RE: Coastal Zone Management - ROW Pipeline - Shell Offshore Inc.

M.Boutwell@shell.com <M.Boutwell@shell.com>
Thu 1/12/2023 8:50 AM
To: Mobile Coastal Mail <Coastal@adem.alabama.gov>
Cc: Mickle, Sarila A <sarila.mickle@adem.alabama.gov>;Brown, Scott <jsb@adem.alabama.gov>

Please find attached the second batch of documentation in support of Shell's Rydberg ROW pipeline grant application.

Thank you,

Michael Boutwell | Regulatory Specialist
Shell Exploration & Production | 701 Poydras St. New Orleans LA 70139
M.Boutwell@shell.com | Office: 504-425-6251 | Cell: 713-363-4001

From: Boutwell, Michael SEPCO-UPD/P/SF
Sent: Thursday, January 12, 2023 8:48 AM
To: Mobile Coastal Mail <Coastal@adem.alabama.gov>
Cc: Mickle, Sarila A <sarila.mickle@adem.alabama.gov>; 'Brown, Scott' <jsb@adem.alabama.gov>
Subject: RE: Coastal Zone Management - ROW Pipeline - Shell Offshore Inc.

Good Morning –

Shell Offshore Inc. is respectfully submitting the attached offshore ROW pipeline grant application to the Alabama Department of Environmental Management for coastal zone management consistency review. This ROW pipeline application is in support of our Rydberg drill center in MC 525 & MC 569. A cover letter with additional details has been attached.

Please Note: Due to email size constraints, a second email will be sent with the second batch of documentation for this ROW pipeline.

If you have any questions, please let me know. We appreciate your time reviewing this application.

Thank you,

Michael Boutwell | Regulatory Specialist
Shell Exploration & Production | 701 Poydras St. New Orleans LA 70139
M.Boutwell@shell.com | Office: 504-425-6251 | Cell: 713-363-4001

From: Brown, Scott <jsb@adem.alabama.gov>
Sent: Wednesday, December 14, 2022 9:47 AM
To: Boutwell, Michael SEPCO-UPD/P/SF <M.Boutwell@shell.com>
Cc: Mobile Coastal Mail <Coastal@adem.alabama.gov>; Mickle, Sarila A <sarila.mickle@adem.alabama.gov>
Subject: RE: Coastal Zone Management - ROW Pipeline - Shell Offshore Inc.

Good morning:

Use the *Mobile Coastal Mail* mailbox as the official portal for all coastal review requests. You may always copy me and also copy Sarila Mickle as insurance.

Call or email anytime with questions.

v/r,

J. Scott Brown, Chief
Mobile Field Office| ADEM
3664 Dauphin Street, Suite B | Mobile, Alabama 36608
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eMail: jsb@adem.alabama.gov
www.adem.alabama.gov

From: M.Boutwell@shell.com <M.Boutwell@shell.com>
Sent: Tuesday, December 13, 2022 3:25 PM
To: Brown, Scott <jsb@adem.alabama.gov>
Cc: Mobile Coastal Mail <Coastal@adem.alabama.gov>
Subject: Coastal Zone Management - ROW Pipeline - Shell Offshore Inc.

Good Afternoon –

Shell Offshore Inc. is preparing to submit ROW pipeline permits to the Bureau of Safety and Environmental Enforcement (BSEE) for our upcoming Rydberg development. The route for these ROW pipelines crosses through Alabama CZM blocks (MC 569, MC 525, MC 481, DC 441, DC 397, DC 353 & MC 393). Can you please advise if submittals for Alabama's CZM consistency review are handled through an online portal, or if these should be submitted to a particular email address?

I appreciate any guidance you can provide.

Thank you,

Michael Boutwell
Regulatory Specialist
Shell Exploration & Production Co.
701 Poydras St., New Orleans, LA 70139

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United States Department of the Interior
Bureau of Safety and Environmental Enforcement
Gulf of Mexico OCS Region
Pipelines Section (GE1035A)
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

January 5, 2023

Attn: Angie Gobert, Pipelines Section, Chief

SUBJECT: **APPOMATTOX FPS** MISSISSIPPI CANYON 437
RYDBERG SUBSEA FIELD ROUTE
MISSISSIPPI CANYON BLOCK 393 / LEASE OCS-G 26254
DESOTO CANYON 353 / LEASE OCS-G 25852
DESOTO CANYON 397 / LEASE OCS-G 37243
DESOTO CANYON 441 / LEASE OCS-G 35357
MISSISSIPPI CANYON 481 / UNLEASED
MISSISSIPPI CANYON BLOCK 525 / LEASE OCS-G 31507
MISSISSIPPI CANYON BLOCK 569 / LEASE OCS-G 31513
ROW Pipeline Grant Application

In accordance with 30 CFR 250 Subpart J regulations, Shell Offshore Inc. ("Shell") submits for your review and approval the enclosed ROW pipeline grant application for the installation and operation of a total of two (2) proposed segments: one (1) production flowline and one (1) dynamic umbilical.

Shell Offshore Inc. requests the following alternate compliance from the regulations:

1. Shell hereby requests an alternate compliance from the requirements of 30 CFR 250.1002(a) to use the provisions of API RP 1111 to calculate the internal design pressure of the proposed flowlines as per NTL No. 2009-G28.

Installation activities are estimated to begin between Q3-Q4 2023 with a dynamically positioned light subsea construction vessel without use of anchors.

No.	Proposed Segments	From	To	Pay.gov Tracking ID	Agency Tracking ID
20889	Production Flowline	MC 525 PLEM FLM-8610	MC 393 PLET FLT-8621	2737Q5BV	76344534131
20944	Dynamic Umbilical	MC 437 Appomattox Host	MC 525 & MC 569 Rydberg XT 1 & XT 2	Associated Umbilical	Associated Umbilical

We are submitting an electronic copy via TIMSWeb per 30 CFR 250.186(a)(3).

Should you have any questions or require additional information, please contact Michael Boutwell at m.boutwell@shell.com or Jason Shoemaker at jason.shoemaker@shell.com.

Sincerely,

Brian Rieth

Brian Rieth

Projects & Production Manager – Regulatory Affairs

Shell Offshore Inc.

Gulf of Mexico

Subsea: Rydberg Project

Rydberg Drill Center: Mississippi Canyon (MC) Block 525, 569

Host: Appomattox Host Semi-Submersible, MC Block 437

Route:

Area Block	Lease
MC 393	OCS-G-26254
DC 353	OCS-G-25852
DC 397	OCS-G-37243
DC 441	OCS-G-35357
MC 481	Unleased
MC 525	OCS-G-31507
MC 569	OCS-G-31513

Table of Contents

I. General Description 3
a. Production Flowline System Description 4
b. Dynamic Umbilical 5
II. Cathodic Protection (CP) 6
III. External Coating System 7
IV. Internal Protective Measures 8
V. Specific Gravity of the Empty Pipe 9
VI. Maximum Source Pressures (MSP) and Temperature 10
VII. Maximum Allowable Operating Pressure and Internal Pressure Calculations 11
VIII. Hydrostatic Test Pressure, Medium, and Duration 12
IX. Worst Case Discharge Calculation 13
X. Downstream Facilities and Design Pressure 14
XI. Commencing Installation and Estimated Time for Construction 15
XII. Protections of Subsea Pipeline Crossings, Subsea Valves, Tabs, and Manifold Assemblies 16
XIII. Standards Used 17
XIV. Pipeline and Component Specifications 18
XV. Connectors, Forgings, and Appurtenances 19
XVI. Appendices 20
Appendix I: Overall Field Layout 21
Appendix II: Safety Flow Schematic 22
Appendix III: Internal Design Pressure Calculations and Specific Gravity 23
Appendix IV: Worst Case Discharge Calculations 25
Appendix V: Survey Plats 27
Appendix VI: Archaeological and Hazards Assessment Survey Report 28
Appendix VII: Dynamic Umbilical Details 29
Appendix VIII: Letter of No Objection 31
Appendix IX: Subsea Structure Detailed Documents 32

I. General Description

Shell Offshore Inc. ("Shell") is developing the Rydberg Project as a subsea tie-in from the Rydberg field to the Appomattox host platform in deep water Gulf of Mexico via a flowline to the existing Vicksburg manifold. The Rydberg drill center is located in MC Block 525 and 569 approximately 12 miles from the Vicksburg drill center in MC Block 393, and approximately 10 miles from the Appomattox host platform in MC Block 437. Rydberg will be developed as a two (2) well drill center (with option for one (1) additional well), with a single production flowline tying directly to a nominated slot on the existing Vicksburg manifold, supported by a single dynamic umbilical from Appomattox.
This pipeline permit application is for the installation and operation of a total of five (5) proposed segments: one (1) flowline jumper one, (1) production flowline, two (2) production well jumper, and one (1) dynamic umbilical

The scope of the Rydberg subsea system is visually depicted in Figure 1. Table 1 lists the proposed segments in this right of way pipeline permit application.

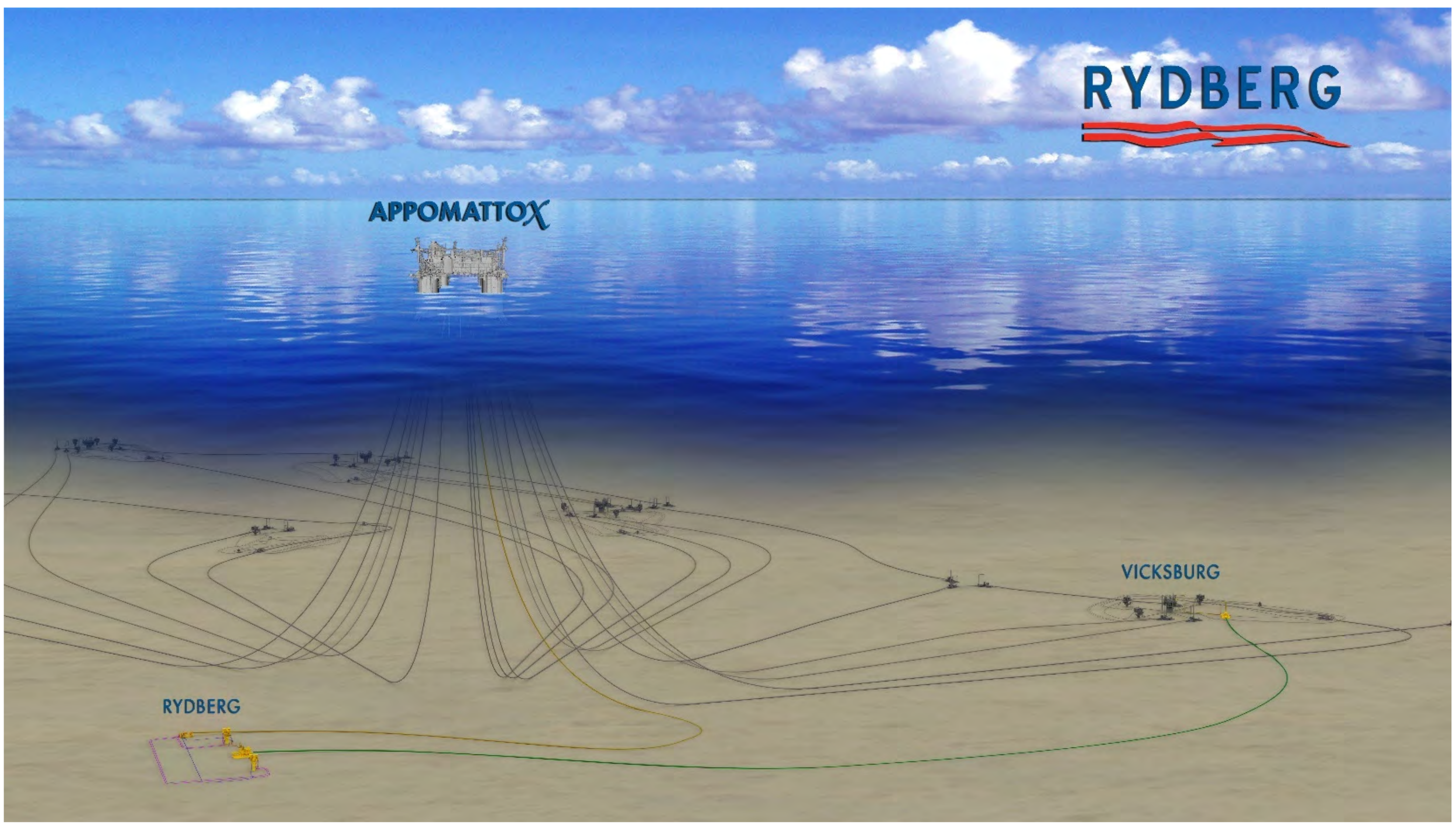


Figure 1: Rydberg Subsea Layout

Table 1: Proposed Rydberg Segments

No	Segment Number	Proposed Segments	BSEE Product Code Requested	From	To
1	20889	Production Flowline	Bulk Oil	Rydberg PLEM (FLM-8610) MC-525	Rydberg PLET (FLT-8621) MC-393
2	20944	Rydberg Dynamic Umbilical	Electrohydraulic Umbilical	Appomattox Host TUPA (SKD-4290) MC-437	QAY-8601 MC-525 QAY-8602 MC-569

a. Production Flowline System Description

The Rydberg production system is designed to transport produced well fluids from the Rydberg 1 and 2 well to the existing Phase 1 drill center and eventually to the Appomattox Host. The Rydberg Drill Center will be developed by two (2) subsea wells, producing through two (2) production well jumpers, one (1) production pipeline end manifold, one (1) production flowline, one (1) production pipeline end termination (PLET), and one (1) flowline jumper. The length of the production flowline is approximately 12 miles long.

The Rydberg production stream is expected to consist of oil, gas and produced water. Details of the transported commodity are described in the table below.

Table 2: Transported Commodity

Target	Rydberg Reservoir
Produced Hydrocarbon	Bulk Oil
API Gravity (degree API @ reservoir conditions)	32.7
Anticipated Max Flow Rate	25 KBLPD

b. Dynamic Umbilical

A dynamic umbilical will be installed from the Appomattox Host to the subsea Umbilical Termination Assembly to supply electrical power, communications, chemicals, and hydraulic power to the Rydberg Drill Center. The umbilical will distribute hydraulic and chemical injection fluids from the host to the Rydberg XT through Steel Flying Leads (SFLs) and power/communication from the host to the XTs through Electrical/Optical Flying Leads (EOFLs).

The dynamic umbilical tubes (16) are super duplex and the tubes, fittings, and connections will be designed for a maximum operating pressure of 15,000 psi. Details of the Dynamic Umbilical cross-section are included in Appendix VII, Dynamic Umbilical.

Table 3: Summary Dynamic Umbilical Information

Data	Value (SI units)
Outside Diameter	202.3 mm
Mass (empty)	54.4 kg/m
Mass (full of water)	61.2 kg/m
Submerged Weight (full & flooded, water)	32.9 kgf/m

II. Cathodic Protection (CP)

In addition to external corrosion coating, cathodic protection of the Rydberg flowlines is planned to meet the design life of 30 years. The Production Flowline will receive CP over its entire length from PLEM to PLET using anodes mounted on subsea structures.

III. External Coating System

Primary protection from external corrosion will be provided by external coatings. See Table 4, below, with flowline's external coating systems.

Table 4: External Coating System

Segment	External Corrosion Coating	Thickness	Other Coating	Thickness
Production Flowline	FBE	0.6 mm	Insulation	63 mm

IV. Internal Protective Measures

Prevention of internal corrosion will be provided by a combination of corrosion inhibition, and corrosion allowance.

- Production Flowline and PLET: Corrosion inhibition, corrosion allowance
- Production PLEM: Internal cladding

V. Specific Gravity of the Empty Pipe

The specific gravity of the empty pipe relative to fresh water for each permitted segment of the production flowline system is shown in Table 5.

Table 5: Specific Gravity of Empty Pipe

No.	Proposed Segment	Specific Gravity of Empty Pipe
1	Production Flowline	1.96

VI. Maximum Source Pressures (MSP) and Temperature

Production System

The production system is designed for a maximum internal pressure of 12,200 psia for a Maximum Source Pressure (MSP) of 12,200 psia, based on the maximum shut-in tubing pressure (SITP) of the Vicksburg wells.

The maximum estimated source temperature is 323°F. The maximum design temperature for the proposed system is 350°F for the jumpers and flowlines.

VII. Maximum Allowable Operating Pressure and Internal Pressure Calculations

The Rydberg production flowlines and jumpers have a design pressure of 12,200 psi.

Shell hereby requests to use API RP 1111 as alternate compliance from the requirements of 30 CFR 250.1002(a) utilizing Item 1 of NTL No. 2009-G28 to calculate the internal design pressure for the flowlines.

The Rydberg production flowline has been designed in accordance with API RP 1111and NTL No. 2009-G28 with a requested MAOP of 12,200 psi. Detailed calculations are included in Appendix III and summarized in Table 6. The calculations show that the flowline design pressures (P_d) per Equation (2) in API RP 1111 is greater than the requested MAOP of 12,200 psi for the Rydberg development.

Table 6: Allowable Design Pressure Determination

Parameter	Production Flowline
D (in)	8.625
t (in)	1.26
Pipe Grade	X65
Pb (psi)	21,770
Pt (psi)	17,634
Pd (psi)	14,107
MAOP (psi)	12,200
P_d > MAOP?	Yes

Per API RP 1111:

(a) D = nominal outside diameter of pipe
(b) t = selected nominal wall thickness of pipe
(c) P_d = maximum design pressure of pipe (internal – external), psi
(d) P_t = maximum hydrostatic test pressure of pipe (internal – external), psi
(e) P_b = specified minimum burst pressure of pipe, psi

VIII. Hydrostatic Test Pressure, Medium, and Duration

The proposed flowline segments will be hydrostatically pressure tested in accordance with 30CFR 250.1002(c)(2) as shown in Table 7 below.

Table 7: Production and Gas Lift Flowlines Offshore Hydrotest Summary

Segment No.	Proposed Segments	Hydrostatic Test Pressure (psi)	Basis of Hydrotest Pressure	Test Medium	Test Duration (hours)
20889	Production Flowline (FAY-631)	15,250	1.25 x MAOP	Water	8

IX. Worst Case Discharge Calculation

The maximum possible discharge of oil into the environment is calculated per 30 CFR 254.47.c1-3 and is considered the sum of the volume of oil discharged before all wells can be shut-in, plus the total volume of oil in the flowline released prior to pressure equalization.

This estimation assumes: a single horizontal pipeline segment and a full pipeline break or rupture. Though this ROW permit is only for the flowline segment of the production system (Appendix IV).
$Vrel$ is the total released volume of oil for the production flowline system, which includes Vicksburg Flowline and Rydberg.

Table 8: Total Released Volume

No.	Proposed Segments	V_{rel}
Vicksburg Flowline (19413)	Production Flowline and Riser (Segment 19413)	684 bbl
Rydberg Flowline	Production Flowline (FAY-8631 Segment 20889)	1006 bbl
Total Production System		1690 bbl

X. Downstream Facilities and Design Pressure

The proposed Rydberg production system will be tied-in to the existing Vicksburg subsea production system, which has an approved MAOP of 12,200 psi.

XI. Commencing Installation and Estimated Time for Construction

Production Flowline

The estimated time for installation of the production flowlines is approximately 2 weeks. The offshore installation window for this work is between Q3 2023 and Q4 2023. The method of installation will be from a reeled pipelay dynamically positioned (DP) vessel without anchors. Prior to installation, Shell will perform a pre-lay survey.

Dynamic Umbilical

The estimated time for installation of the Dynamic Umbilical is approximately 2 weeks. The offshore installation for this work is planned to occur from a dynamically positioned (DP) light construction vessel without anchors between Q3/Q4 2023. Prior to installation, Shell will perform a pre-lay survey.

XII. Protections of Subsea Pipeline Crossings, Subsea Valves, Tabs, and Manifold Assemblies

There are two crossings planned which will have 18in separation:

- Production flowline over existing Shell pipeline (Segment 19418) in block DC 353
- Production flowline over existing Shell umbilical (Segment 18685) in block DC 353

XIII. Standards Used

Standards incorporated in the design of the flowlines and jumpers, as per 30 CFR 250.198, are summarized in Table 9 below.

Table 9: Standards Used

Standard	Standard Title	Component
API RP 14C	Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms	For subsea devices of the subsea infrastructure shown in Appendix II.
API RP 1111	Design, Construction, Operation, and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design) Fifth Edition, September 2015	For design pressure of the proposed segments
API Spec 6A	Specification for Wellhead and Christmas Tree Equipment	For subsea equipment listed in Section XV.
API Spec 17D	Design and Operation of Subsea Production Systems-Subsea Wellhead and Tree Equipment	For subsea equipment listed in Section XV.
API Spec 17E (ISO 13628-5)	Specification for Subsea Umbilicals	For dynamic umbilical

XIV. Pipeline and Component Specifications

Parameter	Production Flowline
Approximate Length	12 mi
Pipe System	Single
Pipe Specification	API 5L SMLS
Pipe Material Grade	X65
Outer Diameter (OD)	8.625 in
Wall Thickness (WT)	1.26 in

XV. Connectors, Forgings, and Appurtenances

The TFMC-provided forgings, valves, connectors, and PLET valves are designed in accordance with API Spec 6A and 17D and will be rated for 15,000 psi.

XVI. Appendices

Appendix I: Overall Field Layout
Appendix II: Safety Flow Schematic
Appendix III: Internal Design Pressure Calculations
Appendix IV: Worst Case Discharge Calculations
Appendix V: Survey Plats
Appendix VI: Archeological and Hazards Assessment Survey Report
Appendix VII: Umbilical Details
Appendix VIII: Letter of No Objection
Appendix IX: Subsea Structure Detailed Document
Appendix X: Buoyancy Details
Appendix XI: Crossing Details

Appendix I: Overall Field Layout

This is provided as a separate file for all the proposed segments.

RYD-500-UA-4180-9990002-000_004_1_p RYD-500-UA-4180-9990001-000_004_1_p RYD-500-UA-4180-9990003-000_004_1_p RYD-500-UA-4180-9990005-000_004_1_p

Appendix II: Safety Flow Schematic

This is provided as a separate file.

SFD - Vicksburg DC - APX-500-PX-2368-5

SFD - Rydberg DC - APX-500-PX-2368-55

Appendix III: Internal Design Pressure Calculations and Specific Gravity

	Production Flowline
D (in)	8.625
t (in)	1.26
Pipe Grade	X65
f(d)	0.9
f(t)	0.9
f(e)	1.0
P_b (psi)	21,770
P_t (psi)	17,634
P_d (psi)	14,107
MAOP (psi)	12,200
P_d > MAOP?	Yes

Minimum Burst Pressure (P_b)

The minimum burst pressure of the pipe is calculated in accordance with Equation (4) from API RP 1111, as follows:

$$P_b = 0.45 \times (S + U) \times \ln\left(\frac{D}{D - 2 \times t}\right)$$

where :

P_b= specified minimum burst pressure of pipe, psi
S = specified minimum yield strength of pipe material = 65,300 psi
U= minimum ultimate tensile strength of pipe material = 77,600 psi

Hydrostatic Test Pressure (P_t)

The hydrostatic test pressure that must not be exceeded for the pipe is calculated in accordance with Equation (1) of API RP 1111, as follows:

$$P_t \le f_d \times f_e \times f_t \times P_b$$

where :
P_t= maximum hydrostatic test pressure of pipe (internal – external), psi
P_b= specified minimum burst pressure of pipe, psi
f_d= design factor = 0.9 for flowlines, 0.75 for risers
f_e= longitudinal joint factor = 1.0 (seamless pipe)
f_t = temperature derating factor => refer to table above

Design Pressure (P_d)

The design pressure that must not be exceeded for the pipe is calculated in accordance with Equation (2) of API RP 1111, as follows:

$P_d \leq 0.8 \times P_t$

where :
P_d= maximum design pressure of pipe (internal – external), psi
P_t= maximum hydrostatic test pressure of pipe (internal – external), psi

In accordance with the requirements of Item 1(a) within NTL No. 2009-G28, the calculations in Appendix III demonstrate that the production flowline and gas lift flowline design pressure (P_d) in Equation (2) in API RP 1111 is greater than the requested MAOP of 12,200 psi for the Rydberg development.

Specific Gravity Inputs

Inputs	Values
	Production
Content Density	42.9 pcf
Steel Density	490 pcf
Steel Young's Modulus	2.90 x 10^7 psi
Steel Shear Modulus	1.17 x 10^7 psi
Sea Water Density	64 pcf
Fresh Water Density	64 pcf
	Production
Outside Diameter	8.625 in
Nominal Wall Thickness	1.26 in
Coating	5LPP Thickness – 63.1 mm

Appendix IV: Worst Case Discharge Calculations

The maximum possible discharge of oil into the environment is calculated per 30 CFR 254.47.c1-3 and is considered the sum of the volume of oil discharged before all wells can be shut-in, plus the total volume of oil in the flowline released prior to pressure equalization.

This estimate assumes: a single horizontal pipeline segment and a full pipeline break or rupture.

Worst case discharge calculation
(c) For a pipeline facility, the size of your worst case discharge scenario is the volume possible from a pipeline break. You must calculate this volume as follows:

(1) Add the pipeline system leak detection time to the shutdown response time

$$t_{ld} = leak\ detection\ time = 90\ sec.$$

$$t_{sd} = shutdown\ response\ time = 75\ sec.$$

$$t_{wcd} = worst\ case\ discharge\ duration = t_{ld} + t_{sd} = 165\ sec.$$

(2) Multiply the time calculated in paragraph (c)(1) of this section by the highest measured oil flow rate over the preceding 12-month period. For new pipelines, you should use the predicted oil flow rate in the calculation.

$$Q_{peak} = peak\ oil\ flow\ rate = 25{,}000\ bopd$$

$$V_d = dicharge\ volume = Q_{peak} \times t_{wcd} = \frac{25{,}000}{86{,}400}\ bbl/s \times 165\ s = 47.74\ bbl$$

(3) Add to the volume calculated in paragraph (c)(2) of this section the total volume of oil that would leak from the pipeline after it is shut in. Calculate this volume by taking into account the effects of hydrostatic pressure, gravity, frictional wall forces, length of pipeline segment, tie-ins with other pipelines, and other factors.

The entire length of the Rydberg segment is considered

$$L = 66{,}000\ ft.$$

The volume contained in the Rydberg segment is

$$V_p = L \times \frac{\pi D^2}{4} = 66{,}000\ ft. \times 12\frac{in}{ft} \times \frac{\pi(6.105)^2}{4} in^2 = 23.2E6\ in^3 = 2392\ bbl$$

The volume contained in the Phase 1 segment, per the Phase 1 RoW permit is:

$$V_{line} = \left(\frac{ID_{line}}{24}\right)^2 \; x \; L_{line} \; x \; \pi$$

Flowline	PROD
L_{fl} (ft)	12,200
V_{fl} (ft^3)	528
Riser	**PROD**
L_{scr1} (ft)	10766
V_{scr1} (ft^3)	510

Release Volume Fraction:

$$\Delta P_{rel} = \frac{P_{pipe}}{P_{ambient}} = 4$$

$$P_{ambient} = 0.446533 * d = 1786 \; psi$$

From Table 1.3 in the Calculation Guide:

At Max Water Depth			
ΔP_{rel}	f_{rel}	G_{max}	f_{GOR}
4	0.47	505 scf/stb	0.85
At Top of Riser			
ΔP_{rel}	f_{rel}	G_{max}	f_{GOR}
4	0.77	505 scf / stb	0.85

Total release of volume (Eq. 1.1):

$$V_{VxB} = \left(0.1787 * \; V_{fl} * f_{GOR} * f_{rel}\right) + \left(0.1787 * \; V_{scr1} * f_{GOR} * f_{rel}\right) + V_{pre-shut} = 684 \; bbl$$

Thus, the worst-case discharge is

$$V_{tot} = V_{Ryd} + V_{VxB} = 1006 \; bbl + 684 \; bbl = \mathbf{1690 \; bbl}$$

Appendix V: Survey Plats

This is provided as a separate file for all the proposed segments.

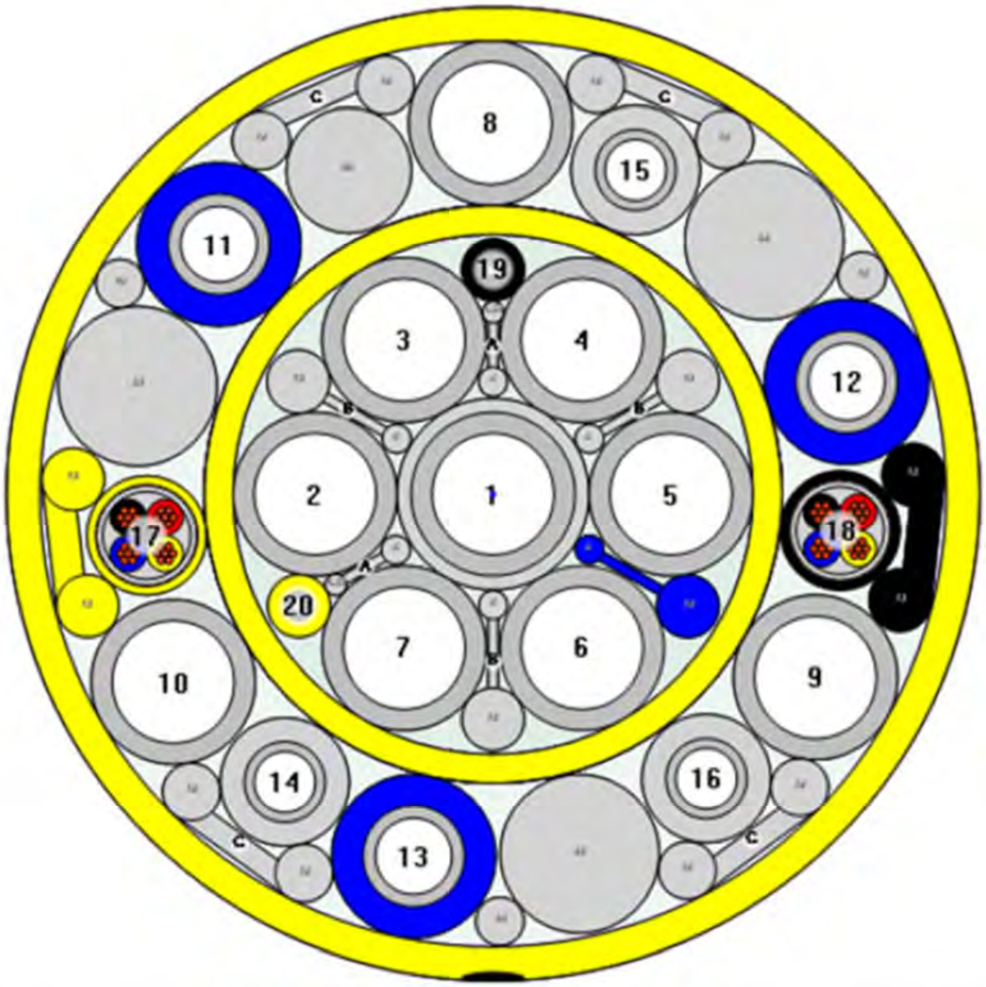
220210-OII-DRW-PRM-002-00-R0.pdf   220210-OII-DRW-PRM-001-00-R0.pdf

Appendix VI: Archaeological and Hazards Assessment Survey Report

This is provided as a separate file for all the proposed segments.

220210-OII-RPT-AA
G-01_R0.pdf

Appendix VII: Dynamic Umbilical Details



Item no.	Component Type	Quantity	ID (mm) [in]	WT (mm) [in]	Description
1-10	Tube Type 1	10	25.40 [1]	4.34 [0.171]	SDSS
11-13	Tube Type 2	3	15.88 [0.63]	2.60 [0.102]	SDSS
14-16	Tube Type 3	3	12.70 [0.50]	2.08 [0.082]	SDSS
17-18	LV Cable	2	-	-	16mm^2 TQBrd
19-20	FO Cable	2	-	-	12 SM, Armoured
-	10mm Solid Round (Natural)	3	-	-	Polymer
-	26mm Solid Round (Natural)	1	-	-	Polymer
-	33mm Solid Round (Natural)	3	-	-	Polymer
-	Shaped – A (Natural)	2	-	-	Polymer
-	Shaped – B (Natural)	3	-	-	Polymer
-	Shaped – C (Natural)	4	-	-	Polymer
-	Shaped (Blue)	1	-	-	Polymer
-	Shaped (Yellow)	1	-	-	Polymer
-	Shaped (Black)	1	-	-	Polymer

Parameter and UOM	Value
Outer Diameter (mm) [in]	202.3 [7.96]
Mass in Air Lines Empty (kg/m) [lb/ft]	54.4 [36.58]
Mass in Air Lines Full with Fluid, Interstices Empty (kg/m) [lb/ft]	61.2 [41.14]
Mass Filled with Fluid and Flooded with Sea Water (kg/m) [lb/ft]	65.8 [44.22]
Submerged Weight Filled with Fluid (kgf/m) [lbf/ft]	28.3 [19]
Submerged Weight Filled with Fluid and Flooded with Sea Water (kgf/m) [lbf/ft]	32.9 [22.08]
Specific Weight Ratio	2.0
Submerged Weight to Diameter Ratio	162.5
Max. Allowable Axial Compression (kN)	5

Appendix VIII: Letter of No Objection

Transmittal Letter
to CNOOC - Rydberg

Appendix IX: Subsea Structure Detailed Documents

The Rydberg production flowline terminates to a PLEM/PLET on either side.

For these structures, PE Stamped Geotechnical analysis, structural analysis and GA Drawings will be submitted.

Appendix X: Buoyancy Details

Buoyancy modules will be used at 15 locations along the flowline route. A total of 16 buoyancy modules will be installed at each location called out on the overall field layout. The modules will be installed on the reel lay installation vessel using 2 straps to clamp 2 half shells together. See below for Buoyancy Module GA.

RYD-500-UA-4018-9
990052-001_001_2_p

Appendix XI: Crossing Details

Appendix XI Crossing 2.pdf

Appendix XI Crossing 1.pdf

Rydberg Project

	TechnipFMC	Shell
Document Title:	Rydberg - Overall Field Layout - Flowline & Umbilical	
Document No.:	SHSHRYD-200-DW-5516-1000	RYD-500-UA-4180-9990001-000
Document Status:	Issued for Review	
Revision:	E	004
Revision Date:	14-September-2022	
Vendor Doc Code:		
ECCN:		EAR99

Purchase Order No.:	4513866004
Purchase Order Title:	
Equip/Tag No(s):	GAY-8610, FAY-8631, FLT-8621, UMB-8600

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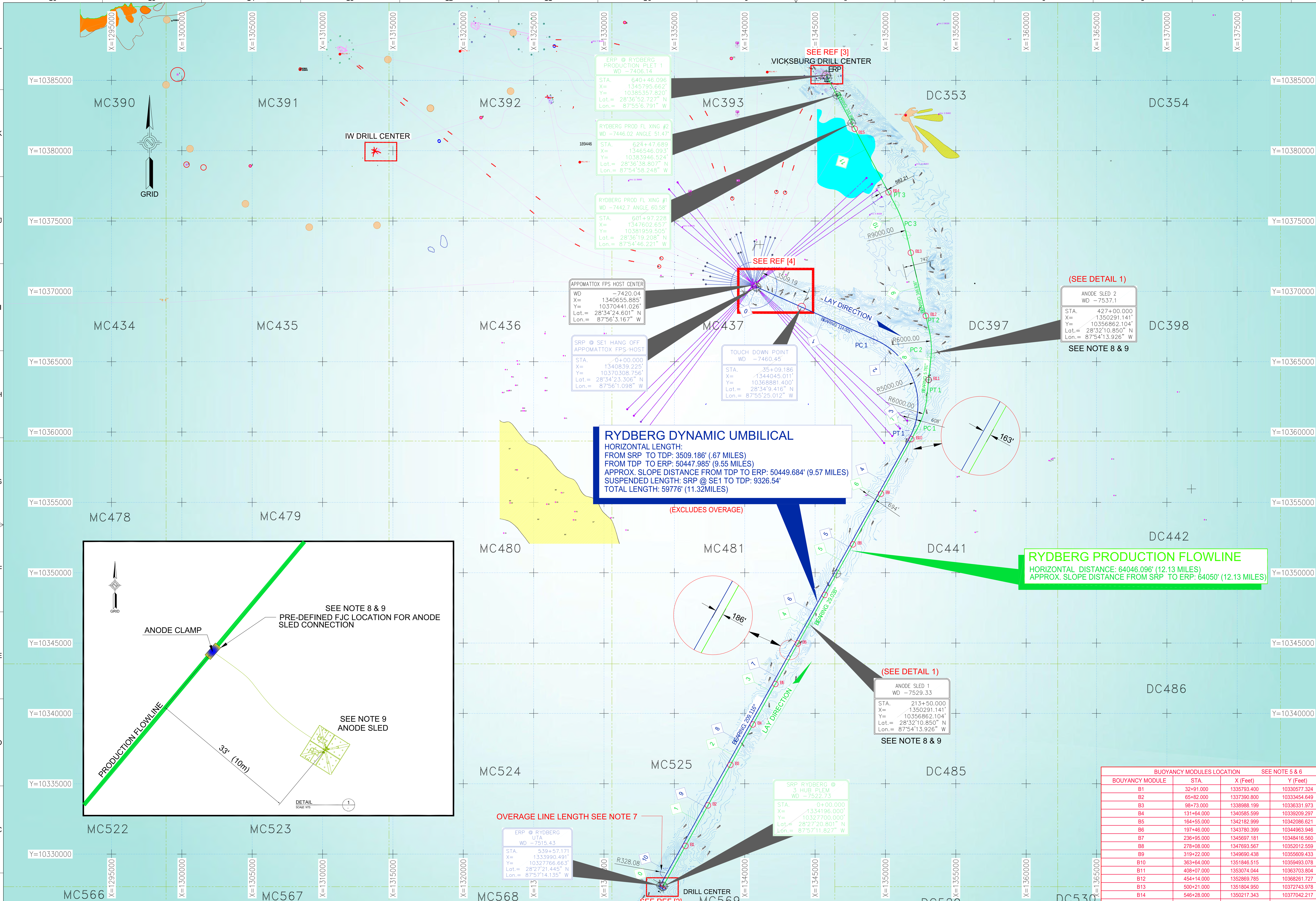

VICINITY MAP

DYNAMIC UMBILICAL					
POINT	STA.	X (Feet)	Y (Feet)	BEARING	RADIUS
SRP	0+00.000	1340839.230	10370308.760		
TDP	35+09.186	1344045.011	10368881.400		
PC1	93+08.205	1349342.645	10366522.652	114.001°	
PI1		1354337.502	10364298.714		5000.000
PT1	176+08.589	1351677.071	10359522.041	209.116°	
ERP	539+57.171	1333990.490	10327766.660		

RYDBERG PRODUCTION FLOWLINE					
POINT	STA.	X (Feet)	Y (Feet)	BEARING	RADIUS
SRP	0+00.000	1334196.000	10327700.000		
PC1	371+48.155	1352227.132	10360178.665	29.038°	
PI1		1352826.439	10361258.171		6000.000
PT1	395+83.571	1352950.810	10362486.598	5.781°	
PC2	424+01.443	1353234.651	10365290.138	5.781°	
PI2		1353336.574	10366296.853		6000.000
PT2	444+06.302	1353102.699	10367281.316	346.636°	
PC3	513+03.633	1351508.490	10373991.881	346.636°	
PI3		1351241.323	10375116.479		9000.000
PT3	536+02.842	1350698.642	10376137.065	331.999°	
XING 1	601+97.228	1347602.657	10381959.505		
XING 2	624+47.689	1346546.093	10383946.524		
ERP	640+46.096	1345795.660	10385357.820		

LEGEND

POINTS

PC POINT OF CURVATURE
PT POINT OF TANGENCY
CP CENTER POINT
PI POINT OF INTERSECTION
SRP START REFERENCE POINT
ERP END REFERENCE POINT

R = RADIUS
T = TANGENT LENGTH
△ = DELTA
L = LENGTH
MILE POST

PRODUCTION FLOWLINE
DYNAMIC UMBILICAL
DYNAMIC UMBILICAL WITH OVERAGE
FLEXIBLE JUMPER
RIGID JUMPER
EXISTING LINES
EXISTING FLYING LEADS
CONTOURS 2ft INTERVALS
EFL / OFL / ASD
PROPOSED SFL
MOORING
LEASE BLOCK
COORDINATE POINT
BUOYANCY MODULES
HAZARDS:
SONAR CONTACT
TRANSPONDER FRAMES
DEBRIS
BURIED MASS TRANSPORT DEPOSIT (~75' DEEP)
DISTURBED SEAFLOOR
SLOPE INSTABILITY ZONE
SEAFLOOD MTD 2-FILL
SEAFLOOR DISTURBANCE
SEAFLOOR DRILLING SPLAY
MASS TRANSPORT DEPOSIT

HORIZONTAL SCALE
1=3200
0 1600 3200 6400

BUOYANCY MODULES LOCATION SEE NOTE 5 & 6			
BOUYANCY MODULE	STA.	X (Feet)	Y (Feet)
B1	32+91.000	1335793.400	10330577.324
B2	65+82.000	1337390.800	10333454.649
B3	98+73.000	1338988.199	10336331.973
B4	131+64.000	1340585.599	10339209.297
B5	164+55.000	1342182.999	10342086.621
B6	197+46.000	1343780.399	10344963.946
B7	236+95.000	1345697.181	10348416.560
B8	278+08.000	1347693.567	10352012.559
B9	319+22.000	1349690.438	10355609.433
B10	363+64.000	1351846.515	10359493.078
B11	408+07.000	1353074.044	10363703.804
B12	454+14.000	1352869.785	10368261.727
B13	500+21.000	1351804.950	10372743.978
B14	546+28.000	1350217.343	10377042.217
B15	597+28.000	1347822.954	10381545.205

GEODETIC INFORMATION

PROJECTION:	UTM	DATUM:	NAD 27
ELLIPSOID:	CLARKE 1866	CENTRAL MERIDIAN:	90°W - 84°W
ZONE:	16N	GRID UNITS:	US SURVEY FEET

References:

DRAWING NUMBER	CLIENT DRAWING NUMBER	DRAWING TITLE
[1] SHSHRYD-200-DW-5516-1000	RYD-500-UA-4180-9990001-000	OVERALL FIELD LAYOUT - FLOWLINE & UMBILICAL
[2] SHSHRYD-200-DW-5516-1001	RYD-500-UA-4180-9990002-000	RYDBERG DRILL CENTER
[3] SHSHRYD-200-DW-5516-1002	RYD-500-UA-4180-9990003-000	VICKSBURG DRILL CENTER
[4] SHSHRYD-200-DW-5516-1004	RYD-500-UA-4180-9990005-000	DYNAMIC UMBILICAL APPROACH AT HOST PLATFORM
[5] SHSHRYD-200-DW-5516-1010	RYD-500-UA-4180-9990006-000	FLOWLINE ALIGNMENT SHEET 1 OF 3
[6] SHSHRYD-200-DW-5516-1011	RYD-500-UA-4180-9990006-001	FLOWLINE ALIGNMENT SHEET 2 OF 3
[7] SHSHRYD-200-DW-5516-1012	RYD-500-UA-4180-9990006-002	FLOWLINE ALIGNMENT SHEET 3 OF 3
[8] SHSHRYD-200-DW-5616-2010	RYD-500-UA-4180-9990007-000	UMBILICAL ALIGNMENT SHEET 1 OF 3
[9] SHSHRYD-200-DW-5616-2011	RYD-500-UA-4180-9990007-001	UMBILICAL ALIGNMENT SHEET 2 OF 3
[10] SHSHRYD-200-DW-5616-2012	RYD-500-UA-4180-9990007-002	UMBILICAL ALIGNMENT SHEET 3 OF 3
[11] SHSHRYD-200-DW-5518-1100	RYD-500-UA-4180-9990004-000	RYDBERG PRODUCTION FLOWLINE CROSSING #1
[12] SHSHRYD-200-DW-5518-1101	RYD-500-UA-4180-9990012-000	RYDBERG PRODUCTION FLOWLINE CROSSING #2

CLIENT DRAWING NUMBER

[7] APX-500-UA-4182-2501000-001-RYD_7C2 — SUBSEA LAYOUT REFERENCE CASE

Notes:

1. ALL DIMENSIONS ARE IN FEET UNLESS NOTED OTHERWISE.
2. ALL BEARINGS SHOWN RELATIVE TO UTM GRID NORTH ANGULAR CONVERGENCE IN THE ASSUMED DIRECTION OF INSTALLATION.
3. BACKGROUND ON PLAN VIEW FOR PICTORIAL PURPOSE ONLY.
4. ALL ROUTE LENGTHS SHOWN ARE 2D LENGTH AND EXCLUDE ANY OVERAGE LOOPS.
5. THE BM LOCATION COORDINATES ARE SPECIFIED AT THE CENTER OF THE BM SECTION.
6. THE RIGID FLOWLINE INCLUDES FIFTEEN (15) BUOYANCY MODULE SECTIONS EACH APPROX 208 FT [63.3M] LONG. FOR MORE DETAILS ON BM SECTION LOCATION REFER TO TABLE 1
7. UMBILICAL LINE WITH OVERAGE:
   - SUSPENDED LENGTH: SRP @ SE1 TO TDP: 9326.54'
   - HORIZONTAL LENGTH TDP TO ERP: 50447.985'
   - APPROXIMATE SLOPE LENGTH ON SEABED WITH OVERAGE LOOP FROM TDP TO ERP: 50886.6'
   - TOTAL LENGTH SUSPENDED LENGTH 9326.54' + APPROXIMATE SLOPE LENGTH ON SEABED WITH OVERAGE LOOP 50886.6' = 60211.17'
8. APPROXIMATE 3D FLOWLINE LENGTH LOCATIONS OF ANODE SLED 1 AND 2 ARE 21351' AND 42702' RESPECTIVELY FROM THE RYDBERG PLEM.
9. FINAL ANODE SLED LOCATION TO BE DEFINED AFTER FLOWLINE LAYDOWN BASED ON AS-BUILT LOCATION OF PRE-DEFINED FJC FOR ANODE CLAMP CONNECTION. SLED TO BE LANDED APPROXIMATELY 10m AWAY FROM FLOWLINE PIPE.

Rev.	Rev. Cl.	Date (dd-mm-yy)	Description	Drawn By	Checked By	Engineered By	Approved By	Client Approval
E	004	12-SEP-2022	ISSUED FOR REVIEW	JBB	RV	VPA	DW	
D	003	02-JUN-22	ISSUED FOR REVIEW	GFC	RV	VPA	DW	
C	002	13-MAY-22	ISSUED FOR REVIEW	GFC	RV	SP	DW	
B	001	05-APR-22	ISSUED FOR REVIEW	GFC	RV	SP	DW	
A		30-MAR-20	ISSUED FOR INTERNAL REVIEW	GFC	RV	SP	DW	

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SHELL RYDBERG

OVERALL FIELD LAYOUT
FLOWLINE & UMBILICAL

Scale: 1=3200 | Sheets: 01 / 01 | Format: D

Client Doc. Ref.: RYD-500-UA-4180-9990001-000 — Revision Cl.: 004

TechnipFMC Doc. Ref.: SHSHRYD-200-DW-5516-1000 — Revision: E

Rydberg Project

	TechnipFMC	Shell
Document Title:	Rydberg - Detail Layout - Rydberg Drill Center	
Document No.:	SHSHRYD-200-DW-5516-1002	RYD-500-UA-4180-9990003-000
Document Status:	Issued for Review	
Revision:	E	004
Revision Date:	14-September-2022	
Vendor Doc Code:		
ECCN:		EAR99

Purchase Order No.:	4513866004
Purchase Order Title:	
Equip/Tag No(s):	GAY-8610, FAY-8631, UMB-8600

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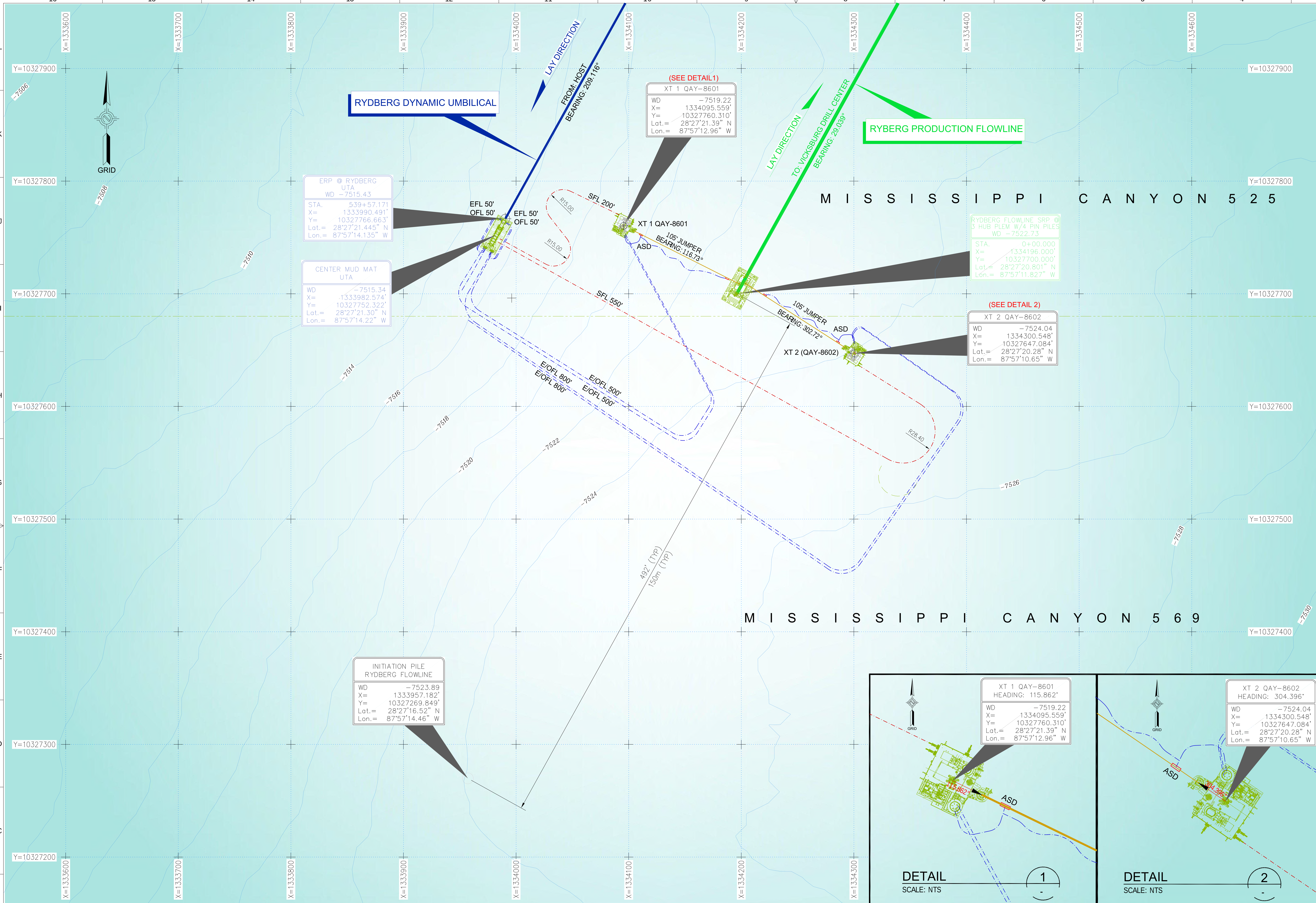

VICINITY MAP

LEGEND

POINTS

- PC POINT OF CURVATURE
- PT POINT OF TANGENCY
- CP CENTER POINT
- PI POINT OF INTERSECTION
- R = RADIUS
- T = TANGENT LENGTH
- △ = DELTA
- L = LENGTH
- SRP START REFERENCE POINT
- ERP END REFERENCE POINT
- MILE POST

- PROPOSED PRODUCTION FLOWLINE
- PROPOSED DYNAMIC UMBILICAL
- FLEXIBLE JUMPER
- RIGID JUMPER
- EXISTING LINES
- EXISTING FLYING LEADS
- CONTOURS 2ft INTERVALS
- PROPOSED EFL / OFL / ASD
- PROPOSED SFL
- MOORING
- LEASE BLOCK
- COORDINATE POINT

HAZARDS:

- SONAR CONTACT
- TRANSPONDER FRAMES
- DEBRIS
- BURIED MASS TRANSPORT DEPOSIT (~75' DEEP)
- DISTURBED SEAFLOOR
- SLOPE INSTABILITY ZONE
- SEAFLOOD MTD 2-FILL
- SEAFLOOR DISTURBANCE
- SEAFLOOR DRILLING SPLAY
- MASS TRANSPORT DEPOSIT

HORIZONTAL SCALE
1=40
0 20 40 80

GEODETIC INFORMATION

PROJECTION:	UTM	DATUM:	NAD 27
ELLIPSOID:	CLARKE 1866	CENTRAL MERIDIAN:	90°W - 84°W
ZONE:	16N	GRID UNITS:	US SURVEY FEET

References:

DRAWING NUMBER	DRAWING NUMBER	DRAWING TITLE
[1] SHSHRYD-200-DW-5516-1000	RYD-500-UA-4180-9990001-000	OVERALL FIELD LAYOUT - FLOWLINE & UMBILICAL

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C	002	10-MAY2022	ISSUED FOR REVIEW	GFC	RV	SP	DW	
B	001	05-APR-2022	ISSUED FOR REVIEW	GFC	RV	SP	DW	
A		30-MAR-2022	ISSUED FOR INTERNAL REVIEW	GFC	RV	SP	DW	

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SHELL RYDBERG

RYDBERG DRILL CENTER

Scale: 1=40 | Sheets: 01 / 01 | Format: D

Client Doc. Ref.: RYD-500-UA-4180-9990003-000 | Revision Cl.: 004

TechnipFMC Doc. Ref.: SHSHRYD-200-DW-5516-1002 | Revision: E

	Rydberg Project

	TechnipFMC	Shell
Document Title:	**Rydberg - Detail Layout - Dynamic Umbilical Approach at Host Platform**	
Document No.:	**SHSHRYD-200-DW-5516-1004**	**RYD-500-UA-4180-9990005-000**
Document Status:	**Issued for Review**	
Revision:	**E**	**004**
Revision Date:	**14-September-2022**	
Vendor Doc Code:		
ECCN:		**EAR99**

Purchase Order No.:	**4513866004**
Purchase Order Title:	
Equip/Tag No(s):	**UMB-8600**
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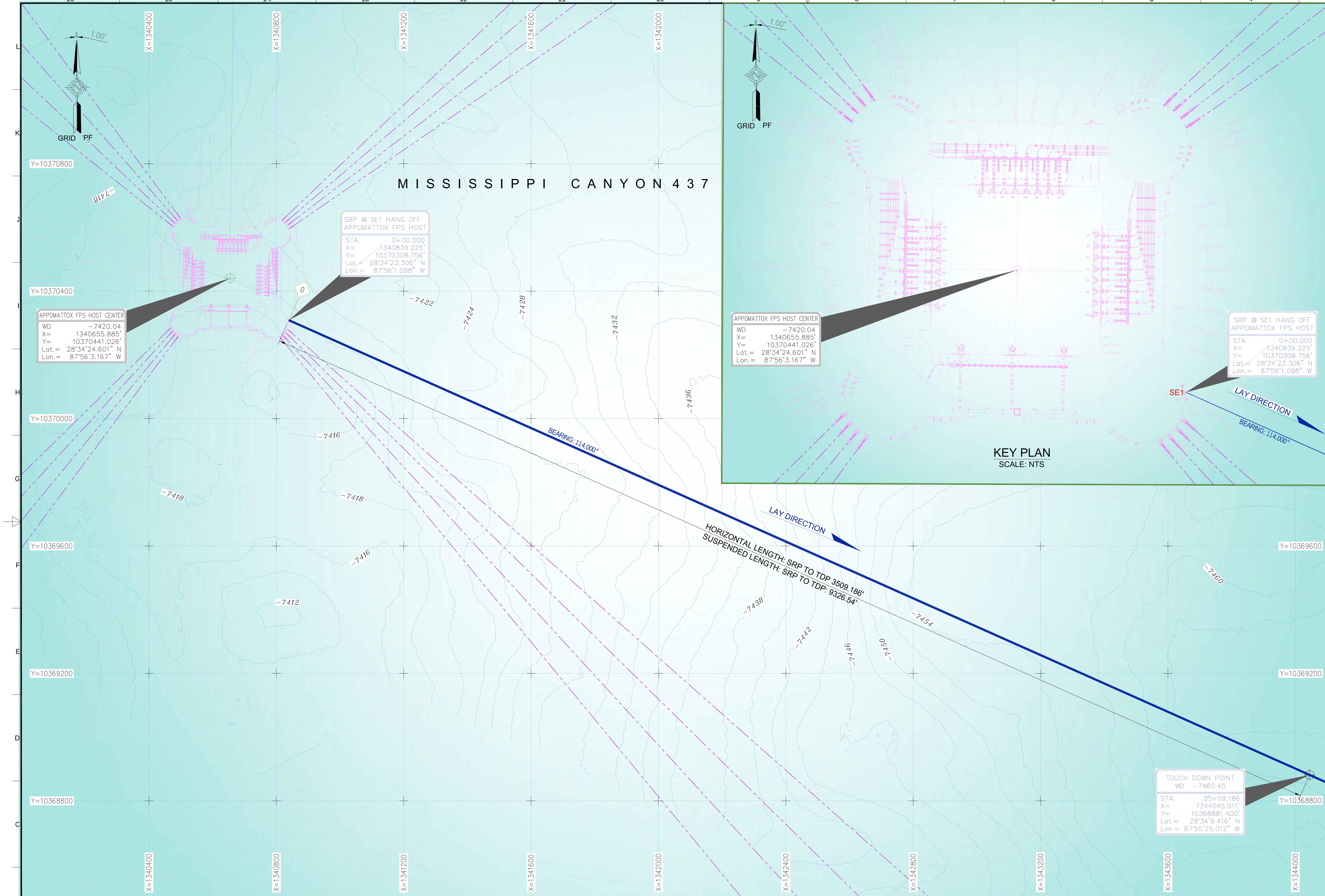

VICINITY MAP

LEGEND

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PT POINT OF TANGENCY
CP CENTER POINT
PI POINT OF INTERSECTION
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T = TANGENT LENGTH
△ = DELTA
L = LENGTH
SRP START REFERENCE POINT
ERP END REFERENCE POINT
1 MILE POST

PROPOSED PRODUCTION FLOWLINE
PROPOSED DYNAMIC UMBILICAL
FLEXIBLE JUMPER
RIGID JUMPER
EXISTING LINES
EXISTING FLYING LEADS
CONTOURS 2ft INTERVALS
PROPOSED EFL / OFL / ASD
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MOORING
LEASE BLOCK
COORDINATE POINT

HAZARDS:

SONAR CONTACT
TRANSPONDER FRAMES
DEBRIS
BURIED MASS TRANSPORT DEPOSIT (~75' DEEP)
DISTURBED SEAFLOOR
SLOPE INSTABILITY ZONE
SEAFLOOD MTD 2-FILL
SEAFLOOR DISTURBANCE
SEAFLOOR DRILLING SPLAY
MASS TRANSPORT DEPOSIT

HORIZONTAL SCALE
1=140
0 70 140 280

GEODETIC INFORMATION

PROJECTION: UTM	DATUM: NAD 27
ELLIPSOID: CLARKE 1866	CENTRAL MERIDIAN: 90°W - 84°W
ZONE: 16N	GRID UNITS: US SURVEY FEET

References:

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C	002	10-MAY-2022	ISSUED FOR REVIEW	GFC	RV	SP	DW	
B	001	05-APR-2022	ISSUED FOR REVIEW	GFC	RV	SP	DW	
A		30-MAR-2022	ISSUED FOR INTERNAL REVIEW	GFC	RV	SP	DW	

TechnipFMC

SHELL RYDBERG

DYNAMIC UMBILICAL APPROACH AT APPOMATTOX FPS HOST PLATFORM

Scale: 1=140 | Sheets: 01 / 01 | Format: D

Client Doc. Ref.: RYD-500-UA-4180-9990005-000 — Revision Cl.: 004

TechnipFMC Doc. Ref.: SHSHRYD-200-DW-5516-1004 — Revision: E

QAY-8601/8602

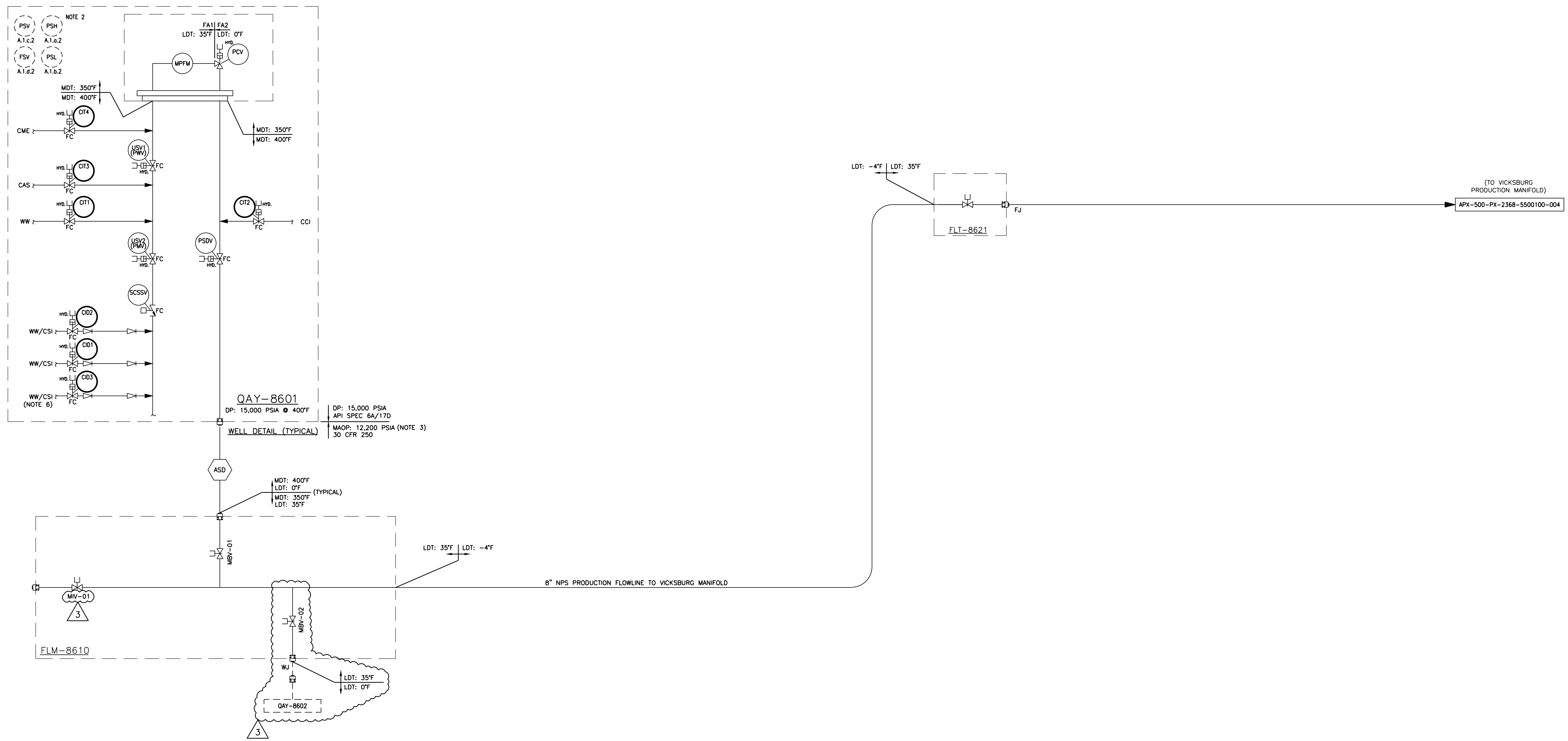
PRODUCTION TREE (TYPICAL)
DESIGN PRESSURE: 15,000 PSIA AT 400°F (NOTE 4)
LDT UPSTREAM OF CHOKE: 35°F
LDT DOWNSTREAM OF CHOKE: 0°F
MATERIAL CLASS: HH (PRODUCTION)
MATERIAL CLASS: EE (ANNULUS)

FLM-8610

PRODUCTION PLEM
DESIGN PRESSURE: 12,200 PSIA AT 350°F (NOTES 3 & 5)
LOWER DESIGN TEMP (LDT): 35°F
MATERIAL: HH, SOUR SERVICE

FLT-8621

PRODUCTION PLET
DESIGN PRESSURE: 12,200 PSIA AT 350°F (NOTES 3 & 5)
LOWER DESIGN TEMP (LDT): 35°F
MATERIAL: CARBON STEEL, SOUR SERVICE



NOTES:

1. FOR SYMBOLS AND ABBREVIATIONS SEE APPOMATTOX LEGEND SHEETS DRAWING SERIES APX-300-PX-2365-011.
2. PSV, FSV, PSH, PSL ARE SAC'D OUT FOR A FA1 PER API RP 14C.
3. THE MAOP OF THE PIPING SYSTEM IS 12,200 PSIA (REFERENCED AT SURFACE, 100 FEET ABOVE MSL). THE SITP OF THE RYDBERG WELLS WILL NOT EXCEED 12,200 PSIA.
4. THE TREE IS RATED FOR 400°F, BUT THE FLOW MODULE IS RATED FOR 350°F.
5. ALL VALVES AND MACHINED COMPONENTS ARE DESIGNED TO 15,000 PSIA.
6. "WW/CSI" REPRESENTS "WASH WATER WITH CHEMICAL SCALE INHIBITOR."

REV	DATE	DESCRIPTION	DRAWN	CHK or TECH REP	DES ENG.	PROJ ENG.
003	2022-09-07	APPROVED	MGS	JD	JD	SJ
002	2022-08-18	ISSUED FOR APPROVAL	MGS	JD	JD	SJ
001	2022-07-26	ISSUED FOR REVIEW	MGS	JD		

SIEP Projects & Technology Upstream Major Projects - Americas

SAFETY FLOW DIAGRAM (SFD)
APPOMATTOX WELLS AND MANIFOLD
RYDBERG
APPOMATTOX FPS
MISSISSIPPI CANYON BLOCKS 437

DRG No. APX-500-PX-2368-5500100-006 REV. 003

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Appendix IV: Worst Case Discharge Calculations

The maximum possible discharge of oil into the environment is calculated per 30 CFR 254.47.c1-3 and is considered the sum of the volume of oil discharged before all wells can be shut-in, plus the total volume of oil in the flowline released prior to pressure equalization.

This estimate assumes: a single horizontal pipeline segment and a full pipeline break or rupture.

Worst case discharge calculation
(c) For a pipeline facility, the size of your worst case discharge scenario is the volume possible from a pipeline break. You must calculate this volume as follows:

(1) Add the pipeline system leak detection time to the shutdown response time

$$t_{ld} = leak\ detection\ time = 90\ sec.$$

$$t_{sd} = shutdown\ response\ time = 75\ sec.$$

$$t_{wcd} = worst\ case\ discharge\ duration = t_{ld} + t_{sd} = 165\ sec.$$

(2) Multiply the time calculated in paragraph (c)(1) of this section by the highest measured oil flow rate over the preceding 12-month period. For new pipelines, you should use the predicted oil flow rate in the calculation.

$$Q_{peak} = peak\ oil\ flow\ rate = 25{,}000\ bopd$$

$$V_d = dicharge\ volume = Q_{peak} \times t_{wcd} = \frac{25{,}000}{86{,}400}\ bbl/s \times 165\ s = 47.74\ bbl$$

(3) Add to the volume calculated in paragraph (c)(2) of this section the total volume of oil that would leak from the pipeline after it is shut in. Calculate this volume by taking into account the effects of hydrostatic pressure, gravity, frictional wall forces, length of pipeline segment, tie-ins with other pipelines, and other factors.

The entire length of the Rydberg segment is considered

$$L = 66{,}000\ ft.$$

The volume contained in the Rydberg segment is

$$V_p = L \times \frac{\pi D^2}{4} = 66{,}000\ ft. \times 12 \frac{in}{ft} \times \frac{\pi (6.105)^2}{4} in^2 = 23.2E6\ in^3 = 2392\ bbl$$

The volume contained in the Phase 1 segment, per the Phase 1 RoW permit is:

$$V_{line} = \left(\frac{ID_{line}}{24}\right)^2 \; x \; L_{line} \; x \; \pi$$

Flowline	**PROD**
L_{fl} (ft)	12,200
V_{fl} (ft^3)	528
Riser	**PROD**
L_{scr1} (ft)	10766
V_{scr1} (ft^3)	510

Release Volume Fraction:

$$\Delta P_{rel} = \frac{P_{pipe}}{P_{ambient}} = 4$$

$$P_{ambient} = 0.446533 * d = 1786 \; psi$$

From Table 1.3 in the Calculation Guide:

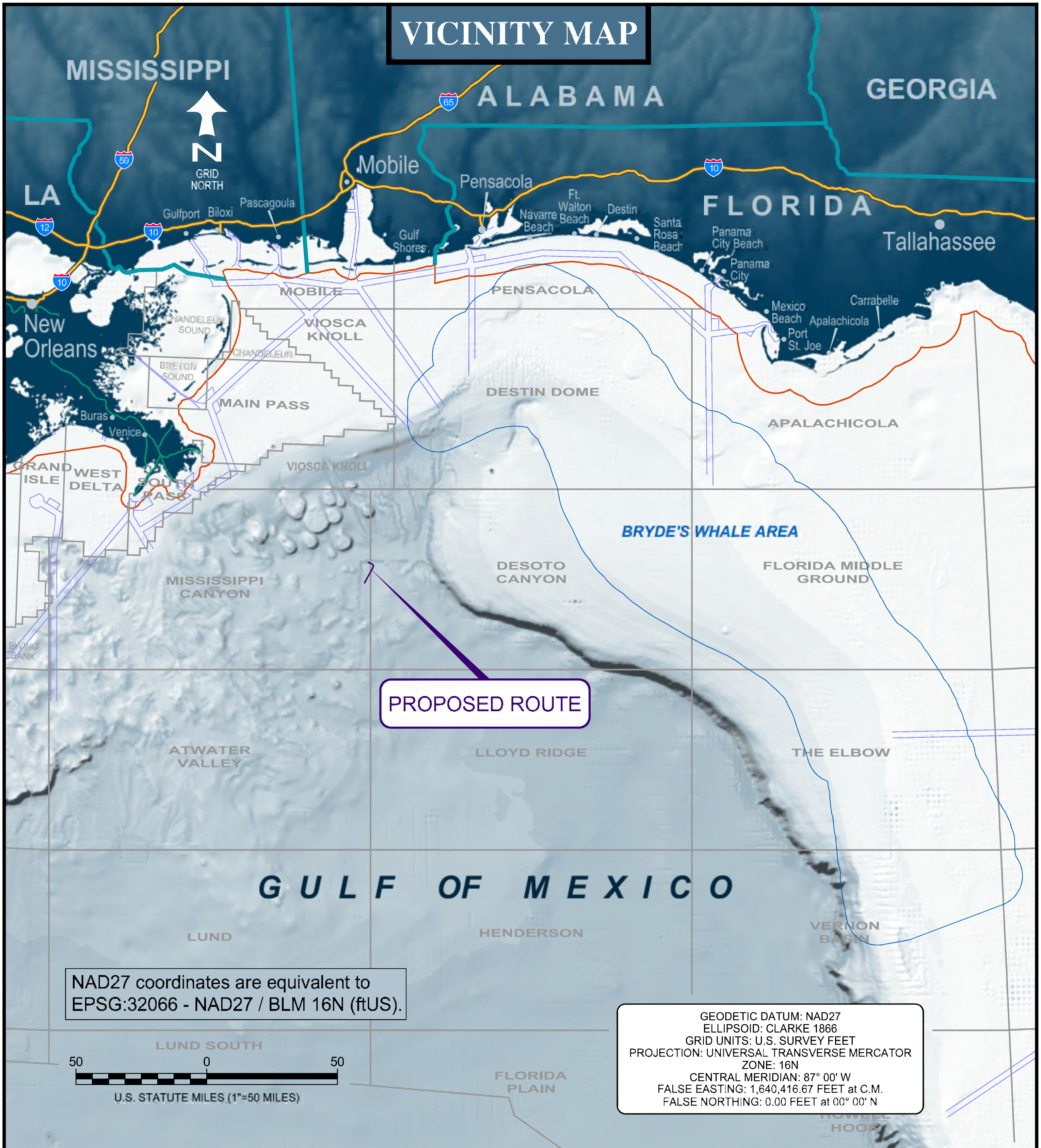
At Max Water Depth			
ΔP_{rel}	f_{rel}	G_{max}	f_{GOR}
4	0.47	505 scf/stb	0.85
At Top of Riser			
ΔP_{rel}	f_{rel}	G_{max}	f_{GOR}
4	0.77	505 scf / stb	0.85

Total release of volume (Eq. 1.1):

$$V_{VxB} = \left(0.1787 * \; V_{fl} * f_{GOR} * f_{rel}\right) + \left(0.1787 * \; V_{scr1} * f_{GOR} * f_{rel}\right) + V_{pre-shut} = 684 \; bbl$$

Thus, the worst-case discharge is

$$V_{tot} = V_{Ryd} + V_{VxB} = 1006 \; bbl + 684 \; bbl = \mathbf{1690 \; bbl}$$



Shell

PROPOSED 8.5" RYDBERG DYNAMIC UMBILICAL ROUTE

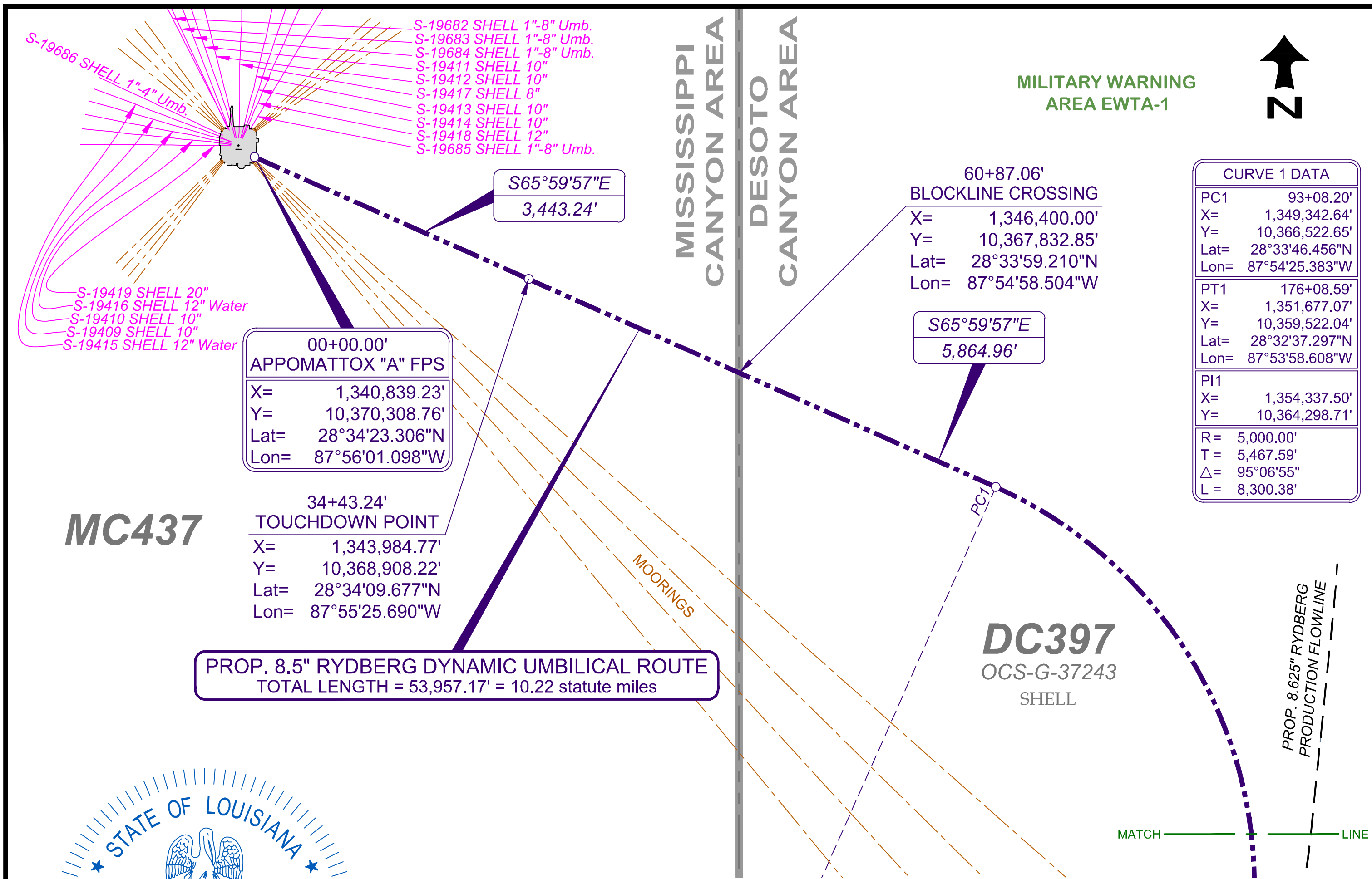
Block 437 Appomattox "A" FPS to Block 525 UTA
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022	
CKD: J. Guidry	APP: R. Frost	SHEET 1 of 6	REV. 0
DOC: 220210-OII-DRW-PRM-002-01			

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:16 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-002.DWG



STATE OF LOUISIANA
ROBERT M. FROST
License No. 4573
PROFESSIONAL LAND SURVEYOR

THE PROPOSED ROUTE IS ACCURATELY REPRESENTED.

ROBERT M. FROST
PROFESSIONAL LAND SURVEYOR
LOUISIANA REGISTRATION No. 4573

Digitally signed by: Robert M. Frost, PLS
Date: 2022.09.27 13:03:39 -05'00'

FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

PLAN

0 2,000
SCALE IN US SURVEY FEET

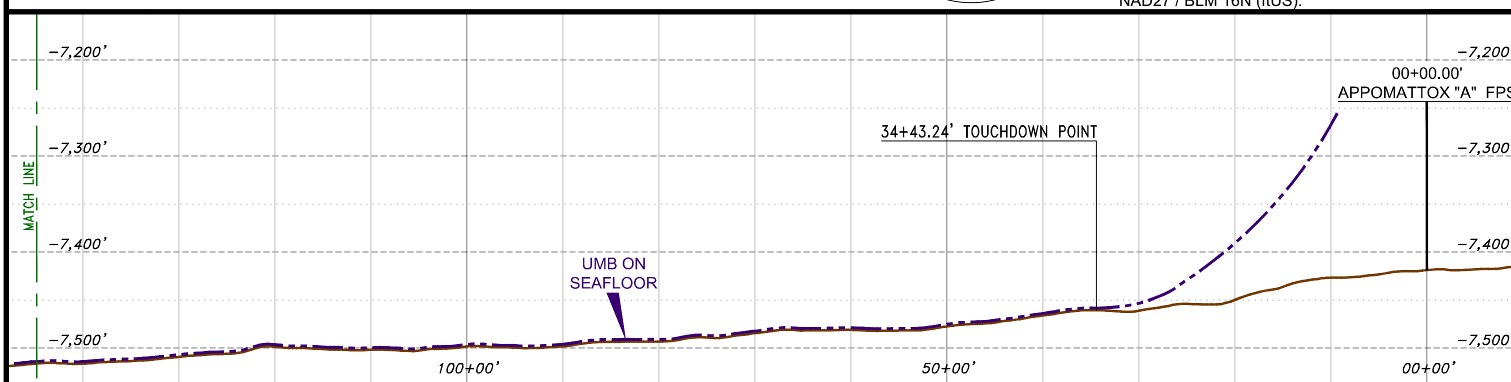
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL

PROP. R-O-W
PROP. C/L
100'
100'
PROP. R-O-W

GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10
HORIZONTAL: 0 2,000
VERTICAL: 0 200
U.S. SURVEY FEET

Shell

PROPOSED 8.5" RYDBERG DYNAMIC UMBILICAL ROUTE

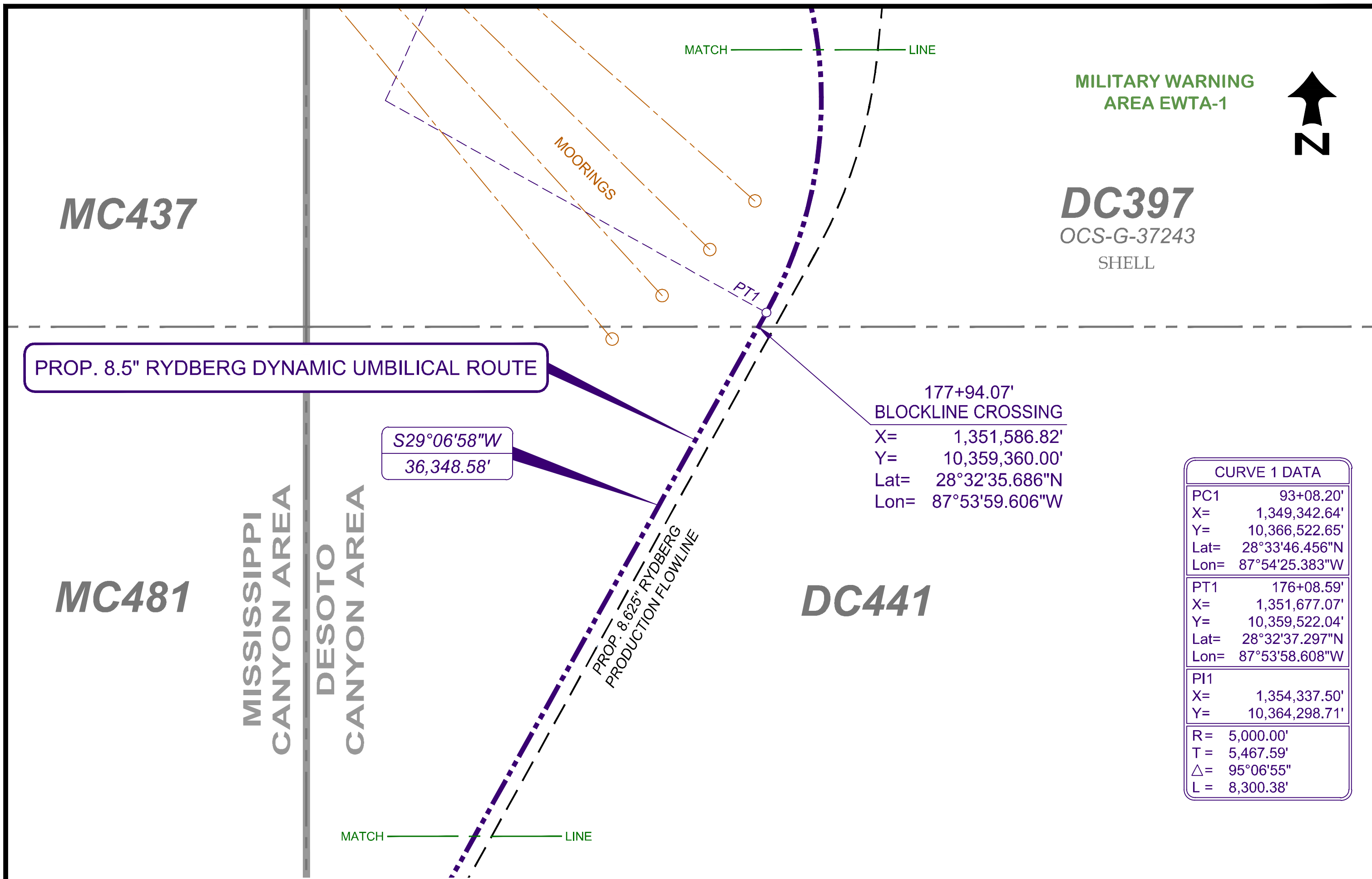
Block 437 Appomattox "A" FPS to Block 525 UTA
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 2 of 6 — REV. 0
DOC: 220210-OII-DRW-PRM-002-02		

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:16 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-002.DWG



FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

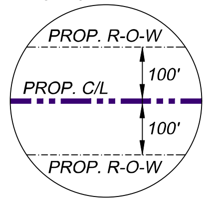
PLAN

0 2,000

SCALE IN US SURVEY FEET

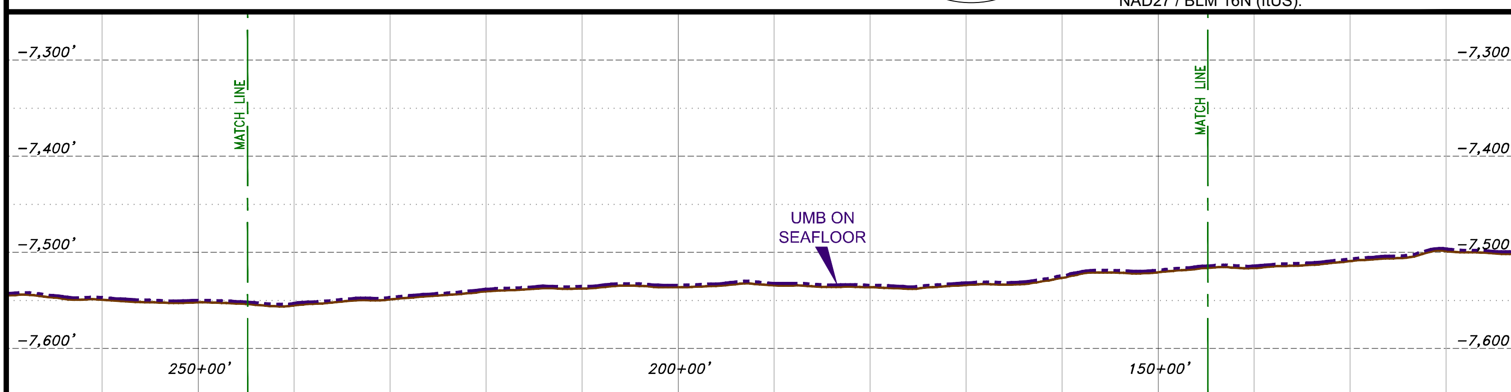
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



VERTICAL EXAGGERATION = 10

PROFILE

HORIZONTAL: 0 2,000
VERTICAL: 0 200
U.S. SURVEY FEET

Shell

PROPOSED 8.5" RYDBERG DYNAMIC UMBILICAL ROUTE

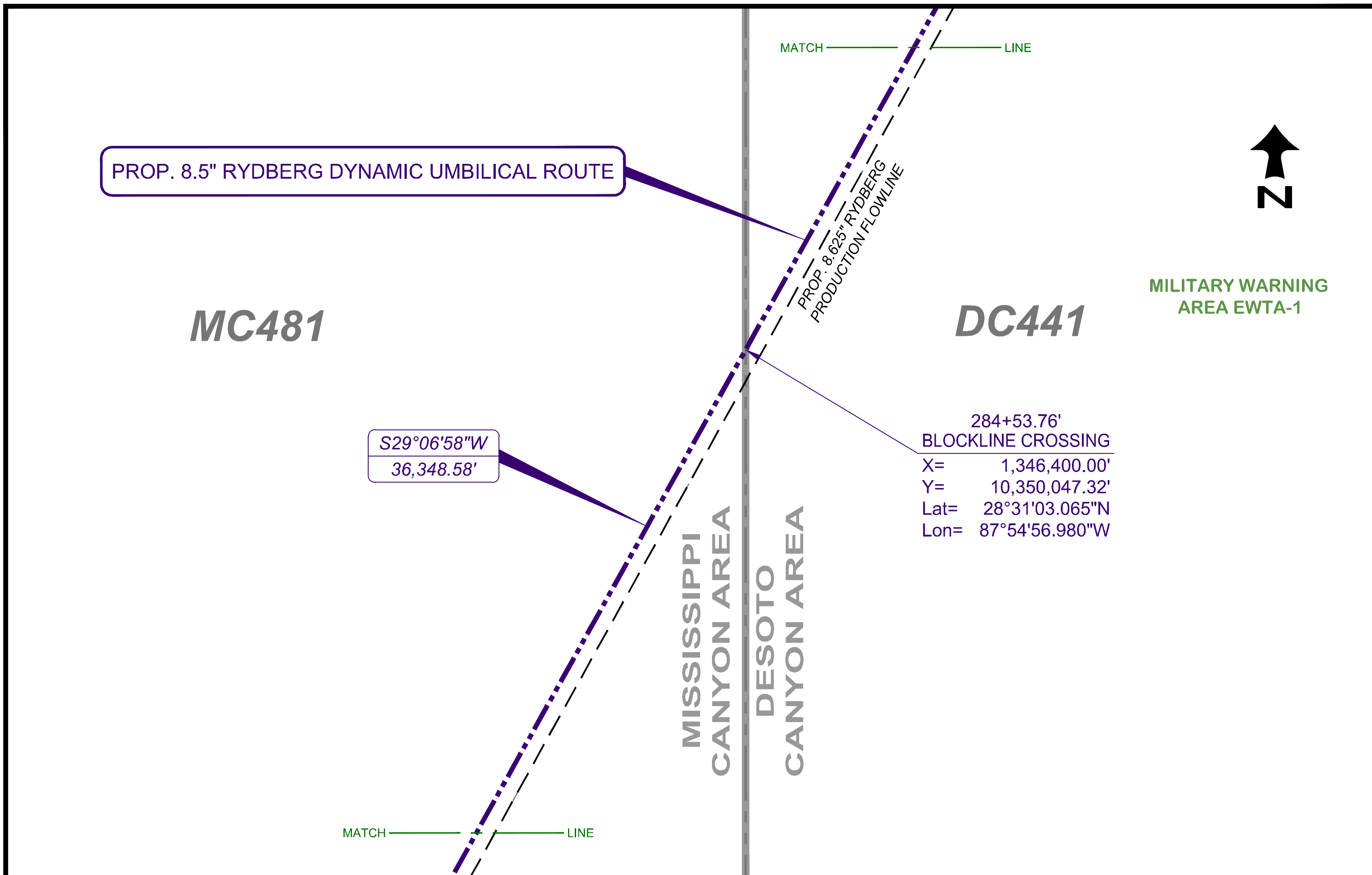
Block 437 Appomattox "A" FPS to Block 525 UTA
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 3 of 6 — REV. 0
DOC: 220210-OII-DRW-PRM-002-03		

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:17 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-002.DWG



FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

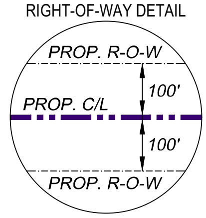
PLAN

0 2,000

SCALE IN US SURVEY FEET

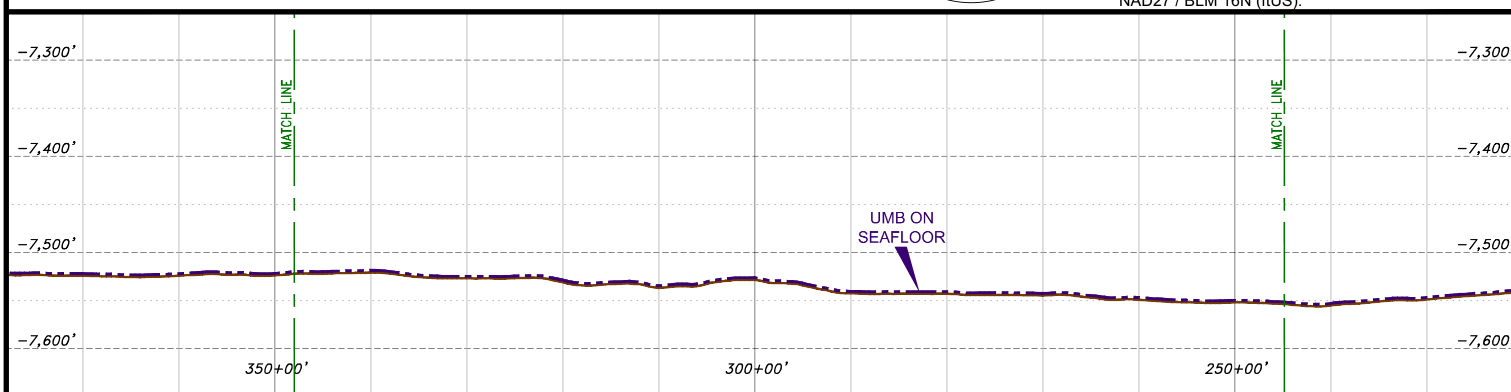
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10

HORIZONTAL: 0 2,000
VERTICAL: 0 200

U.S. SURVEY FEET

Shell

PROPOSED 8.5" RYDBERG DYNAMIC UMBILICAL ROUTE

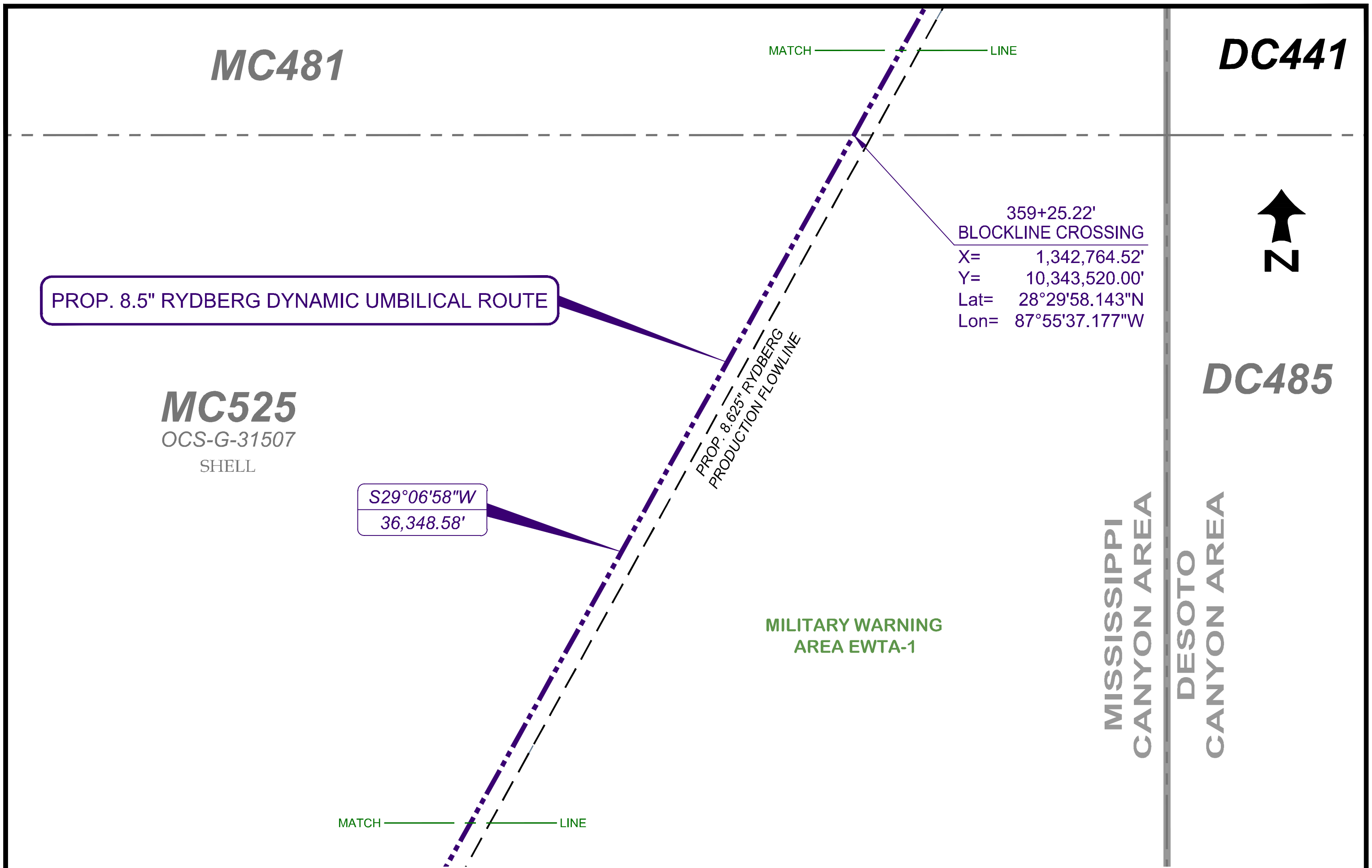
Block 437 Appomattox "A" FPS to Block 525 UTA
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 4 of 6 — REV. 0
DOC: 220210-OII-DRW-PRM-002-04		

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:17 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-002.DWG



FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

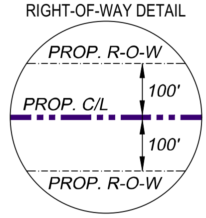
PLAN

0 2,000

SCALE IN US SURVEY FEET

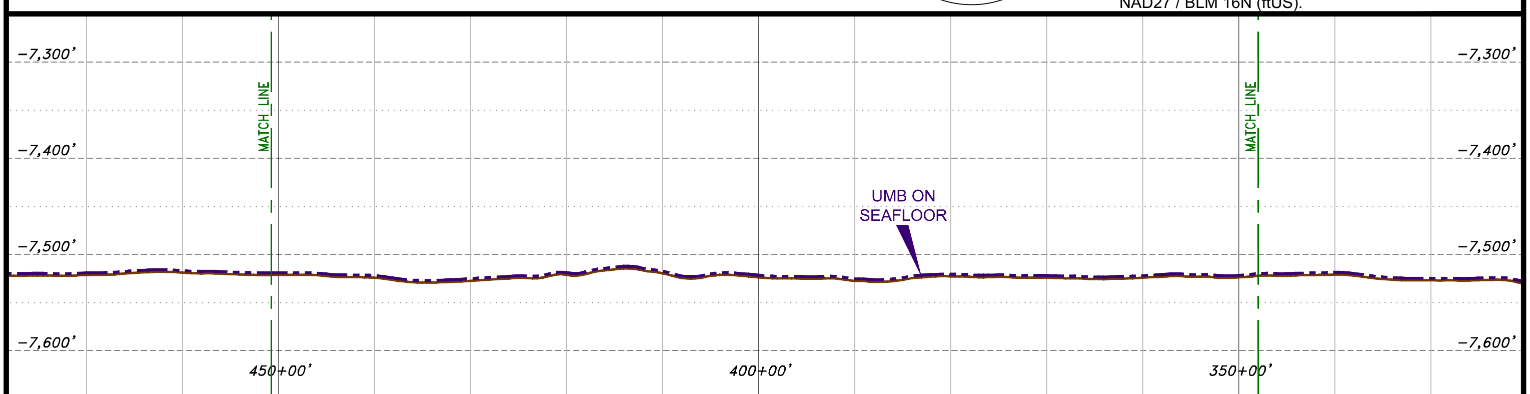
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10

HORIZONTAL: 0 2,000
VERTICAL: 0 200

U.S. SURVEY FEET

Shell

PROPOSED 8.5" RYDBERG DYNAMIC UMBILICAL ROUTE

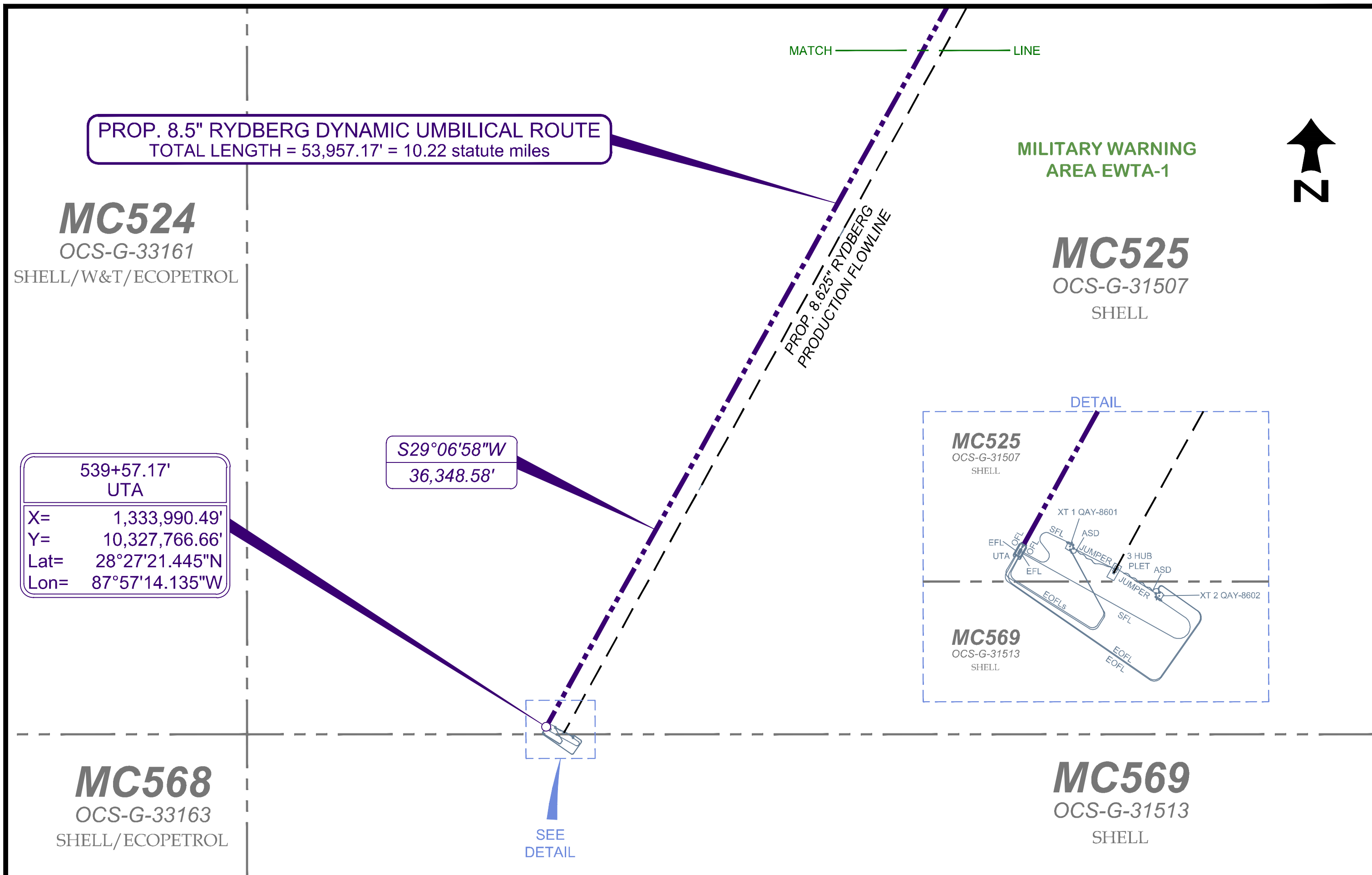
Block 437 Appomattox "A" FPS to Block 525 UTA
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 5 of 6 — REV. 0
DOC: 220210-OII-DRW-PRM-002-05		

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:17 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-002.DWG



FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

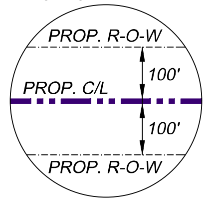
PLAN

0 2,000

SCALE IN US SURVEY FEET

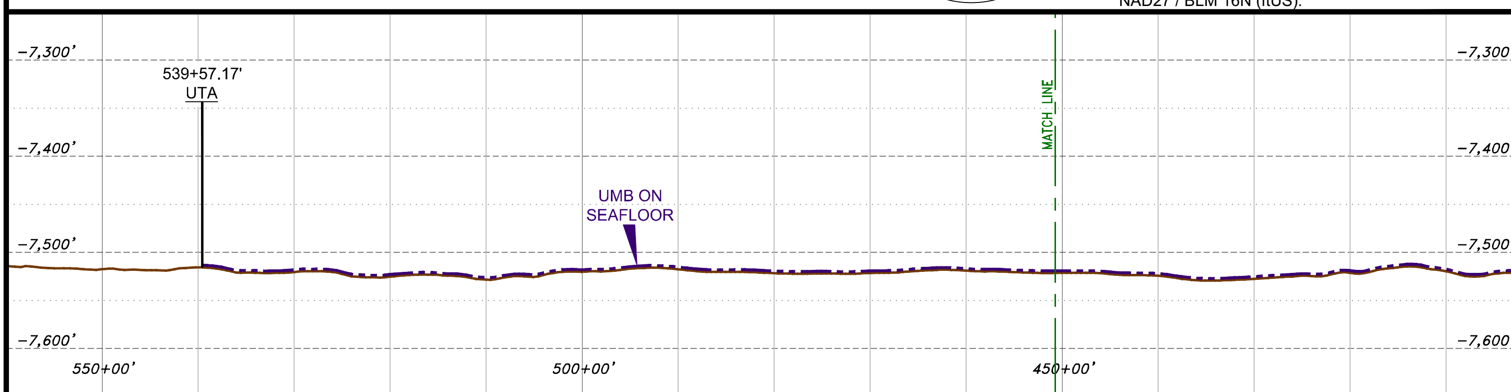
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10

HORIZONTAL: 0 2,000
VERTICAL: 0 200
U.S. SURVEY FEET

Shell

PROPOSED 8.5" RYDBERG DYNAMIC UMBILICAL ROUTE

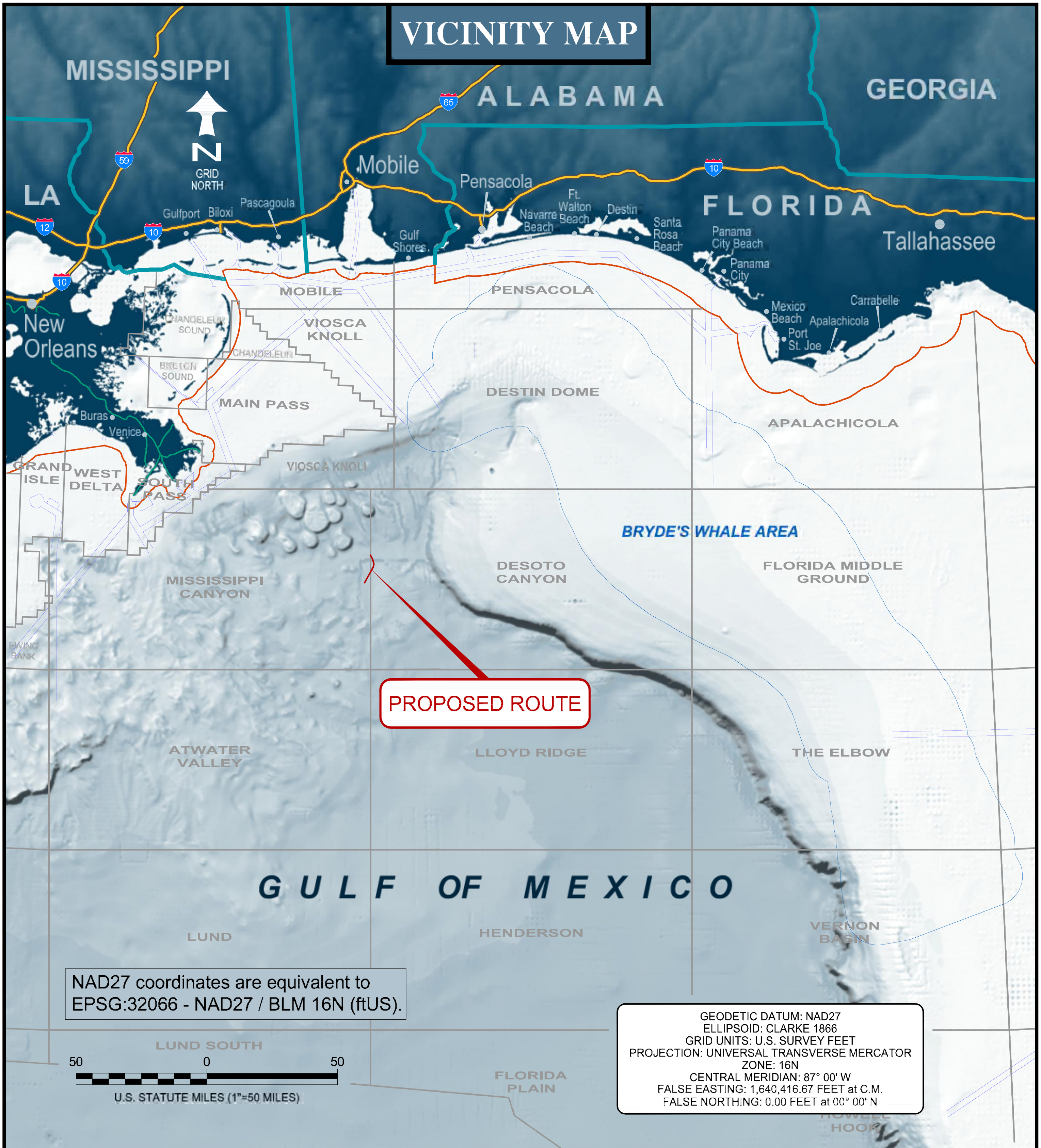
Block 437 Appomattox "A" FPS to Block 525 UTA
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022	
CKD: J. Guidry	APP: R. Frost	SHEET 6 of 6	REV. 0
DOC: 220210-OII-DRW-PRM-002-06			

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:17 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-002.DWG



Shell

PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE

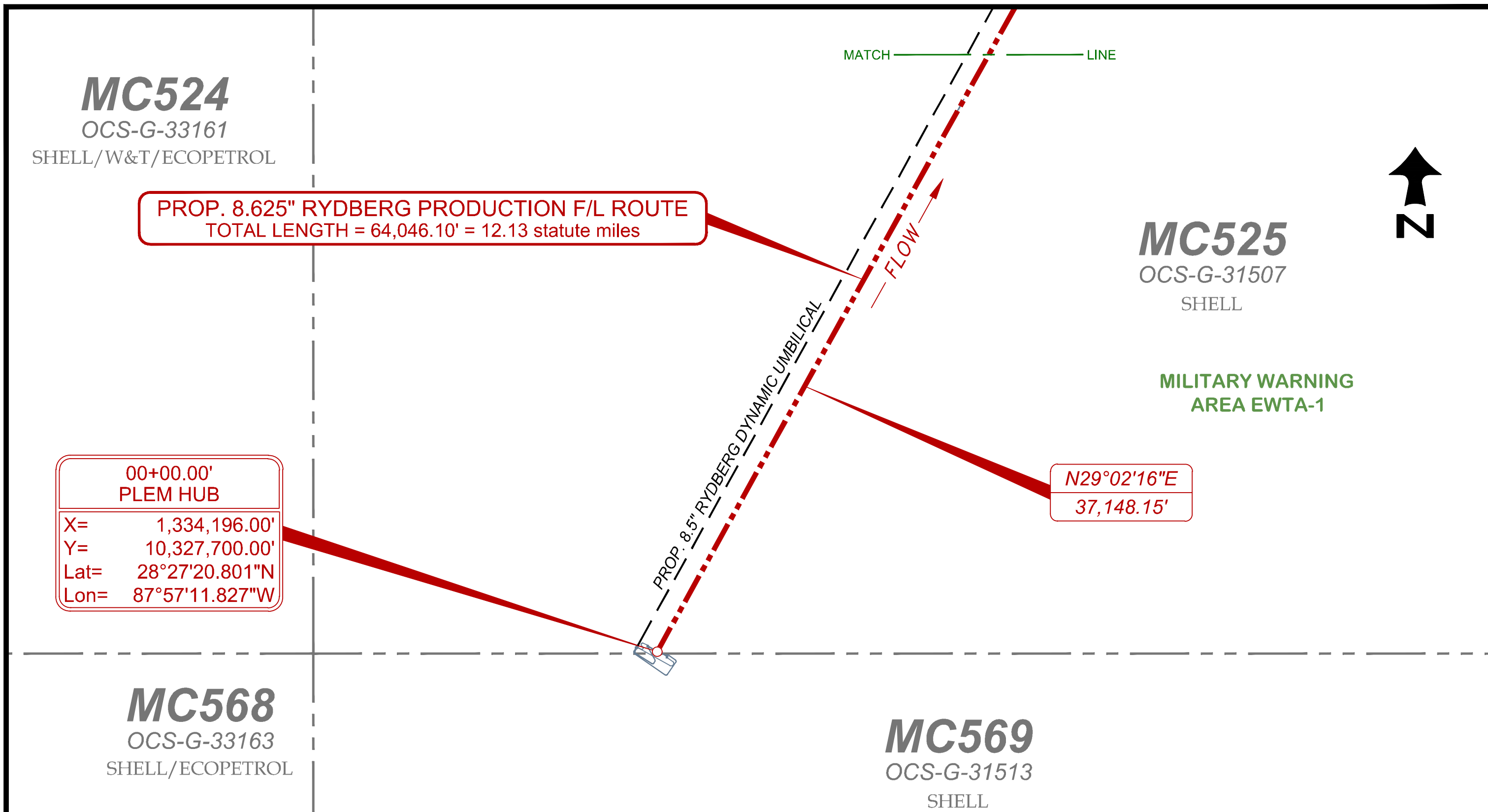
Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

PREPARED BY: OCEANEERING®

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022	
CKD: J. Guidry	APP: R. Frost	SHEET 1 of 8	REV. 0
DOC: 220210-OII-DRW-PRM-001-01			

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:09 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-001.DWG



STATE OF LOUISIANA
ROBERT M. FROST
License No. 4573
PROFESSIONAL LAND SURVEYOR

THE PROPOSED ROUTE IS ACCURATELY REPRESENTED.

ROBERT M. FROST
PROFESSIONAL LAND SURVEYOR
LOUISIANA REGISTRATION No. 4573

Digitally signed by: Robert M. Frost, PLS
Date: 2022.09.27 12:54:11 -05'00'

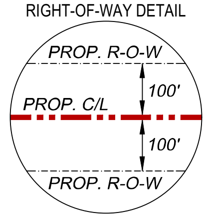
FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

PLAN

0 2,000
SCALE IN US SURVEY FEET

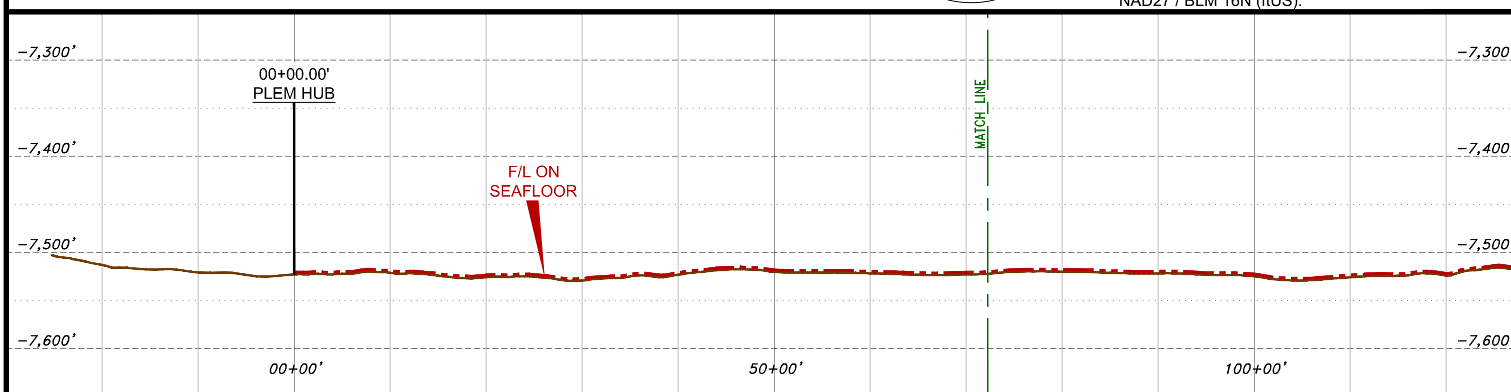
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10
HORIZONTAL: 0 2,000
VERTICAL: 0 200
U.S. SURVEY FEET

Shell

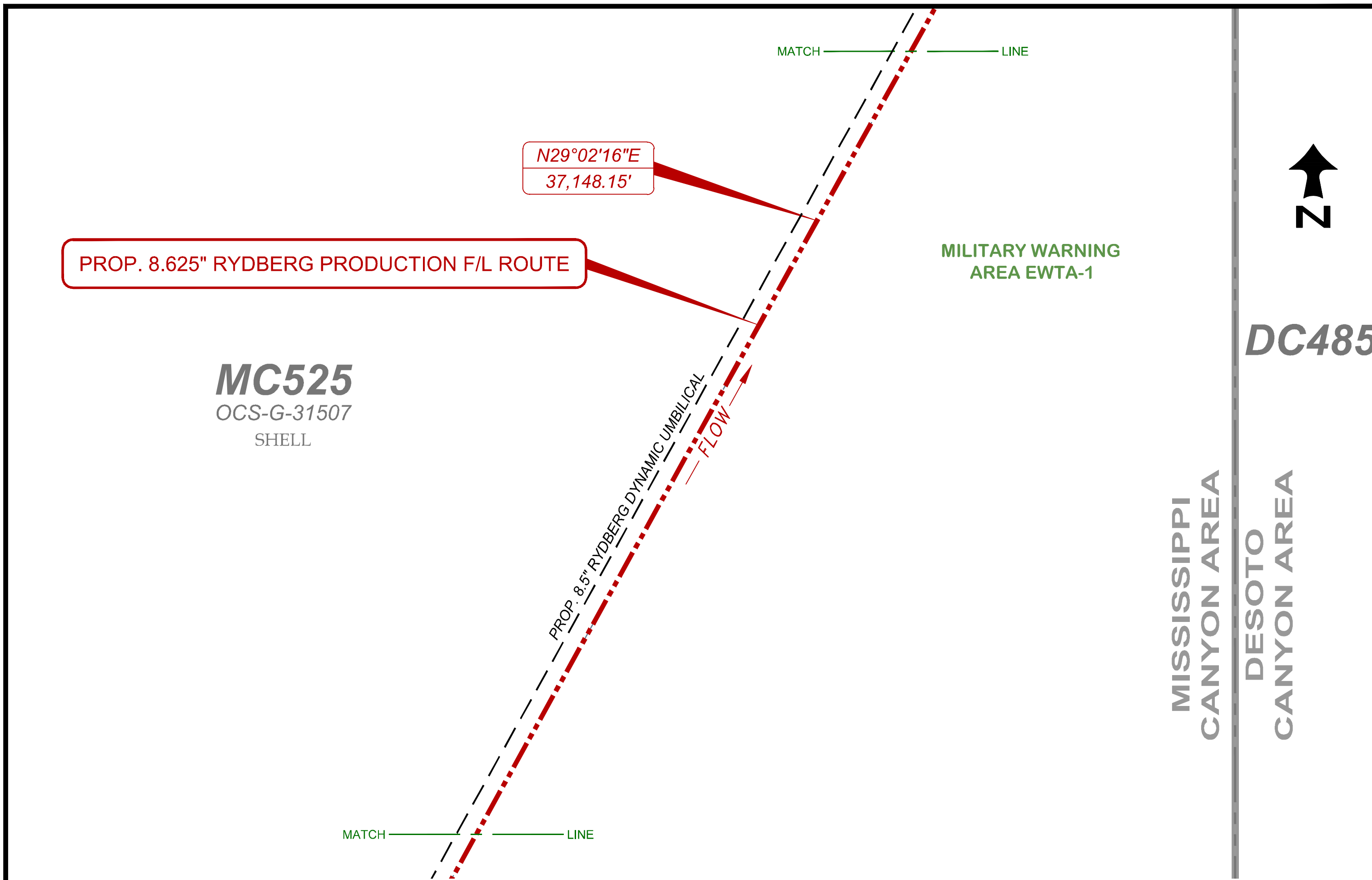
PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE
Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 2 of 8 — REV. 0
DOC: 220210-OII-DRW-PRM-001-02		

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:09 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-001.DWG



FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

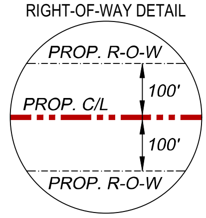
PLAN

0 2,000

SCALE IN US SURVEY FEET

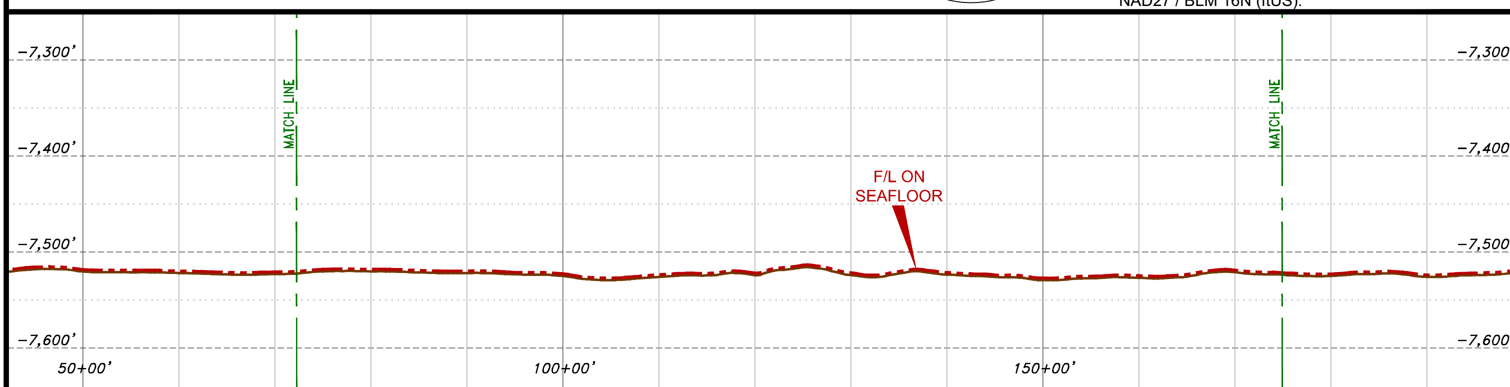
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10

HORIZONTAL: 0 2,000

VERTICAL: 0 200

U.S. SURVEY FEET

Shell

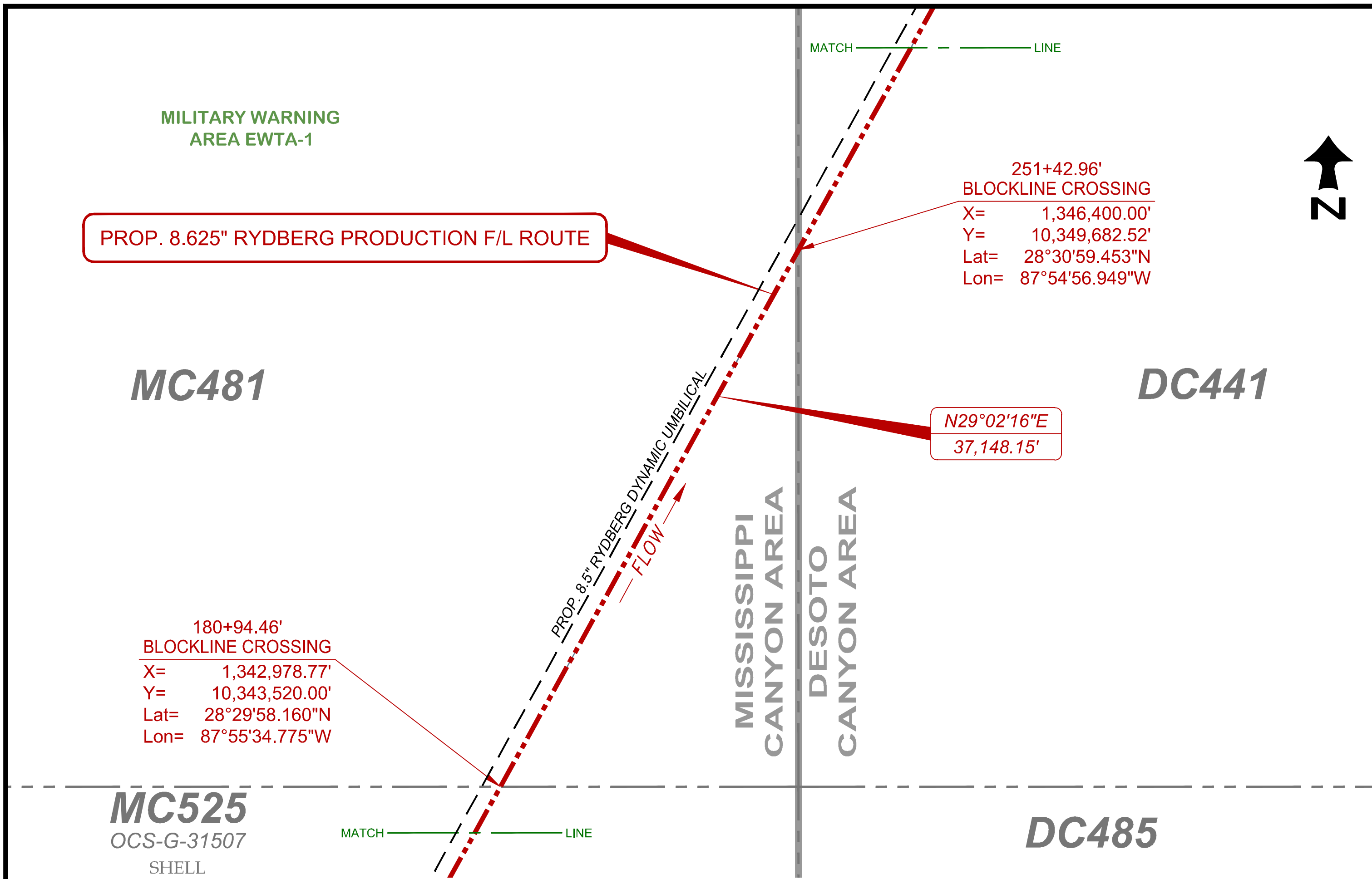
PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE
Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022	
CKD: J. Guidry	APP: R. Frost	SHEET 3 of 8	REV. 0
DOC: 220210-OII-DRW-PRM-001-03			

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:09 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-001.DWG



FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

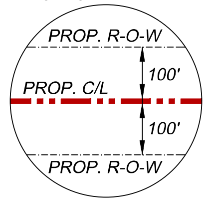
PLAN

0 2,000

SCALE IN US SURVEY FEET

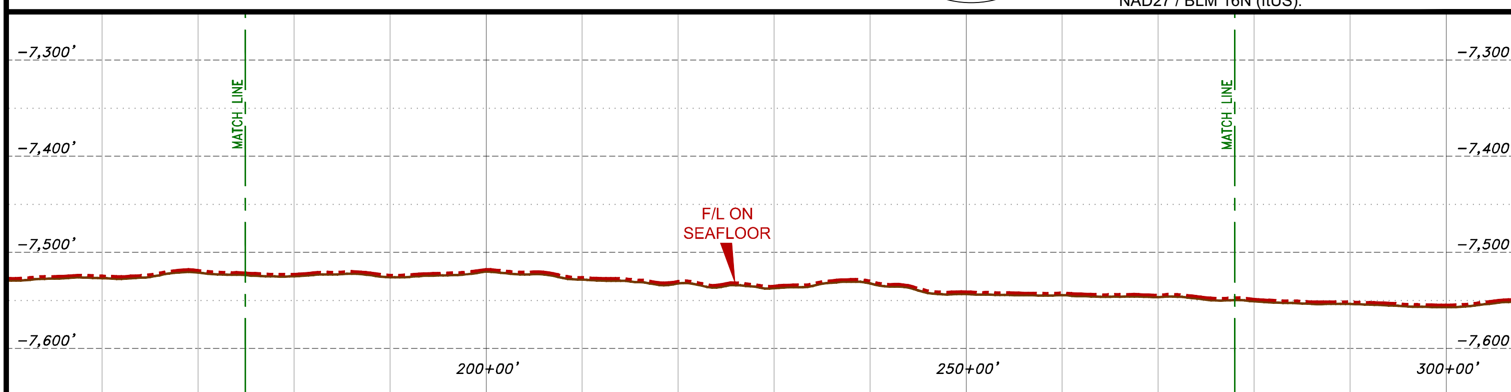
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10

HORIZONTAL: 0 2,000

VERTICAL: 0 200

U.S. SURVEY FEET

Shell

PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE

Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

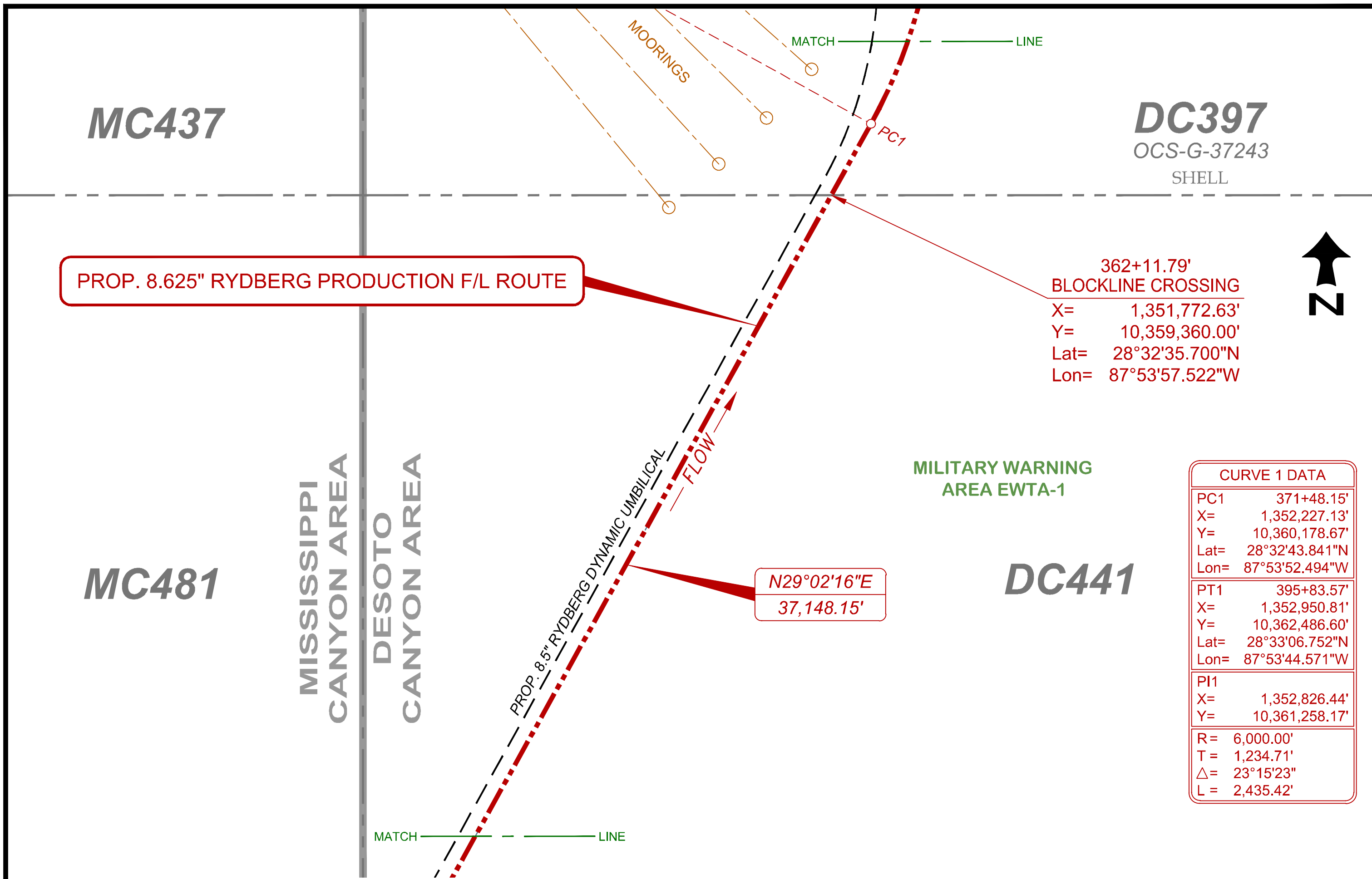
PREPARED BY:

OCEANEERING®

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 4 of 8 — REV. 0
DOC: 220210-OII-DRW-PRM-001-04		

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:10 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-001.DWG



CURVE 1 DATA	
PC1	371+48.15'
X=	1,352,227.13'
Y=	10,360,178.67'
Lat=	28°32'43.841"N
Lon=	87°53'52.494"W
PT1	395+83.57'
X=	1,352,950.81'
Y=	10,362,486.60'
Lat=	28°33'06.752"N
Lon=	87°53'44.571"W
PI1	
X=	1,352,826.44'
Y=	10,361,258.17'
R=	6,000.00'
T=	1,234.71'
△=	23°15'23"
L=	2,435.42'

FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

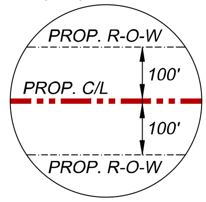
PLAN

0 2,000

SCALE IN US SURVEY FEET

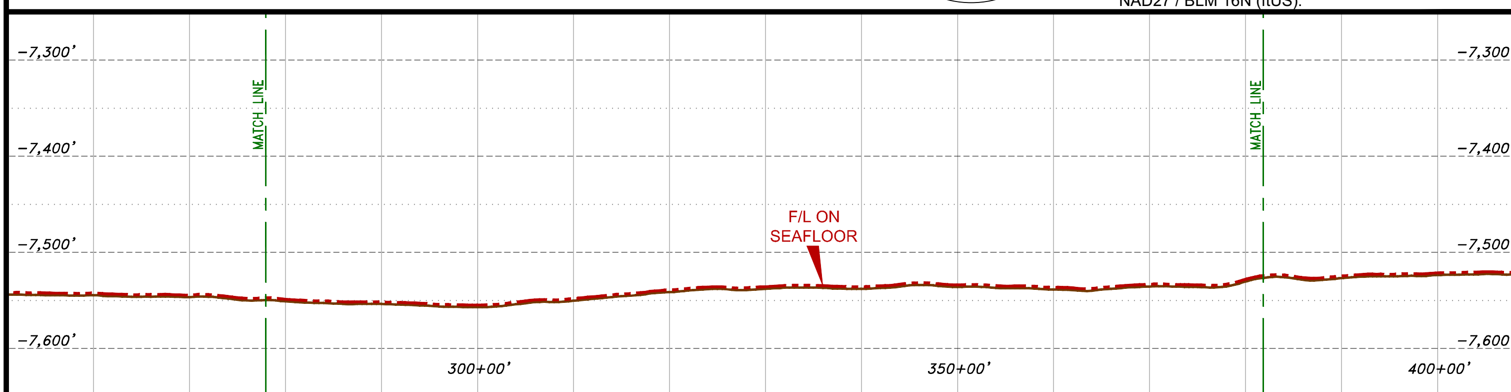
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10

HORIZONTAL: 0 2,000
VERTICAL: 0 200
U.S. SURVEY FEET

Shell

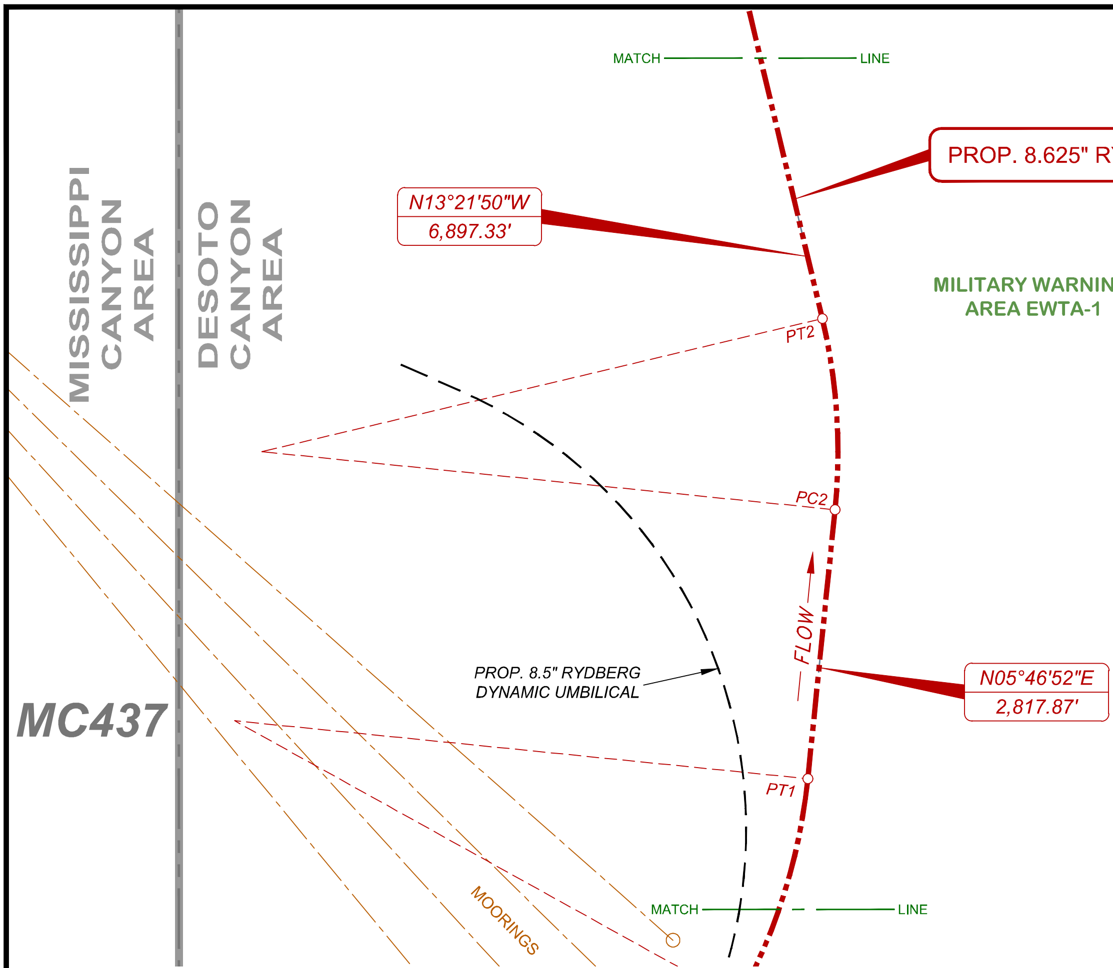
PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE

Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 5 of 8 — REV. 0
DOC: 220210-OII-DRW-PRM-001-05		



CURVE 1 DATA	
PC1	371+48.15'
X=	1,352,227.13'
Y=	10,360,178.67'
Lat=	28°32'43.841"N
Lon=	87°53'52.494"W
PT1	395+83.57'
X=	1,352,950.81'
Y=	10,362,486.60'
Lat=	28°33'06.752"N
Lon=	87°53'44.571"W
PI1	
X=	1,352,826.44'
Y=	10,361,258.17'
R =	6,000.00'
T =	1,234.71'
△=	23°15'23"
L =	2,435.42'

CURVE 2 DATA	
PC2	424+01.44'
X=	1,353,234.65'
Y=	10,365,290.14'
Lat=	28°33'34.539"N
Lon=	87°53'41.622"W
PT2	444+06.30'
X=	1,353,102.70'
Y=	10,367,281.32'
Lat=	28°33'54.250"N
Lon=	87°53'43.269"W
PI2	
X=	1,353,336.57'
Y=	10,366,296.85'
R =	6,000.00'
T =	1,011.86'
△=	19°08'42"
L =	2,004.86'

FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

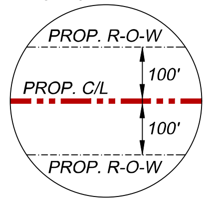
PLAN

0 2,000

SCALE IN US SURVEY FEET

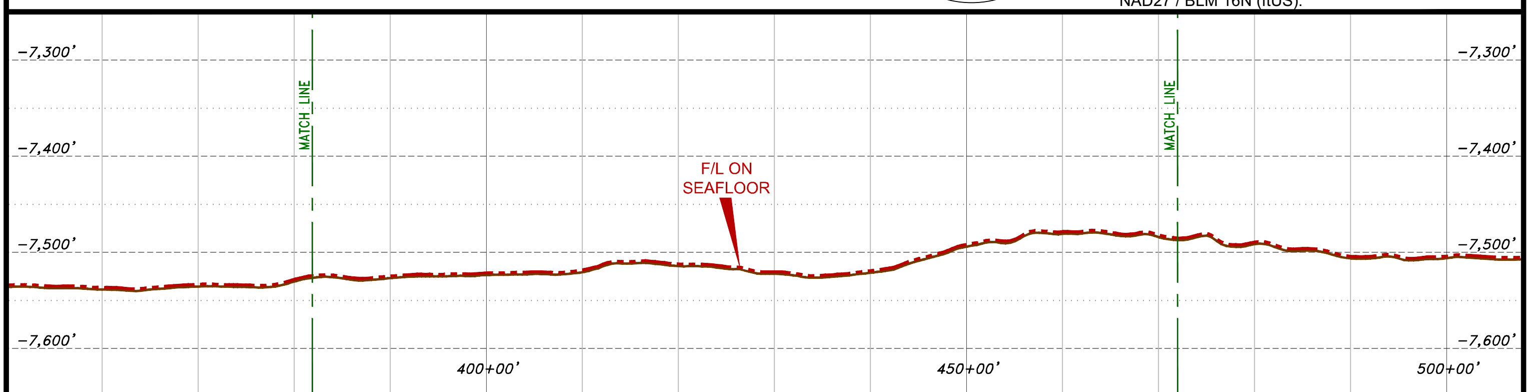
NADCON version 2.1 utilized for WGS84-NAD27 conversions.

RIGHT-OF-WAY DETAIL



GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10
HORIZONTAL: 0 2,000
VERTICAL: 0 200
U.S. SURVEY FEET

Shell

PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE

Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
(337) 210-0000
LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 6 of 8 — REV. 0
DOC: 220210-OII-DRW-PRM-001-06		

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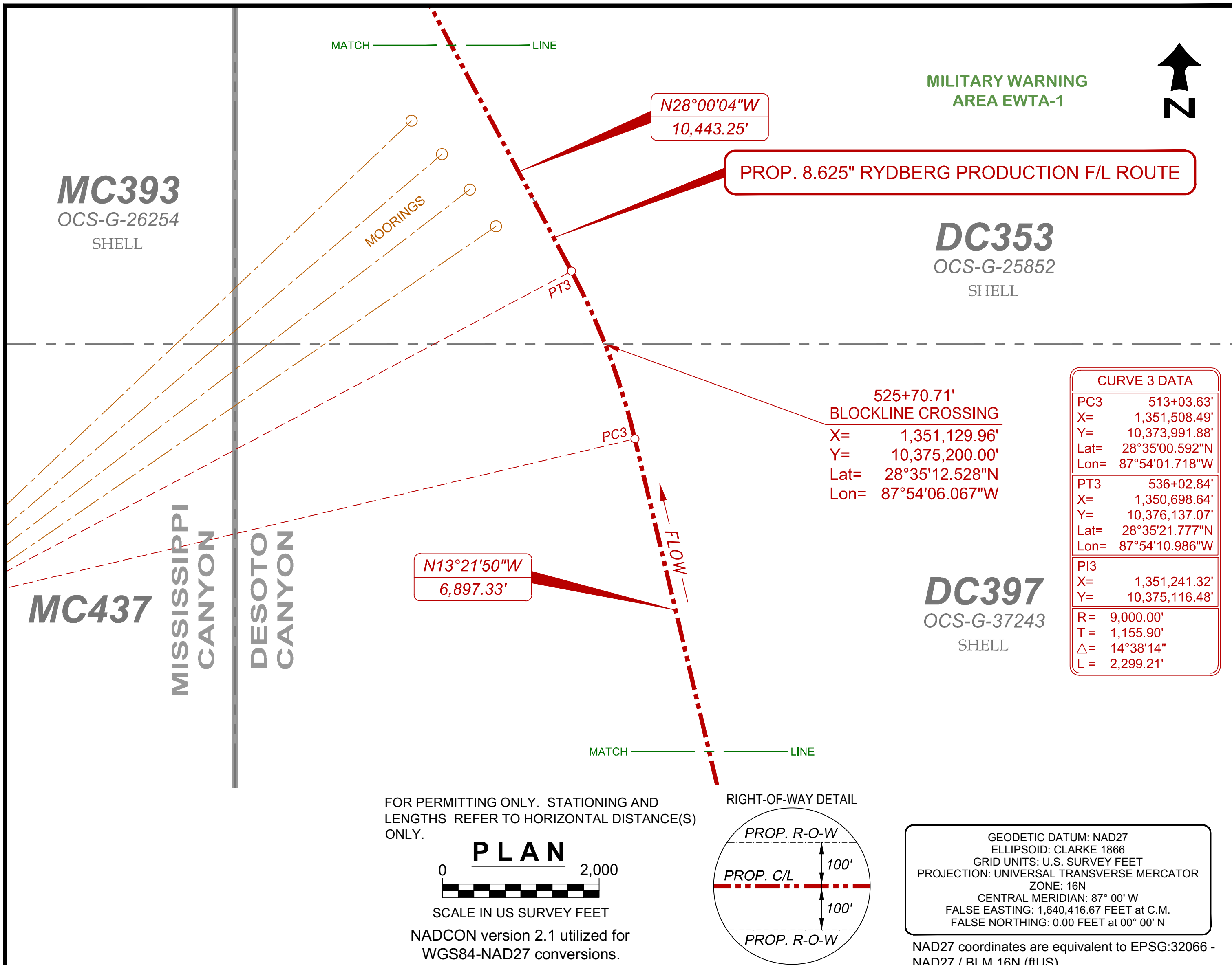

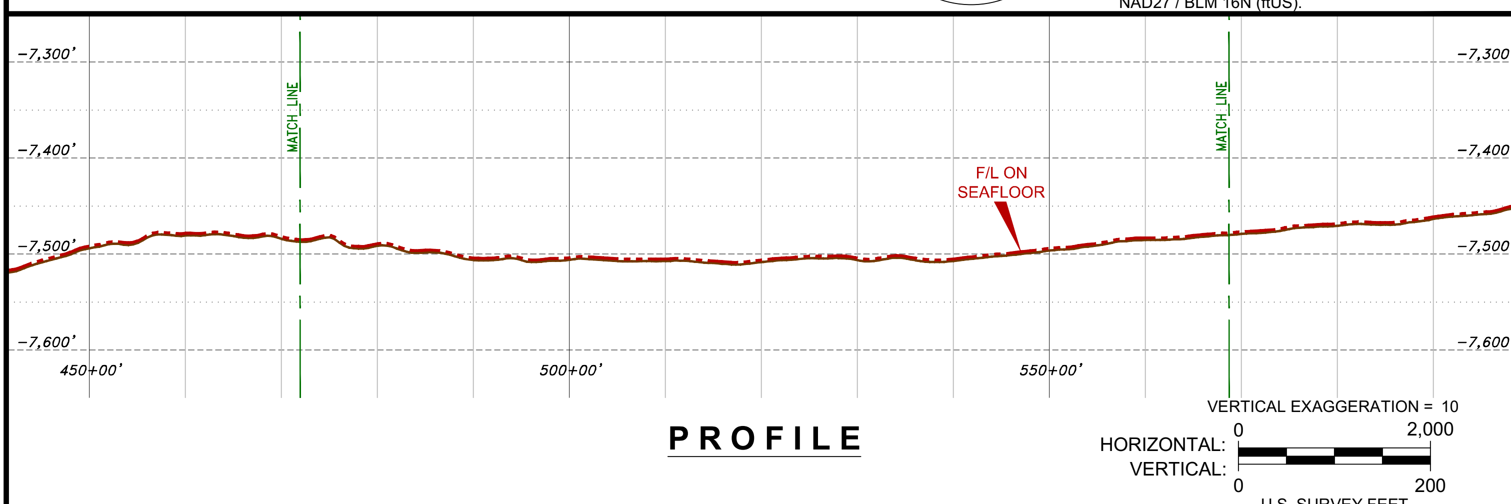

Shell

PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE

Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

PREPARED BY: OCEANEERING®

OCEANEERING INTERNATIONAL, INC.
202 STANTON STREET
BROUSSARD, LA 70518
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LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 7 of 8 — REV. 0
DOC: 220210-OII-DRW-PRM-001-07		

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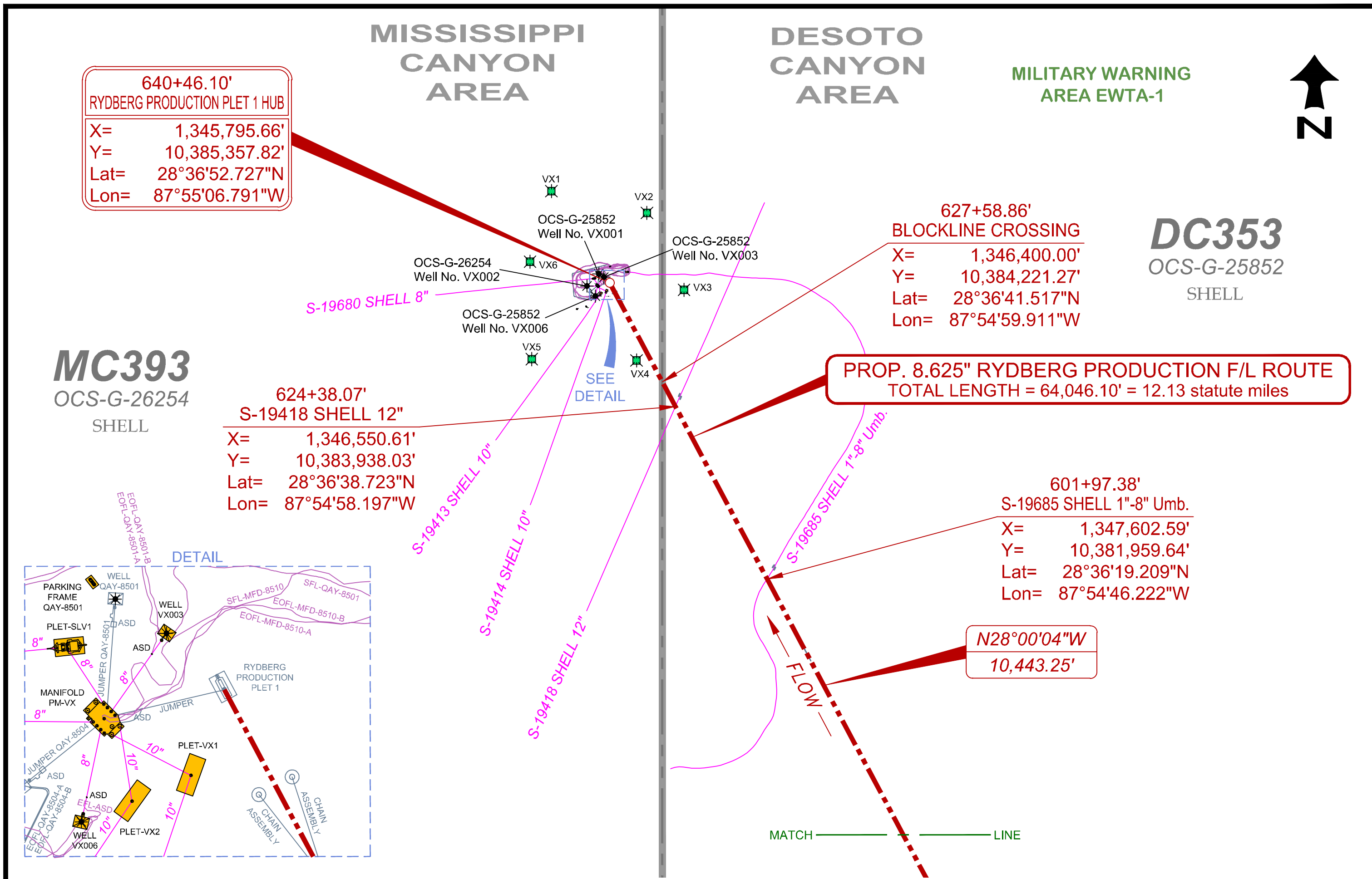


FOR PERMITTING ONLY. STATIONING AND LENGTHS REFER TO HORIZONTAL DISTANCE(S) ONLY.

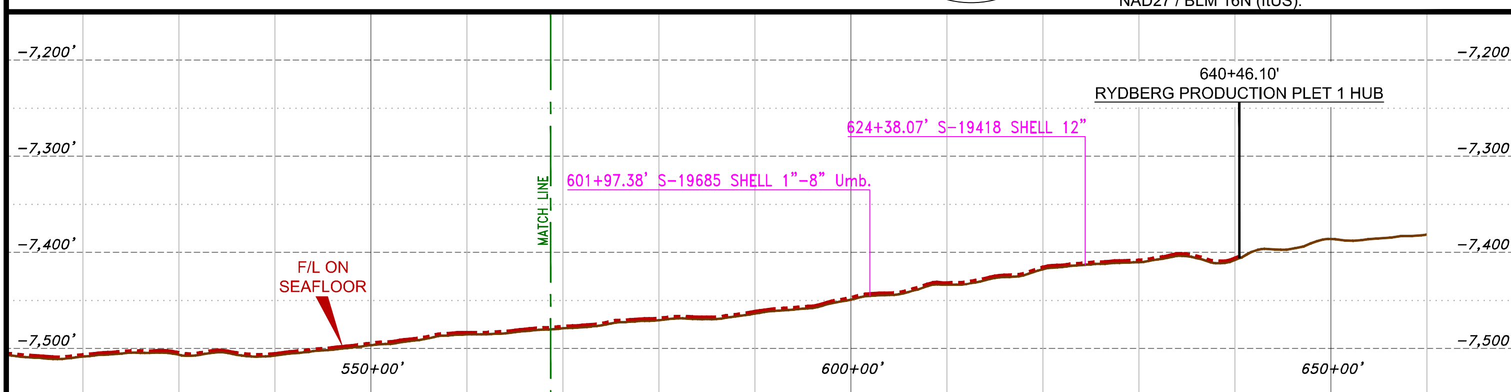
PLAN

0 — 2,000
SCALE IN US SURVEY FEET

NADCON version 2.1 utilized for WGS84-NAD27 conversions.

GEODETIC DATUM: NAD27
ELLIPSOID: CLARKE 1866
GRID UNITS: U.S. SURVEY FEET
PROJECTION: UNIVERSAL TRANSVERSE MERCATOR
ZONE: 16N
CENTRAL MERIDIAN: 87° 00' W
FALSE EASTING: 1,640,416.67 FEET at C.M.
FALSE NORTHING: 0.00 FEET at 00° 00' N

NAD27 coordinates are equivalent to EPSG:32066 - NAD27 / BLM 16N (ftUS).



PROFILE

VERTICAL EXAGGERATION = 10
HORIZONTAL: 0 — 2,000
VERTICAL: 0 — 200
U.S. SURVEY FEET

Shell

PROPOSED 8.625" RYDBERG PRODUCTION FLOWLINE
Block 525 PLEM Hub to
Block 393 Rydberg Production PLET 1 Hub
Mississippi Canyon Area

PREPARED BY: OCEANEERING

OCEANEERING INTERNATIONAL, INC.
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LA Reg. No. 747

JOB: 220210	DRW: ALM, BDP	DATE: September 27, 2022
CKD: J. Guidry	APP: R. Frost	SHEET 8 of 8 — REV. 0
DOC: 220210-OII-DRW-PRM-001-08		

SIZE: 8.5" X 11" DATE: 09/27/2022 TIME: 09:12 FILENAME: Z:\220210\ACAD\PERMIT\220210-OII-DRW-PRM-001.DWG

SHELL

ARCHAELOGICAL AND GEOHAZARD ASSESSMENT

PROPOSED 8.625-INCH PRODUCTION FLOWLINE ROUTE
PROPOSED 8.5-INCH DYNAMIC UMBILICAL ROUTE
BLOCKS 525 TO 393 AND 437, MISSISSIPPI CANYON AREA
GULF OF MEXICO

OCEANEERING®

Oceaneering Document Number:	220210-OII-RPT-AAG-01	Project Date Range:	31 March to 19 April 2011 & 24 December 2016 to 7 January 2017
Client Document Number:	N/A	Location:	MC525 to MC393 & MC437
Client:	Shell Exploration and Production Company	Vessel:	M/V *Ocean Project* R/V *Fugro Enterprise*

REVISION HISTORY

Rev	Reason for Issue	Author	Reviewed	Approved	Rev Date
A	Client Review	B. Broussard, R. Church	A. Breaux	C. Baker	02 Aug 2022
0	Final For Use	B. Broussard, R. Church	A. Breaux	C. Baker	27 Sep 2022

Signature Box

B. Broussard
Brittany Broussard
Geoscientist

Robert Church
Senior Marine Archaeologist

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS 4
1.0 GEOHAZARD ASSESSMENT 6
1.1 INTRODUCTION 6
1.1.1 PURPOSE AND SCOPE 6
1.1.2 PROJECT PERSONNEL 9
1.1.3 PROPOSED ROUTES 9
1.2 SURVEY DESCRIPTION 10
1.2.1 ACQUISITION DATES AND WEATHER CONDITIONS 10
1.2.2 GEOPHYSICAL AND SURVEY EQUIPMENT 10
1.2.3 SURVEY METHODS AND DESIGN 10
1.2.4 HORIZONTAL DATUM 11
1.2.5 VERTICAL DATUM 11
1.2.6 CORING PROCEDURES 12
1.3 REGIONAL GEOLOGIC SETTING 12
1.3.1 BATHYMETRY 14
1.3.2 SEAFLOOR FEATURES 14
1.3.3 SUBSURFACE GEOLOGY 15
1.3.4 ASSESSMENT OF DEEPWATER BENTHIC COMMUNITIES 20
1.3.5 MAN-MADE FEATURES 20
1.3.6 BOX AND PISTON CORING 22
1.4 GEOHAZARDS CONCLUSIONS AND RECOMMENDATIONS 23
1.5 REFERENCES 24
2.0 ARCHAEOLOGICAL ASSESSMENT 25
2.1 INTRODUCTION 25
2.1 HISTORIC BACKGROUND 26
2.2 HISTORIC POTENTIAL 30
2.3 ASSESSMENT OF DATA 30
2.3.1 BATHYMETRY RECORD 30
2.3.2 SIDE SCAN SONAR RECORD 31
2.4 CONCLUSIONS AND RECOMMENDATIONS 32
2.5 REFERENCES 33

LIST OF FIGURES

Figure 1. Regional map of the survey area. 7
Figure 2. Vicinity map of the survey area. 8
Figure 3. Deepwater depositional environments of the northern Gulf of Mexico Slope (Modified from Bryant *et al*., 1991).... 13
Figure 4. Subsurface Geologic Conditions in MC393 showing buried MTDs.... 16
Figure 5. SSS Line 528 Showing Seafloor Conditions in DC397 (FGSI) 17
Figure 6. Hemipelagic drape, seafloor irregularities, and MTD A along the centerline (Line 103.1.b) of the proposed flowline route 18
Figure 7. MTD B along the centerline (Line 103.1.a) of the proposed flowline route near box core BC-02 19
Figure 8. Gulf of Mexico shipping routes, 1763 - 1821 (Modified from Pearson *et al*., 2003).... 27
Figure 9. Gulf of Mexico shipping routes, 1821 - 1862 (Modified from Pearson *et al*., 2003).... 28
Figure 10. Side scan sonar data showing Sonar Contact No. 4, which is considered a potential archaeological resource. 32

LIST OF TABLES

Table 1. Key Office Personnel 9
Table 2. Lease Blocks Crossed by the Proposed Routes.... 9
Table 3. Geodetic Parameters 11
Table 4. Interpreted MTDs within the Rydberg Survey Area.... 15
Table 5. Existing Infrastructure within Rydberg Survey Area. 21
Table 6. Existing Pipelines and Umbilical's Within the Rydberg Survey Area 21
Table 7. Box and Piston Core Locations and Water Depth 22
Table 8. Shipwrecks reported within 10 nautical miles of the survey area 30
Table 9. Archaeological Avoidances 33

APPENDICES

APPENDIX A: SONAR CONTACT TABLEs & REPORTs 35
APPENDIX B: SURVEY CONFIGURATION DIAGRAM, EQUIPMENT DESCRIPTIONS, INSTRUMENT SETTINGS, & CREW LIST.... 41
APPENDIX C: OII SURVEY LOGS 64
APPENDIX D: FGSI SURVEY LOGS 85
APPENDIX E: SOUND VELOCITY PROFILES & TIDE CURVES.... 107

STUDY MAPS

Proposed 8.625-inch Oil Flowline Route (Sheets 1–2) — Horizontal Scale 1″ = 1,000’; Vertical Scale 1” = 100’

Proposed 8.5-inch Dynamic Umbilical Route (Sheets 3–4) — Horizontal Scale 1″ = 1,000’; Vertical Scale 1” = 100’

DIGITAL DELIVERABLES

Report and Maps (PDF), AutoCAD (DWG) and associated files, ArcGIS Files

ABBREVIATIONS AND ACRONYMS

AUV	Autonomous Underwater Vehicle
APE	Area of Potential Effect
BML	Below Mud Line
BOEM	Bureau of Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
DC	Desoto Canyon
DGPS	Differential Global Positioning System
DVL	Doppler Velocity Log
FGSI	Fugro
GOM	Gulf of Mexico
HiPAP	High Precision Acoustic Positioning System
INS	Inertial Navigation System
MBES	Multibeam Echosounder
MC	Mississippi Canyon
MSL	Mean Sea Level
MTD	Mass Transport Deposit
M/V	Motor Vessel
NAD27	North American Datum of 1927
NTL	Notice to Lessees
OII	Oceaneering International Inc.
R/V	Research Vessel
SBP	Subbottom Profiler
Shell	Shell Exploration and Production Co.
SSS	Side Scan Sonar
SVP	Sound Velocity Profile
USBL	Ultra-Short Base Line
UTM	Universal Transverse Mercator
XTF	Extended Triton Format

EXECUTIVE SUMMARY

- Shell Exploration and Production Co. (Shell), contracted Oceaneering International, Inc. (OII) to perform a deepwater AUV Archaeological and Geohazard Assessment for a proposed 8.625-inch Oil Flowline route and 8.5-inch Dynamic Umbilical route within Blocks 569, 525, 393, and 437, Mississippi Canyon Area (MC), Gulf of Mexico and Blocks 353, 397, and 441, Desoto Canyon Area (DC), Gulf of Mexico.
- Additional data was utilized for the proposed routes and will be mentioned throughout this report. Water depths within the survey area range from 7,415 feet MSL to 7,560 feet MSL.
- This assessment is based on three previous assessments. The first is AUV geophysical survey data acquired by Fugro Enterprise between March 31 and April 1–19, 2011. The second is an Archaeological, Engineering, and Hazard Assessment based on the interpretation of geophysical data collected by OII from December 24th to 28th, 2016. The third is seafloor infrastructure data acquired by TechnipFMC between June 3 and June 6 through 7, 2022. The AUV geophysical data include multibeam bathymetry, side scan sonar, and subbottom profiler.
- The length of the proposed 8.625-inch Oil Flowline route is 64,046.10 U.S. Survey Feet (12.13 statute miles). The length of the proposed 8.5-inch Umbilical route is 53,957.17 U.S. Survey Feet (10.22 statute miles).
- The multibeam bathymetric data depicts a smooth and slightly undulating seafloor topography which slopes gently to the east-southeast at an average gradient of between 1° and 5°. There were no gradients of greater than 2° identified along either proposed routes.
- The seabed is covered by a 6-to-10-foot hemipelagic clay drape underlain by alternating beds of silt and clay. Buried mass transport deposits are the most common subsurface feature occurring within the survey corridor. There were no other seafloor or subsurface geohazards to pipeline installation activities noted along either route.
- Two unidentified sonar contacts (Nos 8 and 14) are located within 100 feet of the proposed routes. Sonar Contact No. 8, measuring 13.4 x 5.1 with no measurable height, is located between the proposed Umbilical and Flowline routes in MC481. It is 54 feet from the proposed Flowline route and over 130 feet from the proposed Umbilical route. Contact No. 14, measuring 16.6 x 12.4 with no measurable height, is located 80 feet from the proposed Flowline route in DC397.
- Sonar contact No.4 in MC525 is a potential archaeological resource and has a recommended 100-foot radius archaeological avoidance zone. The other ten sonar contacts in the OII sonar contact list are at a recommended 30-foot radius hazard avoidance. The one sonar contact recorded within the route corridor from Fugro has no determined hazard avoidance zone. Sonar Contact No. 8 lies 130 feet east of the proposed Umbilical and 54 feet west of the proposed Oil Flowline. Sonar Contact No. 5 is located 80 feet east of the proposed Oil Flowline.
- Two existing lines are crossed by the proposed 8.625-inch Oil Production Flowline route; the S-19685 Shell 1-8-inch Umbilical and S-19418 Shell 12”, both in DC353. There are no crossing locations along the proposed 8.5-inch Dynamic Umbilical route.
- There were no features identified along either route that had potential to support deepwater benthic (chemosynthetic or coral) communities.
- Thirteen box core samples were collected along the proposed routes onboard OII’s M/V Ocean Project between December 28, 2016 and January 6, 2017. One piston core was collected on June 15, 2017.

1.0 GEOHAZARD ASSESSMENT

1.1 INTRODUCTION

Shell Exploration and Production Co. (Shell), contracted Oceaneering International, Inc. (OII) to perform a deepwater AUV Geohazard and Archaeological Assessment for a proposed 8.625-inch Oil Flowline route and a proposed 8.5-inch Dynamic Umbilical route between Mississippi Canyon Area (MC) and Desoto Canyon Area (DC), Gulf of Mexico, within MC393, MC437, MC525, MC569, DC353, DC397, and DC441. The proposed 8.625-inch Oil Flowline route extends from MC525 to MC393, and the proposed 8.5-inch Dynamic Umbilical route extends from MC437 to MC525. The study area is located approximately 145 statute miles southeast of Fourchon, Louisiana, and is displayed on the Regional and Vicinity Maps (Figure 1 and Figure 2).

Previous survey assessments utilized for this assessment were completed by Fugro Geoservices, Inc. (FGSI) (Fugro Report No. 2411-500, 2011) and OII (Project No. 180110, 2017). This assessment is based on the AUV surveys conducted by OII and FGSI and designed to meet current hazard and archaeological regulatory requirements. The survey work and reporting comply with the U.S. Department of Interior's Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE) Notice to Lessees (NTL) No. 2008-G05 (Shallow Hazards Program), NTL No. 2005-G07 (Archaeological Resource Surveys and Reports), NTL No. 2011-JOINT-G01 (Revisions to the List of OCS Blocks Requiring Archaeological Resource Surveys and Reports), NTL No. 2009-G34 (Ancillary Activities), NTL No. 2014-G04 BOEM (Military Warning and Water Test Areas), and NTL No. 2009-G40 (Deepwater Benthic Communities). The NTLs are current as BOEM NTL No. 2015-N01 and BSEE NTL No. 2014-N01 eliminate the expiration dates for NTLs pending review and reissuance.

Appendix A of this report contains the sonar contact report and table. Appendix B contains all equipment specifications, instrument settings, and a crew list. Appendix C contains the OII survey logs and Appendix D contains Fugro survey logs. Appendix E contains the Sound Velocity Profiles (SVP) and tide curves used to correct the multibeam bathymetry data.

1.1.1 PURPOSE AND SCOPE

The purpose of this Archaeological and Geohazard assessment is to characterize the nature of the site and to identify potential geological and man-made hazards, constraints to construction-related activities, potential biological communities, and determine the general seafloor and subsurface conditions within the study area. Geological hazards within the study area may include, but are not limited to, features such as slumps, areas of outcropping (hard grounds), pockmarks, seafloor depressions, faults, fluid or gas saturation zones, expulsion features, and potential for deepwater benthic (chemosynthetic and coral) communities. Potential man-made hazards may include shipwrecks, pipeline infrastructure, wells, and extraneous debris associated with lease developments and maritime activities.

Additionally, this assessment aims to identify potential submerged archaeological and cultural resources that could be impacted by lease development activities (See Section 2.0). This hazard assessment is intended to assess seafloor hazards and engineering constraints for the installation, construction, and integrity of the proposed flowline and umbilical.

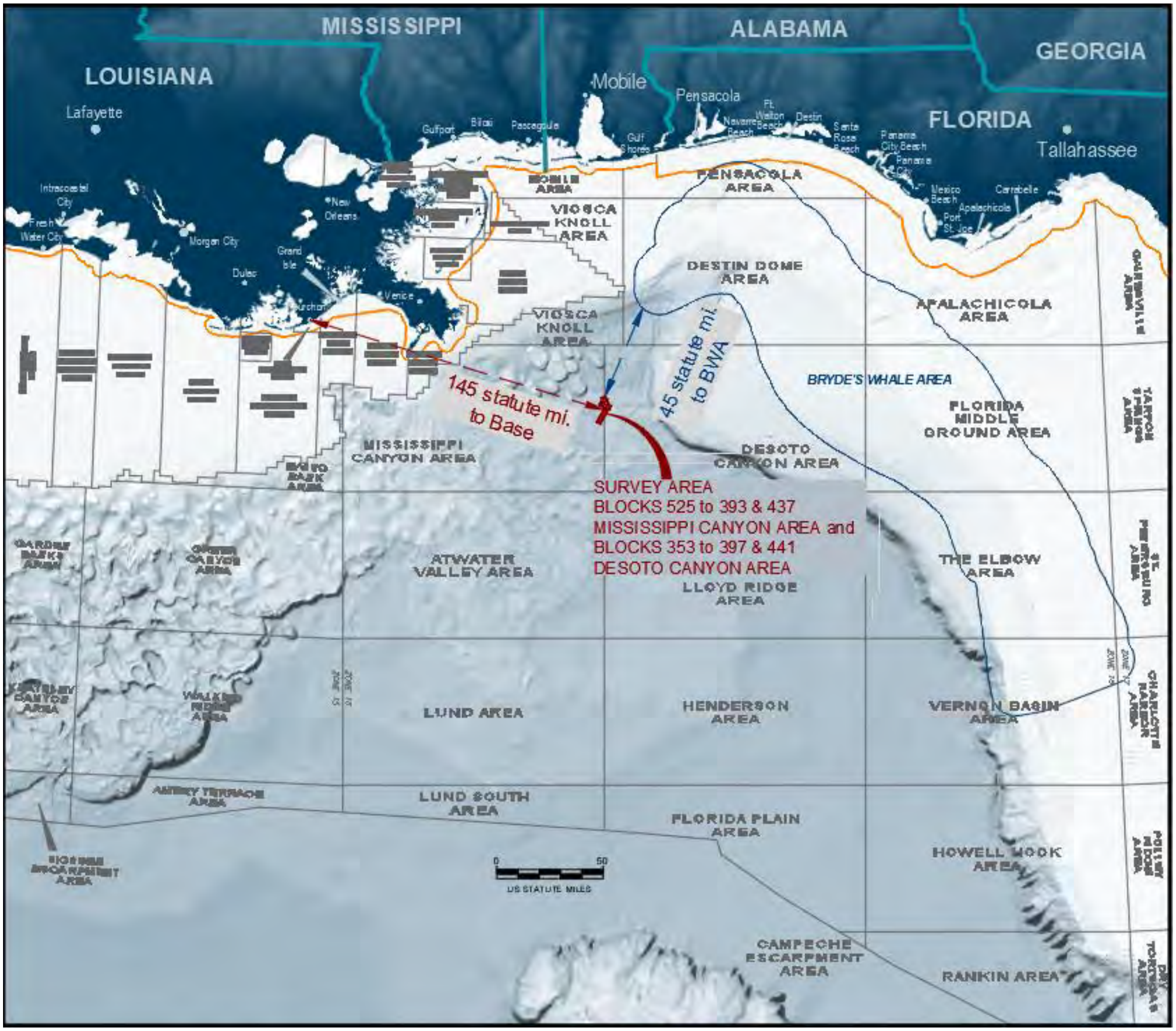

Figure 1. Regional map of the survey area.

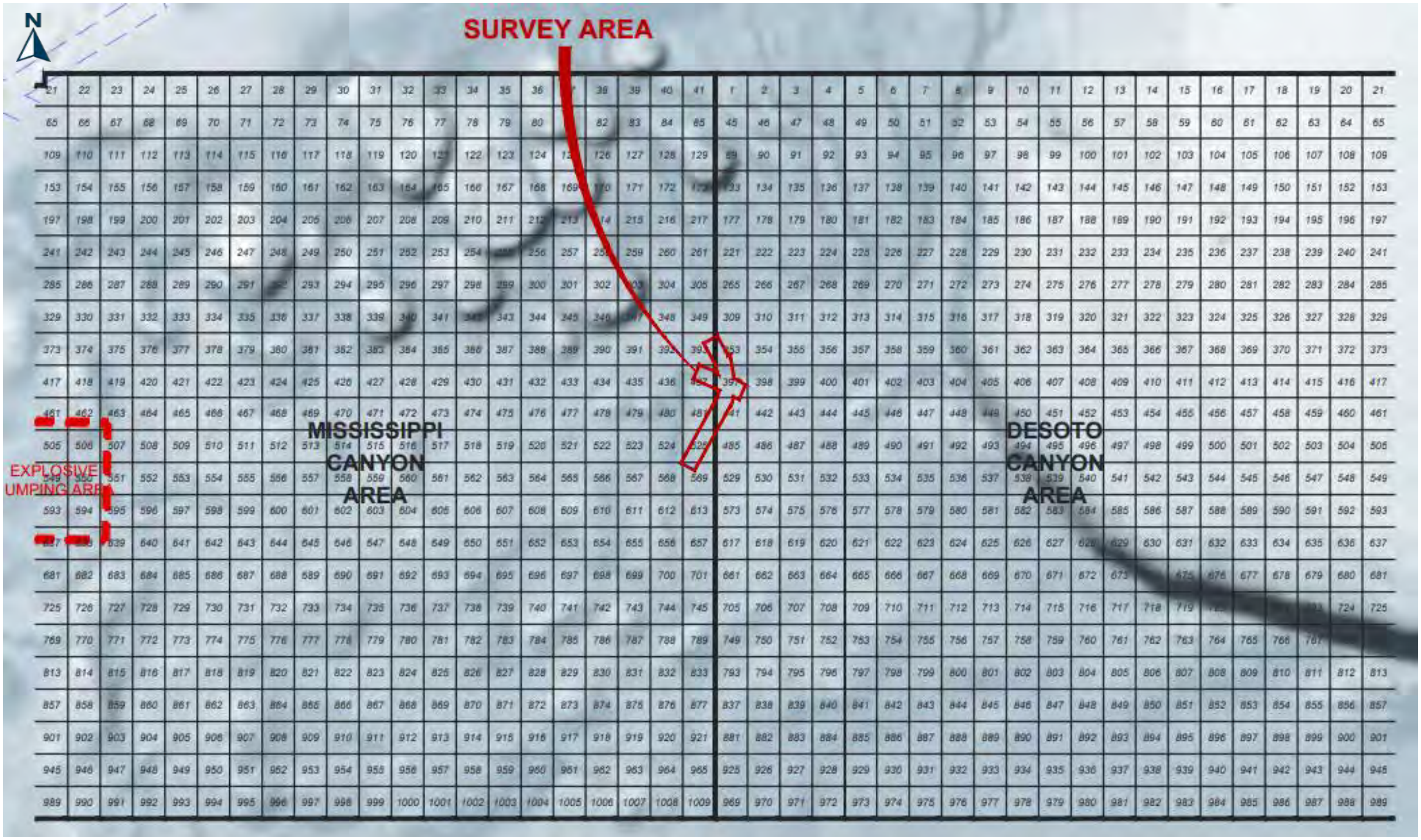

Figure 2. Vicinity map of the survey area.

1.1.2 PROJECT PERSONNEL

The following table (Table 1) identifies key Oceaneering office personnel.

Table 1. Key Office Personnel

Name	Company	Position
Jason Duplechin	OII	Sr. Manager, Data Management
Chris Baker	OII	Manager, Geoscience Reporting
Andrew Mayet	OII	GIS & Mapping Analyst
Robert Church	OII	Archaeologist
Brittany Broussard	OII	Geoscientist

1.1.3 PROPOSED ROUTES

The survey area is located approximately 145 miles east-southeast of Fourchon, Louisiana. The survey area is within the bounds of Military Warning Area EWTA-1. Table 2 lists the Outer Continental Shelf (OCS) blocks crossed by the proposed routes with the current Lease Operator.

Table 2. Lease Blocks Crossed by the Proposed Routes

EASE BLOCK NUMBER	OCS LEASE NUMBER	LEASE OPERATOR
MC393	OCS-G-26254	Shell
MC437	OCS-G-33733	Shell
MC481	Relinquished	N/A
MC525	OCS-G-31507	Shell
DC353	OCS-G-25852	Shell
DC397	OCS-G-25853	Shell
DC441	OCS-G-35357	Shell

Proposed 8.625-inch Oil Flowline Route

The proposed 8.625-inch Oil Flowline route originates at a proposed PLEM 3 Hub in MC525 (X: 1,334,196.00’, Y: 10,327,700.00’) in a water depth of approximately 7,522 feet MSL. The proposed route traverses north-northeast to Block 397, DeSoto Canyon Area (DC), then turns north, and northwest terminating at the Rydberg Production PLET 1 Hub in MC393 (X: 1,345,795.66’ Y: 10,385,357.82’) in a water depth of approximately 7,405 feet MSL. The total route length is 64,046.10 feet (12.13 statute miles). The proposed 8.625-inch Oil Flowline route is presented on the enclosed Sheets 1 and 2.

Proposed 8.5-inch Dynamic Umbilical Route

The proposed 8.5-inch Dynamic Umbilical route originates at the Appomattox “A” FPS in MC437 (X: 1,340,839.23’, Y: 10,370,308.76’) in a water depth of approximately 7,420 feet MSL. The proposed route traverses southeast to DC397, then turns south-southwest, terminating at a UTA in MC525 (X: 1,333,990.49’ Y: 10,327,766.66) in a water depth of approximately 7,515 feet MSL. The total route length is 53,957.17 feet or 10.22 statute miles. The proposed 8.5-inch Dynamic Umbilical route is presented on the enclosed Sheets 3 and 4.

1.2 SURVEY DESCRIPTION

1.2.1 ACQUISITION DATES AND WEATHER CONDITIONS

Fugro conducted field operations aboard the R/V *Fugro Enterprise* between March 31, and April 1-19, 2011. Sea conditions aboard the R/V *Fugro Enterprise* were between calm to 6 feet during the FGSI AUV survey. OII conducted a geophysical assessment and geotechnical field operations aboard the M/V *Ocean Project* from December 24 to 28, 2016, and from January 3 to 6, 2017. Sea conditions aboard the M/V *Ocean Project* during the survey operations were 1 to 8 feet with winds varying in direction with speeds ranging from calm to 27 knots. Although surface conditions affect AUV deployment and recovery operations, they have no effect on the data acquisition or data quality.

1.2.2 GEOPHYSICAL AND SURVEY EQUIPMENT

For the FGSI survey, the acoustically-aided inertial navigation system (INS), coupled with an acoustic Doppler velocity speed log and USBL (Ultra Short Base Line) positioning from the survey vessel, is used for primary positioning of the AUV. Data collected during the AUV survey include side-scan sonar (SSS), subbottom profiler (SBP), multibeam echosounder bathymetry and backscatter (MBES), and velocimeter cast data. Horizontal positioning of the survey vessel was accomplished with the FUGRO STARFIX® Differential Global Positioning System, which has a field accuracy of ±3 meters. In addition, the AUV is tracked with an USBL system and receives position updates via an acoustic modem to continually augment the INS navigation. The AUV performed pre-programmed survey missions collecting 200 kHz multibeam bathymetry and backscatter, 120 and 410 kHz chirp side-scan sonar, and 2-12 kHz chirp subbottom profiler data.

For the OII surveys, acquired geophysical instruments onboard the *O-Surveyor III* included the Simrad EM 2040 Multibeam Echosounder (200, 300 and 400 kHz), an EdgeTech Full Spectrum 2200M Chirp Dual Frequency Side Scan Sonar (120/410 kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5–10.0 kHz). All raw digital data were logged utilizing proprietary software developed by OII.

1.2.3 OII SURVEY METHODS AND DESIGN

Survey Vessel and AUV Positioning
Vessel headings were accomplished using two Meridian Surveyor Gyrocompasses and surface positioning was accomplished using OII's C-Nav 3050 L-band globally corrected DGPS with an integrated C-Nav/RTK Extended Receiver. C-Nav utilizes two independent satellite communications (NET1 and NET2) for its high accuracy global DGPS data, delivering positions in real time at sub-meter accuracy.

Underwater positioning of the *O-Surveyor III* AUV was accomplished using acoustically aided INS. AUV positions were calculated using a Kalman filter algorithm, which utilizes input data from a Kongsberg HiPAP, INS, and DVL systems. The inertial navigation system consists of a precision gyro and accelerometers to maintain the AUV-track mission plan. The AUV positions were recorded continuously with navigational fixes generated at 125-meter (~410-foot) intervals. The post-processed positions for the AUV are accurate to within ± 4 meters (~13 feet).

Survey Grid and Coverage
Survey tracklines were designed for overlapping coverage with the side scan sonar and multibeam systems, and representative coverage for the subbottom profiler system. The majority of the survey grid for the proposed route consists of a centerline, a 50-meter offset line, and two 200-meter wing lines. Several additional survey lines were run for route development and to provided additional survey coverage. The centerline for the proposed umbilical route is Line 203. The centerline for the proposed

flowline route is Line 202 from MC525 to DC397. Coverage for the proposed flowline from DC397 to MC393 is provided from multiple survey lines including the FGSI 2011 survey. The FGSI 2011 survey lines providing coverage for the route corridor include 33 main tracklines (518–550) run east-west at 200-meter lines spacing and two tie-lines (605 and 606) run north-south at 900–meter lines spacing. Shot points (event marks) are annotated every 125 meters (~410 feet) on all tracklines.

1.2.4 HORIZONTAL DATUM

The geodetic datum used to generate the study maps is the North American Datum of 1927 (NAD27) on the Clarke 1866 ellipsoid and projected using the Universal Transverse Mercator (UTM), Zone 16 North (16N). NADCON software version 2.1 was utilized to convert the GPS positions from the WGS84 datum to the local NAD27 datum. All coordinates referenced on the study maps and within this report are presented in this projection. All grid units, scales and measurements are in U.S. Survey Feet. The geodetic survey parameters are listed in Table 3.

Table 3. Geodetic Parameters

Parameter	Data Acquisition	OII Reporting and Maps
Geodetic Datum	WGS84	NAD27
Ellipsoid	WGS84	Clarke 1866
Grid Units	Meters	U.S. Survey Feet
Projection	Universal Transverse Mercator	Bureau of Land Management
Zone	16N	16N
Central Meridian	87° 00’ W	87° 00’ W
False Easting	500,000 meters at C.M	1,640,416.67 feet at C.M.

1.2.5 VERTICAL DATUM

The MBES data were processed at a 3-meter grid cell size and corrected for the field-measured water column harmonic mean velocity and predicted tides for the days of data collection. Predicted tides were generated from the NASA Goddard Global Ocean Tide Model. Additionally, barometric pressure readings were logged during the survey and corrections were applied to the recorded pressure sensor depth data in the AUV. The resulting water depth values are referenced to MSL. These data are provided herein with units in feet.

1.2.6 Mapping

The geodetic datum used to generate the study maps is the North American Datum of 1927 (NAD27) on the Clarke 1866 ellipsoid and projected using the Universal Transverse Mercator (UTM), Zone 16 North (16N). NADCON software version 2.1 was utilized to convert the GPS positions from the WGS84 datum to the local NAD27 datum. All coordinates referenced on the study maps and within this report are presented in this projection. All grid units, scales and measurements are in U.S. Survey Feet. The geodetic survey parameters are listed in Table 3.

The survey results are presented on the enclosed alignment charts for the proposed flowline and umbilical routes. The alignment charts are at a horizontal scale of 1 inch = 1,000 feet and consist of four panels each. The first panel contains the color shaded bathymetry overlain with contours at 5-foot intervals. The second panel exhibits the interpreted seafloor and subbottom features. The third panel displays the side scan sonar mosaic. The fourth panel shows the seafloor profile at a vertical scale of 1 inch = 100 feet.

1.2.6 CORING PROCEDURES

All core locations mentioned in this report were predetermined by Shell and are presented on the AE&H Maps. Coring procedures commenced from the back deck of the M/V *Ocean Project* and utilized a modified Grab Sample Box Corer and a Kullenberg Piston Corer on December 28th, 2016, January 6th, 2017, and June 15th, 2017. In survey area Rydberg coring operations were performed in water depths ranging from 7,411 to 7,607 feet MSL.

The piston coring device used on the M/V *Ocean Project* consists of a 20-foot long, 3-inch diameter steel pipe (core barrel) equipped with a hard metal nose piece (core cutter) at one end and a vane with dead weights added toward the other end. The corer is lowered with an electro-hydraulic winch until a tripping mechanism (30'–50' weighted line) senses the ocean bottom, releasing the corer so that the last part of the descent is made in free fall. Drag across the vane stabilizes the corer during the free fall and the weights drive the core barrel into the sediments. To facilitate the extraction of the sediment core, the barrel is equipped with a plastic liner, which can be slipped out and sealed to retain the core sample for analysis. A piston, located inside the liner and toward the core cutter, moves up the liner as the core barrel penetrates the sediments, permitting hydrostatic pressures to draw in the sample while removing the water. A brass, orange-peel like core catcher is located between the core cutter and the liner, preventing the sediment sample from washing out during retrieval. Each piston core sample is cut into 3-foot sections. All samples are retained and labeled. Samples that meet the depth requirement undergo offshore geotechnical analyses, including visual inspection of the sediments, handheld torvane and miniature vane shear strengths (undisturbed, residual, and remolded), density, moisture contents, and carbonate contents.

The Grab Sampler Box Corer device used on the M/V *Ocean Project* consists of a 2-foot wide, 3-foot long rectangular steel corer. The box core has dead weights on both sides and is lowered with an electro-hydraulic winch to the seafloor. Upon retrieval, steel jaws located at the base of the box core close shut and a lid at the top of the box core falls into place, ensuring that the sediment does not wash out during retrieval. The retrieved box core was inspected for sufficient recovery and approved before undergoing geotechnical analyses.

Two T-bar tests were conducted to measure shear strength on the M/V *Ocean Project*. The first T-bar testing method consisted of full penetration and full extraction, and the second test consisted of penetration and extraction at a depth of approximately 1 foot with an amplitude of +/- 4 inches. A miniature vane machine was then attached to the box core, and shear strength limits were recorded at 2-inch intervals to the full recovery depth of the core sample. A vacuum pump was used to preserve integrity of the samples as four (4) 3-inch diameter sub-sample sediment tubes were extruded from each box core. Three (3) sub-sample sediment tubes were sealed, labeled, and preserved for onshore geotechnical laboratory testing, while the fourth sub-sample underwent field geotechnical testing onboard the vessel. Field tests included density and moisture content analysis. The results of said onshore laboratory analyses were to be provided to Shell as a stand-alone report from a 3rd party entity. OII has submitted a Geotechnical Operations Report detailing the offshore geotechnical procedures, test results, and photographs.

1.3 REGIONAL GEOLOGIC SETTING

The Gulf of Mexico is a semi-enclosed basin that has been receiving sediment influx dominated by the Mississippi River since the Late Jurassic. Mesozoic and Cenozoic sediments have attained a thickness in excess of 9 miles (Coleman *et al.*, 1991). The prograde shelf sequence consists of intercalated coastal plain, delta, estuarine, and marine sediments. Sediment deposition along the northern rim of the Gulf of

Mexico resulted in particularly thick Tertiary and Quaternary sections. These rapidly deposited sediments have prograde the Cretaceous shelf-edge up to 185 miles basin ward. The exceptionally high rate of shelf-edge progradation is on the order of 3.0 to 3.7 miles per 1,000 years.

The near surface geology across the Gulf Coast region is the product of fluctuating sea levels associated with climatic variations over the past 20,000 years. During this time, low sea levels left the continental shelf exposed to subaerial weathering and other erosional processes. Streams and rivers meandered and down cut into the exposed landmass, depositing their bedload along the modern-day shelf break. Fan systems were formed, and mass movement events were common as deltaic sediments were deposited on the steep upper continental slope. As the climate warmed, seas transgressed, and marine sediments were deposited on the shelf.

Deepwater Depositional Environments

Deepwater depositional environments as referred to in this report are the regions that lie beyond the shelf break in the northern Gulf of Mexico. They extend predominantly southward across the continental slope into bathyal and abyssal depths. The northern Gulf of Mexico can be broken up into three unique deepwater depositional environments: the Mississippi Canyon and Fan regions, the Texas-Louisiana Slope region, and the Rio Grande Slope region (Bryant *et al.*, 1991, Figure 3). The study area is located within an area defined as the Mississippi Canyon and Fan region, which is described as follows.

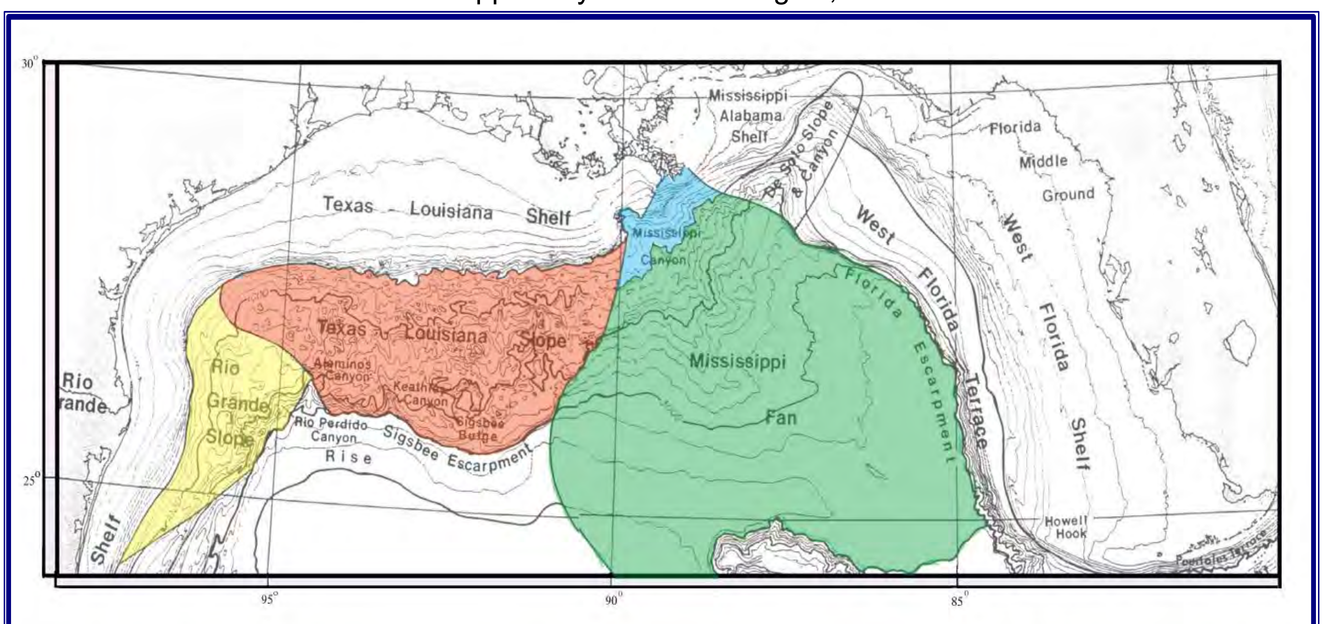

Figure 3. Deepwater depositional environments of the northern Gulf of Mexico Slope (Modified from Bryant *et al*., 1991).

Mississippi Canyon and Fan Region

The survey area is located in the eastern portion of the recent Mississippi Fan. The Mississippi Fan is a large, regional, deepwater feature that exists in the east-central Gulf of Mexico. The fan is a channel-levee-overbank complex that is approximately 350 miles long and up to 373 miles wide. It extends southeast from the base of the continental slope at a depth of approximately 1,000 feet at the base of the slope and 10,500 feet on the abyssal plain. The fan has been described as a broad, arcuate submarine fan comprised of several fan lobes separated by pelagic oozes or muddy sediment (Bouma et al., 1989).

The Mississippi Fan is split into three sections: upper fan, middle fan, and lower fan. The upper fan has a slightly convex shaped surface with a wide channel at its apex, which is flanked by laterally discontinuous reflectors believed to be over bank deposits. The middle fan holds the greatest accumulation of sediment and is imaged on sonar data as a leveed, sinuous channel complex that averages 0.7 to 1.6 miles wide. Less prominent channel complexes that undergo rapid channel abandonment define the lower fan. It can be assumed similar fans have been active during the geologic past in the entire Mississippi Canyon, Atwater Valley, Lloyd Ridge, and Lund Areas. Deposits in the channels consist of fining upward turbidite sequences (gravel to clay size) with the base of the gravel representing the time of the episodic event (Bouma et al., 1989).

The Mississippi Canyon formed approximately 30,000 years ago and continues to serve as a transport pathway moving sediment from the Mississippi River and continental shelf to a vast offshore fan that covers thousands of square kilometers and is over 3,000 meters thick.

1.3.1 BATHYMETRY

Fugro used a Kongsberg EM2000 Multibeam Bathymetric System which was utilized to determine accurate water depths across the survey area. OII used a Kongsberg EM 2040 Swath Bathymetry System which was utilized to determine accurate water depths across the survey area. Water depths are referenced to MSL and are shown at 5-foot intervals on the Color Shaded Bathymetry Maps (Sheets 1–4). Water depths range from 7,415 feet to 7,560 feet MSL within the study area.

Water depths along the proposed 8.625-inch Oil Flowline Route measure approximately 7,522 feet MSL at the beginning of the route at a proposed PLEM 3 Hub in MC525 to 7,405 feet MSL at the proposed termination point at the Rydberg Production PLET 1 Hub in MC393.

Water depths along the proposed 8.5-inch Dynamic Umbilical route measure approximately 7,420 feet MSL at the beginning of the route at the Appomattox “A” FPS in MC437 to 7,515 feet MSL at the proposed termination point at a UTA in MC525.

The seafloor is relatively flat across the entire study area with gradients averaging less than 2° and water depths gently decreasing to the east-southeast. Throughout this survey area the seafloor has mounded areas and buried MTDs, with gradients of up to 5° noted along these features. The largest gradient observed along either route measures 2.0° at Mile Point (MP) 11.5 along the proposed oil flowline route.

1.3.2 SEAFLOOR FEATURES

Color shaded bathymetry and side scan sonar data were used to delineate seafloor features across the survey area (Sheets 1–4). This survey area has smooth to slightly irregular topography. Slightly irregular seafloor is likely related to past events of regional and local mass transport and deposition as well as mini-basin sediment infill, many of which are buried beginning at 8 feet below mudline (BML) (Figure 4). Side scan sonar imagery along the proposed route displays low to moderate acoustic reflectivity indicative of fine-textured seafloor sediments.

In 2011 Fugro reported drag scars present in Block 397, Desoto Canyon Area. In OIIs investigation in 2017 no drag scars were identified. In Report No. 2411-5001 these drag scars were interpreted to be related to seafloor disturbance from the installation of the anchor piles in DC397. These drag scars can be seen in Figure 5.

1.3.3 SUBSURFACE GEOLOGY

The SBP recorded high-resolution subsurface stratigraphy up to depths of approximately 175 feet BML. Subsurface features interpreted from the SBP data are presented on the Seafloor and Subbottom Features Panel. In general, the stratigraphy is comprised of alternating high- and low-amplitude parallel reflectors with interspersed MTDs. These reflectors represent deposition of hemipelagic clay drape underlain by cyclic deposition of slay and silty turbidites with exception of locations with cyclic deposition interrupted by mass transport deposits (MTDs) and ponded sediments.

The MTDs in this survey area are considered buried gravity flows composed of chaotic, unconsolidated sediments likely related to a massive landside from the shelf during the last sea level regression. An extensive mass transport deposit is buried 115 to 140 feet below the seafloor (BSF) and blankets the entire survey corridor (Figure 6). In shallower units of the subbottom there are much smaller MTDs present. MTD A in DC353 and DC397 occurs below the hemipelagic drape, buried 7 to 10 feet BSF and MTD B in MC525 ranges in depth from 83 to 90 feet BSF (Figure 6 and Figure 7). Zones of micro-fracturing and dewatering are present near the larger of these features MTD B and are considered to have a negligible effect on pipeline construction activities. The shallow depth of MTD A should be considered when operating in the vicinity. Another buried MTD is located along the southern border between MC393 and DC353, and is buried approximately 75 feet below the seafloor. This MTD ranges in thickness around 20 feet. (Figure 6). Interpreted MTDs along both routes are shown within Panel 4 of the enclosed maps.

Table 4. Interpreted MTDs within the Rydberg Survey Area.

Name	Top of MTD Depth Range (ft BML)	Location
Buried MTD	75	MC393 and DC353
MTD A	7 to 10 feet BSF	DC353 and DC397
MTD B	83 to 90 feet BSF	MC525

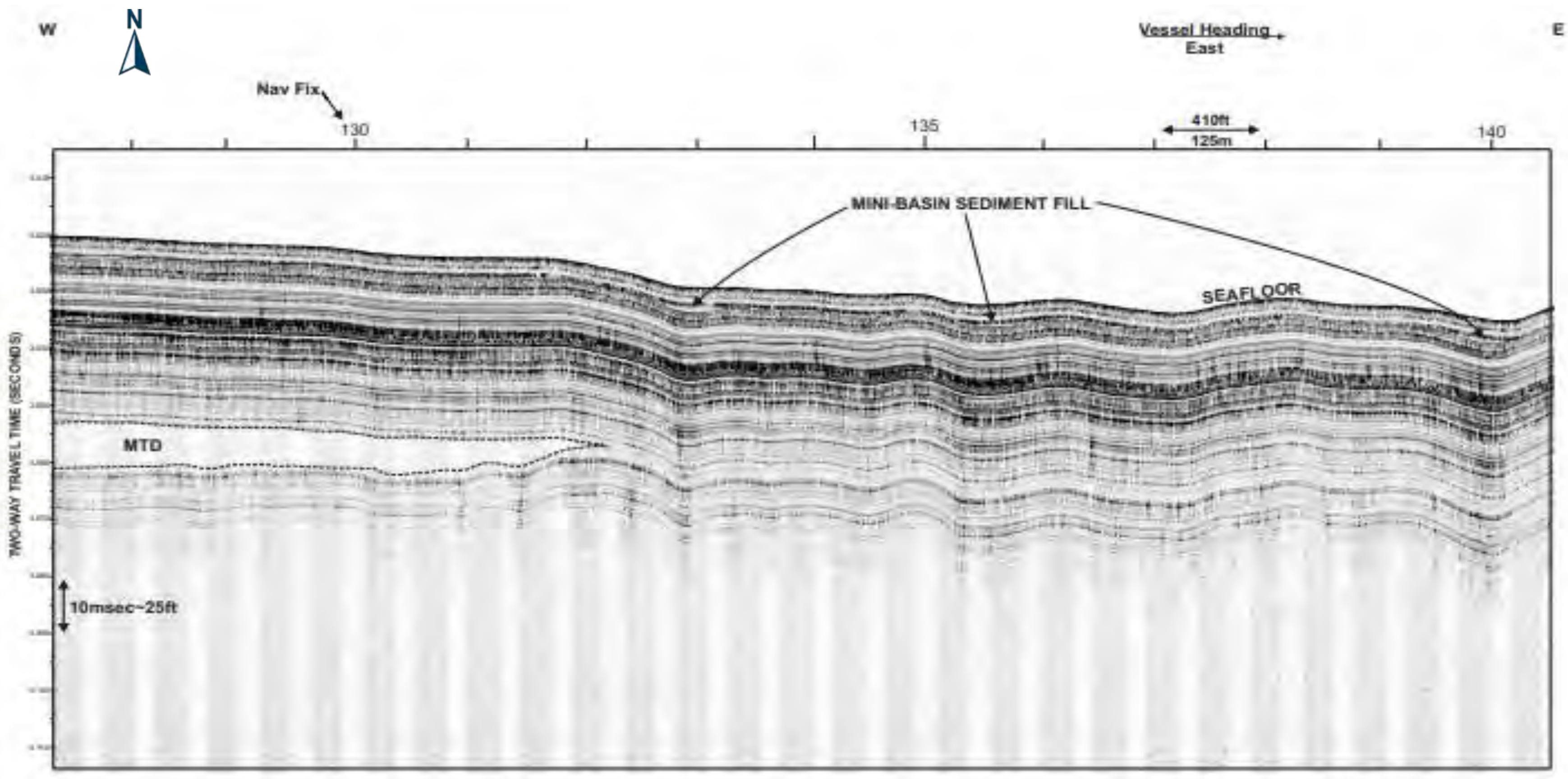

Figure 4. Subsurface Geologic Conditions in MC393 showing buried MTDs

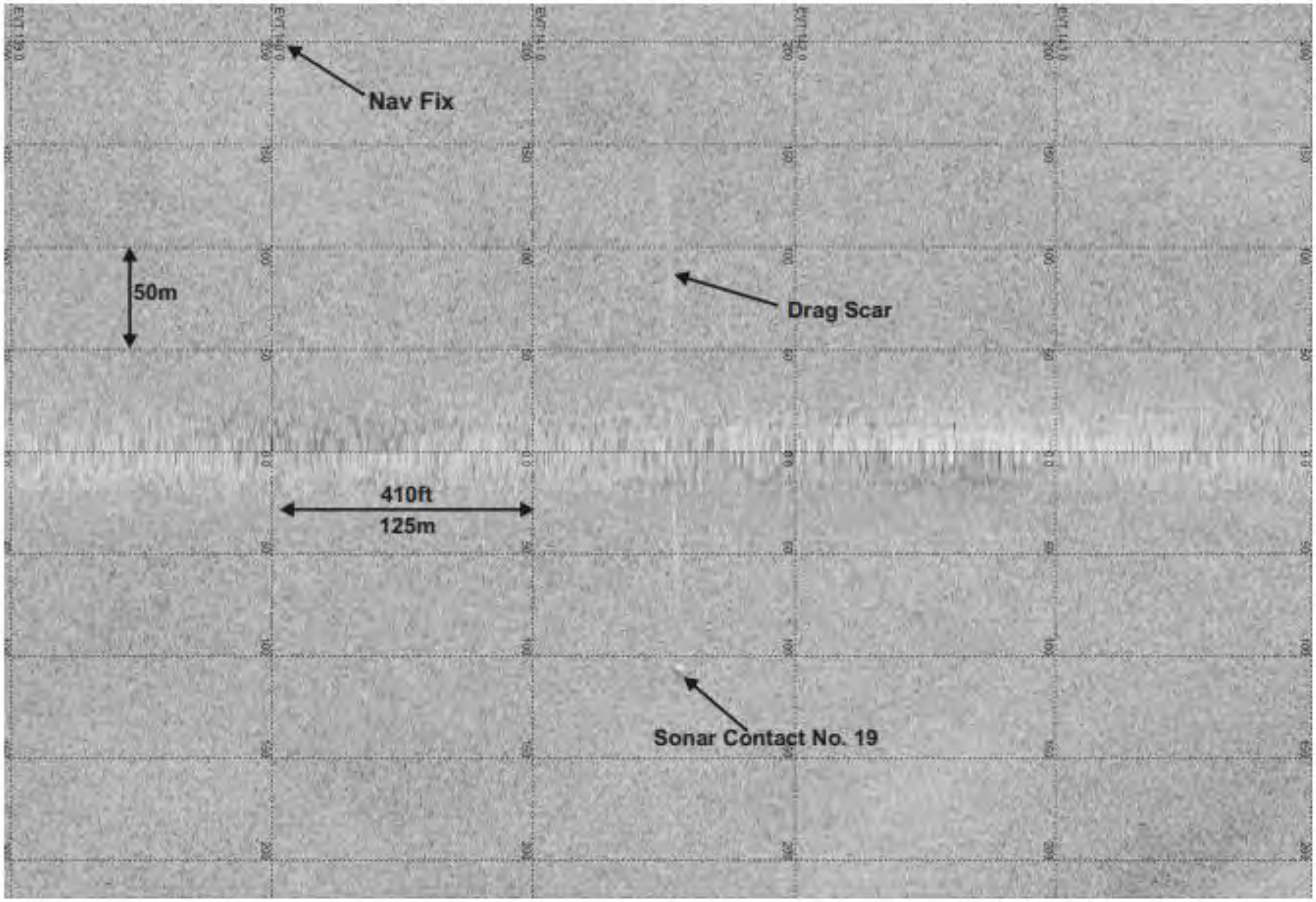

Figure 5. SSS Line 528 Showing Seafloor Conditions in DC397 (FGSI)

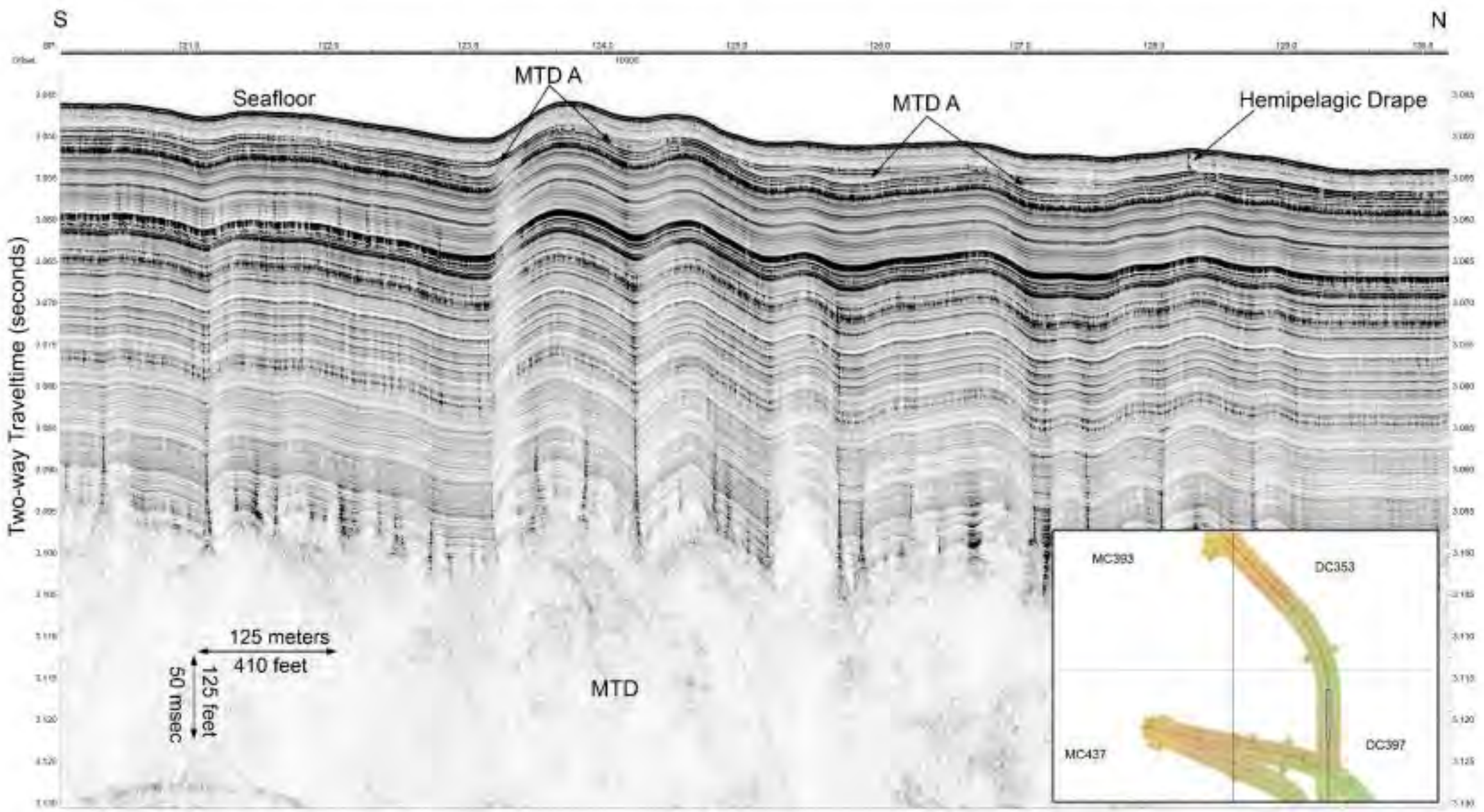

Figure 6. Hemipelagic drape, seafloor irregularities, and MTD A along the centerline (Line 103.1.b) of the proposed flowline route

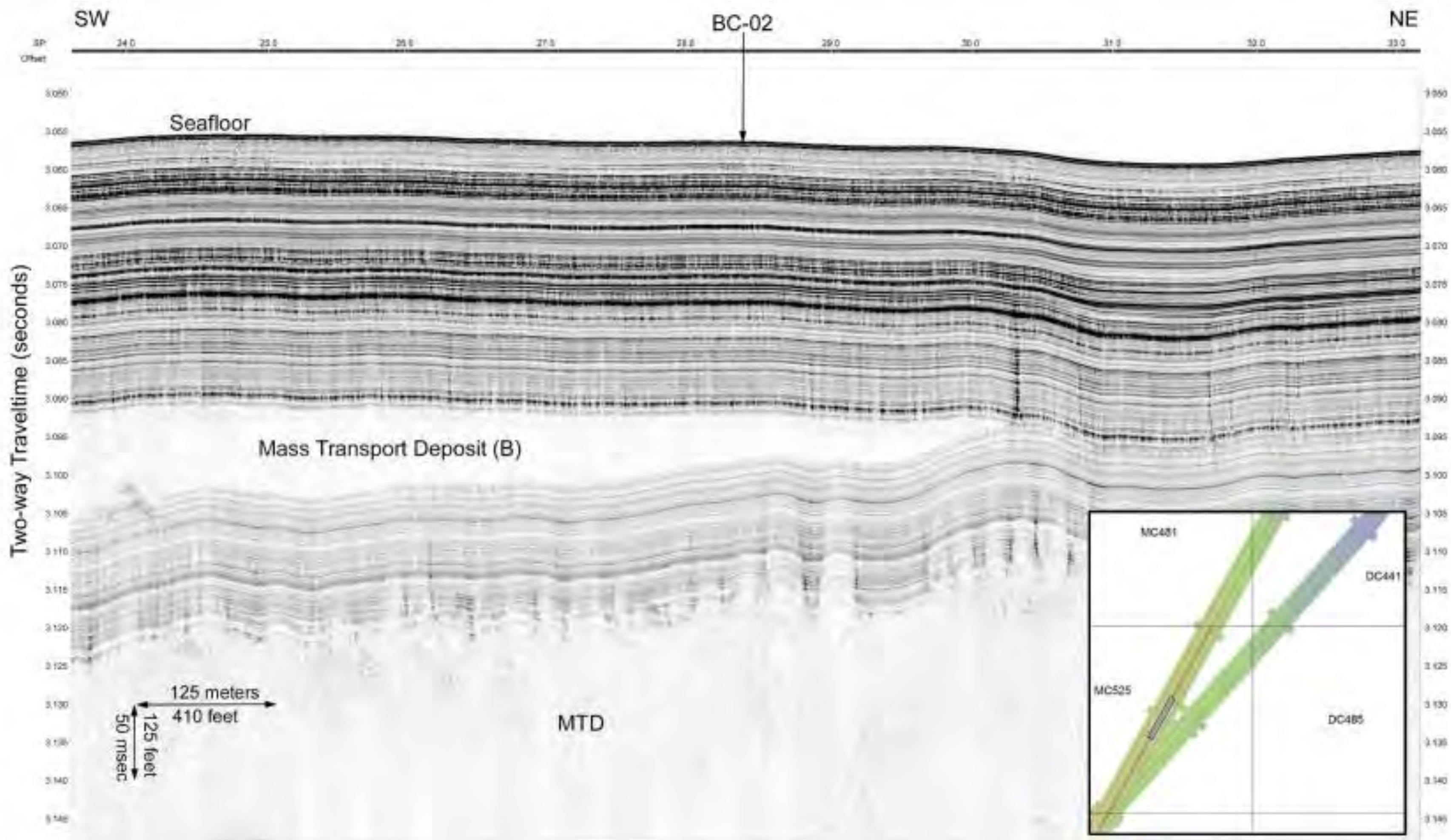

Figure 7. MTD B along the centerline (Line 103.1.a) of the proposed flowline route near box core BC-02

1.3.4 ASSESSMENT OF DEEPWATER BENTHIC COMMUNITIES

The Notice to Lessees (NTL), Operators and Pipeline Right-of-Way Holders No. 2009-G40 became effective on January 27, 2010. The BOEM/BSEE issued this NTL for oil and gas companies operating in water depths greater than 300 meters (984 feet) implementing measures to detect and protect high-density deep-water benthic (chemosynthetic and coral) communities in the Gulf of Mexico Outer Continental Shelf (OCS) region.

Deepwater chemosynthetic communities were first discovered in the central Gulf of Mexico in 1984. These communities typically exist in water depths greater than 300 meters (984 feet) and consist of assemblages of tubeworms, clams, mussels, bacterial mats, and a variety of associated organisms. They feed on a carbon source independent of photosynthesis and are therefore independent of the photosynthetic food chain (MacDonald *et al.*, 1990). While most of these communities support low densities of organisms, high-density chemosynthetic communities have been noted where hydrocarbon-charged sediments and acoustic void zones are associated with surface faulting. Anomalous mounds or knolls and gas or oil seeps may also support high-density chemosynthetic communities. The presence of high-density chemosynthetic communities is often linked with zones of seafloor fluid vents, accumulations of hydrates, and outcrops of authigenic carbonate rock in the Gulf of Mexico (Behrens, 1988). Hydrocarbon flow rate through the seafloor is important in sustaining healthy chemosynthetic communities (Roberts, 2001). However, not all areas of high seafloor amplitudes surrounded by other contributing features will support high-density chemosynthetic communities. Visual inspection of areas of high-amplitude seafloor reflectors is necessary to confirm the presence of high-density chemosynthetic communities.

Deepwater coral communities have been known to occur in the Gulf of Mexico for several decades. Various environmental factors including availability of suitable substrate, water temperature, current speed, organic input, and seepages of hydrocarbons have been proposed to regulate deep-water corals (CSA International, Inc., 2007). The known occurrences of deep-water corals in the Gulf of Mexico are almost exclusively on hard substrate of authigenic carbonate created by chemosynthetic communities although limited observations and sample collections indicate the corals are probably widely distributed. Common species include the scleractinian corals *Lophelia pertusa* and *Madrepora oculata,* the gorgonian *Callogorgia americana delta*, antipatharians, sponges, anemones, and various crustaceans. *Lophelia* has been found in water depths as shallow as 309 meters (1,014 feet) in the Gulf of Mexico and reported in water depths up to 3,000 meters (9,842 feet) in some parts of the world. Deepwater coral colonization can be on scattered small solitary features or spread over larger areas. These complex communities form three-dimensional structures that create habitat hot-spots of biodiversity.

Features or areas that could support deepwater benthic (chemosynthetic or coral) communities were not identified within the survey area. Therefore, impact to potential deep-water benthic communities is considered negligible.

1.3.5 MAN-MADE FEATURES

A review of OII's proprietary database and BOEM/BSEE public databases indicate there are several LBL acoustic transponder frames and one well within the bounds of the Rydberg survey area that are all active. A review of these LBL acoustic transponders and Vicksburg well can be seen in Table 5. Details of all existing pipelines and umbilicals within the Rydberg survey area can be found in Table 6.

Eleven unidentified sonar contacts from the OII 2016 survey are recorded within the survey corridor (Nos. 1–4, 6–9 and 14–16). One unidentified sonar contact from the FGSI 2011 survey is recorded within the survey corridor (No. 19). Most sonar contacts are relatively small measuring less than 25 feet in length or width, except Sonar Contact No. 4 (Figure 10). Sonar Contact No. 4, measuring 42.5 x 23.3 with no measurable height, is located near the eastern edge of the survey corridor in MC525 and approximately 685 feet from the proposed Flowline route. The original archeological assessment that accompanied the 2016 survey determined Sonar Contact No. 4 had archaeological potential and a 100-foot avoidance was recommended. More information is detailed in the Archeological Assessment portion of this report (Section 2.0).

Two unidentified sonar contacts (Nos 8 and 14) are located within 100 feet of the proposed routes. Sonar Contact No. 8, measuring 13.4 x 5.1 with no measurable height, is located between the proposed Umbilical and Flowline routes in MC481. It is 54 feet from the proposed Flowline route and over 130 feet from the proposed Umbilical route. Contact No. 14, measuring 16.6 x 12.4 with no measurable height, is located 80 feet from the proposed Flowline route in DC397.

Sonar Contact No. 19 from the FGSI 2011 survey, measuring 15.7 x 7.8 feet with no measurable height, is associated with an anchor drag scar and is likely a depression with a low sedent mound from a former anchor location. The remaining sonar contact are interpreted as modern debris or geological in origin.

Table 5. Existing Infrastructure within Rydberg Survey Area.

Name	Type of Infrastructure	Block Location	Active	Easting (X) (ft)	Nothing (Y) (ft)
OCS-G-	Vicksburg well	MC393	Yes	1,345,535	10,385,322
VX1	LBL acoustic transponder	MC393	Yes	1,345,127	10,386,409
VX2	LBL acoustic transponder	MC393	Yes	1,346,223	10,386,161
VX3	LBL acoustic transponder	MC393	Yes	1,346,649	10,385,277
VX4	LBL acoustic transponder	MC393	Yes	1,346,104	10,384,468
VX5	LBL acoustic transponder	MC393	Yes	1,344,902	10,384,482
VX6	LBL acoustic transponder	MC393	Yes	1,344,882	10,385,600

Table 6. Existing Pipelines and Umbilical's Within the Rydberg Survey Area

PIPELINES AND UMBILICALS	BLOCK(s)
S-19419 SHELL 20"	MC431
S-19416 SHELL 21" Water	MC432
S-19410 SHELL 10"	MC433
S-19409 SHELL 10"	MC434
S-19415 SHELL 12" Water	MC435
S-19686 SHELL 1"-4" Umb	MC436
S-19686 SHELL 1"-4" Umb	MC437
S-19682 SHELL 1"-8" Umb	MC437 AND MC388
S-19683 SHELL 1"-8" Umb	MC437 AND MC389
S-19684 SHELL 1"-8" Umb	MC437 AND MC390
S-19411 SHELL 10"	MC437 AND MC391
S-19412 SHELL 10"	MC437 AND MC392
S-19417 SHELL 8"	MC437 AND MC393
S-19413 SHELL 10"	MC437 AND MC394
S-19414 SHELL 10"	MC437 AND MC395
S-19418 SHELL 12"	MC437, MC393, AND DC353
S-19685 SHELL 1"-8" Umb	MC437, MC393, AND DC353

Two existing lines are crossed by the proposed 8.625-inch Oil Production Flowline route; the S-19685 Shell 1-8-inch Umbilical and S-19418 Shell 12", both in DC353. There are no crossing locations along the proposed 8.5-inch Dynamic Umbilical route.

1.3.6 BOX AND PISTON CORING

Between December 28th, 2016 and January 6th, 2017 thirteen box core samples were collected along the proposed routes onboard OII's M/V *Ocean Project*. On June 15th, 2017 one piston core was collected. All coring operations were performed in water depths ranging from 7,411 to 7,607 feet MSL. Field visual classifications and geotechnical analyses were performed on each sample onboard the vessel.

The seabed soils were interpreted to be medium to light brown, very soft, slightly sandy clays. The soil color transitioned from brown to gray as tests were performed at increasing depths of four-inch intervals for the box core samples. The piston core maintained the same color throughout the entire core sample but stiffness increased with depth. The geotechnical tests generally indicated stiffer soil at increasing depths. OII provided the test results for all the box cores to Shell in a standalone Geotechnical Operations Report. OII will submit a separate Geotechnical Operations Report for the one piston core collected. Table 7 presents the location and water depths of each core.

Table 7. Box and Piston Core Locations and Water Depth

CORE NO.	EASTING (X) (ft)	NORTHING (Y) (ft)	WATER DEPTH (ft)
BC-01	1,334,153	10,327,753	7,520
BC-02	1,338,604	10,335,749	7,520
BC-03	1,342,764	10,343,060	7,522
BC-04	1,348,383	10,353,227	7,553
BC-05c	1,353,375	10,362,894	7,525
BC-06	1,353,235	10,376,490	7,510
BC-07d	1,346,033	10,385,177	7,411
BC-08	1,346,943	10,367,580	7,479
BC-09	1,341,373	10,335,620	7,541
BC-10	1,348,805	10,343,899	7,556
BC-11	1,355,842	10,351,739	7,607
BC-12	1,358,068	10,361,826	7,562
BC-13b	1,350,482	10,368,511	7,482
PC-01	1,334,221	10,327,708	7,526

The geotechnical investigation along the proposed routes recovered thirteen successful box core samples and one successful piston core location. Field visual classifications and geotechnical analyses were performed on each sample onboard the vessel. The seabed soils were interpreted to be medium to light brown, very soft, slightly sandy clays. The soil color transitioned from brown to gray as tests were performed at increasing depths of four-inch intervals for the box core samples. The piston core maintained the same color throughout the entire core sample but stiffness increased with depth. The geotechnical tests generally indicated stiffer soil at increasing depths. OII provided the test results for all the box cores to Shell in a standalone Geotechnical Operations Report. OII will submit a separate Geotechnical Operations Report for the one piston core collected. Table 6 presents the actual location and water depths of each core.

1.4 GEOHAZARDS CONCLUSIONS AND RECOMMENDATIONS

OII conducted an Archaeological and Geohazard assessment for a proposed 8.625-inch Oil Flowline route from MC525 to MC393 and a proposed 8.5-inch Dynamic Umbilical route from MC437 to MC525.

The proposed 8.625-inch Oil Flowline route originates at a proposed PLEM 3 Hub in MC525 (X: 1,334,196.00’, Y: 10,327,700.00’) in a water depth of approximately 7,522 feet MSL. The proposed route traverses north-northeast to Block 397, DeSoto Canyon Area (DC), then turns north, and northwest terminating at the Rydberg Production PLET 1 Hub in MC393 (X: 1,345,795.66’ Y: 10,385,357.82’) in a water depth of approximately 7,405 feet MSL. The total route length is 64,046.10 feet (12.13 statute miles).

The proposed 8.5-inch Dynamic Umbilical route originates at the Appomattox “A” FPS in MC437 (X: 1,340,839.23’, Y: 10,370,308.76’) in a water depth of approximately 7,420 feet MSL. The proposed route traverses southeast to DC397, then turns south-southwest, terminating at a UTA in MC525 (X: 1,333,990.49’ Y: 10,327,766.66) in a water depth of approximately 7,515 feet MSL. The total route length is 53,957.17 feet or 10.22 statute miles.

This assessment is based on three previous surveys/assessments. The first is an AUV geophysical survey data acquired by Fugro Enterprise between March 31 and April 1-19, 2011. The second is an Archaeological, Engineering and Hazard Assessment based on the interpretation of geophysical data collected by OII’s from December 24th to 28th, 2016. The third is seafloor infrastructure data acquired by TechnipFMC between June 03, 2022, and June 06 through 07, 2022. AUV geophysical data includes multibeam bathymetry, side scan sonar, and subbottom profiler.

The multibeam bathymetric data depicts a smooth and slightly undulating seafloor topography which slopes gently to the east-southeast at an average gradient of between 1° and 5°. There were no gradients of greater than 2° identified along either proposed routes.

The primarily low to moderate acoustic reflectivity displayed on the multibeam backscatter and side scan sonar data suggests the seabed composition is primarily made of fine-grained sediments.

The seabed is covered by a 6-to-10-foot hemipelagic clay drape underlain by alternating beds of silt and clay. Buried mass transport deposits are the most common subsurface feature occurring within the survey corridor. There were no other seafloor or subsurface geohazards to pipeline installation activities noted along either route.

Two unidentified sonar contacts (Nos 8 and 14) are located within 100 feet of the proposed routes. Sonar Contact No. 8, measuring 13.4 x 5.1 with no measurable height, is located between the proposed Umbilical and Flowline routes in MC481. It is 54 feet from the proposed Flowline route and over 130 feet from the proposed Umbilical route. Contact No. 14, measuring 16.6 x 12.4 with no measurable height, is located 80 feet from the proposed Flowline route in DC397.

Two existing lines are crossed by the proposed 8.625-inch Oil Production Flowline route; the S-19685 Shell 1-8-inch Umbilical and S-19418 Shell 12”, both in DC353. There are no crossing locations along the proposed 8.5-inch Dynamic Umbilical route.

There were no features identified which could support deepwater benthic (chemosynthetic or coral) communities.

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2.0 ARCHAEOLOGICAL ASSESSMENT

2.1 INTRODUCTION

Shell Exploration and Production Company (Shell) contracted Oceaneering International, Inc. (OII) to perform an Archaeological and Geohazard Assessment for a proposed 8.625-inch Oil Flowline route and proposed 8.5-inch Dynamic Umbilical Route between Block 393, 437 and 525, Mississippi Canyon Area (MC), Gulf of Mexico. Regional and Vicinity maps of the study area are shown as Figures 1 and 2, respectively. This assessment is based on Autonomous Underwater Vehicle (AUV) surveys completed by OII in 2016 and 2017 (OII Job No. 180110) and Fugro GeoServices, Inc. (FGSI) in 2011 (FGSI Job No. 2408-5022). The purpose of this assessment was to identify potential submerged archaeological resources that could be impacted by proposed construction activities. The survey fieldwork and this report comply with the U.S. Department of Interior's Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE) Notice-To-Lessees (NTL) No. 2005-G07 for Archaeological Resource Survey and Reports. The survey was carried out in blocks designated by the BOEM/BSEE as having a high probability for historic shipwrecks.

Proposed 8.625-inch Oil Flowline Route

The proposed 8.625-inch Oil Flowline route originates at a proposed PLEM 3 Hub in MC525 (X: 1,334,196.00', Y: 10,327,700.00') in a water depth of approximately 7,522 feet MSL. The proposed route traverses north-northeast to Block 397, DeSoto Canyon Area (DC), then turns north, and northwest terminating at the Rydberg Production PLET 1 Hub in MC393 (X: 1,345,795.66' Y: 10,385,357.82') in a water depth of approximately 7,405 feet MSL. The total route length is 64,046.10 feet (12.13 statute miles). The proposed 8.625-inch Oil Flowline route is presented on the enclosed Sheets 1 and 2.

Proposed 8.5-inch Dynamic Umbilical Route

The proposed 8.5-inch Dynamic Umbilical route originates at the Appomattox "A" FPS in MC437 (X: 1,340,839.23', Y: 10,370,308.76') in a water depth of approximately 7,420 feet MSL. The proposed route traverses southeast to DC397, then turns south-southwest, terminating at a UTA in MC525 (X: 1,333,990.49' Y: 10,327,766.66) in a water depth of approximately 7,515 feet MSL. The total route length is 53,957.17 feet or 10.22 statute miles. The proposed 8.5-inch Dynamic Umbilical route is presented on the enclosed Sheets 3 and 4.

OII field operations were conducted aboard the M/V *Ocean Project* between December 24, and 28, 2016 using the *O-Surveyor III* AUV and box cores collected between January 3 and 6, 2017. During the survey, the sea conditions were between 1 to 8 feet and winds varied in direction with speeds ranging from calm to 27 knots. Although surface conditions do not affect geophysical data collection or quality, it can affect AUV launch and retrieval operations.

FGSI field operations were conducted aboard the R/V *Fugro Enterprise* between March 31, and April 19, 2011. Sea conditions were between calm to 6 feet during the FGSI AUV survey. The FGSI 2011 survey provides supplemental coverage for a portion of the Flowline route that passes through MC393, DC353, and DC397. An assessment of the FGSI data is provided by Shell in a report by FGSI marine archaeologists Mark Melancon on August 4, 2011. Those survey results are included in the following assessment.

Survey tracklines were designed for overlapping coverage with the side scan sonar and multibeam systems, and representative coverage for the subbottom profiler system. The majority of the survey grid for the proposed route consists of a centerline, a 50-meter offset line, and two 200-meter wing lines. Several additional survey lines were run for route development and to provided additional survey coverage. The centerline for the proposed Umbilical route is Line 203. The centerline for the proposed flowline route is Line 202 from MC525 to DC397. Coverage for the proposed Flowline from DC397 to MC393 is provided from multiple survey lines including the FGSI 2011 survey. The FGSI 2011 survey lines providing coverage for the route corridor include 33 main tracklines (518–550) run east-west at 200-meter lines spacing and two tie-lines (605 and 606) run north-south at 900–meter lines spacing. Shot points (event marks) are annotated every 125 meters (~410 feet) on all tracklines.

The Sonar Contact Reports and Tables listing all unidentified sonar contacts are in Appendix A. The specifications and instrument settings for the survey equipment used for data acquisition, survey configuration, and a listing of field personnel involved in this project are in Appendix B. Appendix C contains the OII survey logs. Appendix D contains the FGSI OII survey logs. Appendix E contains the water column sound velocity profiles and tide curves used to correct the bathymetric data.

The *O-Surveyor III* AUV was deployed from the M/V *Ocean Project* using inertial navigation as the primary positioning system. Geophysical instruments integrated into the *O-Surveyor III* AUV and used for the survey include a Kongsberg EM 2040 Multibeam Echosounder (200 kHz), EdgeTech 2200M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120 kHz), and EdgeTech DW106 Chirp Subbottom Profiler (1.5–4.5 kHz). All the raw digital data were logged utilizing OII's proprietary software.

Surface positioning of the M/V *Ocean Project* was accomplished using C-NAV® L-Band globally corrected differential GPS (DGPS). C-NAV® provided positions in real time with sub-meter accuracy. Underwater positioning of the *O-Surveyor III* AUV was accomplished with acoustically aided inertial positioning. AUV positions were calculated using a Kalman filter algorithm, which uses input data from a Kongsberg HiPAP (High Precision Acoustic Positioning) USBL (Ultra-Short Base Line) System, inertial navigation, and Doppler Velocity Log (DVL). The post-processed positions for the AUV are accurate to within ± 4 meters.

The FGSI AUV was deployed from the R/V *Fugro Enterprise* using inertial navigation coupled with Doppler velocity logger. Surface positioning of the R/V *Fugro Enterprise* was accomplished using FUGRO STARFIX® DGPS, which provides accuracy of ±3 meters. The AUV was tracked using a USBL system and the positions were updated using an acoustic modem. Geophysical instruments integrated into the FGSI AUV and used for the survey include Multibeam Echosounder, Side Scan Sonar, and a Subbottom Profiler.

The geodetic datum used to generate the study maps is the North American Datum 1927 (NAD27) on the Clarke 1866 ellipsoid and projected using the Universal Transverse Mercator (UTM), Zone 16 North (16N). NADCON version 2.1 was utilized to convert the GPS positions from the WGS84 datum to the local NAD27 datum. All coordinates given are presented in this projection on the study maps and referenced within this report. All grid units, scales and measurements are in U.S. Survey Feet.

2.1 HISTORIC BACKGROUND

The northern coast of the Gulf of Mexico (GOM) has a long history of maritime activity. The Spanish were active in Louisiana waters by the early sixteenth century. In 1519, the Governor of Jamaica, Francisco Garay, sent Alonzo Alvarez de Piñeda to explore the northern coast. The governor hoped he might discover the Strait of Anián, a mythical waterway that supposedly could be followed to the Orient. During his voyage, Piñeda charted the coastline from the tip of La Florida to the general area near the present-day city of Tampico, Mexico (Mahan, 1967).

Alvar Nuñez Cabeza de Vaca's account of the ill-fated expedition led by Pánfilo de Narváez is also one of the earliest recorded accounts of Spanish explorers in the region. After exploring the interior of Florida, the expedition tried to sail across the GOM in four sailing barges, which were constructed from local resources. All four vessels were lost, most likely along the coast of Texas. Although Narváez's party originally numbered 400, only Cabeza de Vaca and three other survivors reached Mexico (Weddle, 1985; Pearson *et al.*, 1989).

Spanish treasure fleets regularly sailed through Gulf waters transporting raw materials and treasure from the New World back to Spain. Three vessels from the 1554 *Nueva España Flota*, under the command of Captain-General Bartolomé Carreño, the *Santa María de Yciar*; the *Espíritu Santo*; and the *San Estebán* wrecked in a violent storm off Padre Island, Texas. The Texas Antiquities Committee subsequently located and excavated the *San Estebán* between 1972 and 1975 (Arnold and Weddle, 1978; Keith, 1988).

The French turned their attention to the GOM by the end of the seventeenth century. In 1685, the French explorer, Rene Robert Sieur de La Salle, received a royal commission to establish a colony near the mouth of the Mississippi River. La Salle headed to the Gulf with four ships loaded with colonists and supplies. The expedition ended in failure after the Spanish captured one of the vessels and two others were lost along the coast of Texas. The supply ship *L'Aimable*, laden with 4,500 pounds of lead, 60 kegs of wine, muskets, tools and everything else the Frenchmen needed to establish a new colony, ran aground and sank off Pass Caballo while entering Matagorda Bay in February 1685. The following year, the barque *La Belle* wrecked in Matagorda Bay during a storm (Arnold, 1997; Bruseth and Turner, 2005).

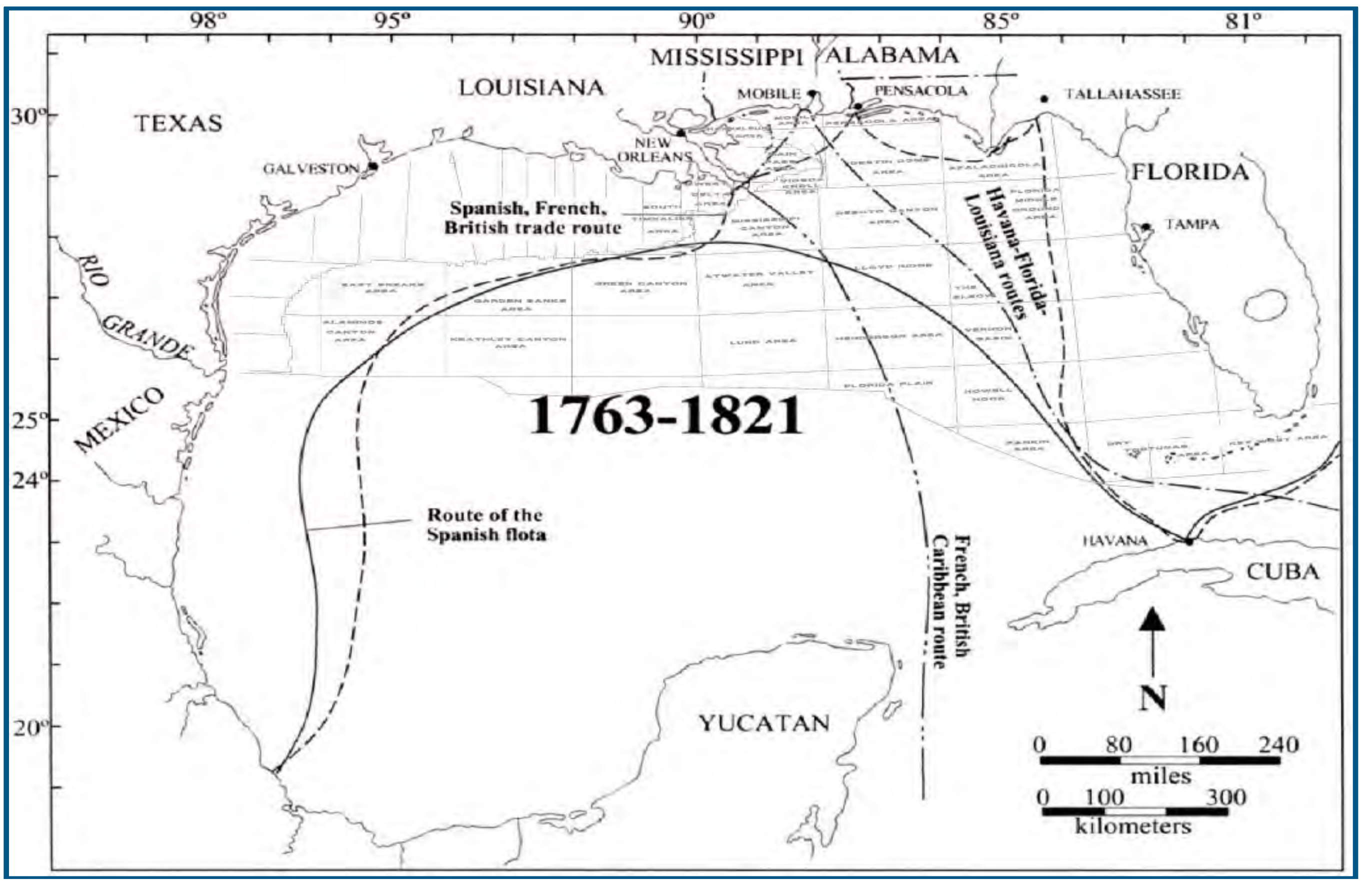

Figure 8. Gulf of Mexico shipping routes, 1763 - 1821 (Modified from Pearson *et al.*, 2003)

In 1699, the French sent Pierre le Moyne, Sieur de Iberville to colonize the lower Mississippi Valley. Iberville established a French settlement at Biloxi Bay in 1699. After 1701, the settlement was moved to Mobile Bay. In 1718, Iberville's brother, Jean Baptiste le Moyne, Sieur de Bienville established a colony at New Orleans. Four years later, the seat of French government was transferred from Biloxi to New Orleans (Pearson *et al*., 1989).

In 1762, the French ceded control of the Louisiana Territory to Spain. As Spain's interests in the Gulf increased, Spanish vessels became more numerous along the coast and archaeological examples from that period have been periodically discovered. Researchers documented the remains of *El Nuevo Constante*, which wrecked off the Louisiana coast in 1766. *El Nuevo Constante* was a Spanish merchant vessel referred to as a frigate in contemporary documents. A second vessel of the fleet, *Corazón de Jesús y Santa Bárbara*, was also lost during the same storm, but remains undiscovered (Pearson *et al*., 1989; Pearson and Hoffman, 1995).

In 1800, Napoleon Bonaparte secretly bargained control of Louisiana from Spain. Thomas Jefferson, fearing Napoleon's control of the Mississippi outlet could pose a serious threat to American shipping in the Gulf, dispatched Robert Livingston to Paris. Livingston successfully negotiated the sale of the Louisiana Territory to the United States in April 1803. The boundaries of the territory were left vague giving the United States a strong claim to Texas and "West Florida." From 1810 to 1813, the American government laid claim to the Florida parishes of Louisiana, the coast of Mississippi, Alabama, and West Florida (Tindall, 1988).

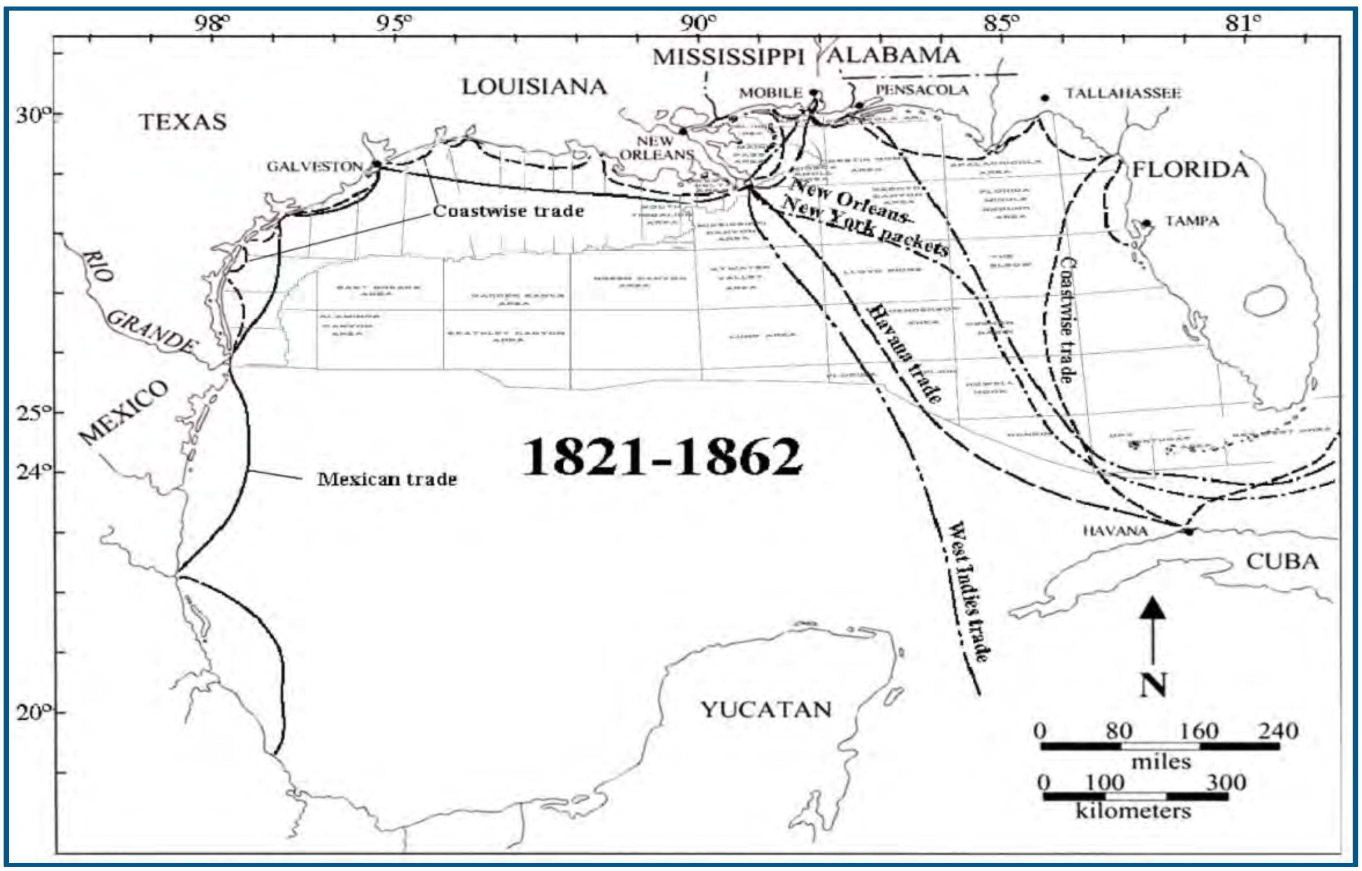

Figure 9. Gulf of Mexico shipping routes, 1821 - 1862 (Modified from Pearson *et al*., 2003)

Prior to 1812, most waterborne commerce in the central part of the Gulf was centered on New Orleans. On January 10, 1812, the first steamboat arrived at New Orleans from Pittsburgh. Soon after the introduction of steam vessels, maritime commerce in the Gulf of Mexico increased dramatically. By the dawn of the Civil War, several major steamship lines were servicing New Orleans (Pearson *et al.*, 1989). The growth in maritime activity led to a proportionate increase in ship losses and several examples from that period have been documented. Salvors located a mid-nineteenth century steam vessel off High Island, Texas. The wreck site was the side-wheeler, *New York*, which operated between New Orleans and Galveston, and was lost during a hurricane on September 7, 1846 (Irion, 1998). Seventeen of her passengers and crew drowned, including five young children, while 36 people survived by holding onto debris until rescued two days later by the S.S. *Galveston* (Bowers, 2008). Today, the ship's bell and other artifacts recovered from the steamship *New York* are on public display at the Bayou Teche Museum located in downtown New Iberia, Louisiana.

Between 1997 and 1999, MMS Archaeologists identified the nineteenth century steamship *Josephine*, which sank off the coast of Mississippi in 1881 (Irion and Ball, 2001). J. Barto Arnold III (1997) and others also discovered several nineteenth century steamships in Matagorda Bay, Texas while looking for La Salle's ships.

During the Civil War, the Gulf of Mexico was also a theater of conflict for Union blockaders, daring blockade-runners, and Confederate "commerce raiders" or privateers. Early in the war, U.S. President Abraham Lincoln proclaimed a blockade of Southern ports. Confederate President Jefferson Davis responded to this action by issuing *letters of marque* to Confederate privateers allowing them to attack Union shipping. In June 1861, the converted mail steamer CSS *Sumter*, under the command of Raphael Semmes, breached the blockade at New Orleans and by January 1862, had captured or destroyed eighteen Union merchant ships on her cruise to Gibraltar. Semmes was promoted to captain and placed in command of CSS *Alabama*. Semmes and his crew sank the steamer USS *Hatteras* off the coast of Galveston, Texas in the summer of 1862. CSS *Alabama* sank a record 76 vessels before being sunk by the USS *Kearsarge* off the coast of Cherbourg, France on June 19, 1864 (Semmes, 1869; Watts, 1988).

After the Civil War, the presence of stern-wheelers began to increase in frequency. Throughout the last half of the nineteenth century a variety of sailing crafts such as schooners, clippers, and "New Orleans" luggers were in use along the northern Gulf coast. The need for steam propulsion decreased with the beginning of oil production in Louisiana and Texas at the onset of the twentieth century. By c. 1915, steam engines and paddle wheelers began to fade away to diesel engines and screw propellers (Pearson *et al*., 1989).

By the start of World War II, steel hull ships powered by petroleum driven screws were plying the Gulf. Several German U-boats also operated in the Gulf of Mexico during World War II. *U-507* under the command of Korvettenkapitän Harro Schacht claimed the first victim in Gulf waters with the sinking of the freighter *Norlindo* on May 4, 1942 off Key West, Florida (Wiggins, 1995). Other U-boats soon joined the onslaught in the Gulf, including *U-166*, commanded by Kapitänleutnant Hans-Günther Kühlmann. *U-166* took up position off the mouth of the Mississippi River to lay mines and attack merchant shipping. Kühlmann sank the passenger freighter SS *Robert E. Lee* approximately 45 miles southeast of the Mississippi River on July 30, 1942. *PC-566*, the naval vessel escorting the freighter, then in turn sank *U-166*. In all, 17 U-boats sank 56 vessels and damaged 14 others over the course of approximately one year with only one U-boat lost in the Gulf of Mexico (Church and Warren, 2002). Although many of these war casualties have been found, many others have yet to be discovered.

2.2 HISTORIC POTENTIAL

Typically, there is a direct correlation between shipwreck locations and traditional shipping routes. Sailing vessels used routes that passed near the project area since roughly the 1760s and steamships have been using routes north of the area after the early 1820s (Figure 8 and Figure 9, Pearson et al., 2003).

BOEM records list seven shipwrecks within 10 nautical miles of the proposed routes (Table 8). Three of shipwrecks are known to be historic (50 years or older). The Onion Bottle Wreck (or Desoto Canyon Wreck) is a late seventeenth to early eighteenth-century shipwreck site located approximately three nautical miles east of the proposed routes. Further to the east, the steam sidewheeler, *Vanderbilt* (or *Black Hawk*; *Black Joker*) was lost while enroute from New Orleans to Havana, Cuba in March 1862. *Vanderbilt's* located reliability is poor, and the vessel may be several files away from its reported location. Approximately seven nautical miles south of the proposed routes, is a late nineteenth century sailing vessel referred to as the 7,000-Foot Wreck. Also, another unidentified wreck is listed over 9 nautical miles northwest of the proposed routes. The date of the vessel is unknown and therefore potentially historic.

In additional, there are three modern shipwrecks listed: *Callisto, Providence*, and USS *Peterson*. *Callisto* was a small sailing vessel lost in 1994. *Providence* was a fishing vessel lost in 1982. The Spruance-class destroyer USS *Peterson* (DD-969) was a decommissioned naval vessel intentionally sunk by the US Navy during fleet training exercises in February 2004.

Table 8. Shipwrecks reported within 10 nautical miles of the survey area

Name	Date Built	**Date of Loss**	**Location Reliability***
Onion Bottle Wreck	c. late 17th to early 18th Century	Unknown	1
USS *Peterson*	1975	2004	1
Vanderbilt	1837	1862	4
7,000-Foot Wreck	c. late 19th Century	Unknown	1
Callisto (Tentative ID)	Unknown	1994	1
Providence	Unknown	1982	4
Unidentified Shipwreck	Unknown	Unknown	1

**Location reliability based on scale 1 to 4, 1 being reliable, and 4 being unreliable.*

Deepwater areas such as the Mississippi Canyon and Desoto Canyon Areas were thought to have a low potential for undocumented shipwrecks, although the silty clay sediment found in the area should allow for good preservation of submerged cultural resources. The recent discoveries, however, of undocumented well-preserved historical wrecks in the Green Canyon, Mississippi Canyon, DeSoto Canyon, Ewing Bank, and Viosca Knoll Areas suggest the shipwreck potential for deep-water areas of the GOM are higher than originally estimated.

2.3 ASSESSMENT OF DATA

2.3.1 BATHYMETRY RECORD

Multibeam bathymetric data were used to determine water depths across the study area. Water depths are referenced to Mean Sea Level (MSL) and contoured at 5-foot intervals on the Color Shaded

Bathymetry Panels of the enclosed study maps. Water depths within the survey corridor range from 7,385 feet MSL in MC393 to 7,575 feet MSL in DC397 and DC441. Water depth near the Rydberg Production PLET 1 Hub in MC393 is 7,405 feet MSL. Water depth near the Appomattox FPS in MC437 is 7,420 feet MSL. Water depths near the southern end point of the routes range from 7,515 to 7,525 feet MSL in MC525.

2.3.2 SIDE SCAN SONAR RECORD

The side scan sonar imagery showed low to moderate acoustic reflectivity through most of the survey area, suggesting predominantly fine-textured sediments with isolated areas of higher reflectivity likely representing coarser sediments. Eleven unidentified sonar contacts from the OII 2016 survey are recorded within the survey corridor (Nos. 1–4, 6–9 and 14–16). One unidentified sonar contact from the FGSI 2011 survey is recorded within the survey corridor (No. 19). The majority of sonar contacts are relatively small measuring less than 25 feet in length or width, except Sonar Contact No. 4 (Figure 10). Sonar Contact No. 4, measuring 42.5 x 23.3 with no measurable height, is located near the eastern edge of the survey corridor in MC525 and approximately 685 feet from the proposed Flowline route. The original archeological assessment that accompanied the 2016 survey determined Sonar Contact No. 4 had archaeological potential and a 100-foot avoidance was recommended.

Two unidentified sonar contacts (Nos 8 and 14) are located within 100 feet of the proposed routes. Sonar Contact No. 8, measuring 13.4 x 5.1 with no measurable height, is located between the proposed Umbilical and Flowline routes in MC481. It is 54 feet from the proposed Flowline route and over 130 feet from the proposed Umbilical route. Contact No. 14, measuring 16.6 x 12.4 with no measurable height, is located 80 feet from the proposed Flowline route in DC397.

Sonar Contact No. 19 from the FGSI 2011 survey, measuring 15.7 x 7.8 feet with no measurable height, is associated with an anchor drag scar and is likely a depression with a low sedent mound from a former anchor location. The remaining sonar contact are interpreted as modern debris or geological in origin.

One of the sonar contacts is potentially archaeologically significant and is recommended for investigation or avoidance. An Archaeological Avoidances table with avoidance criteria is listed below. An image, location, description and details of each of the unidentified sonar contacts are shown in the Side Scan Sonar Contact Reports located in Appendix A. The unidentified sonar contacts are listed in the Unidentified Sonar Contact Tables in Appendix A and depicted on the Archaeological and Geohazard Maps.

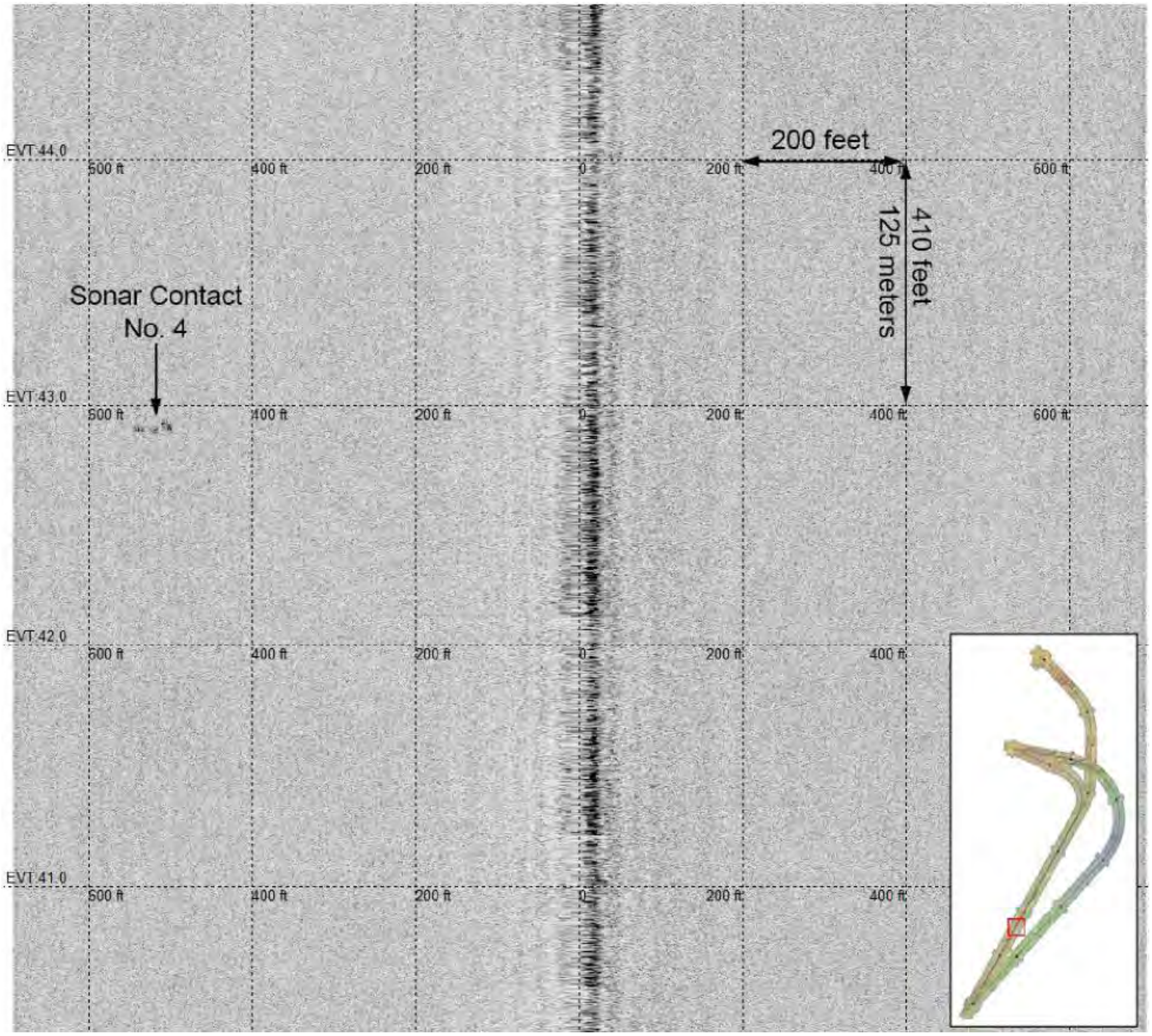

Figure 10. Side scan sonar data showing Sonar Contact No. 4, which is considered a potential archaeological resource.

2.4 CONCLUSIONS AND RECOMMENDATIONS

The Archaeological and Geohazard Route Survey revealed 12 total unidentified sonar contacts within the survey corridor. Most of the unidentified sonar contacts are interpreted as modern debris or possibly natural seafloor features. One sonar contact (No. 4) is recommended for avoidance based on archaeological potential. A recommended avoidance of 100 feet is from the original Archeological Assessment Report authored June 2017 and listed in Table 9. Archaeological Avoidances below.

There is a possibility that shipwreck remains could be undetected or unidentified within the survey area. If any material that could possibly be related to a shipwreck is encountered during construction or other lease development or construction activities, the BOEM/BSEE archaeologists must be contacted within 48 hours for an assessment of any antiquities. Material indicating the presence of a historic shipwreck may include, but is not limited to wooden ship beams, hull planking, rigging, anchors, ceramics, or other possible cultural material. In this event, no activities should be conducted near the area of discovery until advised by the appropriate BOEM/BSEE personnel (See NTL No. 2005-G07, Archaeological Resource Surveys and Reports, Sections “Authority” through “Required Notification of the Discovery of Shipwrecks on the Seafloor”).

Table 9. Archaeological Avoidances

SSS Ref. No.	Area	Block	Dimensions (ft)			Shape	NAD 27		Avoidance (ft)
			Length	Width	Height		Latitude	Longitude	
4	MC	525	42.5	23.3	0.0	Irregular	28.491660	-87.928859	100

2.5 REFERENCES

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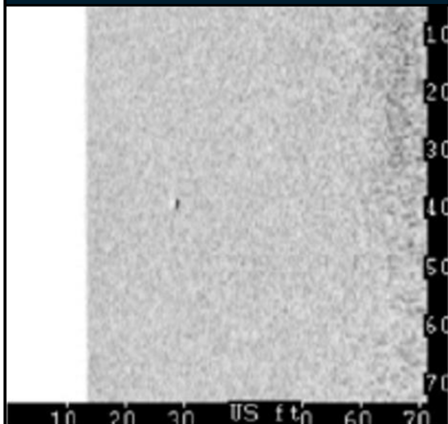
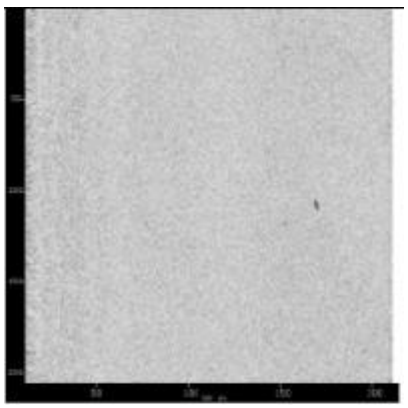
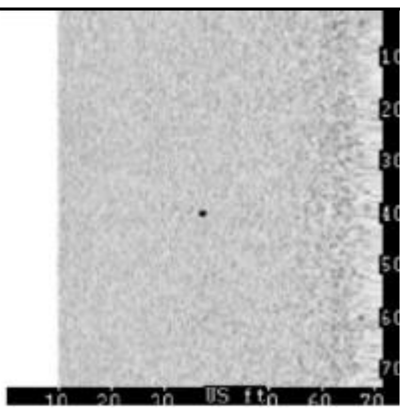
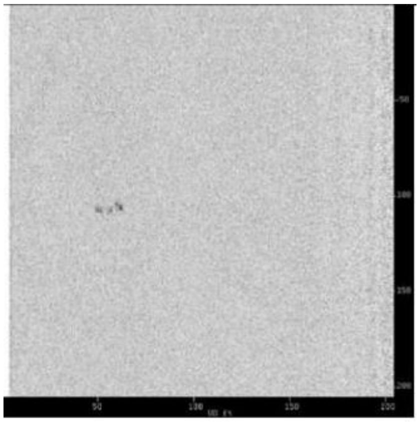
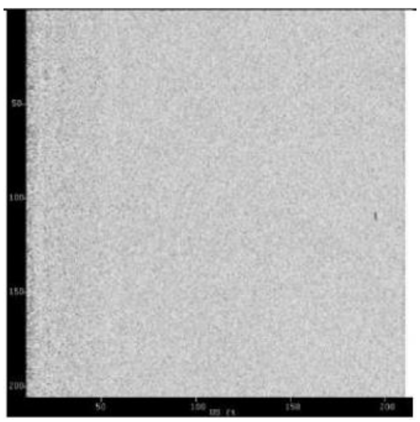
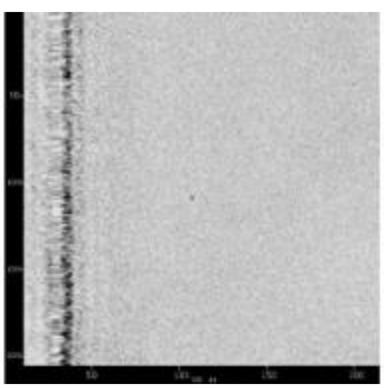
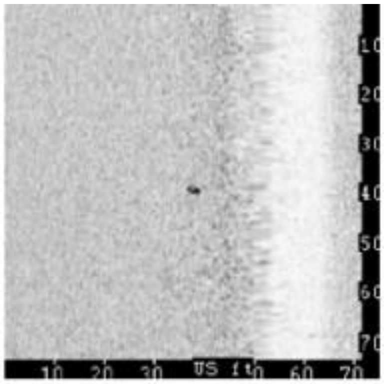
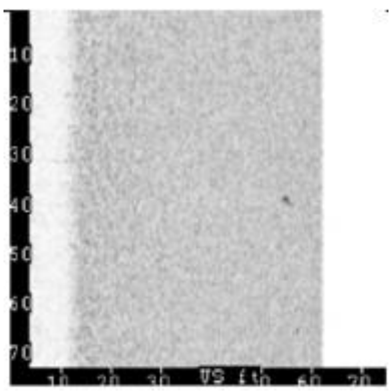
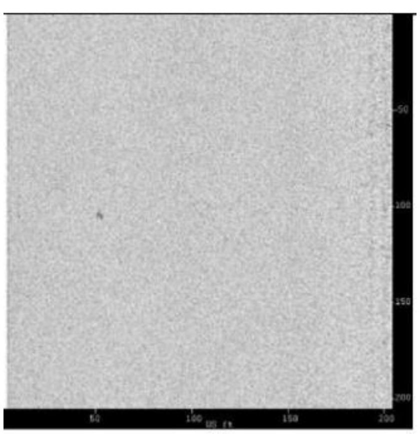
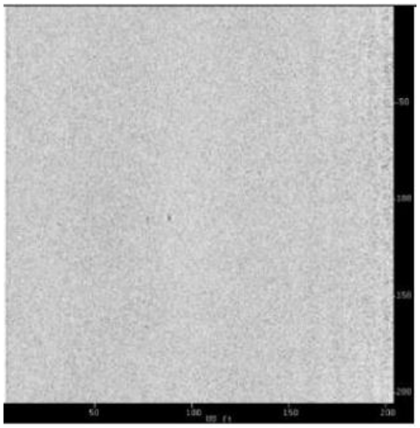
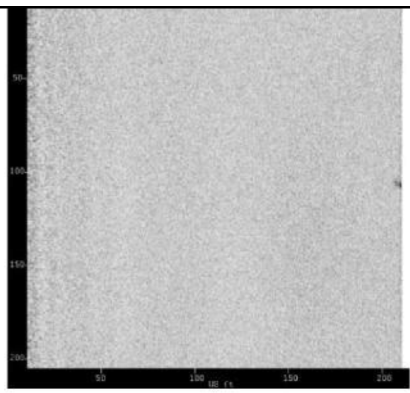
APPENDIX A: SONAR CONTACT TABLES & REPORTS

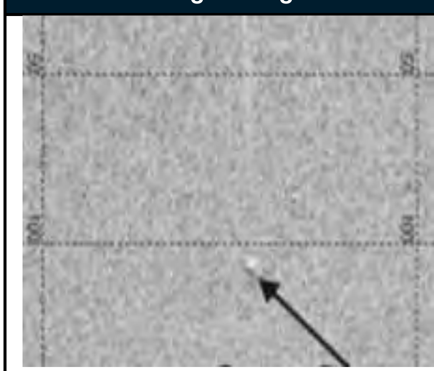
Side Scan Sonar Contact Report

Target Image	Target Info	User Entered Info
	1 • Sonar Time at Target: 12/26/2016 05:35:52.430 • Click Position (Lat/Lon Coordinates) 28.4538877719 -87.9534703033 (WGS84) 28.4536417752 -87.9534858962 (NAD27) • Click Position (Projected Coordinates) (X) 1334125.36 (Y) 10326924.06 • Map Proj: UTM27-16F • Ping Number: 134101 • Range to Target: 45.99 meters • Fish Height: 42.57 meters • Heading: 209.752 degrees • Event Number: 5 • Line Name: 102e.1.a.0.et.high	Dimensions and attributes • Target Height: = 1.4 US Feet • Target Length: 4.1 US Feet • Target Shadow: 2.1 US Feet • Target Width: 3.2 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 569 • Description: Rectangular shape
	2 • Sonar Time at Target: 12/27/2016 09:12:01.140 • Click Position (Lat/Lon Coordinates) 28.4553877857 -87.9492004102 (WGS84) • 28.4551418241 -87.9492161404 (NAD27) • Click Position (Projected Coordinates) (X) 1335501.32 (Y) 10327458.44 • Map Proj: UTM27-16F • Ping Number: 49340 • Range to Target: 170.77 meters • Fish Height: 41.80 meters • Heading: 40.520 degrees • Event Number: 3 • Line Name: 304.1.a.0.et.low	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 23.0 US Feet • Target Shadow: 0.0 US Feet • Target Width: 8.2 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 569 • Description: Irregular shape
	3 • Sonar Time at Target: 12/27/2016 15:22:19.320 • Click Position (Lat/Lon Coordinates) 28.4682538350 -87.9429907722 (WGS84) 28.4680082580 -87.9430065444 (NAD27) • Click Position (Projected Coordinates) (X) 1337532.81 (Y) 10332119.33 • Map Proj: UTM27-16F • Ping Number: 111771 • Range to Target: 33.69 meters • Fish Height: 43.01 meters • Heading: 220.130 degrees • Event Number: 16 • Line Name: 301.1.b.0.et.high	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 4.9 US Feet • Target Shadow: 0.0 US Feet • Target Width: 3.0 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 525 • Description: Square shape

Target Image	Target Info	User Entered Info
	4 • Sonar Time at Target: 12/26/2016 04:47:55.020 • Click Position (Lat/Lon Coordinates) 28.4916604958 -87.9288585153 (WGS84) • 28.4914156097 -87.9288744739 (NAD27) • Click Position (Projected Coordinates) (X) 1342137.88 (Y) 10340591.91 • Map Proj: UTM27-16F • Ping Number: 126064 • Range to Target: 159.02 meters • Fish Height: 41.80 meters • Heading: 209.020 degrees • Event Number: 43 • Line Name: 102e.1.a.0.et.low	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 42.5 US Feet • Target Shadow: 0.0 US Feet • Target Width: 23.3 US Feet • Mag Anomaly: NA • Avoidance Area: 100-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 525 • Description: Irregular shape – Target has potential to be an archaeological resource
	6 • Sonar Time at Target: 12/25/2016 20:03:37.910 • Click Position (Lat/Lon Coordinates) 28.4989525271 -87.9245628103 (WGS84) 28.4987078564 -87.9245788240 (NAD27) • Click Position (Projected Coordinates) (X) 1343537.76 (Y) 10343231.80 • Map Proj: UTM27-16F • Ping Number: 37672 • Range to Target: 195.10 meters • Fish Height: 41.80 meters • Heading: 31.010 degrees • Event Number: 50 • Line Name: 103.1.a.0.et.low	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 14.3 US Feet • Target Shadow: 0.0 US Feet • Target Width: 5.2 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 525 • Description: Rectangular shape
	7 • Sonar Time at Target: 12/27/2016 16:50:24.840 • Click Position (Lat/Lon Coordinates) 28.4989556715 -87.9238340317 (WGS84) 28.4987109989 -87.9238500729 (NAD27) • Click Position (Projected Coordinates) (X) 1343771.78 (Y) 10343231.14 • Map Proj: UTM27-16F • Ping Number: 126606 • Range to Target: 76.72 v • Fish Height: 41.38 meters • Heading: 28.880 degrees • Event Number: 50 • Line Name: 101.1.a.0.et.low	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 7.5 US Feet • Target Shadow: 0.0 US Feet • Target Width: 5.4 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 525 • Description: Square shape

Target Image	Target Info	User Entered Info
	8 • Sonar Time at Target: 12/25/2016 20:11:12.520 • Click Position (Lat/Lon Coordinates) 28.5061411675 -87.9225483409 (WGS84) • 28.5058967141 -87.9225643399 (NAD27) • Click Position (Projected Coordinates) (X) 1344204.72 (Y) 10345839.79 • Map Proj: UTM27-16F • Ping Number: 38938 • Range to Target: 15.53 meters • Fish Height: 43.08 meters • Heading: 28.250 degrees • Event Number: 56 • Line Name: 103.1.a.0.et.high	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 13.4 US Feet • Target Shadow: 0.0 US Feet • Target Width: 5.1 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 481 • Description: Irregular shape
	9 • Sonar Time at Target: 12/27/2016 16:59:39.020 • Click Position (Lat/Lon Coordinates) • 28.5067640242-87.9193186511 (WGS84) • 28.5065195810-87.9193347645 (NAD27) • Click Position (Projected Coordinates) (X) 1345243.44 (Y) 10346058.23 • Map Proj: UTM27-16F • Ping Number: 128176 • Range to Target: 54.96 meters • Fish Height: 43.23 meters • Heading: 28.920 degrees • Event Number: 58 • Line Name: 101.1.a.0.et.high	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 7.1 US Feet • Target Shadow: 0.0 US Feet • Target Width: 5.2 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Mississippi Canyon • Block: 481 • Description: Irregular shape
	14 • Sonar Time at Target: 12/25/2016 21:08:11.060 • Click Position (Lat/Lon Coordinates) 28.5540436277 -87.8957464991 (WGS84) 28.5538005782 -87.8957629347 (NAD27) • Click Position (Projected Coordinates) (X) 1352940.38 (Y) 10363186.38 • Map Proj: UTM27-16F • Ping Number: 48468 • Range to Target: 162.80 meters • Fish Height: 41.59 meters • Heading: 13.540 degrees • Event Number: 104 • Line Name: 103.1.b.0.et.low	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 16.6 US Feet • Target Shadow: 0.0 US Feet • Target Width: 12.4 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Desoto Canyon • Block: 397 • Description: Irregular shape

Target Image	Target Info	User Entered Info
	15 • Sonar Time at Target: 12/26/2016 08:25:12.190 • Click Position (Lat/Lon Coordinates) 28.5680646340 -87.9068264965 (WGS84) 28.5678220509 -87.9068423407 (NAD27) • Click Position (Projected Coordinates) (X) 1349423.09 (Y) 10368309.58 • Map Proj: UTM27-16F • Ping Number: 162615 • Range to Target: 127.05 meters • Fish Height: 41.17 meters • Heading: 279.430 degrees • Event Number: 135 • Line Name: 302.1.b.0.et.low	Dimensions and attributes • Target Height: = 1.5 US Feet • Target Length: 7.9 US Feet • Target Shadow: 5.0 US Feet • Target Width: 6.0 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Desoto Canyon • Block: 397 • Description: Rectangular shape
	16 • Sonar Time at Target: 12/26/2016 00:43:38.990 • Click Position (Lat/Lon Coordinates) 28.6048503095 -87.9096564684 (WGS84) 28.6046088726 -87.9096717592 (NAD27) • Click Position (Projected Coordinates) (X) 1348616.71 (Y) 10381687.63 • Map Proj: UTM27-16F • Ping Number: 84812 • Range to Target: 208.95 meters • Fish Height: 42.22 meters • Heading: 136.446 degrees • Event Number: 155 Line Name: 102a.1.a.0.et.low	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 9.8 US Feet • Target Shadow: 0.0 US Feet • Target Width: 7.9 US Feet • Mag Anomaly: NA • Avoidance Area: 30-foot radius • Classification 1: Debris • Area: Desoto Canyon • Block: 353 • Description: Irregular shape

Target Image	Target Info	User Entered Info
	19 • Sonar Time at Target: 04/08/2011 • Click Position (Lat/Lon Coordinates) 28.574564000 -87.900291000 (WGS84) 28.574322000 -87.900307000 (NAD27) • Click Position (Projected Coordinates) (X) 1351538.04 (Y) 10370656.20 • Map Proj: UTM27-16F • Ping Number: Unknown • Range to Target: 103.75 meters • Fish Height: ~42.00 meters • Heading: ~90.000 degrees • Event Number: 142 • Line Name: ssl-528-20110408-091457-LF	Dimensions and attributes • Target Height: = 0.0 US Feet • Target Length: 15.7 US Feet • Target Shadow: 0.0 US Feet • Target Width: 7.8 US Feet • Mag Anomaly: NA • Avoidance Area: none • Classification 1: Debris • Area: Desoto Canyon • Block: 397 • Description: Rectangular shape

OII SONAR CONTACT TABLE

Ref. No.	Block	Dimensions LxWxH	Shape	ZONE: 16 NORTH, 090°W TO 084°W, CM:087°W						Avoid. Dist. (ft)
				NAD 27		NAD 27		NAD 83		
				X (ft)	Y (ft)	Lat. (°)	Long. (°)	Lat. (°)	Long. (°)	
1	MC569	4.1'x3.2'x1.4'	Rectangular	1334125	10326924	28.453642	-87.953486	28.453888	-87.953470	30
2	MC569	23.0'x8.2'x0.0'	Irregular	1335501	10327458	28.455142	-87.949216	28.455388	-87.949200	30
3	MC525	4.9'x3.0'x0.0'	Square	1337533	10332119	28.468008	-87.943007	28.468254	-87.942991	30
4	MC525	42.5'x23.3'x0.0'	Irregular	1342138	10340592	28.491416	-87.928874	28.491660	-87.928859	100
6	MC525	14.3'x5.2'x0.0'	Rectangular	1343538	10343232	28.498708	-87.924579	28.498953	-87.924563	30
7	MC525	7.5'x5.4'x0.0'	Square	1343772	10343231	28.498711	-87.923850	28.498956	-87.923834	30
8	MC481	13.4'x5.1'x0.0'	Irregular	1344205	10345840	28.505897	-87.922564	28.506141	-87.922548	30
9	MC481	7.1'x5.2'x0.0'	Irregular	1345243	10346058	28.506520	-87.919335	28.506764	-87.919319	30
14	DC397	16.6'x12.4'x0.0'	Irregular	1352940	10363186	28.553801	-87.895763	28.554044	-87.895747	30
15	DC397	7.9'x6.0'x1.5'	Rectangular	1349423	10368310	28.567822	-87.906842	28.568065	-87.906826	30
16	DC353	9.8'x7.9'x0.0'	Irregular	1348617	10381688	28.604609	-87.909672	28.604850	-87.909656	30

FGSI SONAR CONTACT TABLE

Ref. No.	Block	Dimensions LxWxH	Shape	ZONE: 16 NORTH, 090°W TO 084°W, CM:087°W						Avoid. Dist. (ft)
				NAD 27		NAD 27		NAD 83		
				X (ft)	Y (ft)	Lat. (°)	Long. (°)	Lat. (°)	Long. (°)	
19	DC397	15.7’x7.8’x0.0’	Irregular	1351538	10370656	28.574322	-87.900307	28.574564	-87.900291	none

APPENDIX B: SURVEY CONFIGURATION DIAGRAM, EQUIPMENT DESCRIPTIONS, INSTRUMENT SETTINGS, & CREW LIST

O-Surveyor III AUTONOMOUS UNDERWATER VEHICLE (AUV)

The *O-Surveyor III* Autonomous Underwater Vehicle (AUV) was designed to collect deepwater, high-resolution geophysical data for site and route surveys in water depths of up to 4,500 meters. Kongsberg produces the base platform and Oceaneering upgraded the AUV from more than 12 years of AUV operating experience. The system is designed for portability and survey work from vessels of opportunity (Figure 1).

Primary survey sensors found in the system payload include a Kongsberg EM 2040 Swath Multibeam Sonar (200 kHz), an EdgeTech 2200-M Side Scan Sonar (120 kHz) and a custom EdgeTech DW106 Subbottom Profiler (Chirp 1 to 4.5 kHz) with four projectors and six receive hydrophones. An acoustically aided inertial navigation system coupled with an acoustic Doppler velocity speed log and USBL (Ultra Short Base Line) positioning from the survey vessel is used for primary positioning of the AUV. Ancillary sensors include survey precision depth sensors, altimeter, and Seabird CTD (Conductivity, Temperature and Depth) probes. A Kongsberg HiPAP 350P System is typically implemented for tracking the AUV acoustically. A Linkquest Acoustic Modem provides data communications and data through the Acoustic Command Link (ACL) and the Acoustic Data Link (ADL). The shipboard operator communicates with and controls the AUV through the ACL and the ADL provides bandwidth for obtaining subsets of the geophysical data. A Lithium Ion Polymer Battery powers the AUV, allowing operational times of up to 35 to 40 hours. Emergency ascent systems include drop weights and an air bag. An emergency acoustic transponder, GPS system, wireless Ethernet, flashing strobe light and Iridium phone system output visual and remote sensing aids for locating the AUV in the event communications are lost with the survey ship.

Fig 1. *O-Surveyor III* recovery

Three computers control the system functions onboard *O-Surveyor III*. These computing centers are referred to as the HUGIN (High-Precision Untethered Geosurvey and Inspection), payload and navigation processors. These processors use artificial intelligence algorithms based on feedback returned from more than 75 sensors to monitor system health and make real-time decisions regarding performance, maneuverability and data collection. The computers, data storage and sensor electronics are housed in two titanium spheres designated as the payload and control.

Three topside workstations are dedicated to continuous communications with the vehicle while on missions. The HUGIN Operator Station monitors all AUV sensors related to the vehicle health and maneuverability. The monitoring software warns operators when values are outside of optimal range.

The Payload Operator Station computer provides graphical views of reduced data subsets of subbottom, bathymetry and side scan sonar. The user can turn the geophysical systems on or off, adjust instrument settings and control the data bandwidth as needed. The HiPAP Operator Station provides real-time graphic displays of the *O-Surveyor III* position and the survey ship, which normally follows the AUV on the surface while collecting data.

Oceaneering's C-NAV DGPS signals provide the survey ship position during AUV missions. The track line acquisition sequence is downloaded to the onboard computer system prior to deployment. The AUV vehicle positions are calculated with a complex Kalman filter algorithm using statistically weighted inputs from the DGPS, Ultra-Short Base Line (USBL) acoustics, inertial navigation and Doppler velocity speed log. The inertial system consists of a precision gyro and accelerometers to maintain the AUV track for the mission plan.

The Kongsberg EM 2040 Bathymetry System collects soundings in a ~210-meter swath underneath the AUV vehicle when operating at 40m altitude. The EM 2040 is capable of frequency ranges of 200 kHz or 400 kHz. The beam pattern at 400 kHz is 0.7° x 0.7° over a 140° swath yielding ~256 beams.

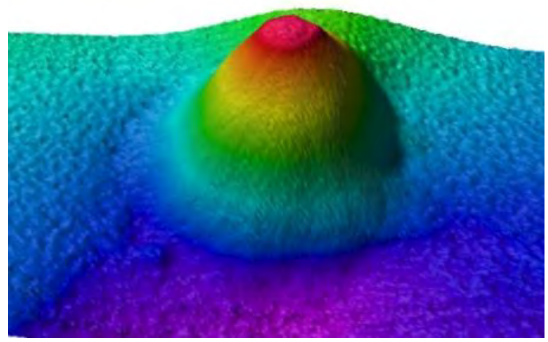


Figure 2. Multibeam bathymetry imagery of 12m high mud volcano

The AUV normally maintains an altitude of 40 meters above the seabed. An onboard velocimeter records water column velocity corrections and provides real-time data at the transducer face to maintain proper beam forming of the acoustic transmissions. The data are normally processed and filtered with Oceaneering's proprietary HydroMap software, or QPS' Qimera software. A survey precision depth sensor provides the vehicle depth that is added to the raw multibeam soundings. Atmospheric pressure is recorded aboard the survey vessel and applied as a depth sensor corrector in post-processing. Tidal corrections are applied using the Goddard deepwater ocean tide model (Ray, 1999). The final bathymetric dataset is normally delivered at a 3-meter bin size (Figure 2), however, 2-meter bin size processing is becoming more frequent.

The *O-Surveyor III* is equipped with a dual frequency EdgeTech 2200-M Side Scan Sonar that employs a calibrated wide band, digital frequency modulated (FM) signal to provide high resolution, low-noise images. This sonar is capable of simultaneously transmitting linearly swept frequency modulated pulse centered at two discrete frequencies: 120 kHz and 410 kHz. The raw data files are post-processed and converted to XTF (eXtended Triton Format) for digital interpretation and hardcopy generation.

The seismic profiles onboard OII's *O-Surveyor III* are collected with a custom high power EdgeTech Chirp Subbottom Profiler (DW106). The four subbottom transducers are capable of transmitting a frequency modulated, high power pulse in the bandwidth between 1 kHz and 6 kHz. The source pulse used on most surveys is between 1.5 kHz and 10 kHz. The source pulse is convolved with the recorded trace to prevent source ringing and to remove the source signature from the response of near seabed strata. The four-transducer system provides significantly more penetration and resolution than a single transducer system.

The raw seismic data can be post processed to create SEG-Y or XTF datasets. The SEG-Y data can be written with static or variable length traces

O-SURVEYOR III SENSOR SPECIFICATIONS

AUV Vessel
Depth Rating: 4,500 meters (2.8 miles)
Length: 6.4 meters (20.5 feet)
Maximum Diameter: 1.0 meter (3.3 feet)
Normal Speed: 3.5–3.8 knots
Underwater Endurance @ 3.8 knots: ~35 hours
Power: Lithium Battery

Ancillary Sensors
Inertial Navigation
Kongsberg HiPAP USBL
Doppler Velocity Log
Fiber Optic Gyro
Motion Reference Unit
DigiQuartz Depth Unit
Single-Beam Altimeter
DGPS
Acoustic Communications
Command and Control (Low Speed Acoustic Modem)
Data Uplink (High Speed Acoustic Modem)
Kongsberg EM 2040 Multibeam Echosounder

Frequency	200 kHz
Maximum Ping Rate	70 Hz
Number of Beams per Ping	256
Beamwidth	1.5° × 1.5° @ 200 kHz
Beam Spacing	Equiangle or equidistant
Coverage Sector	140°
Range Resolution	0.5% of AUV altitude
Sonar Head Depth Rating	6,000 meters (3.7 miles)

EdgeTech 2200-M Side Scan Sonar
Modulation Full spectrum chirp frequency modulated pulse with amplitude and phase weighting

Dual Frequency Combinations	120 or 410 kHz	
Common		
Vertical Beam Width	50º	
Depression Angle	20º from horizontal	
Dynamic Range	20 Bits Effective	
Sample Rate	~2,000 samples per channel	
Frequency Specific		
Center Frequency	120 kHz	410 kHz
Pulse Length	4 msec.	2.4 msec.
Range Scale Selection (per side)	100–250 meters (328–820 ft)	75–125 meters (246–410 ft)
Maximum Ping Rate	30 pps	41 pps
Range Resolution	3.8 cm (1.5 in)	2 cm (0.8 in)
Horizontal 3 dB Beam Width	0.75º	0.75º
Transmit Power	2 Joules	2 Joules

Peak Source Level (ref = 1µPa @ 1 m)	210 dB	210 dB
Receiver Sensitivity (ref = 1 V/µPa @ center frequency)	-190 dB	-196 dB

<u>EdgeTech DW106 Chirp Subbottom Profiler</u>

Modulation	Frequency modulated pulse with amplitude and phase weighting
Ping Rate	3 Hz average
Calibration	Each system is acoustic tank tested to calibrate for reflection coefficient measurements
Frequency Band	1–6 kHz (normal operation is 1.5 to 4.5 kHz)
Number of Hydrophone Arrays	6
Resolution	6–10 cm (2.4–3.9 in)
Beam Width	15º–25º
Peak Source level	216 db ref 1µPa @ 1 m

AUV INSTRUMENT SETTINGS

Shell Exploration & Production Company
Blocks 437 to 525 to 393, Mississippi canyon Area

KONGSBERG EM 2040 MULTIBEAM ECHOSOUNDER (MBES)

Frequency	200kHz
Ping Rate	3 Hz at 40m
Beams per Ping	256
Beam width	1.5° × 1.5° (200 kHz)
Pulse Type	Short CW
Depth Resolution	10 cm (4 in) (40-meter or 131-foot AUV altitude)
Range Sampling Rate	10 kHz

EDGETECH FULL SPECTRUM CHIRP DUAL FREQUENCY SIDE SCAN SONAR (SSS)

Frequency	120 kHz and 400kHz
Ping Rate	3.0 Hz
Acoustic Source Level	210 dB re 1μPa @ 1 m
Receiver Sensitivity	-190 dB re 1 V/μPa @ center frequency
Range	~200 meters (660 feet) per channel
Pulse Bandwidth	120 kHz
Pulse Length	12 milliseconds
Setback	None (acoustically positioned)

EDGETECH CHIRPED SUBBOTTOM PROFILER (SBP)

Frequency	1.5 kHz–10.0 kHz (Chirped/Frequency Modulated)
Ping Rate	3.0 Hz
Acoustic Source Level	216 dB re 1 μPa at 1 meter
Beam Width	28°–36°
Record Length	175 meters (1,500 meters/second or 5,000 feet/second)
Delay	Variable in meters
Setback	None (acoustically positioned)

SURVEY VESSEL

AUV *O-Surveyor III* Avg. Survey Speed	3.8 knots
Altitude	40 meters

C-Nav® DIFFERENTIAL GPS

C-Nav® is a globally corrected differential GPS system owned and operated by Oceaneering International, Inc. The C-Nav® GPS Receiver combines a dual-frequency, geodetic grade, GPS Receiver with an integrated L-BAND communication RF detector and decoder all linked by an internal microprocessor. C-Nav® uses monitoring stations strategically located around the globe to provide worldwide accuracies on the order of 0.10 meters (4 inches).

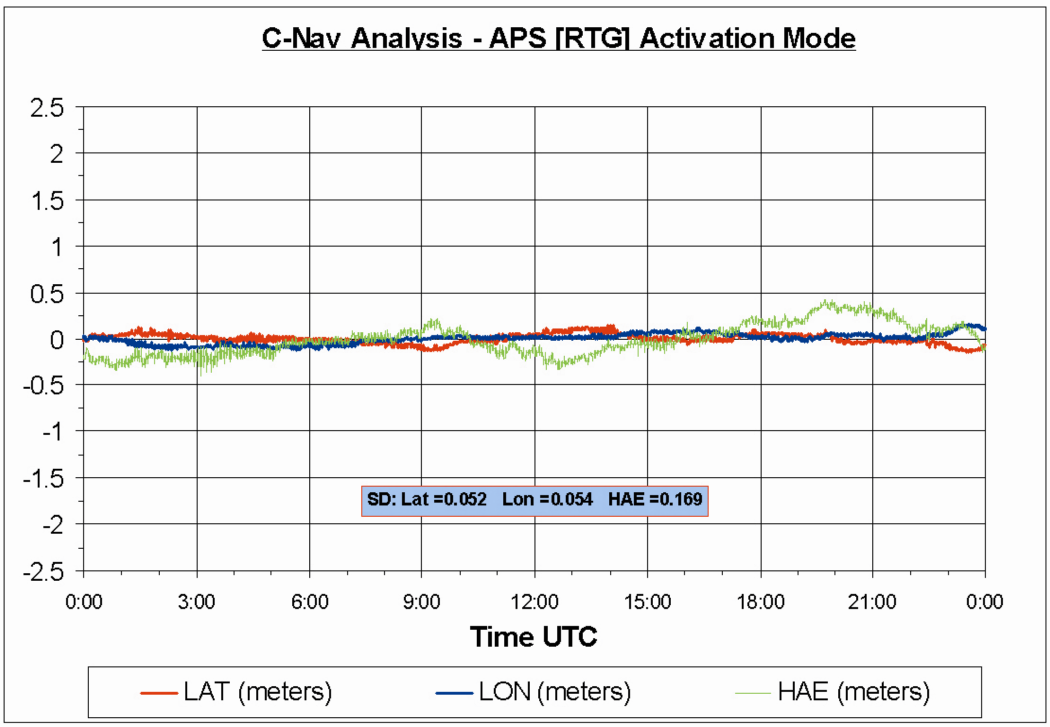
Infrastructure:

The system utilizes the GPS satellite system, L-band communication satellites, and a worldwide network of referencing stations to deliver real time high precision positioning. To provide this unique service, C-Nav® has built a global network of dual frequency reference stations, which constantly receive signals from the GPS satellites that orbit the earth. Data from these reference stations are input to the USA processing centers in Torrance, California, and Moline, Illinois and processed to generate the differential corrections. The correction data are uploaded via redundant and independent communication links to satellite uplink stations at Laurentides, Quebec, Canada; Perth, Australia; Burum, the Netherlands; Santa Paula, California; Auckland, New Zealand; and Southbury, Connecticut for rebroadcast via the geostationary satellites.

The key to the accuracy and convenience of the C-Nav® system is the source of SBAS corrections. GPS satellites transmit navigation data on two L-band frequencies. The C-Nav® reference stations are all equipped with geodetic-quality, dual-frequency receivers. These reference receivers decode GPS signals and send precise, high quality, dual-frequency pseudorange and carrier phase measurements back to the processing centers together with the data messages, which all GPS satellites broadcast. At the processing centers, C-Nav®'s proprietary differential processing techniques used to generate real time precise orbits and clock correction data for each satellite in the GPS constellation. This proprietary Wide Area DGPS (WADGPS) algorithm is optimized for a dual frequency system such as the C-Nav® Correction Service in which dual frequency ionospheric measurements are available at both the reference receivers and the user receivers. It is the use of dual-frequency receivers at both the reference stations and the user equipment together with the advanced processing algorithms, which makes the exceptional accuracy of the C-Nav® system possible.

Creating the corrections is the first part. Differential corrections are sent to the Land Earth Station (LES) for uplink to L-band communications satellites. The uplink sites for the network are equipped with C-Nav-built modulation equipment, which interfaces to the satellite system transmitter and uplinks the correction data stream to the satellite that broadcasts it over the coverage area. Each L-band satellite covers more than a third of the earth. Users equipped with a C-Nav® precision GPS receiver actually have two receivers in a single package; a GPS receiver, and an L-band communications receiver, both designed by the C-Nav® for this system. The GPS receiver tracks all the satellites in view and makes pseudorange measurements to the GPS satellites. Simultaneously, the L-band receiver receives the correction messages broadcast via the L-band satellite. After corrections are applied to the GPS measurements, a position measurement of unprecedented real-time accuracy is produced.

Reliability:
The entire system meets or exceeds a target availability of 99.99%. In order to achieve this, every part of the infrastructure has a built-in backup system. All the reference stations are built with duplicate receivers, processors and communication interfaces, which switch automatically or in response to a remote-control signal from the processing centers.



The data links from the reference stations use the Internet as the primary data link and are backed up by dedicated communications lines, but in fact, the network is sufficiently dense that the reference stations effectively act as backup for each other. If one or several fails, the net effect on the correction accuracy is not impaired.

There are two continuously running processing centers, each receiving all the reference site inputs and each with redundant communications links to the uplink LES. The LESs are equipped with two complete and continuously operating sets of uplink equipment arbitrated by an automatic failover switch. Finally, a comprehensive team of support engineers maintains round the clock monitoring and control of the system. The network is a fully automated self-monitoring system. To ensure overall system integrity, an independent integrity monitor receiver, similar to a standard C-Nav® user receiver, is installed at every reference station to monitor service quality. Data from these integrity monitors is sent to the two independent processing hubs in Torrance, California and Moline, Illinois. Through these integrity monitors, the network is continuously checked for overall SBAS positioning accuracy, L-band signal strength, data integrity, and other essential operational parameters.

C-Nav3050®

Technical Specifications

Features

- All-in-view parallel tracking with 66-channels
- Satellite-based augmentation system (SBAS) tracking (WAAS / EGNOS / MSAS / GAGAN)
- Built-in **C-NavC¹®** and **C-NavC²®** L-Band receiver
- C-NavC²® operating mode with automatic fail-safe to C-NavC¹®
- C/A, P1, P2, L2C, L5, G1, and G2 code tracking
- L1, L2, L5, G1 and G2 full wavelength carrier phase tracking
- C-Nav corrections over Internet
- High-sensitivity / low-signal level tracking
- Fast signal acquisition / re-acquisition
- Superior interference suppression (both in- and out-of-band) using custom tuned antennas
- Patented multipath rejection
- RTK Extend™
- C-Nav over-the-air activation capabilities
- Configurable as real time kinematic (RTK) base or rover
- Programmable output rates
- Event marker input / 1 pulse-per-second (PPS) output
- 2GB internal data storage
- C-Setup PC control software included

For more information: **oceaneering.com/cnav**

oceaneering.com/cnav

Dimensions/weight	
Length	6.47 in / 164 mm
Width	4.60 in / 117 mm
Height	2.37 in / 60 mm
Weight	1.1 lb / 0.5 kg

Front status indication

Power/GNSS Status, correction service status, interface status, and Bluetooth status

External power	
Input	AC / DC Adapter 110 / 220 VAC 12 VDC Nominal 0.5A (9.0 V to 32 VDC)

Connectors	
I/O ports	2 x 9 pin Positronic
DC ports	1 x 9 pin Positronic
RF connector	TNC (with 5VDC bias for antenna / LNA)

Temperature (ambient)	
Operating	-40°F to 158°F / -40°C to 70°C
Humidity	95% non-condensing

Accuracy (RMS) horizontal/vertical	
RTK (<40km)	1 cm + 0.5ppm / 2cm + 1ppm
C-Nav services (95%)	8 cm / 15 cm
Code DGNSS (<200 km)	40 cm + 3 ppm / 90 cm + 3 ppm
Velocity	0.01 m/s
RTK extend (<15 mins)	3 cm + 1 ppm / 6 cm + 2 ppm

User programmable output rate	
Position/velocity/time	1, 5, 10, 25, 50, or 100 Hz
Raw data	1, 5, 10, 25, 50, or 100 Hz

Data latency	
Position/velocity/time	10 ms at all rates
Raw data	10 ms at all rates

Time-to-first-fix	
Cold/warm/hot	< 60 s / < 50 s / < 20 s (Typical values measured per ION-STD 101)

I/O connector assignments	
Data interfaces	2 x RS232 (1-changeable to RS422, 4800 - 115200 baud rates) 1 x USB 2.0 (host or device) Bluetooth Ethernet (10T / 100T)

Input/output data messages	
NMEA-0183	ALM, GBS, GGA, GLL, GRS, GSA, GST, GSV, RMC, RRE, VTG, ZDA, GFA, DTM, GNS, MLA
Differential correction	RTCM 2.3 and 3.0, SBAS and C-Nav (proprietary)
RTK connection	CMR / CMR+, RTCM, NavCom Ultra RTK
Receiver control	NavCom proprietary commands (ASCII)

Compliance/Approvals

- IMO performance standard for GPS: IEC 60529
- IMO performance standard for GNSS: IEC 61108-1:2003
- NMEA-0183 compatibility up to V4.1
- FCC Part 15 Class B, CE
- QC message strings comply with the recommendations in OGP 373-19 and IMCA S015 (July 2011)

MBRTK - Range and Bearing Option

- High-accuracy range and bearing data between vessels
- Multiple rovers can use a common base
- RTK levels of accuracy for range, irrespective of differential correctors
- Converter available to emulate a fanbeam output
- Heading accuracy (degrees at 1 sigma) + 0.6 / baseline length in meters
- Baseline horizontal accuracy + 1 cm + 1 ppm
- MBRTK NMEA-0183 Outputs: HDT, TTM, ROT

OCEANEERING®

SEACAT SBE 19-01

The Seacat SBE 19-01 Profiler from Sea-Bird Electronics, Inc., measures electrical conductivity and temperature versus pressure (depth) in marine environments to depths up to 6,800 meters (22,309 feet). The maximum sampling rate is two scans per second. Self-powered and self-contained, the SBE 19 features proven Sea-Bird conductivity and temperature sensors and a precision semiconductor strain-gauge pressure transducer. A 64-kilobyte solid-state memory allows 1.5 hours of recording (six hours with optional 256-kilobyte memory) while sampling at two scans per second. Set-up, check-out, and data extraction are performed without opening the housing. Simultaneous real time monitoring is possible using the Seacat Profiler's two wire RS-232C transmit capability. Sea-Bird's powerful Seasoft CTD software derives salinity, density, sound velocity, and other ocean parameters from stored CTD (conductivity, temperature, depth) and may be used for data analysis, plotting and archival. Small external sensors may be powered, and frequency or voltage outputs acquired by the SBE 19.

Seacat Profiler options include 1) aluminum housings for use to 3,400 or 6,800 meters (11,154 feet or 22,309 feet); 2) 256 kilobyte memory; 3) an extra bulkhead connector for auxiliary inputs; 4) SBE 5 submersible pump for pumped conductivity; 5) an opto-isolated junction box for supplying power and interconnecting Seacat Profiler and a companion computer necessary in real-time mode.

Use of conductivity, temperature, and depth measurement for determination of sound velocity is appealing because these instruments are simpler, more rugged and resolution, accuracy, and stability lead to better precision than can be obtained with direct sound velocity measuring devices. Three equations are widely used for deriving sound velocity from CTD data (Wilson, 1959; Del Grosso, 1972; Millero and Chen, 1977). Absolute sound velocities derived from these equations differ on the order of .5 meter/second for various combinations of water temperature, salinity, and pressure. The work of Millero and Chen is the most modern and builds upon and attempts to incorporate the work of the earlier investigators. Millero and Chen's 1977 equation is used in the Sea-Bird Seasoft software and is the one which is endorsed by the UNESCO/SCOR/ICES/IASPO Joint Panel on Oceanographic Tables and Standards which comprises the internationally recognized authority for measurements of ocean parameters.

Specifications:

	Measurement Range	Initial Accuracy	Resolution	Sensor Calibration
Conductivity	0 to 7 S/m	+/- 0.001 S/m	+/- 0.0001 S/m	0–7 S/m Physical calibration over the range 1.4 to 6 S/m, plus zero conductivity (air)
Temperature (ºC)	-5 to + 35	+/- 0.01	+/-0.001	-1 to +31 (Measurements outside this range may be at slightly reduced accuracy due to extrapolation errors)
Depth	68 to 1,000 m	+/- 0.25%	+/- 0.015%	Minimum 5 values between 0 and full scale

DUAL TSS MERIDIAN SURVEYOR GYROCOMPASS

The Meridian Surveyor boasts a wide range of interfaces to enable use on any marine vessel. The unit utilizes a dry tuned element (DTG) gyro element which provides exceptional performance with accuracy unmatched by even the latest fiber optic designs. Unlike conventional spinning mass gyrocompasses, the Meridian Surveyor uses a DTG that removes the need for routine maintenance thereby significantly reducing cost of ownership.

Remarkably stable heading can be maintained for turn rates in excess of 200° per second making the system ideal for use on fast survey craft and in river/harbor environments.

- IMO and Wheelmark certified
- Innovative chassis design incorporating state-of-the art digital electronics for improved reliability
- Maintenance-free DTG element
- Dynamic heading accuracy of ±0.2°
- Static heading accuracy of 0.05°
- <40 minutes settling time
- Start-up power requirement of 1.8A
- Comprehensive range of analogue and digital output options
- MTBF of 30,000 hours
- High turn rate of 200° per second
- User friendly digital set up and self-test

SBE-19PLUS V2 SEACAT PROFILER CTD (OVER-THE-SIDE)

The SBE 19plus is the next generation Personal CTD, bringing numerous improvements in accuracy, resolution (in fresh as well as salt water), reliability, and ease-of-use to the wide range of research, monitoring, and engineering applications pioneered by its legendary SEACAT predecessor. The 19plus samples faster (4 Hz vs 2 Hz), is more accurate (0.005 vs 0.01 in T, 0.0005 vs 0.001 in C, and 0.1% vs 0.25% - with seven times the resolution - in D) and has more memory (8 Mbyte vs 1 Mbyte). There is more power for auxiliary sensors (500 ma vs 50), and they are acquired at higher resolution (14-bit vs. 12-bit). Cabling is simpler and more reliable due to four differential auxiliary inputs on two separate connectors, and a dedicated connector for the pump. All exposed metal parts are titanium, instead of aluminum, for long life and minimum maintenance.

The 19plus can be operated without a computer from even the smallest boat, with data recorded in non-volatile FLASH memory and processed later on PC. Simultaneous with recording, real time data can be transmitted over single-core, armored cable directly to your PC's serial port (maximum transmission distance dependent on number of auxiliary sensors, baud rate, and cable properties). The 19plus' faster sampling and pump-controlled TC-ducted flow configuration significantly reduces salinity spiking caused by ship heave and allows slower descent rates for improved resolution of water column features. Auxiliary sensors for dissolved oxygen, pH, turbidity, fluorescence, and PAR can be added.

Use of conductivity, temperature, and depth measurement for determination of sound velocity is appealing because these instruments are simpler, more rugged, and resolution, accuracy, and stability lead to better precision than can be obtained with direct sound velocity measuring devices. Three equations are widely used for deriving sound velocity from CTD data (Wilson, 1959; Del Grosso, 1972; Millero and Chen, 1977). Absolute sound velocities derived from these equations differ on the order of 0.5 meter/second for various combinations of water temperature, salinity, and pressure. The work of Millero and Chen is the most modern and builds upon and attempts to incorporate the work of the earlier investigators. Millero and Chen's 1977 equation is used in the Sea-Bird Seasoft software and is the one endorsed by the UNESCO/SCOR/ICES/IASPO Joint Panel on Oceanographic Tables and Standards which comprises the internationally recognized authority for measurements of ocean parameters.

Specifications:

	Measurement Range	Initial Accuracy	Resolution	Sensor Calibration
Conductivity	0 to 9 S/m	+/- 0.0005 S/m	+/- 0.00005 S/m	0 to 9 S/m Physical calibration over range 1.4 to 6 S/m, plus zero conductivity (air)
Temperature (ºC)	-5 to +35	+/- 0.005	+/-0.0001	-1 to +31
Depth	7,000 m	+/- 0.25%	+/- 0.015%	Min 5 values between 0 and full scale

SBE-49 FASTCAT CTD SENSOR (AUV)

SUMMARY

- Conductivity, Temperature, and Pressure, at 16 Hz (16 samples/second).
- Pump-controlled, T-C ducted flow to minimize salinity spiking.
- RS-232 serial interface, no memory or batteries — intended for use on vehicles that can supply power and acquire data.
- Unique flow path, pumping regimen, and (optional) expendable anti-foulant devices, for maximum bio-fouling protection.
- Depths to 350 meters (plastic housing) or 7000 meters (titanium housing).

DESCRIPTION

The SBE 49 FastCAT is an integrated CTD sensor intended for use as a modular component in towed vehicles, ROVs, AUVs, or other autonomous platforms that can supply DC power and acquire serial data. FastCAT's pump-controlled / TC-ducted flow feature minimizes salinity spiking, and its 16 Hz sampling provides very high spatial resolution of oceanographic structures and gradients.

FastCAT's temperature thermistor and conductivity cell are the same as used in our premium 911*plus* CTD system. The strain-gauge pressure sensor is offered in eight full scale ranges from 20 to 7000 dbars. Sophisticated interface circuitry provides very high resolution and accuracy.

FastCAT is an easy-to-use, light, and compact instrument ruggedly made of titanium and other low-maintenance (plastic) materials; it is well suited to even the smallest vehicle. There are straightforward commands for continuous (full rate or averaged) or single sample acquisition. EEPROM-stored calibration coefficients permit data output in ASCII engineering units (degrees C, Siemens/m, decibars, Salinity [PSU], and sound velocity [m/sec]), or the user can select raw data output if desired.

FastCAT must be externally powered, and its RS-232C data logged or telemetered by the vehicle to which it is mounted. As FastCAT does not support auxiliary sensors, where such sensors are required the user's vehicle must be equipped to acquire their signals independently.

SAMPLING MODES

FastCAT has two sampling modes:
- **Autonomous sampling –** FastCAT runs continuously, sampling at sixteen scans per second (16 Hz). It can be set to average up to 255 samples, transmitting only the averaged data. Programmable real-time processing (aligning, filtering, and correcting for conductivity cell thermal mass effects) provides high quality data for applications where post-processing is not feasible. FastCAT can be programmed to begin autonomous sampling when power is applied or on command.
- **Polled sampling –** On command, FastCAT takes one sample and transmits the data.

CONFIGURATION

A standard FastCAT is supplied with titanium housing for depths to 7000 meters, strain-gauge pressure sensor, internal pump and T-C Duct, and XSG 4-pin I/O bulkhead connector. FastCAT options include:
- Plastic housing for depths to 350 meters
- MCBH Micro connector in lieu of XSG
- Expendable anti-foulant devices

SOFTWARE

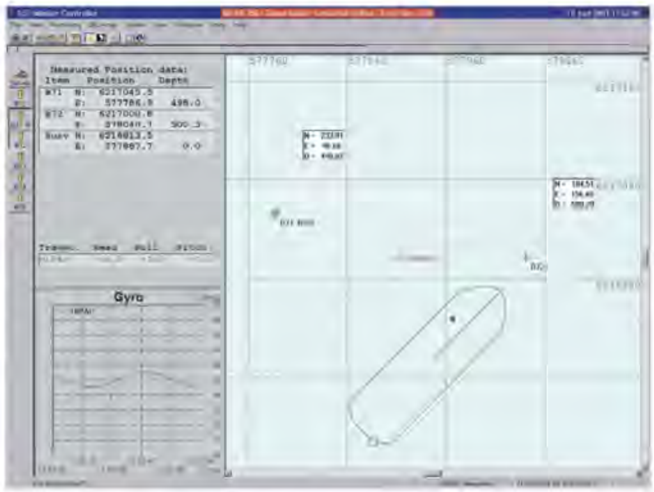
FastCAT is supplied with a powerful Win 2000/XP software package, Seasoft© V2. Seasoft's modular programs include:
- Seaterm — terminal program for instrument setup and data display.
- Seasave — real-time data acquisition and display.
- SBE Data Processing — filtering, aligning, averaging, and plotting of CTD data and derived variables.

KONGSBERG HIPAP 350 USBL ACOUSTIC POSITIONING SYSTEM

System features

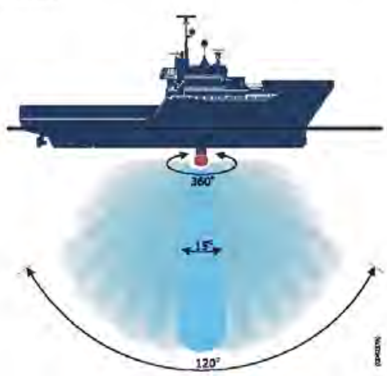
The right system for your application

The HiPAP family of underwater positioning systems lets you choose the right system level for your application. HiPAP 350 has been developed to provide the market's best accuracy where HiPAP 500 extreme accuracy and long-range capabilities are not required.
With this unique transducer array, measuring only 320 mm in diameter (and thus smaller than HiPAP 500), the HiPAP 350 can be used with all existing HPR gate valves.



Acoustic beam pointing control

The HiPAP 350 uses the unique technology of *narrow pointing beams*. This minimizes the effect of noise from propellers and thrusters. This technology gives the system maximum Signal-to-Noise ratio, and this is the major key to successful acoustic performance. The curved transducer creates a narrow beam pointed towards the transponder(s) within a large sector below the vessel. Outside this sector, the pointing beam will increase in width. Data from roll, pitch and heading sensors are used to compensate for vessel movements.



Super-Short Base Line functionality

The Super-Short Base Line (SSBL) principle has the obvious advantage that it only requires installation of one hull-mounted transducer and one subsea transponder to establish a three-dimensional position of the transponder. To provide this position, the SSBL system measures both the horizontal and vertical angles, as well as the range to the transponder.

Long Base Line functionality

At some point of range, depending on the application, the SSBL principle will have accuracy limitation. Long Base Line (LBL) accuracy is independent of range. An LBL system can position more accurately, but only within an array of seabed transponders.
The HiPAP with the optional LBL features is a very flexible system combining the advantages of both the SSBL and LBL principles.
The HiPAP has better long range performance than traditional wider beam systems. This is because the Signal-to-Noise ratio of the detected seabed transponders' replies are higher than when using one wide beam that needs to cover the seabed footprint of a transponder array.

Multi vessel positioning

The Multi-User LBL (MULBL) function enables several individual vessels and ROV units to position themselves using the same seabed transponder array.

LBL for subsea construction

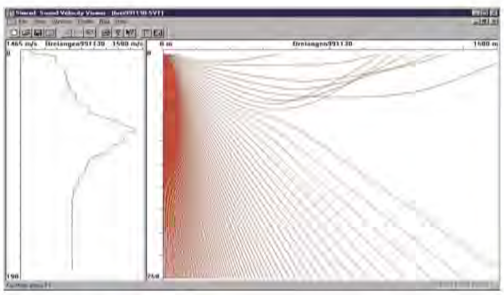
Kongsberg Simrad introduced the LBL system in 1992, and has since become the market leader in supplying LBL and combined LBL / SSBL systems for vessel positioning.
The current LBL systems use intelligent, instrumented transponders and deep water transceivers and transducers. These are all rated for 3000 m water depth, and fulfil any requirements within subsea construction, survey and metrology.

Accuracy a function of transducer size

Accuracy is always dependent on the beam width and the "active surface" of any transducer. The HiPAP 350 will therefore have some reduced performance compared to the more accurate HiPAP 500 which has several more transducer elements.

Automatic compensation for ray bending and sound velocity errors

The HiPAP takes input of the local sound velocity profile, calculates, error compensates and displays the effect of the physical phenomena of sound velocity differences in the water column.



"World Record" in transponder channels

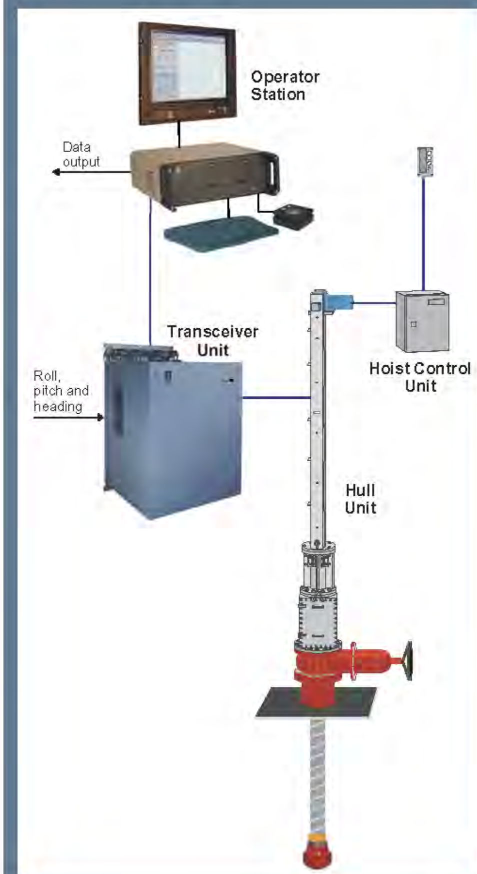
The HiPAP systems can operate with up to 56 transponder channels, and feature transponder telemetry communication for use with transponder release, sensor readings and all LBL functionalities.

Typical applications

The HiPAP 350 has been developed for use in situations where positioning is within a sector of +/-60 degrees below the vessel, but will also perform outside this sector at some reduced accuracy and range capability. This level of functionality makes the HiPAP 350 ideal for drill-rigs, ROV tracking and dynamic positioning reference. It is also ideal for other operations where the underwater positioning is relatively directly below, and where extreme accuracy, shallow water horizontial positioning and ultra deep performance are not required.

HiPAP 350 - ideal for HPR upgrades

The HiPAP 350 system is without question the ideal solution for upgrade of older HPR systems. With its small diameter, the HiPAP 350 transducer can be used with all HPR system gate valves, and may also be installed on the existing hull units to replace the HPR transducer. The upgrade is limited to a minimum of cabling and work.



Typical HiPAP® 350 configuration

The HiPAP® 350 system operates with the transducer mounted on a hull unit. Several hull unit models are available, these enable the transducer to be lowered approximately 1.5 to 5.5 m below the keel. A Transceiver Unit containing the transmitter, preamplifier and beamforming electronics is mounted close to the hull unit. The system can be configured with one or two hull mounted transducers. The use of two transducers will increase accuracy and redundancy.
The system operation is performed on a Windows XP® based operator station.

Technical specifications

HiPAP 350 basic specifications

Gate valve size required:	350 mm (14 inches)
Transducer diameter:	320 mm
Acoustic operating area:	+/- 60° (Recommended)
Number of active elements:	46
Angle accuracy:[1)]	0 dB S/N: 0.40°
	10 dB S/N: 0.23°
	20 dB S/N: 0.18°
Range detection accuracy:[1)]	< 20 cm
Typical operating range:[1)]	1 to 3000 m
Narrow pointing receiver beam:	+/- 7.5°

Note that the technical specifications are subject to change without prior notice.

1) The specifications are based on; Line of sight from transducer to transponder, no influence from ray bending, Signal-to-Noise ratio as specified in water in the 250 Hz receiver band, no error from heading / roll / pitch sensors, and use of correct sound velocity. Operating ranges are typical and conservative, and are assumed by using sufficient transponder source level (up to 206 dB dependant on range).

HiPAP 350 standard features

56 transponder channels
Hull unit for transducer deployment
Windows XP® based operating system
Receive frequency band: 27,0 – 30,5 kHz
Telemetry frequency band: 24,5 – 27,0 kHz
Transmit frequency band: 21,0 – 24,5 kHz
Comprehensive on-line help
Automatic transducer alignment calibration
Compensation for ray-bending
Display of ray-bending
External Depth sensor interface
Position and angle alarm limits
Responder mode
Telegram output to dynamic positioning system
Telegram output to survey system
Transponder Telemetry for full utilization
DGPS Interface

HiPAP 350 optional features

Beacon Mode
Compass Transponder Mode
Depth Sensor Transponder Mode
Inclinometer Transponder Mode
Long Base Line (LBL) functionality
Geographical LBL Calibration
Multi-User LBL functionality (MULBL)
Operator Station Master / Slave function
Blow Out Preventer (BOP) telemetry function
Offshore Loading Telemetry function
Submerged Turret Loading function
Fast LBL Transponder Positioning mode *
LBL Accurate Metrology mode*
(standard in LBL function)*

INERTIAL MOTION UNIT (IMU)

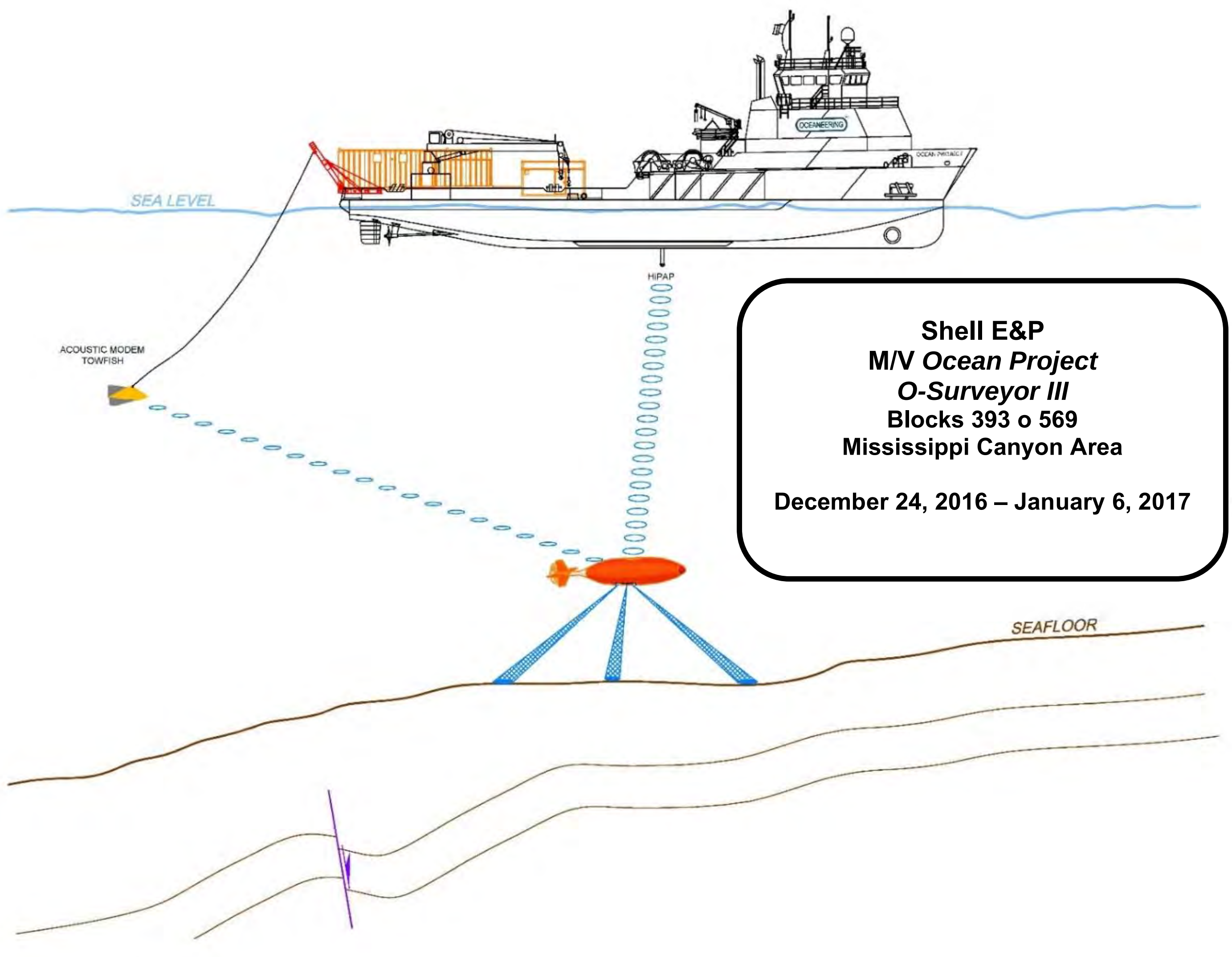
The following are excerpts from Kongsberg's Hydroacoustic Aided Inertial Navigation Instruction Manual (Kongsberg, 2014):

The base of inertial navigation is the inertial measurement unit (IMU) which measures the acceleration and angular rate in all three dimensions. This is normally done by having three perpendicular gyroscopes and accelerometers. The IMU consists of three accelerometers and three gyros that measure the vehicle's accelerations and rotation in three axes.

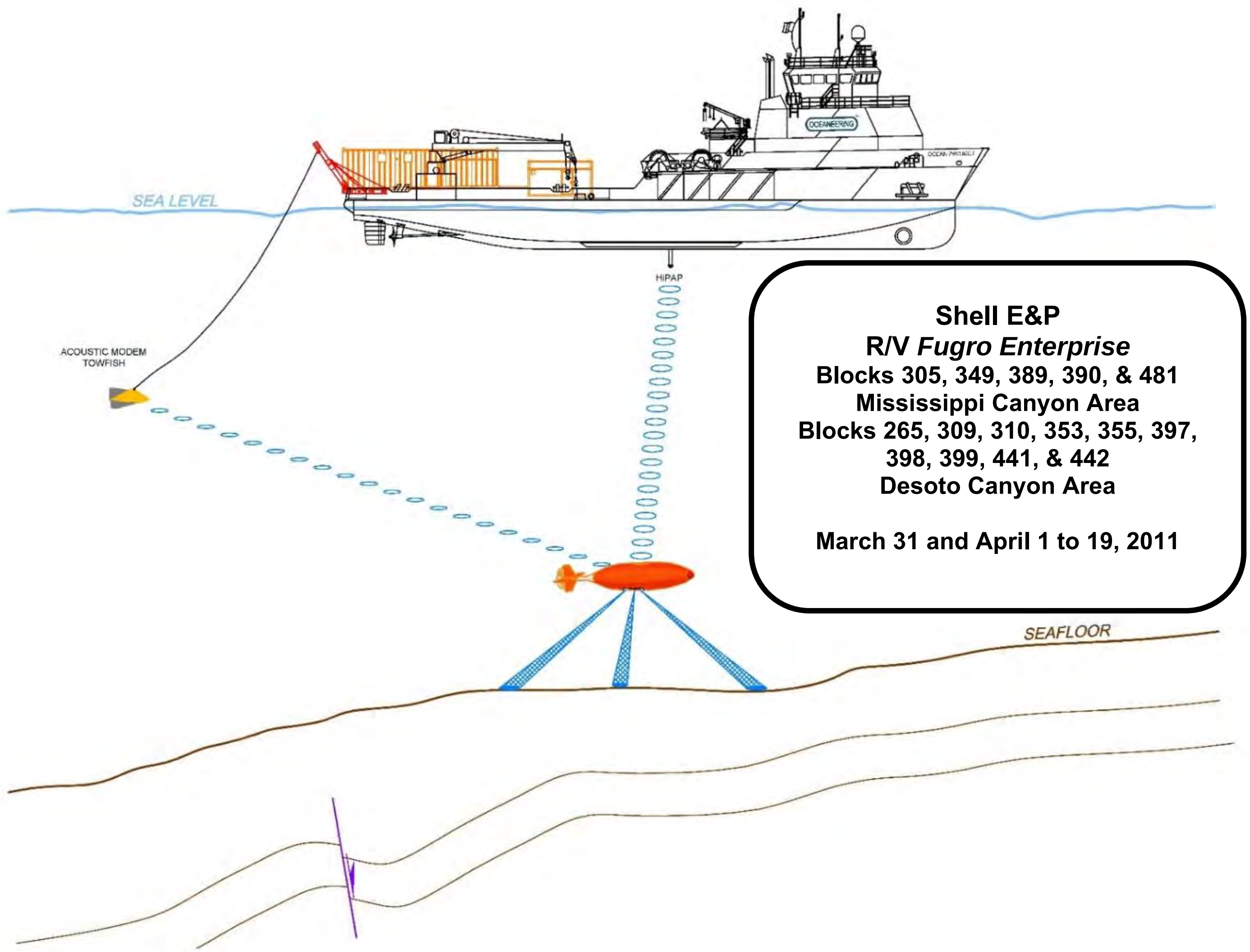
Navigation on inertial measurement is based on knowing the initial values of position, orientation, and velocity, and integrating the measurements from the IMU from these initial values. This means that the angular rates are integrated to give orientation; the accelerations are integrated to give velocities; and the calculated velocities are integrated to give positions.

Technical Specifications:
Depth Rating: 4,000 meters
Dynamic Range, Gyros: +- 500°/s
Dynamic Range, Accelerometers: +- 30 g
Power Requirements: 24 Vdc
Power Consumption: 12 W
Configuration: Serial (RS-422 preferably)
Data rate: 100 Hz
Parity: N
Databits: 8
Stopbits: 1
Baudrate: 115200 kbs

O-Surveyor III Survey Configuration



Enterprise Survey Configuration



OII Survey Field Personnel

AUV & GEOTECHNICAL SURVEY CREW			
Position	Name		Company
	Last	First	
AUV Offshore Manager	Hollie	Beau	Oceaneering Survey Services
Hydrostation Operator Days (Shift Leader)	Patin	Todd	Oceaneering Survey Services
COS Operator Days	Melancon	Jonah	Oceaneering Survey Services
Hydrostation Operator Nights	Picard	Jed	Oceaneering Survey Services
COS Operator Nights (Shift Leader)	Gates	Ali	Oceaneering Survey Services
Operator	Snyder	Justin	Oceaneering Survey Services
AUV Offshore Technical Manager	Perez	Felix	Oceaneering Survey Services
AUV Technician	Havens	Dan	Oceaneering Survey Services
AUV Technician	Boudreaux	Brian	Oceaneering Survey Services
AUV Data Analyst	Tobeck	John	Oceaneering Survey Services
Geologist	Olivier	Ross	Oceaneering Survey Services
Marine Geologist	Fournet	Stephen	Contract - OSS
Geotechnical Engineer	Dobias	John	GEMS/Forum
Geotechnical Engineer	Svrcek	Ivan	TDI-Brooks
Medic	Erwin	Robert	SMS / Acadian
Client Representative	Neurauter	Thomas	SHELL
HSE Representative	Thomas	Colby	SHELL

M/V *OCEAN PROJECT* VESSEL CREW			
Position	Name		Company
	Last	First	
Master	Burns	Lowell	Oceaneering Marine
Chief Mate	Fulton	David	Oceaneering Marine
Chief Engineer	Rodgers	Russell	Oceaneering Marine
Assistant Engineer	Ekundare	Oluyinka	Oceaneering Marine
AB	Sutherlin	Timmy	Oceaneering Marine
AB	Labell Jr	Jack	Oceaneering Marine
O/S Oiler	Bellow	Lance	Oceaneering Marine
O/S Oiler	Lawton	Corey	Oceaneering Marine
Chief Cook	Holloway	Madeline	Oceaneering Marine
Galley Hand	Poindexter	Cleodis	Oceaneering Marine

FGSI Survey Field Personnel

FUGRO AUV SURVEY CREW			
Position	Name		Company
	Last	First	
Party Manager	Harris	Marc	Fugro
Technical Coordinator	Boudreaux	John	Fugro
AUV Assistant Technical Coordinator	Smith	Wyatt	Fugro
AUV Shift Supervisor	McDowell	Daniel	Fugro
Shift Supervisor	Wootan	Lane	Fugro
AUV Tech	Williams	John	Fugro
AUV Tech	Brashear	Daniel	Fugro
AUV Tech	Gabik	Koral	Fugro
AUV Tech	Miller	Mitch	Fugro
AUV Tech/ HSE Officer	Corkin	Brian	Fugro
AUV Tech	Boullard	Brian	Fugro
AUV Tech	Jackson	Derrick	Fugro
Navigator	Chaumont	Brad	Fugro
Navigator	King	Don	Fugro
Processor	Smith	Darrel	Fugro
Processor	Bridges	Matt	Fugro
Medic	Tony Pippin	Tony	Fugro
Client Rep (QC)	Landry	Laura	Fugro
Client Rep (HSE)	Hamm	Greg	Fugro
1st Captain	Haltom	John	Fugro
2nd Captain	Reeves	Richard	Fugro
3rd Captain	Naquin	Joe	Fugro
Engineer	Liner	Thomas	Fugro
Cook	Bush	Ed	Fugro
Deckhand	Jolivette	Larry	Fugro
Deckhand	Dupuy	Mike	Fugro

APPENDIX C: OII SURVEY LOGS

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG				Page No. 3
JobNo: 180110	**Client: Shell Offshore Inc.**	**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III TM	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log	
Date: (UTC) 12/26/16	**Areas: MC / DC Blocks:525-393/441-353 Units: Meters**	**Mission**: Run161225_1	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0108	164	2288	135	102A	EOL
0115	250	2287	5	407	SOL
0123	250	2268	0	407	EOL
0130	160	2286	137	102B	SOL
0213	197	2291	103	102B	EOL
0223	102	2285	0	406	SOL
0233	102	2294	7	406	EOL
0239	195	2290	105	102C	SOL
0316	209	2280	76	102C	EOL
0323	299	2302	5	405	SOL
0330	299	2277	0	405	EOL
0338	209	2300	78	102D	SOL
0416	209	2289	48	102D	EOL
0424	119	2286	0	404	SOL
0431	119	2292	5	404	EOL
0438	209	2289	50	102E	SOL
0536	209	2289	4	102E	EOL
0539	042	2287	0	302	SOL
0545					Shift change: A. Gates, J. Picard
0600				Wx	Winds: 20-25 kts Seas: 4-7' Bar: 1022mb
0856	281	2253	160	302	EOL
0902	024	2255	0	412	SOL
0910	024	2259	5	412	EOL
0913	204	2261	5	411	SOL
0920	204	2257	0	411	EOL
0929	101	2254	160	303A	SOL
1005	104	2277	132	303A	EOL
1011	191	2276	5	417	SOL
1019	191	2286	0	417	EOL
1026	101	2278	134	303B	SOL
1101	162	2302	107	303B	EOL
1109	072	2301	0	416	SOL

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG					Page No. 4
JobNo: 180110	**Client: Shell Offshore Inc.**		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III TM		**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: (UTC) Dec-26-2016	**Areas**: MC / DC **Blocks**:525-393/441-353 **Units: Meters**	**Mission**: Run161225_1	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N		**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1115	072	2306	5	416	EOL
1122	161	2303	109	303C	SOL
1159	222	2315	80	303C	EOL
1200				Wx	Winds: E 18-22 kts Seas: 4-6' Bar: 1023 mb
1206	312	2317	5	415	SOL
1213	312	2313	0	415	EOL
1221	221	2316	82	303d	SOL
1256	222	2299	54	303d	EOL
1303	132	2299	0	414	SOL
1311	132	2302	5	414	EOL
1317	222	2300	56	303e	SOL
1354	222	2296	27	303e	EOL
1359	299	2298	10	403	SOL
1413	299	2289	0	403	EOL
1420	132	2291	0	413	SOL
1434	132	2298	10	413	EOL
1441	222	2296	29	303f	SOL
1517	222	2289	0	303f	EOL
1525	029	2283	0	203	SOL
1745					Shift change: T. Patin, J. Melancon
1800				WX	Winds: ESE 16 kts Seas: 3-5 ft Bar: 1023 mb
1814	294	2257	140	203	EOL
1816	114	2257	140	202a	SOL
1842	114	2280	120	202a	EOL
1850	024	2276	0	410	SOL
1901	024	2275	8	410	EOL
1911	114	2277	122	202b	SOL
1946	207	2297	95	202b	EOL
1947					External guidance stopped / Begin normal ascent
1957					EM2040 – Off
2000					EdgeTech – Off
2053					AUV emergency ascent / No ACL comms

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG					Page No. 5
JobNo: 180110	**Client: Shell Offshore Inc.**		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III TM	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log	
Date: (UTC) 12/26/16	**Areas**: MC / DC **Blocks**:525-393/441-353 **Units: Meters**	**Mission**: Run161225_1	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
2108					AUV on surface / Recover AUV
2227					AUV in van / Split-pin in
2234					Data down load started
2337					Data download complete
2339					CP is down – Battery Swap
0000				New Day	12/27/2016
----					Lat: 28°31.792927 Lon: -87°51.404724
----					X: 416172.98 Y: 3156000.77
----				WX	Winds: E 13-14 kts Seas: 3-4 ft Bar: 1023 mb
0030					Transit to CTD location 161227A
0117					Arrived at CTD location
0125					Going down with CTD161227A
0206					CTD on bottom – wd: 2317m – blk: DC441
-					Lat: 28°32.210281 Lon: -87°53.024277
-					X: 413537.66 Y: 3156790.59
0241					CTD on deck
0300					Pre-dive started run161227_1
0320					Pre-dive complete
0323					AUV in armed state
0324:29					Split-pin pulled
0325:15					AUV in the water
0326:34					AUV running on surface
0327:35					AUV diving
0331:06					HiPAP comms
0332:34					Towfish in the water
0333:52					ADL comms
0334:42					ACL comms
0423					EdgeTech – On
0459					EM2040 – On
0501					External guidance activated
0511	004	2291	100	201	SOL
0545					Shift change: A. Gates, J. Picard

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG						Page No. 6
JobNo: 180110	**Client: Shell Offshore Inc.**		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III TM		**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log	
Date: (UTC) 12/27/16	**Areas**: MC / DC **Blocks**:525-393/441-353 **Units: Meters**		**Mission**: Run161227_1	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0600				Wx	Winds: SSE 5-8 kts Seas: 3-5' Bar: 1024 mb
0604	294	2257	140	201	EOL
0608	114	2255	140	204	SOL
0900	209	2282	0	204	EOL
0908	042	2290	1	304	SOL
1200				WX	Winds: E 15 kts Seas: 3-5' Bar: 1023mb
1225	281	2256	160	304	EOL
1242	101	2272	148	301	SOL
1528	221	2292	12	301	EOL
1549	029	2284	0	101	SOL
1745					Shift change: T. Patin, J. Melancon
1800				WX	Winds: E 5-7 kts Seas: 2-4 ft Bar: 1022 mb
1916	316	2249	170	101	EOL
1921	136	2247	170	104	SOL
2047	204	2289	100	104	EOL / End of mission
2048					External guidance stopped
2054					EM2040 – Off
2057					EdgeTech – Off
2146					AUV entered MP line 24
2156					AUV on final ascent to surface
2159					Acoustic fish on deck
2206					AUV on surface / Recover AUV
2256					AUV in van / Split-pin in
2259					Data download started
2327					Data download complete
2329					On location for CTD 161228A
2348					Going down with CTD161228A
0000				New Day	12/28/2016
----					Lat: 28º37.253990 Lon: -87º54.447071
----					X: 411288.32 Y: 3166121.24
----				WX	Winds: N 3-5 kts Seas: 2-3 ft Bar: 1020 mb
0020					CTD on bottom wd: 2272m blk: DC353

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG					Page No. 7
JobNo: 180110	**Client**: Shell Offshore Inc.		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III ™	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log	
Date: (UTC) 12/28/2016	**Areas**: MC / DC **Blocks**:525-393/441-353 **Units:** Meters	**Mission**:	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-6 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0020					Lat: 28°37.260986 Lon: -87°54.404640
----					X: 411357.55m Y: 3166133.63m
0054					CTD on deck
0112					Preparing for box cores / Safety meeting
0256					BC-07 in the water
0321					BC-07 on bottom – WD: 2269m
----					X: 410272.47 Y: 3165421.39
----					Lat: 28°36.871078 Lon: -87°55.067223
0403					BC-07 on deck, failed to actuate
0432					BC-07 in the water
0506					BC-07 on bottom – WD: 2266m
----					X: 410279.66 Y: 3165420.08
----					Lat: 28°36.870125 Lon: -87°55.062801
0545					BC-07 on deck, failed to actuate
0600				WX	Winds: SE 5-8kts Seas: 2-3ft Bar: 1021mb
0622					BC-07 in the water
0643					BC-07 on bottom – WD: 2262m
----					X: 410250.35 Y: 3165418.64
----					Lat: 28°36.869225 Lon: -87°55.080764
0723					BC-07 on deck – analyzing sample
----					Sample invalid – short 2 inches of recovery
----					Adding 8 lead bricks
0855					BC-07 attempt 4 in the water
0919					BC-07 on bottom – WD: 2266m
----					Lat: 28°36.863632 Lon: -87°55.067585
----					X: 410271.77 Y: 3165408.15
1000					Box Core On Deck – Analyzing Sample
					Sample is Good – Analyzing, Transit To BC - 06
1200				WX	Winds: SE 4-6kts Seas: 2-4ft Bar: 1020.16mb
1621					BC-06 in the water
1648					BC-06 on bottom – WD: 2291
----					Lat: 28°33.438828 Lon: -87°53.708286

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG					Page No. 8
JobNo: 180110	**Client**: Shell Offshore Inc.		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III TM	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log	
Date: (UTC) 12/28/2016	**Areas**: MC / DC **Blocks**:525-393/441-353 **Units:** Meters	**Mission**:	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-6 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1648					X: 412466.92 Y: 3162760.42
1728					BC-06 on deck, analyzing sample, Transit To BC - 13
1745					Shift change: T. Patin, J. Melancon, F. Perez, D. Havens
1800				WX	Winds: SW 0-5kts Seas: 1-2ft Bar: 1020.15mb
2114					BC-13 in the water
2138					BC-13 on bottom – WD: 2285
----					Lat: 28°34.129990 Lon: -87°54.198063
----					X: 411650.44 Y: 3160349.62
2215					BC-13 on deck, failed to actuate
2238					BC-13 in the water
2312					BC-13 attempt #2 on bottom – WD: 2285
----					Lat: 28°34.118511 Lon: -87°54.211891
----					X: 411627.73 Y: 3160328.60
2354					BC-13 on deck, analyzing sample
0000				New Day	12/29/2016
----					Lat: 28°34.627014 Lon: -87°54.023132
----					X: 411942.50 Y: 3161265.24
----				WX	Winds: SW 5 kts Seas: 2-3 ft Bar: 1018.80 mb
0342					Back deck secured
0446					HiPAP pole is up
----					Transiting to dock
0545					Shift change: A. Gates, J. Picard
0600				WX	Winds: SSW 20-23 kts Seas: 2-4 ft Bar: 1018 mb
1745					Shift change: T. Patin, J. Melancon
1800				WX	Winds: NNW 40 kts Seas: 2-3 ft Bar: 1019 mb
2040					Vessel arrived at dock
0000				New Day	1/3/2017
0300					Crew Arrives back on board
0748					Departing Dock
1200				WX	Winds: N 10kts Seas: 5-7ft Bar: 1013mb
1745					Shift change: A. Gates, J. Melancon
1800				WX	Winds: E 10-15kts Seas: 3-5ft Bar: 1014mb

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG — Page No. 9

JobNo: 180110 | **Client**: Shell Offshore Inc. | **Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III ™ | **Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log

Date: (UTC) 01/04/2017 | **Areas**: MC / DC **Blocks**:525-393/441-353 **Units:** Meters | **Mission**: | **Datum:** NAD27 **Projection:** UTM **Zone:** 16N | **Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)

Time (UTC) (-6 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0000				New Day	04 January 2017
----					Lat: 28.569189 Long: -87.960901
----					X: 406017.07 Y: 3160432.92
----				Wx	Winds: W 1-3 kts Seas: 2-4ft Bar: 1013mb
0030					Arrive at BC-08, first box core location – Lowering HiPAP ram
0045					HiPAP ram lowered - Preparing for box cores / Safety meeting
0137					BC-08 in the water
0208					BC-08 on bottom – WD: 2283
----					Lat: 28°33.960392 Lon: -87°54.872192
----					X: 410549.14 Y: 3160044.80
0250					BC-08 on deck, analyzing sample, Transit to BC-05
0652					BC-05 in the water
0724					BC-05 on bottom – wd: 2301m – blk: DC397
----					Lat: 28°33.196125 Lon: -87°53.665840
----					X: 412505.13 Y: 3158618.71
0804					BC-05 on deck, failed to trigger
----					Transit to BC-05 for second attempt
0844					BC-05 (second attempt) in the water
0908					BC-05 on bottom – wd: 2301m – blk: DC397
----					Lat: 28°33.190765 Lon: -87°53.668758
----					X: 412500.30 Y: 3158608.86
0947					BC-05 on deck, failed to trigger, transit to BC-05
1020					BC-05 (third attempt) in the water
1049					BC-05 on bottom – wd: 2299m – blk: DC397
----					Lat: 28°33.194962 Lon: -87°53.663074
----					X: 412509.62 Y: 3158616.53
1128					BC-05 on deck, analyzing sample, transit to BC-12
1200				WX	Winds: NW 8kts Seas: 3-4ft Bar: 1012mb
1532					BC-12 in the water
1559					BC-12 on bottom – wd: 2309 – blk: DC397
----					Lat: 28°33.024387 Lon: -87°52.784321
----					X: 413939.97 Y: 3158290.96

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG					Page No. 10
JobNo: 180110	**Client**: Shell Offshore Inc.		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III ™		**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: (UTC) 01/04/2017	**Areas**: MC / DC **Blocks**:525-393/441-353 **Units:** Meters	**Mission**:	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N		**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)

Time (UTC) (-6 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1641					BC-12 on deck, analyzing sample, transit to BC-11
1800				WX	Winds: NW 15-20kts Seas: 3-4ft Bar: 1013.64mb
2025					BC-11in the water
2051					BC-11 on bottom – WD: 2323 m – block: DC441
----					Lat: 28°31.357815 Lon: -87°53.186581
----					X: 413261.36 Y: 3155216.46
2131					BC-11 on deck, analyzing sample, transit to BC-04
0000				New Day	1/5/2017
----					Lat: 28°31.359716 Lon: -87°53.186718
----					X: 413261.16 Y: 3155221.97
----				WX	Winds: NW 10-12kts Seas: 3-4ft Bar: 1013.24mb
0118					BC-04 in the water
0146					BC-04 on bottom – WD: 2307m – block: DC441
----					Lat: 28°31.592985 Lon: -87°54.582607
----					X: 410987.99 Y: 3155669.76
0225					BC-04 on deck, analyzing sample, transit to BC-03
0600				WX	Winds: N 5-10kts Seas: 2-3ft Bar: 1013.62mb
0618					BC-03 in the water
0643					BC-03 on bottom – WD: 2296m – block: MC525
----					Lat: 28°29.907778 Lon: -87°55.618084
----					X: 409275.30 Y: 3152570.94
0724					BC-03 on deck, analyzing sample, transit to BC-10
1142					BC-10 in the water
1200				WX	Winds: variable 0-5kts Seas: 2-3ft Bar: 1013.47mb
1212					BC-10 on bottom – WD: 2305m – block: DC441
----					Lat: 28°30.053909 Lon: -87°54.490585
----					X: 411116.52 Y: 3152826.71
1251					BC-10 on deck, analyzing sample, transit to BC-09
1648					BC-09 in the water
1713					BC-09 on bottom – WD: 2301m – block: MC525
----					Lat: 28°28.678034 Lon: -87°55.867153
----					X: 408851.39 Y: 3150303.35

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG					Page No. 11
JobNo: 180110	**Client**: Shell Offshore Inc.		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III ™	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log	
Date: (UTC) 01/05/2017	**Areas**: MC / DC **Blocks**:525-393/441-353 **Units:** Meters	**Mission**:	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-6 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1752					BC-09 on deck, analyzing sample, transit to BC-02
1800				WX	Winds: 0kts Seas: 1-2ft Bar: 1012.98mb
2128					BC-02 in the water
2159					BC-02 on bottom – WD: 2295 m – block: MC525
----					Lat: 28°28.695793 Lon: -87°56.384716
----					X: 408007.23 Y: 3150342.72
2236					BC-02 on deck, analyzing sample, troubleshooting T-bar
0000				New Day	1/6/2017
----					Lat: 28°27.210289 Lon: -87°57.379826
----					X: 406361.84 Y: 3147612.55
----				WX	Winds: 0kts Seas:1-2ft Bar: 1011.93mb
0205					T-Bar is working
0434					BC-01 in the water
0510					BC-01 on bottom – WD: 2297 m – block: MC525
----					Lat: 28°27.370081 Lon: -87°57.204239
----					X: 406650.72 Y: 3147905.33
0549					BC-01 on deck, analyzing sample
0600				WX	Winds: E 15kts Seas:1-2ft Bar: 1011.91mb
0646					HiPAP ram is up – analyzing sample still
----					Begin slow transit to compatt location
1022					Core analysis complete, deck secure, full transit speed
1200				WX	Winds: SW 15-20kts Seas:1-2ft Bar: 1011.21mb
1800				WX	Winds: N 22-27kts Seas:3-5ft Bar: 1010.84mb
----					Crew change: A. Gates, J. Melancon
0000				New Day	07 January 2017
----					Lat: 29°03.776504 Long: -90°13.845369
----					X: 185427.53 Y: 3219068.31
----				Wx	Winds: N 40 kts Seas: 3-5' Bar: 1014.92mb
0135					Boat arrives at dock
0000				New Day	06-13-2017 – Switch From Job 182844
---					Vessel In Transit To Piston Core Location

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG			Page No. 12
JobNo: 180110	**Client:** Shell Offshore Inc.	**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III ™	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log

Date: (UTC) 06/13/2017	**Areas:** MC / DC **Blocks:** 525-393/441-353 **Units:** Meters	**Mission:**	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0000				New Day	06-13-2017 – Switch From Job 182844
---					Vessel In Transit To Piston Core Location
---					Lat: 27° 35.423363 Lon: -90 47.291416m
---					X: 125978.38m Y: 3057361.59m
---				WX	Winds: E 15-20 kts Seas: 2-4 ft Bar: 1014.01
0600				WX	Winds: E 15-20 kts Seas: 3-4 ft Bar: 1014.59
1045					Shift Change: J. Page, R. Hargroder
0600				WX	Winds: E 5 kts Seas: 2-3 ft Bar: 1015.76
1045					Shift Change: J. Page, R Hargroder
1200				WX	Winds: ESE 5-10 Knots Seas: 2-3 Feet Bar: 1015
1700					Vessel On Location – Setup For Coring
---					And CTD Operations
1744					Going Down With CTD
1800				WX	Winds: SE 0-6 Knots Seas: 1-3 Feet
1810		2292			CTD On Bottom 170614A – MC569
---					LAT: 28° 27.3480 LON: -87° 57.1743
---					X: 406699.21 Y: 3147864.30
1840					CTD On Deck – Rigging For Coring Operations
---					CTD 170614A1 Applied APOS
1902					JSEA For Coring Dart Crane Ops
1939					Coring Dart In Trough – Crane Ops Complete
---					Continue Rigging For Coring
2135					Rigging Completed – Deploying Core PC01
2142					Going Down With PC01
2209		2292			PC01 On Bottom – Blk: MC525
---					~~Lat: 28° 27.538446 Lon: -87° 57.191582~~
---					~~X: 406444.96 Y: 3148217.87~~
---					Updated Position – HiPAP Tracing Lost
---					At Time Of Position Fix
---					Lat: 28° 27.3692804 Lon: -87 57.191582
---		2292			X: 406671.27 Y: 3147891.73
2250					Piston Core 01 On Deck
---					Analyzing Piston Core

OCEANEERING SURVEY SERVICES HYDROSTATION SURVEY LOG					Page No. 13
JobNo: 180110	**Client**: Shell Offshore Inc.		**Vessel:** M/V *Ocean Project* **Remote Vessel:** C-Surveyor-III ™		**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: (UTC) 06/13/2017	**Areas**: MC / DC **Blocks**: 525-393/441-353 **Units:** Meters	**Mission**:	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
2314					PC01 Sample = 14.5 Recovery
---					Rigging For Second Attempt
0000				New Day	06-15-2017
---					Lat: 28° 27.346876' Lon: -87° 57.236813'
---					X: 406597.23 Y: 3147862.90
---				WX	Winds: 0kts Seas: 0-1 ft
0011					Rigging complete, Deploying Core
0034		2295			Core PC01A Attempt 2 on bottom – Blk: MC525
---					Lat: 28° 27.363285' Lon: -87° 57.201519'
---					X = 406655.06 Y = 3147892.74
0134					PC01A Sample = 13 3/4 Recovery
0142					Analyzing Core sample / Standing by for results
0230					Analyzing Complete / Core Successful
---					Securing Deck For Transit
0313					Deck Secured – Starting Transit
0400					Switched To Job 184338

OCEANEERING SURVEY SERVICES COS SURVEY LOG						Page No. 1
Job No: 180110 **Mission Name**: run161225_1				**Client**: Shell Offshore Inc.	**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: 12/24/16	**Area**: MC/DC **Blocks**: 525-393/441-353			**Survey Units**: Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0000					New Day 12/25/16
0545					Shift Change: J. Picard, A. Gates
1444					Predive Started run161225_1
----					Troubleshooting HydroStation
1630					Continue Predive
1637:24					AUV In Armed State
1638:21					Split Pin Pulled
1639:14					AUV In Water
1640:26					AUV Running On Surface
1641:55					AUV Appears To Have Dove
1642:09					HiPAP Comms Established
1643:19					Acoustic Towfish In Water
1643:34					ADL Comms Established
1644:40					ACL Comms Established
----					Troubleshooting HiPAP ---- Changed AUV From CSV To CSIII In AUV Config
1716					AUV @ 600m P: -1.5° R: 0.0° SP: 0.5° D: 599.3m
1720					Heading Ref. 180°
1722					Depth Ref. 2000m
1751					Course change 090
1807					AUV at 2000m P:-1.8 R:0.1 SP:0.3 D:1999.2
1809					AUV sent to 2200m depth
1811					Course change 000

OCEANEERING SURVEY SERVICES COS SURVEY LOG					Page No. 2
Job No: 180110 **Mission Name**: run161225_1		**Client**: Shell Offshore Inc.		**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: 12/25/16	**Area**: MC/DC **Blocks**: 525-393/441-353	**Survey Units**: Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1817					AUV at 2200m
1818					AUV sent to 2250m depth
1820					AUV at 2250m
1821					Altitude mode 40m
1826					Activated external guidance
1833	299	2290	5	401	SOL
1840	299	2279	0	401	EOL
1844	119	2281	0	402	SOL
1851	119	2292	5	402	EOL
1903	029	2283	0	103	SOL
2228	316	2250	170	103	EOL
2233	180	2252	0	1001	SOL
2240	180	2254	5	1001	EOL
2243	000	2256	5	1003	SOL
2250	000	2254	0	1003	EOL
2253	180	2253	0	1002	SOL
2300	180	2252	5	1002	EOL
2302	000	2255	5	1001A	SOL
2310	000	2253	0	1001A	EOL
2313	180	2254	0	1003A	SOL
2320	180	2255	5	1003A	EOL
2327	270	2255	5	1005	SOL

OCEANEERING SURVEY SERVICES COS SURVEY LOG						Page No. 3
Job No: 180110 **Mission Name**: run161225_1		**Client**: Shell Offshore Inc.			**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: 12/25/16	**Area**: MC/DC **Blocks**: 525-393/441-353	**Survey Units**: Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N		**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
2335	270	2250	0	1005	EOL
2338	090	2249	0	1004	SOL
2345	090	2256	5	1004	EOL
2350	226	2256	7	409	SOL
0000	226	2253	0	409	EOL/ New Day 12/26/16
0004	046	2255	0	408	SOL
0014	046	2257	7	408	EOL
0024	136	2249	170	102A	SOL
0108	164	2288	135	102A	EOL
0115	250	2287	5	407	SOL
0123	250	2268	0	407	EOL
0130	160	2286	137	102B	SOL
0213	197	2291	103	102B	EOL
0223	102	2285	0	406	SOL
0233	102	2294	7	406	EOL
0239	195	2290	105	102C	SOL
0316	209	2280	76	102C	EOL
0323	299	2302	5	405	SOL
0331	299	2277	0	405	EOL
0338	209	2300	78	102D	SOL
0416	209	2289	48	102D	EOL
0424	119	2286	0	404	SOL

OCEANEERING SURVEY SERVICES COS SURVEY LOG						Page No. 4
Job No: 180110 **Mission Name**: run161225_1			**Client**: Shell Offshore Inc.		**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: 12/26/16	**Area:** MC/DC **Blocks**: 525-393/441-353		**Survey Units**: Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0431	119	2292	5	404	EOL
0438	209	2289	50	102E	SOL
0536	209	2289	4	102E	EOL
0539	042	2287	0	302	SOL
0545					Shift Change: J. Picard, A. Gates
0856	281	2253	160	302	EOL
0902	024	2255	0	412	SOL
0910	024	2259	5	412	EOL
0913	204	2261	5	411	SOL
0920	204	2257	0	411	EOL
0929	101	2254	160	303A	SOL
1005	104	2276	132	303A	EOL
1011	191	2276	5	417	SOL
1019	191	2286	0	417	EOL
1026	101	2278	134	303B	SOL
1101	162	2302	107	303B	EOL
1109	072	2301	0	416	SOL
1115	072	2306	5	416	EOL
1122	161	2303	109	303C	SOL
1159	222	2315	80	303C	EOL
1206	312	2317	5	415	SOL
1213	312	2313	0	415	EOL

OCEANEERING SURVEY SERVICES COS SURVEY LOG						Page No. 5
Job No: 180110 **Mission Name**: run161225_1		**Client**: Shell Offshore Inc.		**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III		**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: Dec-26-2016	**Area**: MC/DC **Blocks**: 525-393/441-353	**Survey Units**: Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)		

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1221	221	2316	82	303d	SOL
1256	222	2299	54	303d	EOL
1303	132	2299	0	414	SOL
1311	132	2302	5	414	EOL
1317	222	2300	56	303E	SOL
1354	222	2296	27	303E	EOL
1359	299	2298	10	403	SOL
1413	299	2289	0	403	EOL
1420	132	2291	0	413	SOL
1434	132	2298	10	413	EOL
1441	222	2296	29	303F	SOL
1517	222	2289	0	303F	EOL
1525	029	2283	0	203	SOL
1745					Shift Change: J. Melancon, T. Patin
1814	294	2257	140	203	EOL
1816	114	2257	140	202A	SOL
1842	114	2280	120	202A	EOL
1850	024	2276	0	410	SOL
1901	024	2275	8	410	EOL
1911	114	2277	122	202B	SOL
1946	207	2297	122	202B	EOL
1947					Stopped external guidance

OCEANEERING SURVEY SERVICES COS SURVEY LOG						Page No. 6
Job No: 180110 **Mission Name**: run161225_1		**Client**: Shell Offshore Inc.		**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log	
Date: 12/26/16	**Area**: MC/DC **Blocks**: 525-393/441-353	**Survey Units:** Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)		

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1949					Height reference 60m
1952					Depth mode 2230m
1954					AUV sent to 600m depth
2042					AUV @ 600m P: -0.6 R: -0.6 SP: 0.8 D: 599.5m
2053					AUV on emergency ascent
2108					AUV on surface – recover AUV
2227					AUV in van – split pin in
2234					Data download started
2337					Data download complete
2339					CP is down. Battery swap
0000					New Day 12/27/16
0300					Started pre dive
0320					Completed pre dive
0323					AUV in armed state
0324:29					Split pin pulled
0325					AUV in the water
0326					AUV running n surface
0327					AUV appears to have dove
0331					HiPAP comms established
0332					Acoustic Towfish in water
0333					ADL comms established
0334					ACL comms established

OCEANEERING SURVEY SERVICES COS SURVEY LOG

Page No. 7

Job No: 180110 **Mission Name**: run161227_1	**Client**: Shell Offshore Inc.	**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log

Date: 12/27/16	**Area**: MC/DC **Blocks**: 525-393/441-353	**Survey Units**: Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0350					AUV at 600m P:-1.8 R:0.0 SP:0.3 D:599.2
0359					AUV sent to 1200m depth
0406					Course change 180
0418					AUV at 1200m P:-1.9 R:0.1 SP:0.3 D:1199.2
0420					Course change 270
0423					AUV sent to 2100m depth
0444					Course change 000
0453					AUV at 2100m
0454					AUV sent to 2250m depth
0500					Altitude mode 40m
0501					Activated external guidance
0511	004	2291	100	201	SOL
0545					Shift Change: J. Picard, A. Gates
0604	294	2257	140	201	EOL
0608	114	2255	140	204	SOL
0900	209	2282	0	204	EOL
0908	042	2290	1	304	SOL
1225	281	2256	160	304	EOL
1242	101	2272	148	301	SOL
1528	221	2292	12	301	EOL
1549	029	2284	0	101	SOL
1745					Shift Change: J. Melancon, T. Patin

OCEANEERING SURVEY SERVICES COS SURVEY LOG

Page No. 8

Job No: 180110 **Mission Name**: run161227_1	**Client**: Shell Offshore Inc.	**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III	**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: 12/27/16 **Area**: MC/DC **Blocks**: 525-393/441-353	**Survey Units**: Meters **Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)	

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
1916	316	2249	170	101	EOL
1921	136	2247	170	104	SOL
2047	204	2289	0	104	EOL
2040					Stopped external guidance
2049					Height reference 70m
2051					Course change 000
2053					Depth mode 2220m
2054					AUV sent to 600m depth
2140					AUV at 600m P:-0.7 R:0.0 SP:0.7 D:599.5
2146					AUV entered MP line 24
2155					AUV at 300m P:-0.3 R:0.0 SP:1.5 D:299.5
2156					AUV on final ascent to surface
2159					Acoustic Towfish on deck
2206					AUV on surface – recover AUV
2256					AUV in van – split pin in
2259					Data download started
2327					Data download completed
2333					CP is down
0000					New Day 12/28/16
0112					Begin coring procedures
0545					Shift change: A. Gates, J. Picard
1745					Shift change: T. Patin, J. Melancon

OCEANEERING SURVEY SERVICES COS SURVEY LOG							Page No. 9
Job No: 180110 **Mission Name**:			**Client**: Shell Offshore Inc.		**Vessel:** M/V Ocean Project **Remote Vessel**: C-Surveyor III		**Survey Equipment:** DGPS, Inertial Navigation, HiPAP, Doppler Speed Log
Date: 12/29/16	**Area**: MC/DC **Blocks**: 525-393/441-353		**Survey Units**: Meters	**Datum:** NAD27 **Projection:** UTM **Zone:** 16N	**Geophysical Equipment:** Edgetech FSSB Profiler (1.5 – 10 kHz), Edgetech Dual Frequency SSS (120 & 410 kHz), Simrad EM 2040 (200, 300, 400 kHz)		

Time (UTC) (-5 to Local)	Heading	Water Depth	Fix No.	Line Name	Remarks
0000					New Day 12/29/16
0545					Shift change: A. Gates, J. Picard
1745					Shift change: T. Patin, J. Melancon

APPENDIX D: FGSI SURVEY LOGS

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	**31-Mar-2011 Thu Julian Day: 090**	**CLIENT:**	**Shell E & P Company**
PROSPECT / SITE:	Appomattox Extension	**JOB DESCRIPTION:**	AUV Survey
NAV. SYSTEM:	Starfix	**AREA & BLOCK:**	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	**R/V:**	Fugro Enterprise
JOB DAY #:	Day: 1	**No. of SURVEY LINES:**	114 — 913.62 Kilometers
CRP TO STERN:	0.00 N/A	**ORIGINAL JOB TOTAL:**	913,623.86 — 0.0% Complete

NAV. DIVIDE BY:	1
NAV. FIX DISTANCE:	125
SURVEY UNITS:	Meters
NAUTICAL MILE:	6080.0

VESSEL MANAGER(S)	
Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux
CLIENT REPRESENTATIVE(S)	
Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW	
AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW	
1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin
DATA PROCESSORS	
Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:			
Wx - 1200:			
Wx - 1800:			
Wx - 2400:			

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	**Mitch Miller**	
Toolbox:		
Shift Change:		
Safety:	**Yes**	**Abandon Ship Drill**
Pre/Post Job:	**Yes**	**Pre-Job Kick off**

TIME		OP	LINE INFORMATION								DNP	DETAILED SURVEY INFORMATION
FROM	TO	CODE	LINE NUMBER	HEADING	BSP	ESP	Fath (ft)	SeaSpy (ft)	SSS Fish (m)		DNP	
0800	1015	**MD**										En route to Patterson from Lafayette
1015	1100	**SM**							1,225.0			HSE meeting with Shell and Vessel crew
1100	1300	**SM**										Shell Kickoff meeting
1300	1340	**SM**										Abandon Ship Drill
1340	2400	**IT**										Underway to Desoto Canyon

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	01-Apr-2011 Fri Julian Day: 091	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 2	No. of SURVEY LINES:	114 / 913.62 Kilometers / 0.0% Complete
CRP TO STERN:	0.00 N/A		

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Hallon
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:			
Wx - 1200:	2-3	5-10	S
Wx - 1800:	2-3	5-10	SE
Wx - 2400:	2-3	5-10	S

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	Geo Gear Deployment, L&R JSA's
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP	Fath (ft)	SeaSpy (ft)	SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	1000	IT										Underway to Desoto canyon
1000	1050	CAL										Change direction to make way for a USBL calibration site in MP69
1050	1100	CAL										Misunderstanding regarding cal site, change course for MC69
1100	1230	CAL										Underway to MC69
1230	1250	CAL										Arrive at calibration site, some disagreement with regards to water depth of calibration site
1250	1310	CAL										Proceed to aquire SVP casts, SVP 24115011_USBLCAL Y = 3,198,035 X = 331,217
1310	1348	CAL										Shell has agreed that this site is suitable for the USBL calibration, proceeding with calibration
1348	1540	CAL										Transponder deployed begin the USBL calibration
1540	1610	CAL										Recorving compatt to the surface, calibtation complete
1610	2105	IT										Underway to jobsiteMisalignment(change) Hdg=184.61(.01) Pitch=0.11(0.01) Roll=-0.78(0.01)
2105	2215	VP										SVP 24115011-1 Y = 3,153,313 X = 423,126 Depth = 1230 Desoto Canyon 443
2215	2310	OW										Underway to launch point avg density to 2340m=1031.99
2310	2400	OW										Preparing AUV for deployment

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	02-Apr-2011 Sat Julian Day: 092
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 3
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company	
JOB DESCRIPTION:	AUV Survey	
AREA & BLOCK:	Desoto Canyon 353 and Vicinity	
R/V:	Fugro Enterprise	
No. of SURVEY LINES:	114	913.62 Kilometers 12.1% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	1-3	10-15	SE
Wx - 1200:	1-3	5-10	SE
Wx - 1800:	1-3	10-15	SE
Wx - 2400:	1-3	10-15	SE

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0119	OW										Preparing AUV for launch
0119	0415	OW										AUV launched run_110401_271 making the descent
0415	0622	OL	606	000.0°	100	236			42.0			Note: a portion of this line will need to be re-run due to ACL problems, The port side ram on A-Frame broke during towfish deployment
0622	0658	LT										
0658	0703	OL	PT1	304.0°	104	100			42.0			Center Line 175 RPM
0703	0708	LT										
0708	0715	OL	PT2	124.0°	100	104			42.0			Center line 145RPM
0715	0721	LT										
0721	0727	OL	PT3	304.0°	104	100			42.0			Center line 145RPM
0727	0733	LT										
0733	0739	OL	PT4	124.0°	100	104			42.0			Wing Line(86m offset) 145 RPM
0739	0748	LT										
0748	0754	OL	PT5	033.0°	100	104			42.0			Tie Line 145 RPM
0754	0807	LT										
0807	0813	OL	614	180.0°	236	231			42.0			
0813	0822	LT										
0822	0830	OL	615	000.0°	231	236			42.0			
0830	0838	LT										
0838	0845	OL	616	180.0°	236	231			42.0			
0845	0853	LT										
0853	0900	OL	617	000.0°	231	236			42.0			
0900	0907	LT										
0907	0914	OL	618	180.0°	236	231			42.0			
0914	0927	LT										
0927	1156	OL	605	180.0°	236	100			42.0			
1156	1205	LT										
1205	1226	OL	604	000.0°	100	117			42.0			
1226	1234	LT										
1234	1254	OL	603	180.0°	117	100			42.0			
1254	1303	LT										
1303	1324	OL	602	000.0°	100	117			42.0			
1324	1333	LT										
1333	1352	OL	601	180.0°	117	100			42.0			

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

Ver 2.1.2010-A

DATE:	02-Apr-2011 Sat Julian Day: 092
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 3
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 — 913.62 Kilometers, 12.1% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

TIME		OP	LINE INFORMATION								
FROM	TO	CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fim (m)		DNP
1352	1401	LT									
1401	1421	OL	600	000.0°	100	117			42.0		
1421	1443	LT									
1443	1635	OL	500	090.0°	100	197			42.0		
1635	1638	LT									
1638	1824	OL	501	270.0°	197	100			42.0		
1824	1827	LT									
1827	2019	OL	502	090.0°	100	197			42.0		
2019	2024	LT									
2024	2208	OL	503	270.0°	197	100			42.0		
2208	2211	LT									
2211	2400	OL	504	090.0°	100	197			42.0		

DETAILED SURVEY INFORMATION

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	03-Apr-2011 Sun Julian Day: 093	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 4	No. of SURVEY LINES:	114 / 913.62 Kilometers / 19.7% Complete
CRP TO STERN:	0.00 N/A		

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	2-4	10-15	SE
Wx - 1200:	3-5	15-20	SE
Wx - 1800:			
Wx - 2400:			

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:	Yes	Towfish recovery
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

FROM	TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0003	LT										
0003	0152	OL	505	270.0°	197	100			42.0			
0152	0155	LT										
0155	0342	OL	506	090.0°	100	197			42.0			
0342	0344	LT										
0344	0537	OL	507	270.0°	197	100			42.0			
0537	0539	LT										
0539	0725	OL	508	090.0°	100	197			42.0			
0725	0728	LT										
0728	0919	OL	509	270.0°	197	100			42.0			
0919	0951	LT										
0951	1109	OL	510	090.0°	127	197			42.0			
1109	1351	OW										Begin AUV recovery to surface due to WX and unconventional towfish recovery
1351	1408	OW										Recoverying Towfish and AUV to deck
1408	2400	WS										Underway to Fourchon for weather and A-Frame repairs

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	04-Apr-2011 Mon Julian Day: 094	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 5	No. of SURVEY LINES:	114 — 913.62 Kilometers, 19.7% Complete
CRP TO STERN:	0.00 N/A		

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 364032
Edgtech 2200 Side Scan 120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3456-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:			
Wx - 1200:			
Wx - 1800:			
Wx - 2400:			

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:		
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0300	WS										Underway to Fourchon
0300	0515	WS										Stand by for dockspace
0515	0820	WS										Dockside Fourchon
0820	1400	WS										Welders arrive begin A-Frame repair
1400	2400	WS										Hydraulic Cylinders being brought in to service company, stabd by for repaired Hydraulic cylinders.

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

Ver 2.1 2010-A

DATE:	05-Apr-2011 Tue Julian Day: 095	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 6	No. of SURVEY LINES:	114 — 913.62 Kilometers, 19.7% Complete
CRP TO STERN:	0.00 N/A		

VESSEL MANAGER(S)	
Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux
CLIENT REPRESENTATIVE(S)	
Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW	
AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW	
1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin
DATA PROCESSORS	
Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:			
Wx - 1200:			
Wx - 1800:			
Wx - 2400:			

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:		
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	2130	WS										Stand by dockside Fourchon
2130	2400	WS										Repaired rams have arrived, begin reassembling the A-Frame.

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	06-Apr-2011 Wed Julian Day: 096
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 7
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 — 913.62 Kilometers, 19.7% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-433
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Hallon
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:			
Wx - 1200:			
Wx - 1800:	4-6	20-25	S
Wx - 2400:	3-5	15-20	S

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	GeoGear Deploy & L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	1515	WS										Underway to Desoto Canyon
1515	1624	VP										SVP 24115001-2 Y = 3,153,615 X = 422,820 Depth 2394 m DC-443
1624	1720	OW										Underway to launch site
1720	2030	WS										Stand by for seas to subside
2030	2127	OW										Preparing the AUV for deployment
2127	2400	OW										AUV launched run_110406_272, begin the descent

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	08-Apr-2011 Fri Julian Day: 098
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 9
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 — 913.62 Kilometers, 51.7% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW	
AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW	
1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	2-4	5-10	SE
Wx - 1200:	2-4	5-10	SE
Wx - 1800:	2-4	5-10	SE
Wx - 2400:	2-4	5-10	SE

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP
0000	0104	OLC	525	270.0°	184	127			42.0		
0104	0106	LT									
0106	0237	OL	526	090.0°	127	208			42.0		
0237	0240	LT									
0240	0412	OL	527	270.0°	208	127			42.0		
0412	0415	LT									
0415	0532	OL	528	090.0°	127	197			42.0		
0532	0535	LT									
0535	0655	OL	529	270.0°	197	127			42.0		
0655	0658	LT									
0658	0816	OL	530	090.0°	127	197			42.0		
0816	0818	LT									
0818	0939	OL	531	270.0°	197	127			42.0		
0939	0941	LT									
0941	1059	OL	532	090.0°	127	197			42.0		
1059	1102	LT									
1102	1221	OL	533	270.0°	197	127			42.0		
1221	1224	LT									
1224	1343	OL	534	090.0°	127	197			42.0		
1343	1346	LT									
1346	1504	OL	535	270.0°	197	127			42.0		
1504	1507	LT									
1507	1627	OL	536	090.0°	127	197			42.0		
1627	1629	LT									
1629	1747	OL	537	270.0°	197	127			42.0		
1747	1749	LT									
1749	1909	OL	538	090.0°	127	197			42.0		
1909	1913	LT									
1913	2030	OL	539	270.0°	197	127			42.0		
2030	2033	LT									
2033	2152	OL	540	090.0°	127	197			42.0		
2152	2155	LT									
2155	2313	OL	541	270.0°	197	127			42.0		

DETAILED SURVEY INFORMATION

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

Ver 2.1 2010-A

DATE:	08-Apr-2011 Fri Julian Day: 098	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 9	No. of SURVEY LINES:	114 — 913.62 Kilometers, 51.7% Complete
CRP TO STERN:	0.00 N/A		

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

TIME		OP CODE	LINE INFORMATION								DNP
FROM	TO		LINE NUMBER	HEADING	BSP	ESP			888 Fish (m)		
2313	2319	LT									
2319	2400	OL	542	090.0°	127	163			42.0		

DETAILED SURVEY INFORMATION

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	09-Apr-2011 Sat Julian Day: 099
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 10
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 / 913.62 Kilometers / 55.1% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304033
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	2-4	5-10	SE
Wx - 1200:	2-4	5-10	SE
Wx - 1800:	3-5	10-15	SE
Wx - 2400:	3-5	10-15	SE

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:	Yes	Fire Drill
Pre/Post Job:		

TIME		OP	LINE INFORMATION									
FROM	TO	CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0034	OLC	542	090.0°	163	197			42.0			
0034	0037	LT										
0037	0156	OL	543	270.0°	197	127			42.0			
0156	0159	LT										
0159	0317	OL	544	090.0°	127	197			42.0			
0317	0319	LT										
0319	0440	OL	545	270.0°	197	127			42.0			
0440	0703	OW										Recoverying AUV to the surfacet due to scheduled battery maintenance
0703	0729	OW										Recoverying AUV to deck
0729	1230	OW										Replacee battery
1230	1430	OW										Ballast test AUV, battery not performing, trouble shooting battery problem
1430	2400	WS										HP dosing line were air bound causing no HP to be delivered to battery cells, decide to postpone launch until after the weather system

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

Ver 2.1.2010-A

DATE:	10-Apr-2011 Sun Julian Day: 100
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 11
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 — 913.62 Kilometers, 55.1% Complete

VESSEL MANAGER(S)	
Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux
CLIENT REPRESENTATIVE(S)	
Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	#304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW	
AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW	
1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin
DATA PROCESSORS	
Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	2-4	10-15	SE
Wx - 1200:	2-4	10-15	SE
Wx - 1800:	2-4	10-15	SE
Wx - 2400:	3-5	20-25	SE

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	1430	WS										Stand by for weather system to pass
1430	1527	VP										Underway to SVP site
1527	1623	VP										SVP 24115001-3 Y = 3,152,114 X = 420,689 Depth = 2409 meters Block DC-487
1623	2400	WS										Underway back to launch site

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	11-Apr-2011 Mon Julian Day: 101		CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension		JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix		AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001		R/V:	Fugro Enterprise
JOB DAY #:	Day: 12		No. of SURVEY LINES:	114 / 913.62 Kilometers / 58.1% Complete
CRP TO STERN:	0.00 N/A			

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-491
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW	
AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW	
1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin
DATA PROCESSORS	
Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	4-6	15-20	SE
Wx - 1200:	4-6	10-15	SW
Wx - 1800:	3-5	10-15	SW
Wx - 2400:	4-6	15-20	W

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	1200	WS										Stand by for seas to calm
1200	1325	OW										Preparing AUV for deployment
1325	1532	OW										AUV launched run_110411_273, begin the descent
1532	1540	OL	619	000.0°	100	104			42.0			
1540	1546	LT										
1546	1655	OL	587	090.0°	100	160			42.0			
1655	1658	LT										
1658	1807	OL	586	270.0°	160	100			42.0			
1807	1811	LT										
1811	1919	OL	585	090.0°	100	160			42.0			
1919	2142	LT										Transit East to Primary survey area
2142	2226	OL	546	090.0°	127	167						After surveying 5km of line 546 the battery voltage began to tank
2226	2244	E329										Unable to sustain a working voltage, instruct HOS operators to turn power off to payload and begin ascent at a dimished RPM on the screw
2244	2400	E329										Voltage dropped below critical level & the AUV issued an emergency ascent, recoverying AUV to surface

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	12-Apr-2011 Tue Julian Day: 102
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 13
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 — 913.62 Kilometers, 58.1% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	5-7	20-25	SE
Wx - 1200:	4-6	20-25	SE
Wx - 1800:	3-5	15-20	SW
Wx - 2400:	2-4	5-10	W

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0020	E329										Recoverying AUV to surface
0020	0045	E329										Recoverying AUV to deck
0045	0130	E329										Trouble shooting battery failure
0130	0600	E329										Crystals found in HP distribution box, removed HP and flushed out bags and replaced hoses
0600	1530	WS										AUV is ready for deployment, the sea conditions prohibit launching, stand by for weather
1530	1710	OW										Preparing AUV for launch
1710	1811	OW										AUV launched run_110412_274, begin the descent
1811	1940	E329										Battery not responding, recovering AUV to surface
1940	1959	E329										Recovering AUV to deck
1959	2330	E329										AUV on deck changing out battery
2330	2400	E329										Battery has been replaced preparing the AUV for deployment

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	13-Apr-2011 Wed Julian Day: 103
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 14
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114
	913.62 Kilometers
	72.6% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Hallon
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	Calm		
Wx - 1200:	Calm		
Wx - 1800:	Calm		
Wx - 2400:	Calm		

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0035	E329										Preparing AUV for launch
0035	0233	OW										AUV launched run_110412_275, begin descent
0233	0315	OLC	546A	090.0°	167	197			42.0			
0315	0318	LT										
0318	0438	OL	547	270.0°	197	127			42.0			
0438	0441	LT										
0441	0600	OL	548	090.0°	127	197			42.0			
0600	0639	LT										
0639	0842	OL	549	270.0°	230	127			42.0			Trouble with the ACL this line a portion of it will need to be re-run
0842	0843	LT										
0843	1037	OL	550	090.0°	127	230			42.0			The beginning of this line will need to be re-run
1037	1040	LT										
1040	1237	OL	551	270.0°	230	127			42.0			
1237	1240	LT										
1240	1359	OL	552	090.0°	127	197			42.0			
1359	1403	LT										
1403	1521	OL	553	270.0°	197	127			42.0			
1521	1524	LT										
1524	1645	OL	554	090.0°	127	197			42.0			
1645	1646	LT										
1646	1805	OL	555	270.0°	197	127			42.0			
1805	1808	LT										
1808	1928	OL	556	090.0°	127	197			42.0			
1928	1931	LT										
1931	2049	OL	557	270.0°	197	127			42.0			
2049	2052	LT										
2052	2211	OL	558	090.0°	127	197			42.0			
2211	2215	LT										
2215	2333	OL	559	270.0°	197	127			42.0			
2333	2336	LT										
2336	2400	OL	560	090.0°	127	148			42.0			

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	14-Apr-2011 Thu Julian Day: 104	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 15	No. of SURVEY LINES:	114
CRP TO STERN:	0.00 N/A	ORIGINAL JOB TOTAL:	913,623.86

NAV. DIVIDE BY:	1
NAV. FIX DISTANCE:	125
SURVEY UNITS:	Meters
NAUTICAL MILE:	6080.0

913.62 Kilometers
88.6% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 394032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	1-3	5-10	SE
Wx - 1200:	2-4	10-15	SE
Wx - 1800:	2-4	10-15	SE
Wx - 2400:	3-5	15-20	SE

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

LINE INFORMATION

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP
0000	0053	OLC	560	090.0°	148	195			42.0		
0053	0058	LT									
0058	0212	OL	561	270.0°	193	127			42.0		
0212	0215	LT									
0215	0327	OL	562	090.0°	127	191			42.0		
0327	0334	LT									
0334	0443	OL	563	270.0°	189	127			42.0		
0443	0446	LT									
0446	0554	OL	564	090.0°	127	188			42.0		
0554	0559	LT									
0559	0706	OL	565	270.0°	186	127			42.0		
0706	0709	LT									
0709	0813	OL	566	090.0°	127	184			42.0		
0813	0818	LT									
0818	0921	OL	567	270.0°	182	127			42.0		
0921	0924	LT									
0924	1023	OL	568	090.0°	127	180			42.0		
1023	1029	LT									
1029	1127	OL	569	270.0°	178	127			42.0		
1127	1130	LT									
1130	1225	OL	570	090.0°	127	176			42.0		
1225	1229	LT									
1229	1324	OL	571	270.0°	175	127			42.0		
1324	1327	LT									
1327	1418	OL	572	090.0°	127	173			42.0		
1418	1424	LT									
1424	1514	OL	573	270.0°	171	127			42.0		
1514	1517	LT									
1517	1601	OL	574	090.0°	127	169			42.0		
1601	1610	LT									
1610	1655	OL	575	270.0°	167	127			42.0		
1655	1658	LT									
1658	1742	OL	576	090.0°	127	165			42.0		

DETAILED SURVEY INFORMATION

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1 2010-A

DATE:	14-Apr-2011 Thu Julian Day: 104	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 15	No. of SURVEY LINES:	114 — 913.62 Kilometers
CRP TO STERN:	0.00 N/A	ORIGINAL JOB TOTAL:	913,623.86 — 88.6% Complete
NAV. DIVIDE BY:	1		
NAV. FIX DISTANCE:	125		
SURVEY UNITS:	Meters		
NAUTICAL MILE:	6080.0		

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			888 Fish (m)		DNP	DETAILED SURVEY INFORMATION
1742	1746	LT										
1746	1828	OL	577	270.0°	164	127			42.0			
1828	1831	LT										
1831	1911	OL	578	090.0°	127	162			42.0			
1911	1916	LT										
1916	1954	OL	579	270.0°	160	127			42.0			
1954	1957	LT										
1957	2032	OL	580	090.0°	127	158			42.0			
2032	2037	LT										
2037	2110	OL	581	270.0°	156	127			42.0			
2110	2114	LT										
2114	2145	OL	582	090.0°	127	154			42.0			
2145	2150	LT										
2150	2244	OL	583	270.0°	152	104			42.0			
2244	2247	LT										
2247	2340	OL	584	090.0°	104	150			42.0			
2340	2400	OW										Begin AUV recovery to surface winds are up and the seas are following

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	15-Apr-2011 Fri Julian Day: 105	CLIENT:	Shell E & P Company
PROSPECT / SITE:	Appomattox Extension	JOB DESCRIPTION:	AUV Survey
NAV. SYSTEM:	Starfix	AREA & BLOCK:	Desoto Canyon 353 and Vicinity
FGSI JOB #:	2411-5001	R/V:	Fugro Enterprise
JOB DAY #:	Day: 16	No. of SURVEY LINES:	114 / 913.62 Kilometers / 88.6% Complete
CRP TO STERN:	0.00 N/A		

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW	
AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	Daniel McDowell
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	John "Wil" Williams
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	Brian Corkin, Daniel Brashear
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW	
1st Captain:	John Halton
2nd Captain:	Richard Reeves
3rd Captain:	Jeremy Driskill
Engineer:	Richard Reeves
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin
DATA PROCESSORS	
Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:			
Wx - 1200:			
Wx - 1800:			
Wx - 2400:			

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:		
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0155	OW										Recovering AUV to surface
0155	0220	OW										Recovering AUV to deck
0220	1200	WS										Stand by for weather
1200	2200	WS										Underway to Pascagoula
2200	2400	WS										Stand By dockside Pascagoula

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

Ver 2.1.2016-A

DATE:	16-Apr-2011 Sat Julian Day: 106
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 17
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 / 913.62 Kilometers / 88.6% Complete

VESSEL MANAGER(S)	
Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux
CLIENT REPRESENTATIVE(S)	
Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW	
AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	John "Wil" Williams
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	Daniel Brashear
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW	
1st Captain:	John Halton
2nd Captain:	Bruce Grimball
3rd Captain:	Joe Naquin
Engineer:	Tom Liner
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin
DATA PROCESSORS	
Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:			
Wx - 1200:			
Wx - 1800:	6-8	20-25	N
Wx - 2400:	4-6	15-20	N

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0400	WS										Taking on fuel and water dockside Pascagoula
0400	1430	WS										Underway to Desoto Canyon
1430	2400	WS										Arrive in work area, sea conditions still way to large to consider working

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	17-Apr-2011 Sun Julian Day: 107
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 18
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 — 913.62 Kilometers, 93.8% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-401
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	John "Wil" Williams
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	Daniel Brashear
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	0
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Bruce Grimball
3rd Captain:	Joe Naquin
Engineer:	Tom Liner
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

Time	Sea State	Wind Speed	Dir.
Wx - 0600:	4-6	20-25	S
Wx - 1200:	3-5	15-20	S
Wx - 1800:	2-4	10-15	SE
Wx - 2400:	2-4	10-15	SE

HSE Reporting (Place an "x" in the box, with brief description

HSE OFFICER:	Mitch Miller	
Toolbox:		
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP
0000	0950	WS									
0950	1051	VP									
1051	1200	OW									
1200	1441	OW									
1441	1635	OW									
1635	1906	OL	607	180.0°	236	100			42.0		
1906	1915	LT									
1915	2140	OL	608	000.0°	100	229			42.0		
2140	2153	LT									
2153	2400	OL	609	180.0°	223	110			42.0		

DETAILED SURVEY INFORMATION

Stand by for Weather to subside
Velo 24115001-4 Y = 3,156,214 X = 422.281 WD 2413m DC443.(WGS84Utm16M)
Underway tp launch site, fueling up the vehicles battery
Making the AUV ready for deployment
AUV launched run_110417_276, begin the descent

FUGRO GEOSERVICES, INC.
GEOPHYSICAL JOBLOG

ver 2.1.2010-A

DATE:	18-Apr-2011 Mon Julian Day: 108
PROSPECT / SITE:	Appomattox Extension
NAV. SYSTEM:	Starfix
FGSI JOB #:	2411-5001
JOB DAY #:	Day: 19
CRP TO STERN:	0.00 N/A

CLIENT:	Shell E & P Company
JOB DESCRIPTION:	AUV Survey
AREA & BLOCK:	Desoto Canyon 353 and Vicinity
R/V:	Fugro Enterprise
No. of SURVEY LINES:	114 / 913.62 Kilometers / 100.0% Complete

VESSEL MANAGER(S)

Party Manager:	Marc Harris
Technical Coordinator	John Boudreaux

CLIENT REPRESENTATIVE(S)

Client Rep (QC):	Laura Landry
Client Rep (HSE):	Greg Hamm
Client Rep #3:	
Client Rep #4:	

GEOPHYSICAL EQUIPMENT	EQUIP #
Kongsberg EM2000 MBE 200khz	# 304032
Edgtech 2200 Side Scan120khz	# 1
Edgtech SBP 2-12khz	# 1
ADCP 307khz	# 1
ACL - 24-28khz 55bits/sec.	# 1
ADL - 22.5khz 4250bits/sec.	# 1
Ixsea IMU90	3458-493
Doppler Velocity Log RDI WHN300	
Paroscientific Digiquartz 9001K-101	
CTD FSI Micro-CTD	

GEOPHYSICAL CREW

AUV Ass't TC:	Wyatt Smith
AUV Shift Supervisor:	John "Wil" Williams
AUV Shift Supervisor:	Lane Wootan
AUV Tech:	Daniel Brashear
"	Mitch Miller
"	Derrick Jackson
"	Brian Boullard
"	Koral Gabik
"	0
FGSI Navigator:	Don King
FGSI Navigator:	Brad Chaumont

VESSEL CREW

1st Captain:	John Halton
2nd Captain:	Bruce Grimball
3rd Captain:	Joe Naquin
Engineer:	Tom Liner
Cook:	Ed Bush
Deckhand:	Larry Jolivette
Deckhand:	Michael Dupuy
Medic:	Tony Pippin

DATA PROCESSORS

Data Processor:	Matt Bridges
Data Processor:	Darrel Smith

WEATHER REPORT

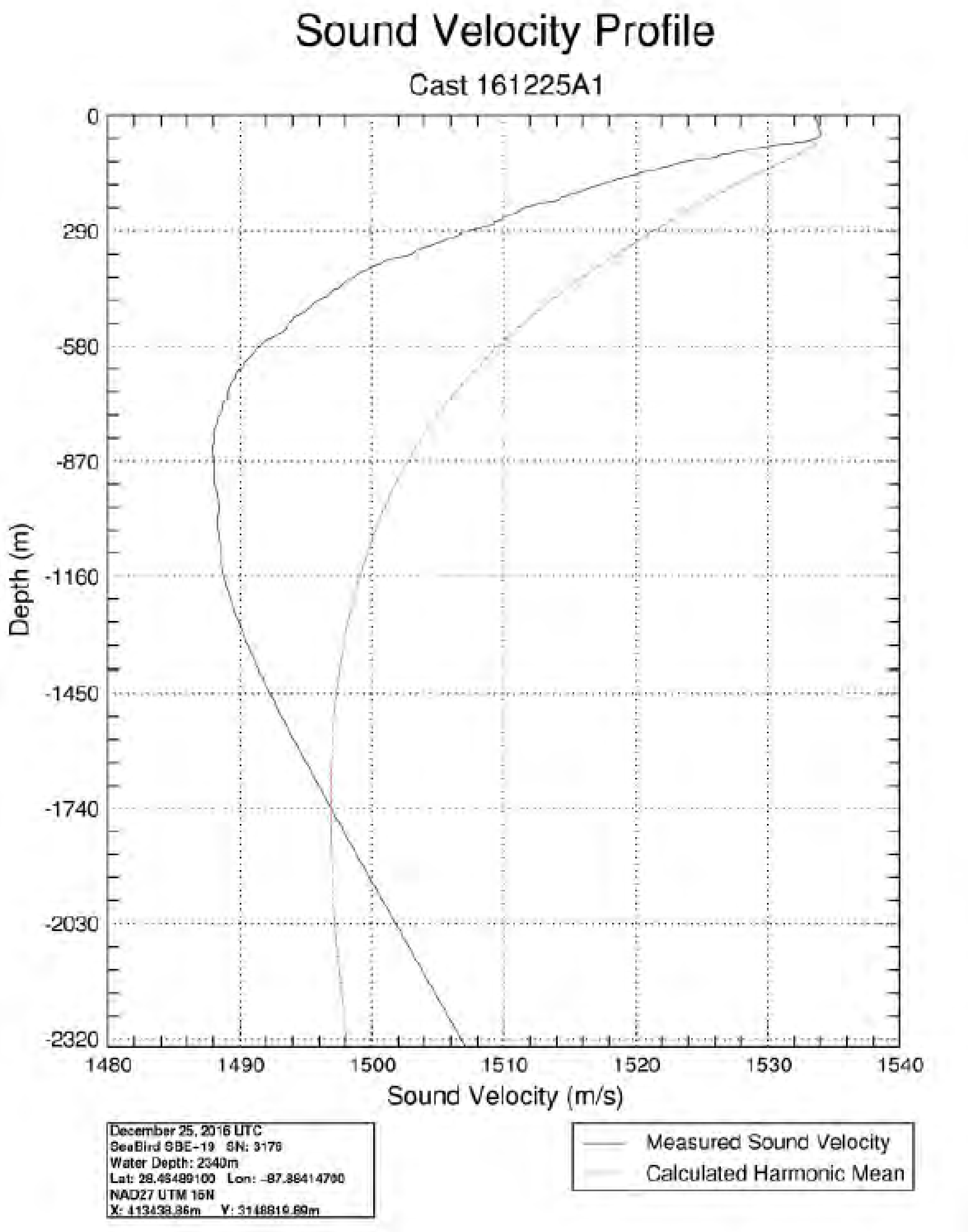
Time	Sea State	Wind Speed	Dir.
Wx - 0600:	2-4	10-15	SE
Wx - 1200:	2-4	15-20	SE
Wx - 1800:	3-5	15-20	SE
Wx - 2400:			

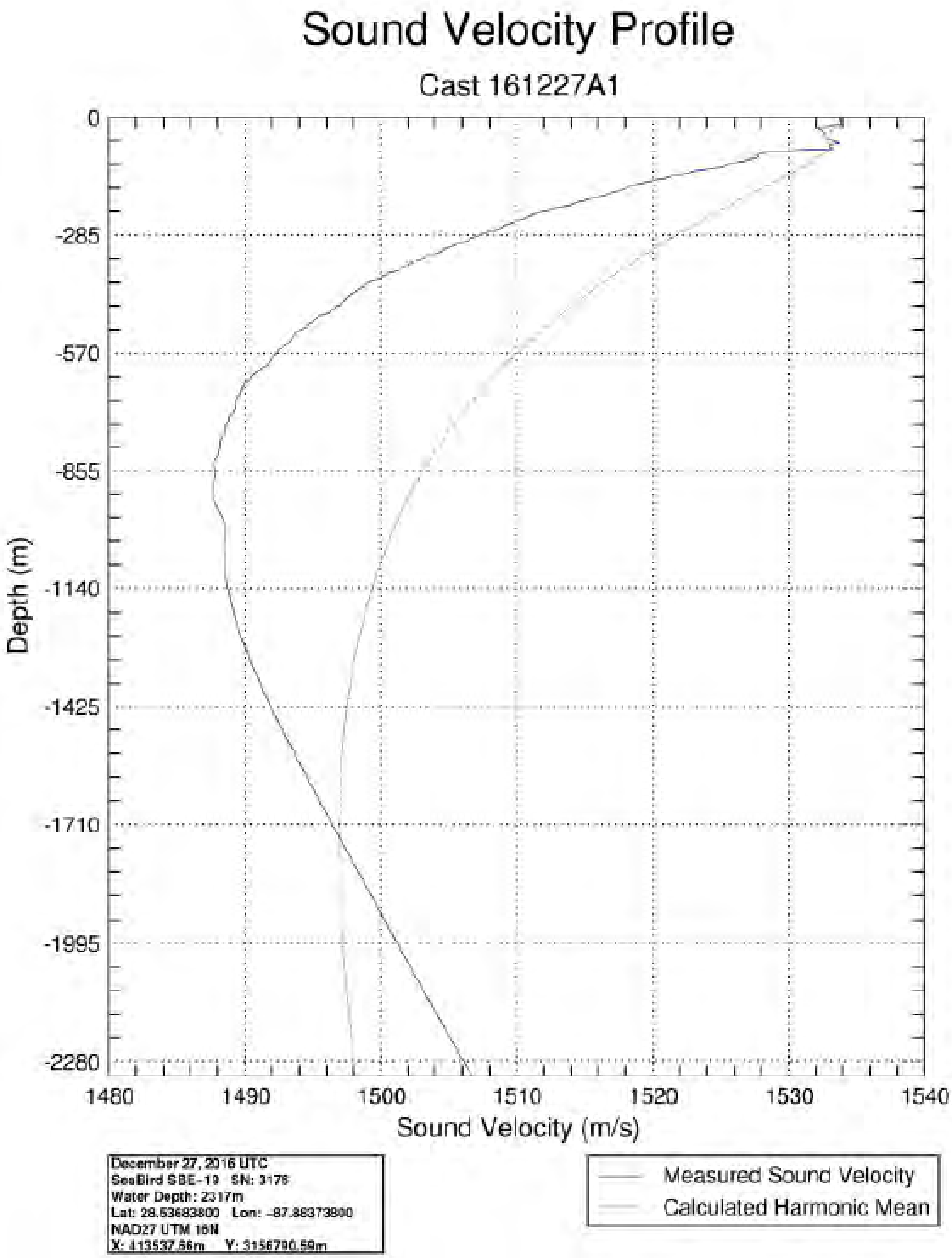
HSE Reporting (Place an "x" in the box, with brief description

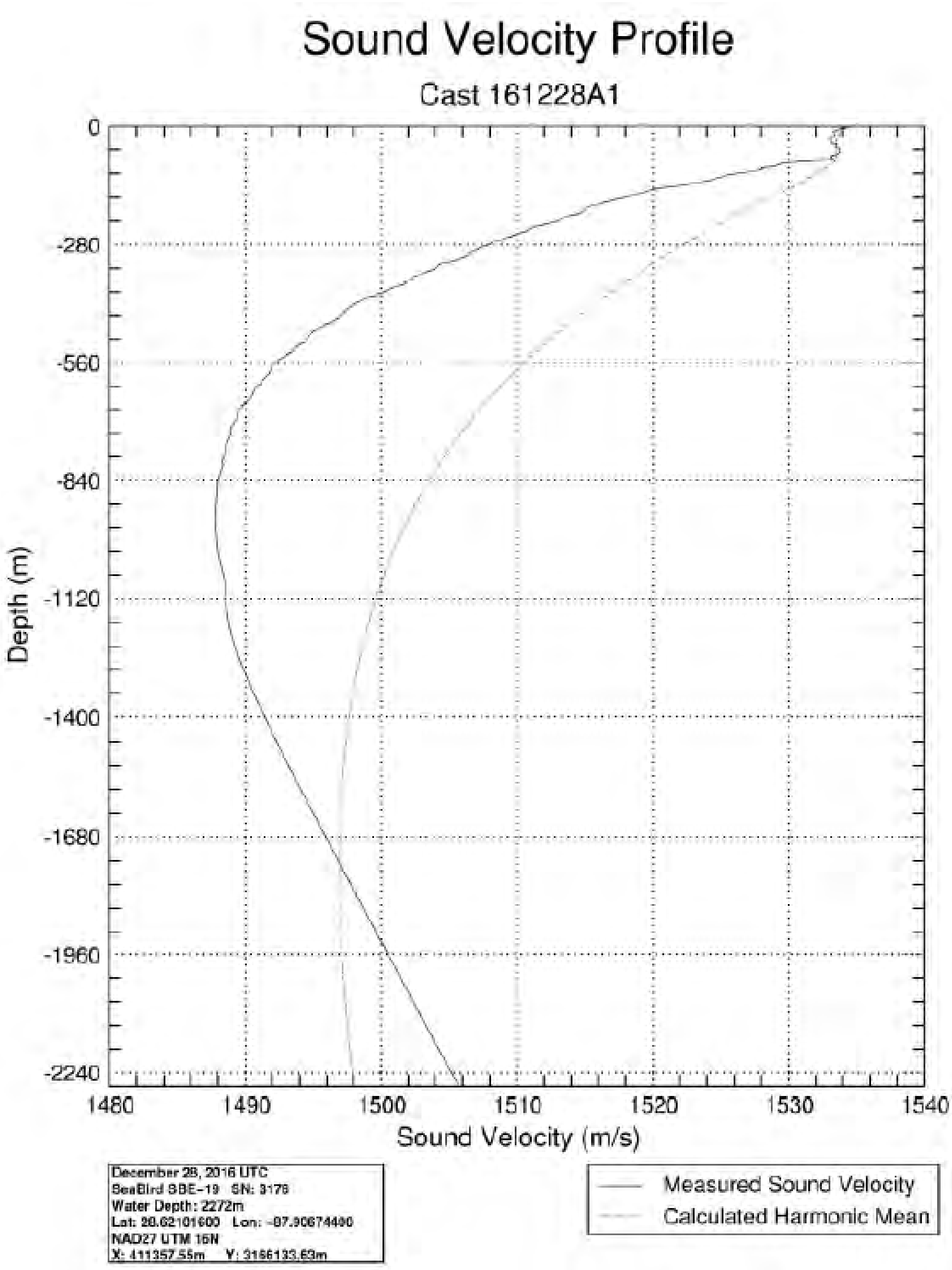
HSE OFFICER:	Mitch Miller	
Toolbox:	Yes	Pre-Recovery
Shift Change:	Yes	L&R JSA
Safety:		
Pre/Post Job:		

TIME FROM	TIME TO	OP CODE	LINE NUMBER	HEADING	BSP	ESP			SSS Fish (m)		DNP	DETAILED SURVEY INFORMATION
0000	0011	OLC	609	180.0°	110	100			42.0			
0011	0019	LT										
0019	0229	OL	610	000.0°	100	216			42.0			
0229	0241	LT										
0241	0445	OL	611	180.0°	210	100			42.0			
0445	0454	LT										
0454	0649	OL	612	000.0°	100	204			42.0			
0649	0702	LT										
0702	0852	OL	613	180.0°	197	100			42.0			
0852	0924	LT										
0924	0945	OL	620	000.0°	100	118			42.0			
0945	1024	E375										
1024	1139	E375	549A	270.0°	185	127			42.0			
1139	1142	E375										
1142	1149	E375	550A	090.0°	127	132			42.0			
1149	1410	OW										Begin Recovery to the surface
1410	1425	OW										Recovering AUV to deck
1425	1510	VP										Underway to SVP site
1510	1605	VP										SVP 24115001-5 Y = 3,115,920 X = 422,311 Depth = 2388 meters Desoto Canyon 443(WGS84Utm16M)
1605	2400	IT										Underway to MC806

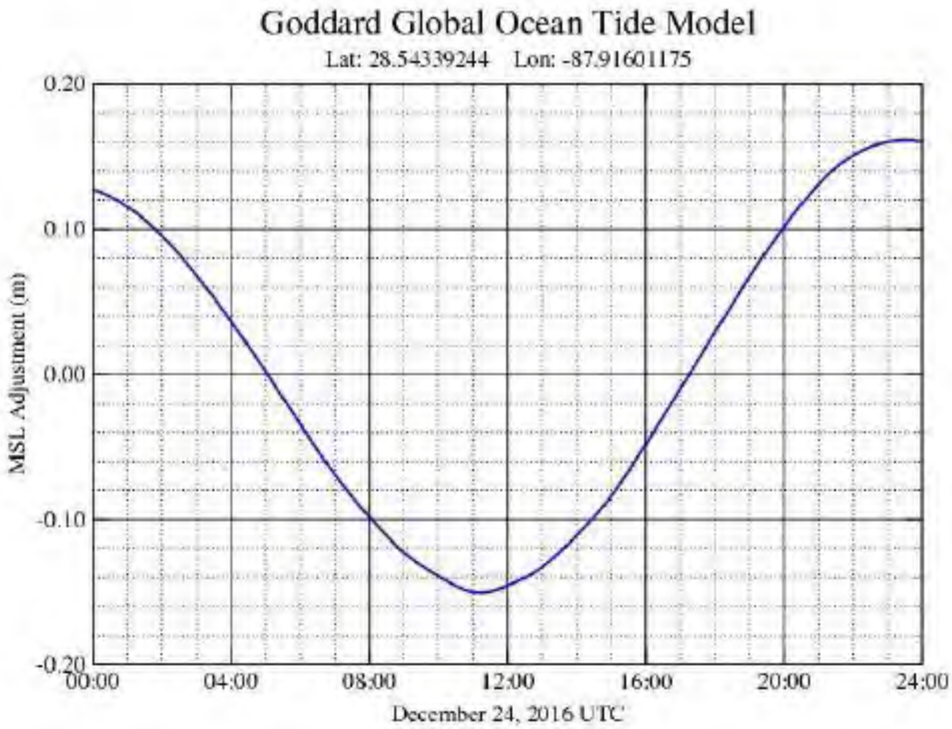
APPENDIX E: SOUND VELOCITY PROFILES & TIDE CURVES

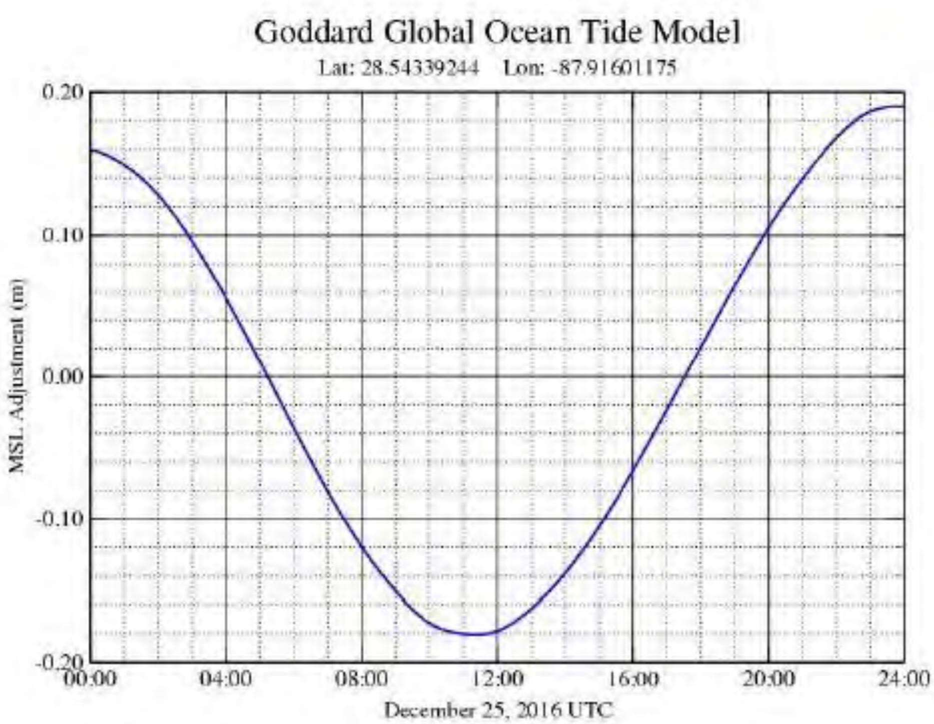

Sound Velocity Profile
Cast 161225A1
Depth (m)
0
-290
-580
-870
-1160
-1450
-1740
-2030
-2320
1480
1490
1500
1510
1520
1530
1540
Sound Velocity (m/s)
December 25, 2016 UTC
SeaBird SBE-19 SN: 3179
Water Depth: 2340m
Lat: 28.46489100 Lon: -87.38414700
NAD27 UTM 16N
X: 413438.86m Y: 3148819.89m
Measured Sound Velocity
Calculated Harmonic Mean

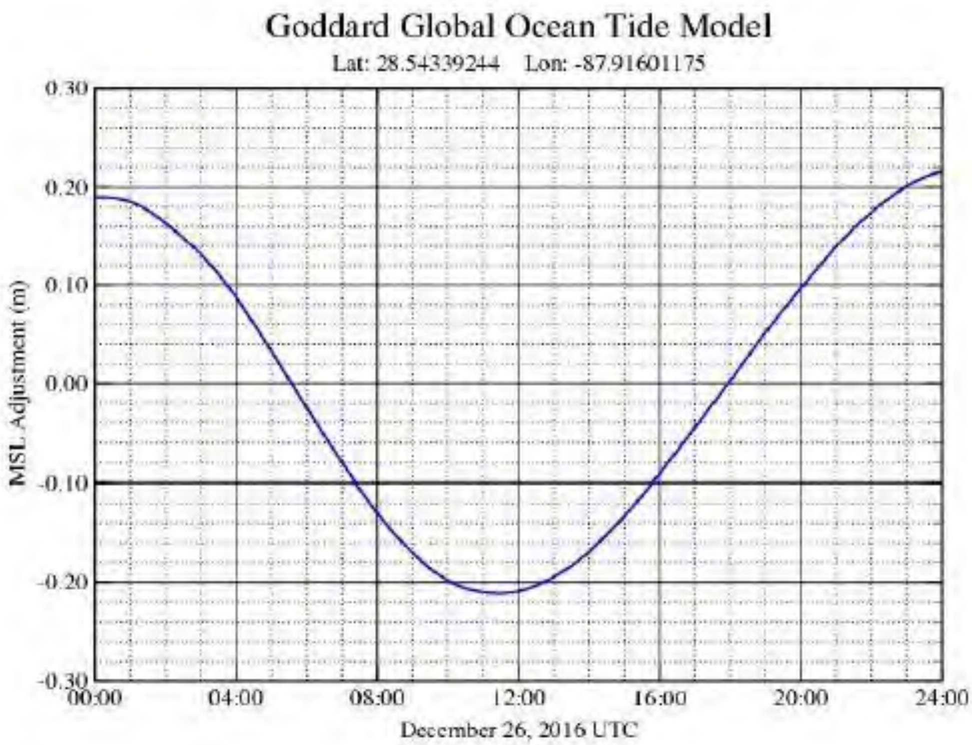

Sound Velocity Profile
Cast 161227A1
Depth (m)
0
-285
-570
-855
-1140
-1425
-1710
-1995
-2280
1480
1490
1500
1510
1520
1530
1540
Sound Velocity (m/s)
December 27, 2016 UTC
SeaBird SBE-19 SN: 3176
Water Depth: 2317m
Lat: 28.53683800 Lon: -87.86373800
NAD27 UTM 16N
X: 413537.66m Y: 3156790.59m
Measured Sound Velocity
Calculated Harmonic Mean



Sound Velocity Profile
Cast 161228A1
Depth (m)
0
-280
-560
-840
-1120
-1400
-1680
-1960
-2240
1480
1490
1500
1510
1520
1530
1540
Sound Velocity (m/s)
December 28, 2016 UTC
SeaBird SBE-19 SN: 3178
Water Depth: 2272m
Lat: 28.62101600 Lon: -87.90674400
NAD27 UTM 16N
X: 411357.55m Y: 3166133.63m
Measured Sound Velocity
Calculated Harmonic Mean


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
0.20
0.10
0.00
-0.10
-0.20
00:00
04:00
08:00
12:00
16:00
20:00
24:00
December 24, 2016 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
0.20
0.10
0.00
-0.10
-0.20
00:00
04:00
08:00
12:00
16:00
20:00
24:00
December 25, 2016 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
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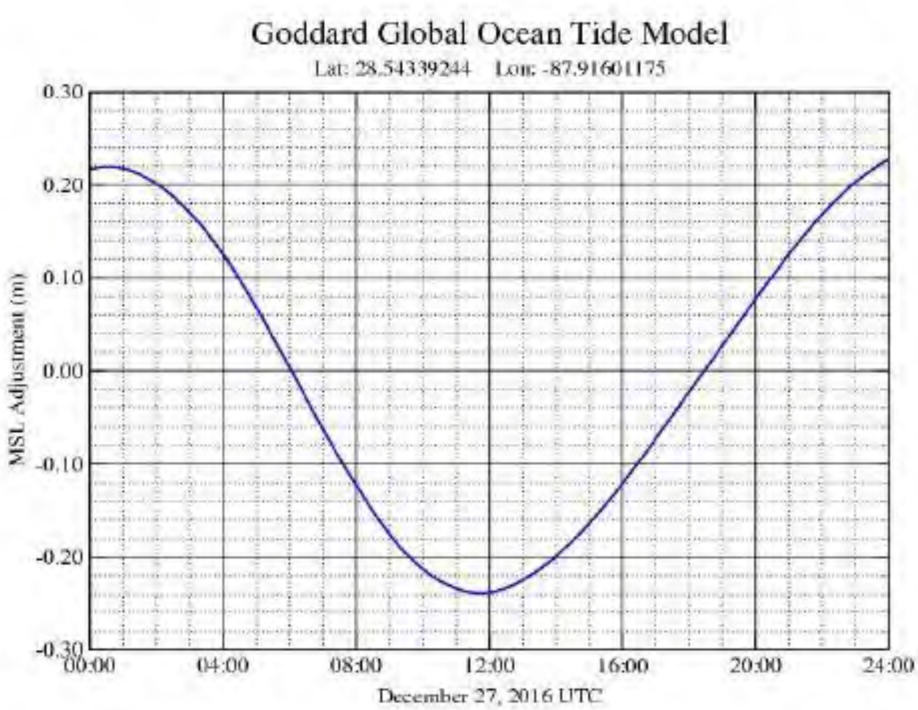
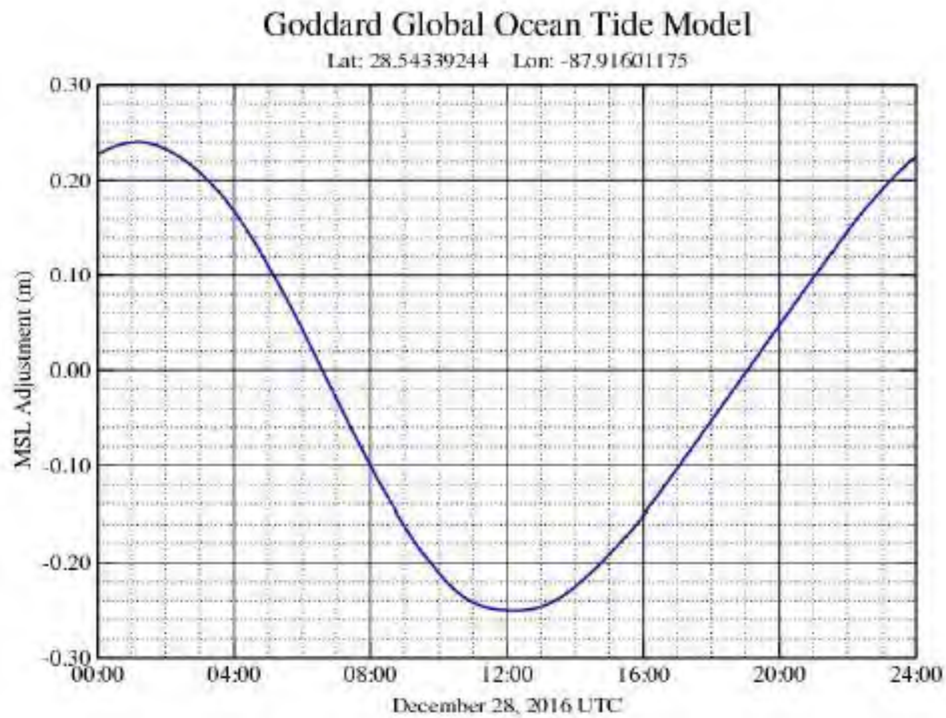
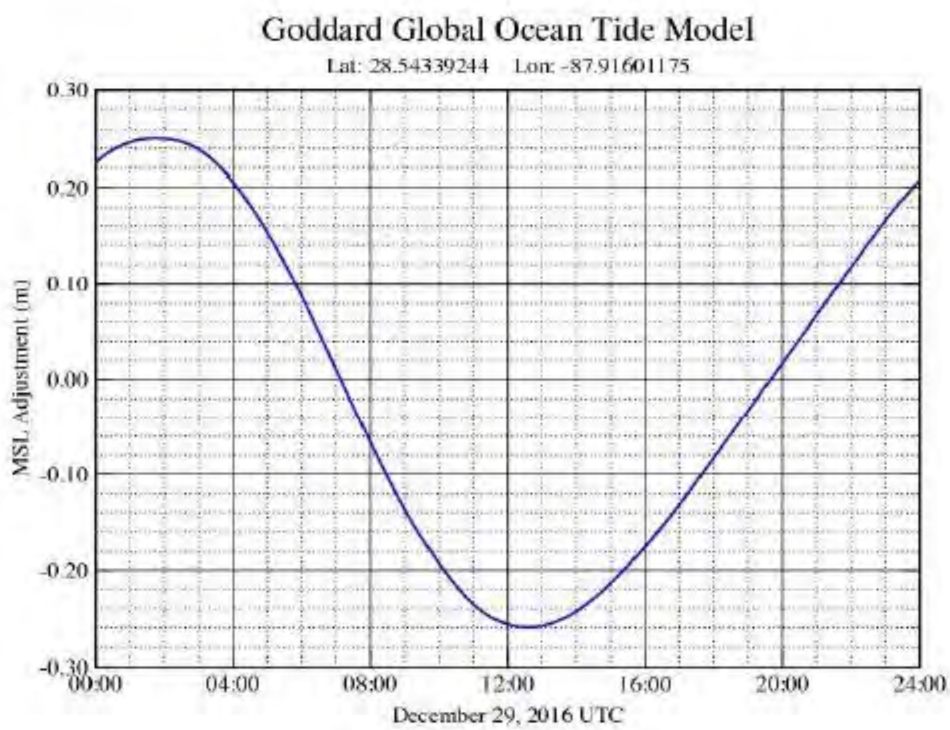
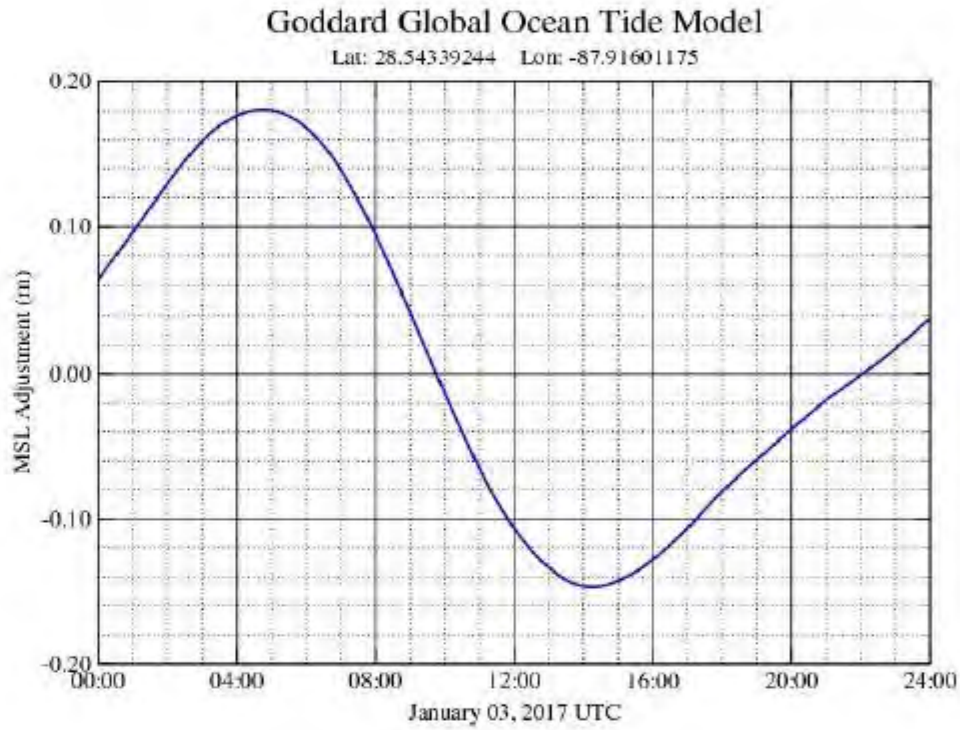
0.20
0.10
0.00
-0.10
-0.20
-0.30
00:00
04:00
08:00
12:00
16:00
20:00
24:00
December 26, 2016 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
00:00
04:00
08:00
12:00
16:00
20:00
24:00
December 27, 2016 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
00:00
04:00
08:00
12:00
16:00
20:00
24:00
December 28, 2016 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
00:00
04:00
08:00
12:00
16:00
20:00
24:00
December 29, 2016 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
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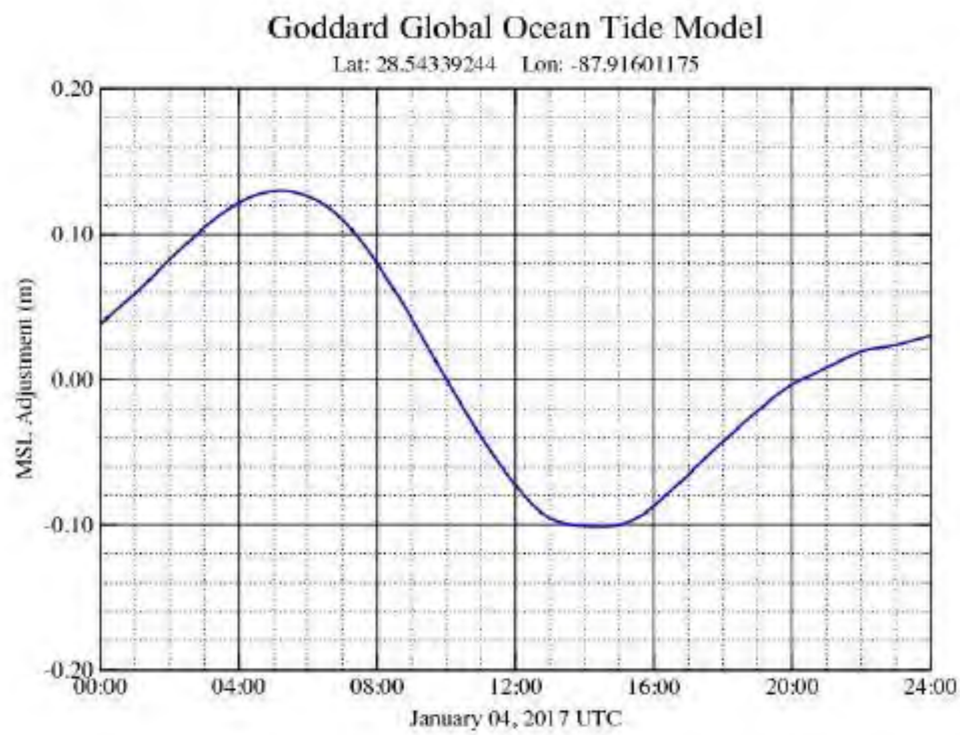
0.10
0.00
-0.10
-0.20
00:00
04:00
08:00
12:00
16:00
20:00
24:00
January 03, 2017 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
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0.00
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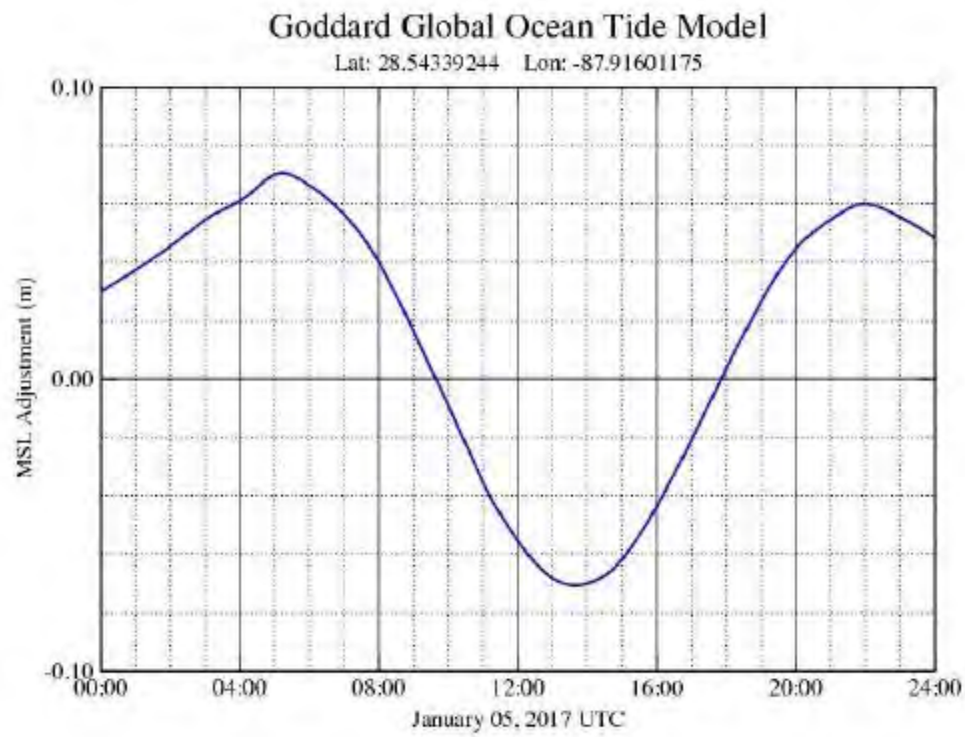
-0.20
00:00
04:00
08:00
12:00
16:00
20:00
24:00
January 04, 2017 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
0.10
0.00
-0.10
MSL Adjustment (m)
00:00
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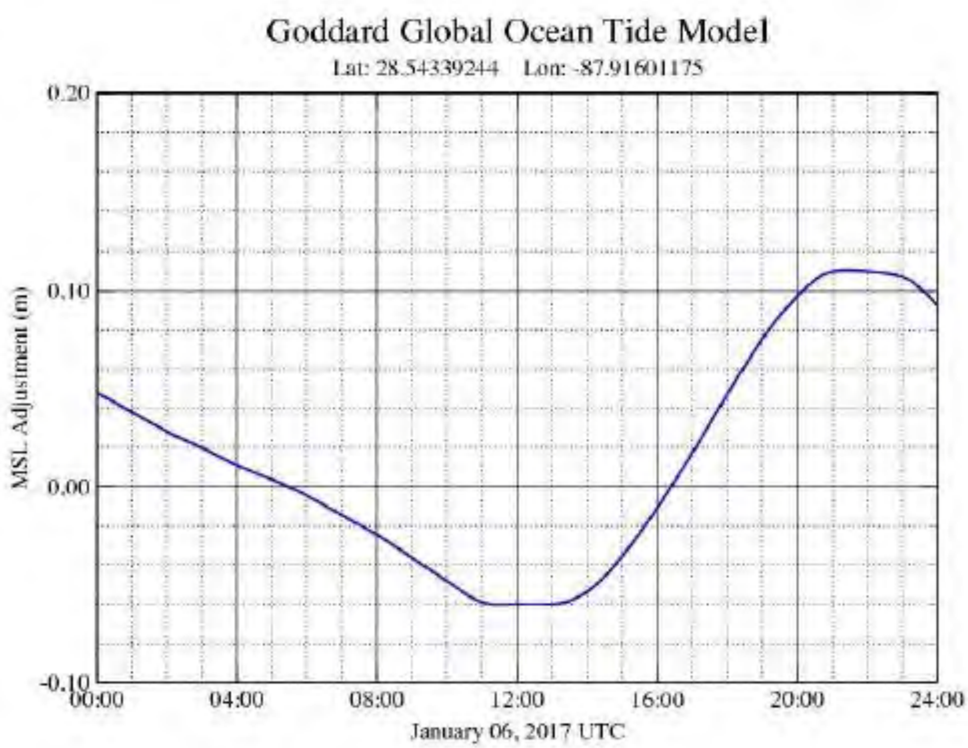
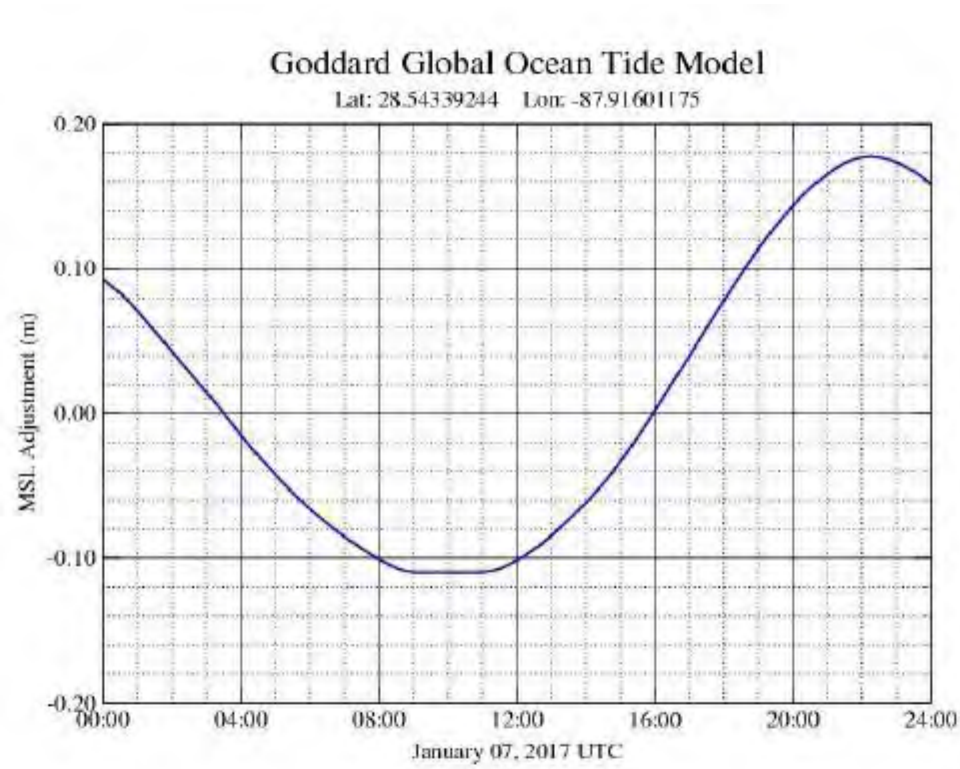
08:00
12:00
16:00
20:00
24:00
January 05, 2017 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
0.20
0.10
0.00
-0.10
MSL Adjustment (m)
00:00
04:00
08:00
12:00
16:00
20:00
24:00
January 06, 2017 UTC


Goddard Global Ocean Tide Model
Lat: 28.54339244 Lon: -87.91601175
MSL Adjustment (m)
0.20
0.10
0.00
-0.10
-0.20
00:00
04:00
08:00
12:00
16:00
20:00
24:00
January 07, 2017 UTC

Shell Offshore Inc.

150 N. Daily Ashford Rd
Houston, TX 77079
United States of America
Tel +832-337-0357
Fax +1 832 337 5646
Email: john.munroe@shell.com

VIA ELECTRONIC MAIL AND FACSIMILE
CNOOCUSGoMCommercial@cnoocltdusa.com
+1 (832) 769-3047

CNOOC Petroleum Offshore U.S.A. Inc.
Attn: CNOOC US GoM Commercial
945 Bunker Hill Road, Suite 1400
Houston, TX 77024

April 13, 2022

**SUBJECT: REQUEST FOR LETTER OF NO OBJECTION FOR RYDBERG FLOWLINES TO BE INSTALLED FROM MC 325 to MC393
NORPHLET AREA DEVELOPMENT
OFFSHORE GULF OF MEXICO**

To Whom It May Concern:

Shell Offshore Inc. ("Shell") and its affiliates are in the process of applying to the Bureau of Safety and Environmental Enforcement ("BSEE") for the installation of the Rydberg flowlines to be installed across Blocks MC 325, DC353, DC397, DC441, MC451, MC 481, MC525, MC393, a portion of which crosses leasehold where you are a co-working interest owner.

In accordance with BSEE requirements, enclosed is a copy of the proposed pipeline route for your review. Updated plats can be provided upon your request, if and when available.

Please indicate that you have no objection to this proposed pipeline installation by signing the letter in the space provided below and returning to my attention. Should you have any questions, please do not hesitate to give me a call at +1 832-337-0357 or send me an email at john.munroe@shell.com.

Kind regards,

SHELL OFFSHORE INC.
By: Shell Exploration & Production Company, pursuant to applicable Service Level Agreements

John Munroe

John Munroe – Commercial Operations

CONSENT GRANTED THIS 27th **DAY OF** April **, 2022**

CNOOC PETROLEUM OFFSHORE U.S.A. INC.

BY: ___________________________________

NAME: Ariel Schneider

TITLE: VP Finance, Production & Planning

Shell Responses to 2020 NOAA Biological Opinion BOEM/BSEE Request for Information (RFI)

Rydberg Installation Permit

Pipeline Installation/Modification Questions:

1. *Information on any proposed explosive-severance charges and/or New or Unusual Technology (NUT).*

   There will be no explosive severance operations and no New and Unusual Technology (NUT), as defined by BSEE, used in these activities.

2. *Additional vessel identification and information if you propose use of the vessel's moon pool(s).*

   Shell's pipelay activities will be conducted using the Deep Energy. The Umbilical will be installed using the Skandi Africa. Pipelay and umbilical support activities will be performed by the Olympic Challenger. The Jumper segments will be installed using the Ocean Evolution or Cade Candies (Or similar pending vessel availability).

   Information for the two moon pools is below.

   Deep Energy:
   - Moon pool dimensions: Pipelay Moonpool - 7.5 m wide x 15.2 m long; ROV Moonpool – 4.8 m wide x 3.28 m long
   - Hatches: No bottom hatch
   - Cameras: Cameras in the moonpool area for monitoring pipelay/moonpool activities

   Skandi Africa:
   - Moon pool dimensions: Moonpool – 9.4 m wide x 7.2 m long
   - Hatches: No bottom hatch
   - Cameras: Cameras in the moonpool area for monitoring pipelay/moonpool activities

   Olympic Challenger:
   - Moon pool dimensions: Pipelay Moonpool – 7.2 m wide x 7.2 m long and ROV Moonpool – 4.8 m wide x 4.8 m long
   - Hatches: No bottom hatch
   - Cameras: To be confirmed*

   Ocean Evolution:
   - Moon pool dimensions: 23'x 23' square feet
   - Hatches: No bottom hatch, with 3 separate sections for the top cover. All 3 sections can be independently removed as needed for the project.
   - Cameras: a back-deck camera is available to monitor the moon pool, if the moon pool needs to be used to support the activities.

   Cade Candies:
   - Moon pool dimensions: 25' x 21'8" square feet
   - Hatches: No bottom hatch
   - Cameras: A back deck camera is available for watching the moonpool, if the moon pool needs to be used to support the activities.

Note *: We will not know camera details until we get more information on those vessels as they are third party vessels. However, if we do use those moonpools there is very likely we will have cameras in the area for monitoring work.

3. *Information on equipment that may have an entanglement or entrapment risk (e.g., flexible lines/ropes) to ESA-listed species.*

The umbilical will be deployed from the installation vessel using a crane wire with deployment rigging (slings/shackles/masterlinks, etc.) connected to the umbilical head. ROVs will be in the water to monitor activities with their cameras and assist with the landing and connection of the ends. The umbilical head will be transferred to a topsides winch and pulled into the Appomattox asset. All rigging will be recovered.

Initiation pile will be deployed using the Olympic Challenger or Deep Energy main crane wire to lower to transfer depth. Pile will be lowered to depth using either the 360 or 150 Te winch wires. ROVs will be in the water to monitor activities with their cameras and assist with the landing and suction/pumping for pile into/out of seabed. Pile will be recovered along with all rigging.

Rigid Flowlines will be deployed using the Deep Energy A&R wire. ROVs will be in the water to monitor activities with their cameras and assist with the landing of the PLETs. Once the PLETs are landed, all rigging will be recovered to surface on the A&R. There is no intent to leave any rigging on the structures after installation is complete.

EFL Frames will be deployed using the LCV crane. Those will be landed on the seabed and recovered once the EFLs are installed. ROV will do a visual inspect to ensure no species are on those items prior to recovery. All rigging will be recovered with the frames.

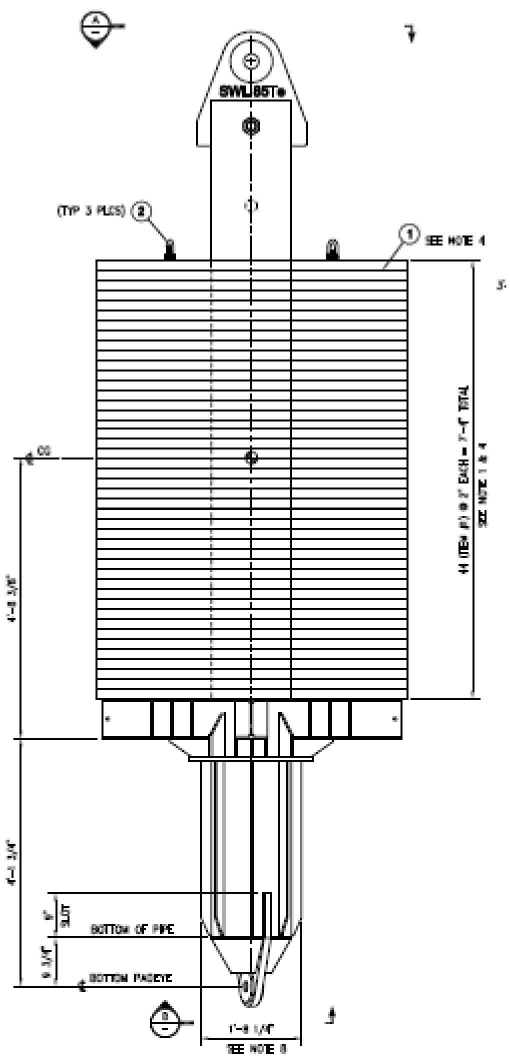
Concrete Mattresses will be deployed through the splash zone using a mattress frame with synthetic slings from the Olympic Challenger Crane for deployment to the seabed. Once the mattresses are installed, the frame will be recovered to surface along with all rigging. ROV will monitor slings during disconnection to endure no entanglement during sling recovery. There is no intent to leave any rigging on the lines after installation is complete.

Sleepers will be installed with a spreader bar and deployment rigging (slings/ shackles/masterlinks, etc.) using the Olympic Challenger crane for lift and deployment through splash zone. ROV will monitor slings during disconnection to endure no entanglement during sling recovery. All rigging will be recovered to surface on the A&R wire. There is no intent to leave any rigging on the structures after installation is complete.

Note: ROV cages also have cameras to ensure that no species is within the cages prior to recovery.

The vessels used by Shell will comply with the GOM Marine and Trash Requirements in Appendix B and GOM Vessel Strike Avoidance and Protected Species Reporting Requirements in Appendix C of the 2020 NMFS BiOp and all other BOEM/BSEE Regulations.

4. *Information on any impact/pile hammers you may require for installation of subsea components.*
If required, a pin pile clump weight to assist with the installation of the pin piles to full penetration. The clump weight will sit on the top of the pile but will not have any repetitive impact force like seen in hammers. Below is drawing of the existing clump weight. Weight is approximately 40 Te.



5. Details on the proposed decommissioning-in-place of any infrastructure (manifolds, pumps, sleds, PLETs, etc.) or facility other than a pipeline. If an SSTI is present, will the SSTI be abandoned in place or will the SSTI remain in service with another pipeline?
N/A

6. Please provide a vicinity map, to support your application under 30CFR§250.1751(a) or §250.1752(a), to include all associated support bases proposed for your operations and provide a statement to note if any vessels supporting your proposed activities, including pipelay, supply, and crew vessels, will require crossing or entering the Bryde's whale area (see attached map).

No vessels will transit the Bryde's whale area.

7. Any additional information associated with your proposed operation s that can assist BOEM in the review of your application as it related to the protection of ESA-listed species and their critical habitat, as outlined in the 2020 Biological Opinion and the applicable Appendices (A, B, C, and J) referenced below. The Biological Opinion can be found here:

https://www.fisheries.noaa.gov/resource/document/biological-opinion-federally-regulated-oil-and-gas-program-activities-gulf-mexico. The Appendices may be found here: (https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico).

Appendix A: No seismic survey activities will take place with these vessels.

Appendix B: Shell will comply with GOM Marine and Trash Requirements in Appendix B 2020 NMFS BiOp and BOEM/BSEE Regulations.

Appendix C: Shell will comply with GOM Vessel Strike Avoidance and Protected Species Reporting Requirements in Appendix C and BOEM/BSEE Regulations.

Appendix J: There will be no explosive severance operations or trawling supporting decommissioning conducted from the vessel that may result in potential for entanglement or entrapment of endangered marine species requiring resuscitation measures. For all other operations, we will apply Appendix J in circumstances where we are advised by NMFS to do so, as long as it can be applied without compromising safety of personnel and operations.

8. NOAA *(NMFS) is requesting additional information regarding the Diver Activities. Please provide specific information related to the following:*

1. *Specific activity diver will be involved in.*

There will be no diver activity associated with this activity. The activities are supported by ROVs launched from the back deck of the vessels.

2. *How the line will be weighted, moored or attached.*

Not applicable

3. *Whether there separate descent lines that are also loose or if the divers free-descending/swimming to the activity area.*

Not applicable

4. Whether divers and/or tenders would be able to monitor lines.

Not applicable

5. How long lines are expected to be in the water.

Not applicable

6. How many hours/days the activity will last.

Not applicable.

Appendix B

COASTAL ZONE MANAGEMENT PROGRAM
CONSISTENCY CERTIFICATION FORMAT

Consistency certification format for all right-of-way pipeline applications that affect Gulf and Atlantic States.

COASTAL ZONE MANAGEMENT PROGRAM
CONSISTENCY CERTIFICATION

MC 525

From (Area and Block)

MC 393

To (Area and Block)

12.2

Length (miles)

The proposed activities described in detail in this right-of-way pipeline application comply with the enforceable policies of [*Alabama*] approved Coastal Management Program(s) and will be conducted in a manner consistent with such Program(s).

Shell Offshore Inc.

Right-of-way Applicant

Certifying Official

January 5, 2023

Date