SD Public Utilities

POINT LOMA OCEAN OUTFALL ANNUAL INSPECTION REPORT

2023

POINT LOMA WASTEWATER TREATMENT PLANT

NPDES Permit No. CA 0107409
Order No. R9-2017-0007 (as amended by Order No. R9-2022-0078)

Environmental Monitoring and Technical Services
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Public Utilities Department
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ISO 14001

THE CITY OF SAN DIEGO

MEMORANDUM

DATE: June 30, 2024

TO: Peter Vroom, Deputy Director Public Utilities Department/EMTS

FROM: Stephen Cann, Senior Civil Engineer, Public Utilities Department/WWTD

SUBJECT: Point Loma Ocean Outfall 2023 Annual Inspection Report

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Transmitted herewith is a copy of the report entitled "Point Loma Ocean Outfall 2023 Annual Inspection Report." This report presents the results of the annual external inspection of the outfall performed by the City of San Diego staff on April 10, 11, 15, 16, and 17, 2024.

In general, the findings of this survey agree with the conclusions of earlier inspections: the ballast, the diffusers and the exterior of the outfall system are in good condition, with the same isolated areas showing reduced rock levels. Comparisons of video from this year and former inspections suggest that while very minor rock surface modifications may be occurring because of external oceanographic forces, the ballast level along the outfall appears largely unchanged.

This year's video shows that while many of the visible active anodes are consumed to some degree, or detached in some cases, there is no visible corrosion of the metal cribs or the terminal diffuser sections, suggesting that the cathodic protection has been effective up to this point. This year, cathodic protection structure-to-electrolyte potential readings were measured and recorded for the first time. The data indicates that the new south diffuser leg and the intermediate wye structure have acceptable levels of cathodic protection. The new wye structure was determined to have partial levels of cathodic protection, and the north diffuser leg appears to have inadequate cathodic protection. We recommend that the process of unwrapping the passive anodes be initiated and also that new anode sleds be designed and installed for each of the structures.

I conclude that during the 2023 external inspection, the Point Loma Ocean Outfall looks to be in good condition. Should you have any questions or require additional information, I can be reached at (619) 221-8741.

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Attachment: Point Loma Ocean Outfall 2023 Annual Inspection Report cc: Ryan Kempster, Senior Marine Biologist, PUD/EMTS

Adriano Feit, Marine Biologist III, PUD/EMTS

This report summarizes the results of the 2023 Point Loma Ocean Outfall (PLOO) annual inspection. The inspection was completed over five days, on April 10, 11, 15, 16, 17, 2024, by City of San Diego (City) Ocean Monitoring Program personnel (Public Utilities Department). This report was completed to ensure compliance with the following:

(1) Lease No. PRC 7029.9 issued by the California State Lands Commission.
(2) Order No. R9-2017-0007 (as amended by Order No. R9-2022-0078) for the City of San Diego's Point Loma Wastewater Treatment Plant (NPDES No. CA0107409).

DESCRIPTION AND BACKGROUND

Historical Background

The PLOO was completed and placed into service in October 1963. The outfall conveyed primary treated sewage effluent from the Point Loma Wastewater Treatment Plant (PLWTP) to the ocean for dispersion at a water depth of 210 ft, approximately 11,400 linear feet (LF) from shore. The first 2,700 LF of the outfall was built as a concrete-covered trench excavated into the rock, and the remainder of the outfall was laid on the ocean bottom, over a layer of bedding, with ballast rock placed up to the pipe Spring Line (a horizontal line, running the length of the pipe, marking the widest part of the pipe). The outfall was constructed by San Diego Constructors, a joint venture formed by M.H. Golden, Trepte Construction Co., Inc., and Gunther and Shirley Company.

On November 17, 1983, the State Water Resources Control Board (SWRCB) modified the California Ocean Plan to designate the kelp beds offshore from Point Loma as a water-contact sports area. With this designation, the City was no longer in compliance with specific Ocean Plan bacteriological standards. The PLWTP effluent had been identified as the major source of the elevated bacterial levels in the kelp beds. The City was ordered to meet the bacteriological standards set forth in the Ocean Plan by August 24, 1994. After the completion of an engineering study, an outfall extension was determined to be the preferred method for meeting Ocean Plan standards.

The City entered into an agreement with Engineering-Science, Inc. (ESI, the former name of Parsons Corporation), to design an outfall extension. As part of this effort, ESI investigated the condition of the existing outfall and determined the maximum length the outfall could be extended, based on the hydraulic pressure of the system. Over the course of the investigation, air entrainment was identified as a major problem with the original construction. A separate project, incorporating multiple sleeve valves, was constructed to control effluent flows, dissipate excess head, and correct the air entrainment problem in the Vortex structure. A history of outfall inspections is documented in Appendix A.

The outfall extension was completed and commissioned on November 24, 1993. It is now one of the longest, largest, and deepest reinforced concrete bell and spigot ocean outfalls in the world, reaching 4.5 miles in length and discharging at a depth of 320 ft below sea level. The outfall extension consists of 12,500 LF of 144-inch inner diameter pipe between the original outfall terminus and a Wye structure, plus two 2,500 LF diffusers that provide for dispersion of the effluent.

Original Outfall (1963 - 1993)

The Main Barrel of the outfall consists of 11,226 LF of 9 ft inner diameter reinforced concrete pipe with a wall thickness of 10 inches. The Main Barrel of the original outfall terminates at the connection to the Original Diffuser Wye structure (station 114+34), which is where the offshore portion of the Main Barrel starts. The plan and profile of the current outfall system are shown in Appendix B.1 and B.2.

Design and construction of the original Main Barrel incorporated the following sections:

- Between station 2+08 and 26+50, the Main Barrel was constructed in a trench with the entire pipe below the seabed. The pipe was placed in the trench with a minimum bedding thickness of 1 ft that extended up to the Spring Line. Above the Spring Line, the trench was backfilled with concrete and a minimum concrete thickness of 2 ft was maintained over the top of the pipe.

- Between station 26+50 and 30+40, a transition zone occurs where the pipe emerges from the rock trench and is laid upon the ocean floor. The Spring Line of the Main Barrel was constructed roughly at the seabed.
- Between station 30+40 and 114+34, the Main Barrel was placed on bedding with a minimum clearance of 1 ft from the seabed to the bottom of the pipe. The bedding ballast extends up to the Spring Line. Side slopes for the bedding ballast were set at 1.5:1 (horizontal to vertical). In the months immediately following construction of the original outfall, an additional ton of rock was placed on top of the ballast from station 26+50 to 62+50.

In March 1990, an internal inspection of the outfall was made from the Vortex structure to a point approximately 350 ft west. The inspection revealed that the outfall was in reasonably good condition, with no debris or obstructions, despite 27 years of operation. A minor loss of concrete detected at the top of several pipe joints (within the joint gap) appeared similar to corrosion damage typically associated with hydrogen sulfide. The source of the problem was determined to be caused by air entrainment in the Vortex structure. It was later remedied by the construction of new outfall intake structures.

During a second survey in February 1991, the exterior of the original outfall was inspected from station 28+00 to 55+00. The elevation of each joint was measured, and a few high spots (about 8 inches in height) were identified. Both inspection reports are presented in the Point Loma Outfall Extension Report, Volume II, Engineering Studies, prepared for the City in April 1991.

Parsons Corporation (Parsons) prepared a third inspection report in July 1991. This report presented the results of an internal inspection from the Vortex structure to station 29+58. Forty-two percent of the joints had some sign of concrete corrosion at the crown, and three joints had more severe corrosion. Subsequent work to correct internal corrosion problems was performed by another consultant under a separate contract to the City.

In 1995 and 1996, Parsons issued subsequent reports, based on prior year ROV inspections of the entire outfall, concluding that the overall condition of the PLOO appeared to be good. The 1996 report noted that a portion of the Main Barrel had low rock ballast. Re-ballasting of this portion (from station 67+15 to the Original Wye structure) was conducted between October 1997 and January 1998. Two types of rock were used for the re-ballasting: a larger rock (Class A Stone) for the shallower section from station 67+15 to 81+00, and a smaller rock (Class B2 Stone) for the remaining length.

Original Outfall Diffusers (1963 - 1993)

The original Diffusers and Wye structure incorporate provisions for isolation and flushing. Slots were provided for the insertion of reinforced concrete bulkheads (gates) at the following locations: (1) the inlet to each Diffuser Leg at the Wye structure; (2) the Main Barrel of the Wye structure, immediately downstream of the Diffuser Leg connections. A bolted bulkhead was installed at the end structure of each Diffuser Leg. Flow into the Diffuser Legs is presently blocked by bulkheads, which were inserted when the outfall extension was brought online.

The two original Diffuser Legs branch from the Wye structure at station 114+50 on the Main Barrel. The internal angle between the two Diffuser Legs is 128 degrees. Each Diffuser Leg has a total length of 1,368 LF, and inner diameter of 78 inches, and a wall thickness of 7.5 inches. Each Diffuser Leg is constructed of reinforced concrete, bell and spigot pipe of the raised bell type, with one gasket at each joint. Built at a depth of approximately 210 ft below sea level, the original Diffuser Legs were laid directly on the ocean floor with bedding ballast placed up to the Spring Line of the pipe.

The end structure of each Diffuser Leg consists of a reducer from 78- to 54-inch diameter that also functions as a thrust block. An anti-scour apron crib is located at the Diffuser Termination point to allow flushing of the Diffuser Leg without the risk of undermining the Diffuser. The 78-inch Diffusers were originally intended as only the first part of the diffuser system, with additional lengths of 54-inch Diffuser pipe to be added later as flow increased.

Diffuser ports are located at the Spring Line on both sides of the Diffuser pipe. On one side of each Diffuser Leg, the ports are spaced at a constant interval of 96 LF. Ports on the opposite side of each Diffuser Leg are spaced at the same interval, but are located at intermediate points such that, measured along the Diffuser centerline, there is a net spacing of 48 LF between ports. The first 10 ports on each Diffuser Leg closest to the Main Barrel have a diameter of 8 inches, and the remaining 18 ports have a diameter of 9 inches. A rectangular terminal port of 10 by 12 inches is located at the bottom of the terminal bulkhead. During early years of operation of the original outfall, when there were low flows, the port openings were reduced in size by the use of Monel orifice plates. All ports on the Original Diffuser Legs are presently open, however, as previously mentioned, flow into these Diffuser Legs is now blocked.

Intermediate Wye

The purpose of the Intermediate Wye structure is to permit a future 12 ft diameter outfall connection that could parallel and replace the original outfall. The Wye branch is oriented at 45 degrees to the Main Barrel and intersects the Main Barrel at station 2+59. A reinforced concrete bulkhead is currently set in a special slot on the Wye and will be removed upon connection of the parallel outfall conduit. Two Monel lifting hooks are provided for retrieval of the bulkhead.

Constructed of a combination of 3/4-inch steel plate and 6-inch reinforced concrete liner, the Intermediate Wye is set within a 19 ft high, 48 ft diameter, circular steel plate crib. The space between the Wye and the steel ring is backfilled with rock, which provides thrust restraint. The steel crib is coated with 180 mil of an epoxy compound that provides both corrosion resistance and mechanical protection.

Cathodic protection for the steel plate ring at the Intermediate Wye is provided by a total of 14 active and 14 passive sacrificial anodes arranged in two rows around the periphery of the ring. All anodes are aluminum alloy ingots that contain 3 percent zinc by weight and are joined to the steel plate ring by welded straps. Each ingot weighs approximately 90 pounds. The passive anodes are encapsulated in a wax tape coating to reduce or eliminate current output. The anodes on the

Intermediate Wye will be consumed (sacrificed) for the protection of the structure as current is discharged from them into the surrounding substrate or seawater. It is estimated that the active sacrificial anodes will be consumed in about 50 years. At that time, or earlier, it will be necessary to remove the wax tape coating from the passive anode surfaces. Upon activation, the life of the passive anodes should exceed the service life of the original outfall. It is difficult to estimate the rate of consumption of an anode, thus, the condition of the anodes must be monitored to determine when activation of the passive anodes is required. A dielectric coating additionally protects the steel plate crib.

Emergency Repairs to Original Outfall

On February 2, 1992, a major failure of the original PLOO occurred between stations 33+28 and 37+60. Emergency repair work was designed and completed within 60 days of the failure and involved: (1) Replacement of 432 LF of the Main Barrel, using 360 degree, poly vinyl chloride (PVC) lined, 9 ft diameter reinforced concrete pipe; (2) Placement of bedding, intermediate rock, and armor rock for the 432 ft section; (3) Placement of a cover of 1.5 ton (median) armor rock with a minimum thickness of 4.5 ft above the top of the pipe from station 27+90 to 60+00; (4) Placement of armor rock flush with the top of the pipe from station 60+00 to 67+15; (5) Provision of a manhole and air relief valve assembly at station 3+52.50.

The pipe used for the repair section was of the flush bell type with double gaskets. Steel rings on the pipe bell and spigot formed the joint. A 3/4-inch thick, 18-inch wide external steel split sleeve surrounded each joint and incorporated two O-ring gaskets to provide a tight seal. Silicone grease was injected into the annular space between the sleeve and the outside wall of the pipe through 1-inch diameter fittings on the coupling.

A special closure piece was fabricated to affect the closure of the repair work. The closure piece, capable of covering a 33½ ft long gap, incorporated a 25 ft long, internal steel cylinder, that provided support for two 13 ft, 7½-inch long, reinforced concrete telescoping pipe sections. Double gaskets on each of the telescoping pipe sections provided a seal between the internal steel cylinder and the pipe. A reinforced, tremie concrete collar joined the telescoping pipe sections.

After the connection was made, concrete was pumped into the steel form, locking in place the two telescoping sections.

Outfall Extension (1993 – present day)

The PLOO extension was completed in 1993. The purpose of extending the original outfall was to achieve compliance with the modified California Ocean Plan bacterial standards for water contact recreation in the Point Loma kelp beds. The outfall extension accomplished this objective by preventing the diluted wastewater discharged from the outfall (waste field) from encroaching into the kelp beds. The outfall extension was designed to achieve a 75-year service life.

The Main Barrel of the outfall extension is connected to the original Wye structure immediately downstream from the original Diffuser Legs. A slot for a reinforced concrete bulkhead is located in the original Wye structure between the Diffuser Legs and the connection for the outfall extension. The bulkhead had been removed to allow flow to pass through the outfall extension, and a lid was secured to the top of the slot.

Between the start of the outfall extension at station 0+08 and 1+88, the diameter of the reinforced concrete pipe conduit is 108 inches and the wall thickness is 10 inches. A special transition pipe is provided at station 1+88, that increases the outfall extension diameter from 108 to 144 inches. The Intermediate Wye structure starts at station 2+31.

The top 90 degrees of the inside circumference of the Main Barrel, centered on the crown of the pipe, is lined with a PVC, which is permanently imbedded in the concrete with integral locking extensions. Vertical surfaces at pipe joints are lined with PVC that is bonded to the pipe with a special adhesive.

A maintenance access hatch is provided in the 9 ft section of the outfall extension at station 0+20. The cover of the 42-inch hatch opening is made of cast Ni-Resist alloy that has a low rise (almost flush with the exterior of the pipe). A two-inch threaded opening in the hatch, presently plugged, was designed to allow piezometric testing of the outfall.

The Main Barrel was laid on a leveled course of bedding material. Following placement of the Main Barrel, bedding was completed and then ballast rock was placed up to the Spring Line.

Outfall Extension from Intermediate Wye to New Diffuser Wye

Between the downstream end of the Intermediate Wye at station 2+88 and the upstream end of the Diffuser Wye structure at station 124+97, the diameter of the conduit is 144 inches and the wall thickness is 12 inches. Pipe joints, lining, bedding, ballast, and exterior marking are identical to those described for the 9 ft. diameter portion of the outfall extension.

Maintenance access hatches, identical to the one located in the area between the original and Intermediate Wye, are provided at an interval of roughly 1000 LF on the 12 ft. diameter portion of the Main Barrel. Twelve access hatches are provided between the Intermediate Wye and the Diffuser Wye structures.

New Diffuser Wye Structure

The Diffusers branch from the main outfall at the Diffuser Wye structure (station 125+23) at a bottom depth of 310 ft. below sea level. The Diffuser Wye, similar to the Intermediate Wye, is also constructed of fabricated steel plate and reinforced concrete liner, and is set within a 19 ft. high, 42. ft diameter, circular steel plate crib. The space between the wye and the steel ring is backfilled with gravel to provide thrust restraint.

Cathodic protection for the steel plate ring at the New Diffuser Wye is provided by a total of 12 active and 12 passive sacrificial anodes arranged in two rows around the periphery of the ring. Four of the anodes, 2 active and 2 passive are completely buried by ballast rock and are not visible during the inspection. As with the Intermediate Wye, the anode life for the Diffuser Wye is also estimated to be about 50 years. At the time of depletion of the active anodes, it will be necessary to remove the wax tape coating from the passive anode surfaces. Upon activation, the life of the passive anodes for the Diffuser Wye is estimated to be over 50 years. Similar to the Intermediate Wye, the steel plate crib is protected by a dielectric coating.

Slots for three reinforced concrete bulkheads (gates) are provided at the Diffuser Wye structure inside the steel plate crib. Two of the bulkheads can be used to shut off flow to the two Diffuser Legs and can be used during outfall maintenance. A maintenance access hatch is provided in the Diffuser Wye structure. As part of routine maintenance, a bulkhead can be inserted at one Diffuser Leg to enable cleaning, inspection, or repair of the isolated Diffuser Leg with a minimum interruption of flow. Under normal operation, the Diffuser Slide Gates are not in place and the gate slot is covered by a reinforced concrete lid. A third slot is provided on the 12 ft diameter Main Barrel, immediately downstream from the Diffuser branches. This slot, which normally has the bulkhead in place, allows full diameter access to the Main Barrel of the outfall and could be used for mainline cleaning or for a future outfall extension.

The reinforced concrete lids are rectangular in shape, are secured in place by Monel bolts, and rest on collars that are integrally cast into the Diffuser Wye. A gasket in a rectangular pattern on the collar ensures a watertight seal. Two lifting hooks are provided on each lid.
A 2-inch diameter port is located in the crown of the pipe, immediately upstream of the Wye. The purpose of the port is to prevent the accumulation of air, oil, grease, and floatable materials that could otherwise impair the function of the Diffusers.

New Outfall Diffusers Legs

The two Diffuser Legs for the outfall extension are built on the seabed at water depths between 310 and 316 ft below sea level. The Diffuser Legs are oriented with an internal angle of roughly 152 degrees. Each Diffuser Leg is 2,496 LF long and consists of sections of 7 ft, 5.5 ft, and 4 ft internal diameter pipe. Pipe lengths, port spacing, and numbers of ports on each Diffuser Leg are summarized in Table 1. Diffuser Ports are set in the middle of each pipe on opposite sides, 6 inches above the Spring Line of the pipe.

Table 1

Configuration of the new Diffuser Legs on the PLOO extension.

Section Length Per Leg (ft)	Internal Diameter (ft)	Pipe Thickness (In)	Port Spacing[1] (ft)	Port Diameter (In)	Number of Ports per Leg	Approx. Range of Depth[2] MLLW (ft)	Port Design Flow Rate (max. mgd)
1008	7.0	9	24	3.75	84	306–309	1.09
840	5.5	9	24	4.25	70	309–311	1.15
648	4.0	9	24	4.75	54	311–313	1.13

[1] Port spacing shown is for ports on the same side of diffuser leg. Ports are located on both sides on the diffuser leg.
[2] Distance from the centerline of the ports to the ocean surface.

The Diffusers (excluding the final 160 ft long section of the 4 ft Diffuser) are constructed of PVC-lined, reinforced concrete pipe similar to the pipe used for construction of the Main Barrel. Unlike the Main Barrel of the outfall extension, all pipe joints on the Diffuser have a single gasket. The final 160 ft section of each Diffuser Leg is constructed of a single piece of steel pipe, which serves as a restraining block. Steel plate used in fabrication of the pipe has a thickness of 5/8 inches and is lined internally with 5 inches of reinforced concrete. Externally, the steel is coated with a 180-mil thick layer of Carboline. Cathodic protection for each of the two steel Diffuser Termination sections is provided by four active and four passive sacrificial anode ingots arranged on the top of the pipe in four groups of two.

The internal PVC lining of the Diffusers is identical to that of the Main Barrel of the outfall extension. Bedding for the Diffusers is similar to that for the Main Barrel; however, the ballast is depressed at the ports to avoid blockage of the flow. Likewise, the stripe painted along the Spring Line of the Diffusers to indicate the height of the ballast rock is depressed in a "V" shape at the ports. To aid inspections, a line is also painted along the circumference of the Diffuser from the top of the pipe to each individual Diffuser Port.

METHODS

Survey Equipment

City Monitoring Vessel

The City's *M/V Oceanus* is a 48 ft, twin diesel engine-powered, aluminum hull, modified crew boat, with a rear-mounted hydraulic A-frame and a bow winch and fixed A-frame from which the clump weight is deployed. The vessel is used by the Public Utilities Department's Environmental Monitoring and Technical Services Division primarily as an ocean monitoring and outfall inspection platform.

Remotely Operated Vehicle (ROV)

The external inspection of the PLOO was carried out using the City's SAAB Seaeye Falcon Remotely Operated Vehicle (ROV). This ROV is equipped with high sensitivity, and high resolution, color and low-light black and white video cameras for recording high quality footage of the outfall (inspection video footage is available upon request – see Appendix C for details). It is also equipped with a digital sonar, and an ultra-short baseline tracking system, which uses acoustic telemetry to locate the position of the ROV relative to the support vessel in real time. In addition, the ROV is equipped with a precision navigation and positioning system composed of a doppler velocity log (DVL). Due to the depth of the PLOO, the low light black and white video camera was used for most portions of the survey. This camera provides a good visual perspective of the outfall and its surroundings in low light/low visibility environments and offers greater detail than a color camera would have been capable in the same situation.

Outfall Survey

The ROV is deployed on designated outfall sites from the City's monitoring vessel, from which City staff can remotely orient the ROV to the designated survey area, based on Global Positioning System (GPS) coordinates. Once in the water, the ROV is kept on the surface and moved a distance of 300 ft from the bow of the ship. The umbilical is then attached to a 300 lb clump weight, which is slowly lowered through the water column. As the weight is lowered, the umbilical is attached to the winch line at standard increments. The ROV descends to the seafloor and the clump weight is deployed to a depth that is approximately 30 ft above the ROV. The outfall is located using the ROV's sonar system, and then the support vessel, and the ROV, are simultaneously moved into position to begin the inspection.

The survey was conducted by moving the ROV inshore along each side of the pipe. Pipe observations were made facing along the length of the pipe, and location on the pipe was identified using a clock face orientation. For example, 9 o'clock corresponds to the Spring Line on the north side, 12 o'clock identifies the top of the pipe, and 3 o'clock corresponds to Spring Line on the south side of the pipe. During the inspection process, the outfall pipe sections were counted to determine progress. Verifying pipe joint numbers was possible by having previously determined accurate positions of the visible manhole covers. The ROV was positioned on top of each of the covers, after which the boat was moved directly over the ROV using the tracking system. The location of each cover was then recorded by the vessels GPS system. Using this information with other reference features has made possible real-time corrections in joint numbering during each inspection. Accurate joint numbering is important when assessing the condition of the outfall and its supporting structures from year to year.

The ROV system was used to survey the following parts of the outfall structure in this order: New Diffuser Legs, New Diffuser Wye, Outfall Extension Main Barrel, Original Outfall Main Barrel, Intermediate Wye, Original Diffuser Wye, Original Diffuser Legs, and Inshore pipe section toward shore to the offshore limit of the Point Loma Kelp Forest. The kelp forest poses significant entanglement problems to the ROV, thus the inspection was concluded where kelp begins along the 92 ft depth contour.

Outfall ROV Cathodic Protection Survey

A cathodic protection survey was conducted for the first time on the ocean outfall during May 7 and 9, 2024. The survey utilized a specially designed contact probe and a deep water silver-silver chloride (AgCl) reference electrode attached to the ROV to measure structure-to-electrolyte potentials on the cathodically protected sections of the outfall. The data was transmitted through the ROV umbilical cable and displayed on the monitors within the survey vessel. The ROV, using the attached probe, was used to make physical contact with existing, exposed anode cores in order to measure the structure potentials. Full levels of cathodic protection are typically indicated by structure-to-electrolyte potentials more negative than -0.800 volts versus an AgCl reference electrode. The recorded measurements and levels of cathodic protection is discussed in each section below as applicable.

OBSERVATIONS

After careful review of the video recordings for the 2023 inspection, and a side by side comparison of the 2022 survey video few if any changes have been noted in the overall condition of the outfall since the previous survey. For example, the ballast, the Diffusers, and the exterior of the outfall system are all in good condition, and the general ballast levels everywhere along the outfall appear unchanged.

Water clarity is a highly variable feature of the Point Loma region. The substantial water depth, coupled with a very dynamic environment, and a large amount of suspended organic material, often contributes to creating a very turbid environment in which images appear foggy. The solids in suspension did not seem to be a factor of the outfall discharge, as the turbidity was distributed equally along the pipe both far and near from the active Diffusers.

Ballast rock levels often increase and decrease along the length of the pipe sections in an oscillating motion. Similar to prior year's observations, the consensus remains that the ballast has still not exhibited any noticeable movement. This finding combined with similar conclusions from earlier reports continues to support the premise that the observed undulations likely resulted from the original placement of the rock at the time of construction rather than having resulted from movement associated with external oceanographic forces.

As in previous years, the 2023 survey included detailed inspections of the New Diffuser Legs and the inactive Original Diffuser Legs. Although the Original Diffuser Legs are no longer an active part of the outfall, a video inspection of the structures continues to be a standard feature of each annual inspection in order to detect changes that might have occurred since the last survey. The inspection of the new legs was conducted in a manner similar to previous surveys.

Original Outfall Main Barrel

The original Main Barrel of the outfall, extending inshore from the original Wye through the Point Loma kelp bed to where it descends beneath the seafloor, is well protected from oceanographic forces by having been covered with high levels of armor rock during the re-ballasting effort in 1997–98. The rock in most areas entirely covers or is piled to the top of the pipe.

Original Outfall Diffuser Wye

The overall condition of this structure was seen to have changed little since the last inspection: the metal crib of the Wye continues to slowly degrade and the damage to the upper rim of the crib from repositioning the barge anchors during construction of the outfall extension is still apparent. As noted in earlier reports, the status of the metal crib is of no concern as it was only intended to be a sacrificial form for the grouting of ballast rock. The new and larger rock placed on top and around the crib during the re-ballasting of the original outfall continues to provide additional support for the corroding structure. This new rock now partially overlays the cover of the South Diffuser Stop Log.

Original Outfall North Diffuser Leg

The condition of this Diffuser Leg appears unchanged since the last survey apart from two sections of bell offshore N03 to N02 which has evidence of a leak at the transition. At this transition, there is a white bacterial mat present as well some effluent being discharged. A side by side comparison to last year's inspection video indicated the leak has increased. This discharge still appears to be small, less than the discharges that occurs at a few ports near the Old Wye. The bell at section N51 to N50 also appears to be leaking. The bell is separating from the transition. The position of the separation is almost the entire transition. Overall, the ballast levels continue to be adequate and small amounts of effluent continue to escape from the first few ports nearest to the Old Wye. The observed variability in the rate and volume of discharge from year to year may be due to the differing times of day at which the surveys were conducted rather than having been the result of changes in the physical state of the Diffuser Legs. Effluent volume from each port noticeably decreased with increasing distance from the Old Wye

Original Outfall South Diffuser Leg

The inspection of this structure took place on the same day as the Original North Diffuser Leg. Overall, the structure was intact, ballast levels were adequate and seemed unchanged. As with the other leg, effluent continued to escape from around the gate closure at the Wye and exhibited variable rates of puffing at the first several ports on either side of the leg.

Original Outfall Inshore Main Barrel

The section of the outfall from the Old Diffuser Wye inshore to the piezometer located at the 92 ft contour showed that the armor rock continues to cover most of the outfall. There are instances where the top of the outfall can be seen, but this is limited to comparatively few sections of pipe. One small section on the Inshore Main Barrel was surveyed but not included in the report as the video was corrupted. This occurred in the survey from ~ 11:47 A.M. to 11:53 A.M. There were no unusual observations noted during this time period.

Intermediate Wye

As in previous surveys, all visible sections of the intermediate wye remain in good condition. However, it should be noted, eight of the original 28 anodes remain buried under ballast rock making conclusions about their condition impossible. Passive anode 9U was detached from its mounting bracket soon after construction, presumably due to a fouled anchor line, and passive anodes 3U and 5U are also missing. Six of the lower, active anodes still exhibit uniform levels of degradation and seem to have retained approximately 50% of their original mass. Many of the protective wrappings on the upper ring of the passive anodes have loosened over time and have become active to varying degrees, but they all appear to have retained much of their original mass. Cathodic protection structure-to-electrolyte potentials were measured and recorded on the intermediate wye on May 9, 2024. Measurements were taken at exposed anodes and anode cores as conditions allowed and included anodes 1U, 2U, 2L, 3L, 4U, and 4L. Measured potentials varied from -0.940 volts to -0.970 volts with an average of -0.953 volts. These measurements indictae that the intermediate wye structure is receiving full levels of cathodic protection.

New North Diffuser Leg

All Diffuser ports continue to flow freely except for three. Offshore ports and N99-4 and N99-3 and inshore port N99-3 are partially obstructed. Flows for all three of these ports are partially restricted by pieces of a white material in the port openings, which is thought to be eroded sections of the PVC liner from the interior of the pipe. Inshore port N98 previously obstructed appears to be flowing freely this year. Additionally, the air vents at N77 and N42 remain blocked again this year. The active anodes on the A, B, C and D anode pairs on the terminal Diffuser section are missing and are assumed to be have been prematurely consumed. The passive anodes are in relatively good condition, but are all unwrapped to varying degrees and exhibit evidence of degradation. The metal terminal section of the Diffuser Leg looks to be in very good condition and shows no sign of corrosion. As in previous years leaking was observed emanating from the seams of the North Leg Terminus. In the 2021 and 2022 survey's it was noted the leakage from the north terminus gate cover appeared to be flowing more than previous years. This continues to be the case in the 2023 inspection. The ballast rock level was satisfactory throughout the North Diffuser Leg.

Cathodic protection structure-to-electrolyte potentials were measured and recorded on the north diffuser leg terminal structure on May 7, 2024. Measurements were taken at exposed anodes and anode cores as conditions allowed and included anodes A Offshore, B Inshore, C Offshore, and D inshore. All potentials measured -0.550 volts. For comparison, the potential of an unprotected bare steel stake was measured at -0.522 volts. These measurements indictae that north offshore terminal structure is not receiving adequate levels of cathodic protection.

New Diffuser Wye

The structure continues to be in overall good condition. A schematic of the twelve pairs of anodes on the New Diffuser Wye is shown in Appendix B.3. Lower anodes 1, 2, and 8, along with its mounting bracket are missing or consumed. The remaining eight lower anodes were thought to have been buried with armor rock during construction, thus no conclusion can be drawn regarding their condition. The protective wrappings on the remaining anodes of the upper ring have loosened over time to varying degrees, which has caused them to become partially active. These eight anodes, however, have continued to retain much of their original mass. No corrosion of the metal crib structure was noted and it is assumed, therefore, that the remaining anodes continue to provide adequate cathodic protection. Localized areas of leaking were observed emanating from the seams of the North and South Leg Gate Cover as well as, the Stubout Gate Cover. This observation is not new and is likely a function of the time of day the survey is being performed and, thus, the accompanying pressure inside the pipe. Effluent continues to leak from different locations on the perimeter of Stubout Gate. However, these leaks are of little consequence, in regard to water quality, as the initial dilution of this low flow effluent escaping is much higher than that of effluent being discharged from the nearby Diffuser Ports.

Cathodic protection structure-to-electrolyte potentials were measured and recorded on the new diffuser wye on May 7, 2024. Measurements were taken at exposed anodes and anode cores as conditions allowed and included anodes 4U, 7U, 8L, and 12U. Measured potentials varied from -0.620 volts to -0.640 volts with an average of -0.630 volts. These measurements indictae that the intermediate wye structure is receiving partial levels of cathodic protection.

New South Diffuser Leg

Apart from the blockage of the offshore port on S97 by the same material obstructing the port on the New North Diffuser Leg, all the Diffuser Ports on this Diffuser Leg appear to be flowing normally. Three feet or more of the liner material continues to protrude from the offshore port of S97, partially restricting the flow. Air vent S42 and S77 was flowing freely with no restriction.. The active anodes on the terminal diffuser section exhibit uniform levels of corrosion and appear to retain 50% of their original mass. All the passive anodes appear to be adequately wrapped and in good condition with a few of the anodes showing some consumption around the ends where the protective wrapping appear to have come loose. The level of protective rock along this structure was satisfactory.

Cathodic protection structure-to-electrolyte potentials were measured and recorded on the south diffuser leg terminal structure on May 7, 2024. Measurements were taken at exposed anodes and anode cores as conditions allowed and included anodes A Inshore, B Offshore, C Inshore, and D Offshore. Measured potentials varied from -0.950 volts to -0.960 volts with an average of -0.958 volts. These measurements indictae that the south offshore terminal structure is receiving full levels of cathodic protection.

Outfall Extension Main Barrel from New Diffuser Wye to Intermediate Wye

The ballast levels do not appear to have changed noticeably since the previous survey. Rock levels along the Main Barrel continue to be generally adequate. Levels on both sides of the outfall occasionally fell below the Spring Line (3 and 9 o'clock positions), but rarely fell below 8 and 4 o'clock positions on the north and the south sides, respectively. The sections between joints 69 and 86, and 17 and 30 on the south side continue to show areas of ballast as low as the 4 o'clock level. On the north side, the ballast between pipe joints 17 and 30 was lower (down to approximately 8 o'clock position) in localized areas, but the majority of the area bordering these sections is well protected by levels of armor rock at or above the Spring Line. There is a difference in the distribution of low spots between sides: there are isolated areas of low rock levels on the south side that extend in places over two sections; on the north side low spots are limited to much less than half a pipe segment. The variation in rock level is thought to be an artifact of rock placement rather than movement by external oceanographic forces. As recorded in previous surveys, the vent on the top of the last pipe segment (J619) remains blocked, and has been this way for at least 13 years.

Outfall Extension Main Barrel from Original Diffuser Wye to Intermediate Wye

This area is generally well protected by rock with the exception of the previously observed low areas on north side of J2 and J3. The ballast level on these sections were at approximately 8 o'clock. The vent on segment J10 remains plugged this year and is not flowing.

Manholes

There are 20 manholes on the original outfall (14 on the Main Barrel and three each on the Diffuser Legs) and 15 on the outfall extension. One manhole cover is made of concrete, the others are made of Ni-Resist alloy. Of the 14 "Main Barrel" manholes on the original outfall, five were visible in the ROV inspection. The first three manholes on the original outfall are within the area where the pipe is covered by a concrete cap. Four manholes are within the area of the pipe covered by armor rock and were not visible. Manhole 9 has a piezometer box atop of it and armor rock piled high on both sides. While there has been some concern that movement of the large armor rock might damage the piezometer box and cause a leak, the position of the rock has remained stable. The manholes on the Main Barrel all appear to be in good condition. The visible manholes on the Old Diffuser Legs, including the new manhole fabricated with Monel alloy near the old Wye, are in good condition. The rest of the manholes observed in the survey are also in good condition and no leaks were detected. Table 2 lists the manhole status for the original outfall while Table 3 lists the status of the manholes in the outfall extension.

Table 2

Status of original PLOO manholes

Station #	Manhole #	Comments
02+20	1	Not observed
16+38	2	Not observed
26+46	3	Not observed
36+87	4	Not observed
44+74	5	Not observed
51+48	6	Not observed
60+15	7	Not observed
69+56	8	Not observed
77+22	9	Good condition
84+89	10	Good condition
92+55	11	Good condition
100+23	12	Good condition
107+92	13	Good condition
114+34	WYE	Good condition
New Manhole at N1	0	Good condition
05+00 North Leg	1	Good condition
10+00 North Leg	2	Good condition
13+85 North Leg	3	Good condition
New Manhole at S1	0	Good condition
05+00 South leg	1	Good condition
10+00 South leg	2	Good condition
13+85 South leg	3	Good condition

Table 3

Status of extended PLOO manholes.

Station #	Manhole #	Section #	Comments
0+78	1	4	Good condition
10+80	2	52	Good condition
20+63	3	101	Good condition
30+90	4	152	Good condition
41+34	5	204	Partially covered in rock, no apparent damage
50+59	6	250	Good condition
60+83	7	301	Good condition
70+76	8	351	Good condition
80+94	9	401	Good condition
90+56	10	449	Partially covered in rock, no apparent damage
100+60	11	499	Good condition
110+64	12	549	Good condition
120+66	13	599	Good condition
125+15	14	621	Good condition

CONCLUSIONS

Comparisons of the 2023 and 2022 video surveys show that while very minor rock surface modifications may be occurring as a result of external oceanographic forces, the ballast level along the outfall appears unchanged. Based on the limited information that can be gathered from the ROV inspection presented here, overall, the Point Loma Ocean Outfall appears to be in good condition with some localized areas of less than optimal rock levels.

Noteworthy Observations

1. There are localized areas of less than optimal rock protection towards the beginning of the outfall extension. However, these levels have not changed over time, and are likely an artifact of rock placement during the original construction activities.

2. Inshore port N99-3 and offshore port N99-3 and N99-4 on the New North Diffuser Leg, along with offshore port S97 on the New South Diffuser Leg, are partially blocked by a material of unknown origin. There is some thought that this blockage may be due to pieces of PVC liner material that have eroded from the interior of the pipe. Obstruction at S97 appears worse than last year.

3. As seen in the 2021 and 2022 surveys the leakage from the north terminus/gate cover on the new north leg continues to be flowing more than previous years. This may be due to daily variable flow discharge rates from the treatment plant.

4. Air vent S42 and S77 on the New South Diffuser Leg was observed to be flowing normally during this year's inspection.As in previous surveys, both air vents on the New North Diffuser Leg are blocked. .

5. The coating of the outfall's metal structures remains in good condition, with the exception of the uncoated Original Diffuser Wye. Corrosion of this structure is not a concern since it is not active and most of the rock mass is grouted. Minor damage was imparted to the

Original Wye by barge anchoring cables during the 1999 construction activity. Additional rock was added to this structure in 1997–1998.

~~6.~~ The original north outfall diffuser leg has started to degrade. Sections N02-N03 and N51-N50 now appear to be delaminating. The delamination of the bell housing was also observed in the 2022 survey.

7. The results of the cathodic protection survey indicate that the terminal structure of the south diffuser leg and the intermediate wye structure are still receiving full levels of cathodic protection from the active anodes. The new diffuser wye is receiving partial levels of cathodic protection while the terminal structure for the north diffuser leg appears to have very little to no cathodic protection. It is not fully clear why the north and south terminal structures, which are identical in design, have such different levels of cathodic protection. The most likely reason is an increased cathodic protection current demand caused by more uncoated surface area but this cannot be visually confirmed. Low potentials on the new diffuser wye may be attributed to damage to the active anodes. Three active anodes are either missing or fully consumed and the others cannot be evaluated because they are covered with the ballast rock. It is recommended that, at the very minimum, the passive anodes on the north diffuser leg terminal structure and the new diffuser wye be unwrapped and placed into service. Because of the cost involved in doing this, it may be cost effective to also install new, sled mounted anodes on all the structures at the same time. The new anodes would be connected, via a cable, to the existing consumed and exposed anode cores.

Appendix A

History of PLOO Inspections (1964 – 2023).

Date	Inspectors	Inspection Method	Finding/Remarks
March 1964	Jon Lindberg & Associates	Visual by divers	Inspection of additional rock placement.
February 1965	Ocean Systems, Inc.	Visual 2-man submersible visual	Reported rocks and pipe appear stable.
June 1976	Contract Divers	Diver inspection	Reported rocks and pipe appear stable. City has diver's log.
July 1986	Pelagos	Video monitor of entire outfall exterior	Complete video baseline.
1989	Parsons ES	Piezometer test	Discovered air in line
February 1990	Parsons ES	Diver inspection of the pipe interior	Some problems with deterioration at top of pipe at joints reported
February 1990	Pelagos/Parsons ES	Diver inspection of pipe exterior plus core samples	26+46 to 55+21 elevations taken at each joint.
May 1991	Underwater Resources/ Parsons ES	Diver inspection of interior	Interior deterioration noted in few joint locations. Inspection extended to Sta. 28+50.
February 1992	Pelagos	Diver inspection of exterior from 25+00 to 65+00 ROV inspection of interior to Sta. 65+00 and exterior to end of outfall	Discovered separate joints at 57+80 and damaged piezometer at 51+48 as well as areas where ballast rock was well below Spring Line.
November 1993	City	ROV video	Video inspection of outfall exterior, including new construction. Outfall is in good condition.
September – December 1994	City	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition.
September – October 1995	City	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition.
September – October 1996	City	Video by ROV, divers, and sonar survey.	Video inspection of outfall exterior and ballast sonar survey. Outfall is in good condition.
November 1997	City	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition.

Appendix A Continued…

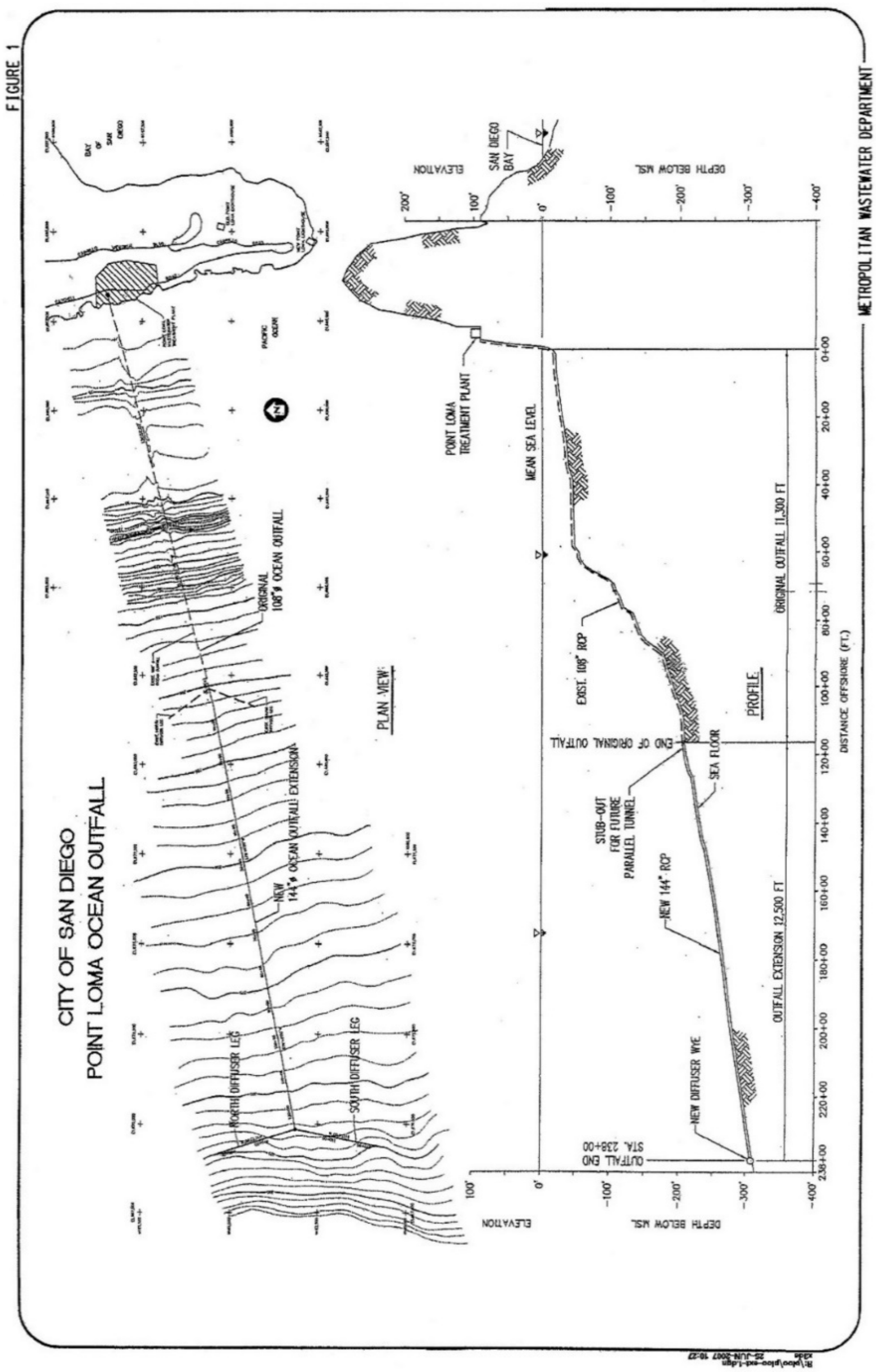
Date	Inspectors	Inspection Method	Finding/Remarks
September – October 1998	City	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition. Some concern regarding the ballast rock of the outfall extension at the beginning of the extension near the Intermediate Wye.
December 1999 – February 2000	City	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition. Some concern regarding the ballast rock of the outfall extension at the beginning of the extension near the Intermediate Wye.
November 2000 – January 2001	City	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition. Concern regarding the ballast rock at the beginning of the outfall extension answered through comparison of previous years, finding that rock moves little, if any over the course of the past few years.
August – November 2001	City	Video by ROV and divers	Improved video addresses some of the inspection concerns. Visibility however remains a problem. It appears that some rock is missing from the first section of the extension and on the North side up to 2400 ft of the 12-ft pipe.
August - September 2002	City	Video by ROV and divers	Excellent video due to markedly improved video quality allows clarification of the status of the rock in areas where existed concern. The Point Loma outfall is deemed to be in good overall condition
September 2003 – April 2004	City	Video by ROV and divers	Visibility average to mediocre. Introduction of DVD recording for inspection. PLOO is in good condition.
August 2004 – May 2005	City	Video by ROV	Inspection delayed due to equipment malfunction. Visibility average to very poor. PLOO is in good condition with small areas of less than optimal rock level.

Appendix A Continued…

Date	Inspectors	Inspection Method	Finding/Remarks
November 2006 – March 2007	City	Video by ROV and visual inspection by divers	Visibility average to poor. PLOO is in good condition with localized areas of less than optimal rock levels.
April – June 2008	City	Video by ROV and visual inspection by divers	Visibility average to poor. PLOO is in good condition with localized areas of less than optimal rock levels.
January – June 2009	City	Video by ROV and visual inspection by divers	Visibility excellent to better than average. PLOO is in good condition with localized areas of less than optimal rock levels.
April – June 2010	City	Video by ROV and visual inspection by divers	Visibility poor in most cases. PLOO is in good condition with localized areas of less than optimal rock levels.
September 2010 – March 2011 & June 2011	City	Video by ROV and visual inspection by divers	Visibility variable: good in 2010; poor in 2011. PLOO is in good condition with localized areas of less than optimal rock levels.
January– March – June 2012	City	Video by ROV and visual inspection by divers	Visibility poor in most cases. PLOO is in good condition with localized areas of less than optimal rock levels.
April 2014	City	Video by ROV	Visibility good in offshore areas, but becomes poor to extremely poor inshore. PLOO is in good condition with localized areas of less than optimal rock levels.
September – December 2014 & March - June 2015	City	Video by ROV	Visibility good in offshore areas, but becomes poor, workable inshore. PLOO is in good condition with localized areas of less than optimal rock levels.
September 2015	City	Video by ROV	Visibility was generally good throughout the inspection. PLOO is in good condition with localized areas of less than optimal rock levels.

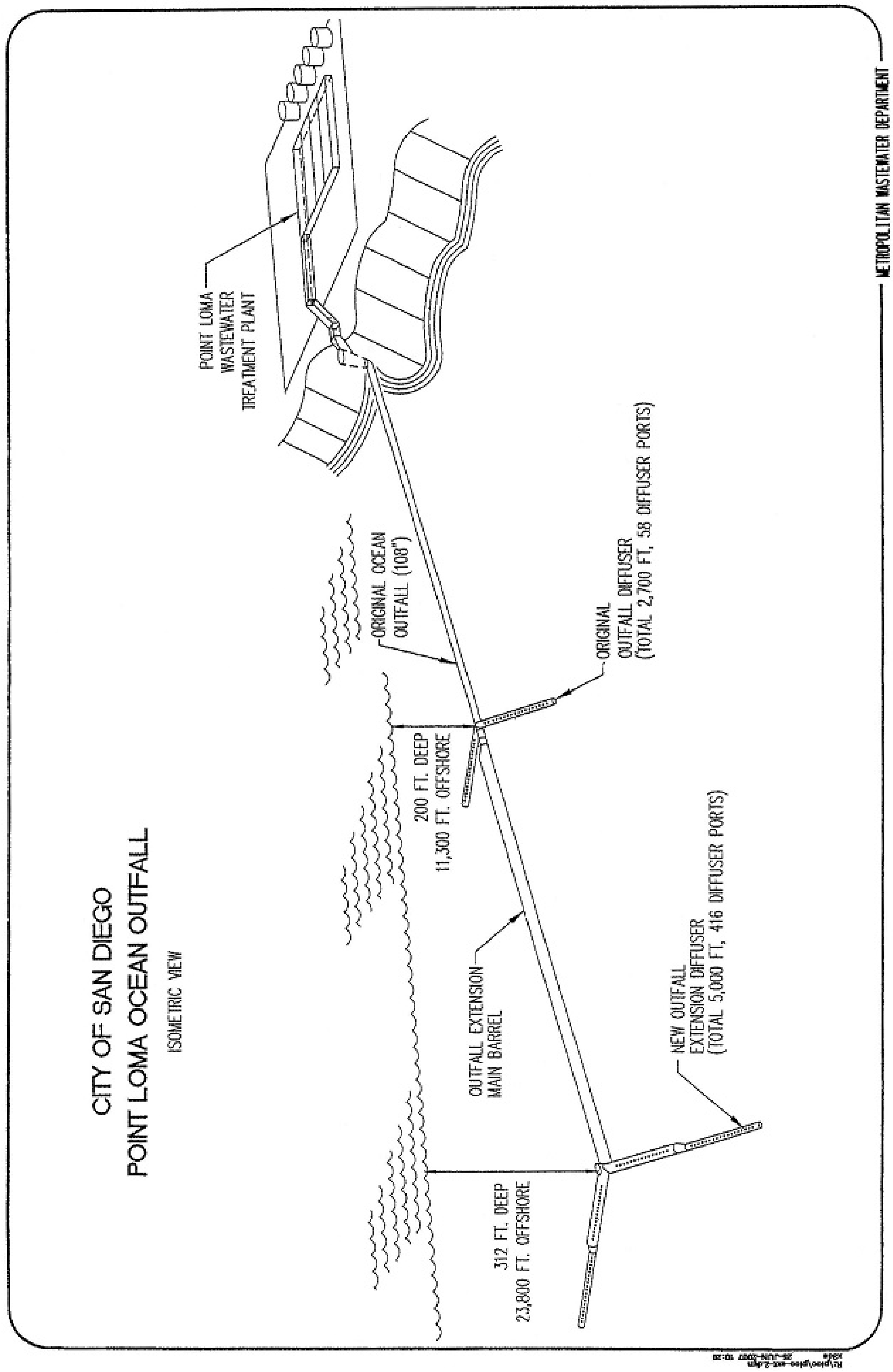
Appendix A Continued…

Date	Inspectors	Inspection Method	Finding/Remarks
September 2016	City	Video by ROV	Visibility was variable, but was generally good throughout the inspection. PLOO is in good condition with localized areas of less than optimal rock levels.
September 2017	City	Video by ROV	Visibility was variable, but was generally good throughout the inspection. PLOO is in good condition with localized areas of less than optimal rock levels.
October 2018 – April 2019	City	Video by ROV	Visibility was good in October 2018, but was generally low throughout the inspection performed in April 2019. PLOO is in good condition with localized areas of less than optimal rock levels.
September 2019	City	Video by ROV	Visibility was variable, but was generally good throughout the inspection September 2019. PLOO is in good condition with localized areas of less than optimal rock levels.
September 2020	City	Video by ROV	Throughout the 2020 inspection, visibility was variable, but generally better than previous years. PLOO is in good condition with localized areas of less than optimal rock levels.
2021 (surveyed May and June of 2022)	City	Video by ROV	Throughout the 2021 inspection, visibility was variable, but generally workable. PLOO is in good condition with localized areas of less than optimal rock levels.
2022 (surveyed April and May of 2023)	City	Video by ROV	Throughout the 2022 inspection, visibility was variable, but generally very good. PLOO is in good condition with localized areas of less than optimal rock levels.
2023 (surveyed April 2024)	City	Video by ROV	Throughout the 2023 inspection, visibility was variable, but generally very good. PLOO is in good condition with localized areas of less than optimal rock levels.



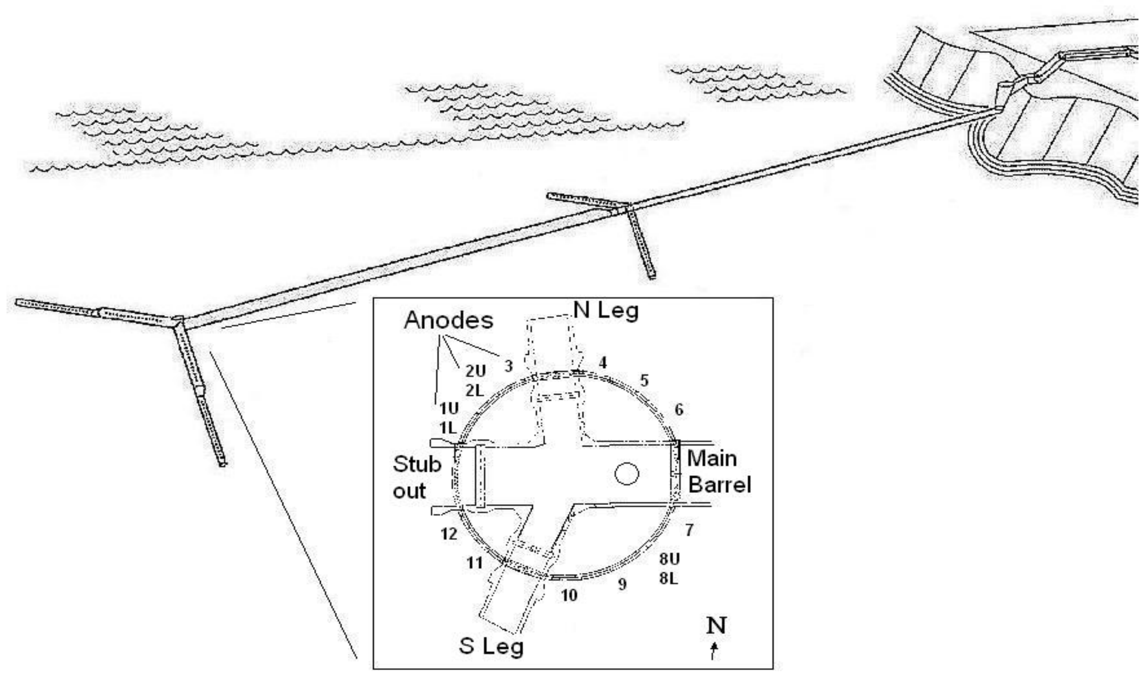
Appendix B.1

Schematic diagram of the PLOO.



Appendix B.2

Isometric diagram of the PLOO.



Appendix B.3

Anode Schematic of PLOO extension.

Appendix C

Directory of Survey Video Files on the USB Flash Drive.

File Name	Survey Date
2023 PLOO ROV SURVEY - 1 - NEW NORTH DIFFUSER LEG	April 11, 2024
2023 PLOO ROV SURVEY - 2 - NEW WYE	April 10, 2024
2023 PLOO ROV SURVEY - 3 - NEW SOUTH DIFFUSER LEG	April 10, 2024
2023 PLOO ROV SURVEY - 4 - MAIN BARREL SOUTH SIDE	April 16, 2024
2023 PLOO ROV SURVEY - 5 - MAIN BARREL NORTH SIDE	April 15, 2024
2023 PLOO ROV SURVEY - 6 - OLD WYE, OLD NORTH AND SOUTH DIFFUSER LEGS	April 17, 2024
2023 PLOO ROV SURVEY - 7 - INTERMEDIATE WYE, INSHORE MAIN BARREL	April 17, 20024