SD Public Utilities

Point Loma Ocean Outfall Annual Inspection Report

2016

City of San Diego Ocean Monitoring Program
Environmental Monitoring & Technical Services Division

The City of
SAN DIEGO
Public Utilities Department
Environmental Monitoring & Technical Services Division

June 30, 2017

David W. Gibson, Executive Officer
California Regional Water Quality Control Board
San Diego Region
2375 Northside Drive, Suite 100
San Diego, CA 92108

Attention: POTW Compliance Unit

Dear Mr. Gibson:

Subject: Point Loma Ocean Outfall Annual Inspection Report

Enclosed is the Point Loma Ocean Outfall 2016 Annual Inspection Report as per requirements set forth in Order No. R9-2009-0001 for the City of San Diego's Point Loma Wastewater Treatment Plant (NPDES No. CA0107409). The report has been certified by Mr. Richard Snow, a registered professional engineer in the State of California. The accompanying video of the inspection, on which much of this report is based, is also available if you would like to review it. Please call Dr. Tim Stebbins, Senior Marine Biologist, at (619) 758-2329 if you have any questions.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Peter S. Vroom, Ph.D.
Deputy Director, Public Utilities Department

TS/mk

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THE CITY OF SAN DIEGO

M E M O R A N D U M

REGISTERED PROFESSIONAL ENGINEER
RICHARD H. SNOW
No. C65359
Exp 9/17
CIVIL
STATE OF CALIFORNIA

DATE: June 23, 2017

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

FROM: Richard Snow, Senior Civil Engineer, Public Utilities Department/ WWTD

SUBJECT: Point Loma Ocean Outfall 2016 Annual Inspection Report

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Transmitted herewith is a copy of the report entitled "Point Loma Ocean Outfall 2016 Annual Inspection Report." This report presents the results of the 2016 annual outfall external inspection, performed by the City of San Diego staff.

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 as a result of external oceanographic forces, the ballast level along the outfall appears largely unchanged.

A second corrosion evaluation of the cathodic protection was performed in June 2012 by the Public Utilities Department Senior Corrosion Engineer using video from the 2012 survey. He concluded that the anodes were indeed being consumed and some level of cathodic protection was being provided. 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 remaining anode mass is probably sufficient to provide an adequate level of protection to the structures. City Staff will be using a cathodic protection probe on the ROV during next year's inspection. Those results should help determine whether there should be any long term concern with the amount of cathodic protection currently being provided. Based on those findings, subsequent action may be warranted including unwrapping of passive anodes, and/or complete replacement of the currently active ingots.

I conclude that during the 2016 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 x18321.

Richard H. Snow, P.E.
Senior Civil Engineer, PUD/WWTD
RS/rhs

Attachment: Point Loma Ocean Outfall 2016 Annual Inspection Report

cc: Juan Guerreiro, Deputy Director, PUD/WWTD
Tim Stebbins, Senior Marine Biologist, PUD/EMTS
Mike Kelly, Marine Biologist III, PUD/EMTS

SD Public Utilities

Point Loma Ocean Outfall Annual Inspection Report 2016

Point Loma Wastewater Treatment Plant
(Order No. R9-2009-0001; NPDES Permit No. CA0107409)

Prepared by:

City of San Diego Ocean Monitoring Program

Environmental Monitoring & Technical Services Division

Timothy D. Stebbins, Editor

Michael J. Kelly, Managing Editor

June 2016

SECTION 1.0

INTRODUCTION

This report presents the results of the 2016 Point Loma Ocean Outfall (PLOO) external inspection as required per Order No. R9-2009-0001, NPDES Permit No. CA0107409, issued by the San Diego Regional Water Quality Control Board, and the conditions set forth in Lease PRC 7029.9 as amended by the State of California State Lands Commission. The inspection of the PLOO was conducted over five days by City of San Diego (City) Ocean Monitoring Program personnel (Public Utilities Department, Environmental Monitoring and Technical Services Division) on September 9, 12, 20, 21 and 28, 2016.

1.1 Inspection Method

The external PLOO inspection was facilitated using the City's Saab Seaeye Falcon Remotely Operated Vehicle (ROV). This vehicle is equipped with high sensitivity and resolution color and low light black and white video cameras, sonar, and an ultra-short base line tracking system (tracking system) that uses acoustic telemetry to locate the position of the ROV relative to the City's support vessel.

The ROV system was used to survey the following parts of the outfall structure: 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 it begins at approximately the 92 ft depth contour.

The video records for the inspection are available and will be provided on request on a USB flash drive. This medium reduces the time needed to archive the video, eases access to the component elements of the ROV survey, and reduces the space necessary to store bulkier media. The video archive is summarized in Appendix A.

1.2 Positioning

During each survey day the City's support vessel is positioned to deploy the ROV using a Global Positioning System (GPS). Once in the water, the ROV is kept on the surface and moved a distance of 400' from the bow of the ship. The umbilical is then attached to a 300 lb clump weight that 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 feet above the vehicle. The outfall is located using the ROV's sonar system, and then the support vessel and the ROV are moved into position to begin the inspection.

During the inspection process, the outfall pipe sections are counted to determine progress. Verifying pipe joint numbers has been made 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 onboard tracking system. The location of each cover was then recorded by the City's customized onboard navigation integration system (Mission Manager). 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.

1.3 History of Inspection of the Point Loma Ocean Outfall

There have been many external inspections of the outfall since 1964. Table 1 identifies some of these inspections and summarizes their conclusions.

Table 1

Point Loma Ocean Outfall Inspections
(1964 – 2015)

Date	Inspectors	Inspection Method	Finding/Remarks
March 1964	Jon Lindberg & Associates	Visual by divers	Inspection of additional rock placement
February 1965 February 1965 June 1976	Ocean Systems, Inc. Ocean Systems, Inc. Contract Divers	Visual 2-man submersible visual	Reported rocks and pipe appear stable. City of San Diego 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 300′ 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 of San Diego	ROV video	Video inspection of outfall exterior, including new construction. Outfall is in good condition.
September–December 1994	City of San Diego	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition.
September–October 1995	City of San Diego	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition.
September–October 1996	City of San Diego	Video by ROV, divers, and sonar survey.	Video inspection of outfall exterior and ballast sonar survey. Outfall is in good condition.
November 1997	City of San Diego	Video by ROV and divers	Video inspection of outfall exterior. Outfall is in good condition.
September/ October 1998	City of San Diego	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 of San Diego	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 of San Diego	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 of San Diego	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 feet of the 12-foot pipe.
August–September 2002	City of San Diego	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 15, 2003 – April 30, 2004	City of San Diego	Video by ROV and divers	Visibility average to mediocre. Introduction of DVD recording for inspection. PL outfall is in good condition.
August 2004 – May 2005	City of San Diego	Video by ROV	Inspection delayed due to equipment malfunction. Visibility average to very poor. PL outfall is in good condition with small areas of less than optimal rock level.
November 2006 – March 2007	City of San Diego	Video by ROV and visual inspection by divers	Visibility average to poor. PL outfall is in good condition with localized areas of less than optimal rock levels.
April– June 2008	City of San Diego	Video by ROV and visual inspection by divers	Visibility average to poor. PL outfall is in good condition with localized areas of less than optimal rock levels.
January 2009 Dive June 3, 2009	City of San Diego	Video by ROV and visual inspection by divers	Visibility excellent to better than average. PL outfall is in good condition with localized areas of less than optimal rock levels.
April 2010, Dive June 24, 2010	City of San Diego	Video by ROV and visual inspection by divers	Visibility poor in most cases. PL outfall is in good condition with localized areas of less than optimal rock levels.

September 2010–March 2011 Dive June 15, 2011	City of San Diego	Video by ROV and visual inspection by divers	Visibility variable: good in 2010; poor in 2011. PL outfall is in good condition with localized areas of less than optimal rock levels.
January–March 2012 Dive June 27, 2012	City of San Diego	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 of San Diego	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 of San Diego	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 of San Diego	Video by ROV	Visibility was generally good throughout the inspection. PLOO is in good condition with localized areas of less than optimal rock levels
September 2016	City of San Diego	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

SECTION 2.0

POINT LOMA OCEAN OUTFALL FACILITIES

2.1 Historical Background

The City of San Diego's Point Loma Ocean Outfall was completed and placed into service in October 1963. The outfall conveyed primary treated sewage effluent from the plant to the ocean for dispersion at a water depth of 210 feet, 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. 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. Point Loma Wastewater Treatment Plant 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 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 hydraulic head available for the extension. In the course of the investigation, it was determined that air entrainment had been a problem since 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.

The extension of the Point Loma Ocean Outfall 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 feet below sea level. The outfall extension consists of 12,500 LF of 144-inch diameter pipe between the original outfall terminus and a wye structure, plus two 2,500 LF diffusers that provide for dispersion of the effluent.

2.2 Original Outfall

2.2.1 Main Pipe

The main barrel of the original Point Loma outfall consists of 11,226 LF of 9-foot diameter reinforced concrete pipe with a wall thickness of 10 inches. The offshore portion of the main barrel starts at the connection to the 9-foot diameter, concrete-

encased, steel pipe leading from the Vortex Structure (Station 2+08). Station 2+08 is approximately 20-feet downstream from the connection with the 7-foot diameter conduit from the throttling valve and turbine. The main barrel of the original outfall terminates at the connection to the Original Diffuser Wye structure (Station 114+34). The plan and profile of the current outfall system are shown on Figure 1. Figure 2 shows an isometric view of the same Point Loma outfall system.

Design and construction of the original main barrel incorporated the following typical sections.

- Between Station 2+08 and Station 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 foot that extended up to the spring line. Above the spring line, the trench was backfilled with concrete and a minimum concrete thickness of 2 feet was maintained over the top of the pipe.
- Between Station 26+50 and Station 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 Station 114+34, the main barrel was placed on bedding with a minimum clearance of 1 foot 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 Station 62+50.

In March 1990, an internal inspection of the outfall was made from the Vortex Structure to a point approximately 350 feet west. The inspection revealed that the outfall, after 27 years of operation, was in reasonably good condition with no debris or obstructions. 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 Station 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 of San Diego in April 1991.

Figure 1 - Point Loma Ocean Outfall Plan

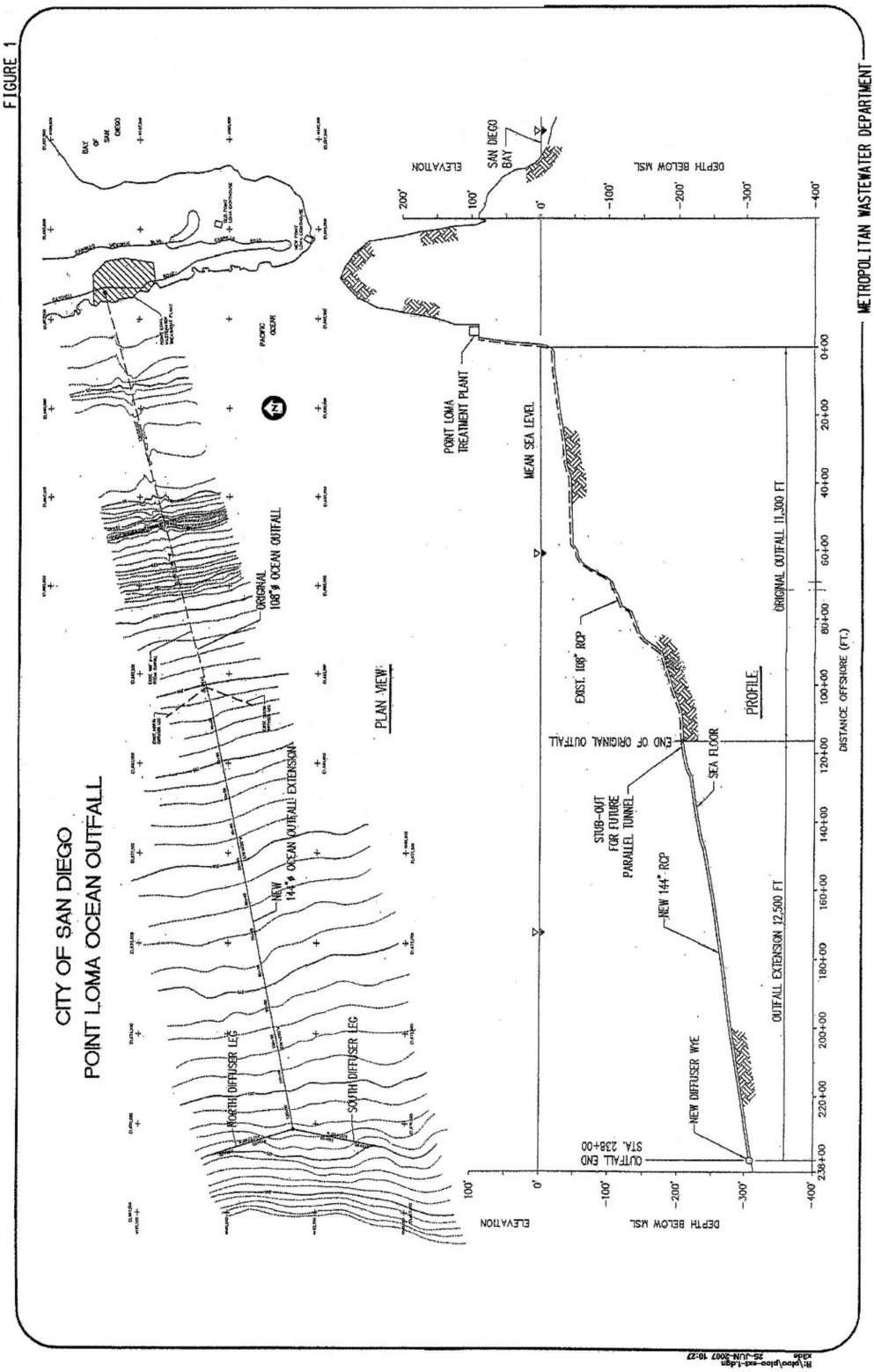
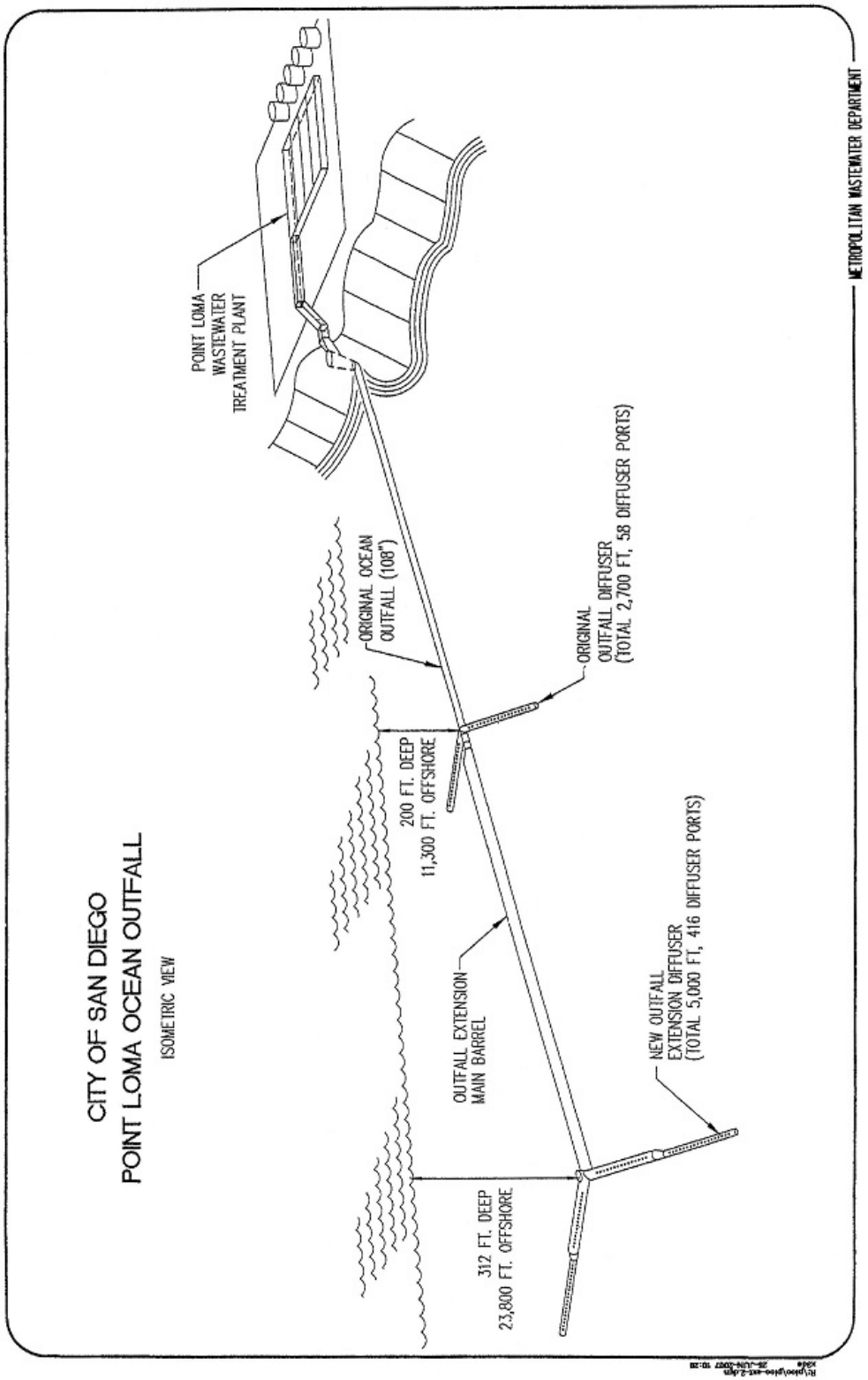


Figure 2 - Point Loma Outfall Isometric View



The Parsons Corporation prepared a third outfall 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, Parsons prepared another report based on the 1994 ROV survey inspection of the entire outfall. Annual reports have been prepared thereafter.

In January 1996, Parsons issued a report based on the 1995 ROV inspection of the entire outfall, which concluded that the overall condition of the Point Loma Outfall appeared to be good at that time. It also noted that a portion of the main barrel had low rock ballast. Consequently, re-ballasting of this portion (from Station 67+15 to the Original Wye structure) was conducted between October 1997 and January 1998 using two types of rock: 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.

2.2.2 Original Diffusers and Wye Structure

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, and (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 on line in 1993.

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, a 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 feet below mean lower low water (MLLW), 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 the diffuser legs is now blocked.

2.3 Emergency Repairs to Original Outfall

On February 2, 1992, a major failure of the original Point Loma Ocean Outfall occurred between Stations 33+28 and 37+60. Emergency repair work was designed and completed within 60 days of the failure and involved:

- Replacement of 432 LF of the main barrel using 360 degree-PVC lined, 9-foot diameter reinforced concrete pipe
- Placement of bedding, intermediate rock, and armor rock for the 432 foot section
- Placement of a cover of 1.5 ton (median) armor rock with a minimum thickness of 4.5 feet above the top of the pipe from Station 27+90 to Station 60+00
- Placement of armor rock flush with the top of the pipe from Station 60+00 to Station 67+15
- 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-foot long gap, incorporated a 25-foot long, internal steel cylinder, that provided support for two 13-foot, 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.

2.4 Outfall Extension

2.4.1 Outfall Extension from Original Wye to Intermediate Wye

The Point Loma Ocean Outfall 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 Station 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 provided with a poly vinyl chloride (PVC) liner that 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-foot 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.

2.4.2 Intermediate Wye

The purpose of the Intermediate Wye structure is to permit a future 12-foot 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-foot high, 48-foot 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 mils 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 soil 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. Because it is difficult to estimate the rate of consumption of an anode, 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.

2.4.3 Outfall Extension from Intermediate Wye to 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-foot 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-foot diameter portion of the main barrel. Twelve access hatches are provided between the Intermediate Wye and the diffuser wye structures.

2.4.4 New Diffuser Wye Structure

The diffusers branch from the main outfall at the diffuser wye structure (Station 125+23) at a bottom depth of approximately 310 feet below MLLW. 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-foot high, 42-foot 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. All anodes are aluminum alloy ingots that contain 3 percent zinc by weight and are joined to the steel plate ring by welding 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 diffuser wye will be consumed (sacrificed) for the protection of the structure as current is discharged from them into the surrounding soil or seawater. 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-foot 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.

2.4.5 Diffusers for the Outfall Extension

The two diffuser legs for the outfall extension are built on the seabed at water depths between 310 and 316 feet below MLLW. 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-foot, 5.5-foot, and 4-foot internal diameter pipe. Pipe lengths, port spacing, and numbers of ports on each diffuser leg are summarized in Table 2. Diffuser ports are set in the middle of each pipe on opposite sides, 6 inches above the spring line of the pipe.

Table 2

Point Loma Ocean Outfall Extension Diffuser Configuration

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 (mgd) (maximum)
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-foot long section of the 4-foot 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-foot 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 diffuser 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.

SECTION 3.0

2016 ROV VIDEO SURVEY

The 2016 external survey of the Point Loma Ocean Outfall described herein includes the Original Main Barrel offshore of Station 34+32, to the Original Wye, the Original Wye and Original Diffuser Legs, the New Main Barrel, the Intermediate Wye, the New Wye, and the New Diffuser Legs. City of San Diego personnel conducted the video inspections of the Point Loma outfall using a Saab Seaeye Falcon Remotely Operated Vehicle (ROV) deployed from the City's research vessel, and along with City engineering staff performed the subsequent evaluation of the outfall's present status.

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 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.

Despite improved water quality during the 2016 survey compared to the previous year, the low light black and white video camera was used for all portions of the survey. This camera provides a good visual perspective of the outfall and its surroundings in low light/low visibility environments an offers greater detail than a color camera would have been capable of in the same situation.

In any instance where the level of protective rock cradling the outfall pipe is estimated, standard "clock" positions are used to denote where the highest point of the ballast contacts the pipe. The survey was conducted by driving the ROV inshore along each side of the pipe. Pipe observations were made facing along the length of the pipe in order to improve the view and provide accurate estimations of the clock position. With this orientation on the New Main Barrel, 9 o'clock corresponds to ballast at the spring line on the north side, 12 o'clock identifies ballast at the top of the pipe, and 3 o'clock corresponds to ballast at the spring line on the south side.

Ballast rock levels often increase and decrease along the length of the pipe sections in an oscillating motion. After comparing this year's video to previous observations, the consensus is that the ballast exhibited no 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.

The 2016 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 these 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.

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.

3.1 Summary of 2016 ROV Annual Inspection Findings

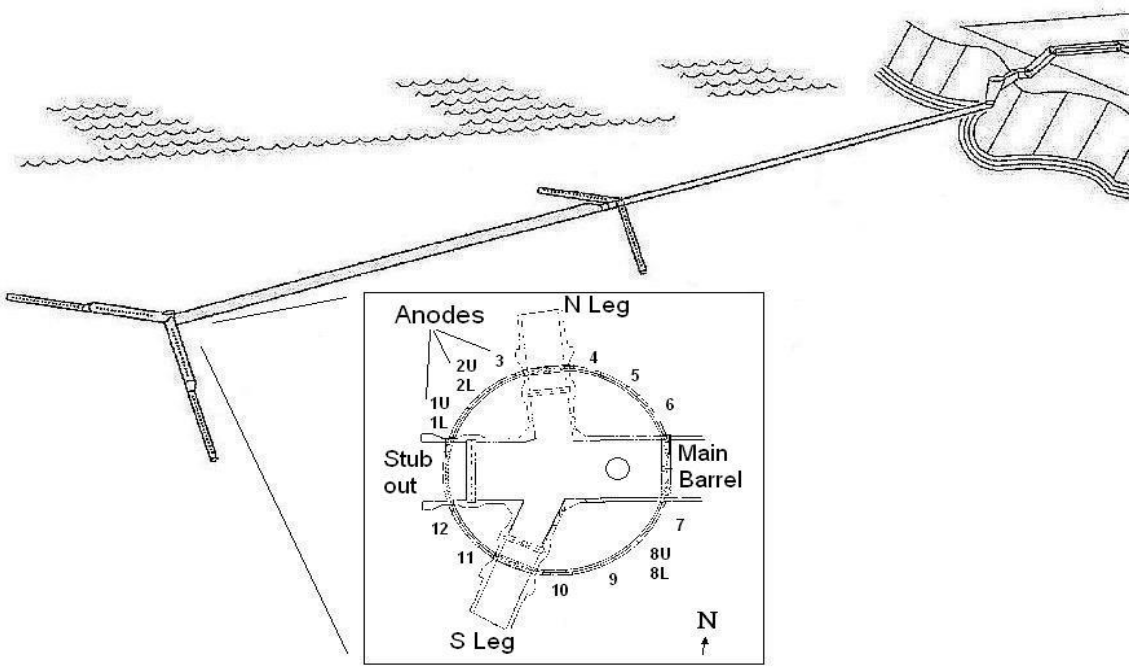
The results of the 2016 annual outfall inspection survey are similar to those of previous years. For example, the ballast, the diffusers, and the exterior of the outfall system are all still in good condition, and the general ballast levels everywhere along the outfall structure appear unchanged.

New North Diffuser Leg: All diffuser ports continue to flow freely except for the persistent obstructions seen in the offshore port of N99-6, the inshore port of N99-5, the inshore port of N98 and the offshore port of N-90. In all instances the flows at these ports are partially restricted by pieces of a bluish-white material protruding from the port openings, which is thought to be eroded sections of the PVC liner from the interior of the pipe. Flows at the extreme offshore ports of the terminal section were unusually low, presumably due to low pressure in the outfall at the time of the survey. Flows at ports inshore of that area progressively increased in volume with greater distance inshore. 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 assumed to be have been prematurely consumed. The passive anodes are in relatively good condition, but are all unwrapped to some degree and show some degradation around the ends. The metal terminal section of the diffuser leg looks to be in very good condition and shows no sign of corrosion. The ballast rock level was satisfactory throughout the North Diffuser Leg.

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 below in Figure 3. Lower anodes 1, 2, 8 and 9, and upper anode 9 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, the remaining anodes continue to provide adequate cathodic protection. Localized areas of leaking were observed emanating from the seams of all the gate covers. This observation is not new and is likely a function of the time of day the survey is being performed and the accompanying pressure inside the pipe. Effluent continues to leak from different locations on the perimeter of Stubout Gate. All the leaks are of little consequence from a

water quality standpoint as the initial dilution of the effluent escaping is much higher than that at the nearby diffuser ports.

Figure 3: Anode Schematic



New South Diffuser Leg: Apart from the blockage of the offshore port on S97 by the same material obstructing the ports 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 vents S77 and S42 were flowing freely again this year. The active anodes on the terminal diffuser section exhibit uniform levels of corrosion and appear to retain 50% or more 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.

Outfall Extension Main Barrel from New Diffuser Wye to Intermediate Wye: The ballast levels seemed not 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 springline (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 at as low as the 4 o'clock level. On the north side, the ballast between pipe joints 17 and 30 was lower (8:00 to 8:30) in localized areas, but the majority of the area

bordering these sections is well protected by levels of armor rock at or above the springline. 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.

Intermediate Wye: This structure remained in good condition during the 2016 survey. Eight of the original 28 anodes are not visible in the inspection video and no conclusion can be drawn regarding their condition. 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.

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.

Original Diffuser Wye: The condition of this structure has changed little since the previous 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 North Diffuser Leg: The overall condition of this diffuser leg seems unchanged. 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 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 Main Pipe: 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. It is unlikely that anything could happen in this region unless other offshore reaches of the pipe are damaged first.

Manholes There are 20 manholes in the original outfall (14 on the main barrel and three on each of the two diffuser legs) and 15 manholes in the outfall extension. One manhole cover is made of concrete, while the others are made of Ni-Resist alloy. Of the 14 manholes on the original outfall, five were visible in the ROV inspection. The first three manholes in 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 3 lists the manhole status for the original outfall while Table 4 lists the status of the manholes in the outfall extension.

Table 3
Status of Manholes ORIGINAL OUTFALL – 108″ LINE

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 4
Status of Manholes OUTFALL EXTENSION - 144″ LINE

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

SECTION 4.0

CONCLUSIONS

Based on the survey findings summarized in subsection 3.1 it is concluded that the Point Loma Ocean Outfall remained in good overall condition during the 2016 external inspection survey, with localized areas of less than optimal rock levels. Additional specific conclusions reached as a result of this annual investigation are as follows:

Low light conditions, coupled with turbidity and the presence of suspended solids, contributed to the water clarity ranging from very good in the offshore regions of the outfall to less than optimal but workable in the inshore areas. In spite of the variability in general visibility, comparison of the 2016 video survey with the 2015 survey results show that while very minor rock surface modifications may be occurring as a result of external oceanographic forces, ballast levels along the outfall appear unchanged.

- There are localized areas towards the beginning of the outfall extension, where rock protection may be considered "low." However, these levels have persisted unchanged over time and are likely an artifact of the original rock placement during original construction activities.

- The offshore port of N99-6, the inshore ports of N99-5 and N98 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.

- Air vents S77 and S42 on the New South Diffuser Leg were observed to be flowing normally during the 2016 survey. The remaining four air vents on the outfall were found to be blocked.

- The Senior Corrosion Engineer for the Public Utilities Department performed two separate evaluations of the cathodic protection system of the outfall using video from the previous 2006 and the 2012 outfall inspections. Based on the results of this comparison it was concluded that some level of cathodic protection was still being provided even though the anodes were being consumed. Although the number of the visible active anodes that have been totally consumed has increased somewhat, there is no visible corrosion of the new metal cribs or the terminal diffuser sections. Consequently, this suggests that the remaining anode mass is likely sufficient to provide continued protection to the relevant outfall structures. The rate of consumption of the anodes on the New North Diffuser Leg and the New Wye appears to be much greater than at other locations. The images of the anodes from the 2016 survey will be resubmitted for evaluation and a reassessment of cathodic protection on the outfall.

- The coating of the metal structures of the outfall extension appeared intact and the structures themselves remained in good condition in 2016. The uncoated metal crib at the Original Diffuser Wye is the one exception to this observation. This structure, however, has been in place since 1963, lacks a protective coating, and suffered minor damage to its upper ring during the outfall extension construction activity. Additionally, the condition of the crib is not considered a significant concern since it is not active and most of the associated rock mass is grouted.

Appendix A

Directory of Survey Files on the USB Flash Drive

File Name	Survey Date
2016 PLOO ROV SURVEY - 1 - NEW NORTH DIFFUSER LEG	9/20/2016
2016 PLOO ROV SURVEY - 2 - NEW SOUTH DIFFUSER LEG	9/12/2016
2016 PLOO ROV SURVEY - 3 - NEW WYE	9/12/2016
2016 PLOO ROV SURVEY - 4 - MAIN BARREL SOUTH SIDE	9/21_28/2016
2016 PLOO ROV SURVEY - 5 - MAIN BARREL NORTH SIDE	9/28/2016
2016 PLOO ROV SURVEY - 6 - INTERMEDIATE WYE THRU OLD WYE	9/09/2016
2016 PLOO ROV SURVEY - 7 - OLD NORTH_SOUTH DIFFUSER LEGS AND OLD WYE	9.09.2016
2016 PLOO ROV SURVEY - 8 - INSHORE MAIN BARREL	9/09/2016