Post-Drilling Seabed Survey and Sampling Report

Newfoundland & Labrador Orphan Basin Exploration Drilling Program

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Signature Block	**Name**	**Role**	**Signature / Date**
Owner	Dunphy, Robert	Environment Advisor	
Stakeholder	Monique Boudreaux	HSE Team Lead	
Stakeholder	Mark Kiely	Engineering Manager	
Approver	Allen Sherritt	Sr. Wells Manager	

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Operating Management System (OMS) – Sub Elements and Group Essentials

Sub Element	Sub Element Title	Group Essentials
3.6	Environment	
7.1	Regulatory	

Reviewers

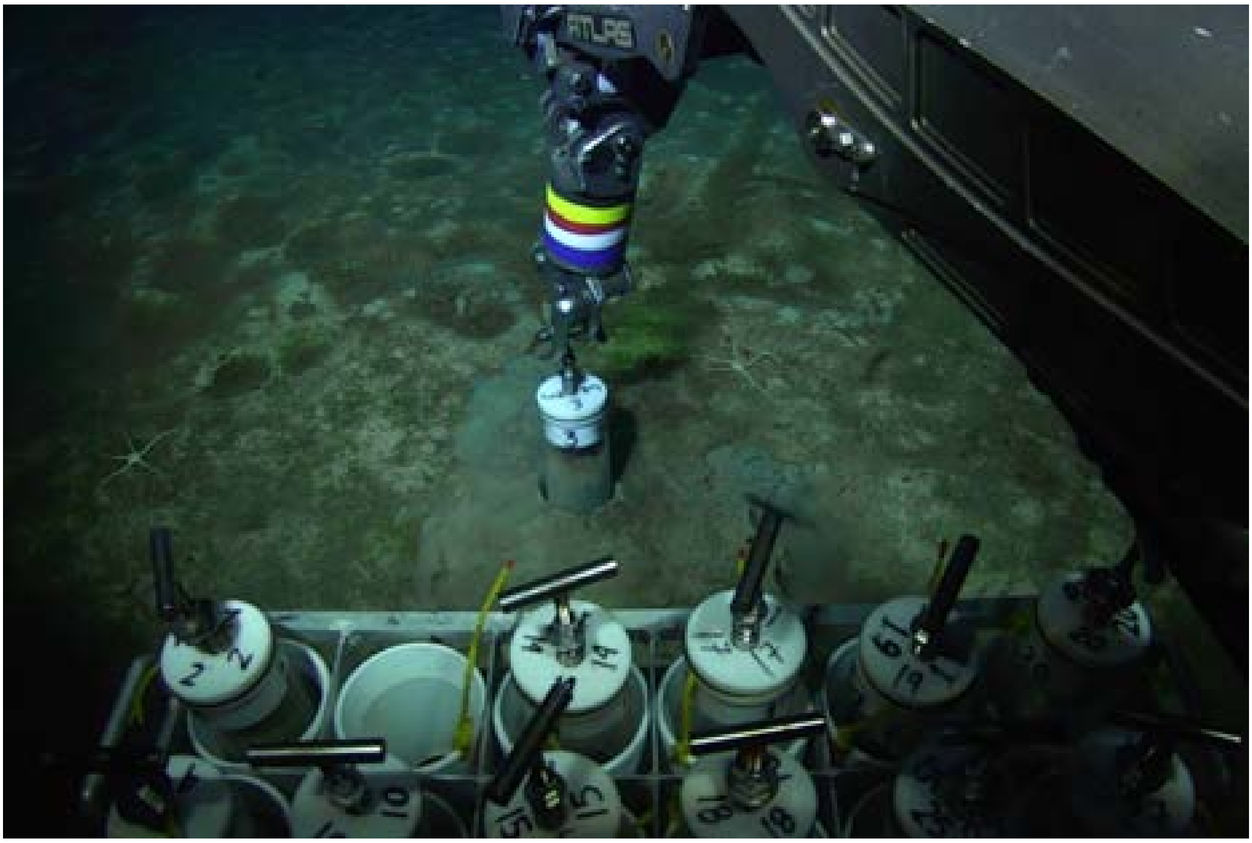
Name	Role	Type of Review	Date Reviewed
Maarten Kuijper	Biodiversity SME	Technical	September 6, 2023

BP CANADA ENERGY GROUP ULC

bp POST-DRILLING SEABED SURVEY and Sampling REPORT

EPHESUS PROSPECT ROV SURVEY

August 28, 2024



bp POST-DRILLING SEABED SURVEY AND SAMPLING REPORT

EPHESUS PROSPECT ROV SURVEY

BP CANADA ENERGY GROUP ULC

VERSION 4

PROJECT NO.: ME2382602
DATE: AUGUST 28, 2024

WSP
36 PIPPY PLACE
ST. JOHN'S, NL
A1B 3X4

T: +1 709-722-7023
F: +1 709-722-7353
WSP.COM

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Foreword

This report was prepared by WSP Canada Inc. to support the bp Canada Energy Group ULC (bp) Ephesus F-94 exploration well drilling program.

Acronyms and Abbreviations

ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
bp	bp Canada Energy Group ULC
CCME	Canadian Council of Ministers of the Environment
C-NLOPB	Canada-Newfoundland Offshore Petroleum Board
DFO	Fisheries and Oceans Canada
E	East
EIS	Environmental Impact Statement
EL	Exploration License
ESRI	Environmental Systems Research Institute
GNSS	Global Navigation Satellite System
HiPAP	High Precision Acoustic Positioning System
HYCOM	Hybrid Coordinate Ocean Model
kg	Kilogram
km	Kilometre
m	Metre
LBL	Long Baseline Positioning
MDL	Method Detection Limit
µg	Microgram
mg	Milligram
mm	Millimetre
N	North
NAD83	North American Datum of 1983
NL	Newfoundland and Labrador
OECM	Other Effective Area-Based Conservation Measure
PAH	Polycyclic Aromatic Hydrocarbons
RDL	Reportable Detection Limit
ROV	Remotely-operated vehicle
S	South
SiBA	Significant Benthic Area
UBL	Ultra Short Baseline Positioning
UTM	Universal Transverse Mercator
VPH	Volatile Petroleum Hydrocarbons
W	West

WAM	Weak Acid Extractable Metals
WGS	World Geodetic System
WoRMS	World Register of Marine Species
WSP	WSP Canada Inc.

1. Background

BP Canada Energy Group ULC (bp) contracted Stena Drilling Ltd. (Stena Drilling) for the *Stena IceMax* drillship to drill an exploratory well (Ephesus) to evaluate the potential of oil-bearing formations in the summer of 2023. The Ephesus well is located in Exploration License EL 1148 (formerly 1145 and 1146) in the West Orphan Basin and is located approximately 395 km northeast of St. John's, NL in a water depth of approximately 1,340 m. The location of the Ephesus exploration well is detailed in Figure 1-1. The well is located within a sea pen Significant Benthic Area (SiBA) as well as in the Northeast Newfoundland Slope Other Effective Area-Based Conservation Measure (OECM) area as shown in Figure 1-2.

For a more detailed description of the drilling program see Section 2.0 of the September 2018 *Newfoundland Orphan Basin Exploration Drilling Program Environmental Impact Statement* (EIS) which was conducted under the *Canadian Environmental Assessment Act 2012* (CEAA 2012) (registration number 80147) which can be found on the IAAC-AEIC Website.

Prior to the commencement of drilling, bp conducted a pre-drilling benthic (coral and sponge) survey in June of 2022 and a physical (sediment) sampling survey in April of 2023. This report describes the pre- and post-drilling benthic survey, sediment sampling efforts, and the pre- and post -drilling sediment chemistry analysis results.

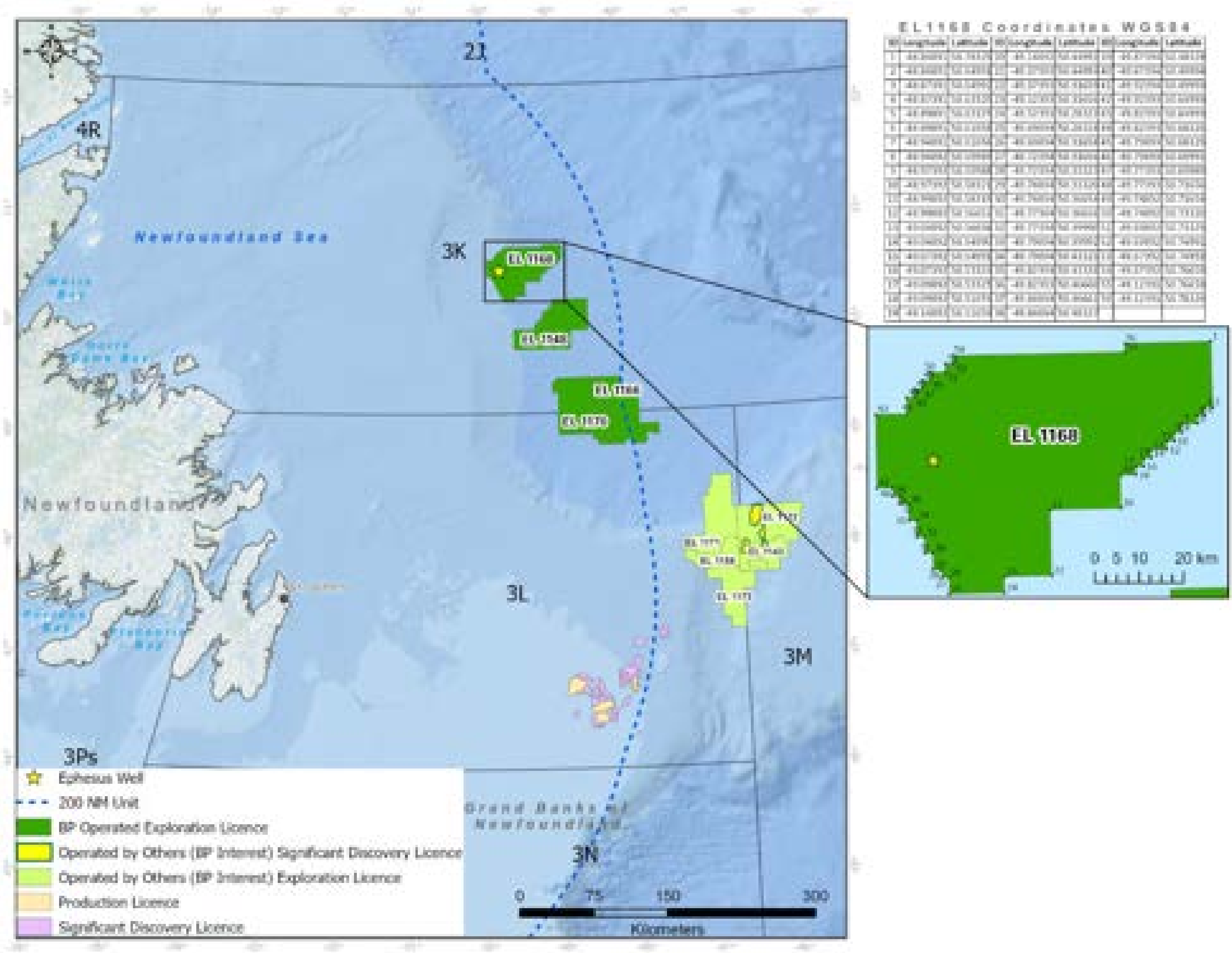


Figure 1-1 Ephesus Well Location.

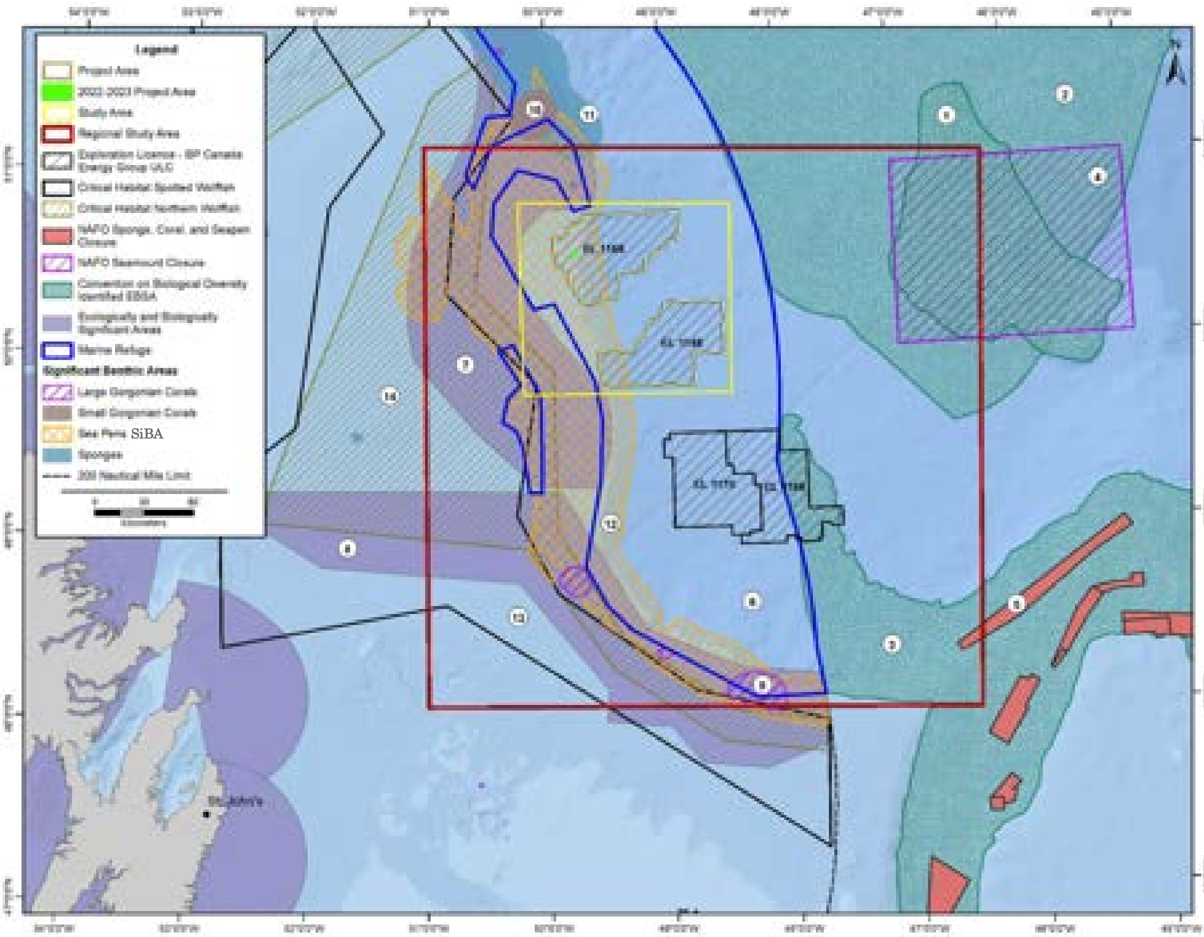


Figure 1-2 Survey Area Relative to the NE Newfoundland Slope Marine Refuge (OECM) and the Sea Pen SiBA.

1.1. Pre-Drilling Surveys

bp completed a pre-drilling coral and sponge visual survey in June of 2022 (bp 2022a, 2023a). A remotely operated vehicle (ROV) was used to collect video data covering 97,515 m^2 of seafloor around the Ephesus primary and alternate wellsites, two relief wells, and two designated reference areas. The video data was analyzed primarily for coral and sponge abundance, density, and condition. The most observed coral functional groups included sea pens (*Pennatula* sp.) and small gorgonians (*Acanella* sp.). Soft corals were observed at low abundances within the survey area. Two black corals were observed, and their identity confirmed prior to the start of the post-drilling survey. Sponges were also observed within the survey area, most commonly Hexactinellida and thin walled/complex (likely *Asconema foliatum*). The presence of megafauna including other invertebrates and fish were noted for presence only.

In April of 2023 bp completed a sediment sampling program to obtain baseline (pre-drilling) sediment chemistry data. The results of this survey can be found *in bp Pre-Drilling Sediment Survey Report* CN002-EV-REP-600-00015 (bp 2023c). The primary focus of the sediment analysis was to obtain the pre-drilling (baseline) concentrations of barium, a primary constituent of drilling muds. Above background barium concentrations in the post-drilling data could then be used as an indicator of drill mud and cuttings dispersion.

1.2. Lessons Learned

As stated in the post-drilling plan (bp 2023b), several lessons learned during the pre-drilling coral and sponge survey and sediment sampling survey were incorporated during the execution of the post-drilling survey. These lessons learned arose from ongoing and open communications between bp and Fisheries and Oceans Canada (DFO) during the planning and reporting stages of the surveys.

Key lessons learned from previous surveys implemented during the post-drilling sampling include:

- Flew the ROV at lower speeds (<0.5 knots) during the visual survey;
- The ROV camera colour was corrected underwater to improve image quality prior to the commencement of the survey. Bands of coloured (red, white, blue and yellow) tape were wrapped around the manipulator arm and the camera colour settings adjusted accordingly;
- Video review was conducted onshore after the survey;
- Proven reliable line scaling lasers were identified and installed by experienced personnel;
- High-quality images were taken of individual corals and sponges, with multiple photos focusing on the whole individual, attachment point, and polyps (if applicable); and
- Corals and sponges were identified to the lowest possible taxonomic level, using accepted taxonomic keys.

Lessons learned from the post-drilling survey include providing the ROV contractor with detailed specifications on how dive log entries are to be made and how video and still image files are to be named to aid with efficient review onshore. The dive log entries should reflect the start and end time of each video and between those times entries for the activities in the video should be entered. Video names should reflect the line name, start time of each video, and activity taking place. Local time should be used for dive log entries as well as for video and still image file naming. Additionally, audio should be added to announce the start and end of surveys lines and the ROV display screen should be labelled with the survey line number.

A significant amount of detritus in the water column was first evident June 18 -19th. Detritus accumulation on the seafloor continued up to the start of the post-drilling survey at which time it was evident that visibility of the seafloor was impaired and sessile benthic organisms were at times covered. However, visual observation of fauna (including corals and sponges) and the seafloor substrate was still possible. As these events are unpredictable, no particular suggestions for future surveys can be made, however the use multiple of methodologies for drilling cuttings delineation did aid in determining the cuttings footprint.

1.3. Drilling Discharge Dispersion Model Summary

In 2018, a dispersion modelling study was conducted to assess the potential environmental impact of mud and cuttings suspensions and deposition associated with the release of drilling muds and cuttings (Appendix B of the EIS) (bp 2018). The modelling was conducted using the SINTEF Marine Environmental Modelling Workbench software, which includes the numeric Dose-related Risk and Effects Assessment Model (DREAM) for chemical releases and a Particle Tracking model for drilling discharges.

The drilling mud and cuttings dispersion modelling study was updated in July 2022 after the Ephesus F-94 wellsite was selected to reflect the site-specific data for the Ephesus F-94 well site location, updated well design, and drilling program data (bp 2022b). The updated model was intended to validate the previous 2018 modelling work and align with the pre-drilling benthic fauna survey design requirements detailed in the DFO Regional Guidance on Measures to Protect Corals and Sponges (DFO 2022) available at the time.

The DFO (2022) guidance requires use of a dispersion model to predict an area on the seafloor within which the deposition of drill cuttings may have an adverse effect. The dispersion modelling completed for the EIS provided estimates of how far solids could disperse, as well as how the thickness of the solid layer could vary within the dispersal area. At deposition thicknesses ≥ 6.5 mm, which is considered to be the predicted no effect threshold (PNET) for non-toxic sedimentation, benthic communities comprised of sedentary or slow-moving species (bivalves and crustacean species) may be smothered (burial) and the sediment quality will be altered in terms of nutrient enrichment and oxygen depletion. However, DFO has indicated the 6.5 mm threshold may not be suitable for corals and sponges as more recent studies indicate that some corals are susceptible to burial or other adverse effect at the 6.5 mm deposition or less. Therefore, the guidance recommended a more conservative 1.5 mm threshold to be used for the development of pre-drill surveys to account for more sensitive species.

In the July 2022 dispersion modelling report (bp 2022b), four scenarios were modelled which varied by water depth and current speed. These scenarios modelled drill cuttings discharged near the surface and at the seafloor. To capture the range of environmental conditions that may occur during the drilling program, the four scenarios (modelled based on an analysis of the 5-year hybrid coordinate ocean model (HYCOM) hydrodynamic dataset for the well location) were combined to form one predicted cuttings dispersion modelled footprint for the wellsite. Across the four scenarios, up to 5,937 m^2 may be subject to a 6.5 mm (and above) accumulation and up to 59,348 m^3 may be subject to an accumulation of >1.5 mm. The maximum distances these PNET zones are predicted to extend from the well site are 89 m and 558 m, respectively. Modelling results indicated a deposition of < 1mm could extend beyond 1 km from the well. (bp 2022b).

2. Purpose

The purpose of the 2023 post-drilling survey program was to fulfill follow-up monitoring requirements described in Condition 3.12 of the February 2020 Decision Statement issued for the project EIS titled Newfoundland Orphan Basin Exploration Drilling Program September 2018 (bp 2018) (Table 2-1).

The requirements described in Condition 3.12 were addressed by the two scopes of the survey program. The first scope was to conduct a visual survey of the seafloor to verify the accuracy of the environmental assessment and effectiveness of mitigation measures as they pertain to the effects of drill cuttings discharges on benthic habitat. This included the identification of coral and sponge taxa present as well as their abundance, density, and condition. The second scope included the collection of sediment to support the visual observations of the drill cutting extent and to determine drill cutting thickness post-drilling to verify the drill waste deposition modeling predictions. This scope included taking sediment samples at 18 locations for chemical analysis to enable comparison of barium concentrations pre- and post-drilling.

Table 2-1 EIS Decision Statement Conditions.

Condition	Condition Details
2.5	The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement, determine the following information, for each follow-up program:
2.5.1	the methodology, location, frequency, timing and duration of monitoring associated with the follow-up program as necessary to verify the accuracy of the environmental assessment predictions as they pertain to the particular condition and to determine the effectiveness of any mitigation measure(s);
2.5.2	the scope, content, and frequency of reporting of the results of the follow-up program
2.5.3	the levels of environmental change relative to baseline conditions and predicted effects as described in the environmental impact statement, which would require the Proponent to implement modified or additional mitigation measure(s), including instances where the Proponent may be required to stop Designated Project activities; and
2.5.4	the technically and economically feasible mitigation measures to be implemented by the Proponent if monitoring conducted as part of the follow-up program shows that the levels of environmental change have reached or exceeded the limits referred to in condition 2.5.3
2.6	The Proponent shall submit the information referred to in condition 2.5 to the Board prior to the implementation of each follow-up program. The Proponent shall update that information in consultation with relevant authorities during the implementation of each follow-up program, and shall provide the updated information to the Board within 30 days of the information being updated
2.7	The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement:
2.7.1	conduct the follow-up program according to the information determined pursuant to condition 2.5;

Condition	Condition Details
2.7.2	undertake monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure(s);
2.7.3	determine whether modified or additional mitigation measures are required based on the monitoring and analysis undertaken pursuant to condition 2.7.2; and
2.7.4	if modified or additional mitigation measures are required pursuant to condition 2.7.3, develop and implement these mitigation measures in a timely manner and monitor them pursuant to condition 2.7.2.
3.12	The Proponent shall develop and implement follow-up requirements, pursuant to condition 2.5, to verify the accuracy of the predictions made during the environmental assessment as it pertains to fish and fish habitat, including marine mammals and sea turtles, and to determine the effectiveness of mitigation measures identified under conditions 3.1 to 3.11. As part of these follow-up requirements, for the duration of the drilling program, the Proponent shall:
3.12.2	For the first well in each exploration licence, and for any well where drilling is undertaken in an area determined by seabed investigation surveys to be sensitive benthic habitat, and for any well located within a special area designated as such due to the presence of sensitive coral and sponge species, or a location near a special area where drilling cuttings dispersion modelling predicts that drilling cuttings deposition may have adverse effects, develop and implement, in consultation with Fisheries and Oceans Canada and the Board, follow-up requirements to verify the accuracy of the environmental assessment and effectiveness of mitigation measures as they pertain to the effects of drill cuttings discharges on benthic habitat. Follow-up shall include:
3.12.2.1	Measurement of sediment deposition extent and thickness post-drilling to verify the drill waste deposition modeling predictions;
3.12.2.2	Benthic fauna surveys to verify the effectiveness of mitigation measures; and
3.12.2.3	The Proponent shall report the information collected, as identified in conditions 3.12.2.1 and 3.12.2.2, including a comparison of modelling results to *in situ* results, to the Board within 60 days following the drilling of the first well in each exploration licence.

3. Methodology

With the support of WSP Canada Inc. (WSP) and in consultation with the Canada Newfoundland Offshore Petroleum Board (C-NLOPB) and DFO, bp developed the *bp Post-Drilling Seabed Survey Plan CN002-EV-PLN-600-00008* (bp 2023b). The seabed coral and sponge survey was completed in July 2023 using a ROV that collected sediment samples, video, and still imagery. Sediment samples were sent to Bureau Veritas (BV) Laboratories (St. John's, NL) for chemical analysis.

This report reflects a comparison of pre- and post-drilling coral and sponge survey data as well as pre- and post-drilling sediment chemistry data with a particular focus on barium and hydrocarbons in the C_{10}-C_{21} range, the range within which the drilling base fluid Puredrill IA-35 occurs.

3.1. Post-drilling ROV survey

3.1.1. Preliminary Drill Cuttings Survey (*Stena IceMax*)

Near the end of the well activities and prior to the post-drilling survey, the *Stena IceMax* ROV was used to complete a preliminary visual survey of the drill solids mound around the wellhead. The preliminary survey was intended to inform and confirm the approach described in the post-drilling survey plan (bp 2023b) which reflected the utilization of the *Maersk Mobiliser* ROV. The preliminary survey was used to confirm the actual drill solids mound footprint was directionally aligned (i.e., predominantly southerly) with the dispersion model results. To a limited extent, the preliminary ROV survey was also used to assess the general extent and shape of the cuttings pile footprint based on the ROV operators' judgement.

3.1.2. Primary Drill Cuttings Survey (*Maersk Mobiliser*)

During the post-drilling visual ROV survey completed using the *Maersk Mobiliser*, referred to herein as the primary survey, coral and sponge still imagery and video was obtained along 34 transect lines, and 32 sediment samples were collected from 16 sampling stations. This survey was completed using a Magnum Plus 170 work-class ROV equipped with a Teledyne Bowtech Surveyor HD Pro ultra wide angle HD colour zoom camera and five OceanLight LED underwater lights (see Appendix C for technical specification). This survey focused on the predicted cuttings depositional area and the immediate surrounding area defined as 100-m buffer around the predicted footprint (Figure 3-2). WSP provided onboard biologists for the execution of the survey plan. This included monitoring ROV operations to ensure the collection of video and images appropriate for characterizing cold-water corals and sponge groups and general characterization of fish and other invertebrates. Video imagery was used to visually assess coral and sponge functional group abundances, densities, and condition. Representative images are available for individuals of each functional group although it was not always possible to capture close-ups of polyps and attachment points (see Section 4.1 for details on challenges related to visibility during this survey). The ROV travelled between 0.2 and 0.3 knots at an altitude of <1.5 m above the seabed and was equipped with line lasers for scaling. The survey video and imagery were geo-referenced using the vessels HiPAP system. The high-definition video was encoded with a digital overlay that displayed depth (m), coordinates (UTM and NAD83), heading, date and time (Newfoundland Standard Time), and altitude above seafloor. Still images were encoded with a date and time stamp (UTC) and numbered sequentially.

3.2. Visual Analysis

To address the requirements outlined in Section 2, the pre- and post-drilling survey video data were compared. Benthic video imagery was analysed for surficial geology (primary and secondary substrate types), drill cuttings dispersion, and coral and sponge abundance, distribution, and condition. Invertebrate and fish taxa were noted for presence only. For sea pens, survey transects were binned into 50 m lengths for analysis of abundance, density, and condition. Individual observations were conducted for the other functional groups. All corals and sponges were identified visually to functional groups as outlined in DFO (2022) (Table 3-1). See bp (2023b) for full details.

Table 3-1 Coral and Sponge Functional Groups (DFO 2022).

Functional Group	Example Taxa
Habitat Forming	
Black Corals	*Stauropathes* sp.
Small Gorgonians	*Acanella* sp.
Large Gorgonians	*Paragorgia* sp.
Sea Pens	*Anthoptilum* sp.
Sponges	Calcarea, Hexactinellida, Demospongiae
Other Groups	
Other Corals[1]	*Duva* sp., *Desmophyllum dianthus*
[1] Includes soft corals, hard corals, and hydrocorals	

3.3. Sediment Collection and Processing

Sample collection (in duplicate) was attempted at 18 stations (36 samples total) including each of the two reference sites (Figure 3-2). Sediment collection was not successful at two stations (i.e., four samples), resulting in a total of 32 samples collected at 16 stations. Ten of these stations were sampled for the pre-drilling sediment survey (bp 2023c), with six additional stations added during the post-drilling survey. Sediment sample locations were located within and outside of the predicted drill cuttings footprint as shown in Figure 3-2. Sampling sites were geo-tagged with a survey waypoint (Table 4-6).

A rack of twelve (12) push cores was attached to a sampling skid mounted under the ROV to transport the cores to and from the seafloor (Figure 3-1 and Figure 3-3A). To prevent damage caused by air entrapment inside the core, before the ROV was deployed a piece of polypropylene rope was inserted under the push core vent which is incorporated into the push core cap (Figure 3-3 and Figure 3-4).

Once on the seafloor the ROV manipulator arm removed each core from the rack, inserted it in the seafloor and then returned the core containing a sample to the rack. To the extent possible, ROV operators held the cores in a vertical position and executed movements in slow, non-jerky and continuous motion.

When the ROV returned to the vessel deck, the push core rack was removed and brought to the on-deck processing laboratory (Figure 3-3C). To prevent sample loss when the cores were removed from each of the push core storage tubes, each tube was equipped with a removeable base plug which was released from the tube and retained in the base of the push core when handled for sample processing (Figure 3-4). The total amount of sample recovered was measured as well as the thickness of the cuttings layer if present. Each sample was also photographed, and a redox potential measurement was taken with a YSI Pro1030 with an ORP probe (Figure 3-3B and Appendix A).

Each push core was then placed in an extruder device and the sample was slowly and continuously pushed (using the base plug), undisturbed, out through the top of the push core. The top 15 cm was removed, homogenized, and placed in pre-labelled sample jars. Sediment samples to be tested for volatile petroleum hydrocarbons (VPH) were preserved in methanol as per laboratory protocols.

The sediment sample analysis completed are described in Table 3-2. Elevated concentrations above background were determined as any value above two standard deviations of the mean determined from the pre-drilling survey sediment chemistry data.

Figure 3-1 ROV with Push Core Rack Mounted on Sampling Skid.

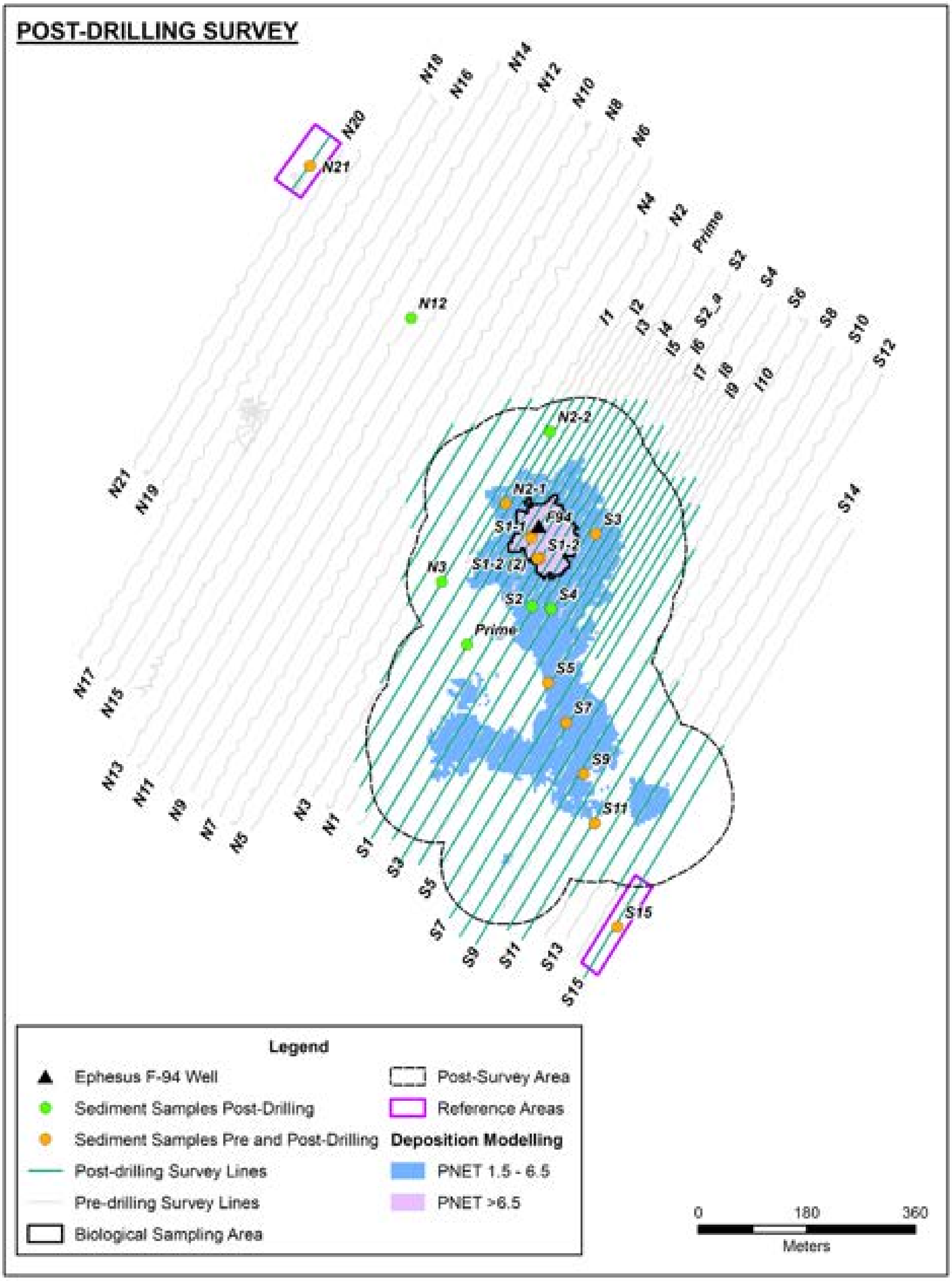


Figure 3-2 ROV Survey Track Lines and Actual July 2023 Sediment Sample Site

Figure 3-3 Photos of Sediment Sampling and Processing: A) Push Cores and Rack, B) Sediment Recovery Measurement, C) Laboratory Setup, and D) *in situ* Sampling with ROV.

Figure 3-4 Push Core Holder with Base Plug.

3.4. Digiquartz Depth Sensor

During the primary survey, the ROV onboard the MV *Maersk Mobiliser* deployed a ParoScientific digiquartz 8DP130-2 depth sensor to obtain digital depths of the seafloor within a 24 m radius of the well (see Appendix C for technical specification). Water depth was obtained on top of the cuttings pile and the value then deducted from the water depth measured for adjacent undisturbed natural seafloor. The resulting value was assumed to reflect an estimate of cuttings deposition thickness.

Digiquartz depth sensors are a standard part of the marine surveyor's toolbox and are commonly used industry wide. A pressure transducer is incorporated into a submersible housing, allowing it to be mounted directly on an ROV or in an ROV-friendly tool. In this case, it was mounted inside a tool and placed on the seabed at each depth station. The Digiquartz sensor is used in tandem with a digital surface barometer such as the Vaisala PTB 210. Both sensors measure environmental pressure at their respective reference points. Water depth must be calculated using these two pressure readings in combination with the average water column density and geographic location. The water column density is measured when collecting a Conductivity, Temperature, Density (CTD) cast and geographic latitude. For the post-drilling survey these values were observed via an AML MinosX Probe and the Global Navigation Satellite System (GNSS) respectively. The geographic latitude is used to account for the influence of gravity using the IGF80 model. The device is regularly used in the industry for the following tasks:

- Seabed depth surveys such as dredging grids.
- LBL array establishment (measuring relative depths between structures, e.g., LBL transponders).
- Structural depth / relative depth inclination surveys.
- Measuring well conductor stickup height.
- Subsea metrology surveys (determining vertical separation between flanges for spool piece fabrication and installation).
- Multibeam echosounder bathymetric surveys

3.5. Sediment Analysis

Collected sediments were sent for analysis to BV Laboratories (St. John's, NL) for the standard suite of analytes reflected in Table 3-2. Only the top 15 cm of each recovered sample was homogenised and used for chemical analysis and stored in onboard refrigerators at 4°C for transport to the laboratory.

Table 3-2 Sediment Chemical and Physical Analysis.

Analyte	Test Method – Bureau Veritas Lab	Description
Metals	Solids Acid Extraction ICPMS and MS-WAM ATL SOP 00058 / EPA 6020B R2 m	Solid Extractable and Solid Acid Extractable Metals, including aluminum, barium, cadmium, chromium, copper iron, lead, lithium, uranium, zinc, and others
Hydrocarbons	ATL SOP 00111 / Atl RBCA v3.1 m ATL SOP 00119 / Atl RBCA v3.1 m Volatiles (VPH) to be field preserved with methanol	Total petroleum hydrocarbons including >C_6-C_{10} (less BTEX), >C_{10}-C_{16}, >C_{16}-C_{21}, >C_{21}-<C_{32}, Benzene, toluene, ethylbenzene, xylenes
PAH's	By GC/MS. CAM-SOP-00318 / EPA 8270E	Suite of polyaromatic hydrocarbons
Particle Size Analysis	MSAMS'78 / WREP-125R3m	Particle size distribution
Redox	Field detection using YSI Pro1030 with ORP probe	Oxidation reduction potential

Analyte	Test Method – Bureau Veritas Lab	Description
Moisture	OMOE handbook 1983m	Sediment moisture reported by percent

3.6. Data Recording

An experienced marine surveyor specializing in geoservices provided position data for the surveys. The sample collection locations are presented below (Table 4-6) and a copy (.xlsx) will be submitted with this report.

Position information was obtained using acoustic Long Baseline positioning (LBL); this is the same methodology used to perform the Ephesus well legal survey. Ultra-short Baseline positioning (USBL) was required for locations >350 m from the well. The process involved the following:

- Calibrated vessel-mounted GNSS, attitude and Ultra Short Baseline (USBL) sensors were used to determine the absolute geographic positions on each LBL transponder.
- An LBL array calibration was performed determining the relative depths (vertical separation) and slope ranges between each transducer. Final transponder coordinates were determined using least-squares adjustment techniques.
- The position of the ROV conducting the surveys was tracked using the LBL array which enabled a 2m positioning accuracy. For activity > 350 m from the well, USBL positioning was used enabled position accuracy of 8.7m (Post-N21-1, Post-S9-1, Post-S11-1).
- When a sample was taken, the position of the front centre of the ROV was recorded.

3.7. Mapping Observations

Actual sample lines (visual survey) completed as well as sediment sampling locations are shown in Figure 3-2. Maps were generated using ArcGIS 10.8 (ESRI 2020) in WGS 1984 UTM zone 22N.

3.8. ROV Mounted Lasers

The two lasers used for scaling were the Imenco Silky Shark Subsea Line Lasers mounted 20 cm apart. The Silky Shark laser operates with 518nm wavelength and a sapphire lens system and was developed around a high-quality Laser Module with 90° fan angel (in air). The line uniformity is very high, producing a clear, sharp line.

The lasers were mounted in a machined bracket which established a separation distance of 20 cm. The brackets are finely machined and allow the lasers to be set at pre-drilled angles and set screws are used to ensure they are force aligned with each other, (i.e., parallel). During this process both lasers are also rotated such that each beam is vertical. This ensures the separation distance of the beams are common with that of the bracket. The lasers were physically centered with the HD camera to both give the best forward-facing view. The downward angle was set to project the beams at the seabed sample location while giving the brightest return. The 20cm separation was verified on deck by powering up the lasers and measuring between the beams with a tape measure at a point approximately 1-1.5 m in front of the ROV. When determining the field of view width, the separation distance used was that occurring between the lasers approximately 1-1.5m in front of the ROV. The beams were always projected with fixed 20cm separation.

4. Results

Thirty-four transects were surveyed totalling 16.85 km and over 38 hours of video were recorded. The post-drilling survey focused on the predicted drill cutting dispersion footprint around the primary wellsite whereas the 2022 pre-drilling survey covered an additional four sites. Comparisons between the surveys were focused on the area around the primary wellsite cutting dispersion footprint. To ensure consistency and enable comparison with the pre-drilling survey, sea pen abundance and density data are presented in 50 m transect bins. Individual observations were conducted for the other functional groups.

4.1. Visibility

Visibility during the survey was significantly impacted by marine detritus present in the water column and covering the seafloor (Figure 4-1). The entire survey area including reference areas were impacted making observations of taxa and visually determining drill cuttings extent difficult. This marine detritus accumulated in depressions along the seafloor and on sessile taxa such as sponges and corals, and at times covered >80% of the visible seafloor along all lines. To assess the extent of the detritus the ROV travelled up to 500 m to the north of the well site and confirmed the detritus was still present. The detritus was a fluffy like material that adhered to corals and settled to the seafloor but appeared to be able to be readily resuspended and redistributed.

Due to the impact of detritus in the water column on ROV lighting, lighting on the ROV was adjusted to best observe the seafloor. Under normal lighting levels, the reflection of the detritus in the water column substantially impaired visibility and can be compared to driving in heavy snow or fog with high beam lights on. Any survey transect that did not have sufficient visibility to enable observations of the seafloor or upcoming hazards (e.g., hard substrates) were aborted and re-run later in the survey. The lighting adjustment was necessary to obtain the visibility needed for observations, but it resulted in an impact on the field of view (i.e., reduced). The field of view is the area within which there is sufficient lighting of the seafloor to do reliable observations; observations are not completed in the dim periphery.

The increase in marine detritus was likely a natural but infrequent phenomenon (Thiel et al. 1989, Smith et al. 1996, Nodder et al. 2007) and not associated with the drilling program activities. The detritus was not observed in the pre-drilling survey which was conducted a year prior (Figure 4-1).

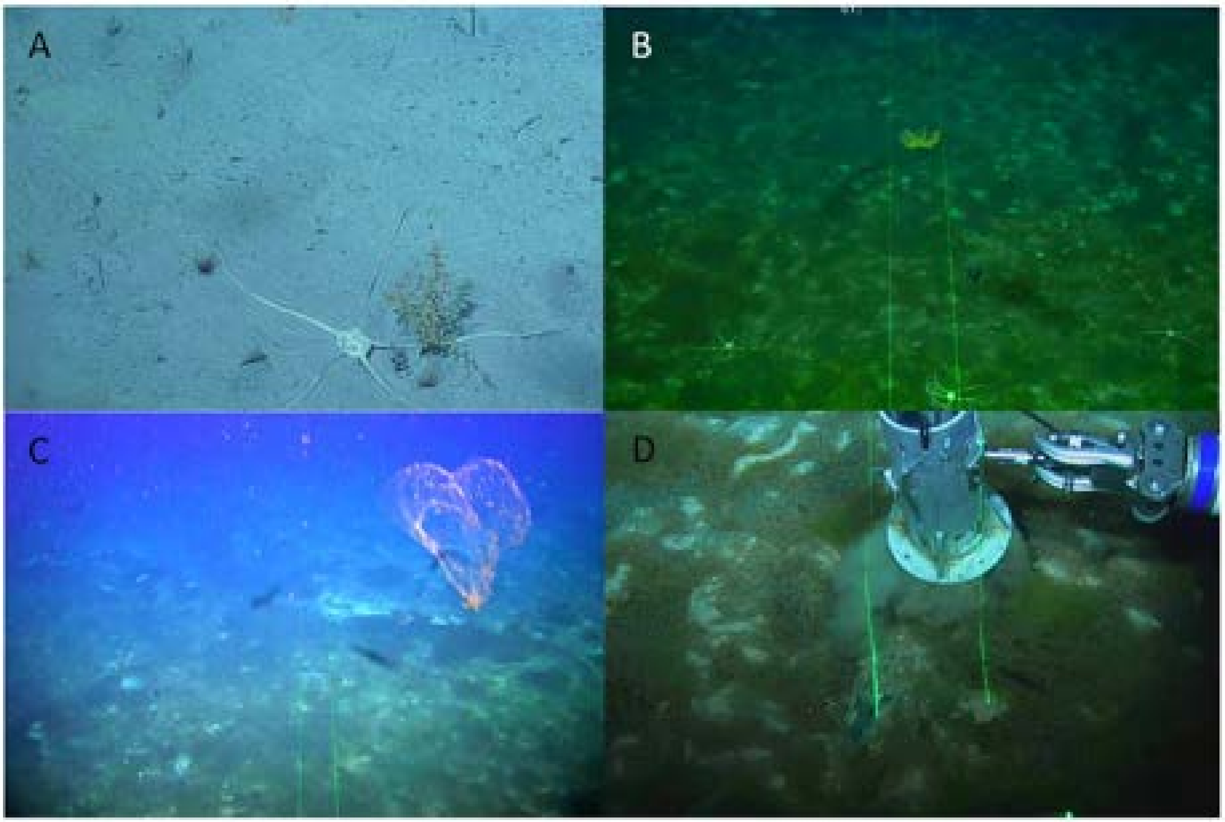


Figure 4-1 Visibility Photos Post-drilling: A) Pre-drilling Clear Seafloor, B) Marine Detritus on the Seafloor, C) Marine Detritus in the Water Column, and D) Close-up of the Seafloor During Depth Measurement

4.2. Surficial Substrate

Surficial substrate at the Ephesus wellsite, where visible, was predominantly fines (>90%) interspersed with medium and coarse hard substrate. Visual assessment of the seabed was impeded by the presence of detritus.

However, where the seafloor was visible cuttings were visually distinct from the regular fine substrate present at the site (see section 4.5.1). For additional information on pre-drilling substrate see bp (2022a).

4.3. Coral and Sponge Observations

The sections and figures below describe the results of coral and sponge condition assessment which was based on Annex C of the DFO Regional Guidance on Measures to Protect Corals and Sponges (DFO 2022).

4.3.1. Sea Pens

Coral and sponge abundance, density, and condition were recorded during the post survey analysis (Table 4-1). The sea pen coral functional group (mainly *Pennatula* sp.) were the most abundant corals observed. Sea pen species observed included *Pennatula* sp., *Anthoptilum* spp., and whip-like sea pens *Distichoptilum gracile* and *Balticina* spp. (Figure 4-2). These species were also observed in the pre-drilling survey in 2022. Post-drilling sea pen abundance ranged between 1 to 144 individuals per 50 m bin (Table 4-1) and densities ranged between 0.01 to 1.17 ind/m^2. Sea pens present in the pre-drilling survey in the area surrounding the well centre are still present in the post-drilling survey (Figure 4-3, Figure 4-4). Lower abundance and density in the area to the south of the well centre compared to the pre-drilling survey corresponds to the area with visible cuttings (Section 4.5.1).

Overall, sea pen condition post-drilling was considered 98.9% 'Good' with corals appearing upright with all polyps (Figure 4-2, Table 4-2). Similar to the pre-drilling survey, sea pens that appeared in 'Poor' condition were often observed lying flat on the seafloor with their body exposed or were missing polyps (mainly whip-like sea pens). Sea pens covered in detritus were also considered to be 'damaged'. Sea pens near the well centre appear to have had condition decrease in the post-drilling survey compared to the pre-drilling survey, though sea pens to the south of the well centre are mostly 'Good' (Figure 4-5). It is important to note that the marine detritus was often observed on corals and sponges and as such were given a 'Poor' or 'Damaged' condition rating. In some areas the detritus obscured coral visibility and the condition could not be reported.

Table 4-1 Pre- and Post-drilling Sea Pen Abundance and Density

Area	Mean	St.dev.	Median	Min.	Max
PRE-DRILLING SURVEY					
Abundance					
Pre-drilling (Clipped) Survey Area[1]	48	23	28	0	118
Reference Areas	44.3	20.9	52	10	69
Density					
Pre-drilling (Clipped) Survey Area[1]	0.32	0.15	0.32	0.00	0.78
Reference Areas	0.29	0.14	0.34	0.07	0.46
POST-DRILLING SURVEY					
Abundance					
Post-drilling Survey Area	33.6	16.3	32	1	144
Reference Areas	32.3	13.2	35	6	48
Density					
Post-drilling Survey Area	0.27	0.13	0.26	0.01	1.17
Reference Areas	0.29	0.06	0.28	0.22	0.39

[1] Pre-drilling data clipped for comparison to Post-drilling footprint
Pre-drilling: Total # survey sections n=380, Infill Area and Drill Cuttings Zone n=291, Reference Areas n=6.
Post-drilling: Total number of survey sections n=336, and Reference Areas n=6.
Most sections were 50 m linear distance unless otherwise noted in the reporting spreadsheet.
Average field-of-view for the pre-drilling survey was 3.02 m, and for the post-drilling survey was 2.46 m.
Mean is the average abundance or density value across each survey section in the pre- or post-drilling survey areas.

Table 4-2 Pre- and Post-drilling Sea Pen Condition Within the Post-Drilling Survey Area.

	Good		Damaged[1]		Dead	
	Abundance	Percent	Abundance	Percent	Abundance	Percent
PRE-DRILLING SURVEY						
Post-drilling Survey Area	18099	98%	22	0.12%	9	0.05%
Reference Areas	266	100%	0	0%	0	0%
POST-DRILLING SURVEY						
Drill Cuttings Zone and Infill Area	11144	98.9%	106	1.0%	7	0.1%
Reference Areas	194	100%	0	0%	0	0%
[1] Sea pens in the post-drilling survey covered in detritus were also assigned to the 'damaged' category.						

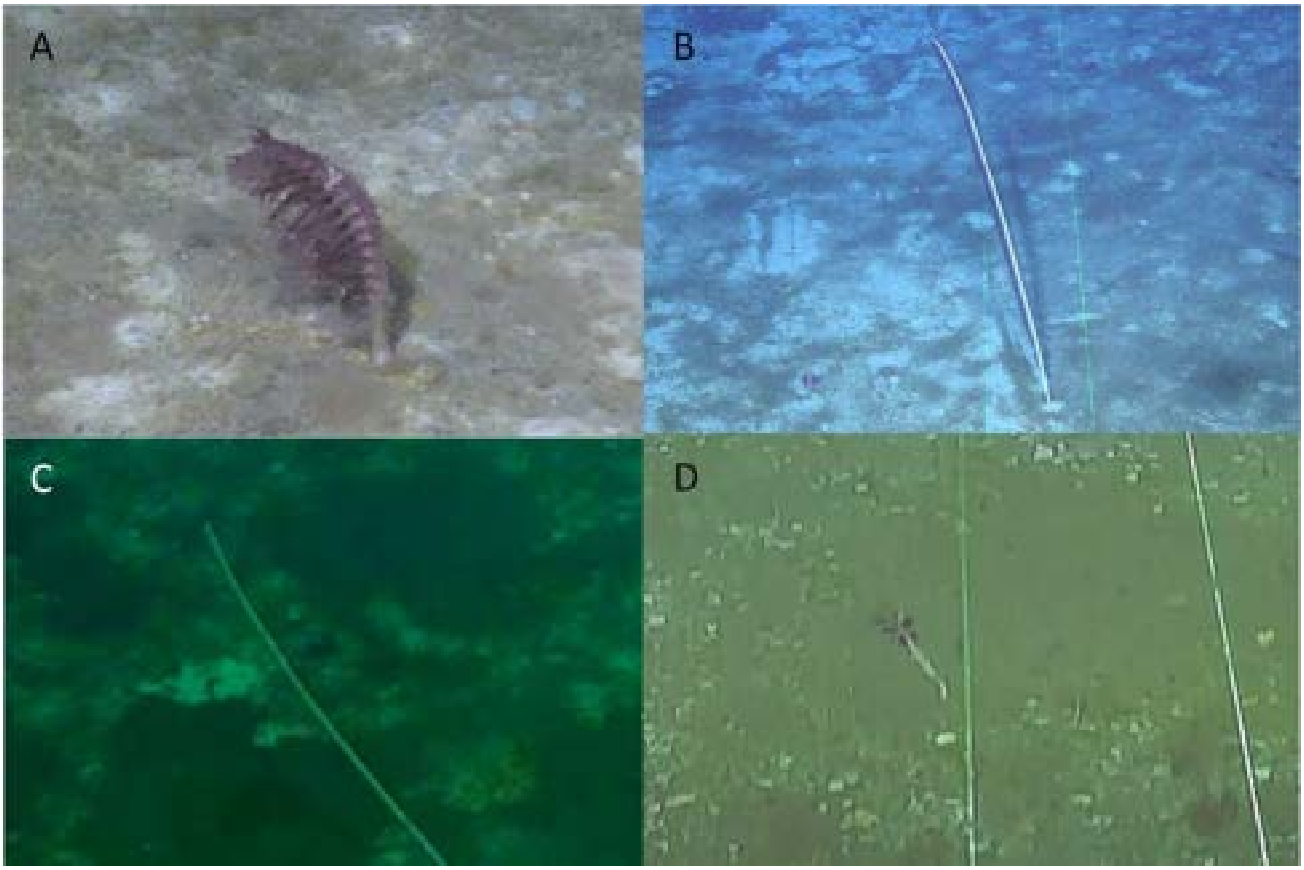


Figure 4-2 Representative Images of Sea Pens and Condition Observed During the Post-Drilling Survey: A) *Pennatula* sp. on Line N4, B) *Balticina* sp.(Synonymous with *Halipteria* sp.: WoRMS 2023) on Line I4 C) Damaged Sea Pen on Line N7 (*Balticina* sp. with no Polyps, and D) Dead Pennatula sp. on Line I6

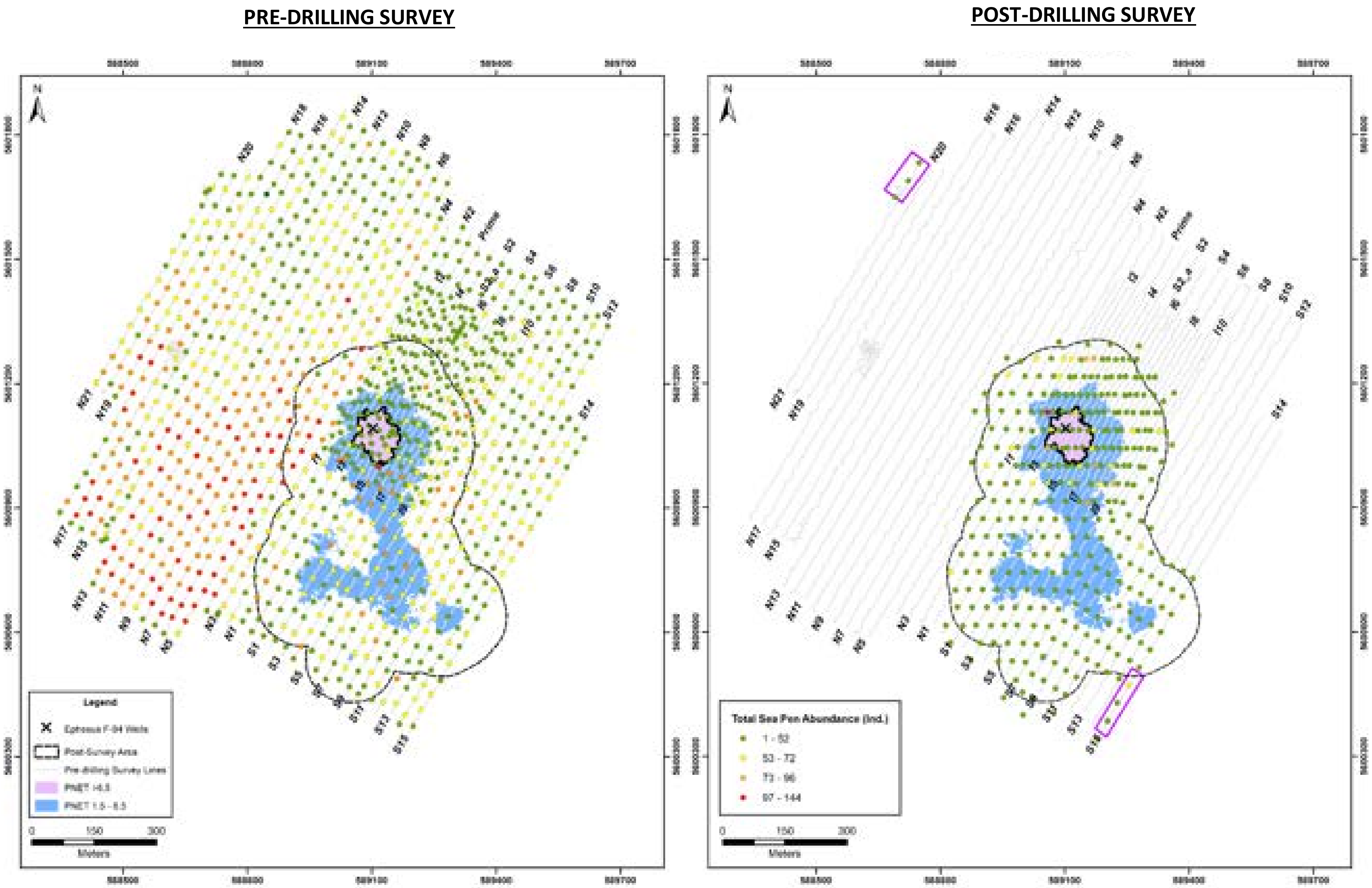


Figure 4-3 Sea Pen Abundance During the Pre- and Post-Drilling Surveys.

PRE-DRILLING SURVEY **POST-DRILLING SURVEY**

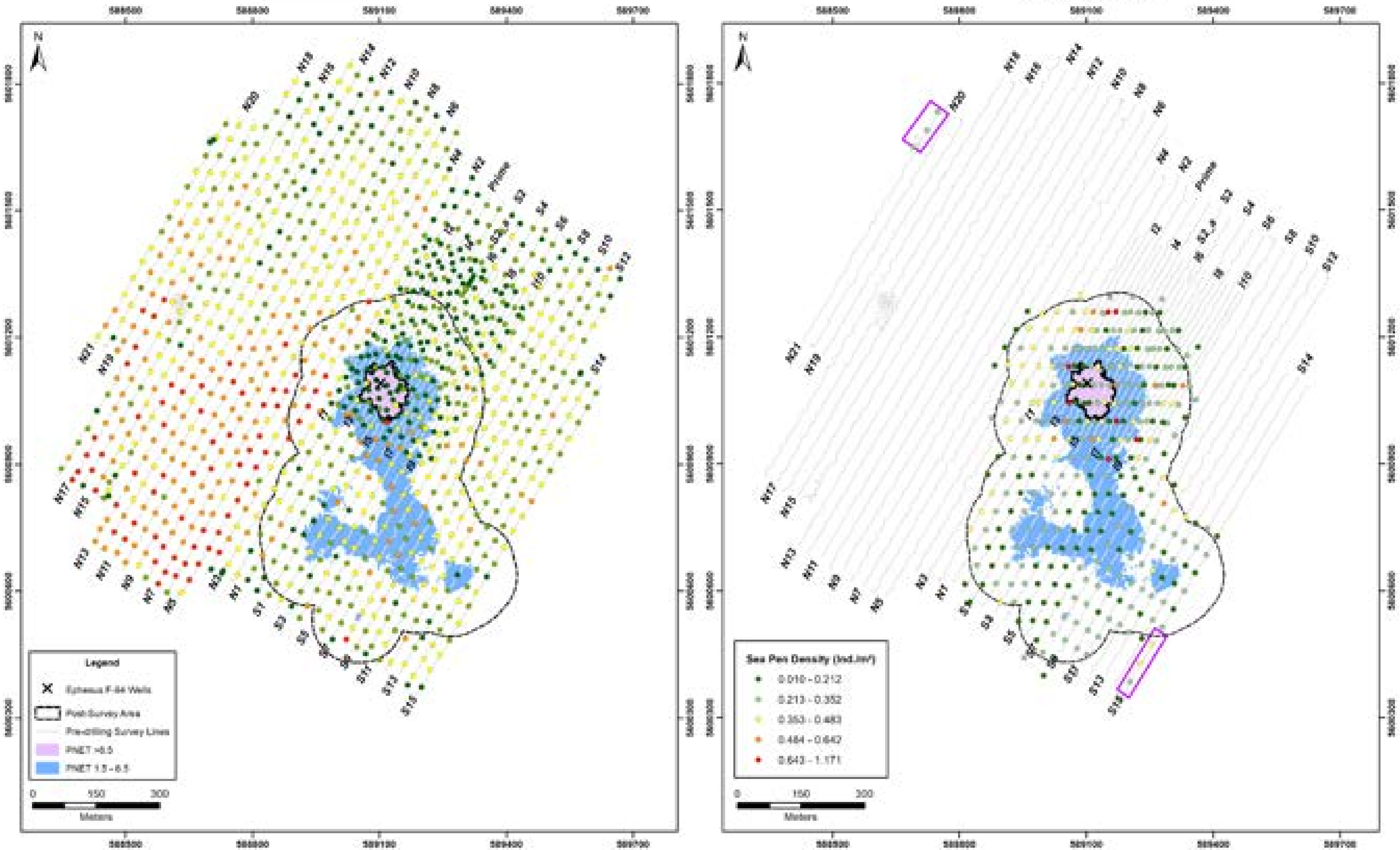


Figure 4-4 Sea Pen Density During the Pre- and Post-drilling Surveys.

PRE-DRILLING SURVEY **POST-DRILLING SURVEY**

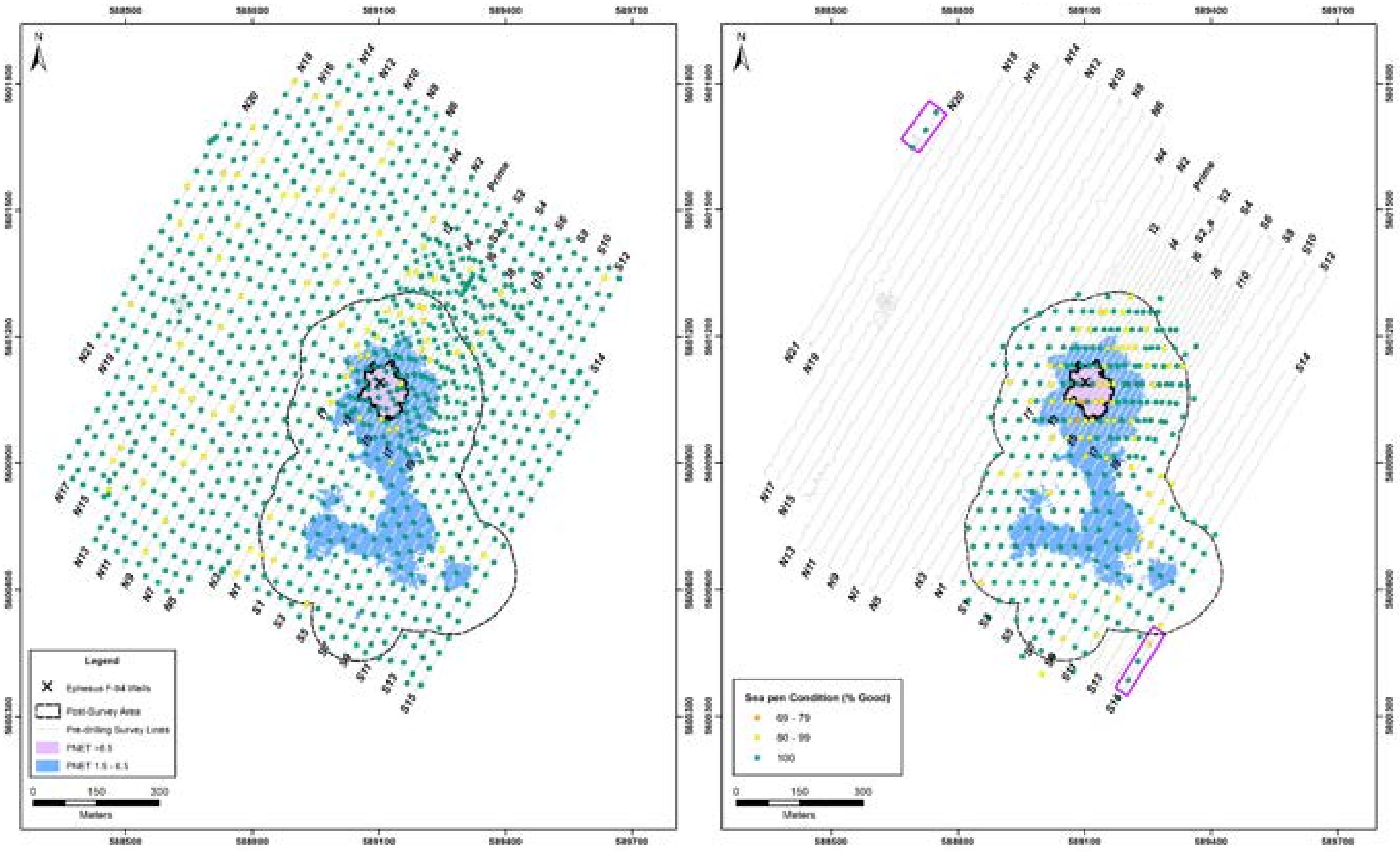


Figure 4-5 Sea Pen Condition During the Pre- and Post-drilling Surveys.

4.3.2. Other Corals and Sponges

Other coral groups observed included the functional groups Other Corals (soft corals and hard corals), Black Corals, and Small Gorgonians (mainly *Acanella* sp.) (Table 4-3, Figure 4-7, Figure 4-9). No large gorgonians were noted. Small gorgonians, specifically *Acanella* sp. were commonly observed in both the pre- and post-drilling surveys, and a small decrease in abundance and density was noted between the pre- and post-drilling surveys. Fewer small gorgonians were observed in the area around the well centre and in areas to the south in the post-drilling survey (Figure 4-12, Figure 4-13). Other corals (largely soft corals; Capnellidae) were distributed in low numbers throughout the survey area, with slightly lower abundances in the post-drilling survey especially near the well centre and to the south (Figure 4-14, Figure 4-15). A total of 25 unknown corals were recorded, 18 of which were whip-like corals. A total of four black corals were observed during the post-drilling survey (Figure 4-10, Figure 4-11). Two were previously identified and confirmed as black corals in the pre-drilling sediment sampling ROV survey on the Prime transect and I6 transect respectively (Figure 4-7). Two additional black corals were observed on S5 and S14 and were rated ‘Good’. The I6 black coral was rated ‘Good’ in the pre-drilling survey, but ‘Damaged’ in the post-drilling due to detritus and sedimentation (Figure 4-6), while the prime line black coral remained rated ‘Good’ (Table 4-3).

Figure 4-6 Black Coral I6

Sponges were sparsely distributed throughout the entire survey area with 92 individuals observed. The morphological group thin-walled, complex (glass sponges; Hexactinellida) were the most abundant sponges and the groups solid/massive (Demospongiae) and Other Sponge (encrusting) were also observed. Abundance and density between the pre- and post-drilling surveys were similar for sponges (Table 4-3), though sponges noted near the well centre and to the south are absent in the post-drilling survey (Figure 4-16, Figure 4-17).

The condition of corals and sponges observed in the survey was affected by the presence of the marine detritus with most gorgonians and the black corals having detritus trapped amongst their branches. Overall, corals were rated ‘Good’, ranging from 64.4% to 76.6% (Table 4-4, Figure 4-18). Sponges were overall rated ‘Good’, but many sponges had some marine detritus on their surface and were deemed in the condition category ‘Poor’ (Table 4-4, Figure 4-18). Overall condition in the post-drilling survey is lower than in the pre-drilling survey, however this may be due to differences in how condition was assessed in each survey. During the pre-drilling survey condition was assessed in the field and all individuals may not have been assigned a condition.

The post-drilling survey was assessed during the office-based review where each individual was assigned a condition.

Table 4-3 Other Coral and Sponge Pre- and Post-drilling Abundance and Density.

Taxa	Area	Mean	St.dev.	Median	Min.	Max
PRE-DRILLING SURVEY						
Abundance						
Small gorgonians	Pre-Drilling[1]	2.09	1.77	2	0	11
	Reference Area	2.17	2.54	1	0	7
Black corals	Pre-Drilling[1]	<0.01	0.05	0	0	1
	Reference Area	0	0	0	0	0
Other Corals	Pre-Drilling[1]	0.22	1.01	0	0	10
	Reference Area	0	0	0	0	0
Sponges	Pre-Drilling[1]	0.42	0.83	0	0	5
	Reference Area	1.67	1.37	1	0	4
Density						
Small gorgonians	Pre-Drilling[1]	0.017	0.014	0.016	0	0.089
	Reference Area	0.018	0.021	0.008	0	0.057
Black corals	Pre-Drilling[1]	<0.001	<0.001	0	0	0.008
	Reference Area	0	0	0	0	0
Other Corals	Pre-Drilling[1]	0.002	0.008	0	0	0.081
	Reference Area	0	0	0	0	0
Sponges	Pre-Drilling[1]	0.003	0.007	0	0	0.041
	Reference Area	0.014	0.011	0.008	0	0.033
POST-DRILLING SURVEY						
Abundance						
Small gorgonians	Post-Drilling	2.41	2.09	2	0	9
	Reference Area	1.00	1.53	0	0	4
Black corals	Post-Drilling	0.02	0.13	0	0	1
	Reference Area	0	0	0	0	0
Other Corals	Post-Drilling	0.21	1.52	0	0	22
	Reference Area	0	0	0	0	0
Sponges	Post-Drilling	0.41	0.84	0	0	5
	Reference Area	0.50	0.76	0	0	2
Density						
Small gorgonians	Post-Drilling	0.020	0.017	0.016	0	0.073
	Reference Area	0.008	0.012	0	0	0.033
Black corals	Post-Drilling	<0.001	0.001	0	0	0.008
	Reference Area	0	0	0	0	0
Other Corals	Post-Drilling	0.002	0.012	0	0	0.179
	Reference Area	0	0	0	0	0
Sponges	Post-Drilling	0.003	0.007	0	0	0.041
	Reference Area	0.004	0.006	0	0	0.016

[1] Results from the pre-drilling survey are clipped to match the area used for the post-drilling survey.
Pre-drilling: Total number of survey sections n=340 (clipped to the area of the post-drilling survey), and Reference Area n=6.
Post-drilling: total number of survey sections n=336, and Reference Area n=6.
Most sections were 50 m linear distance unless otherwise noted in the reporting spreadsheet.
Average field-of-view for the pre-drilling survey was 3.02 m, and for the post-drilling survey was 2.46 m.
Mean is the average abundance or density value across each survey section in the pre- or post-drilling survey areas.

Table 4-4 Pre- and Post-drilling Coral and Sponge Condition.

Taxa	Area	Good*		Damaged*		Dead*	
		Abundance	Percent	Abundance	Percent	Abundance	Percent
PRE-DRILLING SURVEY							
Small gorgonians	Pre-Drilling[1,2]	576	96.0%	10	1.7%	14	2.3%
	Reference Area[1,3]	8	72.7%	0	0%	3	27.3%
Black coral	Pre-Drilling	2	100%	0	0%	0	0%
	Reference Area	0	0%	0	0%	0	0%
Other Coral	Pre-Drilling[1,4]	31	86.1%	5	13.9%	0	0%
	Reference Area	0	0%	0	0%	0	0%
Sponge	Pre-Drilling[1,5]	70	97.2%	2	2.8%	-	
	Reference Area[1,6]	7	100.0%	0	0%		
POST-DRILLING SURVEY							
Small gorgonian	Post-Drilling	345	64.4%	190	35.4%	1	0.2%
	Reference Area	4	66.7%	2	33.3%	0	0%
Black coral	Post-Drilling	1	25.0%	3	75.0%	0	0%
	Reference Area	0	0%	0	0%	0	0%
Other Coral	Post-Drilling	36	76.6%	11	23.4%	0	0%
	Reference Area	0	0%	0	0%	0	0%
Sponge	Post-Drilling	62	67.4%	30	32.6%	-	
	Reference Area	2	66.7%	1	33.3%		

* The pre-drilling survey used different condition categories (bent, covered, and slightly covered were considered to be damaged) and was completed during the field survey and may be less accurate than the post-drilling analyzed survey. In the post-drilling survey, a rating of damaged was assigned if detritus was present.
[1] Results from the pre-drilling survey are clipped to match the area used for the post-drilling survey.
[2] 109 individuals were not assigned a condition and are considered of "Unknown" condition.
[3] 2 individuals were not assigned a condition.
[4] 40 individuals were not assigned a condition.
[5] 70 individuals were not assigned a condition.
[6] 3 individuals were not assigned a condition.

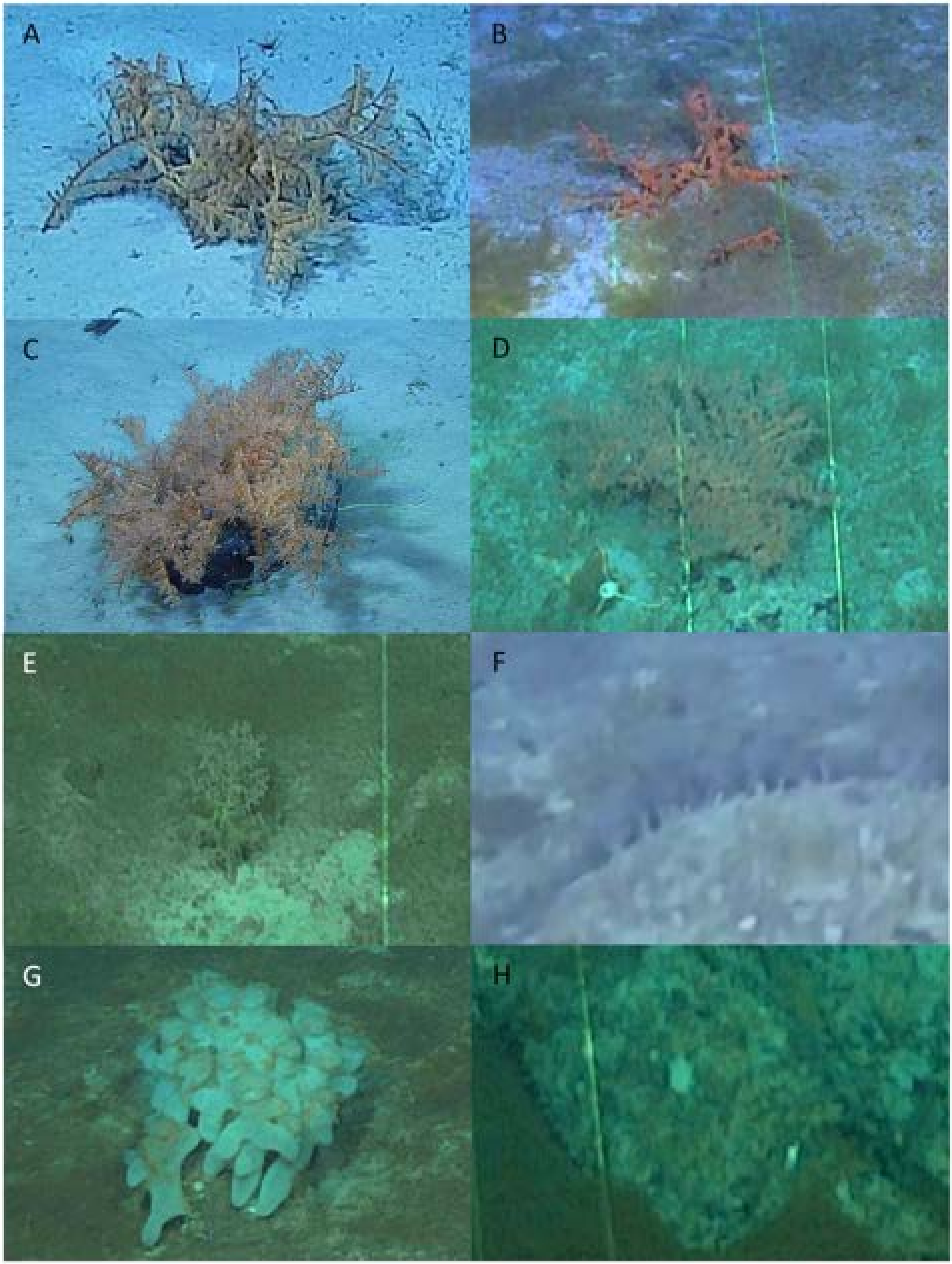


Figure 4-7 Example Photos of Corals and Sponges: A) Pre-drilling I6 Black Coral, B) Post-drilling I6 Black Coral, C) Pre-drilling Prime Transect Black Coral, D) Post-drilling Prime Transect Black Coral, E) Small Gorgonian (*Acanella* sp.) on Line S13, F) Other Coral (Capnellidae) On Line I2, G) Thin-Walled Complex Sponge on Line S15, and H) Solid/Massive Sponge on Line S5.

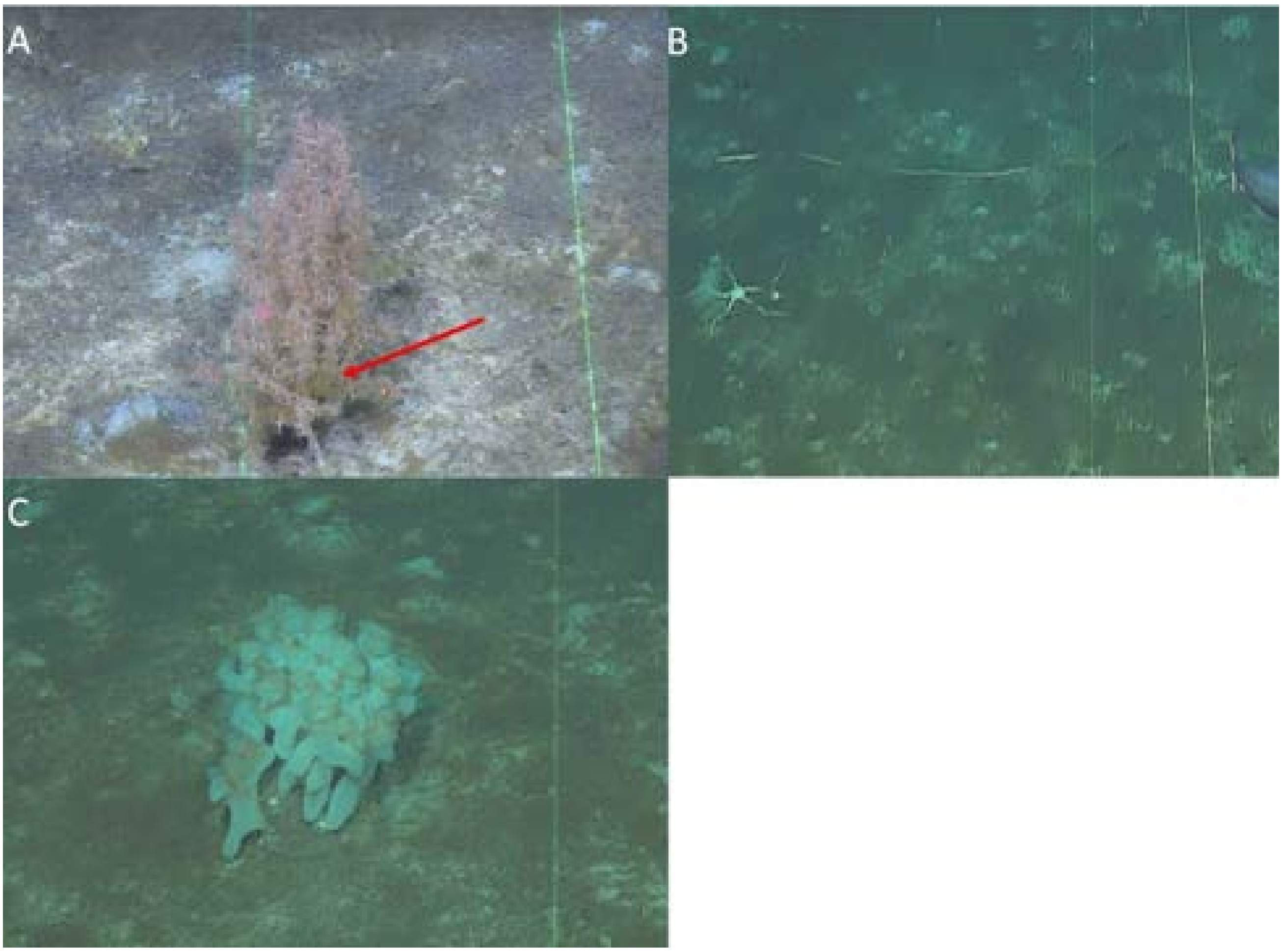


Figure 4-8 Example Photos of Other Coral and Sponge Conditions: A) Damaged Small Gorgonian on S2 (red arrow to detritus), B) Dead Whip Coral on S10, and C) Damaged Sponge on S15.

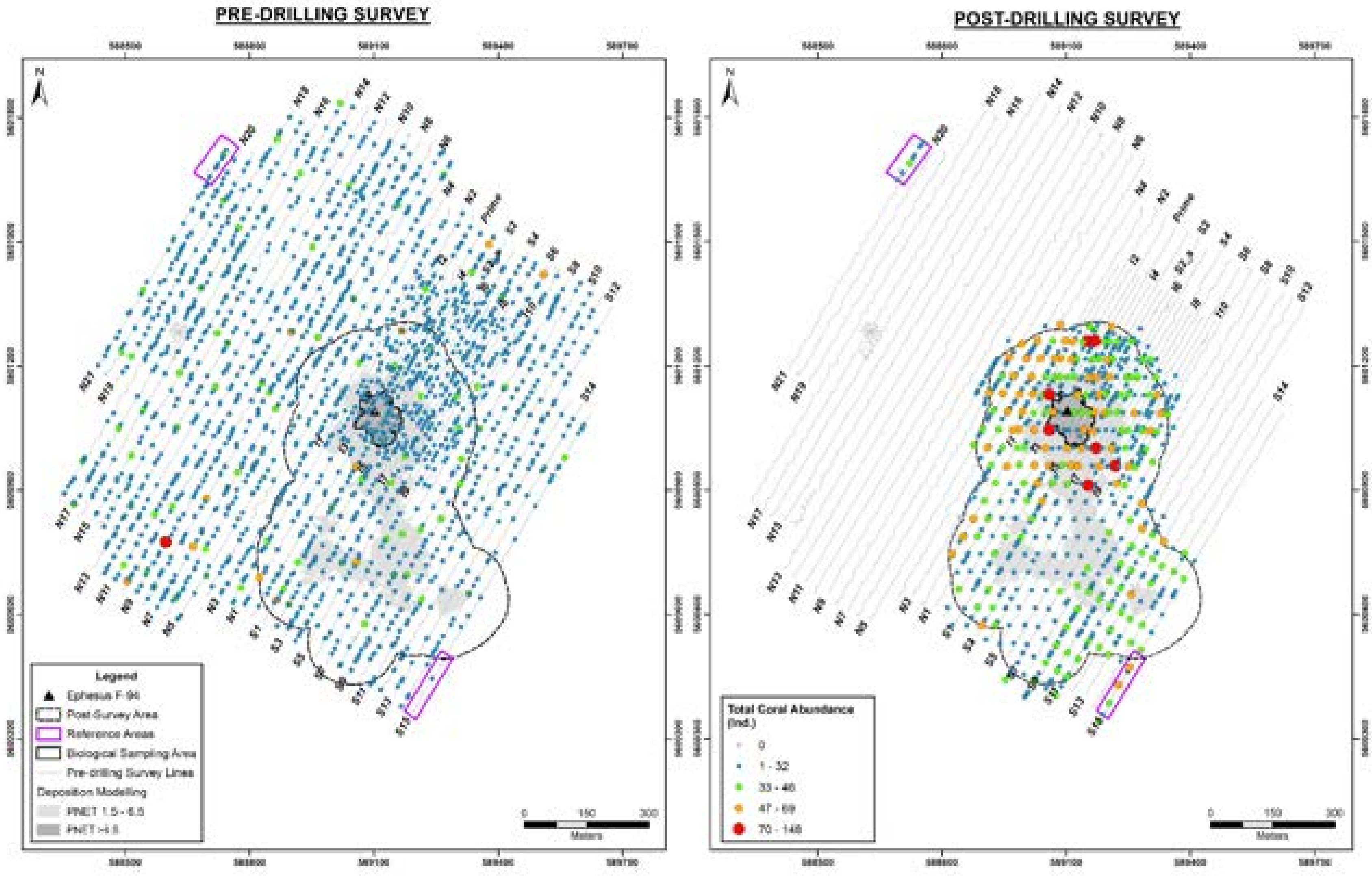


Figure 4-9 Pre- and Post-drilling All Coral Group Abundance. Note: This Includes Sea Pens

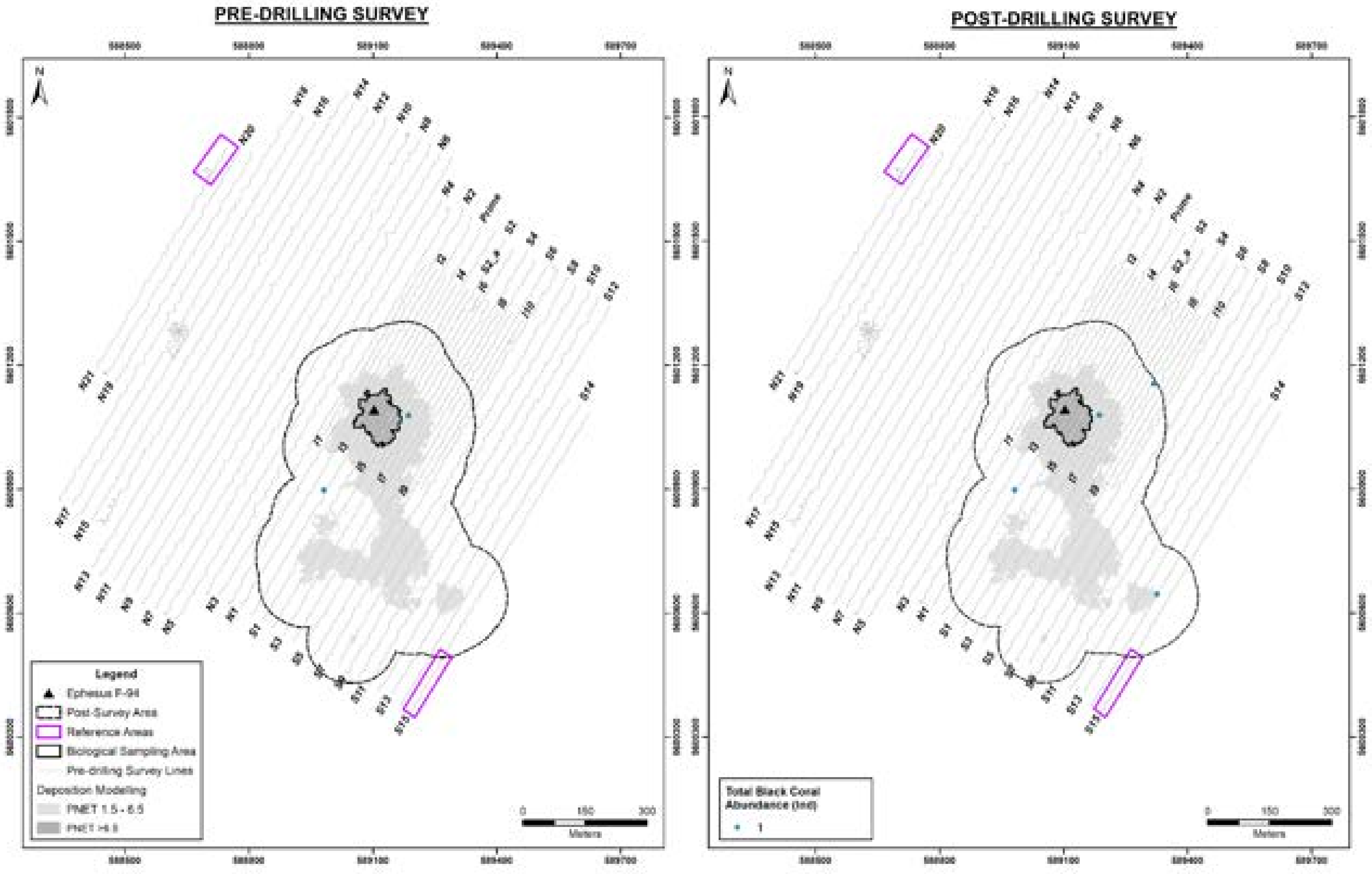


Figure 4-10 Pre- and Post-drilling Black Coral Abundance.

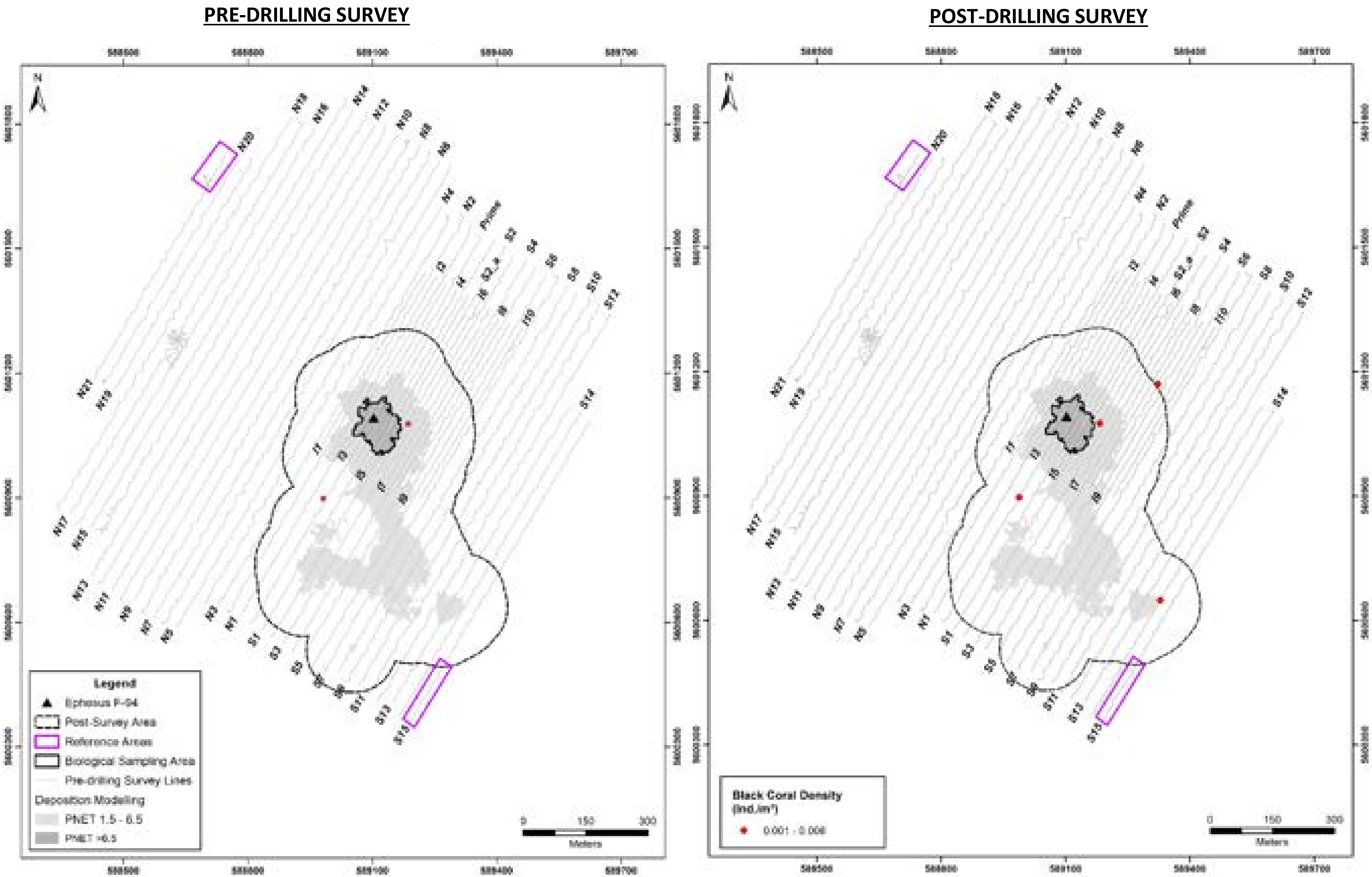


Figure 4-11 Pre- and post-drilling black coral density.

PRE-DRILLING SURVEY **POST-DRILLING SURVEY**

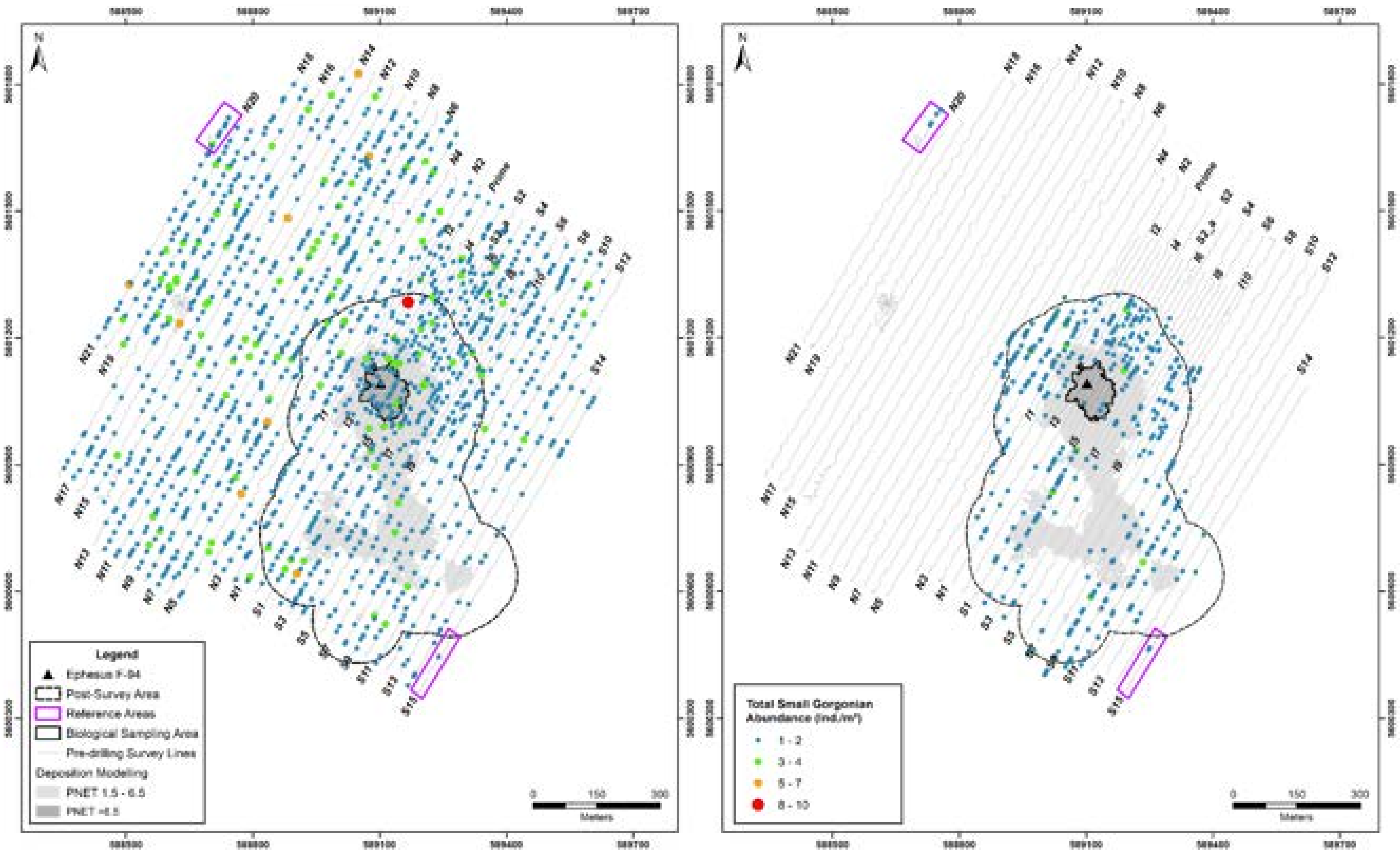


Figure 4-12 Pre- and Post-drilling Small Gorgonian Abundance.

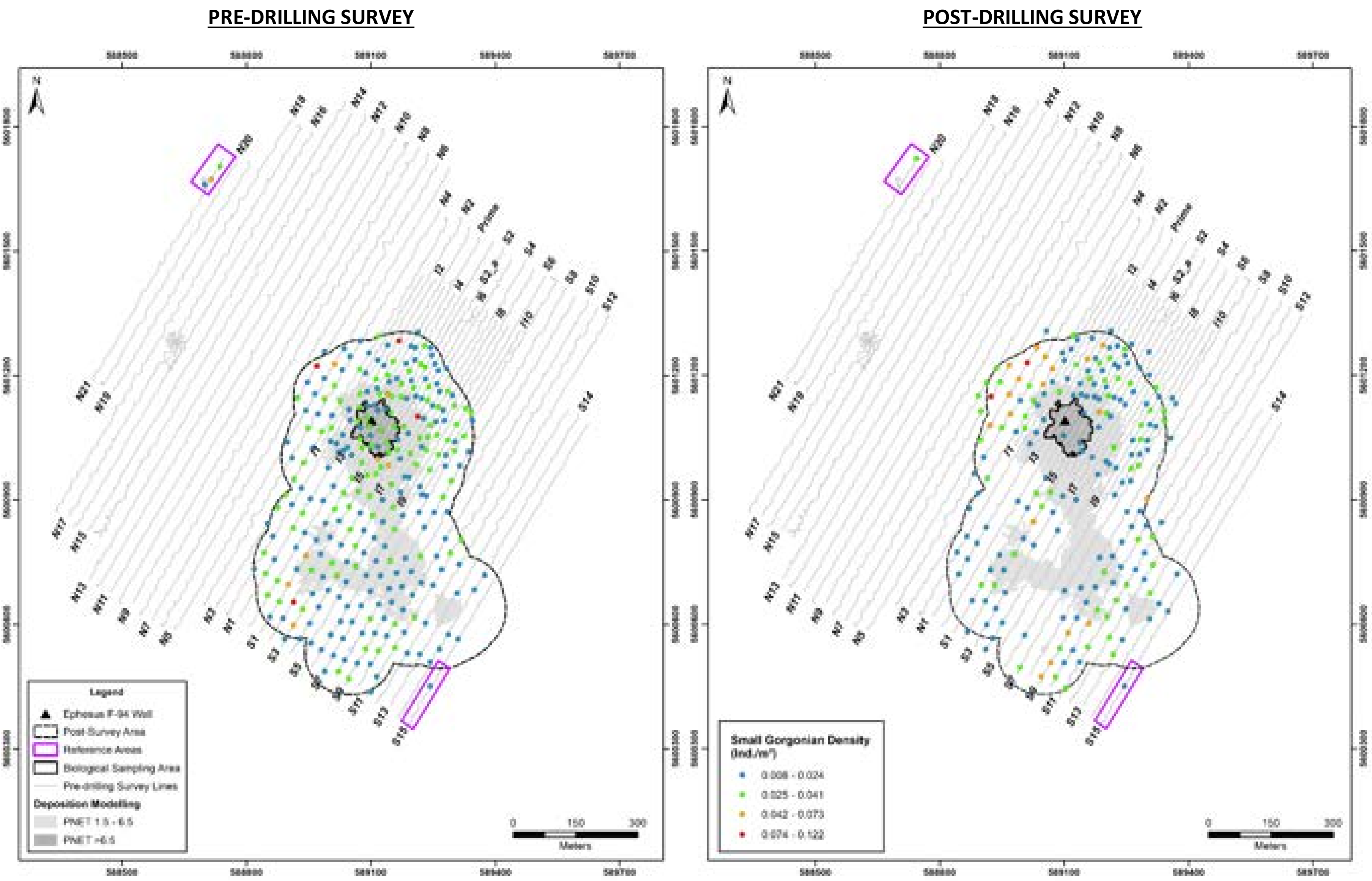


Figure 4-13 Pre- and Post-drilling Small Gorgonian Density.

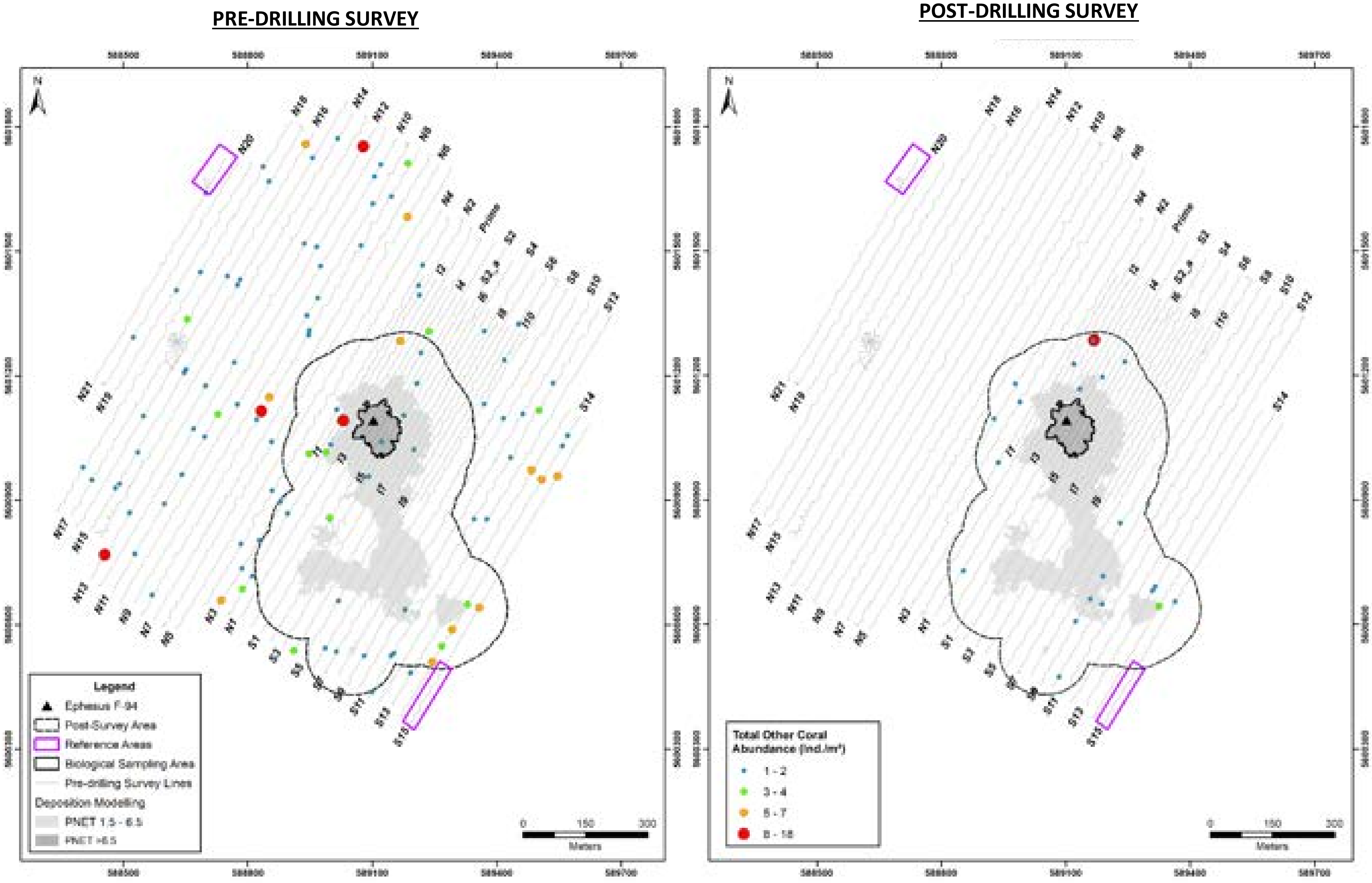


Figure 4-14 Pre- and Post-Drilling Other Coral Abundance.

PRE-DRILLING SURVEY | **POST-DRILLING SURVEY**

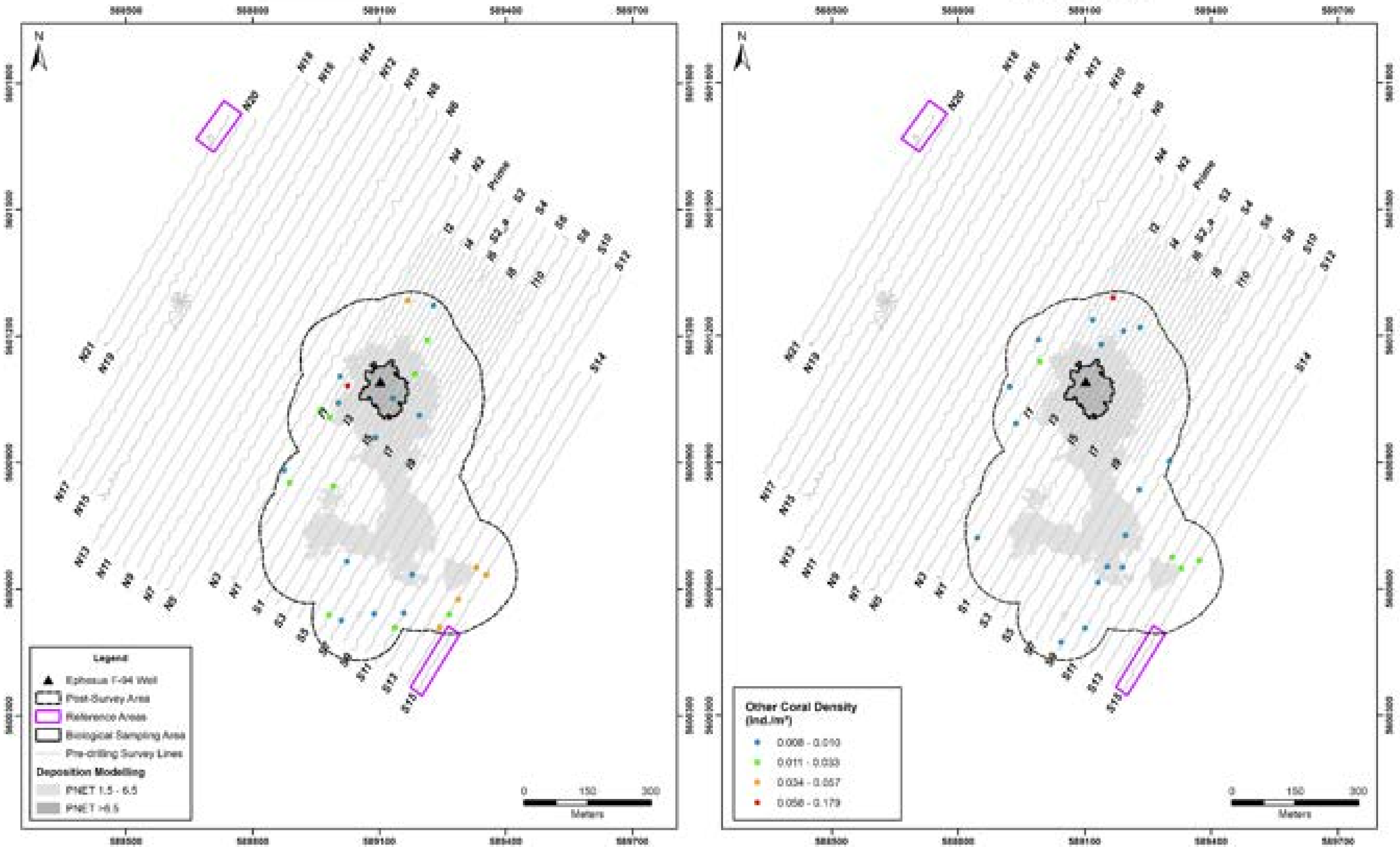


Figure 4-15 Pre- and Post-drilling Other Coral Density.

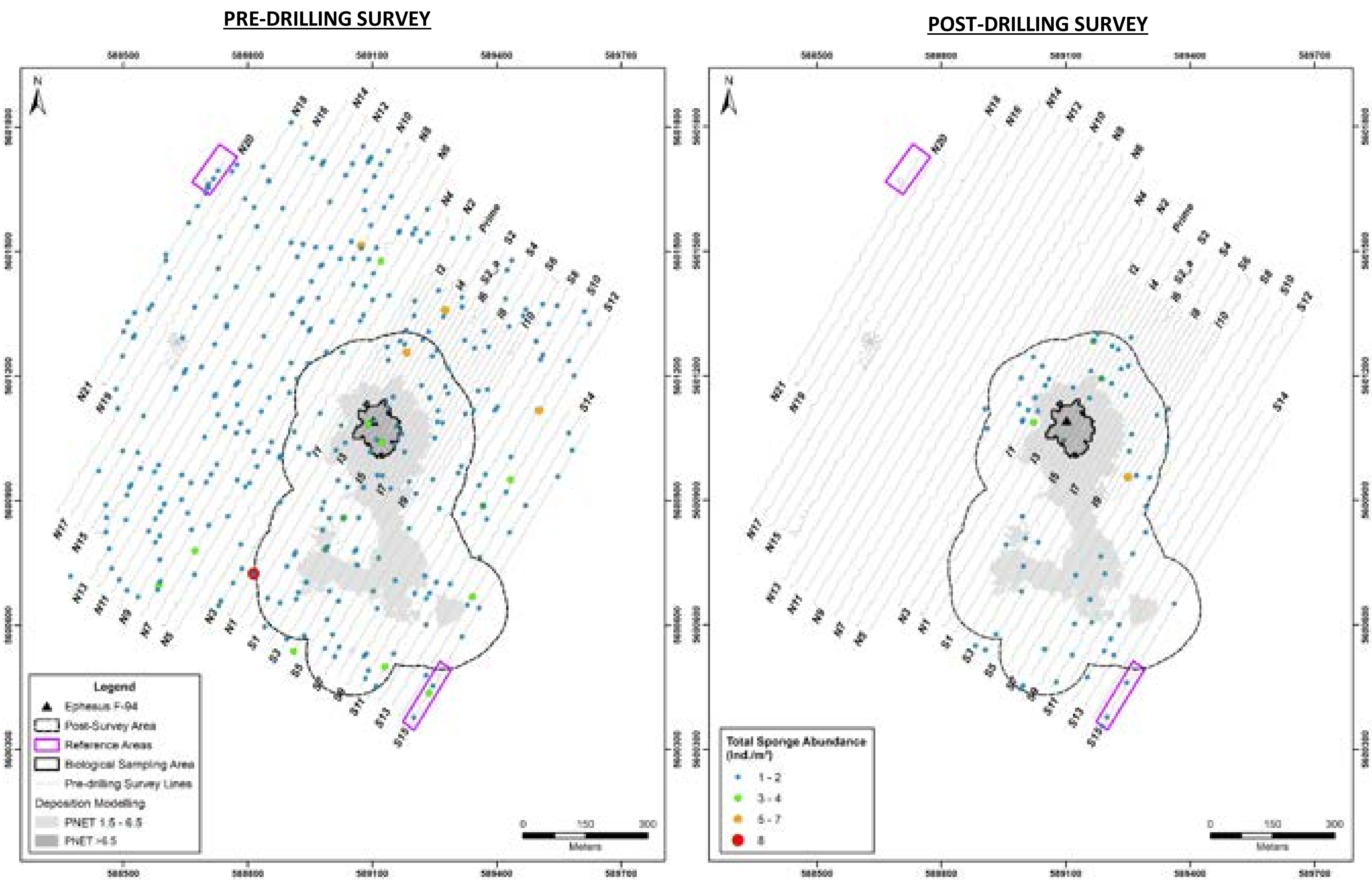


Figure 4-16 Pre- and Post-Drilling Sponge Abundance.

PRE-DRILLING SURVEY

POST-DRILLING SURVEY

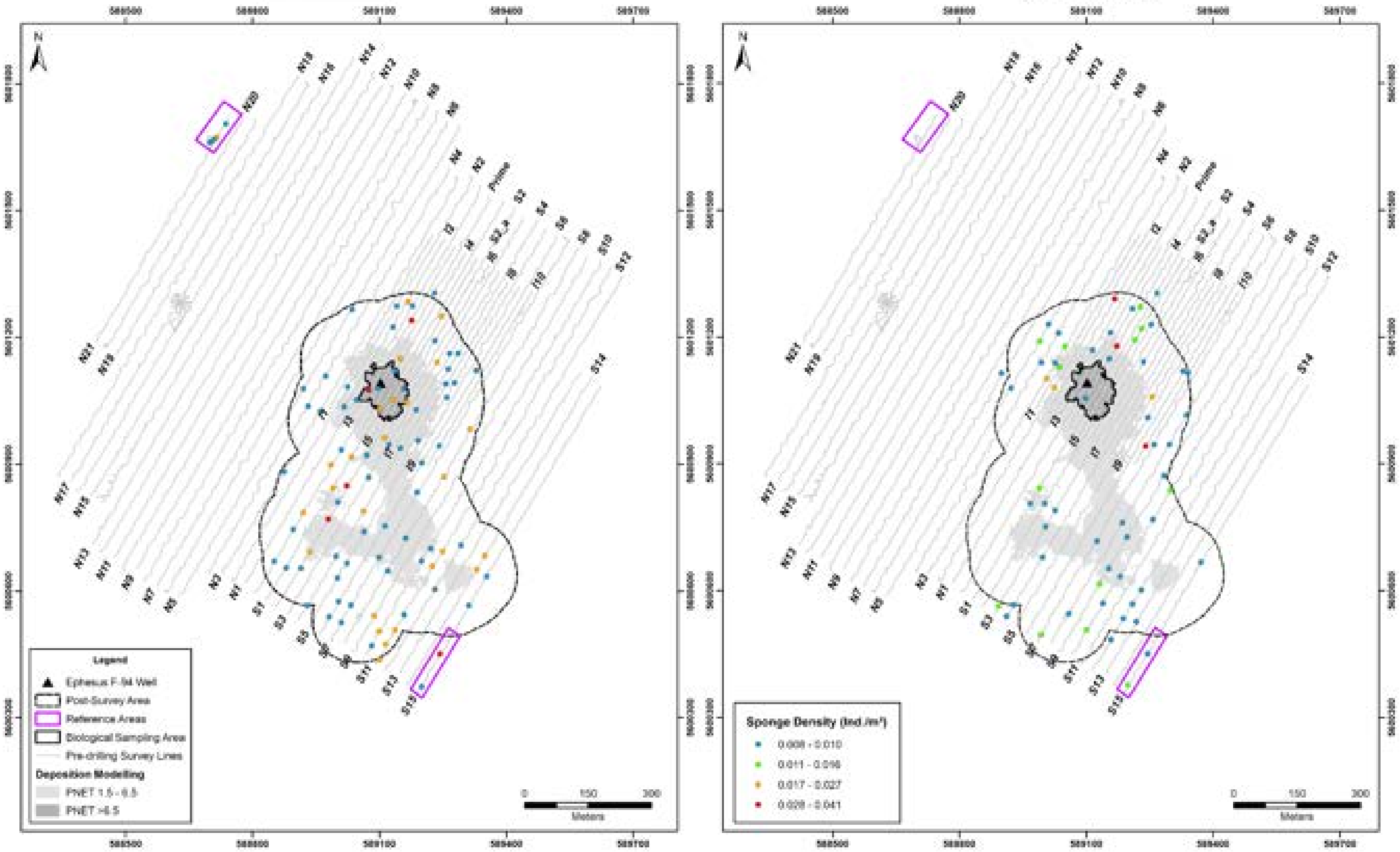


Figure 4-17 Pre- and Post-drilling Sponge Density.

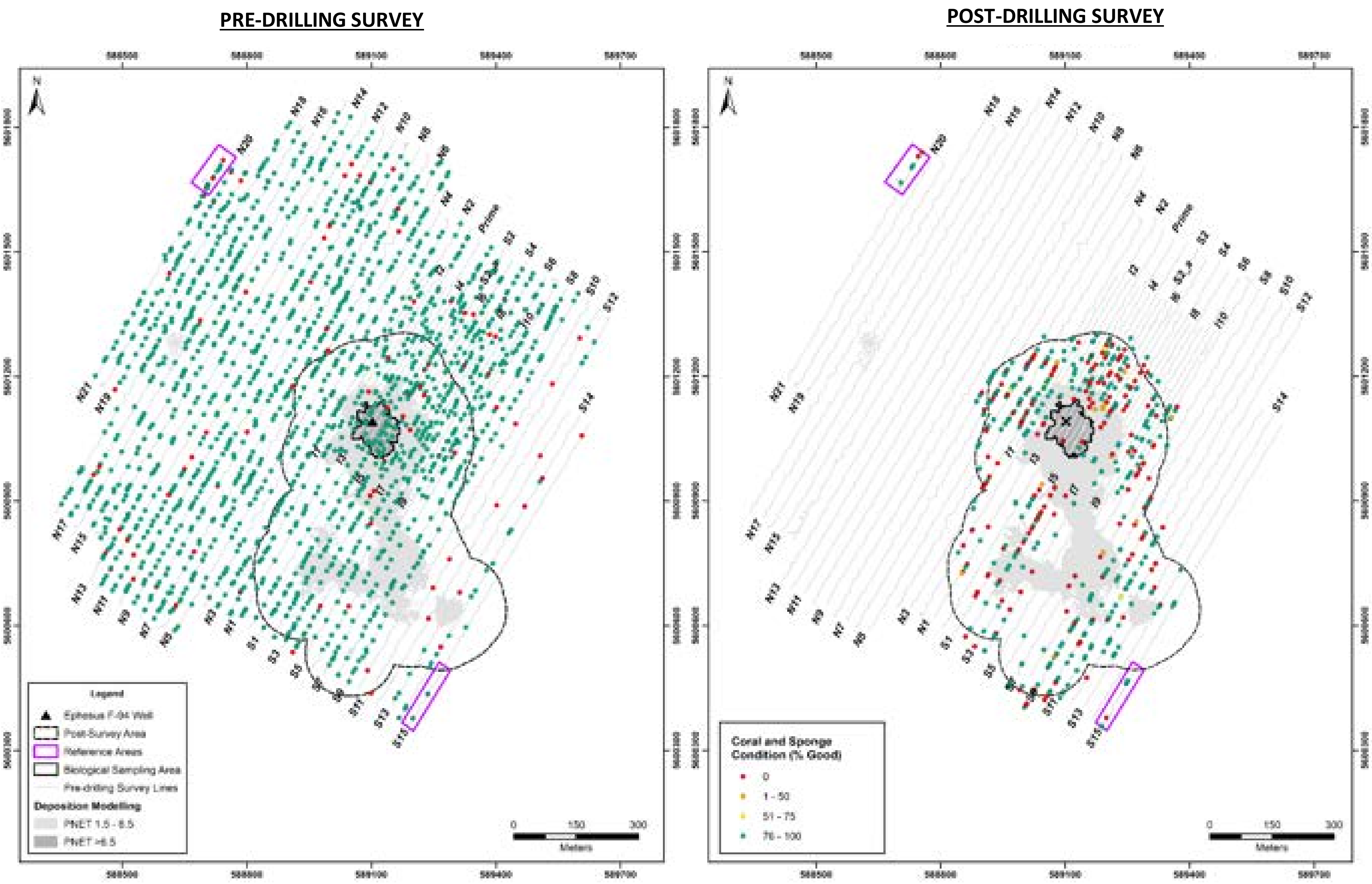


Figure 4-18 Pre- and Post-drilling Coral And Sponge Condition (Percent Good). Note: Excludes Sea Pens.

4.4. Invertebrates (non-coral and sponge) and fish

4.4.1. Invertebrates

Similar to the pre-drilling survey, a variety of non-coral and sponge invertebrates were noted during the post-drilling survey (Figure 4-19). Predominant groups include echinoderms (sea stars, sea urchins, and brittle stars), cnidarians (anemones), molluscs (squid and octopus), and arthropods (shrimp). Less common groups include comb jellies (ctenophores) and brachiopods. Observation of benthic sessile organisms was difficult due to the detritus on the seafloor.

4.4.2. Fish

Fish were observed throughout the post-drilling survey area, with taxa observed similar to those noted during the pre-drilling survey reports (Figure 4-19). Predominant species present include blue hake (*Antimora rostrata*), grenadiers (Macrouridae), and longnose eels (*Synaphobranchus kaupii*). Less common fish observed include rocklings (Lotidae) and skates (likely Abyssal (*Rajella bathyphila*) or Jensen's (*Amblyraja jenseni*) skates).

Two wolffish were observed during the post-drilling survey, one on line I6 and one visible during sediment sample collection. Both appeared to be Northern Wolffish (*Anarhichas denticulatus*) which is listed as Threatened under SARA Schedule 1.

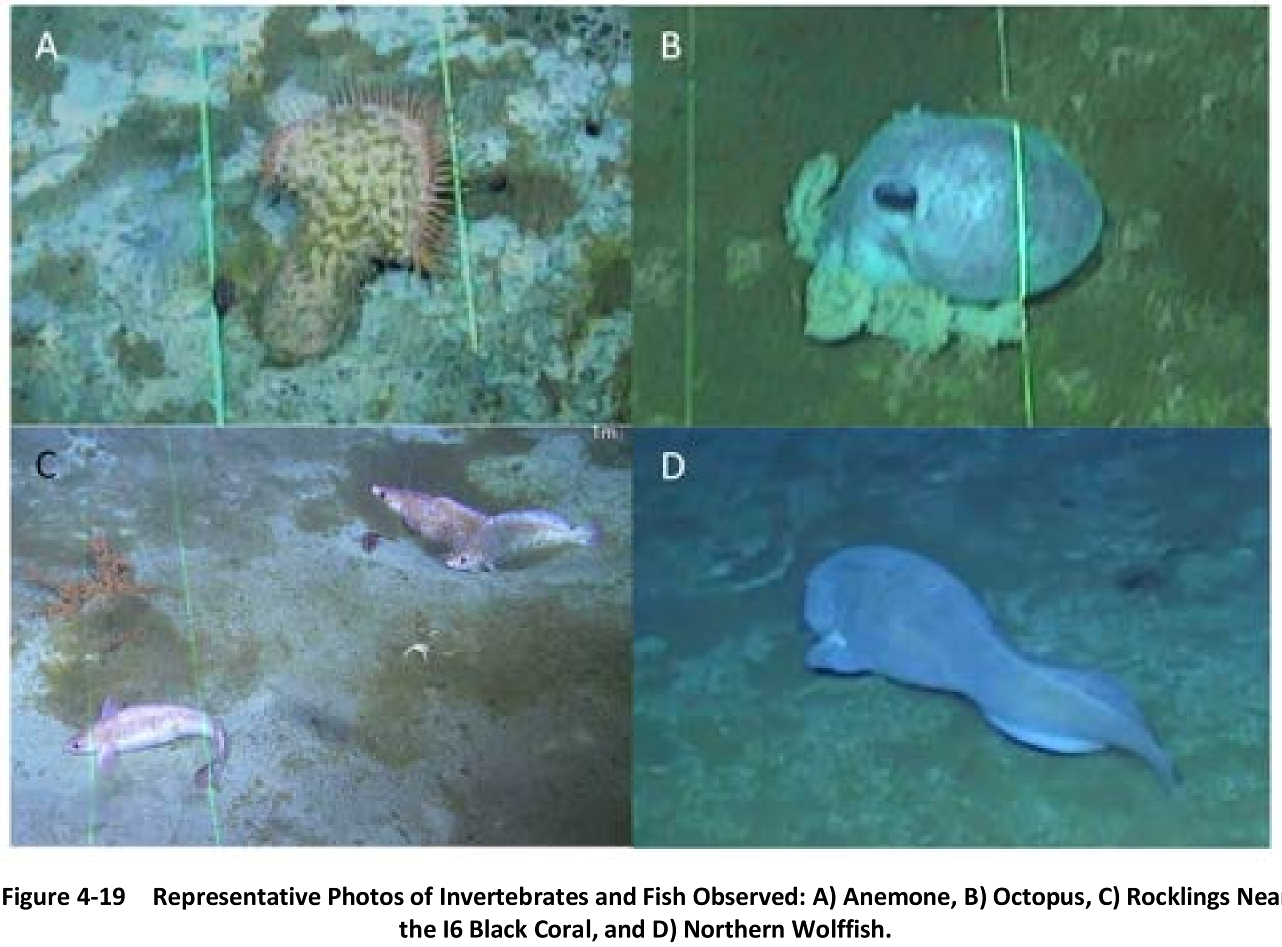


Figure 4-19 Representative Photos of Invertebrates and Fish Observed: A) Anemone, B) Octopus, C) Rocklings Near the I6 Black Coral, and D) Northern Wolffish.

4.5. Model Validation-Drill Cutting Extent and Deposition

4.5.1. Drilling Process Summary

When comparing actual dispersion of mud and cuttings to that predicted by dispersion modelling it is helpful to understand the fundamental steps in the well drilling process and how, when, and where the releases of mud and cuttings to sea occur.

The drilling process for a subsea well can be described in two distinct phases. The initial phase consists of drilling riserless into the seabed. Riserless drilling occurs in the early stage of drilling, the drilling of the tophole sections, before the marine riser and blowout preventer (BOP) are installed. At this point there is no closed/complete circulation path between the drillship and the well. As the drill bit enters the seafloor, mud and cuttings are deposited directly to the seafloor not unlike when using an electric drill at home and debris accumulates around the bit. As the drill bit moves down through the earth, water and water-based mud is pumped down through the inside of the drill pipe and out through holes in the bit. The water and mud and any rock cuttings are carried up to the seabed where they are all deposited directly to the seafloor.

On the Ephesus well, bp drilled through sediments on the seabed which were mostly very fine grained, however, some coarser grained cobbles and boulders were prognosed as a result of glacial erratics released from icebergs and the retreating ice sheet. Some coarser grained material the size of "a clenched fist" was recovered off one of the drilling tools when the drilling assembly was recovered to surface.

The cuttings and fluid discharge that characterised the riserless drilling phase would be expected to be a mix of fine sand with occasional cobbles (glacial erratic) and gravel being discharged at the well centre and forming a cone around the well. The water-based mud being of a higher density and viscosity than the seawater would be expected to spread out across the seabed filling any depressions and slowly follow the slope of the seabed. The coarse rocks would be deposited close to the well centre and the sand would also drop out close to the well centre.

Two hole sections, the conductor and the surface hole sections, were drilled riserless and then casing was installed and cemented in so the low-pressure wellhead housing and high-pressure wellhead housing could be installed. Each wellhead housing sits atop of a cemented casing string which effectively forms the foundation for the well. The BOP stack is deployed on the end of marine riser string and latches onto the high-pressure wellhead housing. The high-pressure housing and the cemented casing string below it provides a foundation to take the weight of the BOP stack and also to manage any pressure that might be encountered while drilling the well.

Once the riser and BOP are installed the drillship is now connected to the seabed and there is a circulation path from the drillship down through the inside of the drill pipe and through the drill bit and then back up to the drillship outside the drill pipe and inside the riser pipe. At this point, the water-based mud system is displaced and the synthetic oil-based mud system is circulated. This is known as riser drilling.

The synthetic oil-based mud and cuttings which are returned back up the riser pipe to the surface are passed over a series of shakers positioned on the drillship (industrial sieves) to remove the rock cuttings that were generated by the drill bit and then entrained in the circulating mud stream. The "clean" mud is then pumped back down the well and the process continues. The rock cuttings that are removed at the shakers are processed and dried and then discharged just below the sea surface within prescribed limits.

The geological sequence at Ephesus consisted for the most part of uniform claystone. The drilling proceeded very smoothly indicating that the drilling process was working effectively. The claystone sequence tends to generate a bi-modal particle size distribution. The grain size tends to vary from chips of the order of ½ a thumb nail down to granulated sugar down to individual clay particles or a material called rock flour. The reservoir section was found to consist of a very high-quality sand. This would have effectively been seen at the shakers as a mix of sizes from granulated sugar down to rock flour.

As this material is discharged at sea level it has to fall through >1300 m of water column during which a certain amount of separation occurs between the coarsest rock chips which are deposited closest to the well versus the granulated sugar like material and the fine rock flour which will deposit at greater distances.

Another source of variability we might expect would be the increase in rock firmness with depth which is an increase in rock compaction. This may also impact how quickly the cuttings would settle through the water column.

4.5.2. Visual Extent and Thickness

Prior to the post-drilling survey and the *Stena IceMax* abandoning the well, the ROV onboard *Stena IceMax* conducted a small (50 m radius around the wellhead) preliminary visual survey of the drill cuttings pile. As illustrated in Figure 4-21, the preliminary survey, which was completed before the appearance of marine detritus, confirmed the cuttings pile was directionally aligned (i.e., predominantly southerly) with dispersion modelling results and therefore the post-drilling survey plan (bp 2023b) was relevant for the observed dispersion of cuttings. During the preliminary survey, the pile observed was flat with an angle of repose between 11 to 18 degrees. The pile extended 3 to 4 m to the east of the well, 8 to 10 m west, and 15 m south. This observation is supported by current data recorded at the site which indicates from April 12, 2023, to July 9, 2023, current at near surface and mid-depth was predominantly in a southerly direction with fluctuations from southwest and southeast (bp 2023d). It should be noted however, currents were often northerly during May. The distances noted above were based on a visual estimate only. The preliminary survey was not intended to provide a description of extent based on precision positioning data.

A comparison of the wellhead as-built drawings to ROV images of the wellhead when drilling was completed resulted in an engineering estimate of 1 to 1.2 m accumulation of cuttings at the wellhead. Cuttings thickness at the wellhead was also estimated during the primary post-drilling survey, when the ROV onboard the *MV Maersk Mobiliser* deployed a ParoScientific digiquartz 8DP130-2 depth sensor to take digital depths of the seafloor within a 24 m radius of the well (Table 4-5, Figure 4-22). The difference in detected depth between adjacent seafloor and the cuttings mound was concluded to be the height of the cuttings. A total of 16 measurements were taken, 10 measurements were taken on the Prime transect across the well centre, and 3 each on transects I3 and I4. Station D1 was considered the benchmark station (i.e., undisturbed seafloor) for depth measurements. As shown in Table 4-5, the depth sensor measurement taken 2.6 m from the wellhead at station D5 was 1.004m. This aligns well with the engineering estimate of 1 to 1.2 m as described above. Both align with the model predictions.

Figure 4-20 below illustrates the relationship between cuttings thickness vs distance from the wellsite as measured by the depth sensor. As expected, drill cuttings thickness correlates well with distance from the wellhead.

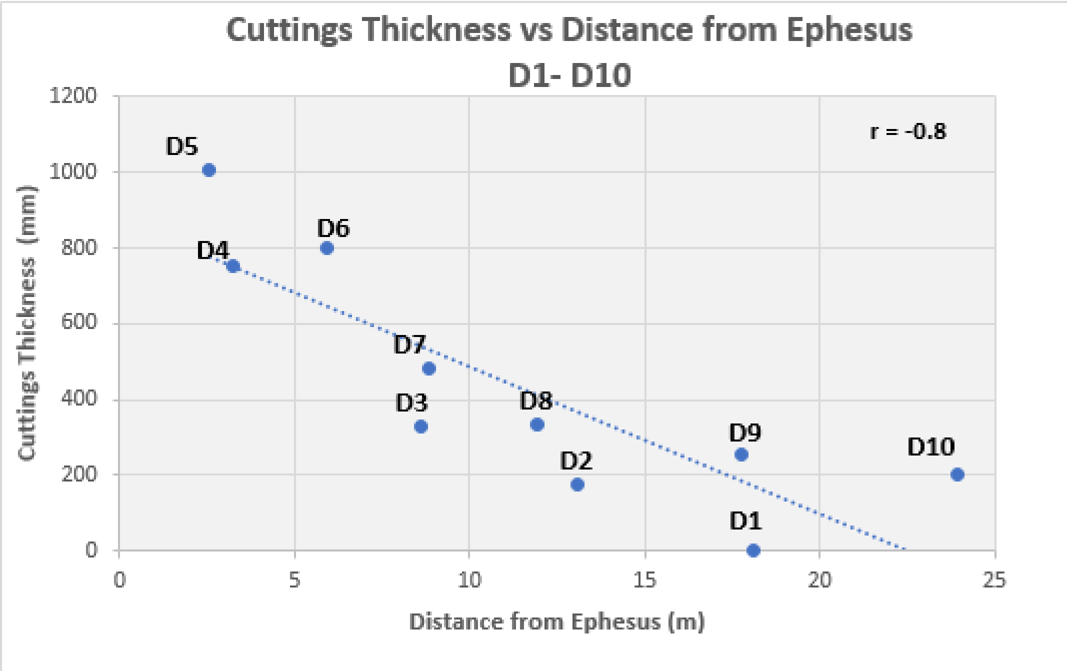


Figure 4-20 Cuttings Thickness vs Distance from the Ephesus Well

Observations (visually detectable) of potential drill cuttings were also noted during the survey (Figure 4-23). Potential drill cuttings were observed as small patches (<1 m) or over several meters. Large clumps of sediment were also observed on the seafloor that were not previously observed in the pre-drilling survey (Figure 4-24). These clumps could have originated in the riser or BOP and became dislodged during the return to the *Stena IceMax* deck. While these observations are not specifically drill cuttings, their presence was noted during the analysis.

While the marine detritus obscured the seafloor sediments, there were still some areas that potential drill cuttings depositions were visible. Drill cuttings were visually observed along the Prime transect near the well (Figure 4-24). Other areas along the transects that could potentially be drill cuttings were noted and mapped (Figure 4-23). Cuttings (visually identifiable) were largely restricted to an area around the well centre out to approximately 200 m, with a few observations beyond that towards the south (Figure 4-23). Sediment samples were taken in two areas that were identified as potential drill cuttings depositions during the survey (Station S2-1A/B and S4-1A/B). The ROV operators noted that when the ROV rested on the seafloor in these areas to collect samples, it was more difficult to dislodge the ROV from the seafloor. Chemical analysis results for these cores are presented in the following section.

There are various factors that could cause results to deviate from the model predictions. In May, the current direction at both the near surface and near seabed locations had significant northerly components. The northerly components used for modelling were significantly lower than actual northerly currents. Among the current direction data points recorded, those currents having a direction occurring within an arc from 270° through north to 90° were over 50% for both surface and near seabed currents. The percentages were much lower for the modelled scenarios which ranged from 6% to <24%. The northerly components of the actual current direction could have resulted in cuttings dispersing north of the well site. Also worthy of note, of the total amount of drilling mud and cuttings discharged, 95% were released in May when the larger diameter upper hole sections were drilled. Additionally, the discharge point on the Stena IceMax was located 20m forward of the well. Based upon the heading of the drillship, which would be governed by winds and/or currents, this would mean the cuttings would have been discharged in a 20m arc to the north of the well as the vessel was unable to take a heading outside of that arc.

Table 4-5 Cuttings Thickness Based on Depth Sensor Readings Within 24 m of the Well and Visible Depth in Sampling Cores (WGS 1984 UTM zone 22N).

ID	Transect	Distance from Ephesus (m)	Estimated Cuttings Thickness (mm)
Depth Sensors			
D1	Prime	18.1	0
D2	Prime	13.1	176
D3	Prime	8.6	330
D4	Prime	3.3	750
D5	Prime	2.6	1004
D6	Prime	5.9	799
D7	Prime	8.9	484
D8	Prime	11.9	334
D9	Prime	17.8	253
D10	Prime	23.9	204
D11	I4	17.5	337
D12	I4	17.0	446
D13	I4	23.0	477
D14	I3	19.6	397
D15	I3	13.1	365
D16	I3	17.9	190
Sampling Stations			
N21	N21	707.3	0
N2-1	N2	66.1	0
N2-2	N2	157.2	0
F94	Prime	21.4	30 - 40
S1-1	S1	23.7	<50
S1-2	S1	54.1	<0.1
S3	S3	95.3	<0.1
S5	S5	260.9	0
S7	S7	329.6	0
S9	S9	418.6	0
S11	S11	502.2	0
S15	S15	678.4	0
S2	S2	134.5	0
S4	S4	139.4	30 - 45
Prime-2	Prime	230.4	10
N3	N3	185.9	0
N12	N12	404.3	0

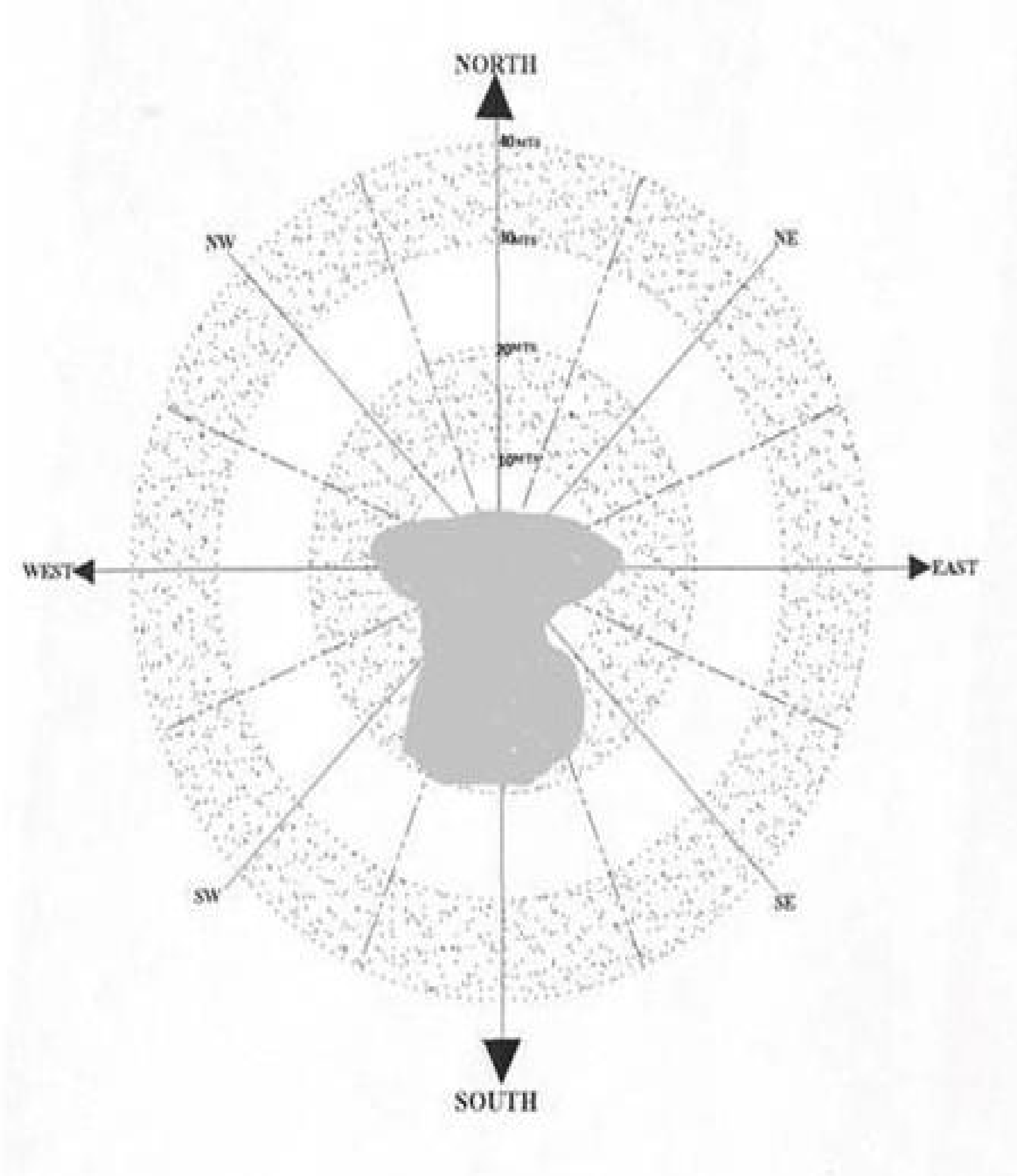


Figure 4-21 An Estimation of the Drill Cuttings Pile Footprint Outline from Preliminary Visual Survey Conducted Using the *Stena IceMax* ROV.

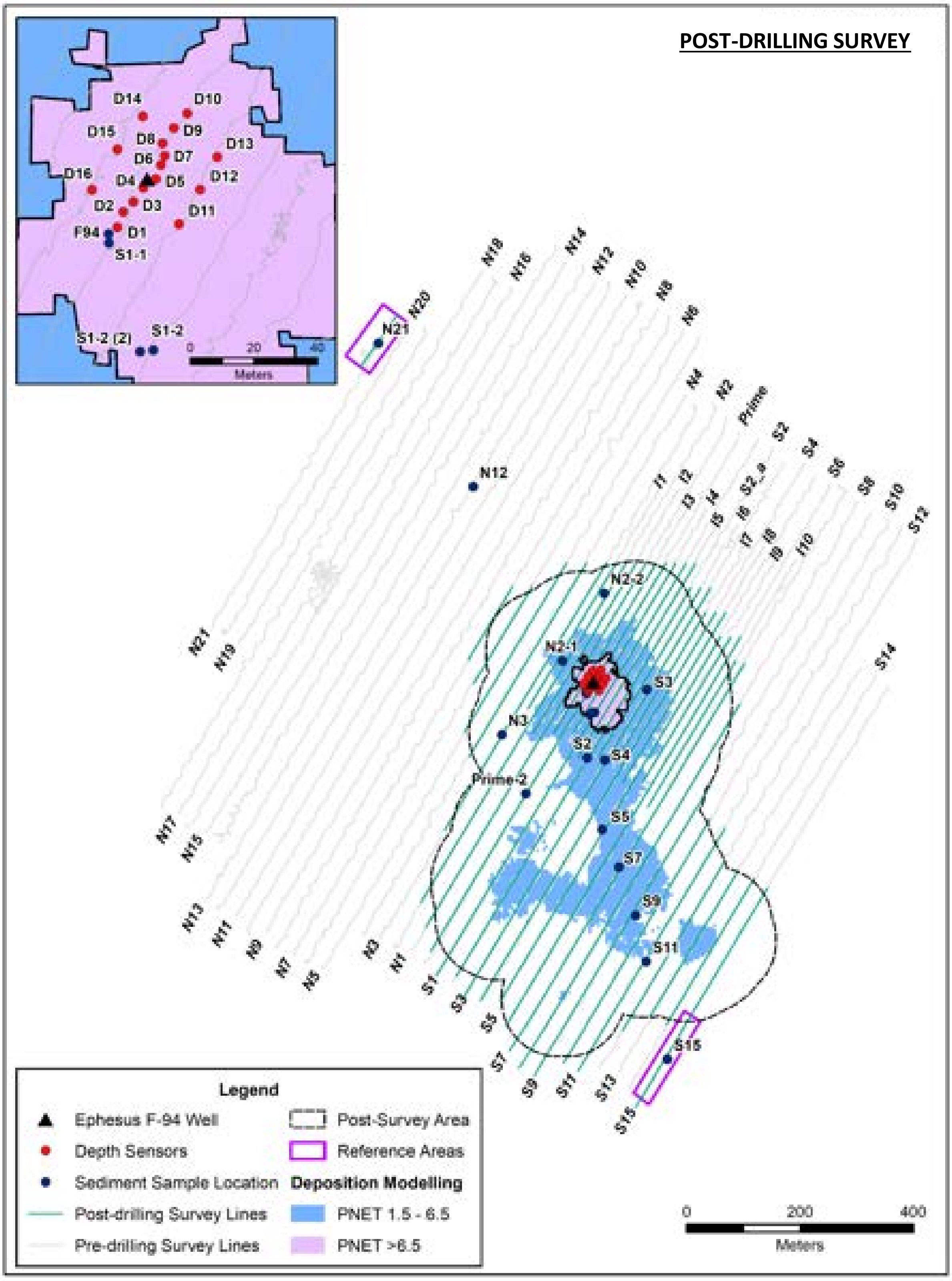


Figure 4-22 Digiquartz Depth Sensor Measurement and Sediment Sampling Locations.

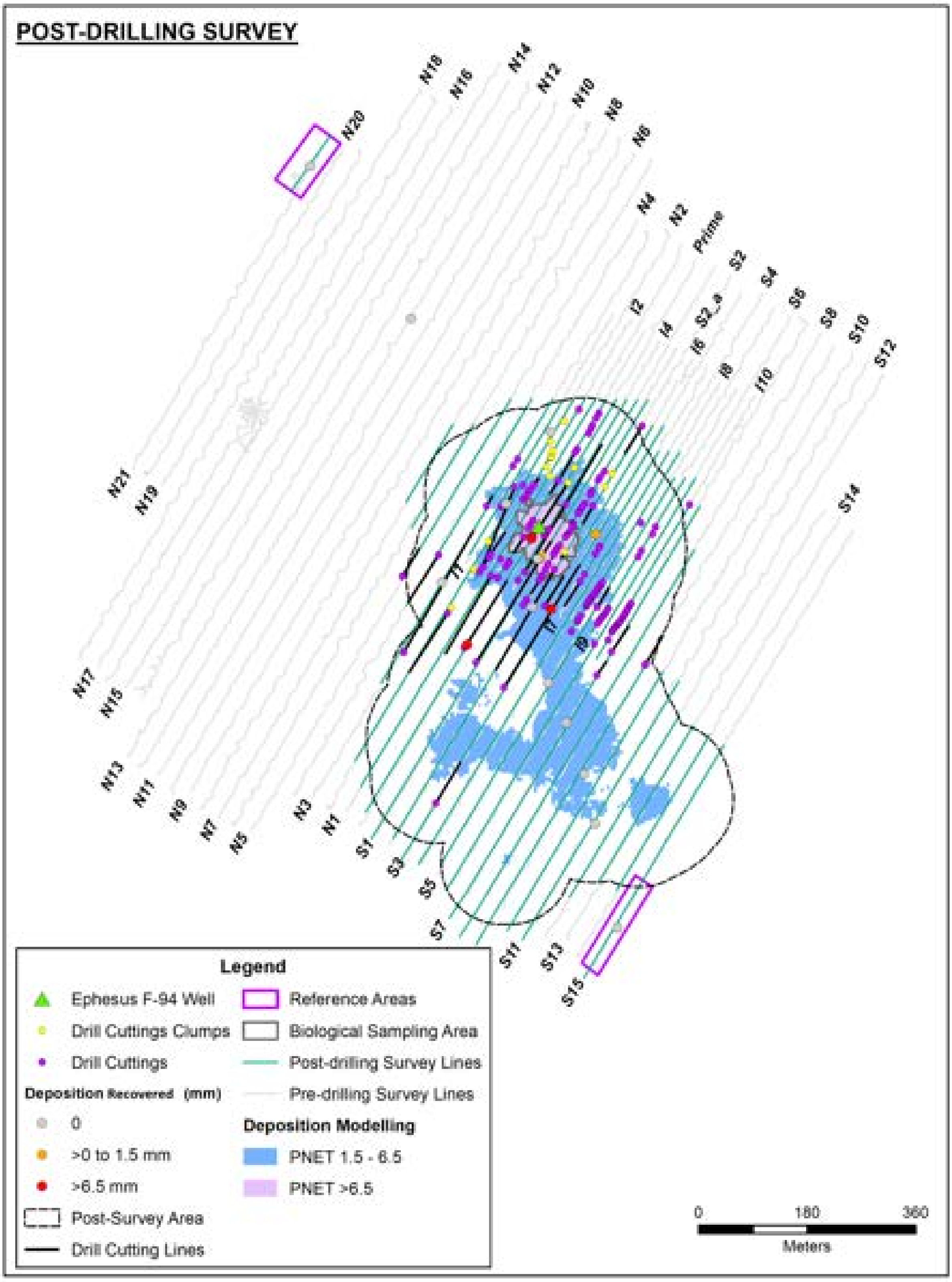


Figure 4-23 Locations of Observed Distinguishable Indications of Drill Cuttings and Recovered Cuttings Deposition (Sediment Cores). Solid black lines indicate the extent on the seafloor of each observation but does not quantify accumulation.

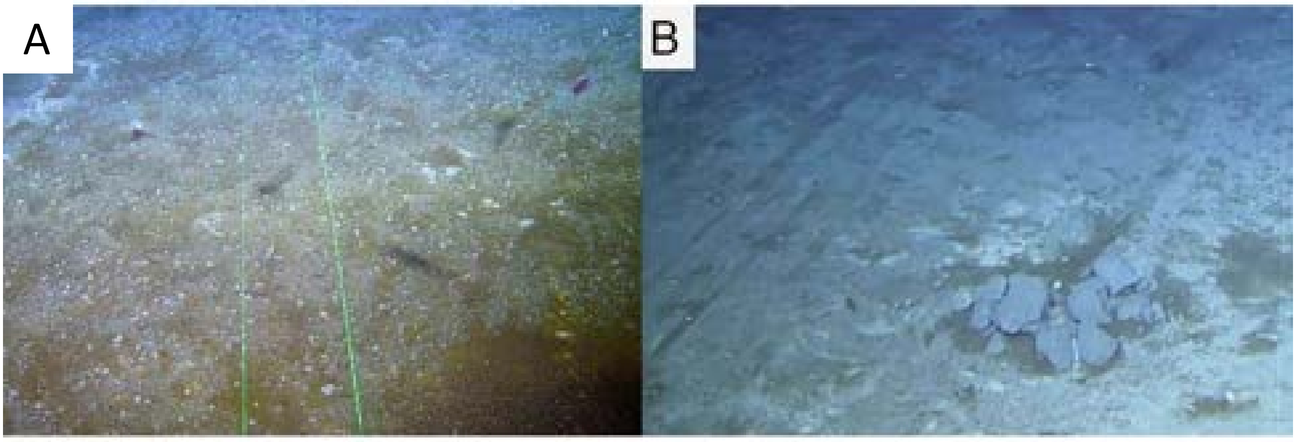


Figure 4-24 Drill Cuttings Images: A) Visible Cuttings Near the Well Centre (Larger Grain Material), and B) Clump (Light Grey Mound observed on I4).

4.5.3. Sediment Sampling

Sediment samples were collected in both the pre- and post-drilling surveys. In the post-drilling survey, all the pre-drilling stations were resampled as well as additional sites totalling 16 stations (32 samples). The actual locations of the sediment sample sites are presented in Table 4-6. In addition to the original ten pre-drilling stations, six additional sample stations were selected based on consultation with the regulators and visual observations of drill cuttings during the survey. Three sites were selected based on in-field visual observations of potential drill cutting deposition and included stations N3-1A/B, S2-1A/B, and S4-1A/B (Figure 3-2).

A total of 36 seabed sediment samples were attempted with successful recovery of 32 samples (Table 4-7). Samples were documented and processed onboard the vessel shortly after retrieval. The seafloor sediment consisted of olive-grey clay with no sulphurous odours. Several samples had a pink colouration present at the surface. The barite supplier has noted that barite has a pink colour and could form small clumps after treatment and discharge. This was visible in 10 sediment cores from 7 stations including cores taken on the Prime transect near the well centre (Table 4-6, Figure 4-23, Figure 4-25). The pink colour was not observed in either of the reference areas. Image plates for all sediment samples recovered are presented in Appendix A.

Table 4-6 Actual Post-drilling Sediment Sample Coordinates (WGS 1984 UTM zone 22N).

ID	Sampled	Distance from Ephesus (m)	Easting (m)	Northing (m)	Colour Observed
N21	Pre + Post	707.3	588723.798	5601689.247	
N2-1	Pre + Post	66.1	589048.283	5601129.248	Pink (A)
N2-2	Post	157.2	589122.061	5601248.262	
F94	Pre + Post	21.4	589090.784	5601074.705	Pink (A, B)
S1-1	Pre + Post	23.7	589090.908	5601071.849	Pink (A)
S1-2	Post	54.1	589104.914	5601038.128	
S3	Pre + Post	95.3	589197.446	5601078.631	Pink (A)
S5	Pre + Post	260.9	589118.485	5600831.769	
S7	Pre + Post	329.6	589148.299	5600765.754	Pink (B)
S9	Pre + Post	418.6	589177.934	5600680.366	
S11	Pre + Post	502.2	589196.007	5600598.703	
S15	Pre + Post	678.4	589233.376	5600426.431	

ID	Sampled	Distance from Ephesus (m)	Easting (m)	Northing (m)	Colour Observed
S2	Post	134.5	589091.759	5600958.171	
S4	Post	139.4	589123.296	5600954.285	Pink (A, B)
Prime-2	Post	230.4	588983.854	5600895.028	Pink (A, B)
N3	Post	185.9	588942.100	5600999.238	
N12	Post	404.3	588891.102	5601436.493	

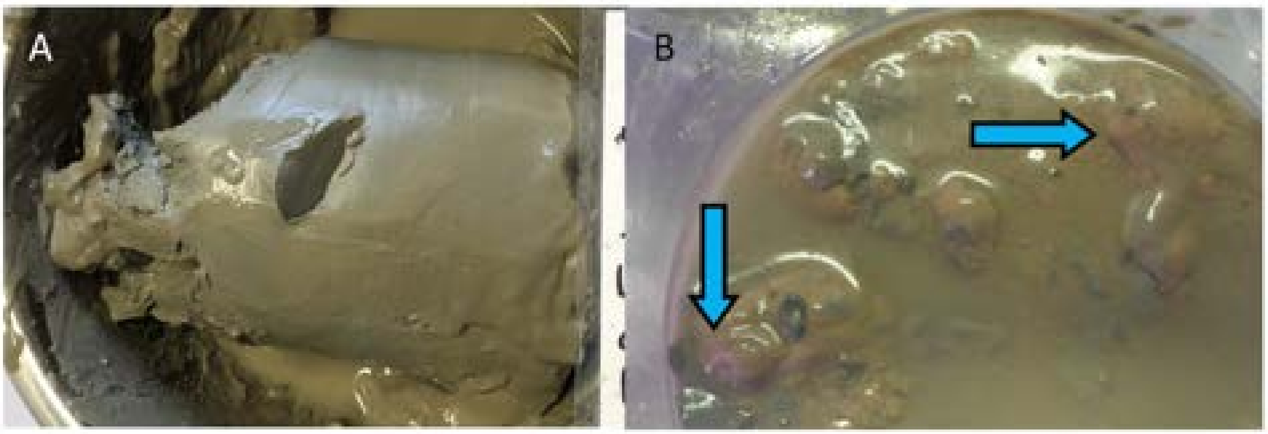


Figure 4-25 Seabed Samples: A) N2-1-B Showing Typical Olive-grey Clay, and B) S4-1-B with Arrows Highlighting Areas of Pink Colouration.

Table 4-7 Pre- and Post-drilling Sediment Sample Recovery and Redox Potential

Station	Recovery (cm)		Cuttings (cm)		Redox Potential (mV)*		Station	Recovery (cm)		Cuttings (cm)		Redox Potential (mV)*	
	A	B	A	B	A	B		A	B	A	B	A	B
Pre-Drilling													
N21	22.5	20			139	149	**S5**	21.5	15			258	129
N2	22.5	19.5			224	241	**S7**	21	21			212	195
F94	21	20	-		178	254	**S9**	17	18.5	-		217	116
S1	16	18.5			90	200	**S11**	19	21.5			138	101
S3	21	22			105	239	**S15**	13	23			200	249
Post-Drilling													
F94	25.5	26	3	4	130	175	**S1-2**	<5	8	<0.01	<0.01	-	18
N12	16	25	0	0	205	216	**S15**	20.5	22	0	0	116	126
N2-1	23	25	0	0	191	188	**S2**	22	-	0	0	62	-
N2-2	16	22	0	0	135	135	**S3**	17	<10	<0.01	0	-10	-
N21	20	23	0	0	19	62	**S4**	25	28	3	4.5	-8	-57
N3	23	24	0	0	188	191	**S5**	26.5	27.5	0	0	198	203
Prime-2	28	29	1	1	107	118	**S7**	16	26.5	0	0	-40	-63
S11	20.5	22.5	0	0	-6	69	**S9**	22	26.5	0	0	58	92
S1-1	10	10	<5	0	54	92	-	-	-	0	0	-	-

*In-field measurement
Cells with a pink colouration indicate the potential presence of barite based on visual assessment.
Sediment Recovery was measured from the top of the rubber base plug (plug thickness is 4 cm) to the top of the sediment.

4.5.4. Sediment Sample Analysis

Of the 36 seabed sediment samples that were attempted, 32 had successful recovery and were sent for analysis. The summary statistics for all analytes above the reportable detection limit (RDL) as well as others of general interest are presented in Table 4-8. The notable results are summarized as follows:

- In the pre-drilling survey, no hydrocarbons were detected. For the post-drilling survey, 11 of 32 samples were above RDL for >C_{10}-C_{16} hydrocarbons, 8 samples above RDL for >C_{16}-C_{21} hydrocarbons, and 1 sample above RDL for >C_{21}-C_{32} hydrocarbons (Table 4-9, Figure 4-30). The furthest station above RDL for >C_{10}-C_{16} hydrocarbons was 329 m from the well centre (station S7), and the furthest for >C_{16}-C_{21} hydrocarbons was 230 m (Prime Station) (Figure 4-27, Figure 4-28).

- Higher than expected hydrocarbon concentrations were noted to occur at sample sites distant from the well relative to closer sample sites (i.e., Prime-2 and F-94; see Table 4-5 for distances from source). Synthetic based cuttings were released from the Stena IceMax via a discharge point at approximately 11 m depth and positioned approximately 20m forward of the well centre. Surface releases result in coarser and heavier cuttings settling near the well. Finer material settles at greater distances due to the water depth. Due to the larger surface area on the finer particles, the same mass of fine cuttings can be expected to have a higher residual synthetic oil concentration than the coarser particles near to the wellsite. This may explain the increase in hydrocarbon concentrations with distance from the well site in certain areas. Synthetic based cuttings are known to form small clumps once released to sea, and pink clumps were observed in sample S-4B. Clumping may have been a factor in concentrating hydrocarbons and possibly barium.

- 17 acid extractable metals were above their RDLs in most samples for both surveys. Results from the pre- and post-drilling results are similar for 15 of those metals, with barium and lead having higher results in the post-drilling analysis.

- Average concentration of barium for the pre-drilling survey was 141.5 mg/kg, and the average for the post-drilling survey was 525 mg/kg (Figure 4-31). Table 4-9 summarizes the barium concentrations at each station in the pre- and post-drilling survey, as well as the distance to the well centre from each station and the presence of cuttings. Nearly all samples in the post-drilling survey were greater than two standard deviations above the pre-drilling survey baseline mean value, with the exception of both samples from N2-2, N12, N21, and sample S5-A (Figure 4-29). The barium standard deviation based on the 20 pre-drilling samples was 7.6. Figure 4-26 illustrates a moderate correlation of barium with distance from the well.

- Average concentration of lead for the pre-drilling survey was 4.3 mg/kg, and the average for the post-drilling survey was 16.9 mg/kg (Figure 4-32). About half of the samples in the post-drilling survey were greater than two standard deviations above the pre-drilling survey baseline mean value. The extractable lead standard deviation based on the 20 pre-drilling samples was 0.3.

- Weak acid extractable metal (WAM) barium was above RDL in every sample for both surveys, with a mean of 31 mg/kg in the pre-drilling survey and 32 mg/kg in the post-drilling survey (Figure 4-31). Stations S2, S4, and F94 had elevated level compared to the pre-drilling mean value.

- All PAHs were below their RDLs in both surveys, with the exception of 2-Methylnaphthalene above RDL at one station in the post-drilling survey (station S1-1A).

- The average percent fines for all samples in the pre-drilling survey was 97.81%, and 97.61% for the post-drilling survey.

- Laboratory measured redox potential was 266.0 mV in the pre-drilling survey, and 278.1 mV in the post-drilling survey. While these values are similar, the post-drilling survey varies significantly more (standard deviation of 4.97 mV for the pre-drilling and 97.3 mV for the post-drilling).

- For both reference sites (N21 and S15), no hydrocarbons were detected pre- and post-drilling. Barium was not elevated at the N-21 reference site but was elevated at the S-15 site. There was no indication of a material change in concentrations of WAM barium or lead at these sampling stations.

Among the analytes of interest discussed above, hydrocarbons, barium, and lead were all elevated (i.e., greater than two standard deviations above the baseline mean) at the same post-drilling sampling stations: F94, N3, PRIME, S1-1, S1-2, S3, S4, and S7 (Table 4-9, Figure 4-27, Figure 4-28, Figure 4-29). This is consistent with the sediment sampling results, with those stations having cuttings visible in the sampling tube and/or a pink colouration visible at the core surface (with the exception of N3) (Table 4-7, Table 4-9, Figure 4-24). These stations are the closest to the well centre (within 329 m) and were largely taken within the visual cuttings pile. Station N3 had no visible cuttings or pink colour in the sample but was elevated for barium and hydrocarbons. Stations N2-1 and S7 had no cuttings depth recorded for samples but had a pink colour visible on the surface of the sample. These stations did not have elevated hydrocarbons, WAM barium, or lead, but small increases in barium was noted at these stations (Table 4-9, Figure 4-31 bottom). Station S7 is located 329 m from the well centre and had elevated barium levels and was above RDL in one sample for >C_{10}-C_{16} hydrocarbons (Table 4-9). The full sediment chemical analysis results are presented in Appendix B and are provided in an excel file issued by the laboratory.

There are many factors that could cause results appearing anomalous relative to model predictions and there are no definitive causal statements that can be made. One possible factor however is current direction. In May the current direction at both the near surface and near seabed locations had significant northerly components and the northerly components used for modelling were significantly lower than actual northerly currents. Among the current direction data points recorded, those currents having a direction occurring within a arc from 270º through north to 90º were over 50% for both surface and near seabed currents. The percentages were much lower for the modelled scenarios which ranged from 6% to <24%. The northerly components of the actual current direction could have caused deviations from the model predictions. Additionally, the discharge point on the Stena IceMax was located 20m forward of the well. Based upon the heading of the drillship which would be governed by winds and/or currents, this would mean that the cuttings would have been discharged in a 20m arc to the north of the well.

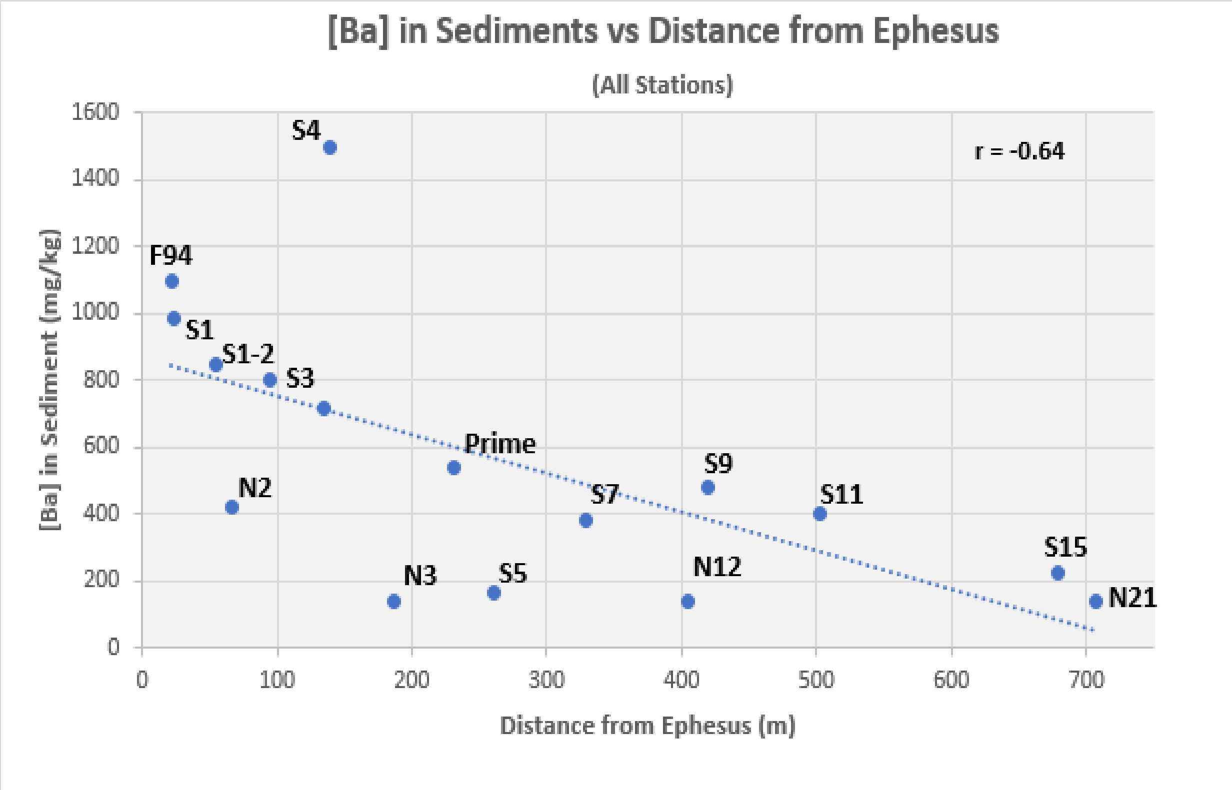


Figure 4-26 Barium Concentration in Sediments vs Distance from the Ephesus Well

Table 4-8 Sediment Chemistry Statistics

Analyte	RDL	Unit	Pre-drilling							Post-drilling						
			# of samples	# above RDL	Mean	St.dev	Median	Min.	Max	# of samples	# above RDL	Mean	St.dev	Median	Min.	Max
Particle Size Analysis																
Gravel	0.1	%	20	2	0.54	0.21	0.54	<0.1	0.74	31[1]	2	0.12	0.08	<0.1	<0.1	0.57
Sand	0.1	%	20	20	2.12	0.15	2.1	1.8	2.4	31[1]	31	2.33	0.67	2.2	1.9	5.8
Percent Fines	0.1	%	20	20	97.81	0.39	98	97	98	31[1]	31	97.61	0.79	98	94	98
Solid Acid Extractable Metals																
Aluminum	10	mg/kg	20	20	9150	339.85	9100	8500	9700	32	32	8934	413.5	8900	8100	9800
Barium	5	mg/kg	20	20	141.5	7.26	140	130	150	32	32	525	434	320	140	1700
Chromium	2	mg/kg	20	20	28.5	1.18	28	26	30	32	32	28.1	1.1	28	25	30
Cobalt	1	mg/kg	20	20	5.43	0.21	5.40	5.00	5.80	32	32	5.6	0.20	5.6	5.2	6
Cooper	2	mg/kg	20	20	9.78	0.25	9.85	9.20	10.00	32	32	11.9	3.9	10	9.7	27
Iron	50	mg/kg	20	20	16850	572.28	17000	16000	18000	32	32	16562	555.5	17000	16000	18000
Lead	0.5	mg/kg	20	20	4.30	0.30	4.30	3.80	5.00	32	32	16.9	28.7	4.75	3.7	130
Lithium	2	mg/kg	20	20	16.20	0.75	16.00	15.00	17.00	32	32	15.8	0.97	16	12	17
Manganese	2	mg/kg	20	20	207.5	11.78	210	190	230	32	32	226.9	47.6	210	190	410
Mercury	0.1	mg/kg	20	4	0.12	0.02	0.11	0.10	0.15	32	7	0.111	0.034	<0.1	<0.1	0.27
Nickel	2	mg/kg	20	20	16.20	0.60	16.00	15.00	17.00	32	32	16.7	0.80	17	16	19
Rubidium	2	mg/kg	20	20	22.90	1.09	23.00	21.00	25.00	32	32	22.1	1.38	22	16	24
Strontium	5	mg/kg	20	20	84.25	3.48	85.00	78.00	90.00	32	32	96.9	13.9	91	83	130
Thallium	0.1	mg/kg	20	18	0.12	0.01	0.12	0.11	0.13	32	31	0.111	0.009	0.11	0.1	0.13
Uranium	0.1	mg/kg	20	20	0.83	0.09	0.83	0.66	1.00	32	32	0.815	0.120	0.82	0.62	1.2
Vanadium	2	mg/kg	20	20	32.45	1.40	32.00	30.00	35.00	32	32	32.56	1.30	33	29	35
Zinc	5	mg/kg	20	20	39	1.84	39.50	35.00	42.00	32	32	39.7	5.5	37.5	35	58
Weak-acid Extractable Metals																
Barium	5	mg/kg	20	20	31	2.66	32	21	34	32	32	32	11	29	18	61
Hydrocarbons																
Benzene	0.005	mg/kg	20	0	-	-	-	<RDL	<RDL	32	0	-	-	-	<RDL	<RDL
Toluene	0.05	mg/kg	20	0	-	-	-	<RDL	<RDL	32	0	-	-	-	<RDL	<RDL
Ethylbenzene	0.01	mg/kg	20	0	-	-	-	<RDL	<RDL	32	0	-	-	-	<RDL	<RDL
Xylenes	0.05	mg/kg	20	0	-	-	-	<RDL	<RDL	32	0	-	-	-	<RDL	<RDL
C_6 - C_{10} (less BTEX)	2.5	mg/kg	20	0	-	-	-	<RDL	<RDL	32	0	-	-	-	<RDL	<RDL
$>C_{10}$-C_{16}	10	mg/kg	20	0	-	-	-	<RDL	<RDL	32	11	123.8	451.6	10	<RDL	2600
$>C_{16}$-C_{21}	10	mg/kg	20	0				<RDL	<RDL	32	8	41.4	122.4	10	<RDL	710
$>C_{21}$-C_{32}	15	mg/kg	20	0	-	-	-	<RDL	<RDL	32	1	15.3	1.7	15	<RDL	25
Redox																
Redox Potential	-	mV	20	-	266.0	4.97	270	260	270	31[1]	31	278.1	97.3	230	160	450

Polycyclic Aromatic Hydrocarbons																
Acenaphthene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Acenaphthylene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Anthracene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Benzo(a)anthracene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Benzo(a)pyrene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Benzo(b/j) fluoranthene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Benzo(g,h,i)perylene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Benzo(k)fluoranthene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Chrysene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Dibenzo(a,h)anthracene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Fluoranthene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Fluorene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Indeno(1,2,3-cd) pyrene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
1-Methylnaphthalene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
2-Methylnaphthalene	<0.050*	µg/g	20	0	-	-	-	-	-	32	1	0.008	0.008	<RDL	<RDL	0.013
Naphthalene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Phenanthrene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Pyrene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Benzo(b)fluoranthene	<0.030*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Perylene	<0.050*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Benzo(j)fluoranthene	<0.030*	µg/g	20	0	-	-	-	-	-	32	0	-	-	-	-	-
Values below RDL are presented as RDL value for comparative purposes. *RDL occasionally higher than reported due to limited sample amounts [1] Sample S3-B did not have enough sample for redox or particle size analysis																

Table 4-9 Pre- and Post-drilling Barium, $>C_{10}$-C_{16}, $>C_{16}$-C_{21} Hydrocarbons, and Lead Concentrations.

Station	Distance to well centre (m)	Cuttings (cm)		Pre-drilling barium (mg/kg)		Post-drilling barium (mg/kg)		Pre-drilling $>C_{10}$-C_{16} HC (mg/kg)		Post-drilling $>C_{10}$-C_{16} HC (mg/kg)		Pre-drilling $>C_{16}$-C_{21} HC (mg/kg)		Post-drilling $>C_{16}$-C_{21} HC (mg/kg)		Pre-drilling Lead (mg/kg)		Post- drilling Lead (mg/kg)	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
F94	21	3	4	140	130	1000	1200	<RDL	<RDL	24	54	<RDL	<RDL	<RDL	27	4.2	4.3	31	60
S1-1	24	<5	0	150	130	770	1200	<RDL	<RDL	120	<RDL	<RDL	<RDL	44	<RDL	4.4	3.8	130	7.2
S1-2	54	<0.01	<0.01	-	-	850		-	-	59		-	-	34		-	-	45	45
N2-1	66	-	0	150	130	600	250	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	5	4.3	5.1	3.9
S3	95	<0.01	0	130	150	1400	200	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	3.9	4.2	5.2	4.1
S2	134	0	0	-	-	720	-	-	-	<RDL	-	-	-	<RDL	-	-	-	5.7	-
S4	139	3	4.5	-	-	1700	1300	-	-	34	290	-	-	<RDL	100	-	-	15	92
N2-2	157	0	0	-	-	140	140	-	-	<RDL	<RDL	-	-	<RDL	<RDL	-	-	3.8	3.7
N3	186	0	0	-	-	200	180	-	-	360	81	-	-	110	30	-	-	5.1	4.4
Prime-2	230	1	1	-	-	490	590	-	-	2600	110	-	-	710	31	-	-	5.4	6.1
S5	261	0	0	150	140	150	180	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	4.9	4.4	3.8	3.8
S7	329	0	0	140	140	310	460	<RDL	<RDL	19	<RDL	<RDL	<RDL	<RDL	<RDL	4.4	4.2	4.1	5
N12	404	0	0	-	-	140	140	-	-	<RDL	<RDL	-	-	<RDL	<RDL	-	-	4	4.8
S9	418	0	0	140	140	700	260	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	4.5	4.5	6.1	4.4
S11	502	0	0	140	140	330	470	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	3.9	3.8	4.5	4.5
S15	678	0	0	150	150	260	190	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	4.2	4.2	4.7	4.5
N21	707	0	0	150	140	140	140	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	<RDL	4.5	4.4	4.1	3.8

HC = Hydrocarbon
Cells with a tan colouration indicate values greater than two standard deviations from the baseline mean.
Cells with a pink colouration indicate the potential presence of barite based on visual assessment.

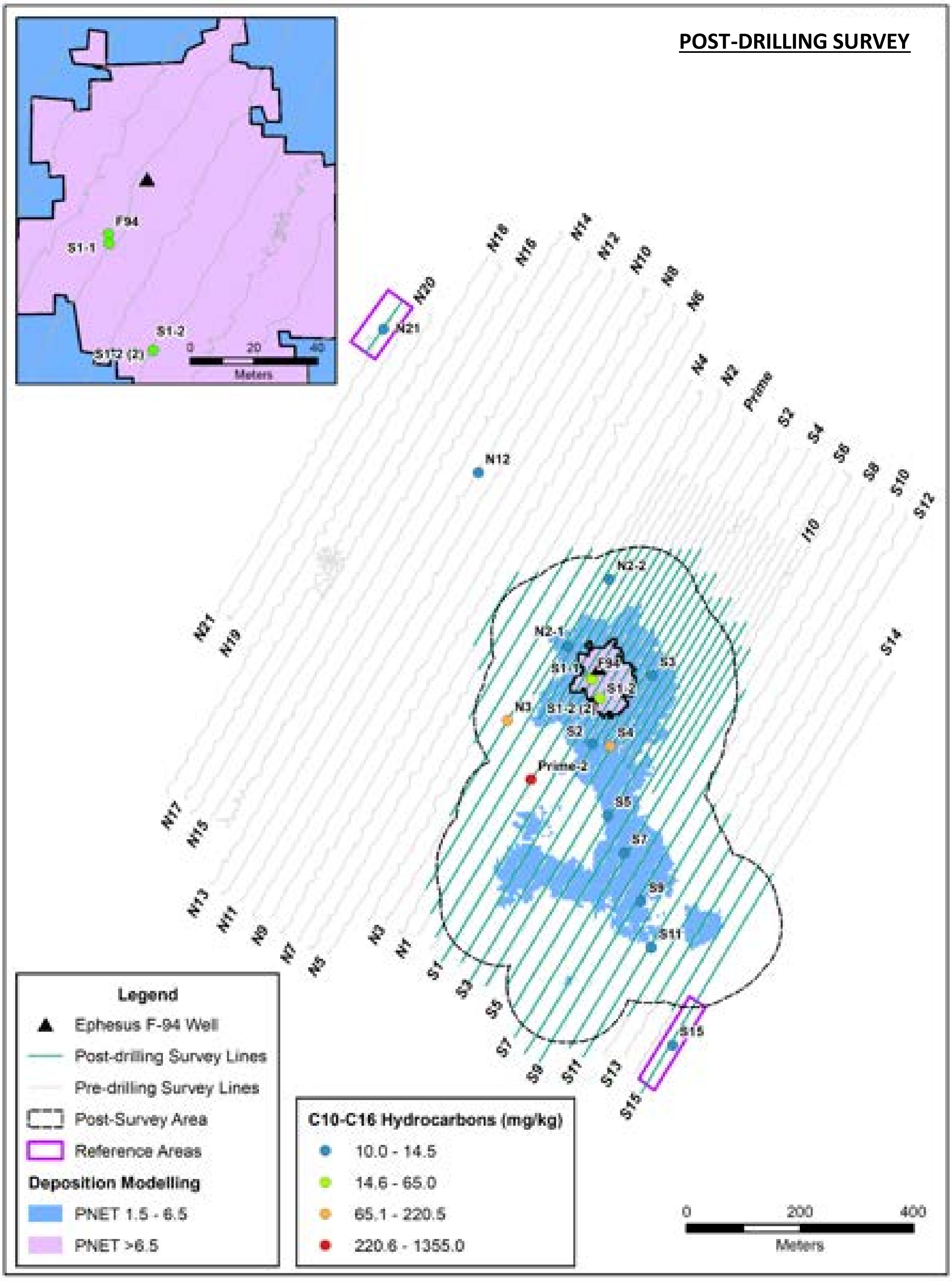


Figure 4-27 Post-drilling >C_{10}-C_{16} Hydrocarbon Concentrations (mg/kg).

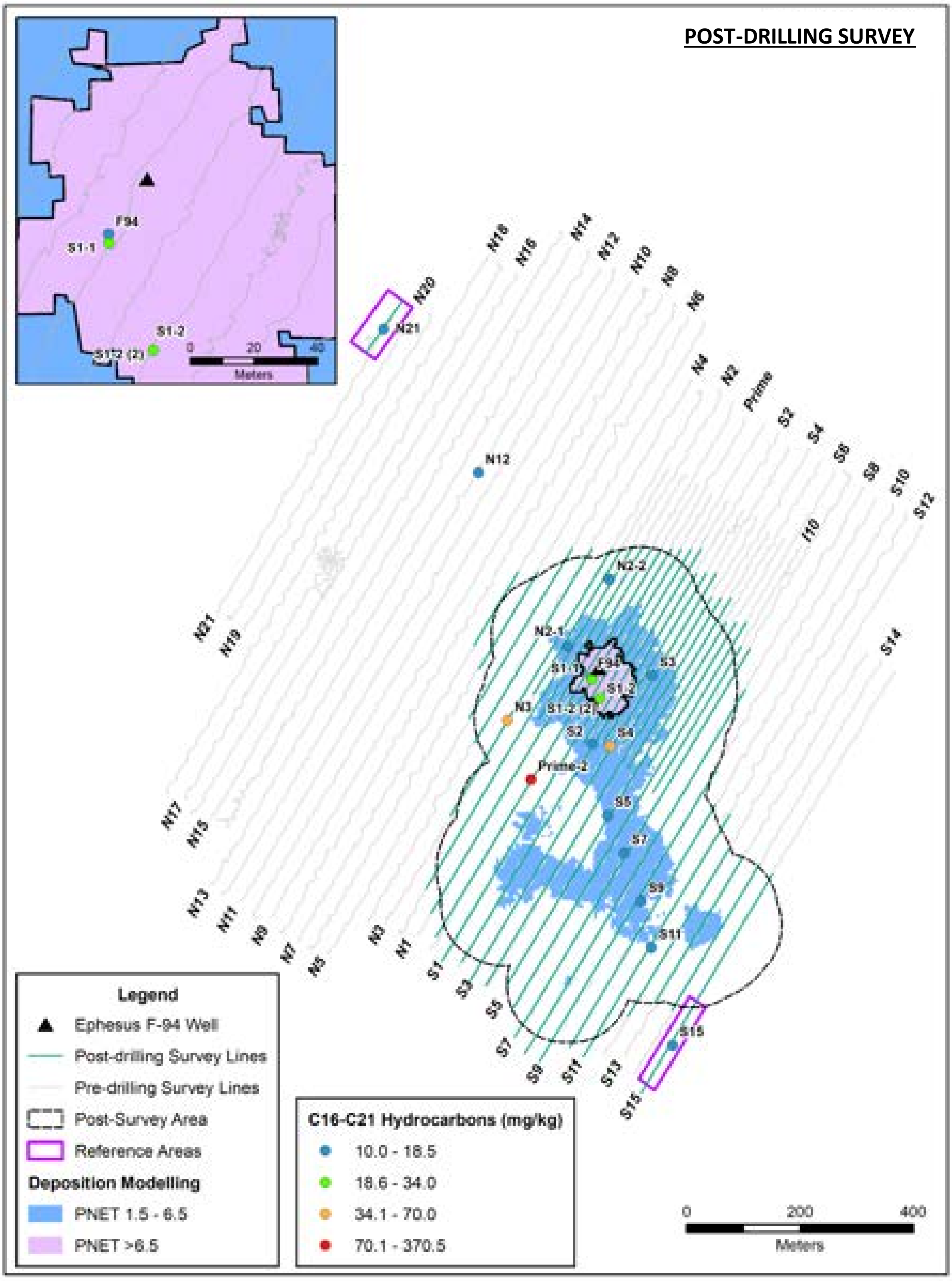


Figure 4-28 Post-drilling >C_{16}-C_{21} Hydrocarbon Concentrations (mg/kg).

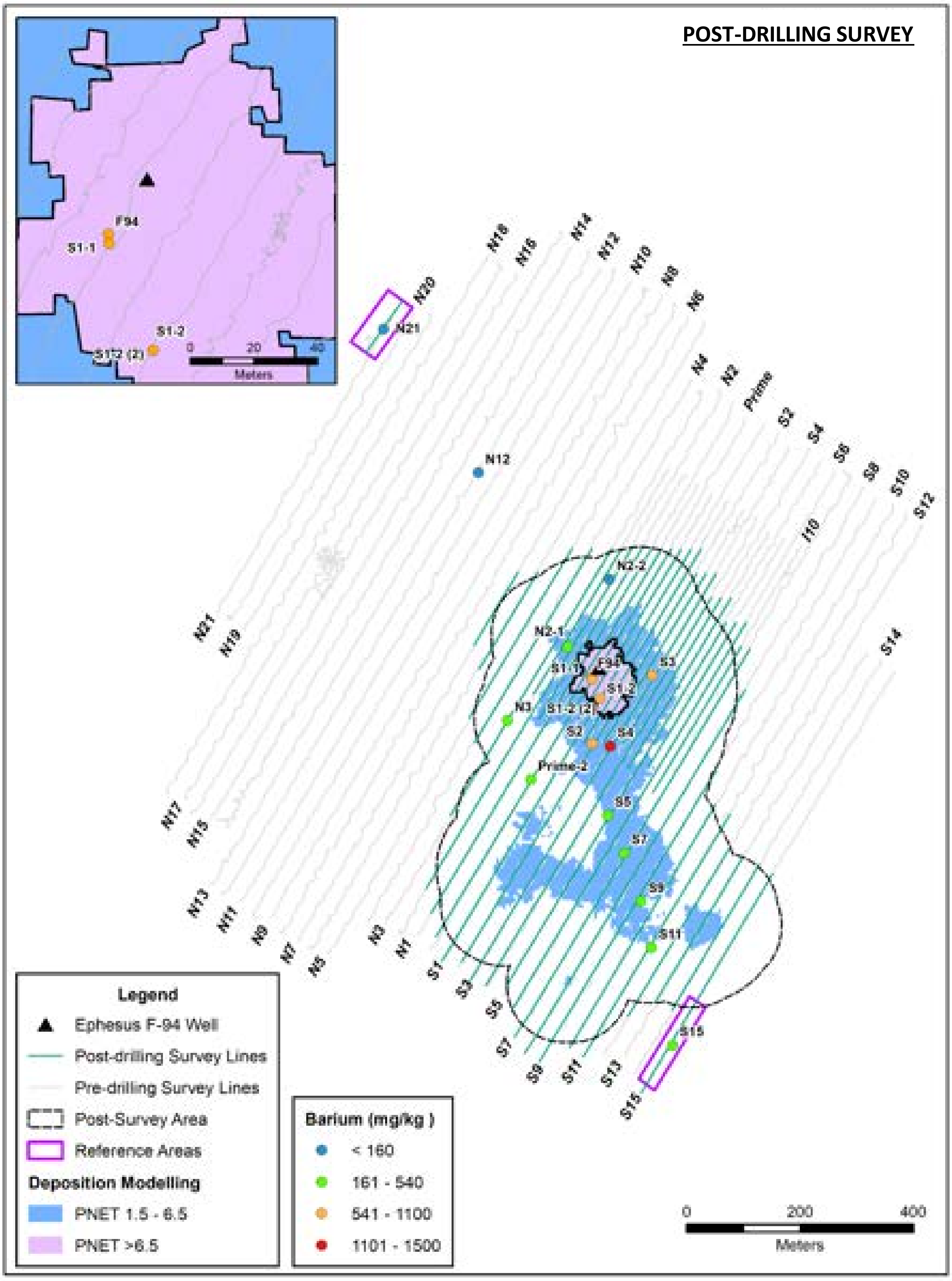


Figure 4-29 Post-drilling Barium Concentrations (mg/kg).

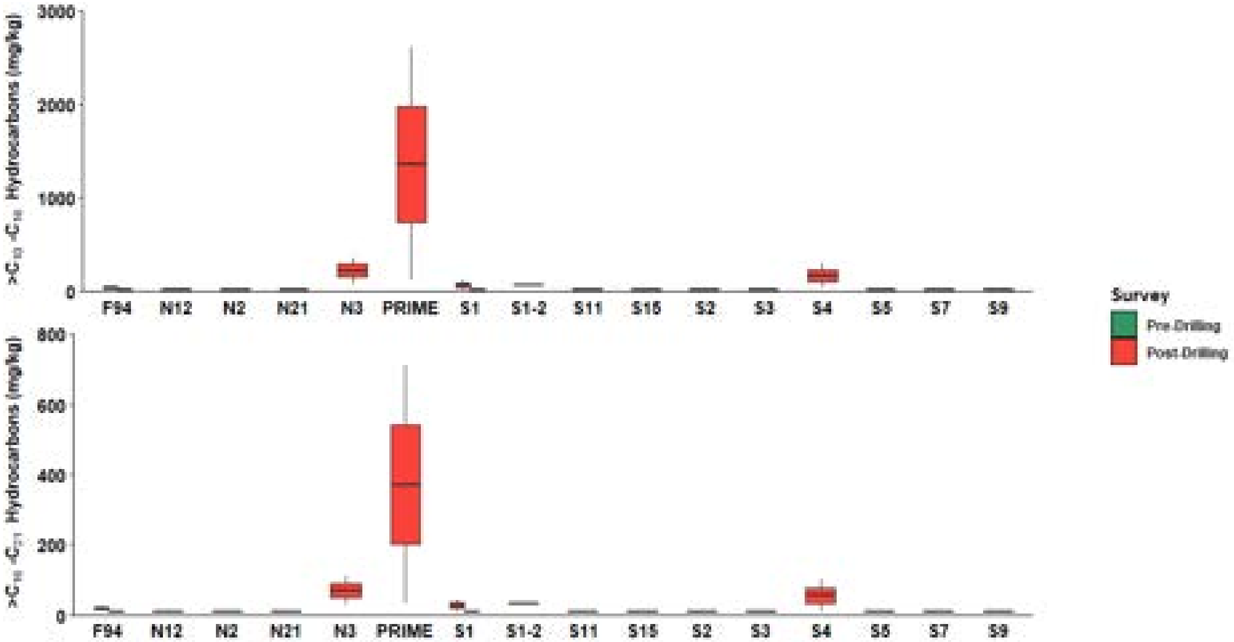


Figure 4-30 >C_{10}-C_{16} (Top) And >C_{16}-C_{21} (Bottom) Hydrocarbons Pre- and Post-drilling. Note: Not All Stations were Surveyed Pre-drilling.

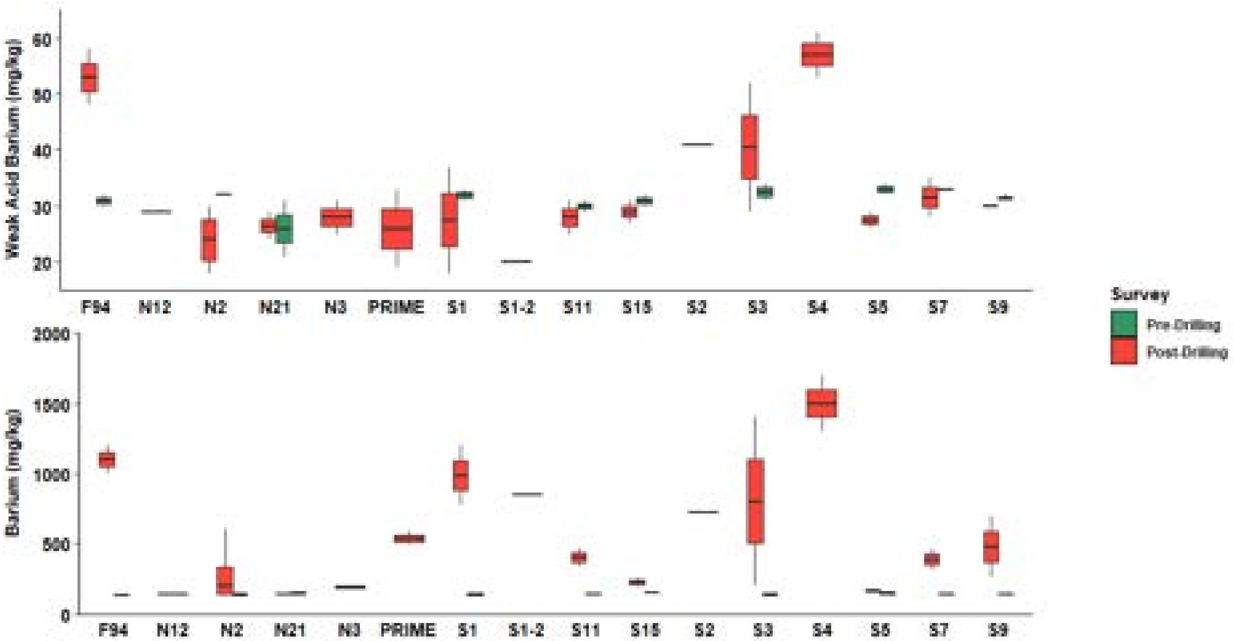


Figure 4-31 Weak Acid Extractable Barium (Top) and Solid Acid Extractable Barium (Bottom) Pre- and Post-drilling. Note: Not All Stations Were Surveyed Pre-drilling.

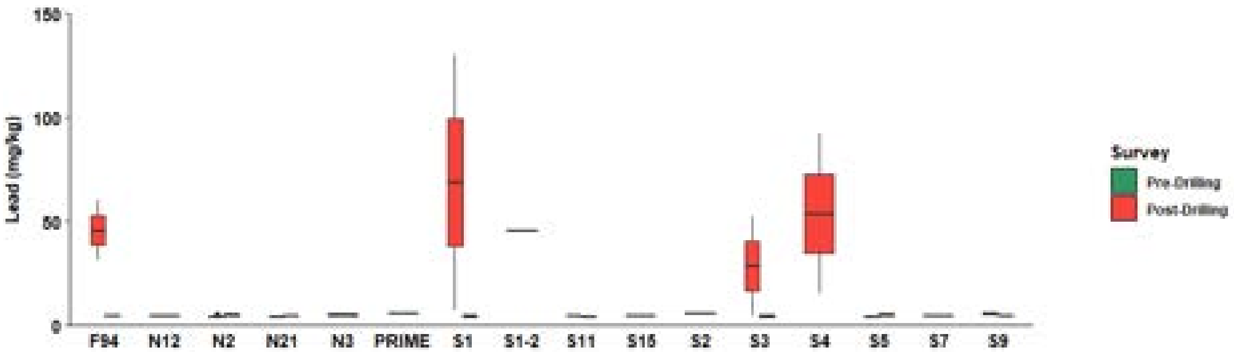


Figure 4-32 Lead Pre- and Post-drilling. Note: Not All Stations Were Surveyed Pre-Drilling.

5. Mitigations and Effects Summary

The mitigations implemented to reduce the potential harm from drilling activities to deep-sea corals and sponges included the collection of data pre- and post-drilling on the abundance, density and overall condition of coral and sponges to inform placement of the well centre (bp 2022a, 2023a). An assessment of the presence and condition of corals within the survey area post-drilling was conducted to confirm the zone of influence from drilling cuttings dispersion and the associated effect on corals and sponges. The monitoring program was designed in consideration of the project location which is inside an Other-Effective Area-Based Conservation Measure (OECM), or marine refuge, area that was established for the protection of corals and sponges including sea pens. As reported herein, the results from the post-drilling survey were compared to the results from the pre-drilling survey. For sea pens, small decreases in abundance, density, and condition were recorded. These changes are likely due to the decline of individuals within the drill cuttings footprint. Small decreases in abundance, density, and condition were reported for other coral and sponge functional and morphological groups.

The detritus noted during this survey is the first such observation made during a pre- or post-drilling survey in the Newfoundland offshore area. The detritus visually blocked the seafloor and covered sessile benthic organisms, however, visual observation of fauna (including corals and sponges) and the seafloor substrate was still possible. As these events are unpredictable, no particular suggestions for future surveys can be made, though the use of multiple methodologies for drilling cuttings delineation did aid in determining the cuttings footprint.

The change in the ‘Good’ condition for sea pens from the pre- to the post-drilling survey was a decrease of 0.8%, while the change for other coral and sponge groups was on average a decrease of 23.6% (excluding black corals). Few dead corals and sponge were observed, and the decrease in condition is due to the increase in ‘Damaged’ corals and sponges. As corals and sponges with detritus present on their surface were rated as ‘Damaged’, this likely explains the majority of the condition decrease.

Deposition extent was described by visual observation by both the *Stena IceMax* ROV, and the *Maersk Mobiliser* ROV during the post-drilling ROV survey (Section 4.5.1). The *Stena IceMax* ROV visual extent aligns with the modelled footprint and predominant current direction during drilling, with cuttings dispersed mainly to the south and lesser amounts to the east and west (Figure 4-21; bp 2022b). The visual survey conducted by the *Maersk Mobilizer* confirmed visually detectable cuttings were largely restricted to within 200 m of the well centre with occasional observations to the south (Figure 4-23). While the detritus limited visibility of the seafloor, the extent of visually detectable cuttings was largely within the predicted cuttings dispersion modelling (bp 2022b). Observations of cuttings to the north outside of the PNET zones was not predicted but was likely due to the northerly currents in May which did not occur in the current data used for modelling. Another important consideration is that 95% of the total combined seabed and surface releases of mud and cuttings were released in May when the larger diameter conductor and surface hole sections were drilled.

Sediment chemistry analyses indicated that the most elevated results for hydrocarbons, barium, and lead occurred within 329 m of the well centre (Table 4-9, Figure 4-30, Figure 4-31, Figure 4-32). Barium at the S15 reference site, located 678 m south of the well, was higher than pre-drilling levels at the same site. S15 was in the dominant direction of cuttings deposition as predicted by the model (Table 4-9, Figure 4-31). Chemical detection at S-15 is aligned with model predictions which predicted a deposition of <1 mm up to and beyond 1 km (bp2022b Annex B). Barium concentrations at S5 located 261 m south of the well site were lower than barium at S15. This may be indicative of a patchy distribution of cuttings as predicted by the dispersion modelling. Barium at N2-2 located 157 m to the north of the well reflected background barium concentrations. This suggests cuttings deposition to the north of the well was limited as predicted by the modelling results.

The Canadian Council of Ministers of the Environment (CCME) have set an Interim Sediment Quality Guideline (ISQG) for the protection of aquatic life at 30.2 mg/kg for lead, with a probable effect level (PEL) of 112 mg/kg (CCME 2023). Six of the sixteen stations in the post-drilling exceed the ISQG (stations S1, S1-2, S3, S4, and both samples at F94), with one of the thirty-two samples, S1-1A, exceeding the PEL guideline. CCME guidelines are for total lead, whereas the analysis completed for this survey was acid extractable lead which is likely to be lower than total lead.

The thickness of the cuttings pile was assessed using a comparison of post-drilling ROV images and wellhead drawings (i.e., engineering estimate), the use of a ParoScientific digiquartz depth sensor, and the depth of cuttings present on the surface of collected sediment sampling cores. Deposited cuttings near the wellhead were predicted to be above 500 mm thick. A comparison of the wellhead as-built drawings to ROV images of the wellhead when drilling was completed suggested the total cuttings accumulation was 1 - 1.2 m. Thickness estimates using the depth sensor found a cuttings depth of 1.004 m along the Prime transect at 2.6 m from wellhead. Sediment cores taken at S1-2 (54m from well centre) revealed a cuttings depth of less than 1 mm whereas Station S4 (139.4m from well centre) revealed a thickness of 45 mm. These samples were taken within the predicted 1.5 mm to 6.5 mm cuttings thickness areas. The cuttings thickness observed S4 was not predicted but may be due to the sample site location being a low-lying area where cuttings could accumulate. Overall, cuttings thickness was generally within the predictions set out in the cuttings dispersion model report (bp 2022b).

6. EIS Decision Statement Condition Compliance

This section is intended to provide a brief overview of the steps taken by bp to ensure compliance with requirements for a benthic habitat follow-up monitoring program to verify the accuracy of the project environmental assessment and effectiveness of mitigation measures as they pertain to the effects of drill cuttings discharges as described in the February 2020 Decision Statement issued for the drilling program environmental assessment.

Conditions 2.5.1, 2.5.2, 2.5.3, 2.5.4, 2.6, were addressed via submission of the bp Post-Drilling Seabed Survey and Sampling Plan CN002-EV-PLN-600-00008 (bp 2023b) which the C-NLOPB accepted on June 14, 2023. The information provided in this report demonstrates that bp has addressed Decision Statement conditions 2.7, 2.7.1, 2.7.2, 2.7.3, 2.7.4, 3.12, 3.12.2, 3.12.2.1, 3.12.2.2, and 3.12.2.3.

Conditions 2.7, 2.7.1, 2.7.2, 2.7.3, 2.7.4. *The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement: conduct the follow-up program according to the information determined pursuant to condition 2.5; undertake monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure; determine whether modified or additional mitigation measures are required based on the monitoring and analysis undertaken pursuant to condition 2.7.2; and if modified or additional mitigation measures are required pursuant to condition 2.7.3, develop and implement these mitigation measures in a timely manner and monitor them pursuant to condition 2.7.2.*

- The approved benthic habitat follow-up program (bp 2023b) was implemented and consisted of two pre-drilling surveys and one post-drilling survey. Baseline data was collected prior to and after drilling and an analysis was completed to understand effects and to verify environmental assessment predictions. The results of the follow-up program are described herein. Modifications to existing mitigations was not deemed necessary and no new mitigations were required.

Condition 3.12.2.1. *Measurement of sediment deposition extent and thickness post-drilling to verify the drill waste deposition modelling predictions;*

- The extent of the cuttings deposition has been confirmed both visually and though chemical analysis in which barium and hydrocarbons were used as indicators of drilling waste dispersion (see Section 5 for a discussion).

- Thickness of the cuttings pile was assessed using known depth markers on the side of the wellhead, the use of a ParoScientific digiquartz depth sensor, and the depth of cuttings present on the surface of collected sediment sampling cores (see Section 5 for a discussion).

- As described herein, overall, cuttings thickness was largely within the predictions set out in the drill mud and cuttings dispersion model (bp 2022b).

- Variations from the model may be explained by the northerly currents in May when the discharge of the majority of muds and cuttings occurred and due to local topography resulting in accumulations.

Condition 3.12.2.2. *Benthic fauna surveys to verify the effectiveness of mitigation measures; and*

- The pre-drilling survey completed in June of 2022 verified that the selected location of the Ephesus well site and the predicted drill cuttings footprint would result in the least environmental impact within the survey area.

- The impact of the detritus on visibility would have resulted in lower than actual abundances to coral and sponges and possibly higher than actual occurrences of damaged or poor coral and sponge condition.

- With the similarity in coral and sponge densities and distributions in the pre- and post- drilling surveys and the overall coral condition being good in both surveys, it is therefore concluded that the drilling activities observed were within the EIS predictions of the project not resulting in significant adverse environmental effects.

Condition 3.12.2.3. *The Proponent shall report the information collected, as identified in conditions 3.12.2.1 and 3.12.2.2, including a comparison of modelling results to in situ results, to the Board within 60 days following the drilling of the first well in each exploration licence.*

- As described in the preceding sections of this report, the pre-drilling survey results were compared to in situ post-drilling survey results and found that the 2022 survey further confirms the effects to corals and sponges from drilling activities were mainly limited to the area within a couple hundred meters of the drill centre. The data reflected in this report enables the conclusion that the EIS model predictions were valid.

7. Closure

This report has been prepared for the exclusive use of bp. The environmental investigation was conducted using standard assessment practices and in accordance with verbal and written request from the client. No further warranty expressed or implied is made. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

8. References

bp Canada Energy Group ULC. 2023a. Newfoundland & Labrador Orphan Basin Exploration Drilling Program - bp Ephesus Pre-Drilling Benthic Fauna (Coral and Sponge) Seabed Survey Video Re-Analysis for Sea Pen Abundance and Density Report. Prepared by Wood E&I Canada for bp Canada Energy Group ULC.

bp Canada Energy Group ULC. 2023b. bp Post-Drilling Sediment Survey Plan - Ephesus Prospect ROV Survey. Doc. No. CN0002-EV-PLN-00008.

bp Canada Energy Group ULC. 2023c. Newfoundland & Labrador Orphan Basin Exploration Drilling Program - bp Ephesus Pre-Drilling Sediment Survey Report. Prepared by WSP E&I Canada for bp Energy Group ULC.

Bp Canada Energy Group ULC. 2023d. Newfoundland & Labrador Orphan Basin Exploration Drilling Program – bp Physical Environment Report. Prepared by Oceans Ltd for bp Canada Energy Group ULC.

bp Canada Energy Group ULC. 2022a. Newfoundland & Labrador Orphan Basin Exploration Drilling Program - BP Ephesus Pre-Drilling Benthic Fauna (Coral and Sponge) Seabed Survey Report. Prepared by RPS for Atlantic Towing Company.

bp Canada Energy Group ULC. 2022b. Ephesus Exploration Drilling Project: Drilling Mud and Cuttings Dispersion Modelling. HSEC-EA-REP-2022-0001B02. July 2022.

bp Canada Energy Group ULC. 2018. Newfoundland Orphan Basin Exploration Drilling Program Environmental Impact Statement. Prepared by Stantec Consulting Ltd. September 2018.

CCME (Canadian Council of Ministers of the Environment). 2023. Sediment Quality Guidelines for the Protection of Aquatic Life. Accessed August 14th, 2023, from https://ccme.ca/en/summary-table.

DFO (Fisheries and Oceans Canada). 2022. Regional Guidance on Measures to Protect Corals and Sponges During Exploratory Drilling in the Canada-Newfoundland and Labrador Offshore Area. August 2022. Draft.

ESRI (Environmental Systems Research Institute, Inc.). 2020. Version 10.8. Redlands, Ca, USA.

Nodder, S.D., Duineveld, G.C.A., Pilditch, C.A., Sutton, P.J., Probert, P.K., Lavaleye, M.S.S., Witbaard, B., Chang, F.H., Hall, J.A., Richardson, K.M. 2007. Focusing of phytodetritus deposition beneath a deep-ocean front, Chatham Rise, New Zealand. *Limnology and Oceanography*, 52(1): 299-314.

Smith, C.R., Hoover, D.J., Doan, S.E., Pope, R.H., Demaster, D.J., Dobbs, F.C., and Altabet, M.A. 1996. Phytodetritus at the abyssal seafloor across 10° of latitude in the central equatorial Pacific. Deep-sea Research II, 43(4-6): 1309-1338.

Thiel, H., Pfannkuche, O., Schriever, G., Lochte, K., Gooday, A.J., Hemleben, C., Mantoura, R.F.G., Turley, C.M., Patching, J.W., and Riemann, F. 1989. Phytodetritus on the deep-sea floor in a central oceanic region of the Northeast Atlantic. *Biological Oceanography*, 6(2): 203-239.

WoRMS (World Register of Marine Species). 2023 Available from https://www.marinespecies.org at VLIZ. Accessed January 2023. Doi:10.14284/170.

Appendix A: Sediment Recovery Plates

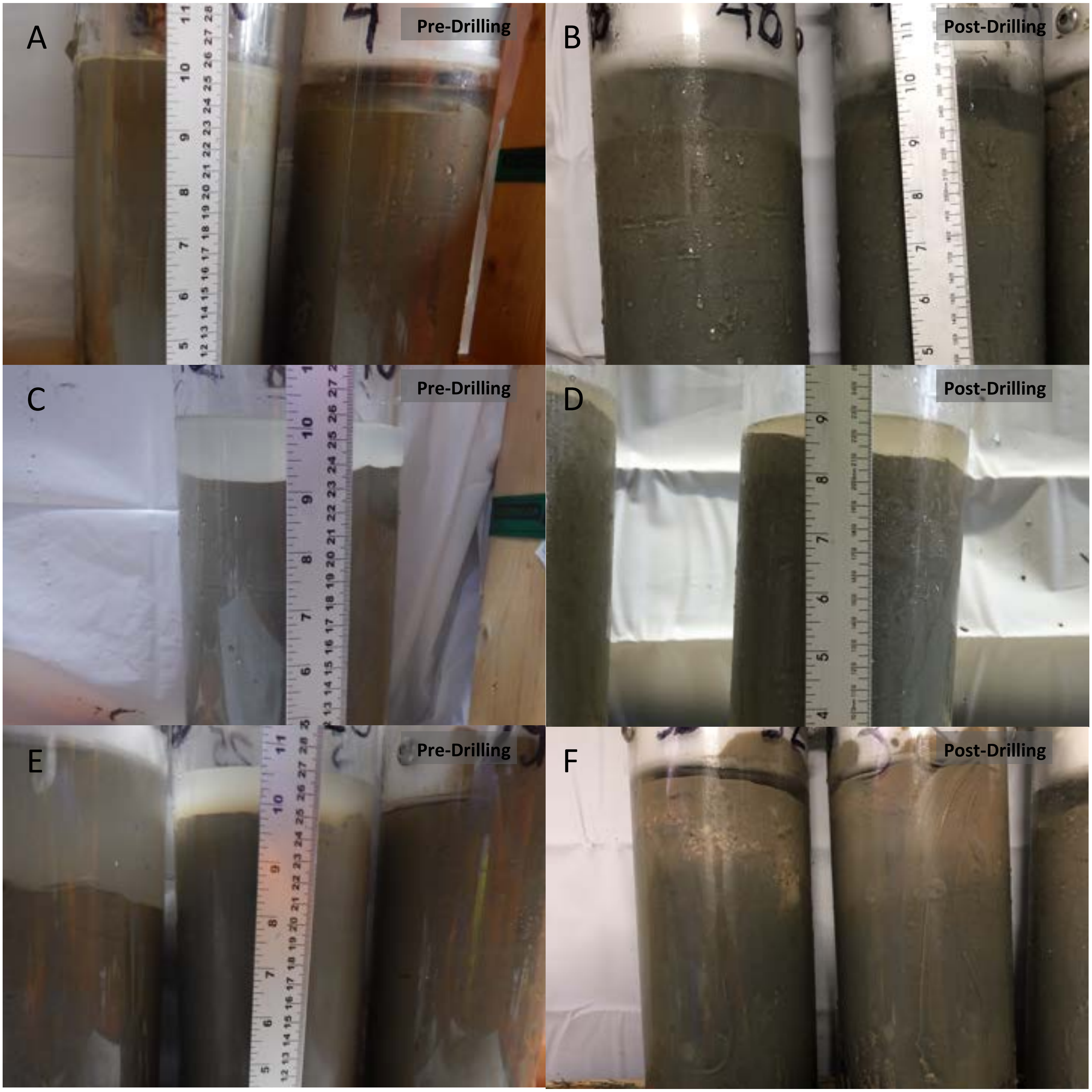


Figure A-1: Comparison of Sediment samples from pre-drilling (Pre) and post-drilling (post): A) Pre-N21-1-A (left), B) Post-N-21-1-B (right), C) Pre-N2-1-A, D) Post-N2-1-B, E) Pre-F94-1-A (middle), F) Post-F94-1-A (left) and Post-F94-1-B (right),

Figure A-2: Comparison of Sediment samples from pre-drilling (Pre) and post-drilling (post): A) Pre-S1-1-B, B) Post-S1-1-B, C) Pre-S3-1-B, D) Post-S3-1-B, E) Pre-S5-1-A (right), F) Post-S5-1-A (middle).

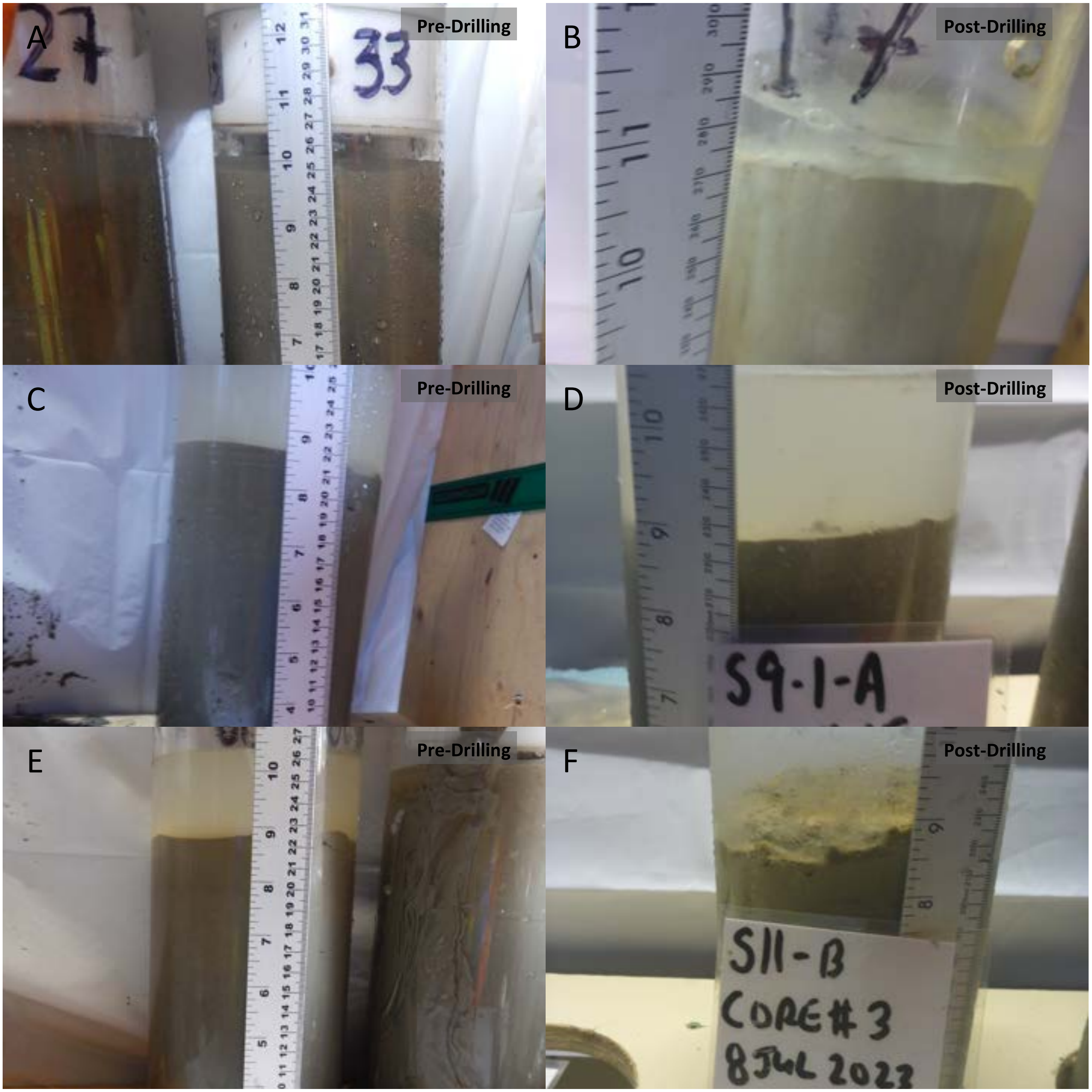


Figure A-3: Comparison of Sediment samples from pre-drilling (Pre) and post-drilling (post): A) Pre-S7-1-A (right), B) Post-S7-1-B, C) Pre-S9-1-A, D) Post-S3-1-B, E) Pre-S11-1-A (left), F) Post-S11-1-B.

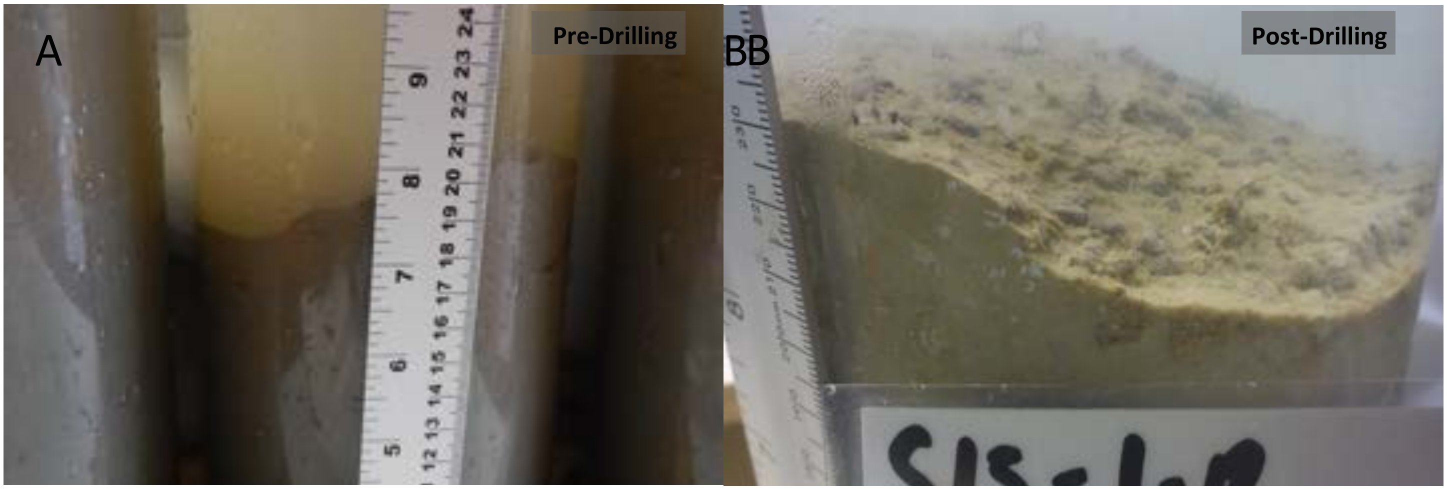


Figure A-4: Comparison of Sediment samples from pre-drilling (Pre) and post-drilling (post): A) Pre-S15-1-A (middle), B) Post-S15-S15-1-B

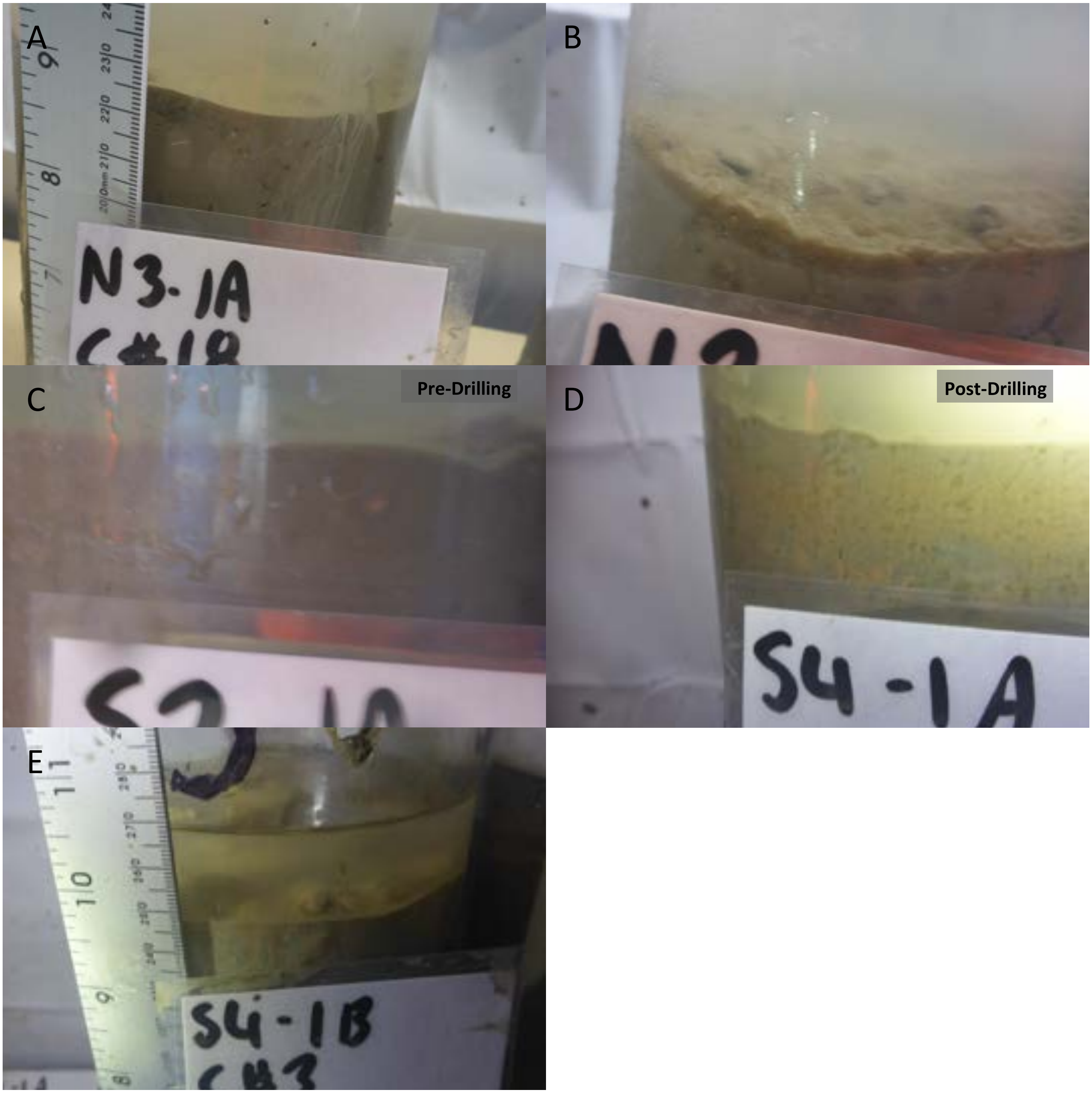


Figure A-5: Comparison of Sediment samples from pre-drilling (Pre) and post-drilling (post): A) N3-1-A B) N3-1-B, C) S2-1-A, D) S4-1-A, E) S4-1-B

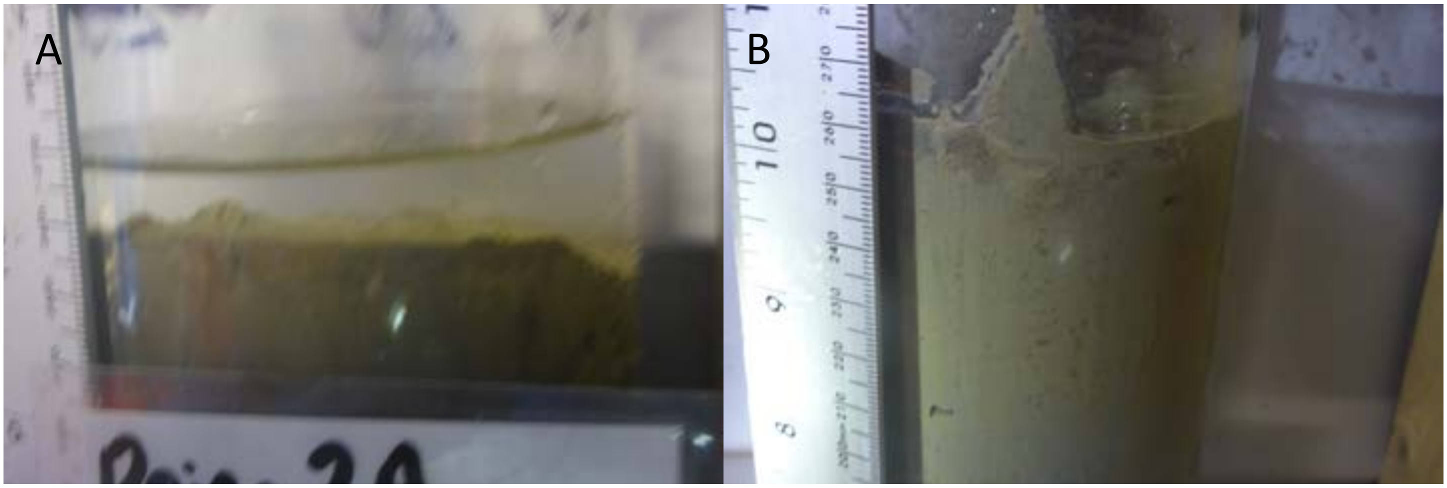


Figure A-6: Comparison of Sediment samples from pre-drilling (Pre) and post-drilling (post): A) Post-Prime-2A, B) Post-Prime-2B

Appendix B: Sediment Chemistry Results

Table B-1: Pre-drilling Sediment Chemistry Laboratory Results Hydrocarbons

Bureau Veritas Job Number: C3A7223
Report Date: 2023/05/05

WSP E&I Canada Limited
Client Project #: ME2382602.3000.*.5290.573000

Your P.O. #: ME2382602.3000.*.529

RBCA HYDROCARBONS IN SOIL (FIELD PRES.)

Bureau Veritas ID		VOM345	VOM346	VOM347	VOM348	VOM349	VOM350	VOM351	VOM352	VOM353	VOM354		VOM355	VOM355	VOM356	VOM357	VOM358	VOM359	VOM360	VOM361	VOM362	VOM362		VOM363	VOM364			
Sampling Date		2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13		2023-04-13	2023-04-13	2023-04-13	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14		2023-04-14	2023-04-14			
COC Number		926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01		926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01		926537-02-01	926537-02-01			
	UNITS	PRE-S7-1-A	PRE-S7-1-B	PRE-S5-1-A	PRE-S5-1-B	PRE-S3-1-B	PRE-F94-1-B	PRE-S1-1-B	PRE-N2-1-B	PRE-S3-1-A	PRE-F94-1-A	QC Batch	PRE-S1-1-A	PRE-S1-1-A Lab-Dup	PRE-N2-1-A	PRE-S15-1-A	PRE-S15-1-B	PRE-S9-1-B	PRE-S9-1-A	PRE-S11-1-A	PRE-S11-1-B	PRE-S11-1-B Lab-Dup	QC Batch	PRE-N21-1-A	PRE-N21-1-B	RDL	MDL	QC Batch
Petroleum Hydrocarbons																												
Benzene	mg/kg	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	8615949	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	N/A	8618205	<0.0050	<0.0050	0.005	N/A	8618205
Toluene	mg/kg	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	8615949	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	N/A	8618205	<0.050	<0.050	0.05	N/A	8618205
Ethylbenzene	mg/kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	8615949	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	N/A	8618205	<0.010	<0.010	0.01	0.03	8618205
Total Xylenes	mg/kg	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	8615949	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	N/A	8618205	<0.050	<0.050	0.05	N/A	8618205
C6 - C10 (less BTEX)	mg/kg	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	8615949	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	N/A	8618205	<2.5	<2.5	2.5	N/A	8618205
>C10-C16 Hydrocarbons	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	8620807	<10	N/A	<10	<10	<10	<10	<10	<10	<10	<10	8620807	<10	<10	10	N/A	8620873
>C16-C21 Hydrocarbons	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	8620807	<10	N/A	<10	<10	<10	<10	<10	<10	<10	<10	8620807	<10	<10	10	N/A	8620873
>C21-<C32 Hydrocarbons	mg/kg	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	8620807	<15	N/A	<15	<15	<15	<15	<15	<15	<15	<15	8620807	<15	<15	15	N/A	8620873
Modified TPH (Tier1)	mg/kg	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	8613209	<15	N/A	<15	<15	<15	<15	<15	<15	<15	N/A	8613209	<15	<15	15	N/A	8613209
Reached Baseline at C32	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8620807	NA	N/A	NA	NA	NA	NA	NA	NA	NA	N/A	8620807	NA	NA	N/A	N/A	8620873
Hydrocarbon Resemblance	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8620807	NA	N/A	NA	NA	NA	NA	NA	NA	NA	N/A	8620807	NA	NA	N/A	N/A	8620873
Surrogate Recovery (%)																												
Isobutylbenzene - Extractable	%	96	96	96	94	94	96	91	93	91	98	8620807	97	N/A	87	95	97	96	94	97	93	94	8620807	100	101	N/A	N/A	8620873
n-Dotriacontane - Extractable	%	102	102	103	101	99	105	99	99	98	108	8620807	104	N/A	97	101	101	102	100	100	104	109	8620807	105	103	N/A	N/A	8620873
Isobutylbenzene - Volatile	%	101	97	98	97	96	101	92	94	93	89	8615949	106	103	104	108	98	99	96	100	96	N/A	8618205	98	92	N/A	N/A	8618205

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Table B-2: Pre-drilling Sediment Chemistry Laboratory Results PAHs

Bureau Veritas Job Number: C3A7223
Report Date: 2023/05/05

WSP E&I Canada Limited
Client Project #: ME2382602.3000.*.5290.573000

Your P.O. #: ME2382602.3000.*.529

PAH IN SOIL TO MISSISSAUGA (SEDIMENT)

Bureau Veritas ID		VOM345			VOM346	VOM347			VOM348	VOM349	VOM350	VOM351			VOM352	VOM353	VOM354			VOM355			VOM356			VOM357	VOM358			VOM359	VOM359			VOM360	VOM361	VOM362	VOM363	VOM364			
Sampling Date		2023-04-13			2023-04-13	2023-04-13			2023-04-13	2023-04-13	2023-04-13	2023-04-13			2023-04-13	2023-04-13	2023-04-13			2023-04-13			2023-04-13			2023-04-14	2023-04-14			2023-04-14	2023-04-14			2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14			
COC Number		926537-01-01			926537-01-01	926537-01-01			926537-01-01	926537-01-01	926537-01-01	926537-01-01			926537-01-01	926537-01-01	926537-01-01			926537-02-01			926537-02-01			926537-02-01	926537-02-01			926537-02-01	926537-02-01			926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01			
	UNITS	**PRE-S7-1-A**	**RDL**	**MDL**	**PRE-S7-1-B**	**PRE-S5-1-A**	**RDL**	**MDL**	**PRE-S5-1-B**	**PRE-S3-1-B**	**PRE-F94-1-B**	**PRE-S1-1-B**	**RDL**	**MDL**	**PRE-N2-1-B**	**PRE-S3-1-A**	**PRE-F94-1-A**	**RDL**	**MDL**	**PRE-S1-1-A**	**RDL**	**MDL**	**PRE-N2-1-A**	**RDL**	**MDL**	**PRE-S15-1-A**	**PRE-S15-1-B**	**RDL**	**MDL**	**PRE-S9-1-B**	**PRE-S9-1-B Lab-Dup**	**RDL**	**MDL**	**PRE-S9-1-A**	**PRE-S11-1-A**	**PRE-S11-1-B**	**PRE-N21-1-A**	**PRE-N21-1-B**	**RDL**	**MDL**	**QC Batch**
Polyaromatic Hydrocarbons																																									
Acenaphthene	ug/g	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	0.05	0.02	<0.10	<0.10	<0.10	0.1	0.04	<0.050	0.05	0.02	<0.10	0.1	0.04	<0.050	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.02	8630548
Acenaphthylene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Anthracene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Benzo(a)anthracene	ug/g	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	0.05	0.02	<0.10	<0.10	<0.10	0.1	0.04	<0.050	0.05	0.02	<0.10	0.1	0.04	<0.050	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.02	8630548
Benzo(a)pyrene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Benzo(b/j)fluoranthene	ug/g	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	0.05	0.02	<0.10	<0.10	<0.10	0.1	0.04	<0.050	0.05	0.02	<0.10	0.1	0.04	<0.050	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.02	8630548
Benzo(g,h,i)perylene	ug/g	<0.050	0.05	0.04	<0.10	<0.10	0.1	0.08	<0.050	<0.050	<0.050	<0.050	0.05	0.04	<0.10	<0.10	<0.10	0.1	0.08	<0.050	0.05	0.04	<0.10	0.1	0.08	<0.050	<0.050	0.05	0.04	<0.10	<0.10	0.1	0.08	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.04	8630548
Benzo(k)fluoranthene	ug/g	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	0.05	0.02	<0.10	<0.10	<0.10	0.1	0.04	<0.050	0.05	0.02	<0.10	0.1	0.04	<0.050	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.02	8630548
Chrysene	ug/g	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	0.05	0.02	<0.10	<0.10	<0.10	0.1	0.04	<0.050	0.05	0.02	<0.10	0.1	0.04	<0.050	<0.050	0.05	0.02	<0.10	<0.10	0.1	0.04	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.02	8630548
Dibenzo(a,h)anthracene	ug/g	<0.050	0.05	0.04	<0.10	<0.10	0.1	0.08	<0.050	<0.050	<0.050	<0.050	0.05	0.04	<0.10	<0.10	<0.10	0.1	0.08	<0.050	0.05	0.04	<0.10	0.1	0.08	<0.050	<0.050	0.05	0.04	<0.10	<0.10	0.1	0.08	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.04	8630548
Fluoranthene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Fluorene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Indeno(1,2,3-cd)pyrene	ug/g	<0.050	0.05	0.04	<0.10	<0.10	0.1	0.08	<0.050	<0.050	<0.050	<0.050	0.05	0.04	<0.10	<0.10	<0.10	0.1	0.08	<0.050	0.05	0.04	<0.10	0.1	0.08	<0.050	<0.050	0.05	0.04	<0.10	<0.10	0.1	0.08	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.04	8630548
1-Methylnaphthalene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
2-Methylnaphthalene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Naphthalene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Phenanthrene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Pyrene	ug/g	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	0.05	0.01	<0.10	<0.10	<0.10	0.1	0.02	<0.050	0.05	0.01	<0.10	0.1	0.02	<0.050	<0.050	0.05	0.01	<0.10	<0.10	0.1	0.02	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	0.01	8630548
Benzo(b)fluoranthene	ug/g	<0.030	0.03	N/A	<0.060	<0.060	0.06	N/A	<0.030	<0.030	<0.030	<0.030	0.03	N/A	<0.060	<0.060	<0.060	0.06	N/A	<0.030	0.03	N/A	<0.060	0.06	N/A	<0.030	<0.030	0.03	N/A	<0.060	<0.060	0.06	N/A	<0.030	<0.030	<0.030	<0.030	<0.030	0.03	N/A	8630548
Perylene	ug/g	<0.050	0.05	N/A	<0.10	<0.10	0.1	N/A	<0.050	<0.050	<0.050	<0.050	0.05	N/A	<0.10	<0.10	<0.10	0.1	N/A	<0.050	0.05	N/A	<0.10	0.1	N/A	<0.050	<0.050	0.05	N/A	<0.10	<0.10	0.1	N/A	<0.050	<0.050	<0.050	<0.050	<0.050	0.05	N/A	8630548
Benzo(j)fluoranthene	ug/g	<0.030	0.03	N/A	<0.060	<0.060	0.06	N/A	<0.030	<0.030	<0.030	<0.030	0.03	N/A	<0.060	<0.060	<0.060	0.06	N/A	<0.030	0.03	N/A	<0.060	0.06	N/A	<0.030	<0.030	0.03	N/A	<0.060	<0.060	0.06	N/A	<0.030	<0.030	<0.030	<0.030	<0.030	0.03	N/A	8630548
Surrogate Recovery (%)																																									
D10-Anthracene	%	102	N/A	N/A	89	108	N/A	N/A	92	109	86	93	N/A	N/A	88	103	96	N/A	N/A	97	N/A	N/A	101	N/A	N/A	104	98	N/A	N/A	90	93	N/A	N/A	93	101	102	108	96	N/A	N/A	8630548
D14-Terphenyl (FS)	%	101	N/A	N/A	96	96	N/A	N/A	95	101	97	97	N/A	N/A	98	95	95	N/A	N/A	97	N/A	N/A	95	N/A	N/A	95	97	N/A	N/A	95	93	N/A	N/A	97	95	94	90	94	N/A	N/A	8630548
D8-Acenaphthylene	%	96	N/A	N/A	91	91	N/A	N/A	90	92	93	90	N/A	N/A	89	91	93	N/A	N/A	90	N/A	N/A	90	N/A	N/A	88	91	N/A	N/A	88	92	N/A	N/A	93	93	90	84	91	N/A	N/A	8630548

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Table B-3: Pre-drilling Sediment Chemistry Laboratory Results Inorganics (Particle Size & Moisture)

WSP E&I Canada Limited
Bureau Veritas Job Number: C3A7223 Client Project #: ME2382602.3000.*.5290.573000
Report Date: 2023/05/05
Your P.O. #: ME2382602.3000.*.529

RESULTS OF ANALYSES OF SEDIMENT

Bureau Veritas ID		VOM345	VOM345	VOM346	VOM347		VOM348		VOM348	VOM349	VOM350	VOM351	VOM352
Sampling Date		2023-04-13	2023-04-13	2023-04-13	2023-04-13		2023-04-13		2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13
COC Number		926537-01-01	926537-01-01	926537-01-01	926537-01-01		926537-01-01		926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01
	UNITS	**PRE-S7-1-A**	**PRE-S7-1-A Lab-Dup**	**PRE-S7-1-B**	**PRE-S5-1-A**	**QC Batch**	**PRE-S5-1-B**	**RDL**	**PRE-S5-1-B Lab-Dup**	**PRE-S3-1-B**	**PRE-F94-1-B**	**PRE-S1-1-B**	**PRE-N2-1-B**
CONVENTIONALS													
Redox Potential	mV	270	N/A	260	270	8631818	270	N/A	270	260	260	270	270
Inorganics													
Moisture	%	35	N/A	40	35	8615851	35	1	N/A	34	32	34	35
< -1 Phi (2 mm)	%	100	100	100	100	8619222	100	0.1	N/A	100	100	100	100
< 0 Phi (1 mm)	%	100	100	100	100	8619222	100	0.1	N/A	100	100	100	100
< +1 Phi (0.5 mm)	%	100	100	100	100	8619222	100	0.1	N/A	100	100	100	100
< +2 Phi (0.25 mm)	%	100	100	99	100	8619222	100	0.1	N/A	100	100	100	100
< +3 Phi (0.12 mm)	%	99	99	99	99	8619222	99	0.1	N/A	99	99	99	99
< +4 Phi (0.062 mm)	%	98	98	98	98	8619222	98	0.1	N/A	98	98	98	98
< +5 Phi (0.031 mm)	%	79	78	81	79	8619222	78	0.1	N/A	80	82	81	80
< +6 Phi (0.016 mm)	%	48	49	47	50	8619222	49	0.1	N/A	48	50	49	49
< +7 Phi (0.0078 mm)	%	28	28	27	29	8619222	29	0.1	N/A	28	28	29	29
< +8 Phi (0.0039 mm)	%	25	25	24	26	8619222	26	0.1	N/A	25	25	25	25
< +9 Phi (0.0020 mm)	%	21	21	20	22	8619222	21	0.1	N/A	20	21	21	21
Gravel	%	<0.10	<0.10	0.33	<0.10	8619222	<0.10	0.1	N/A	<0.10	<0.10	<0.10	<0.10
Sand	%	2.1	2.1	2	2.2	8619222	2.1	0.1	N/A	2.1	2	2.4	2.3
Silt	%	73	73	73	72	8619222	72	0.1	N/A	73	73	72	72
Clay	%	25	25	24	26	8619222	26	0.1	N/A	25	25	25	25

Bureau Veritas ID	VOM352	VOM353	VOM354	VOM355	VOM356	VOM357	VOM358	VOM359	VOM360	VOM361	VOM362	VOM363	VOM364			
Sampling Date	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14			
COC Number	926537-01-01	926537-01-01	926537-01-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01			
	PRE-N2-1-B Lab-Dup	**PRE-S3-1-A**	**PRE-F94-1-A**	**PRE-S1-1-A**	**PRE-N2-1-A**	**PRE-S15-1-A**	**PRE-S15-1-B**	**PRE-S9-1-B**	**PRE-S9-1-A**	**PRE-S11-1-A**	**PRE-S11-1-B**	**PRE-N21-1-A**	**PRE-N21-1-B**	**RDL**	**MDL**	**QC Batch**
CONVENTIONALS																
Redox Potential	N/A	260	260	270	260	260	260	270	270	270	270	270	260	N/A	N/A	8631818
Inorganics																
Moisture	34	33	33	35	34	34	33	34	32	32	35	35	33	1	0.2	8616633
< -1 Phi (2 mm)	N/A	100	100	100	100	99	100	100	100	100	100	100	100	0.1	N/A	8619222
< 0 Phi (1 mm)	N/A	100	100	100	100	99	100	100	100	100	100	100	100	0.1	N/A	8619222
< +1 Phi (0.5 mm)	N/A	100	100	100	100	99	100	100	100	100	100	100	100	0.1	N/A	8619222
< +2 Phi (0.25 mm)	N/A	100	100	100	100	99	100	100	100	100	100	100	100	0.1	N/A	8619222
< +3 Phi (0.12 mm)	N/A	99	99	99	99	99	99	99	99	99	99	99	99	0.1	N/A	8619222
< +4 Phi (0.062 mm)	N/A	98	98	98	98	98	98	98	98	98	98	98	98	0.1	N/A	8619222
< +5 Phi (0.031 mm)	N/A	79	80	79	80	79	80	80	80	82	81	82	81	0.1	N/A	8619222
< +6 Phi (0.016 mm)	N/A	49	50	50	49	51	51	48	49	49	52	50	51	0.1	N/A	8619222
< +7 Phi (0.0078 mm)	N/A	28	28	29	28	29	29	28	28	28	29	29	29	0.1	N/A	8619222
< +8 Phi (0.0039 mm)	N/A	25	25	26	25	26	26	26	25	26	26	26	26	0.1	N/A	8619222
< +9 Phi (0.0020 mm)	N/A	21	21	21	21	22	21	21	21	21	22	21	22	0.1	N/A	8619222
Gravel	N/A	<0.10	<0.10	<0.10	<0.10	0.74	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.1	N/A	8619222
Sand	N/A	2.1	2	2.4	2.2	1.8	2.2	2.3	2.2	2.2	1.9	2.1	2	0.1	N/A	8619222
Silt	N/A	73	73	72	73	72	72	72	72	72	72	72	72	0.1	N/A	8619222
Clay	N/A	25	25	26	25	26	26	26	25	26	26	26	26	0.1	N/A	8619222

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Table B-4: Pre-drilling Sediment Chemistry Laboratory Results Weak Acid Extractable

WSP E&I Canada Limited
Bureau Veritas Job Number: C3A7223 Client Project #: ME2382602.3000.*.5290.573000
Report Date: 2023/05/05
Your P.O. #: ME2382602.3000.*.529

ELEMENTS BY ICP/MS (SEDIMENT)

Bureau Veritas ID		VOM345	VOM346	VOM347	VOM348	VOM349	VOM350	VOM351	VOM352	VOM353	VOM354	VOM355	VOM356	VOM357	VOM358	VOM359	VOM360	VOM360	VOM361	VOM362	VOM363	VOM364			
Sampling Date		2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14			
COC Number		926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01			
	UNITS	**PRE-S7-1-A**	**PRE-S7-1-B**	**PRE-S5-1-A**	**PRE-S5-1-B**	**PRE-S3-1-B**	**PRE-F94-1-B**	**PRE-S1-1-B**	**PRE-N2-1-B**	**PRE-S3-1-A**	**PRE-F94-1-A**	**PRE-S1-1-A**	**PRE-N2-1-A**	**PRE-S15-1-A**	**PRE-S15-1-B**	**PRE-S9-1-B**	**PRE-S9-1-A**	**PRE-S9-1-A Lab-Dup**	**PRE-S11-1-A**	**PRE-S11-1-B**	**PRE-N21-1-A**	**PRE-N21-1-B**	**RDL**	**MDL**	**QC Batch**
Metals																									
Weak Acid Ext. Barium (Ba)	mg/kg	33	33	34	32	34	32	31	32	31	30	33	32	30	32	32	31	20 (1)	29	31	21	31	5	N/A	8626720

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
(1) Poor RPD due to sample inhomogeneity. Verified by repeat digestion and analysis.

Table B-5: Pre-drilling Sediment Chemistry Laboratory Results Metals

ELEMENTS BY ATOMIC SPECTROSCOPY (SEDIMENT)

Bureau Veritas ID		VOM345	VOM346	VOM347	VOM348	VOM349		VOM350	VOM351	VOM352	VOM353		VOM354	VOM355	VOM356	VOM357	VOM358	VOM359	VOM360	VOM361	VOM362	VOM363	VOM364			
Sampling Date		2023-04-13	2023-04-13	2023-04-13	2023-04-13	2023-04-13		2023-04-13	2023-04-13	2023-04-13	2023-04-13		2023-04-13	2023-04-13	2023-04-13	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14	2023-04-14			
COC Number		926537-01-01	926537-01-01	926537-01-01	926537-01-01	926537-01-01		926537-01-01	926537-01-01	926537-01-01	926537-01-01		926537-01-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01	926537-02-01			
	UNITS	**PRE-S7-1-A**	**PRE-S7-1-B**	**PRE-S5-1-A**	**PRE-S5-1-B**	**PRE-S3-1-B**	**QC Batch**	**PRE-F94-1-B**	**PRE-S1-1-B**	**PRE-N2-1-B**	**PRE-S3-1-A**	**QC Batch**	**PRE-F94-1-A**	**PRE-S1-1-A**	**PRE-N2-1-A**	**PRE-S15-1-A**	**PRE-S15-1-B**	**PRE-S9-1-B**	**PRE-S9-1-A**	**PRE-S11-1-A**	**PRE-S11-1-B**	**PRE-N21-1-A**	**PRE-N21-1-B**	**RDL**	**MDL**	**QC Batch**
Metals																										
Acid Extractable Aluminum (Al)	mg/kg	9100	8900	9700	9100	9500	8626934	8900	8700	8800	8500	8620782	9200	9400	9500	9600	9400	9000	8800	9000	8900	9700	9300	10	N/A	8626934
Acid Extractable Antimony (Sb)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	8626934	<2.0	<2.0	<2.0	<2.0	8620782	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2	N/A	8626934
Acid Extractable Arsenic (As)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	8626934	<2.0	<2.0	<2.0	<2.0	8620782	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2	N/A	8626934
Acid Extractable Barium (Ba)	mg/kg	140	140	150	140	150	8626934	130	130	130	130	8620782	140	150	150	150	150	140	140	140	140	150	140	5	N/A	8626934
Acid Extractable Beryllium (Be)	mg/kg	<1.0	<1.0	<1.0	<1.0	<1.0	8626934	<1.0	<1.0	<1.0	<1.0	8620782	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1	N/A	8626934
Acid Extractable Bismuth (Bi)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	8626934	<2.0	<2.0	<2.0	<2.0	8620782	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2	N/A	8626934
Acid Extractable Boron (B)	mg/kg	<50	<50	<50	<50	<50	8626934	<50	<50	<50	<50	8620782	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	50	N/A	8626934
Acid Extractable Cadmium (Cd)	mg/kg	<0.30	<0.30	<0.30	<0.30	<0.30	8626934	<0.30	<0.30	<0.30	<0.30	8620782	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.3	N/A	8626934
Acid Extractable Chromium (Cr)	mg/kg	28	28	30	28	29	8626934	27	26	27	26	8620782	29	29	30	29	29	28	27	28	28	30	29	2	N/A	8626934
Acid Extractable Cobalt (Co)	mg/kg	5.3	5.5	5.8	5.6	5.4	8626934	5.2	5.1	5.3	5	8620782	5.4	5.8	5.6	5.6	5.7	5.4	5.2	5.3	5.4	5.5	5.4	1	N/A	8626934
Acid Extractable Copper (Cu)	mg/kg	9.5	9.6	10	9.8	10	8626934	9.9	9.2	9.8	9.5	8620782	10	10	10	10	10	9.8	9.6	9.4	9.5	10	10	2	N/A	8626934
Acid Extractable Iron (Fe)	mg/kg	17000	17000	18000	17000	18000	8626934	16000	16000	16000	16000	8620782	17000	17000	17000	17000	17000	17000	16000	17000	17000	17000	17000	50	N/A	8626934
Acid Extractable Lead (Pb)	mg/kg	4.4	4.2	4.9	4.4	4.2	8626934	4.3	3.8	4.3	3.9	8620782	4.2	4.4	5	4.2	4.2	4.5	4.4	3.9	3.8	4.5	4.4	0.5	N/A	8626934
Acid Extractable Lithium (Li)	mg/kg	17	16	17	16	17	8626934	15	15	15	15	8620782	16	17	17	17	17	16	16	16	16	17	16	2	N/A	8626934
Acid Extractable Manganese (Mn)	mg/kg	210	210	230	200	220	8626934	190	190	200	190	8620782	210	200	220	210	210	220	200	200	200	230	210	2	N/A	8626934
Acid Extractable Mercury (Hg)	mg/kg	0.15	0.12	0.11	<0.10	<0.10	8626934	<0.10	<0.10	<0.10	<0.10	8620782	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	0.1	<0.10	0.1	N/A	8626934
Acid Extractable Molybdenum (Mo)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	8626934	<2.0	<2.0	<2.0	<2.0	8620782	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2	N/A	8626934
Acid Extractable Nickel (Ni)	mg/kg	16	16	17	17	17	8626934	16	15	16	15	8620782	16	17	17	17	16	16	16	16	16	16	16	2	N/A	8626934
Acid Extractable Rubidium (Rb)	mg/kg	23	22	24	23	24	8626934	22	21	22	21	8620782	23	24	25	24	24	23	21	23	23	23	23	2	N/A	8626934
Acid Extractable Selenium (Se)	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	8626934	<0.50	<0.50	<0.50	<0.50	8620782	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.5	N/A	8626934
Acid Extractable Silver (Ag)	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	8626934	<0.50	<0.50	<0.50	<0.50	8620782	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.5	N/A	8626934
Acid Extractable Strontium (Sr)	mg/kg	84	86	90	86	89	8626934	81	78	81	81	8620782	85	85	89	88	87	86	81	81	78	85	84	5	N/A	8626934
Acid Extractable Thallium (Tl)	mg/kg	0.12	0.12	0.13	0.11	0.13	8626934	0.11	0.11	<0.10	0.11	8620782	0.11	0.12	0.12	0.12	0.12	0.11	<0.10	0.11	0.12	0.11	0.12	0.1	N/A	8626934
Acid Extractable Tin (Sn)	mg/kg	1	1.7	<1.0	<1.0	15	8626934	<1.0	<1.0	<1.0	<1.0	8620782	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.8	<1.0	<1.0	<1.0	1	1	N/A	8626934
Acid Extractable Uranium (U)	mg/kg	0.76	0.87	0.82	0.86	0.96	8626934	0.84	0.75	0.66	0.97	8620782	0.83	0.82	0.84	1	0.94	0.89	0.73	0.69	0.78	0.79	0.75	0.1	N/A	8626934
Acid Extractable Vanadium (V)	mg/kg	32	32	35	32	34	8626934	31	30	31	30	8620782	33	33	34	34	34	32	32	32	31	34	33	2	N/A	8626934
Acid Extractable Zinc (Zn)	mg/kg	40	39	42	38	40	8626934	36	39	35	35	8620782	40	40	40	40	41	39	38	38	39	40	41	5	N/A	8626934

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Table B-6: Post-drilling Sediment Chemistry Laboratory Results Hydrocarbons

Bureau Veritas ID			WIY005	WIY006	WIY007	WIY008	WIY009	WIY010	WIY011	WIY012	WIY013	WIY014	WIY015	WIY016	WIY017	WIY019	WIY020	WIY021	WIY022	WIY022	WIY023	WIY024	WIY025	WIY026	WIY027	WIY028	WIY029	WIY030	WIY031	WIY032	WIY033	WIY034	WIY034	WIY035	WIY036
Sampling Date			2023-07-08	2023-07-08	2023-07-09	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-08	2023-07-08
COC Number			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	UNITS	**RDL**	**POST-S1-1A**	**POST-S1-1B**	**POST-S2-1A**	**POST-S3-1A**	**POST-S3-1B**	**POST-S4-1A**	**POST-S4-1B**	**POST-S5-1A**	**POST-S7-1A**	**POST-S7-1B**	**POST-S9-1A**	**POST-S9-1B**	**POST-S11-1A**	**POST-S15-1A**	**POST-S15-1B**	**POST-F94-A**	**POST-F94-B**	**POST-F94-B Lab-Dup**	**POST-PRIME-2A**	**POST-PRIME-2B**	**POST-N2-1A**	**POST-N2-1B**	**POST-N2-2A**	**POST-N2-2B**	**POST-N3-1A**	**POST-N3-1B**	**POST-N12-1A**	**POST-N12-1B**	**POST-N21-1A**	**POST-N21-1B**	**POST-N21-1B Lab-Dup**	**POST-S5-1B**	**POST-S-1-2-A+B**
Petroleum Hydrocarbons																																			
Benzene	mg/kg	0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.0050	N/A	<0.0050	<0.0050
Toluene	mg/kg	0.050	<0.050	<0.050	<0.10	<0.050	<0.050	<0.10	<0.050	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	<0.050	<0.10	<0.050	<0.050	<0.050	<0.10	<0.050	<0.10	<0.050	<0.10	<0.10	<0.050	<0.050	N/A	<0.050	<0.050
Ethylbenzene	mg/kg	0.010	<0.010	<0.010	<0.020	<0.010	<0.010	<0.020	<0.010	<0.010	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.010	<0.010	<0.010	<0.020	<0.010	<0.010	<0.010	<0.020	<0.010	<0.020	<0.010	<0.020	<0.020	<0.010	<0.010	N/A	<0.010	<0.010
Total Xylenes	mg/kg	0.050	<0.050	<0.050	<0.10	<0.050	<0.050	<0.10	<0.050	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	<0.050	<0.10	<0.050	<0.050	<0.050	<0.10	<0.050	<0.10	<0.050	<0.10	<0.10	<0.050	<0.050	N/A	<0.050	<0.050
C6 - C10 (less BTEX)	mg/kg	2.5	<2.5	<2.5	<5.0	<2.5	<2.5	<5.0	<2.5	<2.5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<2.5	<2.5	<2.5	<5.0	<2.5	<2.5	<2.5	<5.0	<2.5	<5.0	<2.5	<5.0	<5.0	<2.5	<2.5	N/A	<2.5	<2.5
>C10-C16 Hydrocarbons	mg/kg	10	120	<10	<10	<10	<10	34	290	<10	19	<10	<10	<10	<10	<10	<10	24	54	N/A	2600	110	<10	<10	<10	<10	360	81	<10	<10	<10	<10	<10	<10	59
>C16-C21 Hydrocarbons	mg/kg	10	44	<10	<10	<10	<10	<10	100	<10	<10	<10	<10	<10	<10	<10	<10	<10	27	N/A	710	31	<10	<10	<10	<10	110	30	<10	<10	<10	<10	<10	<10	34
>C21-<C32 Hydrocarbons	mg/kg	15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	N/A	25	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Modified TPH (Tier1)	mg/kg	15	160	<15	<15	<15	<15	34	390	<15	19	<15	<15	<15	<15	<15	<15	24	81	N/A	3300	140	<15	<15	<15	<15	470	110	<15	<15	<15	<15	N/A	<15	93
Reached Baseline at C32	mg/kg	N/A	Yes	NA	NA	NA	NA	Yes	Yes	NA	Yes	NA	NA	NA	NA	NA	NA	Yes	Yes	N/A	Yes	Yes	NA	NA	NA	NA	Yes	Yes	NA	NA	NA	NA	N/A	NA	Yes
Hydrocarbon Resemblance	mg/kg	N/A	COMMENT (1)	NA	NA	NA	NA	COMMENT (2)	COMMENT (2)	NA	COMMENT (2)	NA	NA	NA	NA	NA	NA	COMMENT (2)	COMMENT (1)	N/A	COMMENT (2)	COMMENT (2)	NA	NA	NA	NA	COMMENT (3)	COMMENT (3)	NA	NA	NA	NA	N/A	NA	COMMENT (3)
Surrogate Recovery (%)																																			
Isobutylbenzene - Extractable	%	N/A	86	91	90	90	92	88	89	90	91	87	87	86	88	87	88	90	88	N/A	94	88	88	93	96	94	96	89	88	96	93	100	97	90	93
n-Dotriacontane - Extractable	%	N/A	84	91	97	93	95	93	89	92	95	93	99	104	101	99	97	99	93	N/A	104	100	108	113	106	112	100	99	104	127	111	116	107	107	92
Isobutylbenzene - Volatile	%	N/A	121	127	111 (4)	112	111	92 (4)	103	108	116 (4)	105 (4)	103 (4)	95 (4)	99 (4)	103 (4)	96 (4)	120	113	111	94 (4)	92	107	114	99 (4)	97	109 (4)	95	101 (4)	96 (4)	103	98	N/A	97	123

Table B-7: Post-drilling Sediment Chemistry Laboratory Results PAHs

Bureau Veritas ID			WIY005	WIY006	WIY007	WIY008	WIY009	WIY010	WIY011	WIY012	WIY012	WIY013	WIY014	WIY015	WIY016	WIY017	WIY018	WIY019	WIY020	WIY021	WIY022	WIY022	WIY023	WIY024	WIY025	WIY026	WIY027	WIY028	WIY029	WIY030	WIY031	WIY032	WIY033	WIY034	WIY035	WIY036
Sampling Date			2023-07-08	2023-07-08	2023-07-09	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-08	2023-07-08
COC Number			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	UNITS	**RDL**	**POST-S1-1A**	**POST-S1-1B**	**POST-S2-1A**	**POST-S3-1A**	**POST-S3-1B**	**POST-S4-1A**	**POST-S4-1B**	**POST-S5-1A**	**POST-S5-1A Lab-Dup**	**POST-S7-1A**	**POST-S7-1B**	**POST-S9-1A**	**POST-S9-1B**	**POST-S11-1A**	**POST-S11-1B**	**POST-S15-1A**	**POST-S15-1B**	**POST-F94-A**	**POST-F94-B**	**POST-F94-B Lab-Dup**	**POST-PRIME-2A**	**POST-PRIME-2B**	**POST-N2-1A**	**POST-N2-1B**	**POST-N2-2A**	**POST-N2-2B**	**POST-N3-1A**	**POST-N3-1B**	**POST-N12-1A**	**POST-N12-1B**	**POST-N21-1A**	**POST-N21-1B**	**POST-S5-1B**	**POST-S-1-2-A+B**
Polyaromatic Hydrocarbons																																				
Acenaphthene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Acenaphthylene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Anthracene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Benzo(a)anthracene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Benzo(a)pyrene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Benzo(b/j)fluoranthene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Benzo(g,h,i)perylene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Benzo(k)fluoranthene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Chrysene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Dibenzo(a,h)anthracene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Fluoranthene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Fluorene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Indeno(1,2,3-cd)pyrene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
1-Methylnaphthalene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
2-Methylnaphthalene	ug/g	0.050	0.013	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Naphthalene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Phenanthrene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Pyrene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Benzo(b)fluoranthene	ug/g	0.030	<0.0060	<0.030	<0.0030	<0.0060	<0.0030	<0.0030	<0.0060	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0060	<0.0030	<0.0060	<0.0060	<0.0060	<0.0060	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0060	<0.0030	<0.0060	<0.0060	<0.0030	<0.0060	<0.0030	<0.0060
Perylene	ug/g	0.050	<0.010	<0.050	<0.0050	<0.010	<0.0050	<0.0050	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.010	<0.0050	<0.010	<0.010	<0.0050	<0.010	<0.0050	<0.010
Benzo(j)fluoranthene	ug/g	0.030	<0.0060	<0.030	<0.0030	<0.0060	<0.0030	<0.0030	<0.0060	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0060	<0.0030	<0.0060	<0.0060	<0.0060	<0.0060	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0060	<0.0030	<0.0060	<0.0060	<0.0030	<0.0060	<0.0030	<0.0060
Surrogate Recovery (%)																																				
D10-Anthracene	%	N/A	57	114	120	116	79	116	102	116	118	104	111	127	98	125	128	118	113	116	79	105	121	129	119	117	127	115	118	125	113	77	123	85	86	126
D14-Terphenyl (FS)	%	N/A	52	120	92	102	71	102	88	93	111	108	91	107	95	106	107	98	98	102	63	96	104	119	107	98	104	104	93	104	110	68	105	79	77	105
D8-Acenaphthylene	%	N/A	52	120	90	96	70	97	95	80	103	98	80	98	88	91	97	89	94	96	71	95	97	118	98	91	94	94	88	99	96	84	96	84	84	98

Table B-8: Post-drilling Sediment Chemistry Laboratory Results Inorganics (Redox and Particle Size Analysis)

Bureau Veritas ID			WIY005	WIY005	WIY006	WIY007	WIY008	WIY009	WIY010	WIY011	WIY012	WIY013	WIY014	WIY014	WIY015	WIY016	WIY017	WIY018	WIY019	WIY020	WIY021	WIY022	WIY023	WIY024	WIY025	WIY026	WIY027	WIY027	WIY028	WIY029	WIY030	WIY031	WIY032	WIY033	WIY034	WIY034	WIY035	WIY036	WIY036
Sampling Date			2023-07-08	2023-07-08	2023-07-08	2023-07-09	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-08
COC Number			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	UNITS	**RDL**	**POST-S1-1A**	**POST-S1-1A Lab-Dup**	**POST-S1-1B**	**POST-S2-1A**	**POST-S3-1A**	**POST-S3-1B**	**POST-S4-1A**	**POST-S4-1B**	**POST-S5-1A**	**POST-S7-1A**	**POST-S7-1B**	**POST-S7-1B Lab-Dup**	**POST-S9-1A**	**POST-S9-1B**	**POST-S11-1A**	**POST-S11-1B**	**POST-S15-1A**	**POST-S15-1B**	**POST-F94-A**	**POST-F94-B**	**POST-PRIME-2A**	**POST-PRIME-2B**	**POST-N2-1A**	**POST-N2-1B**	**POST-N2-2A**	**POST-N2-2A Lab-Dup**	**POST-N2-2B**	**POST-N3-1A**	**POST-N3-1B**	**POST-N12-1A**	**POST-N12-1B**	**POST-N21-1A**	**POST-N21-1B**	**POST-N21-1B Lab-Dup**	**POST-S5-1B**	**POST-S-1-2-A+B**	**POST-S-1-2-A+B Lab-Dup**
CONVENTIONALS																																							
Redox Potential	mV	N/A	350	290	410	450	220	N/A	210	200	200	220	450	440	190	450	440	420	210	340	380	190	200	370	220	380	180	N/A	210	240	230	230	230	230	210	N/A	200	160	N/A
Inorganics																																							
Moisture	%	1.0	53	N/A	36	36	38	38	36	46	29	36	37	N/A	33	34	33	32	36	35	39	41	37	32	36	33	34	35	35	40	34	39	34	33	34	N/A	31	51	N/A
< -1 Phi (2 mm)	%	0.10	100	N/A	100	100	100	N/A	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	N/A	100	100 (1)	100	100	100	100	100	100	100	100	100
< 0 Phi (1 mm)	%	0.10	100	N/A	100	100	100	N/A	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	N/A	100	100	100	100	100	100	100	100	100	100	100
< +1 Phi (0.5 mm)	%	0.10	100	N/A	100	100	100	N/A	100	100	100	100	100	100	99	100	100	100	100	100	100	100	100	100	100	100	99	N/A	100	100	100	100	100	100	100	100	100	100	100
< +2 Phi (0.25 mm)	%	0.10	99	N/A	100	100	100	N/A	100	100	100	100	100	100	99	100	100	100	100	100	100	100	100	100	100	100	99	N/A	100	100	100	100	100	100	100	100	100	99	100
< +3 Phi (0.12 mm)	%	0.10	98	N/A	99	99	99	N/A	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	N/A	99	99	100	99	99	99	99	99	99	99	99
< +4 Phi (0.062 mm)	%	0.10	94	N/A	97	98	98	N/A	98	98	98	98	98	98	97	98	98	98	98	98	98	98	98	98	98	98	97	N/A	98	97	98	98	98	98	98	98	98	98	98
< +5 Phi (0.031 mm)	%	0.10	75	N/A	78	82	78	N/A	83	81	82	79	80	79	80	80	80	81	83	79	81	79	81	78	81	77	80	N/A	79	81	81	80	83	82	79	81	79	84	81
< +6 Phi (0.016 mm)	%	0.10	50	N/A	47	50	48	N/A	50	53	50	50	50	50	50	49	49	52	51	49	50	52	50	50	51	48	49	N/A	50	49	50	50	51	50	48	49	48	54	53
< +7 Phi (0.0078 mm)	%	0.10	30	N/A	28	30	28	N/A	30	34	28	28	29	30	29	28	28	30	30	29	29	31	28	30	30	28	28	N/A	30	29	29	29	29	29	28	29	29	32	32
< +8 Phi (0.0039 mm)	%	0.10	25	N/A	25	27	25	N/A	26	30	25	25	26	27	26	25	25	27	26	26	26	27	26	26	26	25	25	N/A	26	26	26	26	26	26	25	26	26	38	28
< +9 Phi (0.0020 mm)	%	0.10	19	N/A	20	7.7	21	N/A	22	25	20	21	19	9.1	16	20	21	9.7	13	13	21	22	21	22	21	21	20	N/A	22	21	21	21	22	21	21	21	21	22	22
Gravel	%	0.10	<0.10	N/A	<0.10	<0.10	<0.10	N/A	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.57	N/A	<0.10	0.14	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sand	%	0.10	5.8	N/A	2.7	2.2	2.4	N/A	2.2	2.1	2.1	2.1	2.3	2.3	2.8	2.3	2.3	2.0	2.3	2.2	2.2	2.1	2.4	2.5	2.0	2.2	2.3	N/A	2.0	2.5	1.9	1.9	1.9	2.0	2.0	2.1	2.2	2.4	2.4
Silt	%	0.10	69	N/A	73	71	72	N/A	71	68	73	73	72	71	72	72	73	71	71	72	71	71	72	71	72	73	72	N/A	72	72	72	72	72	72	73	72	72	59	70
Clay	%	0.10	25	N/A	25	27	25	N/A	26	30	25	25	26	27	26	25	25	27	26	26	26	27	26	26	26	25	25	N/A	26	26	26	26	26	26	25	26	26	38	28

Table B-9: Post-drilling Sediment Chemistry Laboratory Results Weak Acid Extractable Barium

Bureau Veritas ID			WIY005	WIY006	WIY007	WIY007	WIY008	WIY009	WIY010	WIY011	WIY012	WIY013	WIY014	WIY015	WIY016	WIY016	WIY017	WIY018
Sampling Date			2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08
COC Number			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	UNITS	**RDL**	**POST-S1-1A**	**POST-S1-1B**	**POST-S2-1A**	**POST-S2-1A Lab-Dup**	**POST-S3-1A**	**POST-S3-1B**	**POST-S4-1A**	**POST-S4-1B**	**POST-S5-1A**	**POST-S7-1A**	**POST-S7-1B**	**POST-S9-1A**	**POST-S9-1B**	**POST-S9-1B Lab-Dup**	**POST-S11-1A**	**POST-S11-1B**
Metals																		
Weak Acid Ext. Barium (Ba)	mg/kg	5.0	18	37	41	39	52	29	53	61	26	35	28	30	30	26	25	31

Bureau Veritas ID			WIY019	WIY020	WIY021	WIY022	WIY023	WIY024	WIY025	WIY026	WIY027	WIY028	WIY029	WIY030	WIY031	WIY032	WIY033	WIY034	WIY035	WIY035	WIY036
Sampling Date			2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-08
COC Number			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	UNITS	**RDL**	**POST-S15-1A**	**POST-S15-1B**	**POST-F94-A**	**POST-F94-B**	**POST-PRIME-2A**	**POST-PRIME-2B**	**POST-N2-1A**	**POST-N2-1B**	**POST-N2-2A**	**POST-N2-2B**	**POST-N3-1A**	**POST-N3-1B**	**POST-N12-1A**	**POST-N12-1B**	**POST-N21-1A**	**POST-N21-1B**	**POST-S5-1B**	**POST-S5-1B Lab-Dup**	**POST-S-1-2-A+B**
Metals																					
Weak Acid Ext. Barium (Ba)	mg/kg	5.0	27	31	48	58	19	33	18	30	21	27	31	25	29	29	29	24	29	29	20

Table B-10: Post-drilling Sediment Chemistry Laboratory Results Metals

Bureau Veritas ID			WIY005	WIY005	WIY006	WIY007	WIY008	WIY009	WIY009	WIY010	WIY011	WIY012	WIY013	WIY014	WIY015	WIY016	WIY017	WIY018	WIY019
Sampling Date			2023-07-08	2023-07-08	2023-07-08	2023-07-09	2023-07-08	2023-07-08	2023-07-08	2023-07-09	2023-07-09	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08	2023-07-08
COC Number			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	UNITS	**RDL**	**POST-S1-1A**	**POST-S1-1A Lab-Dup**	**POST-S1-1B**	**POST-S2-1A**	**POST-S3-1A**	**POST-S3-1B**	**POST-S3-1B Lab-Dup**	**POST-S4-1A**	**POST-S4-1B**	**POST-S5-1A**	**POST-S7-1A**	**POST-S7-1B**	**POST-S9-1A**	**POST-S9-1B**	**POST-S11-1A**	**POST-S11-1B**	**POST-S15-1A**
Metals																			
Acid Extractable Aluminum (Al)	mg/kg	10	8100	7900	9200	9300	9100	9100	9000	9000	8800	9300	9000	8900	8700	9100	8700	8700	8900
Acid Extractable Antimony (Sb)	mg/kg	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acid Extractable Arsenic (As)	mg/kg	2.0	6.7	6.7	<2.0	<2.0	3.3	<2.0	<2.0	<2.0	4.2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acid Extractable Barium (Ba)	mg/kg	5.0	770	710	1200	720	1400	200	210	1700	1300	150	310	460	700	260	330	470	260
Acid Extractable Beryllium (Be)	mg/kg	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acid Extractable Bismuth (Bi)	mg/kg	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acid Extractable Boron (B)	mg/kg	50	54	54	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Acid Extractable Cadmium (Cd)	mg/kg	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Acid Extractable Chromium (Cr)	mg/kg	2.0	25	25	29	29	28	28	28	29	27	28	29	27	28	28	28	28	28
Acid Extractable Cobalt (Co)	mg/kg	1.0	5.2	5.2	5.7	5.6	5.9	5.4	5.5	5.6	6.0	5.5	5.6	5.5	5.6	5.7	5.4	5.7	5.5
Acid Extractable Copper (Cu)	mg/kg	2.0	27	31	10	11	18	10	10	12	21	9.7	10	10	10	10	10	10	10
Acid Extractable Iron (Fe)	mg/kg	50	17000	17000	17000	17000	17000	16000	16000	17000	17000	16000	16000	16000	16000	17000	16000	16000	16000
Acid Extractable Lead (Pb)	mg/kg	0.50	130	140	7.2	5.7	52	4.1	4.3	15	92	3.8	4.1	5.0	6.1	4.4	4.5	4.5	4.7
Acid Extractable Lithium (Li)	mg/kg	2.0	12	12	16	16	16	15	15	16	16	16	15	16	15	16	15	16	15
Acid Extractable Manganese (Mn)	mg/kg	2.0	410	420	220	210	280	210	210	220	300	200	200	200	230	200	200	210	210
Acid Extractable Mercury (Hg)	mg/kg	0.10	0.27	0.25	<0.10	<0.10	0.12	<0.10	<0.10	<0.10	0.18	<0.10	<0.10	<0.10	<0.10	0.11	<0.10	<0.10	<0.10
Acid Extractable Molybdenum (Mo)	mg/kg	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acid Extractable Nickel (Ni)	mg/kg	2.0	16	16	17	17	17	16	16	17	17	17	19	16	16	19	16	16	17
Acid Extractable Rubidium (Rb)	mg/kg	2.0	16	16	22	24	23	22	22	22	21	23	22	22	22	22	22	22	22
Acid Extractable Selenium (Se)	mg/kg	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Acid Extractable Silver (Ag)	mg/kg	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Acid Extractable Strontium (Sr)	mg/kg	5.0	120	120	110	100	130	84	81	120	130	87	92	92	98	87	89	91	91
Acid Extractable Thallium (Tl)	mg/kg	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.11	0.13	0.11	0.10	0.10	0.13	0.12	0.11	0.11	0.12	0.12
Acid Extractable Tin (Sn)	mg/kg	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acid Extractable Uranium (U)	mg/kg	0.10	0.88	0.88	0.75	0.84	0.72	0.64	0.66	1.0	0.68	0.92	0.63	0.80	0.71	0.83	0.77	0.86	0.87
Acid Extractable Vanadium (V)	mg/kg	2.0	29	28	34	35	33	33	34	34	31	33	32	32	32	33	33	32	33
Acid Extractable Zinc (Zn)	mg/kg	5.0	58	66	37	39	48	35	36	40	56	36	42	37	37	39	36	38	37

Bureau Veritas ID			WIY020	WIY021	WIY022	WIY023	WIY024	WIY025	WIY026	WIY027	WIY028	WIY029	WIY030	WIY031	WIY032	WIY033	WIY034	WIY035	WIY036
Sampling Date			2023-07-08	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-09	2023-07-08	2023-07-08
COC Number			n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	UNITS	**RDL**	**POST-S15-1B**	**POST-F94-A**	**POST-F94-B**	**POST-PRIME-2A**	**POST-PRIME-2B**	**POST-N2-1A**	**POST-N2-1B**	**POST-N2-2A**	**POST-N2-2B**	**POST-N3-1A**	**POST-N3-1B**	**POST-N12-1A**	**POST-N12-1B**	**POST-N21-1A**	**POST-N21-1B**	**POST-S5-1B**	**POST-S-1-2-A+B**
Metals																			
Acid Extractable Aluminum (Al)	mg/kg	10	8600	8300	8500	9500	9100	8900	8900	8900	9400	8600	9200	9400	9800	8300	8500	8300	9800
Acid Extractable Antimony (Sb)	mg/kg	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acid Extractable Arsenic (As)	mg/kg	2.0	<2.0	2.2	3.2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.0
Acid Extractable Barium (Ba)	mg/kg	5.0	190	1000	1200	490	590	600	250	140	140	200	180	140	140	140	140	180	850
Acid Extractable Beryllium (Be)	mg/kg	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acid Extractable Bismuth (Bi)	mg/kg	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acid Extractable Boron (B)	mg/kg	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Acid Extractable Cadmium (Cd)	mg/kg	0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Acid Extractable Chromium (Cr)	mg/kg	2.0	27	26	27	30	29	29	29	28	29	27	29	29	30	27	28	27	29
Acid Extractable Cobalt (Co)	mg/kg	1.0	5.4	5.3	5.8	5.9	5.8	5.8	5.9	5.8	5.8	5.4	5.7	5.6	5.7	5.3	5.5	5.5	5.8
Acid Extractable Copper (Cu)	mg/kg	2.0	10	14	18	11	10	10	10	10	10	9.9	11	10	11	10	10	9.7	17
Acid Extractable Iron (Fe)	mg/kg	50	16000	16000	17000	17000	17000	17000	17000	17000	17000	16000	17000	16000	17000	16000	16000	16000	18000
Acid Extractable Lead (Pb)	mg/kg	0.50	4.5	31	60	5.4	6.1	5.1	3.9	3.8	3.7	5.1	4.4	4.0	4.8	4.1	3.8	3.8	45
Acid Extractable Lithium (Li)	mg/kg	2.0	15	16	15	17	17	17	17	17	17	16	17	16	16	16	16	16	15
Acid Extractable Manganese (Mn)	mg/kg	2.0	200	240	320	220	240	200	200	200	200	200	210	200	220	200	200	190	320
Acid Extractable Mercury (Hg)	mg/kg	0.10	<0.10	0.11	0.18	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11
Acid Extractable Molybdenum (Mo)	mg/kg	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acid Extractable Nickel (Ni)	mg/kg	2.0	16	16	17	17	17	16	17	16	17	16	17	17	17	16	16	16	18
Acid Extractable Rubidium (Rb)	mg/kg	2.0	22	21	21	24	23	23	23	23	24	22	23	22	23	22	22	21	21
Acid Extractable Selenium (Se)	mg/kg	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Acid Extractable Silver (Ag)	mg/kg	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Acid Extractable Strontium (Sr)	mg/kg	5.0	87	110	120	92	98	99	89	88	85	89	91	84	83	86	84	84	110
Acid Extractable Thallium (Tl)	mg/kg	0.10	0.11	0.10	0.11	0.10	0.10	0.11	0.11	0.10	0.11	<0.10	0.11	0.13	0.11	0.11	0.12	0.11	0.10
Acid Extractable Tin (Sn)	mg/kg	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acid Extractable Uranium (U)	mg/kg	0.10	0.83	0.73	0.69	0.70	0.62	0.79	0.88	0.84	0.91	0.71	0.93	1.2	0.81	0.81	0.96	0.94	0.84
Acid Extractable Vanadium (V)	mg/kg	2.0	33	30	31	34	33	33	32	32	34	32	33	34	34	31	32	31	34
Acid Extractable Zinc (Zn)	mg/kg	5.0	37	40	48	39	39	37	37	37	38	36	38	37	38	37	36	35	46

Appendix C: Technical Specifications for Equipment Used

Submersible Depth Sensors Series 8000

Digiquartz® Depth Sensors provide the ultimate precision in water level measurements. Typical application **accuracy of 0.01%** is achieved even under difficult environmental conditions. Desirable characteristics include excellent long-term stability, **1 x 10^{-8} resolution**, low power consumption, and high reliability.

The remarkable performance of these depth sensors is achieved through the use of a precision quartz crystal resonator whose frequency of oscillation varies with pressure-induced stress. A quartz crystal temperature signal is provided to thermally compensate the calculated pressure and achieve high accuracy over a broad range of temperatures. The depth sensors include waterproof housings with integral shock protection.

High accuracy, resolution, and stability make Digiquartz® Depth Sensors ideal for applications such as Tsunami detection, wave and tide gauges, platform leveling, underwater pipe laying, and as depth sensors in ROVs and AUVs.

All Depth Sensor ranges are available with either frequency outputs or integral intelligent electronics with bi-directional digital communications.

RANGES

Absolute

0-10 m H_2O to 0-7000 m H_2O
0-30 psia to 0-10,000 psia

Gauge

0-10 m H_2O to 0-140 m H_2O
0-15 psig to 0-200 psig

FEATURES

- 0.01% Accuracy
- 1 x 10^{-8} Resolution
- Unique Anti-Fouling Port
- Low Power Consumption
- High Stability and Reliability
- Fully Calibrated and Characterized
- ISO 9001 Quality System – NIST Traceable
- Frequency Outputs or Dual RS-232 and RS-485 Interfaces

APPLICATION AREAS

- Hydrology
- Oceanography
- Tsunami Detection
- Wave and Tide Gauges
- Offshore Platform Leveling
- Dam and Reservoir Level Sensing
- Underwater Pipe Laying and Surveying
- Remotely Operated and Autonomous Underwater Vehicles

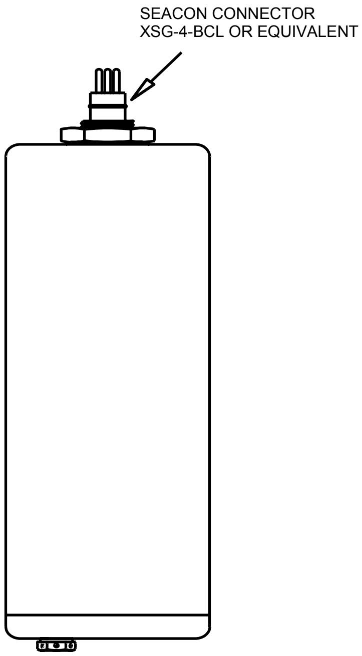
Dual RS-232 and RS-485 interfaces allow complete remote configuration and control of all operating parameters, including resolution, sample rate, and choice of engineering units, integration time, and sampling requests. Commands include: Single sample and send, synchronized sample and hold, continuous sample and send, and special burst sampling modes.

New and enhanced features include support for both serial loop and multi-drop networking, selectable baud rates up to 115,200 baud, synchronization of measurements with time-based integration, 2 or 4 wire RS-485 transmission distances greater than 1 kilometer, improved high-speed continuous pressure measurements, a power management "sleep" mode, data formatting features, and unit identification commands.

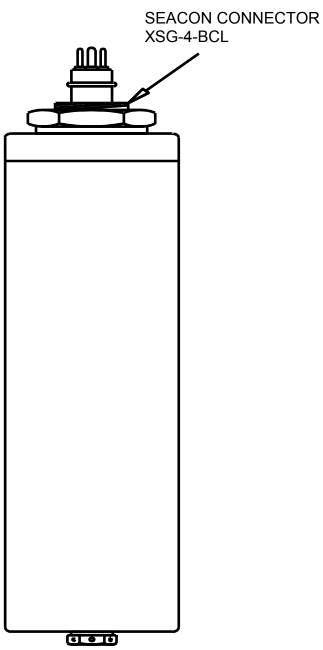
All Digiquartz® transducers come with a limited five-year warranty with the first two years covered at 100%.

Paroscientific,Inc.
Digiquartz® Pressure Instrumentation

Depth Sensors - Frequency Output   Series 8000



Series 8DP (0-700 meters)



Series 8B (0 to 7,000 meters)

PERFORMANCE CHARACTERISTICS

Pressure Performance	Accuracy typically better than 0.01% Full Scale (See SCD)
Calibrated Temperature	-2C to +40C
Hysteresis:	8B ≤± 0.01% Full Scale 8DP ≤± 0.005% Full Scale
Repeatability:	8B≤± 0.01% Full Scale 8DP≤± 0.005% Full Scale
Over Pressure:	1.2 times Full Scale
Thermal Sensitivity:	<0.0008% Full Scale /deg C
Pressure Signal:	Nominal Frequency 37 to 42 KHz
Temperature Signal:	Nominal Frequency 172 KHz

ELECTRICAL CHARACTERISTICS

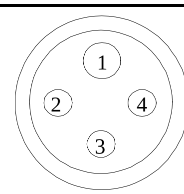
Input Voltage:	+6 (Min) to +25 VDC
Current Consumption:	1.3 mA @ 6VDC (Typical)
Output Signal:	Nominal square wave of 4 volts amplitude peak-to-peak, capacity coupled with source impedance <1,000 Ohms.

ENVIRONMENTAL CHARACTERISTICS

Weight:	8B Dry: 2.55 lbs (1.156 Kg) Max 8DP Dry: 3.48 lbs (1.58 Kg) Max 8DP 700m Dry: 5.00 lbs (2.26 Kg) Max
Housing Materials/Wetted:	8B - Stainless Steel 8DP-PVC Type 1 or Acetal, White

OTHER ACCESSORIES AVAILABLE

- Intelligent Interface Board
- Cables with Mating Connectors

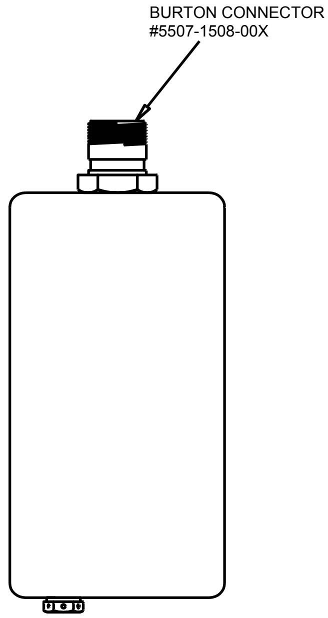


Connector Pin-Out

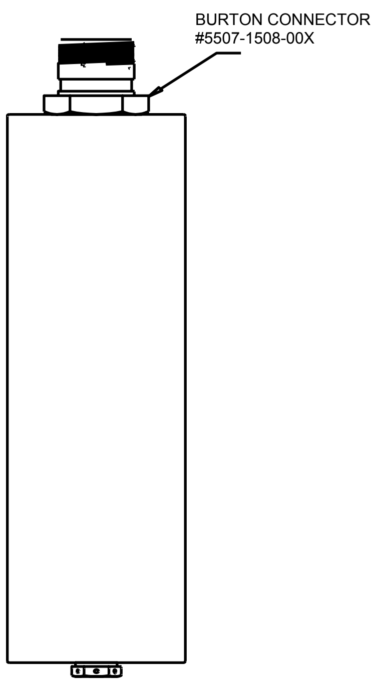
PIN	SIGNAL
1	Temperature Signal
2	Pressure Signal
3	Power/Signal Ground
4	Power

Digiquartz® Pressure Instrumentation

Depth Sensors - Intelligent Output   Series 8000



Series 8CDP (0 to 700 meters)



Series 8CB (0 to 7,000 meters)

PERFORMANCE CHARACTERISTICS

Pressure Performance	Accuracy typically better than 0.01% Full Scale (See SCD)
Calibrated Temperature Range:	-2C to +40C
Hysteresis:	8CB ≤± 0.01% Full Scale 8CDP ≤± 0.005% Full Scale
Repeatability:	8CB≤± 0.01% Full Scale 8CDP≤± 0.005% Full Scale
Over Pressure:	1.2 times Full Scale
Thermal Sensitivity:	<0.0008% Full Scale / deg C

ELECTRICAL CHARACTERISTICS

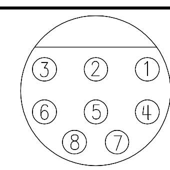
Input Voltage:	+6 (Min) to +16 VDC
Current Consumption:	16.5 mA Quiescent, 32 mA max @ +6 VDC
Output Signal:	RS-232 meets EIA/TIA specs RS-485 meets EIA/TIA specs

ENVIRONMENTAL CHARACTERISTICS

Weight:	8CB Dry: 2.94 lbs (1.33 Kg) Max 8CDP Dry: 3.48 lbs (1.58 Kg) Max 8CDP 700m Dry: 5.0 lbs (2.26 Kg) Max
Housing Materials/Wetted:	8CB - Stainless Steel 8CDP-PVC Type 1 or Acetal, White

OTHER ACCESSORIES AVAILABLE

- Model 715 Remote LCD Display
- Cables with Mating Connectors
- Power Module Kit



Connector Pin-Out

PIN	SIGNAL
1	RS-232 to Computer
2	RS-232 from Computer
3	Power/Signal Ground
4	Power
5	RS-485 RX+
6	RS-485 RX-
7	RS-485 TX+
8	RS-485 TX-

Paroscientific,Inc.

4500 148th Ave. N.E.   Tel : (425) 883-8700
Redmond, WA 98052   Fax : (425) 867-5407
Web: www.paroscientific.com
E-Mail: support@paroscientific.com

Depth Sensors

Series 8000

Depth	Frequency Outputs				Intelligent			
Meters of H_2O	Model	Part Number	Dimensions inch (cm) Dia.	Length	Model	Part Number	Dimensions inch (cm) Dia.	Length
	Series 8DP Absolute Depth Sensors*				Series 8CDP Intelligent Depth Sensors			
0-10	8DP010-2	1116-004-0	3.50(8.9)	8.92(22.7)	8CDP010-I	1705-001-0	3.50(8.9)	8.55(21.7)
0-20	8DP020-2	1116-006-0	3.50(8.9)	8.92(22.7)	8CDP020-I	1705-002-0	3.50(8.9)	8.55(21.7)
0-60	8DP060-2	1116-008-0	3.50(8.9)	8.92(22.7)	8CDP060-I	1705-003-0	3.50(8.9)	8.55(21.7)
0-130	8DP130-2	1116-010-0	3.50(8.9)	8.92(22.7)	8CDP130-I	1705-004-0	3.50(8.9)	8.55(21.7)
0-200	8DP200-2	1116-012-0	3.50(8.9)	8.92(22.7)	8CDP200-I	1705-005-0	3.50(8.9)	8.55(21.7)
0-270	8DP270-2	1116-014-0	3.50(8.9)	8.92(22.7)	8CDP270-I	1705-006-0	3.50(8.9)	8.55(21.7)
0-700	8DP700-2	1116-035-0	3.50(8.9)	14.51(36.8)	8CDP700-I	1705-007-0	3.50(8.9)	10.50(26.7)
	Series 8DP Gauge Depth Sensors*				Series 8CDP Intelligent Depth Sensors			
0-10	8DP010-GV-2	1117-002-0	3.50(8.9)	8.92(22.7)	8CDP010-GVI	1706-001-0	3.50(8.9)	8.80(22.4)
0-15	8DP015-GV-2	1117-010-0	3.50(8.9)	8.92(22.7)	8CDP015-GVI	1706-002-0	3.50(8.9)	8.80(22.4)
0-20	8DP020-GV-2	1117-004-0	3.50(8.9)	8.92(22.7)	8CDP020-GVI	1706-003-0	3.50(8.9)	8.80(22.4)
0-70	8DP070-GV-2	1117-006-0	3.50(8.9)	8.92(22.7)	8CDP070-GVI	1706-004-0	3.50(8.9)	8.80(22.4)
0-100	8DP100-GV-2	1117-012-0	3.50(8.9)	8.92(22.7)	8CDP100-GVI	1706-005-0	3.50(8.9)	8.80(22.4)
0-140	8DP140-GV-2	1117-008-0	3.50(8.9)	8.92(22.7)	8CDP140-GVI	1706-006-0	3.50(8.9)	8.80(22.4)
	Series 8B High Pressure Absolute Depth Sensors *				Series 8CB High Pressure Intelligent Depth Sensors			
0-1400	8B1400-2	1036-002-0	1.61(4.0)	9.85(25.0)	8CB1400-I	1700-001-0	1.61(4.0)	10.83(27.5)
0-2000	8B2000-2	1036-004-0	1.61(4.0)	9.85(25.0)	8CB2000-I	1700-002-0	1.61(4.0)	10.83(27.5)
0-4000	8B4000-2	1036-006-0	1.61(4.0)	9.85(25.0)	8CB4000-I	1700-003-0	1.61(4.0)	10.83(27.5)
0-7000	8B7000-2	1036-008-0	2.17(5.5)	10.68(27.1)	8CB7000-I	1700-004-0	2.17(5.51)	10.83(27.5)

* Non-Temperature Compensated Versions Optionally Available

Paroscientific, Inc.
4500 148th Ave. N.E.
Redmond, WA 98052
Tel: (425) 883-8700
Fax: (425) 867-5407
http://www.paroscientific.com
E-Mail:support@paroscientific.com

Product defined by Specification Control Drawing. Specifications Subject to change without prior notice.
Manufactured under one or more of the following U.S. Patents: 4,454,770 - 4,455,874 - 4,592,663 - 4,724,351 - 4,751,849 - 4,757,228 - 4,764,244 - 4,831,252 - 4,872,343 - 4,912,990 Other patents pending.

OCEANEERING®

oceaneering.com

Magnum® Plus

Heavy work class ROV

The Magnum® ROV is a side entry cage deployed, dual manipulator ROV that operates in water depths up to 10,000 fsw and in severe weather conditions. The cage or tether management system (TMS) supplies an additional 85 hp, powers skids, and has thruster control and auto heading.

FEATURES

Fly-by-wire station keeping system

10,000 fsw / 3,000 msw depth rating (13,000 fsw / 4,000 msw optional)

170 hp

Vehicle Specifications

Weight in air	6,750 lb / 3,060 kg
Dimensions (LxWxH)	8.5 x 5.1 x 6.1 ft / 2.6 x 1.6 x 1.9 m
Depth rating	10,000 ft / 3,000 m (standard)
	13,000 ft / 4,000 m (optional)

Vehicle Power and Performance

Hydraulic power units	2 x 85 hp(E)
Propulsion	4 x vectored horizontal
	2 X vertical
Thrust Forward/reverse: Lateral: Vertical:	 1,600 lb / 725 kg 1,750 lb / 800 kg 1,200 lb / 550 kg

Vehicle Manipulators and Tooling

Manipulators (2)	5 or 7 Function: rate, SC or Hybrid Control
Hydraulic tool control	Multiple directional control valves with proportional pressure and flow control
	Maximum 25 gal/min

Vehicle Cameras and Lighting

Cameras	Standard definition (SD) High definition (HD) 3D HD (optional)
Lighting	Up to 8 x 250 W (quartz halogen or high-intensity LED)

Vehicle Control and Navigation

Automatic control	Fly-by-wire station keeping system Auto heading/depth/altitude Cruise control
Heading and altitude sensors	Survey-grade gyro Backup flux gate compass
Depth sensor	High-resolution digiquartz Backup analog depth sensor
Navigation sensor	Doppler velocity log
Obstacle avoidance sonar	Kongsberg 1071 or 1171 Tritech SeaKing

Vehicle Optional Power and Data Interfaces

Data links	Multiple RS232 and RS485 Ethernet Optical fiber
Power	24 V DC and 110 V AC

Tether Management System (TMS)

Type	Side entry cage or top-hat
Propulsion	2 x horizontal (cage only)
Hydraulic power unit	1 x 85 hp(E)
Electro-optical tether	1,800 ft / 550 m (cage) 4,000 ft / 1,200 m (cage) optional 1,300 ft / 400 m (top-hat)
Cameras	2 x charge-coupled device (CCD)
Lighting	2 x 250 W (quartz halogen or high-intensity LED)

Launch and Recovery Systems (LARS) (choice of)

Overboarding
A-frame w/ or w/o docking head
Heavy-weather overboarding system
Cursor
Winch
Heavy lift winch with conventional or OHRA level wind

OI#0487410
Camera has Seacon FO and 9 pin BCR connectors.

Surveyor-HD-Pro

Ultra Wide Angle HD Colour Zoom Camera

Water corrected optics

The Teledyne Bowtech SURVEYOR-HD PRO ultra-wide angle underwater HD camera is designed to provide the widest angle of view, whilst remaining compact and very competitively priced. The camera is ideal for ROV inspection tasks, scientific observation and broadcast applications. Video output is available as HD or HD-SDI over fibre.

Video output is available as component (Y/Pb/Pr), utilising standard connectors or HD-SDI on hybrid 75Ω coaxial or fibre optic connectors, a composite video output is also available. The camera is available in a variety of control formats, including the Teledyne Bowtech GUI, which facilitates the control of all features including white balance, auto tracking and back light compensation, which can be switched on or off using the GUI.

Excellent images are obtained, through the fused silica hemispherical window and the camera is ideal for overall scenes and close-up inspection. The camera uses a Bluetooth tablet for control setup. The optics are fully corrected for geometric and chromatic aberration. The camera is housed within a 4,000 metre rated titanium housing with a 6,000 metre option.

Applications: ROV/AUV, Defence

PRODUCT FEATURES AND BENEFITS

- High definition 1080p
- Fully geometric and chromatic aberration water corrected optics
- Component, HD-SDI or HD- SDI over fibre output
- 100° ultra-wide diagonal angle of view
- 4000m or 6000m depth rated titanium housing

TELEDYNE BOWTECH
Everywhereyoulook™

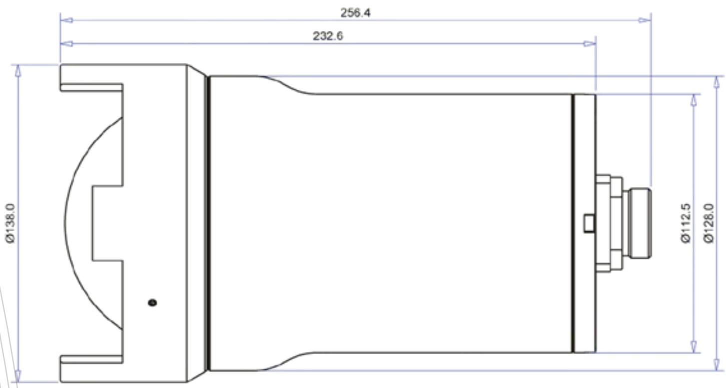
A member of Teledyne Marine

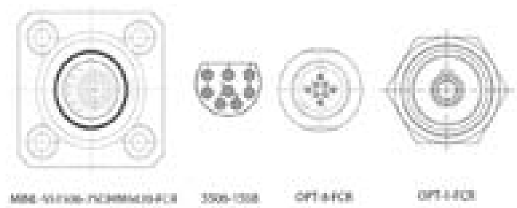
Surveyor-HD-Pro

Ultra Wide Angle HD Colour Zoom Camera

TECHNICAL SPECIFICATIONS

Electrical	Image Size	1920 H x 1080 V, 1280 H x 720 V, 720V x 576 H
	Sensor Type	1/2.8-type Exmor CMOS
	Limiting Scene Illumination	1.7 lux
	Signal to Noise Ratio	>50 dB
	Power Consumption	12 to 24 Vdc
	Current	300 mA typical
	HD Video Output	Component, HD-SDI or HD-SDI over fibre output
	HD Format	1080p/60 1080p/50, 1080i/50, 1080p/30, 1080p/25, 720p/60, 720p/50
	Control Options	Single wire tristate, two wire bipolar, RS232 or RS485 input, Bluetooth tablet control
Environmental	Depth Rating	4000m or 6000m options
	Storage Temperature	-20°C to +60°C
	Operating Temperature	-5°C to +60°C
	Shock	3 axis (operating), 30g peak, 6ms half-sine pulse
	Vibration	10g, 20-150Hz
Optical	Optical Zoom	30:1 4.6mm to 138.0mm focal length
	Iris	Automatic, f1.6 to close
	Focus Control	10mm to infinity (wide), 1500mm to infinity (zoom)
	Angle of View	100° diagonal in water, 100° diagonal in air
	Window	Fused Quartz hemisphere
Mechanical	Dimensions	138.0mm (front retainer) (d) x 232.62mm (l) (excluding connector)
	Weight in Air	5.5kg
	Weight in Water	2.56kg
	Standard Housing	Titanium alloy grade 5 6AL-4VASTM B3 48
	Standard Connector	Large selection of connectors available





TELEDYNE BOWTECH
Everywhereyoulook™

www.teledynemarine.com
Email: bowtech_sales@teledyne.com

Head Office
International Avenue,
ABZ Business Park,
Dyce, Aberdeen
AB21 0BH, UK
Tel: +44 (0)1224 772345
Fax: +44 (0)2114 772900

Houston
10661 Shadow Wood Drive,
Houston, TX 77043, USA
Tel: +1 281 710 7276
Fax: +1 281 712 1757

OceanLight LED Underwater Light

Generations 1 and 2

User Manual

Document No. 955002063, Rev. 3.0

Deep Sea Systems International, Inc.,
a subsidiary of Oceaneering International, Inc.

1130 Rte. 28A
Cataumet, MA 02534
Tel: (508) 540-6732
Fax: (508) 564-7878

www.deepseasystems.com

Warning—Read This First!

Before proceeding with the installation and operation of the Deep Sea Systems International (DSSI) OceanLight LED Underwater Light, it is highly recommended that those responsible first read and understand fully the information in this section, which encompasses some important hazard warnings and recommendations.

Potential Hazards

The OceanLight is a useful tool for undersea operations, yet its utility is not without potential hazards. A flooded or partially flooded light housing is dangerous. Water entering the housing creates two hazardous conditions: electrical shock and explosion. The shock hazard is due to the short circuiting of the internal wiring; the explosion hazard is due to the generation of hydrogen and oxygen gases, a highly explosive mixture. A flooded housing should be removed and serviced immediately, and when servicing, protective clothing and safety glasses should be worn.

Improper Handling

Understanding the risks involved in the installation and operation of an OceanLight is the responsibility of the user. Furthermore, damage resulting from improper handling and use of the system is not covered under DSSI's standard warranty, if applicable.

Purpose of This Manual

The purpose of this manual is to provide the necessary information to install, test, operate, and maintain an OceanLight. Any person involved with its installation and operation should be thoroughly familiar with the contents of this manual, as the information it contains is as current and accurate as is reasonably possible.

Design and Documentation Changes

DSSI reserves the right to make changes to the design or to the specifications of the OceanLight at any time without notice and without the obligation to upgrade previously delivered units. This manual is also subject to change without notice.

Preface

The OceanLight LED Underwater Light is a ruggedly constructed multipurpose underwater light that uses an array of forty-four 5-watt LEDs to produce an ultra high intensity white light.

Purpose of This Manual

The purpose of this manual is to provide the necessary information to install and to operate an OceanLight, both the Generation 1 and Generation 2 versions, where the main difference between them are that the G2 provides an overvoltage indicator and will automatically turn off should the input voltage be exceeded and turn back on when the voltage is reduced to within the proper range. Any person involved with its installation and operation should be thoroughly familiar with the contents of this manual, as the information it contains is as current and accurate as is reasonably possible.

How to Use This Manual

This manual should be used as a reference for installing and operating the OceanLight components. It is divided into the following four sections:

Section 1 - Introduction Provides an overview and functional description of the main components of an OceanLight.

Section 2 - Specifications Lists the physical and environmental specifications for an OceanLight.

Section 3 - Installation Provides procedures for bench testing, mounting, orienting, and connecting an OceanLight.

Section 4 - Maintenance and Repair Provides some inspection and cleaning recommendations as well as a basic troubleshooting guide and associated repair instructions for the OceanLight.

Section 5 - Drawings Provides s a list of outline drawings and wiring diagrams required to install and maintain the OceanLight LED Underwater Light.

Notes and Cautions

Where applicable, special notes and cautions are provided as follows:

NOTE **Recommendations or general information that is particular to the material being presented or a referral to another part of this manual or to another manual.**

CAUTION **Identifies a potential hazard that could be damaging to equipment or could result in the loss of data.**

WARNING Identifies a potential hazard that could cause personal injury or death to yourself or to others.

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SECTION 4
Maintenance and Repair 4-1

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Drawings 5-1

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SECTION 1
Introduction

The OceanLight LED Underwater Light, which is shown in Figure 1-1, produces an ultra high intensity, 135° by 77° (16:9 format when mounted sideways) beam of blue white light using an array of forty LEDs. The light is depth rated to 4000 meters and is specifically designed for installation on a remotely operated vehicle (ROV), particularly those vehicles with high definition television (HDTV) viewing systems. This manual covers both the G1 and G2 versions of the light. The G2 version is identified by a "-II" suffix in the model number.

Figure 1-1: *The OceanLight LED Underwater Light*

When powered up, the OceanLight instantly switches to its maximum brightness as determined by the power input voltage, and the brightness can be varied from fully off to 6500 lux at 1 meter by varying the input voltage from 75 to 120 VAC. At all brightness levels the color temperature remains nearly constant at 5500 K. The OceanLight also includes an overvoltage protection circuit and a thermal switch. For the G1 version, the overvoltage protection circuit trips at 135 VAC and blows a safety fuse which shuts off the light. For the G2 version, the overvoltage circuit trips at 130 VAC, a bright red indicator illuminates on the front of the light, and the light shuts off until the input voltage is lowered to below 125 VAC. The thermal switch, which is self resetting, automatically turns off the light should the internal temperature exceed 70°C, and the light automatically turns back on when cooled. The light output intensity of an OceanLight versus the AC input voltage over the range 75 to 125 VAC is shown in Table 1-1.

Table 1-1: *OceanLight Output Intensity Versus AC Input Voltage*

INPUT VOLTAGE (VAC)	LIGHT INTENSITY (Lux @ 1 meter in water)
75	110
80	190
85	390
90	690
95	1150
100	1760
105	2480
110	3270
115	4570
120	6500
125	7200

Advantages of LEDs

LED lights have a number of advantages over other lights typically used in underwater lighting applications, such as quartz halogen and high intensity discharge (HID) lights. LEDs do not vary their color temperature with light intensity, are extremely shock tolerant, have a long operating life, and light up instantly when powered. They also produce more light output per watt of power consumed than other lights, making them very efficient. The OceanLight uses the most current, latest generation LEDs available.

Main OceanLight Components

The main components of the OceanLight are shown in Figure 1-2. They include an LED array, a plexiglas lens/reflector, a light housing, and a rotatable connector block with a 3-pin bulkhead connector. The LEDs are mounted as an array behind the lens/reflector, and the light housing contains a DC power supply and anti-flicker circuit. The rotatable connector block allows the light to be oriented in one of four different positions. The light housing also includes an O-ring sealed access cover on the back which enables access to the safety fuse should it require replacement.

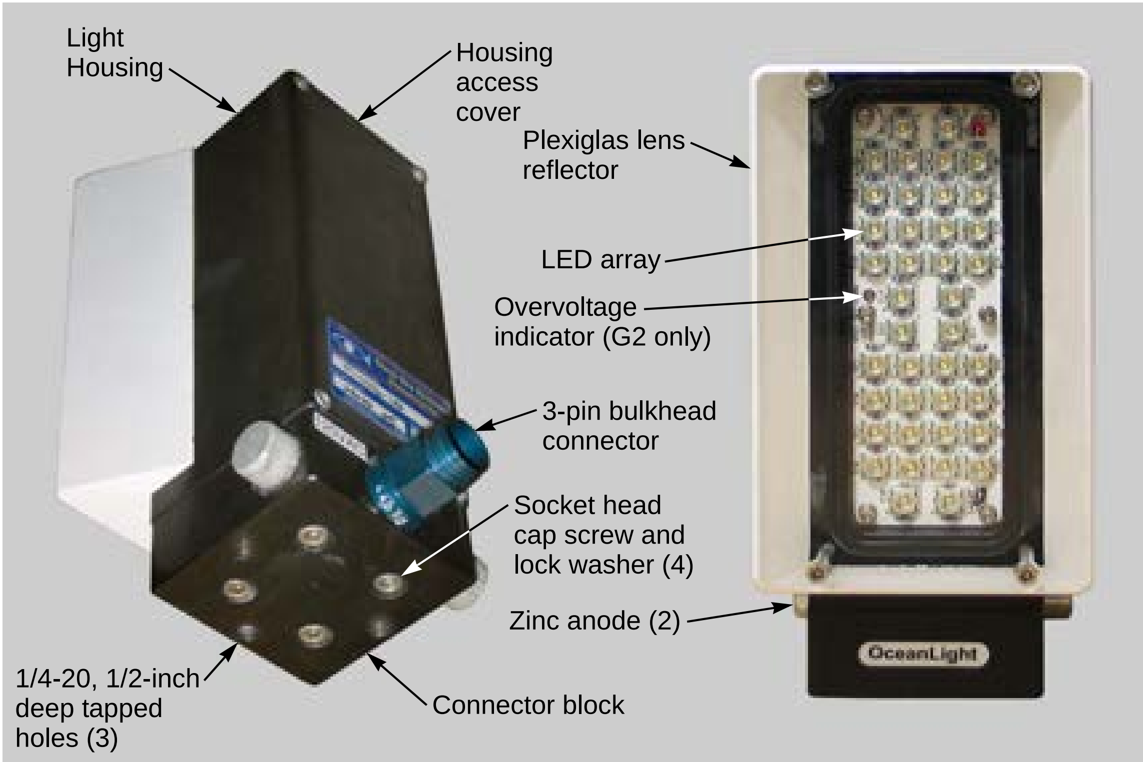

Figure 1-2: *OceanLight Housing Components*

Latest Generation LEDs

The OceanLight uses 40 of the latest generation, brightest available, 5-watt LEDs arranged in an array of 12 rows and in a pattern that produces the maximum light output. The LEDs are reflow soldered onto a printed circuit that is etched onto a high dielectric thin film ceramic substrate. A specially designed heat pump, which is both thermally and mechanically attached to the light housing, efficiently and reliably transfers the heat from the LEDs to the surrounding seawater. Therefore, even at maximum brightness, where the most heat is generated, the OceanLight continuously runs cool when fully submerged.

Plexiglas Lens/Reflector

As shown in Figure 1-2, the plexiglas lens/reflector is a thick piece of clear plexiglas that is O-ring sealed and bolted to the light housing over the LED array. Except for the front, all four sides of the lens/reflector are coated with multiple coats of a white translucent acrylic compound to reflect the light forward while enabling some reverse illumination, which can be useful when illuminating gages on an ROV. Optionally, a black coating can be applied over the white on the outside of the lens/reflector for a completely opaque finish, or a heavy duty removable black tape can be applied to stop any light leakage.

Rotatable Connector Block

Attached to the housing at the bottom is the connector block with its a 3-pin bulkhead connector, which is for power input, two sacrificial zinc anodes for inhibiting crevice corrosion near the connector, and three 1/2-inch deep 1/4-20 tapped holes for mounting the light. The connector block is O-ring sealed to the housing and secured to it with f our socket head cap screws. Removing these screws allows the connector block to be rotated clockwise or counterclockwise in 45-degree increments such that the connection to the light can be made to the front, to the back or to the left or right side, depending on the mounting requirements.

Anti-Flicker Circuit

The OceanLight includes an anti-flicker circuit to ensure that the light output remains constant at all times and to prevent possible noise bars in video images. Unlike other lights, LEDs are instant on and off. The anti-flicker circuit prevents the LEDs from flickering which can occur when rectifying AC input voltages to produce DC voltages.

Overvoltage Indicator

For the G2 version only, an overvoltage indicator is embedded inside the LED array and is viewable from the front of the light. Should the AC input power exceed 130 VAC, the light will shut off and the indicator will illuminate bright red. The light will remain off until the input power is lowered to below 125 VAC, at which time the light will turn back on and the indicator will turn off.

Shock Tolerance

The OceanLight, because of its use of LEDs, is extremely shock tolerant compared to other lights. When properly installed, the OceanLight will continue to function during and after receiving mild to moderate shocks or vibration.

Housing Construction

The OceanLight housing is pressure rated to 4000 meters (13,000 feet) of water depth. It is constructed of hard coat anodized aluminum, and the lens/reflector, connector block and housing access cover are all O-ring sealed to the light housing.

SECTION 2
Specifications

This section lists the physical and environmental specifications for the OceanLight LED Underwater Light. They are subject to change without notice.

Size:	17.8 cm (7.0 in.) high 6.4 cm (2.5 in.) wide, not incl. zinc anodes 8.4 cm (3.3 in.) deep, not incl. connector
Depth rating:	4000 m (13,000 ft)
Light output:	6500 lux @ 1 meter in water and at 120 VAC
LEDs:	40 each 5-watt ultra high intensity
LED life:	35,000 hours at full intensity; 50,000 hours at reduced intensity
Color temperature:	5500 K, at all light intensities
Beam angle:	135° by 77° wide flood (16:9)
Input voltage:	75–120 VAC, 50/60 Hz
Input power:	200 watts at 120 VAC, 60 Hz 222 watts at 120 VAC, 50 Hz
Overvoltage trip voltage:	135 VAC; blows internal safety fuse
Overvoltage cutoff:	130 VAC; shuts off light and illuminates red indicator (G2 version only)
Thermal cutoff:	70°C, self resetable
Connector:	Seacon Global CS-MSAJ-3-BCR; mates with CS-MSAJ-3-CCP
Mounting:	(3) 1/4-20 by 1/2-inch deep tapped holes in a rotatable connector block
Operating temperature:	-15°C to 35°C (5°F to 95°F)
Weight in water:	4.4 kg (2.0 lb)
Weight in air:	1.9 kg (4.2 lb)

SECTION 3
Installation

The OceanLight LED Underwater Light should be mounted in a way that makes optimum use of the light's 135° by 77° wide beam while minimizing backscatter. The mounting arrangement should also take into consideration the optics of the viewing cameras, especially HDTV cameras. Generally, two OceanLights are used in a typical viewing system and can be arranged to meet these requirements. However, before installing an OceanLight, the light should be bench tested. Bench testing an OceanLight involves making some simple electrical checks and temporarily connecting the light to verify its operation. Included in this section are procedures for bench testing an OceanLight, some general guidelines on how to mount and orient the light head, and procedures for making the final connections.

When installing the OceanLight, refer to Drawing 0343644-II for bulkhead connector pinout and dimensional information.

Bench Testing the OceanLight

Before installing an OceanLight, the light should be checked for continuity to housing ground and for electrical leakage to housing ground. Then the light should be temporarily connected on the bench and turned on to verify its operation.

If the OceanLight has been deployed previously and it is suspected that it has leaked water, the plexiglas lens reflector and the housing access cover should be removed immediately and the inside of the light inspected. After the light has been inspected or repaired, it should be bench tested.

CAUTION **Do not operate a OceanLight if it is suspected that it has leaked water. In addition, be sure to immediately disconnect the light to ensure that it will not be accidentally turned on.**

Checking Continuity to Housing Ground

There should be a low resistance conducting path between pin 1 of the bulkhead connector on an OceanLight and housing ground. This low resistance path should be verified before operating the light. A 250-volt megometer is recommended to perform this check. Refer to Drawing 0343644-II for the connector pinout information.

To check continuity to housing ground:

1. Set the megometer to 250 volts.
2. Touch one of the meter probes to one of the zinc anodes on the connector block as shown in Figure 3-1.

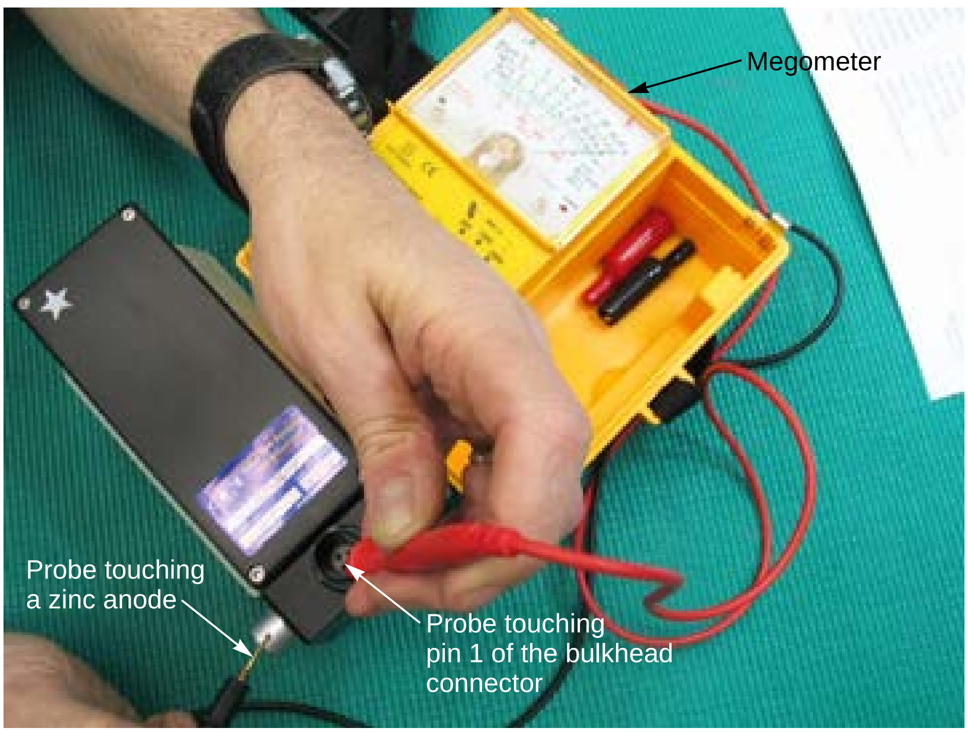

Figure 3-1: *Checking for Continuity to Housing Ground*

3. Touch the other probe to pin 1 of the bulkhead connector.
4. Measure the resistance.

   The resistance should be *less than* 1 ohm.

Checking for Electrical Leakage to Housing Ground

There should be a high electrical resistance between pin 2 and housing ground and pin 3 and housing ground of the bulkhead connector on an OceanLight. This high resistance should be verified before operating the light. A 250-volt megometer is recommended to perform this check. Refer to Drawing 0343644-II for the connector pinout information.

To check for electrical leakage to ground:

1. Set the megometer to 250 volts.
2. Touch one of the meter probes to one of the zinc anodes on the connector block as shown in Figure 3-2.

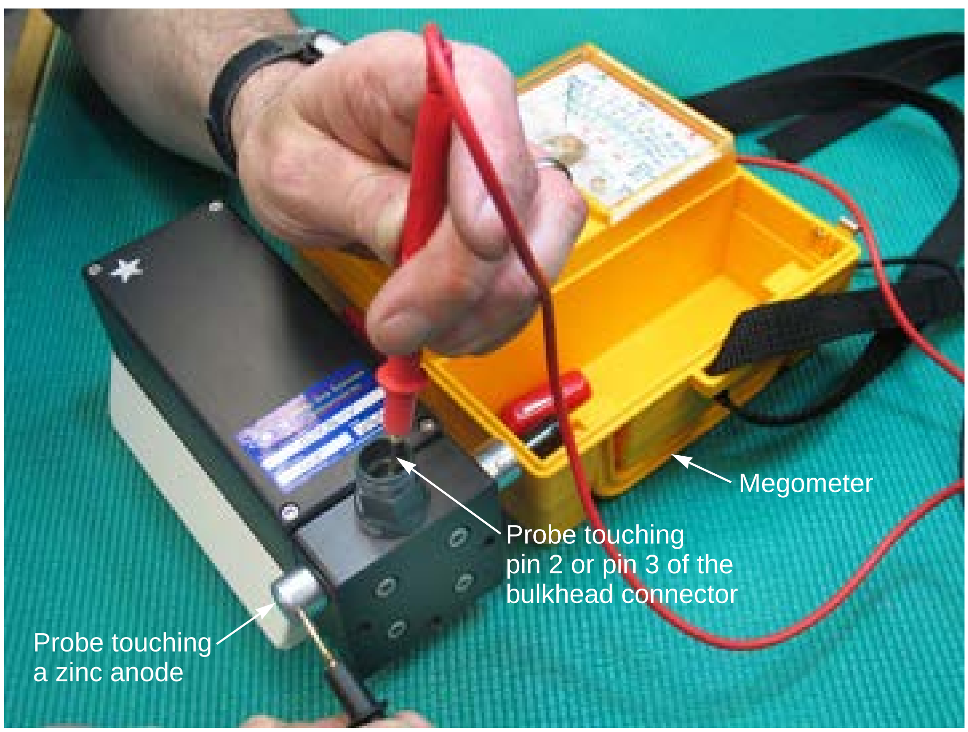

Figure 3-2: *Checking for Electrical Leakage to Housing Ground*

CAUTION **Do not touch the meter probes directly across pins 2 and 3, as doing so may damage the light.**

3. Touch the other probe to pin 2 of the bulkhead connector.

4. Measure the resistance.

   The resistance should be *greater than* 50 megohms.

5. Remove the probe from pin 2 and touch it to pin 3.

6. Measure the resistance.

   The resistance should be *greater than* 50 megohms.

CAUTION **If one or both of the measured resistances are less than 50 megohms, do not operate the light.**

If one or both of the measured resistances are less than 50 megohms, the light may require servicing. Refer to on page v for information on how to contact DSSI for assistance.

Verifying Operation

After successfully checking for continuity to housing ground and electrical leakage to housing ground, an OceanLight can be temporarily connected and its operation verified. This should be done on the bench before installing the light. A CS-MSAJ-3-CCP connector, which mates with the bulkhead connector on the connector block is required to perform this verification. In addition, a 120 VAC, 50/60 Hz or variable AC, 50/60 Hz power source is required.

CAUTION **When connecting an OceanLight to the AC power source, be sure the power is turned off.**

NOTE **Leaving an OceanLight on in air for five minutes or more will cause a thermal shutdown of the light, switching it off. Should this happen the light will automatically switch back on when it cools.**

To verify the operation of an OceanLight:

1. Connect a wire to each of the three pins on the CS-MSAJ-3-CCP connector.

2. Connect the wire from pin 2 to the 120 VAC, 50/60 Hz or variable AC, 50/60 Hz power source HI.

3. Connect the wire from pin 3 to the 120 VAC, 50/60 Hz or variable AC, 50/60 Hz power source LO.
4. Connect the wire from pin 1 to the power source ground.
5. Connect the CS-MSAJ-3-CCP connector to the bulkhead connector on the light.
6. Switch on the AC power source and verify the operation of the light.

   The light should switch on immediately at full brightness for a 120 VAC input.

CAUTION **If using a variable AC power source, do not exceed 135 VAC for the G1 version, as doing so will trip the overvoltage protection circuit and blow the safety fuse. For the G2 version, exceeding 130 VAC will shut off the light and illuminate the red indicator until the voltage is returned to below 130 VAC.**

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7. If a variable AC power source is used to power the light, vary the voltage from approximately 75 VAC to 120 VAC.

   The light should begin to turn on at approximately 75 VAC and reach maximum brightness at 120 VAC. Refer to Table 1-1 on page 1-2 for the light intensity output versus AC input voltage.
8. Switch off the power source after verifying that the light operates properly.
9. Disconnect the cable from the light and from the power source.

Orienting and Mounting the OceanLight

An OceanLight is mounted using the three 1/4-20, 1/2-inch deep tapped holes on the bottom of the connector block. To orient the light and locate the bulkhead connector in a desired position, the connector block can be rotated to any one of four positions, 45 degrees apart. The light should be oriented according to preference. However, if possible, the light should be oriented such that it is pointing in the direction that provides the maximum lighting volume and range with the minimum backscatter. The recommended lighting arrangement in a typical installation of two OceanLights on a remotely operated vehicle (ROV) is shown in Figure 3-3 and Figure 3-4. The arrangement shown in Figure 3-3 is viewed from the top of the ROV, showing both the port and starboard installations. In Figure 3-4 the arrangement is viewed from the port side.

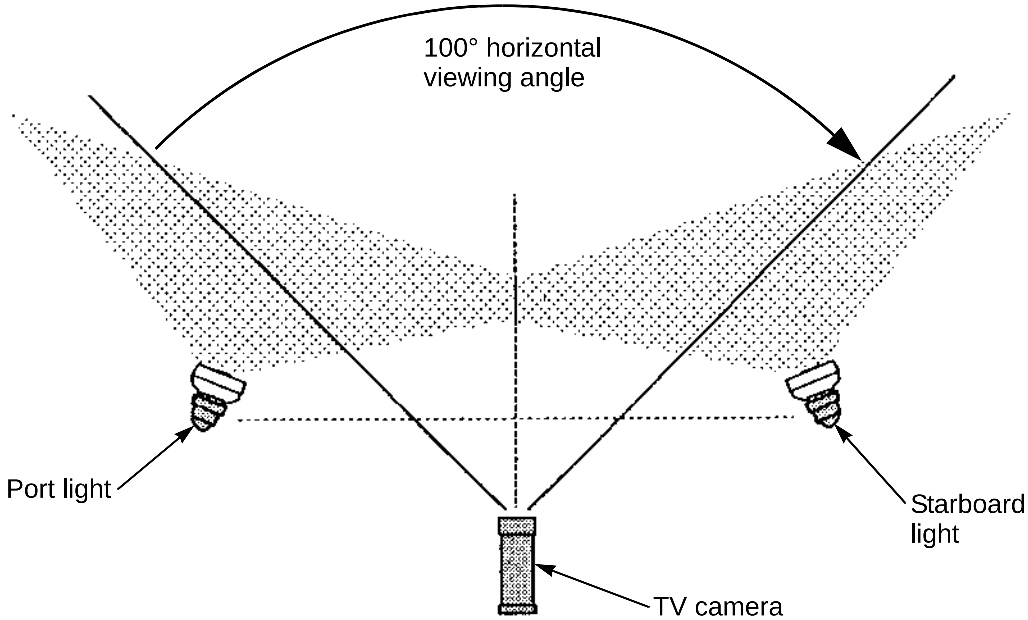

Figure 3-3: *Typical OceanLight Installation—Viewed from the Top*

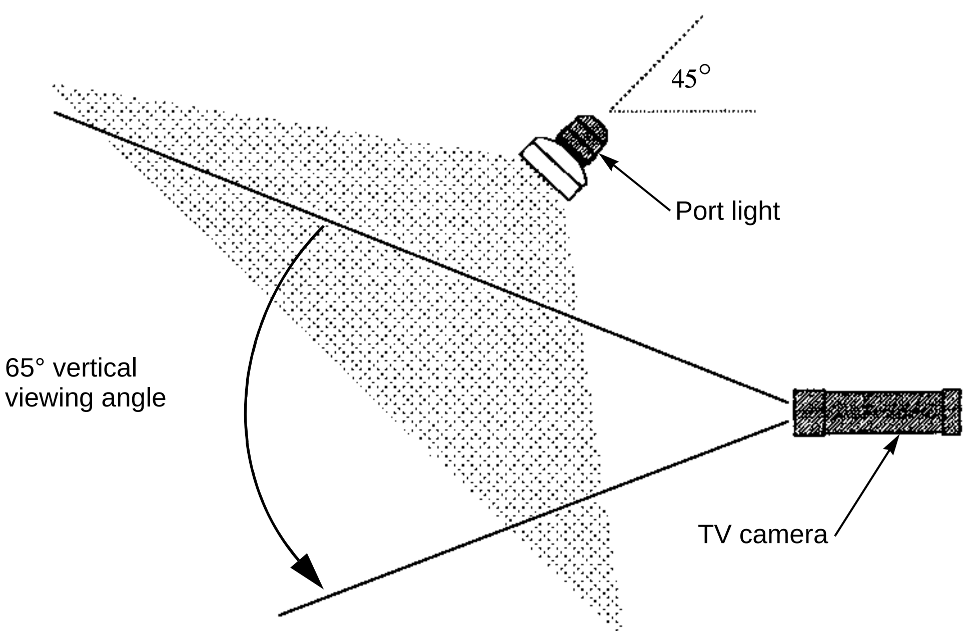

Figure 3-4: *Typical OceanLight Installation—Viewed from the Side*

Changing the Orientation of the Connector Block

To orient an OceanLight and position the bulkhead connector, it may be required to rotate the connector block. A 5/32-inch allen wrench and No. 243 Loctite are required to perform this task.

To change the orientation of the connector block:

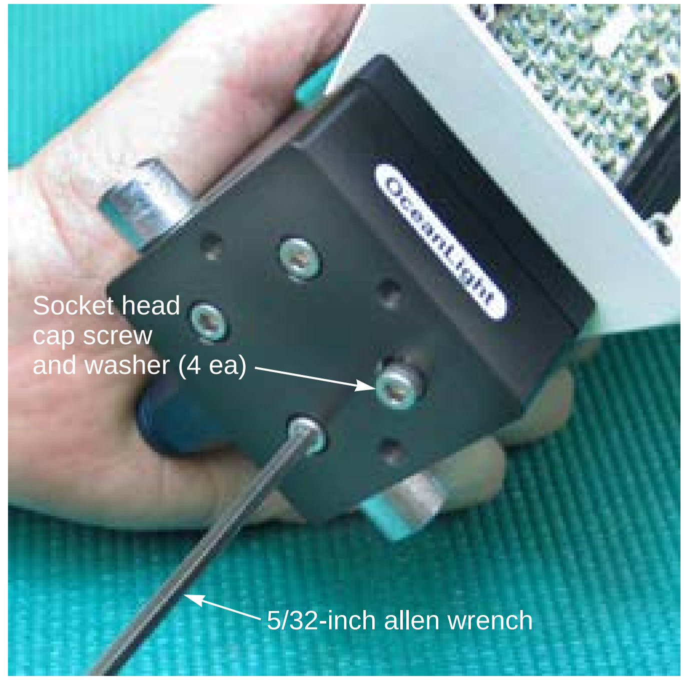

Figure 3-5: *Removing the Four Socket Head Cap Screws And Lock Washers on the Connector Block*

1. Using a 5/32-inch allen wrench, remove the four socket head cap screws and lock washers on the connector block at the bottom of the light as shown in Figure 3-5.
2. Carefully pull the connector block away from the housing.
3. Rotate the connector block into the desired position, and while verifying that the O-ring on the block is properly seated in its groove as shown in Figure 3-6, press the block against the housing.
4. Apply No. 243 Loctite to each of the four socket head cap screws, and then insert them with the lock washers into the connector block and tighten them securely.

Figure 3-6: *Verifying that the O-Ring in the Connector Block is Properly Seated in Its Groove*

Mounting the OceanLight

To mount an OceanLight, use three 1/4-20 screws of sufficient length and insert them through the mounting platform and into the connector block. The tapped holes are 1/2-inch deep. Tighten the screws securely.

Making the Final Connections

To make the final connections:

1. Assemble a cable of the required type and length to a CS-MSAJ-3-CCP connector. Refer to Table 3-1 for the connector wiring.

Table 3-1: ***CS-MSAJ-3-CCP Connector Wiring***

PIN NUMBER	FUNCTION
1	Ground
2	AC HI
3	AC LO

2. Lightly lubricate the O-rings on the CS-MSAJ-3-CCP connector with a silicone lubricant, and then connect it to the bulkhead connector on the light.
3. Wire the cable to the 120 VAC, 50/60 Hz power source.

SECTION 4
Maintenance and Repair

The OceanLight LED Underwater Light requires little care other than cleaning and inspection. However, should the light fail, some basic troubleshooting and repair can be performed. This section provides some inspection and cleaning recommendations as well as a basic troubleshooting guide and associated repair instructions.

CAUTION **Do not attempt to disassemble the light housing, as doing so could result in electrical shock or damage to the light. The troubleshooting and repair information in this manual is for qualified technicians only.**

Cleaning and Inspecting the OceanLight

After each use, the OceanLight should be cleaned and carefully inspected as follows:

- Spray the light with clean *fresh* water and clean the lens/reflector to remove any accumulated dirt or debris.
- Inspect the lens/reflector for signs of damage, such as crazing or cracking.
- Inspect the light housing for signs of corrosion.
- Check around the base of the bulkhead connector for signs of crevice corrosion. If crevice corrosion is found, return the light to DSSI.
- Verify that the zinc anodes are secure and are not excessively corroded.
- Inspect for water leakage or condensation, such as moisture on the inside wall of the lens/reflector.
- Verify that the light is oriented correctly and is securely mounted.
- If the light is mounted on a pan and tilt unit, verify that the cable moves freely with the pan and tilt unit and does not bind or catch.
- Check the bulkhead connector for signs of arcing or decay.

Basic Troubleshooting

A basic troubleshooting guide is presented in Table 4-1. It presents a few possible symptoms, possible causes and recommended corrective actions which should be performed in the order presented until the problem is corrected or isolated. For instructions associated with the recommended corrective actions, refer to the repair instructions in this section.

Table 4-1: ***Basic Troubleshooting Guide***

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
The overvoltage indicator turns on when the light is powered and the light flashes once but does not stay on.	The input voltage is too high.	Lower the input voltage to less than 125 VAC.
The overvoltage indicator remains off when the light is powered but the light does not turn on.	The input voltage is too low or not present.	Disconnect the cable from the light and verify that the AC voltage is at least 75 VAC across pins 2 and 3 of the CS-MSAJ-3-CCP cable connector.
	The light is too hot.	Disconnect the light from power and allow it to cool.
	The fuse has blown.	Open the light and check the fuse. Replace the fuse if it has blown.
	The power MOSFET has failed.	Measure the resistance across lead pairs of the MOSFET. If all are shorted or completely open, replace the power MOSFET.
	The thermal switch as failed.	Reconnect the cable to the light and verify that both pins of the thermal switch are at the same AC input voltage. Measure the voltage between each pin and the green wire connection. If the voltage is present on only one pin, replace the thermal switch.
	There is insufficient voltage or no voltage to the LEDs.	Check the voltage to the LED Light board. The voltage should be 130–132 VDC for an input voltage of 120 VAC. If not, replace the LED Power Supply board. If the voltage is present, replace the LED Light board.

Repairing the OceanLight

To perform any repairs to the OceanLight, it will be required to open and close the light housing. To open and close the housing, the following tools and materials are required:

- 3/32-inch allen wrench
- No. 243 Loctite
- Lint-free cloth or paper towel
- Silicone lubricant (Molykote 55 or equivalent)
- Filtered, moisture free pressurized propellant (Gust Easy Duster or equivalent)

In addition, depending on the repair, some or all of the following additional tools and materials are required or recommended:

- 7/64-inch allen wrench
- Torque socket wrench and 3/4-inch socket
- Needle nose pliers
- Digital multimeter
- Pencil type soldering iron
- Solder
- Solder wick
- Heat gun
- 1.5-inch 4-40 screw
- 3/16-inch shrink tubing
- Cotton swabs
- Alcohol (70%)
- Thermal grease (Dow Corning 340 Silicone Heat Sink Compound or equivalent)

Opening the Light Housing

To open the light housing:

1. Disconnect the cable from the bulkhead connector on the light.
2. Using a 7/64-inch allen wrench, remove the four 6-32 socket head cap screws and lock washers from the back cover.
3. Remove the cover.

Figure 4-1: *Removing the Four Socket Head Cap Screws and Lock Washers from the Back Cover*

Closing the Light Housing

To close the light housing:

1. Clean the O-ring on the housing with a lint-free cloth or paper towel, and after carefully inspecting the O-ring for any nicks or scratches, apply a thin coat of silicone lubricant.

   If any nicks or scratches are found, replace the O-ring with a 2-242 Viton N70, (OI p/n 0035015). When replacing the O-ring, first clean the O-ring surfaces, and then lightly lubricate the new O-ring with silicone lubricant and install it onto the housing.

WARNING Do not pinch any of the orange, blue and red wires inside the light housing when closing the back cover, as doing so can result in electrical shock if the housing is touched with the power on.

2. Tuck the orange, blue and red wires inside the housing and loosely close the cover.
3. Apply No. 243 Loctite to the four 6-32 socket head cap screws, and then insert them with the lock washers through the holes in the cover and into the housing. Rotate the screws a couple of turns, just enough to catch the housing.
4. Lift the cover partially away from the housing and examine under the cover to verify that the orange, blue and red wires are clear of the cover such they are not pinched when the cover is closed.

Figure 4-2: *Closing the Back Cover*

5. Purge the inside of the housing using the pressurized propellent.
6. Completely close the cover and tighten the four screws.

Checking or Replacing the Fuse

To check or replace the fuse:

1. Open the light housing as described in Opening the Light Housing on page 4-4.
2. Push aside the green, black and white wires to expose the fuse.

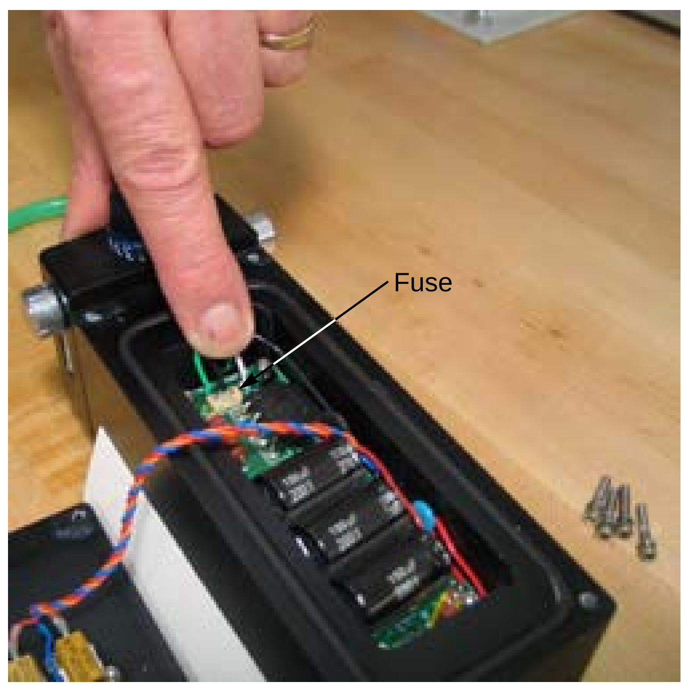

Figure 4-3: *Pushing aside the Green, Black and White Wires to Expose the Fuse*

3. If checking the fuse, use the digital multimeter to measure the continuity across the fuse. If the fuse is good, the multimeter will indicate 0.0–0.1 ohms. If it is bad, the indication will be an open circuit.

If replacing the fuse, use a pair of needle nose pliers to remove the blown fuse as shown in Figure 4-5, and then insert a new fuse (OI p/n 0422856).

Figure 4-4: *Checking the Fuse with a Digital Multimeter*

4. Close the light housing as described in Closing the Light Housing on page 4-4.

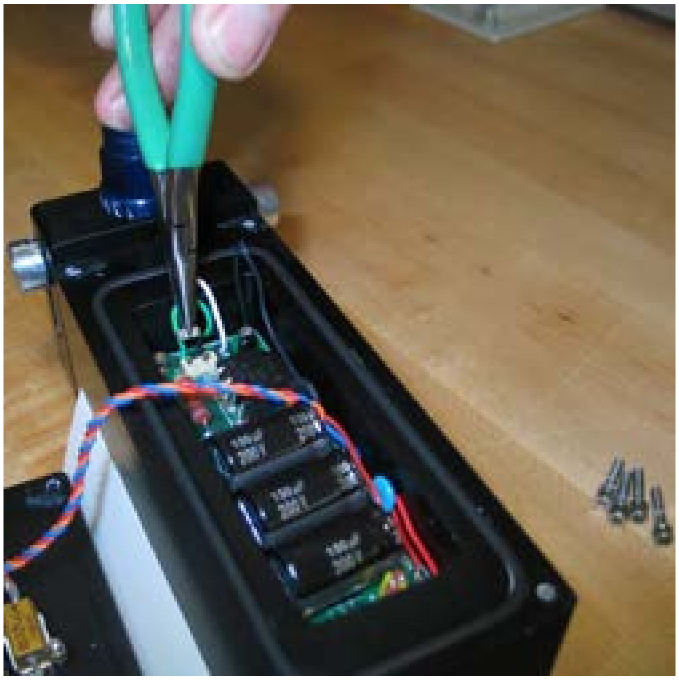

Figure 4-5: *Removing the Fuse*

Checking Voltage to the LED Light Board

The digital multimeter will be required to check the voltage to the LED Light board. The scale, if not automatic, should be set to 200 VDC or higher.

WARNING High voltages are present when the light is connected to power. Use extreme caution when checking the voltage to the LED Light board.

Figure 4-6: *Measuring the Voltage to the LEDs*

To check the voltage to the LED light board:

1. Open the light housing as described in Opening the Light Housing on page 4-4.
2. Connect the light to the AC power source. Refer to SECTION 3, “Installation,” for instructions on how to connect and power the light.

   The light should turn on.
3. Touch the red (+) multimeter probe to the pad labeled "LED+" on the circuit board. This pad has a red wire soldered to it as shown in Figure 4-6.
4. Touch the black (–) multimeter probe to the pad labeled "LED–" on the circuit board. This pad has a black wire soldered to it.
5. Read the voltage indication on the multimeter.

   The voltage should be approximately 130–132 VDC for a 120 VAC input.
6. Disconnect the AC power source.
7. Close the light housing as described in Closing the Light Housing on page 4-4.

Replacing the Power MOSFET or the Thermal Switch

Replacement of the power MOSFET and all references to it apply to the G2 version of the light only. Replacement of the thermal switch applies to both the G1 and G2 versions.

To replace the power MOSFET or the thermal switch:

1. Open the light housing as described in Opening the Light Housing on page 4-4.
2. Perform Steps 1 through 7 of Replacing the LED Power Supply Board on page 4-11.
3. If removing the power MOSFET, use the 3/32-inch allen wrench to remove the 4-40 socket head cap screw which is shown in Figure 4-7, and then remove the bushing, the power MOSFET and the insulator pad. These components are shown in Figure 4-8.

   If removing the thermal switch use the 3/32-inch allen wrench to remove the 4-40 socket head cap screw that secures it and remove the component.

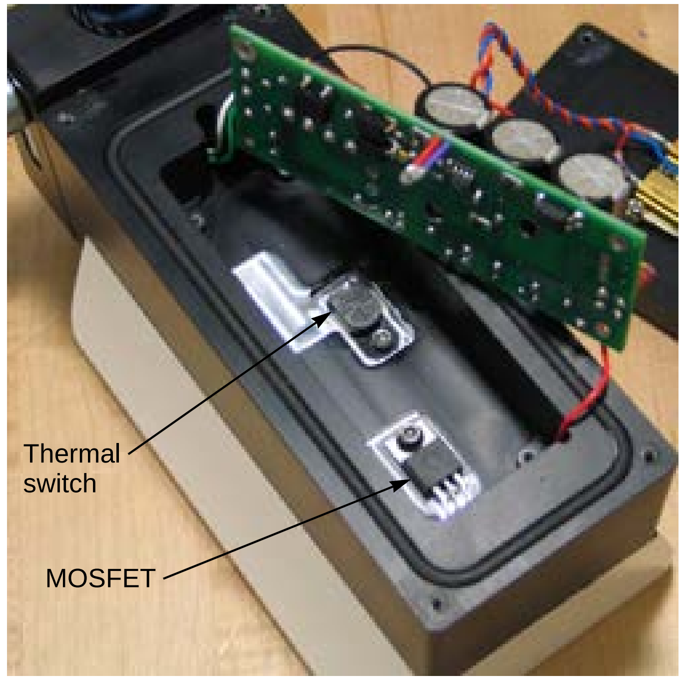

Figure 4-7: *Power MOSFET and Thermal Switch*

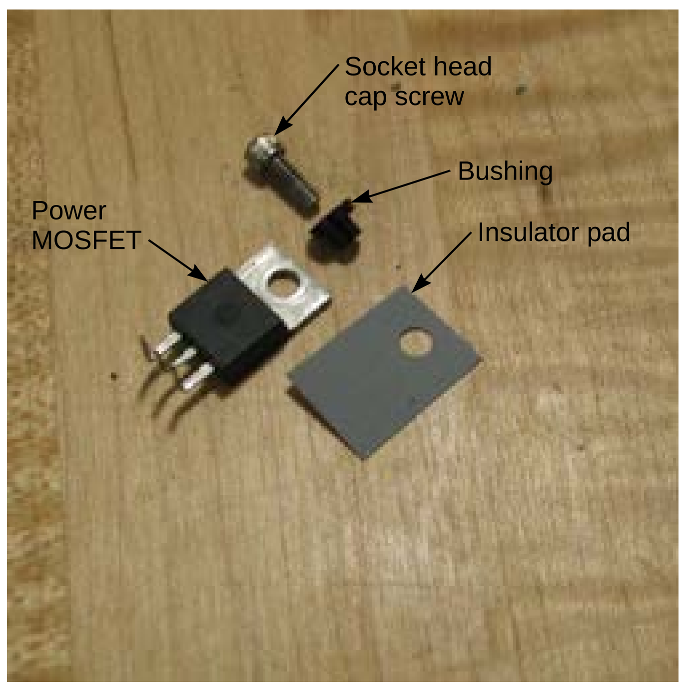

Figure 4-8: *Power MOSFET, Socket Head Cap Screw, Bushing, and Insulator Pad*

4. If replacing the power MOSFET, the insulator pad (OI p/n 0403247) and the bushing (OI p/n 0403145) should also be replaced. Apply a light coat of thermal grease to the housing where the component is to lie, and then place the insulator pad on the grease, lining the hole in the pad with the hole in the housing.

   If replacing the thermal switch, apply a small amount of thermal grease to the housing where the thermal switch is to lie. Apply No. 243 Loctite to the 4-40 socket head cap screw, and then secure the component to the housing.

Figure 4-9: *Insulator Pad in Position*

5. If replacing the power MOSFET, insert the bushing into the hole in the metal tab of the component, and then position the assembly on the housing in the same orientation as the original.

6. Apply No. 243 Loctite to the 4-40 socket head cap screw, and then secure the power MOSFET to the housing.

Figure 4-10: *Power MOSFET Positioned with Bushing Installed*

7. If the power MOSFET was replaced, use the digital multimeter to measure the resistance between the tab of the component and the socket head cap screw. The measurement should indicate an open circuit.

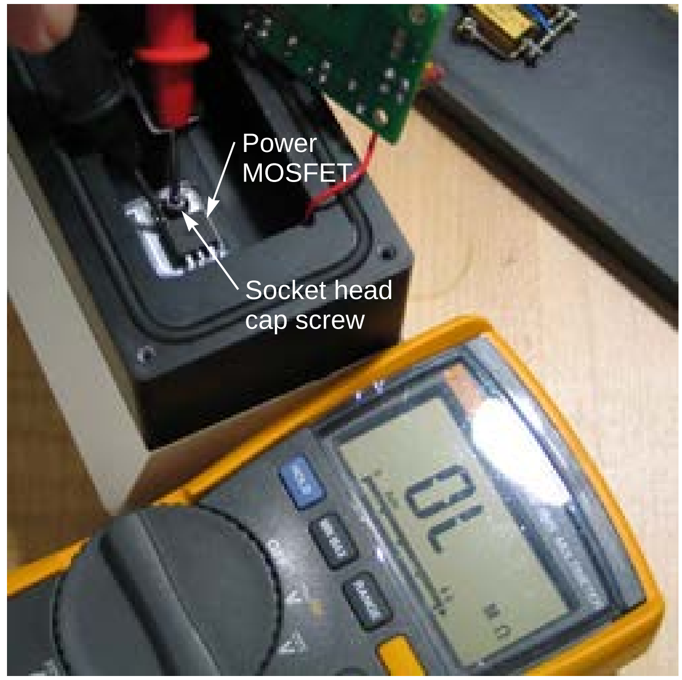

Figure 4-11: *Measuring the Resistance between the Tab of the Power MOSFET and the Socket Head Cap Screw*

8. Install the LED Power Supply board into the housing, being careful to insert the leads from the power MOSFET into the three pads, and the thermal switch, into the two pads. In addition, ensure that the red LED is inserted into the hole in the inside bulkhead of the housing.
9. Apply No. 243 Loctite to the four 4-40 socket head cap screws, and then secure the board to the housing using these screws and the four lock washers.
10. Solder the pins of the power MOSFET and the thermal switch to the tabs.
11. Clean the pads with a cotton swab wetted with 70% alcohol.
12. Close the light housing as described in Closing the Light Housing on page 4-4.

Replacing the LED Power Supply Board

To replace the LED Power Supply board:

1. Open the light housing as described in Opening the Light Housing on page 4-4.
2. Using the 3/32-inch allen wrench, unscrew the four 4-40 socket head cap screws securing the LED Power Supply board to the housing, and then use the needle nose pliers to extract the screws and lock washers as shown in Figure 4-13.

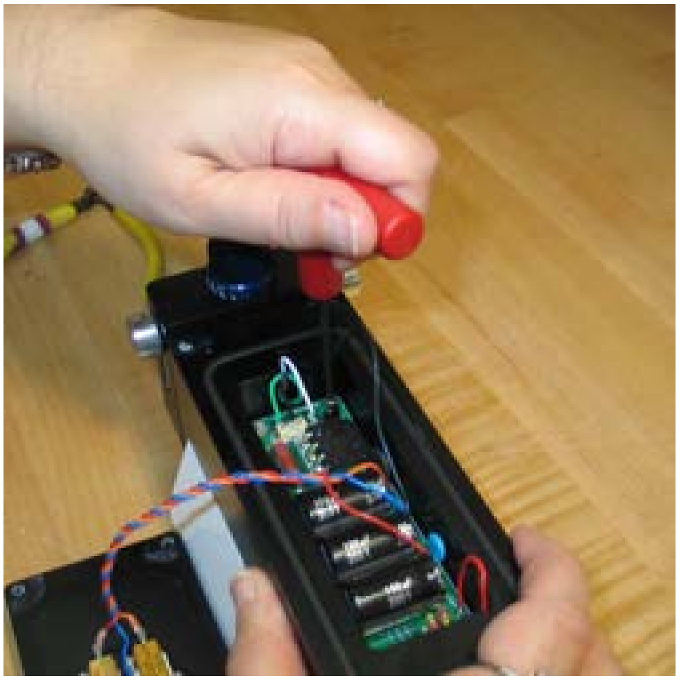

Figure 4-12: *Unscrewing the LED Power Supply Board Mounting Screws*

Figure 4-13: *Extracting the LED Power Supply Board Mounting Screws and Lock Washers*

3. Making sure that there are no wires in the way, use the soldering iron and the solder wick to remove the solder from the two pads at the center of the board. The thermal switch is soldered to these pads and is located under the board and mounted to the housing.

4. Use the needle nose pliers to wiggle the leads inside the pad holes to ensure that they are free. Apply more heat to the leads if required.

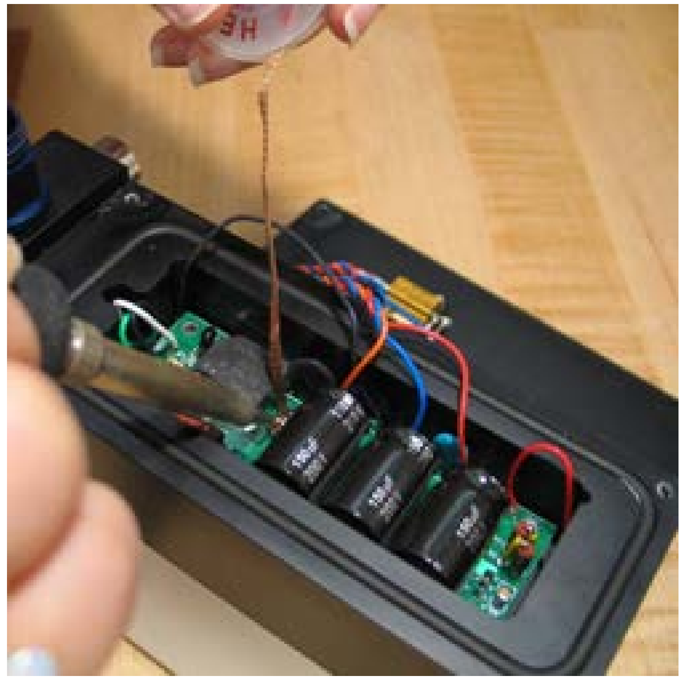

Figure 4-14: *Removing the Solder from the Two Pads at the Center of the LED Power Supply Board*

5. For the G2 version of the light only, and in a similar manner as above, remove the solder from the three pads at the end of the board. The pads are the ones that are lined up close to each other in a single row. The power MOSFET is soldered to these pads and is located under the board and mounted to the housing.

Figure 4-15: *Removing the Solder from the Three Pads at the End of the LED Power Supply Board*

6. While using the soldering iron to reheat the leads and pads, grip the mounting hole at a corner of the board with the needle nose pliers and gently lift the board to free it from the leads. If preferred, you can instead tug on one of the pins of the full wave bridge as shown in Figure 4-17, or you can gently pull on the orange, blue and red wires together.

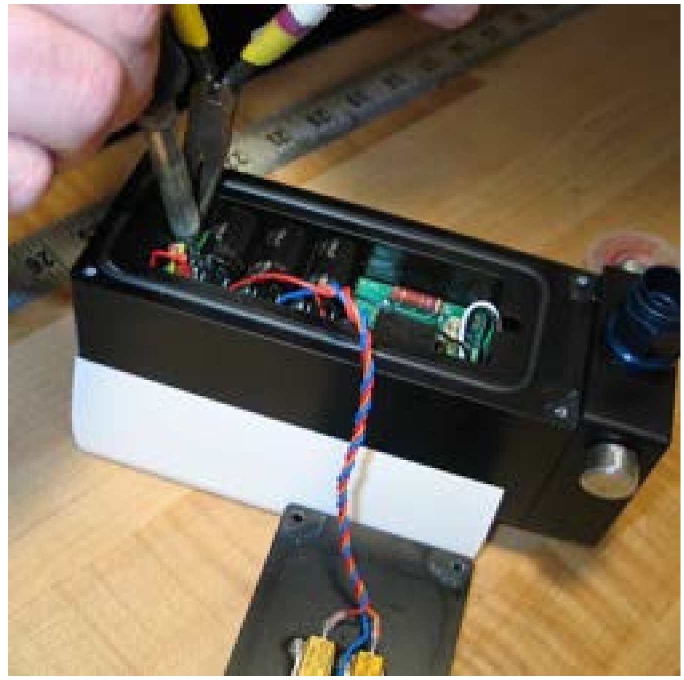

Figure 4-16: *Tugging at a Corner of the LED Power Supply Board to Remove It*

NOTE **If removing the board proves difficult, add a small amount of solder to the pads, and while heating the solder to melt it, extract the board.**

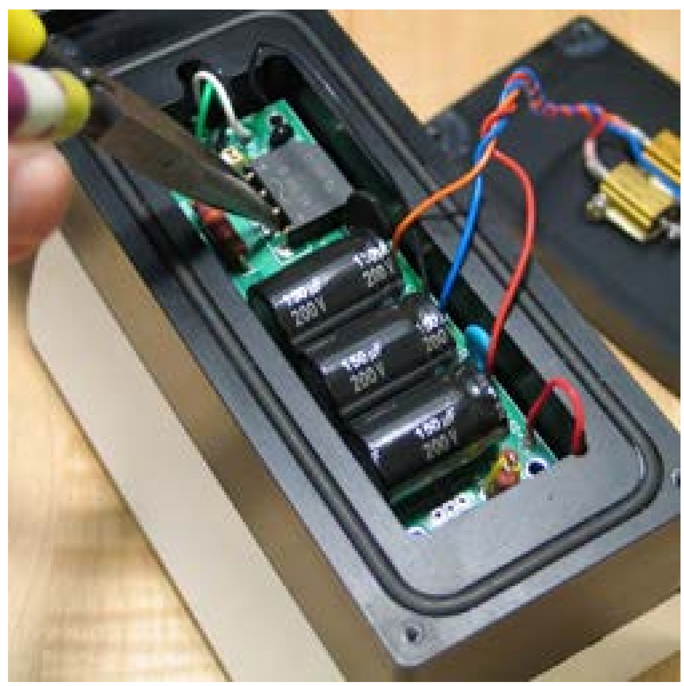

Figure 4-17: *Tugging on a Pin of the Full Wave Bridge to Remove the LED Power Supply Board*

7. Using the soldering iron and the solder wick, remove as much solder as possible from the pads where the leads were removed, both on the top and on the bottom of the board.

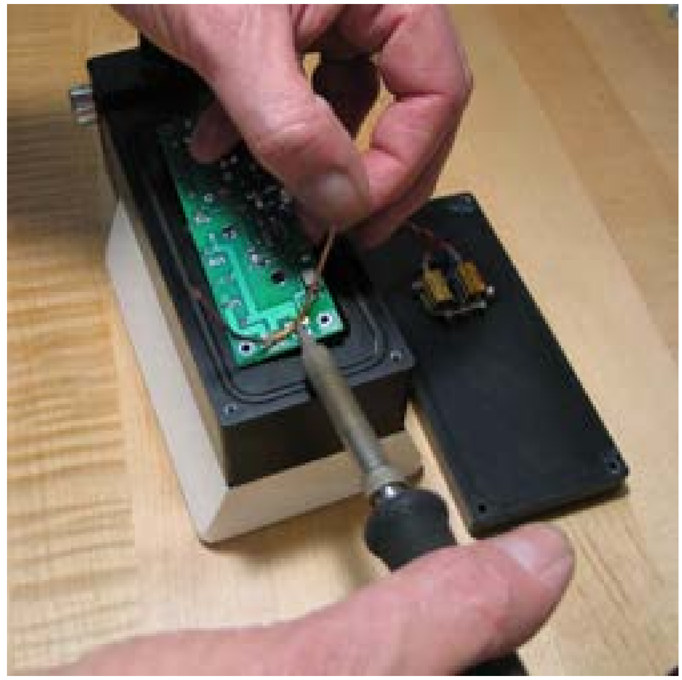

Figure 4-18: *Removing Solder from the Pads*

8. Using a cotton swab wetted with 70% alcohol, clean the pads where the leads were removed.

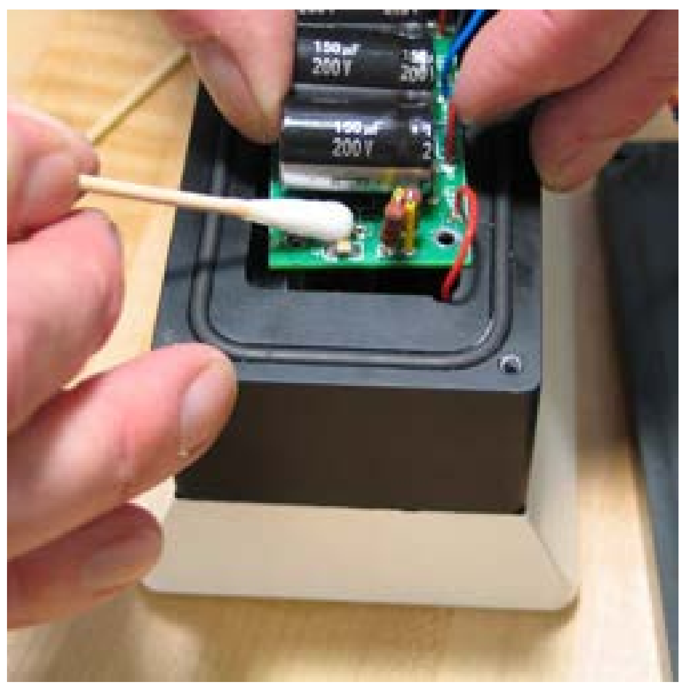

Figure 4-19: *Cleaning the Pads with a Cotton Swab Wetted with 70% Alcohol*

9. Unsolder and disconnect the white, black and green wires from the board.

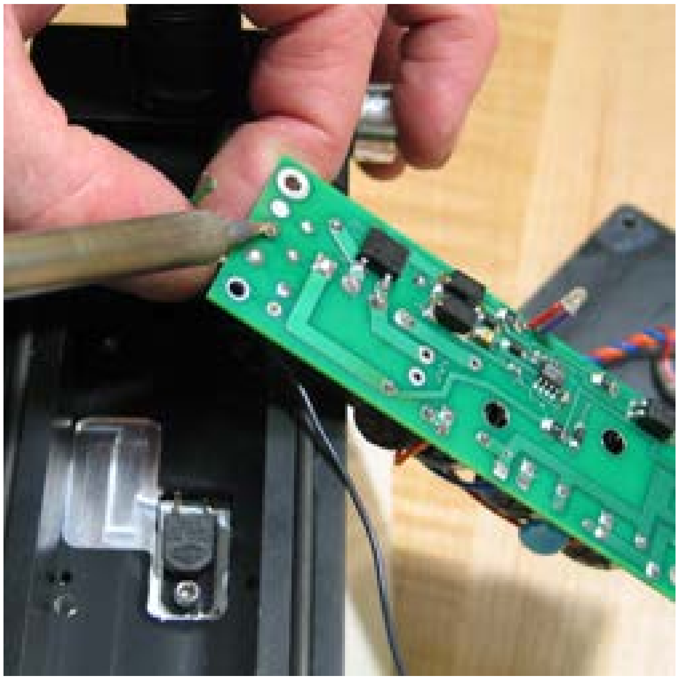

Figure 4-20: *Unsoldering the White, Black And Green Wires*

10. Unsolder and disconnect the orange, blue and red wires from the board.

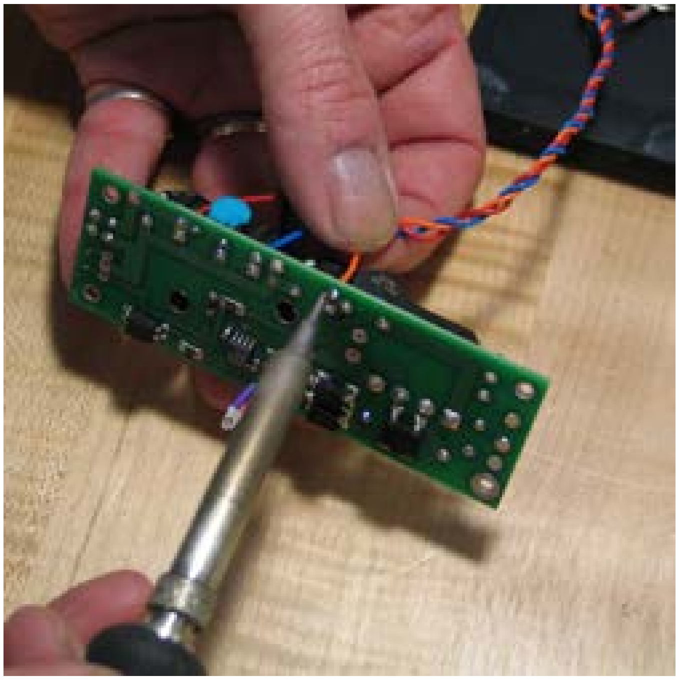

Figure 4-21: *Unsoldering the Orange, Blue and Red Wires*

11. The new LED Power Supply board will include the orange, blue and red wires attached. Unsolder and disconnect these wires.

12. Solder the old orange, blue and red wires to the pads on the new LED Light board in accordance with Table 4-2.

Table 4-2: ***Orange, Red and Blue Wire Connections to LED Light Board***

WIRE COLOR	PAD LABEL
Orange	R2
Blue	R2/3
Red	R3

13. Solder the white, black and green wires to the pads on the new LED Light board in accordance with Table 4-3.

Table 4-3: ***White, Black and Green Wire Connections to LED Light Board***

WIRE COLOR	PAD LABEL
White	N
Black	L
Green	G

14. Install the board into the housing, being careful to insert the leads from the power MOSFET into the three pads, and the thermal switch into the two pads. In addition, ensure that the red LED is inserted into the hole in the inside bulkhead of the housing.

15. Apply No. 243 Loctite to the four 4-40 socket head cap screws, and then secure the board to the housing using these screws and the four lock washers.

16. Solder the pins of the power MOSFET and the thermal switch to the tabs.

17. Clean the pads with a cotton swab wetted with 70% alcohol.

18. Close the light housing as described in Closing the Light Housing on page 4-4.

Replacing the LED Light Board

To replace the LED Light board:

1. Open the light housing as described in Opening the Light Housing on page 4-4.
2. Unsolder and disconnect the red and black wires from the LED Power Supply board.

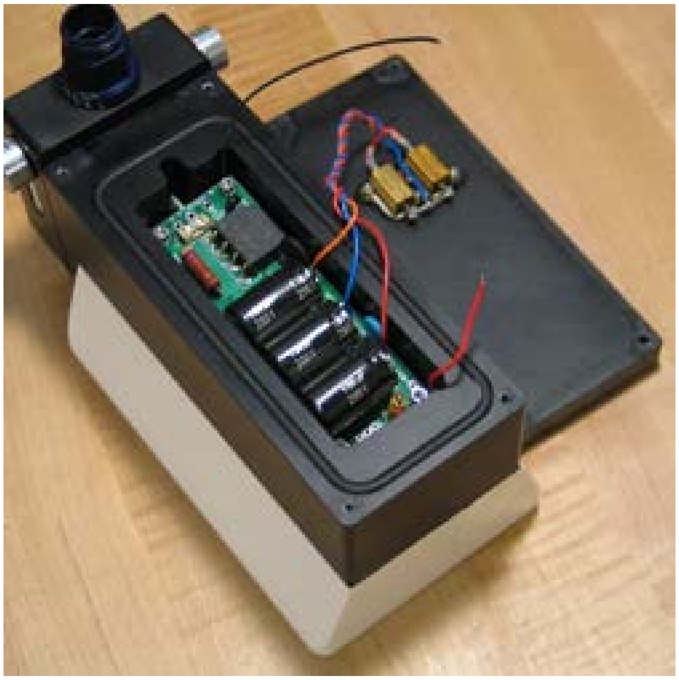

Figure 4-22: *Red and Black Wires Disconnected from LED Power Supply Board*

3. Using the 7/64-inch allen wrench, remove the four 6-32 socket head cap screws and lock washers from the plexiglass window, and then remove the window.

Figure 4-23: *Removing the Four Socket Head Cap Screws and Lock Washers from the Plexiglass Window*

4. Using the 3/32-inch allen wrench, remove the six 4-40 socket head cap screws and lock washers from the LED light board.

Figure 4-24: *Removing the Six Socket Head Cap Screws and Lock Washers from the LED Light Board*

5. Using the 3/32-inch allen wrench, remove a mounting screw and lock washer from any corner of the LED Power Supply board.
6. Temporarily install a 1.5-inch long 4-40 socket head cap screw, such as OI p/n MF191-S05-17 or equivalent, into this corner, slowly turning the screw to push out the LED Light board on the opposite side.

Figure 4-25: *Temporarily Installing a 1.5-Inch 4-40 Socket Head Cap Screw*

7. Completely remove the LED Light board, pulling the red and black wires completely out of the housing.

8. Remove the temporarily installed screw and install the original screw and lock washer.

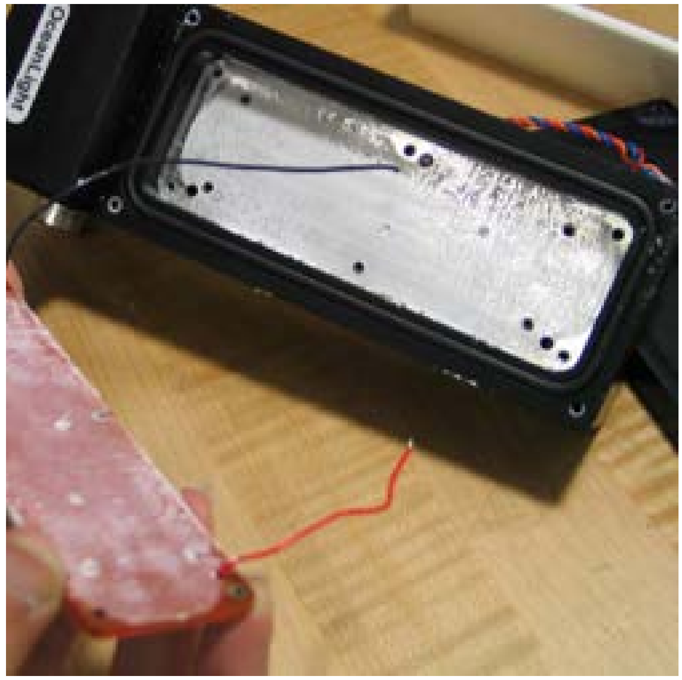

Figure 4-26: *Removing the LED Light Board*

9. Using one or more cotton swabs, remove most of the thermal grease from wall of the housing.

Figure 4-27: *Removing the Thermal Grease from the Wall of the Housing*

10. Using a cotton swab, apply a thin layer of thermal grease over about one third of the surface of the inside bulkhead of the housing, working from the middle outward.

Figure 4-28: *Applying Thermal Grease over about One Third of the Surface of the Inside Bulkhead*

11. Slide the wires of the new LED Light board through the larger holes in the bulkhead, and then carefully lay the board into position flat against the bulkhead. Be careful not to pinch the wires between the board and the bulkhead by gently pulling the wires from the opposite side of the housing as you install the board.

12. Solder the red wire to the pad labeled "LED+" and the black wire to the pad labeled "LED–."

Figure 4-29: *Inserting the Red and Black Wires of the LED Light Board through the Holes in he Bulkhead*

13. Apply No. 243 Loctite to the six 4-40 socket head cap screws, and then secure the LED Light board to the housing using these screws and the six lock washers.

14. Clean the O-ring on the LED Light board side of the housing with a lint-free cloth or paper towel, and after carefully inspecting the O-ring for any nicks or scratches, apply a thin coat of silicone lubricant.

    If any nicks or scratches are found, replace the O-ring with a 2-242 Viton N70, (OI p/n 0035015). When replacing the O-ring, first clean the O-ring surfaces, and then lightly lubricate the new O-ring with silicone lubricant and install it onto the housing.

15. Apply No. 243 Loctite to the four 6-32 socket head cap screws, and then secure the plexiglass window to the housing using these screws and the four lock washers.

16. Close the light housing as described in Closing the Light Housing on page 4-4.

Replacing the Bulkhead Connector

For information on the bulkhead connector, refer to Drawing E-1003-LED-9.

To replace the bulkhead connector:

1. Open the light housing as described in Opening the Light Housing on page 4-4.
2. Unsolder and disconnect the white, black and green wires from the LED Power Supply board.
3. Using the torque socket wrench and 3/4-inch socket, slightly loosen the bulkhead connector. Do not loosen it more than one turn.

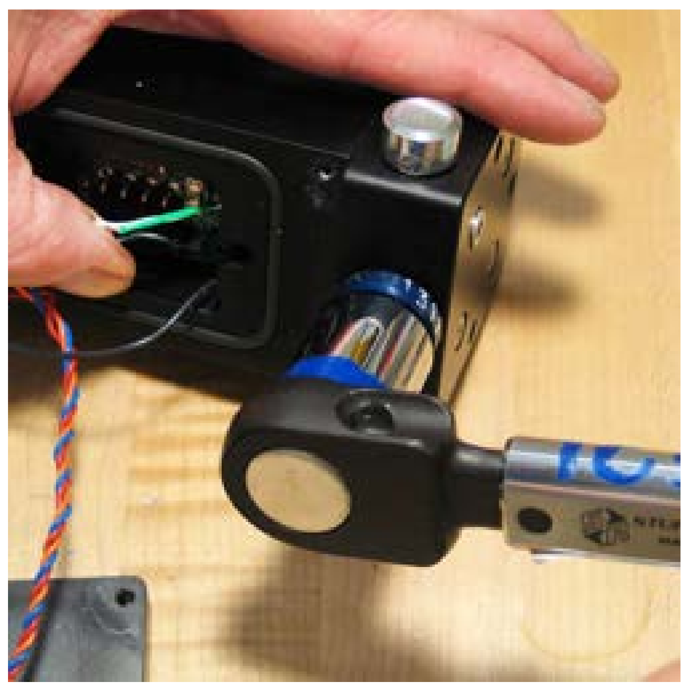

Figure 4-30: *Loosening the Bulkhead Connector*

4. Make a note as to which side the bulkhead connector is facing. This will ensure that when reassembling the connector block to the housing, the connector will be facing as it was originally.

5. Using a 5/32-inch allen wrench, remove the four 10-32 socket head cap screws and lock washers on the connector block at the bottom of the light, and then carefully pull the connector block away from the housing.

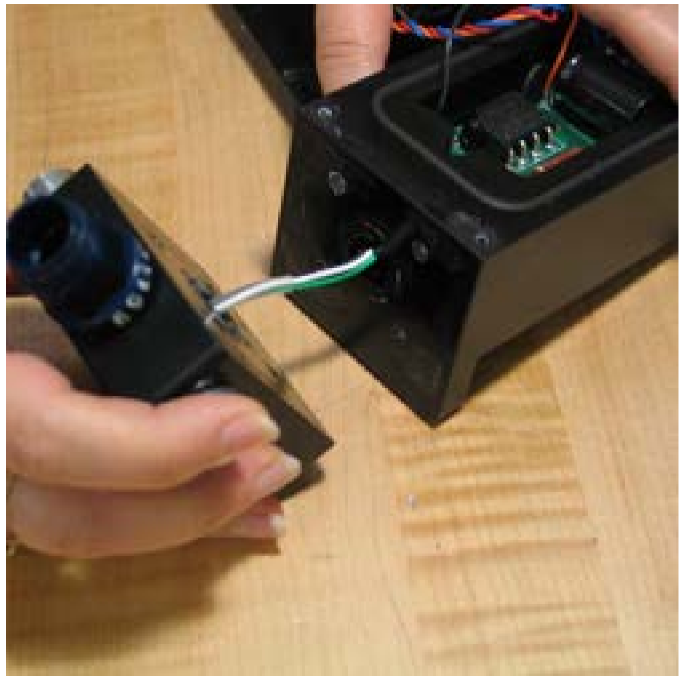

Figure 4-31: *Pulling the Connector Block away from the Housing*

6. Using the torque socket wrench, continue loosening the connector until it can be turned by hand.

Figure 4-32: *Continuing to Loosen the Bulkhead Connector*

7. Completely remove the connector along with its attached wires.

Figure 4-33: *Removing the Bulkhead Connector and its Attached Wires*

8. Remove the O-ring at the center of the connector block.
9. Bend the leads of the new connector such that when inserted into the connector block it will be easier to thread the leads through the hole in the center of the block.
10. Apply No. 243 Loctite around the threads of the new bulkhead connector.
11. Insert the connector wires into the side of the connector block and thread them through the block and out the center of the block.

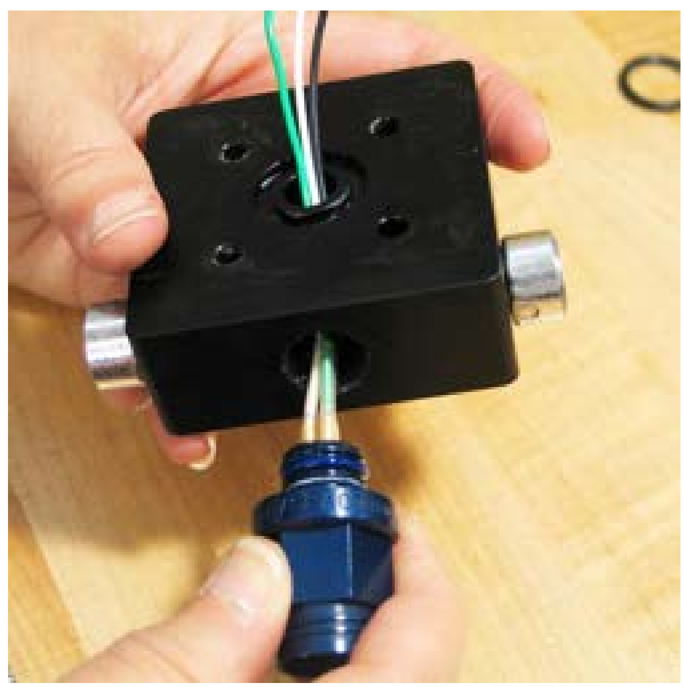

Figure 4-34: *Installing the Bulkhead Connector after Applying No. 243 Loctite to the Connector Threads*

12. Install the connector and hand tighten it first. Then use the torque socket wrench to tighten it to 100 inch-pounds.

13. Slip a 1.5-inch long piece of 3/16-inch shrink tubing over the wires and position the mid point of the tubing inside the hole in the connector block where the wires turn upward. The tubing will provide some protection for the wires.

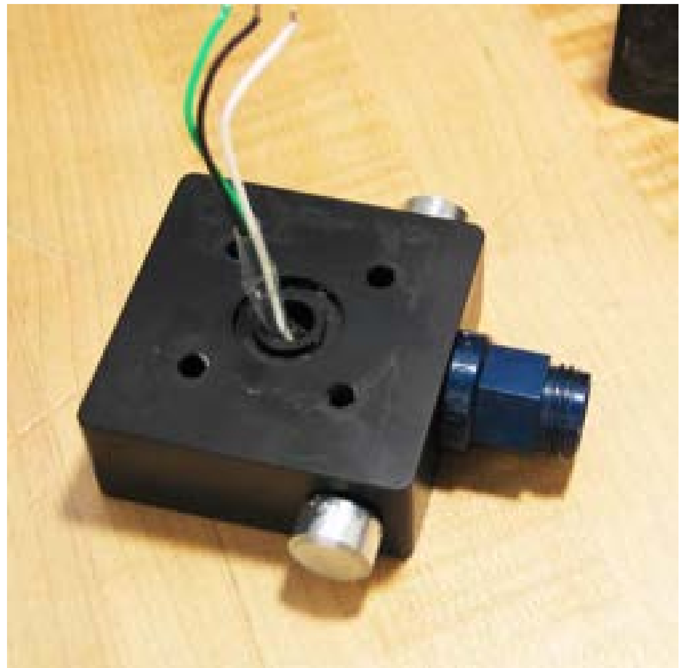

Figure 4-35: *Shrink Tubing Installed over Connector Wires*

14. Using the heat gun, carefully heat the shrink tubing to shrink it.

15. Clean the O-ring removed earlier with a lint-free cloth or paper towel, and after carefully inspecting the O-ring for any nicks or scratches and cleaning the O-ring surfaces, apply a thin coat of silicone lubricant to the O-ring and install it into the O-ring groove on the connector block.

    If any nicks or scratches are found, replace the O-ring with a 2-114 Viton N70, (OI p/n 0399258). When

Figure 4-36: *Shrink Tubing Shrunk over Bulkhead Connector Wires and O-Ring Installed*

replacing the O-ring, first clean the O-ring surfaces, and then lightly lubricate the new O-ring with silicone lubricant and install it into the O-ring groove on the connector block.

CAUTION **Be sure to install the O-ring into the O-ring groove on the connector block. Failure to do so will cause the housing to leak water.**

16. Insert the connector wires through the hole in the housing, and then solder the white, black and green wires to the pads on the LED Light board in accordance with Table 4-3 on page 16.

17. Position the connector block against the housing, orienting the connector as noted earlier, or the orientation can be changed if desired.

18. Apply No. 243 Loctite to the four 10-32 socket head cap screws, and then secure the connector block to the housing using these screws and the four lock washers.

19. Close the light housing as described in Closing the Light Housing on page 4-4.

SECTION 5
Drawings

This section comprises a list of outline drawings and wiring diagrams required to install and maintain the OceanLight LED Underwater Light. The drawings are included on the CD with this manual in Portable Document Format (PDF). They can be opened using Adobe Reader.

0343644	OceanLight LED Underwater Light Assembly, G1
0343644-II	OceanLight LED Underwater Light Assembly, G2
E-1003-LED-9	3-Pin Bulkhead Connector Whip, G1 and G2
0343644-5	LED Light Board Schematic, G1 and G2
0343644-6	LED Power Supply Board Schematic, G1
955001938	LED Power Supply Board Schematic, G2