MARINE TAXONOMIC SERVICES. LTD.
AN NV5 COMPANY

San Elijo Ocean Outfall 2025 Inspection Report

February 20, 2026

Prepared for:

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1 Introduction

The San Elijo Joint Powers Authority (SEJPA) contracted Marine Taxonomic Services, an NV5 company (MTS), to complete the Year 2025 San Elijo Ocean Outfall (SEOO) inspection. Diving operations were conducted on December 5, 2025, and December 10, 2025. Remote operated vehicle (ROV) operations were conducted on December 17 and 18, 2025. Data analyses immediately followed the field effort. The inspection effort included the following elements:

- General diver overview inspection of the outfall corridor from the end cap to burial inshore attentive to the following criteria: Evidence of spalling of the exposed concrete surfaces, cracks or other deficiencies in the outfall, joint integrity, leaks or evidence of degradation, potential hazards, attrition or the loss of efficacy of the ballast material as a result of physical, biological, or geological processes, scouring of the nearby marine sediments, and manmade debris;
- Evaluation of cathodic protection at exposed anodes;
- Clearing kelp that hindered inspection activities or threatened the ballast material;
- Photographic and video documentation;
- Pile support survey;
- Zinc anode replacement;

Procedures, results, analyses, and implications are reviewed here for all elements comprising this project. This report also contains background information regarding the SEOO and a discussion of oceanographic processes (Appendix A) that could affect its structural integrity. Digital video and still images support written descriptions. Full copies of the video records are included on a USB drive with this report. The video log details and notes are included in Appendix B. Photos of all diffuser ports are included in Appendix C. Photos of marine organisms observed along the SEOO are provided in Appendix D.

1-1 Project Background

The SEOO was commissioned in 1965 to discharge treated effluent from the San Elijo Water Reclamation Facility (formally known as the San Elijo Water Pollution Control Facility). In 1974, the Hale Avenue Resource Recovery Facility was connected to the original outfall structure, and the outfall was extended to its current length of 8,000 feet. Given environmental regulations regarding discharges into marine waters and increasing demands on the infrastructure over the past 4 decades, it has been imperative that the pipeline be maintained and monitored for potential damage. To this end, the SEJPA has contracted numerous surveys of the outfall pipeline. This report presents the results of the 2025 survey performed by MTS. Given the large volume of information collected during previous monitoring events, it would be inappropriate to compile this report without including data and information presented in previous reports. For this reason, some of the language, figures, and data presented in this report originated from previous monitoring reports prepared for the SEJPA. The contribution of numerous individual Thales Geosolutions, Inc. reports are acknowledged here but are not cited in this document. The reports and their contents are the property of the SEJPA.

1-2 Outfall Configuration

The SEOO carries treated effluent from the San Elijo Water Reclamation Facility and the Hale Avenue Resource Recovery Facility. It is then transported through the outfall and discharged into the ocean; the discharge is approximately one-and one-half miles from shore at an approximate water depth of 150 feet. The general location of the outfall is shown in Figure 1.

Construction of the original SEOO was completed in 1965. It consisted of a 30-inch diameter reinforced concrete pipeline terminating approximately 4,000 feet offshore. Effluent was discharged at a water depth of 60 feet below the Mean Lower Low Water (MLLW) datum. In 1974, the outfall was extended to a water depth of 150-feet MLLW, approximately 8,000 feet offshore using 48-inch diameter reinforced concrete pipe. The diffuser ports in the original 30-inch diameter line were blocked with fiberglass covers at the completion of the extension. Effluent is presently discharged through a single 1,176-foot-long diffuser section that is composed of two hundred individual two-inch nominal diameter diffuser ports at the end of the 48-inch extension.

Several projects have been executed to keep the outfall in a stable, clean, and efficient operating condition. Re-ballasting projects were conducted inshore of the 55-foot isobath in 1982, 1987, 1993, 1996 and 2005 to replace ballast that had been moved away from the outfall by ocean processes. The erosion of beach sediments from the shoreline, which is occurring all along the southern California coast, has caused exposure and undermining of the most inshore portion of the outfall that was previously buried well beneath the beach sand. To secure this vulnerable stretch of pipe, the pipe was clamped to piles driven into the surrounding sediments in the summer of 1992. In late 1993, additional ballast was placed around the pipe between the water depths of 55 and 85 feet. This 1993 re-ballasting spans the deepest portion of the 30-inch pipe, including the old diffuser section, and the shallow portion of the 48-inch pipe. The new large ballast replenished and augmented the original four-inch quarry rock that was placed around the outfall at the installation of the pipeline. Prior to placing the ballast in 1993, the fiberglass covers that had previously sealed the diffuser ports in the 30-inch leg of the outfall were all replaced by titanium expansion plugs.

The 1996 re-ballasting project stabilized the inshore zone of the ballast pile where a significant drop in the sand level had caused the ballast to move away from a protective position around the pipe. The zone where the pipeline support transitions from pile/clamp assemblies to rip-rap ballast was significantly enhanced, creating an overlap between the two support systems. In addition, several areas within two hundred feet of this transition that had exhibited low ballast coverage were augmented.

The 2005 re-ballasting project included the replacement of zinc anodes used to protect metal supports and access ports, replacement of ballast rock that had shifted away from the structure due to ocean currents and wave energy and the cleaning of the diffuser ports at the end of the structure. Construction commenced in September 2005 and was completed by mid-October 2005. More than 7,365 tons of ballast rock was placed along the length of the outfall and the outfall's 200 diffuser ports were cleaned.

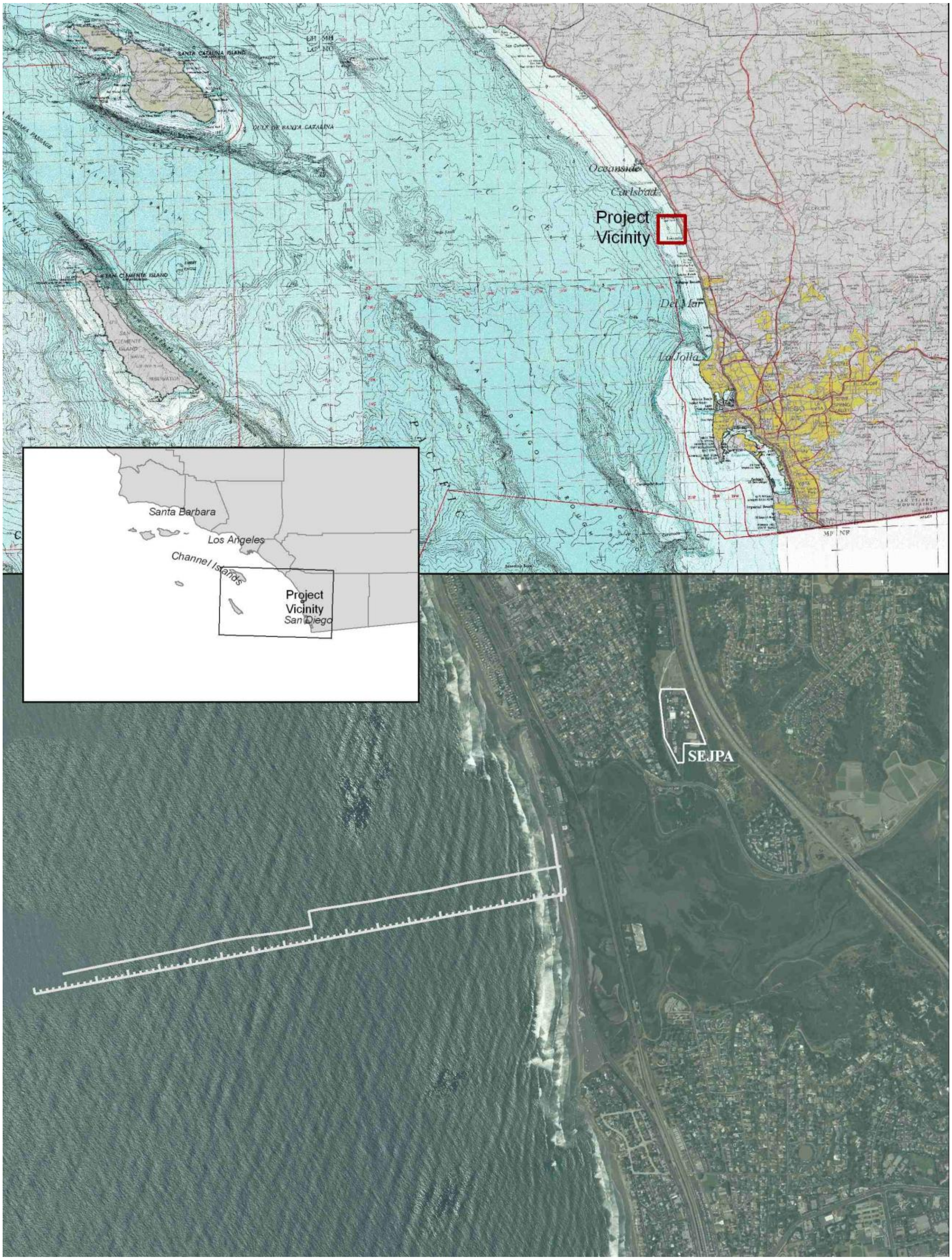


Figure 1. Map displaying San Elijo Joint Powers Authority (SEJPA) location relative to project vicinity.

1-3 Project Summary

MTS performed the Year 2025 SEOO inspection and anode maintenance at the request of the SEJPA. MTS provided SEJPA with the range of services noted in the Request for Proposals (RFP). The inspection involved diver examination of the outfall from the end cap to burial at shore, evaluation of exposed portholes, evaluation of cathodic protection at exposed anodes, kelp clearing, a pile support survey, and diffuser section survey. The anode maintenance involved replacing any anodes that were close to exhaustion or no longer providing cathodic protection to the SEOO.

Photo and video documentation were collected along the entire outfall. The purpose of the inspection was to look for evidence of spalling of the exposed concrete surfaces, cracks or other signs of wear or degradation of the outfall structure. This includes inspecting joint integrity for leaks or evidence of degradation, inspecting diffuser flow, evaluating for other potential hazards and checking attrition or the loss of efficacy of the pipe ballast material.

In general, the SEOO was found to be in excellent overall condition. All areas of the pipeline were stable, and the ballast showed minimal signs of movement based on the diver survey. The outfall showed no signs of spalling, rust staining, or cracking. No leaks were detected. Anodes on the exposed portholes were in good condition and have greater than 50% remaining life expectancy. There were 26 pile supports exposed during this survey, a significantly higher number than that of previous survey years. While all pile supports were cathodically protected, some anodes required replacement or removal. Anodes were added or replaced to pile supports that required additional protection during this survey. Portholes 4, and 5 were not inspected on this survey as, similar to the previous survey, they were buried in shell hash and could not be excavated for inspection. Porthole 1 was not able to be located by divers on this survey and is presumed to also have been buried by shell hash. A separate effort would be required to complete excavation of the buried portholes. Along the base of the pipe, the divers observed numerous large California spiny lobsters (*Panulirus interruptus).* The lobsters were located predominantly in the diffuser portion of the pipe where it appeared they had excavated substrate to create burrows for hiding.

2 Methods and Materials

Numerous techniques were incorporated in executing the current inspection tasks, which were tactically arranged to maximize diver efficiency and safety. In previous surveys, technical divers were used to inspect the entire length of the SEOO. However, due to safety concerns a remotely operated vehicle (ROV) was used to inspect the deeper section of the SEOO whereas SCUBA divers were used to inspect the shallower section. A Blue Robotics BlueROV2 remotely operated vehicle (ROV) was used to inspect and record video from the end of the SEOO to the transition zone. Divers inspected and recorded video from the transition zone to the inshore burial of the pipeline. Additionally, divers were used to inspect and conduct maintenance on anodes at the pile supports.

2-1 Vessel

Two MTS marine research vessels were mobilized for the outfall inspection: a Sea Ray and a Koffler. The 24-foot Sea Ray was used for the diving portion of the survey and was equipped with all essential diving, safety, navigation, and inspection equipment. The Koffler, a 22-ft aluminum survey vessel, served as the ROV platform and carried the necessary power systems to operate an onboard i7 computer running QGroundControl, as well as to charge depleted ROV batteries throughout the survey. Both vessels were transported to and launched from Oceanside Harbor, and all vessel equipment was inspected after each launch to ensure proper working order.

2-2 General Diver Inspection

MTS conducted a general overview inspection of the entire exposed portion of the outfall from the end cap toward shore. During operations, staff was attentive to the following criteria:

- Evidence of spalling of the exposed concrete surfaces;
- Cracks or other deficiencies in the outfall;
- Joint integrity;
- Leaks or evidence of degradation;
- Potential hazards;
- Attrition or the loss of efficacy of the ballast materials as a result of physical, biological, or geologic processes;
- Grading of ballast according to size as a result of oceanographic forces;
- Scour of the nearby marine sediments; and
- Man-made debris;
- Porthole leaks and anode inspection
- Anode inspection at pile supports

General pipeline inspection was achieved by divers and ROV. Shallow water portions of the diver survey were completed by SCUBA. A two-person dive team swam with a hand-held video camera on each side of the pipeline. The divers operated Go-Pro Hero 9 digital video cameras while performing the inspection from the transition zone to the inshore burial of the pipeline. The ROV was equipped with a camera and was navigated down both sides of the pipeline from the end to the transition zone.

2-3 Porthole Inspection

A visual evaluation was conducted of the exposed surfaces for mechanical/structural integrity including examination for leaks, fractures, gasket seal integrity, concrete spalling, etc. The sacrificial anodes were inspected for expected remaining lifespan. There are five portholes along the original 30-inch diameter portion of SEOO. These portholes consist of a circular, Ni-Resist cast iron plate bolted to a flanged riser. A 5/16-inch-thick gasket, composed of neoprene, creates a seal between the cover and the flange. Sacrificial zinc anodes provide cathodic protection to the exposed metallic surfaces of the porthole covers and risers. All exposed portholes were inspected.

2-4 Pile Support Survey

In 1993, thirty-five pile-support assemblies were installed around the pipe between stations 4+41 and 9+69. Piles were driven through the sand to underlying bedrock on both sides of the pipe. Clamps between each pair of pile supports were bolted securely around the pipe and grouted to the piles in pile boxes. Anodes were welded to the pile boxes to provide cathodic protection to the metallic clamps and the piles. In 2005, additional anodes were clamped onto exposed pile supports but broke loose because of poor construction. Roughly each year, broken or exhausted anodes are replaced if the anodes are exposed. A complete visual inspection of the metal pipe shield and the pile supports exposed at the time of the survey was performed and anodes were replaced as necessary

2-5 Diffuser Port Inspection

The diffuser port inspection was completed by visually observing each port with the ROV. The ROV video was monitored at the time of the survey by a technician topside on the vessel. The ROV was deployed on the south side of the SEOO at the offshore end of the ballasted section and then navigated offshore until the diffuser section. Video was recorded at the start of the port diffuser section to the endcap of the SEOO. The ROV was then navigated to the north side of the pipeline and recorded the port diffusers on the north side of the SEOO. The ROV visually observed a total of 200 diffuser ports, 100 on the northern side and 100 on the southern side of the diffuser port segment of the pipe. Each diffuser port was inspected for the presence of biofouling and any other obstructions that may interfere with the proper function of the diffuser port.

3 Results

3-1 General Diver and Deep Inspection

During this present inspection, a visual examination of SEOO's reinforced concrete pipeline was completed on all exposed portions. The condition of the visible portions of the pipeline was generally found to be good. There was no evidence of spalling, cracking or other deficiencies in the concrete pipe. All observed joints were in alignment with no evidence of leaks. There were minimal debris items that could potentially affect the pipeline. Biofouling, or the undesirable accumulation of microorganisms, plants and animals on artificial surfaces, of the deeper pipeline sections was minimal and not expected to have an impact on the pipeline. There were a few instances of giant kelp growing on the pipeline, but all were removed by divers. Finally, there was no evidence of oceanographic impacts to marine sediments or ballast along the pipeline.

There was one notable observation with regards to spiny lobster. Spiny lobster abundance has increased with greater numbers of lobster and larger individuals observed since the SEOO has been included in the Swamis State Marine Conservation Area. During the current inspection, at least three to four lobster were observed at the base of the pipeline adjacent to unballasted strut locations.

While the amount of material excavated is minimal compared to the total area of seafloor the pipeline rests on, the slow movement of material by lobster over time could reduce the contact area with the seafloor and increase the stress on the pipeline.

3-2 Porthole Inspection

All portholes that could be observed were inspected. Porthole 1 was not able to be found by the divers. It seems likely that it was buried under sand or shell hash which obscured it from view. Portholes 4 and 5 were covered by greater than a one-foot thick layer of shell hash that has sluffed down from the adjacent ballast rock placed in 1993. The dive team could not remove enough of the shell hash to inspect the cover or the anode. Portholes 1, 4, and 5 will require excavation through a separate dive effort to inspect and check the cathodic protection.

Visual inspection of portholes 2 and 3 revealed the portholes and associated zinc anodes to be in fair to good condition (Figure 2). There were no signs of concrete spalling, leaks, or fractures. Cathodic protection (CP) readings on zinc anodes were also conducted and the anodes were cleaned of oxidized material and fouling organisms. Data from the 2025 survey, as well as for CP readings from the previous five years of surveys, are presented in Table 1. Cathodic protection (CP) readings and% estimated remaining anode mass results from the 2016-2025 surveys. Readings were not taken in 2018 or 2020. “N/A” indicated portholes that could not be observed. Estimated anode remaining increased from 2017 to 2019, however, anodes were not replaced between surveys. The low values during the current survey are suspected to be in error and due to a problem with the meter.. Due to suspected electrical issues with the CP meter in 2025, readings for Portholes 2 and 3 were substantially lower than in previous years and are suspected to be inaccurate. Visual observations of the anodes and porthole covers give every indication that the structures are currently cathodically protected.

Porthole 2 and porthole 3 had a 1-inch and 0.5-inch-thick biofouling layer, respectively. All exposed portholes are shown in the video data provided with this report. Locations where shell hash obscures portholes 1, 4, and 5 can also be seen in the video.

Figure 2. Porthole 3 cover with zinc anode with approximately 50% remaining life expectancy.

Table 1. Cathodic protection (CP) readings and% estimated remaining anode mass results from the 2016-2025 surveys. Readings were not taken in 2018 or 2020. “N/A” indicated portholes that could not be observed. Estimated anode remaining increased from 2017 to 2019, however, anodes were not replaced between surveys. The low values during the current survey are suspected to be in error and due to a problem with the meter.

Porthole #	2016		2017		2019		2021		2023		2025	
	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass
1	-1.130	>60%	-1.035	>50%	-0.957	>60%	-0.994	>60%	-0.950	>60%	N/A	N/A
2	-0.980	>60%	-1.025	>50%	-0.941	>60%	-1.010	>60%	-0.990	>60%	-0.247	>60%
3	-1.040	>60%	-0.993	>50%	-1.011	>60%	-1.032	>60%	-0.970	>60%	-0.488	>60%
4	-0.970	>60%	-	-	-0.975	>60%	N/A	N/A	N/A	N/A	N/A	N/A
5	-0.950	>60%	-	-	-0.970	>60%	N/A	N/A	N/A	N/A	N/A	N/A

3-3 Pile Support Survey

Historically, much of the pile supports were buried and not able to be inspected. However, similar to the survey conducted in 2024, a majority of the pile supports were exposed during this survey effort. A total of 26 offshore pile supports, (supports 35-10) were exposed and inspected. Note that even numbered pile supports are smaller than odd numbered pile supports; for this reason, even numbered supports should have one anode each and odd numbered supports should have 2 anodes each. However, due to shifting sand and burial of anodes, some pile supports now contain more than 2 anodes.

For the 2025 inspection, 5 new anodes were added to the following pile supports: 16, 21, 27, 29, and 30. All pile supports with single anodes now have greater than 70% remaining life expectancy, whereas all pile supports with two anodes have at least one anode with 50% or greater remaining life expectancy. There were a number of pile supports that had three or more anodes attached to the pile support, likely due to portions of the support and anodes being previously buried. In these cases, the most depleted anodes were removed such that either one or two anodes of at least 70% remained on the pile support. Three anodes were removed from pile support 16, two anodes were removed from pile supports 14 and 25, and one anode was removed from pile supports 15, 18, and 19. There was also one anode that was attached to a chain on the pipeline, which was removed and added onto pile support 25. In summary, a total of 5 new anodes were added to the pipeline and 13 exhausted anodes were removed.

MTS fabricated 8 anodes ahead of the survey to be used to replace anodes on the SEOO. However, only 5 were needed on the pipeline at the time of this survey. There were 13 anodes that were removed from the pipeline; their associated clamping hardware will be cleaned and able to be incorporated into new anode assemblies for future needs on the SEOO.

CP readings data from the 2025 survey, as well as CP readings from the previous four years of surveys, are presented in Table 2. CP readings were taken following any performed anode maintenance. The 2025 pile support CP readings may not be representative of actual conditions due to a suspected intermittent electrical malfunction on the CP meter while conducting the inspection. It should be noted, however, that visual inspection of the pile supports and attached anodes give every indication that each of the pile support structures that was able to be observed by divers is currently cathodically protected.

Table 2. Cathodic Protection (CP) readings and associated % estimated remaining anode mass results from the 2016-2025 pile support surveys. Readings were not taken in 2018 or 2020. Abnormally low values denoted with an "*" are the result of an intermittent error of the CP meter.

Pile Support #	2016		2017		2019		2021		2023		2025	
	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass	CP VDC	% Estimated Remaining Anode Mass	CP-VDC	% Estimated Remaining Anode Mass	CP-VDC	% Estimated Remaining Anode Mass
1	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.798	0/0	Buried	Buried
2	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried
3	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.781	0/0	Buried	Buried
4	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried
5	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.003	100/100%	Buried	Buried
6	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried
7	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.008	100/100%	Buried	Buried
8	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried
9	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.989	50/100%	Buried	Buried
10	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.093*	90/90
11	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.011	100/100%	-0.092*	90/90
12	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.077*	80/80
13	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.003	100/50%	-0.102*	90/50
14	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.808	70
15	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.010	50/50%	-0.109*	90/90
16	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.805	0	-0.978	100/90
17	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.999	50/50%	-0.923	50/50
18	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.991	20/100%	-0.109*	90
19	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.990	30/30%	-0.100*	70/70
20	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.998	100%	-0.064*	90
21	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.007	20/30%	-0.060*	100/30
22	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.008	100%/Buried	-0.089*	80/90
23	-1.010	>70/70%	Buried	Buried	Buried	Buried	Buried	Buried	-1.003	30/100%	-0.066*	80/10
24	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.008	100%/Buried	-0.071*	95
25	-0.980	>80/80%	Buried	Buried	Buried	Buried	Buried	Buried	-0.999	30/100%	-0.050*	90/90
26	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.997	100%	-0.999	90
27	-0.940	>90/30%	Buried	Buried	Buried	Buried	Buried	Buried	-0.991	100/30%	-0.966	100
28	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-1.017	100%	-0.961	90/90
29	-0.910	>70/70% And >20/20%	Buried	Buried	-1.005	100%	Buried	Buried	-0.799	0/0	-0.859	100/95
30	Buried	Buried	Buried	Buried	Buried	Buried	Buried	Buried	-0.813	None	-0.882	100/90
31	-0.950	>50/50%	-0.950	>40/50%	-0.991	100%	Buried	Buried	-1.003	50/10%	-0.889	90/90
32	-0.930	>50/50%	-0.939	>50/50%	Buried	Buried	-0.942	100/100%	-0.802	None	-0.870	90
33	-0.950	>40/40%	-0.950	>40/40%	-1.007	100%	-1.011	>50/100%	-0.993	20/70%	-0.879	95/95
34	Buried	Buried	-1.005	>50/50%	-0.979	100%	-1.001	100/100%	-0.810	None	-0.887	95/95
35	-1.000	>50/50%	-0.950	>40/40%	-1.004	100%	-1.008	>70/100%	-1.010	60/70%	-0.099*	95/95
Pipe Protection Cowling	-0.890	>40%	-0.872	>30%	-0.960	100%	-0.982	100%	-0.798	None		None

3-4 Diffuser Port Inspection

The ROV visually observed all 200 diffuser ports along the diffuser section of the outfall pipe. The presence of biofouling or any kind of notable obstruction was not observed. The diffuser ports on both the south and north side of the pipe closest to the end cap structure were not flowing, however this is the typical condition for these diffuser ports and was not considered to be blocked by any form of obstruction. These "ports" are in the end structure and are not drilled all the way through to the pipeline. All other diffuser ports appeared to be in proper working function with observable flow coming out of the diffuser ports. Video of each diffuser port, with two exceptions, is included with the submission of this report. As the inspection was being conducted, the ROV technician visually observed each diffuser for flow and biofouling. However, in the video record, South Diffusers 19 and 20 are not shown due to a recording error. The ROV technician had assumed that the camera was recording on that portion of the pipeline but later discovered that it was not. Thus, there is no video or still photo from the ROV inspection showing South Diffusers 19 and 20. Still photos of the other 198 diffusers are presented in Appendix C.

4 Summary and Recommendations

The following points summarize the major findings of this inspection:

- In general, the San Elijo Ocean Outfall was found to be in excellent overall condition.
- Ballast rock on the pipeline showed no significant signs of movement since the last re-ballasting project.
- The outfall showed no signs of spalling, rust staining, or cracking.
- Anodes that were observed at portholes were in good condition and have greater than 50% remaining life expectancy where these were visible and could be inspected.
- No anode is present at the metal plate located just offshore of the pile support section.
- Giant kelp was found growing on the pipeline or ballast, but all was removed.
- All 26 of the exposed pile supports surveyed during this inspection are cathodically protected after replacement of 5 anodes. No additional anodes are needed at this time.
- All diffusors were flowing well.
- Several large California spiny lobsters were found along the base of each exposed pile support; it appeared the lobsters had excavated substrate to create burrows.

The following items are recommendations for continued structural integrity and environmentally safe operation of the San Elijo Ocean Outfall. Some of the comments made below were mentioned in previous reports but are included again because they are still valid points.

4-1 Specific Recommendations

- Excavation of portholes 4, and 5 are proposed to remove shell hash on top of the portholes that prevented observation and collection of CP readings.
- Excavation of porthole 1 that prevented observation and collection of CP readings

- Continue to perform routine ROV or rebreather-based dive survey of the diffuser section of the outfall pipe as needed to clear any blocked ports.
- Continue to survey and remove kelp on the pipeline and ballast pile as warranted so that further ballast is not moved away from the pipeline.
- Monitor for re-emergence of all inshore pile support structures and complete structural inspection and addition of anodes once these re-emerge from the littoral sands. They seem to be the most exposed in the winter months such that a survey following a winter storm might allow for additional inspection and service.
- Continue to monitor the presence of "lobster burrows" and possible loss of pipeline bedding material during future surveys.

4-2 General Recommendations

- Continue to perform "rapid-response" overview inspections after periods of extremely high surf or earthquakes in order to identify damage and potential for failure due to scour, high-velocity currents, or major seafloor movements.
- During future inspections, anodes should be replaced when they become ineffective against preventing corrosion to pipe and pile structures.
- Continue preventative maintenance and detailed inspections of the entire pipeline using SCUBA, rebreather, and/or ROV surveys.

Appendix A: Important Oceanographic Processes

General Oceanographic Forces and Processes

(Adapted from prior Thales GeoSolutions Pacific, Inc. reports)

Several phenomena within the ocean environment exert a significant influence on the San Elijo outfall and ballast material. These processes include the hydrodynamic forces due to waves, longshore currents, and sediment transport. The arrival of large waves from local or distant storms increases localized water particle velocities, amplifies the effects of these processes and are capable of damaging the outfall. Each of these phenomena will be discussed in general terms and as they might apply to the San Elijo Ocean Outfall.

Waves and Currents

Beneath deep-water waves, water particles move in a circular orbit. The water particle velocity decreases with depth; the maximum depth of wave-induced particle motion is a function of wave height and period. The larger the wave and longer the period, the deeper the effects of the wave are felt in the water column. As a wave advances toward shore and enters shallow water, it begins to experience the effects of friction with seafloor. The frictional interaction of waves with the seafloor modifies the waveform, causing the wave height to increase, the wavelength to decrease, and the circular orbit of the particles to become increasingly elliptical. As each wave progresses into shallower water, it eventually reaches a height where the wave will break, which typically occurs in a depth of water that is nearly 1.3 times the height of the wave. The highest energy release occurs where waves are breaking. It is in this high-energy area that a pipeline is most likely to be damaged during a storm.

In addition to the wave-induced oscillatory particle motion, waves approaching a straight coastline at an angle can generate a steady longshore current. This longshore current is largely responsible for the erosion and longshore transport of sediment. The impact of this current and sediment load directly affects any structure, which could interrupt the current flow. At San Elijo, current is generally southward from November through April due to the arrival of waves generated by persistent north and northwest winds from large North Pacific storm systems. The longshore current direction occasionally reverses itself during the remaining months due to exposure to Southern Hemisphere swell or infrequent tropical storms. Other components of the nearshore current include tidal currents with semi-diurnal reversing of the onshore/offshore and upcoast/downcoast flow, regional oceanic circulation patterns, and currents produced by local winds such as sea breeze or thunderstorms and squalls. The combination of these wave- and current-related forces make the nearshore a very dynamic environment in terms of sediment transport and generating forces with act on costal structures.

Hydrodynamic Forces

Dynamic forces acting on a submerged object are comprised of the direct impact of the water particles against the object, varying hydrostatic pressure as a wave passes, and the lift/drag forces caused by increased fluid velocities over and around the object. Currents generated by waves can cause movement of the entire water mass, which can cause forces similar to a flowing river. The flow over the top of the San Elijo outfall can cause lift forces due to pressure gradients and drag on the pipe in the direction of the current flow. The lift caused by currents, coupled with the increased oscillation lift associated with localized water particle velocities and drag forces, can cause large objects such as ballast rock to move as a wave passes.

Liquefaction

Shock from breaking ocean waves or earthquake surface waves can cause unconsolidated, water-saturated sediments to go into suspension. This process, called liquefaction, results in the sediment losing its shear strength and therefore it ability to support higher density objects. This process causes objects such as ballast rock resting on the liquefied area to settle.

Sediment Scour and Transport

The forces discussed in previous sections apply to sediments as well as to an ocean outfall pipe. Longshore sediment transport and seasonal beach migration (inshore/offshore) occur when the water particle velocity is great enough to suspend sediment particles and transport them in agitated water as suspended-load and bed-load. The suspension and movement of unconsolidated sediments in the water column may result in lower bottom elevation. Eroded sand may or may not be re-deposited at the same level, depending on the resultant mean current and the up-current sediment supply.

Coastal Sediment Transport and Erosion

The transport of sediment parallel to the shore along Southern California beaches is due primarily to the longshore current generated by waves breaking at an angle to the coastline. The majority of the transport occurs within the littoral zone, extending from shore to just beyond the seaward limits of the breaker zone. The Southern California coast can be divided into a series of cells between the natural features of headlands and submarine canyons (Figure 5-1). At a headland or promontory, the upcoast supply of sand is effectively blocked or deflected offshore into deeper water and lost to the system. Similarly, submarine canyons capture the beach sand and channel it offshore into deeper water where it is also permanently lost to beach replenishment.

The local littoral sediment budget determines whether the coast is likely to experience net erosion or deposition. A beach may be considered to be in a state of equilibrium if the longshore transport into a cell or coastal segment equals the transport out of the cell. However, the coast is a dynamic environment with naturally occurring periods of erosion and deposition. Thus, an imbalance in the budget is difficult to predict due to uncertainty in estimating the magnitude of the various sediment sources and losses. The primary sources of beach material are longshore transport from upcoast segments, river transport, sea cliff erosion, onshore transport, dredging, and sand bypass at harbor entrances. The primary losses of beach material are longshore transport out of area, offshore transport, deposition within submarine canyons, accumulations at harbor entrances, and mining. In general, the contribution of sediment from river transport and runoff has been significantly reduced by the construction of dams and reservoirs. Lagoons normally contribute little to the coastal sediment budget and many actually constitute a net sediment loss. River-transported sediments deposited in shallow coastal lagoons are not normally available to nearby beaches unless there is sufficient tidal exchange to suspend and transport sand-size particles. In some instances, tidal currents may carry sediment into a lagoon where it is deposited due to lower velocity. The exception to this may occur after periods of heavy rainfall when the increased flow due to excessive runoff and coastal flooding may flush deposited sediments onto adjacent beaches.

The Oceanside Littoral Cell extends from Dana Point to the Scripps-La Jolla Submarine Canyon, a distance of approximately 50 miles. Within this cell, the net annual transport is toward the south due to the prevailing wind and wave direction from the northwest during October/November through April/May. During the summer months, the arrival of swell from Southern Hemisphere or tropical storms can reverse the longshore current, producing periods of northward longshore transport. The estimated annual transport offshore through Scripps-La Jolla Submarine Canyon of 260,000 cubic yards is roughly equivalent to the total littoral transport reaching the adjacent upcoast beach (Chamberlain, 1964). Surveys within the Carlsbad Submarine Canyon concluded that it was not currently an active site of beach material loss. No other canyons affect the Oceanside Littoral Cell.

U.S. Army Corps of Engineers studies have suggested the division of littoral cells into segments or subcells based on the following criteria:

Distinctive sediment characteristics due to natural or man-influenced processes such as beach nourishment programs;
Known natural (lagoons and submarine canyons) or man-made (jetties and breakwaters) barriers to littoral sand transport.

The eight-mile-long costal segment between San Marcos Creek at Batiquitos Lagoon and the San Dieguito River includes the communities of Leucadia, Encinitas, Cardiff and Solana Beach. Based on data from 1954 through 1988, the sea cliffs in this area have retreated an average of approximately 0.1 to 0.2 feet per year. This sediment source contributes relatively small amounts of sand, gravel and cobble to the coastal sediment budget. Analysis of aerial photographs and beach profiles for the 50-year interval from 1938 through 1988 showed a nearly stable shoreline position, indicating a close balance in the sediment budget. The normal seasonal onshore/offshore sediment transport and localized changes near the outfall due to the effects of severe storm events or scour are not reflected in the long-term average.

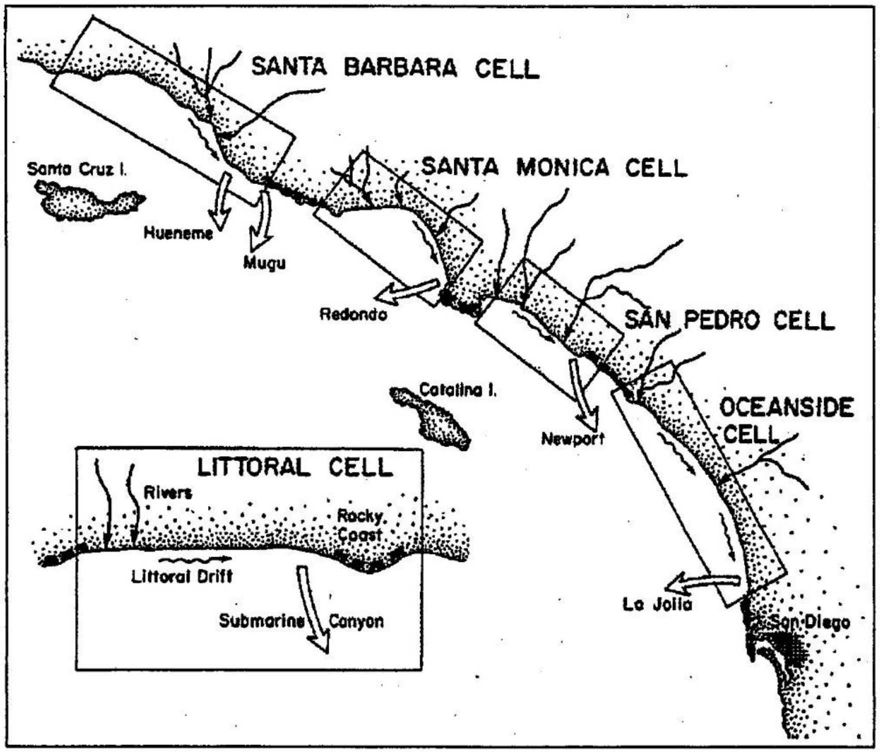


Figure 5-1 Southern California Coast Littoral Transportation Cells

Scour

Depletion of sediment occurs adjacent to offshore structures that have readily transportable sediment near their perimeters. This localized depletion of sediment around an object is called scour. Flow velocity increases as it passes around the edge of a structure, causing a localized increase in the energy proportional to the square of the velocity. This increased energy allows water to transport more sediment and larger size particles. In the case of the San Elijo Ocean Outfall, the sediment typically available for transport is sand. Therefore, at the toe end of a ballast pile, or the outfall terminus, flow passes around stationary or non-transportable material, the area will be more susceptible to scour.

Scour around an outfall can also be noted on a larger scale as differences in bottom elevation of the nearfield sediment distribution around a pipe and ballast pile. On the up-current side of the pipe, the seawater slows down as it approaches the ballast pile and loses some of its energy. As a result, its ability to transport sediment is reduced, thus causing deposition on the up-current side of the pipe. As fluid passes over the pipe and ballast pile it gains energy but not enough to displace correctly designed ballast. As the seawater leaves the down-current edge of the ballast pile, its energy is increased because of the turbulence around the ballast pile and a return to non-deflected flow. This increased energy level enhances the ability to transport sediment. Thus, sediment deposited at the ballast pile is re-suspended and transported away, which results in a lower level of sand on the down-current side. This same phenomenon is typically visible around a jetty where the up-current side experiences buildup of material and the down-current side shows a loss of material.

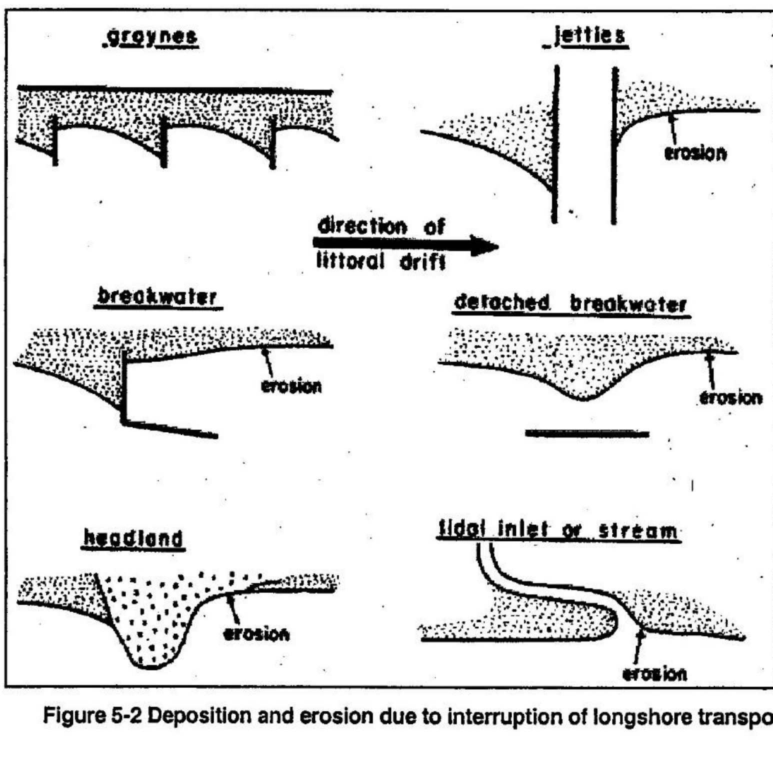


Figure 5-2 Deposition and erosion due to interruption of longshore transport

Scour results in the loss of sand around the toe of the ballast pile, around the pipe, and supporting structures where no ballast exists. Excessive scour can lead to ballast pile setting or collapse and weakened support foundation, which eventually may result in unsupported spans of pipe.

Metallic Corrosion

The galvanic process commonly referred to as corrosion arises when two dissimilar metallic alloys or different areas of the same metal are immersed in an electrolyte (e.g., generally a liquid capable of conducting electricity such as seawater). The connection created between the two metals that has a sufficient voltage potential different to initiate an oxidation reaction. The location of this reaction is known as the anode and is characterized by a negative charge. Once liberated, electrons flow as current through the metallic pathway to a more positively charged region within the cell and begin to generate a reductive reaction at an area known as the cathode.

The circuit is completed by the migration of hydroxide ions from the cathodic region to the anode. The major point of interest is that the rate at which these reactions occur is governed in large part by the rate at which oxygen can be reduced at the cathode. In basic terms, this means that the reduction rate and thus the rate of corrosion are controlled by the amount of dissolved oxygen available in the water column.

Metals immersed in seawater are susceptible to corrosion due to galvanic action, which produces an electrical current in an electrolyte (conducting) solution. Seawater is an electrolyte since it contains a significant percentage of chlorine ions found in solution. More specifically, there are approximately 35 grams of dissolved salt per kilogram of seawater. Sites on the surface of the metal where corrosion or oxidation (electron loss) is occurring are referred to as anodes. The chemical reaction at an anode results in the production of metal ions and free electrons. These electrons pass through the seawater to other sites (referred to as cathodes) where a reaction (electron gain) is occurring. Metal ions can go into solution or react to form corrosion products such as oxides on the surface of the metal, forming the classic reddish-brown rust commonly observed.

All exposed metallic fixtures on the outfall, including the steel pipeline, are susceptible to corrosion. The rate of corrosion can be significantly reduced by attachment of sacrificial zinc alloy anodes. Zinc has a higher corrosion potential than most metals and therefore the resulting loss of material is from the zinc anode and protected parts remain relatively inert.

Kelp Settlement and Growth

Kelp (*Macrocystis sp*.) is a marine alga, which grows in the Shallow Littoral Zone. It grows on hard substrate such as rocks, boulders, outcrops, concrete, and pipeline ballast rock. Substrate attachment is by means of a rhizome-like base called a holdfast. Under suitable nutrient, light, and thermal conditions, kelp plants grow to lengths in excess of 200 feet, with daily growth rates in excess of one percent of plant size. The major parts of a kelp plant are:

Holdfast – Base that anchors the kelp to the ocean floor;
Stipe – A stem-like section that connects the pneumatocysts and blades to the holdfast;
Pneumatocyst – A small, ball-like, gas-filled float between the stipe and the blades, which provides buoyancy;
Blades – Leaflike sections, 0.8 feet to 1.3 feet long and approximately 0.2 feet wide.

Multiple stipes can grow from a single holdfast clump. Kelp has considerable buoyancy and drag potential in the water column.

The entire kelp plant is quite elastic, allowing it to survive high-energy sea conditions. However, under extreme wave and current conditions, a stipe may break and the plant will float away if the stipe elasticity and strength are exceeded by drag forces. Under certain conditions at very low ocean-energy levels, the entire kelp plant, including the holdfast, can be transported away. This occurs when the substrate to which the kelp has attached has insufficient mass to anchor the kelp. Obviously, the smaller the ballast rock, the easier it is for individual kelp plants to carry it away from an outfall. While inspecting San Elijo outfall prior to the most recent reballasting, previous inspectors witnessed kelp growing on small units of ballast in the sand field away from the pipeline. Following reversal of tidal current direction, those same plants were found alongside the pipeline. By this process, a ballast pile can be significantly depleted even during moderate wave conditions if the ballast is not of a suitable size to prevent its removal by kelp drag.

Appendix B: Video Log and Notes

Video Notes

South Flange

Flange #	Notes	Lobsters Present	Flange #	Notes	Lobsters Present
SF1	Unremarkable.	Y	**SF53**	Evidence of excavation from Lobsters.	Y
SF2	Unremarkable.	N	**SF54**	Evidence of excavation from Lobsters.	Y
SF3	Unremarkable.	N	**SF55**	Evidence of excavation from Lobsters.	N
SF4	Unremarkable.	N	**SF56**	Evidence of excavation from Lobsters.	Y
SF5	Unremarkable.	N	**SF57**	Evidence of excavation from Lobsters.	Y
SF6	Unremarkable.	Y	**SF58**	Evidence of excavation from Lobsters.	Y
SF7	Unremarkable.	N	**SF59**	Evidence of excavation from Lobsters.	Y
SF8	Unremarkable.	N	**SF60**	Evidence of excavation from Lobsters.	Y
SF9	Unremarkable.	N	**SF61**	Evidence of excavation from Lobsters.	N
SF10	Unremarkable.	Y	**SF62**	Evidence of excavation from Lobsters.	N
SF11	Unremarkable.	N	**SF63**	Evidence of excavation from Lobsters.	N
SF12	Unremarkable.	N	**SF64**	Evidence of excavation from Lobsters.	N
SF13	Unremarkable.	N	**SF65**	Evidence of excavation from Lobsters.	Y
SF14	Unremarkable.	Y	**SF66**	Evidence of excavation from Lobsters.	Y
SF15	Unremarkable.	Y	**SF67**	Unremarkable.	N
SF16	Unremarkable.	Y	**SF68**	Evidence of excavation from Lobsters.	Y
SF17	Unremarkable.	Y	**SF69**	Unremarkable.	N
SF18	Evidence of excavation from Lobsters.	Y	**SF70**	Unremarkable.	Y
SF19	Evidence of excavation from Lobsters.	Y	**SF71**	Unremarkable.	N
SF20	Unremarkable.	N	**SF72**	Unremarkable.	Y
SF21	Unremarkable.	N	**SF73**	Unremarkable.	N
SF22	Evidence of excavation from Lobsters.	Y	**SF74**	Unremarkable.	Y
SF23	Evidence of excavation from Lobsters.	Y	**SF75**	Unremarkable.	N
SF24	Unremarkable.	Y	**SF76**	Unremarkable.	N
SF25	Unremarkable.	N	**SF77**	Unremarkable.	Y
SF26	Unremarkable.	N	**SF78**	Unremarkable.	N
SF27	Unremarkable.	N	**SF79**	Unremarkable.	N

Flange #	Notes	Lobsters Present	Flange #	Notes	Lobsters Present
SF28	Unremarkable.	N	**SF80**	Unremarkable.	N
SF29	Unremarkable.	N	**SF81**	Unremarkable.	Y
SF30	Unremarkable.	Y	**SF82**	Unremarkable.	N
SF31	Evidence of excavation from Lobsters.	N	**SF83**	Unremarkable.	N
SF32	Unremarkable.	N	**SF84**	Unremarkable.	Y
SF33	Unremarkable.	Y	**SF85**	Unremarkable.	Y
SF34	Unremarkable.	N	**SF86**	Unremarkable.	N
SF35	Unremarkable.	Y	**SF87**	Unremarkable.	N
SF36	Unremarkable.	Y	**SF88**	Unremarkable.	N
SF37	Unremarkable.	Y	**SF89**	Unremarkable.	N
SF38	Evidence of excavation from Lobsters.	Y	**SF90**	Unremarkable.	N
SF39	Unremarkable.	Y	**SF91**	Unremarkable.	Y
SF40	Evidence of excavation from Lobsters.	Y	**SF92**	Unremarkable.	N
SF41	Evidence of excavation from Lobsters.	Y	**SF93**	Unremarkable.	N
SF42	Evidence of excavation from Lobsters.	Y	**SF94**	Unremarkable.	N
SF43	Evidence of excavation from Lobsters.	Y	**SF95**	Unremarkable.	N
SF44	Unremarkable.	N	**SF96**	Unremarkable.	N
SF45	Evidence of excavation from Lobsters.	Y	**SF97**	Unremarkable.	N
SF46	Evidence of excavation from Lobsters.	Y	**SF98**	Unremarkable.	N
SF47	Unremarkable.	Y	**SF99**	Unremarkable.	N
SF48	Unremarkable.	N	**SF100**	Unremarkable.	N
SF49	Evidence of excavation from Lobsters.	Y	**SF101**	Unremarkable.	N
SF50	Evidence of excavation from Lobsters.	Y	**SF102**	Unremarkable.	N
SF51	Evidence of excavation from Lobsters.	Y	**SF103**	Unremarkable.	N
SF52	Evidence of excavation from Lobsters.	N			

North Flange

Flange #	Notes	Lobsters Present	Flange #	Notes	Lobsters Present
NF1	Unremarkable.	Y	**NF53**	Unremarkable.	Y
NF2	Unremarkable.	N	**NF54**	Unremarkable.	Y
NF3	Unremarkable.	Y	**NF55**	Evidence of excavation from Lobsters.	Y
NF4	Evidence of excavation from Lobsters.	Y	**NF56**	Evidence of excavation from Lobsters.	Y
NF5	Evidence of clearing and excavation from Lobsters.	Y	**NF57**	Evidence of excavation from Lobsters.	Y
NF6	Evidence of excavation from Lobsters.	Y	**NF58**	Evidence of excavation from Lobsters.	Y
NF7	Unremarkable.	Y	**NF59**	Evidence of excavation from Lobsters.	Y
NF8	Unremarkable.	N	**NF60**	Evidence of excavation from Lobsters.	Y
NF9	Evidence of excavation from Lobsters.	Y	**NF61**	Evidence of excavation from Lobsters.	Y
NF10	Unremarkable.	N	**NF62**	Evidence of excavation from Lobsters.	Y
NF11	Unremarkable.	Y	**NF63**	Unremarkable.	Y
NF12	Unremarkable.	Y	**NF64**	Unremarkable.	Y
NF13	Unremarkable.	Y	**NF65**	Unremarkable.	Y
NF14	Evidence of excavation from Lobsters.	Y	**NF66**	Unremarkable.	Y
NF15	Unremarkable.	Y	**NF67**	Unremarkable.	Y
NF16	Unremarkable.	Y	**NF68**	Evidence of excavation from Lobsters.	Y
NF17	Evidence of excavation from Lobsters.	N	**NF69**	Unremarkable.	Y
NF18	Unremarkable.	Y	**NF70**	Evidence of excavation from Lobsters.	Y
NF19	Unremarkable.	Y	**NF71**	Evidence of excavation from Lobsters.	Y
NF20	Unremarkable.	Y	**NF72**	Unremarkable.	Y
NF21	Evidence of excavation from Lobsters.	Y	**NF73**	Evidence of excavation from Lobsters.	Y
NF22	Unremarkable.	Y	**NF74**	Unremarkable.	Y
NF23	Unremarkable.	Y	**NF75**	Unremarkable.	Y
NF24	Unremarkable.	Y	**NF76**	Evidence of excavation from Lobsters.	Y
NF25	Evidence of excavation from Lobsters.	Y	**NF77**	Unremarkable.	Y
NF26	Unremarkable.	Y	**NF78**	Unremarkable.	Y
NF27	Evidence of excavation from Lobsters.	Y	**NF79**	Unremarkable.	Y
NF28	Unremarkable.	Y	**NF80**	Unremarkable.	Y
NF29	Evidence of clearing and excavation from Lobsters.	Y	**NF81**	Unremarkable.	Y

Flange #	Notes	Lobsters Present	Flange #	Notes	Lobsters Present
NF30	Evidence of excavation from Lobsters.	Y	**NF82**	Unremarkable.	Y
NF31	Unremarkable.	Y	**NF83**	Unremarkable.	N
NF32	Evidence of excavation from Lobsters.	Y	**NF84**	Unremarkable.	Y
NF33	Evidence of excavation from Lobsters.	N	**NF85**	Unremarkable.	N
NF34	Evidence of excavation from Lobsters.	Y	**NF86**	Unremarkable.	N
NF35	Evidence of excavation from Lobsters.	Y	**NF87**	Unremarkable.	N
NF36	Evidence of excavation from Lobsters.	Y	**NF88**	Unremarkable.	Y
NF37	Evidence of excavation from Lobsters.	Y	**NF89**	Unremarkable.	Y
NF38	Unremarkable.	Y	**NF90**	Unremarkable.	N
NF39	Evidence of excavation from Lobsters. Growth.	Y	**NF91**	Unremarkable.	N
NF40	Evidence of excavation from Lobsters.	Y	**NF92**	Unremarkable.	N
NF41	Evidence of excavation from Lobsters.	Y	**NF93**	Unremarkable.	N
NF42	Unremarkable.	Y	**NF94**	Unremarkable.	N
NF43	Evidence of excavation from Lobsters.	N	**NF95**	Unremarkable.	N
NF44	Evidence of excavation from Lobsters.	Y	**NF96**	Unremarkable.	N
NF45	Evidence of excavation from Lobsters.	N	**NF97**	Unremarkable.	N
NF46	Unremarkable.	Y	**NF98**	Unremarkable.	N
NF47	Unremarkable.	Y	**NF99**	Unremarkable.	N
NF48	Unremarkable.	Y	**NF100**	Unremarkable.	N
NF49	Unremarkable.	Y	**NF101**	Unremarkable.	N
NF50	Evidence of excavation from Lobsters.	Y	**NF102**	Unremarkable.	N
NF51	Evidence of excavation from Lobsters.	Y	**NF103**	Unremarkable.	N
NF52	Evidence of excavation from Lobsters.	Y			

South Diffusors

Diffusor #	Notes		Diffusor #	Notes		Diffusor #	Notes		Diffusor #	Notes
SD1	Unremarkable.		**SD26**	Unremarkable.		**SD51**	Unremarkable.		**SD76**	Unremarkable.
SD2	Unremarkable.		**SD27**	Unremarkable.		**SD52**	Unremarkable.		**SD77**	Unremarkable.
SD3	Unremarkable.		**SD28**	Unremarkable.		**SD53**	Unremarkable.		**SD78**	Unremarkable.
SD4	Unremarkable.		**SD29**	Unremarkable.		**SD54**	Unremarkable.		**SD79**	Unremarkable.
SD5	Unremarkable.		**SD30**	Unremarkable.		**SD55**	Unremarkable.		**SD80**	Unremarkable.
SD6	Unremarkable.		**SD31**	Unremarkable.		**SD56**	Unremarkable.		**SD81**	Unremarkable.
SD7	Unremarkable.		**SD32**	Unremarkable.		**SD57**	Unremarkable.		**SD82**	Unremarkable.
SD8	Unremarkable.		**SD33**	Unremarkable.		**SD58**	Unremarkable.		**SD83**	Unremarkable.
SD9	Unremarkable.		**SD34**	Unremarkable.		**SD59**	Unremarkable.		**SD84**	Unremarkable.
SD10	Unremarkable.		**SD35**	Unremarkable.		**SD60**	Unremarkable.		**SD85**	Unremarkable.
SD11	Unremarkable.		**SD36**	Unremarkable.		**SD61**	Unremarkable.		**SD86**	Unremarkable.
SD12	Unremarkable.		**SD37**	Unremarkable.		**SD62**	Unremarkable.		**SD87**	Unremarkable.
SD13	Unremarkable.		**SD38**	Unremarkable.		**SD63**	Unremarkable.		**SD88**	Unremarkable.
SD14	Unremarkable.		**SD39**	Unremarkable.		**SD64**	Unremarkable.		**SD89**	Unremarkable.
SD15	Unremarkable.		**SD40**	Unremarkable.		**SD65**	Unremarkable.		**SD90**	Unremarkable.
SD16	Unremarkable.		**SD41**	Unremarkable.		**SD66**	Unremarkable.		**SD91**	Unremarkable.
SD17	Unremarkable.		**SD42**	Unremarkable.		**SD67**	Unremarkable.		**SD92**	Unremarkable.
SD18	Unremarkable.		**SD43**	Unremarkable.		**SD68**	Unremarkable.		**SD93**	Unremarkable.
SD19	Unremarkable.		**SD44**	Unremarkable.		**SD69**	Unremarkable.		**SD94**	Unremarkable.
SD20	Unremarkable.		**SD45**	Unremarkable.		**SD70**	Unremarkable.		**SD95**	Unremarkable.
SD21	Unremarkable.		**SD46**	Unremarkable.		**SD71**	Unremarkable.		**SD96**	Unremarkable.
SD22	Unremarkable.		**SD47**	Unremarkable.		**SD72**	Unremarkable.		**SD97**	Unremarkable.
SD23	Unremarkable.		**SD48**	Unremarkable.		**SD73**	Unremarkable.		**SD98**	Unremarkable.
SD24	Unremarkable.		**SD49**	Unremarkable.		**SD74**	Unremarkable.		**SD99**	Unremarkable.
SD25	Unremarkable.		**SD50**	Unremarkable.		**SD75**	Unremarkable.		**SD100**	Unremarkable.

Other Notes Higher Ballast built up along pipe between SD17 and SD18.

North Diffusors

Diffusor #	Notes		Diffusor #	Notes		Diffusor #	Notes		Diffusor #	Notes
ND1	Unremarkable.		**ND26**	Unremarkable.		**ND51**	Unremarkable.		**ND76**	Unremarkable.
ND2	Unremarkable.		**ND27**	Unremarkable.		**ND52**	Unremarkable.		**ND77**	Unremarkable.
ND3	Unremarkable.		**ND28**	Unremarkable.		**ND53**	Unremarkable.		**ND78**	Unremarkable.
ND4	Unremarkable.		**ND29**	Unremarkable.		**ND54**	Unremarkable.		**ND79**	Unremarkable.
ND5	Unremarkable.		**ND30**	Unremarkable.		**ND55**	Unremarkable.		**ND80**	Unremarkable.
ND6	Unremarkable.		**ND31**	Unremarkable.		**ND56**	Unremarkable.		**ND81**	Unremarkable.
ND7	Unremarkable.		**ND32**	Unremarkable.		**ND57**	Unremarkable.		**ND82**	Unremarkable.
ND8	Unremarkable.		**ND33**	Unremarkable.		**ND58**	Unremarkable.		**ND83**	Unremarkable.
ND9	Unremarkable.		**ND34**	Unremarkable.		**ND59**	Unremarkable.		**ND84**	Unremarkable.
ND10	Unremarkable.		**ND35**	Unremarkable.		**ND60**	Unremarkable.		**ND85**	Unremarkable.
ND11	Unremarkable.		**ND36**	Unremarkable.		**ND61**	Unremarkable.		**ND86**	Unremarkable.
ND12	Unremarkable.		**ND37**	Unremarkable.		**ND62**	Unremarkable.		**ND87**	Unremarkable.
ND13	Unremarkable.		**ND38**	Unremarkable.		**ND63**	Unremarkable.		**ND88**	Unremarkable.
ND14	Unremarkable.		**ND39**	Unremarkable.		**ND64**	Unremarkable.		**ND89**	Unremarkable.
ND15	Unremarkable.		**ND40**	Unremarkable.		**ND65**	Unremarkable.		**ND90**	Unremarkable.
ND16	Unremarkable.		**ND41**	Unremarkable.		**ND66**	Unremarkable.		**ND91**	Unremarkable.
ND17	Unremarkable.		**ND42**	Unremarkable.		**ND67**	Unremarkable.		**ND92**	Unremarkable.
ND18	Unremarkable.		**ND43**	Unremarkable.		**ND68**	Unremarkable.		**ND93**	Unremarkable.
ND19	Unremarkable.		**ND44**	Unremarkable.		**ND69**	Unremarkable.		**ND94**	Unremarkable.
ND20	Unremarkable.		**ND45**	Unremarkable.		**ND70**	Unremarkable.		**ND95**	Unremarkable.
ND21	Unremarkable.		**ND46**	Unremarkable.		**ND71**	Unremarkable.		**ND96**	Unremarkable.
ND22	Unremarkable.		**ND47**	Unremarkable.		**ND72**	Unremarkable.		**ND97**	Unremarkable.
ND23	Unremarkable.		**ND48**	Unremarkable.		**ND73**	Unremarkable.		**ND98**	Unremarkable.
ND24	Unremarkable.		**ND49**	Unremarkable.		**ND74**	Unremarkable.		**ND99**	Unremarkable.
ND25	Unremarkable.		**ND50**	Unremarkable.		**ND75**	Unremarkable.		**ND100**	Unremarkable.

Other Notes

Excavation along pipe between NF35 and NF36.

Excavation along pipe between NF37 and NF38.

Video File – Provided as a USB Drive
Video Files are entitled: Offshore North; Inshore North; Offshore South; and Inshore South.

Photo File- "North Flanges_Sized for Report"
Photos of all flanges on the north end of the structure. North Flange 1 is the first flange. Photos are labeled in ascending order until the last flange on the north side, North Flange 103.

Photo File- "South Flanges_Sized for Report"
Photos of all flanges on the south end of the structure. South Flange 1 is the first flange. Photos are labeled in ascending order until the last flange on the south side, South Flange 103.

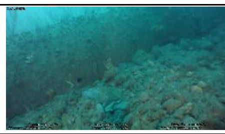
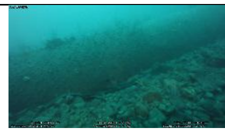
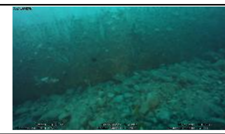
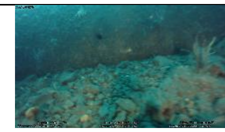
Photo File- "North Diffuser Ports_Sized for Report"
Photos of all diffuser ports on the north end of the structure. North Diffuser 1 is the first diffuser port. Photos are labeled in ascending order until the last diffuser port on the north side, North Diffuser 100.

Photo File- "South Diffuser Ports_Sized for Report"
Photos of all diffuser ports on the south end of the structure. South Diffuser 1 is the first diffuser port. There are no photos of South Diffuser 19 or South Diffuser 20 due to a recording oversight. Photos are labeled in ascending order until the last diffuser on the south side, South Diffuser 100.

All photos are provided as a digital copy.

Appendix C: Photos of all Diffuser Ports

North Diffuser Ports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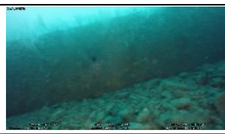				
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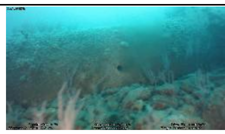		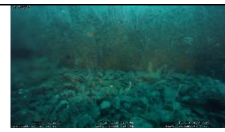		
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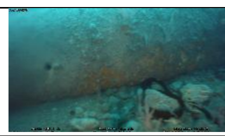
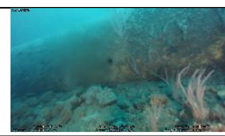
Port 16	**Port 17**	**Port 18**	**Port 19**	**Port 20**
				
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			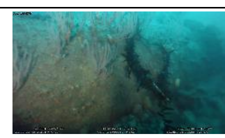	
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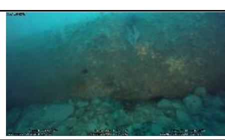				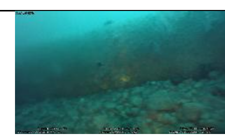
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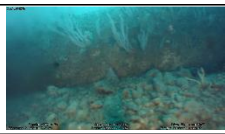	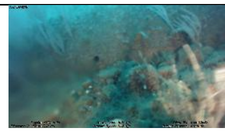	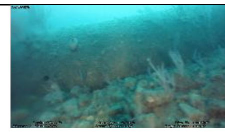		
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		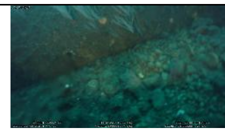	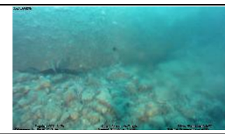	
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				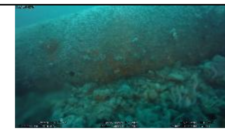
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			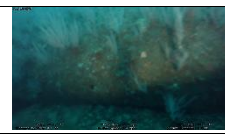	
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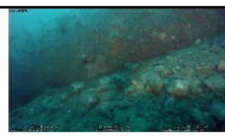
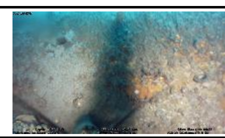
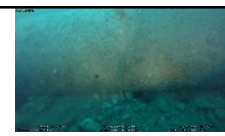
Port 56	**Port 57**	**Port 58**	**Port 59**	**Port 60**
				
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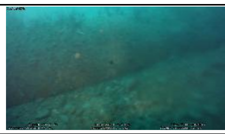
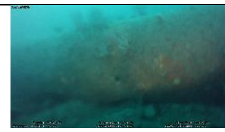
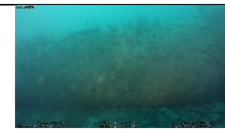
Port 66	**Port 67**	**Port 68**	**Port 69**	**Port 70**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				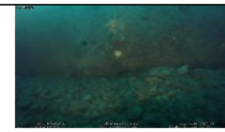
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		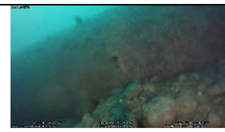	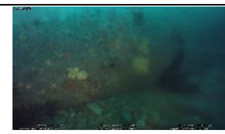	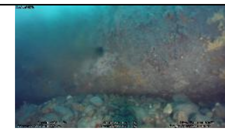
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			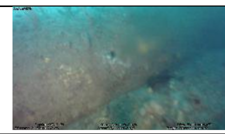	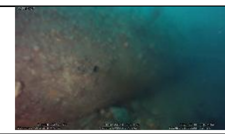
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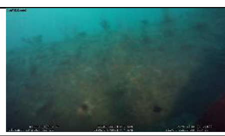		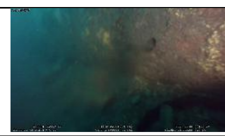		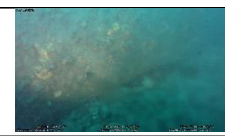
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		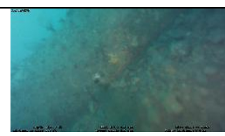		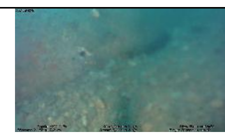
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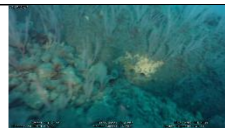
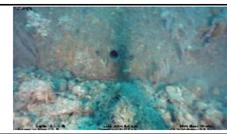
South Diffuser Ports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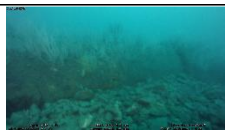				
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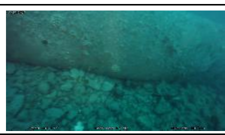			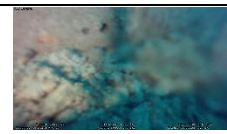	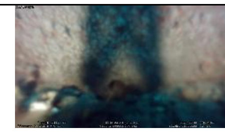
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		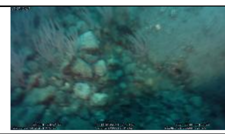	No photo available*	No photo available*
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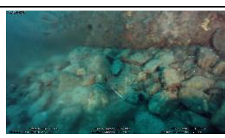				
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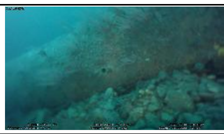				
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			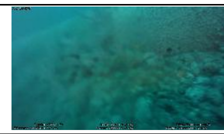	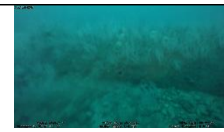
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	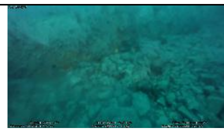	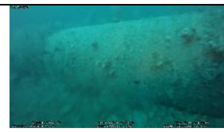	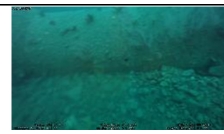	
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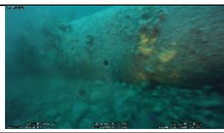			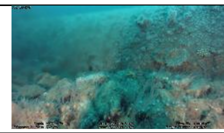	
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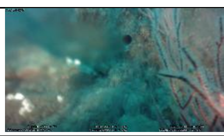		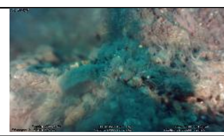		
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	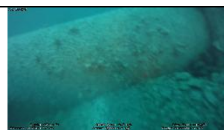			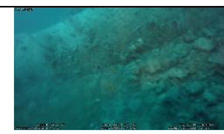
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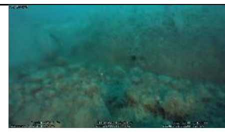
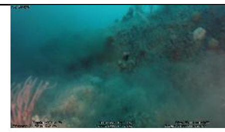
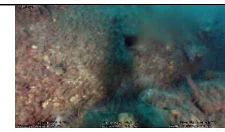
Port 66	**Port 67**	**Port 68**	**Port 69**	**Port 70**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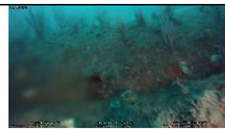
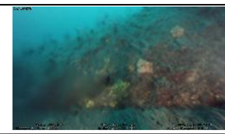
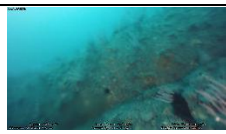
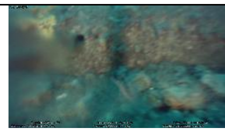
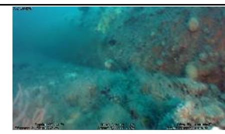
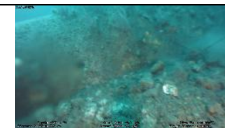
				
Port 76	**Port 77**	**Port 78**	**Port 79**	**Port 80**
				
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			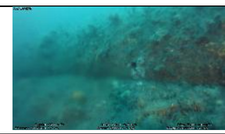	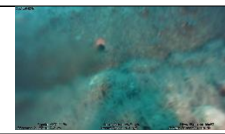
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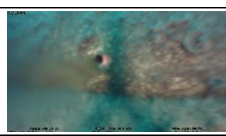	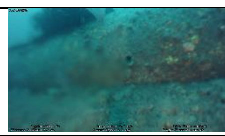	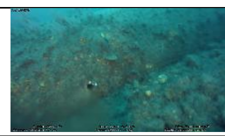		
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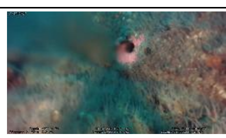
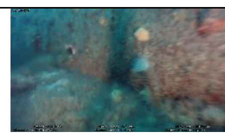
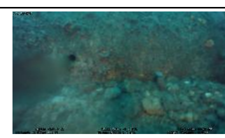
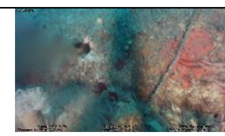
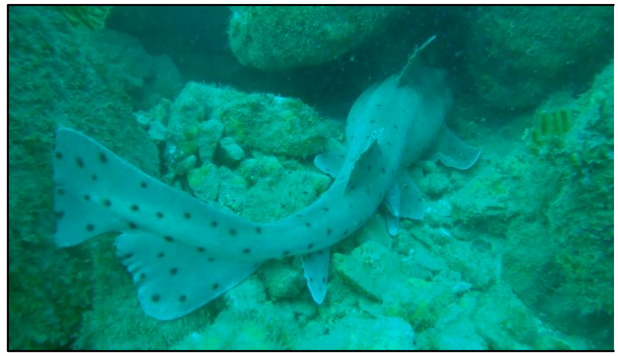
				
Port 96	**Port 97**	**Port 98**	**Port 99**	**Port 100**

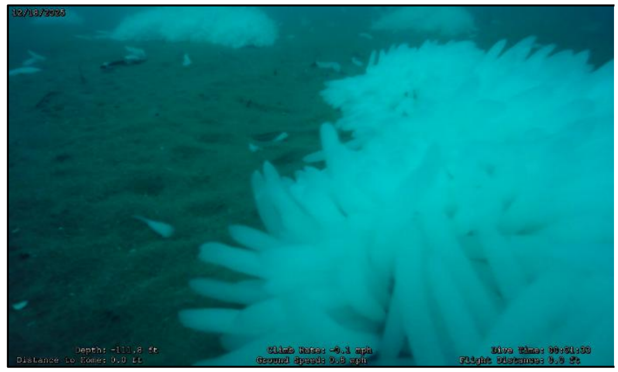
*No still photo or video was recorded for South Port 19 and South Port 20 due to recording oversight. Flow from these ports was observed in real time by technician operating the ROV.

Appendix D: Photos of Marine life present during inspection


Moray Eel


Horn Shark


California Halibut


Squid Eggs


Leopard Shark


California Yellowtail