Environmental Assessment

Carraízo Reservoir Dredging

Puerto Rico

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U.S. Department of Homeland Security
Federal Emergency Management Agency Region 2
Caribbean Area Office - Joint Recovery Office
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APPENDICES

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AADT	Annual Average Daily Traffic
ABFE	Advisory Base Flood Elevation
amsl	above mean sea level
ASP	Agency Specific Procedures
APE	Area of Potential Effects
BFE	Base Flood Elevation
BMP	Best Management Practices
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
COR3	Central Office for Recovery, Reconstruction and Resiliency
CRW	Carraízo Reservoir Watershed
CWA	Clean Water Act
cy	cubic yard(s)
dBA	Decibels (A-weighted)
DCH	Designated Critical Habitat
DNL	Day Night Average Sound Level
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FONSI	Finding of No Significant Impact
FPPA	Farmland Protection Policy Act
ft	feet
FWCA	Fish and Wildlife Coordination Act
GWFP	Gurabo Water Filtration Plant
ICP	Institute of Puerto Rican Culture
IPaC	Information for Planning and Consultation
JPA	Joint Permit Application
km	kilometer(s)
km^2	square kilometer(s)
m	meter(s)
m^3	cubic meter(s)
MBTA	Migratory Bird Treaty Act
MGD	million gallons per day
mi	mile(s)
mi^2	square mile(s)
Mcy	million cubic yard(s)
Mm^3	million cubic meter(s)
MOT	Maintenance of Traffic

NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
OGPe	Puerto Rico Permit Management Office
OSHA	Occupational Safety and Health Administration
PA	Programmatic Agreement
PEIS	Preliminary Environmental Impact Statement
$PM_{2.5}$	particulate matter less than 2.5 micrometers
PM_{10}	particulate matter less than 10 micrometers
PRASA	Puerto Rico Aqueduct and Sewer Authority
PREQB	Puerto Rico Environmental Quality Board
PRDNER	Puerto Rico Department of Natural and Environment Resources
PRDOH	Puerto Rico Department of Health
PRDTOP	Puerto Rico Department of Transportation and Public Works
PRHTA	Puerto Rico Highway and Transportation Authority
PR&G	Principles, Requirements, and Guidelines
PRPB	Puerto Rico Planning Board
RCRA	Resource Conservation and Recovery Act
SEA	Supplemental Environmental Assessment
SCWFP	Sergio Cuevas Water Filtration Plant
SFHA	Special Flood Hazard Area
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SPCC	Spill Prevention, Control, and Countermeasures
SWPPP	Stormwater Pollution Prevention Plan
T&E	Threatened and Endangered Species
TCLP	Toxicity Characteristic Leaching Procedure
TMDL	Total Maximum Daily Load
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USDHS	U.S. Department of Homeland Security
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
VOC	volatile organic compounds
WOTUS	Waters of the U.S.
WQC	Water Quality Certification
yr	year

1 INTRODUCTION

The mission of the Federal Emergency Management Agency (FEMA) is to reduce the loss of life and property and protect our institutions from all hazards by leading and supporting the nation in a comprehensive, risk-based emergency management program of mitigation, preparedness, response, and recovery. Beginning September 17, 2017, Hurricane María caused significant damage to Puerto Rico. A disaster declaration was issued for Hurricane María on September 20, 2017, encompassing all of Puerto Rico. The declaration authorized federal public assistance to affected communities and certain non-profit organizations per FEMA, and in accordance with the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1974 (42 U.S. Code [U.S.C.] 5172) *as amended*; the Sandy Recovery Improvement Act of 2013; and the Bipartisan Budget Act of 2018 (Public Law 115-123). The Central Office for Recovery, Reconstruction and Resiliency (COR3) is the recipient for FEMA grants and multiple agencies may be subrecipients for specific projects.

The Stafford Act authorizes FEMA to provide funding to eligible grant applicants for activities with the purpose of reducing or eliminating risks to life and property from hazards and their effects. The 2018 Bipartisan Budget Act authorizes FEMA to provide assistance to restore disaster damaged facilities or systems that provide the specifically identified critical services to an industry standard without regard to pre-disaster condition (FEMA 2018). Section 406 of the Stafford Act describes critical services as power, water, sewer, wastewater treatment, communications, education, and emergency medical care.

This Environmental Assessment (EA) is prepared in accordance with Section 102 of the National Environmental Policy Act (NEPA) of 1969, *as amended*; and the Regulations for Implementation of the NEPA (40 Code of Federal Regulations [CFR] Parts 1500 to 1508). This EA considers the potential environmental impacts of proposed project alternatives, including a no action alternative, to determine whether to prepare a Finding of No Significant Impact (FONSI) or an Environmental Impact Statement (EIS). In accordance with above referenced regulations, FEMA Directive 108-1, and FEMA Instruction 108-1-1, FEMA, during the decision-making process, evaluates and considers the environmental consequences of major federal actions it funds or undertakes.

2 PURPOSE AND NEED

The Carraízo Reservoir is a major component of the Puerto Rico Aqueducts and Sewer Authority (PRASA) municipal water treatment, transmission, and distribution system, and meets the definition of a critical service. The purpose of the project is to restore the water storage capacity of the Carraízo Reservoir which is the only water source for PRASA's Sergio Cuevas Water Filtration Plant (SCWFP).

The need for the project is to support the long-term ability of PRASA to provide a steady, reliable source of potable water for the SCWFP service area which includes a population of approximately 491,663 individuals within the municipalities of San Juan, Carolina, Canóvanas, Trujillo Alto, Gurabo, Loíza, and Juncos. The Carraízo Reservoir is one of the largest in Puerto Rico. The reservoir supplies approximately 90 million gallons per day (MGD) of water to the SCWFP. Water from the reservoir also supports the major economic drivers of San Juan and adjacent municipalities including manufacturing, finance, and tourism. The excess sediment deposited during Hurricane María significantly reduced the reservoir's storage capacity. The water intake, buried in sediment in the lower segment of the dam, impacts the availability and delivery of potable water during periods of drought and negatively affects the operational flexibility of the SCWFP. If sedimentation from urban development, agricultural practices, heavy rains, landslides, and hurricanes continues at its current rate, the reservoir's storage capacity will be further reduced, and its useful life would end by 2062 (Soler-López and Licha-Soler 2012).

3 PROJECT BACKGROUND

The Carraízo Dam forms a reservoir known as Carraízo Reservoir or Lago Loíza, north of the confluence of Río Gurabo and Río Grande de Loíza in the municipality of Trujillo Alto (Figure 1 in Appendix A). The Carraízo Dam, owned and operated by PRASA, was built in 1953 providing the reservoir with an original capacity of 26.80 million cubic meters (Mm^3) (35 million cubic yards [Mcy]) of water with a maximum pool elevation of 40.14 meters (m) (132 feet [ft]) above mean sea level (amsl). The reservoir was constructed to supply water for the SCWFP service area.

The Carraízo Reservoir and associated rivers are located within the municipalities of Caguas, Gurabo and Trujillo Alto (Figure 1 in Appendix A). The 537.9 square kilometer (km^2) (207.7-square mile [mi^2] Carraízo Reservoir basin in east-central Puerto Rico, is approximately 22 kilometers (km) (13.7 miles [mi]) south-southeast of San Juan. The Carraízo Dam structure is located approximately 21.7 km (13.5 mi) upstream from where Río Grande de Loíza flows into the Atlantic Ocean. The dam is a concrete gravity structure with an intake structure for the pumping station, sluice gates, a trash sluice, radial gates, and a spillway. In 1977, PRASA modified the dam to add one meter to the radial gate height to raise its full operational level to 41.14 m (135 ft) amsl (Soler-López and Gómez-Gómez 2005).

Sedimentation is a natural process that results from the transportation of sediment by creeks and rivers and its deposition into lentic systems. The humid tropical environment and mountainous terrain of Puerto Rico are conducive to high rates of sedimentation (U.S. Geological Survey [USGS] 2019). Sediment from natural erosion as well as erosion that results from human activities in the watershed settles in the reservoirs, reducing the storage capacity and useful life. Heavy rains and major floods associated with hurricanes and tropical disturbances cause extensive land erosion and contribute to increased sediment transport that rapidly depletes the storage capacity of reservoirs, including the Carraízo Reservoir (USGS 2019).

The Carraízo Reservoir storage capacity has been reduced due to the sedimentation process, a condition that has been aggravated as result of the passage of Hurricanes Irma and María in September 2017. Sedimentation at Carraízo Reservoir has been an ongoing challenge that affects the reservoir's retention capacity. A detailed bathymetric survey of Carraízo Reservoir was conducted in November 1994 to calculate the actual storage capacity, sedimentation rate, trap efficiency, and sediment accumulation of the reservoir. The storage capacity of the reservoir in 1994 was 14.2 Mm^3 (18.5 Mcy), equal to 53% of the original capacity of 26.8 Mm^3 (35 Mcy) when the dam was completed in 1953 (Webb and Soler-Lopez 1997).

To address the issue of sedimentation, in 1992, a Preliminary EIS (PEIS) was prepared to study alternatives to increase the water storage capacity of the Carraízo Reservoir (PRASA 1995). Six alternatives were evaluated including:

- The construction of a new dam in a different place and abandoning the existing reservoir
- Reservoir dredging
- Increasing the height of the existing dam

- Management of the dam to reduce the sedimentation
- Reduce the erosion rate in the watershed
- Construct sediment traps upstream of the reservoir

The proposed preferred alternative was to dredge the reservoir using two dredged material disposal methods:

- Discharge the sediments into the Río Grande de Loíza downstream of the dam
- Disposal in an upland location

Due to concerns expressed by several agencies on the method of sediment disposal, the PEIS was put on hold until additional information and studies could be conducted. The need for dredging started again in June 1994 due to low reservoir levels associated with a drought event. The continued sedimentation process drove PRASA to reevaluate the need to dredge the reservoir and a Supplemental EIS was completed in 1995 (PRASA 1995). This document evaluated alternatives to increase the capacity of the reservoir by 6 MGD, including:

- No Action
- Combination of a 250,000 cubic meter (m^3) (326,987 cubic yards [cy]) maintenance dredging and the construction of a desalination plant
- Combination of an initial 6 Mm^3 dredge and annual 250,000 m^3 (326,987 cy) maintenance dredging

The last alternative was selected as the proposed action. Several alternatives were identified to dispose of the dredged material, including:

- Deep ocean dumping
- Disposal in uplands outside the Carraízo Reservoir watershed (CRW)
- Disposal in uplands within the CRW
- Disposal in Lago Loíza below the dam

The disposal in uplands within the CRW was the alternative selected to be evaluated in detail. The Supplemental EIS evaluated twenty-five different locations to build the disposal sites for the dredged material in an upland area within the CRW. After an initial screening, thirteen sites were selected as potential alternatives to be studied in detail. This process narrowed down the alternatives to seven that were then presented and discussed in public hearings. The final approved alternative included dredging the reservoir and designating and constructing three new disposal sites (PRASA 1995).

In 1996, the U.S. Army Corps of Engineers (USACE) issued a 20-year permit to dredge the Carraízo Reservoir to restore its water storage capacity. The permit allowed the dredging of approximately 6.11 Mm^3 (8 Mcy) of sediment from the reservoir during the first five years. Maintenance dredging was authorized to remove approximately 0.5 Mm^3 (0.6 Mcy) bi-annually thereafter for a period of 15 years. The 20-year USACE dredging permit expired on August 29, 2016 (USACE 1996).

The dredging event finished in 1999 with an approximate cost of $100M. The hydraulic pipeline dredging event removed approximately 6 Mm^3 (8 Mcy) of material from the Carraízo Reservoir which was deposited in the new dredged material placement areas (disposal dikes A, B, and C). The decanted water from the disposal dikes was discharged back to the reservoir and adjacent rivers. Once dredging activities were finished, the reservoir water capacity storage was restored to approximately 19.35 Mm^3 (25.3 Mcy) (Soler-López and Gómez-Gómez 2005). Also, this permit authorized the discharge of fill on approximately 3.9 hectares (9.64 acres) of wetlands at disposal site A (USACE 1996).

In total there have been three dredging events at the Carraízo Reservoir since it was constructed: (1) emergency dredging conducted in 1994, (2) dredging conducted between 1996-1999, and (3) emergency shoreline dredging in 2015. The shoreline dredging conducted in 2015 resulted in the removal of approximately 30,000 m^3 (39,238 cy) of dredged material. The dredging activity occurred along the shore area lying in the Río Cañas Ward in Caguas. The material dredged was mostly sand and the dredging works were undertaken by a contractor in an interchange agreement with PRASA (CSA 2021).

The Sedimentation History of Lago Loíza, Puerto Rico, 1953-94 report presents the results from a 1994 study conducted by the USGS in cooperation with PRASA (Webb and Soler-Lopez 1997). The water storage capacity of Carraízo Reservoir in 1994 was computed to be 14.2 Mm^3 (18.5 Mcy). Sedimentation has been episodic, responding to major floods over the last 40 years. More than 3.6 Mm^3 (4.7 Mcy) of sediment were deposited from 1971 to 1979, while only 1.18 Mm^3 (1.5 Mcy) of sediment were deposited from 1979 to 1990. The reduced active storage capacity of the reservoir severely limits the continued utility of the reservoir as the principal water supply for San Juan and adjacent municipalities served by the SCWFP. In 1997, withdrawal from the reservoir to the SCWFP averaged 4.4 m^3 per second (100 MGD) (Webb and Soler-López 1997).

The storage capacity of the reservoir before the 1997-1999 dredging was an estimated volume of 13.26 Mm^3 (17.3 Mcy). The storage capacity after dredging was reported as 19.35 Mm^3 (25.3 Mcy), which represents a 36% increase. The 1999 storage capacity of the reservoir was about 72% of the original 1953 volume of 26.80 Mm^3 (35 Mcy) (CSA 2021).

The storage capacity of the reservoir decreased from 17.53 Mm^3 (23 Mcy) in January 2004 to 16.42 Mm^3 (21.5 Mcy) in July 2009. This reduction of 1.11 Mm^3 (1.5 Mcy) between 2004 and 2009 is equivalent to an annual storage-capacity loss rate of about 0.222 Mm3/year (yr) (0.3 Mcy/yr) (Soler-López and Licha-Soler 2012).

PRASA commissioned the *Sedimentation Survey of Lago Loíza, Puerto Rico* study (GLM 2020) (Appendix B) to determine the current storage capacity of the Carraízo Reservoir and to estimate the amount of sediment deposited in the reservoir after the passage of Hurricane María. The reservoir's capacity is approximately 15.06 Mm^3 (19.7 Mcy) according to the October 2019 bathymetric survey conducted as part of the *Sedimentation Survey of Lago Loíza, Puerto Rico*.

This corresponds to 56% of the 1953 original reservoir storage capacity of 26.8 Mm^3 (35 Mcy) (44% volume loss). The report concluded that the amount of sediment delivered into the reservoir as a result of Hurricane María was 2.35 Mm^3 (3 Mcy). The continuous capacity loss of the reservoir, if left unattended, would result in future service interruptions even under normal non-drought weather conditions. Table 1 presents the storage capacity of the Carraízo Reservoir between 1953 and 2019.

Table 1: Carraízo Reservoir Storage Capacity throughout the years

Date	Carraízo Reservoir Storage Capacity in Mm^3 (Mcy)
1953	26.80 (35)
1994	14.2 (18.5)
1997 (before dredging)	13.26 (17.3)
1999 (after dredging)	19.35 (25.3)
2004	17.53 (22.9)
2009	16.42 (21.4)
2019	15.06 (19.7)

4 ALTERNATIVES

Five alternatives that fulfill the purpose and need for this project were evaluated by FEMA and PRASA, including a No Action Alternative. This consideration is based on engineering constraints, environmental impacts, and available property. The Carraízo Reservoir is considered a critical service therefore, sediment removal would meet PRASA's need to provide a steady, reliable source of potable water for the SCWFP service area. Budgetary constraints are included, but it is not considered the controlling factor.

4.1 ALTERNATIVE 1: NO ACTION ALTERNATIVE

Under the No Action Alternative, FEMA would not provide grant funding for dredging activities to remove the accumulated sediments resulting from Hurricane María. Under the No Action Alternative, the government of Puerto Rico and PRASA would be responsible for funding any dredging. Due to budgetary constraints within Puerto Rico government agencies, including PRASA, FEMA anticipates this project may go unfunded or deferred indefinitely. The most recent study shows that the reservoir's water storage capacity is 15.06 Mm^3 (19.7 Mcy), much less than its' original capacity of 26.80 Mm^3 (35 Mcy) (GLM 2020) (Appendix B). With the No Action alternative, PRASA would not be able to provide a steady, reliable source of potable water for the SCWFP service area.

4.2 ALTERNATIVE 2: DREDGING TO REMOVE 2 MM^3 OF SEDIMENT (PREFERRED ALTERNATIVE)

Alternative 2 would hydraulically dredge the Carraízo Reservoir to remove 2 Mm^3 (2.6 Mcy) of sediment over a two-year period. With Alternative 2 sediment dredged from the reservoir would increase the water storage capacity of the reservoir from 15.06 Mm^3 (19.7 Mcy) to approximately 17.02 Mm^3 (22.3 Mcy). Dredged sediment transfer would be through a pipeline up to 0.6-m (24-inches) in diameter and up to 17 km (10.9 mi) long, with approximately 10 km (6.2 mi) of sections along the reservoir (open water) and approximately 7 km (4.3 mi) of inland aboveground pipeline, generally following the same alignment as the pipeline used during the previous dredging event. Skid-mounted booster pumps would be located along the pipeline alignment, as required. The sediment slurry would be transferred to the three existing disposal dikes (A, B and C) with a combined disposal capacity of approximately 2.6 Mm^3 (3.4 Mcy) (PRASA 2022). With gravity and time, the sediment would settle to the bottom of the disposal dikes and the excess water would be released back into the reservoir and rivers through weir outlets. Once the water drains out, the dry dredged sediment would remain in the disposal dikes, where vegetation would naturally recover over time.

Installation of the sediment pipeline would include both floating platforms/rafts and aboveground pipelines with booster pumps for sediment slurry transfer to the existing disposal dikes. The floating platforms in the reservoir would support booster pumps. Installation and operation of the inland sediment pipelines would require a 12-m-wide (39.3-ft) pipeline easement along approximately 7 km (4.3 mi) of open non-developed and agricultural lands. Site preparation for the inland pipeline would require incidental vegetation clearing and grubbing. To secure the pipeline and limit ground disturbance, installation of the inland pipeline would include non-invasive temporary weighted anchors. weighted anchors

placed on the ground on either side of the pipeline. A metal bracket would be attached to the concrete blocks and would fit over the top of the pipeline (Figure 3 in Appendix A). The booster pumps placed at intervals along the alignment would be mounted on skids and would sit on the ground.

The inland sediment pipeline would have approximately ten intersections with paved and dirt roads, bridges, and narrow water ditches/channels. The pipeline would also lie on top of identified wetlands. For the road and bridge crossings, the pipeline would go under the road through an existing culvert or under the bridges. This method would prevent impediments to traffic. For the private and PRASA-owned dirt road crossings, the pipeline would be laid across the roads. For the crossings over the ditches/channels, these narrow features would allow the pipeline to be laid across the ditch/channel with no support structures. The plan view of proposed inland pipeline alignment and photos of the landscape can be found in Appendix J (CSA 2022a).

Preliminary design drawings were prepared for the project (PRASA 2022) (Appendix C). The drawings include profile drawings of proposed dredging in the reservoir. The drawings for the proposed inland pipeline alignment are divided into two parts: a plan view drawing and a profile drawing. The profile drawing provides information on the existing grade, the potential location of booster pumps, and road/bridge/ditch crossings (PRASA 2022).

Appendix D includes photographs of equipment used for the previous dredging event. These types of equipment could be used for this project. The appendix includes examples of a hydraulic dredge and barge, a floating booster pump station, the floating dredging pipeline, inshore booster pumps, and examples of geotextile tubes.

Site preparation/construction phase (Figure 4 and Figure 5 in Appendix A) actions include:

- Implementation of sediment and erosion control measures at the dredging, staging area and disposal dikes.
- Protection of the archaeological site identified at staging area.
- Equipment mobilization and installation of temporary office trailers at staging area.
- Rehabilitation (including clearing and grubbing, incidental tree removal, refurbishing access roads) of the staging area and disposal dikes A, B and C, and along the pipeline alignment as needed.
- Construction of a temporary dock abutting the staging area to allow hydraulic dredge equipment and support vessels operations. The new temporary dock would be in a location similar to the dock used for the previous dredging event.
- Demolition and reconstruction of existing weir outlets at the disposal dikes for the discharge of decanted water.
- Activities would take place from 7 a.m. to 10 p.m., 5 days a week.

Dredging operation phase actions include:

- Delimit by buoys or other means that facilitates its visual identification, the submerged residential structure, and a 10-m (32.8-ft) buffer zone around it to be avoided/protected by the dredging crew.
- Fueling of the hydraulic dredge barge and support vessels.
- Installation of the sediment pipeline along an alignment that would be similar to the previous dredging project.
- Installation of conventional equipment and dewatering geotextile tubes for sediment management within disposal dikes.
- Dredging activities would occur up to 24-hours a day, 7 days a week.
- Pumping dredged material from the reservoir to the sediment disposal dikes. This operation would take place up to 24-hours a day, 7 days a week.
- On-going maintenance activities for dredging equipment, booster pumps, pipelines, etc., as needed during the dredging period.

Demobilization phase actions include:

- Demobilization of dredging equipment and structures from staging area, disposal dikes and sediment pipeline. To be completed within four months after dredging operations end.
- Removal of temporary dock to be completed within four months after dredging operations end.
- Removal of sediment and erosion control measures at the dredging, staging area, disposal dikes, and along the pipeline within four months after dredging operations end.

4.3 ALTERNATIVE 3: DREDGING TO REMOVE 6 MM^3 OF SEDIMENT

The proposed dredging method and components for Alternative 3 would be similar to Alternative 2, with a variation on the total sediment volume to be removed (6 Mm^3) (7.8 Mcy) and dredging period (20 years). With Alternative 3, sediment dredged from the reservoir would increase the water storage capacity of the reservoir at the end of 20 years from approximately 15.26 Mm3 (19.96 Mcy). The three existing disposal dikes presently have an estimated combined capacity of 2.6 Mm^3 (3.4 Mcy) (PRASA 2022). To achieve the 6 Mm^3 (7.8 Mcy) dredged sediment volume, Alternative 3 would require the annual removal of 300,000 m^3 (392,385 cy) of de-watered sediments from disposal dike A, once the three disposal dikes' storage capacity is reached. Sediment dredging, dewatering, sorting and transportation off-site would continue exclusively at disposal dike A, beginning approximately during year 7 or 8 after initiating dredging activities, and continuing until year 20. Dredging operations at disposal dikes B and C would stop and equipment demobilized.

The dry sediments would be sorted and utilized beneficially as construction materials (sand and gravel) and fill material for various uses. Markets for this material in Puerto Rico include the following:

- Construction material. The sand and gravel portions would be sold in bulk to wholesale and retail marketers, such as permitted hardware stores and quarries.

- Fill material. There are multiple uses for dredged material, especially given chemical test results indicating that these sediments are non-hazardous. Recipients would be operations permitted to receive fill. Some fill material uses:

    - Landfill daily cover. Landfills are required to daily cover the working cells to prevent vermin and disease vectors from reaching deposited municipal solid waste. A dry, clayey material is preferred and used daily by all landfills in Puerto Rico. The de-watered dredged sediment would meet these specifications.

    - Landfill cap. Puerto Rico has 29 active landfills, the majority of which are beyond capacity, and only 10 are currently operating with compliant disposal cells (U.S. Environmental Protection Agency [EPA] 2016; NotiCel 2021). There are twelve landfills operating under closure or compliance orders from EPA (EPA 2016). According to PRDNER, 8 landfills will be brought into compliance and will have lateral expansion, 4 are being evaluated for possible expansion, and 7 have closure orders from EPA (NotiCel 2021). Closure requirements include a surface topography that minimizes puddling, which demands substantial amounts of sediment to cap the landfill.

    - Other fill material uses. The USACE has identified various examples of beneficial use of dredged material such as upland habitat, borrow pit restoration, recontouring shallow water habitat, filling dead-end basins and bird habitat in uplands, and land site remediation such as cover for abandoned contaminated industrial sites known as "brownfields" (USACE 2022).

    - Topsoil. Fill material would be mixed with compost to make a fertile topsoil.

Activities associated with Alternative 3 that would be different or in addition to the activities for Alternative 2 include:

Dredging operation phase actions include:

- Hydraulic pumping of the sediment from the reservoir to disposal dike A once disposal dikes B and C reach capacity.

- Continue dredging and de-watering sediments with the use of geotubes at disposal dike A, and the release of decanted water back into the reservoir.

Sediment processing and transportation phase actions include:

- Construction equipment mobilization and installation at disposal dike A for sorting and loading the dry sediments into dump trucks for transportation off-site.

- Once disposal dikes B and C have reached their respective capacity, processing and removal of dry sediment would begin at disposal dike A.

- Sediment processing would occur within the disposal dike A footprint, and entail construction equipment, such as excavators, skid-steer loaders, bulldozers, mechanical cascade sifters, and dump trucks.

- Sorting, processing as required, and transportation off-site annually of approximately 300,000 m^3 (392,385 cy) of dry sediment material from disposal dike A to different markets in Puerto Rico.

- Off-site sediment transportation would require approximately 77 truckloads with a capacity of 15 m^3 (19 cy) per day, 5 days per week on a yearly basis between 7:00 a.m. and 10:00 p.m.

- The roads employed for transportation of materials off-site would be PR-9189 for 1.4 km (0.9 mi), to PR-189 for 0.4 km (0.25 mi), to PR-30 for 9 km (5.6 mi), and thereon to different markets in Puerto Rico.

Demobilization phase actions include:

- Removal of sediment pipelines, pipeline anchors, booster pumps, and erosion control measures at disposal dikes B and C once their capacity is reached.

- Demobilization of dredging equipment and structures from staging area, disposal dike A and its sediment pipeline, removal of temporary dock, and removal of sediment and erosion control measures at the dredging, staging area and disposal dike A during year twenty.

4.4 ALTERNATIVES CONSIDERED AND DISMISSED

Alternative 4: Raise height of the Carraízo Dam.

Alternative 4 would raise the dam structure to increase the reservoir's water storage capacity. This alternative was evaluated in the 1992 PEIS, which proposed raising the level of the dam to increase the water level and storage capacity of the reservoir by 3.5 m (11.5 ft). Raising the water elevation of the reservoir would raise the elevations of the flood zone for the adjacent Caguas and Gurabo areas. Higher elevation in the reservoir would cause a greater risk of flooding for these communities. Furthermore, the Gurabo areas and other developed locations have already suffered from flooding problems and flood control levees were built in these areas. The conditions and potential impacts evaluated as part of the 1992 PEIS have not changed significantly, therefore, this alternative was discarded due to the high risk of causing increased flood problems.

Alternative 5: Build New Desalination Plant

Alternative 5 would involve the construction of a new desalination plant to provide a new source of water for the SCWFP service area. This alternative would combine the construction and operation of a new reverse osmosis desalination plant and Carraízo Reservoir maintenance dredging to produce approximately 6 MGD of drinking water. Maintenance dredging would remove approximately 250,000 m^3 (326,988 cy) of sediment per year. The desalination plant would require design of a new treatment plant, a new seawater pipeline inlet and a new brine discharge outfall which would extend to the Atlantic Ocean. It is estimated it would take approximately three years for planning, permitting, design, and construction of a new desalination plant before starting operations to deliver drinking water. The desalination plant could be located within an urbanized area near the Atlantic Ocean or within the port of San Juan. Despite the construction of a treatment plant of this nature, the Carraízo Reservoir would still have to be dredged periodically to maintain storage capacity and safe yield, or the reverse osmosis plant would have to be upgraded every two years to increase the drinking water supply to compensate for the continued Carraízo Reservoir capacity loss. Due to projected high construction costs and the elevated energy costs associated with plant operation, including the potential environmental impacts linked to the development of this alternative, the 1992 PEIS determined this alternative was not feasible. Conditions have not changed, and this alternative was discarded due to projected high construction costs, potential environmental impacts, and elevated energy costs.

4.5 SUMMARY OF ALTERNATIVES

Five alternatives were evaluated relative to their ability to fulfill the purpose and need for the project. Two alternatives were dismissed from further consideration. The three remaining alternatives to be evaluated in this EA are:

- Alternative 1: No Action Alternative
- Alternative 2: Dredging to Remove 2 Mm^3 (2.6 Mcy) Preferred Alternative
- Alternative 3: Dredging to Remove 6 Mm^3 (7.8 Mcy).

Section 5 describes the existing conditions and evaluates the potential environmental impacts of the No Action Alternative and Alternatives 2 and 3. Section 9, Impact Summary Table, summarizes the potential impacts evaluated in Section 5.

5 AFFECTED ENVIRONMENT AND POTENTIAL IMPACTS

This section discusses the potential impacts and mitigation measures of the No Action Alternative and the proposed project alternatives. In accordance with NEPA, the affected environment includes the physical, biological, cultural, and human use setting in which the proposed activities would occur, including restorative actions. This EA presents a qualitative evaluation of potential impacts to the affected environment. The qualitative evaluation relies upon a scale that describes the intensity and duration of a potential impact. Table 2 presents the impact scale FEMA used to describe the anticipated intensity of an impact while Table 3 describes the duration of the impact.

Whether it is the No Action Alternative or the project alternatives, the potential impacts resulting from FEMA's decision to either fund or not fund a project may impact a resource in either a beneficial or adverse way. Additionally, impacts to a resource may be direct, indirect, or cumulative.

Table 2: Impact Significance and Context Evaluation Criteria for Potential Impacts

Impact Scale	Criteria
No Effect	There would be no impact on the resource or resource area.
Negligible	Changes would either be non-detectable or, if detected, would have effects that would be slight and local. Adverse impacts would be well below regulatory standards, as applicable.
Minor	Changes to the resource would be measurable, but the changes would be small and localized. Adverse impacts would be within or below regulatory standards, as applicable. Mitigation measures would reduce any potential adverse effects.
Moderate	Changes to the resource would be measurable and have either localized or regional scale impacts. Adverse impacts would be within or below regulatory standards, but alteration of historical conditions may occur on a short-term basis. Mitigation measures would be necessary, and the measures would reduce any potential adverse effects.
Major	Changes to the resource would be readily measurable and would have substantial consequences on regional levels. Adverse impacts would exceed regulatory standards. Mitigation measures to offset the adverse effects would be required to reduce impacts, though long-term changes to the resource would be expected.

Direct impacts occur at the same time and place as project construction such as vegetation removal, vehicle emissions, or erosion control. Indirect impacts occur in a later time or place than the project construction such as the accumulation of sediments downstream or increased traffic on alternate roads. Cumulative impacts occur when impacts from the project area added to the impacts of other past, present, or reasonably foreseeable future actions such as transportation projects funded by other federal sources. For this EA, the definitions used throughout the document are as follows:

- **Direct impacts**: Caused by the action and occur at the same time and place as the action.
- **Indirect impacts**: Reasonably foreseeable effects occurring later in time or in a different location from the action site than direct impacts.

- **Cumulative impacts**: Result from individually minor, but collectively major actions that take place over time; incremental impacts of the action added to the impacts of other past, present, and reasonably foreseeable future actions, regardless of the person or agency or takes them.

Table 3: NEPA Time Scale

Terminology	Definition
Temporary	Impacts and recovery occurring only during the construction period.
Short-Term	Impacts and recovery occurring during a limited, predictable amount of time up to three years.
Long-Term	Impacts and recovery occurring over a period longer than three years but into the reasonably foreseeable future.

Section 9 presents the Summary of Impacts for the Alternatives analysis. The FEMA is omitting the following environmental resource topics (Table 4) from further evaluation under this EA due to inapplicability to the project or locations considered in this NEPA document (Table 4).

Table 4: Eliminated Resource Topics

Topic	Reason
Wild and Scenic River System	There are no Wild and Scenic Rivers designated within the project area.
Essential Fish Habitats	There are no Essential Fish Habitats designated within the project area.
Bald and Golden Eagles	Bald and Golden Eagles are not found in Puerto Rico.
Coastal Resources	There are no coastal resources within the project area.

5.1 GEOLOGY, TOPOGRAPHY, AND SOILS

Geologic and topographic characteristics such as shallow bedrock, steep slopes or excessive erodibility can affect the engineering design, method of construction, potential environmental impacts of the alternatives under evaluation and the effectiveness of impact minimization measures. Soil characteristics within a given area depends on the composition of material in the area and described by "soil series" based on their origins, chemical and physical properties, and slope.

The Farmland Protection Policy Act (FPPA) of 1981 (7 U.S.C. §4201, et seq.) protects designated prime and unique farmlands and farmlands of importance from conversion to non-agricultural uses. Prime farmland is land with the best physical and chemical characteristics to produce food, feed, forage, fiber, and oilseed crops. The FPPA is intended to minimize the impact federally funded programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that to the extent possible federal programs are administered to be compatible with state, local units of government, and private programs and policies to protect farmland. The FPPA applies to not just lands currently under agricultural production but also forestland, pastureland, or other land types that farmers can convert into farmland or ranchland. According to the FPPA, the activities subject to FPPA requirements include projects which may permanently convert (either directly or indirectly) farmland, as defined under the 1981 Act and the final rules published in 1994, to nonagricultural use and are completed by a federal agency or completed with financial or technical assistance from a federal agency.

5.1.1 Existing Conditions

Regional Geology

The Juncos-Caguas Valley is within the east central region of Puerto Rico and occupies an area of approximately 93.2 km^2 (36 mi^2). Bedrock geology in the Carraízo Reservoir basin is approximately 48% volcaniclastic rock, 33% intrusive rock, and 19% Quaternary alluvium. The intrusive bodies weather to sandy loams and loams, whereas the volcaniclastic rocks weather primarily to clays and silty clay loams (Gellis et al. 2006).

The predominant geologic features associated with the disposal dikes are alluvium for disposal dike A, hydrothermally altered rocks for disposal dike B, and alluvial and terrace deposits for disposal dike C (Pease 1968 and Seiders 1971). Alluvium and terrace deposits consist of alluvial sand, gravel, silt, and clay in floodplains. Hydrothermally altered rocks are made of hard, light-gray, and grayish-green altered, metamorphosed, and sheared volcanic and plutonic rocks. Figure 6 (Appendix A) illustrates the geological map for the Carraízo Reservoir and the proposed project area.

Topography

The principal physiographic feature of Puerto Rico is the Cordillera Central and the Sierra de Cayey, which form a continuous mountain range extending in an east-west direction nearly the entire length of the main island. The foothills, which separate the coastal plain from the mountains, begin at an altitude of about 300 m (984 ft) amsl. Throughout most of the mountainous areas, ridge tops reach altitudes of 700 m (2,297 ft) with a maximum altitude of 1,338 m (4,390 ft) found at Cerro de Punta which is north of Ponce. Within the mountainous areas, hillsides are steep with about 50% of the land having slopes greater than 45%. The predominant physiographic feature characterizing the western two-thirds of the northern coast is limestone karst terrain. The limestone karst terrain extends inland as much as 20 km (12.4 mi) (Gómez-Gómez et al. 2014).

The Carraízo Reservoir stores water that flows from the 538 km^2 (207.7 mi^2) watershed. The normal surface elevation of the reservoir is 41.14 m (135 ft) amsl (CSA 2021). The reservoir lies at the end of two flood plains formed by the Río Gurabo and the Río Grande de Loíza with alluvium covering almost 100 km2 (39 mi^2) of the basin. The floodplain is bounded by steeply sloped mountains (Webb and Soler-López 1997). Table 5 and Figure 4 (Appendix A) illustrate the topography of the Carraízo Reservoir and the proposed project area.

Table 5: Topography within the Project Area

Project Area	Elevation (m amsl)	Elevation (ft amsl)
Disposal Dike A[1]	45 – 50 m	148 – 164 ft
Pipeline A[2]	46 – 49 m	150 – 160 ft
Disposal Dike B[1]	50 – 60 m	164 – 197 ft
Pipeline B[2]	40 – 46 m	130 – 150 ft
Disposal Dike C[1]	55 – 70 m	180 – 230 ft
Pipeline C[2]	43 – 52 m	140 – 170 ft

Source:

[1] CSA 2021; [2] USGS 2022 (Maps Aguas Buenas and Gurabo)

Soils and Prime Farmland

Soil characteristics vary greatly across the island due to vast differences in regional geology. According to the U.S. Department of Agriculture (USDA), of the 12 soils orders identified by USDA, Puerto Rico has 10 (Muñoz et al. 2018). Eleven series within the project area are presented in Table 6 and in Figure 7 in Appendix A.

Table 6: Soils Within the Project Area

Soil Series	Map Unit	Soil Type	Drainage Class	Farmland Designation	Project Area
Coloso	Cs	Silty clay loam	Somewhat poorly drained	Prime farmland if drained	Pipeline B
Dique	Dm	Loam	Well drained	Prime farmland	Pipeline C
Estacion	Es	Silty clay loam	Well drained	Farmland of statewide importance	Pipeline C
Juncos	JuD	Clay	Moderately well drained	Prime farmland	Disposal Dike A
Mabí	MaA	Clay	Somewhat poorly drained	Prime farmland	Pipeline A Disposal Dike A
Mabí	MaB	Clay	Somewhat poorly drained	Prime farmland	Pipeline C
Mabí	MaC	Clay	Somewhat poorly drained	Farmland of statewide importance	Pipeline C Disposal Dike C
Múcara	MxE	Clay	Well drained	None	Disposal Dike B

Soil Series	Map Unit	Soil Type	Drainage Class	Farmland Designation	Project Area
Naranjito	NaD2	Silty clay loam	Well drained	Farmland of statewide importance	Disposal Dike B
Reilly	Re	Sandy loam	Excessively drained	None	Pipelines A and C
Río Arriba	RoC2	Clay	Moderately well drained	Prime farmland	Pipelines B and C Disposal Dikes B and C
Toa	To	Silty clay loam	Well drained	Prime farmland	Pipelines A/B/C Disposal Dikes A/B/C
Via	VkC2	Clay loam	Well drained	Prime farmland	Disposal Dike C

Subsoil and geotechnical explorations were recently performed to determine the disposal dikes' reliability for sediment storage. Borings were drilled from the top of the levees to characterize the soil composition (Suelos 2021a-c). The levees that make up disposal dike A consist of stiff consistency, relatively well compacted, brown clay, sometimes intermixed with sandy silt. On average, disposal dike A levee fill material extends to a depth of 4.57 m (15 ft). The levees that make up disposal dike B consist of stiff consistency, relatively well compacted yellowish-brown to olive gray silty to sandy clay, sandy silt, and silty sand in variable proportions. The fill material comprising disposal dike B levees extends to depths between 6 and 15.2 m (20 - 50 ft), depending on the boring location. The levees that make up disposal dike C consist of stiff consistency, relatively well compacted yellowish-brown and brown silty to sandy clay, sandy silt, and silty sand in variable proportions. The native soils appear at a depth between 12 - 15.2 m (40 - 50 ft) measured from the top of disposal dike C levees, depending on the boring location. Appendix E includes the geotechnical reports for disposal dikes A, B and C (Suelos 2021a-c).

The soil series Dique, Juncos, Mabí A, Mabí B, Río Arriba, Toa, and Via are classified as prime farmlands by the USDA-Natural Resource Conservation Service (NRCS) (USDA-NRCS 2015). The soil series Estacion, Mabí C, and Naranjito are classified as farmland of statewide importance, and the soil series Coloso is classified as prime farmland if drained. Informal or subsistence cattle grazing activities were observed at the disposal dikes and other neighboring properties during site visits in the fall of 2021. Prime farmland and farmland of statewide importance classified soils occur along the reservoir's nearby areas (Figure 8 in Appendix A).

Prior to 1960 cropland comprised 48% of the basin and reported erosion rates were high however, following economic shifts during the 1960s, cropland was abandoned and replaced by forest, which increased from 7.6% in 1950 to 20.6% in 1987 (Gellis et al. 2006). The increase in forest area and permanent ground cover vegetation resulted in slower water movement and soil stabilization. Therefore, sedimentation rates during the 1964-1990 period of the reservoir's operation were slightly lower than the rates during the early part of the reservoir's operation (1953-1963).

Seismicity

Puerto Rico and the nearby Caribbean islands are in a seismically active region. In the 20th century alone, there have been several very large earthquakes north of Puerto Rico, with known magnitudes of 7.0 between 1946 and 1953 and magnitude 8.0 in 1946 and four major aftershocks of magnitude 7. An earthquake sequence in southwest Puerto Rico began on December 28, 2019, with a magnitude 4.7 earthquake (USGS 2020). Minor earthquakes causing land slumps and slides are common in the mountainous areas of Puerto Rico (Larsen and Torres Sanchez 1998).

Landslides

Landslides typically occur in areas with specific geologic formations of steep slopes in hilly and mountainous areas of the island due to runoff from extreme rainfall events. During Hurricane María, geology alone did not determine where landslides occurred. Data collected after Hurricane María indicated that soil moisture correlated to the distribution of landslides (Bessette et al. 2019). Torrential rains triggered landslides on three-quarters of the island causing blocked roads, which isolated communities from receiving effective emergency response operations. Hurricane María saturated soils which then led to erodible slopes giving away. Landslides and the subsequent runoff events likely contributed to the sedimentation of the Carraízo Reservoir.

The USGS Puerto Rico Landslide Susceptibility ArcGIS Web tool rates areas using a scale which ranges from low to extremely high landslide susceptibility. According to this scale, the disposal dikes, staging area, and temporary dock area are classified as low landslide susceptibility and the disposal dike levees as moderate landslide susceptibility. The pipeline alignment would run through areas mostly classified as low landslide susceptibility; however, there are some areas where the potential is classified as moderate (USGS 2021).

5.1.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction phase, dredging operations, or demobilization activities under the No Action Alternative. The reservoir sedimentation process would continue. Since the No Action Alternative does not involve subsoil or above-ground activities, it would have no impacts upon the area’s geology, topography, soils, prime farmland resources, seismicity, or landslides.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Alternative 2 would not affect the overall geology in the project area; therefore, there would be no impacts to geology from Alternative 2.

Alternative 2 would not affect topography in the project area, except for the elevation within the disposal dikes which would increase with the deposition of sediments during the dredging process. The disposal dikes were designed and constructed for this purpose as part of the previous dredging event. The dredged sediments would remain in the disposal dikes and with the removal of de-canted water, vegetation would naturally reestablish over time. Alternative 2 would have a negligible direct long-term adverse impact to topography within the disposal dikes.

Under Alternative 2, site preparation/construction activities such as clearing and grubbing associated with installation of the inland sediment pipeline, rehabilitation of the staging area, disposal dikes and access roads, and inland booster pump maintenance during dredging would result in soil compaction, erosion, and sedimentation. The demobilization activities would also disturb soils associated with removal of the inland sediment pipeline and temporary dock. These activities would occur within areas that have previously experienced soil disruption from agriculture and from past dredging activities. Approximately 60% of the sediment pipeline would be floating in the Carraízo Reservoir, the Río Grande de Loíza and the Río Gurabo and would not impact soils. To limit ground disturbance associated with installation of the remaining 40% of the sediment pipeline, PRASA would use existing culverts to go under primary roads and bridges, and above-ground non-invasive temporary weighted anchors and crossing devices for dirt road and ditch/channel crossings.

The dikes were originally designed to sustain the material placed on the interior even under conditions of earthquake shaking. In 2022 geotechnical studies within the disposal dikes determined that the underlying sediments are weak and that if the disposal dikes are filled too rapidly, the underlying sediments could shift. Therefore, close monitoring of the rate of new dredge placement would be conducted (Suelos 2021a-c). This alternative would have minor direct short-term adverse impacts at disposal dikes B and C from the possibility of soil collapse when the dredge material is placed in the disposal dikes. These impacts would be negligible with implementation of Best Management Practices (BMPs) described in the geotechnical studies including daily inspection of all dike perimeters and dredge pipelines. Dredged material would be placed in geotubes in disposal dike A; no new dredged material would be placed against the dikes.

The National Pollutant Discharge Elimination System (NPDES) requirements would contribute to controlling and minimizing adverse impacts to soil resources from on-site erosion, including nearby receptor waters. Under the EPA NPDES program, projects disturbing 0.405 hectare (1 acre) or more require a construction NPDES permit and a Stormwater Pollution Prevention Plan (SWPPP). NPDES permit conditions require the management of soil or debris stockpiles, minimization of disturbance to erodible slopes, preservation of native topsoil, and reduction in soil compaction and erosion.

A Single Incidental Operational Permit would be required by the Puerto Rico Permit Management Office to authorize earthwork and the establishment of erosion control measures on areas where soil disturbance is foreseeable. For Alternative 2, permit requirements and implementation of BMPs associated with the NPDES permit and the Single Incidental Operational Permit would minimize adverse impacts to the physical resources.

Alternative 2 would cause minor direct short-term adverse impacts to soil resources. These impacts would be minor because the area where the sediment pipeline would be installed is relatively level with a low potential for erosion. The pipeline installation would be non-invasive with no excavation. BMPs would be implemented as required to reduce erosion.

Farmland designations, as defined by USDA-NRCS, were observed for soils within the three disposal dikes, staging area and inland sediment pipeline alignment segments (Figure 8 in Appendix A). The disposal dikes and staging area replaced original farmland characteristics when these were originally built for the previous dredging event, therefore there would be no prime farmland losses by the rehabilitation and use of disposal dikes. According to USDA-NRCS soil survey maps, the inland sediment pipeline and booster pumps would temporarily run over soils classified as prime farmland and farmland of statewide importance.

Site preparation/construction and demobilization activities would have minor direct short-term impacts on farmland because the pipeline would be placed aboveground, and no soil disturbance would occur in this area.

Proposed activities under Alternative 2 would have no impacts on seismicity because project activity would not entail the use of explosives or mining activities that would cause an earthquake.

Alternative 2 would not modify current disposal dikes configuration, or the other areas where project components have been proposed to be installed. Therefore, no impacts on landslides susceptibility have been identified for this alternative.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

The proposed dredging method and alternative components for Alternative 3 would be the similar to Alternative 2, with a variation on sediment volume removed and the dredging period of 20 years. Alternative 3 would include sediment processing and transport as part of the proposed dredging event to remove the total volume of 6 Mm^3 (7.8 Mcy). Sediment processing to segregate the sand and gravel portions would occur within the disposal dike A footprint. The destination of the dry sediment would be to authorized operating facilities. The reuse of dredged sediments as construction materials (sand and gravel) and/or as fill material for various uses, such as landfill daily cover, would result in indirect long-term benefits on the region's soils and geology due to sediment reuse instead of new extraction activities. If the dredged material cannot used beneficially, it would be transported to an authorized registered landfill.

Alternative 3 impacts would be similar to those described under Alternative 2 for geology, topography, prime farmlands, and seismicity for the site preparation/construction, dredging operation, and demobilization activities. Impacts would also be similar for soil resources and landslides, however the extended period required to dredge the 6 Mm^3 (7.8 Mcy) would cause these impacts to be long-term. This conclusion also assumes implementation of BMPs.

The transportation of dewatered dry sediments would occur along existing roads and would be sent to currently operating authorized facilities, therefore, impacts on farmland soils or soils compaction would be negligible. The proposed sediment processing activities would not require the use of explosives or mining activities therefore Alternative 3 would have no impacts upon geology, or seismicity. Under this alternative proposed BMPs would be similar to those considered for Alternative 2.

5.2 AIR QUALITY

The Clean Air Act (CAA) of 1970 (42 U.S.C. §7401 et seq.), including its 1977 and 1990 amendments, regulates air emissions from stationary and mobile sources. This law tasks EPA, among its other responsibilities, with establishing primary and secondary air quality standards. Primary air quality standards protect the public's health, including the health of "sensitive populations, such as people with asthma, children, and older adults." Secondary air quality standards protect the public's welfare by promoting ecosystem health, preventing decreased visibility, and reducing damage to crops and buildings. The EPA has set National Ambient Air Quality Standards (NAAQS) for the following six criteria pollutants: carbon monoxide (CO), lead, nitrogen oxide (NO_2), ozone (O_3), particulate matter (less than 10 micrometers [PM_{10}] and less than 2.5 micrometers [$PM_{2.5}$]), and sulfur dioxide (SO_2) (EPA 2022).

Federally funded actions in nonattainment and maintenance areas are subject to EPA conformity regulations (40 CFR Parts 51 and 93), which ensure that emissions of air pollutants from planned federally funded activities would not affect the state's ability to meet the NAAQS.

Section 176(C) of the CAA requires that federally funded projects conform to the purpose of the State Implementation Plan (SIP), meaning that federally funded activities would not cause violations of the NAAQS, increase the frequency or severity of NAAQS violations, or delay timely attainment of the NAAQS or other interim milestone.

The 1990 Amendments to the CAA require that federal agency activities conform to the SIP with respect to achieving and maintaining attainment of NAAQS and to addressing air quality impacts. The EPA's General Conformity Rule requires that a conformity analysis be performed which demonstrates that a proposed action does not: (1) cause or contribute to violation of NAAQS in the area; (2) interfere with provisions in the SIP for maintenance or attainment of NAAQS; (3) increase the frequency or severity of existing violation of NAAQS; or (4) delay timely attainment of NAAQS, interim emission reduction goals, or other milestones included in the SIP.

The conformity requirements of the CAA and its regulations limit the ability of federal agencies to assist, fund, permit, and approve projects that do not conform to the applicable SIP. When subject to this regulation, the federal agency is responsible for demonstrating conformity for its proposed action. Conformity determinations for federal actions other than those related to transportation plans, programs, and projects, funded, or approved under title 23 U.S.C. or the Federal Transit Act (49 U.S.C. 1601 et seq.) must be according to the federal general conformity regulations (40 CFR 93 Subpart B). Exemptions for certain actions and activities from general conformity review include:

- Stationary source emissions regulated under major or minor New Source Review (air permitting) programs
- Alteration and additions of existing structures as specifically required by new or existing applicable environmental legislation
- Actions where the emissions are not reasonably foreseeable
- Actions that a federal agency or state determines are "presumed to conform"
- Activities with total direct or indirect emissions (not including stationary source emissions regulated under New Source Review programs) below *de minimis* levels.

The CFR Title 40, Part 89 contains EPA emission standards for heavy equipment nonroad diesel engines. Heavy equipment includes excavators and other construction equipment, farm tractors and other agricultural equipment, forklifts, and utility equipment such as generators, pumps, and compressors.

5.2.1 Existing Conditions

Under the administration of the CAA, EPA has adopted multiple tiers of emission standards. The implementation of Tier 1, Tier 2, Tier 3, and Tier 4 standards progressively require compliance with more stringent emission standards. In 2004, EPA published the final rule (40 CFR Parts 9, 69, et al.) introducing Tier 4 emission standards, which were phased-in from 2008-2015. To meet the Tier 4 emission standards, engine manufacturers began producing engines with advanced emission control technologies. The EPA has also adopted requirements for in-use diesel fuel to decrease sulfur levels by more than 99%. The resulting Ultra Low Sulfur Diesel Fuel has a maximum sulfur concentration of 15 parts per million (EPA 2021a).

On November 29, 2018, EPA approved Puerto Rico's revised SIP dated February 1, 2016, effective December 31, 2018. The purpose of the revision was to address the interstate transport of air pollution that may interfere with attainment and maintenance of NAAQS. In this action, the approval is pertaining to the 1997 and 2008, ozone O_3, 1997 and 2006 fine particulate matter ($PM_{2.5}$), and 2008 lead NAAQS (EPA 2018).

As of June 30, 2021, EPA's Green Book classified several of Puerto Rico's municipalities as nonattainment areas or in maintenance for criteria pollutants lead and sulfur dioxides and maintenance for particulate matter. If the air quality in a geographic area meets or is cleaner than the national standard, the area is called an attainment area (designated "attainment/unclassifiable"). As of December 2021, and pursuant to 40 CFR 81.355, the municipalities of Trujillo Alto, Caguas, and Gurabo have a designation of attainment/unclassifiable for the NAAQS. The Puerto Rico Environmental Quality Board (PREQB), under the Puerto Rico Department of Natural and Environmental Resources (PRDNER), monitors, manages, and regulates air quality standards using its approved SIP. Activities that generate emissions or air pollutants must comply with Regulation for the Control of Atmospheric Pollution and Regulation with a General Permit from PRDNER.

5.2.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging operations, or demobilization activities under the No Action Alternative. Therefore, this alternative would have no short- or long-term adverse impacts on air quality within the project area or surrounding municipalities.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Emissions from site preparation/construction, dredging operations, and demobilization activities have the potential to affect air quality. Alternative 2 activities would include equipment such as employee-owned trucks and cars, portable power generators, on-road construction-related vehicles, and dust-generating construction activities; dredging equipment, booster pumps, dredging operation support vehicles, and equipment; and vehicles and equipment used for demobilization. Alternative 2 would result in temporary emissions associated with the fuel-burning equipment required to perform the proposed activities. The $PM_{2.5}$ and PM_{10} levels would increase during the site preparation/construction activities within the staging area, disposal dikes, and inland pipeline areas. The potential for fugitive dust following the completion of construction activities would be reduced to negligible levels as project areas would be stabilized in accordance with NPDES regulation.

Dredging equipment and booster pumps would be operated up to 24-hours a day, 7 days a week. The dredging equipment would move at a slow pace in the reservoir as it dredges and sucks sediment into the pipeline. Booster pumps would be used to help push the sediment through the pipeline. Booster pumps would be mounted on floating platforms approximately 1.6 km (1 mi) apart in the reservoir. For the inland pipeline, stationary booster pumps, mounted on skids, would be spaced approximately 0.8 km (0.5 mi) apart. Emissions from dredging equipment, construction vehicles, and booster pumps combustion engines, would temporarily increase the local levels of some of the criteria pollutants including CO, NO_2, O_3, PM_{10}, and non-criteria pollutants such as volatile organic compounds (VOCs).

Implementing BMPs and strict adherence to regulatory requirements and standards would limit adverse impacts to air quality associated with Alternative 2 activities. BMPs would include measures such as traffic management techniques, fugitive dust control, proper vehicle maintenance, and minimizing vehicle idling time, among others. PRDNER, formerly PREQB, Rule 404 Fugitive Emissions requires the implementation of BMPs that would assist in limiting short-term adverse impacts to air quality (PREQB 1995). Ultra-low sulfur diesel fuel would be used, as required by the Clean Air Nonroad Diesel Rule, for equipment such as booster pumps. Alternative 2 does not include the permanent installation of new sources of air emissions; therefore, there would be no long-term adverse impacts to air quality from this alternative.

The site preparation/construction, dredging operations, and equipment demobilization under Alternative 2 would have minor direct short-term impacts on air quality within the project area and neighboring municipalities with implementation of BMPs and regulatory requirements.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Under Alternative 3, impacts to air quality would be similar to Alternative 2 for the site preparation/construction and demobilization phases. The proposed dredging method and project components for Alternative 3 would be similar, with a variation on total sediment volume to be dredged and a longer total dredging duration (20 years). To achieve removal of 6 Mm^3 (7.8 Mcy) sediment, Alternative 3 would require the annual removal of 300,000 m^3 (392,385 cy) of de-watered sediments from disposal dike A, once the three disposal dikes' storage capacity is reached. Sediment dredging, dewatering, sorting and transportation off-site would continue exclusively at disposal dike A beginning approximately during year 7 or 8 after initiating dredging activities, and continuing until year 20. Dredging operations at disposal dikes B and C would stop and equipment demobilized.

Fugitive dust would be generated during the project phases. Dust generated by trucks and processing equipment would be a source of particulate matter. Therefore, particulate matter and carbon monoxide would be air pollutants of concern associated with these activities because of the longer duration. BMPs would be enforced to minimize dust generation within the project area during all phases. Control measures would be implemented and could include water sprinklers or spraying from a truck-mounted tank, frequent washing of trucks carrying material routes to control dust emissions and covering the trucks that carry material while they are in transit to avoid particulate matter emissions.

Transport of dried sediment off-site would require an average of 77 truckloads, five days per week on a yearly basis which would equate to 154 truck trips per day between 7:00 a.m. and 10:00 p.m. The closest air sensitive receptor to disposal dike A is the neighborhood of Santa Bárbara. In this community, there are 26 structures along the property fence line approximately 34.57 m (113.4 ft) from disposal dike A's internal haul road and access gate. At this distance to the air sensitive receptors, air emissions from processing, sorting and dump trucks would be above the allowable federal levels between 7:00 a.m. and 10:00 p.m. each day. If selected, this alternative would require additional studies.

The roads employed for the transport of dry sediment materials would be PR-9189 for 1.4 km (0.9 mi), to PR-189 for 0.40 km (0.25 mi), to PR-30 for 9 km (5.6 mi). For these roads with Annual Average Daily Traffic (AADT) information, the annual increase in traffic from workers and sediment transport trucks, would be in the range of 0.5% to 2.3%. Increase in the levels of some of the criteria pollutants including CO, NO_2, O_3, PM_{10}, and non-criteria pollutants such as VOCs would result in moderate impacts between 7:00 a.m. and 10:00 p.m. each day to the sensitive receptors along these routes. The pollutants would dissipate each night.

Alternative 3 would have major direct long-term adverse impacts to residential communities adjacent to disposal dike A. Implementation of BMPs described under Alternative 2, as well as conducting truck activities during daytime hours would not decrease the level of the impact to less than major. Due to the potential air impacts to residential communities adjacent to disposal dike A, if this alternative is selected, additional studies would be needed.

5.3 WATER RESOURCES AND WATER QUALITY

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. (WOTUS) and regulating quality standards for surface waters. Section 401 of the CWA also requires state certification of federal licenses and permits in which there is a "discharge of fill and/or dredged material into navigable waters of the United States." The process of obtaining a Section 401 Water Quality Certification (WQC) establishes whether an activity, as described in the federal license or permit, would impact site-specific water quality standards. Prior to the issuance of a relevant federal license or permit, Section 401 of the CWA requires that the state first issue a WQC for the project. In Puerto Rico, PRDNER is the local agency with jurisdiction to evaluate and grant the WQC. The most common federal license or permit requiring a WQC is the USACE-issued CWA Section 404(d) permit.

PRDNER takes an active role in water quality-based permitting through the CWA Section 401 certification process. PRDNER issues a local WQC under the authority of the Puerto Rico Water Quality Standards Regulation. The EPA reviews applications for completeness and requests PRDNER certification prior to development of a draft permit. The PRDNER can include water quality-based effluent limits and special conditions in the water quality certificates they develop. The PRDNER has adopted an anti-degradation policy and regulations are in place to protect coastal, surface, and ground waters.

Section 402 of the CWA established the NPDES program, which authorizes EPA to issue permits for the point source discharge of pollutants into WOTUS. Under the NPDES, EPA regulates both point and non-point pollutant sources, including stormwater and stormwater runoff for projects with ground disturbance of more than 0.4 hectare (1 acre). The NPDES permit requires the preparation of a SWPPP for each project that qualifies under the program.

The USACE, through its permit program, regulates the discharge of dredged or fill material into WOTUS pursuant to Section 404 of the CWA, unless the activity is exempt from Section 404 regulation. Activities in WOTUS regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as stormwater/wastewater pipelines, outfall/intake structures, highways and airports) and mining projects. Also, activities regulated pursuant Section 404 of the CWA are the addition of dredged material in waters of the United States; the re-deposit other than incidental fallback of dredged material, including excavated material, into waters of the United States which is incidental to any activity, including mechanized land clearing, ditching, channelization or other excavation; and the runoff or overflow from dredged material contained land or water disposal area to waters of the United States.

The Principles, Requirements, and Guidelines (PR&G) was established pursuant to the Water Resources Planning Act (Public Law 89-8), *as amended* (42 U.S.C. 1962a-2) and consistent with Section 2031 of the Water Resources Development Act of 2007 (Public Law 110-114). The PR&G apply to federal water resource investments that directly or indirectly alter water resources. Agency Specific Procedures (ASP) are developed to help an agency comply with PR&G. The ASP Documentation Template was completed by FEMA to integrate the PR&G analysis into the NEPA analysis for this project (FEMA 2021) (Appendix F).

Section 305(b) of the CWA requires states, territories, and other jurisdictions of the U.S. to biannually submit reports to EPA on the quality of their surface waters. These entities have determined the appropriate uses of each waterbody within their jurisdiction, which in Puerto Rico includes recreation, aquatic life, and drinking water sources. Section 305(b) reports provide information on the water quality status of waters in Puerto Rico, whereas section 303(d) lists are a subset of these waters – reporting those waters that are impaired by a pollutant and in need of a Total Maximum Daily Load (TMDL) plan (EPA 2021c). A TMDL is the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for pollutants. The EPA approves and establishes TMDLs for the assessment unit/pollutant combination. Once the TMDL for a specific waterway is determined, a plan is developed and implemented to improve the waterway's water quality (EPA 2021c).

5.3.1 Existing Conditions

The Carraízo Reservoir was constructed to store water collected from rivers and rainfall within the Caguas-Juncos Valley to provide a source of water for PRASA's SCWFP. The principal rivers that drain into the Carraízo Reservoir are the Río Grande de Loíza, Río Gurabo, and Río Cañas (Soler-López, L.R., and Licha-Soler, N.A. 2012). Two other rivers, the Río Bairoa and Río Cagüitas, discharge into the Río Grande de Loíza just before it enters the reservoir. Although rainfall is abundant generally from April until November, roughly two-thirds of the rainfall is not available as runoff due to evaporation and/or transpiration. Raw water reservoirs, such as Carraízo, accumulate silt and sand on the bottom, affecting the volume of stored water.

Sedimentation at the Carraízo Reservoir has historically been an ongoing challenge affecting the reservoir's retention capacity. Currently, the reservoir's capacity is approximately 15.06 Mm^3 (19.7 Mcy) according to the October 2019 bathymetric survey conducted as part of the *Sedimentation Survey of Lago Loíza, Puerto Rico* (GLM 2020) (Appendix B). This storage corresponds to 56% of the 1953 original reservoir storage capacity of 26.8 Mm^3 (35 Mcy) (44% volume loss). The survey concluded that the amount of sediment delivered into the reservoir as a result of Hurricane María was 2.35 Mm^3 (3.07 Mcy).

Groundwater

The Caguas-Juncos Valley occupies an area of approximately 90.6 km^2 (35 mi^2) within the Puerto Rico east-central region and is on top of a predominantly open alluvial aquifer consisting of clay, silt, fine sands, and gravel. The alluvial aquifer has a maximum thickness of approximately 61 m (200 ft). The alluvial aquifer groundwater flows from recharge areas to main rivers along its extension. The regional flow direction is primarily from east to west within the Gurabo-Juncos area and southwest to northeast within the Caguas area heading to the Carraízo Reservoir along the principal floodplain (Puig and Rodríguez 1993).

Most of the Carraízo Reservoir and disposal dike B are on top of the volcanoclastic, igneous, and sedimentary rock aquifers. Disposal dikes A and C are over the alluvial valley aquifer. Figure 9 in Appendix A presents the groundwater aquifer formations map.

As part of the subsoil and geotechnical exploration, groundwater table levels were observed after drilling was completed. No groundwater table levels were observed at disposal dikes B and C. The groundwater level at disposal dike A was between 7.6 to 15.2 m (25 to 50 ft) within the disposal dike A footprint (Suelos. 2021a-c). Appendix E includes the geotechnical reports for the disposal dikes.

Hydrology

Surface water in the Caguas-Juncos Valley is abundant and numerous perennial streams and creeks traverse the valley. A few creeks are ephemeral, particularly along the eastern boundary of the Gurabo-Juncos subarea. The largest rivers flowing through the valley are the Río Grande de Loíza, the Río Gurabo, the Río Valenciano, the Río Turabo, the Río Cagüitas, and the Río Bairoa (Puig and Rodríguez 1993). Disposal dikes B and C are close to the Río Gurabo. Disposal dike A is close to the Río Cagüitas. The staging area, which was also used during previous dredging activities, is adjacent to the Río Grande de Loíza (Figures 4 and 5 in Appendix A).

The Río Gurabo serves as the main raw water source to the Gurabo Water Filtration Plant (GWFP), which is owned and operated by PRASA. This plant is north of the Jardines de Gurabo residential development, adjacent to the Río Gurabo and within the CRW (Figures 4 and 5 in Appendix A). The GWFP raw water intake in the Río Gurabo is downstream of disposal dike C. The GWFP facility is composed of two independent filtration units, each capable of producing up to 2.0 MGD of potable water for a total capacity of 4.0 MGD (EPA 2018a). The GWFP service area includes the municipality of Gurabo, specifically the Jaguar, Rincón, Hato Nuevo, Celada, and Masas Wards, and a few small sectors of the municipality of Carolina.

Water Quality

According to the 305(b) and 303(d) Integrated Report, there are nineteen possible causes of impairment for rivers and streams (PRDNER 2020). The potential sources of pollution are wastewater collection systems failure, confined animal feeding operations, onsite wastewater systems, and urban runoff/storm sewers. The following paragraphs summarize the findings of the 2020 303(d) report for the Carraízo Reservoir and the Caguas-Juncos Valley rivers and streams.

The 2020 PRDNER 303(d) list of impaired waters indicates that Carraízo Reservoir (Lago Loíza) is impaired for aquatic life and drinking water. Potential pollution sources are collection system failure, confined animal feeding operations, onsite wastewater systems, and urban runoff/storm sewers. The causes of impairment are changes in the levels of copper, dissolved oxygen, pH, temperature, total nitrogen, total phosphorous, and turbidity and implementation of a TMDL plan is required to improve the reservoir's water quality (PRDNER 2020). A TMDL plan was approved in 2007 for Carraízo Reservoir (Lago Loíza) for fecal coliform (PRDNER 2020).

Río Grande de Loíza and the Río Gurabo are impaired for drinking water, aquatic life, and recreation (primary and secondary contact recreation). The potential sources of pollutants for Río Grande de Loíza and Río Gurabo were collection system failure, agricultural collection system failure, confined animal feeding operations, landfills, minor and major industrial point sources, onsite wastewater systems, surface mining, and urban runoff/stormwater (PRDNER 2020). Pollutants related to the impairment listing for these rivers include chromium VI, copper, enterococcus, temperature, total nitrogen, total phosphorus, lead, pesticides, and turbidity (PRDNER 2020). To improve and monitor water quality, TMDL plans were approved for Río Grande de Loíza for fecal coliform in 2003 and 2012, dissolved oxygen in 2007, copper in 2007, and ammonia in 2007. TMDL plans were approved for Río Gurabo for fecal coliform in 2007 and dissolved oxygen in 2007.

The Río Cañas waters meet the applicable water quality standards for aquatic life but are impaired for recreational uses (primary and secondary). For drinking water there is insufficient available data and/or information to determine if the designated use is being attained. The primary sources of pollutants reported were collection system failure, confined animal feeding operations, and onsite wastewater systems. Pollutants related to the impairment listing are not reported (PRDNER 2020).

A sediment sampling event was performed to characterize the sediment accumulated in the reservoir and at the three disposal dikes (GLM 2021) (Appendix G**)**. This characterization includes both granulometry and chemical analysis to determine if hazardous contaminants are present. Sediment core samples were obtained during May 2021. A total of ten cores were collected, and their locations are identified in Figure 10 in Appendix A. Additional cores were collected to provide sufficient material for column settling tests. Two sub-samples were taken from each core for testing purposes, except for cores 4, 5 and 9, where only 1 sample was collected, for a total of 17 samples. The sampling tubes were vibrated into the sediment to the point of rejection, due to coarse sediments or buried debris, or until the core had penetrated to its full length into soft sediments. Recovered sediment core lengths varied from 0.6 m (2 ft) in sand and 1.5 m (5 ft) (full penetration) in fine sediment. Elevations at which samples were taken ranged from 26.35 m to 30.56 m (86.4 to 100.3 ft). The sampling depth was below the planned dredging depth of 30.6 m (100.4 ft) or higher. Six additional samples were collected from the three disposal dikes (two samples per disposal dike).

Sediment samples were analyzed to identify the presence of contaminants that could be subject to dispersion if the sediments were disturbed or resuspended during dredging activities. The sediment samples were analyzed for releasable sulfide, organic matter, corrosivity and pH; Toxicity Characteristic Leaching Procedure (TCLP) herbicides, TCLP VOCs, TCLP semi-volatile organic compounds, TCLP pesticides, TCLP metals, TCLP mercury, and releasable cyanide. A TCLP determines the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes. If the resulting concentrations are below the regulatory level or threshold for the parameter, then the sample is classified as non-hazardous. A complete list of the parameters measured is included as part of the sediment sampling report (GLM 2021) (Appendix G).

According to the sediment samples analysis, detectable TCLP parameters remain well below the regulatory level for hazardous solid wastes in the Carraízo Reservoir. Samples are characterized as non-hazardous, showing levels below threshold limits by several orders of magnitude. Overall, the analysis shows the Carraízo Reservoir sediments to be non-hazardous within sampled depths.

The FEMA requested the EPA Region 2 Environmental Review Team provide feedback on the overall methodology and results of the report. The EPA provided the following comments (Appendix G):

- The EPA concurs with the methodology and tests chosen to analyze the dredged material for storage in containment areas or as landfill or slope cover.
- If it is decided to relocate the storage of the dredged material for another application, further tests may be necessary.

5.3.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging or demobilization activities under the No Action Alternative. The No Action Alternative would not mitigate the impacts to Carraízo Reservoir's water storage capacity after Hurricane María. There would be a continuing deposit of sediments that would eventually prevent the operation of the SCWFP raw water intake. During droughts, sediment barriers would form, reducing the necessary constant water flow to the water intake. This would result in negative impacts due to the permanent reservoir capacity loss.

Major indirect long-term adverse impacts to water resources availability would result from the No Action Alternative since PRASA would eventually not be able to provide a steady, reliable source of potable water for the SCWFP service area. Future service interruptions, even under normal non-drought weather conditions, would occur under this alternative. The reduction of the reservoir's capacity would also reduce the SCWFP water intake operational flexibility, making it unusable at its lower end due to sedimentation. Based on a long-term storage capacity loss of about 0.310

Mm^3/yr (0.405 Mcy/yr), the Carraízo Reservoir's projected useful life would be reached by 2062 (Soler-López and Licha-Soler 2012).

There would be negligible indirect short-term impacts to water quality conditions under the No Action Alternative. However, if the water storage capacity loss remains unattended for an extended period, indirect major long-term impacts to water quality would likely occur, mostly associated with a continued sedimentation process. The constant deposit of soil and sediment into the reservoir would impact water quality parameters such as turbidity and dissolved oxygen levels.

There would be no impacts to the hydrology and groundwater in the region under the No Action Alternative. This alternative would not lead to the exhaustion of the resource, and it would neither interfere with recharge areas nor would it have the potential for groundwater degradation.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

By dredging the reservoir, Alternative 2 would increase water storage capacity to approximately 17.02 Mm^3 (22.26 Mcy) over a two-year period. This would be a beneficial direct long-term impact for the population served by the SCWFP in terms of water availability and PRASA's operational reliability.

The site preparation/construction phase includes clearing and grubbing at the staging area, temporary dock installation, sediment pipeline alignment installation, and disposal dikes' rehabilitation. The temporary dock would be constructed at the staging area to provide access to the dredge barge and other equipment required for dredging. The temporary dock could require installation of support piles that would directly impact water quality. Potential impacts would include a temporary increase in turbidity and total suspended solids levels caused by the sediment disturbance of water bottoms in the temporary dock area.

The site preparation/construction activities could result in sediment runoff, mainly from clearing and grubbing which would expose soils. Mitigation of potential temporary impacts to surface water during the site preparation/construction phase would be achieved using BMPs to control erosion due to surface water runoff (Appendix H). BMPs for runoff impacts would include implementing a SWPPP, as required by local and federal agencies.

Another potential water quality impact would be potential spills that may gain access to surface or groundwater during site preparation/construction and dredging operation phases. Potential contaminants could include fuel, oil, and hydraulic fluids from leaky equipment or during refueling activities, construction dust, and treated wood. A Spill Prevention Control and Countermeasure (SPCC) Plan would be required and would describe the BMPs for oil handling operations, spill prevention practices, discharge or drainage controls, and the personnel, equipment and assigned resources that would be used to prevent oil spills from reaching navigable waters or adjoining shorelines.

During dredging activities, water quality would be impacted by reservoir bottom disturbance. Potential impacts would include an increase in turbidity and total suspended solids levels caused by sediment re-suspension in areas where the dredging equipment would be operating. Overall, the sediments analysis shows the Carraízo Reservoir sediments to be non-hazardous. Based on the sediment sampling analysis, the re-suspension and disposal of dredged sediments would have a negligible potential to disperse contaminants within the reservoir or disposal dikes. Dredging depths for Alternative 2 would not exceed the depth reached during the 1998 dredging event, therefore no new (untested) sediments would be exposed.

Minor to moderate direct short-term impacts to water quality would occur associated with the installation and operation of the dredge, floating sediment pipelines, and floating booster pumps along the Carraízo Reservoir, the Río Grande de Loíza and Río Gurabo.

A Joint Permit Application (JPA) will be submitted by the PRASA to the USACE pursuant to Section 404 of the CWA for the discharge of fill and/or dredged material in waters of the United States associated to the proposed dredging project. A water quality monitoring program and BMPs would be implemented as required by the CWA water quality certificate associated with the JPA or by an agreement with the Puerto Rico Department of Health (PRDOH) or both to reduce potential adverse impacts to water quality.

The following BMPs would be implemented to reduce potential impacts to water quality during dredging.

- Maintain dredging activity at least 1,000 m (3,280 ft) away from the SCWFP potable water supply intake.
- Implement measures to prevent fuel and oil spills within the reservoir during fueling of equipment. Oil booms would be used during fueling operations.
- Implement techniques and equipment necessary to ensure that turbidity and other water quality parameters requirements outlined in the referred WQC or agreement with PRDOH, or both, are met. Turbidity curtains would be used during dredging operations to help control turbidity in the reservoir.

Minor to moderate direct impacts to water quality may occur to waterbody receptors (Río Grande de Loíza and Río Gurabo) during the discharge of decanted water from disposal dikes back to the reservoir. The following approach would be employed to mitigate potential temporary water quality impacts:

- Two methods would be used to extract water from the dredged material and return the water to the rivers. One method would be through conventional direct deposit of dredged material into the disposal dikes with subsequent time to allow the settling of dredged materials and later discharge of decanted water back into the river. The second method for dewatering the dredged material would use geotextile tubes placed within the existing disposal dikes and filled with dredged material. The geotextile tubes would reduce the potential for solids re-suspension and decanting time within the disposal dikes. This method would optimize the capacity of the disposal dikes by increasing the efficiency of the dewatering process. Also, the use of geotextile tubes would reduce the material handling at the disposal dikes and the overall dredging activities duration.

- The disposal dikes have existing weir outlet structures used for the previous dredging project to control the release of decanted water. The existing weirs are no longer operable. This alternative would demolish and construct replacement weir outlet structures to provide operable weirs to control water discharge into the reservoir once water quality parameters are reached.

- Water quality at the disposal dike outfall would be monitored during the decanting process. This monitoring program would provide information needed to make the necessary adjustments in the settling time operations to comply with water quality standards.

The operation of the SCWFP and the GWFP may be indirectly impacted by high turbidity/total dissolved solids conditions and chemical parameters alteration during dredging and sediment de-watering activities. Water quality at the SCWFP and GWFP raw water intakes would be monitored during the dredging process and corresponding adjustments would be implemented for dredging activities as well as the decanting process. Monitoring frequency and parameters would be according to the WQC or agreement with PRDOH or both. The PRASA intends to prepare and implement a Water Interruption Plan specifically for this project if during dredging operations water service is interrupted or modifications to operations are required to comply with water quality standards for the SCWFP and GWFP service area populations. Frequently these filtration plants operate under high turbidity/total dissolved solids conditions suggesting that dredging activities with implementation of BMPs would have no adverse impact on day-to-day operations of the plants (PRASA 2022).

Alternative 2 would result in minor, direct short-term impacts to reservoir water quality during site preparation/construction, dredging, and demobilization with implementation of proposed BMPs. Minor indirect short-term impacts would occur to SCWFP and GWFP operations during dredging activities and demobilization with the implementation BMPs. Activities performed under Alternative 2 would comply with CWA Section 404 issued by USACE and CWA Section 401 WQC issued by PRDNER.

This alternative would not include activities that would lead to the exhaustion of groundwater. It would not increase interference with recharge areas. Implementation of BMPs to protect the quality of surface water would avoid and minimize the potential for groundwater degradation. Minor direct short-term impacts to the hydrology and groundwater in the region would occur under Alternative 2 during site preparation/construction, dredging operations, and demobilization phases with implementation of proposed BMPs.

Alternative 2 proposed activities would have beneficial direct long-term impacts on the water resource with the restoration of the reservoir's water storage capacity. This would be beneficial to the population served by the SCWFP in terms of water availability and operational reliability.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Activities and impacts for Alternative 3 would be similar to Alternative 2 for the site preparation/construction and demobilization phases. The proposed dredging method and project components for Alternative 3 would be similar, with a variation on total sediment volume to be dredged and a longer total dredging duration (20 years). To remove 6 Mm^3 (7.8 Mcy) of sediment, Alternative 3 would require the annual removal of 300,000 m^3 (392,385 cy) of de-watered sediments from disposal dike A, once the three disposal dikes' storage capacity is reached. Sediment dredging, dewatering, sorting and transportation off-site would continue exclusively at disposal dike A beginning approximately during year 7 or 8 after initiating dredging activities, and continuing until year 20. Dredging operations at disposal dikes B and C would stop and equipment demobilized.

Alternative 3 would have minor direct long-term potential impacts to reservoir water quality due to the 20-year duration of the dredging activity, its disturbance of the reservoir's bottom, and water decanting back to the reservoir. BMPs for Alternative 3 would be similar to those described for Alternative 2.

Alternative 3 proposed activities would have beneficial direct long-term impacts on the water resource with the restoration of the reservoir water storage capacity. This would be beneficial to the population served by the SCWFP in terms of water availability and operational reliability.

5.4 WETLANDS

Wetlands are areas saturated or inundated by surface or ground water with a frequency enough to support, or that under normal hydrological conditions does or would support, a prevalence of vegetation or aquatic life typically adapted for these soil conditions. Examples of wetlands include swamps, marshes, estuaries, bogs, beaches, wet meadows, sloughs, mud flats, among others. Wetlands are important because they protect and improve water quality, provide fish and wildlife habitats, provide economic and social benefits, store floodwaters, and maintain surface water and groundwater flow during dry periods. Executive Order (EO) 11990 Wetlands Management requires federal agencies to avoid funding activities that directly or indirectly support occupancy, modification, or development of wetlands, whenever there are practicable alternatives.

The USACE, through its permit program, regulates the discharge of dredged or fill material into WOTUS, including wetlands, pursuant to Section 404 of the CWA. In addition, EPA has regulatory oversight of the USACE permit program, allowing the agency under Section 404c to comment on USACE issued permits with unacceptable environmental impacts.

The PRDNER Regulation for the Conservation and Management of Wildlife, Exotic Species and Hunting (Regulation 6765) does not define wetlands or establish criteria for their delineation. The PRDNER uses the federal process, implemented by USACE through the Section 404 of the CWA, to regulate activities in wetlands areas. The PRDNER participates in the federal regulatory process implementation.

According to the definition of natural habitat provided in the Law 241 of 1999 – *Ley de Vida Silvestre de Puerto Rico,* urbanized land is not considered natural habitat. The disposal dikes are utility infrastructure directly associated with dredging operations of the Carraízo Reservoir and would not be classified as natural habitats. Regulation 6765 does not regulate urbanized areas.

The FEMA uses the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory, state-specific mapping tools and on-site surveys to identify wetlands and evaluate actions with the potential to impact wetlands using the 8-Step Process (FEMA 2022). The agency's regulations on conducting the 8-Step Process are contained in 44 CFR Part 9. The 8-Step Floodplain Management Checklist is included as Appendix M. The Public Notice for the draft EA will be published by FEMA and will include the notice for the 8-Step process.

5.4.1 Existing Conditions

Wetlands within Puerto Rico span a vast range of types, from interior montane wetlands of the rain forest to intertidal mangrove swamps along the coast. Historically, wetlands have been dredged and filled for the purpose of agriculture; residential, commercial, and industrial development; and flood control in Puerto Rico. More recently, urban expansion, transportation, and tourist facilities have impacted Puerto Rico's wetlands.

A Wetlands and U.S. Waters Delineation Study (Wetlands Study) was performed in June 2021 to evaluate if the wetlands within the disposal dikes and the staging area should be considered under USACE jurisdiction (CSA 2021a) (Appendix I). A jurisdictional determination is a process used by USACE to make a definitive, official determination whether aquatic resources in the study area are or are not jurisdictional (33 CFR 331.2). The wetlands studied at the disposal dikes are classified as palustrine, emergent, persistent, seasonally flooded (PEM1C) and palustrine, scrub-shrub, broad-leaved evergreen, seasonally flooded (PSS3C).

Disposal dike A is man-made feature built in a site that had approximately 9.64 acres of wetlands; filling was authorized by the USACE permit issued in 1996 (USACE 1996). The disposal dikes B and C are man-made features constructed in uplands and do not constitute impoundments of traditional navigable waters or tributaries to traditional navigable waters. In disposal dike B, open waters were found with an area and volume that varies according to seasonal rainfall. The Wetlands Study concluded that no USACE jurisdictional wetlands were found in disposal dikes A, B or C. No wetlands or WOTUS were found within the staging area study limits. The reservoir shore at the staging area has a steep slope preventing the establishment of a transition wetland area. This determination will be validated during the USACE's JPA process.

The proposed sediment pipeline alignment was overlaid onto the USFWS National Wetland Inventory layer to identify the potential presence of wetlands along the alignment (Figure 11 in Appendix A). A field inspection was performed on March 18, 2022, by two field biologists to confirm this data (CSA 2022). According to this inspection, the pipeline alignment to disposal dikes A and B would partially lay over palustrine emergent wetlands (PEM) areas along the reservoir shoreline. Other segments of the pipelines to disposal dikes A and B would lay over creeks or drainage canal crossings. The categories of these wetland areas are: riverine, lower perennial, unconsolidated bottom, permanently flooded (R2UBH); riverine intermittent, streambed, seasonally flooded (R4SBC); and riverine, unknown perennial, unconsolidated bottom, permanently flooded (R5UBH). These determinations will also be validated during USACE's JPA process.

5.4.2 Potential Impacts

Alternative 1: No Action

Under the No Action Alternative there would be no site preparation/construction, dredging operations, or demobilization activities. The No Action Alternative would not fill or alter existing wetlands. There would be no change in the acreage of wetlands within the Carraízo Reservoir area. Therefore, this alternative would have no short- or long-term adverse impacts on wetlands within the project area.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Potential impacts to wetlands would occur during site preparation/construction and dredging operation phases. Impacts would be associated with clearing and grubbing activities to install the inland sediment pipeline segments.

Based on the Wetland Study, there would be no impacts to federally jurisdictional wetlands as part of the disposal dikes or staging area rehabilitation because no wetlands are present in these areas. The reservoir shore in the staging area has a steep slope preventing the establishment of a transition wetland area (CSA 2022). The activities along the proposed pipeline alignment easement may cause soil compaction of wetland areas. These actions would result in minor direct short-term adverse impacts to wetlands but would not result in the loss of wetland.

The aboveground pipeline would be installed using non-invasive temporary anchors.

. The skid-mounted booster pumps would also be placed on the ground (Appendix D). A pipeline easement would be used during operation for maintenance of the inland booster pump stations. Most of the 12-m (39.4-ft) wide pipeline easement would be in uplands to avoid impacting wetland areas. Vegetation associations along the pipeline route consist of common and widespread species, dominated by such invasives as catclaw mimosa (*Mimosa pellita*) and bamboo grass (*Paspalum fasciculatum*) (CSA 2022).

The CWA permitting under USACE and the use of preventive measures and construction BMPs would minimize short-term impacts during the site preparation/construction phase and to wetlands within the pipeline alignment associated with the weighted anchors and booster pumps. Wetlands identified along the pipeline would naturally revegetate after demobilization of the pipeline and booster pump equipment.

Alternative 2 would have minor to moderate direct short-term impacts on wetlands based on the minimization approach and with implementation of proposed BMPs. There would be no long-term impacts to wetlands due to the proposed project's activities.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

The impacts associated to Alternative 3 would be similar in area and impact type to Alternative 2 but would occur over a longer period. Alternative 3 would include the sediment processing and sediment transport phase from disposal dike A from approximately year 8 to year 20. Sediment processing would occur within the footprint of disposal dike A, transportation off-site would be along existing roads, and the sediment would be deposited to authorized operating facilities; therefore, this phase would have no impact upon additional wetland areas.

Alternative 3 would have minor to moderate direct long-term impacts to wetlands due to the 20-year duration of the dredging activity and the potential for soil compaction in wetlands from the pipeline weighted anchors and booster pumps.

5.5 FLOODPLAIN

The EO 11988, Floodplain Management, was issued in 1977 to eliminate the short- and long-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative for locating a project outside of the floodplain. Executive Order 11988 applies to federally funded projects and directs agencies to consider alternatives to siting projects within a floodplain. Where there are no practicable alternatives, FEMA is required to use minimization standards to reduce impacts to the floodplain and impacts from the floodplain to a facility. Such standards include elevating facilities or equipment above the Base Flood Elevation (BFE), or floodproofing. FEMA uses the Flood Insurance Rate Maps (FIRM) to identify the floodplains for the National Flood Insurance Program (NFIP). The Puerto Rico Planning Board (PRPB) is the local agency that coordinates the NFIP in Puerto Rico. Actions within the 100-year floodplain, also known as the BFE (or 500-year floodplain for critical action facilities), are evaluated by FEMA using the 8-Step Process. The regulations on conducting the 8-Step Process are contained in 44 CFR Part 9. The 8-Step Floodplain Management Checklist is included as Appendix M.

5.5.1 Existing Conditions

The Río Grande de Loíza watershed is the largest drainage basin in Puerto Rico. The reservoir lies at the end of two floodplains formed by the Río Gurabo and the Río Grande de Loíza with alluvium covering almost 100 km^2 (39 mi^2) of the basin. The largest city within the basin, Caguas, is in the floodplain and is bounded by steeply sloped mountains composed of igneous and volcanic rock.

As the administrator of the NFIP, FEMA created the Advisory Base Flood Elevation (ABFE). The ABFE information serves as a guide to understand current flood hazard conditions and higher elevations that communities should build to reduce impacts of similar storm events in the future. Following Hurricane María, FEMA re-evaluated and re-mapped the floodplain based on high-water marks from the disaster and prepared the ABFE. The PRPB issued a resolution (JP-ABFE-01 and ABFE-02) in 2018 requiring the use of the ABFE maps for permitting processes. The ABFE maps were used to describe the Special Flood Hazard Areas (SFHA) in the project area (PRPB 2018, 2018a, 2019). The ABFE maps cover a broader area for the project area, compared with the FIRM maps.

According to the revised FEMA ABFE dated March 1, 2018, most of this project's components lie in SFHA. Table 7 presents the SFHAs within the project area. Figure 12 in Appendix A presents the FEMA ABFE Maps.

Table 7: SFHAs within the Project Area

Project Component	SFHA	Length or Area within SFHA (meters)	Percent within SFHA
Sediment Pipeline A	Zone A[a]	372.6	18.4
	Floodway[b]	1,653.7	81.6
	Total	**2,026.3**	
Sediment Pipeline B	Zone A	25.8	1.3
	Zone X 0.2% Annual Chance Flood	1.0	0.0
	Floodway	1,977.8	96.2
	Total	**2,004.6**	
Sediment Pipeline C	Zone A	21.4	0.4
	Zone X 0.2% Annual Chance Flood	15.0	0.3
	Floodway	5,009.0	97.9
	Total	**5,045.3**	
Disposal Dike A	Zone A	174,083.4 m^2	97.8
	Floodway	3,957.9 m^2	2.2
	Total	**178,041.3** m^2	
Disposal Dike B	Zone A	32,158.5 m^2	7.7
	Zone X 0.2% Annual Chance Flood	2,260.0 m^2	0.5
	Floodway	8,539.2 m^2	2.1
	Total	**42,957.7** m^2	
Disposal Dike C	Zone A	49,76.0 m^2	1.1
	Zone X 0.2% Annual Chance Flood	10,863.3 m^2	2.4
	Total	**15839.3** m^2	
Staging Area and Temporary Dock	Zone A	20,156.2 m^2	100.0
	Total	**20,156.2**	

a. Zone A - An area of high flood risk subject to inundation by the 1% annual-chance flood event.

b. Floodway - The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base (1%-annual-chance) flood without cumulatively increasing the water surface elevation more than a designated height.
c. Zone X 0.2% Annual Chance Flood - Areas of moderate flood risk within the 0.2% annual chance floodplain; or areas of 1% annual chance flooding where average depths are less than 1 ft, where the drainage area is less than 1 mi^2, or areas protected from this flood level by a levee.

1.1.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative. Under this alternative the continued sedimentation of the Carraízo Reservoir would reduce the reservoir's water storage capacity in the long-term. By 2062 it is estimated that the Carraízo Reservoir's projected useful life would be reached based on a long-term storage capacity loss of about 0.310 Mm^3/yr (0.405 Mcy/yr) (Soler-López, L.R. and Licha-Soler, N.A. 2012). Under the No Action Alternative there would be no impacts to floodplains since no dredging would be performed.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

This alternative would have a negligible short-term impact on the floodplain. Proposed project components are in the SFHA according to the ABFE maps. Since the staging area and disposal dikes are existing structures in the floodway, they have the capacity to displace water during a flood event. The installation of temporary office trailers at the staging area would occur above the BFE, using platforms or jacks.

Approximately 60% of the sediment pipeline would be floating within the Carraízo Reservoir, the Río Grande de Loíza and the Río Gurabo. Floating pipelines would be flexible enough to endure the movement of the water within the reservoir and the currents that may be associated with flood events. Inland portions of the pipeline could result in localized interruption of drainage patterns, such as localized ponding. However, it would be a negligible direct, and short-term adverse effect to the floodplain because the aboveground pipeline installation would use non-invasive temporary weighted anchors and booster pumps would be mounted on skids placed on the ground (Figure 3 in Appendix A). As part of the BMPs, PRASA intends to prepare an emergency demobilization plan for this project to manage equipment and materials if a major atmospheric event is forecasted. No impacts to the floodplain would occur during emergency or the regular demobilization of the pipeline.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Under this alternative the impacts would be similar to those described under Alternative 2 for the site preparation/construction, dredging operations, and demobilization phases. However, the extended period required to dredge would be long-term (20 years). The additional sediment processing and transportation phase would not pose additional impacts to floodplains, as sediment processing would occur within the existing disposal dike A, and sediment transport would employ existing roads.

Inland portions of the pipeline could result in localized interruption of the drainage patterns, such as localized ponding. However, it would be a negligible direct long-term impact which would end when the project is completed. Alternative 3 would have long-term negligible to minor direct adverse impacts on the floodplain associated with the site preparation/construction and dredging operation. No impacts to the floodplain would occur associated with the demobilization phase.

5.6 VEGETATION

Vegetation serves many functions: it can provide essential habitat for wildlife; prevent erosion by stabilizing soil resources; and enhance visual aesthetics. The EO 13112, Invasive Species, directs federal agencies to prevent the introduction of invasive species, provide for their control, and minimize the economic, ecological, and human health impacts caused by their existence. In accordance with EO 13112, federal agencies can not authorize nor provide funding or accomplish actions considered capable of causing or promoting the introduction or dispersion of invasive species to the U.S. unless the agency first considers reasonable measures that diminish the risks.

5.6.1 Existing Conditions

A flora and fauna study completed in December 2021 characterized the vegetation in the proposed project area (CSA 2021b) (Appendix J). The Río Grande de Loíza has the largest drainage basin of Puerto Rico rivers and is classified as Subtropical Moist Forest although its original vegetation has been greatly modified by agricultural, pastures, and urban uses. Four vegetation associations are defined within the project study area: riverbed, riparian forest, old fields, and wetlands (USACE 1991). These associations foster vegetation and conditions that are unique to each.

The riverbed habitat consists of a central channel in which water is usually moving, pools of water either isolated from the channel during normal flows by shoal or connected ephemerally by shallow water, and sand bars or other alluvial deposits. Riparian forests are forested or wooded areas of land adjacent to a body of water. Riparian forest in the project area can exhibit various mixes of woody vegetation including the introduced bamboo (*Bambusa vulgaris*), the introduced Indian almond tree (*Terminalia catappa*), and the introduced African tulip tree (*Spathodea campanulata*). Old fields habitat refers to abandoned agricultural or pasture lands. Wetlands have formed in lower areas, such as swales, where water is more abundant. The vegetation cover and associated communities found along the Carraízo Reservoir are primarily classified as herbaceous wetlands, grasslands, forested areas, and developed areas. Non-native vegetation is distributed island-wide and commonly associated with previously disturbed areas. Plants within the project area are mostly non-native and common to disturbed areas.

Disposal dike A is approximately 15.0 hectare (37 acres) and is mostly covered by an association of shrub dominated by the invasive species catclaw mimosa (*Mimosa pellita*), and herbaceous vegetation, mostly dominated by the non-native Venezuela grass (*Paspalum fasciculatum*), especially in the lower areas of the disposal dike. Trees have grown within the northeast corner, where sediments from former dredging activities were deposited. Trees are also found along the outer perimeter of the disposal dike. The pipeline alignment to disposal dike A is mostly dominated by the non-native Venezuela grass. The dominant tree species are the native Martinique prickly ash (*Zanthoxylum martinicense*) and the introduced African tulip tree (CSA 2021b; 2022) (Appendix J).

Disposal dike B is approximately 24.3 hectare (60 acres) and is mostly covered with an association of shrub dominated by invasive species catclaw mimosa and herbaceous vegetation dominated by non-native Venezuela grass, non-native sensitive plant (*Mimosa pudica*), invasive graceful mimosa (*Mimosa casta),* and the noxious weed rattleweed (*Crotalaria retusa*), especially in the inner slopes of disposal dike. Water accumulation was observed in the center of disposal dike B. The shallow areas are dominated by the non-native cattail (*Typha domingensis*) and species from the Cyperaceae family. The area where the water accumulates is mostly open water, but seasonally it is covered by herbaceous species, mostly by the native fly beaksedge (*Rhynchospora holoschoenoides*). Scattered trees are mostly found in higher ground areas to the north, or in the outer slopes. The proposed inland sediment pipeline alignment, including preliminary booster pump locations, are mostly dominated by non-native Venezuela grass (CSA 2021b; 2022) (Appendix J).

Disposal dike C is approximately 57.5 hectare (142 acres) and is mostly covered by an association of shrubs dominated by the invasive catclaw mimosa, and herbaceous vegetation mostly dominated by non-native Venezuela grass, especially in the inner slopes and the center of disposal dike. Trees have grown within the southwest corner, where sediments from the former dredging activities were deposited (CSA 2021b) (Appendix J).

The proposed inland sediment pipeline alignment would lie within managed and unmanaged pastureland with strips of dense bamboo delineating property boundaries (CSA 2022) (Appendix J). The most common habitat found was unmanaged pastureland dominated by grasslands of non-native Venezuelan grass, the invasive sour paspalum (*Paspalum conjugatum*), and various non-native Mimosa species, mostly catclaw and the giant sensitive plant. Managed pastureland, used by cattle and horses, had a similar composition of vegetation. Wetland indicators were absent except along water crossings. For water crossings, the pipeline would run under two bridges, through existing culverts under roads, and span over dirt roads.

The soil within the staging area is previously disturbed and is mostly composed of fill material however, vegetation has grown within it. Construction materials presumably associated with previous dredging operations and other activities were observed within the staging area. In addition, refuse piles were observed scattered within the site. The staging area is mostly covered by an association of herbaceous vegetation dominated by non-native Venezuela grass and the non-native elephant grass (*Cenchrus purpureus*), and some scattered trees like the non-native African tulip tree, non-native Indian almond tree, tall non-native albizia (*Albizia procera*), and the native fiddlewood (*Citharexylum spinosum*) (CSA 2021b) (Appendix J).

5.6.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative. The vegetation associated with the reservoir, disposal dikes, sediment pipeline alignment, and staging area would remain undisturbed. Therefore, the No Action Alternative would have no impact on the vegetation composition in the area and surrounding municipalities.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Potential adverse impacts to vegetation could occur where site preparation/construction and dredging operations phase activities require incidental vegetation clearing and grubbing. The staging area, temporary dock construction, and disposal dikes rehabilitation would require vegetation removal associated with clearing and grubbing activities. The use of construction equipment and vehicles for the installation of the sediment pipeline would result in impacts to existing vegetation.

Vegetation disturbance and compaction would occur with the installation and use of the inland pipeline with weighted anchors and skid-mounted booster pumps along the 7-km (4.3-mi) section of inland pipeline alignment, which could limit the ability of native species to re-colonize disturbed areas. Most of the 12-m (39.4-ft) wide pipeline easement would be in areas previously used as pasture fields, dominated by the non-native Venezuela grass. This easement was selected to avoid mature trees and forested areas. Soil and vegetation disturbance could cause the spread of invasive plant species, but the magnitude of this potential effect would be reduced with implementation of construction BMPs. Appropriate BMPs, such as minimizing the use of off-road areas, erosion control measures, and placing barriers to delineate the limits between impact areas and conservation zones (such as forested areas) would reduce vegetation disturbance. The proposed activities would occur within established project area limits. These measures would reduce impacts to adjacent areas. Demobilization activities would result in negligible temporary impacts to vegetation. Natural re-vegetation of the disturbed areas would occur after the demobilization phase.

Alternative 2 would have minor direct short-term adverse impacts associated with equipment traffic over vegetated areas, vegetation removal, and the placement and operation of the aboveground sediment pipeline and booster pumps during dredging operations.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Activities and methods would be the similar to Alternative 2; however, Alternative 3 would include the sediment processing and transportation phase from disposal dike A from approximately year 8 to year 20. Once disposal dikes B and C have reached their respective capacity, the pipeline would be removed from those areas, and natural re-vegetation of the easements would occur. The pipeline route to disposal dike A would remain in place to complete the removal of 6 Mm^3 (7.8 Mcy) of sediment. The processing would occur within the disposal dike A footprint, and sediments would be transported off-site along existing paved roads, resulting in no adverse impacts to vegetation outside of the project areas. Natural re-vegetation of the disturbed areas would occur after demobilization. Therefore, impacts to vegetation under Alternative 3 would be minor direct long-term adverse impacts with implementation of the BMPs.

5.7 WILDLIFE AND FISH

In addition to specific regulations such as the Endangered Species Act (ESA) of 1973 (16 U.S.C. §§1531-1543), there are numerous laws and regulations at the federal level that seek to protect and conserve fish and wildlife populations for recreation and commercial values. During the issuance of related permits by federal agencies, the consulting agencies would evaluate regulations governing the preservation and conservation of fish and wildlife.

The Migratory Bird Treaty Act (MBTA) of 1918 provides a program for the international conservation of birds that migrate through lands of the U.S. The lead federal agency for implementing the MBTA is USFWS. The law makes it illegal to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, migratory birds, or the parts, nests, or eggs of such a bird except under the terms of a valid federal permit.

5.7.1 Existing Conditions

Wildlife

Wildlife observation activities at disposal dikes A, B and C, as well as at the staging area, temporary dock, and the proposed inland pipeline alignment resulted in the identification of numerous species of birds, reptiles, and amphibians (CSA 2021b; 2022) (Appendix J). The fauna species identified in the areas for the proposed project are typical of herbaceous wetlands, grasslands, forested and developed areas.

Twenty-two bird species were observed in disposal dike A, three of which are classified as migratory, as is the case of the species belted kingfisher (*Megaceryle alcyon*), Osprey fish hawk (*Pandion haliaetus*), and prairie warbler (*Setophaga discolor*). A total of 13 insect species, mostly Lepidoptera were identified in this area: 2 are classified as endemic as is the case of the Puerto Rican yellow butterfly (*Pyrisitia portoricensis*) and vitellius skipper (*Chorantus vitellius*). Three amphibian species were identified: the endemics include Antillean frog (*Eleutherodactylus antillensis*) and common coqui (*Eleutherodactylus coqui*), and the native resident Caribbean white-lipped frog (*Leptodactylus albilabris*) (CSA 2021b) (Appendix J).

The study of disposal dike B fauna found 20 bird species: 2 are classified as endemic, as is the case of the Puerto Rican woodpecker (*Melanerpes portoricensis*), and Puerto Rican spindalis (*Spindalis portoricensis*). A total of 12 insect species were identified: 1 was classified as endemic as is the case of the Puerto Rican yellow butterfly, and 4 are classified as native including the Gulf Fritillary (*Agraulis vanillae insularis*), statira sulphur (*Aphrissa statira cubana*), Puerto Rican monarch butterfly (*Danaus plexippus portoricensis*), and the zebra longwing butterfly (*Heliconius charitonia charitonia*). Three amphibian species were observed: the endemics Antillean frog and common and grass coqui (*Eleutherodactylus brittoni*), and the resident Caribbean white-lipped frog (CSA 2021b) (Appendix J).

The study of disposal dike C fauna found 25 bird species including the Puerto Rican plain pigeon (*Patagioenas inornata wetmorei*) classified as endemic and endangered. Also identified in this area were the native resident scaly-napped pigeon (*Patagioenas squamosa*), the endemic Puerto Rican woodpecker, and the migratory Northern parula (*Setophaga americana*). A total of 15 insect species were identified: 2 are classified as endemic as is the case of the Puerto Rican yellow butterfly and vitellius skipper, and 4 are classified as native including the Gulf fritillary, statira sulphur, Puerto Rican monarch butterfly, and the zebra longwing butterfly. Amphibians were represented by four species, the endemics Antillean frog, grass, and common *coqui,* and the resident Caribbean white-lipped frog (CSA 2021b) (Appendix J).

The study of the staging and proposed dock area fauna found 31 bird species: 2 are classified as endemic, the Puerto Rican woodpecker and Puerto Rican flycatcher (*Myiarchus antillarum*). Some resident birds were also identified in this area and include the snowy Egret (*Egretta thula*), the native common moorhen (*Gallinula chloropus*), the native, Yellow-crowned night heron (*Nyctanassa violacea*), and the native Pied-billed grebe (*Podilymbus podiceps*). A total of 9 insect species were identified in this area: 1 is classified as endemic, the vitellius skipper, and 2 are classified as native, the zebra longwing butterfly and hanno blue (*Hemiargus hanno watsoni*). Five amphibian species were represented by the endemics Antillean frog, common, and grass coqui, the resident Caribbean white-lipped frog, and the introduced invasive cane toad (*Rhinella marina*) (CSA 2021b) (Appendix J).

Migratory birds protected under the MBTA identified in proposed area surveyed included the belted kingfisher, Osprey fish hawk, prairie warbler, and Northern parula. No nests were observed within the study areas.

Previous fish studies conducted by PRDNER found that the Carraízo Reservoir, including the proposed dock area, is dominated by three exotic fish species: the Mozambique tilapia (*Oreochromis mossambicus*), the red-breasted tilapia (*Tilapia rendalli*), and the catfish (*Ictalurus punctatus*) (PRASA 1995). Other fish species identified in the lake include non-native fish: redear sunfish (*Lepomis microlophus*), bluegill (*L. macrochirus*), redbreast sunfish (*L. auratus*), large-mouth bass (*Micropterus salmoides*), and rosy barb (*Barbus conchoni*). The only native fish found in the reservoir was the big mouth sleeper (*Gobiomorus dormitory).*

A study of the Carraízo Reservoir was conducted to characterize the benthic (bottom) habitat (Biomarine 2022) (Appendix L). A total of thirty samples were collected along transects from the dam area to near the staging area. Only 10 families of macroinvertebrates were found out of 61 families identified in Puerto Rico, indicating poor-quality habitat. The most abundant families were earthworms (*Oligochaetae*), midge larvae (*Chaoboridae*), water mites (*Hidrachnidia*), and bladder snails (*Physidae*). These families are characterized by tolerance to impaired aquatic environments, and the data points to poor water quality in the reservoir (Biomarine 2022).

5.7.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative. The wildlife associated with the reservoir, disposal dikes, sediment pipeline alignment, and staging area would remain undisturbed in the short-term. The continued erosion and sedimentation of the Carraízo Reservoir would cause a negligible to minor indirect long-term adverse impact to wildlife and fish by degraded water quality and reduced open-water habitat.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Activities under Alternative 2 would result in minor direct short-term adverse impacts to wildlife and fish, associated with site preparation/construction, dredging, and demobilization activities. These activities would increase noise levels, human presence, new lighting, disturbances to natural areas, and potential increased suspended sediments in the reservoir and waterways. The disposal dikes and the staging and temporary dock area would be cleared and grubbed which would result in the temporary loss of vegetation that could serve as habitat for wildlife. Site preparation/construction activities would occur between 7:00 a.m. and 10:00 p.m. This would cause some of the fauna that use these areas to be temporarily displaced. Even though the fauna observed in the proposed project areas are common and widely distributed, some individuals would be displaced and would move to neighboring habitats to return once vegetation cover was restored. To reduce the impacts to the wildlife identified in the proposed areas, BMPs would be implemented including placing barriers between the disposal, staging areas, and conservation zones. Construction activities would occur within the established project area limits. These measures would minimize impacts to the areas outside the project area.

Vegetation removal associated with clearing and grubbing at the disposal dikes and staging and dock area could result in the loss of nests, eggs, and young, when nests are present. However, of the four migratory species observed, only the Osprey fish hawk is known to nest in Puerto Rico; their nests are large and prominent, usually on top of power poles therefore, the potential for migratory bird species to nest in and adjacent to the proposed area would be very low. The proposed activities would result in negligible to minor, direct short-term impacts upon migratory bird species, particularly to their feeding areas; however, their mobility allows them to move to adjacent feeding habitat.

During site preparation/construction, specifically while building the temporary dock, wildlife would experience habitat disturbance associated with potential pile driving activities. The type and intensity of the underwater sounds produced would depend on a variety of factors, including, but not limited to, the type and size of the pile, the firmness of the substrate and depth of water into which the pile is being driven, and the type and size of the pile-driving hammer (USACE 2016). The installation of piles and the construction of a temporary dock would result in negligible direct short-term impacts to the Carraízo Reservoir fish communities.

The dredging activities would operate up to 24 hours a day, 7 days a week and would have a moderate impact upon fish in the reservoir. Fish would naturally avoid the vibration associated with the dredging operation, where they could be suctioned by the dredge. Also, fish avoid areas with extremely low dissolved oxygen concentrations such as those identified at the reservoir’s bottom and thus it would be unlikely to find fish at the dredging operation depths (Biomarine 2022). The impact to fish would be minor direct and short-term related to the added suspended sediments and turbidity associated with the dredging. Decanted water released from the disposal dikes back into the reservoir and rivers would also create turbidity in the area immediately surrounding the outfall pipes. These impacts would be minor direct and short-term with the implementation of BMPs such as silt and turbidity curtains to be used during dredging and dewatering activities.

Noise and vibrations can cause behavioral changes in wildlife that result in adverse impacts such as the abandonment of nests. However, the areas around the Carraízo Reservoir and the disposal dikes are in proximity to residential areas, businesses, paved roads, and water infrastructure facilities; thus, wildlife in the project area is acclimated to noise and other human related activities. The noise and vibration generated by site preparation/construction, dredging, and demobilization activities would be short-term and similar to nearby farming, highway, and other human activities. Thus, the proposed activities would have minor direct short-term adverse impacts to wildlife and fish within the project area. The PRDNER Regulation for the Prevention and Control of Noise

Contamination would be observed during construction activities, along with multiple additional BMPs specified in Appendix H.

Work conducted after sunset would require adequate illumination, per OSHA. Most animals can be impacted by light, either are attracted to it, use a circadian rhythm for their active/rest cycle, depend on or escape light for hunting/surviving, etc. Fugitive light can have an impact equivalent to habitat loss, albeit temporary. The PREQB Regulation for the Control and Prevention of Light Pollution is intended, among other purposes, to avoid the excessive and unnecessary light to the dark sky as well as the intrusion of undesired artificial light into properties and natural areas (PREQB 2014). The PRDNER *Practical Guide: Outdoor Lighting for the Prevention of Light Pollution* would be followed by PRASA (PRDNER 2019). Based on the guidelines, BMPs would be implemented to reduce the light that escapes the site and to reduce impact to wildlife (Florida Fish and Wildlife Conservation Commission, 2022). In summary, Alternative 2 impacts on wildlife and fish habitats would be minor direct and short-term with implementation of the BMPs and conservation measures.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Under Alternative 3, impacts to fish and wildlife would be similar to Alternative 2 for site preparation/construction and demobilization phases. The proposed dredging method and project components for Alternative 3 would be similar, with a variation on total sediment volume to be dredged (6 Mm^3 [7.8 Mcy] and a longer total dredging duration (20 years). Activities under Alternative 3 would result in minor direct short-term adverse impacts to wildlife and fish, associated with site preparation/construction, and demobilization activities.

Alternative 3 would require the annual removal of 300,000 m^3 (392,385 cy) of de-watered sediments from disposal dike A, once the three disposal dikes' storage capacity is reached. Sediment dredging, dewatering, sorting, and transportation off-site would continue exclusively at disposal dike A beginning approximately during year 7 or 8 after initiating dredging activities and continuing until year 20. Sorting and processing activities at disposal dike A would take place from 7 a.m. to 10 p.m. Dredging operations at disposal dikes B and C would stop and equipment demobilized. Alternative 3 impacts due to sediment processing and year-round truck traffic to and from disposal dike A would cause an increase in potential noise, fugitive dust and criteria pollutant emissions. Such impacts may cause wildlife displacement from disposal dike A and along the truck routes.

Impacts to wildlife and fish during dredging activities would be similar to those under Alternative 2 except those impacts would be long-term due to the 20-year duration of the proposed activities. Alternative 3 would cause minor direct long-term adverse impacts to fish and wildlife with the implementation of BMPs. In addition, fish or wildlife temporarily displaced during dredging operations would be expected to return following completion of project activities.

5.8 THREATENED AND ENDANGERED SPECIES

The Fish and Wildlife Coordination Act (FWCA) of the U.S. was enacted March 10, 1934 to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. The Act provides the basic authority for the involvement of USFWS in evaluating impacts to fish and wildlife from proposed water resource development projects. The

FWCA requires that wildlife conservation be given equal consideration to other features of water-resource development programs through planning, development, maintenance, and coordination of wildlife conservation and rehabilitation. Wildlife and wildlife resources are defined by the Act to include birds, fish, mammals and other classes of wild animals, and all types of aquatic and land vegetation upon which wildlife is dependent.

The ESA provides policy and authority for the conservation of threatened and endangered (T&E) plants and animals and their habitats. The lead federal agencies for implementing the ESA are USFWS and the National Marine Fisheries Service (NMFS). The law requires federal agencies to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat of such species. The law also prohibits actions that causes a "taking" of ESA listed species.

"Take" is defined in 16 U.S.C. §1532 (19) as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in such conduct." The law's definition of "Harm" includes significant habitat modification or degradation that results in death or injury to ESA listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering (50 CFR §17.3).

Section 7(a)(2) of the ESA requires the lead federal agency to consult with either USFWS or NMFS, depending which agency has jurisdiction over the ESA listed species in question, when a federally funded project either may have the potential to adversely affect an ESA listed species, or a federal action occurs within or may have the potential to impact designated critical habitat (DCH). Section 7 of the ESA requires that federal agencies must ensure that activities authorized, funded, or carried out are not likely to destroy or adversely modify an ESA listed species DCH. When an agency proposes a species for listing as endangered or threatened under the ESA, USFWS or NMFS must consider whether there are areas of habitat believed to be essential to the species' conservation.

5.8.1 Existing Conditions

The USFWS' Information for Planning, and Conservation (IPaC) system and natural heritage data is used by FEMA to identify the potential presence of ESA listed species. The USFWS determines the likelihood of a species occurrence through an evaluation of their habitat requirements, its documented range, and comparing those parameters with existing site conditions. A review of the IPaC tool identified the potential presence of four ESA listed species near Carraízo Reservoir project area and are provided in Table 8, and Appendix J (FEMA 2021a). According to the IPaC tool, the proposed project areas are designated as critical habitat for federally listed T&E species. Not included in the IPaC T&E list, but designated as a critical element by PRDNER, the Puerto Rican Slider or Jicotea (*Trachemys stejnegeri*), was identified at disposal dike C and in the staging area. This species has been designated as a critical element based on the continued loss of habitat and the hybridization potential that this species has experienced with the introduced species the Red-eared Slider (*Chrysemys scripta elegans*).

Table 8: T&E Species with Potential to Occur within the Project Area

Scientific name	Common name	Status	Critical habitat
Buteo platypterus	Puerto Rican Broad-winged hawk	E	No
Amazona vittata	Puerto Rican Parrot	E	No
Patagioenas inornata wetmorei	Puerto Rican Plain Pigeon	E	No
Epicrates inornatus now known as *Chilabothrus inornatus*	Puerto Rican Boa	E	No

E = federally listed endangered species in Puerto Rico

A biological survey was performed from November 24th through December 4th, 2021, to evaluate diurnal and nocturnal fauna species within the proposed area for the presence of terrestrial habitat, wildlife, and T&E species (CSA 2021b) (Appendix J). From the list of species above, the Puerto Rican Plain Pigeon (*Patagioenas inornata wetmorei*) was the only observed species at disposal dike C area during the site visits. Two individuals of this species were observed flying from south to north near the eastern side of disposal dike C (Appendix J).

5.8.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative; therefore, no impacts to T&E species would occur.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

The impacts associated with site preparation/construction, dredging operations, and demobilization would include clearing and grubbing of disposal dikes, inland sediment pipeline alignment, temporary dock construction, and staging area and could result in the temporary displacement of ESA listed species, primarily from vegetation removal and disturbances associated with machinery and vehicular noise, air pollutants, and fugitive dust.

A request for consultation with USFWS was sent December 16, 2021, establishing a determination of *May affect, not likely to adversely affect* for the four listed species in the project area (Table 8). USFWS concurred with FEMA's determination on February 18, 2022 and issued comments as informal consultation in accordance with the FWCA and the ESA (Appendix J). The USFWS, based on the species biology and habitat needs, recommended FEMA not further consider the Puerto Rican parrot or broad-winged hawk, since there is no suitable habitat for these species within the project area.

Site preparation and construction activities would occur between 7:00 a.m. and 10:00 p.m. During the site preparation/construction phase of Alternative 2, PRASA would implement the USFWS conservation measures for the Puerto Rican boa (*Chilabothrus inornatus*) and the Puerto Rican plain pigeon (*Patagioenas inornata wetmorei*) (Appendix J). Both species would likely avoid construction and dredging areas once activities have begun; their mobility should minimize impacts.

In the USFWS letter, the agency stated "With regards to the Fish and Wildlife Coordination Act, the *jicotea* or freshwater turtle is an endemic species found only to Puerto Rico. Several of the disposal areas have ponds or ponded water and wetlands which are reported in the Fauna and Flora study to have the *jicotea*. Since these wetland areas will be eliminated as part of the disposal area rehabilitation, we recommend that prior to any earth movement or filling of these areas, efforts should be made to capture and relocate as many of these turtles as possible. This will help in preserving this species hybridization." (Appendix J).

Alternative 2 would have minor direct short-term adverse impacts to ESA listed species. No DCH were identified within the proposed project area. The USFWS conservation measures would be followed for the Puerto Rican Plain Pigeon (*Patagioenas inornata wetmorei*), the Puerto Rican Boa (*Chilabothrus inornatus*) and the Puerto Rican Slider or Jicotea (*Trachemys stejnegeri*); therefore, Alternative 2 would have negligible direct short-term impacts on this resource (Appendix J).

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Under Alternative 3, the proposed project footprint and its impacts to T&E species would be similar to Alternative 2 for site preparation/construction, dredging operations, and demobilization phases; however, Alternative 3 would include the sediment processing and transportation phase at disposal dike A from approximately year 8 to year 20. Continuous dredging (up to 24 hours a day, 7 days a week) would displace T&E species Puerto Rican Plain Pigeon and the Puerto Rican Boa mostly during site preparation/construction activities. However, these species would gradually return following completion of project activities.

Sediment processing and transporting the sediment from disposal dike A would result in increased truck traffic. Activities would take place from 7 a.m. to 10 p.m. The additional traffic would cause an increase in noise, fugitive dust, and criteria pollutant emissions along the route. This would cause wildlife displacement along these routes.

Alternative 3 would have moderate direct long-term adverse impacts to T&E species, however with implementation of species-specific USFWS conservation measures the impacts would be considered minor, direct long-term.

5.9 CULTURAL RESOURCES

Cultural and historic resources are subject to review under federal and local laws and regulations. The National Historic Preservation Act (NHPA) enacted in 1966, established State Historic Preservation Offices (SHPO) and the National Register of Historic Places (NRHP). The NRHP is the U.S.' official list of significant historic properties and is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archaeological resources. The Secretary of the Interior administers the NRHP through the National Park Service.

Historic properties include districts, buildings, structures, objects, landscapes, archaeological sites, traditional cultural properties, and other resources that are significant in American history, architecture, archaeology, engineering, and culture. The NHPA only applies to historic properties, including archaeological resources, determined eligible for listing in the NRHP. To be eligible for listing, a property must meet eligibility criteria delineated by the Secretary of the Interior and retain sufficient integrity to convey its significance to American culture. Detailed eligibility criteria for listing a property on the NRHP is in 36 CFR Part 60.

Section 106 of the NHPA, *as amended*, and implemented by 36 CFR Part 800, requires federal agencies to consider the impacts of their actions on historic properties and provide the Advisory Council on Historic Preservation, interested parties, and the public an opportunity to comment. This process must take place prior to the expenditure of federal funds. Federal regulation 36 CFR 800.4(a)(1) defines the Area of Potential Effects (APE) as the geographic area(s) within which the undertaking may directly or indirectly affect cultural resources. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking. Projects are evaluated by FEMA to determine the potential impact to cultural resources prior to project actions for both standing structures and archaeology within the APE.

5.9.1 Existing Conditions

The proposed dredging activities would require actions within areas previously surveyed for historic and archaeological resources (PRASA 1995). These studies were conducted as part of required compliance with Section 106 of the NHPA and local Law 112 for PRASA's 1996 Carraízo Reservoir Dredging project. The APE for the 1996 dredging project included the Carraízo Reservoir, the three disposal areas (A, B and C), and the project's staging area (USACE 1995). The APE for the 1996 dredging project corresponds to the geographical limits of the current project, except for the proposed temporary sediment pipeline alignment.

Phase I A and B archaeological studies identified archaeological resources to the north of disposal dike A, within disposal dikes B and C, and within the staging area (PRASA 1995). The 1996 Programmatic Agreement (PA) established among USACE, the Advisory Council on Historic Preservation, PRASA, and the Puerto Rico SHPO defined the requirements to document or protect cultural resources identified within the 1996 project's APE (USACE 1996a).

The archaeological sites identified to the north of disposal dike A were preserved through avoidance. The SHPO recommended the mitigation of adverse impacts by means of Phase III documentation for the archaeological sites within disposal dikes B and C. Phase III studies were performed at the sites identified as eligible for inclusion into the NRHP and where the proposed impacts could not be avoided (referred to as sites B-1, V-1, V-2, and V-3 in the study). As a result of the Phase III archaeological studies performed, the archaeological sites within disposal dikes B and C were mitigated by documentation and the removal of artifacts prior to the start of the 1996 dredging project (PRASA 1995). The archaeological site identified within the staging area was preserved by means of avoidance; a cyclone fence was installed with the required 10-m (32.8-ft) buffer zone (Figure 13 in Appendix A).

The Carraízo Dam, constructed in 1953, is considered eligible for listing in the NRHP however there are no plans to conduct project work on or near the dam. The dam is outside the APE.

Dredging operations would be approximately 0.8 km (0.5 mi) away from dam (Figure 14 in Appendix A).

The FEMA initiated consultation with SHPO for this project based on the requirements of the Second Amendment Programmatic Agreement between FEMA, SHPO, and COR3. A consultation letter was submitted to SHPO on December 21, 2021, and concurrence was received on December 30, 2021. The concurrence letter agreed with FEMA's findings of *No Adverse Effect with Conditions*. Correspondence with SHPO and conditions from this agency are found in Appendix K.

5.9.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative; therefore, there would be no impacts to historic structures or archaeological resources.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Clearing and grubbing activities associated with site preparation/construction, dredging operations, and demobilization have the potential to impact cultural resources within the proposed project's footprint. Based on the conditions required by SHPO, PRASA would avoid known sites and would employ a qualified archaeologist meeting the Secretary of Interior Qualification Standards (36 CFR Part 61) to monitor project activities and respond as needed in the event of an unexpected discovery.

Within the reservoir there is a submerged residential structure (circa 1940) that is exposed during extreme drought events. The proposed dredging operation could have the potential of impacting this structure. The PA for the previous dredging project required that this structure be preserved by avoidance. The avoidance recommendations in the 1996 PA would be followed for this project and a 10-m (32.8-ft) buffer zone would be established around the structure during dredging operations. The area would be delimited by buoys or other means that would facilitate the visual identification of the area.

There are four known archaeological sites adjacent to the northern limit of disposal dike A. The sites would be identified and avoided while vehicles are transiting within the area, when performing clearing and grubbing activities, or with the installation of the inland sediment pipeline. Alternative 2 activities in or near disposal dike A related to the proposed sediment pipeline would not have an impact on cultural resources due to implementation of avoidance measures. Alternative 2 proposed activities within disposal dikes B and C would have no impact on cultural resources.

The proposed activities within the staging area could result in impacts to one archaeological site. The potential impacts would be related to heavy machinery moving over the site, earth movements (including clearing and grubbing operations) and installation of temporary buildings and dock. Per conditions of the SHPO concurrence letter, the archaeological site would be protected by implementing avoidance measures that would establish a buffer zone of 10 m (32.8 ft) with fencing and signage. Contractors would be provided with information on the required protection measures to be implemented prior to initiating work within the staging area.

A review of SHPO records indicated that no historic structures or archaeological resources have been identified along the proposed sediment pipeline alignment. The aboveground pipeline installation would use non-invasive temporary weighted anchors (Figure 3 in Appendix A). If archaeological materials are detected while performing activities (including clearing and grubbing) PRASA would stop work and inform FEMA. The FEMA, in coordination with SHPO and other interested parties, would evaluate the discovery in accordance with applicable federal and local regulations.

Alternative 2 would have no impact to historic structures and archaeological resources with implementation of the above-mentioned avoidance measures and SHPO conditions. A Secretary of the Interior qualified archaeologist would monitor project activities and respond as needed in the event of an unexpected discovery.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

The impacts associated with site preparation/construction, dredging operations, and demobilization for Alternative 3 would be similar to Alternative 2 with a variation on total sediment volume to be dredged (6 Mm^3 [7.8 Mcy]), and a longer total dredging duration (20 years). Alternative 3 would require the annual removal of 300,000 m^3 (392,385 cy) of de-watered sediments from disposal dike A, once the three disposal dikes' storage capacity is reached. The additional dewatering, sorting, and processing would occur within disposal dike A, and transportation would be along existing roads.

Alternative 3 would have no impact upon historic structures or archaeological resources with implementation of SHPO conditions and a Secretary of Interior qualified archaeologist on-site, similar to Alternative 2.

5.10 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations.

Executive Order 12898 also directs agencies to develop a strategy for implementing environmental justice. This would include developing and executing a public involvement plan so that potentially affected minority or low-income populations have meaningful opportunities to participate in and have access to information during the public comment period. Public access would include providing information in Spanish for persons with limited English proficiency, providing information in accessible formats for persons with disabilities, or overcoming other cultural, institutional, or geographic barriers to meaningful participation.

The Council on Environmental Quality (CEQ) guidance states that "minority populations should be identified where either: "a) the minority population of the affected area exceeds 50%; or b) the population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis" (CEQ 1997). Low-income is typically defined as family income that is below the federal poverty level; however, it may also be divided into individuals, households and/or families with children below the poverty level (EPA 2016a).

5.10.1 Existing Conditions

Applying the definition of minority within the project area in Puerto Rico is complicated since most of the population would meet the definition of minority as defined by the EO. In Puerto Rico, most people identify as of Hispanic/Latino origin. According to the U.S. Census Bureau (USCB) QuickFacts, Puerto Rico's racial makeup is 98.7% Hispanic or Latino (USCB 2021). The Census of Population and Housing allows respondents identifying as Hispanic to select additional races. Within the category of Hispanic, the Puerto Rican population self-identified as 65.9% white, 11.7% black, 5.3% mixed, 0.2% American Indian or Alaska Native, and 0.2% Asian. Low-income communities are defined as those with a median household income in a county, census tract, or block group lower than Puerto Rico's median household income. The USCB treats Puerto Rico's municipality legal divisions as equivalents to counties for purposes of data presentation (USCB 2021a).

This environmental justice analysis is focused on the CRW and the SCWFP service area municipalities. The CRW is composed of the municipalities of Caguas, Gurabo, Juncos, San Lorenzo, and portions of Aguas Buenas, Cidra, Las Piedras, San Juan, and Trujillo Alto. The northern part of the reservoir, including the Carraízo Dam, is within the Trujillo Alto municipality. The staging area and temporary dock are in the Caguas municipality. Disposal dikes and proposed sediment pipelines are within the Gurabo municipality. The SCWFP

Population

The EPA developed EJSCREEN as a tool that can be used to identify populations for environmental justice analysis. The EJSCREEN collects data from public sources including environmental and demographic indicators which can be tailored to a specific area. According to EPA's EJSCREEN (Version 2.0), the population of the CRW is approximately 298,524. The population for the SCWFP service area is estimated to be 427,189 (EPA 2022a). Only 1% of the CRW total population reported as non-Hispanic (3,805). Within the CRW, the SCWFP service area municipalities show a small non-Hispanic population of approximately 1.5%. Within the category of Hispanic, the CRW population was self-identified as 63% white, 19% black, and 13% as some other race. The remaining percentage (4%) of Hispanic respondents reported two or more races. Within the category of Hispanic, the SCWFP service area population self-identified as 65% white, 15% black, and 14% as some other race. Similar to the CRW, the SCWFP service area's remaining percentage (5%) of Hispanic respondents reported two or more races (EPA 2022a).

Income and Poverty

According to Puerto Rico's the USCB QuickFacts, the median household income between 2016 and 2020 was $21,058 (USCB 2021). The USCB QuickFacts data indicates the median household income for the CRW municipalities was $24,785. The SCWFP service area median household income between 2016 and 2020 was $24,687 (USCB 2021). Both the CRW service area and SCWFP median household income is higher than Puerto Rico's median income (Table 9).

According to the USCB QuickFacts data, 43.5% of Puerto Rican residents live in poverty (USCB 2021). While all areas of Puerto Rico have residents experiencing poverty, USCB data indicates that the highest levels of poverty typically occur in Puerto Rico's mountainous and rural communities. Approximately 94% of Puerto Ricans live in urban areas (USCB 2021). The highest percentage of persons living in poverty for the municipalities within the CRW is the Juncos municipality (47.4%). In the SCWFP service area, the only municipality reporting values higher than Puerto Rico's poverty level is Loíza (48.2%) (Table 9).

Table 9: Income and Persons in Poverty for the CRW and SCWFP Municipalities

Area	Median Household Income (dollars)	Income per capita (dollars)	Persons in poverty (%)
Puerto Rico	**21,058**	**13,318**	**43.2**
CRW	24,785	13,433	39.9
Aguas Buenas	19,279	11,097	46.6
Caguas	25,136	15,244	37.7
Cidra	19,726	10,980	44.7
Gurabo	35,018	18,518	30.7
Juncos	19,605	10,222	47.4
Las Piedras	21,667	11,475	41.9
San Lorenzo	19,380	11,307	43.9
SCWFP Service Area	24,687	16,605	38.3
Canóvanas	21,267	12,924	42.1
Carolina	29,059	16,846	30.9
Loíza	17,852	9,335	48.2
San Juan	22,710	19,361	41.0
Trujillo Alto	32,545	16,482	29.5

Source: USCB, American Community Survey

Communities Adjacent to Project Components

According to EPA's EJSCREEN, the census tract groups within the project components areas are: 72063210502, 72063210201, and 72063210202 (EPA 2022). These populations self-identified as 68% white, 10% black, and 21% as some other race. The total population for these tracts is estimated as 26,134. The income per capita for the census tract groups was $19,621. The percentage of households with an income base over $25,000 was 69% for the project component areas.

Most project components are adjacent to a combination of residential communities and mixed-use areas. Most of the proposed sediment pipeline would be within the reservoir waters and would not run through developed areas. The inland pipelines would be in open rural areas except for a few sections that would run parallel to existing roads. The following bullets describe the proposed project components' location in relation to neighboring communities (Figure 15 in Appendix A).

- The staging area is between a segment of Río Grande de Loíza and a residential community La Serranía, near the limit of Bairoa and Río Cañas wards in Caguas. The residential community is across PR-796, approximately 20 m (65 ft) southwest from the staging area. Other residential communities Valle del Lago and Estancias del Lago are adjacent to the Carraízo Reservoir within the Caguas municipality. This area is predominantly residential, with associated commercial and institutional areas. Noise and air quality parameters for the staging area are consistent with other rural areas in transition to more developed urban areas.

- Disposal dike A is north of Highway PR-9189, adjoining the community of Paseo de Santa Bárbara in the Celada ward in the Gurabo municipality. Most of the residential development is south/southeast of disposal dike A, with scattered commercial areas. Noise and air quality parameters for the area are consistent with other rural areas in transition to urban more developed areas. The lands north/northwest of the boundaries of disposal dike A are undeveloped. West of disposal dike A is Río Cagüitas.

- Disposal dike B is north of Highway PR-941 and east of Highway PR-942 in the Celada ward in the Gurabo municipality. The closest community is Sector Mr. De Jesus, which is approximately 400 m (1,312 ft) to the north. A review of the area around Disposal dike B shows no residential communities along the adjoining perimeter. The Dos Puentes recreation area is approximately 800 m (2,625 ft) southwest of disposal dike B, along PR-941.

- Disposal dike C is north of Río Gurabo, approximately 67-160 m (220-525 ft) west of the residential community Alturas de Hato Nuevo in the Gurabo municipality. An existing dirt road runs south of PR-944, approximately 0.6 km (0.37 mi), west of Alturas de Hato Nuevo, and serves as access to the disposal dike. Other residential communities Urb. Los Flamboyanes and Urb Monte Moriah, in the Hato Nuevo ward, are approximately 95 m (312 ft) east. There is no development adjacent to disposal dike C on its north and south boundaries.

- Sediment Pipeline. Of the 17 km (10.9 mi) long sediment pipeline, approximately 10 km (6.2 mi) would be in the reservoir (open water) and approximately 7 km (4.3 mi) would be inland and aboveground. The inland pipeline would run through areas classified as farmland and state-wide significant farmland, and wetlands, and/or adjacent to local roads. The portion of the sediment pipeline that connects to disposal dike C is east of the residential communities of Flamboyán and Monte Moríah, south of the residential communities of Flamboyán, Robles, and Hacienda El Mílagro, north of the residential communities of San José and Jardines de Gurabo, and west of residential communities Extensión Hato Nuevo and Alturas Hato Nuevo.

For purposes of this analysis, communities of concern would be those that identify within the category of Hispanic as Hispanic/Black, Hispanic/Mixed, Hispanic, and American Indian or Native American, Hispanic/Asian, and other.

5.10.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative; therefore, no impacts to communities of concern.

In the long-term, the No Action Alternative would cause moderate indirect adverse impacts to the low-income and minority populations of the SCWFP service area if the ongoing sedimentation of the Carraízo Reservoir remains unattended. The Carraízo Reservoir storage capacity decrease would eventually require the establishment of a water rationing schedule for the SCWFP-served population. These water interruptions could impact employment rates if businesses have reduced service hours. Reduced or rationed water could impact the services of health professionals and facilities within the SCWFP service area. Water rationing would adversely impact low-income and minority populations because of their limited resources to supplement SCWFP provided water with purchased bottled water.

Under the No Action Alternative, moderate indirect long-term adverse impacts to socioeconomic conditions and environmental justice communities would occur within the SCWFP service area.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Alternative 2 would cause impacts due to site preparation/construction, dredging, and demobilization activities which could include construction noise, traffic delays, and emissions from heavy machinery. Site preparation and construction activities would occur between 7:00 a.m. and 10:00 p.m., 5 days a week. Dredging activities would occur up to 24 hours a day, 7 days a week. Both dredging and the discharge of decanted water into the Río Gurabo could impact water quality which would disrupt SCWFP and GWFP operations. This could result in temporary water service interruptions for the municipalities within the SCWFP and GWFP service areas. The staging area and disposal dikes are existing, and no new sites would be constructed; therefore Alternative 2 would not require the acquisition of new property that could displace low-income residents.

In reviewing census data, there are no communities of concern within the CRW and the SCWFP service area. The three disposal dikes are within the Gurabo municipality. The municipality's poverty rate is the lowest in the CRW and the second lowest in the SCWFP service area. The staging area is within the Caguas municipality. This municipality has the second lowest poverty rate in the CRW and the third lowest in the SCWFP service area. Therefore, Alternative 2 would not directly impact low-income residents, populations living in poverty, or minority communities.

Alternative 2 would have minor indirect short-term impacts to communities of concern within the SCWFP service area due to potential to water interruptions during dredging activities.

Alternative 2 would have beneficial direct long-term impacts to communities of concern within the SCWFP service area by having a reliable water supply for public health, safety, and economic activities.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Under Alternative 3, impacts to low-income communities would be similar to Alternative 2 for the site preparation/construction and demobilization phases. The proposed dredging method and project components for Alternative 3 would be the similar, with a variation on total sediment volume to be dredged and a longer total dredging duration (20 years). To remove 6 Mm^3 (7.8 Mcy) of sediment, Alternative 3 would require the annual removal of 300,000 m^3 (392,385 cy) of de-watered sediments from disposal dike A, once the three disposal dikes' storage capacity is reached. Sediment dredging, dewatering, sorting, and transportation off-site would continue exclusively at disposal dike A beginning approximately during year 7 or 8 after initiating dredging activities and continuing until year 20. Dredging operations at disposal dikes B and C would stop and equipment demobilized.

Similar to Alternative 2, there would be no direct impacts to low-income residents, populations living in poverty, or minority communities since no communities of concern are in the project areas with Alternative 3.

Alternative 3 would have minor indirect long-term impacts to communities of concern within the SCWFP service area due to potential to water interruptions during dredging activities.

Similar to Alternative 2, Alternative 3 would have beneficial direct long-term impacts to communities of concern within the SCWFP service area by having a reliable water supply for public health, safety, and economic activities.

5.11 LAND USE AND PLANNING

Comprehensive land use plans determine land use within the vicinity of urban and rural areas. These plans specify the types of present and future land development that can occur within a specified area. In most cases, the preparation of comprehensive land use plans occurs through a public participation process. Once finalized, publicly elected officials approve the land use plans. The intent of this process, which involves public participation, is to capture local values and attitudes towards future development. Within Puerto Rico, zoning ordinances and land use regulations vary substantially depending upon location and municipality.

5.11.1 Existing Conditions

The Puerto Rico Land Use Plan (Land Use Plan), enacted in 2015, establishes general classifications of land use according to its characteristics and values (existing and potential) (PRPB 2015). Based on the Land Use Plan, both PRPB and the municipalities update the zoning maps and the municipal zoning plans, respectively. Updates to the plan complies with due process regarding public participation and the Uniform Administrative Procedure Law (Law 170-1988, *as amended*). Within the project area, the following land classifications are identified in the plan:

- Water – The main sediment pipeline and a portion of disposal dike B lies within this classification.
- Urban Land – The staging area lies within this classification.
- Specially Protected Rustic Land – Hydric – Portions of the sediment pipeline where it splits at Río Grande de Loíza towards disposal dikes A, B, and C.
- Specially Protected Rustic Land-Agricultural/Hydric – Disposal dike A and the sediment pipeline to disposal dike A and portions of the sediment pipeline lie along Río Gurabo to disposal dikes B and C.
- Specially Protected Rustic Land-Agricultural – Most of disposal dike B lies in this classification.
- Specially Protected Rustic Land-Ecological/Hydric – Disposal dike C and portions of the sediment pipeline lie in this classification.

The Land Use Plan does not prohibit specific activities within the Specially Protected Rustic Land areas; however, activities in these areas that change the land use to other purposes, especially those than encourage the urban or commercial development of these areas, is prohibited. Figure 16 in Appendix A shows the land classification map for the Carraízo Reservoir area, based on the Land Use Plan (PRPB 2015).

In the lower Río Grande de Loíza Basin most of the land use has changed from agricultural use to residential, commercial, and industrial use (FEMA 2017). Vegetative cover in the basin consists primarily of improved pasture, such as pangola-grass (*Digitaria eriantha*), star grass (*Cynodon nlemfuensis*), and merker grass (*Pennisetum purpureum*). In areas still in agricultural use within the basin, most is pastureland used for beef and dairy cattle. The principal agricultural crops in the basin are plantains, tanniers, yams, and tobacco (FEMA 2017).

5.11.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative; therefore, there would be no impact to land use and zoning within the Carraízo Reservoir area. The comprehensive plans developed by PRPB, and the corresponding municipalities would continue to guide land use in this area.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Activities projected as part of the proposed dredging process would be temporary in nature and would improve the reservoir’s storage capacity. The staging and disposal dikes areas already exist and were used in the past dredging event. The proposed improvement to these areas would not change the current use and zoning. The installation of the inland sediment pipelines to connect with disposal dikes would require a 12-m-wide (39-ft) easement along approximately 7 km (4.35 mi) of open non-developed and agricultural lands. The proposed aboveground pipeline alignment would cross privately owned land requiring corresponding short-term agreements between

PRASA and the properties owners to minimize interference with the current land uses. After completion of the dredging project, the temporary dock and sediment pipeline would be removed, and the land would return to open space. No changes to the existing zoning would be necessary.

Alternative 2 site preparation/construction, dredging, and demobilization activities would have minor direct short-term adverse impacts to existing land uses and no impact to zoning in the project area.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

The proposed dredging method and alternative components would be similar to Alternative 2 but would include the sediment processing and transportation phase from disposal dike A from approximately year 8 to year 20. Under this alternative, the impacts to land use and zoning would be similar to those described under Alternative 2. The destination of processed sediment materials would be to authorized operating facilities; therefore, no impacts to land use and zoning would occur associated to this activity. Alternative 3 would have minor direct long-term adverse impacts to existing land uses and no impact to zoning adjacent to the project area.

5.12 NOISE

Noise is defined by EPA as unwanted or unwelcomed sound measured in decibels (dBA) on the A-weighted scale. The scale classifies noise based on the range of sounds that the human ear can hear. Noise that occurs between 10 p.m. and 7 a.m. is more disturbing than those sounds that occur during normal waking hours between 7 a.m. and 10 p.m. The Noise Control Act of 1972 required EPA to create a set of noise criteria. In response, EPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* in 1974 which explains the impact of noise on humans (EPA 1974). The Day Night Average Sound Level (DNL or Ldn) is an average measure of sound. The DNL descriptor, accepted by federal agencies, is the standard for estimating sound impacts and establishing guidelines for compatible land uses. The EPA report found that keeping the maximum 24-hour DNL value below 70 dBA protects most people from hearing loss. The Noise Control Act, however, only charges implementation of noise standards to those federal agencies that operate noise-producing facilities or equipment.

The Quiet Communities Act of 1978 enabled the development of state and local noise control programs to provide an adequate federal noise control research program. According to published lists of noise sources, sound levels and their effects causes pain starting at approximately 120 to 125 dBA and can cause immediate irreparable damage at 140 dBA. The Occupational Safety and Health Administration (OSHA) has adopted a standard of 140 dBA for maximum impulse noise exposure.

Within Puerto Rico, PRDNER/PREQB regulates noise in accordance with the Noise Pollution Control Regulation (PREQB 2011). The regulation establishes the threshold for industrial, commercial, residential, and quiet zones, as indicated in Table 10. Quiet Zones are areas that have additional considerations including hospitals, schools, court houses, and daycare centers for the elderly and children. The rule states that signs must be conspicuously posted in Quiet Zones indicating the designation.

Table 10: Puerto Rico Noise Emission Standards

Emitting Sources	Receptors[a,b,c]							
	Zone I (Residential)		Zone II (Commercial)		Zone III (Industrial)		Zone IV (Quiet)	
	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
Zone I	60	50	65	55	70	60	55	50
Zone II	65	50	70	60	75	65	55	50
Zone III	65	50	70	65	75	75	55	50
Zone IV	65	50	70	65	75	75	55	50

[a] Sound Levels Exceeded in 10% during monitoring period (L10).
[b] The daytime, or diurnal, period corresponds to the period between 7:00 a.m. and 10:00 p.m.
[c] The nighttime, or nocturnal, period corresponds to the period between 10:01 p.m. and 6:59 a.m.

5.12.1 Existing Conditions

For the proposed project, noise levels would vary by each site location and depend on the sound level generated by existing activities and the observer's distance from the source. Existing background noise in the project area is from agricultural industrial activities and vehicular noise. Project components' classification and approximate distance to closest receptors are included in Table 11.

Table 11: Project Areas and Adjoining Noise Receptors

Project Area	Type of Closest Noise Receptor	Geographic Location to Project Component	Distance to Closest Receptor m (ft)
Staging Area	Residential	South	33.5 (110)
Proposed Sediment Pipeline (Dike C segment)	Residential	Northeast	45.1 (148)
Disposal Dike A – entrance gate	Residential	East	30 (98.4)
Disposal Dike B	Residential/Commercial	East	94.5 (310)
Disposal Dike C	Residential	East	78.6 (258)

Target noise levels for the closest noise receptors are 65 dBA during daytime hours and 50 dBA during nighttime hours, except for receptors east of disposal dike B, which shows a mixed use (commercial/residential) area which has a 70 dBA daytime noise target level and a 65 dBA nighttime noise target level. State Road PR-796 runs between the staging area and the closest residence to the south, which could result in higher than typical background noise levels for the residential receptors, mostly associated with traffic. The proposed pipeline to dikes A and B would be in vacant fields, far from receptors and its location would minimize impacts associated with booster pumps during dredging operations. The schools Daniel Díaz Santana (northeast of the staging area) and the Second Unit Josefina Sitiriche (east of the disposal dike C) are 0.4 km (0.25 mi) away, the closest quiet zones to the proposed project sites (Figure 16 in Appendix A).

5.12.2 Potential Impacts

Alternative 1: No Action

No site preparation/construction, dredging, or demobilization activities would occur under the No Action Alternative; therefore, no changes to noise levels are expected. The No Action Alternative would have no impact on ambient noise levels within the Carraízo Reservoir area.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Noise emitted by the site preparation/construction, dredging operations, and demobilization equipment would result in a temporary short-term increase in ambient noise levels near the proposed project sites. The site preparation/construction activities would take place between 7 a.m. and 10 p.m., the diurnal period. The noise level would vary during the site preparation/construction period, depending on the number of construction equipment and the distance to the noise receptor. The sound levels generated by typical equipment are included in Table 12.

Table 12: Typical Noise Levels Generated by Construction Equipment

Equipment Description	Noise Level at 50 ft in dBA
Backhoe	80
Chain Saw	85
Compactor (ground)	80
Compressor (air)	80
Crane	85
Dozer	85
Dump Truck	84
Excavator	85
Front End Loader	80
Generator	82
Impact Pile Driver (diesel or drop)	95
Pumps	77
Roller	85
Scrapper	85

Source: Adapted from Federal Highway Administration (FHWA) Highway Construction Noise Handbook (2006)

As seen in Table 12, noise levels associated with site preparation/construction would be between 77 and 95 dBA at approximately 15 m (50 ft). Alternative 2 would require the use of construction equipment to rehabilitate the staging area and disposal dikes, and installation of the inland sediment pipeline. The staging area would experience the highest noise levels, mostly associated with temporary dock construction. The preferred construction method for the temporary dock has not been determined; however, it may be a floating dock or a pile dock structure. Pile driving is one of the construction activities with the highest potential for noise impacts, even with various dampening and shielding methods (FHWA 2006). Considering the size of the proposed dock and the location, timber piles could be used which would generate less noise than steel or concrete piles. Piles could be installed using an impact hammer or a vibratory hammer. A vibratory hammer makes less noise than an impact hammer, and in combination with a timber pile would produce much less underwater noise than concrete or steel piles. Should pile driving take place in the water, noise and vibration could also harm aquatic life at close range, and further away from the dock might cause behavioral impacts (Bureau of Ocean Energy Management 2012). For construction of the temporary pier, depending on the design and number of piles needed, the installation method, and type of pile, it is estimated that installation of piles would be no more than two days and construction of the dock would take two weeks.

The noise levels of the construction equipment associated with the disposal dikes rehabilitation range from 77 to 85 dBA. The noise levels would increase during site preparation/construction activities; however, once the disposal dikes and staging area have been rehabilitated, the noise associated with construction equipment would decrease considerably. After rehabilitation of the staging area and disposal sites, light trucks and small construction equipment would remain to provide operations and maintenance support during dredging activities.

Once dredging operations begin, the sound levels generated by the equipment would range from 77 to 85 dBA range, including noise generated by the booster pumps as part of the sediment pipeline. The noise levels would vary considerably depending on the dredge location and distance to receptors within the reservoir. There are less than 100 residential structures within 76 to 122 m (250-400 ft) of the reservoir's shoreline for the 10 km (6.2 mi) proposed dredging area. Dredging activities would occur up to 24 hours a day, 7 days per week. Table 13 shows the estimated noise levels that could be expected for the closest receptors closest to project areas, using the highest noise generating construction equipment and approximate distance to project areas.

Table 13: Estimated Noise Levels for the Closest Noise Receptors to Project Areas

Source	**Distance from Closest Noise Receptor m (ft)**	**Construction Equipment Noise dBA at 50 ft**[a]	**Leq Construction dBA**[b]	**Estimated Background Noise L_{10}**[c]	**L_{10} Total**[d]	**Noise Pollution Control Regulation (Diurnal /Nocturnal)**
Staging Area	33.5 (110)	85	78.15	65.0	78.4	65/50
Sediment Pipeline (Dike C segment)	45.1 (148)	85	75.57	65.0	76.0	65/50

Source	Distance from Closest Noise Receptor m (ft)	Construction Equipment Noise dBA at 50 ft[a]	Leq Construction dBA[b]	Estimated Background Noise L_{10}[c]	L_{10} Total[d]	Noise Pollution Control Regulation (Diurnal /Nocturnal)
Dike A	51.8 (170)	85	74.37	65.0	74.9	65/50
Dike B	94.5 (310)	85	69.15	65.0	70.6	70/65
Dike C	78.6 (258)	85	70.75	65.0	71.8	65/50

Notes:
a. Adapted from FHWA Highway Construction Noise Handbook (2006).
b. Leq is the Equivalent Continuous Sound Pressure Level.
c. L10 for background noise.
d. L10 is the sound level exceeded for 10% of the time of the measurement period (t).

The estimated noise generated by construction equipment for the closest receptors, using the equipment with the highest sound level generation would range from 0.6 to 13.4 dBA over the estimated background noise and PRDNER noise regulation thresholds. BMPs to keep sound levels within accepted thresholds could include controlling working hours and using noise attenuating equipment. Noise intensity decreases exponentially with increased distance from the source; therefore, locating noise sources away from receptors would effectively decrease receptor noise substantially from the values in Table 13. Regulations for the Control of Noise Pollution would be followed during construction activities to limit noise levels (PREQB 2011). Implementation of BMPs such as sound dampers and sound suppressors, while operating close to residences and quiet zones areas, would be required.

Actions under Alternative 2 would expose construction workers to elevated levels of noise. The PRASA would follow OSHA regulations and would provide the appropriate level of personal protective equipment to minimize adverse impacts during proposed daily activities.

Site preparation/construction activities may also generate vibrations that could result in ground-borne noise. The adverse impacts associated with ground vibrations would be minor direct and short-term, and mostly associated with the possibility of using piles for the temporary dock construction. Alternative 2 would not include new permanent sources of noise or vibration. Noise impacts associated with dredging would be from booster pumps, generators, and the tugboat associated with the dredge barge operation. The tugboat would generate noise from its engine which would be typical of small outboard motors currently used by recreational boats on the Carraízo Reservoir. Following requirements of Puerto Rico’s regulations on noise contamination, all equipment such as dredges, booster pumps, and generators, shall include sound dampers and sound suppressors (PREQB 2011).

Activities under Alternative 2 would result in minor to moderate, direct short-term impacts with implementation of BMPs.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

The noise impacts associated with Alternative 3 would be similar to Alternative 2 but would create additional noise during the sediment processing and transportation phase from disposal dike A from approximately year 8 to year 20. This alternative would require the use of sediment processing equipment such as an excavator and a conveyor belt system to segregate sand and gravel. This equipment would generate increased sound levels for residential receptors adjacent to disposal dike A. The noise levels of the excavator would be approximately 85 dBA at 15.24 m (50 ft). The closest noise sensitive receptor to the potential location of the excavator would be a row of residences 44.5 m (146.2 ft) from the disposal dike A eastern levee and scattered houses approximately 48.5 m (159 ft) from the disposal dike southern levee (Figure 18 in Appendix A).

Transporting sediment off-site would require an average of 77 truckloads, five days per week on a yearly basis which would equate to 154 truck trips per day between 7:00 a.m. and 10:00 p.m. The closest noise sensitive receptor to the access road would be the aforementioned row of residences, approximately 20.4 m (66.8 ft), while the closest noise sensitive receptor to the disposal dike A access gate would be the house in the neighborhood of Santa Barbara from the disposal dike A road and 30 m (98.4 ft) from the access gate. For example, noise from dump trucks would be over 84 dBA at 15.24 m (50 ft) from the source. The roads employed for transporting materials off-site would be PR-9189 for 1.4 km (0.9 mi), to PR-189 for 0.4 km (0.25 mi), to PR-30 for 9 km (5.6 mi).

Alternative 3 would have major direct long-term adverse impacts to residential communities adjacent to disposal dike A. Implementation of BMPs described under Alternative 2, as well as conducting truck activities during daytime hours would not decrease the level of the impact to less than major. Due to the potential noise impacts to residential communities adjacent to disposal dike A, if this alternative is selected, additional studies would be needed.

5.13 TRANSPORTATION

The Puerto Rico Department of Transportation and Public Works (PRDTOP) is responsible for managing both maritime and non-maritime transportation facilities. PRDTOP is comprised of four agencies: the Puerto Rico Highway and Transportation Authority (PRHTA), the Puerto Rico Port Authority, the Maritime Transport Authority, and the Metropolitan Bus Authority. PRHTA is a government-owned corporation responsible for constructing, operating, and maintaining roads, bridges, avenues, highways, tunnels, public parking, tolls, and other transit facilities.

5.13.1 Existing Conditions

Disposal dike A is north of Highway PR-9189, west of Urb. Paseo de Santa Bárbara, and east of Río Loíza in the Gurabo municipality. The PR-9189 is a two-lane, two-way tertiary local road which begins at its intersection with PR-189. It has a length of 1.79 km (1.11 mi) and ends at disposal dike A. The roadway width ranges from approximately 12 m (39 ft), at its intersection with PR-189, to 4 m (13 ft) in the area bordering the south part of disposal dike A. Road PR-9189 passes through several residential areas (Figure 19 in Appendix A).

Disposal dike B is north of PR-941 and east of PR-942 in the municipality of Gurabo. The PR-941 is a two-lane, two-way tertiary collector road which begins at its intersection with PR-943 in

Gurabo. It has a length of 14.87 km (9.24 mi) and ends at its intersection with PR-851 in the municipality of Trujillo Alto. The roadway width ranges from 6 m (16 ft) to 8 m (26 ft) until its end. This road begins at the town center of Gurabo and passes through several residential and rural areas bordering Río Gurabo and the Carraízo Reservoir. The PR-942 is a two-lane, two-way tertiary collector road which begins at its intersection with PR-941 and has a length of 5 km (3.1 mi). The roadway width ranges from 4 m to 6 m (13 ft to 20 ft) and passes through several residential and rural areas (Figure 19 in Appendix A).

Disposal dike C is north of Río Gurabo River and west of Urb. Alturas de Hato Nuevo in the municipality of Gurabo. An existing dirt road runs south, approximately 0.6 km, (0.37 mi) and serves as the access to disposal dike C from PR-944. The PR-944 is a two-lane, two-way tertiary local road which begins at its intersection with PR-181. It has a length of 6.10 km (3.8 mi) and ends at its intersection with PR-945. The roadway width ranges between 6 m (19.7 ft) and 8 m (26.2 ft) and flows through several residential and rural areas (Figure 19 in Appendix A).

The staging area is north of PR-796 and south of the Carraízo Reservoir. The PR-796 is a two-lane, two-way tertiary collector road which begins at its intersection with PR-798, has a length of 8.20 km (5.1 mi), and ends in its intersection with PR-1. The roadway width ranges between 6 m (19.7 ft) and 12 m (39.4 ft) and passes through several residential areas (Figure 19 in Appendix A).

5.13.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging operations, or demobilization activities under the No Action Alternative. Therefore, the No Action Alternative would have no impact upon transportation in the proposed project area or surrounding municipalities.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Under Alternative 2, activities associated with the site preparation/construction, dredging, and demobilization phases would result in minor direct short-term impacts to traffic in the area. The PRPB developed a jobs multiplier to estimate the number of employees for typical construction/manufacturing/agriculture projects based on the estimated project cost (PRPB 2022). According to the PRPB employee multiplier and estimated project cost for this project, up to 385 employees would work for approximately 2 years between the 4 sites. However, a dredging project is considered a specialized project, therefore, a detailed job calculation was made based on information from other dredging projects, to estimate the number of employees required for site preparation and dredging activities. The detailed jobs calculation estimated approximately 120 employees per day, distributed between all project areas (GLM pers. comm. CSA 2022a). The influx of employees and equipment mobilization to the staging area and the three sediment disposal sites would add to the existing traffic and could cause an impact, mainly during the site preparation/construction phase and during the pipeline installation. If extra-wide or extra-heavy loads would need to be transported to the staging area, a delivery plan with the proposed route and equipment details would be prepared for PRHTA's evaluation and approval.

It is foreseen that all employees would arrive at staging area and then would mobilize to the specific project areas as required. Each site would have its own separate route. The AADT for the access roads, according to PRHTA (2018) database is as follows:

- Staging Area: PR-796. No data.
- Disposal Dike A: PR-9189. No data.
- Disposal Dike A: PR-189, 14,800 AADT.
- Disposal Dike B: PR-941, 4,128 AADT.
- Disposal Dike B: PR-943, 1,042 AADT.
- Disposal Dike B: PR-189, 14,800 AADT.
- Disposal Dike C: PR-944. No data.
- Disposal Dike C: PR-181 13,380 AADT.

For the roads with AADT information, the increase in traffic from employees, based on the additional trips per day estimate above, would be in the range of 1.3% to 4.7%. These additional trips would account for most of the increase in traffic estimated for Alternative 2; equipment and materials delivery, including the pipeline, would be a much smaller number, albeit comprised of larger vehicles.

Preferred travel routes for the project include (Figure 19 in Appendix A):

- Staging area: PR-796 to PR-1
- Disposal dike A: PR-9189 to PR-189 to PR-30
- Disposal dike B: PR-941 to PR-943 to PR-189 to PR-30
- Disposal dike C: PR-944 to PR-181 to PR-30

Parking for employees/workers would be provided within the staging area and the disposal dikes. It is estimated that the staging area could accommodate up to 96 vehicles and the disposal dikes areas could accommodate up to 140 vehicles. There would be three working shifts for the project with an estimated 120 employees per day (up to 40 employees per shift). It is expected that all employees would arrive at the staging area and then mobilize to the specific project areas as required (GLM pers. comm. CSA 2022a).

A Maintenance of Traffic (MOT) Plan is a plan to establish a project work zone, providing related transportation management and temporary traffic control on streets and highways rights-of-way. PRASA would prepare a MOT Plan for those areas where equipment and supply deliveries and the installation of the inland sediment pipeline would disrupt normal traffic. As required by local PRDTOP regulations, the MOT Plan would include recommendations regarding traffic signs and speed limits to guarantee the safety of users and construction crews. Implementation of BMPs would be required to limit adverse impacts to noise levels, air quality, and traffic associated with Alternative 2 proposed activities. These BMPs would include measures such as traffic management techniques, fugitive dust control, proper vehicle maintenance, and minimizing vehicle idling time, among others. BMPs would be established and coordinated with PRDTOP and the municipalities. As part of the MOT Plan, PRASA would include public notices through traditional and social media regarding traffic changes and detours, if required.

Alternative 2 would result in minor direct short-term adverse impacts to transportation during the site preparation/construction phase, dredging operations, and demobilization with implementation of BMPs.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Under Alternative 3, impacts to transportation would be similar to Alternative 2 for the site preparation/construction and demobilization phases. The proposed dredging method and project components for Alternative 3 would be the similar, with a variation on total sediment volume to be dredged and a longer total dredging duration (20 years). To remove 6 Mm^3 (7.8 Mcy) of sediment, Alternative 3 would require the annual removal of 300,000 m^3 (392,385 cy) of de-watered sediments from disposal dike A, once the three disposal dikes' storage capacity is reached. Sediment dredging, dewatering, sorting and transportation off-site would continue exclusively at disposal dike A beginning approximately during year 7 or 8 after initiating dredging activities and continuing until year 20. Dredging operations at disposal dikes B and C would stop and equipment demobilized.

Off-site sediment transportation would require an average of 77 truckloads, five days per week on a yearly basis which would equate to 154 truck trips per day between 7:00 a.m. and 10:00 p.m. The roads employed for materials transportation would be PR-9189 for 1.4 km (0.9 mi), to PR-189 for 0.40 km (0.25 mi) to PR-30, and thereon to different markets in Puerto Rico. The AADT for the materials transportation roads, according to PRHTA (2018) database is as follows:

- Disposal Dike A: PR-9189. No data.
- Disposal Dike A: PR-189, 14,800 AADT.
- Disposal Dike A: PR-30, 64,755 AADT.

For the roads with AADT information, the increase in traffic from workers and sediment transport trucks, would be in the range of 0.5% to 2.3%. The additional traffic from heavy trucks would cause wear and tear of these roads at a faster pace than would normally occur. To address the potential additional wear and tear on the roads, PRDTOP would impose an impact fee to cover the anticipated increased maintenance costs.

Alternative 3 would result in major direct long-term adverse impacts during the project duration. Implementation of BMPs and compliance with requirements of PRDTOP would be required. Due to the potential impacts to residential communities adjacent to disposal dike A and communities along the transportation route, if this alternative is selected, additional studies would be needed.

5.14 PUBLIC SERVICES AND UTILITIES

A public utility is an organization that maintains the infrastructure for a public service. The interruption of service from public utilities can cause public health concerns. A reduction in the reliability of public utility services affects areas of daily life. The proposed project seeks to improve the reliability of the source water for PRASA's SCWFP service area.

5.14.1 Existing Conditions

Hurricane María resulted in a substantial impact to the capacity of the Carraízo Reservoir. The existing resources that would be affected by this project include the Carraízo Reservoir as the sole source of water for the SCWFP; the SCWFP and GWFP, as potable water treatment and delivery systems; and the disposal dikes. The Santa Bárbara wastewater lift station is located within the boundaries of disposal dike A.

PRASA owns and operates Puerto Rico's public water and wastewater system. It maintains five operational regions: Metro, North, South, East, and West. The proposed project is in the Metro Region, which includes the municipalities of Bayamón, Canóvanas, Carolina, Cataño, Guaynabo, Loíza, San Juan, Toa Baja, and Trujillo Alto. PRASA has more than 32,187 km (20,000 mi) of water and wastewater pipelines. These facilities treat millions of gallons of wastewater and water per day (PRASA 2021). The Carraízo Reservoir is a major component of PRASA's municipal water treatment, transmission, and distribution system and is considered a critical service.

The Carraízo Reservoir is the largest source of drinking water supply for SCWFP service area. The reservoir had an original capacity of 26.8 Mm^3 (35 Mcy), which was reduced to 15.06 Mm^3 (19.7 Mcy) by sedimentation due to Hurricane María. Dredging was previously performed in 1998 when 6 Mm^3 (7.8 Mcy) of sediment was removed and discharged into three confined disposal dikes, the same three disposal dikes which would be used for this project.

The water supply intake to the GWFP in the Río Gurabo is downstream of disposal dike C; and therefore, would be subject to water quality impacts (turbidity) from water decanted from disposal dike C. GWFP is a 4 MGD plant that serves the populations of Los Flamboyanes, Hato Nuevo Los Robles, Celada Centro, Celada, Masas, and Santa Rita wards. The Santa Bárbara wastewater lift station is located in the northeast corner of disposal dike A. It collects wastewater from nearby service areas and discharges it into the Caguas Regional Wastewater Treatment Plant, approximately 2.4 km (1.5 mi) west of lift station. Its operations are separate from the SCWFP and the GWFP and does not use water from the rivers or reservoir for its operations.

Historically, PRASA has managed turbidity issues at the SCWFP and the GWFP due to on-going issues of sedimentation. Due to existing issues of sedimentation and high turbidity levels, the water filtration plants can handle high levels of suspended sediment without affecting operations (PRASA 2022).

5.14.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative. This would result in a continued decrease in the reservoir's water storage capacity, eventually failing as the sole source of water for the SCWFP. Under the No Action Alternative, the population served by the SCWFP would experience potable water service interruptions in the long-term. These interruptions would have potential impacts to the service area population's health since piped water for human consumption is required for essential activities such as drinking, toilet flushing, bathing, and oral hygiene. Commercial businesses, governmental offices, and public health facilities depend on a reliable source of water. Potable water service interruptions would limit firefighting capabilities resulting in serious safety and health hazards. Potable water service interruption would also have the potential to severely impact the major economic drivers of Puerto Rico, including manufacturing, finance, and tourism, which also rely on the SCWFP operation.

Based on USCB data for the total population of Puerto Rico and the population served by the SCWFP, the No Action Alternative would have major indirect long-term adverse impacts to Puerto Rico at large, and more specifically for approximately 15% of the island's population served by the SCWFP (USCB 2021).

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Under Alternative 2, activities associated with site preparation/construction, dredging, and demobilization phases would result in minor direct short-term impacts to SCWFP and GWFP operations. Activities during dredging operations and sediment de-watering would increase turbidity and suspended solids in the reservoir and rivers. Water quality at the SCWFP and GWFP raw water intakes would be monitored to determine the level of turbidity and total dissolved solids conditions during the dredging process and release of decanted water, respectively. Monitoring frequency and parameters would be according to the WQC, the agreement with PRDOH, or both. Due to existing long-term issues with sedimentation and high turbidity levels, the water filtration plants can handle high levels of suspended sediment without affecting operations (PRASA 2022). Dredging activities would not require the removal or relocation of existing water or power infrastructure. Since the Santa Bárbara wastewater lift station does not use water from the reservoir or rivers, turbidity and water quality would not impact the lift station operations.

Alternative 2 would have minor direct short-term impacts on Puerto Rico's public services and utilities. BMPs would be implemented to minimize water quality disturbances and not disrupt the SCWFP and GWFP operations.

Alternative 2 would result in beneficial direct long-term impacts to public services and utilities by having a reliable water supply for public health, safety, and economic activities.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

The impacts associated with Alternative 3 would be similar to Alternative 2 but would include the sediment processing and transportation phase from disposal dike A from approximately year 8 to year 20. Sediment processing to segregate the sand and gravel portions would occur within the disposal dike A footprint. Impacts from this activity to public services and utilities would be minor and long-term and result mainly from potential water quality impacts to the SCWFP and the GWFP from the site preparation/construction and dredge operation phases.

Alternative 3 would result in potential minor direct long-term adverse impacts to water quality for both the SCWFP and the GWFP; similar to those of Alternative 2. BMPs would be implemented to help minimize impacts from Alternative 3.

Alternative 3 would result in beneficial direct long-term impacts to public services and utilities, similar to those of Alternative 2, due to improved water storage capacity of the reservoir.

5.15 PUBLIC HEALTH AND SAFETY

Numerous health and safety laws and regulations exist for a wide variety of activities. The U.S. Congress enacted the Occupational Safety and Health Act of 1970, 29 U.S.C. §651, et seq. to assure safe and healthy working conditions for working men and women.

The EPA, through the Safe Drinking Water Act, requires that PRASA monitor water quality in the filtration plants and distribution systems. Water quality sampling is determined by the population of the specific distribution system and results and analysis are reported to PRDOH and EPA. Failing to comply means violations to standards, monitoring, and reports, which could result in monetary fines. It is expected that water utilities comply 100% with the Safe Drinking Water Act and with National Primary Standards. National Primary Standards protect the public health by establishing an acceptable level of contaminants in drinking water.

5.15.1 Existing Conditions

Within Puerto Rico, the primary public and health services include fire protection, law enforcement, and medical emergency services. The following describes the primary authorities tasked with ensuring public health and safety:

- The 9-1-1 system is operational throughout Puerto Rico and is the first call in case of emergency.
- The closest fire station to the disposal dikes is Gurabo Fire Station Nº 128, at Road or PR-9944, Gurabo. The closest fire station to the staging areas is the Caguas Fire Station, located at Avenue Rafael Cordero, in Caguas. Both stations can be reached 24 hours a day.
- Local police departments provide law enforcement and emergency services for each community and the surrounding areas. The closest state police office to the project area is the located at Eugenio Sánchez Lopez Street, in Gurabo Municipality. A central phone number provides access to the state police 24 hours a day. The Gurabo municipal police, located at is closest to the disposal dikes. The Caguas municipal police station, located at is closest to the staging area.

- Emergency medical services in include hospitals, clinics, and local medical professionals' offices within the SCWFP service area. There are twenty-seven hospitals, numerous private and non-profit clinics, and medical professionals who support the public health of the SCWFP service area and the population of Puerto Rico (U.S. Department of Homeland Security [USDHS] 2019).

5.15.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action Alternative; therefore, there would be no impacts to public health and safety in the short-term. In the long-term, the No Action Alternative would lead to major health issues if the Carraízo Reservoir is not dredged to restore its capacity to reliably supply the population served by the SCWFP. Potable water is the basic measure of sanitation, providing for personal hygiene and removal of human waste in a sanitary fashion. The population within the service area would suffer service interruptions when the water storage capacity reaches the minimum operational thresholds due to unchecked sedimentation. Service interruption would also result in service line pressure losses, which would allow the potential for surrounding contaminants to enter the distribution system, thus creating water quality unreliability when the water service is restored.

Interruptions in water service would affect the ability of fire, police, medical institutions, and professionals to provide emergency services and required day-to-day operations thus increasing safety risks for a population of almost half a million in the SCWFP area and the people of Puerto Rico.

Major indirect long-term impacts to the SCWFP service area's public health and safety would occur under the No Action Alternative due to the continuing decrease in water storage capacity and the eventual interruption of the water service.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Under Alternative 2 site preparation/construction, dredging operations, and demobilization phase activities could pose risks to worker safety. The use of qualified trained personnel, site preparation/construction meetings, and equipment trainings would minimize the risk to human health and safety. Appropriate signage would be posted, and construction barriers would be placed to alert the public of potential hazards and prevent unauthorized access to project areas during site preparation/construction, dredging operations, and demobilization.

During project activities, primary roads would be passable, allowing emergency responders to perform their duties. Site preparation/construction, dredging operations, and demobilization could involve short-term lane closures, intermittently during the day, when equipment and materials are delivered to the staging area and disposal dikes and for sediment pipeline installation. A MOT Plan would be developed which would include the use of flaggers to help direct traffic during lane closures. During demobilization there could again be short-term lane closures, intermittently during the day, with the removal of equipment from the staging area and disposal dikes and when the pipeline is dismantled.

Dredging operations would not impact public services/emergency response in water. The fire stations, local police, and state police departments closest to the project sites would be notified before project work begins to advise them of potential disruptions to navigation during dredging, including providing details on the number of supporting vessels and location of the floating sediment pipeline. Continuous communication with emergency responders would minimize delays if an emergency event occurred in the water. During dredging operations, the inland sediment pipeline alignment would be adjacent to local roads and would cross under primary roads and bridges, therefore there would be no impacts to emergency response times. Activities within the staging area and disposal dikes during dredging operations would not impact transportation routes for emergency responders.

Dredging would increase turbidity in the reservoir which would impact water quality for the SCWFP for two years. Dredging activities would occur up to 24 hours a day, 7 days a week. Decanted water would increase turbidity and total suspended solids which also would impact water quality for the GWFP for two years. However, these activities would pose no impact to public health given that the sediments were characterized as non-hazardous, with most sample results being several orders of magnitude lower when compared to regulatory limits. BMPs would be implemented to reduce potential impacts and not disrupt the SCWFP and GWFP operations.

Alternative 2 would have minor direct short-term impacts to public health and safety due to potential intermittent lane closures during site preparation/construction, dredging operations, and demobilization. A MOT Plan and BMPs would be implemented to manage and reduce potential impacts (Appendix H).

Alternative 2 would be a beneficial indirect long-term impact by having a more reliable potable water source to support public health and safety for the SCWFP service area and the general population of Puerto Rico.

Alternative 3: Dredging to Remove 6 Mm^3 of Sediment

Public health and safety impacts associated with Alternative 3 would be similar to Alternative 2 for site preparation/construction and demobilization phases with a variation on sediment volume and the dredging period of 20 years. Alternative 3 would include sediment processing and transport as part of dredging operations to remove a total volume of 6 Mm^3 (7.8 Mcy). Dredging would increase turbidity in the reservoir which would impact water quality for the SCWFP for 20 years. The continued return of decanted water to the reservoir would prolong the water quality impacts to the GWFP for 20 years.

The additional years of sediment processing activities may pose risks to worker safety. The use of qualified personnel trained in the operation of their equipment as well as the implementation of OSHA safety measures would minimize the risk to human health and safety.

Alternative 3 would result in increased traffic due to sediment transport from disposal dike A for twelve years. The increase in heavy vehicular traffic would be approximately 77 truckloads, 5 days per week on a yearly basis between 7:00 a.m. and 10:00 p.m. These operations could be a risk for other drivers and pedestrians and could reduce response times by fire, police, and emergency medical services. Implementation of a MOT Plan and BMPs would minimize traffic risks (Appendix H).

Alternative 3 would result in minor direct short-term impacts and major direct long-term adverse impacts to public health and safety over the duration of the project. Implementation of a MOT Plan and BMPs would reduce the impacts to moderate.

The Carraízo Reservoir and the SCWFP service area would derive a beneficial indirect long-term impact with additional water storage capacity resulting from this alternative.

5.16 HAZARDOUS MATERIALS

Hazardous substances, materials, and wastes constitute a solid, liquid, contained gaseous or semisolid material, or combinations of materials that pose a substantial present or potential hazard to human health and the environment. Hazardous materials constitute a type of substance that receives extensive regulation by various federal and local environmental, safety occupational, and transportation laws and regulations. Hazardous materials include asbestos, lead, petroleum products, and toxic, highly reactive chemicals. Improper management and disposal of hazardous substances can lead to the pollution and/or contamination of groundwater, surface water, soil, and air.

There are numerous federal and local laws that contain lists of hazardous materials, hazardous substances, and hazardous wastes that require special handling if encountered during project construction. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 U.S.C. §9601, et seq.) and Resource Conservation and Recovery Act (RCRA), Subtitle D are the primary federal laws for the management and disposal of hazardous substances. The Puerto Rico counterparts are the Law to Promote the Reduction of Hazardous Wastes in Puerto Rico, Law 10 of January 19, 1995, and the Regulation for the Control of Hazardous Solid Wastes, *as amended* (1998). The EPA regulates the management of non-hazardous solid waste according to RCRA. Under RCRA, EPA oversees regulating the handling and disposal of hazardous wastes. The U.S. Department of Transportation (USDOT) establishes regulations and training requirements for the transport of hazardous materials by land, water, and air within, from, or through the U.S. and its territories. The PRDNER administers Puerto Rico laws and regulations for hazardous materials, substances, and wastes.

Enforcement of these laws ensures the protection of the environment and human health through the establishment of management systems that include their identification, use, storage, treatment, transportation, and disposal. Hazardous waste regulation is meant to manage wastes from cradle to grave. If this management system fails, these laws provide for the adequate investigation and cleanup of contaminated sites from the release of hazardous materials and hazardous wastes.

For employees working with hazardous materials, OSHA requires that their employers provide them with training and the appropriate personal protective equipment necessary to perform their tasks in a safe and secure manner.

5.16.1 Existing Conditions

Sediment sampling was conducted in the Carraízo Reservoir to characterize the sediment to be dredged. In May 2021 sediment samples were obtained along the length of the reservoir, and from the disposal dikes A, B, and C upstream of the reservoir The sediment samples were analyzed for releasable sulfide, organic matter, corrosivity and pH, TCLP herbicides, TCLP VOCs, TCLP semi-volatile organic compounds, TCLP pesticides, TCLP metals, TCLP mercury, and releasable cyanide.

The results and methods used to characterize the sediments are described in the *Sediment Sampling at Carraízo Reservoir Report* (GLM 2021) (Appendix G). According to the sampling results, detectable TCLP parameters were well below the regulatory level for hazardous solid wastes. Test results above detection limits for disposal dikes samples and results for reservoir sediments are presented in Appendix G. If a tested chemical parameter resulted in a value below the detection limit, it is not listed in these tables. Sediment samples were characterized as non-hazardous, most by several orders of magnitude below appropriate regulatory limits. In a letter dated January 19, 2022, EPA concurred with this assessment (Appendix G).

5.16.2 Potential Impacts

Alternative 1: No Action

There would be no site preparation/construction, dredging, or demobilization activities under the No Action alternative. Therefore, the No Action Alternative would have no impacts upon hazardous materials, substances or wastes in the project area and surrounding municipalities.

Alternative 2: Dredging to Remove 2 Mm^3 of Sediment (Preferred Alternative)

Under Alternative 2, site preparation/construction, dredging operations, and demobilization activities would temporarily use, potentially encounter, or generate hazardous materials and wastes such as lubricants and fuels. The PRASA would be responsible for handling and disposing of hazardous materials and wastes in accordance with federal and local regulations and specific BMPs. The PRASA would be responsible for complying with applicable federal and local laws and regulations in determining the absence or presence of hazardous materials or wastes. If PRASA encounters contaminated soil, sediments, surface water, or groundwater during construction, work would stop and PRDNER and other regulators would be notified in accordance with applicable permits. The PRASA would be responsible for adhering to PRDNER guidance before resuming work. For circumstances where the CWA requires the implementation of a SPCC plan, implementation of appropriate BMPs would contain and limit impacts of hazardous materials to the immediate area of the release.

The dredged sediment disposal operations performed under Alternative 2 would comply with CWA Section 404 and be in accordance with a dredging permit issued by USACE, and CWA Section 401 Water Quality Certification from PRDNER.

The PRASA would ensure that on-site personnel receive appropriate job specific safety training in accordance with OSHA regulations. Demolition and clearing and grubbing activities would be in accordance with federal and local laws and regulations regarding the handling and disposal of hazardous materials and hazardous wastes. Appropriate signage and construction barriers would be installed prior to construction to alert the public of project activities and risks and prevent unauthorized personnel from gaining access to the project area.

For Alternative 2, there would be negligible direct temporary impacts to hazardous materials with implementation of BMPs.

Alternative 3 Dredging to Remove 6 Mm^3 of Sediment

The impacts associated with Alternative 3 would be similar to Alternative 2 with a variation on sediment volume and the dredging period of 20 years. Alternative 3 would include sediment processing and transport as part of the proposed dredging event to remove a total volume of 6 Mm^3 (7.8 Mcy). Sediment processing to segregate the sand and gravel would occur within the disposal dike A footprint. The processing of dredged materials on site with heavy machinery would have the potential for spills and leaks, particularly with fuels and hydrocarbons. BMPs and a SPCC plan would be implemented to avoid and minimize impacts (Appendix H).

Under Alternative 3, impacts would be similar to those in Alternative 2. Alternative 3 would result in minor direct long-term potential impacts associated with hazardous materials contamination due to the use of lubricants, fuels, and welding materials within the staging area and disposal dikes. These impacts would be negligible with implementation of BMPs.

5.17 CUMULATIVE IMPACTS

In accordance with NEPA, this EA considers the overall cumulative impact of Alternatives 2 and 3 and similar actions in Puerto Rico's vulnerable natural, cultural, and socioeconomic resources. The statutory basis for considering cumulative impacts for federal actions under NEPA is in Title 42 U.S.C. 4321, et seq. In addition to NEPA, the CWA, CAA, Section 106 of the NHPA, and Section 7 of the ESA individually require an evaluation of cumulative impacts for resources covered under their authorities.

According to CEQ regulations, cumulative impacts represent the "…impact on the environment which results from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what federal agency or person undertakes such actions. Cumulative impacts can result from individually minor but collectively consequential actions taking place over a period" (40 CFR 1508.7). When combined with other actions affecting utilities and similar resources, the activities covered by this EA could lead to cumulative impacts. The scale of those impacts would depend on the number of projects implemented, the size of the projects, and locality and proximity of the projects.

5.17.1 Local Projects

The area of interest for the cumulative impacts of the project in relation to other proposed actions would be the Carraízo Reservoir watershed, which includes the municipalities of Aguas Buenas, Caguas, Gurabo, Juncos, Las Piedras, San Lorenzo, and Trujillo Alto.

For foreseeable future actions, the timeframe considered is five years from the current year 2022. It is assumed that these projects have the potential to be approved. The information of projects other than federally related projects was obtained from the PRPB Physical Planning Office for Site Approval applications submitted from year 2017 to 2022 for the municipalities that comprise the Carraízo Reservoir watershed (PRPB. pers. comm. CSA 2022b). The list of potential future projects excludes those projects denied by the PRPB.

Eighteen siting consultations have been approved within the last 5 years: 9 are land subdivisions, 3 are for commercial establishments (restaurants), 5 are residential, and 1 is a renewable energy project. Siting consultations are required when the proposed use is not allowed under the existing land zoning.

There are 29 siting consultations and other permit applications, such as construction permits and variances, in progress for the five-year period: 11 are for land subdivisions and housing developments; 9 are for various commercial operations, from restaurants to shopping centers and a gym; 2 are for educational facilities; 3 are for industrial facilities; 2 are for services (therapy, skin care); 1 is for an earth crust materials extraction (quarry); and 1 is for a recreational facility (PRPB pers. Comm. 2022c). Most of the above represent new construction and earth movement, with the ensuing erosion/sedimentation impacts when BMPs are not strictly implemented. Other impacts from these types of projects could include impacts to air quality, noise, traffic, socioeconomics and environmental justice, land use and planning, hazardous materials and waste, and biological, cultural, and water resources (PRPB. pers. comm. CSA 2022c)

5.17.2 Federal Actions

The *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico* (Puerto Rico Recovery Plan) includes a list of projects to rebuild damaged communications facilities and infrastructure, potable water, wastewater and stormwater systems, and the electrical grid (COR3 2018). The plan states there would be multiple sources of funding from up to seventeen different federal agencies for the restoration of Puerto Rico. Funding could come from agencies supporting housing, communications, health and human services, energy, and education (COR3 2018).

Funding was recently obligated by FEMA to rebuild PRASA's water and wastewater infrastructure (PRASA 2021). The FEMA reserved the obligated funds to repair, improve, or replace PRASA's infrastructure as per FEMA's Public Assistance Alternative Procedures, according to Section 428 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, and in compliance with the U.S. Congress 2018 Bipartisan Budget Act. The PRASA is required to provide safe water and wastewater service and supply the 1.2 million active clients through the following infrastructure (PRASA 2021):

- 51 Wastewater Treatment Plants (WWTP)
- 114 Water Treatment Plants (WTP)
- PRASA buildings
- 8 dams

- Approximately 3,800 ancillary facilities:1,560 tanks, 1,977 pump stations and 249 water wells

- Over 32,187 km (20,000 mi) of potable water and wastewater collection pipes

Hurricane María reconstruction work is currently underway in Puerto Rico for improvements to most infrastructure, mainly paid for with federal funding. This effort has triggered substantial construction work, which has resulted in heavy competition for human, equipment, and materials resources, and which will continue over the coming 10 to 20 years. According to USDOT post-Hurricane María analysis (FEMA 2020):

- There are 351 major and 54 minor landslides with correction designs in progress by 25 engineering companies.

- Approximately 148 bridges have damages that may be eligible for FEMA funding under the Stafford Act.

- PRHTA will submit applications for 354 projects for permanent work. Of these 354 projects, PRHTA anticipates 90% of the projects will be submitted to FEMA for funding while remaining 10% will be submitted to the USDOT for funding (FEMA 2020).

- The 2019-2022 Statewide Transportation Improvement Program for Puerto Rico included over 40 construction/renovation projects in the municipalities within the Carraízo Reservoir watershed (area of interest for the cumulative impacts analysis). These projects include projects eligible for USDOT funding (PRDTOP 2021).

- The Puerto Rico Recovery Plan (COR3 2018) projects to rebuild communications, potable water, wastewater, and stormwater systems and the electrical grid.

Although most of these projects are restorations and replacement for existing facilities, and therefore would not result in substantial environmental impacts individually, the cumulative adverse impact of these projects could result in short- and long-term impacts to multiple environmental resources including, air, water, natural and cultural resources, noise, and transportation. These projects would also add to the demand for products and services.

Within the described project area and time frame criteria of past, present, and reasonably foreseeable future, two utility projects are proposed by FEMA and PRASA. These are the proposed improvement projects to the SCWFP and the GWFP. According to the PRASA and FEMA Accelerated Award Strategy Workplan, the SCWFP rehabilitation is scheduled as part of the near-term (2021-2023) construction effort (PRASA 2021). The GWFP rehabilitation work is scheduled to occur as part of the mid-term (2024-2027) construction effort. The proposed rehabilitation and improvement projects have not started the design/development phase yet, however the rehabilitation of these facilities does not imply changes in land use or major impacts to existing resources. Both the Carraízo Reservoir project and the locally proposed projects are illustrated in Figure 20 (Appendix A).

5.17.3 Summary of Cumulative Impacts

Cumulative impacts occur when the impacts of a proposed action are added to past, present, and future projects within the same general area. Such activities increase pressure on environmental and human resources, for example:

- Deforestation from clearing of land for agriculture, urban development, and other infrastructure.
- Increased demands on water resources and generation of wastes and other pollution.
- Increased air emissions due to construction of new roads, public utilities, and infrastructure.
- Increased traffic congestion and road repairs due to additional construction, utility, and staff and contractor vehicles on the roads.
- Impacts to possible endangered flora and fauna species, wildlife habitats, and ecosystems in general.
- Increased noise levels due to multiple new projects constructed near one another.

Development activity in Puerto Rico has experienced a downward trend due to the contraction of the population of Puerto Rico in recent years which is the result of increasing emigration, in part related to post-Hurricane María impacts and a reduction in the birth rate, among other demographic phenomena (USCB 2020). However, even at a slow pace, it is expected that the demand for goods and services from the current population would continue triggering development activity in Puerto Rico. In addition, post-Hurricane María reconstruction work will trigger an increased demand for goods and services.

Both Alternative 2 and Alternative 3 would meet PRASA's existing needs and could support new development. These alternatives would support PRASA's ability to provide a steady, reliable water source for the SCWFP service area, by increasing the water storage capacity of the Carraízo Reservoir.

Based on the proposed activities for Alternative 2 and Alternative 3, the most relevant cumulative environmental impacts would be related to air quality, noise, and traffic increases. BMPs would be implemented by PRASA to avoid and minimize impacts to these resources in the project area. Minimization measures would also be coordinated as part of the environmental review process with PRDNER, USACE, PRDOH, and OGPe.

Adverse impacts of the Preferred Alternative, Alternative 2, would be minor, direct, and short-term when combined with other past, on-going, or planned projects, since most of the federal funding actions involve the repair, replacement, or rehabilitation of projects that are similar in function, size, and locality to the existing systems. Therefore, most cumulative impacts from the initial installation and temporary restoration of the projects on the human environment have already occurred prior to and after Hurricane María. Dredging the Carraízo Reservoir would have beneficial, indirect long-term impacts to the SCWFP service area and Puerto Rico by restoring water storage capacity to approximately 17.02 Mm^3 (22.3 Mcy).

For Alternative 3, most impacts would be similar to those for Alternative 2, except that they would be long-term occurring over 20 years. However,

operating for a twelve-year period would exceed regulatory standards for air quality and noise due to the proximity of residential areas. Increased truck traffic would also adversely impact communities along transportation routes.

Dredging the Carraízo Reservoir would have beneficial, indirect long-term impacts to the SCWFP service area and Puerto Rico by restoring water storage capacity at the end of 20 years to approximately 15.26 Mm3 (19.96 Mcy).

6 PERMITS AND ENVIRONMENTAL REQUIREMENTS

The PRASA is responsible for obtaining applicable federal and Puerto Rico permits, including authorizations and environmental compliance for project implementation prior to construction, and adherence to permit conditions and regulatory requirements. Any substantive change to the approved scope of work will require re-evaluations by FEMA for compliance with NEPA and other laws and EOs.

The PRASA must also adhere to the following conditions during project implementation and consider the below conservation recommendations:

1. **PRASA:** Must comply with the environmental and historic preservation applicable laws. Federal funding is contingent upon acquiring the necessary federal, Puerto Rico and local permits. Noncompliance with this requirement may jeopardize the receipt of federal funds.

2. **Utility Clearance:** For ground disturbing activities, PRASA is responsible for locating utilities. The OSHA mandates that if a utility provider cannot respond to a request to locate underground utility installations or cannot establish the exact location of these installations, the contractor may proceed, provided they use detection equipment or other acceptable means to locate utility installations.

3. **Stormwater and Soils:** A Construction NPDES permit and a SWPPP will be prepared and implemented by PRASA. The agency will implement BMPs to manage any piles of soil or debris, minimize steep slope disturbance, preserve native topsoil unless infeasible, and minimize soil compaction and erosion.

4. **Erosion and Sediment Control:** The BMPs and guidelines recommended in the Puerto Rico Erosion and Sediment Control Handbook for Developing Areas (PRDNER/PREQB and USDA-NRCS 2005) will be implemented by PRASA for the preferred alternative. The agency will be responsible for obtaining the necessary permits such as an NPDES permit and implementing the associated erosion and sediment control plans included as part of the PRPB Joint Regulation Single Incidental Operational Permit and SWPPP.

5. **Spill Prevention, Control and Countermeasure:** A SPCC Plan will be prepared by PRASA to establish procedures, methods, and equipment requirements to prevent fuel or lubricants from reaching navigable waters and adjoining shorelines, and to contain discharges of harmful substances.

6. **Endangered Species Act:** An ESA Section 7 informal consultation letter was submitted to the USFWS with the determination of impacts to listed federal threatened or endangered species. The USFWS, in a communication dated February 18, 2022, concurred with FEMA on a determination of *May Affect but not likely to Adversely Affect* determination. Appendix J includes the USFWS concurrence letter, including conservation measures.

7. **Fish and Wildlife Coordination Act:** The USFWS, in the communication dated February 18, 2022 (Appendix J), concurred with the conservation measures proposed by FEMA, and provided indications on species in which to concentrate efforts. The PRASA will comply

with the conservation measures required by USFWS. The PRASA is responsible for coordinating with PRDNER to comply with Puerto Rico's requirements related to natural and environmental resources.

8. **Work Affecting Water:** The PRASA is responsible for initiating the permitting process with USACE to obtain a Section 404 permit. The agency is responsible for obtaining appropriate permits prior to the beginning of work and implementing permits requirements, including pre-construction notification. Section 401 CWA water quality certification will be issued by the PRDNER as part of the USACE Section 404 permitting process.

9. **Floodplain:** The BMPs will be implemented for sediment control by PRASA. In addition, PRASA will comply with permit requirements to limit construction activities in floodplains.

10. **Wetlands:** The PRASA will use preventive measures and construction BMPs to minimize impacts to WOTUS including wetlands that might be within the sediment pipeline alignment during the construction phase. The agency is responsible for initiating the permitting process with USACE in compliance with mentioned regulations.

11. **Historic Preservation/Archaeological Resources:** A consultation letter was submitted to the SHPO in compliance with Section 106 of the NHPA, on which FEMA determined that the proposed activities would result in *No Adverse Effect to Historic Properties with Conditions*. A communication from SHPO dated December 30, 2021, stated that the office concurs with FEMA's determination (Appendix K). The PRASA will comply with the conditions required by SHPO. It will also be responsible for coordinating with the Institute of Puerto Rican Culture (ICP) to comply with Puerto Rico's historic preservation and archaeological requirements. If any cultural materials or human remains are discovered during construction or dredging operations, the contractor must halt work immediately and contact FEMA. The FEMA staff will evaluate the discovery in coordination with SHPO.

12. **Built Historic Heritage and Terrestrial Archaeology:** The PRASA consulted the ICP through an archaeological recommendation to obtain concurrence and recommendations on the proposed action. Appendix K includes the ICP communication and recommendations regarding the proposed action. The ICP letter includes conditions similar to those of the SHPO for identified resources and for disposal dike and staging site preparation and dredging activities.

13. **Construction Material and Debris:** The PRASA is responsible for obtaining required permits for the handling and transportation of construction material and debris. It will identify, handle, transport, and dispose of hazardous materials and/or toxic waste in accordance with EPA and PRDNER requirements, including the details associated with the proposed action construction materials and debris handling as part of the PRPB Joint Regulation, General Consolidated Permit of the Single Incidental Operational Permit. It is also responsible for ensuring that non-recyclable debris generated from project activities will be disposed at a PRDNER permitted landfill.

14. **Clean Air Act:** The PRASA is responsible for complying with applicable EPA and PRDNER requirements for fugitive dust suppression. Vehicular emission and airborne dust particulates resulting from construction activities and equipment operation shall be de minimis. An Operation Plan to implement emissions control measures would be included as part of the Single Incidental Operational Permit application, as required by the PRPB Joint Regulation.

15. **Atmospheric Pollution Control:** The PRASA will evaluate the proposed equipment associated to the proposed action to comply with Regulation 5300 and PRDNER requirements. A Puerto Rico General Consolidated Permit application will be prepared and submitted to the PRDNER for a permit for operation of emergency generators.

16. **Tree Cutting:** The PRASA is responsible for complying with the requirements of the PRPB Joint Regulation on the requirements to mitigate trees that are impacted by the proposed action. A tree inventory would be prepared by an OGPe Planting Authorized Inspector to identify trees within the proposed action areas, as part of the Single Incidental Operational Permit as required by the PRPB Joint Regulation. A permit will be required for tree cutting prior to beginning clearing and grubbing.

17. **Invasive Species** Act: The PRASA is responsible for restoring disturbed soils with planting native, non-invasive species once project activities are completed. Construction equipment should be power washed prior to initial transport to the construction site and prior to changing locations to prevent spread of noxious weeds.

18. **Compliance with State (Local) Permit Requirements:** The PRASA will submit to the OGPe and PRDNER the corresponding applications to obtain, if required, the following environmental protection permits and endorsements:

    a. Natural Habitat Categorization Certification – PRASA will submit to the PRDNER an application to request concurrence on the habitat classification for the proposed project.

    b. Infrastructure and Utilities Recommendations – The proposed action information is presented for consideration and comments for conformity with State Utility agencies for building requirements.

    c. Maintenance of Public Infrastructure Works Permit – Required for maintenance of public infrastructure facilities.

    d. Single Incidental Operational Permit – This permit includes the Incidental Activity Permit for Public Infrastructure Works, Trees Cutting and Pruning Authorization, and the General Consolidated Permit.

7 AGENCY COORDINATION AND PUBLIC INVOLVEMENT

This Draft EA is available for agency and public review and comment for a period of 30 calendar days. The public information process will include a public notice in both English and Spanish with information about the proposed action in the *El Vocero* newspaper with targeted outreach to environmental justice populations through notices to community organizations. A Spanish translation of the Draft EA, Executive Summary, and Public Notice will also be posted on websites of FEMA, PRASA, and COR3.

The Draft EA is available for download at the following websites:

- FEMA: https://www.fema.gov/emergency-managers/practitioners/environmental-historic/nepa-repository
- PRASA: https://www.acueductospr.com/cumplimiento
- COR3: https://recovery.pr.gov/es/document-library#

The website link for the Draft EA will also be posted on the following Facebook pages:

- FEMA: https://www.facebook.com/FEMAPuertoRico/
- PRASA: https://www.facebook.com/Acueductospr/

A hard copy of the Draft EA will be available for review at the following locations:

- Canóvanas Municipality - Planning and Economic Development Office at Edificio Multiusos, Second Floor, Autonomía Street (PR-185 km 0.2), Pueblo Ward, Canóvanas, Puerto Rico.
- Carolina Municipality - Infrastructure Management Office at City Hall, Second Floor, Manuel Fernández Juncos Ave, Pueblo Ward, Carolina, Puerto Rico.
- Gurabo Municipality - Municipal Secretary's Office at Matías González García Street, Pueblo Ward (behind Sports Museum), Gurabo, Puerto Rico.
- Juncos Municipality - Municipal Zoning and Planning Office-CRIM at City Hall, First Floor, Paseo Escuté Street, Pueblo Ward, Juncos, Puerto Rico.
- Loíza Municipality - Planning Office at Carlos Escobar Street, Escobar #3, Pueblo Ward, Loíza, Puerto Rico.
- San Juan Municipality - Compliance and Environmental Planning Office, Third Floor, Trilito Building, José De Diego Avenue #130, corner 54 street SE, Urb. La Riviera (in front of Suiza Dairy), San Juan, Puerto Rico.
- Trujillo Alto Municipality - Planning and Municipal Zoning Office at Raymond H. Rivera Fusté Government Center, Fifth Floor, Muñoz Rivera Avenue #46, Pueblo Ward, Trujillo Alto, Puerto Rico.

- Caguas Municipality - Environmental Affairs Office at William Miranda Marín City Hall, Second Floor, Street Padial, corner José Mercado Avenue, Pueblo Ward, Caguas, Puerto Rico.

- PRASA:

    - PRASA Central Office - Sergio Cuevas Bustamante Building, 604 Barbosa Avenue, Hato Rey, Puerto Rico.

    - PRASA East Region – Caguas Office, Gautier Benítez Street, Plaza Gautier Benítez Building, 2nd level, Caguas, Puerto Rico.

    - PRASA Metro Region – San Juan Office, Calle Robles, Río Piedras, San Juan, Puerto Rico (adjacent to the Tren Urbano Station).

Interested parties may request an electronic copy of the EA by emailing FEMA at FEMA-EHP-DR4339@FEMA.DHS.GOV. This Draft EA reflects the evaluation and assessment of the federal government, the decision maker for the federal action; however, FEMA will take into consideration any substantive comments received during the public review period to inform the final decision regarding grant approval and project implementation. The public is invited to submit written comments by emailing FEMA-EHP-DR4339@FEMA.DHS.GOV or via mail to:

FEMA Region 2 – DR-4339-PR
Puerto Rico Joint Recovery Office
50 State Road 165, Suite 3
Guaynabo, PR 00968
Attn: Environmental Assessment Carraízo Reservoir Dredging Public Comments

If FEMA receives no substantive comments from the public and/or agency reviewers, FEMA will adopt the EA as final and will issue a FONSI. If FEMA receives substantive comments, it will evaluate and address comments in the FONSI, revise and issue a FINAL EA for further comment or issue a notice of intent to prepare an EIS.

8 LIST OF PREPARERS

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9 SUMMARY OF IMPACTS

Resource Section	Alternative 1 No Action	Alternative 2 2 Mm^3, 2-year duration	Alternative 3 6 Mm^3, 20-year duration (0.3 Mm^3/year)
Section 5.1	• **Geology:** No impact. • **Topography:** No impact. • **Soil Resources/FPPA**: No impact. • **Seismicity:** No impact. • **Landslides:** No impact.	• **Geology:** No impact. • **Topography:** Negligible, direct, long- term. • **Soil Resources/FPPA**: Minor, direct, short-term with BMPs implemented. • **Seismicity:** No impact. • **Landslides:** No impact.	• **Geology:** No impact. • **Topography:** Negligible, direct, long-term. • **Soil Resources/FPPA**: Minor, direct, long-term with BMPs implemented. • **Seismicity:** No impact. • **Landslides:** No impact.
Section 5.2	• **Air Quality:** No impact.	• **Air Quality:** Minor, direct, short-term with implementation of BMPs and regulatory requirements.	• **Air Quality:** Major, direct, long-term. BMPs would not reduce the impact.
Section 5.3	• **Water Resource:** Major, indirect, long-term. • **Groundwater and Hydrology:** No impact. • **Water Quality**: Negligible indirect, short-term; Major, direct, long-term	• **Water Resource:** Beneficial, direct, long-term. • **Groundwater and Hydrology:** Minor, direct, short-term with BMPs implemented. • **Water Quality**: Minor, direct, short-term with BMPs implemented. • **SCWFP and GWFP operations**: Minor, indirect, short-term with BMPs implemented	• **Water Resource**: Beneficial, direct, long-term. • **Groundwater and Hydrology:** Minor, direct, long-term with BMPs implemented. • **Water Quality**: Minor, direct, long-term with BMPs implemented. • **SCWFP and GWFP operations**: Minor, indirect, long-term with BMPs implemented.
Section 5.4	• **Wetlands**: No impact.	• **Wetlands**: Minor to moderate, direct, short-term with BMPs implemented.	• **Wetlands**: Minor to moderate, direct, long-term with BMPs implemented.
Section 5.5	• **Floodplain**: No impacts.	• **Floodplain**: Negligible, direct, short-term.	• **Floodplain**: Negligible to minor, direct, long-term.
Section 5.6	• **Vegetation**: No impact.	• **Vegetation**: Minor, direct, short-term with BMPs implemented.	• **Vegetation**: Minor, direct, long-term with BMPs implemented.
Section 5.7	• **Wildlife and Fish**: Negligible to minor, direct, long-term.	• **Wildlife and Fish**: Minor, direct, short-term with BMPs/Conservation measures implemented.	• **Wildlife and Fish**: Minor, direct, long-term with BMPs/Conservation implemented.
Section 5.8	• **Threated and Endangered Species**: No impact.	• **Threated and Endangered Species**: Minor, direct, short-term with BMPs/Conservation measures implemented.	• **Threated and Endangered Species**: Minor, direct, long-term with BMPs/Conservation measures implemented.
Section 5.9	• **Cultural Resources**: No impact.	• **Cultural Resources**: No impact with SHPO Conditions implemented.	• **Cultural Resources**: No impact with SHPO Conditions implemented.
Section 5.10	• **Socioeconomic and Environmental Justice**: Moderate, indirect, and long-term.	• **Socioeconomic and Environmental Justice**: Minor, indirect, short-term. • **Beneficial Impact**: Beneficial, direct, long-term.	• **Socioeconomic and Environmental Justice**: Minor, indirect, long-term. • **Beneficial Impact**: Beneficial, direct, long-term.
Section 5.11	• **Land Use**: No impact.	• **Land Use**: Minor, direct, short-term.	• **Land Use**: Minor, direct, long-term.

Resource Section	Alternative 1 No Action	Alternative 2 2 Mm^3, 2-year duration	Alternative 3 6 Mm^3, 20-year duration (0.3 Mm^3/year)
	• **Zoning**: No impact.	• **Zoning**: No impact.	• **Zoning**: No impact.
Section 5.12	• **Noise**: No impact.	• **Noise**: Minor to moderate, direct, short-term with BMPs implemented.	• **Noise**: Major, direct, long-term. BMPs would not reduce the impact.
Section 5.13	• **Transportation**: No impact.	• **Transportation**: Minor, direct, short-term with BMPs implemented.	• **Transportation**: Major, direct, long-term with BMPs implemented.
Section 5.14	• **Public Services and Utilities:** Major, indirect, long-term.	• **Public Services and Utilities:** Minor, direct, short-term with BMPs implemented • **Beneficial Impact**: Beneficial, direct, long-term.	• **Public Services and Utilities:** Minor, direct, long-term with BMPs implemented. • **Beneficial Impact**: Beneficial, direct, long-term.
Section 5.15	• **Public Health and Safety:** Major, indirect, long-term.	• **Public Health and Safety:** Minor, direct, short-term with BMPs implemented. • **Beneficial Impact**: Beneficial, indirect, long-term.	• **Public Health and Safety:** Minor short-term and moderate long-term with BMPs implemented. • **Beneficial Impact**: Beneficial, indirect, long-term
Section 5.16	• **Hazardous Materials**: No impact.	• **Hazardous Materials**: Negligible, direct, temporary with BMPs implemented.	• **Hazardous Materials**: Minor, direct, long-term with BMPs implemented.
Section 5.17	• **Cumulative Impacts:** Major, indirect, long-term.	• **Cumulative Impacts:** Minor, direct, short-term. • **Beneficial Impact**: Beneficial, indirect, long-term.	• **Cumulative Impacts:** Major, direct, long-term. • **Beneficial Impact**: Beneficial, indirect, long-term

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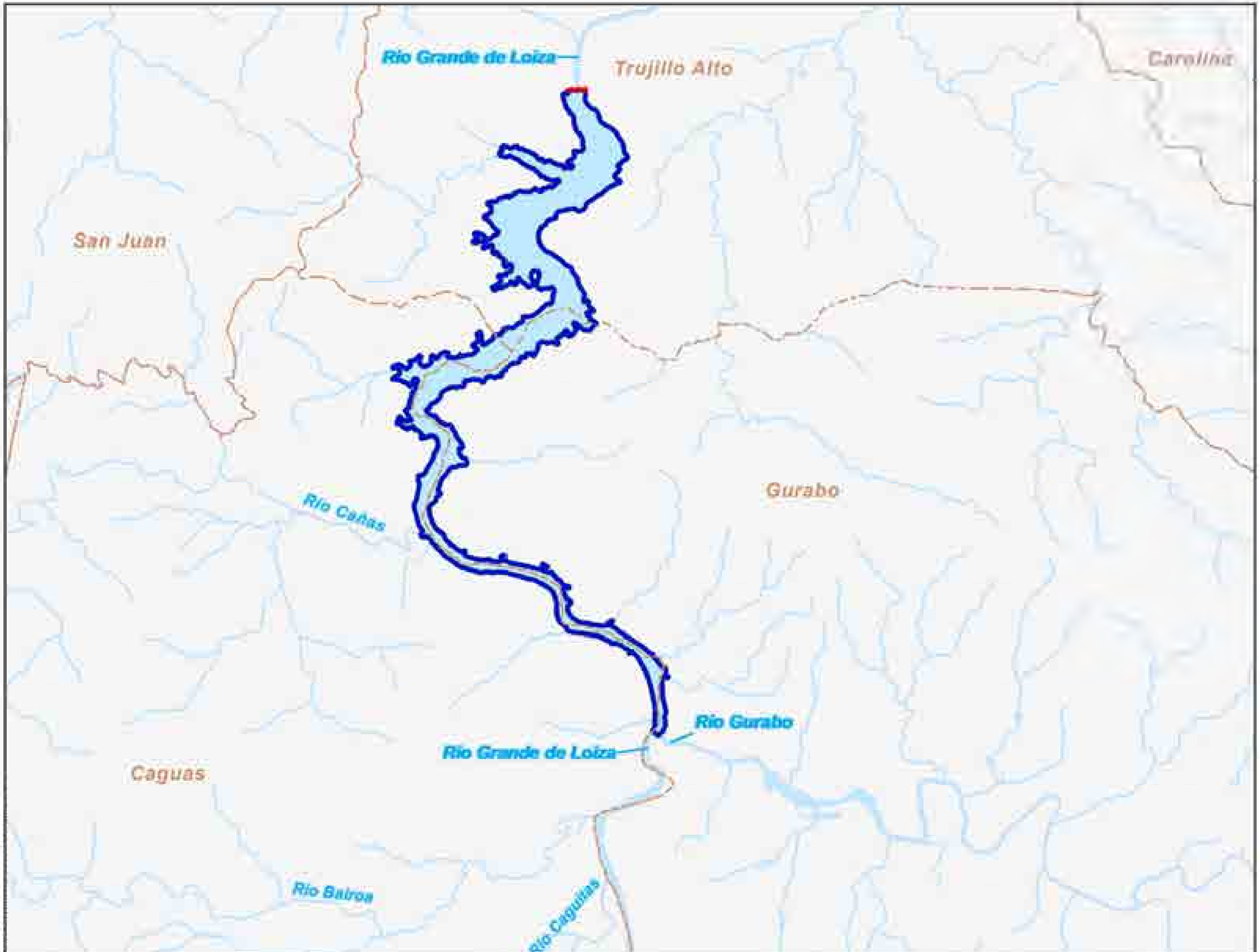
APPENDIX A FIGURES (MAPS)

Environmental Assessment Carraizo Reservoir Dredging Figure 1. Carraizo Reservoir Location



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Legend

- Carraizo Dam
- Carraizo Reservoir
- Hydrography[1]
- Municipal Limit[2]

Sources:
1. United States Geological Survey, National Hydrography Dataset, 2020
2. Puerto Rico Planning Board, 2015

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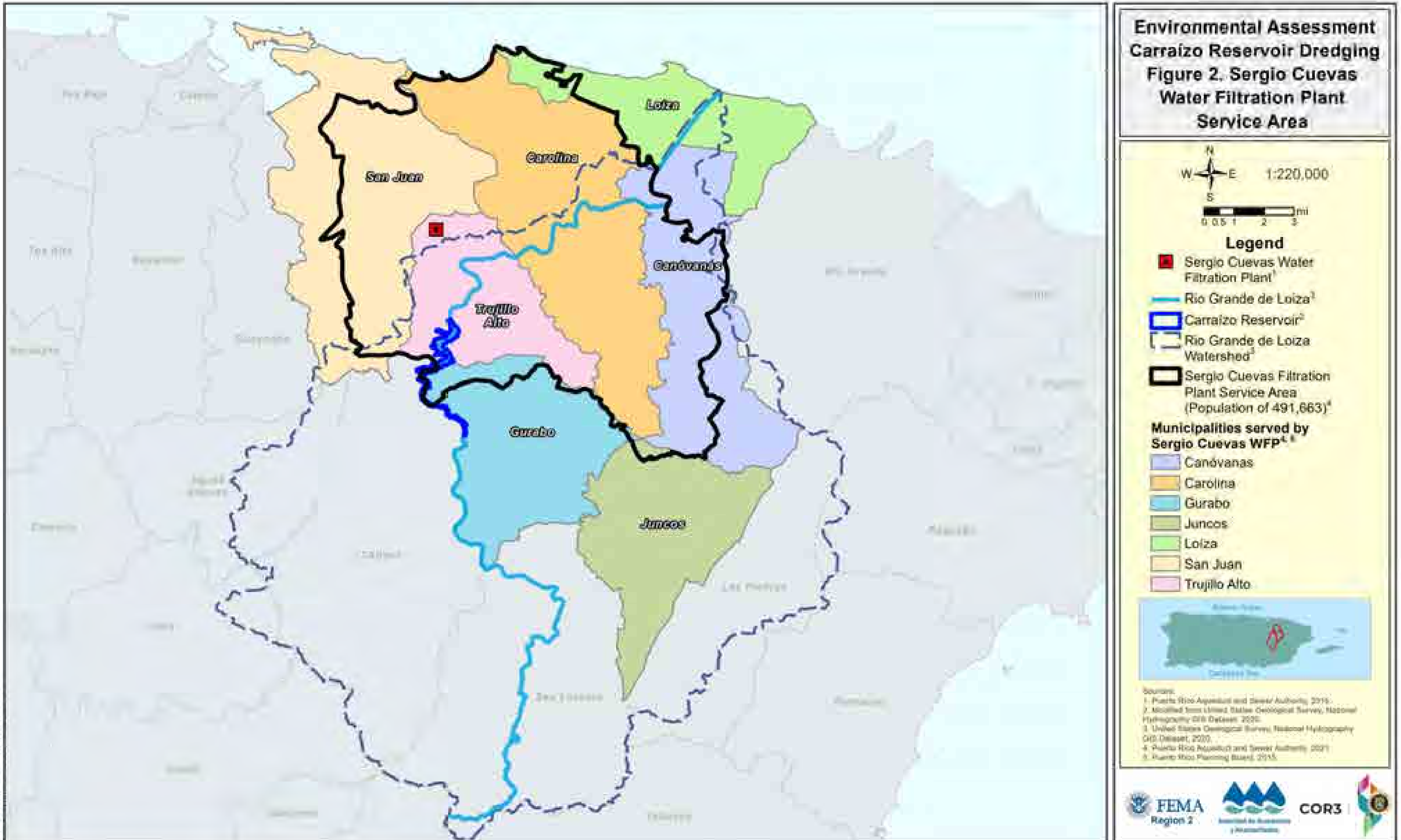
Environmental Assessment
Carraízo Reservoir Dredging
Figure 2. Sergio Cuevas
Water Filtration Plant
Service Area
San Juan
Carolina
Loiza
Trujillo Alto
Canóvanas
Gurabo
Juncos
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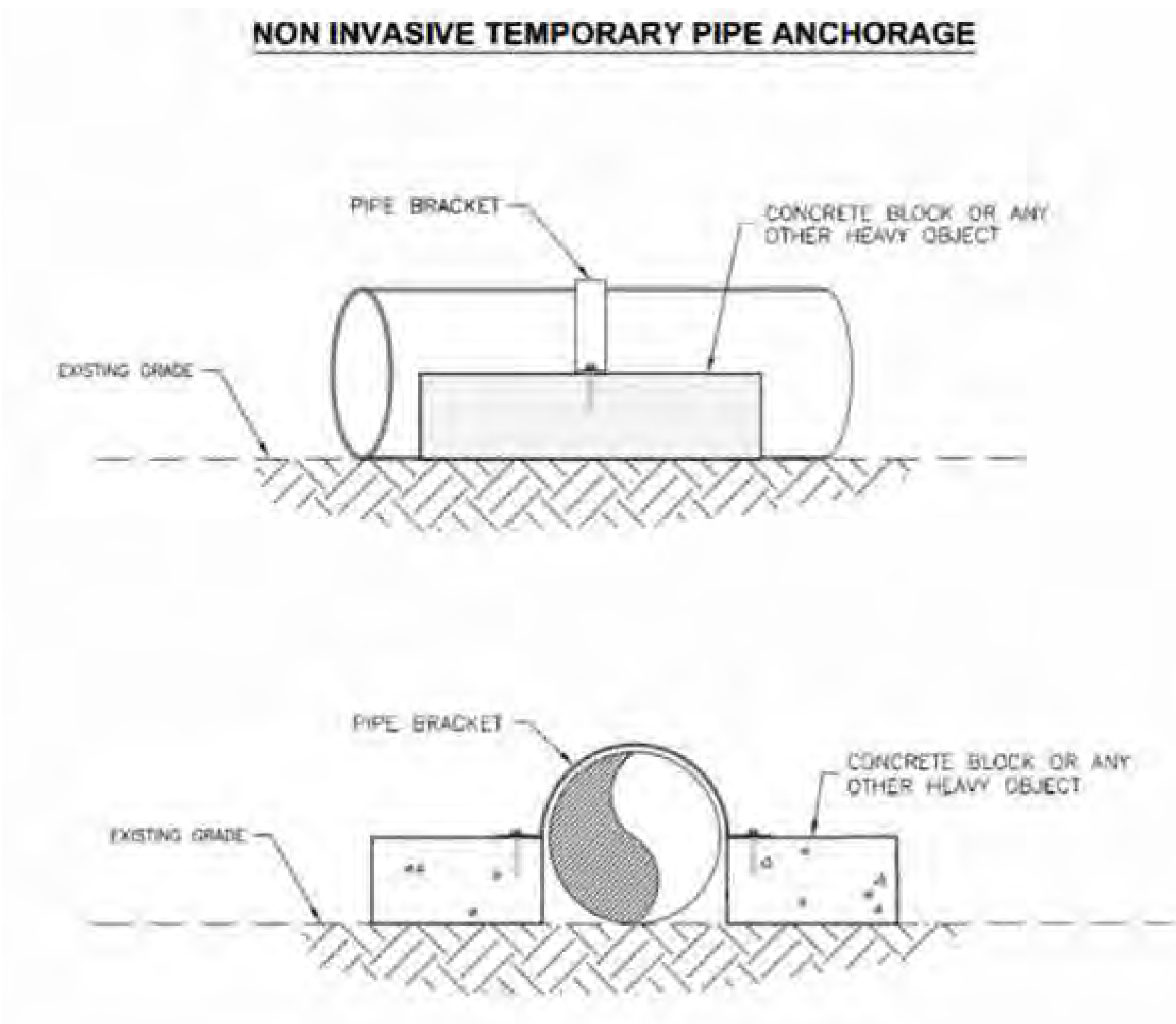
Legend
Sergio Cuevas Water Filtration Plant[1]
Rio Grande de Loiza[3]
Carraízo Reservoir[2]
Rio Grande de Loiza Watershed[3]
Sergio Cuevas Filtration Plant Service Area (Population of 491,663)[4]
Municipalities served by Sergio Cuevas WFP[4, 5]
Canóvanas
Carolina
Gurabo
Juncos
Loíza
San Juan
Trujillo Alto
Sources:
1. Puerto Rico Aqueduct and Sewer Authority, 2019.
2. Modified from United States Geological Survey, National Hydrography GIS Dataset, 2020.
3. United States Geological Survey, National Hydrography GIS Dataset, 2020.
4. Puerto Rico Aqueduct and Sewer Authority, 2021.
5. Puerto Rico Planning Board, 2015.
FEMA
Region 2
COR3

Environmental Assessment
Carraízo Reservoir Dredging
Figure 3. Non-Invasive Temporary Pipe Anchorage



Source:
CSA Group, 2022.

FEMA Region 2

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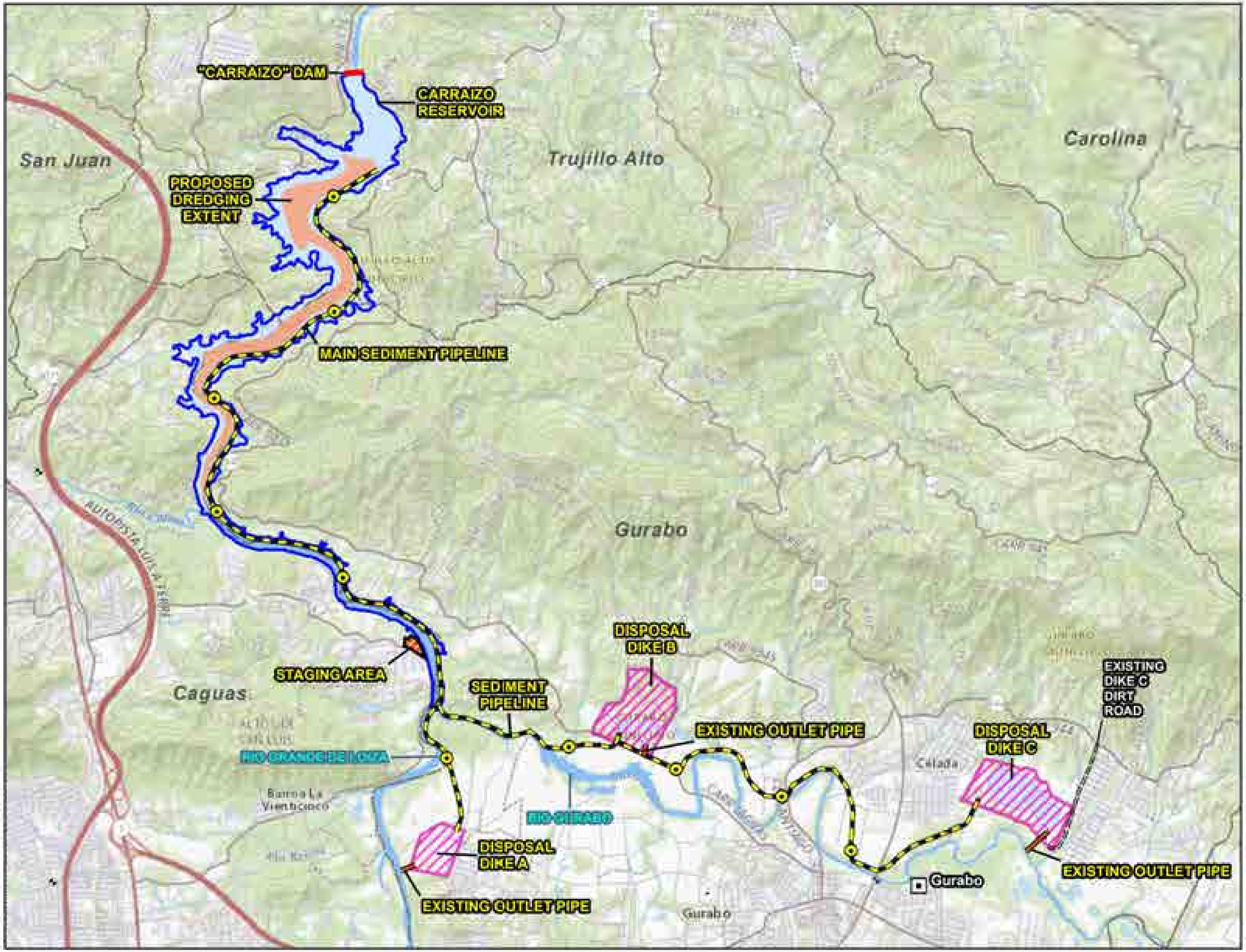
Environmental Assessment
Carraizo Reservoir Dredging
Figure 4. Alternative 2 and Alternative 3 Components* over Topographic Map



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Legend

- Potential Booster Pump Location
- Carraizo Dam
- Sediment Pipeline**
- Outlet Pipe
- Carraizo Reservoir
- Disposal Dike
- Dredging Extent
- Staging Area
- Filtration Plant[1]
- Municipal Limit[2]

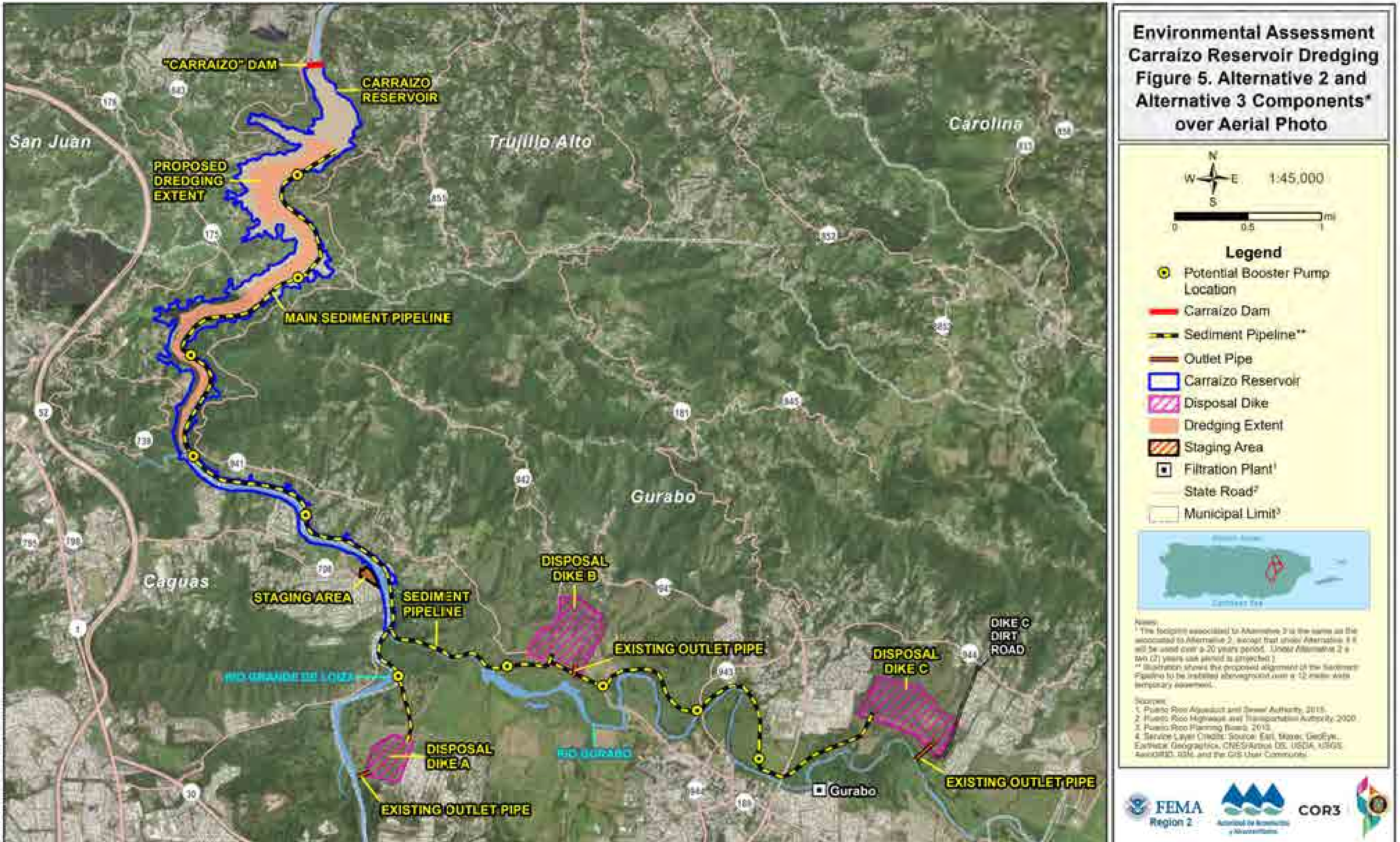
Notes:
* The footprint associated to Alternative 3 is the same as the associated to Alternative 2, except that under Alternative 3 it will be used over a 20 years period. Under Alternative 2 a two (2) years use period is projected.)
** Illustration shows the proposed alignment of the Sediment Pipeline to be installed aboveground over a 12 meter wide temporary easement.

Sources:
1. Puerto Rico Aqueduct and Sewer Authority, 2015.
2. Puerto Rico Planning Board, 2015
3. United States Geological Survey (USGS) Topographic Map, Aguas Buenas and Juncos Quadrangles, 2018. Contour Interval is 20 feet.
4. Service Layer Credits: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

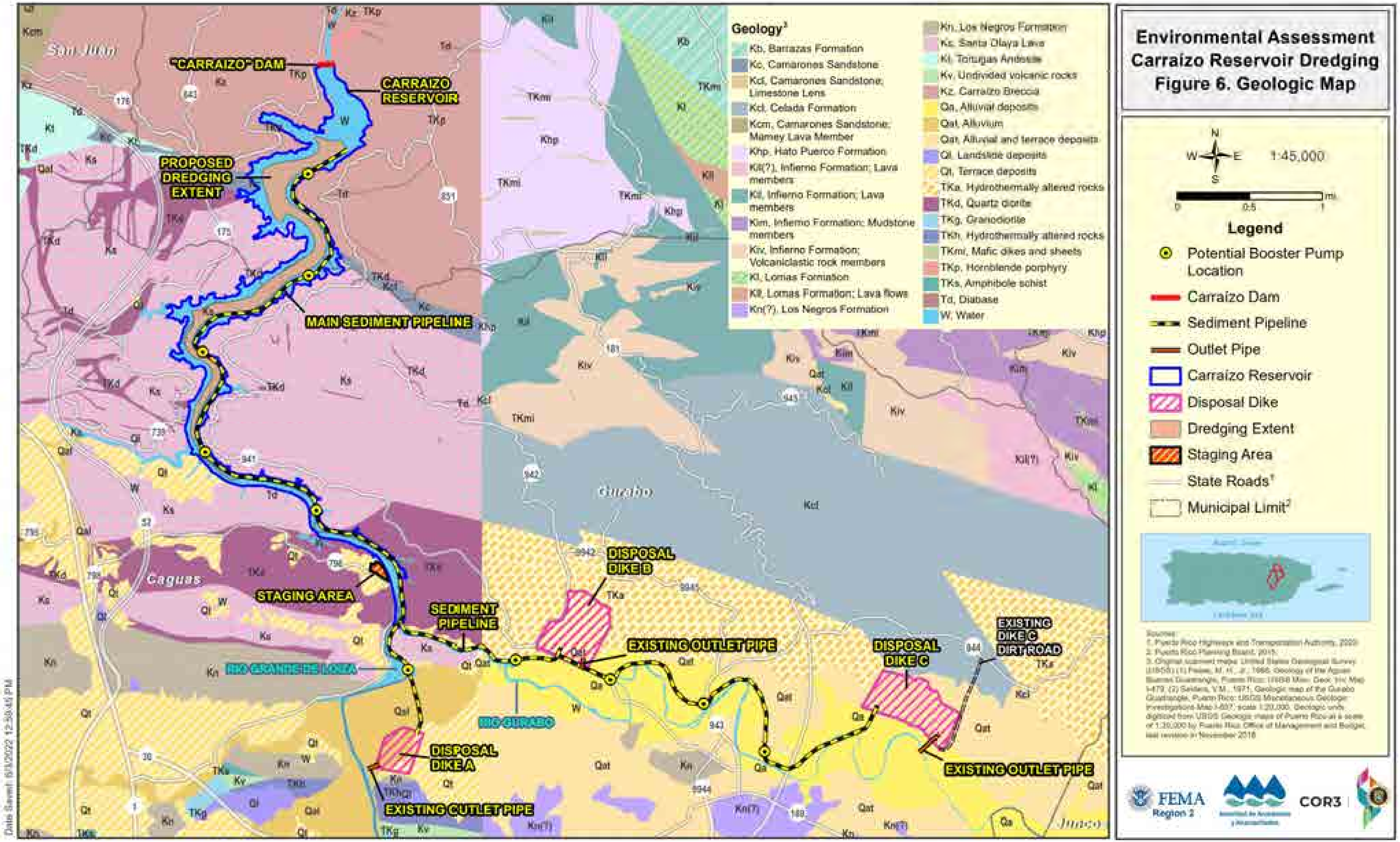
FEMA Region 2

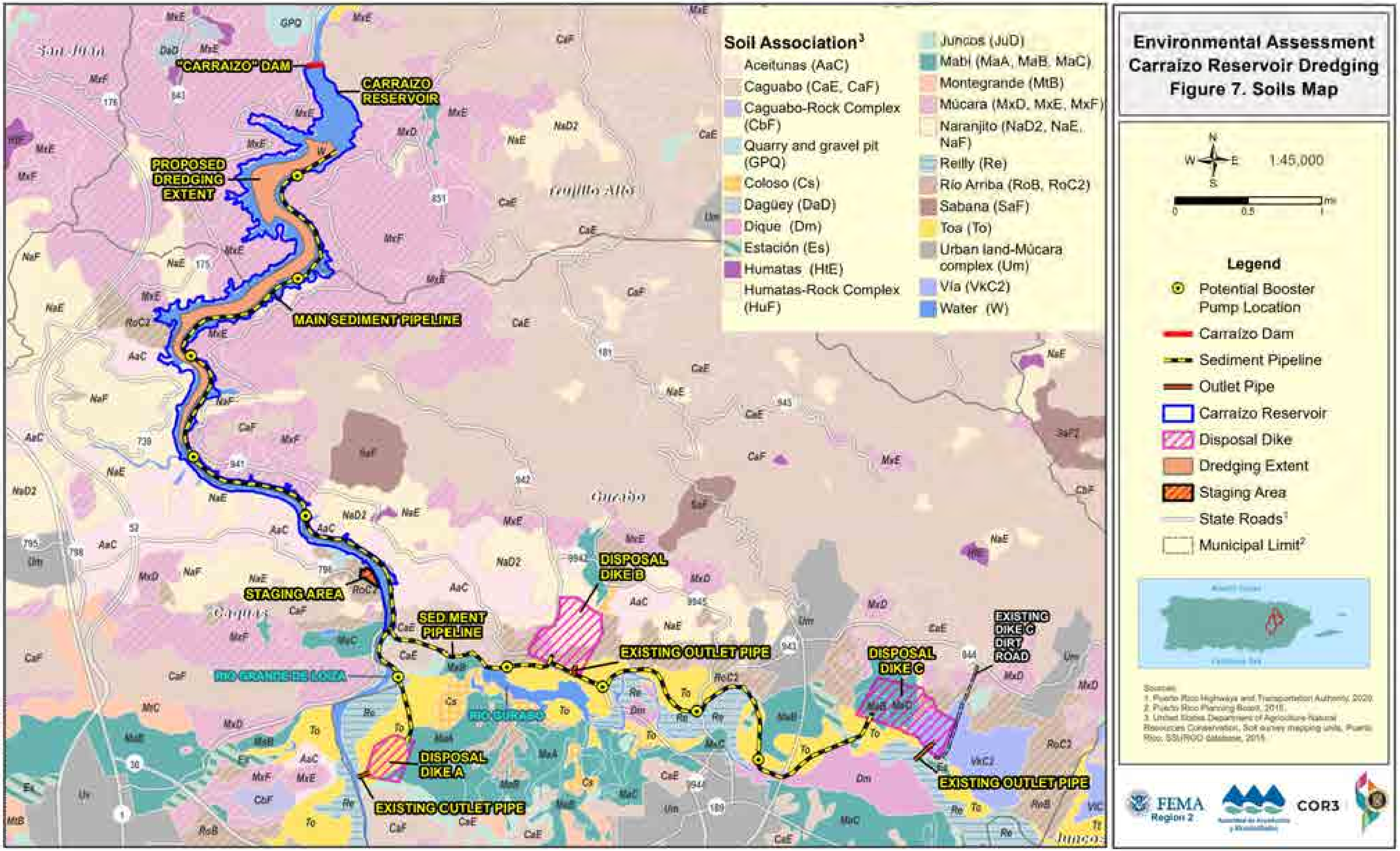
COR3

Environmental Assessment Carraízo Reservoir Dredging Figure 5. Alternative 2 and Alternative 3 Components* over Aerial Photo

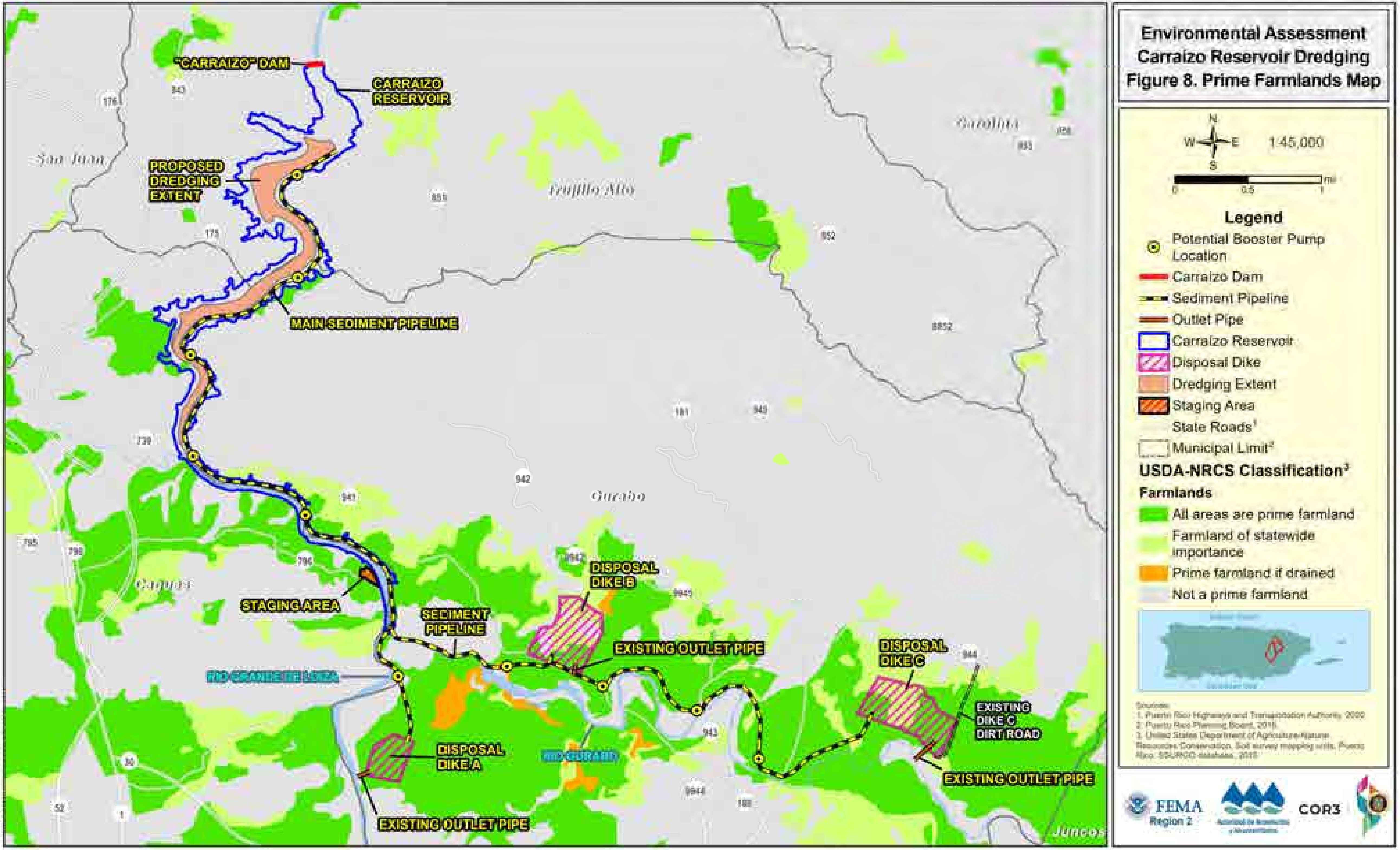


Environmental Assessment
Carraízo Reservoir Dredging
Figure 6. Geologic Map





Environmental Assessment
Carraízo Reservoir Dredging
Figure 7. Soils Map
Soil Association[3]
Aceitunas (AaC)
Caguabo (CaE, CaF)
Caguabo-Rock Complex (CbF)
Quarry and gravel pit (GPQ)
Coloso (Cs)
Dagüey (DaD)
Dique (Dm)
Estación (Es)
Humatas (HtE)
Humatas-Rock Complex (HuF)
Juncos (JuD)
Mabí (MaA, MaB, MaC)
Montegrande (MtB)
Múcara (MxD, MxE, MxF)
Naranjito (NaD2, NaE, NaF)
Reilly (Re)
Río Arriba (RoB, RoC2)
Sabana (SaF)
Toa (To)
Urban land-Múcara complex (Um)
Vía (VkC2)
Water (W)
1:45,000
Legend
Potential Booster Pump Location
Carraízo Dam
Sediment Pipeline
Outlet Pipe
Carraízo Reservoir
Disposal Dike
Dredging Extent
Staging Area
State Roads[1]
Municipal Limit[2]
"CARRAIZO" DAM
CARRAIZO RESERVOIR
PROPOSED DREDGING EXTENT
MAIN SEDIMENT PIPELINE
STAGING AREA
SEDIMENT PIPELINE
DISPOSAL DIKE A
DISPOSAL DIKE B
DISPOSAL DIKE C
EXISTING OUTLET PIPE
EXISTING DIKE C DIRT ROAD
RIO GRANDE DE LOIZA
RIO GURABO
San Juan
Trujillo Alto
Gurabo
Caguas
Juncos
FEMA
Region 2
COR3


Environmental Assessment
Carraizo Reservoir Dredging
Figure 8. Prime Farmlands Map
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mi
Legend
Potential Booster Pump Location
Carraizo Dam
Sediment Pipeline
Outlet Pipe
Carraizo Reservoir
Disposal Dike
Dredging Extent
Staging Area
State Roads[1]
Municipal Limit[2]
USDA-NRCS Classification[3]
Farmlands
All areas are prime farmland
Farmland of statewide importance
Prime farmland if drained
Not a prime farmland
"CARRAIZO" DAM
CARRAIZO RESERVOIR
PROPOSED DREDGING EXTENT
MAIN SEDIMENT PIPELINE
STAGING AREA
SEDIMENT PIPELINE
RIO GRANDE DE LOIZA
DISPOSAL DIKE A
DISPOSAL DIKE B
DISPOSAL DIKE C
EXISTING OUTLET PIPE
EXISTING OUTLET PIPE
EXISTING OUTLET PIPE
EXISTING DIKE C DIRT ROAD
RIO GURABO
San Juan
Trujillo Alto
Carolina
Gurabo
Caguas
Juncos
FEMA
Region 2
COR3

Environmental Assessment
Carraízo Reservoir Dredging
Figure 9. Aquifers

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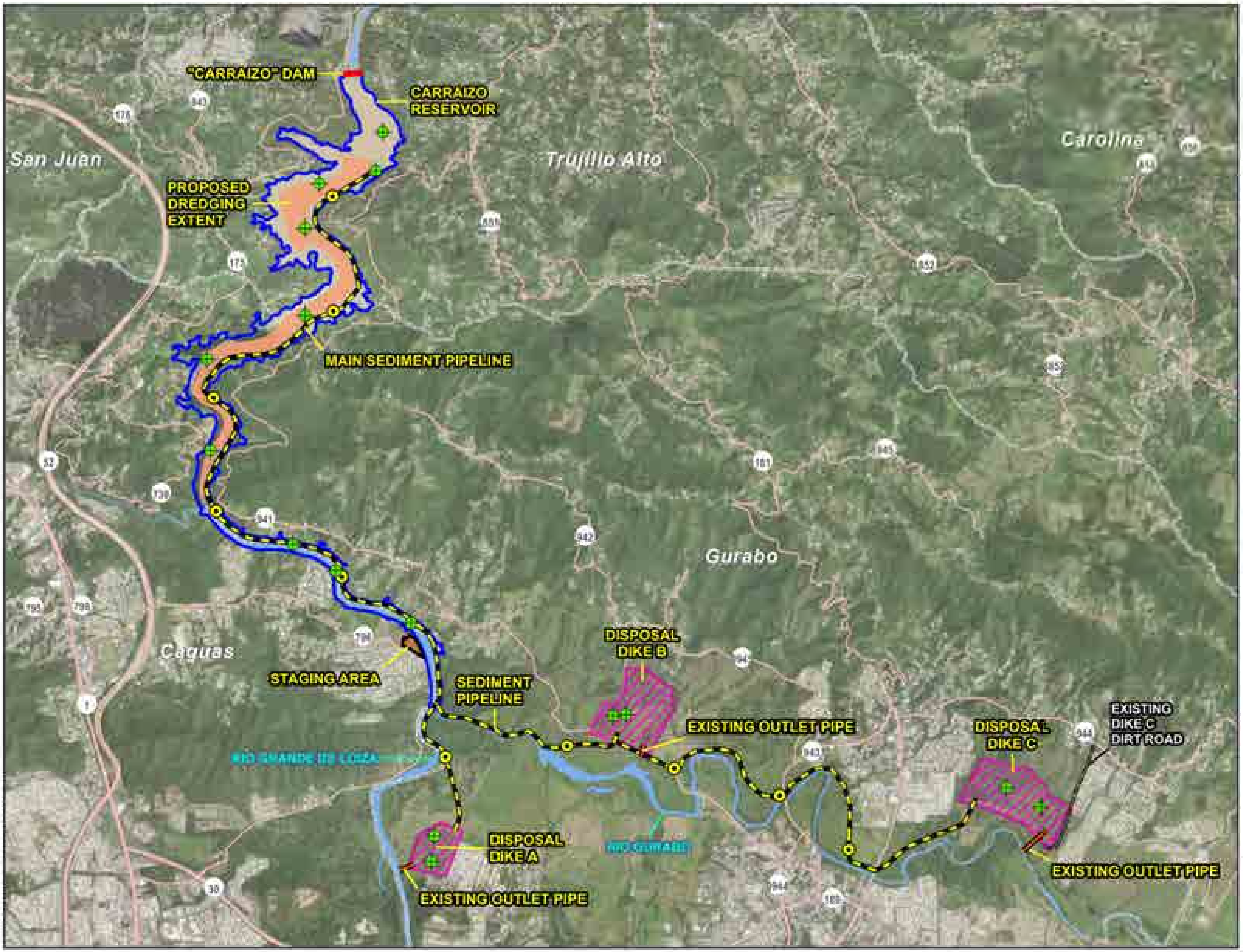
Environmental Assessment
Carraizo Reservoir Dredging
Figure 10. Location of Sediment Cores Sampling Collected in the Carraizo Reservoir in May 2021



Legend

- Sediment Core[1]
- Potential Booster Pump Location
- Carraizo Dam
- Sediment Pipeline
- Outlet Pipe
- Carraizo Reservoir
- Disposal Dike
- Dredging Extent
- Staging Area
- State Road[2]
- Municipal Limit[3]

Sources:
1. GLM Engineering Group, PSC; Sediment Sampling at Carraizo Reservoir, Puerto Rico, May 2021 (September 2021).
2. Puerto Rico Highways and Transportation Authority, 2020.
3. Puerto Rico Planning Board, 2018.
4. Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

FEMA Region 2

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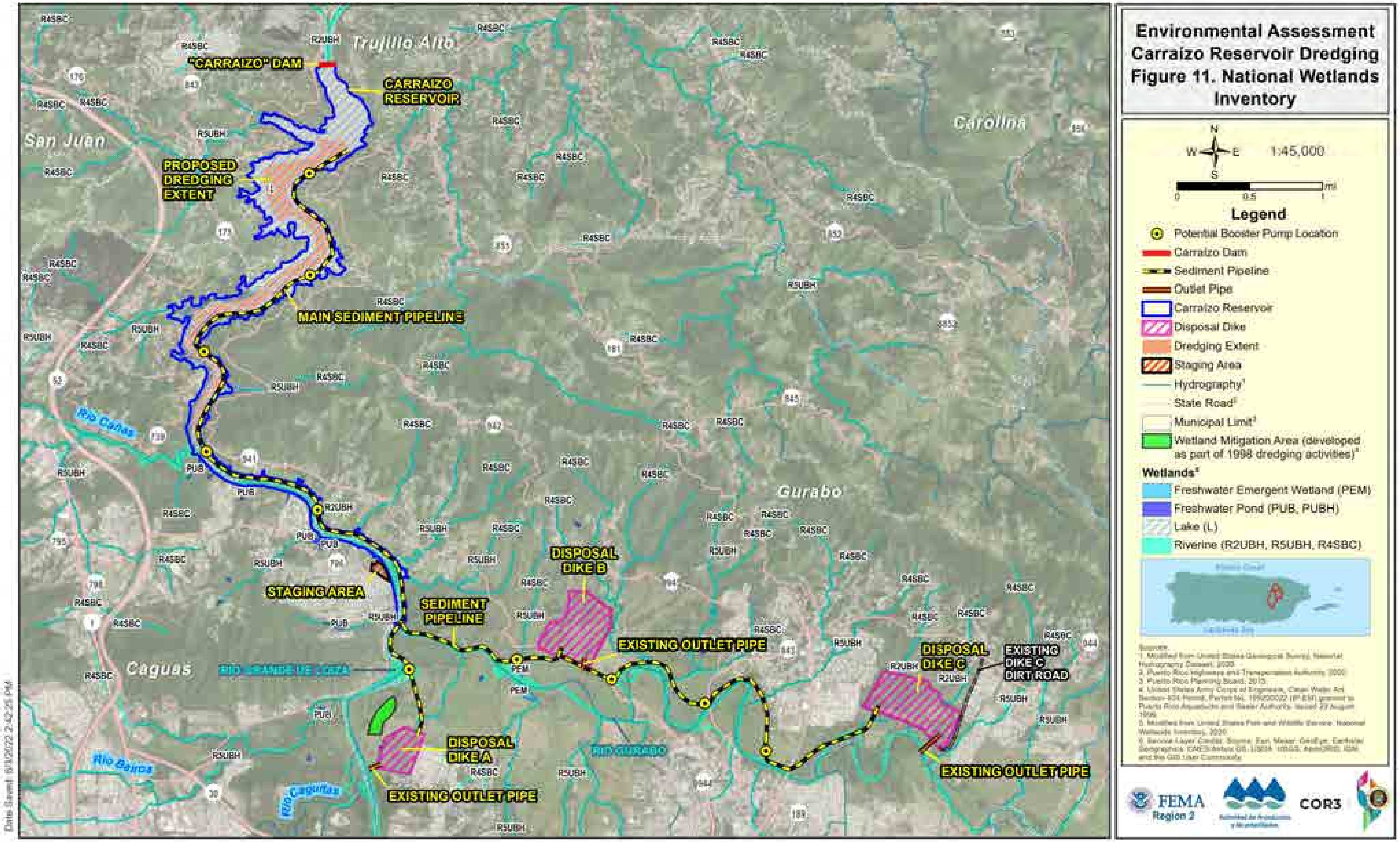
Environmental Assessment
Carraizo Reservoir Dredging
Figure 11. National Wetlands Inventory
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Legend
Potential Booster Pump Location
Carraizo Dam
Sediment Pipeline
Outlet Pipe
Carraizo Reservoir
Disposal Dike
Dredging Extent
Staging Area
Hydrography[1]
State Road[2]
Municipal Limit[3]
Wetland Mitigation Area (developed as part of 1998 dredging activities)[4]
Wetlands[5]
Freshwater Emergent Wetland (PEM)
Freshwater Pond (PUB, PUBH)
Lake (L)
Riverine (R2UBH, R5UBH, R4SBC)
Sources:
1. Modified from United States Geological Survey, National Hydrography Dataset, 2020
2. Puerto Rico Highways and Transportation Authority, 2020
3. Puerto Rico Planning Board, 2015
4. United States Army Corps of Engineers, Clean Water Act Section 404 Permit, Permit No. 199200022 (IP-EM) granted to Puerto Rico Aqueduct and Sewer Authority, issued 23 August 1998
5. Modified from United States Fish and Wildlife Service, National Wetlands Inventory, 2020
6. Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
FEMA
Region 2
COR3
"CARRAIZO" DAM
CARRAIZO RESERVOIR
PROPOSED DREDGING EXTENT
MAIN SEDIMENT PIPELINE
STAGING AREA
SEDIMENT PIPELINE
DISPOSAL DIKE A
DISPOSAL DIKE B
DISPOSAL DIKE C
EXISTING OUTLET PIPE
EXISTING DIKE C DIRT ROAD
RIO GRANDE DE LOIZA
Rio Gurabo
Rio Cañas
Rio Bairoa
Rio Caguitas
Trujillo Alto
San Juan
Carolina
Gurabo
Caguas
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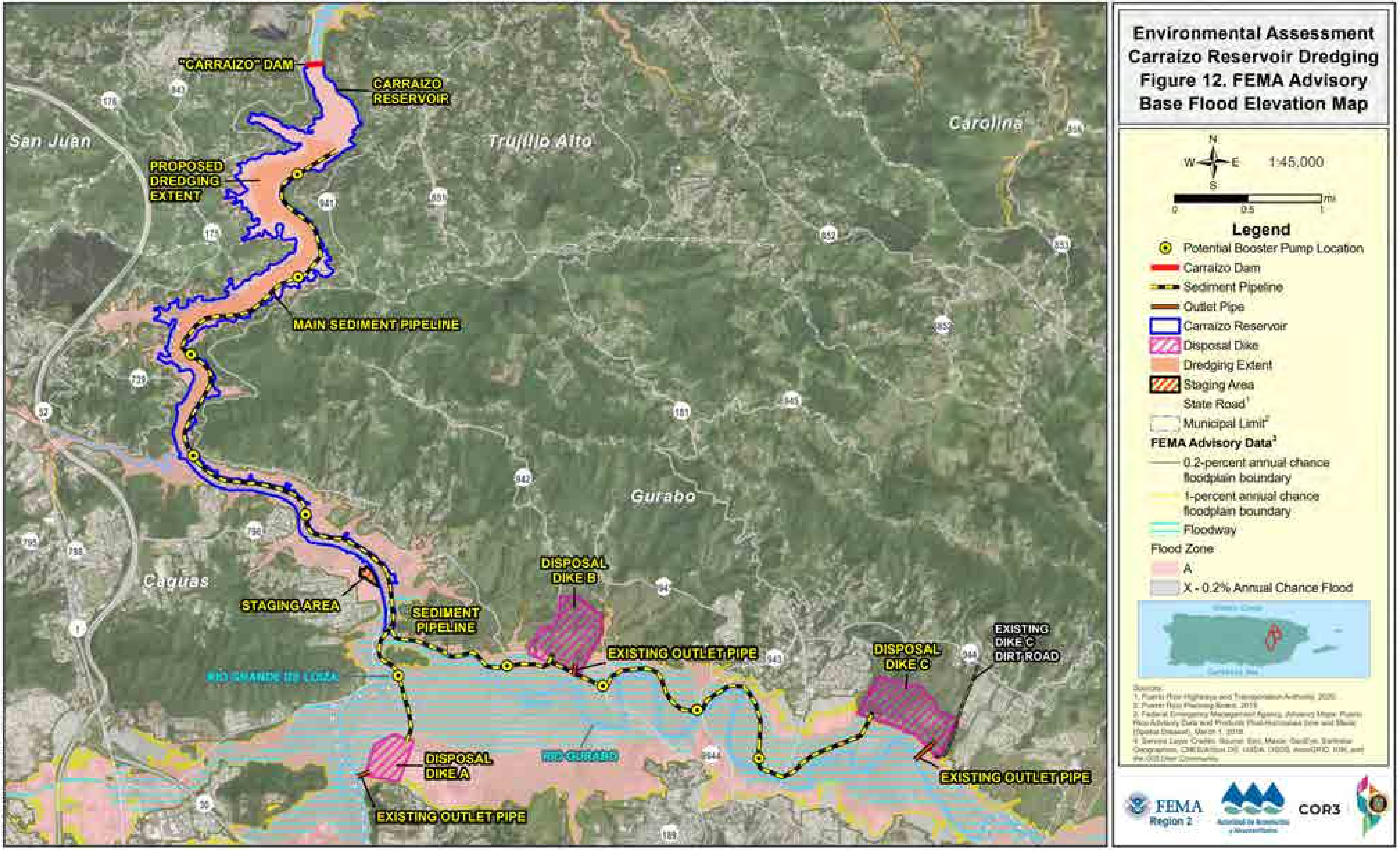

Environmental Assessment Carraizo Reservoir Dredging Figure 12. FEMA Advisory Base Flood Elevation Map

Environmental Assessment Carraizo Reservoir Dredging Figure 13. Archaeological Site Location Map

N
W E
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1:1,500

0 0.025 0.05 mi

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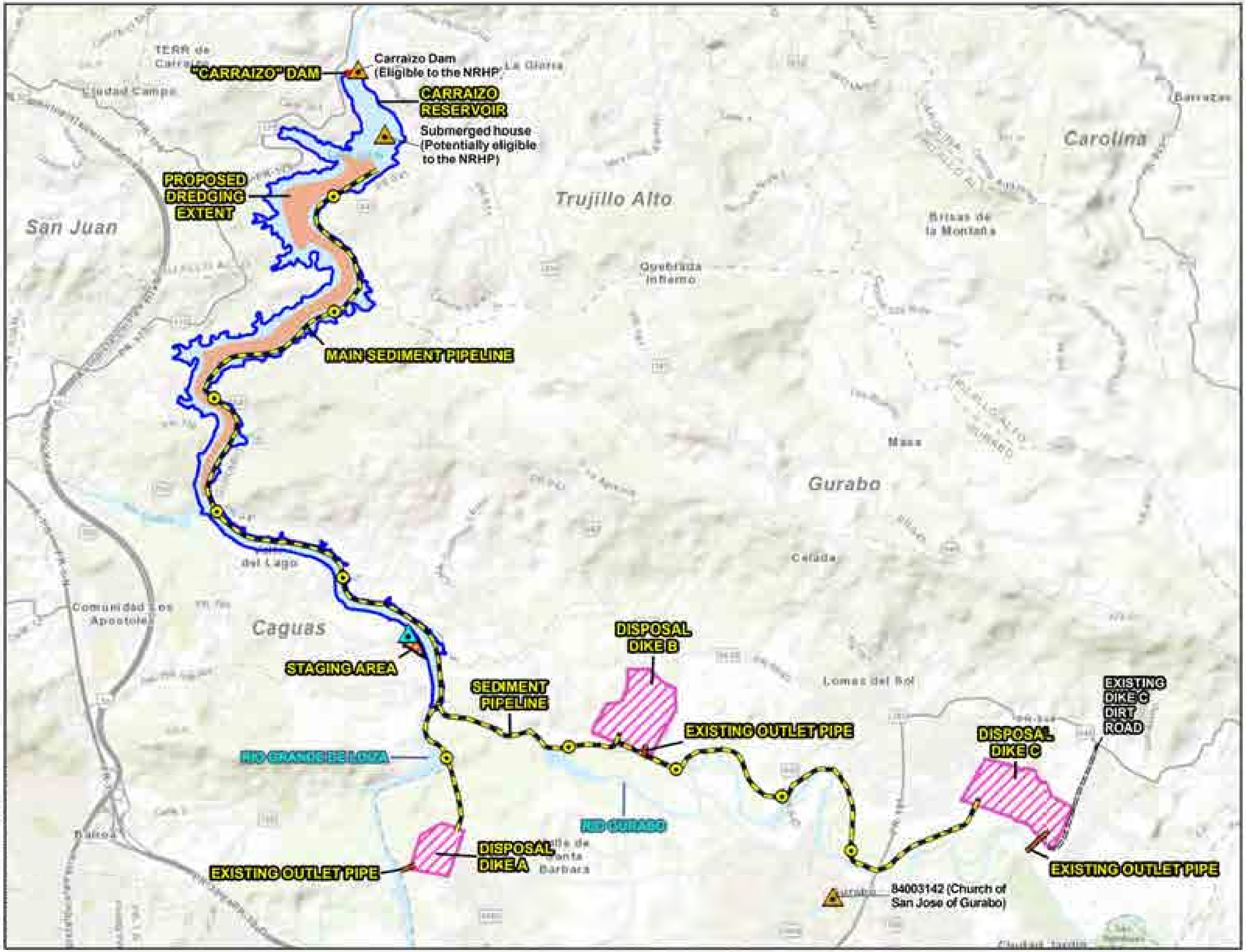
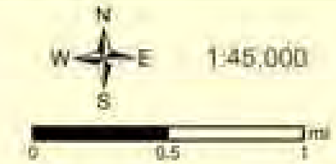
Environmental Assessment
Carraizo Reservoir Dredging
Figure 14. Cultural Resources





Legend

- Potential Booster Pump Location
- Carraízo Dam
- Sediment Pipeline
- Outlet Pipe
- Carraízo Reservoir
- Disposal Dike
- Dredging Extent
- Staging Area
- Archeological site at the staging area (to be protected)[1]
- Structure (NRHP)[2]

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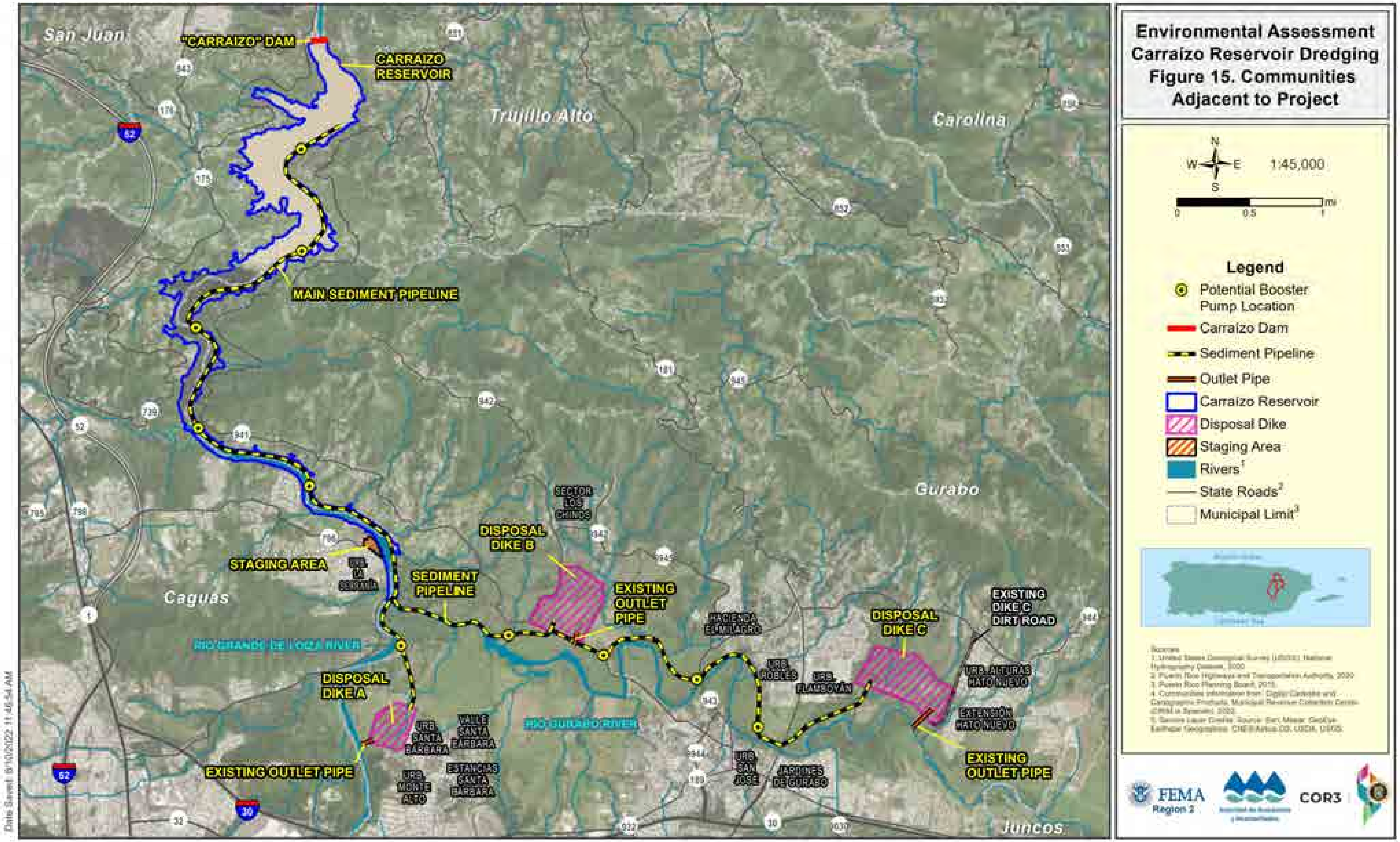
COR3


Environmental Assessment
Carraizo Reservoir Dredging
Figure 15. Communities Adjacent to Project
N
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mi
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1
Legend
Potential Booster Pump Location
Carraizo Dam
Sediment Pipeline
Outlet Pipe
Carraizo Reservoir
Disposal Dike
Staging Area
Rivers[1]
State Roads[2]
Municipal Limit[3]
FEMA
Region 2
COR3
San Juan
"CARRAIZO" DAM
CARRAIZO RESERVOIR
Trujillo Alto
Carolina
MAIN SEDIMENT PIPELINE
Gurabo
Caguas
SECTOR LOS CHINOS
DISPOSAL DIKE B
STAGING AREA
URB. LA SORAMÍA
SEDIMENT PIPELINE
EXISTING OUTLET PIPE
HACIENDA EL MILAGRO
DISPOSAL DIKE C
EXISTING DIKE C DIRT ROAD
RIO GRANDE DE LOIZA RIVER
DISPOSAL DIKE A
URB. ROBLES
URB. FLAMBOYÁN
URB. ALTURAS HATO NUEVO
EXTENSIÓN HATO NUEVO
URB. SANTA BÁRBARA
VALLE SANTA BÁRBARA
RIO GURABO RIVER
EXISTING OUTLET PIPE
URB. MONTE ALTO
ESTANCIAS SANTA BÁRBARA
URB. SAN JOSÉ
JARDINES DE GURABO
EXISTING OUTLET PIPE
Juncos
52
30
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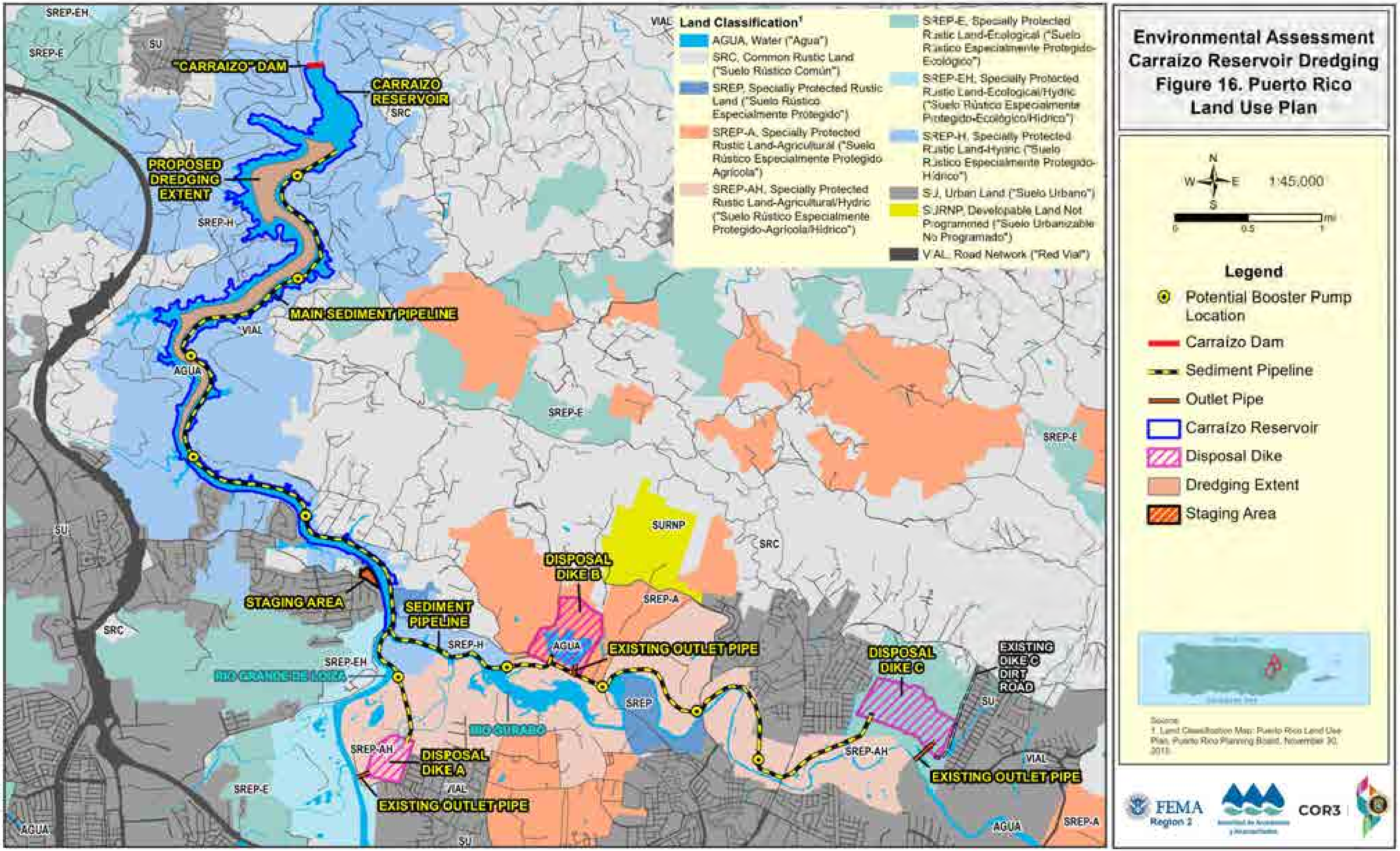

Environmental Assessment
Carraizo Reservoir Dredging
Figure 16. Puerto Rico
Land Use Plan
Land Classification[1]
AGUA, Water ("Agua")
SRC, Common Rustic Land ("Suelo Rústico Común")
SREP, Specially Protected Rustic Land ("Suelo Rústico Especialmente Protegido")
SREP-A, Specially Protected Rustic Land-Agricultural ("Suelo Rústico Especialmente Protegido Agrícola")
SREP-AH, Specially Protected Rustic Land-Agricultural/Hydric ("Suelo Rústico Especialmente Protegido-Agrícola/Hídrico")
SREP-E, Specially Protected Rustic Land-Ecological ("Suelo Rústico Especialmente Protegido-Ecológico")
SREP-EH, Specially Protected Rustic Land-Ecological/Hydric ("Suelo Rústico Especialmente Protegido-Ecológico/Hídrico")
SREP-H, Specially Protected Rustic Land-Hydric ("Suelo Rústico Especialmente Protegido-Hídrico")
SU, Urban Land ("Suelo Urbano")
SURNP, Developable Land Not Programmed ("Suelo Urbanizable No Programado")
VIAL, Road Network ("Red Vial")
N
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1
mi
Legend
Potential Booster Pump Location
Carraízo Dam
Sediment Pipeline
Outlet Pipe
Carraízo Reservoir
Disposal Dike
Dredging Extent
Staging Area
"CARRAIZO" DAM
CARRAIZO RESERVOIR
PROPOSED DREDGING EXTENT
MAIN SEDIMENT PIPELINE
STAGING AREA
SEDIMENT PIPELINE
DISPOSAL DIKE B
EXISTING OUTLET PIPE
DISPOSAL DIKE C
EXISTING DIKE C DIRT ROAD
DISPOSAL DIKE A
RIO GRANDE DE LOIZA
RIO GURABO
SREP-EH
SREP-E
SU
SRC
SREP-H
VIAL
AGUA
SURNP
SREP-A
SREP
SREP-AH
Source:
1. Land Classification Map: Puerto Rico Land Use Plan, Puerto Rico Planning Board, November 30, 2015.
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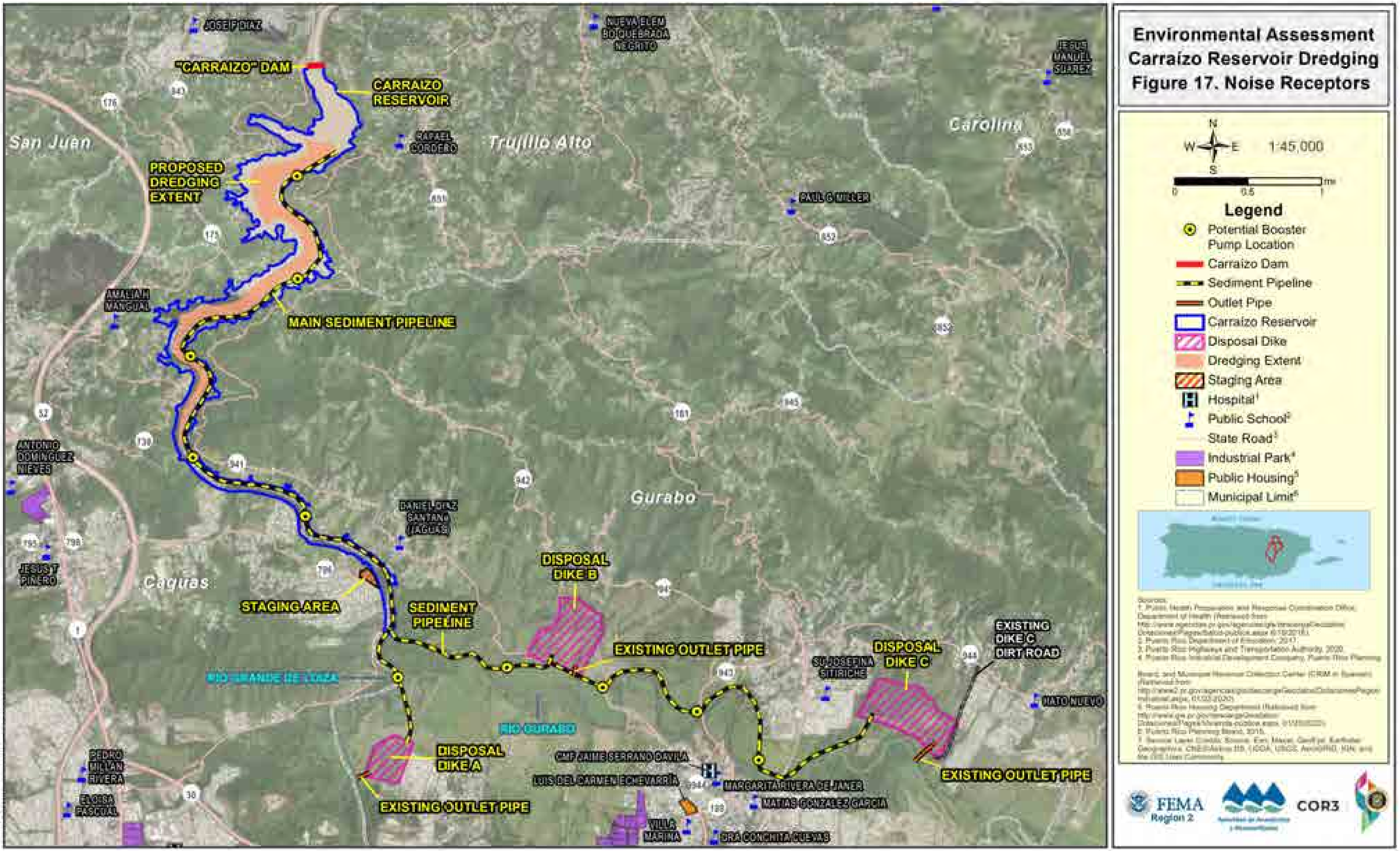
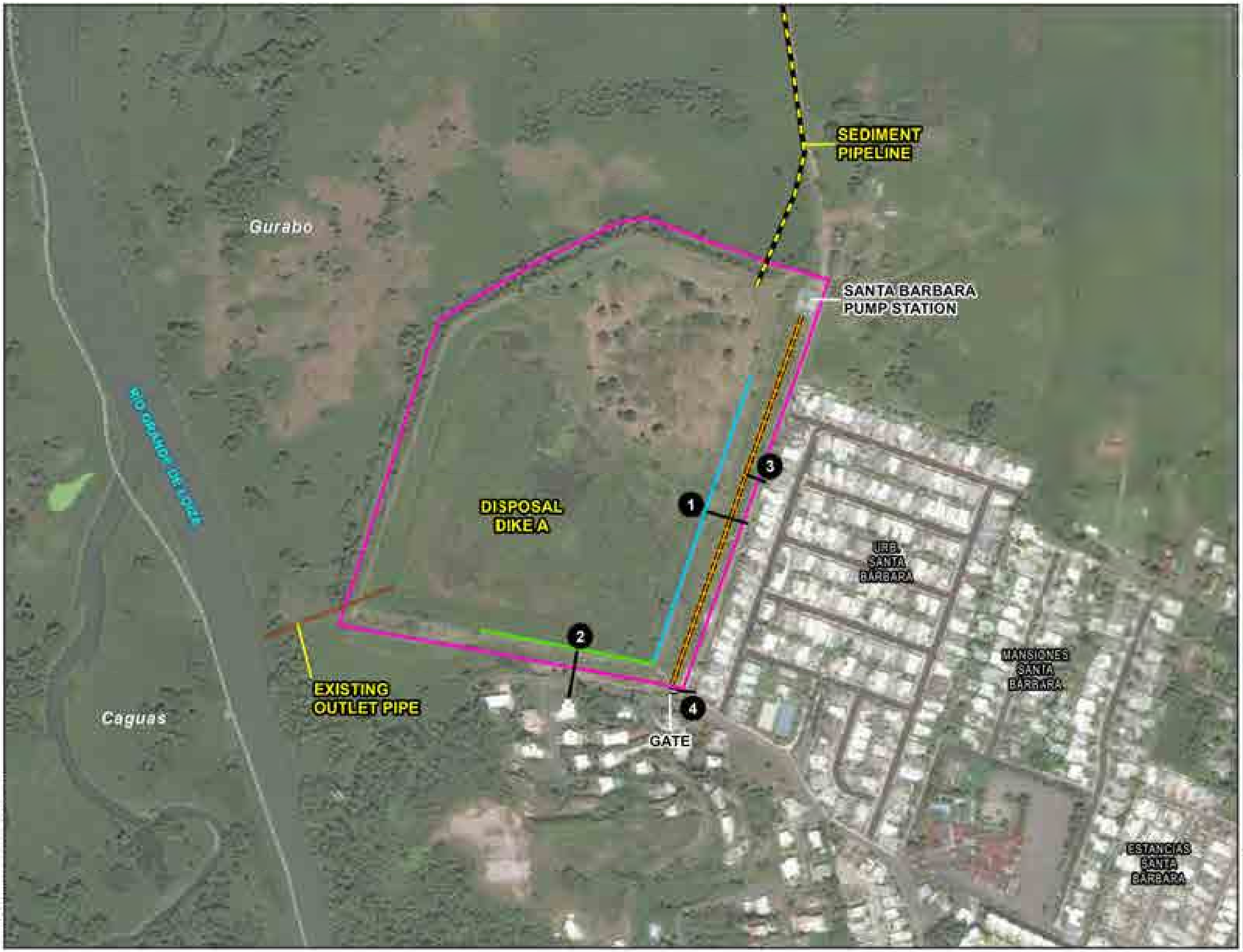
Environmental Assessment Carraízo Reservoir Dredging Figure 17. Noise Receptors





Environmental Assessment Carraizo Reservoir Dredging Figure 18. Disposal Dike A, Alternative 3 Sediment Removal Route

N W E S 1:5,000

0 0.0625 0.125 Miles

Legend

- Disposal Dike A
- Dirt Access Road
- Sediment Pipeline
- Oulet Pipe
- Top of eastern levee closest to a noise sensitive area
- Top of southern levee closest to a noise sensitive area

1. Distance from eastern levee to row of residences 44.55 m (146.2 ft)
2. Distance from southern levee to scattered houses 48.47 m (159.0 ft)
3. Distance from the dirt access road to row of residences 20.36 m (66.8 ft)
4. Distance from the access gate to the house at the neighborhood of Santa Bárbara southwest corner 19.19 m (62.9 ft)

Sources:
1. Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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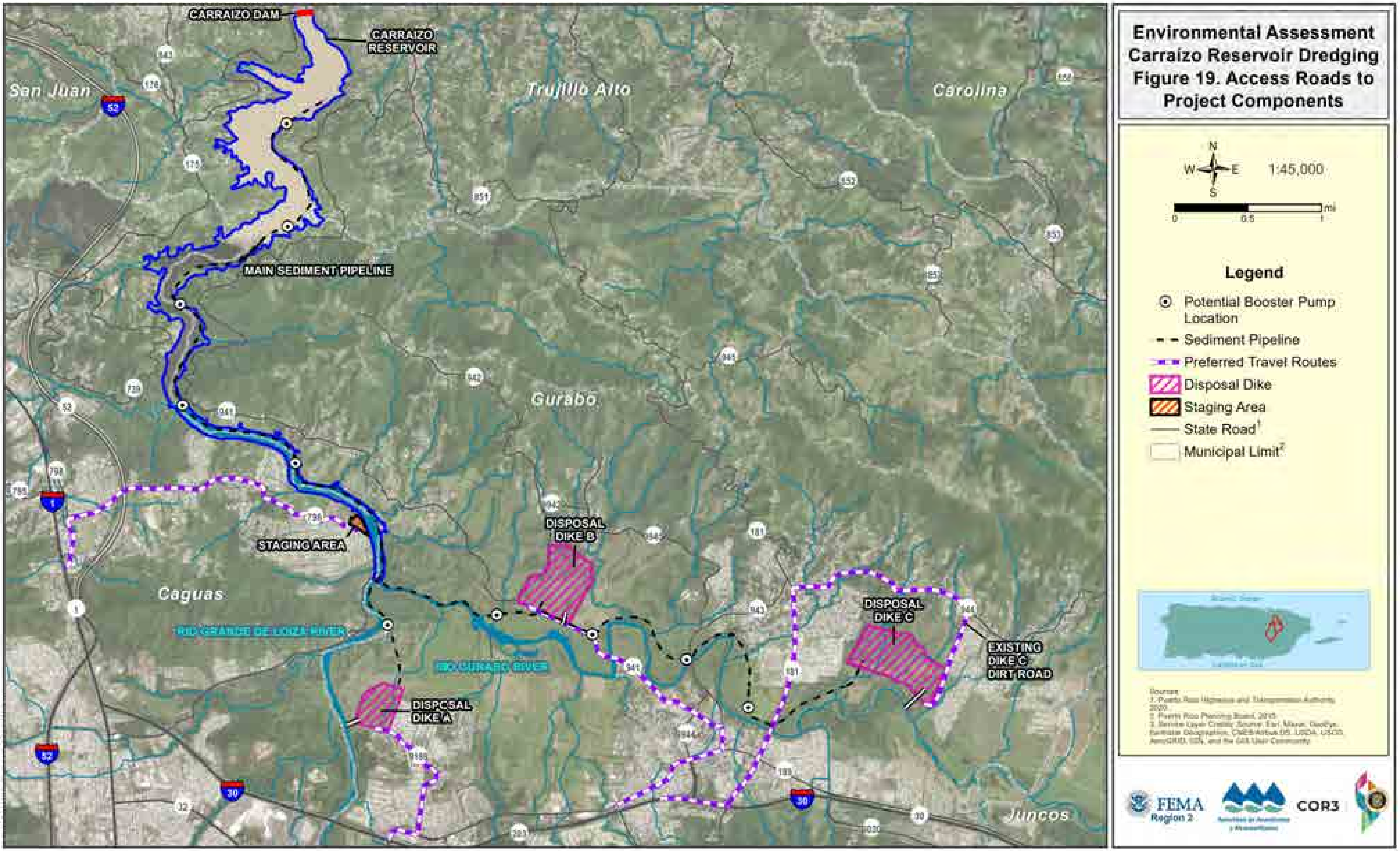
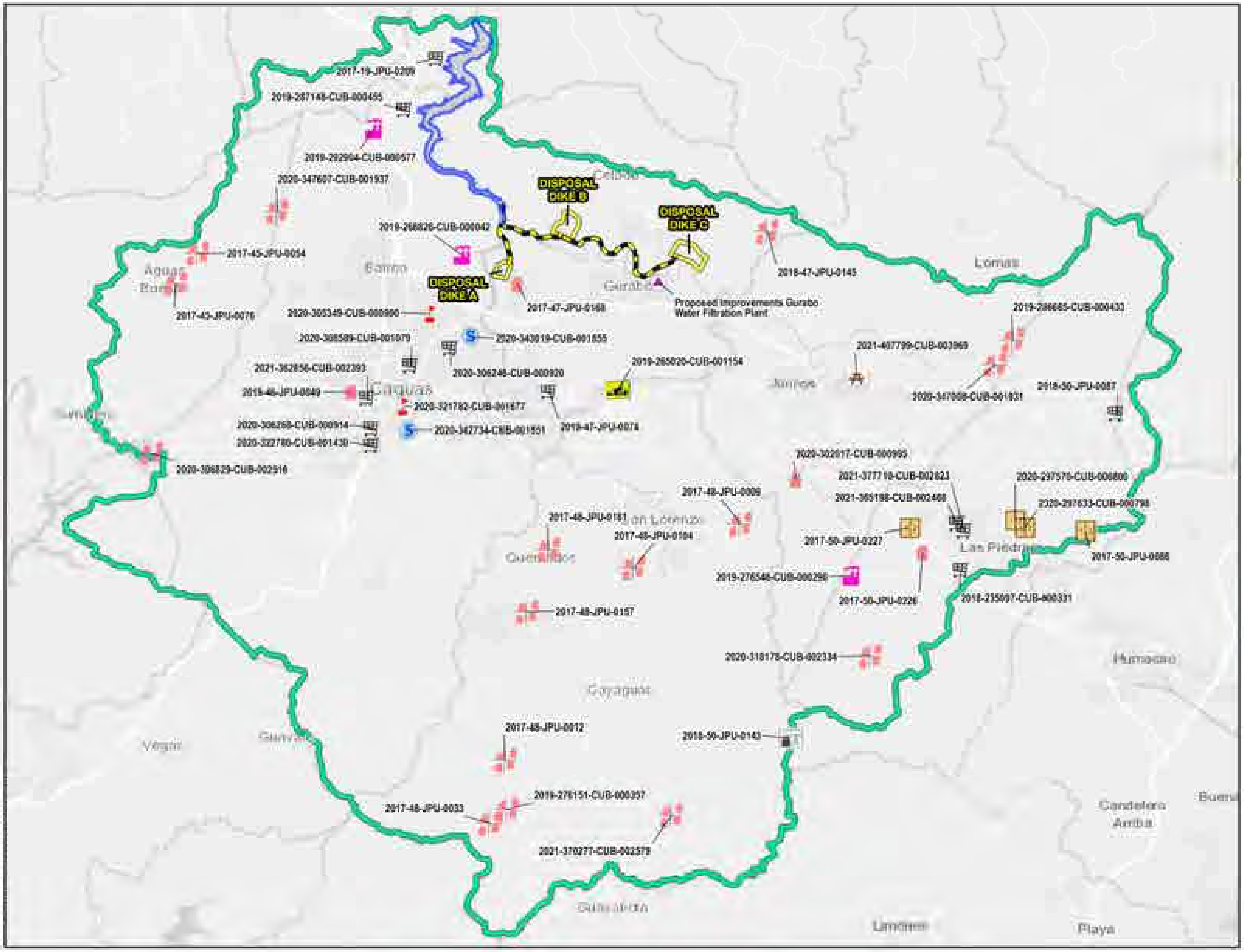

Environmental Assessment
Carraízo Reservoir Dredging
Figure 19. Access Roads to Project Components
1:45,000
0 0.5 1 mi
N S E W
Legend
Potential Booster Pump Location
Sediment Pipeline
Preferred Travel Routes
Disposal Dike
Staging Area
State Road[1]
Municipal Limit[2]
CARRAIZO DAM
CARRAIZO RESERVOIR
MAIN SEDIMENT PIPELINE
STAGING AREA
DISPOSAL DIKE B
DISPOSAL DIKE C
DISPCSAL DIKE A
EXISTING DIKE C DIRT ROAD
RIO GRANDE DE LOIZA RIVER
RIO GURABO RIVER
San Juan
Trujillo Alto
Carolina
Gurabo
Caguas
Juncos
FEMA Region 2
COR3

Environmental Assessment Carraízo Reservoir Dredging Figure 20. Projects Considered in the Cumulative Impact Analysis



N
W E
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1:140,000
0 0.5 1 2 mi

Legend

- Sediment Pipeline
- Carraízo Reservoir
- Disposal Dike
- Loíza Reservoir Watershed[1]

Proposed Federal Actions

- Utility

Site Approval Applications[2]

- Commercial
- Educational
- Energy
- Extraction
- Industrial
- Recreational
- Residential
- Segregation
- Services
- Land plot subdivision

Source:
1. United States Geological Survey, National Hydrography GIS Dataset, 2020.
2. Approved Site Approval Applications filed from 2017 to 2022. Puerto Rico Planning Board, Physical Planning Office, 2022.
3. Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community.

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