Deepwater Port License Application
Blue Marlin Offshore Port (BMOP) Project

Volume IIa – Offshore Project Components Environmental Evaluation (Public)
Topic Report 9: Geologic Resources

Submitted to:

Maritime Administration
Office of Deepwater Ports and Offshore Activities
1200 New Jersey Avenue SE, W21-309
Washington, DC 20590

United States Coast Guard
Commandant (CG-OES-2)
Stop 7509
2703 Martin Luther King Jr. Ave. SE
Washington, DC 20593-7509

Submitted by:

Blue Marlin Offshore Port LLC
8111 Westchester Drive
Suite 600
Dallas, Texas 75225

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Deepwater Port License Application
Blue Marlin Offshore Port (BMOP) Project

Volume I:	General (Public), including Deepwater Port License Application and Appendices (*under separate cover*)
Volume IIa:	**Offshore Project Components Environmental Evaluation (Public)** **(*herein*)**
Volume IIb:	Onshore Project Components, Environmental Evaluation (Public) (*under separate cover*)
Volume III:	Technical Information [***Confidential***] (*under separate cover*)
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ABBREVIATIONS AND ACRONYMS

Applicant	Blue Marlin Offshore Port LLC
BOEM	United States Bureau of Ocean Energy Management
BMOP	Blue Marlin Offshore Port
BMPs	Best management practices
BMSL	Below Mean Sea Level
bph	barrels per hour
BSEE	Bureau of Safety and Environmental Enforcement
CALM	Catenary Anchor Leg Mooring
CFR	Code of Federal Regulations
DGPS	Differential GPS
DWP	Deepwater Port
DWPA	Deepwater Port Act
EC	East Cameron
Echo Offshore	Echo Offshore, LLC
FERC	Federal Energy Regulatory Commission
Fugro	Fugro Inc
g	gravity
GMNA	Geologic Map of North America
GOM	Gulf of Mexico
LQ	living quarters
MARAD	United States Maritime Administration
MLV	mainline valve
MP	milepost
NT	Nederland Terminal
NTL	Notice to Lessees
NPDES	National Pollutant Discharge Elimination System
OCS	Outer Continental Shelf
OD	outer diameter
PLEMs	Pipeline End Manifolds
plug and abandonment	P&A
Project	Blue Marlin Offshore Port Project
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VBT	Vent Boom Tripods
VLCCs	very large crude carriers
WC	West Cameron

PROJECT FAST FACTS

General Project Terminology	
Applicant	Blue Marlin Offshore Port LLC
Project Name	Blue Marlin Offshore Port (BMOP)

BMOP Location and General Information	
Nederland Terminal (NT)	The location where the oil for BMOP originates. This is the existing Sunoco Partners Marketing & Terminals L.P. facility located in Nederland, Jefferson County, Texas
New 42-inch Pipeline	37.02 miles of 42-inch pipeline from NT to Station 501
Existing Mainline from Cameron parish Louisiana to WC 509	Cameron Parish, Louisiana Louisiana State Blocks: WC 11, 20, 21 OCS Blocks: WC 21, 44, 43, 58, 79, 78, 95, 114, 113, 132, 133, 148, 169, 170, 183, 196, 205, 212, 213, 224, 230, 241, 245, 246, 255, 258, 259, 266, 269, 276, 275, 277, 282, 408, 431, 432, 433, 456, 459, 482, 483, 484, 508, 509
Deepwater Port Location (Platform – CALM Buoys)	West Cameron Block 509 (WC 509) West Cameron 508 (WC 508) East Cameron 263 (EC 263)
Deepwater Port Water Depth	156 to 162 feet water depth
Loading Capacity	80,000 barrels per hour (bph)

BMOP Deepwater Port Components	
Existing Stingray Pipeline (Mainline)	One existing 36-inch Outer Diameter (OD) pipeline, approximately 104 miles long from Station 501 in Cameron Parish, Louisiana to WC 509. This line consists of the existing 36-inch OD subsea line from WC 509 to Station 701 and the existing 36-inch OD onshore line from Station 501 to Station 701.
Deep Water Port (DWP)	The offshore loading facility site located in WC 509, WC 508, and EC 263. The facilities consist of the existing WC 509 Platform Complex; two new PLEMs and CALM Buoys in WC 508 and EC 263; two new Crude Oil Loading Pipelines from the WC 509 Platform Complex to the PLEMs and the flexible hoses attached to the CALM Buoys. The WC 509 Platform Complex will be converted from gas service to oil and gas service. The converted platforms will support oil export and natural gas transportation.
WC 509 Platform Complex (509 Complex)	The existing WC 509 Platform Complex consists of three platforms and two Vent Boom Tripods (VBT). The WC 509A Platform is the natural gas gathering platform. This will also house the 36-inch riser and pig barrel of the crude oil Mainline. The WC 509B Platform currently is the natural gas compression and control platform. It houses natural gas compressors, separators, the Control Room and Platform Complex's utilities. The WC 509B Platform will continue to house the natural gas separation facilities and the Platform Complex's utilities. It will also house the crude oil Control Room, metering facilities, and pig barrels for the two Crude Oil Loading Lines. The WC 509C Platform is the Living Quarters (LQ) platform and will continue in that role. The WC 509 VBTs are utilized to bridge the natural gas vent piping to a point approximately 660 feet from the 509B Platform and will continue in this role for any planned and emergency natural gas blowdowns.

BMOP Deepwater Port Components	
WC 148 Platform	The existing WC 148 Platform will be converted from natural gas transportation service to oil transportation service. All gas piping facilities on the deck will be removed and replaced with new pipe and a new Mainline Valve (MLV). This valve will be able to be remotely operated.
Catenary Anchor Leg Mooring (CALM) System	There will be two floating Calm Buoys installed approximately 4,710 feet and 6,085 feet from the WC 509B Platform. The CALM Buoys will be installed with a minimum of 5,000 feet separation. Each Buoy will be moored in place with 6 or more anchor chains connected to engineered anchors installed at locations around the Buoy. Flexible hoses will be connected from the PLEMs to the Calm Buoys. Floating flexible hoses will also be connected to the CALM Buoy and, during loading, the opposite end will be connected to the ship. CALM Buoy No. 1 will be installed in WC 508 and CALM Buoy No. 2 will be installed in EC 263.
Crude Oil Loading Pipelines	Two 36-inch diameter pipelines from the existing WC 509B Platform to the PLEMs.
Pipeline End Manifold (PLEM)	One PLEM will be installed on the seafloor at each CALM Buoy. Each PLEM will be connected to a 36-inch Crude Oil Loading Pipeline from the WC 509B Platform and a CALM Buoy floating above the PLEM. The two PLEMs will be in WC 508 and EC 263.
VLCC or other Crude Carrier	Very Large Crude Carriers (VLCCs), Suezmax, Aframax or other large capacity seafaring vessels.
Meter for Measuring Departing Crude Oil	The DWP will have two-meter stations with associated prover and lab facilities. One of the meter stations will be located at the new BMOP Pump Station adjacent to the NT and one will be located on the offshore crude export platform (WC 509B Platform).
Pre-fabrication Yards	Existing yards will be used along the northern Gulf of Mexico (GOM) coast.
Support Facility	An onshore support base will be established at an existing port facility to provide the necessary security to support the DWP operations.

BMOP Onshore Pipeline Components	
BMOP Pump Station	The onshore metering, pumping, and pig launcher station will be located in Nederland, Texas, adjacent to the existing NT.
Onshore Crude Oil Pipeline	A new, approximate 37.02-mile, 42-inch OD pipeline connecting the existing NT in Jefferson County, extending across Orange County, Texas to the existing 36-inch OD Mainline at Station 501 in Cameron Parish, Louisiana.
Station 501	The existing NGPL/Stingray interconnect facility (Station 501) will be abandoned and demolished. A new pig receiver and launcher will be installed to connect the new 42-inch OD onshore pipeline with the existing 36-inch OD onshore Stingray Mainline.
Station 701	The existing compressor Station 701 in Cameron Parish, Louisiana will be demolished. All existing natural gas equipment will be removed from the Station except for several large 10,000-barrel storage tanks. Approximately 1,000 feet of new 36-inch pipe, surge tanks, surge valves, and a new MLV will be installed. The existing 10,000-barrel tanks located at Station 701 will be converted to surge relief tanks.
Stingray ANR Tap Removal Site	BMOP will remove the tap and install 36-inch pipe in its place.

BMOP Onshore Pipeline Components	
Mainline Valves (MLV)	Six new MLVs will be installed within the permanent pipeline right-of-way (ROW) of the new build pipeline. MLVs will also be installed at the BMOP Pump Station, Station 501, and Station 701. These valves will be used for isolation and spill control purposes.
Pipeline Pig Launchers and Receivers	Pig Launchers/Receivers will be located at the BMOP Pump Station, Station 501, and the DWP. These are utilized for cleaning the pipelines and running intelligent devices to assess pipeline integrity.
Access Roads and Canals	The Project will utilize existing access roads and canals. One new temporary access road and four new permanent access roads will be required.
Pipe and Contractor Yards	BMOP will utilize existing facilities along the northern GOM coast, U.S. or international locations for manufacturing pipe and for fabricating the PLEMs, CALM Buoys, and end connectors. Pipe coating activities will be performed at existing facilities along the northern GOM coast. Selection of the marine contractor will be completed after the MARAD filing; however, the successful contractor(s) will utilize existing fabrication and logistical facilities located along the northern GOM coast.

PROJECT ENVIRONMENTAL EVALUATIOLN ASSESSMENT CRITERIA

Environmental Evaluation Assessment Criteria		
Criteria	**Values**	**Definition**
Outcome	**Direct**	***Direct effects*** are "caused by the action and occur at the same time and place" of the Project (40 CFR § 1508.8).
	Indirect	***Indirect effects*** are "caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect impacts may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems" (40 CFR § 1508.8). Indirect impacts are caused by the Project, but do not occur at the same time or place as the direct impacts.
	Cumulative	***Cumulative impact*** is "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR § 1508.7).
Type	**Adverse (Negative)**	***Adverse*** would cause unfavorable or undesirable outcomes for the natural or social environment. Negative impacts result in a net loss to the resource.
	Beneficial (Positive)	***Beneficial*** impact would cause positive or desirable outcomes for the natural or social environment. Beneficial impacts result in a net benefit to the resource.
Duration	**Short-term (Temporary)**	***Short-term (or temporary)*** impacts are those that would occur only during a specific phase of the proposed Project, such as noise during construction or certain installation activities. Short-term impacts would end at the time, or shortly after, construction activities ceased. The duration of most short-term impacts would be a few hours to a few days.
	Long-term	***Long-term*** impacts would occur either continually or periodically throughout the life of the Project (e.g., operational air emissions, stormwater discharge), or would last for years after an impact-producing activity occurred (e.g., removal of wildlife habitat).
Magnitude	**Negligible**	***Negligible*** impacts are generally those that might be perceptible, but in certain cases may be undetectable.
	Minor	***Minor*** effects are those that could be perceptible but are of very low intensity and may be too small to measure.
	Moderate	***Moderate*** impacts are more perceptible, can often be quantified, and may approach the thresholds for major impacts.
	Major	***Major*** impacts, based on their context and intensity (or severity), have the potential to meet the thresholds for significance set forth in CEQ regulations (40 CFR § 1508.27). Major impacts warrant additional attention in a NEPA analysis and a review of potential mitigation measures that would fulfill the policies set forth in NEPA, which include avoiding, minimizing, or mitigating major impacts.
Likelihood	**Unlikely**	Low probability.
	Potential	Possible or probable.
	Likely	Certain.

9.0 GEOLOGIC RESOURCES

9.1 PROJECT OVERVIEW

Blue Marlin Offshore Port LLC (the Applicant) is proposing to develop the Blue Marlin Offshore Port (BMOP) Project (Project) in the Gulf of Mexico (GOM) to provide crude oil transportation and loading services for crude oil produced in the continental United States (U.S.). A Project overview map is provided in **Figure 9-1**. The Deepwater Port (DWP) will be utilized to load the transported crude oil onto very large crude carriers (VLCCs) (and other crude oil carriers) for export to the global market. The Applicant is filing this application for a license to construct, own, and operate the DWP pursuant to the Deepwater Port Act (DWPA) of 1974, as amended, and in accordance with U.S. Coast Guard (USCG) and U.S. Maritime Administration (MARAD) implementing regulations.

The primary purpose of the Project will be to provide for safe and reliable long-term supply of crude oil for export to the global market. Oil for export will be transported out of the existing Sunoco Partners Marketing and Terminals, L.P. terminal and storage facility in Jefferson County, Texas (Nederland Terminal or NT). This terminal is connected to multiple crude oil pipelines connecting to production from across the U.S. In addition, an affiliate of the Applicant owns the Stingray Pipeline System and has confirmed that its subsea pipeline and offshore platforms are suitable for converting to facilitate crude oil export from a DWP in the northern GOM. The Applicant has the exclusive right to lease or purchase the Stingray Pipeline System for use in the Project.

The DWP will be located in federal waters within and adjacent to the Outer Continental Shelf (OCS) in West Cameron Lease Blocks (WC) 509 and 508 and East Cameron (EC) Block 263. Following the existing Stingray pipeline, the DWP will be approximately 99 statute miles off the coast of Cameron Parish, Louisiana, with an approximate water depth of 162 feet. Crude oil will be routed from pumps at Nederland, through a new 42-inch outer diameter (OD) onshore pipeline to the existing Stingray Mainline at Station 501, and from there through the existing Stingray Mainline to the DWP. The crude oil will be metered at the BMOP Pump Station at the NT and on the existing WC 509B Platform and routed through two Crude Oil Loading Lines to Pipeline End Manifolds (PLEMs) located on the seafloor below two Catenary Anchor Leg Mooring (CALM) Buoys located in WC 508 and in EC 263. From each PLEM, the crude oil will be routed to its respective floating CALM Buoy through submerged flexible hoses. VLCCs (or other large seafaring crude oil vessels) will moor at a CALM Buoy, retrieve and connect the floating crude oil hoses connected to the CALM Buoy and the crude oil will then route from the Buoy to the VLCC for loading. Up to 365 VLCCs (or other crude oil carriers) will load per year.

In summary, the BMOP facilities consist of the pumps and meters at NT; a new approximate 37-mile, 42-inch OD pipeline; the existing 36-inch OD Mainline; an existing fixed, manned platform complex at WC 509; an existing platform at WC 148; two new Crude Oil Loading Pipelines; and two new PLEM and CALM Buoys located in WC 508 and EC 263. A schematic of the proposed DWP is provided in **Figure 9-2**. The crude oils that would be exported range from light to heavy grade crudes from the existing the NT facility.

This Topic Report describes the existing geologic resources that are located within the offshore Project area and discusses the potential geologic hazards that may be encountered during construction and operation of the Project. In addition, this report discusses mineral resources that may be present in the Project area. To characterize the geology of the Project area, offshore geotechnical, geophysical, and archaeological surveys were conducted at the DWP location and any areas of anticipated seafloor disturbance. The complete geotechnical, geophysical, and archaeological reports are presented, respectively, in Appendix C, Geotechnical Investigation, Appendix D, Geophysical and Hazard Survey, and Appendix E, Archeological

Investigations (Onshore and Offshore) of Volume III (*Confidential*). Sediments and sedimentation are discussed in Topic Report 3, "Water and Sediment Quality and Use" (Volume IIa).

9.1.1 Abandonment and Conversion of Existing Facilities

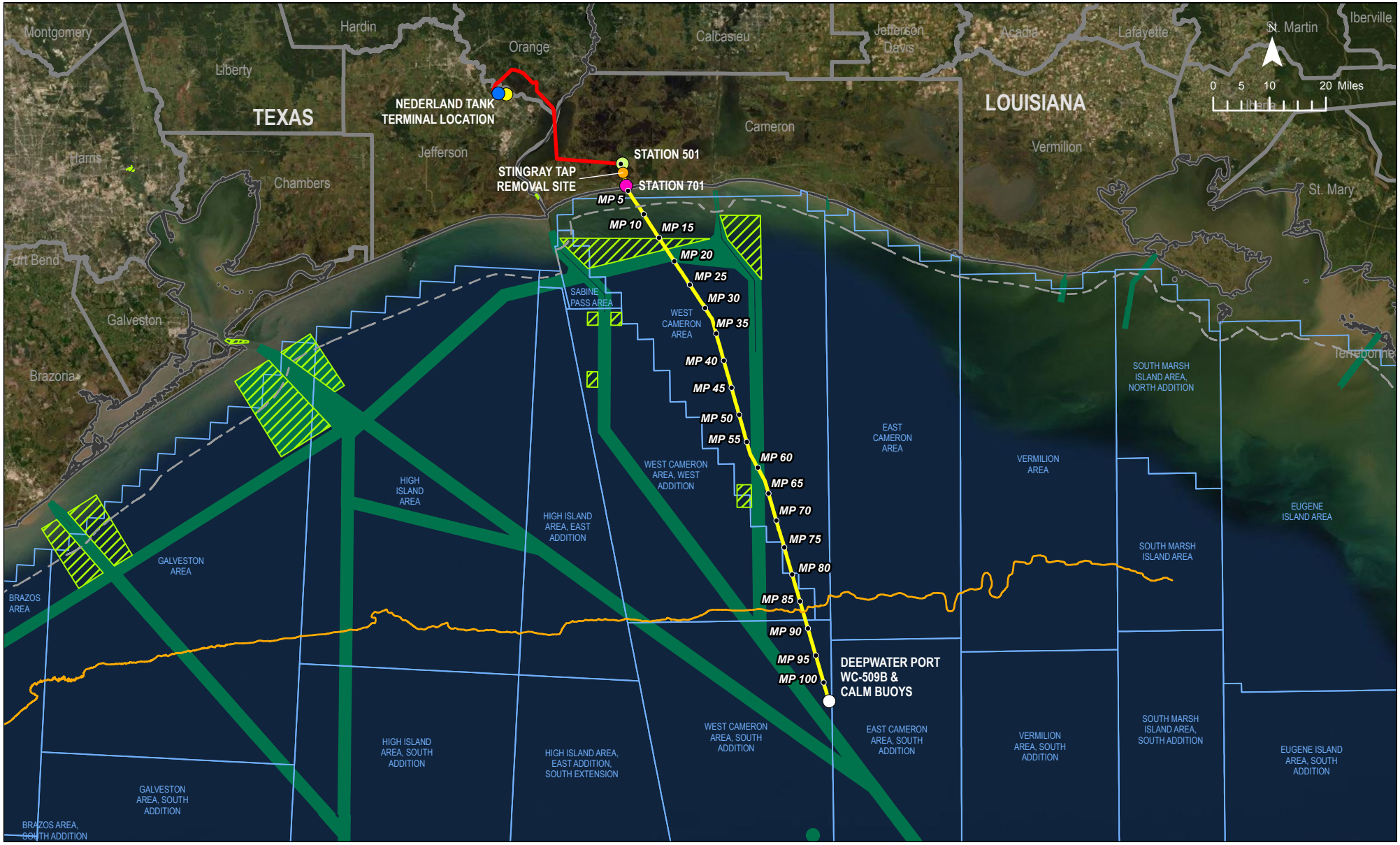
The Stingray Pipeline is currently comprised of a 36-inch pipeline (Mainline) that is fed natural gas and natural gas liquids by multiple lateral pipelines from various suppliers and producers. Stingray transports natural gas and liquids on the Mainline from the WC 509 Platform Complex to the onshore compressor station facility (Station 701) near Holly Beach in Cameron, Louisiana, and northward approximately four additional miles to the Natural Gas Pipeline Co. (NGPL)/Stingray interconnect (Station 501). The Stingray facilities from WC 509 to Station 501 will be abandoned through a FERC 7(b) Order and converted to use as DWP facilities (the filing has been made for abandonment). The Applicant intends to use all existing records and inspection data and perform additional engineering studies to obtain the appropriate agency approvals for converting all existing, reusable facilities. This includes updating the facilities to meet current regulations and guidelines, where appropriate. Abandonment under FERC 7(b) will be considered complete when the Mainline is completely isolated from all-natural gas sources and all-natural gas and produced liquids have been removed from the pipeline. This work will be completed by Stingray. Stingray will assign the existing right-of-way (ROW) Grant (and associated facilities—platforms at WC 148 and WC 509) to BMOP or another affiliate of ET for use in the BMOP Project. The Applicant intends to operate the new facilities under 49 Code of Federal Regulations (CFR) Part 195.

Conversion of the Stingray facilities involves converting service to crude oil and changing flow direction in the Mainline; converting the platform at WC 148, herein referred to as the WC 148 Platform, to crude oil service from natural gas service; and converting the platform complex at WC 509, herein referred to as the WC 509 Platform Complex, to crude oil and natural gas service.

9.1.2 Major Offshore Project Components

All facilities for the proposed BMOP Project will be designed, constructed, tested, operated, and maintained in accordance with the U.S. Department of Transportation (USDOT) regulations in 49 CFR Part 195 (Transportation of Hazardous Liquids by Pipeline) and other applicable federal and state regulations. The Project will consist of both onshore supply components and offshore/marine components. Offshore components are described below and depicted in **Figure 9-1**.

BMOP PROJECT - FIGURE 9-1 - PROJECT OVERVIEW MAP



LEGEND

- EXISTING OFFSHORE PIPELINE MILEPOSTS
- STINGRAY TAP REMOVAL SITE
- NEDERLAND TANK TERMINAL LOCATION
- NEDERLAND PUMP STATION
- STATION 701 (TO BE CONVERTED TO OIL SERVICE)
- STATION 501 (TO BE CONVERTED TO OIL SERVICE)
- DEEPWATER PORT WC-509B AND CALM BUOYS
- EXISTING PIPELINE TO BE CONVERTED TO OIL SERVICE
- PROPOSED ONSHORE PIPELINE (NEW BUILD)
- DEPTH CONTOUR -108'
- STATE WATERS BOUNDARY
- SAFETY ANCHORAGES
- PROTRACTION AREA
- SHIPPING FAIRWAY
- COUNTY / PARISH
- STATE BOUNDARY

BLUE MARLIN OFFSHORE PORT PROJECT

PROJECT OVERVIEW MAP

COUNTY/PARISH:	VARIOUS	DRAWN BY:	CA
STATE:	TX/LA	CHECKED BY:	CW

DATE:	2020/09/17
PROJECTION:	NAD 1983 UTM Zone 15N

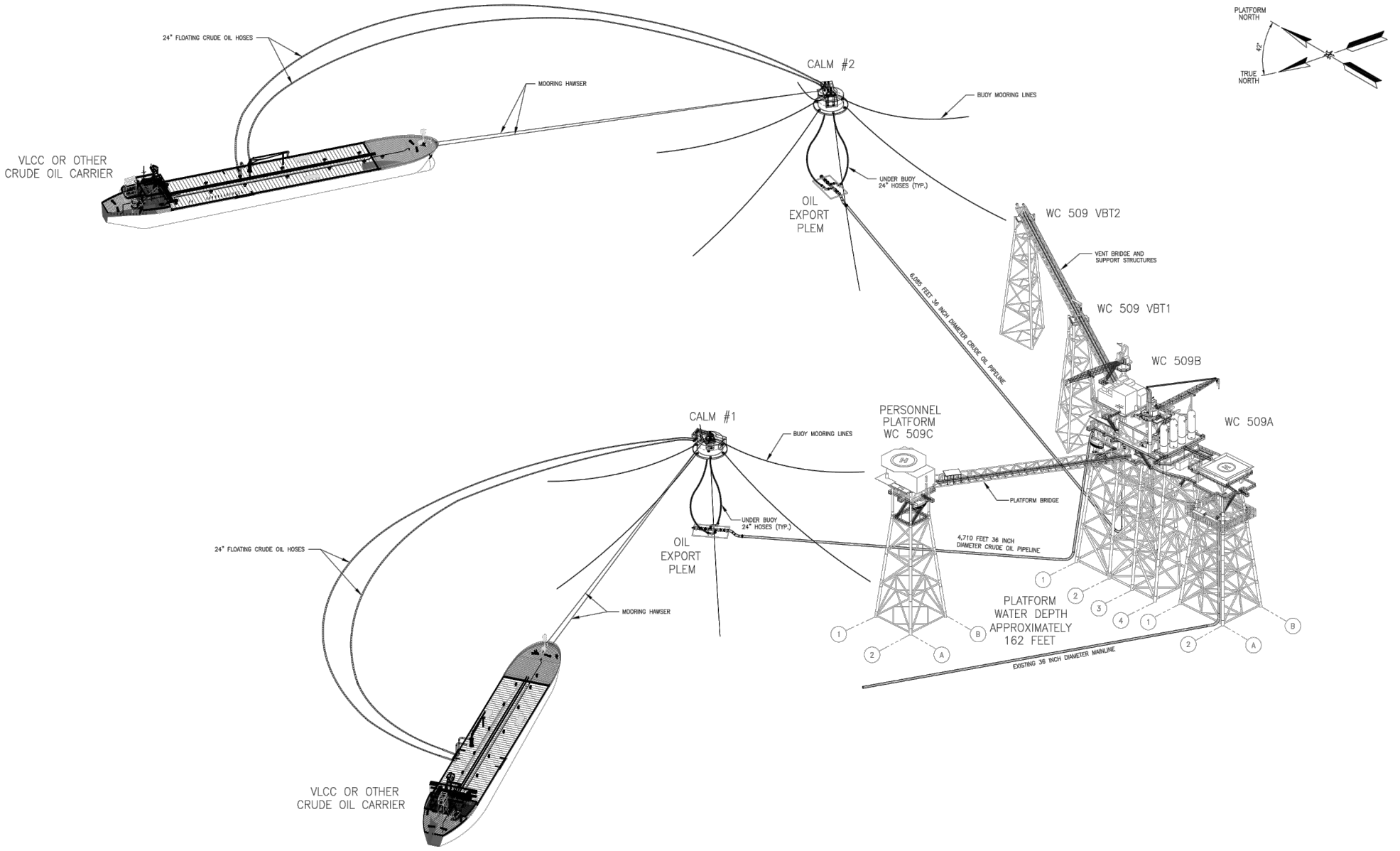
PREPARED BY

EXP Energy Services Inc.
T: +1.850.385.5441
F: +1.850.385.5523
1800 WEST LOOP SOUTH, SUITE 850
HOUSTON, TX 77027, USA

BLUE MARLIN OFFSHORE PORT PROJECT
FIGURE 9-1

DWG:	0802-01-005	SHEET:	1 OF 1

FIGURE 9-2 - BMOP DWP SCHEMATIC WITH VLCCs



Conversion of Existing Facilities

- The existing Station 501 is located at approximate MP 37 of the new 42-inch pipeline in Cameron Parish, Louisiana. All existing natural gas-related equipment owned by BMOP will be removed from the Station and new pipeline facilities will be installed. The new 42-inch pipeline will tie into the existing 36-inch Mainline at the site. The conversion of Station 501 will be expanded to include:
    - New pig receiver for the new 42-inch pipeline termination;
    - New pig launcher for existing 36-inch Mainline; and
    - New MLV.
- The existing compressor Station 701 in Cameron Parish, Louisiana, will be demolished. All existing natural gas equipment will be removed from the Station except for two 10,000-barrel storage tanks. The new facility will maintain office space, a natural gas interconnect, and surge tanks. Approximately 1,500 feet of new pipe, surge tanks, surge valves, and a new MLV will be installed. The existing 10,000-barrel tanks located at Station 701 will be converted to surge relief tanks.
- The existing ANR Tap (Stingray Tap Removal Site) is located at approximately Stingray Mainline MP 1.61 on the Stingray Mainline in Cameron Parish, Louisiana (approximate MP 38.6 on the BMOP pipeline system). BMOP will install a 36-inch OD pipe segment following removal of the tap.
- The existing Mainline from Station 501 to the WC 509 Platform Complex will be converted to crude oil service.
- The WC 148 Platform will be converted to crude oil service and a new mainline valve installed.
- The existing WC 509 Platform Complex will be converted from a gas transmission facility to a dual-purpose gas transmission and crude oil export facility. The existing equipment that will remain at the Platform Complex will include:
    - Existing natural gas piping and risers on WC 509A Platform;
    - Natural gas Vent Boom on WC 509 VBTs;
    - Natural gas separation facilities on WC 509B Platform;
    - and
    - Heliport and helicopter fuel tank on WC 509A Platform.

New Offshore Facilities

- Two new CALM Buoys installed, one in WC 508 (CALM Buoy No. 1) and the other in EC 263 (CALM Buoy No. 2). The CALM Buoys will be anchored to the seafloor via an engineered mooring system capable of accommodating mooring forces exerted by a VLCC or other large seafaring vessels during loading operations. Two 24-inch diameter floating hoses will be connected to each CALM Buoy. The hoses will be approximately 1,500 feet long and used for loading operations.
- Two new PLEMs installed and anchored on the seafloor under the CALM Buoys. Two 24-inch undersea flexible hoses will be connected to each PLEM and associated CALM Buoy.
- Two Crude Oil Loading Pipelines, approximately 4,710 feet long to PLEM / CALM Buoy No. 1 and 6,085 feet long to PLEM / CALM Buoy No. 2, installed from the WC 509 Platform Complex to the PLEM and CALM locations, one for each PLEM and CALM Buoy (see **Figure 9-2**). The pipelines will be installed with the top of pipe at least three feet below the natural seafloor.
- New MLV on WC 148 Platform;

- Two new 36-inch risers connected to the Crude Oil Loading Pipelines on WC 509B Platform;
- New control room on WC 509B Platform;
- Three new pig barrels, one on the WC 509A Platform and two on WC 509B Platform;
- Meter station for crude oil on the WC 509B Platform;
- New living quarters (LQ) and heliport on WC 509C Platform;
- Surge valves and tank on the WC 509B Platform; and
- New ancillary equipment for the 509 Platform Complex (e.g., power generators, instrument/utility air system, fuel tanks, ac units, freshwater makers, firewater system, seawater and freshwater system, sewage treatment unit, fuel gas system, diesel system, closed drain system, open drain system, hydraulic power unit, hypochlorite system, cranes, communications tower and system, radar) to support operation of the offshore facilities.

Offshore Support Facilities

Support facilities for the Project will include:

- Safety Zone - The Applicant is requesting that the USCG Captain of the Port establish a Safety Zone around the entire DWP operations area. The Safety Zone will only be open to entry for VLCCs or other crude oil carriers prepared for connection for loading of crude oil, and the necessary service vessels supporting that process.
- Anchorage area – Existing USCG-designated anchorage areas will be utilized for VLCCs (or other crude carriers) awaiting mooring at a CALM Buoy or if they must disconnect from the CALM Buoys for safety reasons.
- Support vessel mooring area – A designated Service Vessel Mooring Area will be established in proximity to the offshore WC 509 facilities.
- Temporary pre-fabrication yards – Component fabrication will occur at multiple existing fabrication facilities within the GOM coastal region.
- Support facilities – Facilities within the GOM coastal region providing support for offshore operations and maintenance activities (e.g., helicopters, supply vessels, work boats, equipment suppliers, and maintenance workers).

9.2 EXISTING ENVIRONMENT

9.2.1 Geologic Setting

The proposed DWP is located in the northern GOM basin. The GOM basin was created by an episode of crustal extension and seafloor spreading dividing the Mesozoic breakup of Pangea (Sawyer et al., 1991; Jacques and Clegg, 2002). Separation of South American Plate from its North American counterpart continued throughout the Mesozoic Era (approximately 252.3 to 66 million years ago) and into the Cenozoic Era (approximately 66 million years ago to present day). Combined extension and cooling—as crust migrated away from the axial spreading center and subsequently cooled after spreading ceased—caused a total tectonic subsidence of approximately 3 to 5 miles of the central thin transitional and oceanic crust (Sawyer et al., 1991). In conjunction with sediment loading, the Cenozoic Era is dominated by this activity, developing into the GOM basin seen today. Alternating with regressive and progressive marine conditions resulted in periods of shallow quiet seas characterized by limestone and evaporite deposition (Law Engineering Testing Company, 1981). The Louann salt was deposited in the late Jurassic period (approximately 157 million years ago), later playing an important role in the development of salt domes within the GOM. Thick quaternary deposits of sandy, silty, and clay sediments layered over these deposits from uplifted inland sources and carried to the GOM by Fluvial and Deltaic systems. The modern geologic history of the GOM is very unique and owes its geologic character mostly to Quaternary sea level fluctuations and resulting transgressions and regressions of the shoreline; fluctuations in sediment supply to the coast by rivers such as the Mississippi, Sabine, and Calcasieu; and the frequency of major storms (Williams et al., 2011).

9.2.2 Project Area Geology

The offshore Project area is located on the continental shelf within the Northern GOM basin, part of the Atlantic Coastal Plain physiographic province. Offshore of Holly Beach in Cameron Parish, Louisiana, the intertidal zone consists of well-sorted medium to fine sand. The seafloor bottom steps down to approximately 35 feet within a mile offshore. Traversing southeast along the existing Mainline, the seafloor slopes at a gradient of approximately 1.25 feet per linear mile to the approximate location of the WC 148 Platform. Traversing southeast towards the continental slope, the seafloor steepens along the Mainline at approximately 2.7 feet per linear mile to the approximate location of the offshore WC 509 Platform Complex.

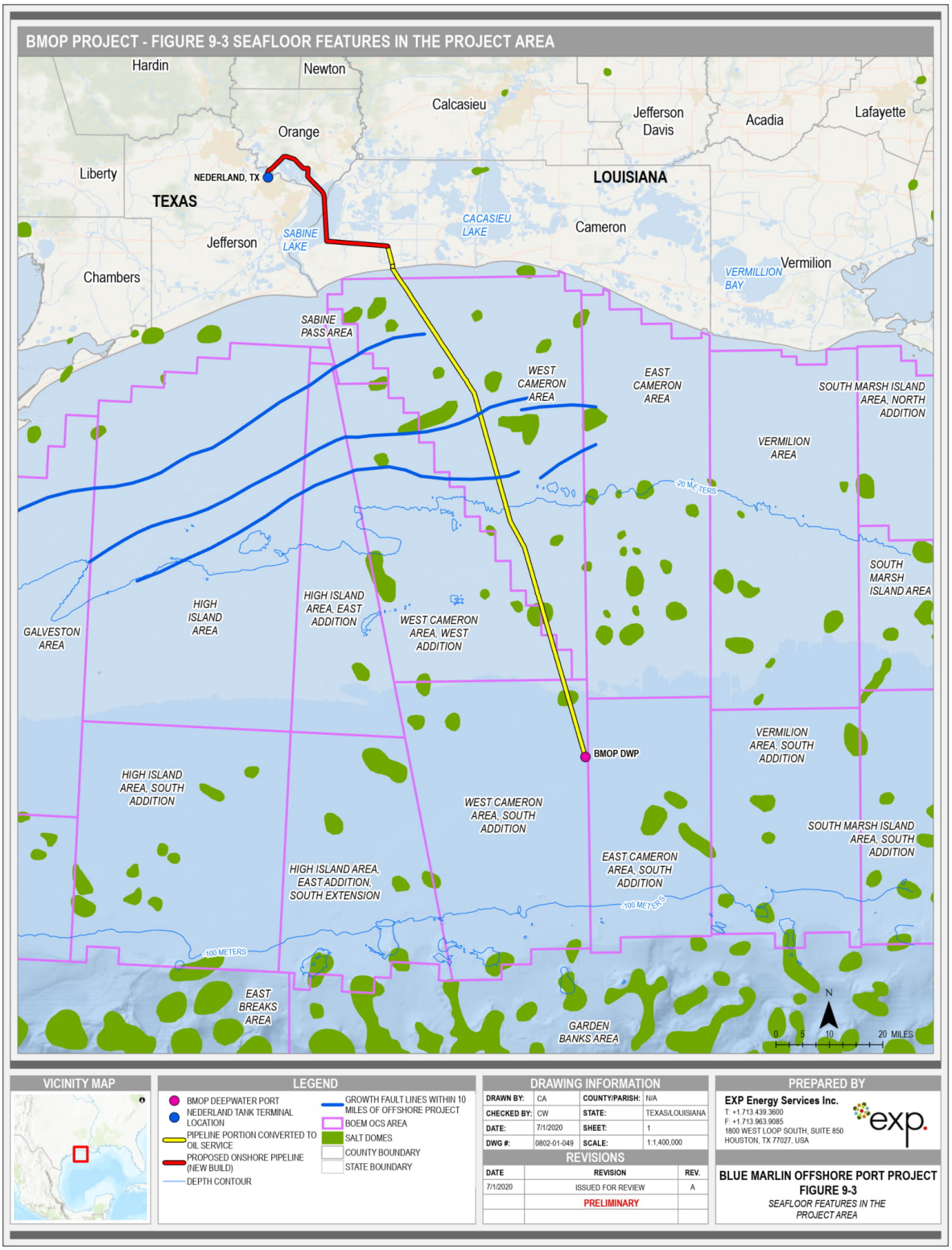
In general, silty and clay sediments interspersed with fine sand sediments are consistent throughout the length of the Mainline and around the WC 148 Platform and WC 509 Platform Complex. The existing WC 509 Platform Complex is constructed on the continental shelf, approximately 30 miles from the edge of the continental slope.

More detail is presented in Section 9.2.4, "Geologic Hazards," and geophysical and geotechnical data for the Project area is provided below. **Figure 9-3** illustrates the approximate locations of seafloor features, including salt domes and fault structures, in the Project area.

9.2.3 Geophysical and Geotechnical Survey Description

To characterize the geology of the Project area, the Applicant referred to the offshore geotechnical survey conducted by Fugro Inc (Fugro) in 2019 (Fugro, 2019) and the Echo Offshore, LLC (Echo Offshore) which are both within Project areas of anticipated seafloor disturbance.

FIGURE 9-3 Seafloor Features in the Project Area



The geotechnical survey scope of work was designed to meet the requirements specified by Bureau of Safety and Environmental Enforcement (BSEE) Notice to Lessees (NTL) 98-20 "Shallow Hazards Requirements" and NTL 2005-G07 "Archaeological Resource Surveys and Reports." A geotechnical survey and follow-on laboratory testing were also performed to evaluate the shallow sediments for geotechnical properties to inform engineering of the requirements for PLEM and buoy installation. The pre-construction surveys were conducted in agreement with:

- U.S. Bureau of Ocean Energy Management (BOEM) Guidelines for Providing Geophysical, Geotechnical, and Geohazards Information Pursuant to 30 CFR Part 585;
- BOEM Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585;
- The National Historic Preservation Act, as amended in 36 CFR Part 800 (Protection of Historic Properties); and
- USCGDWP regulations pursuant to 33 CFR § 148.105(o) (Archaeological Information).

The complete geotechnical, geophysical, and archaeological reports are presented in Appendices C, D, and E, respectively, of Volume III (*Confidential*). The geotechnical survey included collection of sediment cores for sediment classification and geotechnical analysis. The geotechnical survey and geophysical investigation results for the proposed DWP are summarized below.

9.2.3.1 *Geophysical and Geotechnical Results*

In 2019, Fugro Inc performed a geotechnical survey of WC 509 Platform Complex (an existing fixed, manned platform complex within the lease block), approximately 100 miles off the Louisiana coast. Bores were drilled to depths of 480 feet beneath the ocean floor. The first 200 feet is dominated by stiff clays interspersed with silts and fine sands. Below 200-feet, sediments coarsen to sands laminated with clay and slit. Fugro evaluated the increase in axial capacity with 42- and 48-inch pipe piles installed 45 years ago for the existing WC 509 Platform Complex. Based on this study, the average vertical pile penetration for the existing 42-inch pile is 201 feet and 290 feet for the existing 48-inch pile. This increase in shaft resistance is caused by continuous driving of clay, causing remolding around the clay generating large excess pore water pressures. Excess pore pressure decreases rapidly with radial distance from the pipe causing the excess pore water to flow laterally out of the disturbed zone consolidating the clay. As pore pressures dissipate, pile capacity increases. Field measurements from historical pile studies show the time required for driven piles to regain ultimate capacity is found to be relatively long.

In 2020, Echo Offshore, LLC (Echo Offshore) performed a geophysical investigation of WC 509 Platform Complex and adjacent WC 507, 508 510, 532, and EC 262, 263, and 280. The study area consisted of approximately 18 square miles on the Louisiana OCS 82 miles offshore water depths ranging from 148 to 172 feet, and an ambient seafloor across the area sloping to the southeast. The topographic high of 148 feet is located across the top of a bank in the northwestern portion of the study area. Depths reach as shallow as 154 feet across a smaller ridge located in the northeast.

The sonar recorded a moderately reflective seafloor interrupted by numerous pockmarks, occasional drag scars and faint trawl scars. Trends of larger diameter collapsed depressions are located throughout the area. A bathymetric shoal extends across the western portion of the Project area with a topographic high in the northwest. The study identified two faults located in the southern portion of the study area. Seafloor delineations were evident in the south and corresponded with underlying fault trends. A zone of small diameter, low relief possible outcrops was evident in the southern portion of the study area. These features do not correspond with known or designated banks and are not within designated Topographic Stipulation blocks within the study area. These features do not exhibit the 8-feet of relief to meet consideration as

"potentially sensitive biologic features" as outlined in BOEM NTL 2009-G39. These zones are not within the Project footprint and will not be impacted during activities that involve seafloor disturbance.

The study area overlies the Clemente-Tomas fault trend that parallels the Texas coast along the inner shelf. Plio-Pleistocene sediments are approximately 1.8 to 2.0 seconds thick (Watkins et al., 1996). No known salt diapirs are located beneath the study area (Watkins et al., 1996). Sub-bottom data indicates that shallow sediments were generally well layered and are interpreted as probably clays and silts. This stratigraphy is interrupted periodically by cut and fill channel complexes with margin depths just beneath the seabed. These channels are relatively shallow with thalwegs reaching as deep as 30 feet below mean sea level (BMSL) and contain a higher concentration of sands and/or organic materials. Some evidence of sediment sag is evident on the downthrown side of these faults. Sporadic patches of increased reflectivity atop the bank may represent higher concentrations of courser grained sediments at the seafloor.

A total of 38 sonar targets and 119 magnetic anomalies were identified in the study area. Targets 6, 30, and 36 were associated with magnetic anomalies and an additional 5 small sonar targets were identified via high frequency sonar data as part of a separate pipeline route investigation. Ten of the magnetic anomalies were recommended for avoidance as potential hazards to operations. Verified infrastructure located in the study area at the time of the project included 12 pipelines, 15 open-water plugged and abandoned (P&A) wells, 4removed platforms, and 3 extant platforms. Some of the verified pipelines had minor discrepancies between their as-found and as-built positions. Published coordinates for these structures contained in the BOEM database disagree with data acquired during this survey. Potential hazards to construction and operation activities have been noted and will be appropriately mitigated prior to activity. Designated infrastructure, magnetic anomalies, and sonar targets will be marked with Differential GPS (DGPS) during construction vessel movement and vessel use during operations. A separate archaeological assessment addressing this data set has been prepared by RC Goodwin and Associates (see Appendix E, Volume III [*Confidential*]).

9.2.4 Geologic Hazards

Geologic hazards are naturally occurring or induced conditions that can result in damage to land and structures, or cause injury to people. Potential geologic hazards in the Project area include movement along existing faults, seismic activity related to earthquakes, and seabed settlement due to subsidence.

9.2.4.1 *Faults*

The existing pipeline is located in a belt of predominantly seaward-facing normal faults that border the northern GOM from western Florida through southern Texas. The nearest fault is approximately 40 miles from any construction activity associated with the Project. A series of normal growth faults border the basin and reflect gravitational collapse of thick post-rifting sediments within the basin. Growth faults have a finite time span of primary growth that can be associated with one or more successive episodes of clastic sediment accumulation in the GOM. In addition, the full array of gravity tectonic structure domains of the northern GOM basin includes the salt diapirs and related structures of east Texas and North Louisiana (Galloway, 2008).

A rifted margin opened the GOM in the early- to middle- Mesozoic era and was buried beneath thick Middle-Jurassic Louann Salt and an overlying carbonate and clastic marine sequence that continues to accumulate today. This post-rift sequence thickens seaward. It is at least 1.2 miles thick everywhere in the belt of gulf-margin normal faults. The sequence is at least 6.2 miles thick along the coastline west of the Mississippi River and exceeds 7.5 miles thick under coastal Texas. The fault belt formed from rapid deposition leading to enormous thicknesses of post-rift sediments. The massive sediment accumulation caused this sequence to collapse under load and spread seaward. Salt pierced upward under the weight of

the overlying sediments, eventually forming salt diapirs. The overlying sediments extended on listric (curved), normal, growth faults that flatten downward into detachments in the salt and in over-pressured shales. In addition to causing seaward gravitational collapse of the thick post-rift sequence, the crustal load from rapid Quaternary sedimentation may also aid Quaternary normal faulting and reactivate the older Tertiary faults of the coastal zone by imposing extensional bending stresses on the post-rift sequence (Wheeler and Crone, 2000)

Salt structures can represent potential hazards, including activation of faults and fault scarps, slumping, and formation of shallow gas pockets, seeps, and vents. According to the Geologic Map of North America (GMNA), which provides regional scale fault locations, the Project will be located within 10 nautical miles of three northeast-southwest trending growth faults (Garrity and Soller, 2009). **Figure 9-4** provides the approximate growth fault locations in proximity to the Project. It should be noted, however, that the data used to compile the GMNA are regional in scale, so the precise locations of the faults are unknown (Garrity and Soller, 2009).

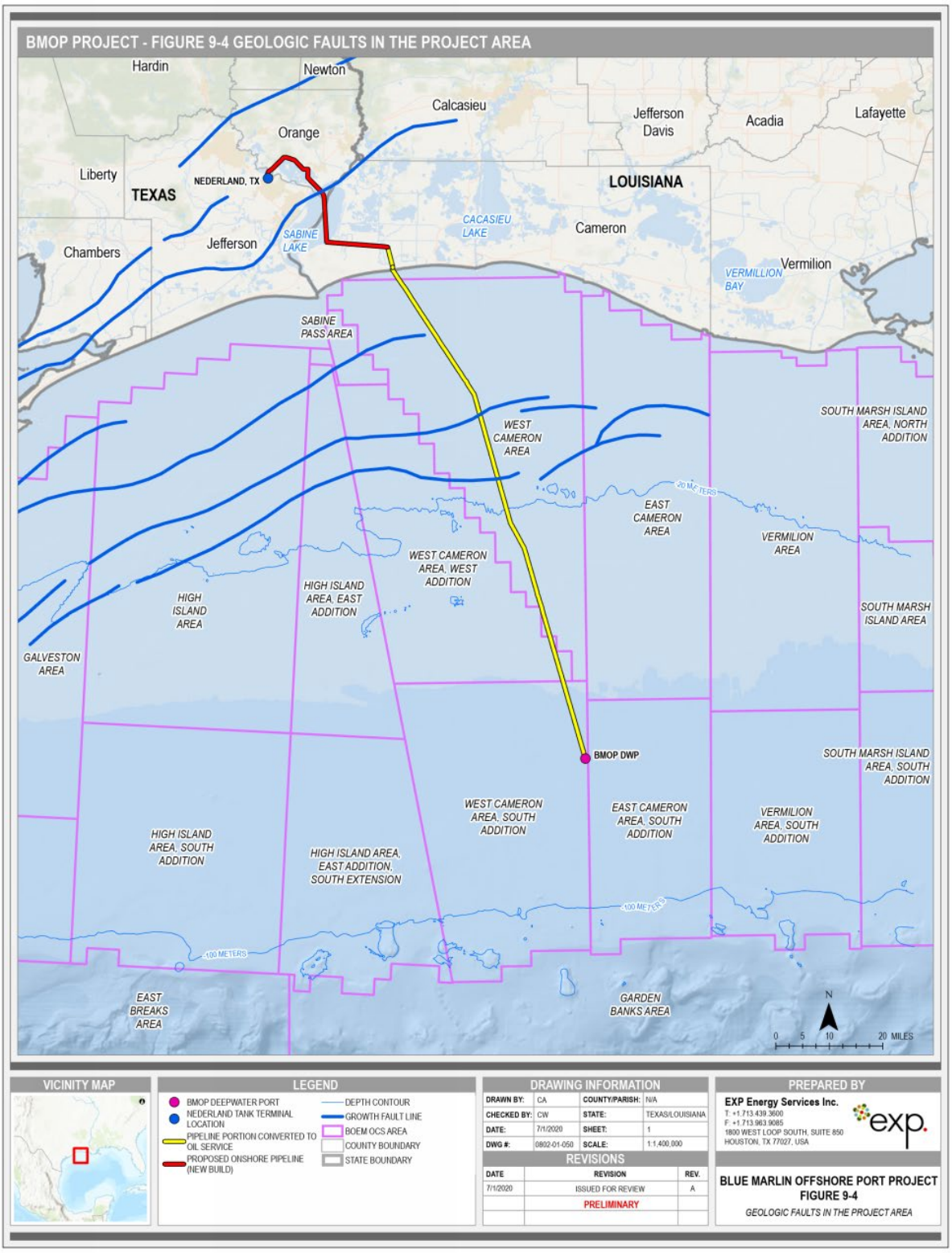
The Echo study identified two (2) faults that extend to the seafloor, and exhibit 13 to 16 feet of throw in the sub-surface in the southern half of the Platform study area in Lease Block WC 509, however they have not been mapped in **Figure 9-4** because, according to the study, do not pose a hazard or constraint to anchoring (see Appendix E, Volume III [*Confidential*]). The first fault trends ENE/WSW across the entire site in the southern half of the study area and is downthrown to the ENE. The second fault trends northwest/southeast in the south of the study area and is downthrown to the southwest and is not as extensive. Both faults had evidence of sediment sag on the downthrown side, are eroded near the seabed, and only reflect a minor offset across the seafloor.

9.2.4.2 *Seismic Hazards*

The Quaternary Fault and Fold Database of the United States, compiled by the U.S. Geological Survey (USGS), characterizes the seismicity of the region as sparse and of low magnitude. Low seismicity may be due to the post-rift sequence and its belt of gulf-margin normal faults being mechanically decoupled from the underlying crust. In addition, the salt and over-pressured shales may be too ductile to transmit tectonic stresses upward from the underlying crust into the post-rift sequence. Additionally, the post-rift sequence itself is young, only partly dewatered, and poorly lithified, particularly in its Cenozoic part. The post-rift sequence lacks the elastic strength to transmit tectonic stresses as efficiently as upper crustal metamorphic and igneous rocks. In particular, the post-rift sequence may be unable to support the widespread, high stresses that are necessary to drive a large, seismogenic rupture. The sequence may be similarly unable to support the propagation of high stresses or seismogenic ruptures that might enter it from the underlying crust. This suggestion is consistent with the observation that low-velocity, near-surface materials—whether they are thick fault gouge (crushed and ground-up rock produced by friction of sides of fault during fault moves) or poorly lithified sediments—tend to suppress the propagation of seismic ruptures (Wheeler and Crone, 2000).

The USGS Earthquake Hazards Program maintains an Earthquake Catalog that includes information from numerous data sources. Each data source covers a unique time period. Additional details describing the information sources utilized and the timeframe covered by each are available online from the USGS. A query of the Earthquake Catalog data was conducted for events within 250 miles of the Project. The query revealed 42 records. The closest earthquake took place in 1983. It registered a magnitude 3.8 event with an epicenter located approximately 32 miles to the north. The farthest earthquakes within the search area took place in 2017 and 2019. They were magnitude 2.9 and 3.0 with epicenters located approximately 191 to the north and 205 miles to the west, respectively. The greatest energy earthquake was a magnitude 5.3 event that took place in 2006. The epicenter of this earthquake was located approximately 176 miles to the southwest.

FIGURE 9-4 Growth Fault Locations in Proximity to the Project



The most recent earthquake was a magnitude 2.5 event that took place in March 2020. The epicenter of this quake was located approximately 133 miles to the north. **Table 9-1** provides details on earthquakes that were identified within 250 miles from the Project.

TABLE 9-1
USGS Earthquake Catalog - Earthquakes within 250 Miles of the Project

Distance from Project (miles)	Latitude	Longitude	Date	Magnitude
132.90	31.9557	-94.3945	2020-03-23	2.5
117.95	31.6026	-94.8065	2019-10-12	2.4
126.34	31.8468	-94.4226	2019-07-27	2.6
204.75	29.0257	-97.2069	2019-03-04	3.0
97.85	31.4703	-94.1354	2019-01-20	3.3
158.20	32.351	-93.7648	2018-12-04	2.4
128.94	31.8921	-94.3874	2018-09-12	2.5
134.18	31.9613	-94.4343	2018-09-04	3.5
168.02	26.1169	-92.1408	2018-02-26	4.3
191.36	29.6797	-97.1635	2017-10-20	2.9
180.64	29.4721	-96.9411	2015-02-19	3.1
111.57	31.6761	-94.0554	2014-10-03	3.1
128.77	31.8831	-94.4222	2013-09-06	2.4
130.62	31.9095	-94.428	2013-09-02	4.3
135.74	31.9656	-94.526	2013-09-02	4.2
126.14	31.860	-94.332	2013-05-31	2.9
70.13	27.875	-92.043	2013-03-11	2.9
103.15	31.545	-94.162	2013-02-03	2.1
133.10	31.939	-94.466	2013-01-31	2.8
127.20	31.866	-94.389	2013-01-29	2.8
124.72	31.844	-94.300	2013-01-25	4.1
130.14	31.905	-94.414	2012-12-22	2.6
127.82	31.873	-94.401	2012-12-07	2.8
128.58	31.878	-94.434	2012-06-16	2.1
128.07	31.878	-94.394	2012-05-26	2.5
130.62	31.904	-94.458	2012-05-20	2.7
131.01	31.926	-94.369	2012-05-17	4.8
134.77	31.964	-94.465	2012-05-10	3.9
135.55	31.983	-94.427	2011-07-04	2.2
177.55	30.815	-90.854	2010-08-02	3
172.42	30.753	-96.755	2007-09-15	2.7
175.60	27.828	-90.210	2006-02-10	5.3
168.79	30.258	-90.708	2005-12-20	3.0
126.27	27.117	-94.442	2002-05-27	3.8

TABLE 9-1 USGS Earthquake Catalog - Earthquakes within 250 Miles of the Project				
Distance from Project (miles)	**Latitude**	**Longitude**	**Date**	**Magnitude**
175.06	28.027	-90.171	2000-12-09	4.3
181.49	29.450	-96.950	1995-01-04	2.7
176.24	27.911	-90.177	1994-06-30	4.2
149.96	30.100	-96.500	1992-04-07	2.3
32.21	30.243	-93.393	1983-10-16	3.8
156.03	32.021	-95.262	1981-11-06	3.2
145.96	32.142	-94.399	1981-06-09	3.0
146.80	30.000	-91.000	1930-10-19	4.2

The 2014 USGS Hazard Mapping Program probabilistic seismic hazard analyses for peak ground acceleration expected near the proposed Project site, expressed as a factor of gravity (g), indicates a 10 percent probability of exceeding 0.01g within a 50-year period (see **Figure 9-5**). The program indicates a 2 percent probability of exceeding 0.02 to 0.04g within a 50-year period due to seismic events (see **Figure 9-6**) (Petersen et al., 2014).

9.2.4.3 *Seabed Subsidence*

Seabed subsidence is the sinking or gradual downward settling of the seafloor surface, which can be due to erosion from salt domes or karst terrain. The closest salt dome is located approximately 10 miles from the DWP (see **Figure 9-3**). The USGS reports that the Gulf Coast Salt Dome Evaporite Basin does not extend into the GOM in the area of the DWP and there are no known carbonate rocks or unconsolidated calcareous or carbonate rocks in the vicinity of the Project (Hosman, 1996).

9.2.5 Mineral Resources

Based on review of available geologic data, no currently exploitable mineral resources are present within the DWP Project area centered around the WC 509 Platform Complex. Lease Blocks with significant sediment resources that cross the existing Stingray Pipeline System are found in the West Cameron Area OCS Lease Blocks and include: WC 21, 43, 44, 58, 113, 132, 133, 148, 169, and 170 (BOEM, 2020).

The WC 509 Platform Complex is not located in an area with significant sediment resources (BOEM, 2020). With respect to oil and gas, the DWP is located within the western portion of the Mesozoic Deep Shelf play (an area of similar potential for oil and gas). The play is a series of large, four-way dipping structural closures of source, reservoir, and seal lithologies that comprise 6.5 million acres of seismically correlated units of Upper Jurassic through Upper Cretaceous age (BOEM, 2017). While this is a recognized potential play, there are no proven or unproven reserves on the area as of 2012 (BOEM, 2012).

In order to deliver crude oil from the existing Nederland oil terminal in Jefferson County, Texas, to the DWP offshore of Louisiana, the existing Mainline of the Stingray Pipeline System will be converted to oil service from the existing Stingray Station 501 out to the existing WC 509 Platform Complex.

FIGURE 9-5 Seismic Hazard Map, Peak Ground Acceleration (10% Probability of Exceedance)

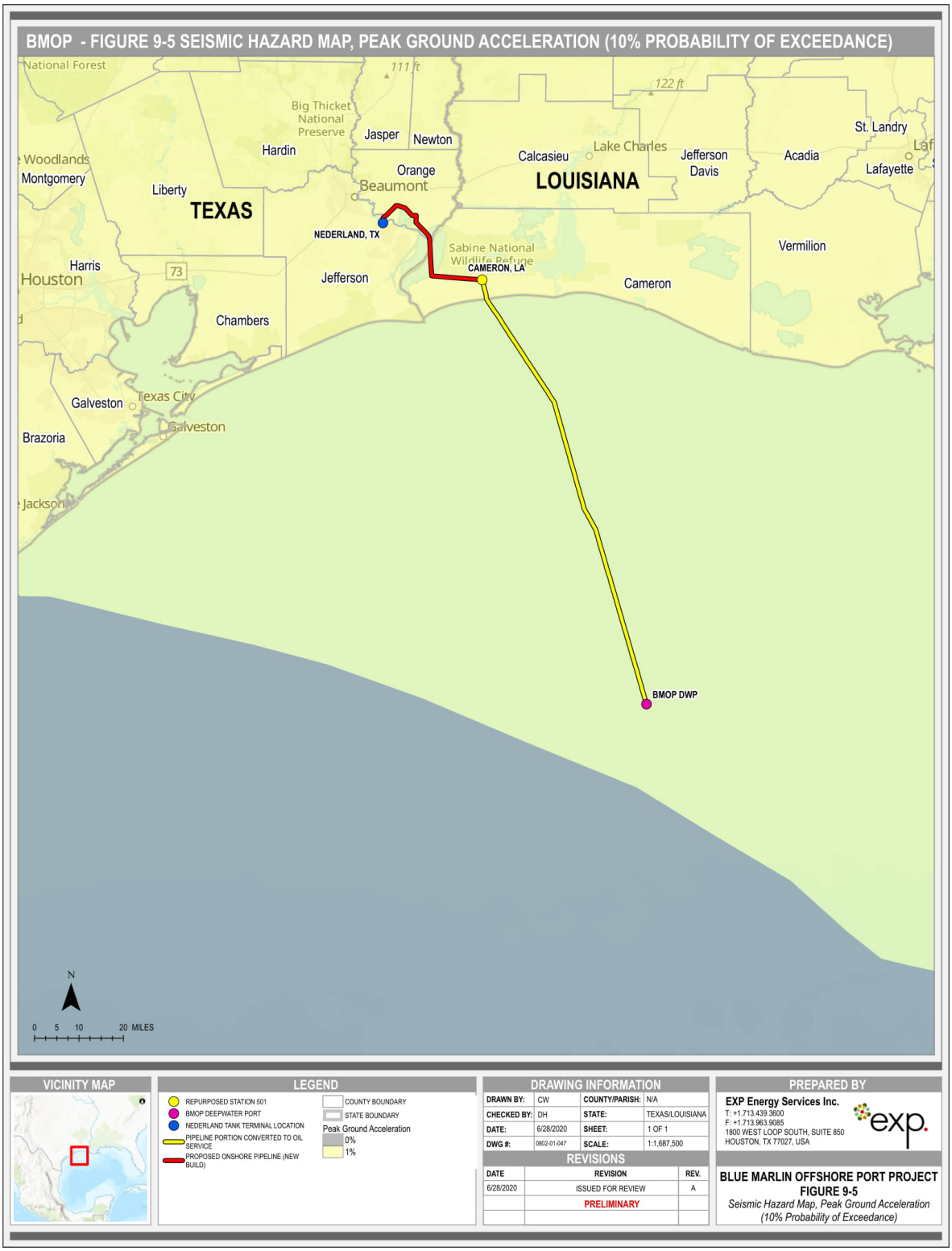
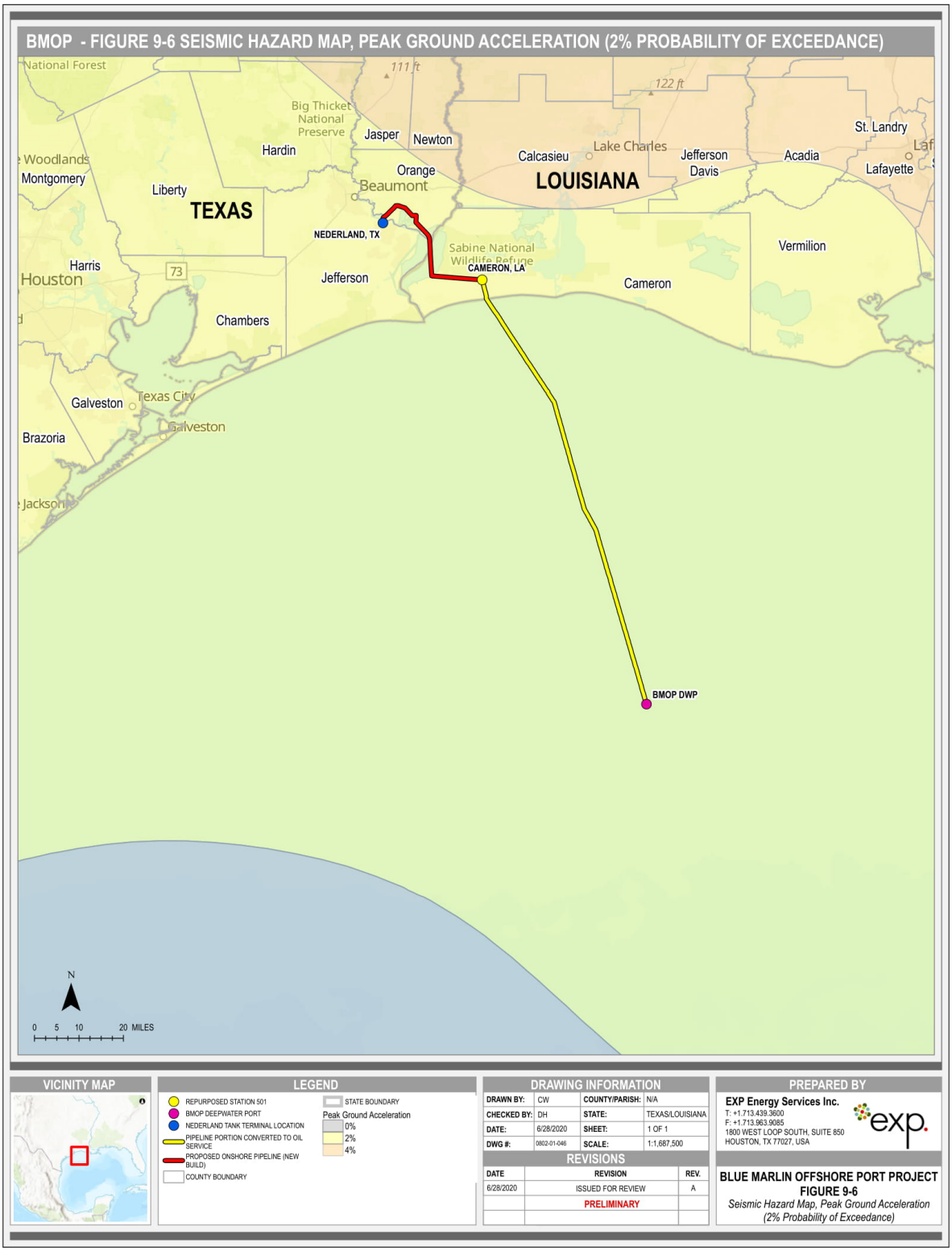


FIGURE 9-6 Seismic Hazard Map, Peak Ground Acceleration (2% Probability of Exceedance)



9.3 ENVIRONMENTAL CONSEQUENCES

This section includes a discussion of the impacts that could result from the construction and operation of the offshore components of the Project. The study area within which potential impacts were assessed includes the area that would be affected physically by Project activities during construction and operation. As described in **Table 1-19** in Section 1.9.2 (Evaluation Criteria) of Topic Report 1, "Project Description, Purpose, and Need" (Volume IIa), the Project's potential effects on offshore geologic resources have been evaluated based on their potential to:

- Increase the potential for geologic hazards to occur, such as seismic events;
- Degrade unique geologic features;
- Prevent recovery of mineral resources due to site(s) of facilities;
- Alter the lithology, stratigraphy, or geologic structures that control or contribute to groundwater quality, the distribution of aquifers and confining beds, and groundwater availability; and/or
- Degrade or prevent the study or recovery of paleontological resources (discussed in Appendix E, Volume III [*Confidential*]).

Sediment resource areas are addressed in Volume IIa, Topic Report 3.

TABLE 9-2
Potential Impacts on Geologic Resources

Activity	Details	Duration of Impact	Mitigation Measures	Anticipated Level of Impact
Construction				
Mainline Conversion	• The amount of seafloor disturbance is significantly reduced due to the Project's ability to convert the existing Mainline. Minimal impacts from sealing existing side taps and removal of the MLV at WC 277. • Hydrostatic test water discharge	Short-term	Comply with USACE permit conditions; Use of a filtration spread offshore and compliance with EPA NPDES Permit	Negligible to minor and localized
Crude Oil Loading Pipeline Construction	• Seafloor disturbance during pipeline burial. • Turbidity and sedimentation during pipeline burial and lay barge anchoring. Hydrostatic test water discharge.	Short-term	Compliance with USACE Permit, EPA Permit, and BOEM Right-of-Way (ROW) grant conditions	Negligible to minor and localized
Platform Conversion	• Pollution due to potential spills of fuels or other hazardous materials.	Short-term	Compliance with MARAD and BOEM/BSEE Permit conditions; Adherence to Spill Prevention, Control, and Countermeasures (SPCC) Plan	Negligible to minor and localized

TABLE 9-2
Potential Impacts on Geologic Resources

Activity	Details	Duration of Impact	Mitigation Measures	Anticipated Level of Impact
CALM Buoy and PLEM Installation	• Seafloor disturbance during PLEM, CALM Buoy, and vessel mooring anchor installation.	Short-term	Compliance with USACE Permit and BOEM ROW grant conditions	Negligible to minor and localized
Construction Vessel Operations	• Increase in turbidity and sedimentation due to anchoring • Pollution due to potential oil spill	Short-term	Compliance with federal regulations for vessel operations; Adherence to SPCC Plan	Negligible to minor and localized
Operations				
Vessel Operations	• Increase in turbidity and sedimentation due to anchoring. • Loss of seafloor from DWP operations and safety zones, • Pollution due to potential oil spill	Lifetime of Project	Compliance with federal regulations for vessel operations; Adherence to Energy Transfer's Sea Robin Oil Spill Response Plan (O-726), modified to include BMOP	Negligible to minor and localized
Decommissioning				
Platform and CALM Buoy Removal	• Seafloor disturbance during removal. • Potential vessel related impacts, similar to facility construction.	Short-term	Compliance with USACE and EPA Permit and BOEM ROW grant conditions, and MARAD license	Negligible to minor and localized
Facility Abandonment in Place	• Seafloor disturbance during abandonment preparations.	Short-term	Compliance with USACE and BOEM/BSEE Permit conditions; Adherence to Energy Transfer's Sea Robin Oil Spill Response Plan (O-726), modified to include BMOP; MARAD license conditions	Negligible to minor and localized
Support Vessel Operations	• Increase in turbidity and sedimentation due to anchoring and prop wash/scour (shallow areas).	Short-term	Compliance with federal regulations for vessel operations; Adherence to Energy Transfer's Sea Robin Oil Spill Response Plan (O-726),	Negligible to minor and localized

TABLE 9-2 Potential Impacts on Geologic Resources				
Activity	**Details**	**Duration of Impact**	**Mitigation Measures**	**Anticipated Level of Impact**
			modified to include BMOP	

Activities associated with the construction, operation, and decommissioning of the DWP and associated pipeline that may have environmental consequences on geologic resources are discussed in more detail below.

9.3.1 Geologic Hazards

9.3.1.1 *Faults*

The nearest fault is approximately 40 miles from any construction activity associated with the Project. The Mainline conversion of the existing pipeline crosses faults with no known seafloor displacement or geologic features that could impact the pipeline that would preclude siting, construction, and operation of the proposed Project.

9.3.1.2 *Seismic Hazards*

According to the USGS, there is a low probability of seismic activity in the offshore Project area.

9.3.1.3 *Seabed Subsidence*

Seabed subsidence at salt domes does not pose a risk in the area of the proposed Project. The closest salt dome is located approximately 10 miles from the DWP (see **Figure 9-3**). The USGS reports that the Gulf Coast Salt Dome Evaporite basin does not extend into the GOM in the area of the DWP, and there are no carbonate rocks or unconsolidated calcareous in the vicinity of the Project (Hosman, 1996). Accordingly, karst terrain does not underlie the proposed Project; therefore, potential for subsidence due to collapse of karst structures does not exist.

9.3.2 Mineral Resources

There are no impacts anticipated to mineral resources because there are no currently exploitable mineral resources present within the DWP Project area centered around the WC 509 Platform Complex. The WC 509 Platform Complex is not located in an area with significant sediment resources, and there are no proven or unproven oil and gas reserves in the area of the Project.

9.3.3 Construction and Installation

9.3.3.1 *Seafloor Disturbance*

Construction activities related to pipeline construction, anchor placement, and pile driving may have potential environmental consequences for the geologic resources described in the subsections below. Further, the amount of construction disturbance required and potential impacts to geologic resources have been significantly reduced with the planned conversion of the existing Mainline and WC 509 Platform Complex.

Mainline

The Mainline will be converted from natural gas service to oil service and will not impact geologic resources. Sealing of existing side taps and removal of the MLV in WC 277 by divers and re-burial of portions of the Mainline may cause minor, localized impacts to the sandy seafloor. The minor work to seal side taps and remove the MLV at WC 277 will be completed in the existing ROW Grant.

Crude Oil Loading Pipelines

At the DWP Project location, two new Crude Oil Loading Pipelines will need to be installed on the seafloor between the WC 509B Platform and two newly installed PLEMs. Details of the proposed pipeline construction are provided in Section 1.4.3.1, Deepwater Port Components, of Topic Report 1 (Volume IIa). Pipeline installation and lowering would temporarily disturb approximately 467 acres of seafloor. Most of the disturbance would be due to the sweeping of anchor cables across the seafloor surface as the pipe laybarge is winched forward with the anchors in place. Such effects on the seafloor would be minor and short-term as the relatively level seafloor consists of unconsolidated mud and sand. Over time, the ambient currents are expected to return the seafloor to similar bathymetry contours as before installation of the pipelines. Any potentially adverse impacts to the substrate are expected to be short-term and minor.

Pile installation for the PLEMs and CALM Buoys will affect the seafloor. The CALM Buoys will be attached to the seafloor via chains attached to anchor piles. Similarly, the PLEMs will also be fixed to the seafloor with pilings. Combined, the anchor piles for the CALM Buoys and piles of the PLEMs will affect approximately 2.1 acres of seafloor. Impacts from installation of the DWP's PLEMs and CALM Buoys are anticipated to be long-term but minor and negligible.

Vessel Mooring

Three Service Vessel Mooring locations will be constructed and will impact approximately three acres from the 250-foot radius cable sweep of support vessels. Within each of the areas, blocks will be placed on the seafloor for mooring buoys. The mooring blocks will only affect the seafloor where they are placed. The proposed mooring areas are not located in proximity to any sensitive or unique geologic habitat or underlain by a geologic constraint. Impacts from installation of the mooring blocks are anticipated to be long-term, but minor and negligible.

Construction Vessels

Construction vessels will impact the seafloor when anchoring; however, as noted above, the conversion of the existing Mainline will avoid the need for extensive pipe lay barge anchoring. The majority of construction vessel anchoring will occur at the DWP location. When inshore, it is expected that construction vessels will be able to utilize existing port locations, minimizing the need for anchoring. Construction vessels may anchor within two overlapping areas surrounding the WC 509 Platform Complex, the Crude Oil Loading Pipelines, PLEMS, and CALM Buoys. These areas were included in the geophysical and archeological survey conducted for the BMOP Project and encompass approximately 1,748 acres. However, the amount of actual seafloor disturbance within these areas is significantly much less.

Anchor placement and retrieval from the seafloor may result in a temporary disturbance to the seafloor. Impacts of anchor placement will be of relatively shallow penetration and over a minimal spatial area. After anchor retrieval, the ambient currents are expected to return the bathymetry contours of the seafloor to pre-construction conditions. Potentially adverse impacts from construction vessel anchoring are anticipated to be short-term, intermittent, and minor with no long-term or significant impacts expected.

There is no shallow water construction required because the existing Mainline will be converted for the proposed Project. Further, construction vessels will be expected to utilize existing channels and waterways when transiting from shore to the DWP platform location. There should be no propeller wash impacts at any of the construction locations.

9.3.3.2 *Hydrostatic Testing*

Best management practices (BMPs) will be adhered to so that hydrostatic test water discharges do not cause seafloor scouring. Offshore discharges will be made near the water surface from a filtration spread adjacent to the WC 509 Platform Complex, over 160 feet from the seafloor. All water to be discharged will be filtered/treated as required to meet regulatory and/or National Pollutant Discharge Elimination System (NPDES) permit requirements prior to being discharged. Potential impacts on the coastal and marine environment from hydrostatic testing are anticipated to be negligible.

9.3.4 Operations

The existing WC 509 Platform Complex will be converted to support oil export and natural gas transportation. The Project will not require the placement of new platforms in the area. To minimize and avoid potential impacts, the Project will also follow the BMPs in its Port Operations Manual (see Appendix G, Volume III [*Confidential*]).

9.3.4.1 *Seafloor Disturbance*

As noted in Topic Report 3 (Volume IIa), the BMOP Project will convert the existing WC 509 Platform Complex and will not result in any new platform pilings; therefore, operation of the DWP will not result in a change to the ambient conditions found at the platform complex.

During operations, the Crude Oil Loading Pipelines and Mainline will be buried below the seafloor and are not anticipated to affect geologic resources. Any required maintenance activities of the pipelines that requires excavation are anticipated to have similar impacts to those described for pipeline construction. However, the potential area affected would be localized to the place of repair/replacement.

The pilings for the CALM Buoys and PLEMs and the mooring blocks in the Service Vessel Mooring Areas will affect approximately 2.1 acres of seafloor. Although the impact will be negative, it will be minor and reversible upon decommissioning.

During operations the DWP will receive up to 365 very large crude carriers (VLCC) or other crude oil carriers annually. By having an assigned Service Vessel Mooring Areas potential impacts from vessel anchoring will be minimized.

The CALM Buoy anchor chains will be susceptible to movement during operations (waves, currents, vessel attachment and weather vaning), and VLCC movement and could sweep across the seafloor in proximity to the anchor pile. Similar to the CALM Buoy chains, the chain between the mooring blocks and associated mooring buoys in the Service Vessel Mooring Areas may also result in disturbance to the seafloor as the chain will sweep along the bottom in a 360 degree area around the mooring block. The area effected will be limited to the maximum swing of the chain. Adverse impacts from the chain sweeps will be long-term but intermittent, minor, and localized.

9.3.4.2 *Maintenance Activities*

Periodic maintenance of the pipelines, CALM Buoys, and platforms will be required over the life of the Project. These activities could result in disturbance similar to those described for construction with

anchoring vessels. Potential impacts will be short-term, intermittent, and minor. No significant impacts are anticipated as a result of maintenance activities.

9.3.5 Decommissioning

Decommissioning will involve removal of the DWP Platforms as well as the piles to approximately 15 feet below the seabed and abrasive cutters, explosives, or water cutters may be used during the decommissioning. After removal, the jacket will likely be used as an artificial reef as part of the Rigs-to-Reef program which would provide a long-term benefit to fish and other marine life. The offshore pipelines will be abandoned in place, and all other offshore components (i.e., PLEMs, CALM Buoys, moorings) will be removed and transported to shore for reuse or disposal.

Potential impacts to the geologic resources from decommissioning will be similar to those described for construction. Removal of the DWP Platform and anchor piles will temporarily disturb the seafloor. Vessel anchoring to support the decommissioning activities will also result in disturbance to the seafloor. Further, over time, the currents are expected to return the seafloor to similar bathymetry contours as before installation of the Project.

Overall, decommissioning activities will involve localized, short-term, and negligible to minor affects to geologic resources. No significant impacts are anticipated as a result of Project decommissioning.

9.4 CUMULATIVE IMPACTS

A complete discussion of cumulative impacts is included in **Appendix C,** Framework for Cumulative Impacts Analysis – Offshore and Onshore" (Volume IIa).

9.5 SUMMARY OF IMPACTS

The Project is not expected to:

- Violate a federal, state, local, or federally recognized international water quality criterion or waste discharge requirement;
- Cause irreparable harm to human health, aquatic life, beneficial uses of aquatic ecosystems, or geologic resources; and/or
- Increase contaminant levels in the water column, sediment, or biota to levels shown to have the potential to harm organisms, even if the levels do not exceed the formal water quality criteria.

No live-bottom, reefs, or other special marine resources are located near the proposed Project; therefore, no significant impacts to these resources are expected. Converting of the Mainline, WC 509 Platform Complex, and WC 148 Platform will result in a reduction in the amount of potential impacts that will be required during Project construction. Potential impacts to geologic resources from Project construction, operation, and decommissioning of the Project are expected to be negligible to minor with most impacts short-term (**Table 9-2**). None of the potential impacts to geologic resources are expected to be significant or irreversible.

9.6 MITIGATION MEASURES

The DWP does not present any significant impacts to geologic resources, would not be impacted by geologic hazards, and does not impact mineral resources. Further, converting the existing Mainline, the existing WC 509 Platform Complex, and adhering to all regulations and permit requirements will limit potential impacts from construction and operation of the proposed DWP. Therefore, no mitigation measures specifically directed at geologic resources are proposed.

9.7 REFERENCES

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