 1996. *Guam Country Profile.* Accessed: September 4, 2015. Retrieved from: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&ved=0CEcQFjAGahUKEwi6nI6LzLLHAhVIUYgKHTRSAdU&url=http%3A%2F%2Fict.sopac.org%2FVirLib%2FCP0004.pdf&ei=5B_TVbqaG8iioQS0pIWoDQ&usg=AFQjCNFSesigi8yg7eZdOTL5NdQBhtVT1A&sig2=u6inAyUxLoRmKO6H7fV5bQ

SPC-EU (Secretariat of the Pacific Community-European Union). 2013. *Deep Sea Minerals and the Green Economy*. Accessed: September 4, 2015. Retrieved from: http://www.sopac.org/dsm/index.php/publications-and-reports

Tarbuck, E.J. and Frederick K. Lutgens. 1996. *Earth: An Introduction to Physical Geology*. Upper Saddle River, New Jersey: Prentice Hall.

USGS (U.S. Geological Survey). Undated. *USGS Groundwater Information – What is Karst?* Accessed: August 28, 2015. Retrieved from: http://water.usgs.gov/ogw/karst/pages/whatiskarst

_____. 1997. *Tsunamis*. Accessed: August 28, 2015. Retrieved from: http://www.usgs.gov/science/science.php?term=1195 (updated January 2016)

_____. 2004. *Landslide Types and Processes. U.S. Geological Survey Fact Sheet 2004-3072*. Accessed: August 27, 2015. Retrieved from: http://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

_____. 2012. *Earthquake Hazards Program. Earthquake Glossary – Richter Scale*. Accessed: August 26, 2015. Retrieved from: http://earthquake.usgs.gov/learn/glossary/?term=Richter%20scale

_____. 2013. *USGS Groundwater Information – Land Subsidence*. Accessed: August 28, 2015. Retrieved from: http://water.usgs.gov/ogw/subsidence.html

_____. 2015a. *2010-2011 Minerals Yearbook: Puerto Rico Advance Release*. The Mineral Industry of Puerto Rico and the Administered Islands. Accessed: September 11, 2015. Retrieved from: http://minerals.usgs.gov/minerals/pubs/state/2010_11/myb2-2010_11-pr.pdf

_____. 2015b. *Earthquake Hazards Program*. Accessed: September 9, 2015. Retrieved from: http://earthquake.usgs.gov/earthquakes/index.php

Water and Environmental Research Institute of the Western Pacific and Island Research and Education Initiative. Undated. *Digital Atlas of Northern Guam: Northern Guam Geospatial Information Server*. Accessed: September 20, 2015. Retrieved from: http://north.hydroguam.net/gis_download.php

Water Resources

FEMA (Federal Emergency Management Administration). 2015. *FEMA Map Service Center.* Accessed: June 2015. Retrieved from: http://msc.fema.gov/portal/

National Wild and Scenic Rivers System. 2015. *National Wild and Scenic Rivers System*. Accessed: June 2015. Retrieved from: http://www.rivers.gov/index.php

USDA Geospatial Data Gateway (U.S. Department of Agriculture Geospatial Data Gateway). 2015. *Watershed Boundary Dataset*. Accessed: June 2015. Retrieved from: http://nhd.usgs.gov/data.html

USDA Service Center (U.S. Department of Agriculture Service Center Agencies). 2015. *National Hydrography Dataset*. Accessed: June 2015. Retrieved from: http://nhd.usgs.gov/
Metadata from: https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/NHD24K.html

USEPA (U.S. Environmental Protection Agency). 2009. *National Sole Source Aquifer GIS Layer*. Accessed: June 2015. Retrieved from: http://www.epa.gov/ogwdw

_____. 2010. *Guam Water Quality Assessment Report*. Accessed: June 15, 2015. Retrieved from: http://ofmpub.epa.gov/waters10/attains_state.control?p_state=GU&p_cycle=2010

_____. 2014. *Sole Source Aquifers.* Accessed: June 2015. Retrieved from: http://www.epa.gov/dwssa (updated January 2016)

USGS (U.S. Geological Survey). 2003. *Water-Resources Investigation Report 03-4126.* Accessed: June 2015. Retrieved from: http://pubs.usgs.gov/wri/wri034126/htdocs/wrir03-4126.html

_____. 2014. *Water Resources of the United States*. November 2014. Accessed: July 2015. Retrieved from: http://www.usgs.gov/water/

_____. 2015. *Reservoir Capacity and Sedimentation of the Fena Valley Reservoir, Guam.* USGS California Water Science Center. Accessed: June 2015. Retrieved from: http://ca.water.usgs.gov/projects/fena-guam.html

Ward, P.E., S.H. Hoffrad, and D.A. Davis. 1965. *Hydrology of Guam.* Geological Survey Professional Paper 403-H.

Wetlands

Cowardin, L.M., V. Carter, F.C. Golet, E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* U.S. Fish and Wildlife Service Report No. FWS/OBS/-79/31. Washington, D.C.

Dahl, T.E. 2011. *Status and Trends of Wetlands in the Conterminous United States 2004 to 2009.* Washington, D.C.: U.S. Department of the Interior Fish and Wildlife Service. 108 pp.

GCMP (Guam Coastal Management Program). 2008. *Guam Coastal and Estuarine Land Conservation Program (CELCP) Plan*. April 30, 2008. Accessed: September 2015. Retrieved from: https://coast.noaa.gov/czm/landconservation/media/celcpplangudraft.pdf (updated January 2016)

Government of Guam. 1978. *Executive Order No. 78-21: Protection of Wetlands*. Office of the Governor. September 7, 1978. Accessed: September 2015. Retrieved from: http://documents.guam.gov/wp-content/uploads/E.O.-78-21-Protection-of-Wetlands.pdf

Guam EPA (Guam Environmental Protection Agency). 2015. *Land Use Permits*. Accessed: April 2015. Retrieved from: http://epa.guam.gov/documents/environmental-land-use-permits-and-policy/

Joint Guam Program Office. 2010. *Final Environmental Impact Statement, Guam and CNMI Military Relocation: Relocating Marines from Okinawa, Visiting Aircraft Carrier Berthing, and Army Air and Missile Defense Task Force.* Naval Facilities Engineering Command, Pacific.

NCDEQ (North Carolina Department of Environmental Quality). Undated. *Frequently Asked Questions: What is a Stream?* Accessed: January 2016. Retrieved from: http://portal.ncdenr.org/web/wq/swp/ws/401/waterresources/faqs#What_is_a_stream_

NOAA (National Oceanic and Atmospheric Administration Office of Response and Restoration.). 2015a. *Photo: Marine Intertidal Wetland*. Accessed: September 2015. Retrieved from: http://response.restoration.noaa.gov/training-and-education/education-students-and-teachers/oil-spills-waters-edges.html

_____. 2015b. Environmental Sensitivity Index Mapping. Accessed: September 2015. Retrieved from: http://response.restoration.noaa.gov/esi

Siha, S. 1991. *The Wetlands of Guam: A Guidebook for Decision Makers*. Funded by the U.S. Department of Commerce, Office of Ocean and Coastal Resource Management and the Guam Coastal Management Program.

USEPA (U.S. Environmental Protection Agency). 1995. *America's Wetlands: Our Vital Link Between Land and Water.* EPA843-K-95-001. Accessed: April 21, 2015. Retrieved from: http://water.epa.gov/type/wetlands/fish.cfm

_____. 2004. *Wetlands Overview*. Office of Water Technical Publication EPA 843-F-04-011a. December 2004. Accessed: September 2015. Retrieved from: http://water.epa.gov/type/wetlands/upload/2005_01_12_wetlands_overview.pdf

USFS (U.S. Forest Service). 2006. *Guam Vegetation Mapping Using Very High Spatial Resolution Imagery.* Methodology. Authored for USFS by Zhangeng Liu and Lisa Fischer, Pacific Southwest Region, Forest Health Protection. McClellan, CA.

USFWS (U.S. Fish and Wildlife Service). Undated. *National Wetland Inventory Notes to Users: Guam*. Accessed: September 2015. Retrieved from: http://www.fws.gov/wetlands/Data/SupMapInf/R01Y05P10.pdf

_____. 2015. *National Wetlands Inventory, Wetland Mapper.* Accessed: April 2015. Retrieved from: http://www.fws.gov/wetlands/data/mapper.HTML

USGS (U.S. Geological Survey). 1996. *National Water Summary – Wetland Resources.* Prepared by U.S. Geological Survey and U.S. Fish and Wildlife Service. Water Supply Paper 2425. Accessed: May 2015. Retrieved from: http://pubs.usgs.gov/wsp/2425/report.pdf

_____. 1997. *Restoration, Creation, and Recovery of Wetlands: Wetland Functions, Values, and Assessment.* National Water Summary on Wetland Resources USGS Water Supply Paper 2425. Accessed: April 2015. Retrieved from: https://water.usgs.gov/nwsum/WSP2425/functions.html

Biological Resources

Terrestrial Vegetation

Global Invasive Species Database. Undated. *Guam*. Accessed: June 26, 2015. Retrieved from: http://www.issg.org/database/species/search.asp?sts=sss&st=sss&fr=1&sn=&rn=Guam&hci=-1&ei=-1&lang=EN&x=0&y=0

Guam DOA DAWR (Department of Agriculture Division of Aquatic and Wildlife Resources). 2015. *Guam Draft Comprehensive Wildlife Management Strategy.* January 20, 2015. Accessed: June 11, 2015. Retrieved from: http://dawr.guam.gov/wp-content/uploads/2015/02/Guam-State-Wildlife-Action-Plan-2015.pdf

Liu, Zhanfeng and Lisa Fischer. 2006. *Guam Vegetation Mapping Using Very High Spatial Resolution Imagery*. 17 pp.

USFS (U.S. Forest Service). 2006. *Land Cover Monitoring – U.S. Affiliated Islands*. Pacific Islands Imagery Consortium Vegetation Mapping and Monitoring, Vegetation Data Packages. Accessed: June 11, 2015. Retrieved from: http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046690

USFWS (U.S. Fish and Wildlife Service). 2012. *Pacific Islands Fish and Wildlife Office, Endangered Species*. Accessed: June 29, 2015. Retrieved from: http://www.fws.gov/pacificislands/species.html

_____. 2015. *Environmental Conservation System Online: Listed Species Believed or Known to Occur in Guam.* Accessed: July 29, 2015. Retrieved from: http://ecos.fws.gov/tess_public/reports/species-listed-by-state-report?state=GU&status=listed

Wildlife

Amori, G. and M. Clout. 2003. "Rodents on Islands: A Conservation Challenge." In G. Singleton, L. Hinds, C. Krebs, D. Spratt. *Rats, Mice and People: Rodent Biology and Management*. ACIAR Monograph No. 96. 564pp.

Birdlife International. 2015a. *Country Profile: Guam (to USA)*. Accessed: October 2015. Retrieved from: http://www.birdlife.org/datazone/country/guam/ibas

_____. 2015b. *Species Factsheet: Todiramphus cinnamominus*. Accessed: October 2015. Retrieved from: http://www.birdlife.org/datazone/species/factsheet/22725862

Coral Reef Alliance. 2014. *Types of Coral Reef Formations.* Accessed: September 2015. Retrieved from: http://coral.org/coral-reefs-101/coral-reef-ecology/types-of-coral-reef-formations/

Cummings, V. 2002. "Sea Turtle Conservation in Guam." In I. Kinan (ed.). *Proceedings of the Western Pacific Sea Turtle Cooperative Research and Management Workshop*. Honolulu, HI: Western Pacific Regional Fishery Management Council. Pp. 37-38.

Eldredge, L.G. 2003. *The Marine Reptiles and Mammals of Guam*. Micronesica, 35-36: 653-660.

Guam DAWR (Guam Division of Aquatic and Wildlife Resources). 2006. *Guam Comprehensive Wildlife Conservation Strategy*. Guam Division of Aquatic and Wildlife Resources. Department of Agriculture, Government of Guam.

GNWR (Guam National Wildlife Refuge). 2009. *Guam National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment.* Accessed: June 2015. Retrieved from: http://www.fws.gov/pacific/planning/main/docs/HI-PI/Guam/GuamDraftCCP%20July%202009.doc.pdf

Kerr, A.M. 2013. *Illustrated Guide to the Reptiles and Amphibians of the Mariana Islands, Micronesia*. University of Guam Marine Laboratory Technical Report 150. Accessed: October 2015. Retrieved from: http://www.guammarinelab.com/publications/uogmltechrep150.pdf

NOAA (National Oceanic and Atmospheric Administration). 2015. *Habitat Focus Area: Guam's Manell-Geus Watershed.* Accessed: June 2015. Retrieved from: http://www.habitat.noaa.gov/habitatblueprint/pdf/hbguam_factsheet.pdf

NOAA-CRIS (National Oceanic and Atmospheric Administration-Coral Reef Information System). 2015. *Guam*. Accessed: July 2015. Retrieved from: http://coris.noaa.gov/portals/guam.html

Randall, R.H. and L.G. Eldredge. 1976. *Atlas of the Reefs and Beaches of Guam*. University of Guam Marine Laboratory. Technical Report 19: 1-191.

Stone, B.C. 1970. *The Flora of Guam*. Micronesica, 6: 1-659.

WERI-IREI (Water and Environmental Research Institute of the Western Pacific – Island Research and Education Initiative). 2015. *Mangroves in Southern Guam.* Accessed: July 2015. Retrieved from: http://south.hydroguam.net/environment-mangroves.php

Wiles, G. 2000. *Recent Records of Reptiles and Amphibians Accidentally Transported to Guam, Mariana Islands*. Division of Aquatic and Wildlife Resources. Micronesica, 32(2): 285-287.

U.S. Bureau of Reclamation. 1985. *Special Report and Environmental Assessment: Potential Water Resources Development, Guam.* Bureau of Reclamation, Guam Study Office. January 1, 1998.

USDA (U.S. Department of Agriculture). 2006. *Guam Comprehensive Wildlife Conservation Strategy (GCWCS)*. Guam Division of Aquatic and Wildlife Resources. Accessed: September 2015. Retrieved from: http://www.usgs.gov/core_science_systems/csas/swap/sgcn/source_documentation/Guam.pdf

_____. 2009. *Bats of the U.S Pacific Islands*. Natural Resources Conservation Service. Technical Note No. 20.

USFWS (U.S. Fish and Wildlife Service). 1992. *Recovery Plan for the Mariana Islands Population of the Vanikoro Swiftlet, Aerodramus vanikorensis bartschi.* Public. Updated: September 3, 2014.

_____. 2011. *Eagle Conservation Plan Guidance Questions and Answers*. Accessed: July 2015. Retrieved from: http://web.archive.org/web/20130722031541/http://www.fws.gov/windenergy/docs/Eagle_Conservation_Plan_Guidance_Q_and_AFINAL.pdf (updated January 2016)

_____. 2012. *Endangered Species in the Pacific Islands*. Pacific Islands Fish and Wildlife Office, Pacific Region. Accessed: September 2015. Retrieved from: http://www.fws.gov/pacificislands/fauna/marianabat.html

_____. 2015. *Service Reopens Public Comment Period on Proposal to Protect 23 Species in Guam and CNMI – News Bulletin.* Honolulu, Hawaii: Pacific Islands Fish and Wildlife Office. January 12, 2015. Accessed: July 2015. Retrieved from: http://www.fws.gov/pacificislands/news%20releases/FINAL%20NR%20Guam%20CNMI%20%20Reopen%20Comment%20Period%20011215.pdf

USGS GAP (U.S. Geological Survey, Gap Analysis Program). 2012. *Protected Areas Database of the United States (PADUS).* Version 1.3 Combined Feature Class. November 2012.

Fisheries and Aquatic Habitats

Anderson, Miles. 2004. *Benthic Habitats of Guam Derived from IKONOS Imagery, 2001-2003*. Version 1.1. Kailua, Hawaii: Analytical Laboratories of Hawaii.

Guam DOA (Department of Agriculture). 2000. *Guam's Marine Preserves Flyer*. Accessed: June 2015. Retrieved from: http://www.marinepreserves.com/files/mpas.pdf

_____. 2015. *Division of Aquatic and Wildlife Resources*. Accessed: August 2015. Retrieved from: http://dawr.guam.gov/guams-water-resources/

GNWR (Guam National Wildlife Refuge). 2009. *Guam National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment*. Accessed: June 2015. Retrieved from: http://www.fws.gov/pacific/planning/main/docs/HI-PI/Guam/GuamDraftCCP%20July%202009.doc.pdf

Joint Guam Program Office. 2010. *Final Environmental Impact Statement, Guam and CNMI Military Relocation: Relocating Marines from Okinawa, Visiting Aircraft Carrier Berthing, and Army Air and Missile Defense Task Force*. Pearl Harbor, Hawaii: Naval Facilities Engineering Command, Pacific.

Liu, Zhanfeng and Lisa Fischer. 2006. *Guam Vegetation Mapping Using Very High Spatial Resolution Imagery*. USDA Forest Service. Accessed: July 13, 2015. Retrieved from: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_046054.pdf

Monterey Bay Aquarium. 2015. *Wild Seafood: Overfishing*. Accessed: June 2015. Retrieved from: http://www.seafoodwatch.org/ocean-issues/wild-seafood/overfishing

NOAA (National Oceanic and Atmospheric Administration). 2006. *NOAA Fisheries Glossary*. NOAA Technical Memorandum NMFS-F/SPO-69. October 2005. Revised Edition, June 2006.

_____. 2007. *Essential Fish Habitat*. Accessed: August 2015. Retrieved from: http://www.fpir.noaa.gov/Library/HCD/EFHfactsheet.pdf

_____. 2011. *NOAA Releases First National Bycatch Report: Establishes Methodology, Baseline for Future Studies*. Accessed: June 2015. Retrieved from: http://www.noaanews.noaa.gov/stories2011/20110922_bycatchreport.html

_____. 2015a. *Fish Watch: U.S. Seafood Facts*. Accessed: May 2015. Retrieved from: http://web.archive.org/web/20150905232600/http://www.fishwatch.gov/wild_seafood/what_is_a_fishery.htm (updated January 2016)

NOAA and USDOI (National Oceanic and Atmospheric Administration and U.S. Department of the Interior). 2014. *U.S. Marine Protected Areas Boundaries: MPA Inventory*. ArcGIS 1.0, Digital Map. 2014 Annual Update. September 10, 2014.

NOAA and SFWR (National Oceanic and Atmospheric Administration and Sport Fish and Wildlife Restoration). 1994. *Species Factsheets*. Accessed: June 2015. Retrieved from: http://dawr.guam.gov/DAWR-F%26W_Fact_Sheet.pdf

Siha, Sesonyan. 1991. *The Wetlands of Guam: A Guidebook for Decision Makers*. Funded by the U.S. Department of Commerce, Office of Ocean and Coastal Resource Management and the Guam Coastal Management Program.

WPRFMC (Western Pacific Regional Fishery Management Council). 2009. *Fishery Ecosystem Plan for the Mariana Archipelago*. Accessed: June 2015. Retrieved from: http://www.wpcouncil.org/fep/WPRFMC%20Mariana%20FEP%20(2009-09-22).pdf

Threatened and Endangered Species and Species of Conservation Concern

Cotter, Krista M. 2005. *Critical Habitat Summary for Mariana Fruit Bat.* Animal Legal & Historical Center, Michigan State University (MSU) College of Law.

GDA (Guam Department of Agriculture). 2006. *Comprehensive Wildlife Conservation Strategy*. Accessed: August 5, 2015. Retrieved from: http://dawr.guam.gov/wp-content/uploads/2013/02/Guam%20DAWR2006CWCSRevised%20copy%202.pdf

_____. 2009. *Endangered Species Regulation Number 9*. Accessed: July 30, 2015. Retrieved from: http://dawr.guam.gov/wp-content/uploads/2013/02/Guam-ES-List-No_90011.pdf

IUCN (International Union for the Conservation of Nature). 2013. *IUCN Red List of Threatened Species Version 2015.2*. Species accounts. Accessed: November 2015. Retrieved from: http://www.iucnredlist.org/

_____. 2015. *IUCN Red List of Threatened Species Version 2015.2*. Species accounts. Accessed: August 2015. Retrieved from: http://www.iucnredlist.org/

NMFS (National Marine Fisheries Service National Oceanic Atmospheric Administration). 2015. *Endangered and Threatened Marine Species under NMFS' Jurisdiction*. Accessed: August 2015. Retrieved from: http://www.nmfs.noaa.gov/pr/species/esa/listed.htm

USFWS 2004. *Endangered and Threatened Wildlife and Plants – Designation of Critical Habitat for the Mariana Fruit Bat and Guam Micronesian Kingfisher on Guam and the Mariana Crow on Guam and in the Commonwealth of the Northern Mariana Islands; Final Rule*). 50 CFR Part 17 RIN 1019-AI25. Accessed: August 4, 2015. Retrieved from: http://ecos.fws.gov/docs/federal_register/fr4349.pdf

_____. 2015a. *Endangered Species Permits: Habitat Conservation Plans (HCPs) and Incidental Take Permits*. Accessed: August 11, 2015. Retrieved from: http://www.fws.gov/midwest/endangered/permits/hcp/index.html

_____. 2015b. *Environmental Conservation System Online: Listed Species Believed or Known to Occur in Guam.* Accessed: July 29, 2015. Retrieved from: http://ecos.fws.gov/tess_public/reports/species-listed-by-state-report?state=GU&status=listed (updated January 2016)

Land Use, Air Space, and Recreation

Bureau of Statistics and Plans (Government of Guam, Bureau of Statistics and Plans). 2009. *North and Central Guam Land Use Plan*. September. (ICF International #00824.08.) Seattle, Washington. Prepared for Bureau of Statistics and Plans—Government of Guam. Accessed: August 25, 2015. Retrieved from: http://bsp3.guam.gov/wp-content/uploads/LUP_2009-09.pdf

Chamorro Land Trust Commission. 2011. *A Report to the Citizens of Guam, Fiscal Year 2011*. Accessed: October 11, 2015. Retrieved from: http://www.opaguam.org/sites/default/files/CLTC_CCR11_0.pdf

Di Gregorio, Antonio and Louisa J. M. Jansen. 1998. *Land Cover Classification System (LCCS): Classification Concepts and User Manual*. Rome: Food and Agriculture Organization of the United Nations.

DOD (U.S. Department of Defense). 2015. *Andersen AFB (Joint Region Marianas), Guam*. Accessed: October 11, 2015. Retrieved from: http://www.militaryinstallations.dod.mil/MOS/f?p=MI:CONTENT:0::::P4_INST_ID,P4_CONTENT_TITLE,P4_CONTENT_EKMT_ID,P4_CONTENT_DIRECTORY:2110,Installation Overview,30.90.30.30.30.0.0.0.0,1

FAA (Federal Aviation Administration). 2014. *Federal Aviation Administration, Air Traffic Organization*. Accessed: June 2015. Retrieved from: http://www.faa.gov/about/office_org/headquarters_offices/ato/

_____. 2015a. *Airport Data & Contact Information*. Last updated August 20, 2015. Accessed: August 25, 2015. Retrieved from: http://www.faa.gov/airports/airport_safety/airportdata_5010/

_____. 2015b. *Enplanements at US Airports in CY 2014, by State*. Last updated August 13 2015. Accessed: August 20, 2015. Retrieved from: http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/cy14-all-enplanements.pdf

_____. 2015c. *Flight Standards District Offices (FSDO)*. Accessed: June 2015. Retrieved from: http://www.faa.gov/about/office_org/field_offices/fsdo/

_____. 2015d. *Obstruction Marking and Lighting, Advisory Circular 70/7460-1L*. December 4, 2015. U.S. Department of Transportation. Accessed: January 6, 2016. Retrieved from: https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.current/documentNumber/70_7460-1 (updated January 2016)

Merriam Webster Dictionary. 2015. *Airspace*. Accessed: June 2015. Retrieved from: http://www.merriam-webster.com/dictionary/airspace

MRLC (Multi Resolution Land Characteristics Consortium). 2014. *National Land Cover Database 2011*. Product Legend. U.S. Geological Survey. Last updated August 26, 2014. Accessed: August 3, 2015. Retrieved from: http://www.mrlc.gov/nlcd11_leg.php

NPS (National Park Service). 2014. *Park Planning.* Accessed: October 7, 2015. Retrieved from: http://www.nps.gov/akso/management/park_planning.cfm

NOAA (National Oceanic and Atmospheric Administration). 2011. *C-CAP FTP Download*. Data for Guam. Accessed: August 5, 2015. Retrieved from: http://coast.noaa.gov/ccapftp/

USAF (U.S. Air Force). 2015. *36th Wing*. Accessed: October 11, 2015. Retrieved from: http://www.andersen.af.mil/library/factsheets/factsheet.asp?id=7113%20

USFWS (U.S. Fish and Wildlife Service). 2009. *Guam National Wildlife Refuge Comprehensive Conservation Plan*. Accessed: October 11, 2015. Retrieved from: http://www.fws.gov/refuge/Guam/what_we_do/planning.html

USGS (U.S. Geological Survey). 2001. *National Land Cover Database*.

_____. 2012a. *Protected Areas Database of the United States (PADUS).* Version 1.3, November 30, 2012.

_____. 2012b. *USGS Land Cover Institute*. December 2012. Accessed: August 2015. Retrieved from: http://landcover.usgs.gov/classes.php/

Visual Resources

BLM (Bureau of Land Management). 1984. *Manual 8400: Visual Resource Management*. Washington, D.C.: Department of the Interior, Bureau of Land Management.

FAA (Federal Aviation Administration). 2015. *Obstruction Marking and Lighting, Advisory Circular 70/7460-1L*. December 4, 2015. U.S. Department of Transportation. Accessed: January 6, 2016. Retrieved from: https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.current/documentNumber/70_7460-1 (updated January 2016)

Guam Visitors Bureau. 2015. *Things to Do.* Accessed: October 7, 2015. Retrieved from: http://www.visitguam.com/things-to-do/

NPS (National Park Service). 1983. *General Management Plan, War in the Pacific National Historical Park*. March 1983.

Sullivan, Robert and Mark Meyer. 2014. *Guide to Evaluating Visual Impact Assessments for Renewable Energy Projects, Natural Resource Report NPS/ARD/NRR—2014/836*. August 2014. Accessed: August 17, 2015. Retrieved from: https://irma.nps.gov/App/Reference/Profile/2214258

USFWS (U.S. Fish and Wildlife Service). 2013. *DRAFT 2013 U.S. Fish and Wildlife Service (USFWS) Revised Guidelines for Communication Tower Design, Siting, Construction, Operation, Retrofitting, and Decommissioning -- Suggestions Based on Previous USFWS Recommendations to FCC Regarding WT Docket No. 03-187, FCC 06-164, Notice of Proposed Rulemaking, "Effects of Communication Towers on Migratory Birds," Docket No. 08-61, FCC's Antenna Structure Registration Program, and Service 2012 Wind Energy Guidelines.* Last updated March 14, 2013.

Socioeconomics

Guam Attorney General. 2015. *What You Should Know About Guam.* Accessed: June 22, 2015. Retrieved from: http://web.archive.org/web/20150523103157/http://www.guamattorneygeneral.com/what-you-should-know-about-guam/ (updated January 2016)

Guam Department of Revenue and Taxation. 2013. *Citizen Centric Report 2013.* Page 3.

GNWR (Guam National Wildlife Refuge). 2009. *Guam National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessmen*t. Accessed: June 2015. Retrieved from: http://www.fws.gov/pacific/planning/main/docs/HI-PI/Guam/GuamDraftCCP%20July%202009.doc.pdf

Hernandez, Maria. 2015. *Indigenous Chamorros Seek Subsistence Fishing Rights in Guam.* Pacific Islands Report. May 5, 2015. Accessed: July 8, 2015. Retrieved from: http://pidp.eastwestcenter.org/pireport/2015/May/05-05-10.htm

Joint Guam Program Office. 2010. *Final Environmental Impact Statement, Guam and CNMI Military Relocation: Relocating Marines from Okinawa, Visiting Aircraft Carrier Berthing, and Army Air and Missile Defense Task Force*. Naval Facilities Engineering Command, Pacific.

U.S. Census Bureau. 2000. *2000 Decennial Census.* Accessed: June 23, 2015. Retrieved from: http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml

_____. 2010. *2010 Decennial Census.* Accessed: June 23, 2015. Retrieved from: http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml

_____. 2015. *Urban and Rural Classification.* Accessed: June 26, 2015. Retrieved from: https://www.census.gov/geo/reference/urban-rural.html

U.S. Department of Labor. 2015. *Labor Force Statistics from the Current Population Survey*. Accessed: October 7, 2015. Retrieved from: http://data.bls.gov/timeseries/LNS14000000

UVA (University of Virginia). 2015. *Projections for the 50 States and D.C.* Weldon Cooper Center for Public Service. Accessed: June 18, 2015. Retrieved from: http://www.coopercenter.org/demographics/national-population-projections

Environmental Justice

Bishaw, Alemayehu. 2014. *Changes in Areas with Concentrated Poverty: 2000 to 2010.* U.S. Census Bureau American Community Survey Report ACS-27, issued June 2014. Accessed: June 7, 2015. Retrieved from: http://www.census.gov/library/publications/2014/acs/acs-27.html

CEQ (Council on Environmental Quality). 1997. *Environmental Justice: Guidance under the National Environmental Policy Act*. Washington, D.C. December 10, 1997.

HUD (U.S. Department of Housing and Urban Development). Undated. *Resources: Glossary of HUD Terms*. Accessed: June 7, 2015. Retrieved from: http://www.huduser.org/portal/glossary/glossary_all.html#m

U.S. Census Bureau. 2010. *2010 Decennial Census*. Accessed: June 18, 2015. Retrieved from: http://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml

_____. 2012. *Geographic Terms and Concepts – Block Groups.* Accessed: June 21, 2015 Retrieved from: https://www.census.gov/geo/reference/gtc/gtc_bg.html

USEPA (U.S. Environmental Protection Agency). 2014. *Policy on Environmental Justice for Working with Federally Recognized Tribes and Indigenous Peoples*. Accessed: June 29, 2015. Retrieved from: http://www.epa.gov/environmentaljustice/resources/policy/indigenous/ej-indigenous-policy.pdf

_____. 2015. *Overview of Demographic Indicators in EJSCREEN.* Accessed: August 11, 2015. Retrieved from: http://www2.epa.gov/ejscreen/overview-demographic-indicators-ejscreen

Cultural Resources

ACHP (Advisory Council on Historic Preservation). 2008. *Consultation with Indian Tribes in the Section 106 Review Process: A Handbook*. Washington D.C.: Government Printing Office. Accessed: September 24, 2015. Retrieved from: http://www.achp.gov/regs-tribes2008.pdf

Bowers, N. 1950. *Problems of Resettlement on Saipan, Tinian, and Rota, Mariana Islands*. Coordinated Investigation of Micronesian Anthropology Report, No. 31. Ann Arbor, Michigan: Pacific Science Research Board and National Research Council.

Driver, M. and O. Brunal-Perry (eds.). 1995. C*arolinians in the Marianas in the 1800*s. Micronesia Area Research Center (MARC), University of Guam.

Bulgrin, L. 2006. *"Fina`okso Antigo" Prehistoric Soil Mounds in the Interior of Rota*. Micronesian Journal of the Humanities and Social Sciences, 5(1/2): 31-41.

Butler, B. 1990. *Pots as Tools: The Marianas Case*. Micronesia Supplement, 2: 33-46.

CMNI DHP (Commonwealth of the Northern Mariana Islands, Division of Historic Preservation). 2011. *Preservation CNMI: Caring for the Past in an Uncertain Future*. CNMI Division of Historic Preservation, Saipan.

Coomans, Fr. P. 1997. *History of the Mission in the Mariana Islands: 1667-1673*. Occasional Historical Papers Series No. 4, Division of Historic Preservation, Saipan.

Denfield, C. 1997. *Hold the Marianas, The Japanese Defense of the Islands*. Shippensburg, PA: White Mane Publishing Company, Inc.

Driver, M. 1993. *Fray Juan Pobre in the Marianas 1602*. MARC Miscellaneous Series No. 8. Micronesian Area Research Center (MARC), University of Guam.

Driver, M. and O. Brunal-Perry (eds.). 1993. *Carolinians in the Marianas in the 1800s*. Micronesian Area Research Center (MARC), University of Guam.

Guam HDR (Guam Historic Resources Division). 2006. *Historic Preservation Review*. Guam Historic Resources Division, Department of Parks and Recreation, Guam.

_____. 2015. *Register Listing - By Village*. Accessed: September 24, 2015. Retrieved from: http://historicguam.org/register.htm

Haun, A.E., J.A. Jimenez, M.A. Kirkendall, and S.T. Goodfellow. 1999. *Archaeological Investigations at Unai Chulu, Island of Tinian, Commonwealth of the Northern Mariana Islands*. Prepared for Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, HI by Paul H. Rosendahl, Ph.D., Inc. Hilo, HI.

Higuchi, W. 2008. *Japan's Industrial Development of a U.S. Territory: Guam, 1941-1944*. Pacific Studies, 31: 55-104.

Kurashina, H. and R. Clayshulte. 1983. S*ite Formation Processes and Cultural Sequence at Tarague, Guam*. Bulletin of the Indo-Pacific Prehistory Association, 4: 114-122.

Morgan, W. 1988. *Prehistoric Architecture in Micronesia*. Austin, Texas: University of Texas Press.

NPS (National Park Service). 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties*. Accessed: September 24, 2015. Retrieved from: http://www.nps.gov/nr/publications/bulletins/nrb38/

Reinman, F. 1977. *An Archaeological Survey and Preliminary Test Excavations on the Island of Guam, Mariana Islands, 1965-1966*. Miscellaneous Publications No.1. Micronesian Area Research Center, University of Guam, Mangilao.

Rogers, R. 1995. *Destiny's Landfall a History of Guam*. Honolulu, Hawaii: University of Hawai`i Press.

Stutts, M. 2014. *National Register of Historic Places*. Geospatial Dataset-2210280. Accessed: September 24, 2015. Retrieved from: https://irma.nps.gov/App/Reference/Profile/2210280/

Tomonari-Tuggle, M.J., H.D. Tuggle, J. Allen, D.J. Welch, and M.T. Carson. 2007. *Archaeological Assessment Study in Support of the Strategic Forward Basing Initiative, Guam and the Commonwealth of the Northern Mariana Islands*. Prepared for Department of the Navy, Naval Facilities Engineering Command, Pacific, Pearl Harbor, HI by International Archaeological Research Institute, Inc. Honolulu, HI.

U.S. Department of the Navy. 2015. *Commonwealth of the Northern Mariana Islands Join Military Training Environmental Impact Statement/Overseas Environmental Impact Statement*. Accessed: September 24, 2015. Retrieved from: http://www.cnmijointmilitarytrainingeis.com/documents

Air Quality

GEPA (Guam Environmental Protection Agency). 2015. *Air Pollution.* Accessed: June 7, 2015. Retrieved from: http://epa.guam.gov/programs/air-pollution/

Guam Office of the Attorney General. 2013. *Legal Memorandum Re: Public Law 30-184; Mobil Oil Guam's Request for Clarification in Re: Transshipping Automotive Diesel Oil Through Guam*. Accessed: June 7, 2015. Retrieved from: http://www.guamag.org/ag_opinion/2013/09-03-13%20GEPA%2013-0622.pdf

USEPA (U.S. Environmental Protection Agency). 2010. *Visibility in Scenic Areas*. Accessed: May 24, 2015. Retrieved from: http://www.epa.gov/airtrends/2010/report/visibility.pdf

_____. 2012a. *Diesel Fuel: Alaska and U.S. Territories*. Accessed: June 6, 1015. Retrieved from: http://www.epa.gov/oms/fuels/dieselfuels/alaska.htm

_____. 2012b. *List of 156 Mandatory Class I Federal Areas*. Accessed: May 24, 2015. Retrieved from: http://www.epa.gov/visibility/class1.html

_____. 2013. *The Clean Air Act in a Nutshell: How It Work*s. Accessed: May 21, 2015. Retrieved from: http://www.epa.gov/air/caa/pdfs/CAA_Nutshell.pdf

_____. 2014a. *National Ambient Air Quality Standards (NAAQS)*. Accessed: May 24, 2015. Retrieved from: http://www3.epa.gov/ttn/naaqs/criteria.html (updated January 2016)

_____. 2014b. *New Source Review: Guam Permit Contacts*. Accessed: June 7, 2015. Retrieved from: http://www.epa.gov/caa-permitting/caa-permitting-epas-pacific-southwest-region (updated January 2016)

_____. 2014c. *New Source Review: Where You Live*. Accessed: June 24, 2015. Retrieved from: http://www.epa.gov/caa-permitting (updated January 2016)

_____. 2015a. *Status of SIP Requirements for Designated Areas*. Accessed: May 24, 2015. Retrieved from: http://www.epa.gov/airquality/urbanair/sipstatus/reports/gu_areabypoll.html

_____. 2015b. *The Green Book Nonattainment Areas for Criteria Pollutants*. Accessed: June 4, 2015. Retrieved from: http://www.epa.gov/airquality/greenbook/index.html

_____. 2015c. *Visibility*. Accessed: September 30, 2015. Retrieved from: http://www3.epa.gov/visibility/index.html

_____. 2015d. *Air Quality Green Book: Sections of the Clean Air Act*. Accessed: October 2015. Retrieved from: http://www3.epa.gov/airquality/greenbook/caa-t1p.html

Noise

Bies, David A. and Colin H. Hansen. 2009. *Engineering Noise Control: Theory and Practice.* 4th Edition. School of Mechanical Engineering, University of Adelaide, South Australia.

Cavanaugh, William J. and Gregory C. Tocci. 1998. *Environmental Noise the Invisible Pollutant*. Accessed: May 9, 2015. Retrieved from: http://www.nonoise.org/library/envarticle/

Yevette Cruz (Guam EPA Deputy Administrator), Personal Communication with Franklin Bourdeau (former ERM Staff Engineer), March 19, 2015.

USEPA (U.S. Environmental Protection Agency). 1974. *Information on Levels of Environmental Noise Requisite to Protect Public Welfare with an Adequate Margin of Safety*. March 1974.

_____. 2012. *Noise Pollution*. Accessed: August 4, 2015. Retrieved from: http://www.epa.gov/air/noise.html

WSDOT (Washington State Department of Transportation). 2015. *Biological Assessment Preparation for Transportation Projects - Advanced Training Manual*. Version 02-2015. February 2015. Accessed: June 2015. Retrieved from: http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#manual

Climate Change

AIA Guam and Micronesia. 2012. *Regional Facts. Guam: Geography and Facts.* A Chapter of the American Institute of Architects. Accessed: June 5, 2015. Retrieved from: http://www.aiaguam.org/regional-facts/

CIA (Central Intelligence Agency). 2006. *The World Factbook: Australia-Oceania--Guam*. Accessed: June 5, 2015. Retrieved from: https://www.cia.gov/library/publications/resources/the-world-factbook/geos/gq.html

IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate Change 2007: Synthesis Report*. Accessed: January 2016. Retrieved from: www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

_____. 2013a. *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Accessed: July 28, 2015. Retrieved from: https://www.ipcc.ch/report/ar5/wg1/

_____. 2013b. *Summary for Policy Makers*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Accessed: July 28, 2015. Retrieved from: https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

Keener, V.W., K. Hamilton, S.K. Izuka, K.E. Kunkel, L.E. Stevens, and L. Sun. 2013. *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 8. Climate of the Pacific Islands*. U.S. NOAA Technical Report NESDIS 142-8. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C. Accessed: July 28, 2015. Retrieved from: http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-8-Climate_of_the_Pacific_Islands.pdf

Keener, V.W., J.J. Marra, M.L. Finucane, D. Spooner, and M.H. Smith (eds.). 2012. *Climate Change and Pacific Islands: Indicators and Impacts*. Report for the 2012 Pacific Islands Regional Climate Assessment. Washington, D.C.: Island Press. Accessed: July 28, 2015. Retrieved from: http://www.pacificrisa.org/projects/pirca

NC State (North Carolina State University). Undated_a. S*tate Climate Office of North Carolina. Pacific Decadal Oscillations (PDO)*. Accessed: June 5, 2015. Retrieved from: https://www.nc-climate.ncsu.edu/climate/patterns/PDO.html

_____. Undated_b. *State Climate Office of North Carolina. Global Patterns - El Niño-Southern Oscillation (ENSO)*. Accessed: June 5, 2015. Retrieved from: https://www.nc-climate.ncsu.edu/climate/patterns/ENSO.html

NOAA (National Oceanic and Atmospheric Administration). 2012. *Comparative Climatic Data For the United States Through 2012*. Asheville, North Carolina: National Environmental Satellite, Data and Information Service – National Climatic Data Center.

_____. 2015. *National Climatic Data Center (NCDC) Storm Events Database for Guam*. Accessed: June 5, 2015. Retrieved from: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=98%2CGUAM

Villaverde, Rudolph. 1995. *Guam's Climate*. Accessed: June 5, 2015. Retrieved from: http://ns.gov.gu/climate.html

USEPA (U.S. Environmental Protection Agency). 2012. *Climate Change Indicators in the United States, 2012*. 2nd Edition. Accessed: January 2016. Retrieved from: http://www.epa.gov/climatechange/pdfs/climateindicators-full-2012.pdf

USGCRP (U.S. Global Change Research Program). 2014. *Climate Change Impacts in the United States: The Third National Climate Assessment*. Accessed: July 23, 2015. Retrieved from: http://nca2014.globalchange.gov/

Human Health and Safety

Booth, Heather. 2010. *The Evolution of Epidemic Suicide in Guam: Context and Contagion.* Suicide Life Threatening Behavior, 40(1):1-13. doi: 10.1521/suli.2010.40.1.1. Accessed: July 2015. Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/20170257

BLS (Bureau of Labor Statistics). 2013a. *Fatal Occupational Injuries in Puerto Rico*. Accessed: July 2015. Retrieved from: http://www.bls.gov/iif/oshwc/cfoi/tgs/2013/iiffw43.htm

_____. 2013b. *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types.* Accessed: July 2015. Retrieved from: http://data.bls.gov/gqt/InitialPage (updated January 2016)

CDC (Centers for Disease Control and Prevention). 2013a. *Deaths: Final Data for 2013*. Accessed: June 2015. Retrieved from: http://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_02.pdf

_____. 2013b. *BRFSS Prevalence and Trends Data*. Accessed: August 2015. Retrieved from: http://www.cdc.gov/brfss/brfssprevalence/

_____. 2014b. *CDC Dengue Homepage*. Accessed: August 2015. Retrieved from: http://www.cdc.gov/dengue/epidemiology/

_____. 2015a. *Suicide: Risk and Protective Factors*. Accessed: July 31, 2015. Retrieved from: http://www.cdc.gov/violenceprevention/suicide/riskprotectivefactors.html

_____. 2015b. *Chikungunya Virus: Geographic Distribution*. Accessed: August 2015. Retrieved from: http://www.cdc.gov/chikungunya/geo/

Guam State Epidemiological Outcomes Workgroup. 2015. *Guam Health Partners*. Fact Sheet. Accessed: July 2015. Retrieved from: http://guamhealthpartners.com/photo_albums/pdfs/prevention_briefsmall.pdf

HEI (Health Effects Institute). 2010. *HEI Panel of the Health Effects of Traffic-Related Air Pollution: Traffic-related Air Pollution: a Critical Review of the Literature on Emissions, Exposure, and Health Effects.* Accessed: June 2015. Retrieved from: http://pubs.healtheffects.org/view.php?id=334

HHS (U.S. Department of Health and Human Services). 2015. *Mental Health and Substance Abuse: Suicide*. Accessed: August 2015. Retrieved from: http://www.hhs.gov/answers/mental-health-substance-abuse/suicide/suicide-contagion.html

Kelly, F.J. and J.C. Fussell. 2011. *Air Pollution and Airway Disease.* Clin. Exp. Allergy, 41(8): 1059-71.

Levy, J.I., S.L. Greco, J.D. Spengler. 2002. *The Importance of Population Susceptibility for Air Pollution Risk Assessment: A Case Study of Power Plants near Washington, DC.* Environmental Health Perspectives, 110(12): 1253-1260.

Marianas Variety. 2013b. *Guam Issues Alert on Fever Outbreak in Yap*. Accessed: August 2015. Retrieved from: http://www.mvariety.com/regional-news/60631-guam-issues-alert-on-fever-outbreak-in-yap

National Drug Intelligence Center. 2003. *Guam Drug Threat Assessment: Methamphetamine*. Accessed: October 2015. Retrieved from: http://www.justice.gov/archive/ndic/pubs4/4001/meth.htm

Nishimura, Katherine K., Joshua M. Galanter, Lindsey A. Roth, Sam S. Oh, Neeta Thakur, Elizabeth A. Nguyen, Shannon Thyne, Harold J. Farber, Denise Serebrisky, Rajesh Kumar, Emerita Brigino-Buenaventura, Adam Davis, Michael A . LeNoir, Kelley Meade, William Rodriguez-Cintron, Pedro C. Avila, Luisa N. Borrell, Kristen Bibbins-Domingo, Jose R. Rodrigues-Santana, Saunak Sen, Fred Lurmann, John R. Balmes, an Esteban G. Burchard. 2013. *Early Life Air Pollution and Asthma Risk in Minority Children: The GALA II and SAGE II Studies*. AJRCCM Article in press.

Office on Women's Health. 2014. *Health Disparities Profiles*. Accessed: July 2015. Retrieved from: http://www.healthstatus2020.com/disparities/ChartBookData_list.asp

O'Neill M.S., A. Veves, A. Zanobetti, J.A. Sarnat, D.R. Gold, P.A. Economides, E.S. Horton, and J. Schwartz. 2005. *Diabetes Enhances Vulnerability to Particulate Air Pollution-associated Impairment in Vascular Reactivity and Endothelial Function*. Circulation, 111(22): 2913-20.

O'Neill, M.S., A. Veves, J.A. Sarnat, A. Zanobetti, D.R. Gold, P.A. Economides, E.S. Horton, and J. Schwartz. 2007. *Air Pollution and Inflammation in Type 2 Diabetes: a Mechanism for Susceptibility*. Occupational and Environmental Medicine, 64(6): 373-9.

OSHA (United States Occupational Safety and Health Administration). 2015. *Safety and Health Topics: Radiofrequency and Microwave Radiation*. Accessed: July 2015. Retrieved from: https://www.osha.gov/SLTC/radiofrequencyradiation/standards.html

Patel, M.M. and R.L. Miller. 2009. *Air Pollution and Childhood Asthma: Current Advances and Future Directions*. Current Opinion in Pediatrics, 21(2): 235-42.

Peace Guam. 2015a. *One Nation: Alcohol-free*. Accessed: July 2015. Retrieved from: http://www.peaceguam.org/Underage_Drinking/OneNation.htm

_____. 2015b. *Suicide Prevention*. Accessed: July 2015. Retrieved from: http://www.peaceguam.org/Prevention/suicide_prevention.htm

Sarnat, Jeremy A. and Fernando Holguin. 2007. *Asthma and Air Quality*. Current Opinion in Pulmonary Medicine, 13(1): 66-63.

USEPA (U.S. Environmental Protection Agency). 2009. *Integrated Science Assessment for Particulate Matter*. EPA National Center for Environmental Assessment, Office of Research and Development. EPA/R-08/139B.

_____. 2013a. *Resource Conservation and Recovery Act (RCRA)*. Accessed July 2015. Retrieved from: http://www.epa.gov/agriculture/lrca.html

_____. 2013b. *Superfund*. Accessed: July 2015. Retrieved from: http://cumulis.epa.gov/supercpad/Cursites/srchsites.cfm (updated January 2016)

_____. 2013c. *TRI Analysis: State – Guam*. Accessed: July 2015. Retrieved from: http://iaspub.epa.gov/triexplorer/tri_factsheet.factsheet_forstate?&pstate=GU&pyear=2013&pDataSet=TRIQ1

_____. 2015a. *Emergency Planning and Community Right-to-know Act*. Accessed: July 2015. Retrieved from: http://www2.epa.gov/epcra

_____. 2015b. *Summary of the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)*. Accessed: July 2015. Retrieved from: http://www2.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act

_____. 2015c. *Toxic Substances Control Act (TSCA)*. Accessed: July 2015. Retrieved from: http://www.epa.gov/oppt/tsca8e/

_____. 2015d. *What is EPCRA?* Accessed: July 2015. Retrieved from: http://www.epa.gov/oppt/tsca8e/

World Bank. 2013. *Mortality Rate, Under-5 (per 1,000 live births)*. Accessed: July 2015. Retrieved from: http://data.worldbank.org/indicator/SH.DYN.MORT

WHO (World Health Organization). 2011. *Guam Country Profile*. Accessed: August 2015. Retrieved from: http://www.wpro.who.int/countries/gum/9GUMpro2011_finaldraft.pdf?ua=1

6.3.3. Environmental Consequences

Infrastructure

GlobalSecurity.org. 2015. *Guam Army National Guard*. Accessed: August 4, 2015. Retrieved from: http://www.globalsecurity.org/

Dumat-ol Daleno, Gaynor. 2015. *Local International Experts on Undersea Cable Discuss Importance of Redundant Systems, Security*. Pacific Daily News (Guam). July 11, 2015. Accessed: October 2, 2015. Retrieved from: http://www.guampdn.com/story/news/2015/07/10/undersea-cable-break-offers-lessons-guam-world/29950811/

Paul Budde Communication. 2015. *Guam - Telecoms, Mobile and Broadband - Market Insights and Statistics*. Accessed: September 11, 2015. Retrieved from: http://www.budde.com.au/Research/Guam-Telecoms-Mobile-and-Broadband-Market-Insights-and-Statistics.html?r=51

USDOC & USDHS (U.S. Department of Commerce and U.S. Department of Homeland Security). 2008. *Public Safety Interoperable Communications Grant Program.* November 2008.

Geology

EIA (U.S. Energy Information Administration). 2015. *Guam Territory Profile and Energy Estimates*. Accessed: September 4, 2015. Retrieved from: http://www.eia.gov/state/analysis.cfm?sid=GQ

Mueller, Charles S., Kathleen M. Haller, Nicholas Luco, Mark D. Petersen, and Arthur D. Frankel. 2012. *Seismic Hazard Assessment for Guam and the Northern Mariana Islands*. USGS Open-File Report 2012-1015. Accessed: September 21, 2015. Retrieved from: http://pubs.usgs.gov/of/2012/1015/

USGS (U.S. Geological Survey). 2015. *2010-2011 Minerals Yearbook: Puerto Rico Advance Release*. The Mineral Industry of Puerto Rico and the Administered Islands. Accessed: September 11, 2015. Retrieved from: http://minerals.usgs.gov/minerals/pubs/state/2010_11/myb2-2010_11-pr.pdf

Water Resources

USDA Geospatial Data Gateway (U.S. Department of Agriculture Geospatial Data Gateway). 2015. *Watershed Boundary Dataset*. Accessed: June 2015. Retrieved from: http://nhd.usgs.gov/data.html

USGS and NRCS (U.S. Geological Survey and Natural Resources Conservation Service). 2013. *Federal Standards and Procedures for the National Watershed Boundary Dataset (WBD) (4 ed.): U.S. Geological Survey Techniques and Methods 11–A3*. 63 pp. Accessed: September 2015. Retrieved from: http://pubs.usgs.gov/tm/tm11a3/

Wetlands

GCMP (Guam Coastal Management Program). 2008. *Guam Coastal and Estuarine Land Conservation Program (CELCP) Plan*. April 30, 2008. Accessed: September 2015. Retrieved from: https://coast.noaa.gov/czm/landconservation/media/celcpplangudraft.pdf (updated January 2016)

Government of Guam. 1978. *Executive Order No. 78-21: Protection of Wetlands*. Office of the Governor. September 7, 1978. Accessed: September 2015. Retrieved from: http://documents.guam.gov/wp-content/uploads/E.O.-78-21-Protection-of-Wetlands.pdf

Siha, S. 1991. *The Wetlands of Guam: A Guidebook for Decision Makers*. Funded by the U.S. Department of Commerce, Office of Ocean and Coastal Resource Management and the Guam Coastal Management Program.

USACE (U.S. Army Corps of Engineers). 2014. *Ratios for Compensatory Mitigation*. May 4, 2014. Accessed: August 2015. Retrieved from: http://www.poa.usace.army.mil/Portals/34/docs/regulatory/HOWWetlandCategoriesRatios.pdf

USFWS (U.S. Fish and Wildlife Service). 2015. *National Wetlands Inventory, Wetland Mapper.* Accessed: April 2015. Retrieved from: http://www.fws.gov/wetlands/data/mapper.HTML

USGS (U.S. Geological Survey). 1997. *Restoration, Creation, and Recovery of Wetlands: Wetland Functions, Values, and Assessment*. National Water Summary on Wetland Resources USGS Water Supply Paper 2425. Accessed: April 2015. Retrieved from: https://water.usgs.gov/nwsum/WSP2425/functions.html

USGS and NRCS (U.S. Geological Survey and Natural Resources Conservation Service). 2013. *Federal Standards and Procedures for the National Watershed Boundary Dataset (WBD) (4 ed.): U.S. Geological Survey Techniques and Methods 11–A3*. 63 p. Accessed: September 2015. Retrieved from: http://pubs.usgs.gov/tm/tm11a3/

Biological Resources

Terrestrial Vegetation

Guam DOA DAWR (Guam Department of Agriculture Division of Aquatic and Wildlife Resources). 2015. *Guam Draft Comprehensive Wildlife Management Strategy.* January 20, 2015. Accessed: June 11, 2015. Retrieved from: http://dawr.guam.gov/wp-content/uploads/2015/02/Guam-State-Wildlife-Action-Plan-2015.pdf

USFS (U.S. Forest Service). Undated. *Invasive Plants*. Accessed: September 4, 2015. Retrieved from: http://www.fs.fed.us/wildflowers/invasives/

Wildlife

Amesbury, S. 2007. *National Wildlife Rehabilitation Conference Proceedings 2007: Wildlife Friendly Fencing*. Accessed: September 2015. Retrieved from: http://www.awrc.org.au/uploads/5/8/6/6/5866843/amesbury_steve_fencing.pdf

Bell, D.V. and L.W. Austin. 1985. *The Game-Fishing Season and Its Effects on Overwintering Wildfowl*. Biological Conservation, 33: 65-80.

Buden, D.W. 2000. *A Comparison of 1983 and 1994 Bird Surveys of Pohnpei, Federated States of Micronesia*. Wilson Bulletin, 112: 403-410.

Burger, J. 1986. *The Effect of Human Activity on Shorebirds in Two Coastal Bays in North Eastern United States*. Environmental Conservation, 13: I23-DO.

_____. 1988. *Effects of Demolition and Beach Clean-Up Operations on Birds on a Coastal Mudflat in New Jersey, USA*. Estuarine, Coastal and Shelf Science, 27: 95-108.

Ceballos, G. and J. H. Brown. 1995. *Global Patterns of Mammalian Diversity, Endemism, and Endangerment*. Conservation Biology, 9(3): 559–568. June 1995.

Cryer, M., N.W. Linley, R.M. Ward, J.O. Stratford, and P.F. Anderson. 1987. *Disturbance of Overwintering Wildfowl by Anglers at Two Reservoir Sites in South Wales*. Bird Study, 34: 191-199.

Gannon, M.R., A. Kurta , A. Rodríguez-Durán, and M.R. Willig. 2005. *Bats of Puerto Rico—an Island Focus and Caribbean Perspective*. Lubbock, Texas: Texas Tech University Press. 239 pp.

Guam DAWR (Department of Agriculture Division of Aquatic and Wildife Resources). 2015. *Guam Draft Comprehensive Wildlife Management Strategy*. January 20, 2015.

Hockin, D., M. Ounsted, M. Gorman, D. Hill, V. Keller, and M.A. Barker. 1992. *Examination of the Effects of Disturbance on Birds with Reference to its Importance in Ecological Assessments.* Journal of Environmental Management, 36: 253-286.

Korschgen, C.E., L.S. George, and W.L. Green. 1985. *Disturbance of Diving Ducks by Boaters on a Migrational Staging Area*. Wildlife Society Bulletin, 13: 290-296.

Lardner, B., R.N. Reed, A.A. Yackel-Adams, M.J. Mazurek, T.J. Hinkle, P.M. Levasseur, M.S. Palmer, and J.A. Savidge. 2013. *Selective Predation by Feral Cats on a Native Skink on Guam.* International Reptile Conservation Foundation (IRCF) Reptiles and Amphibians, 20(1): 16-19. March 2013.

Lusseau, David and Lars Bejder. 2007. *The Long-Term Consequences of Short-Term Responses to Disturbance Experiences from Whale Watching Impact Assessment*. International Journal of Comparative Psychology, 20: 228-236.

Major, H.L., I.L. Jones, M.R. Charette, and A.W. Diamond. 2006. *Variations in the Diet of Introduced Norway Rats (Rattus norvegicus) Inferred Using Stable Isotope Analysis*. Journal of Zoology, 271: 463-468.

Moors, P.J. and I.A.E. Atkinson. 1984. *Predation on Seabirds by Introduced Animals, and Factors Affecting Its Severity.* ICBP Technical Publication No. 2: 667-690.

NRCS (Natural Resource Conservation Service). 2009. *Bats of the U.S. Pacific Islands*. Biology Technical Note No. 20. United States Department of Agriculture, Natural Resources Conservation Service, Pacific Islands Area. Accessed: June 2015. Retrieved from: http://www.ctahr.hawaii.edu/sustainag/Downloads/HI-NRCS-bats-20.pdf

NZDC (New Zealand Department of Conservation). 2007. *Whales in the South Pacific*. Wellington, New Zealand: Department of Conservation. April 2007. Accessed: July 2015. Retrieved from: http://www.doc.govt.nz/documents/conservation/native-animals/marine-mammals/whales-in-the-south-pacific.pdf

Nytch, C.J., W.C. Hunter, F. Núñez-García, C. Fury, M. Quiñones. 2015. *Avian Conservation Planning Priorities for Puerto Rico and the U. S. Virgin Islands (BCR 69)*. U.S. Fish and Wildlife Service, Atlantic Coast Joint Venture, Caribbean Landscape Conservation Cooperative. February 2015.

Oceanic Society. 2015. *Sea Turtle Migration*. Accessed: July 2015. Retrieved from: http://www.seeturtles.org/sea-turtle-migration/

Parsons, E.C.M. 2012. *The Negative Impacts of Whale-watching*. Journal of Marine Biology, 2012. Article ID 807294. 9 pp.

PWNET (Prince William Network). 2015. *Shorebird Migration Flyways*. Accessed: July 2015. Retrieved from: http://migration.pwnet.org/pdf/Flyways.pdf

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise*. San Diego, CA: Academic Press.

Reeder, D.M. and K.M. Kramer. 2005. *Stress in Free-ranging Mammals: Integrating Physiology, Ecology, and Natural History*. Journal of Mammalogy, 86(2): 225-235.

ScienceNordic. 2012. *Iguana Faeces Reveal Stress*. Accessed: September 2015. Retrieved from: http://sciencenordic.com/iguana-faeces-reveal-stress

Semlitsch, R.D. 2000. *Principles for Management of Aquatic-breeding Amphibians.* J. Wildl. Manage., 64(3).

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, P.L. Tyack. 2007. *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendation*. Aquatic Mammals, 33: 411–521.

Tuite, C.H., M. Owen, and D. Paynter. 1983. *Interaction Between Wildfowl and Recreation at Llangorse Lake and Talybont Reservoir, South Wales*. Wildfowl, 34: 48-63.

USDA (U.S. Department of Agriculture). 2015. *National Invasive Species Information Center: Brown Tree Snake*. Accessed: September 2015. Retrieved from: http://www.invasivespeciesinfo.gov/animals/bts.shtml

USEPA (U.S. Environmental Protection Agency). 2015. *Vernal Pools*. Accessed: October 2015. Retrieved from: http://water.epa.gov/type/wetlands/vernal.cfm

USFWS (U.S. Fish and Wildlife Service). 2012. *Frequently Asked Questions About Invasive Species: What Are Invasive Species*? Accessed: July 2015. Retrieved from: http://www.fws.gov/invasives/faq.html#q1

_____. 2015. *Service Reopens Public Comment Period on Proposal to Protect 23 Species in Guam and CNMI – News Bulletin*. Honolulu, Hawaii: Pacific Islands Fish and Wildlife Office. January 12, 2015. Accessed: July 2015. Retrieved from: http://www.fws.gov/pacificislands/news%20releases/FINAL%20NR%20Guam%20CNMI%20%20Reopen%20Comment%20Period%20011215.pdf

Fisheries and Aquatic Habitats

Burdick, David, Valerie Brown, Jacob Asher, Mike Gawel, Lee Goldman, Amy Hall, Jean Kenyon, Trina Leberer, Emily Lundblad, Jenny McIlwain, Joyce Miller, Dwayne Minton, Marc Nadon, Nick Pioppi, Laurie Raymundo, Benjamin Richards, Robert Schroeder, Peter Schupp, Ellen Smith, and Brian Zgliczynski. 2008. *The State of Coral Reef Ecosystems of Guam.* Accessed: July 8, 2015. Retrieved from: http://coastalscience.noaa.gov/research/dohttp://ccma.nos.noaa.gov/ecosystems/coralreef/coral2008/pdf/Guam.pdfcs/CoralReport2008.pdf (updated January 2016)

Codarin, A., L.E. Wysocki, F. Ladich, and M. Picciulin. 2009. *Effects of Ambient and Boat Noise on Hearing and Communication in Three Fish Species Living in a Marine Protected Area (Miramare, Italy)*. Accessed: September 2015. Retrieved from: http://homepage.univie.ac.at/friedrich.ladich/Codarin%20et%20al.,%202009%20in%20press.pdf

Dahl, P.H., J.H. Miller, D.H. Cato, and R.K. Andrew. 2007. *Underwater Ambient Noise*. Acoustics Today, 3(1): 23-24.

DAWR (Division of Aquatic and Wildlife Resources). 2000. *Marine Protected Areas (MPAs)*. Department of Agriculture. Accessed: September 2015. Retrieved from: http://dawr.guam.gov/fishing-rules-regulations/go/

Ladich, F. and R.R. Fay. 2013. *Auditory Evoked Potential Audiometry in Fish*. Rev. Fish. Biol. Fisheries, 23: 317–364.

Liu, Zhanfeng and Lisa Fischer. 2006. *Guam Vegetation Mapping Using Very High Spatial Resolution Imagery*. USDA Forest Service. Accessed: July 13, 2015. Retrieved from: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_046054.pdf

Nico, L.G. and S.J. Walsh. 2011. *Non-Indigenous Freshwater Fishes on Tropical Pacific Islands: A Review of Eradication Efforts*. In C.R. Veitch, M.N. Clout, and D.R. Towns (eds.). *Island Invasive: Eradication and Management*. Rome: IUCN.

NOAA (National Oceanic and Atmospheric Administration). 2006. *Fisheries Glossary*. U.S. Department of Commerce. Accessed: August 8, 2015. Retrieved from: https://www.st.nmfs.noaa.gov/st4/documents/FishGlossary.pdf

_____. 2007. *Magnuson-Stevens Fishery Conservation and Management Act, as Amended Through January 12, 2007*. Accessed October 2015. Retrieved from: http://www.fisheries.noaa.gov/sfa/laws_policies/msa/documents/msa_amended_2007.pdf

_____. 2008. *Impacts to Marine Fisheries Habitat from Nonfishing Activities in the Northeastern United States*. NOAA Technical Memorandum. Accessed: July 13, 2015. Retrieved from: http://www.fpir.noaa.gov/Library/HCD/NOAA%20Technical%20Memo%20NMFS-NE-209.pdf

_____. 2011. *What We Know About Plastic Marine Debris*. NOAA Marine Debris Program. Accessed: August 6, 2015. Retrieved from: http://marinedebris.noaa.gov/sites/default/files/Gen_Plastic-hi_9-20-11_1.pdf

_____. 2015. *Coral Reefs Conservation Program–Fisheries Values.* Accessed: October 5, 2015. Retrieved from: http://coralreef.noaa.gov/aboutcorals/values/fisheries/#g

Pacific Fishery Management Council. 2015. *Regulations for International HMS Fisheries and Related Activities in the Pacific.* Accessed: July 13, 2015. Retrieved from: http://www.pcouncil.org/highly-migratory-species/stock-assessment-and-fishery-evaluation-safe-documents/current-hms-safe-document/regulations-for-international-hms-fisheries-and-related-activities-in-the-pacific/

Popper, Arthur N. and Mardi C. Hastings. 2009. *The Effects of Human-generated Sound on Fish.* Integrative Zoology, 4: 43-52.

Porter, Val, Trina Leberer, Mike Gawel, Jay Gutierrez, David Burdick, Victor Torres, and Evangeline Lujan. 2005. *Status of the Coral Reef Ecosystems of Guam*. NOAA Technical Memorandum. Accessed: July 13, 2015. Retrieved from: http://www.guammarinelab.com/publications/uogmltechrep113.pdf

Rogers, Caroline. 1990. *Responses of Coral Reefs and Reef Organisms to Sedimentation*. Marine Ecology Progress Series, 62: 185-202.

Thrush S.F., J.E. Hewitt, V.J. Cummings, J.I. Ellis, C. Hatton, A. Lohrer, and A. Norkko. 2004. *Muddy Waters: Elevating Sediment Input to Coastal and Estuarine Habitats*. Front. Ecol. Environ., 2(6): 299-306.

University of Maryland. 2000. *Anthropogenic Noise in the Marine Environment*. Conservation and Development Problem Solving Team Graduate Program in Sustainable Development and Conservation Biology, University of Maryland, College Park. Prepared for the National Oceanic and Atmospheric Administration and the Marine Conservation Biology Institute. December 5, 2000. Accessed: October 7, 2015. Retrieved from: http://sanctuaries.noaa.gov/management/pdfs/anthro_noise.pdf

USDOT (U.S. Department of Transportation). 2011. *Construction Noise Handbook.* Federal Highway Administration. Accessed: 7 July 7, 2015. Retrieved from: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook03.cfm

USEPA (U.S. Environmental Protection Agency). 2007. *Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites*. U.S. Environmental Protection Agency. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/npdes/pubs/sw_swppp_guide.pdf

USFWS (U.S. Fish & Wildlife Service). 2012. *Frequently Asked Question About Invasive Species*. Pacific Islands Fish and Wildlife Office. Accessed: July 13, 2015. Retrieved from: http://www.fws.gov/invasives/faq.html

USGS (U.S. Geological Survey). 2014. *Water Properties and Measurements*. Accessed: July 13, 2015. Retrieved from: http://water.usgs.gov/edu/characteristics.html

Vandenberg, Laura N., Claire Stevenson, and Michael Levin. 2012. *Low Frequency Vibrations Induce Malformations in Two Aquatic Species in a Frequency-, Waveform-, and Direction-Specific Manner*. PLoS ONE, 7(12): e51473. doi:10.1371/journal.pone.0051473.

VanDerwalker, John. 1964. *Studies of the Response of Fish to Low Frequency Vibrations*. Fish Passage Research Program. Seattle, Washington: U.S. Bureau of Commercial Fisheries. September 1964.

Western Pacific Regional Fishery Management Council. Undated_a. *Important Pelagic Fishes of the Pacific*. Accessed: July 8, 2015. Retrieved from: http://www.wpcouncil.org/documents/pelagics.pdf

_____. Undated_b. *Essential Fish Habitat*. Accessed: July 8, 2015. Retrieved from: http://wpcouncil.org/outreach/EFH2.pdf

Threatened and Endangered Species and Species of Conservation Concern

American Cetacean Society. 2015. *Species Fact Sheets*. Accessed: September 2015. Retrieved from: http://acsonline.org/education/fact-sheets/

APLIC (Avian Power Line Interaction Committee). 2012. *Reducing Avian Collisions with Power Lines: The State of the Art in 2012.* Washington, D.C.: Edison Electric Institute and APLIC.

Bat Conservation Trust. 2015. *Bat Roosts*. Accessed: September 2015. Retrieved from: http://www.bats.org.uk/pages/bat_roosts.html

Baum, J., S. Clarke, A. Domingo, M. Ducrocq, A.F. Lamónaca, N. Gaibor, R. Graham, S. Jorgensen, J.E. Kotas, E. Medina, J. Martinez-Ortiz, J. Monzini Taccone di Sitizano, M.R. Morales, S.S. Navarro, J.C. Pérez-Jiménez, C. Ruiz, W. Smith, S.V. Valenti, and C.M. Vooren. 2007. *Sphyrna lewini*. The IUCN Red List of Threatened Species 2007. Accessed: September 2015. Retrieved from: http://www.iucnredlist.org/details/39385/0

Berta, A., J.L. Sumich, and K.M. Kovacs. 2015. *Marine Mammals, Third Edition: Evolutionary Biology*. Academic Press. 3rd Edition.

Brown, W. M., R. C. Drewien, and E. G. Bizeau. 1987. *Mortality of Cranes and Waterfowl from Powerline Collisions in the San Luis Valley, Colorado*. J.C. Lewis (ed.). Proc. 1985 Crane Workshop, Grand Island, Nebraska. Pp128-136.

Chapuis, L. 2015. *Perspective: Is Human Noise Pollution Affecting our Sharks? ScienceNetwork Western Australia*. Accessed: September 2015. Retrieved from: http://www.sciencewa.net.au/topics/perspectives/item/3728-is-human-noise-pollution-affecting-our-sharks/3728-is-human-noise-pollution-affecting-our-sharks

Erftemeijer, P.L., B. Riegl, B Hoeksema, and P. Todd. 2012. *Environmental Impacts of Dredging and Other Sediment Disturbances on Corals: A Review*. Marine Pollution Bulletin, 64: 1737-1765.

GDA (Guam Department of Agriculture). 2006. *Comprehensive Wildlife Conservation Strategy*. Accessed: August 5, 2015. Retrieved from: http://dawr.guam.gov/wp-content/uploads/2013/02/Guam%20DAWR2006CWCSRevised%20copy%202.pdf

_____. 2009. *Endangered Species Regulation Number 9*. Accessed: July 30, 2015. Retrieved from: http://dawr.guam.gov/wp-content/uploads/2013/02/Guam-ES-List-No_90011.pdf

IUCN (International Union for Conservation of Nature). 2015. *IUCN Red List Species Profiles*. Accessed: September 2015. Retrieved from: www.iucnredlist.org

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. C*ollisions Between Ships and Whales*. Marine Mammal Science, 17(1): 35–75.

Marsh, H., H. Penrose, C. Eros, and J. Hugues. 2002. *Dugong Status Report and Action Plans for Countries and Territories*. United National Environmental Program Early Warning and Assessment Report Series.

NMFS (National Marine Fisheries Service National Oceanic Atmospheric Administration). 2015. *Endangered and Threatened Marine Species under NMFS' Jurisdiction*. Accessed: August 2015. Retrieved from: http://www.nmfs.noaa.gov/pr/species/esa/listed.htm

Rodda, G.H. and J.A. Savidge. 2007. *Biology and Impacts of Pacific Island Invasive Species* Boiga irregularis*, the Brown Tree Snake (Reptilia: Colubridae)*. Pacific Science, 61: 307–324.

Sea Turtle Conservancy. 2015. *Information about Sea Turtles: Threats from Artificial Lighting*. Accessed: September 2015. Retrieved from: http://www.conserveturtles.org/seaturtleinformation.php?page=lighting

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendation*. Aquatic Mammals, 33: 411–521.

USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.* March 1998. Accessed: September 2015. Retrieved from: https://www.fws.gov/ENDANGERED/esa-library/pdf/esa_section7_handbook.pdf

USFWS (U.S. Fish and Wildlife Service). 2004. *Endangered and Threatened Wildlife and Plants – Designation of Critical Habitat for the Mariana Fruit Bat and Guam Micronesian Kingfisher on Guam and the Mariana Crow on Guam and in the Commonwealth of the Northern Mariana Islands; Final Rule*. 50 CFR Part 17 RIN 1019-AI25. Accessed: September 2015. Retrieved from: http://ecos.fws.gov/docs/federal_register/fr4349.pdf

_____. 2015. *Environmental Conservation System Online: Listed Species Believed or Known to Occur in Guam*. Accessed: August 2015. Retrieved from: http://ecos.fws.gov/tess_public/reports/species-listed-by-state-report?state=GU&status=listed (updated January 2016)

Visual Resources

Bond, Sandy, Sally Sims, and Peter Dent. 2013. *Towers, Turbines and Transmission Lines: Impacts on Property Value*. Chichester, West Sussex, U.K.: Wiley-Blackwell.

FAA (Federal Aviation Administration). 2015. *Obstruction Marking and Lighting, Advisory Circular 70/7460-1L*. December 4, 2015. U.S. Department of Transportation. Accessed: January 6, 2016. Retrieved from: https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.current/documentNumber/70_7460-1 (updated January 2016)

Socioeconomics

Bond, Sandy, Sally Sims, and Peter Dent. 2013. *Towers, Turbines and Transmission Lines: Impacts on Property Value*. Chichester, West Sussex, U.K.: Wiley-Blackwell.

Government of Guam (Government of Guam Bureau of Statistics and Plans). 2009. *Draft North and Central Guam Land Use Plan*. Accessed: October 5, 2015. Retrieved from: http://www.spc.int/lrd/land-use-management-publications/doc_details/1087-draft-north-and-central-guam-land-use-plan-2009?tmpl=component

Maloney, Wayne. 2010. *Job Creation and Labor Training Discussed at Guam Jobs Forum*. Accessed: October 5, 2015. Retrieved from: http://www.fsa.usda.gov/FSA/newsReleases?mystate=hi&area=stnewsroom&subject=stnr&topic=landing&newstype=stnewsrel&type=detail&item=stnr_hi_20100127_rel_021.html

Cultural Resources

ACHP (Advisory Council on Historic Preservation). 2008. C*onsultation with Indian Tribes in the Section 106 Review Process: A Handbook*. Washington D.C.: Government Printing Office. Accessed: September 24, 2015. Retrieved from: http://www.achp.gov/regs-tribes2008.pdf

Higgitt, Catherine. 2010. *Vibration Recommendation*. Prepared by the Department of Conservation and Scientific Research, British Museum. London, U.K.

Jones & Stokes. 2004. *Transportation- and Construction-Induced Vibration Guidance Manual*. June. (J&S 02-039). Sacramento, CA: California Department of Transportation, Noise, Vibration, and Hazardous Waste Management Office.

NPS (National Park Service). 1983. *Archeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines [As Amended and Annotated]*. Accessed: September 24, 2015. Retrieved from: http://www.nps.gov/history/local-law/arch_stnds_0.htm

_____. 1998. *National Register Bulletin: Guidelines for Evaluating and Documenting Traditional Cultural Properties*. Accessed: September 24, 2015. Retrieved from: http://www.nps.gov/nr/publications/bulletins/nrb38/

_____. 2002. *National Register Bulletin: How to Apply the National Register Criteria for Evaluation*. Accessed: September 24, 2015. Retrieved from: http://www.nps.gov/nr/publications/bulletins/nrb15/

Air Quality

CARB (California Air Resources Board). 2008. *Policy: CARB Emission Factors for CI Diesel Engines – Percent HC in Relation to NMHC + NOx*. Electronic Memorandum. Accessed: July 8, 2015. Retrieved from: http://www.baaqmd.gov/~/media/Files/Engineering/policy_and_procedures/Engines/EmissionFactorsforDieselEngines.ashx

Caterpillar. 2006. *Understanding Tractor-Trailer Performance.* Electronic Report. Accessed: July 8, 2015. Retrieved from: http://web.archive.org/web/20151002084619/http://pdf.cat.com/cda/files/2222280/7/LEGT6380.pdf (updated January 2016)

USEPA (U.S. Environmental Protection Agency). 1996. *AP-42: Compilation of Air Pollutant Emission Factors*. Section 3.3: Gasoline and Diesel Industrial Engines. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/ttn/chief/ap42/ch03/final/c03s03.pdf

_____. 1998. *AP-42: Compilation of Air Pollutant Emission Factors*. Section 11.9: Western Surface Coal Mining. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf

_____. 2006. *AP-42: Compilation of Air Pollutant Emission Factors*. Section 13.2.4: Aggregate Handling and Storage Piles. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0204.pdf

_____. 2010a. *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/OMS/models/nonrdmdl/nonrdmdl2010/420r10018.pdf

_____. 2010b. *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/oms/models/nonrdmdl/nonrdmdl2010/420r10016.pdf

Noise

Goodyear Blimp. 2015. *Current Blimps*. Assessed: November 17, 2015. Retrieved from: http://www.goodyearblimp.com/behind-the-scenes/current-blimps.html

Hodgson, Amanda, Natalie Kelly, David Peel. 2013. *Unmanned Aerial Vehicles (UAVs) for Surveying Marine Fauna: A Dugong Case Study.* PLOS ONE, 8(11): e79556. November 4, 2014.

Purdue University. 2015. *Noise Sources and Their Effects*. Assessed: November 17, 2015. Retrieved from: https://www.chem.purdue.edu/chemsafety/Training/PPETrain/dblevels.htm

WSDOT (Washington State Department of Transportation). 2015. *Biological Assessment Preparation for Transportation Projects - Advanced Training Manual*. Version 02-2015. February 2015. Accessed: June 2015. Retrieved from: http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm#manual

Climate Change

Caterpillar. 2006. *Understanding Tractor-Trailer Performance.* Electronic Report. Accessed: July 8, 2015. Retrieved from: http://web.archive.org/web/20151002084619/http://pdf.cat.com/cda/files/2222280/7/LEGT6380.pdf (updated January 2016)

Climate Registry. 2015. *Climate Registry Default Emission Factors*. Accessed: August 28, 2015. Retrieved from: http://www.theclimateregistry.org/wp-content/uploads/2015/04/2015-TCR-Default-EF-April-2015-FINAL.pdf

CEQ (Council on Environment Quality). 2014. *Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts*. Accessed: August 31, 2015. Retrieved from: https://www.whitehouse.gov/sites/default/files/docs/nepa_revised_draft_ghg_guidance_searchable.pdf

Hunter, John. 2012. *A Simple Technique for Estimating an Allowance for Uncertain Sea-level Rise.* Climate Change, 113: 239-252.

IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Accessed: August 28, 2015. Retrieved from: https://www.ipcc.ch/report/ar4/wg1/

_____. 2013. *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Accessed: July 28, 2015. Retrieved from: https://www.ipcc.ch/report/ar5/wg1/

_____. 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Accessed: October 12, 2015. Retrieved from: http://ipcc-wg2.gov/AR5/

Keener, V.W., K. Hamilton, S.K. Izuka, K.E. Kunkel, L.E. Stevens, and L. Sun. 2013. *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 8. Climate of the Pacific Islands.* U.S. NOAA Technical Report NESDIS 142-8. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data and Information Service, Washington, D.C. Accessed: July 28, 2015. Retrieved from: http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-8-Climate_of_the_Pacific_Islands.pdf

Keener, V.W., J.J. Marra, M.L. Finucane, D. Spooner, and M.H. Smith (eds.). 2012. *Climate Change and Pacific Islands: Indicators and Impacts*. Report for the 2012 Pacific Islands Regional Climate Assessment. Washington, D.C.: Island Press. Accessed: July 28, 2015. Retrieved from: http://www.pacificrisa.org/projects/pirca/

Morin, Cory W. and C. Andrew Comrie. 2013. *Climate and Dengue Transmission: Evidence and Implications*. Environ. Health Perspect, 121: 1264-1272. Accessed: October 12, 2015. Retrieved from: http://ehp.niehs.nih.gov/1306556/#tab2

Parris, Adam, Peter Bromirski, Virginia Burkett, Dan Cayan, Mary Culver, John Hall, Radley Horton, Kevin Knuuti, Richard Moss, Jayantha Obeysekera, Abby Sallenger, and Jermey Weiss. 2012. *Global Sea Level Rise Scenarios for the US National Climate Assessment*. NOAA Tech Memo OAR.

USEPA (U.S. Environmental Protection Agency). 1996. *AP-42: Compilation of Air Pollutant Emission Factors*. Section 3.3: Gasoline and Diesel Industrial Engines. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/ttn/chief/ap42/ch03/final/c03s03.pdf

_____. 2010a. *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition*. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/OMS/models/nonrdmdl/nonrdmdl2010/420r10018.pdf

_____. 2010b. *Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling*. Electronic Report. Accessed: July 8, 2015. Retrieved from: http://www.epa.gov/oms/models/nonrdmdl/nonrdmdl2010/420r10016.pdf

USGCRP (U.S. Global Change Research Program). 2014. *Climate Change Impacts in the United States: The Third National Climate Assessment*. Accessed: July 23, 2015. Retrieved from: http://nca2014.globalchange.gov/

Human Health and Safety

Babisch, W. 2011. *Cardiovascular Effects of Noise*. Noise and Health (online publication), 13: 201-204. December 2011. Retrieved from: http://www.noiseandhealth.org/article.asp?issn=1463-1741;year=2011;volume=13;issue=52;spage=201;epage=204;aulast=Babisch.

Bies, D. and C. Hansen. 1996. *Engineering Noise Control*. 2nd Edition. London: E & F.N. Spon.

CDC (Centers for Disease Control and Prevention). 2013a. *BRFSS Prevalence and Trends Data*. Accessed: August 2015. Retrieved from: http://www.cdc.gov/brfss/brfssprevalence/index.html

_____. 2013b. *Deaths: Final Data for 2013*. Accessed: June 2015. Retrieved from: http://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_02.pdf

_____. 2014. *CDC Dengue Homepage*. Accessed: August 2015. Retrieved from: http://www.cdc.gov/dengue/epidemiology/

_____. 2015. *Chikungunya Virus: Geographic Distribution*. Accessed: August 2015. Retrieved from: http://www.cdc.gov/chikungunya/geo/

Evans, Gary W., Peter Lercher, Hartmut Ising, and Walter W. Kofler. 2001. *Community Noise Exposure and Stress in Children*. Journal of the Acoustical Society of America, 109(3): 1023-7. March 2001. Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/11303916 (updated January 2016)

Gingerich, Stephen B. 2003. *Hydrologic Resources of Guam.* U.S. Geological Survey, Water-Resources Investigation Report 03-4178. Honolulu, Hawaii. Accessed: August 2015. Retrieved from: http://pubs.usgs.gov/wri/wri034126/htdocs/wrir03-4126.html

Government of Guam's Office of Highway Safety. 2014. *Guam's 2014 Highway Safety Plan*. Accessed: August 2015. Retrieved from: www.nhtsa.gov/links/StateDocs/FY14/FY14HSPs/GU_FY14HSP.pdf

HEI (Health Effects Institute). 2010. *Traffic-related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects*. A Special Report of the Institute's Panel on the Health Effects of Traffic-Related Air Pollution. Accessed: June 2015. Retrieved from: http://pubs.healtheffects.org/view.php?id=334

IFC (International Finance Corporation). 2007. *Environmental, Health, and Safety (EHS) Guidelines; General EHS Guidelines: Environmental; Noise Management. Noise.* April 30, 2007. Retrieved from: http://www.ifc.org/wps/wcm/connect/06e3b50048865838b4c6f66a6515bb18/1-7%2BNoise.pdf?MOD=AJPERES (updated January 2016)

Kelly, F.J. and J.C. Fussell. 2011. *Air Pollution and Airway Disease*. Clin. Exp. Allergy, 41(8): 1059-71. August 2011.

Levy, Jonathan I., Susan L. Greco, and John D. Spengler. 2002. *The Importance of Population Susceptibility for Air Pollution Risk Assessment: A Case Study of Power Plants near Washington, DC*. Environmental Health Perspectives, 110(12): 1253-1260.

Marianas Variety. 2013. *Guam Issues Alert on Fever Outbreak in Yap.* Accessed: August 2015. Retrieved from: http://www.mvariety.com/regional-news/60631-guam-issues-alert-on-fever-outbreak-in-yap

Nishimura, Katherine K., Joshua M. Galanter, Lindsey A. Roth, Sam S. Oh, Neeta Thakur, Elizabeth A. Nguyen, Shannon Thyne, Harold J. Farber, Denise Serebrisky, Rajesh Kumar, Emerita Brigino-Buenaventura, Adam Davis, Michael A. LeNoir, Kelley Meade, William Rodriguez-Cintron, Pedro C. Avila, Luisa N. Borrell, Kristen Bibbins-Domingo, Jose R. Rodrigues-Santana, Saunak Sen, Fred Lurmann, John R. Balmes, an Esteban G. Burchard. 2013. *Early Life Air Pollution and Asthma Risk in Minority Children: The GALA II and SAGE II Studies*. AJRCCM Article in press.

OSHA (Occupational Safety and Health Administration). 2015. *Occupational Noise Exposures.* Accessed: August 2015. Retrieved from: https://www.osha.gov/SLTC/noisehearingconservation/

Patel, Molini M. and Rachel L. Miller. 2009. *Air Pollution and Childhood Asthma: Recent Advances and Future Directions*. Curr. Opin. Pediatr., 21: 235-42.

Sarnat, Jeremy A. and Fernando Holguin. 2007. *Asthma and Air Quality*. Current Opinion in Pulmonary Medicine, 13(1): 66-63.

Stansfeld, Stephen A. and Mark P. Matheson. 2003. *Noise Pollution: Non-auditory Effects on Health*. British Medical Bulletin, 68: 243-257. Accessed: August 2015. Retrieved from: http://bmb.oxfordjournals.org/content/68/1/243.full

USDOT (U.S. Department of Transportation). 2005. *High-speed Ground Transportation Noise and Vibration Impact Assessment.* Federal Railroad Administration. Office of Railroad Development. October 2005. Accessed: August 2015. Retrieved from: https://www.fra.dot.gov/eLib/Details/L04090

_____. 2006. *Transit Noise and Vibration Impact Assessment*. Federal Railroad Administration. Office of Railroad Development. FTA-VA-90-1003-06. May 2006.

USEPA (U.S. Environmental Protection Agency). 1995. *Health Effects Notebook.* Air Toxics Website. Accessed: August 2015. Retrieved from: http://www.epa.gov/ttn/atw/

_____. 2000. *Pentachlorophenol.* Accessed: August 2015. Retrieved from: http://www.epa.gov/ttnatw01/hlthef/pentachl.html

_____. 2008. *Integrated Science Assessment for Nitrogen Dioxide.* EPA National Center for Environmental Assessment, Office of Research and Development.

_____. 2009. *Integrated Science Assessment for Particulate Matter.* EPA National Center for Environmental Assessment, Office of Research and Development; EPA/R-08/139B.

_____. 2013. *Superfund*. Accessed: July 2015. Retrieved from: http://cumulis.epa.gov/supercpad/cursites/srchrslt.cfm?start=1&CFID=15146634&CFTOKEN=39828868&jsessionid=e0306b210e7254ad6d502b3a6c5b3f201e15

WHO (World Health Organization). 1999. *Guidelines for Community Noise*. Birgitta Berglund, Thomas Lindvall, and Dietrich H. Schwela (eds.). Accessed: August 2015. Retrieved from: http://www.who.int/docstore/peh/noise/guidelines2.html