MOTT MACDONALD

Rich Passage Orchard Rocks Atlantic Salmon Net Pens Engineering Assessment

January 29, 2018

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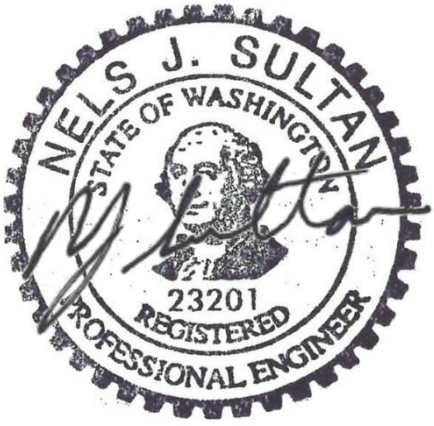
Acronyms and Abbreviations

AGS	American Gold Seafoods
AIS	marine vessel Automatic Identification System
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BAP	Best Aquaculture Practices
DNR	Washington State Department of Natural Resources
ECY	Washington State Department of Ecology
ft.	feet
Hs	Significant Wave height
in.	inch
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
NOAA	National Oceanographic and Atmospheric Administration
OHW	Ordinary High Water
ORN	Orchard Rocks – North
ORS	Orchard Rocks - South
PATON	Coast Guard Private Aids to Navigation
ROV	Remotely Operated Vehicle
Tp	Peak wave period
USACE	US Army Corps of Engineers

Certifications

This report has been prepared by Mott MacDonald under the supervision of a Professional Engineer, including all findings and recommendations.



Date: January 29, 2018 January 29, 2018

1 Introduction

This report presents the results of a document review, site visit and assessment of the net pen facilities at Orchard Rock in Rich Passage owned by Cooke Aquaculture. **Figure 1** is an aerial photo of the facility. This work has been performed by Mott MacDonald for the State of Washington Department of Natural Resources (DNR). The dive inspection portion of the work has been performed by Collins Engineers, Inc. as a sub-consultant to Mott MacDonald.

Figure 1: Orchard Rocks Net Pens – Oblique Aerial Photo - May 2017

Source: Google Earth Aerial Photo

This report is one of seven engineering assessment reports that are being prepared by Mott MacDonald, one for each net pen at different sites in Puget Sound and Port Angeles. DNR holds several lease agreements with Cooke that authorize Cooke to operate Atlantic salmon net pen facilities in Washington state waters at four locations. The locations of these facilities and the planned reports by Mott MacDonald are as follows:

Hope Island	(1 facility)
Port Angeles Harbor	(2 facilities; Primary net pen and Secondary net pen)
Rich Passage	(2 facilities; Orchard Rocks net pen and Fort Ward net pen)
Cypress Island	(2 facilities; Site 1 and Site 3)

In addition to these seven reports, Mott MacDonald previously prepared a report for DNR in October 2017 concerning the Clam Bay net pen facility in Rich Passage. Mott MacDonald is also involved in the investigation of the Cypress Island Site 2 net pen failure that occurred in August 2017.

1.1 Purpose and Methods

The purpose of the work is to conduct a site visit and review available documents to provide an engineering assessment of the Rich Passage Orchard Rocks net pen facility. This report is for use by DNR and state agencies in making proprietary and regulatory decisions.

The document review and site visit includes review of the following general elements:

- DNR lease requirements.
- Best Aquaculture Practices (BAP).
- Permit applicant documentation (inspection reports, design conditions, etc.).
- Inspection type and frequency.
- Maintenance and repair history.
- Facility design documentation and lease requirements.
- Industry standards for design, operations, maintenance, and best management practices.
- Site visit observations and dive inspection with respect to the above listed documents and standards.

This work is limited in scope. Detailed inspection and physical material sampling were not performed. A load rating or structural analysis has not been performed. Repair or maintenance recommendations are not included in this report.

The site visit and inspection only included those elements above water at the time of the site visit. Not included in this review are mechanical systems and utilities, such as lighting, power and water lines and pumps.

This assessment is focused on the structural elements of the net pens. The floating shed and barge between the north and south net pens is included for completeness, but was not inspected in detail. Mott MacDonald did not access closed spaces or access the roof of the barge shed.

1.2 Inspection Scope and Standards

Mott MacDonald and Collins Engineers have followed the recommended standards and practices in ASCE Manual No. 130 - *Waterfront Facilities Inspection and Assessment* published by the American Society of Civil Engineers (ASCE, 2015).

The above water inspection by Mott MacDonald staff is consistent with a Level I visual and tactile inspection of all surfaces that were visible without removing coatings or opening hatches. The methods were consistent with a “Routine” type of inspection. The Collins Engineers dive inspection is consistent with a Level I inspection with a Level II inspection at selected areas. The Level I and II methods and Routine inspection type are defined in ASCE No. 130.

Condition assessment definitions from ASCE Manual No. 30 are applied in this report, copied below in **Table 1**. These are assigned to the major components of the facility.

Table 1: Condition Assessment Rating

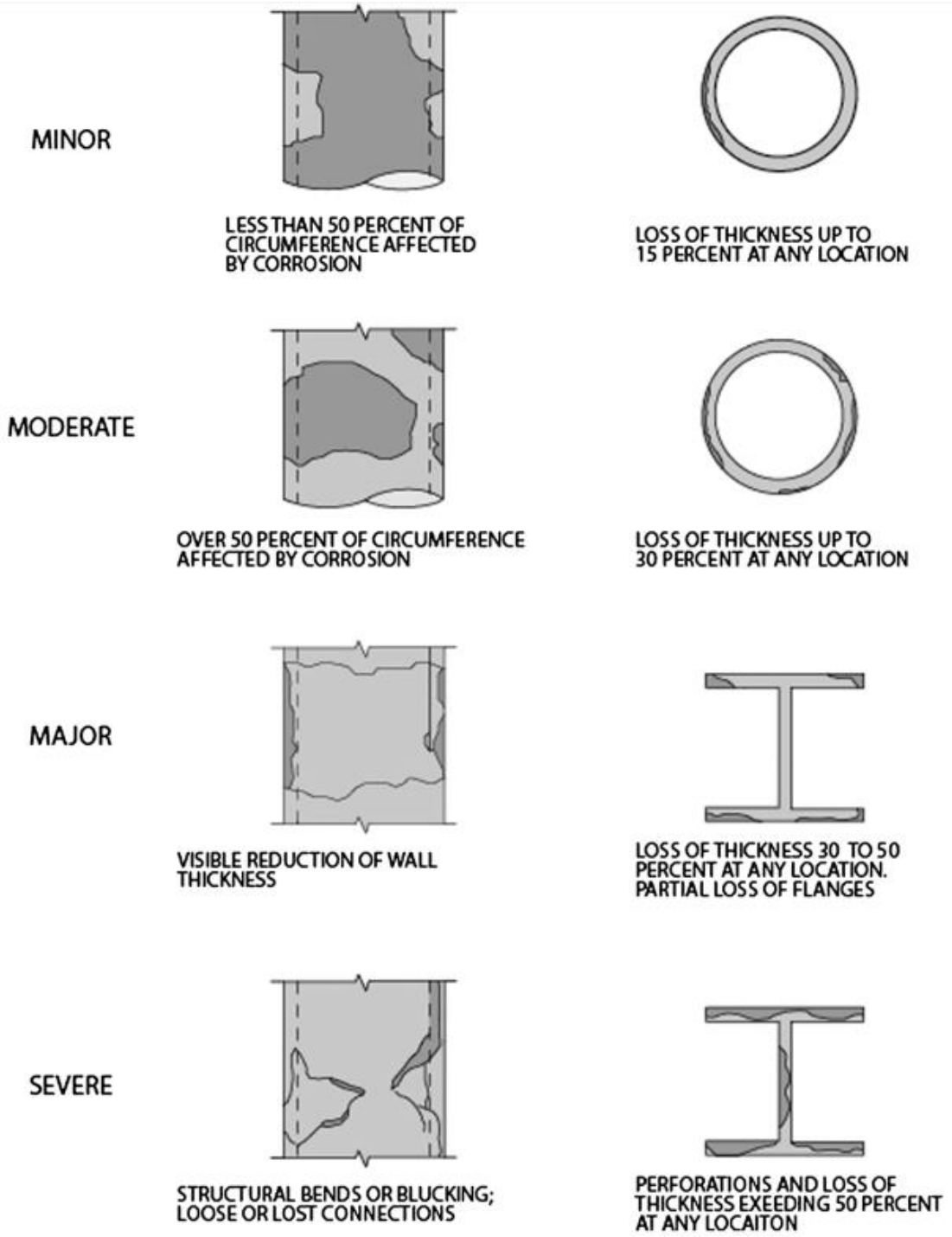
Rating	Description
6 Good	No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs are required.
5 Satisfactory	Limited minor to moderate defects or deterioration observed but no overstressing observed. No repairs are required.
4 Fair	All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not

Rating	Description
	significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low.
3 Poor	Advanced deterioration or overstressing observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may need to be carried out with moderate urgency.
2 Serious	Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible, and loading restrictions may be necessary. Repairs may need to be carried out on a high-priority basis with urgency.
1 Critical	Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. Repairs may need to be carried out on a very high-priority basis with strong urgency.

Source: Table 2-14 in ASCE Manual No. 130

The damage/condition rating system in ASCE Manual No. 130 is applied in this report. It includes the following condition ratings “Minor, Moderate, Major, and Severe,” which are defined for different material types. The damage rating definitions for steel elements are shown below in **Figure 2** for ease of reference. Similar figures from ASCE Manual No. 130 exist for mooring hardware, timber, and other materials.

Figure 2: Damage Rating for Steel Elements

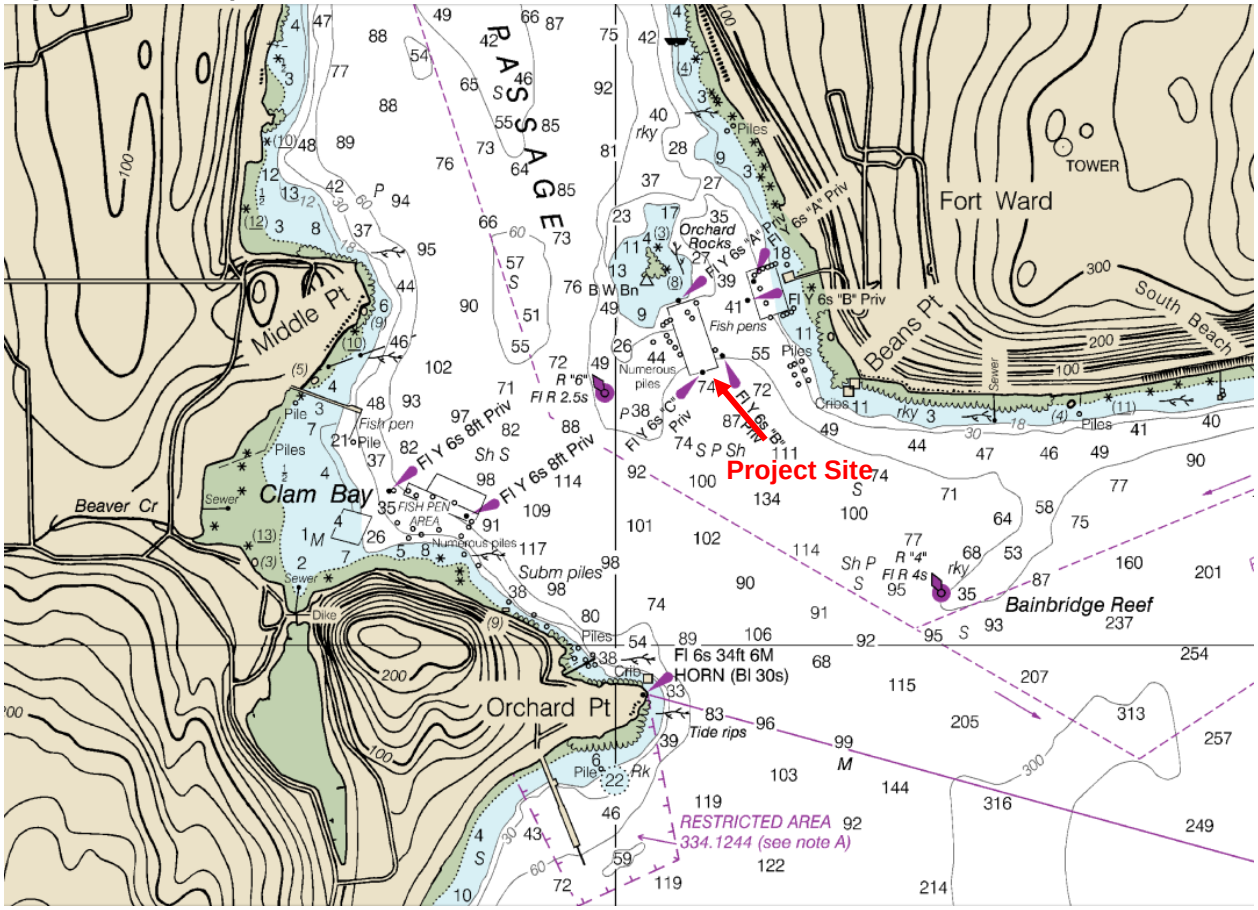


Source: ASCE Standard of Practice No. 130 "Waterfront Facilities Inspection and Assessment"

2 Document Review

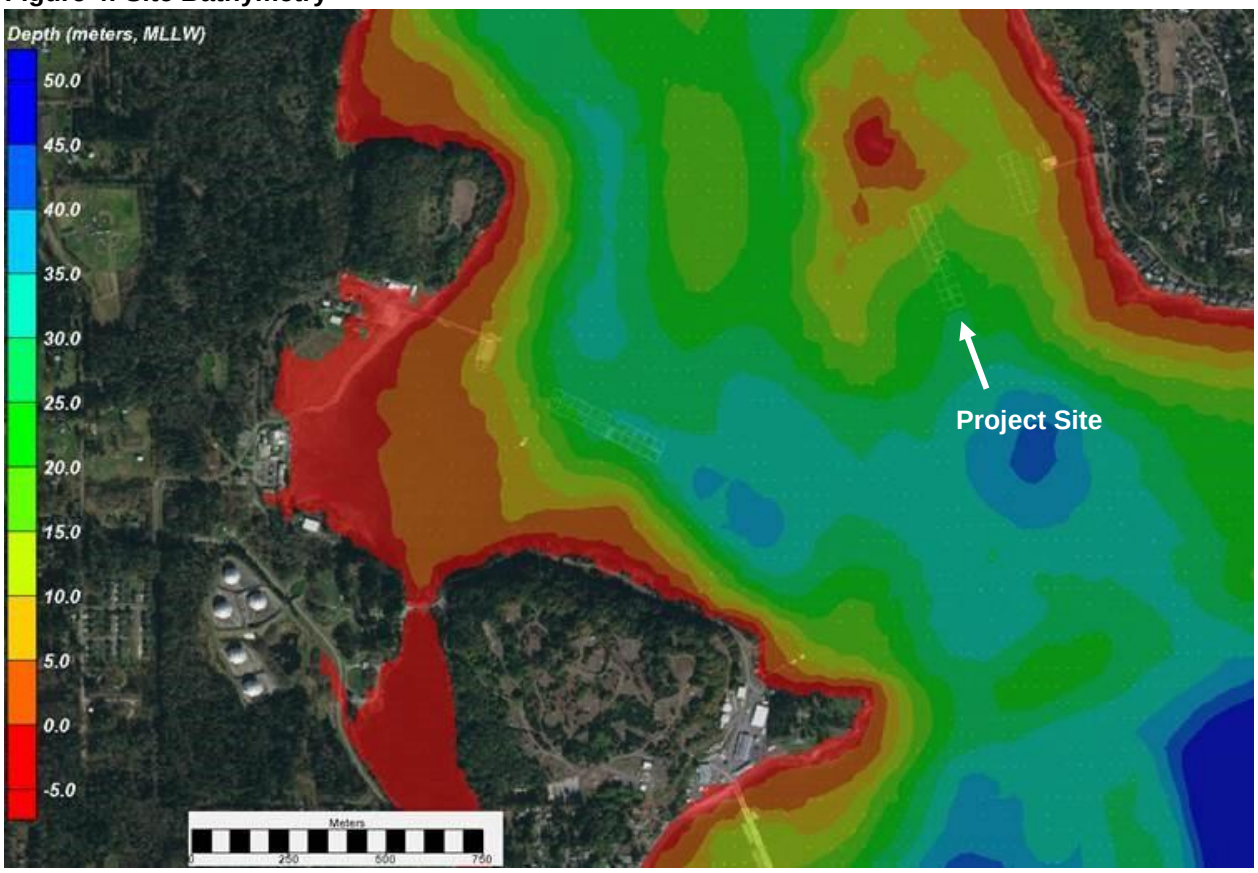
The Orchard Rocks net pens are near the east end of Rich Passage, between Bainbridge Island and the Kitsap Peninsula. The net pen facilities owned by Cooke Aquaculture are located east Fort Ward and south of Orchard Rocks. **Figure 3** is an area map. **Figure 4** shows the bathymetry in more detail. The depths are between 30 feet on the north end and 75 feet (MLLW) on the south end along the length of the Orchard Rocks net pens. Drawings in Appendix A show a general plan and photos of the existing facilities. Additional site photos are in Appendix C.

Figure 3: Area Map



Source: NOAA Chart 18449

Figure 4: Site Bathymetry



Source: NOAA Digital Elevation Model (DEM) of Puget Sound Bathymetry

2.1 Document Review

Documents reviewed by Mott MacDonald are described in Table 2. Document interpretations are included elsewhere in this report.

Table 2: Document Review – Summary

No.	Description	Comments
General Documents received from Cooke		
1	Procean Ocean Catamaran Brochure and Design Drawings, 22 pages	The brochure and drawings contain general information from the manufacturer on the steel pontoon and superstructure, but not the nets or mooring system.
2	October 2017 Pollution Prevention Plan Updated, 6 pages	Not relevant to this report.
3	October 2017 Spill Prevention Control and Response Plan Undated, 5 pages	Not relevant to this report.
4	2017 Cooke Aquaculture Fish Escape Prevention Plan. Updated January 2017, 9 pages.	Outlines requirements for moorage system damage inspections, frequency of inspection and post-storm inspection.
Orchard Rocks Specific Documents received from Cooke		

No.	Description	Comments
5	DNR Rich Passage Lease agreement (No. 20-B10237), executed 2008, 40 pages plus exhibits.	Lease agreement for all 3 Rich Passage net pen sites. Exhibit A includes the land survey. Exhibit B Includes the facility description and plan of operations.
6	Orchard Rocks site plan spill kit locations, 1 page	Includes a site map.
7	Surface Inspection Sheets for 10/30/2017 and 11/6/2017, 4 pages	Inspection sheets including repair logs and inspections for mooring points, shackles, thimbles, hardware, mooring lines, chain connections, hinge points, grating conditions.
8	Ultrasonic Gauging Survey completed by International Inspection in July and on October 13th, 2016, 22 pages	Ultrasonic thickness measurements of the north pontoons No.1-6 and walkways and south pontoons No.1-6 and walkways. Schematic drawings of pontoons and walkways.
9	Orchard Rocks Mooring Diagram, Excel spreadsheet	Mooring diagram of existing conditions, includes piles, anchors, chains, roads, and information on inspection and replacement
10	NPDES Permit Orchard Rocks, 30 pages	Issued 2007 and expired 2012. Not relevant to this report.
11	Square Net Cage drawings, 3 pages	Diagrams and instructions for the net cages
12	Land Survey of Rich Passage net pens in 2008	Survey of the net pen locations and dimensions with legal descriptions.
13	October 2017 Net Inventory	Inventory includes dimensions, mesh size, make, year made, etc.
Standards, Guidelines, Studies, Plans		
17	Norwegian Standard NS 9415.E:2009 -- Marine fish farms Requirements for site survey, risk analyses, design, dimensioning, production, installation, and operation	The standard includes site survey requirements, load and load combinations, general requirements for the main components of a marine fish farm, requirements regarding net pens, floating collars, rafts, and mooring.
18	Aquaculture Facility Certification Salmon Farms Best Aquaculture Practices (BAPs) Certification Standards, Guidelines, - by the Global Aquaculture Alliance	BAPs are practices adopted and self-enforced by the industry. A number of references are available from different states and countries. In Washington state, the BAPs are assumed to include the 1986 interim guidelines (described below).
19	Recommended Interim Guidelines for the Management of Salmon Net-Pen Culture in Puget Sound – Dec. 1986	These interim guidelines prepared for the Washington Department of Ecology are intended to provide a coordinated agency approach to management of salmon net-pens in the Puget Sound. The guidelines are for interim use until a programmatic EIS can be completed and focus on environmental protection. Guidelines include water quality, site selection, and environmental surveys.
Miscellaneous		
20	2014 Fin Fish Aquaculture Plan of Operation – updated June 2014 by American Gold Seafoods	Obtained by Mott MacDonald. The 2014 plan includes an overview of existing farming sites, stock species, and health certifications and screenings. Attachment A lists the facility locations and permits, 2014 Fish Escape Prevention Plan, Employee and guidance for routine handling procedures to minimize the potential for escape.

Source: Mott MacDonald

3 Metocean Review

A metocean review was conducted for two net pens, known as Fort Ward and Orchard Rocks, located in Rich Passage, WA as part of a facility review. Metocean conditions were described by American Gold Seafoods, LLC (the Owner) in Exhibit B of the lease records. This technical memorandum provides qualitative review of the wind, wave, water level, and tidal currents conditions described by the Owner.

3.1 Winds

Winds at the Rich Passage Net Pen site were described in the DNR lease agreement as follows:

- Wind speed is “in excess of 50 knots during major storm events”.
- Estimate was based on “personal observation of farm staff”.

No information on typical wind direction was provided.

A review of nearby wind stations was conducted, based on previous project experience in this area. Long-term (~30-years) wind data records are available from NOAA’s West Point Wind Station (WPOW1). A sustained wind of 50 knots (as reported by the owner) corresponds to a return period of approximately 50 years (2-minute averaged) at West Point.

Mott MacDonald takes no exception to wind conditions reported in the lease agreement.

3.2 Waves

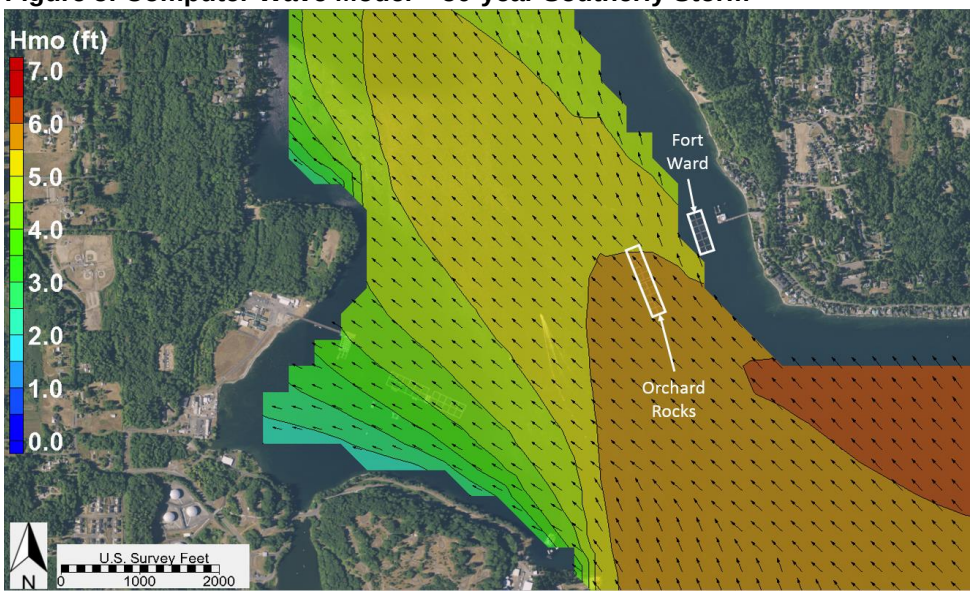
Waves at the Rich Passage Net Pen site were described in the DNR lease agreement as follows:

- Southeast winds create largest waves in the area, typically maximum wave is less than 4 feet
- Primary wave exposure for Fort Ward and Orchard Rocks net pens is for wind-generated waves caused by southeast to easterly winds.
- The largest fetch to the Fort Ward and Orchard Rocks net pens is to the southeast.

No wave measurements were available at the net pen site. In lieu of this, Mott MacDonald has relied on its internal Puget Sound Numerical Wave Model. This model is based on extreme wind analysis from the NOAA West Point wind station, available bathymetric data, and standard wind-wave generation propagation model software. The wave model shows that storm waves can propagate to the project site, with significant wave height (Hm0) for a 50-yr southerly storm estimated at approximately 6 feet at Orchard Rocks and 5 feet at Fort Ward (shown in color format in **Figure 5**). Storms out of the North generate smaller waves than storms from the south due to limited fetch length (~ 4 miles). Significant wave height due to storms out of the north are expected to be less than 2 feet.

Mott MacDonald takes no significant exception to wave conditions reported in the lease agreement. Typical storm (e.g. annual) waves may be less than 4 feet; however, extreme storm significant wave height will likely be greater than 5 feet.

Figure 5: Computer Wave Model – 50-year Southerly Storm



Source: Mott MacDonald

3.3 Water Levels

Water levels in Rich Passage were described by the owner as follows: “Extreme tide range is 14.5 feet.”

No long-term tide measurement data was available for the Fort Ward or Orchard Rock net pen sites. In lieu of this available data, nearby tide measurement stations were reviewed. The extreme tide reported by the owner corresponds exactly to the maximum tide range recorded by the nearest water surface elevation measuring station in Seattle (NOAA Station 9447130).

Mott MacDonald takes no exception to water levels reported in the lease agreement.

3.4 Currents

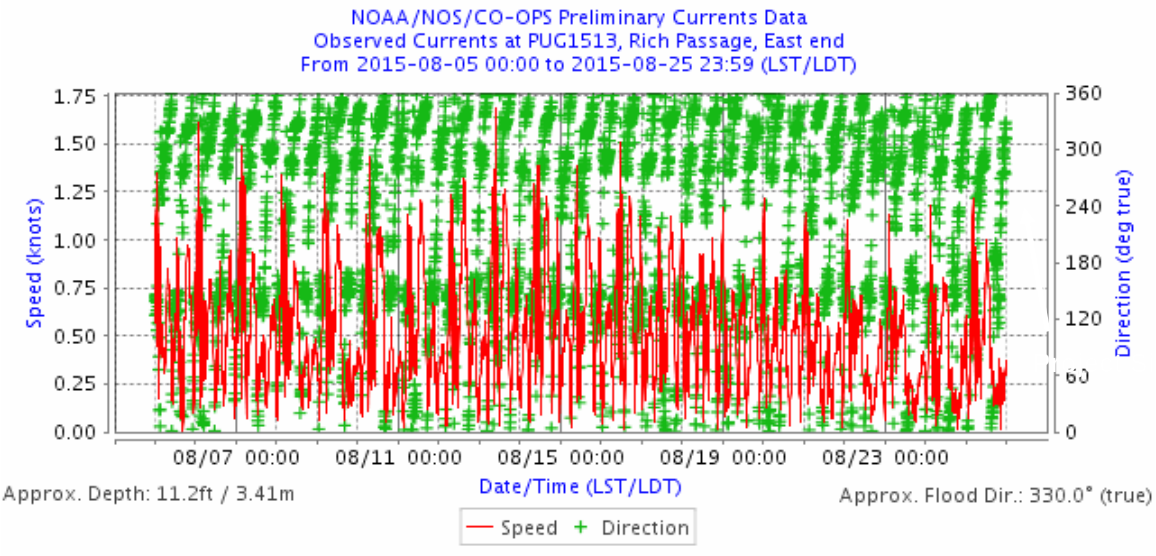
Current speed in Rich Passage were described by the owner as follows: Average is 110 cm/sec (2.1 knots) at midway in water column”. It is not clear whether the reported value is intended to represent the average daily maximum current at the site, or the average current over the entire day.

Current measurements are not available directly at the project site. NOAA has available short-term measured current data, measured at the east end of Rich Passage (NOAA Station PUG1513). NOAA also provides predicted currents at this station.

Currents reported by measurements or predictions at this station may differ from currents at the net pen sites, but may be used as a reference to approximate conditions. The maximum daily predicted current speed in middle of the water column (55-foot depth) was reviewed over a period of 4 months. Predicted current speed was often greater than 2 knots, with a maximum near 4 knots. Measured currents are available for the measurement period of August and September of 2015 only. The maximum current measured (38-foot depth) in the measurement period was approximately 1.8 knots. **Figure 6** shows the measured near-surface currents speed (red) and direction (green) during August of 2015.

Mott MacDonald takes no exception to current speeds reported in the lease agreement, based upon review of measured current data at station PUG1513.

Figure 6: Observed Currents at Rich Passage



Source: NOAA

3.5 Vessel Traffic

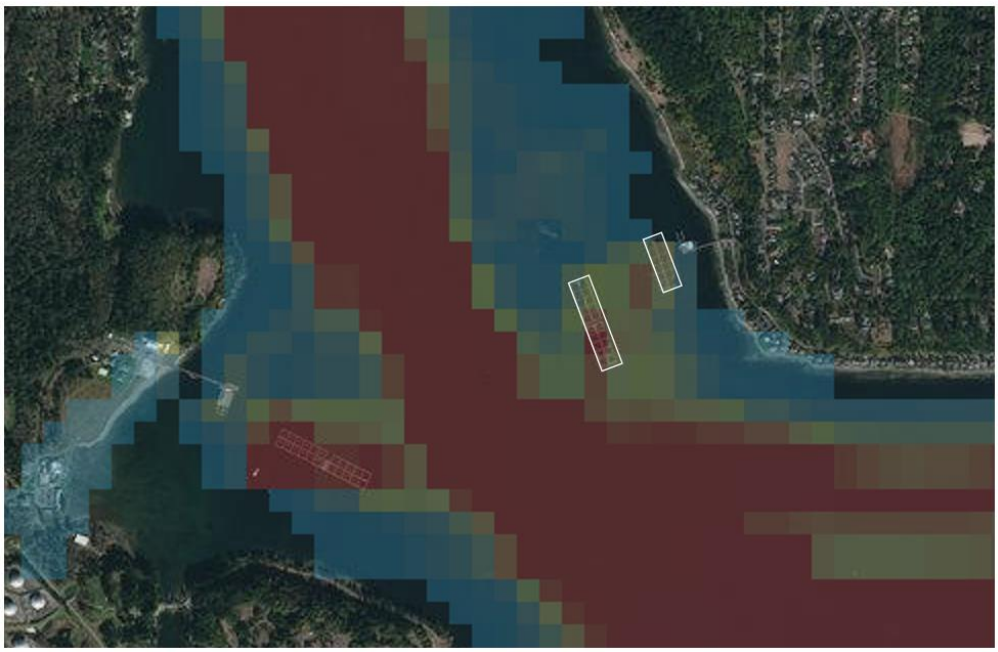
Vessel Traffic conditions at the Rich Passage Net Pen site were described in the DNR lease agreement as follows:

- The marine waters around Rich Passage are open for commercial, private, and public navigation. There is no commercial navigation use of the immediate project site.
- The net pens are registered with the Coast Guard Private Aids to Navigation (PATON) Program. Proper navigational warning lights are maintained by farm personnel.
- There is no impact to commercial navigational uses of Rich Passage. The sites are located well outside the navigation channel of Rich Passage.

Federal navigation charts, publicly available AIS (Automatic Information System) historical vessel tracking data, and state ferry routes were reviewed. Historical AIS (2017) data for Rich Passage is shown in **Figure 7**. It appears that fishing vessels, cargo vessels, pleasure craft, tugboats, Navy ships and passenger vessels were present. The Washington State Ferries Seattle-Bremerton ferry is routed through Rich Passage, and appears to be within 1,000 feet of the net pen facility. In addition, the Kitsap Transit Rich Passage Fast Ferry began service in 2017.

Mott MacDonald takes no significant exception to the vessel traffic conditions reported in the lease agreement. However, the channel appears to be in high use.

Figure 7: Historical AIS data (2011) in Rich Passage



Source: Mott MacDonald
Note: Red indicates higher usage. Net pens are outlined in white.

4 Net Pen Structure

The three Rich Passage net pen structures were initially permitted and installed in the mid 1970's per the lease documents. The net pen structures have undergone several structural improvements, including complete replacement of the floating structures and anchoring equipment during its service life. The lease documents state the last replacement cycle began in 2000 when all three cage structures in Rich Passage (Clam Bay, Fort Ward and Orchard Rocks) were replaced with new steel floating structures. From GoogleEarth, the Orchard Rocks net pens appear to have been installed between 1994 and 5/31/2002. Orchard Rocks facility is composed of two separate net pen structures that are connected together with synthetic lines. Based on all available information, the age of the net pen structures (but not the mooring lines) is estimated to be approximately 17 years for Orchard Rocks. They are referred to by Cooke as Orchard Rocks North (ORN) and Orchard Rocks South (ORS). There are a total of 20 pens at Orchard Rocks north and south.

All the net pen facilities are a Ocean Catamaran Platform system manufactured by Procean. The Ocean Catamaran Platform system is composed of pontoons or catamarans as the main flotation. These pontoons are located crosswise in the system and act as support for the center bridges and outer beams. The pontoons, center bridges, and outer beams are all a fabricated and welded steel. The system also includes mooring brackets, predator and net pen support pipes, handrail and walkway structures that span between the steel pontoons used for flotation.

The net pen system is a moored floating structure relying upon forces imposed on the flotation pontoons and net systems to be resisted by a series of mooring chain and anchors. The following is a summary of the key components of the system which we reviewed as a part of our site assessment work. The basis of the information includes the documents provided for review and our observations during the site visit. Drawings of the net pen structure are in Appendix A.

4.1 Anchors

The mooring line is shackled to the anchor at the seabed. The anchor types include Danforth drag anchors, and fixed mooring points on the seabed called “cans” by Cooke personnel and labeled “Can” on the mooring plan provided by Cooke as well as drilled in 18" steel pipe piles. An additional anchor line (not shown on provided drawings) was observed and inspected between Anchor Lines 6 and 7 at ORS. The additional anchor line was designated as Anchor Line 6A, appeared to be relatively new, and extended to the southeast from the southeast corner of ORS.

4.2 Mooring Line & Hardware

The mooring line is composed of a combination of stud link and navy chain, rode line, shackles, and other mooring hardware. The mooring line is connected to the float frame at the top and the anchor at the seabed. 1.5" thick shackles were the most common however some shackles were measured as 2.25" that were more common at the ends.

Freeboard was measured between 18" and 32" and varied along its length and width. Generally, the freeboard was measured higher at each end of the ORS and ORN. The lowest freeboard was measure on the south west corner of ORN.

4.3 Mooring Line to Float Connection

The mooring lines connect to fixed steel plate mooring brackets on the sides and hinged steel mooring brackets on the ends attached to the walkway structure frame near the walking surface. No buoys are used on any of the mooring anchors to relieve stress on the above water mooring connection. The mooring lines on many locations on the net pens were connected to the perimeter pipe with synthetic rope.

4.4 Predator Exclusion Net

The perimeter predator exclusion net attaches to a 3.5" and 5" diameter steel perimeter pipe that attaches to the outside of the walkway. Additional vertical supports extend the predator exclusion net to roughly 5 feet above the walkway surface.

4.5 Fish Pen Net

The fish stock containment nets were attached to a mixture of the hand railing and 2.5" diameter steel net pen pipes connected to the walkway.

4.6 Walkway Frame

The fabricated steel walkway frame structure provides support for the walkways, main bridge, mooring lines, predator nets and fish pen applied loads. The frame spans between the flotation pontoons and is the primary fixed structure that supports applied loads to the mooring system and flotation pontoons. The center walkway transverse to the pontoons is called the main bridge on the drawings by Procean and is 10' wide. Forklifts only travel on the main bridge. The transverse walkways are 5' wide

4.7 Pontoon

The steel fabricated float pontoons are an octagon cross-section which provide flotation and support to the rest of the structure. The pontoons are 4'-10" tall and 2'-4" wide per the manufacturer’s details.

5 Inspection, Maintenance & Repair History

A review of the inspection, maintenance and repair history was conducted based on the information provided and as described by Cooke personnel during our site visit.

5.1 Background

The following documents and standards apply to the net pen system inspection and maintenance activities.

- DNR Aquatic Lease #20-B10237 (February 7, 2008). Minor maintenance to the cage structures, anchor lines and netting occurs throughout the year and on a continual basis. Major maintenance of cage structures is typically replacement. Average service life expectancy is approximately 15 years. Metal fatigue can be a factor based on constant wave action and corrosive environment. Inspection of submerged mooring systems are to be made periodically by divers and surface connections checked daily.
- Cooke Aquaculture Fish Escape Prevention Plan (January 2017). Document outlines requirements for moorage system damage inspections. It also outlines requirements for frequency of inspection and post-storm inspection requirements.
- Procean - Ocean Catamaran Net Pen System Product Documentation. The manufacturer outlines recommendations for adjustment and tightening of anchor lines (1000 kg per line and even distribution to all lines), maximum level of net fouling (50% of net and thickness not greater than 50 mm), weekly inspections, monthly inspections, annual, and extreme weather event special inspections. Details of each of these types of inspections are outlined for each component of the net pen system.
- Industry Standards. Various industry standards and other governmental standards for marine fish farming facility inspection and maintenance exist. These include requirements in other U.S. States, Canada, and Norway. These other governments and industry practice have a summary of recommended inspection and maintenance activities for net pen systems.

5.2 Inspection

The following documents were reviewed pertaining to inspection of the net pen facility.

- Two weekly inspection forms were reviewed, from October 30 to November 6, 2017. They include a table with condition of the following:
    - System Mooring Points (Pad eyes, Mooring Plates)
    - Surface Shackles, Thimbles, Hardware
    - Mooring Lines
    - Surface Chain Connections
    - Walkway Hinge Points
    - Walkway Grating Condition

- ORN (Orchard Rocks North) and ORS (Orchard Rocks South) Mooring Inspection excel spreadsheet dated October 3rd and 4th, 2017. This spreadsheet includes a mooring diagram with the condition of the shackles, surface chain, thimbles, road line, ground chain, and anchor documented.

- No Dive Inspection Reports were included in our documentation review. Risk Management surveys describe facility staff visual dive inspections occur 3 times per week only of the stock nets, but documentation thereof is not available. The tri-weekly dive inspections are understood to be primarily focused on fish mortality and not the stock nets.

5.3 Maintenance & Repair History

- Square Net Cage Diagrams (5 pages): Contains dimensions and descriptions of the net cage components. Document was prepared by Garware-Wall Ropes Ltd (GWRL) on July 21, 2016. The company is based in India.

- ORFW (Orchard Rocks Fort Ward) Pet Net Inventory (1 page): October 2017. Spreadsheet lists the ID number of each net, its location (pen number), nominal dimensions, depth, mesh size, make, net type, twine type, and year made. The nets are made by Garware and are all from June 2017.

- ORN (Orchard Rocks North) and ORS (Orchard Rocks South) Mooring Inspection excel spreadsheet dated October 3rd and 4th, 2017. The spreadsheet shows which elements of the mooring system were replaced and the total materials needed to make the repairs. It is unknown how often Cooke staff performs maintenance on these components.

5.4 Ultrasonic Thickness Measurements

Mott MacDonald reviewed documents by International Inspection; the July and October 13, 2016 reports titled “Ultrasonic Gauging Surveys”. The documents indicate corroded areas, and include drawings that indicate suggested repairs. The documents do not include an explanation of the figures or provide recommendations for repairs.

Our interpretation of these documents is that the July report is a reconnaissance survey, with more focused inspection of some areas on Oct. 13. The documents do not provide a complete survey. If we are interpreting it correctly it appears the gauging was done at selected areas, called “bands” in the document. The bands circle the pontoons, measuring areas both above and below water, and are spaced approximately 22 feet along the pontoons. The width of the sampling bands is not indicated. It appears parts of the pontoons and structure were not gauged. It is possible weak areas with corrosion exist in the areas between the bands that were not measured.

5.5 Assessment

The following is our assessment of the inspection, maintenance and repairs being conducted at the facility.

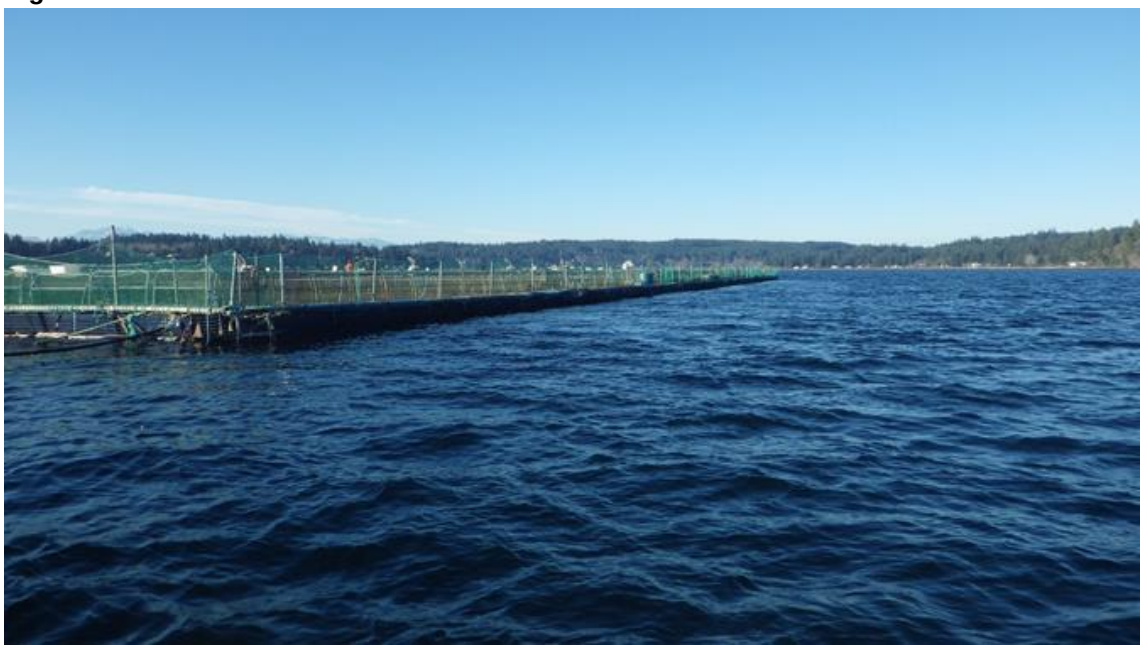
- Inspections appear to be occurring as required by the lease agreement between DNR and the net pen owners.

- Nets, pontoons, walkways, and mooring line systems are inspected on a regular basis and prior to stocking with repairs and component replacement conducted prior to restocking.
- No documentation was provided showing inspection of other key float frame and net support systems such as the predator net support frame and fish net support pipe system. Consideration for inspection of these elements should be made on a go forward basis as they are integral elements of the overall net pen structural support system.
- Inspections as outlined in the supplier documentation and industry standards typically require a greater level of inspection and documentation thereof than what appears to be conducted and as outlined in the information provided for this assessment.
- Although not required in the lease and fish escapement plan, documentation of repairs conducted to implement deficiencies identified in the inspection reports should be provided.

6 Site Visit and Existing Conditions

Mott MacDonald visited the net pen facility between 7:30 am and 4:30 pm on December 11 and December 15, 2017. Collins Engineers performed dive inspections between December 11 and 16, 2017. The time period included dive inspections of the Fort Ward net pens. The personnel present included Nels Sultan and Evan Edgecomb with Mott MacDonald, engineer-divers with Collins, Cooke Aquaculture employees, and Washington State staff. **Figure 8** shows the net pens. Photographs are included in Appendices A and C. The dive inspection report by Collins is in Appendix B.

Figure 8: Orchard Rocks Net Pens – View from East



Source: Mott MacDonald photograph December 11, 2017

During the site visit observations were made and photos were taken. On both days the weather was cold at roughly 40°F at noon with winds light and variable, and the sea calm. Wake waves from ferries up to 1 feet high were observed passing through the structure with no observable motion of the net pen while the waves propagated through the facility. The predicted tide elevations on the first day are below in **Table 3**. Mean Higher High Water (MHHW) is elevation +11.5 feet, MLLW. The mean tide range is 6.7 feet. The predicted currents at the east end of Rich Passage are in **Table 4**. The maximum predicted current speed during the site visit was approximately 0.7 knots. However, the measured current near the south-east corner of the Fort Ward net pen was approximately 1.1 knots at 2017-12-11 15:38h, determined by measuring the time and distance of a floating object relative to points on the net pen. This is approximately equal to the predicted current speed at that time.

Table 3: Predicted Tide: Daily Highs and Lows – Clam Bay (Pacific Standard Time)

Tide	Time (Pacific Daylight)	Elevation
Low	12/11/2017 4:44 am	+3.1 feet, MLLW
High	12/11/2017 11:46 am	+12.3 feet
Low	12/11/2017 6:42 pm	+3.1 feet

Source: Tides&Currents Software

Table 4: Predicted Currents at East End of Rich Passage: Daily Maximum Floods and Ebbs (Pacific Standard Time)

Time (Pacific Daylight)	Speed	Direction
12/11/2017 3:21 am	0.8 knots	143°, Ebb
12/11/2017 6:30 am	0	slack
12/11/2017 9:27 am	0.9	321°, Flood
12/11/2017 12:30 pm	0	slack
12/11/2017 4:26 pm	1.2 knots	143°, Ebb
12/11/2017 8:30 pm	0	slack

Source: Tides&Currents Software

The components and observed deficiencies are discussed below, and summarized in **Table 5**. The assessment is based on the conditions observed on December 11 and 15, 2017, our document review and our professional judgment and experience. See the drawings in Appendix A for the numbering system.

The year built is estimated based on available documents, discussions with Cooke Aquaculture employees on site, and our experience with marine facilities in the region.

Table 5: Orchard Rocks Net Pens – Existing Conditions Summary

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
Anchors	varies	See diagram provided by Cooke Aquaculture. Most underwater anchors appeared in good condition	none observed by divers, although there may be design deficiencies	good
Mooring Lines	varies	See diagram provided by Cooke Aquaculture. Most underwater mooring lines and hardware appeared in good condition, although some are covered in marine growth	The mooring lines were typically in good to satisfactory condition, however a shackle on Anchor 4 on ORN had severe corrosion with 75% estimated loss of section.	satisfactory
Pontoon Floats	2000	steel octagon cross-section pontoons (hollow)	surface rust on pontoons but most segments had adequate anodes	fair
Superstructure above pontoons	2000	spans and structures that support walkway, support nets and attach to anchor chain	surface rust with localized moderate to major corrosion. Critical structural connections measured with 40% section loss.	poor
Walkways and Railings	2000	steel fabrication with metal grate walking surface and hinge connections	surface rust, localized severe corrosion, grating not secured but recently replaced. Railing also appeared newer but the connections to the walkway had areas of major corrosion	poor
Predator Nets	N/A	bird nets and marine mammal nets	not inspected	--
Stock Containment Nets	N/A	nets that contain the salmon	not inspected	--
Records and Documents at site	N/A	The operations plan notes that records are kept on site	not inspected	--

Source: Mott MacDonald

6.1 Anchors

- The anchors and chains are a mix of old and new because they have been replaced over time. The records of anchor maintenance, inspection and replacement are not clear. The type and condition of the anchors has not been directly observed. The age was not certain.
- The anchors are different types, including 3-kilometer and 10-kilometer Danforth, cans and drilled steel piles. Cooke Aquaculture staff noted some are what they call “cans” that may be steel pipe piles or helical screw anchors. The extent and capacity of these anchor systems are not known. Manufacturer’s documentation indicated drag type anchors and no mention of gravity or helical type anchors.
- A dive inspection by Collins Engineers (see Appendix B) observed that portions of the anchor were found exposed at Anchor Lines 1, 2, 4, 5, 11, 13, 14, 15 and 16 of ORN and at Anchor Lines 4, 5, 6, 6A, 11, 12, 13, 14, and 16 of ORS. Overall, all of the anchors (those that were Danforth type) observed were sufficiently buried in the seabed, and there were no anchors that displayed indications that the anchor was unstable and/or shifting its position in the seabed. At ORN Anchors 13, 14, 15 and 16 and ORS Anchors 5, 6, 11 and 16, the seabed anchorage was a driven pipe pile and all conditions suggested adequate stability.
- Slightly less than 50% of the anchor lines inspected had, in most instances, an estimated 90’ (full shot length) or less of the anchor leg chain exposed directly above and/or partially embedded in the seabed, with the anchor shackle and anchor fully buried in the seabed (no anchor exposure).
- Drag anchors must trip, dig-in, and remain stable as they are dragged into place. The holding capacities are dependent not just on the anchor weight and sediment properties, but also the fluke angle, the angle of the chain relative to the bottom, and the lengths that the anchors are dragged upon installation. Keeping the chain angle near zero degrees relative to the bottom, and dragging the anchors for longer distances during installation increases the anchor holding capacities. The mooring system should be designed so that the anchor will drag before the mooring line, mooring bracket, or other structure component fails. Anchor dragging is preferable to a mooring line break because the anchor dragging will re-distribute the load to the other anchors.
- The U.S. Navy (2012) *Handbook for Marine Geotechnical Engineering* recommends sizing the drag embedment anchor as the “weaker link” of a mooring system. In particular, the manual states that “It is preferable to allow the anchor to drag instead of breaking the mooring line. Anchor drag results in redistribution of the overstressed mooring line to its neighboring lines and helps the mooring to survive in storms when environmental loads exceed the design loads”. Accurate soil properties are needed for design.
- Det Norske Veritas (2012) notes that monitoring of the anchor installation should, as a minimum, provide data on line tension, line pitch angle, anchor drag, and anchor penetration. This information was not available for review.

6.2 Mooring Lines

- Above water the anchor mooring lines consist of a mix of new and old steel chains and shackles ranging from 1.5-inch to 2.25-inch diameter. Several mooring lines are taut and at a relatively shallow angle of the chain to the water where it connects to the net pen. Others the mooring line appears to go straight down vertically from the net pen. No

buoys are used on any of the mooring anchors to relieve stress on the above water mooring connection. See for example the mooring chain on the net pen in Appendix C. Mooring lines with too much tension or ones without enough tension when there is minimal wind, wave and current load may become overloaded during an extreme storm event. The Procean manual, section 3.11 notes that “A mooring plan and associated engineering study and report should be conducted…”. We have not reviewed an engineering study or mooring plan for this facility.

- Above water mooring brackets were observed during our site visit to be in fair condition with minor to moderate corrosion. A few of the mooring brackets had reduced steel edge distance where a mooring shackle is connected. This was noted at Anchor 5, 7, 8, 9 at ORN and Anchor 12, 13, 15, 16 at ORS. This would result increased stress in the shackles and low capacity at the mooring bracket. Moderate corrosion was observed at the mooring bracket connecting elements to the steel frame.

- Mooring lines were observed supported by the predator nets at ORN where the line passed through a net. The mooring lines did not have a simple catenary but a change in direction in the line where it passes through the net. When the mooring line is under high stress this arrangement will likely cause a tear in the predator net or other damage. As a result, the pipes supporting the predator nets were bent downward significantly at Anchor 10. (See Appendix A.)

- Hinged mooring brackets at the end of the net pens appear to be seized from corrosion on the longitudinal ends of Orchard Rocks net pen. A seized hinge introduces additional bending stress into the mooring plate. This was observed at anchors ORN 13,14,15,16 and ORS 7,8,9. Major corrosion at the hinge was observed at anchor ORN 13.

- The dive inspection of the anchor line assemblies were typically found to be in good to satisfactory condition, with no structurally significant deterioration in most instances, and in all cases with all connection elements intact and secure. Regarding the various shackles used throughout the system, although presently secure, there were, however, random instances of no cotter pin or safety wire, or locations were the pin nut was deteriorated loose, but still held in place by the cotter pin.

- The extent of marine growth on the anchor line ropes varied with the apparent age (time in service) of the rope, with heavy amounts of marine growth at the following anchor ropes: ORN – 3, 4, 5, 9, 11 and 12; ORS – 2, 3, 5, 9, 10, 12 and 13, and with minimal amounts of marine growth (typically newer vintage ropes) at the following anchor ropes: ORN – 1, 2, 6, 7, 8 and 10; ORS – 1, 4, 6, 6A (additional line running SE from SE corner), 7, 8, 11, 14, 15 and 16. Note: Anchor Lines 13 through 16 only had chain along their runs, presumably due to the rocky nature of the underlying seabed. The anchor rope eye splices had a mixture of thimbles, protective sleeves, wrapped smaller rope, and just bare rope at their connections with no concerns observed.

- Heavier and more notable corrosion with related pitting (generally up to 1/16 in. deep) of the steel was present for some or all of the steel components (chains and shackles) at the following anchor lines: ORN – 3, 4, 5, 9, 11, 12, 14, 15, 16 and 17; ORS – 2, 3, 5, 9, 10, 12 and 13. There was also some random areas of abrasion related section loss for the steel components at ORN Anchor Lines 14 through 16 due to being in contact with the rocky seabed. The heaviest of all corrosion noted was present at Anchor Lines ORN4 and ORS5, with the specific details as follows:

- At ORN4, the upper shackle (at start of rope) had an estimated 75% loss of original section (±1/2 in. diam. remaining), and the lower shackle (at start of anchor leg of chain) had an estimated 20% loss of original section.
- At ORS5, the anchor leg of chain exhibited much heavier corrosion than typical with random links having up to an estimated 25% loss of original section.

6.3 Pontoon Floats

- There are two net pen assemblies, one north and one south that are connected by synthetic mooring lines. The pontoons are transverse to the overall facility. The pontoon system was inspected by International Inspection in July and on October 13th, 2016 with condition and corrective actions noted.
- The pontoons are hollow steel tubes that provide flotation for the entire structure. The metal thickness is 5/16-inch. The pontoons are coated but there is no description of the system used. The Procean drawings call out both paint and primer, but not specifically the pontoons. The Procean drawings say the primer is “WB-14a Zinc”.
- Above water portions of pontoons were visually reviewed by Mott MacDonald and appeared to be in fair condition with surface corrosion and areas of localized minor damage. Steel struts extend from the top of the pontoons to support the net pen superstructure.
- Freeboard was measured and varied by up to 16-inches at different points along the structure. (see Appendix A) The freeboard variability observed was relatively small between each segment. It is not known or could be inspected if the freeboard differences are caused by flooding into the pontoons. It should be noted that freeboard measurements were on average 8”-10” less than Fort Ward even though the structures are the same type but with different ages and walkway details.
- All of the steel pontoons of ORN and ORS were inspected under water and overall were found to have no structurally significant deterioration. The pontoons of ORN generally had very little active corrosion (coverage less than 1% of overall surface area), with just minor surface corrosion having no related loss of steel section. The ORN pontoons did, however, have up to 25% of top coating loss with exposure of the underlying primer coat. The ORS pontoons generally had up to 25% overall coverage of minor surface corrosion, again with negligible related section loss, with the greater extent of corrosion apparently related to marine growth cleaning operations (conducted by the facility) that may have allowed more of the pontoon steel to become exposed. The zinc anodes on the Orchard Rocks pontoons were typically 25% or less consumed, although approximately 33% of the anodes were missing one of two fasteners that secure the anode bracket to the pontoon, and there two anodes that were completely missing.
- Thickness measurements of the steel by International Inspection (2016) indicate areas of corrosion of 14% of the thickness of the steel in places, most of the corrosion identified in the ultra-sound thickness survey was located at or below the waterline.
- Note that under visual inspection, it is difficult to tell the difference between 5/16-inch thick steel (pontoon design thickness) and 1/4-inch thick. This is especially true underwater.
- Corrosion protection includes coating (paint) and sacrificial anodes.

6.4 Steel Framing Superstructure

- The primary structural framing consists of large, steel members. Along the exterior, the frame is approximately 30 inches wide and 30 inches deep. The framing running down the center of the pen, the main bridge, is smaller and there are two main frames. The framing has areas of major corrosion and is in poor condition.
- The framing runs north to south and acts as a bridge, spanning between the pontoons. Steel barrel hinges connect the steel frame segments that also show signs of major corrosion on most joints.
- Thickness measurements of the steel by International Inspection (2016) indicate areas of corrosion that exceed 25% (up to 36%) of the thickness of the steel in places, most of the corrosion identified in the ultra-sound thickness survey. The ultrasound survey denotes this change (25% section loss) as “substantial wastage”.
- Thickness measurements done by Mott MacDonald during the December 15th, 2017 site visit noted places of up to 40% sections loss.
- The cross-sectional shape of the framing was not able to be visually verified. The cross sections are assumed to be the same as those shown in the Procean drawings. Moderate surface rust was observed across most of the frame, with major rust damage in localized areas. The International Inspection 2016 report shows areas of section loss. This was visually confirmed during the site visit.
- No anodes were observed protecting the above water steel structure.

6.5 Walkways and Railings

- The walkways include steel grating panels with diamond surfacing. The main walkway grating runs down the center of the pens and is 78 inches wide, 5 inches deep. It is a heavy duty grating capable of supporting net pen equipment and forklifts, as observed on site. The grating was loose and damaged in places.
- The exterior and pontoon walkways are narrower. ORN used a 2-inch deep steel grating on the perimeter for an 80” walkway while ORS had no additional grating on the perimeter and only had 30” walkway. Grating panels on ORN were observed to be missing bolts holding down the grating, and also displayed significant deflection when walked upon.
- The railings are galvanized 1.5” diameter pipe and border all sides of the walkways. They are removable as needed, slotted into brackets connected to the steel framing. Most of these brackets were moderately covered in rust, with localized cases of major corrosion. The deterioration of the brackets caused the railing to become loose and rotate when pressure was applied.
- Primary structure elements and hinges were exhibiting severe corrosion in places and should be repaired.

6.6 Predator Nets and Connections

- Predator nets include both in-water nets to prevent seals and other marine mammals from entering the pens, and above water nets to prevent bird predation of the salmon.

- The in-water nets are supported by 5-inch diameter pipe rails that are attached to the steel framing are in fair condition with surface rust. The nets are taut, extending straight down into the water and held in place by weighted pipes. To remove marine growth fouling they are pulled up and dried. Full replacement is reported done about every 4 years. Full replacement is reported done about every 4 years.

6.7 Stock Containment Nets and Connections

- The stock containment nets confine the salmon inside each individual pen. The nets are supported by 2.5” diameter pipe rails that surround the perimeter of each pen and the handrails. Surface corrosion was observed on the pipe connections to the frame. The nets observed were in new condition.
- It is not known if it is acceptable by the manufacturer to have the nets be supported by the handrails.

6.8 Records and Documents On-Site

Reviewed documents from Cooke indicate that copies of routine inspection reports would be stored on site. We did not inspect documents on site.

7 Conclusions

Based on our review of all available information and documents, the site investigation and our experience and judgment Mott MacDonald offers the following findings.

1. Site History and Facility Age: Net pens have been at the site since the 1970's based on information in the lease agreement. A cycle began in 2000 to replace all three cage structures in Rich Passage. The exact age of the existing net pens has not been determined. Based on a review of Google Earth aerial photos and historical timelines the Orchard Rocks net pens appear to have been installed between the year 2000 and 5/31/2002.

   Based on all available information, the age of the net pen structures (but not the mooring lines) is estimated to be approximately 17 years for Orchard Rocks. The lease agreement states that "the new cages have an average expected service life of approximately 15 years".

2. Environmental Forces: The net pens are exposed to moderate to strong tidal currents. Wave forces are important due to frequent passing vessel wakes and wind waves from the southeast. This level of tidal current has the potential to exert substantial loads on the nets, structure, and mooring systems. Current induced drag forces, wind wave and passing vessel wakes need to be accounted for in the design and site-specific mooring analysis.

3. System Design. No site specific stamped engineering drawings were available for either the net pens or the mooring system.

4. Net Pen System: Both net pens are an Ocean Catamaran Platform system manufactured by Procean. The fabricated steel structure includes mooring and net pen system and hardware attached to walkway structures which are supported by steel pontoons for flotation. The net pen system is a catenary moored floating structure relying upon forces imposed on the flotation pontoons and net systems to be resisted by mooring chains and anchors.

5. Net Connections: The perimeter predator net attaches to a 5" diameter steel perimeter pipe that attaches to the outside of the walkway. The fish pen nets were attached to a mixture of the hand railing and 2.5" diameter steel net pen pipes connected to the walkway. The handrail supports and the 2.5" diameter steel pipe as well as the connection back to the walkway displayed areas of major corrosion.

6. Mooring Plan: A schematic mooring diagram and notes describing the existing components were provide by Cooke. However, an additional anchor was observed at Anchor 6 on ORS that was not on the mooring plan. Several lines had new galvanized shackles and chain. The mooring plan states the anchors are a mix of different types and sizes of anchors.

7. Mooring Brackets: The mooring lines connect to fixed steel plate mooring brackets on the sides and hinged steel mooring brackets on the ends attached to the walkway structure frame near the walking surface. Most mooring brackets on Orchard Rocks had major corrosion with several brackets showing significantly reduced edge hole distance that introduces increased stress to the mooring line shackles. Additionally, several of the hinged steel mooring brackets appear to be seized from corrosion on the

longitudinal ends of Orchard Rocks net pen. A seized hinge does not rotate and this introduces additional bending stress into the mooring plate. No buoys are used on any of the mooring anchors to relieve stress on the above water mooring connection. It was observed that several shackles and chains were recently replaced. However, some of them were displaying a fair amount of corrosion on both facilities. Additionally, the mooring lines on many locations on both net pens were connected to the perimeter pipe with synthetic rope which would add additional stress and load to the perimeter pipe that supports the predator nets. As a result, the pipes supporting the predator nets were bent downward significantly in some locations on Orchard Rocks.

8. Underwater Components: The following are some of the findings based on the underwater inspection.

    a. The anchor and mooring line assemblies were typically found by the divers to be in good to satisfactory condition, with some exceptions:

        i. A shackle under water at Anchor 4 on ORN was observed to have lost 75% of its section and should be replaced.

        ii. The chain at Anchor on ORS, exhibited much heavier corrosion than typical with random links having up to an estimated 25% loss of original section.

    b. The steel pontoons at Orchard Rocks were found to have no structural significant deterioration. The pontoons had approximately 25% overall coverage of minor surface corrosion, with negligible related section loss.

    c. Zinc anodes were observed attached to the bottom of the pontoons. They ranged from new to almost depleted needing replacement. Generally, the zinc anodes at Orchard Rocks had sufficient section.

    d. The mooring system includes a mix of different anchor types, mooring lines, line tension, angles, and lengths. Moorings should be designed to be symmetrical where possible, with the same anchor type, holding capacity and line tension around the perimeter of the structure.

    e. Some mooring lines were observed supported by the predator nets where the line passed through a net. The mooring lines did not have a simple catenary but a change in direction in the line where it passes through the net. When the mooring line is under high stress this arrangement will likely cause a tear in the predator net or other damage.

9. Above Water Components: The above water portions of the net pen structure float system appear to be in poor condition at Orchard Rocks. Surface rust was widespread with serious localized corrosion damage observed on many elements of the structure where corrosion would be classified as major. This includes the steel walkway frame connecting the pontoons, the mooring brackets, the predator and net pen supports, the supports for the handrail and the main net pen hinges that connect the net pens together.

    Freeboard was measured on site and varies as much as foot between different net pen segments. On average the older Orchard Rocks freeboard was measures roughly 8”-10” less than new Fort Ward net pens even though the systems are the same.

10. Inspections and Maintenance: Inspections of critical structure elements should be conducted weekly, monthly, and annually per the manufacturer's specifications. It could not be determined the frequency and thoroughness of the inspections by the Owner. Maintenance conducted by the Owner does not appear in accordance with manufacturer's recommendations or industry standards.
11. Anchor Locations: Anchor locations on the Orchard Rocks net pen appear to be inside of the lease boundary based on the length of the diver umbilical used for anchor line inspection. A multi-beam bathymetric survey is recommended to locate the anchors.

The findings and results of this assessment work by Mott MacDonald do not constitute a certification of the facility structural integrity but rather an overall review of the condition as represented by the applicant and verified in the field during a site visit and dive inspection.

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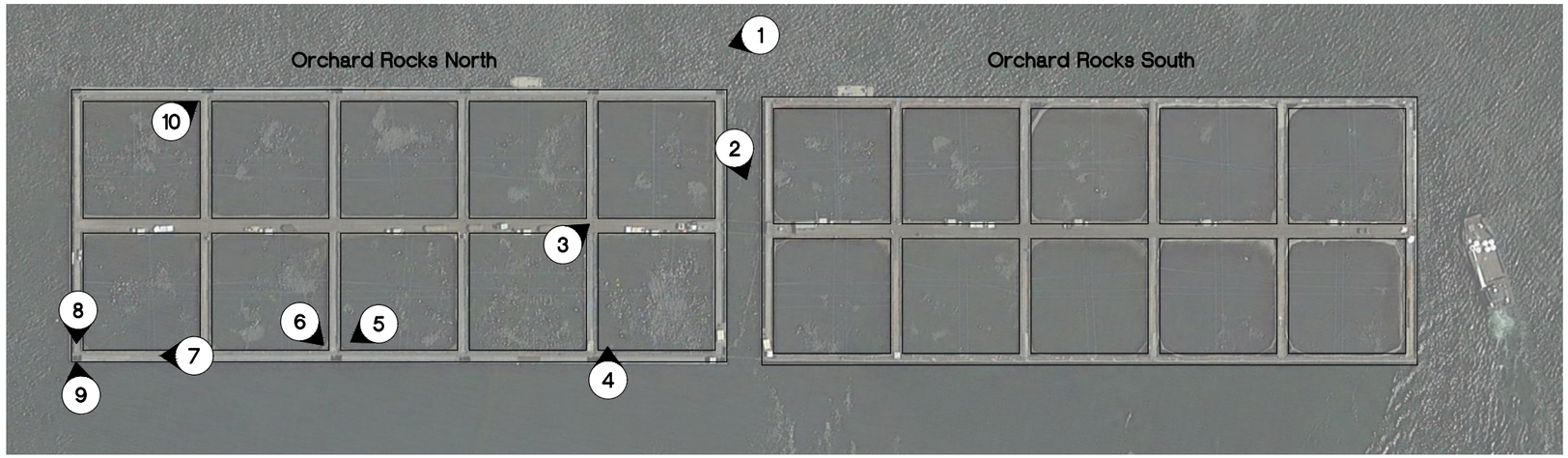

LEGEND

1 PHOTO LOCATION AND ORIENTATION

NOTES

MOORING SYSTEM NOT SHOWN, SEE SHEET 3

ORCHARD ROCKS NET PENS - NORTH

PHOTOS–PLAN

0 50 100

SCALE IN FEET

PHOTO 1
EXTERIOR VIEW OF NET PENS LOOKING NORTH

PHOTO 2
EXTERIOR WALKWAY / PREDATOR NET

PHOTO 3
DAMAGE DUE TO CORROSION ON CENTER BRIDGE

PHOTO 4
FISH NET CORRODED SUPPORT PIPE

PHOTO 5
ANCHOR 10/MOORING CHAIN CONNECTED TO PREDATOR PIPE

PHOTO 6
ANCHOR 10 MOORING CHAIN CAUSING BENDING TO PREDATOR NET SUPPORT PIPE

PHOTO 7
MAJOR CORROSION ON WALKWAY

PHOTO 8
ANCHOR 13

PHOTO 9
SEIZED HINGE AT ANCHOR 13

PHOTO 10
TYPICAL HINGE CONNECTION BETWEEN PENS

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Rev	Date	Drawn	Description	Ch'k'd	App'd
1	1/5/18	CT	PLAN AND PHOTOS	JL	NS

Designed	E. Edgecomb		Eng check	S. Phillips	
Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

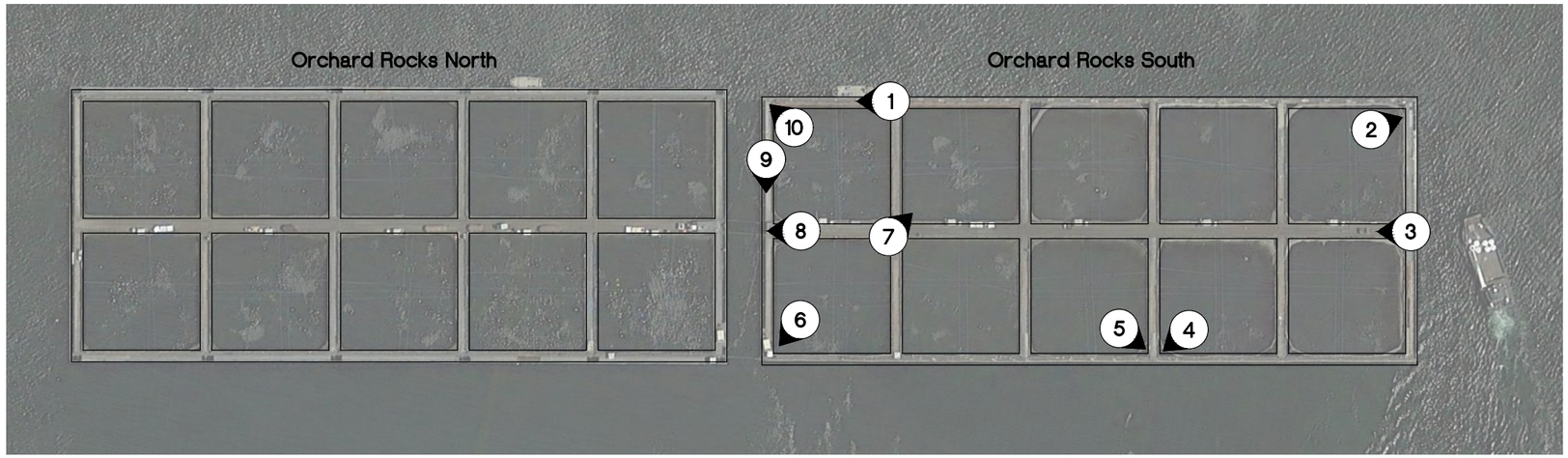
Scale at ANSI D: As Shown | Status | Rev | Security

Project Number: 391980 | B/O: 1 | Total: 6

Drawing Number

Title: Washington State Department of Fish and Wildlife Orchard Rocks Net Pens

Site Assessment Plan
Orchard Rocks - North



LEGEND

1 PHOTO LOCATION AND ORIENTATION

NOTES

MOORING SYSTEM NOT SHOWN, SEE SHEET 3

ORCHARD ROCKS NET PENS - SOUTH

PHOTOS–PLAN

0 50 100

SCALE IN FEET

PHOTO 1
EXTERIOR WALKWAY / PREDATOR NET

PHOTO 2
EXTERIOR WALKWAY / PREDATOR NET

PHOTO 3
CENTER BRIDGE

PHOTO 4
CORRODE SHACKLES AND MOORING BRACKET AT ANCHOR 13

PHOTO 5
PEN HINGE WITH MAJOR CORROSION / 40% LOSS IN SECTION

PHOTO 6
NEW SHACKLE AND CHAIN WITH MAJOR CORROSION ON MOORING BRACKET

PHOTO 7
PEN AND BIRD NET

PHOTO 8
HINGE CONNECTION AND LINE TO NORTH NET PEN

PHOTO 9
EXTERIOR WALKWAY / PREDATOR NET

PHOTO 10
GRATING AND PREDATOR NET RAIL SUPPORTS

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Rev	Date	Drawn	Description	Ch'k'd	App'd
1	1/5/18	CT	PLAN AND PHOTOS	JL	NS

Project Number 391980 | B/O 2 | Total 6

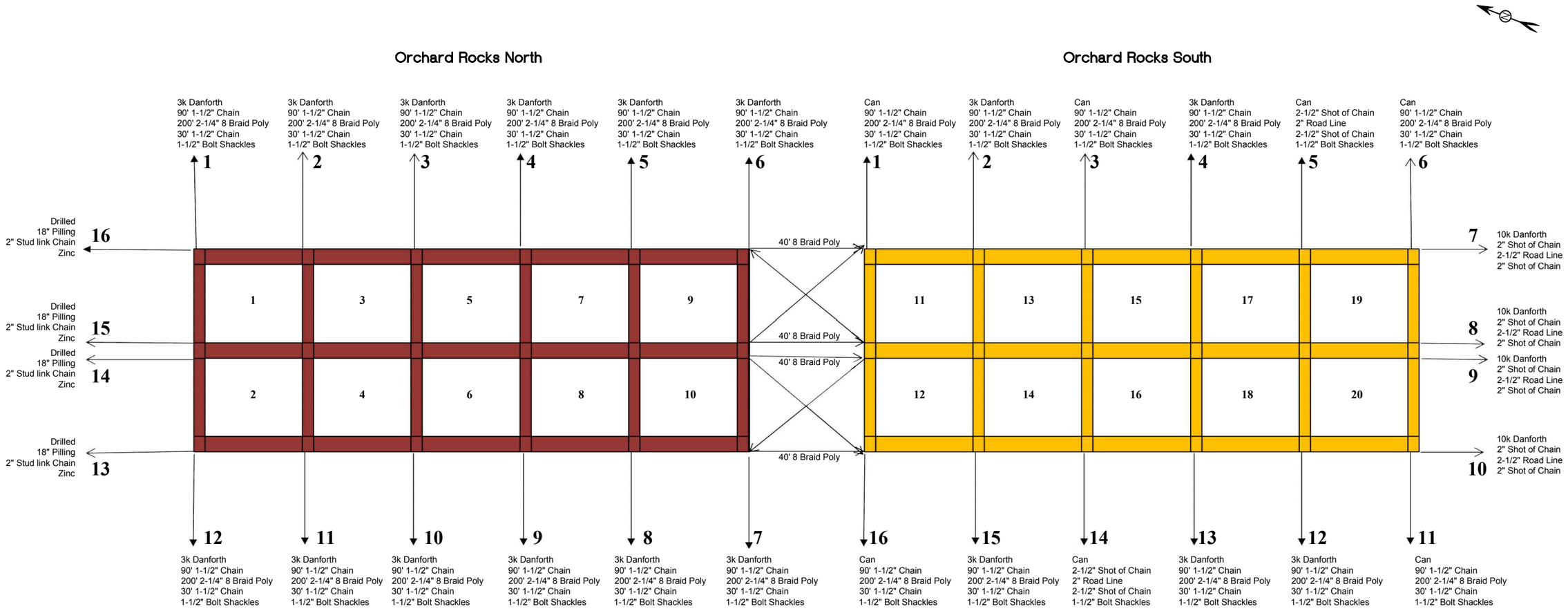
Designed	E. Edgecomb		Eng check	S. Phillips	
Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

Scale at ANSI D: As Shown | Status | Rev | Security

Drawing Number

Title: Washington State Department of Fish and Wildlife
Orchard Rocks Net Pens

Site Assessment Plan
Orchard Rocks - South



ORCHARD ROCKS NET PEN

MOORING PLAN

NOT TO SCALE

NOTES

MOORING SYSTEM SCHEMATIC PLAN
PROVIDED BY COOKE AQUACULTURE.

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Rev	Date	Drawn	Description	Ch'k'd	App'd
1	1/5/18	CT	PLAN AND PHOTOS	JL	NS

Project Number: 391980 | B/O: 3 | Total: 6

Designed	E. Edgecomb		Eng check	S. Phillips	
Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

Scale at ANSI D: As Shown | Status | Rev | Security

Drawing Number

Title: Washington State Department of Fish and Wildlife Orchard Rocks Net Pens

Mooring Schematic

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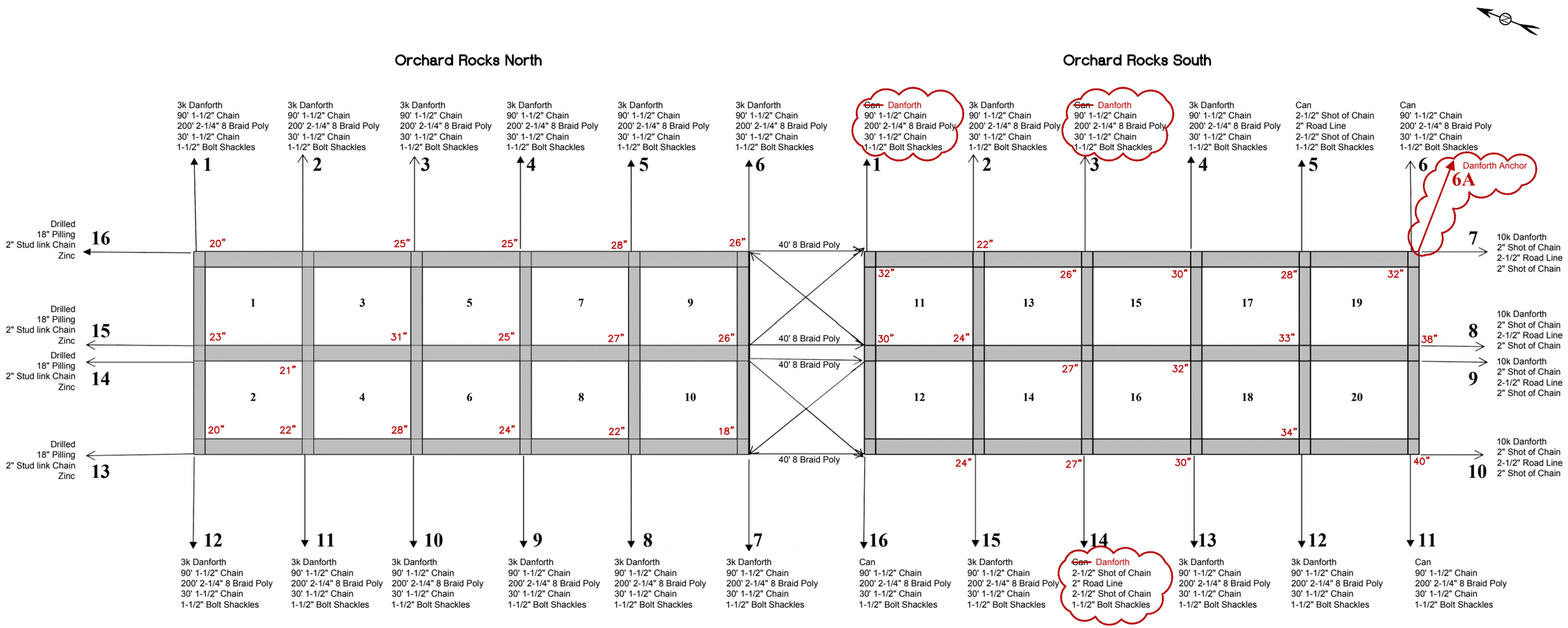

3k Danforth
90' 1-1/2" Chain
200' 2-1/4" 8 Braid Poly
30' 1-1/2" Chain
1-1/2" Bolt Shackles

ORCHARD ROCKS NET PEN

MOORING PLAN

NOT TO SCALE

LEGEND

18" FREEBOARD MEASURED 12–5–2017

NOTES

1. MOORING SYSTEM SCHEMATIC PLAN PROVIDED BY COOKE AQUACULTURE.
2. CORRECTIONS AND NOTES BY MOTT MACDONALD ARE IN RED.

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Client: Washington Department of Natural Resources

Rev	Date	Drawn	Description	Ch'k'd	App'd
1	1/5/18	CT	PLAN AND PHOTOS	JL	NS

Project Number: 391980 | B/O: 4 | Total: 6

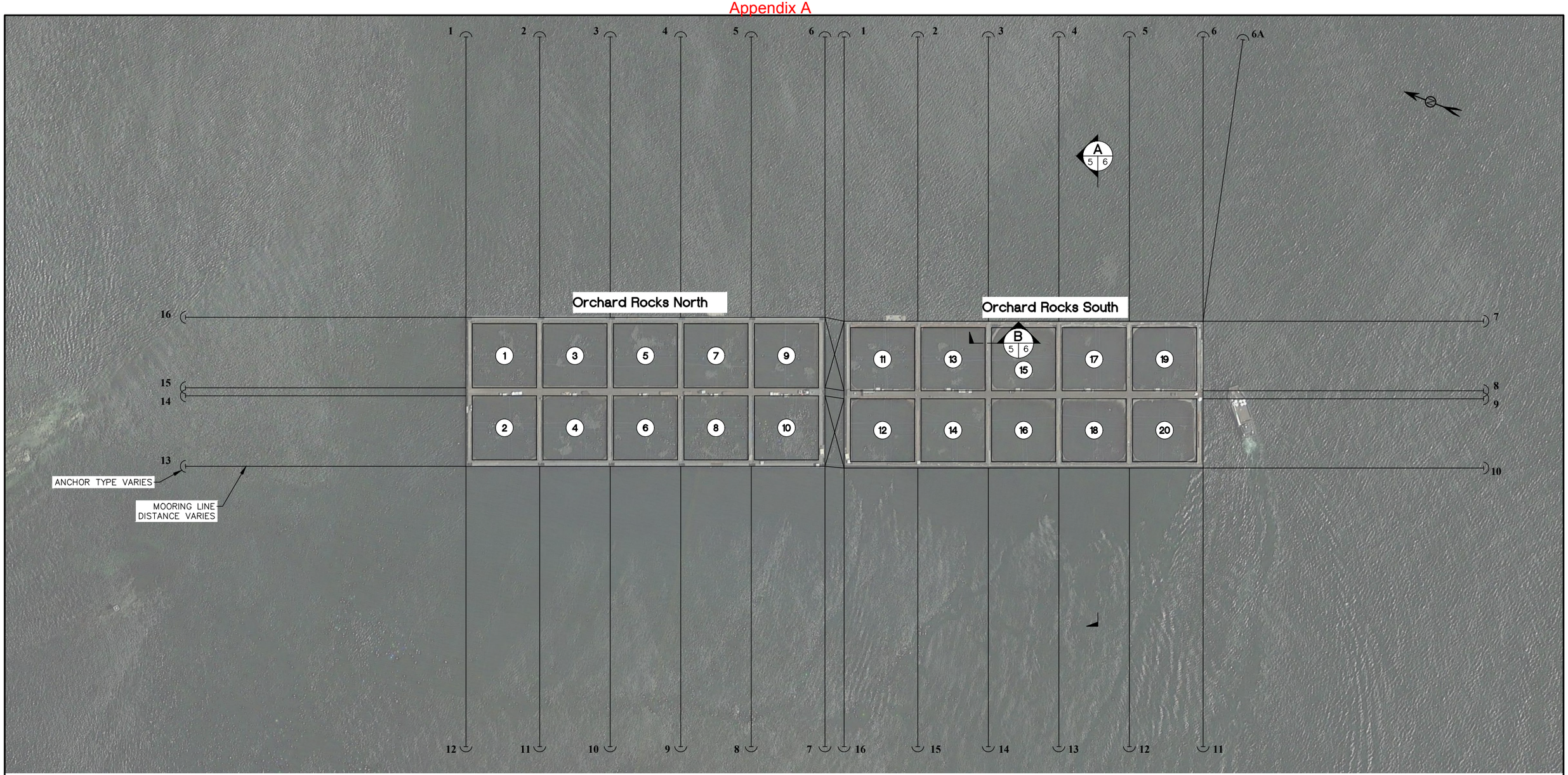
Designed	E. Edgecomb		Eng check	S. Phillips	
Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

Scale at ANSI D: As Shown | Status | Rev | Security

Drawing Number

Title: Washington State Department of Fish and Wildlife Orchard Rocks Net Pens

Mooring Schematic Revised, with Notes



ORCHARD ROCKS NET PENS

0 60 120

SCALE IN FEET

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WASHINGTON DEPARTMENT OF NATURAL RESOURCES

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Scale at ANSI D	Status	Rev	Security
As Shown			

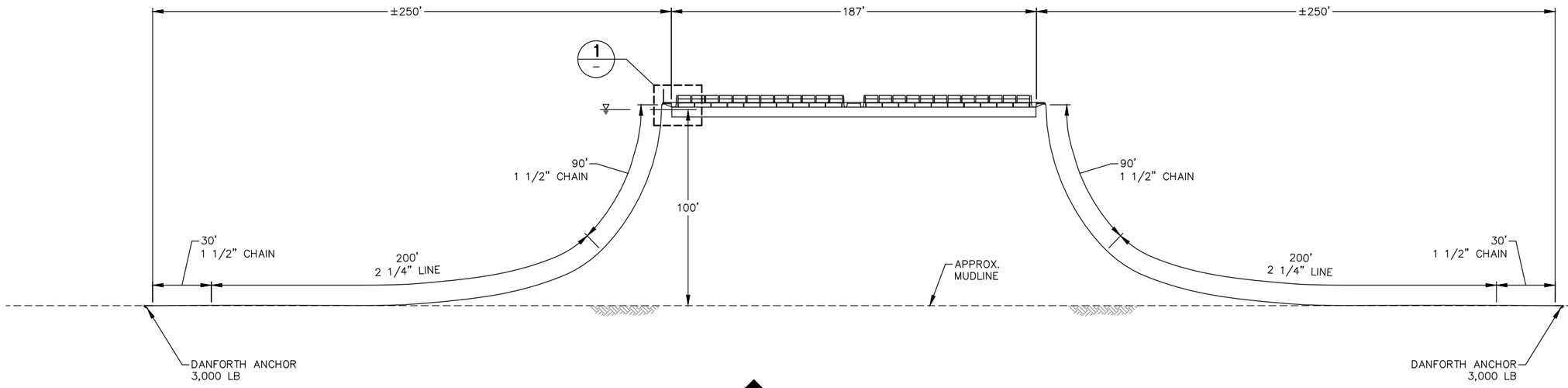
Drawing Number

Title

Washington State
Department of Fish and Wildlife
Orchard Rocks Net Pens

Existing Site - Moorings

pw:\\pimspwise.hmmg.cc:pw_ports_harbors\Documents\391980-PUGET SOUND NET PEN ASSESSMENT\Drawings_Models\12_MA_Marine\7 - Design\CAD\E - Preliminary\391980-Rich Passage Plan - Orchard.dwg Jan 5, 2018 - 9:44AM TAY70899



A 5 6 **SECTION**

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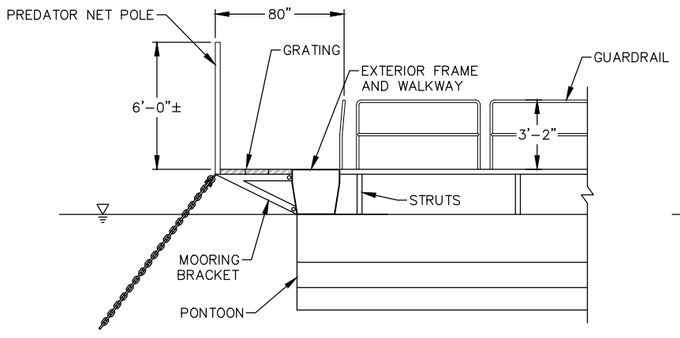

1 **DETAIL**

ORCHARD ROCKS – NORTH

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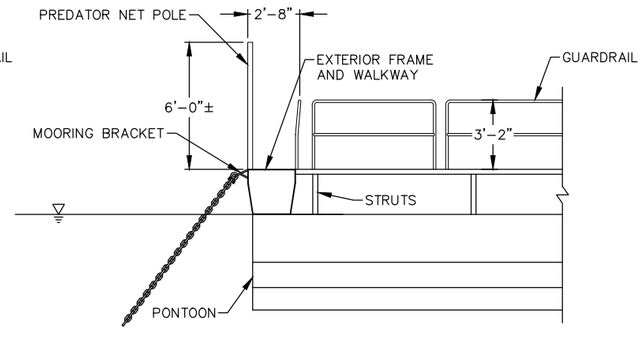

1 **DETAIL**

ORCHARD ROCKS – SOUTH

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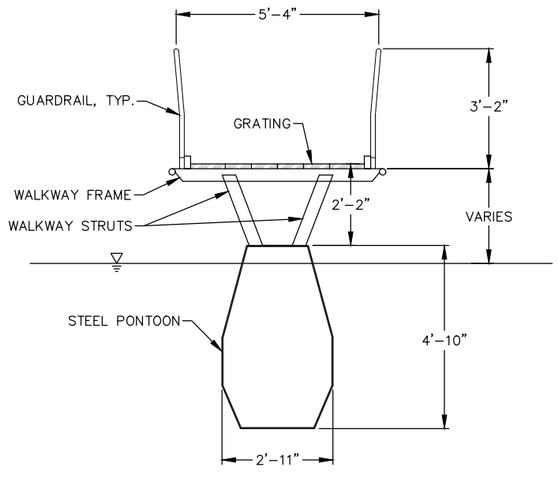

B 5 6 **SECTION**

0 2 4

SCALE IN FEET

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WASHINGTON DEPARTMENT OF NATURAL RESOURCES

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Project Number	B/O	Total
391980	6	6

Designed	E. Edgecomb		Eng check	S. Phillips	
Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		
Scale at ANSI D: As Shown	Status		Rev		Security
Drawing Number					

Title

Washington State
Department of Fish and Wildlife
Orchard Rocks Net Pens

Section - Mooring

January 29, 2018
Collins Job No. 45-10819

Underwater Inspection of the Orchard Rocks
Fish Net Pen System in Rich Passage, WA

Mr. Nels Sultan, Ph.D, P.E.
Principal Engineer
North America Ports, Coastal and Offshore
Mott MacDonald
110 James Street, Suite 101
Edmonds, WA 98020

Dear Mr. Sultan,

Collins Engineers, Inc. conducted an underwater inspection of the Orchard Rocks North and South Fish Net Pens System located in Rich Passage, WA from December 11 through December 16, 2017. The scope of the inspection was to perform a below water visual and tactile inspection of the facility, consisting of the anchor line assemblies and the floating pontoons of the net pens system, and then based on the findings, comment on the integrity and stability of those submerged components of the fish net pen system.

The fish net pens system components inspected included all of the floating pontoons that support the overall system, their attachments to the various anchor lines, and all of the anchor line assemblies. The inspection intensity consisted primarily of a Level I inspection effort (visual and tactile techniques), with very limited cleaning of existing marine growth, and the overall inspection process followed the guidelines established by the ASCE Manual of Practice 101 – Underwater Investigations: Standard Practice Manual and ASCE Manual of Practice 130 – Waterfront Facilities Inspection and Assessment. The inspection was performed by a dive team consisting of five (5) Association of Diving Contractors (ADCI) engineer/divers with rotating rolls to optimize dive time and safety. Since all of the submerged fish net pens system components inspected were located in water depths of 100 fsw or less (low tide conditions were utilized for some anchor line inspections to ensure water depths no greater than 100 fsw, which is the OSHA limitation for commercial dive operations not requiring a recompression chamber to be onsite), all inspections were accomplished by diving.

It should be noted that the inspection of the anchor lines was accomplished with the use of surface-supplied diving equipment (air hose and hard-wire communications gear) that included a 300 ft

umbilical in support of the diver's movements during inspection. At times, given the waterway currents creating a bow in the umbilical and/or the anchor location (either an exposed anchor or the point where the anchor chain became embedded in the seabed), there was a need to supplement the range of the diver's umbilical with a line from the inspection vessel that allowed it to move away from the fish net pens system for some necessary distance. Although no record or rough measurement of length of umbilical and/or line from the vessel was ever made during the inspection, it is reasonable to say that some of the anchor lines, to the point of inspection completion, may have reached a length from the net pens of up to 350 ft.

Refer to Photographs 1 through 98 for views of the typical and specific conditions observed during the underwater inspection of the Orchard Rocks North (ORN) and Orchard Rocks South (ORS) fish net pens system components. In addition, all of the photographs and videos taken during the underwater inspection of the Orchard Rocks fish net pens system components have been made available for reference digitally.

Overall, the underwater inspection revealed the following key findings:

- The anchor line assemblies were typically found to be in good to satisfactory condition, with no structurally significant deterioration in most instances, and in all cases with all connection elements presently intact and secure. Regarding the various shackles used throughout the system, although presently secure, there were, however, random instances of no cotter pin or safety wire, or locations where the pin nut was corroded and loose, but still held in place by the cotter pin.

- The extent of marine growth on the anchor line ropes varied with the apparent age (time in service) of the rope, with heavy amounts of marine growth at the following anchor ropes: ORN – 3, 4, 5, 9, 11 and 12; ORS – 2, 3, 5, 9, 10, 12 and 13, and with minimal amounts of marine growth (typically newer vintage ropes) at the following anchor ropes: ORN – 1, 2, 6, 7, 8 and 10; ORS – 1, 4, 6, 6A (additional line running SE from SE corner), 7, 8, 11, 14, 15 and 16. (Note: Anchor Lines 13 through 16 only had chain along their runs, presumably due to the rocky nature of the underlying seabed.) The anchor rope eye splices had a mixture of thimbles, protective sleeves, smaller rope lashing, and just bare rope at their connections. Although there were no present concerns with any of the rope splice connections, the locations with just bare rope should ideally be better protected with either a thimble or a protective sleeve.

- Heavier and more notable corrosion with related pitting (generally up to 1/16 in. deep) of the steel was present for some or all of the steel components (chains and shackles) at the following anchor lines: ORN – 3, 4, 5, 9, 11, 12, 14, 15, 16 and 17; ORS – 2, 3, 5, 7, 9, 10, 12, 13 and 15. There was also some random areas of abrasion related section loss for the steel components at ORN Anchor Lines 14 through 16 due to being in contact with the

rocky seabed. The heaviest of all corrosion noted was present at Anchor Lines ORN 4 and ORS 5, with the specific details as follows:

  - At ORN 4, the upper shackle (at start of rode line rope) had an estimated 75% loss of original section (±1/2 in. diam. remaining), and the lower shackle (at start of the anchor chain) had an estimated 20% loss of original section.
  - At ORS 5, the lower anchor chain exhibited much heavier corrosion than typical with random links having up to an estimated 25% loss of original section.

- Slightly less than 50% of the anchor lines inspected had, in most instances, an estimated 90’ (full shot length) or less of the anchor leg chain exposed directly above and/or partially embedded in the seabed, with the anchor shackle and anchor fully buried in the seabed (no anchor exposure). Portions of the anchor were found exposed at ORN Anchor Lines 1, 2, 4, 5, 11, 13, 14, 15 and 16 and at ORS Anchor Lines 4, 5, 6, 6A, 11, 12, 13, 14, and 16. Overall, all of the anchors (those that were Danforth type) observed were sufficiently buried in the seabed, and there were no anchors that displayed indications that the anchor was unstable and/or shifting its position in the seabed. At ORN Anchors 13, 14, 15 and 16 and ORS Anchors 5, 6, 11 and 16, the seabed anchorage was a driven pipe pile and all conditions suggested adequate stability.

- An additional anchor line (not shown on provided drawings) was observed and inspected between Anchor Lines 6 and 7 of ORS. The additional anchor line was designated as Anchor Line 6A, appeared to be rather new overall, and extended to the southeast from the southeast corner of ORS.

- All of the steel pontoons of ORN and ORS were inspected and overall were found to be in good to satisfactory condition with no structurally significant deterioration. The pontoons of ORN generally had very little active corrosion (coverage less than 1% of overall surface area), with just minor surface corrosion having no related loss of steel section. The ORN pontoons did, however, have up to 25% of top coating loss with exposure of the underlying primer coat. The ORS pontoons generally had up to 25% overall coverage of minor surface corrosion, again with negligible related section loss, with the greater extent of corrosion apparently related to marine growth cleaning operations (conducted by the facility) that may have allowed more of the pontoon steel to become exposed.

- The zinc anodes on the Orchard Rocks pontoons were typically 25% or less consumed, although approximately 33% of the anodes were missing one of two fasteners that secure the anode bracket to the pontoon, and there were two anodes that were completely missing.

Anchor Line Assemblies

The anchor line assemblies typically consisted of:

- Connection to floating pontoon of net pens system
- Upper Anchor Chains (±30 ft)
- Ropes (±200 ft – rode line)
- Lower Anchor Chains (±90 ft – one shot of chain)
- Anchors (Danforth or can/pile type)

Regarding the connection of the anchor lines to the various pontoons around the entire perimeter of the net pen system, they were always found to be fully intact and secure in what could always be deemed as being in good to satisfactory condition. Typically, the item of the pontoon-to-anchor line connections that exhibited the greatest deterioration was observed to be the steel plate (padeye) that serves as a means of connecting the anchor line shackle to the steel bracket assembly that connects to the pontoon and pen system perimeter walkway. As for these connection plates, which reside in the splash zone, they typically exhibited moderate corrosion that had some associated pitting (generally up to 1/8 in. deep) and rust delaminations. Overall, however, there still appeared to be minimal loss of original steel plate thickness related to the corrosion. Attached to these connection plates, the anchor line shackles typically exhibited little, if any, deterioration, and in many instances appeared to be relatively new hardware. The upper anchor chain shackles were always found to be properly aligned and secure, and cotter pins for the shackle pins were typically in place. The exception to this was for the "screw-in" type shackle pins, which although always secure, typically did not have any pin-restraining wire in place. The inspection of the accessible portions of the steel framing that provides the overall attachment between the aforementioned shackle plates, the pen system pontoons, and the perimeter walkway construction typically revealed that framing to be sound and secure with no concerns for instability.

The upper and lower anchor chain (shackle) to rope eye splice connections (bare rope, steel thimble, protective hose sleeve or smaller rope lashing/protection) were also typically found to be fully intact, secure, and in good to satisfactory condition. The steel thimbles, when used for the rope eye splices, typically exhibited minimal deterioration, and the ropes were typically secured beyond the thimble with an eye splice weave of sufficient length and integrity. Similarly, adequate eye splice lengths were typically present and the rope loop was adequately protected at locations where either a protective sleeve (blue PVC or "fire hose" type material) or smaller rope lashing was used for the eye splice connection. At locations where only bare rope was around the shackle (ORN 4, 11 & 12 and ORS 2, 5, 8 and 13), there was again sufficient splice weave and presently no apparent damage to the unprotected rope. Although there were no present concerns with any of the rope splice connections, the locations with just bare rope should ideally be better protected with either a thimble or a protective sleeve.

In most instances, the steel shackles at the rope to chain connections exhibited no structurally significant deterioration, and were typically found to be properly aligned and secure with cotter pins for the shackle pins typically in place and properly installed. When corrosion was present on the shackles, it generally had minimal associated section loss, and ranged in extent from just surface corrosion to corrosion with pitting that was up to 1/16 in. deep. The one main exception to this was found at ORN Anchor Line 4, where the shackle at the upper end of the rode line rope exhibited an estimated 75% of section loss (±1/2 in. diam. remaining), and the shackle at the other end of the rope had an estimated 20% loss of section. In general, when the shackles exhibited corrosion, it appeared to be related to an overall anchor line that was older in vintage. Conversely, there were a number of anchor lines that appeared to be relatively new (ORN 1, 2, 6, 7 & 10 and ORS 1, 4, 6, 6A, 11, 14 & 16) that had very little or essentially no shackle corrosion. The vast majority of the shackles were the type with the pin held in place by a nut, and as previously indicated, the pins in most instances were properly secured with a cotter pin. There were, however, random locations where no cotter pin was in place, but presently for those cases, the shackle pins were still sufficiently secure. There were also some instances (ORN 3 and ORS 2, 3 & 12) where the cotter pin was present and holding the pin nut in place, but the nut was no longer engaged due to thread deterioration, and at ORS 2 in particular, the pin nut was no longer in place due to apparent deterioration.

The ±30 ft long upper anchor chains were typically found to be in good to satisfactory condition, with corrosion levels, similar to that of the shackles, which ranged, depending on the apparent age of the overall anchor line, from little or no corrosion (refer to previous newer anchor line listing in shackle discussion) to more advanced corrosion with pitting that generally was up to 1/16 in. deep. In addition, the older upper anchor chains also had heavier pitting and rust delaminations between the padeye connection and the water surface (above water splash zone), with pitting depths and delamination thicknesses of up to 1/8 in. (±3/16 in. at ORN 4 and ORS 5, which appeared to be two of the oldest anchor lines). In general, however, regardless of the current extent of corrosion, none of the upper chain corrosion exhibited what would be deemed as structurally significant loss of section. Similar to the corrosion, the amount of marine growth on the upper lengths of chain again varied with the apparent time in service of the chain, with newer lengths having essentially no growth and older lengths having 3 in. to 6 in. thick growth that included hard, large barnacle growth.

The ±200 ft long ropes (rode lines) were typically found to be in good to satisfactory condition with no significant fraying or detectable abrasion damage. The extent of marine growth on the anchor line ropes varied from essentially no growth at all to growth that was generally 3 in. to 6 in. thick, and at times up to 12 in. thick, that included both soft growth and hard, large barnacle growth. Clearly, the amount of growth on each anchor line was directly related to the apparent age (time in service) of the rope, with heavy amounts of marine growth at the following anchor ropes (as well as adjoining upper shackles and chains): ORN – 3, 4, 5, 9, 11 and 12; ORS – 2, 3, 5, 9, 10, 12 and 13, and with minimal amounts of marine growth (typically newer vintage ropes) at

the following anchor ropes (as well as adjoining upper shackles and chains): ORN – 1, 2, 6, 7, 8 and 10; ORS – 1, 4, 6, 6A (additional line running SE from SE corner), 7, 8, 11, 14, 15 and 16. Although not particularly an item of concern, it should be noted that the rode line at ORS Anchor Line 16 ran higher in the water column than all other rode lines before then going down to the seabed, possibly suggesting that there was no strain in the anchor line due to excess rope in the line. It should also be noted that ORN Anchor Lines 13 through 16 did not have any rode line rope, and only consisted of chain from the net pens to the seabed anchorage, presumably due to the rocky and abrasive nature of the seabed on the northerly side of the Orchard Rocks net pens system.

The ±90 ft long (one shot of chain) lower anchor chains were typically found to be in good to satisfactory condition, with no structurally significant deterioration and minimal marine growth regardless of the apparent age of the overall anchor line. Similar to the upper anchor chains, the heaviest corrosion for the lower anchor chains typically only had pitting that was 1/16 in. deep or less and negligible loss of original chain section. The one exception to this was noted at ORS Anchor Line 5, where the lower anchor chain had notably heavier corrosion with link section losses that were typically in the range of 10% to 20% and as much as an estimated 25% in some instances. For all of the Orchard Rocks anchor lines, the anchor chain was resting on or embedded to some extent in the seabed, as it should be, until the point where it either became completely embedded or the connection to the anchor was reached. In most instances, the length of lower anchor chain exposed to some extent for inspection ranged between 45 ft and 90 ft (full shot length). At ORN Anchor Line 9 and ORS Anchor Lines 9 and 10, there was approximately 180 ft (± two shots of chain) of lower anchor chain exposed before the chain became fully embedded in the seabed, and at ORN Anchor Lines 13 through 16, there was chain exposed for the full distance between the fish net pens and the seabed anchorage, since those anchor lines did not have any rope as part of their makeup. The lower anchor chain typically resting on and/or embedded in the seabed suggests an appropriate anchor location and anchor line assembly length (scope) to promote proper setting and subsequent grip of the Danforth type anchors. In most instances, the manner in which the chain was on or in the seabed, with no notable rutting or plowing of the seabed, suggests that the lower anchor chains are not being lifted up or being moved from side-to-side in the seabed. The exception to this was noted at ORN Anchor Lines 8 and 9 and ORS Anchor Lines 4, 6A and 15, where there was some slight rutting (up to 6 in. deep valleys), although it did not appear to be enough seabed disruption to suggest that there was any problem with the anchor line's overall anchorage. In addition, it was also observed that some of the lower anchor chain runs along the easterly and westerly side of the Orchard Rocks system had a northerly "bend" between the connection to the rode line rope and the anchor. This situation may suggest some movement with respect to the net pens and the point of initial anchor placement; however, the condition appeared stable and to have been situated as such for some time.

As for the anchors of the Orchard Rocks system, slightly less than 50% were found to be completely buried (including the shackle connection), which suggests that those anchors (purported to be Danforth type) were well-seated and adequately gripping into the seabed. The

Danforth type anchors that were found to be exposed to some extent were located at ORN Anchor Lines 1, 2, 4, 5 and 11 and ORS Anchor Lines 4, 6A, 12, 13, and 14. In general, the amount of anchor exposure at these anchors was minimal, with a majority of the anchor stem and flukes typically embedded in the seabed, such that each anchor was adequately founded in the channel bottom with no indications of any recent anchor slippage or other movement. At ORN Anchor Lines 13 through 16 and ORS Anchor Lines 5, 6, 11 and 16, the anchor type was that of a driven pipe pile, with the anchor chain either secured to the pile anchor using either a padeye connection or with the chain wrapped around the pile, and in all instances, the existing conditions suggested a stable anchorage.

Floating Pontoons of the Net Pens System

As for the floating pontoons of the net pen system, the inspection of those components always revealed them overall to be in good to satisfactory condition with no significant deterioration, damage or any other reasons for concern identified. For the most part, the submerged surfaces had the majority of their protective coatings intact and well-adhered, although there was a notable difference in the amount of corrosion present between the ORN pontoons and the ORS pontoons. In general, all of the pontoons exhibited an estimated 25% of protective coating (black colored top coat) breakdown and failure, although for the ORN pontoons there was only corrosion across an estimated 1% or less of their submerged surface area (the other ±24% was exposed underlying primer coat), while the similar estimated corrosion percentage for the ORS pontoons was in the neighborhood of 25%. In this regard, the difference appeared to be related to marine growth cleaning operations (conducted by the facility) that may have allowed more of the ORS pontoon steel to become exposed and subject to corrosion. As for the marine growth, which was only on the ORN pontoons and for the most part removed from the ORS pontoons, it consisted of an estimated 75% coverage of a mostly light layer of small barnacles and a soft, grass-like marine growth. For both the ORN and ORS pontoons, where coating loss was evident on the below water surfaces of the pontoons, there was always just minor surface corrosion and a light dusting of rust scale, which could be easily brushed away with a gloved hand, with no notable loss of steel section related to the corrosion detected.

The pontoon inspections also included the inspection of the various cathodic protection anodes attached to the pontoons, with the sacrificial anodes (zincs) attached with a bracket bolted directly to the pontoons. For both the ORN and ORS pontoons, the anodes on average were found to have up to 25% consumption. Aside from the typical amount of consumption, it was also observed that two anodes were completely missing, and for approximately 33% of the in place anodes, while still securely attached to the pontoon, there was one of the two bracket connecting bolts missing. Overall, given the present amount of anode consumption, there still appeared to be more than sufficient anode population to afford proper cathodic protection of the pontoons, which seemed to be evidenced by the very minimal and light corrosion on the areas of exposed pontoon steel below water.

Conclusions

Overall, the anchor line assemblies were typically found to be in good to satisfactory condition, with for the most part no structurally significant deterioration, and with all connection elements presently sound and secure. The rating of good to satisfactory is deemed appropriate since good implies essentially no deficiencies, and satisfactory implies that there may be some deterioration or other defects present, but those conditions are primarily minor and not compromising the integrity of the affected component. The only exception to this would be for Anchor Line 4 of the Orchard Rocks North system and Anchor Line 5 of the Orchard Rocks South system, where there was more significant corrosion and related section loss noted for some of the chain or shackle components. With respect to these two more heavily deteriorated anchor lines, it was clearly evident they were some of the oldest anchor lines of the Orchard Rocks net pens system, and therefore, should most likely be the first lines to be considered for renewal in the future. As for the aforementioned other anchor lines that appeared to be of older vintage, the current extent of corrosion on the steel components, as well as the generally heavy marine growth on the upper anchor chains and rode line ropes, did not appear to be overly detrimental to the anchor lines themselves or the overall facility at this time. Regarding the floating pontoons of the net pens systems, they also were found to be in good to satisfactory condition, with no significant deterioration and no other concerns for the pontoon themselves or their cathodic protection anodes at this time.

If you have any questions or require any additional information with respect to the underwater inspection findings, please don't hesitate to contact me.

January 29, 2018

Very truly yours,

COLLINS ENGINEERS, INC.

Daniel G. Stromberg, P.E.
Chief Structural Engineer/Diver

Photograph 1: Overall View of the Orchard Rocks North Fish Net Pens System, Looking West.

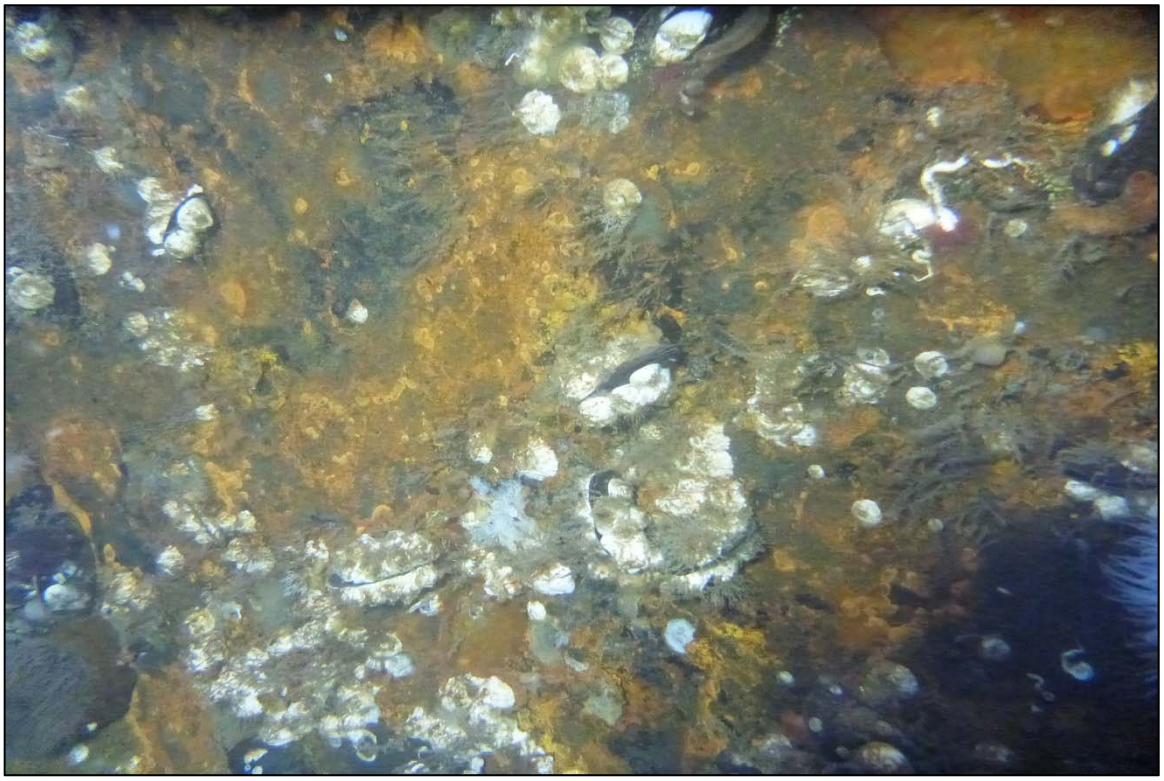
Photograph 2: Overall View of the Orchard Rocks North Fish Net Pens System, Looking East.

Photograph 3: Overall View of the Orchard Rocks North Fish Net Pens System, Looking East.

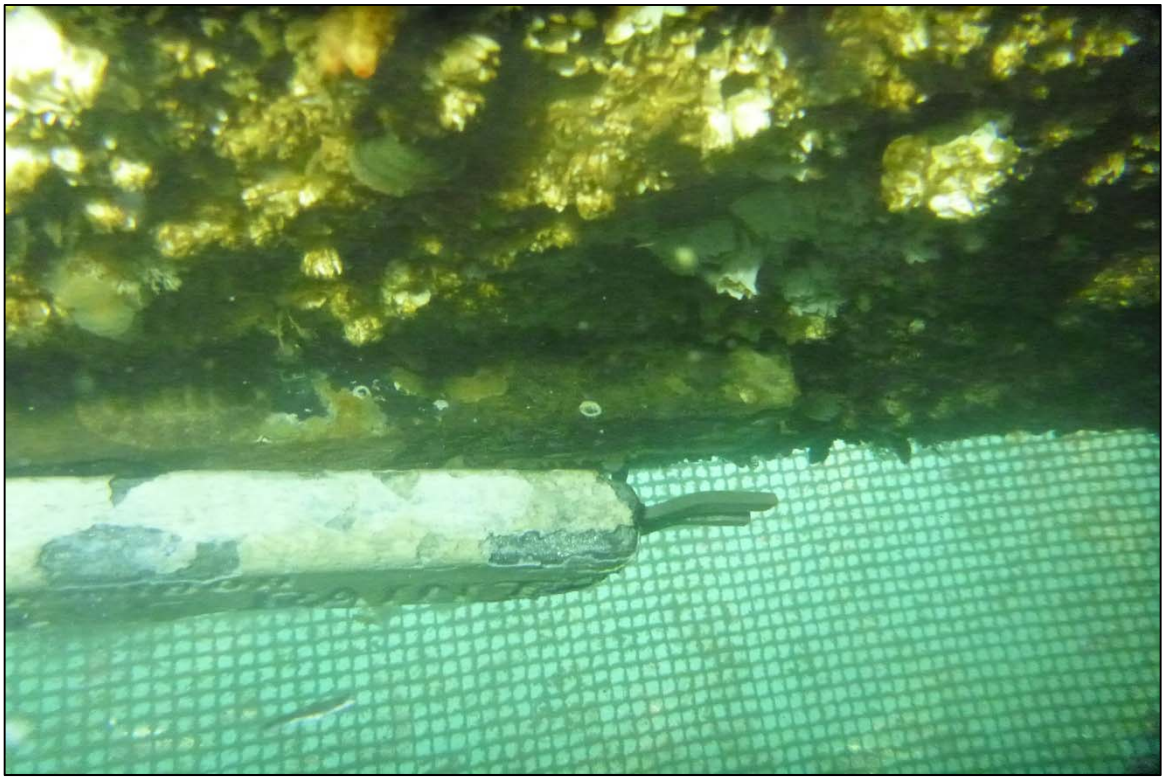
Photograph 4: Overall View of the Orchard Rocks South Fish Net Pens System, Looking West.

Photograph 5: Overall View of the Orchard Rocks South Fish Net Pens System, Looking Northeast.

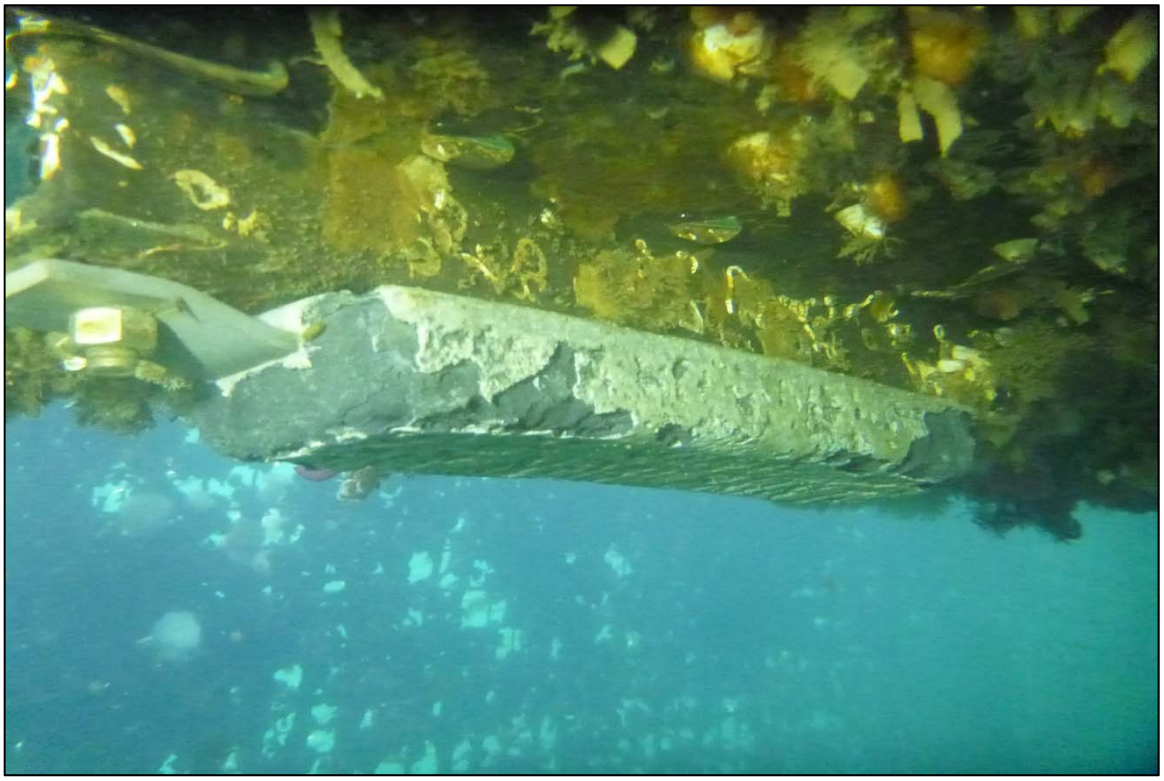
Photograph 6: Overall View of the Orchard Rocks South Fish Net Pens System, Looking East.



Photograph 7: View of the Steel Pontoon Condition at Orchard Rocks North Fish Net Pens System, Looking North.



Photograph 8: View of Missing Connection of the Anode on the Steel Pontoons at Orchard Rocks North Fish Net Pens System, Looking Northwest.



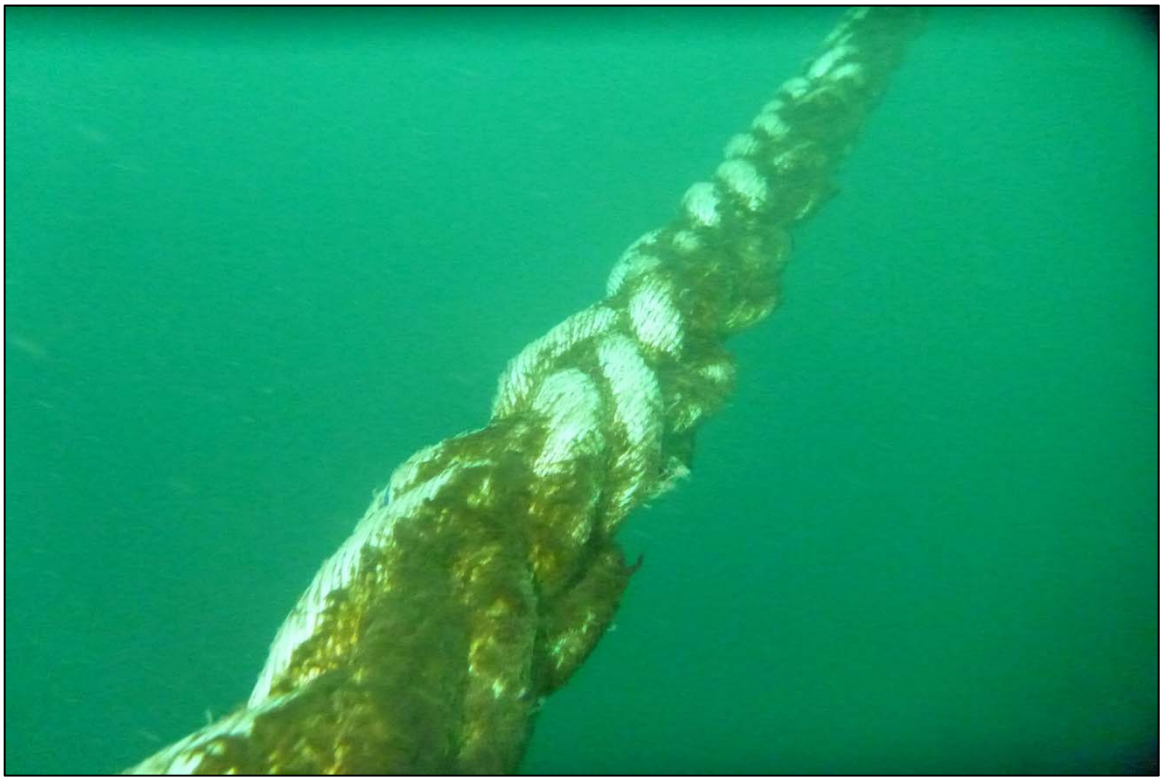
Photograph 9: View of the Bolted Style Anode Condition on the Steel Pontoons at Orchard Rocks North Fish Net Pens System, Looking Northwest.

Photograph 10: View of Upper Anchor Chain to Float Connection at Orchard Rocks North Anchor Line 2, Looking West.

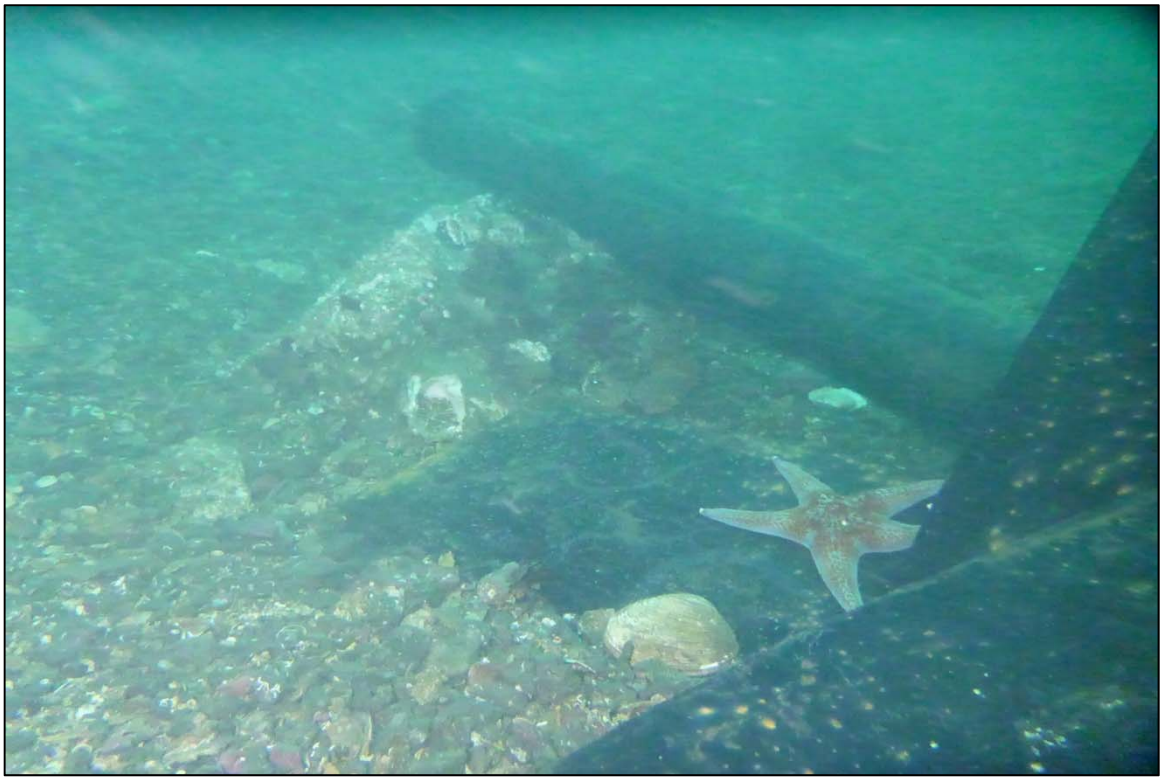
Photograph 11: View of Upper Anchor Chain to Float Connection at Orchard Rocks North Anchor Line 9, Looking East.

Photograph 12: View of Upper Anchor Chain to Float Connection at Orchard Rocks North Anchor Line 12, Looking East.

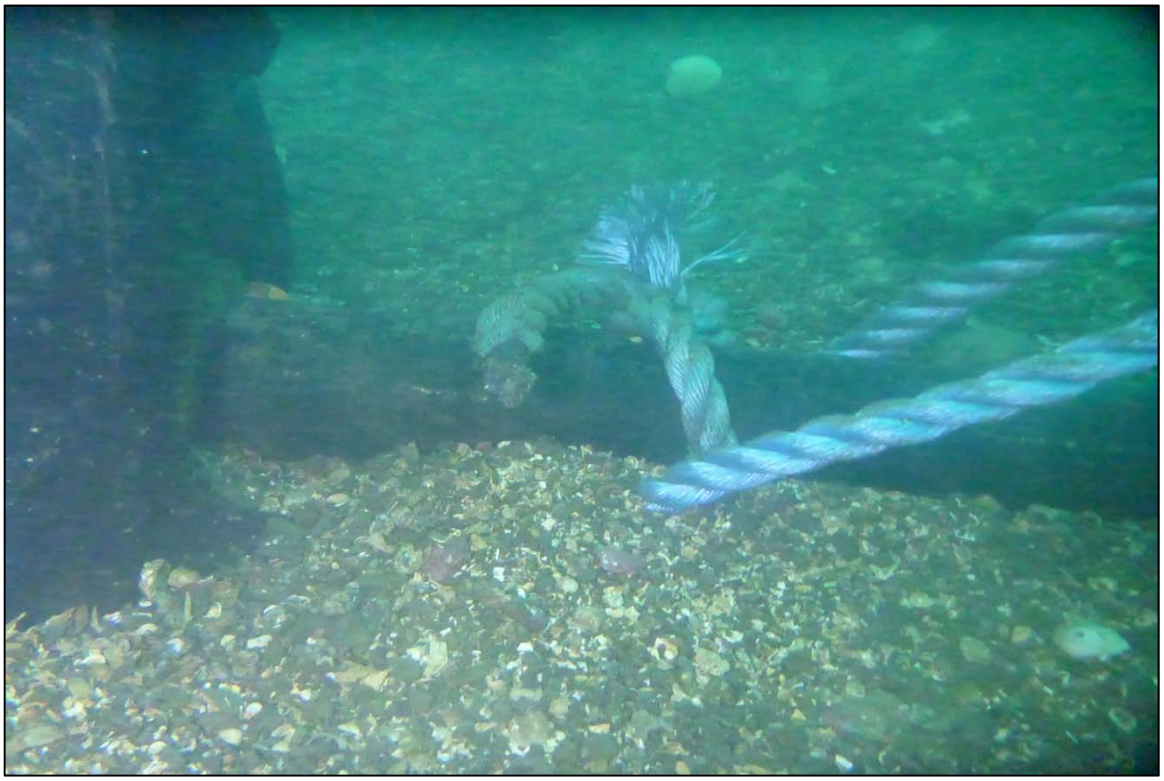
Photograph 13: View of Upper Anchor Chain to Rope Connection (Shackle and Thimble) Orchard Rocks North Anchor Line 1, Looking Northeast.



Photograph 14: View of Rope Condition with Light Marine Growth at Orchard Rocks North Anchor Line 1, Looking East.

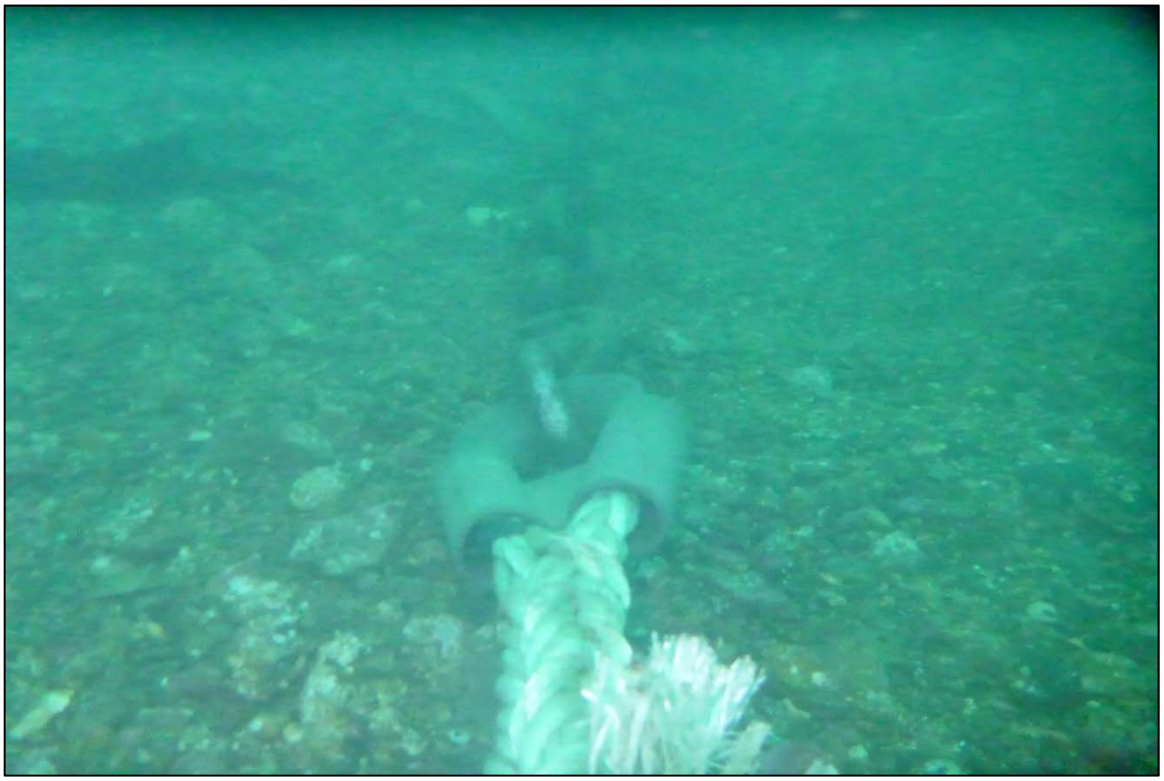


Photograph 15: View of Anchor North Fluke Embedment at Orchard Rocks North Anchor Line 1, Looking Northeast.



Photograph 16: View of Anchor Fluke Embedment at Orchard Rocks North Anchor Line 1, Looking East.

Photograph 17: View of Upper Anchor Chain to Rope Connection (Shackle and Thimble) at Orchard Rocks North Anchor Line 2, Looking West.



Photograph 18: View of Rope to Lower Anchor Chain Connection (Shackle and Thimble) at Orchard Rocks North Anchor Line 2, Looking East.

Photograph 19: View of Anchor Embedment in the Channel Bottom at Orchard Rocks North Anchor Line 2, Looking East.

Photograph 20: View of Upper Anchor Chain to Float Connection with Severe Corrosion at Orchard Rocks North Anchor Line 3, Looking West.

Photograph 21: View of Upper Anchor Chain Condition with Heavy Marine Growth at Orchard Rocks North Anchor Line 3, Looking North.

Photograph 22: View of Rope to Lower Anchor Chain Connection (Shackle) with Severe Corrosion and Thread Loss on the Bolt at Orchard Rocks North Anchor Line 3, Looking North.

Photograph 23: View of Lower Anchor Chain Condition at Orchard Rocks North Anchor Line 3, Looking North.

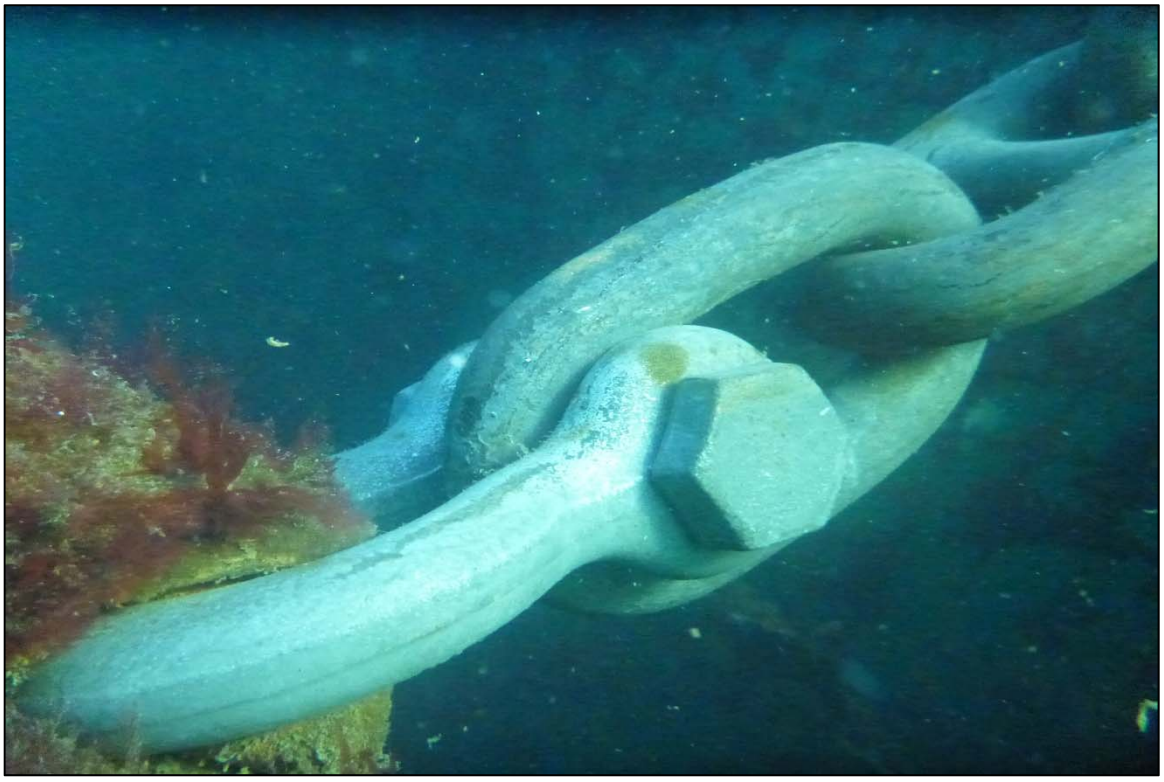
Photograph 24: View of Upper Anchor Chain Condition with Heavy Corrosion and Delamination at Orchard Rocks North Anchor Line 4, Looking West.

Photograph 25: View of Upper Anchor Chain Shackle with up to 75% Section Loss at Orchard Rocks North Anchor Line 4, Looking North.

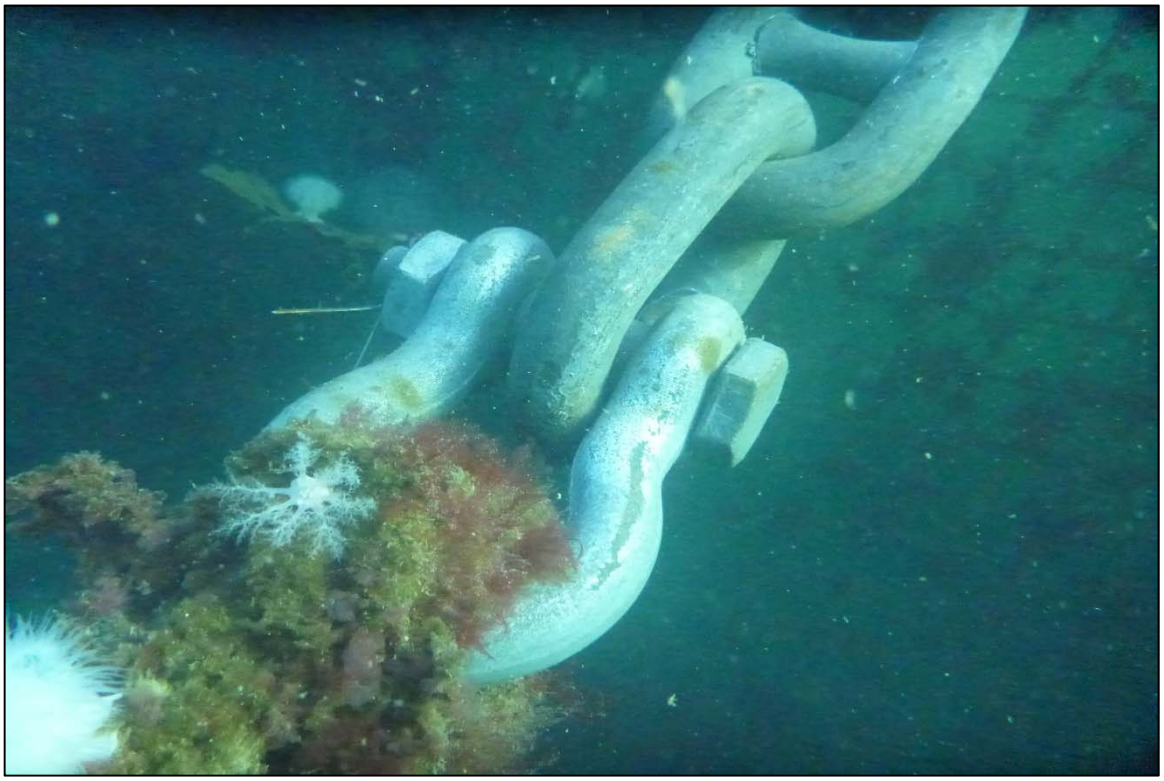
Photograph 26: View of Rope Condition with Heavy Marine Growth at Orchard Rocks North Anchor Line 4, Looking Northeast.

Photograph 27: View of Rope to Lower Anchor Chain Connection (Shackle and Thimble) at Orchard Rocks North Anchor Line 5, Looking East.

Photograph 28: View of Lower Anchor Chain on the Channel Bottom at Orchard Rocks North Anchor Line 5, Looking East.

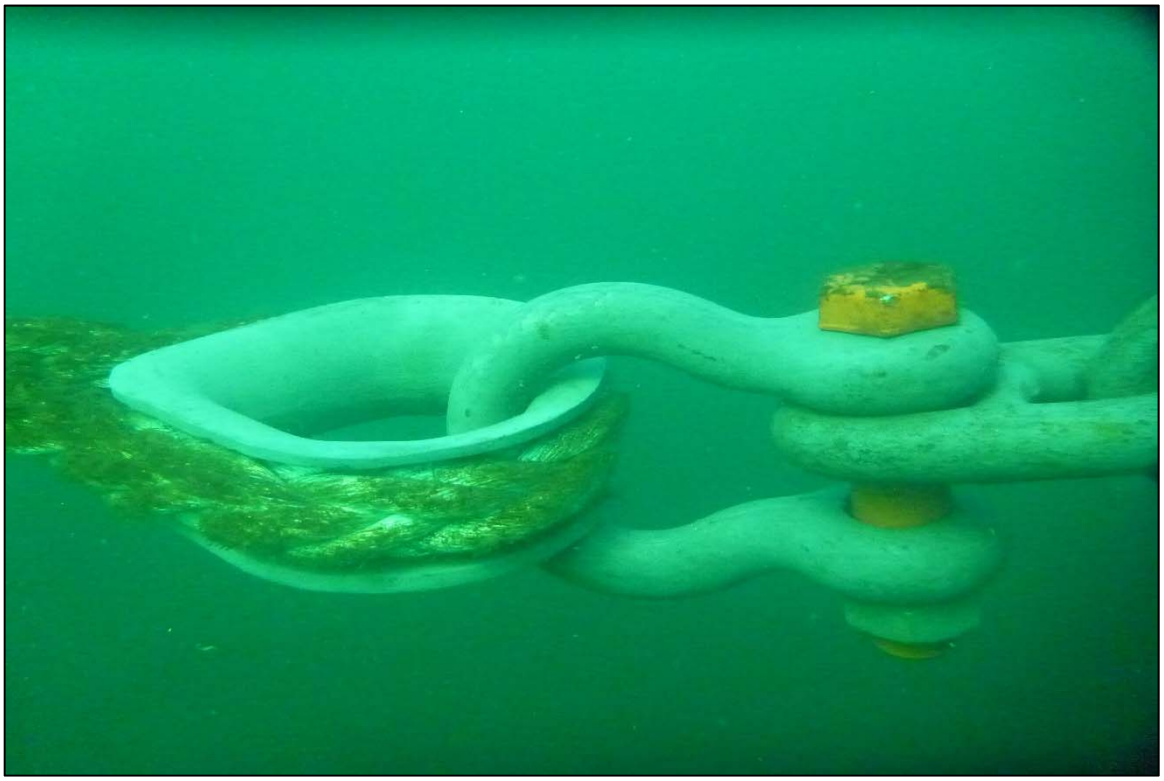


Photograph 29: View of Upper Anchor Chain Condition at Orchard Rocks North Anchor Line 9, Looking North.



Photograph 30: View of Lower Anchor Chain to Rope Connection (Shackle) at Orchard Rocks North Anchor Line 9, Looking East.

Photograph 31: View of Rope to Lower Anchor Chain Connection (Shackle and Sleeve) at Orchard Rocks North Anchor Line 9, Looking North.

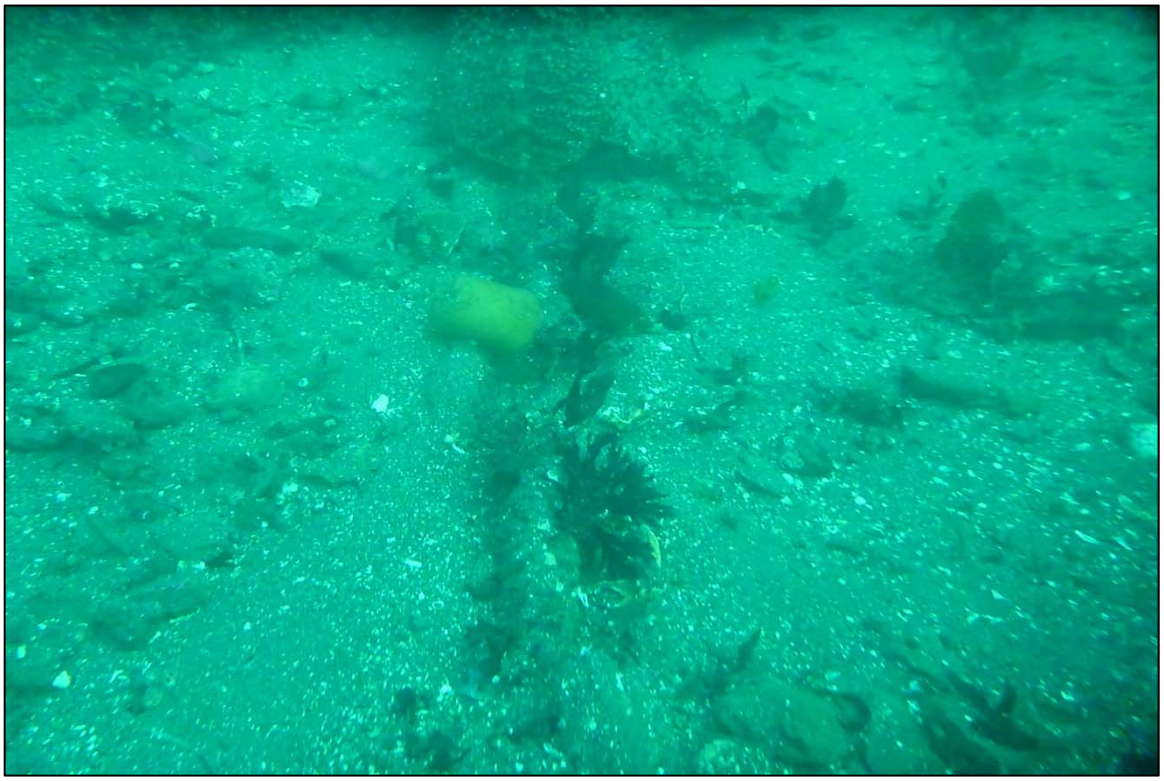


Photograph 32: View of Upper Anchor Chain to Rope Connection (Shackle and Thimble) at Orchard Rocks North Anchor Line 10, Looking North.

Photograph 33: View of Rope Condition with Light Marine Growth at Orchard Rocks North Anchor Line 10, Looking Northwest.

Photograph 34: View of Lower Anchor Chain on Channel Bottom at Orchard Rocks North Anchor Line 10, Looking West.

Photograph 35: View of Light Marine Growth on the Upper Anchor Chain at Orchard Rocks North Anchor Line 11, Looking North.

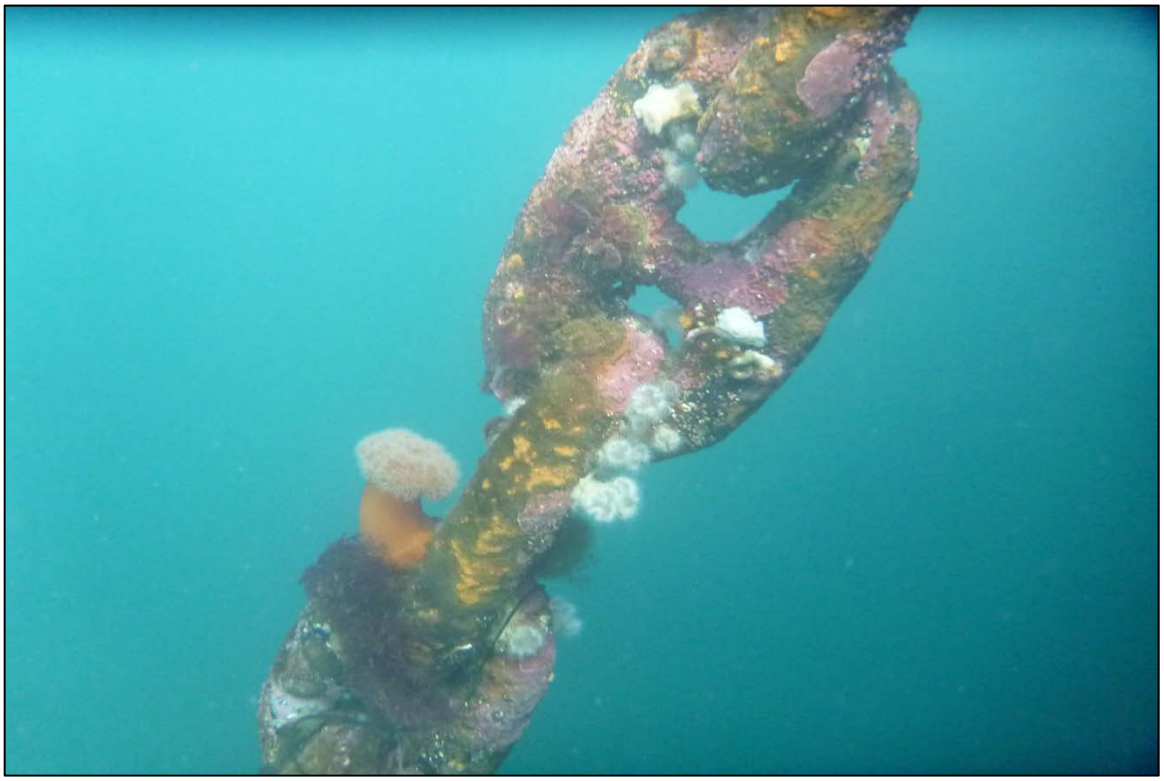


Photograph 36: View of Lower Anchor Chain Embedment at Orchard Rocks North Anchor Line 11, Looking West.

Photograph 37: View of the Anchor on the Channel Bottom at Orchard Rocks North Anchor Line 36, Looking West.

Photograph 38: View of Upper Anchor Chain Condition at Orchard Rocks North Anchor Line 13, Looking East.

Photograph 39: View of the Rope to Lower Anchor Chain (Shackle and Sleeve) at Orchard Rocks North Anchor Line 12, Looking Northeast.



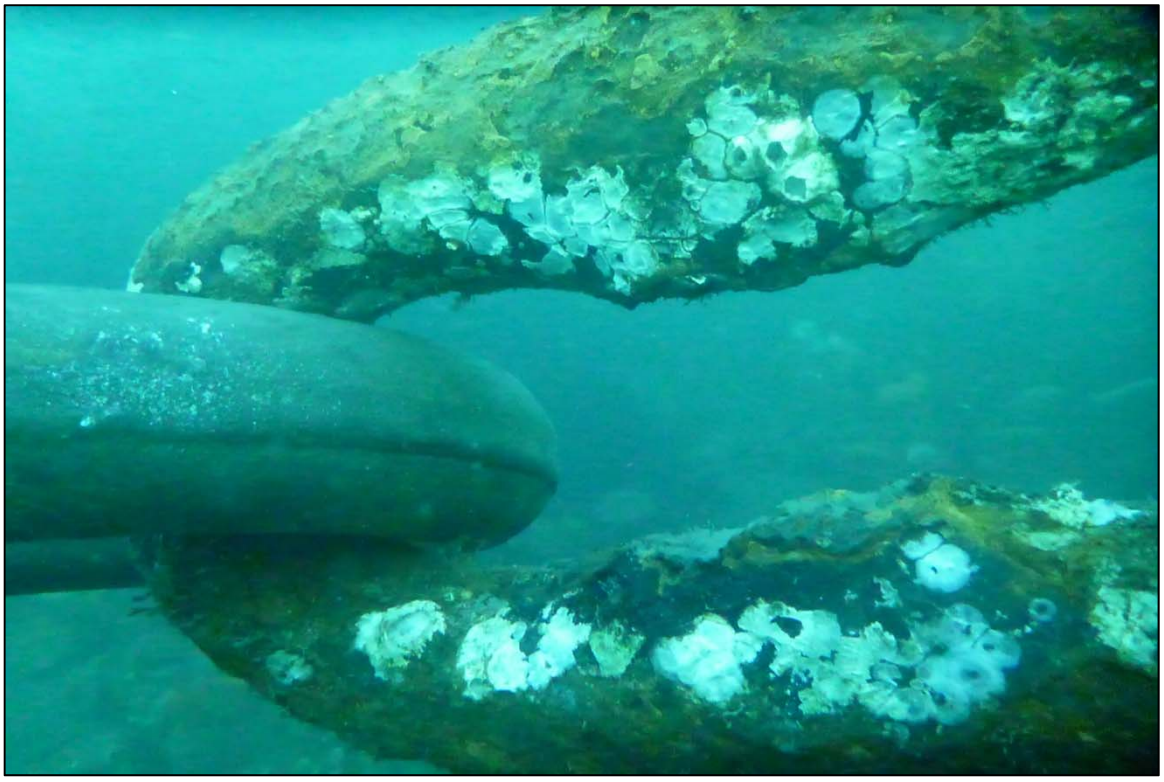
Photograph 40: View of Upper Anchor Chain Condition at Orchard Rocks North Anchor Line 13, Looking East.

Photograph 41: View of Lower Anchor to Anchor Connection at Orchard Rocks North Anchor Line 13, Looking Northwest.

Photograph 42: View of Pipe Anchor Condition at Orchard Rocks North Anchor Line 13, Looking North.

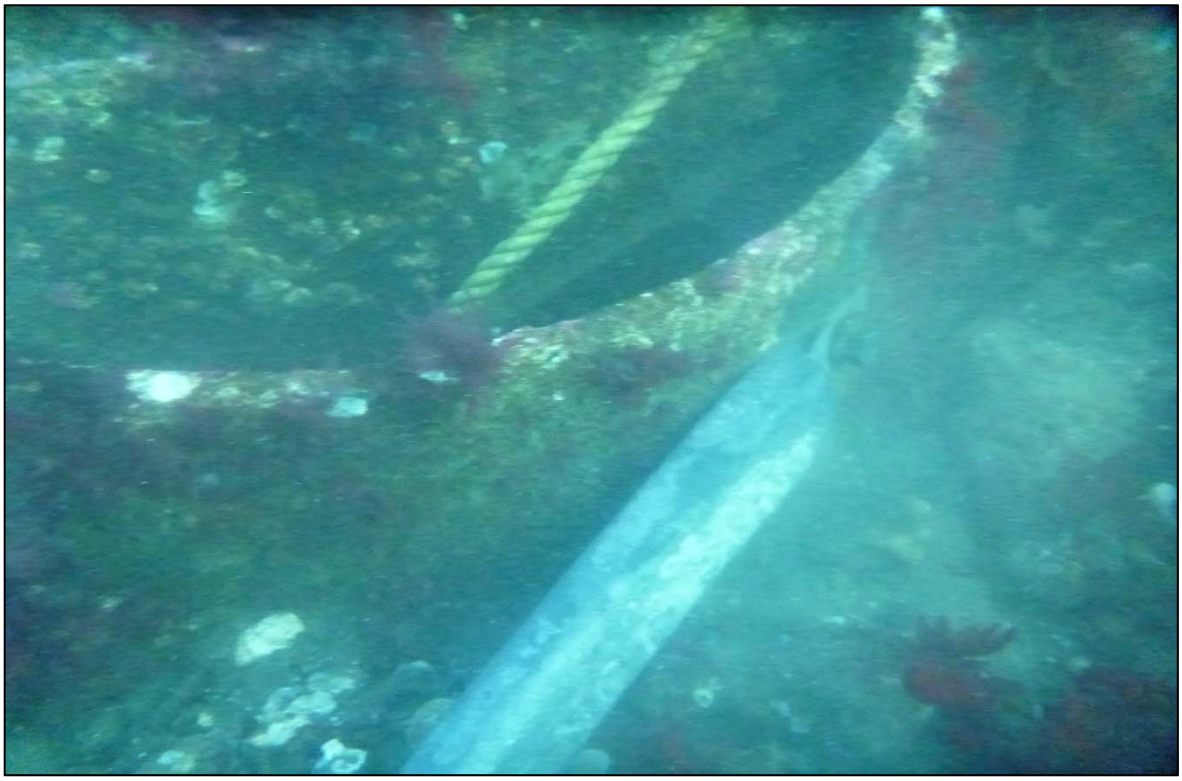
Photograph 43: View of Shackle Connection in the Anchor Chain at Orchard Rocks North Anchor Line 14, Looking Northeast.

Photograph 44: View of Anode at the Pipe Anchor at Orchard Rocks North Anchor Line 14, Looking West.



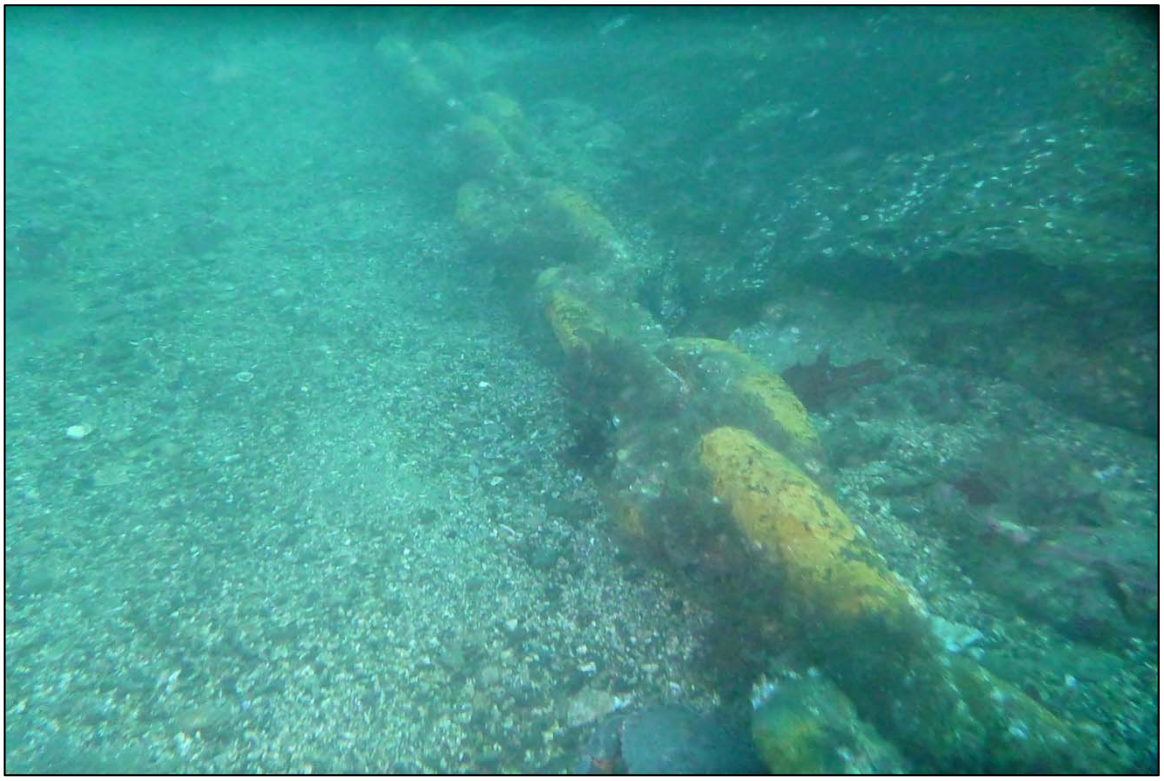
Photograph 45: View of Section Loss and Missing Stud in the Anchor Chain at Orchard Rocks North Anchor Line 15, Looking East.

Photograph 46: View of the Anchor Chain to Pipe Anchor Connection at Orchard Rocks North Anchor Line 15, Looking East.

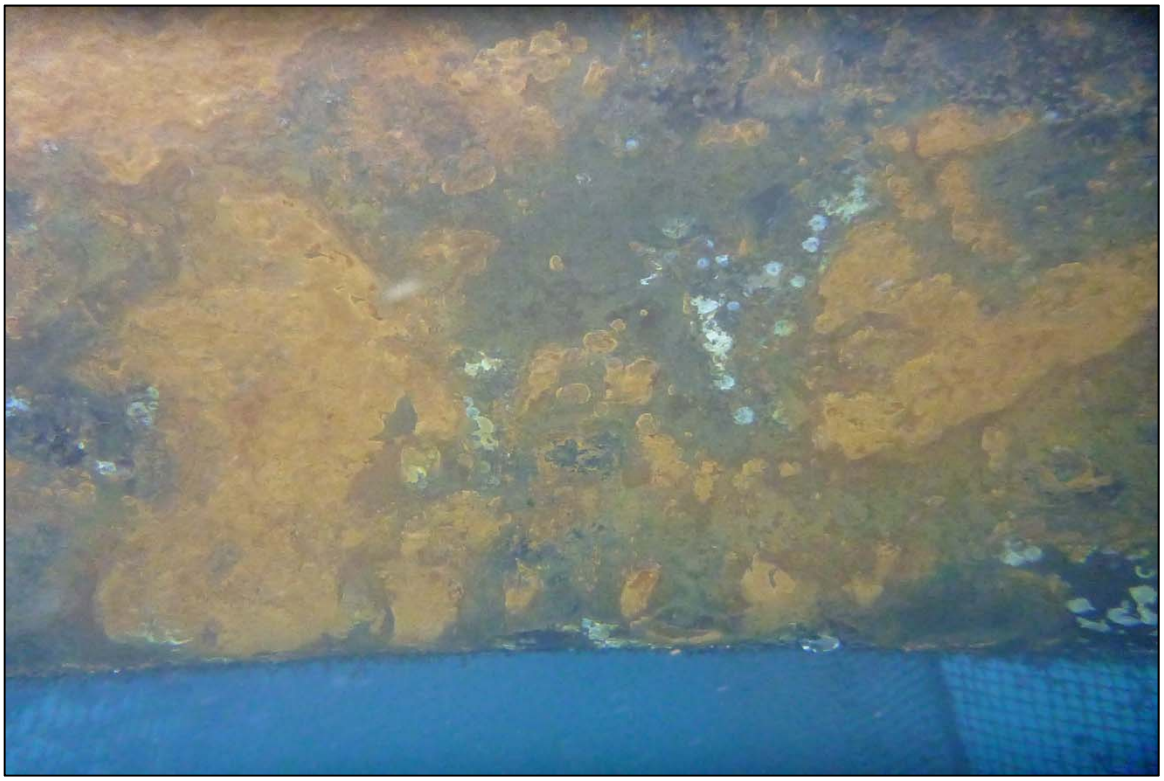


Photograph 47: View of Anode at the Pipe Anchor at Orchard Rocks North Anchor Line 15, Looking East.

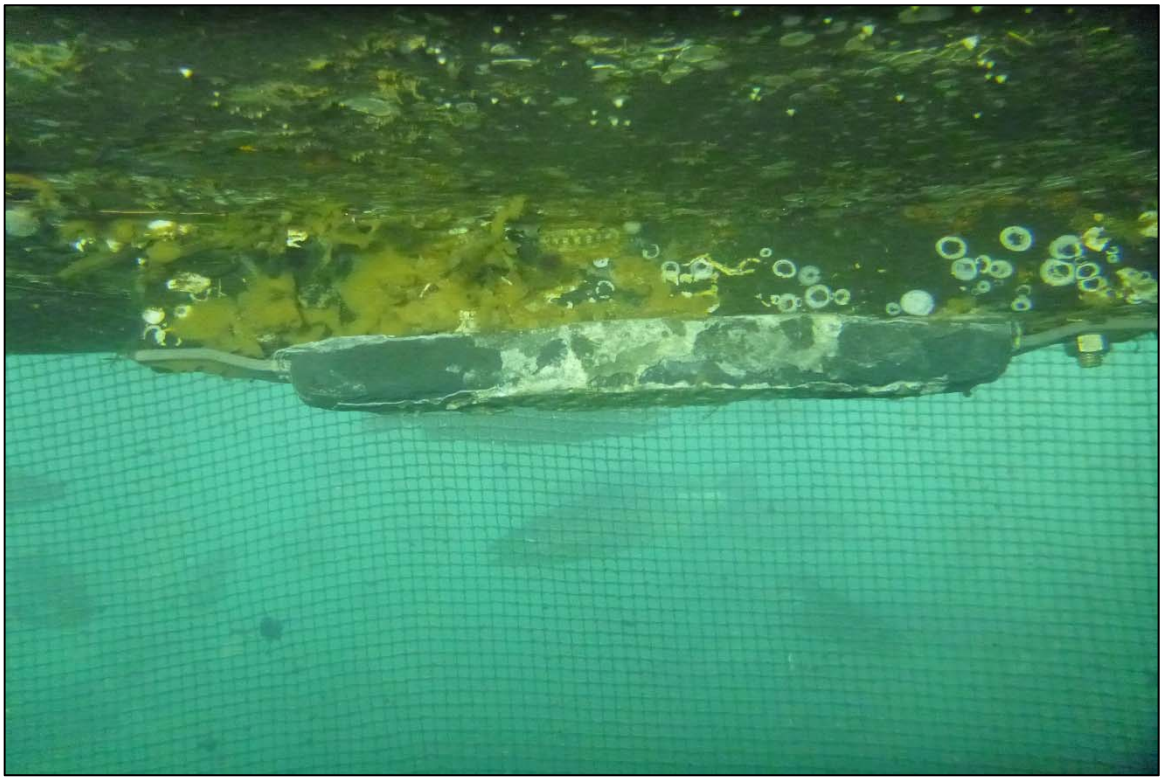
Photograph 48: View of Lower Anchor Shackle with Heavy Corrosion and Section Loss at Orchard Rocks North Anchor Line 16, Looking North.



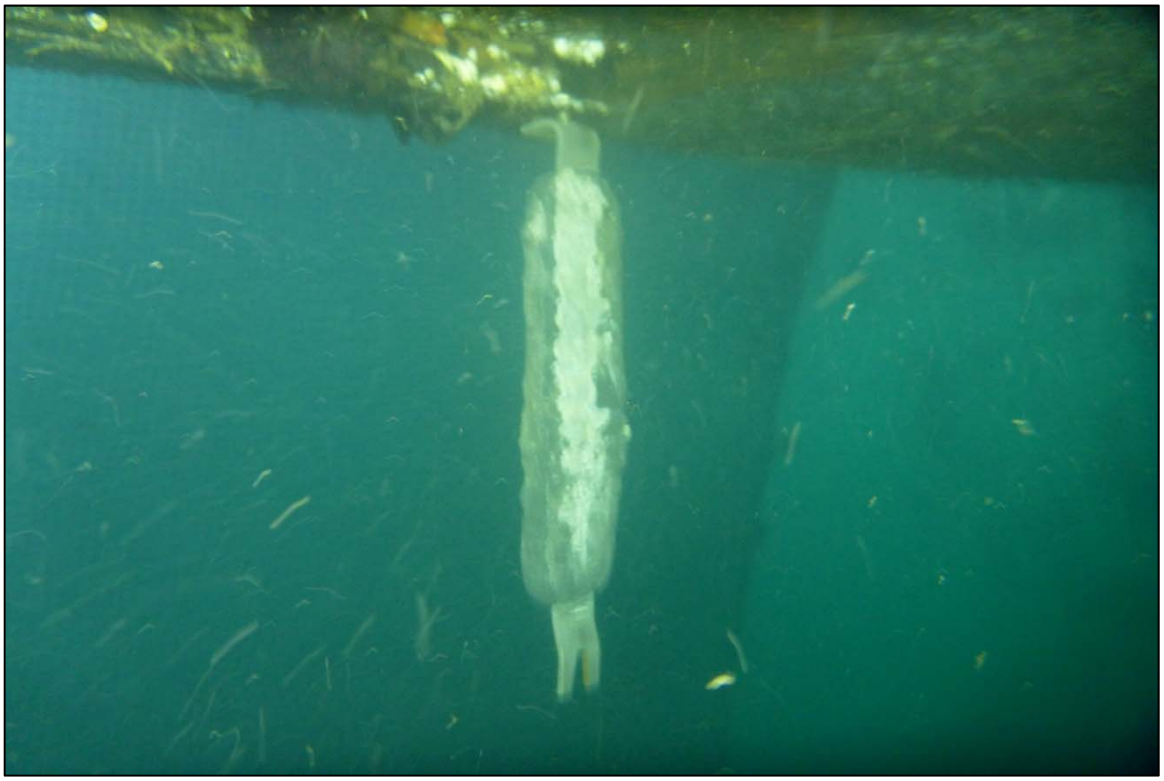
Photograph 49: View of the Anchor Chain on the Channel Bottom at Orchard Rocks North Anchor Line 16, Looking North.



Photograph 50: View of the Steel Pontoon Condition at Orchard Rocks South Fish Net Pens System, Looking South.

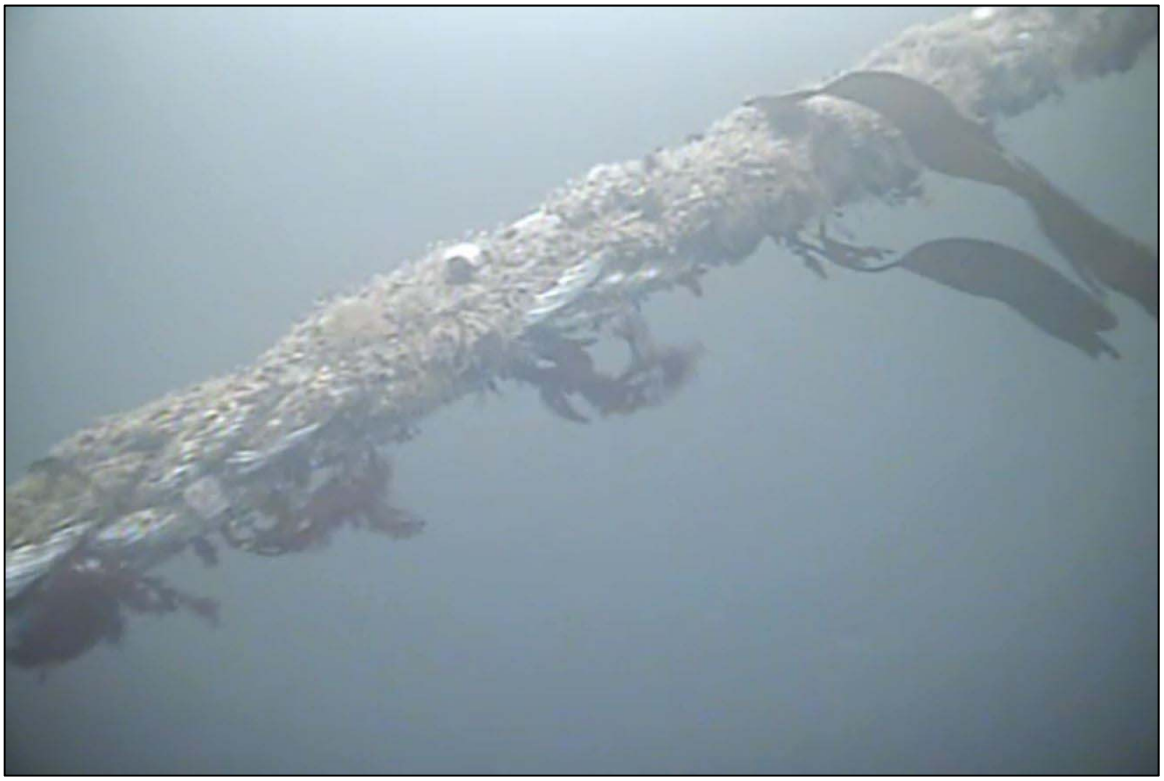


Photograph 51: View of the Bolted Style Anode Condition on the Steel Pontoons at Orchard Rocks South Fish Net Pens System, Looking South.



Photograph 52: View of the Partially Detached Anode Condition on the Steel Pontoons at Orchard Rocks South Fish Net Pens System, Looking North.

Photograph 53: View of Upper Anchor Chain to Float Connection at Orchard Rocks South Anchor Line 3, Looking West.



Photograph 54: View of Light Marine Growth on the Rope at Orchard Rocks South Anchor Line 1, Looking South.

Photograph 55: View of Rope to Lower Anchor Chain Connection (Shackle and Thimble) at Orchard Rocks South Anchor Line 1, Looking East.

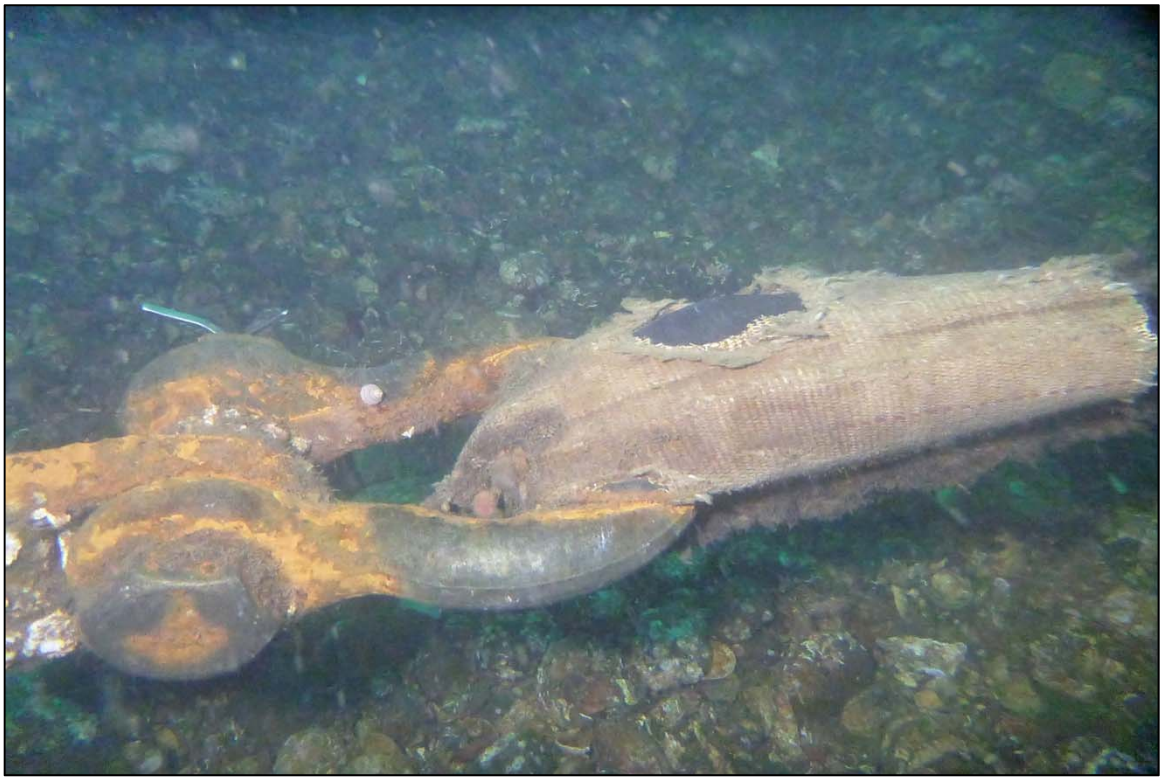
Photograph 56: View of Upper Chain Condition at Orchard Rocks South Anchor Line 2, Looking East.

Photograph 57: View of Upper Chain to Rope Connection (Shackle) at Orchard Rocks South Anchor Line 2, Looking South.

Photograph 58: View of Heavy Marine Growth on the Rope at Orchard Rocks South Anchor Line 2, Looking Southeast.

Photograph 59: View of Rope to Lower Anchor Chain Connection (Shackle and Sleeve) with Missing Nut and Cotter Pin at Orchard Rocks South Anchor Line 2, Looking South.

Photograph 60: View of Upper Anchor Chain to Rope Connection (Shackle and Sleeve) with Missing Cotter Pin at Orchard Rocks South Anchor Line 3, Looking South.



Photograph 61: View of Rope to Lower Anchor Chain (Shackle and Sleeve) at Orchard Rocks South Anchor Line 3, Looking South.

Photograph 62: View of Lower Anchor Chain on the Channel Bottom at Orchard Rocks South Anchor Line 3, Looking South.

Photograph 63: View of Upper Anchor Chain to Float Connection at Orchard Rocks South Anchor Line 4, Looking West.

Photograph 64: View of Upper Anchor Chain to Anchor Rope Connection (Shackle) at Orchard Rocks South Anchor Line 4, Looking West.

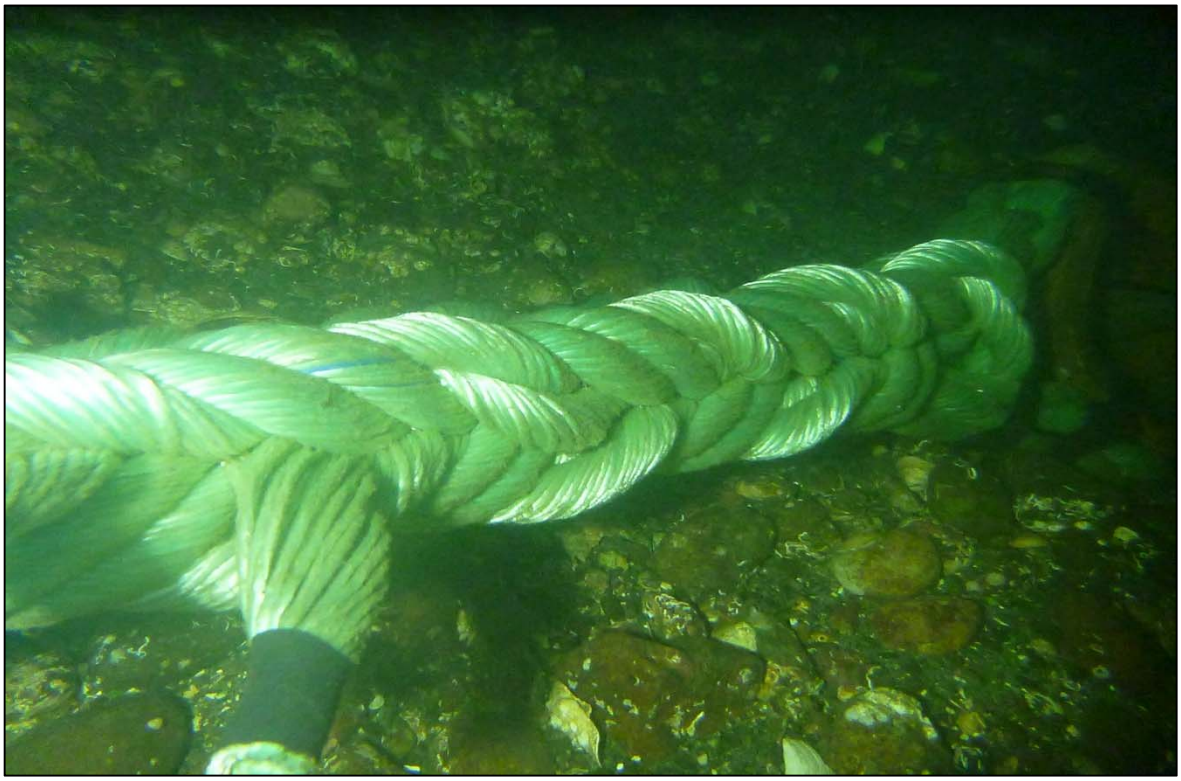
Photograph 65: View of Secure Lower Anchor Chain to Float Connection at Orchard Rocks South Anchor Line 4, Looking West.

Photograph 66: View of Upper Anchor Chain Moderate Marine Growth at Orchard Rocks South Anchor Line 5, Looking South.

Photograph 67: View of Lower Anchor Chain Moderate Corrosion at Orchard Rocks South Anchor Line 5, Looking East.

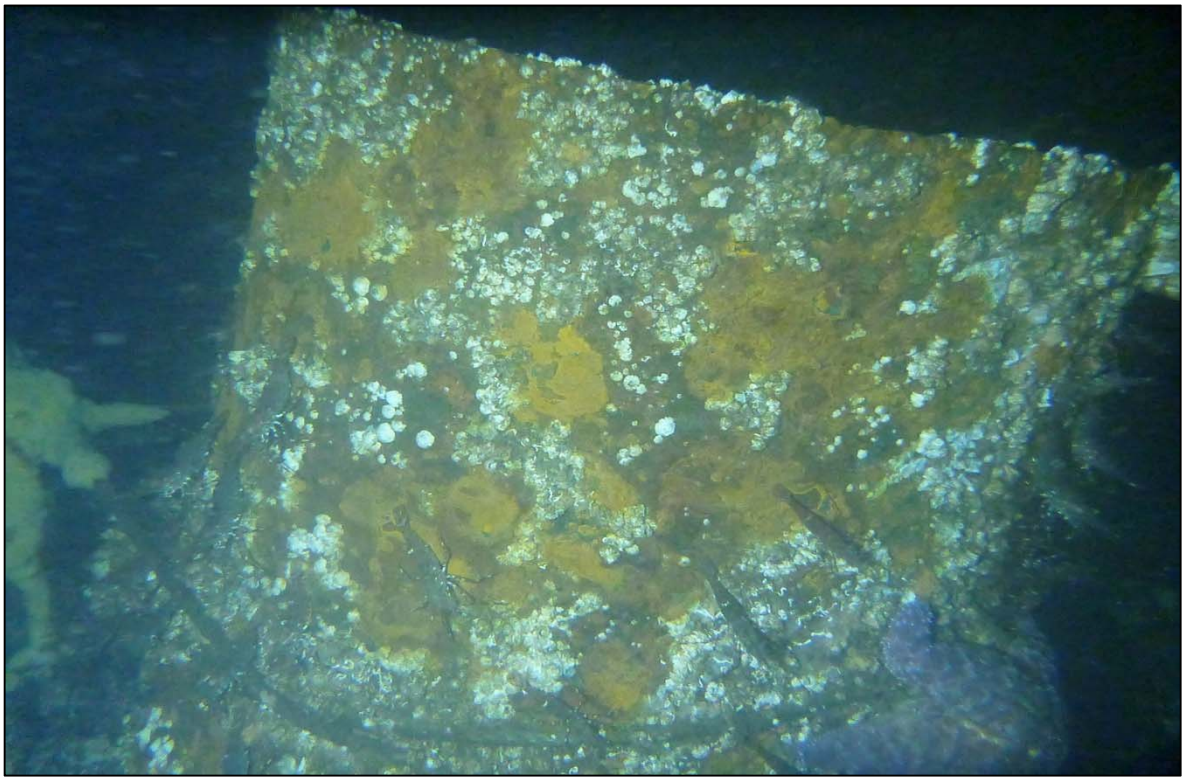
Photograph 68: View of Lower Anchor Chain to Anchor Rope Connection at Orchard Rocks South Anchor Line 5, Looking East. Bolt Head is Not Flush with Shackle indicating the bolt is likely loose.

Photograph 69: View of Upper Anchor Chain to Float Connection for Anchor 6 and 6A at Orchard Rocks South Anchor Line 4, Looking West.

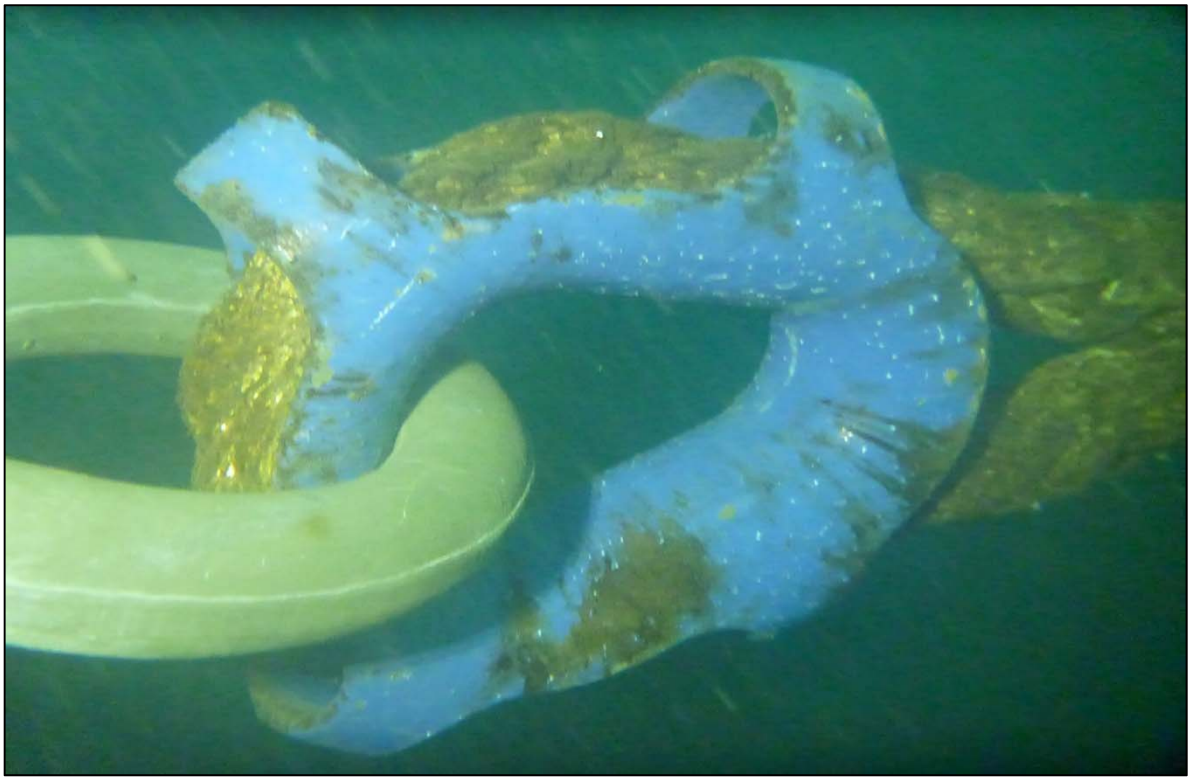


Photograph 70: View of Upper Rope Splice at Orchard Rocks South Anchor Line 6, Looking West.

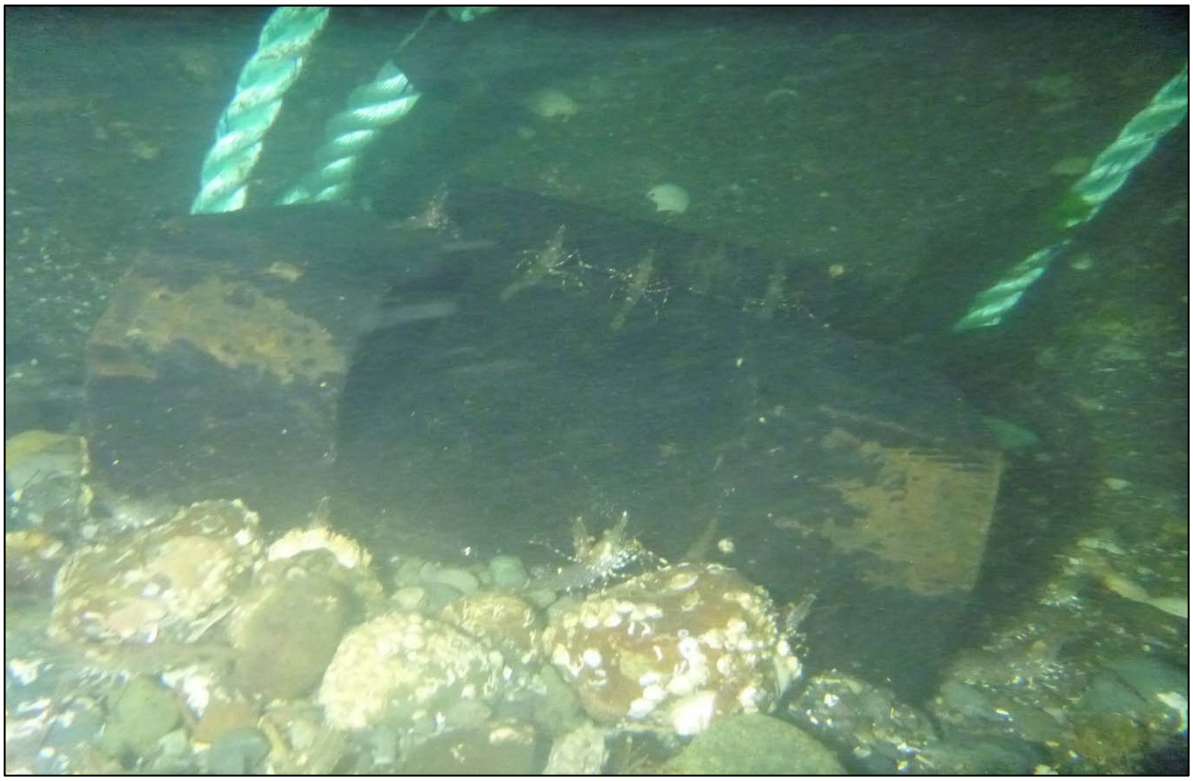
Photograph 71: View of Lower Anchor Chain to Anchor Rope Connection at Orchard Rocks South Anchor Line 6, Looking West.



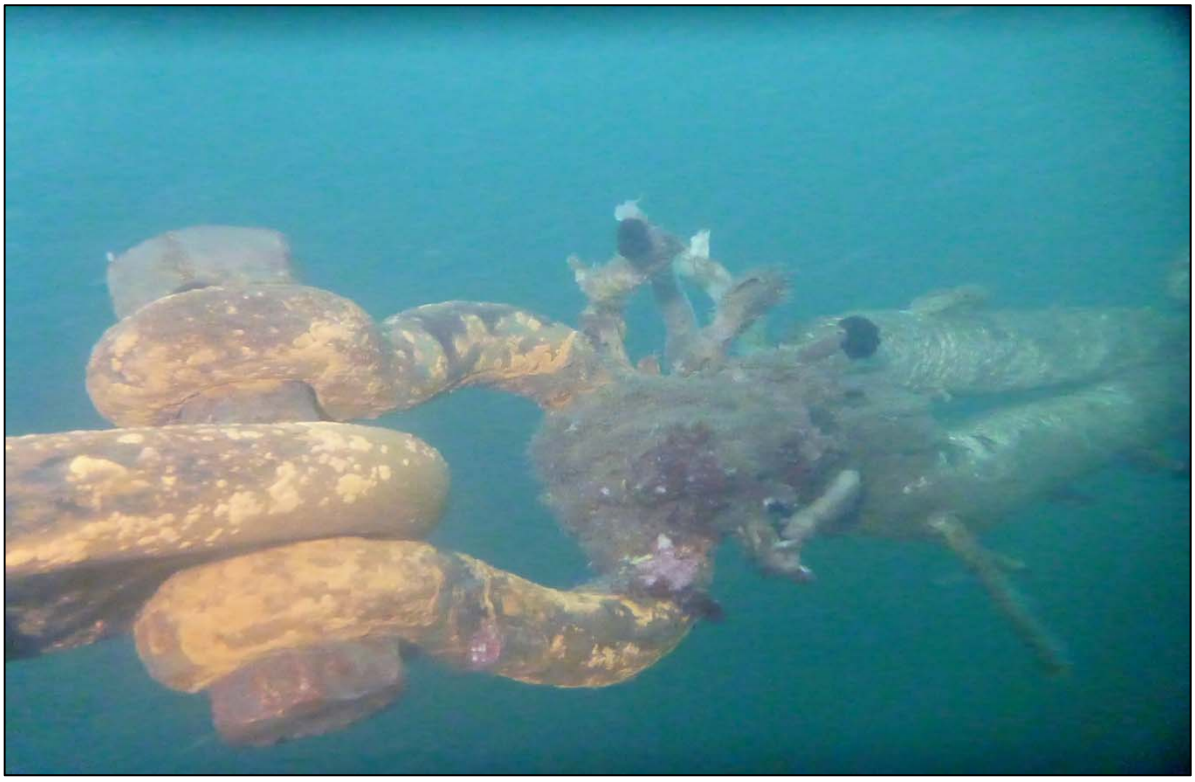
Photograph 72: View of Pipe Anchor at Orchard Rocks South Anchor Line 6, Looking East.



Photograph 73: View of Upper Anchor Chain to Anchor Rope Connection (Thimble and Shackle) at Orchard Rocks South Anchor Line 6A, Looking West.



Photograph 74: View of Top of Danforth Anchor at Orchard Rocks South Anchor Line 6A, Looking West.



Photograph 75: View of Upper Anchor Chain to Anchor Line Connection (Shackle and Lashing) at Orchard Rocks South Anchor Line 7, Looking South.

Photograph 76: View of Upper Anchor Chain to Float Connection Moderate Corrosion at Orchard Rocks South Anchor Line 7, Looking West.

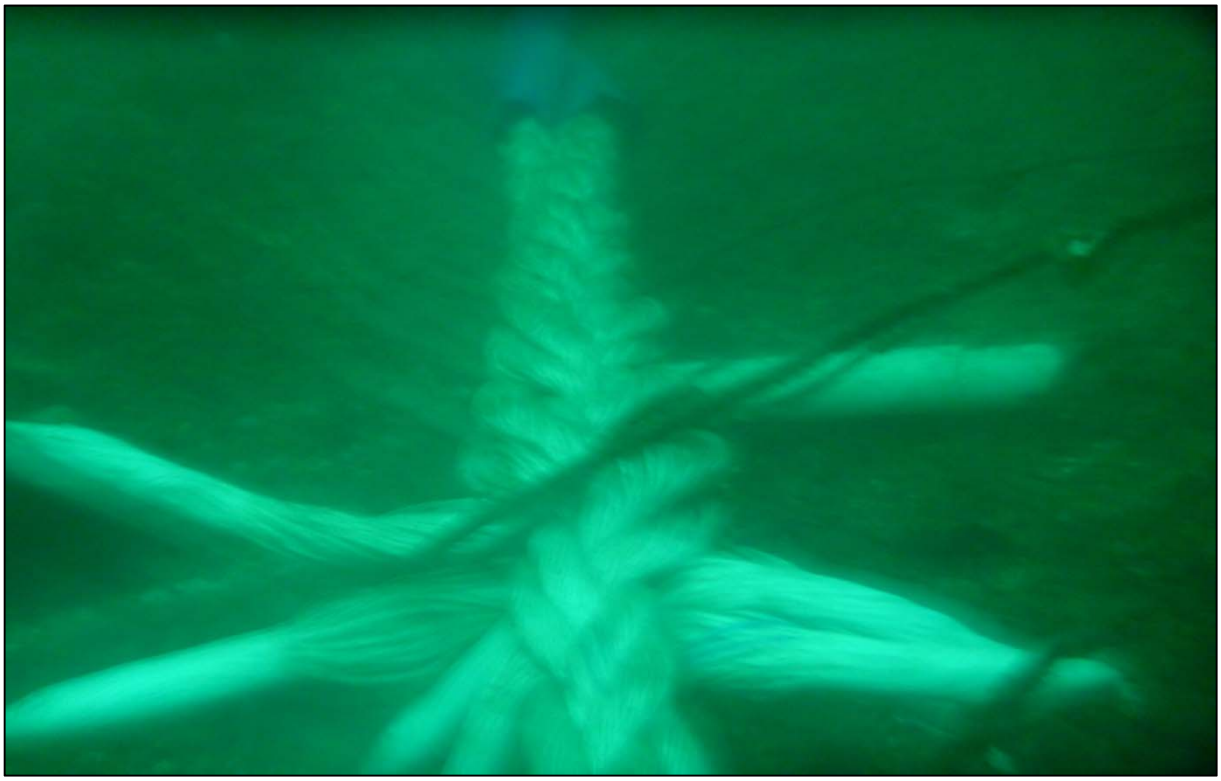
Photograph 77: View of Lower Anchor Chain to Anchor Rope Connection with Lashing at Orchard Rocks South Anchor Line 7, Looking South.

Photograph 78: View of Lower Anchor Chain to Anchor Rope Connection (Lashing) at Orchard Rocks South Anchor Line 8, Looking South.

Photograph 79: View of Upper Anchor Chain Connection at Orchard Rocks South Anchor Line 10, Looking South.

Photograph 80: View of Upper Anchor Chain to Anchor Line Connection (Shackle and Lashing) at Orchard Rocks South Anchor Line 10, Looking South.

Photograph 81: View of Lower Anchor Chain to Anchor Connection (Shackle) at Orchard Rocks South Anchor Line 10, Looking South.



Photograph 82: View of Lower Anchor Rope Splice at Orchard Rocks South Anchor Line 11, Looking South.

Photograph 83: View of Lower Anchor Chain to Anchor Rope Connection (Shackle and PVC) at Orchard Rocks South Anchor Line 11, Looking South.

Photograph 84: View of Lower Anchor Chain to Steel Pipe Anchor at Orchard Rocks South Anchor Line 11, Looking South.

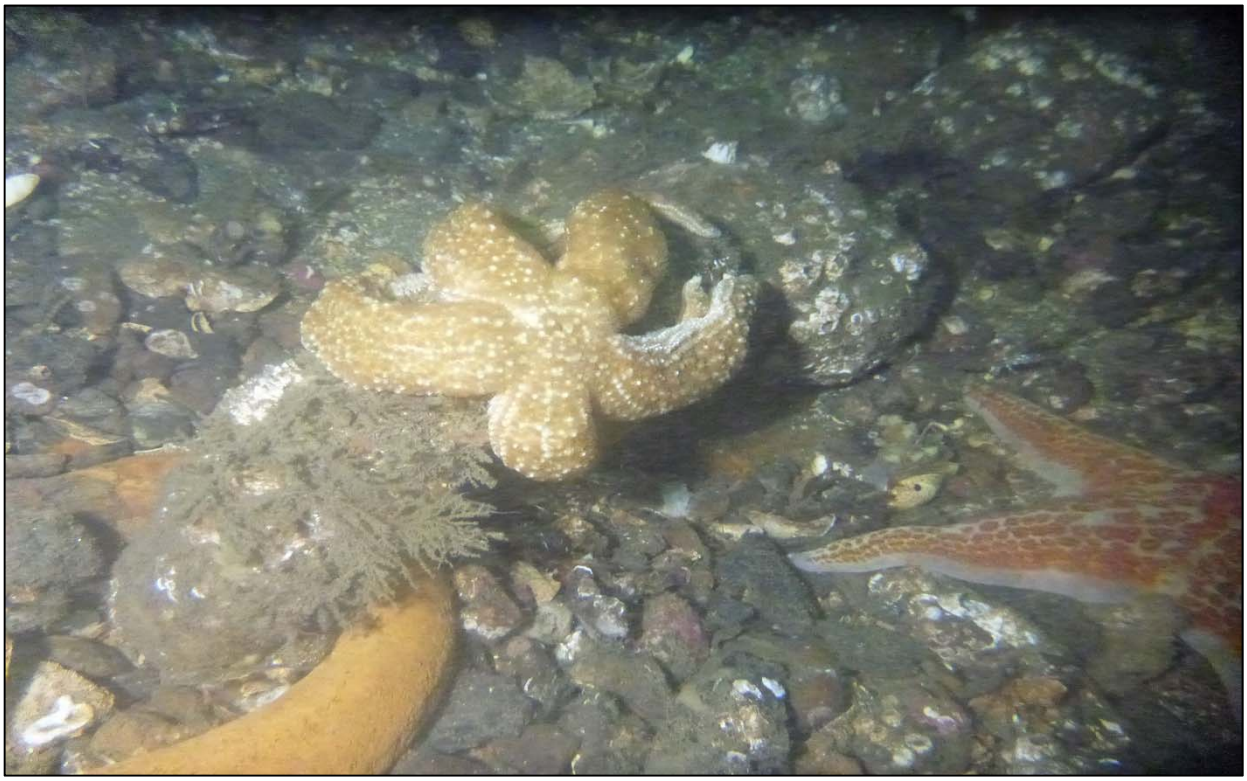
Photograph 85: View of Upper Anchor Chain at Orchard Rocks South Anchor Line 12, Looking East.

Photograph 86: View of Lower Anchor Chain Shackle at Orchard Rocks South Anchor Line 12, Looking South.

Photograph 87: View of Top of the Danforth Anchor at Orchard Rocks South Anchor Line 12, Looking East.

Photograph 88: View of Upper Anchor Chain Connection at Orchard Rocks South Anchor Line 13, Looking North.

Photograph 89: View of Lower Anchor Rope to Anchor Rope Connection (Shackle) at Orchard Rocks South Anchor Line 13, Looking South.



Photograph 90: View of Lower Anchor Chain at Orchard Rocks South Anchor Line 13, Looking South.

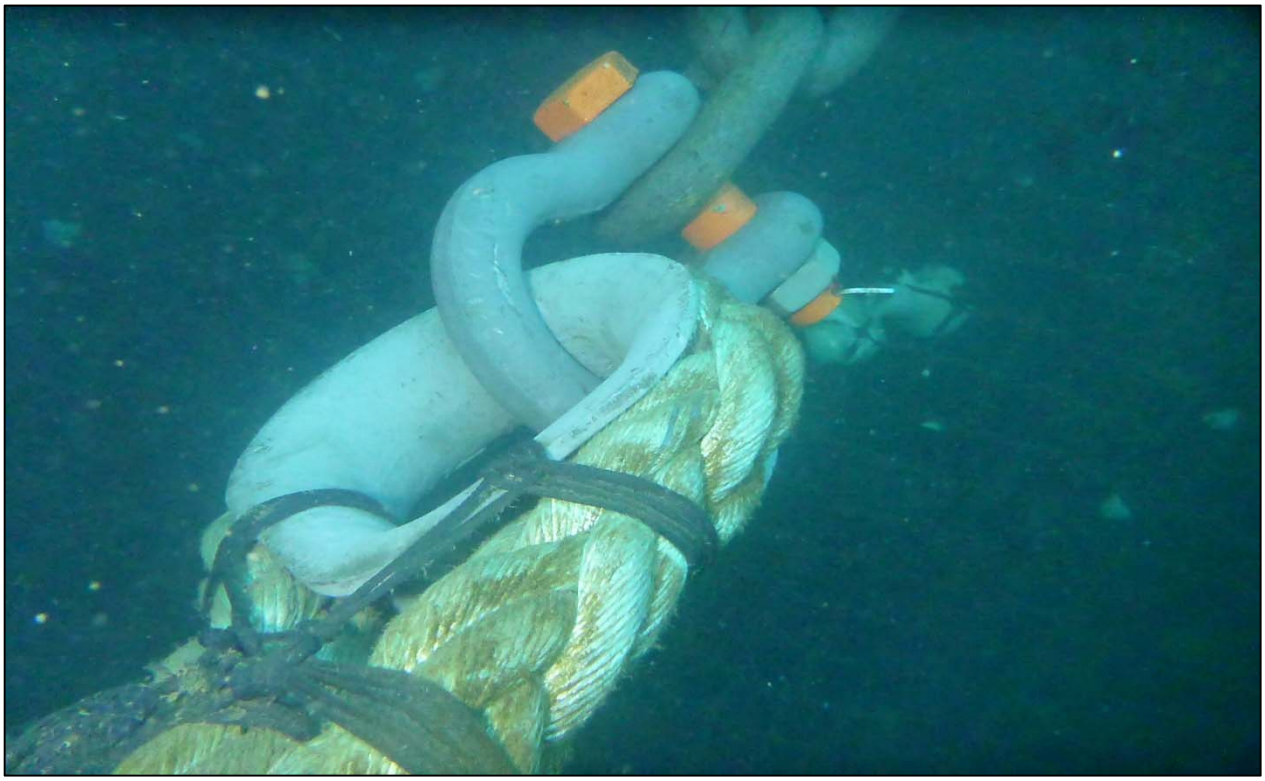
Photograph 91: View of Lower Anchor Chain to Anchor Rope Connection (Shackle and Thimble) at Orchard Rocks South Anchor Line 14, Looking West.

Photograph 92: View of Lower Anchor Chain to Anchor Connection (Shackle) at Orchard Rocks South Anchor Line 14, Looking West.

Photograph 93: View of Top of the New Anchor Rope at Orchard Rocks South Anchor Line 14, Looking West.

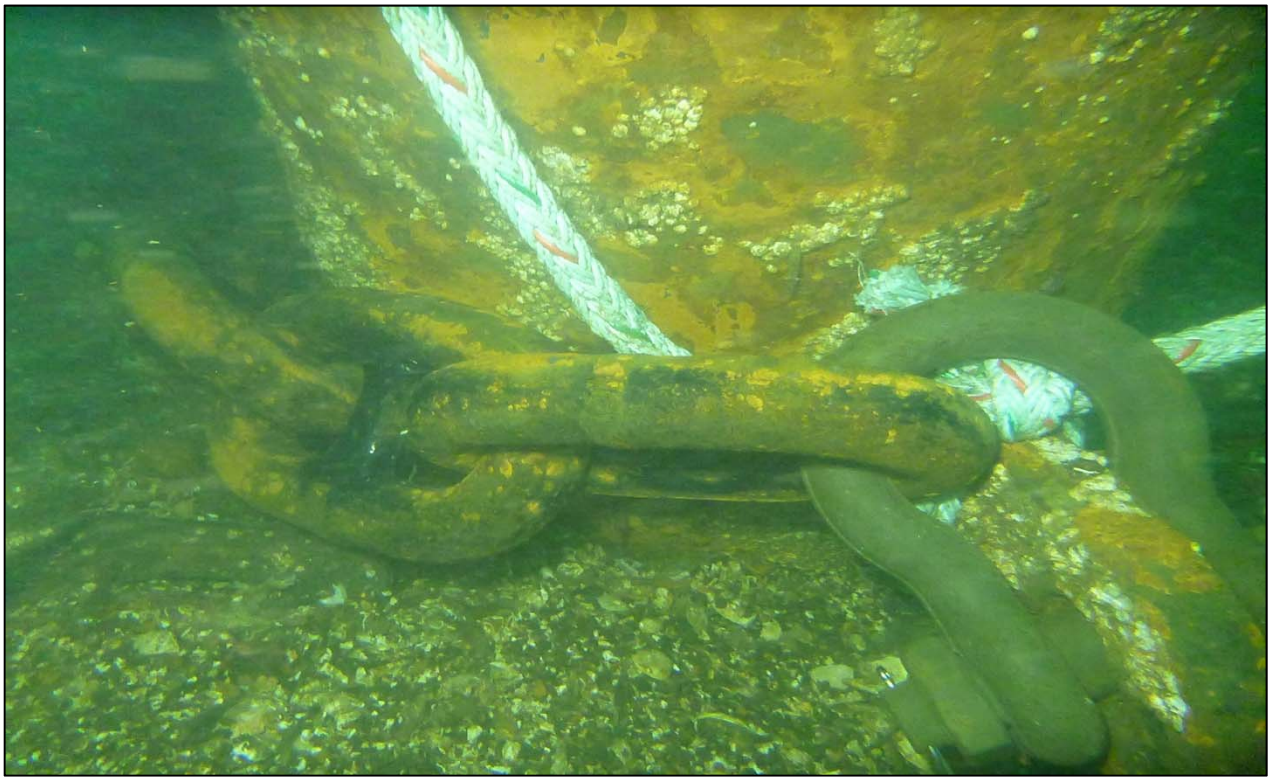
Photograph 94: View of Lower Anchor Chain 90% Buried at Orchard Rocks South Anchor Line 15, Looking South.

Photograph 95: View of Lower Anchor Rope to Anchor Rope Connection (Shackle) at Orchard Rocks South Anchor Line 15, Looking South.



Photograph 96: View of Upper Anchor Chain to Anchor Rope Connection (Shackle and Thimble) at Orchard Rocks South Anchor Line 16, Looking South.

Photograph 97: View of Lower Anchor Chain to Anchor Rope Connection (Shackle and PVC) at Orchard Rocks South Anchor Line 16, Looking North.



Photograph 98: View of Lower Anchor Rope to Pipe Anchor Connection (Shackle) at Orchard Rocks South Anchor Line 16, Looking South.

Appendix C – Photos at Rich Passage Orchard Rocks Net Pens - NORTH

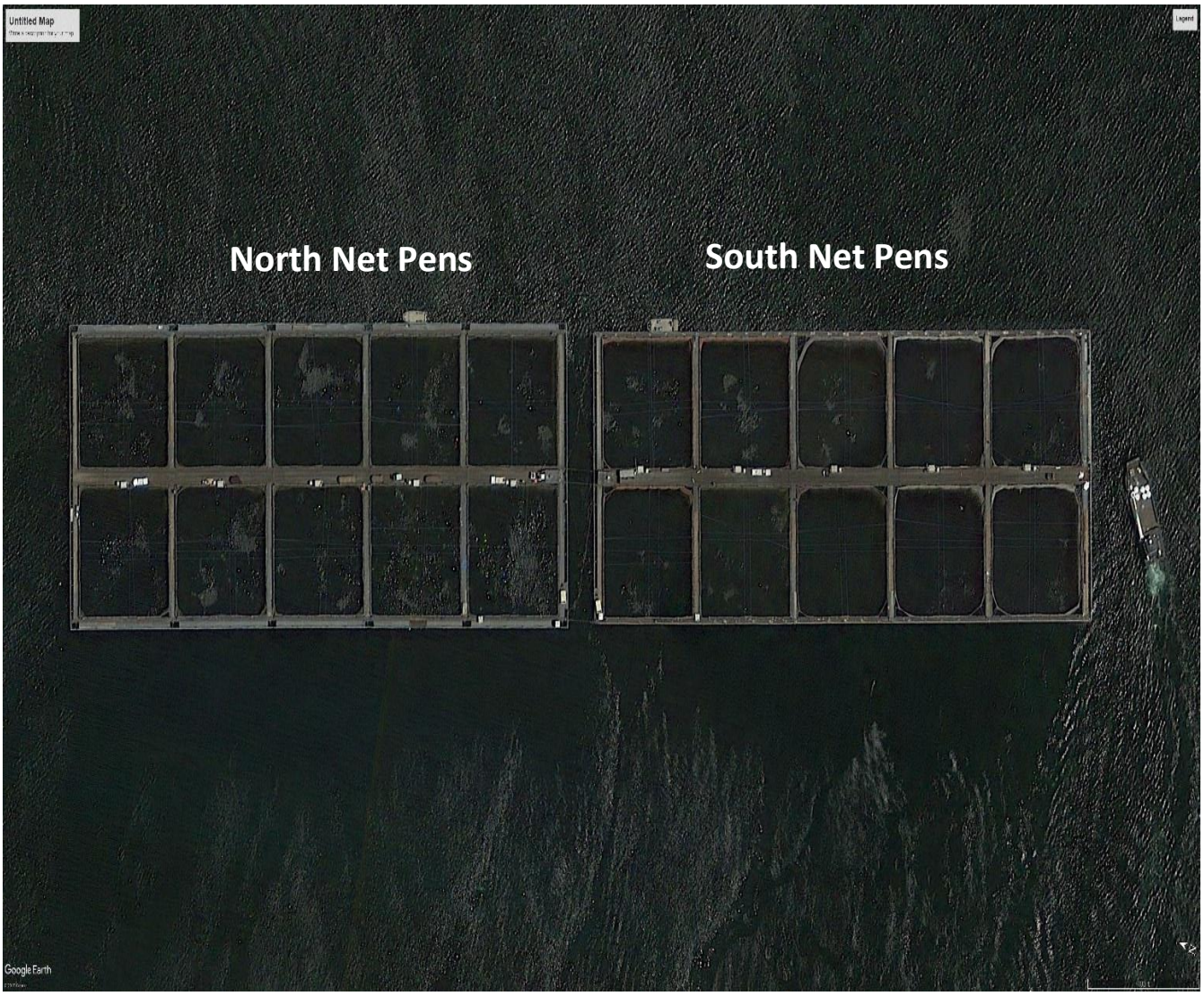


Figure C-1: Rich Passage – Orchard Rocks Net Pens (GoogleEarth - 2017)

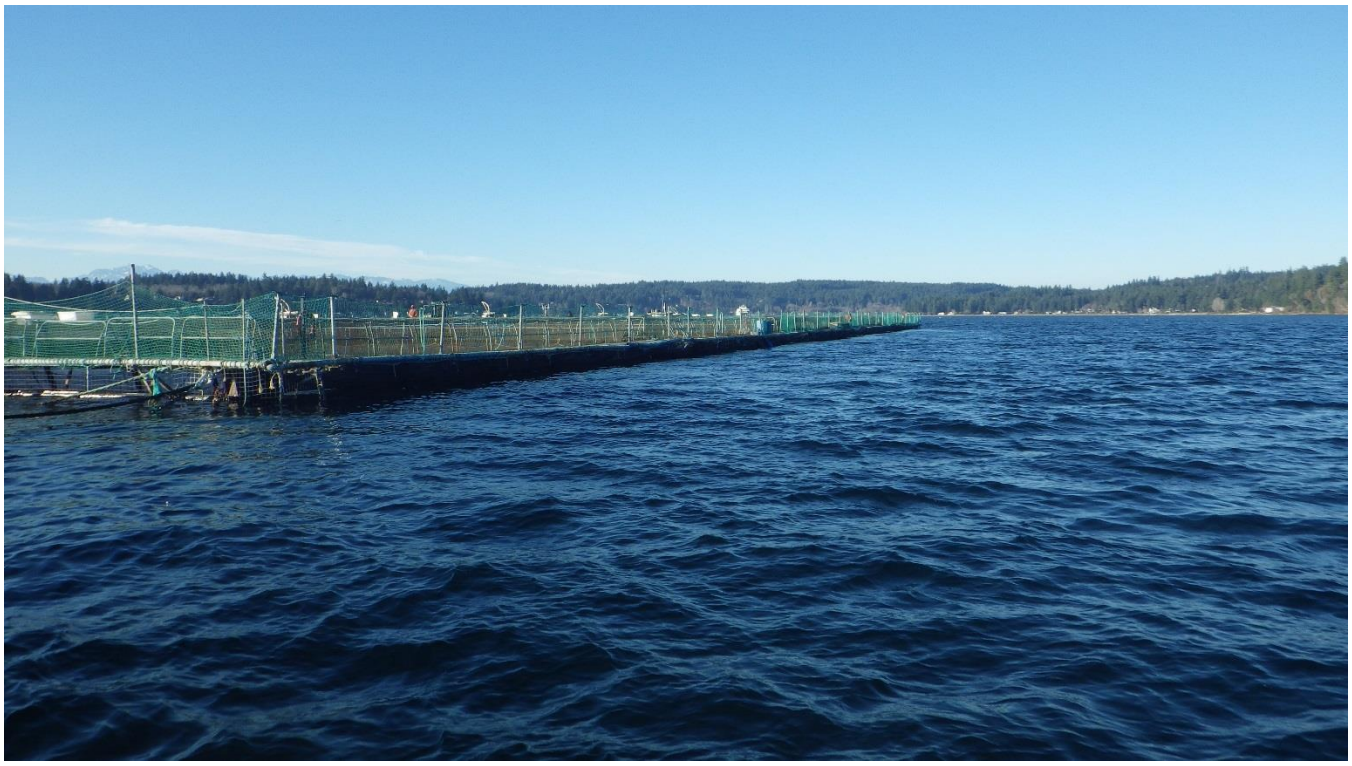


Figure C-2: Rich Passage – Orchard Rocks North Net Pen - View Looking North

Figure C-3: Orchard Rocks North Net Pen – View Looking North

Figure C-4: Center Bridge and staff shed

Figure C-5: Interior Staff Shed

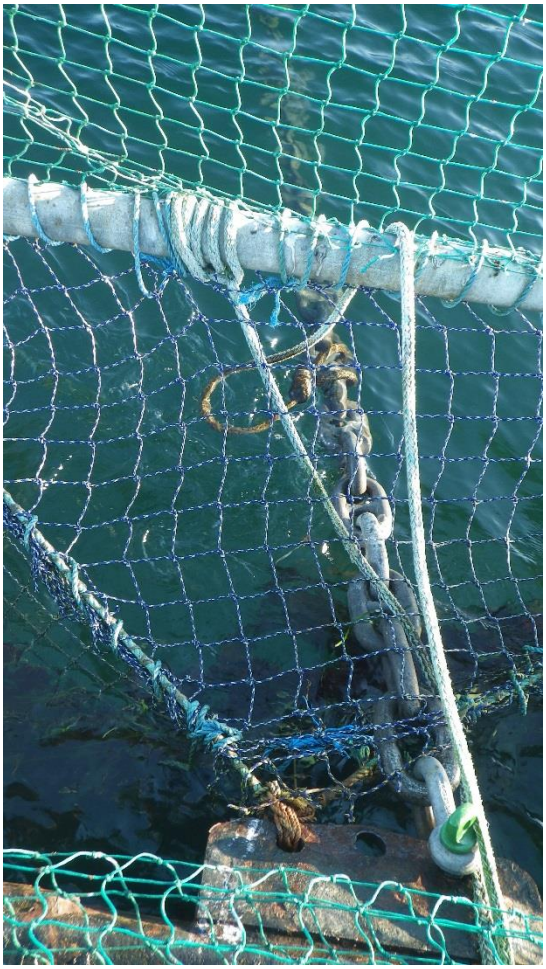


Figure C-6: Anchor #1, NE Corner of the North Net Pen. New shackle and chain.

Figure C-7: Anchor #1, NE Corner of the North Net Pen

Figure C-8: Anchor #2, East Side of the North Net Pen. New shackle and chain.

Figure C-9: Anchor #2, East Side of the North Net Pen. Old anchor access port.

Figure C-10: Anchor #3, East Side of the North Net Pen. New shackle, old chain, moderate corrosion.

Figure C-11: Anchor #3, East Side of the North Net Pen

Figure C-12: Anchor #4, East Side of the North Net Pen

Figure C-13: Anchor #4, East Side of the North Net Pen

Figure C-14: Anchor #5, East Side of the North Net Pen

Figure C-15: Anchor #5, East Side of the North Net Pen. Note chain tied to predator support pipe.

Figure C-16: Anchor #6, SE Corner of the North Net Pen. Chain attached to predator support pipe.

Figure C-17: Anchor #7, SW Corner of the North Net Pen. New shackle and chain. Chain tied to predator support pipe.

Figure C-18: Anchor #8, West Side of the North Net Pen. New shackle and chain. Chain tied to predator support pipe.

Figure C-19: Anchor #8, West Side of the North Net Pen

Figure C-20: Anchor #9, West Side of the North Net Pen. New shackle and chain.

Figure C-21: Anchor #9, West Side of the North Net Pen. Chain tied to predator support pipe.

Figure C-22: Anchor #10, West Side of the North Net Pen. New shackle and chain. Chain tied to predator support pipe.

Figure C-23: Anchor #10, West Side of the North Net Pen.

Figure C-24: Anchor #11, West Side of the North Net Pen. New shackle with old chain. Minor corrosion on chain. Chain tied to predator support pipe.

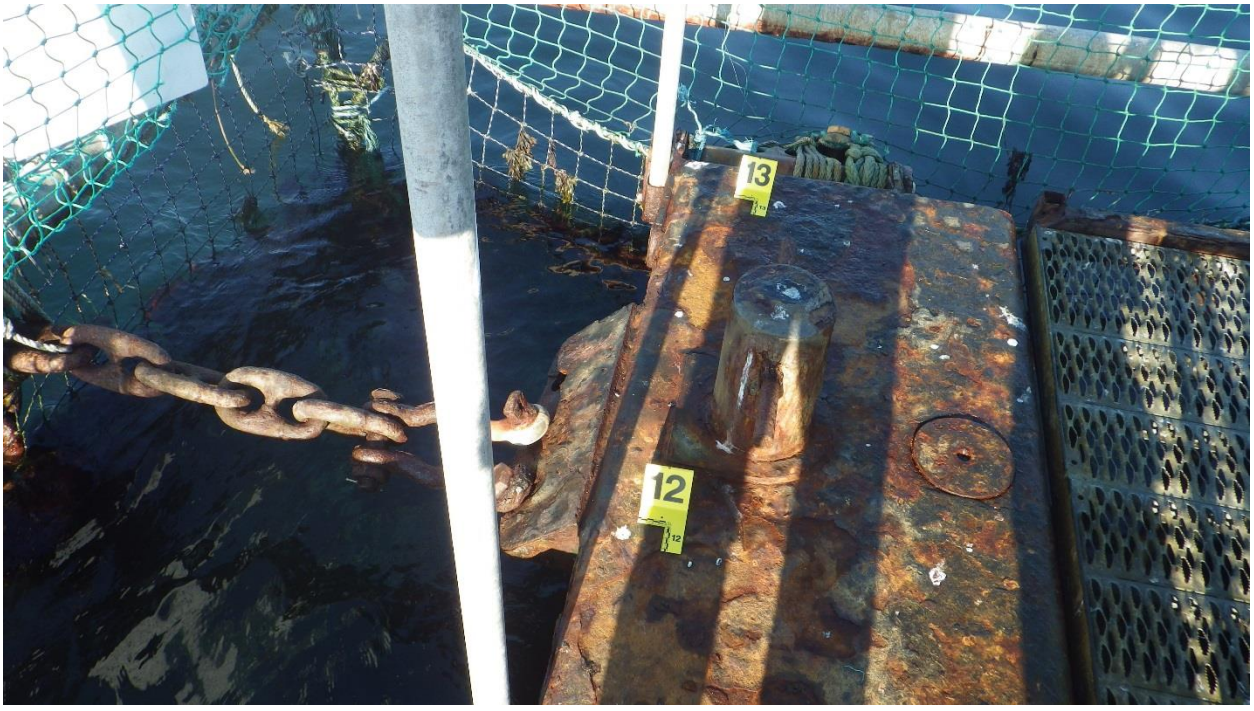


Figure C-25: Anchor #12, NW Corner of the North Net Pen. Moderate corrosion on chain.

Figure C-26: Anchor #12, NW Corner of the North Net Pen. Chain tied to predator support pipe.

Figure C-27: Anchor #13, NW Corner of the North Net Pen. Hinge appears to be seized.

Figure C-28: Anchor #13, NW Corner of the North Net Pen. Moderate corrosion at hinge.

Figure C-29: Anchor #13, NW Corner of the North Net Pen. Moderate or major corrosion at hinge.

Figure C-30: Anchor #13, NW Corner of the North Net Pen. Hinge at different angle than chain.

Figure C-31: Anchor #14, North Side of the North Net Pen. Hinge at different angle than chain.

Figure C-32: Anchor #15, North Side of the North Net Pen

Figure C-33: Anchor #15, North Side of the North Net Pen. Hinge at different angle than chain.

Figure C-34: Anchor #15, North Side of the North Net Pen. Hinge at different angle than chain.

Figure C-35: Anchor #16, NE Corner of the North Net Pen. Hinge at different angle than chain.

Figure C-36: North East Mid – Interconnection of North and South Net Pens

Figure C-37: North West Hinge – Connection of North and South Net Pens. Hinge with moderate corrosion.

Figure C-38: North West Mid – Interconnection of North and South Net Pens. Hinge with moderate corrosion.

Figure C-39: North East Hinge – Connection of North and South Net Pens. Hinge with moderate corrosion.

Figure C-40: North East Hinge – Connection of North and South Net Pens. Hinge with moderate corrosion.

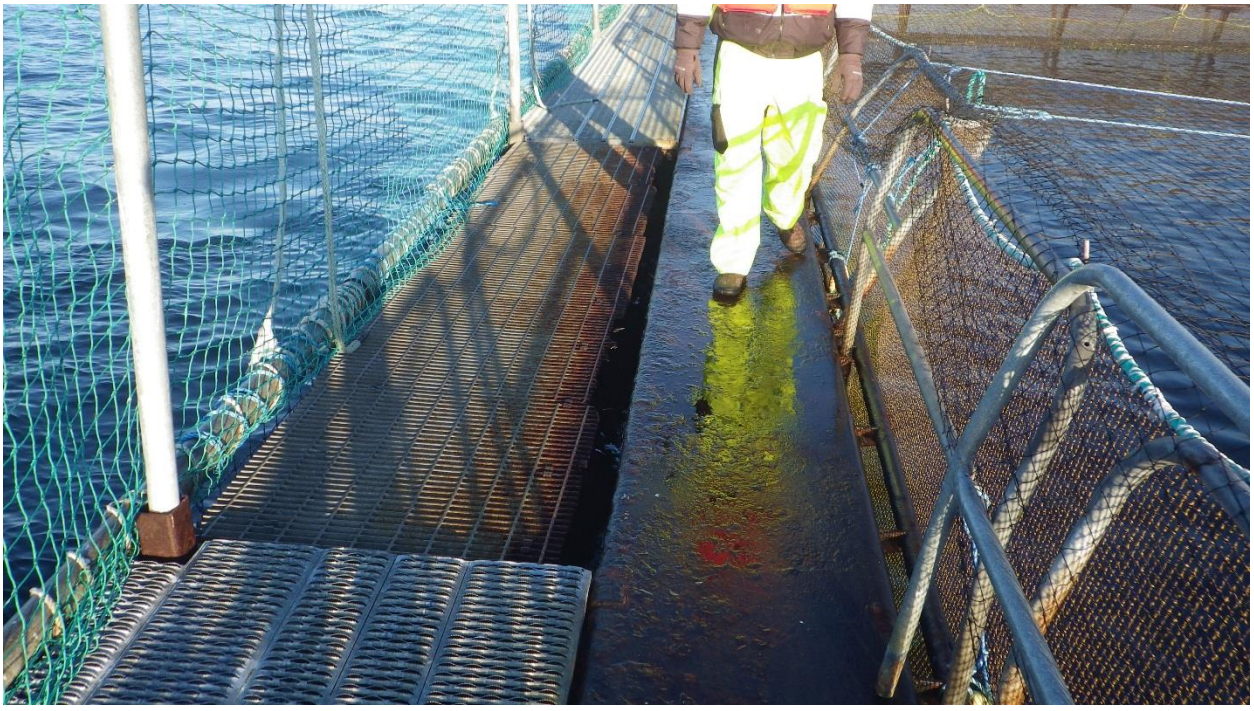


Figure C-41: Old Walkway Grating on west side. Note gap in grating.

Figure C-42: Rusted Outer Steel Frame on North East side walkway. Moderate to major corrosion.

Figure C-43: Rusted Outer Steel Frame on North East side walkway. Moderate to major corrosion.

Figure C-44: Typical Fixed Ladder Connection on East side, Used for Divers

Figure C-45: Rusted Additional Grating Panels

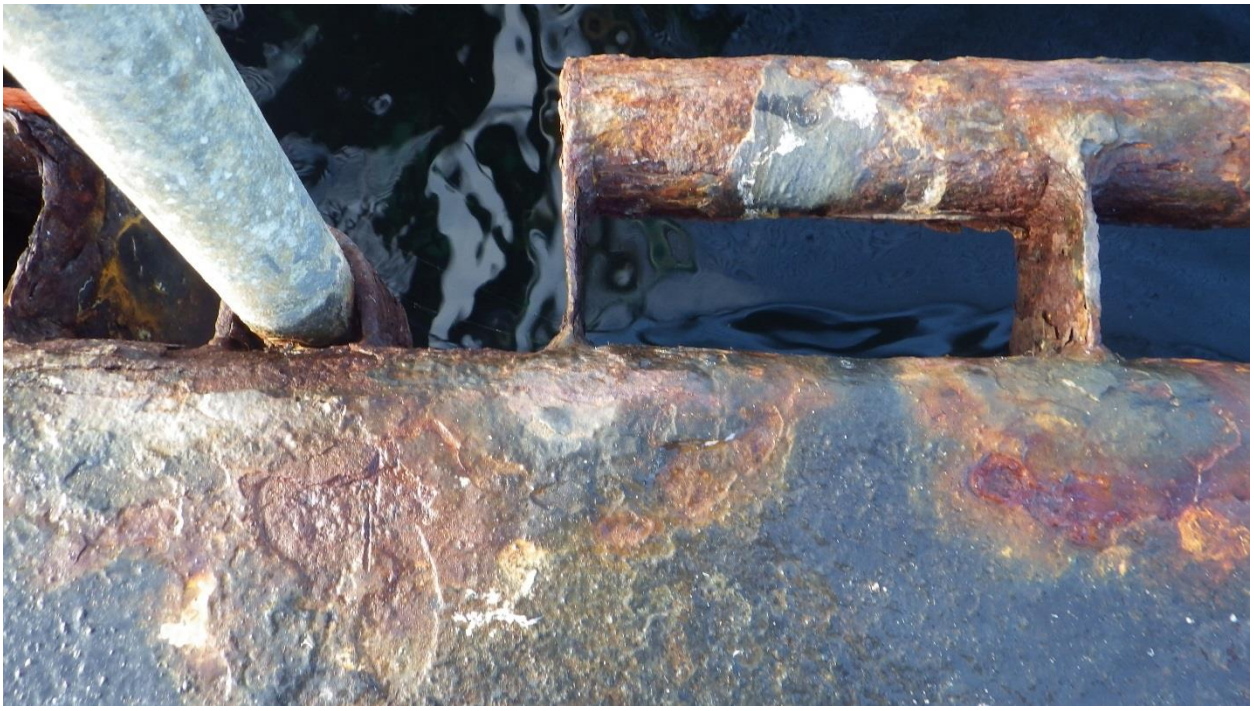


Figure C-46: Rusted Net Pen Support Rail and Handrail Bracket. Major corrosion.

Figure C-47: Fish Containment Net Attached to Handrails

Figure C-48: Rusted Handrail Bracket and Structural Framing. Major corrosion.

Figure C-49: Rusted Grating and Steel Walkway Framing. Old grating has lost section. New grating not bolted down.

Figure C-50: Rusted Net Pen Support Railing. Major corrosion.

Figure C-51: Rusted Grating and Steel Walkway Framing. Major corrosion.

Figure C-52: Damaged Grating Panel at Center Bridge.

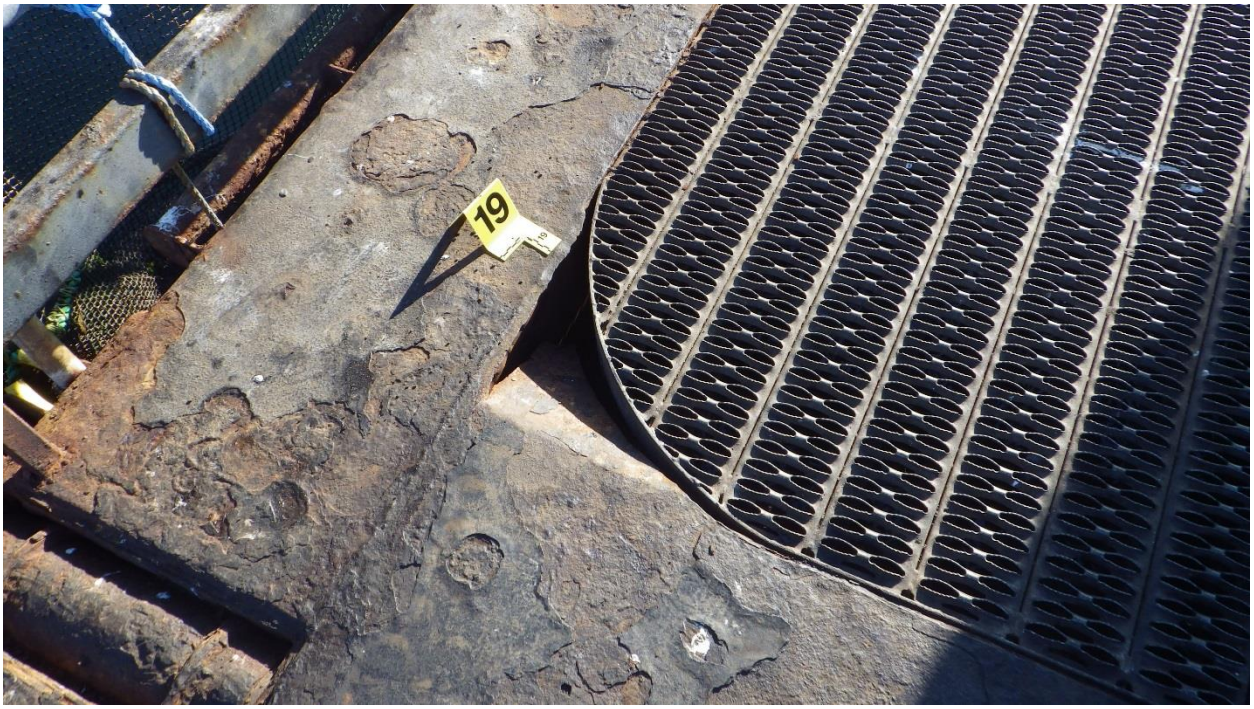


Figure C-53: Damaged Walkway on Center Bridge due to corrosion

Figure C-54: Steel Plates Welded on Top of Rusted Grating. Moderate corrosion.

Figure C-55: Near Anchor 10, Discontinuous Predator Net Railing – Bent due chain connection load.

Figure C-56: Near Anchor 10, Discontinuous Predator Net Railing – Bent due chain connection load.

Figure C-57: Rusted Hinge between anchors 5 and 6. Major corrosion.

Figure C-58: Rusted Hinge between anchors 2 and 3. Major corrosion.

Figure C-59: Rusted Hinge between anchors 2 and 3. Major corrosion.

Figure C-60: Rusted Hinge between anchors 9 and 10. Moderate corrosion.

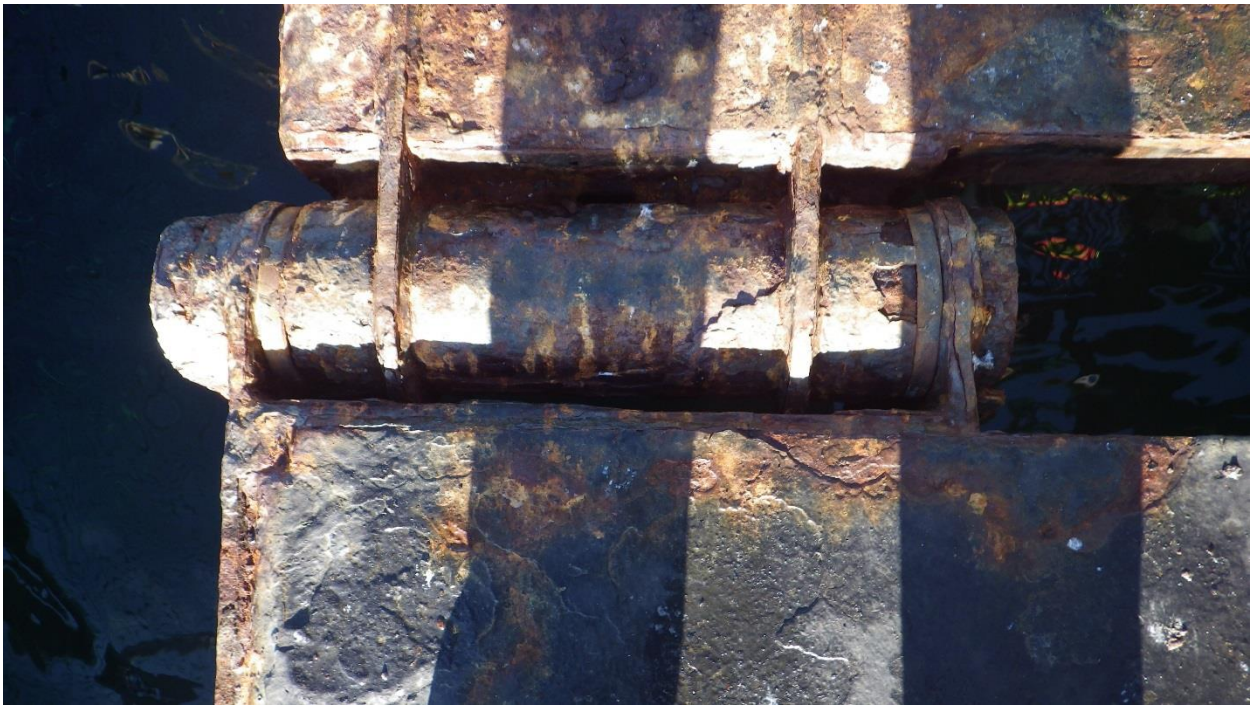


Figure C-61: Rusted Hinge between anchors 11 and 12. Moderate to major corrosion.

Figure C-62: Rusted walkway between anchors 11 and 12. Major corrosion.

Appendix D – Photos at Rich Passage Orchard Rocks Net Pens - SOUTH

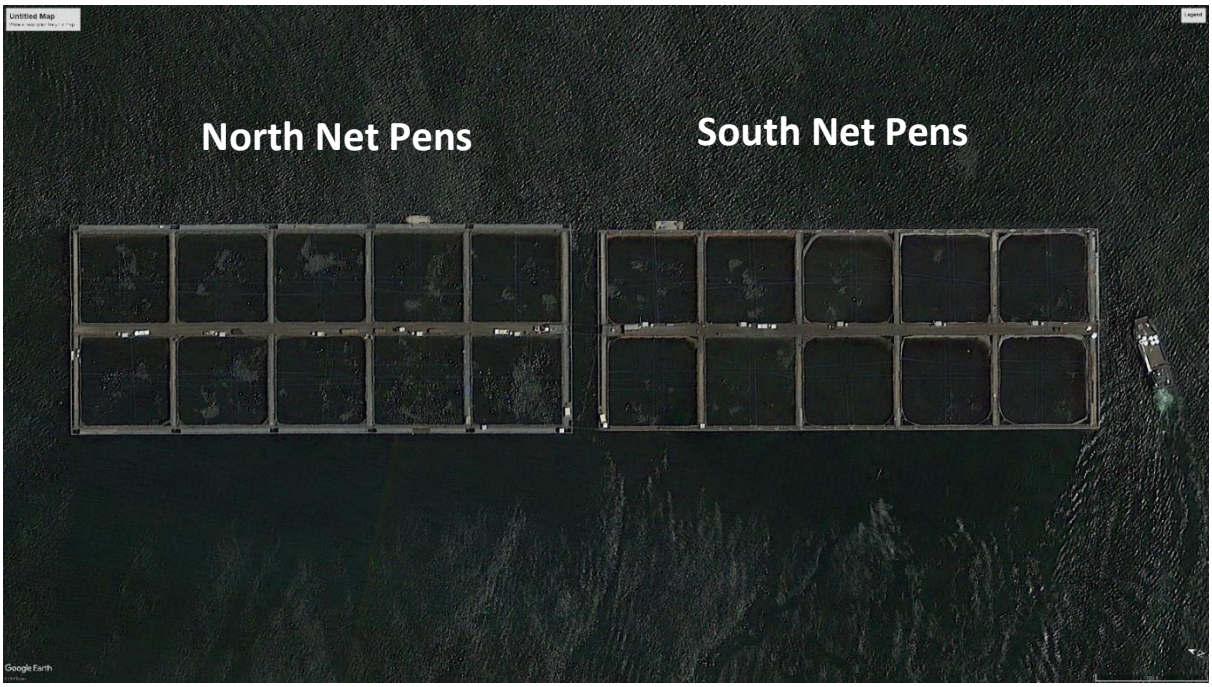


Figure D-1: Rich Passage – Orchard Rocks Net Pens (GoogleEarth - 2017)

Figure D-2: South Net Pens - View from the East Side, Looking South.

Figure D-3: View from East Side of South Net Pens, Looking North

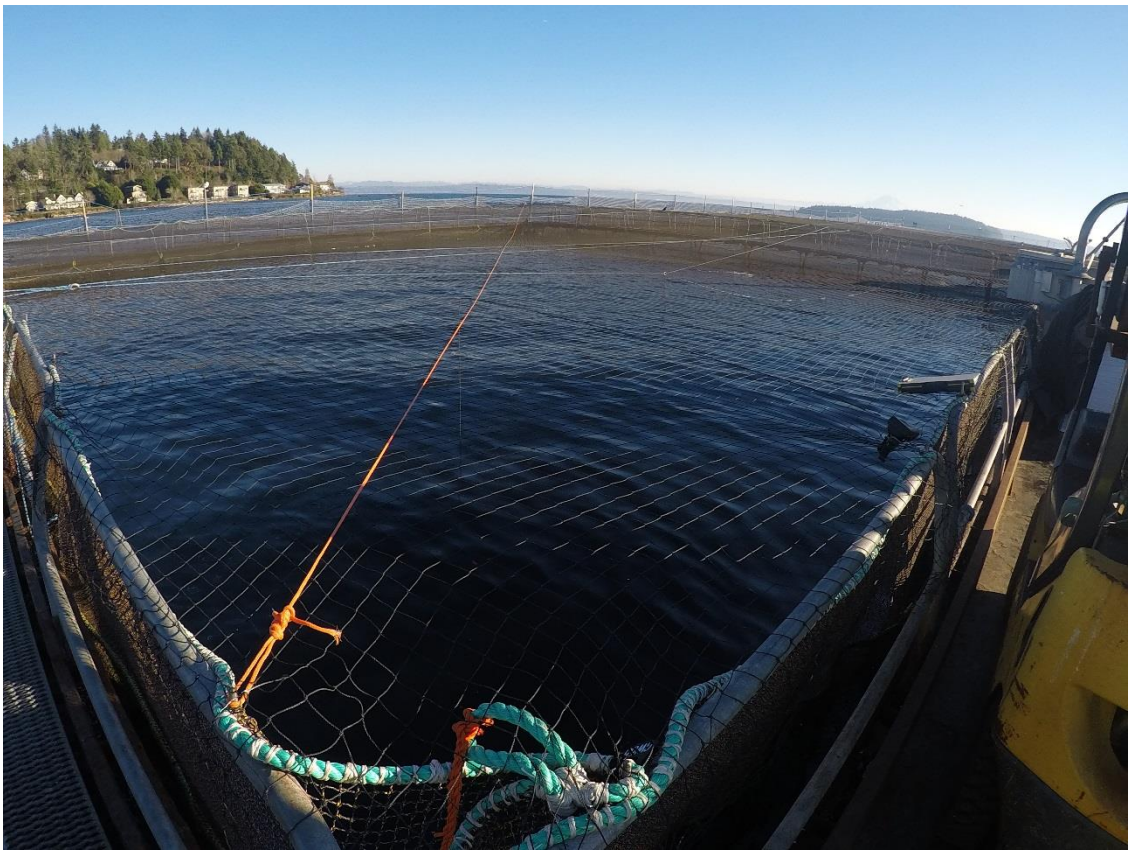


Figure D-4: Net Pen – Example Net Pen bird netting.

Figure D-5: Anchor #1, NE Corner of the South Net Pen

Figure D-6: Anchor #2, East Side of the South Net Pen.

Figure D-7: Anchor #2, East Side of the South Net Pen. Newer shackle, old chain.

Figure D-8: Anchor #3, East Side of the South Net Pen

Figure D-9: Anchor #3, East Side of the South Net Pen

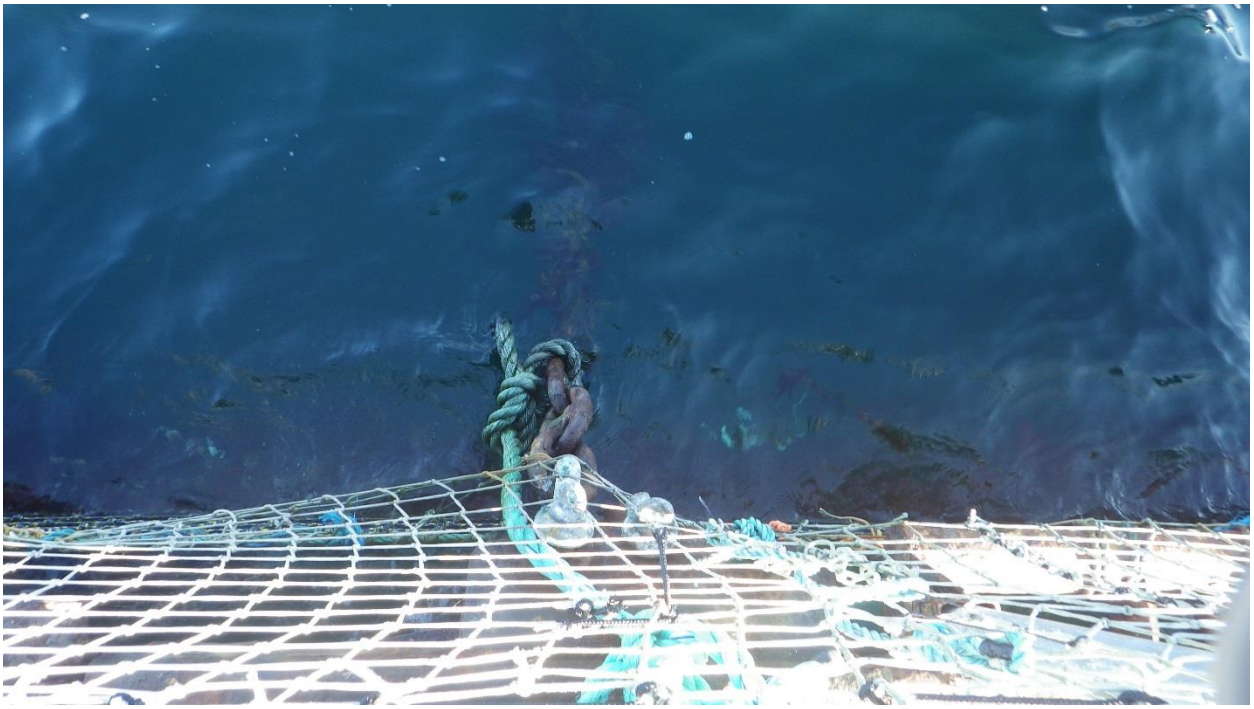


Figure D-10: Anchor #3, East Side of the South Net Pen. Newer shackle, old chain with moderate corrosion.

Figure D-11: Anchor #4, East Side of the South Net Pen

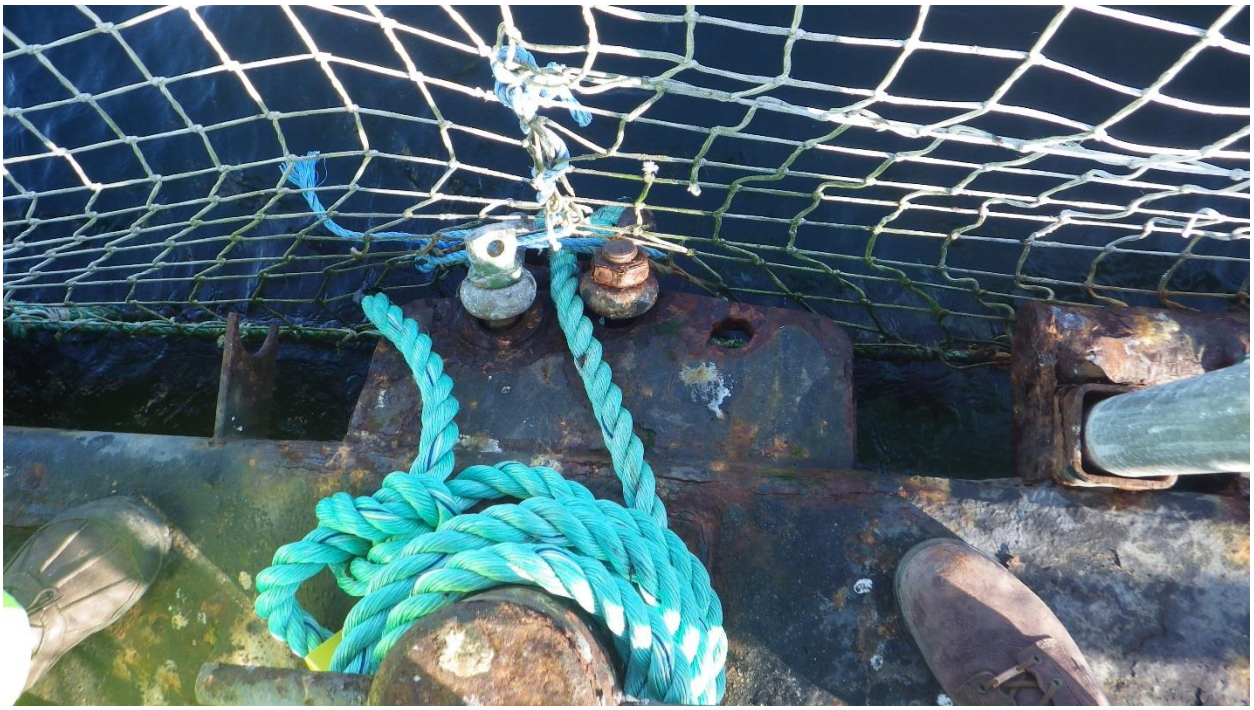


Figure D-12: Anchor #4, East Side of the South Net Pen

Figure D-13: Anchor #5, East Side of the South Net Pen

Figure D-14: Anchor #5, East Side of the South Net Pen. Mooring bracket hole reinforced.

Figure D-15: Anchor #6, SE Corner of the South Net Pen

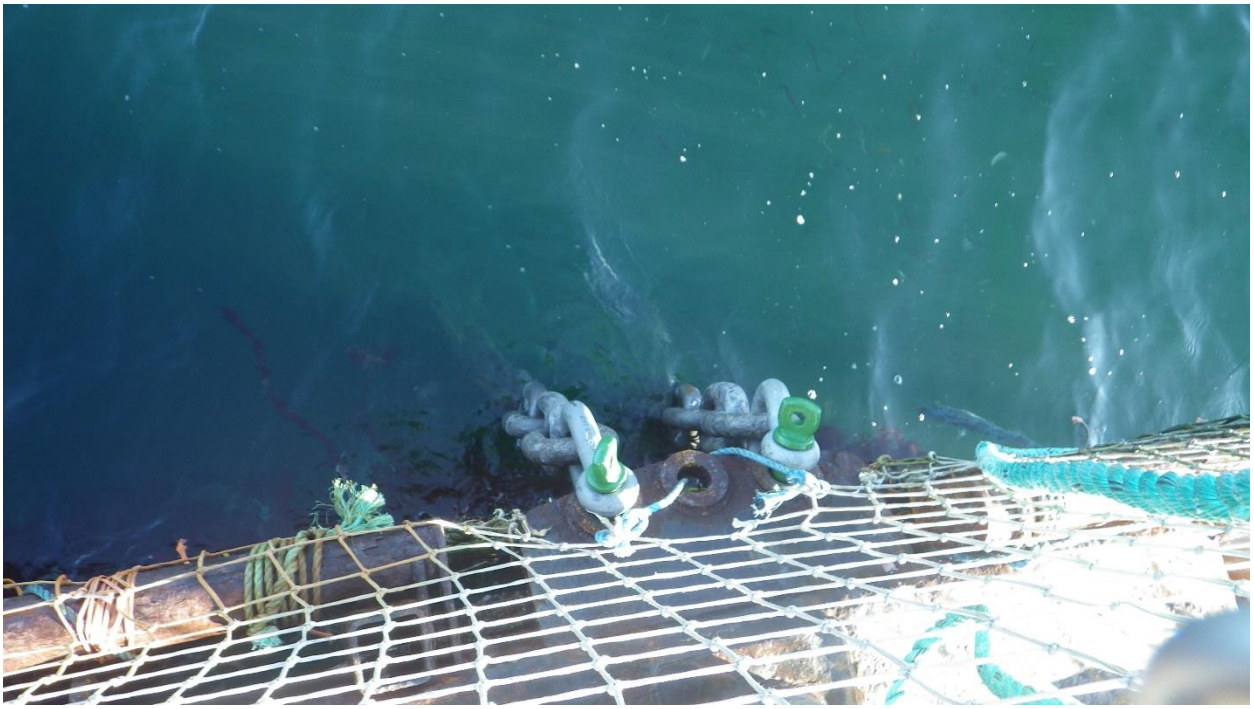


Figure D-16: Anchor #6, SE Corner of the South Net Pen. Additional anchor chain and anchor 6A.

Figure D-17: Anchor #7, SE Corner of the South Net Pen. Hinge with minor to moderate corrosion.

Figure D-18: Anchor #7, SE Corner of the South Net Pen

Figure D-19: Anchor #8, South Side of the South Net Pen. Hinge with moderate corrosion.

Figure D-20: Anchor #8, South Side of the South Net Pen

Figure D-21: Anchor #8, South Side of the South Net Pen. Hinge with moderate corrosion.

Figure D-22: Anchor #8, South Side of the South Net Pen

Figure D-23: Anchor #9, South Side of the South Net Pen. Hinge with moderate corrosion.

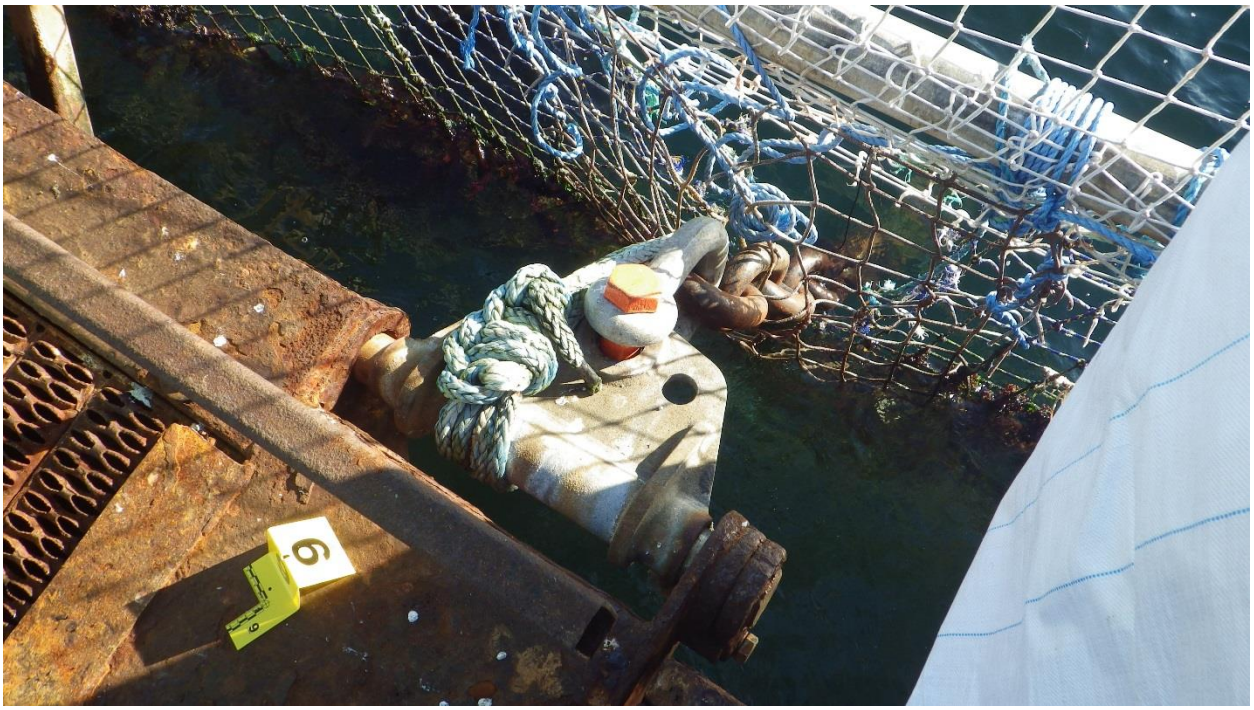


Figure D-24: Anchor #9, South Side of the South Net Pen

Figure D-25: Anchors #10 and #11, SW Corner of the South Net Pen.

Figure D-26: Anchors #10 and #11, SW Corner of the South Net Pen. Hinge with moderate corrosion.

Figure D-27: Anchor #11, SW Corner of the South Net Pen. New shackle and chain.

Figure D-28: Anchor #11, SW Corner of the South Net Pen. Reinforced hole on mooring bracket.

Figure D-29: Anchor #12, West Side of the South Net Pen

Figure D-30: Anchor #12, West Side of the South Net Pen

Figure D-31: Anchor #13, West Side of the South Net Pen. Moderate corrosion on shackle.

Figure D-32: Anchor #14, West Side of the South Net Pen

Figure D-33: Anchor #14, West Side of the South Net Pen. New shackle and chain.

Figure D-34: Anchor #15, West Side of the South Net Pen

Figure D-35: Anchor #15, West Side of the South Net Pen, with reduced edge hole distance.

Figure D-36: Anchor #15, West Side of the South Net Pen. New shackle, with minor corrosion on chain.

Figure D-37: Anchor #16, West Side of the South Net Pen, with new shackle and chain.

Figure D-38: Anchor #16, West Side of the South Net Pen

Figure D-39: South East Hinge connected to North pen with moderate corrosion.

Figure D-40: South East Hinge connected to North pen.

Figure D-41: South East Mid Hinge connected to North pen with minor corrosion.

Figure D-42: South West Hinge connected to North pen with moderate to major corrosion.

Figure D-43: South West Hinge connected to North pen.

Figure D-44: South West Mid Hinge connected to North pen.

Figure D-45: Rusted Hinge Between Anchors #2 and #3 with moderate corrosion.

Figure D-46: Rusted Hinge Between Anchors #12 and #13 with moderate to major corrosion.

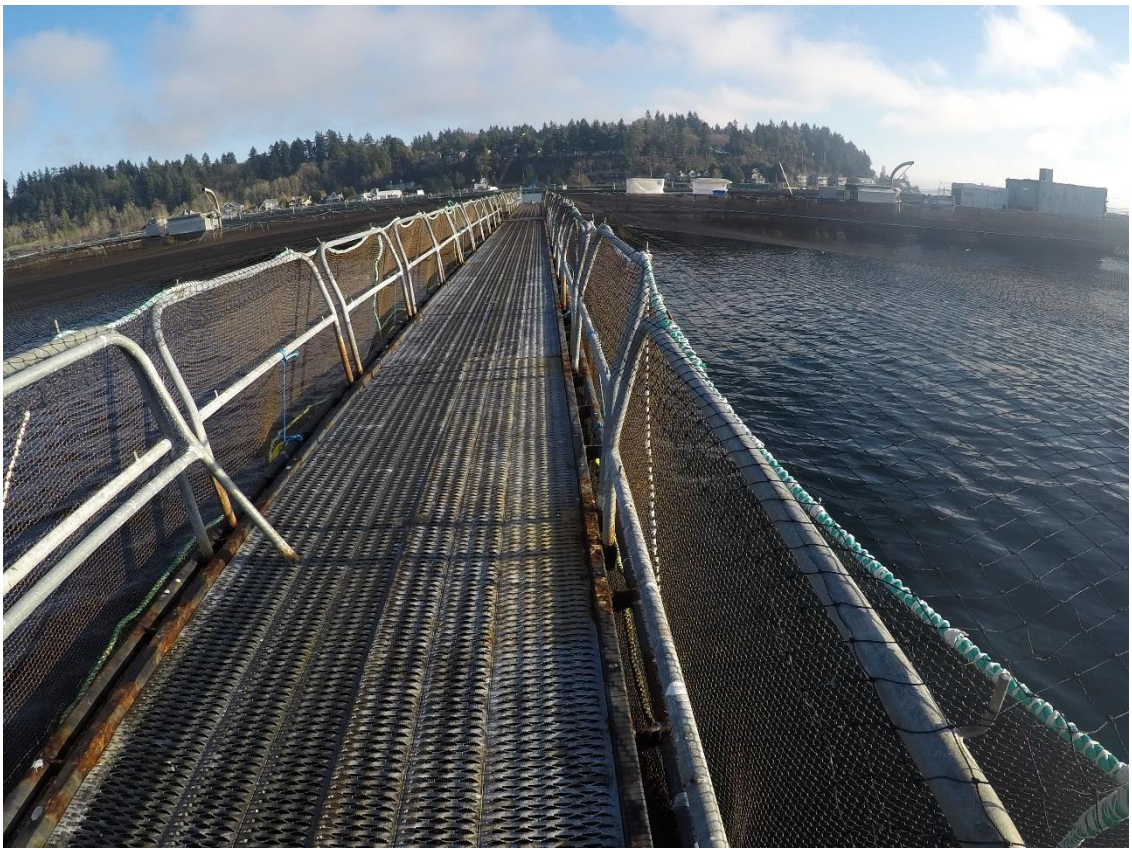


Figure D-47: Grating Walkway between net pens.

Figure D-48: Rusted Anchor Shackle at Anchor 13. Note Reduced Edge Bolt Hole on Mooring Bracket.

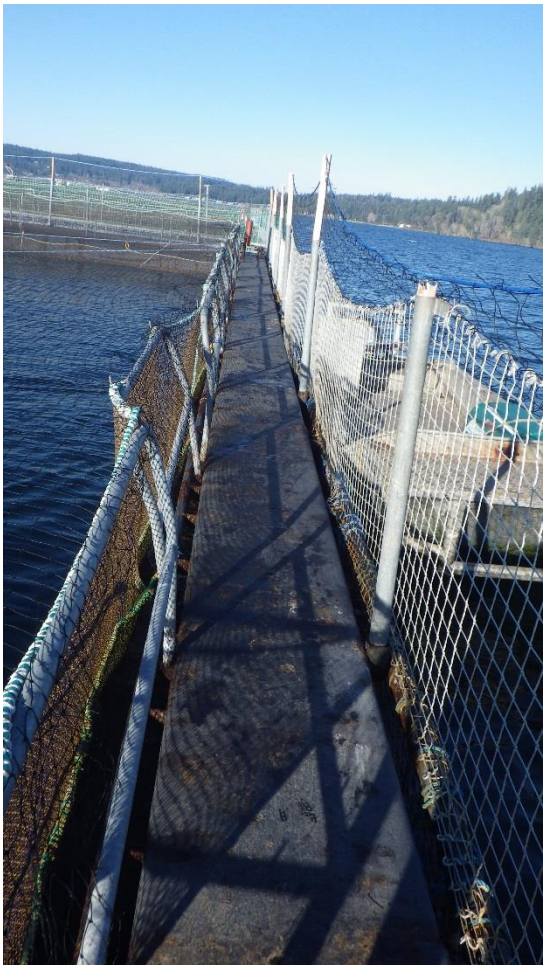


Figure D-49: Steel Framing Walkway. Note that Grating is Absent.

Figure D-50: Rusted Grated Walkway and Center Bridge and staff shed.

Figure D-51: Rusted Steel Framing, Handrail Brackets, and Net Pen Support Railings, moderate to major corrosion.

Figure D-52: Rusted Predator Net Support Railing with moderate corrosion.

Figure D-53: Cantilevered Predator Net Supports - Moderate corrosion.

Figure D-54: Central Bridge with moderate corrosion.

Figure D-55: Rusted Steel Framing, Handrail Brackets, and Net Pen Support Railings with moderate to major corrosion.

Figure D-56: Rusted Steel Framing, Handrail Brackets, and Net Pen Support Railings with moderate to major corrosion.

Figure D-57: Rusted Steel Framing, Hole in Framing Member with total section loss, major to severe corrosion.

Figure D-58: Rusted Hinge Connection, Major Corrosion, Reduced Section of 40%.

Figure D-59: Rusted Hinge Connection, Major Corrosion, Reduced Section of 40%.