# Pacifica Municipal Fishing Pier

## 2023 Condition Assessment Report

City of Pacifica

→ The Power of Commitment

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# 1. Introduction

The Pacifica Municipal Pier (Pier) was built in 1972 and originally designed as the support structure for an outfall pipe, extending from Beach Boulevard into the ocean. The outfall is inactive, and the Pier is currently used as a recreational fishing pier by the local community. It is located at 2100 Beach Boulevard, Pacifica.

The L-shaped concrete pier, as shown in Figure 1.1, is supported on concrete piles and pier abutment wall. The Pier's abutment is a polygon shaped structure accommodating a building structure that includes Chit-Chat Café (current tenant) and restrooms. The Pier deck is comprised of prestressed concrete box girders with cast-in-place concrete handrails. The deck features include lights, water fountains, fish cleaning stations, and concrete benches.

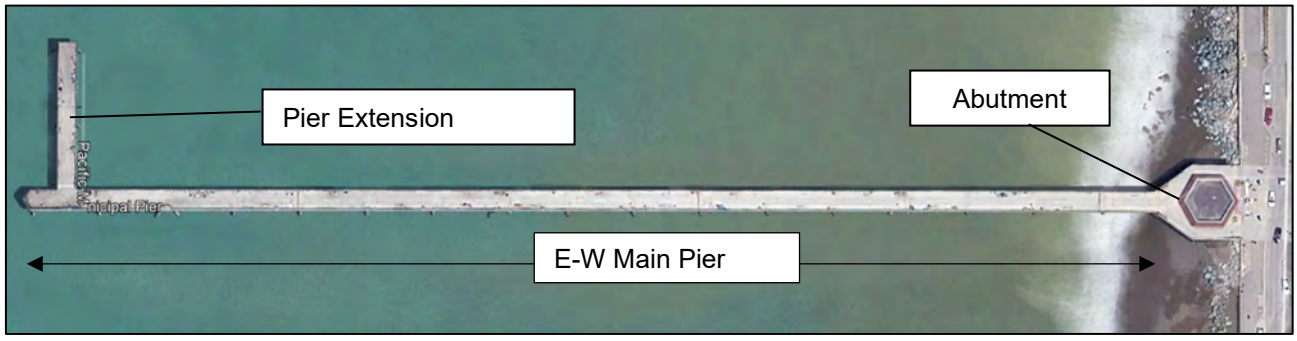



*Figure 1.1 Pacifica Municipal Pier Layout*

## 1.1 Purpose of this report

The Pier sustained damage to a section of the handrail during winter storms in December 2020 and January 2021, as shown in Figure 1.2. The damage was likely caused by large waves and/or strong winds impacting a handrail weakened by ongoing corrosion. The City of Pacifica engaged GHD to assess the condition of the existing structure at other locations and gather information that may assist with planning for future repairs and maintenance. The Condition Assessment Report documents the assessment methodology, field observations, assessments, and includes recommendations for potential repairs needed.

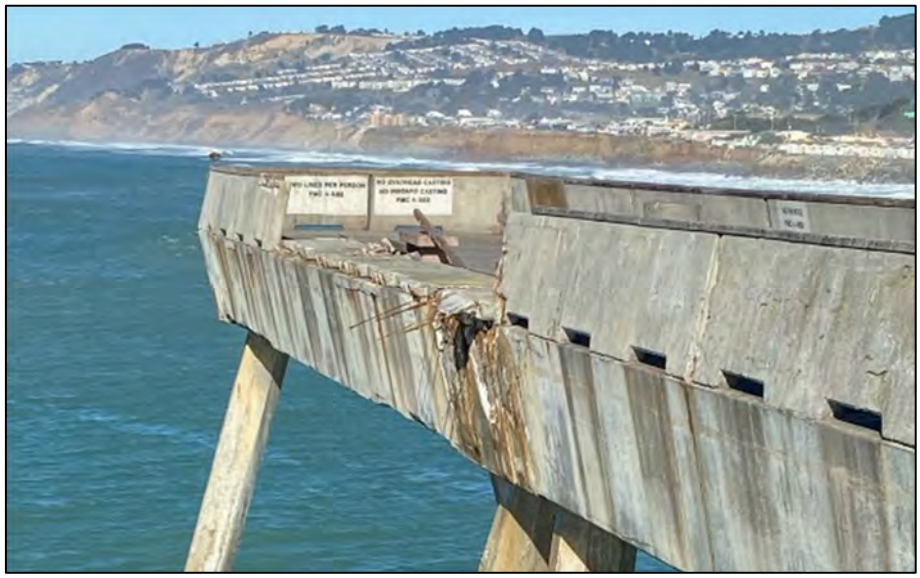


*Figure 1.2 Damaged Pier Handrail (January 2021)*

## 1.2 Scope and limitations

### 1.2.1 Scope

GHD and its specialty subconsultants performed the condition assessment of the Pier abutment and the Pier structure, including the piles. The as-built information for the Pier and Pier abutment were available for reference. The general scope of the assessment included the following:

1. Visual assessment of the deck.
2. Delamination survey of the deck.
3. Drone-assisted assessment of the Pier exteriors, including soffit and piles.
4. Diver-assisted assessment of several piles below water.
5. Drilling through Pier abutment to check for voids under the deck.

The observations were documented with photos and field notes.

### 1.2.2 Limitations

This report has been prepared by GHD for the City of Pacifica and may only be used and relied on by the City of Pacifica for the purpose agreed between GHD and the City of Pacifica as set out in Section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than City of Pacifica arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and recommendations in this report are based on conditions encountered and information reviewed at the date of the condition assessment. The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. GHD disclaims liability arising from any of the assumptions being incorrect.

**Accessibility of documents**

*If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.*

*The opinions, conclusions and recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

# 2. Existing Structure

The Pier is an L-shaped, open waterfront structure built in 1972. It is located on Sharp Park Beach and exposed to strong winds and waves on the open waters. The Pier structure comprises of two sections, a 1020’ long Main Pier extending from shore to the ocean in the East-West direction and a 120’ Pier Extension spanning in the North-South direction at the offshore end of the Main Pier.

The typical Pier section consists of two prestressed concrete box girders, a cast-in-place slab, cast-in-place pile cap (referred to as “bent”) and prestressed precast concrete piles as indicated in the 1973 as-built drawings. The two 5’ deep box girders are joined together with a cast-in-place slab, 6.5” deep at the top and bottom as shown in Figure 2.1. A bent is a reinforced concrete pile cap spanning across piles. The 30” sewer outfall pipe passes through the center of the Main Pier, in the space between the top and bottom cast-in-place slabs.

Concrete handrails are cast-in-place panels connected to the deck through rebar extending from prestressed concrete box girders into the handrail. The handrails have experienced damage over the years and have been repaired by replacing portions of the handrail panels with drill and bond connection with the deck.

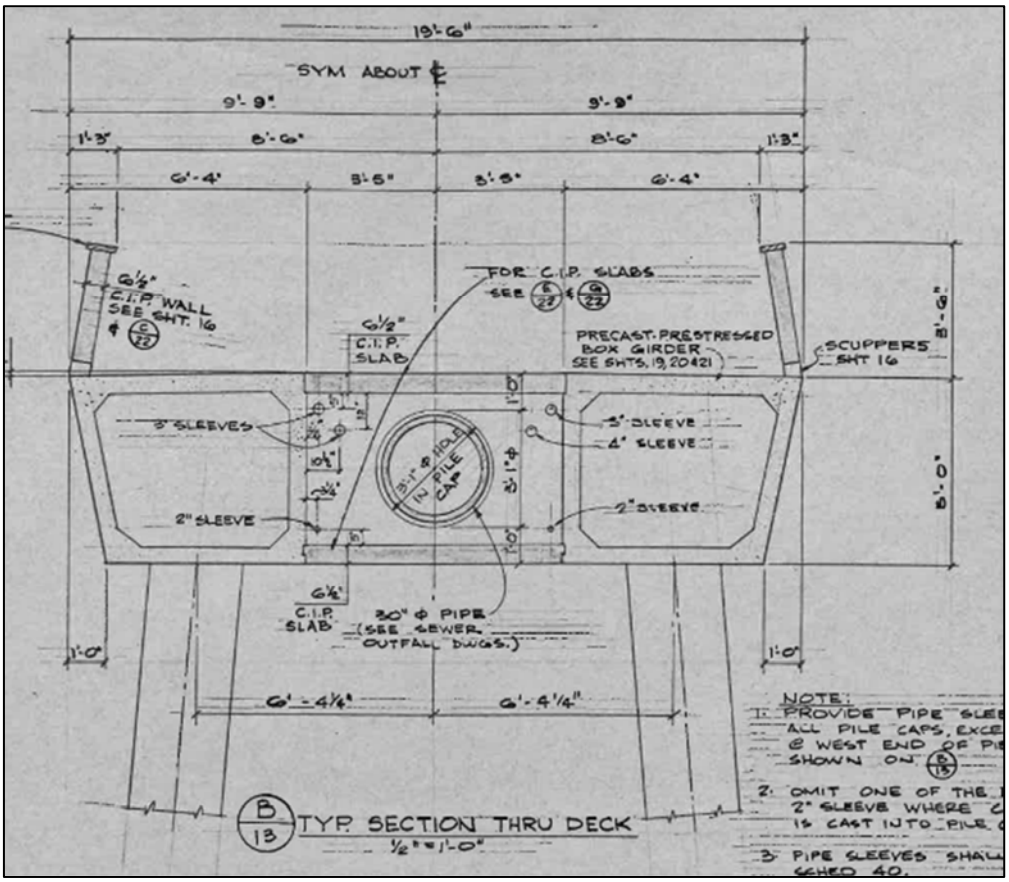



*Figure 2.1 Typical Section through Deck*

The Main Pier is supported on 30” and 24” prestressed precast octagonal concrete piles (Figure 2.2). The Pier Extension is supported on 30” piles. All piles are approximately 75’ to 110’ long and typically spaced at 60’ along the pier length. Typically, there are two battered piles at each bent; a few bent locations consist of four piles. The Pier Extension is separated from the Main Pier by a 6” joint, as shown in Figure 2.3.

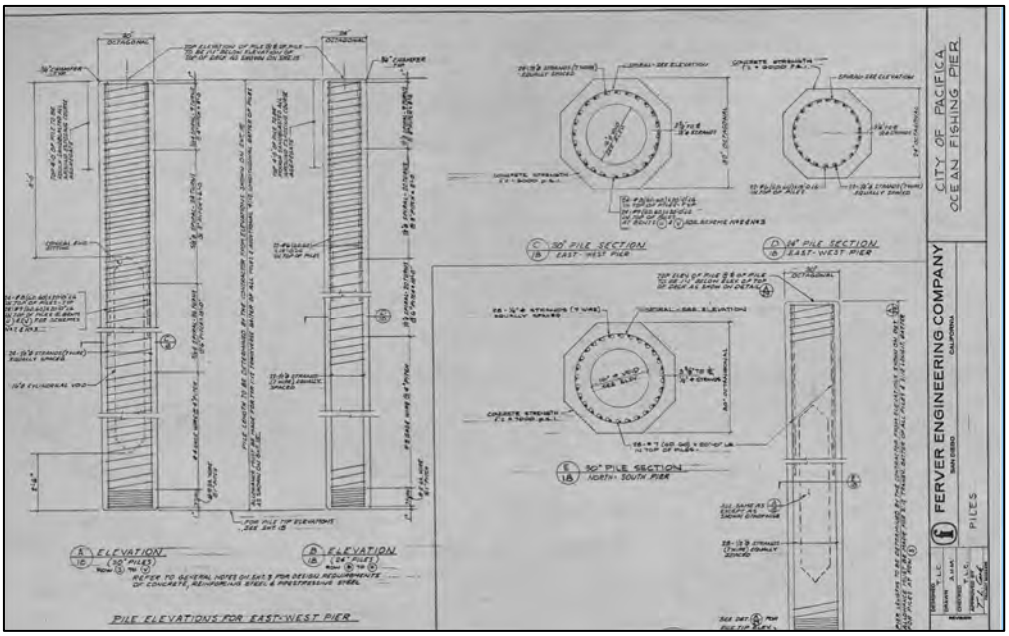



*Figure 2.2 Pile Details*

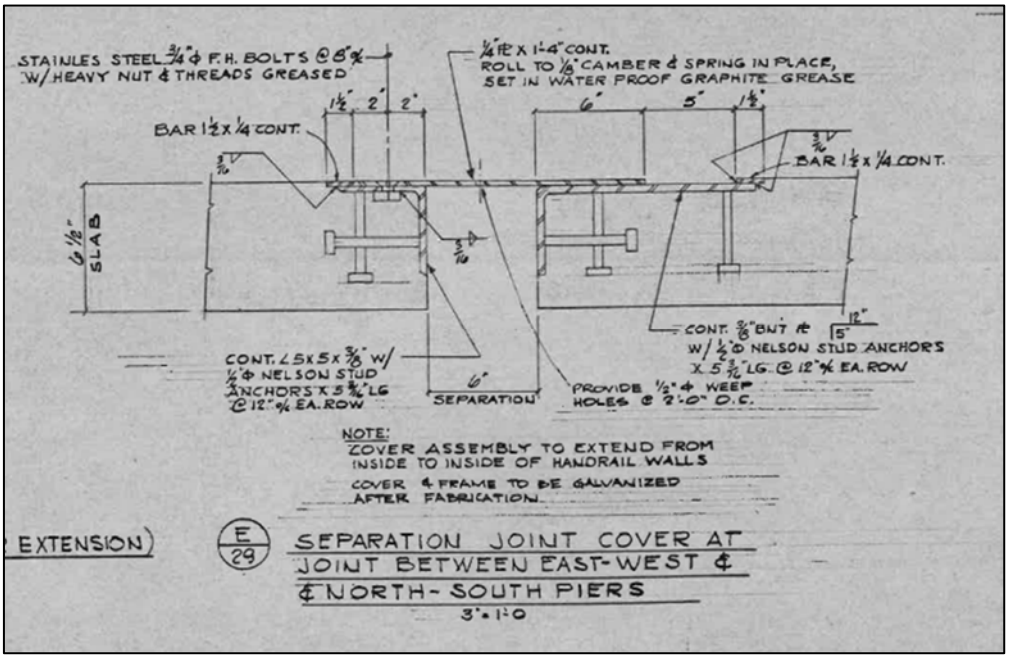



*Figure 2.3 Separation Joint at Pier Extension and Main Pier*

The Pier abutment was supported by steel sheet piles backed by a soil cement slurry gravity wall. The sheet pile and gravity wall extend approximately 115’ seaward from the Beach Boulevard centerline and provide the foundation for the Pier deck and building at the base of the Pier. Today, the shoreside end of the Pier is supported on a reinforced concrete retaining wall with an opening for the sewer outfall pipe.

A variety of maintenance and repair projects have been implemented on the Pier over the years. Throughout the years the Pier suffered pile damages and a partially collapsed cement slurry wall. In 1993, piles were repaired with pile jackets and a reinforced concrete wall was installed at the pier abutment behind the corroding sheet piles, as shown in Figure 2.4 and Figure 2.5, respectively. In 2013, the City undertook repairs to address spalling and unsound concrete, exposed reinforcing steel, and to replace the removable deck panels.

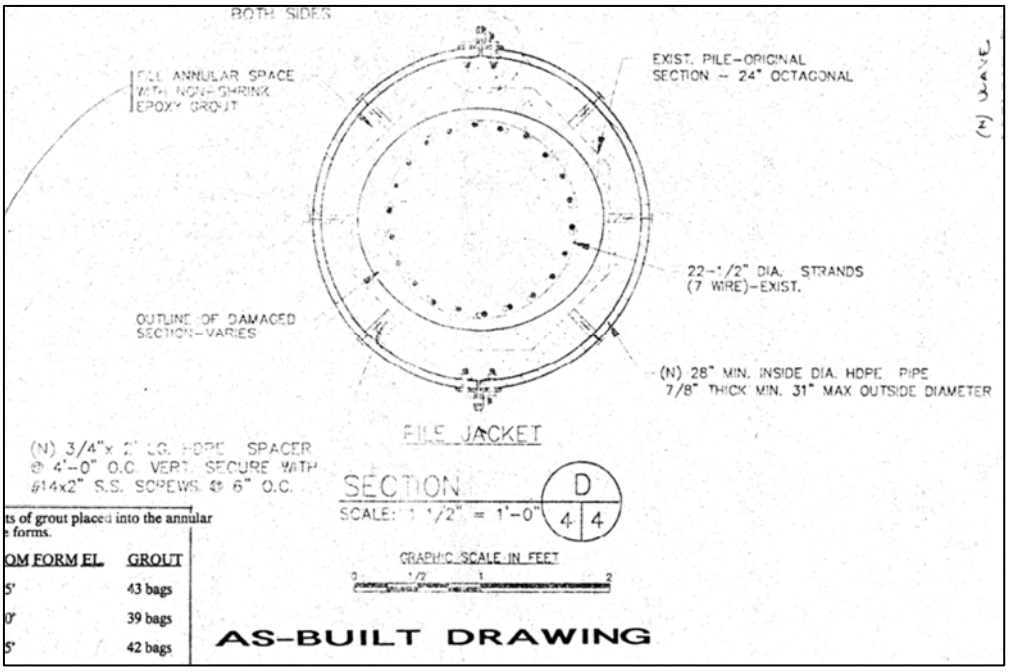



*Figure 2.4 Pile Jacket Repair – 1993 Project*

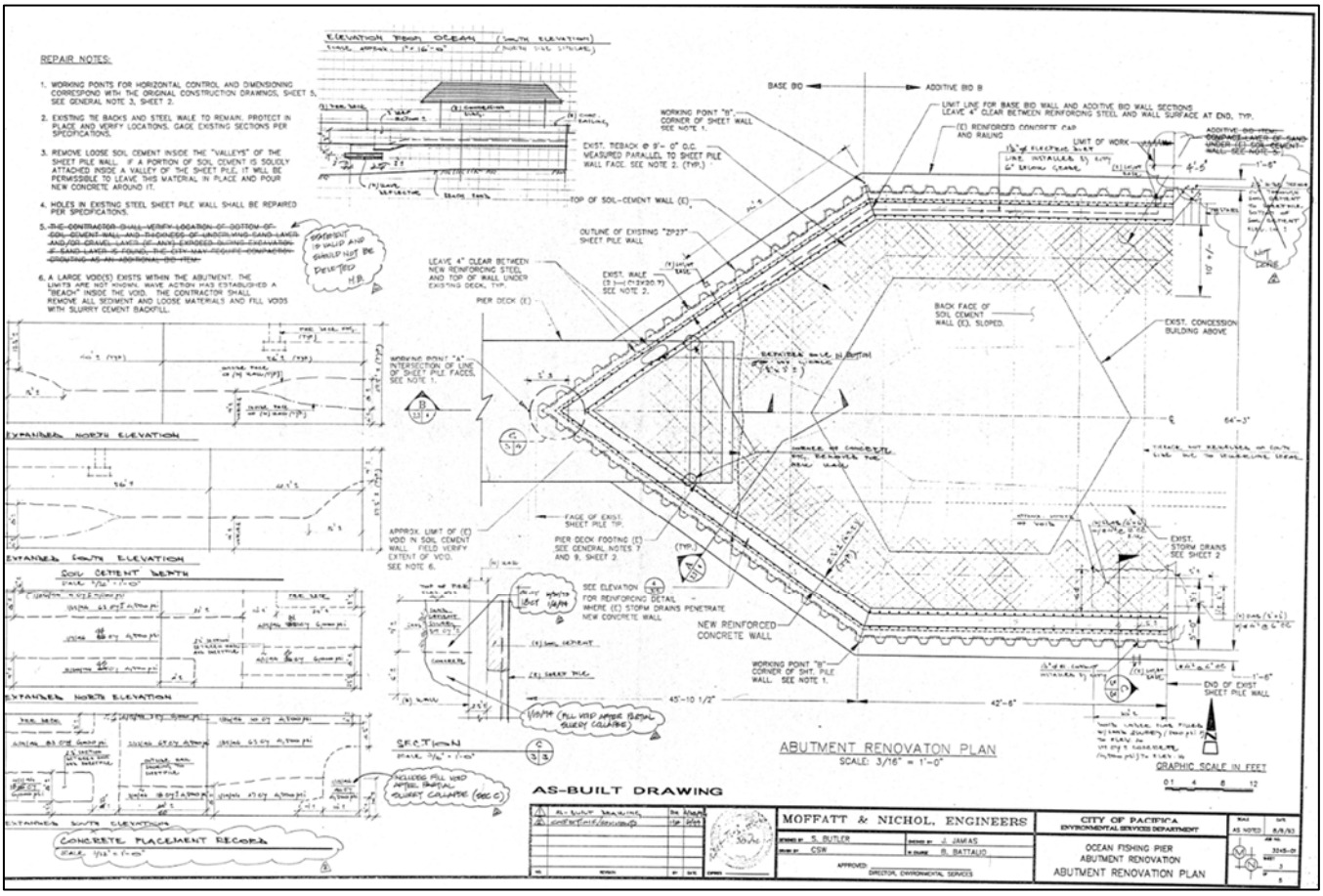



*Figure 2.5 Reinforced Concrete Wall at Pier Abutment – 1993 Repair Project*

# 3. Condition Assessment Methodology

The following sections describe the methodology to assess the condition of the Pier Abutment and Pier, along with the rating corresponding to the level of damage observed for the elements.

## 3.1 Pier Abutment

GHD's subcontractor, Eleven Engineering, drilled through the concrete deck for the purpose of detecting voids in the abutment. The drilling was performed vertically through the deck surface between the Pier abutment sheet pile wall face and the material behind the wall.

Concrete cores had to be drilled through the deck to gain access to the in-fill material under the deck. The ten coring locations were spaced to cover the deck area all around the pier abutment. Drilling was planned to be done to penetrate until the hard pan founding layer or at least 25' to 30' below the concrete deck. As much of the material below deck was expected to be the hard concrete slurry or compacted fill, a sudden drop in pressure required to progress the drill would indicate a potential void under the abutment.

## 3.2 Pier

### 3.2.1 Handrails

A condition assessment of the handrails, including the inside and outside faces was completed in March 2021 and June 2022. Typically, areas of potential damage can be visually differentiated by the presence of cracks and rust stains caused by corrosion of reinforcing steel within the concrete. A hammer was used to sound the concrete and determine the extent of delamination and closed spall. In areas of damage, the hammer produces a hollow sound instead of a sharp ringing sound in areas of good concrete.

### 3.2.2 Deck, Sides and Soffit

The delamination survey was conducted on the top deck of the Pier to identify locations of damage. Delamination indicates failure of the bond between concrete and reinforcing steel due to corrosion of the reinforcing steel.

Delamination testing was conducted in accordance with ASTM D4580 "Standard Practice for Measuring Delamination in Concrete Bridge Decks by Sounding"; the survey was performed by dragging a steel chain along the surface of the concrete. A delaminated section of concrete produces a different frequency sound than an intact section of concrete. Delaminated locations as identified by the "drummy" sound were recorded. After identifying the general area of delamination on the deck, a hammer was used to sound the concrete and determine the extent of delamination. In areas of damage, the hammer produces a hollow sound instead of a sharp ringing sound in areas of good concrete.

GHD's subcontractor, New Age Aerials used an Unmanned Aerial Vehicle (UAV) to capture imagery of the Pier abutment and the Pier structure, including the exterior sides and soffit that are not visible from the deck. The UAV traveled in planned overlapping paths to capture the entire structure from different perspectives. The images were recorded in a video format and provided to GHD's engineers to review and assess the conditions.

### 3.2.3 Piles

GHD's subcontractors, Sea Engineering and New Age Aerials, both performed inspections of the Piles. Sea Engineering used their qualified divers to perform both Level I and Level II assessments of the piles below water whereas New Age Aerials used UAV for above water and ROV (Remote Operated Vehicle) with capability to capture imagery under water to perform visual assessment of the piles.

The Level I effort included a close examination above and underwater, either visually and/or a tactile using large sweeping motions of the hands as visibility is limited underwater. It also included limited probing of the substructure.

The detectable defects for concrete sections for Level I are:

– Broken piles.
– Major spalling and cracking.
– Severe reinforcement corrosion where exposed.
– Permanent deformation.
– Mechanical damage.

Level II effort included detailed inspection by removing marine growth from portions of the structure. As marine growth removal requires extensive effort in strenuous conditions, a limited number of piles were recommended for Level II assessments.

In addition to the defects identifiable with Level I assessments, Level II assessments can also identify the following:

– Surface cracking, spalling (delamination), and erosion
– Rust staining
– Exposed reinforcing steel and/or prestressing strands
– Material Degradation

There were challenges in mobilizing the divers to perform the assessments, due to the tides and waves at the site not being suitable until July and August 2023. While there was uncertainty over the divers being able to safely assess the piles, a ROV was deployed to capture the condition of the piles below water at the far end of the pier. Although the ROV was able to be deployed in moderate weather; the fishing wires and other debris near mudline proved detrimental for the ROV to navigate around the piles.

Sea Engineering performed the Level I assessment of 20 piles from the mudline to the Mean High Water (MHW) level mark. Level II cleaning and close visual and tactile inspection at mudline, mid-water, and tidal zone was performed on three (3) piles, where one (1) pile was located at the Pier Extension and two (2) piles along the Main Pier.

## 3.3 Damage Ratings

ASCE Manuals and Reports on Engineering Practice No. 130, *Waterfront Facilities Inspection and Assessment* (ASCE 130) provides guidance on assigning a damage rating to various elements based on the field observations. The rating reflects the condition of the individual element only and provides a qualitative description of an element's condition based on the level of damage.

Damage ratings for the reinforced concrete elements such as portion of the deck slab, pile cap (bent) are described in Table 3.1 and depicted in Figure 3.1. Similarly, damage ratings for prestressed concrete elements such as the deck box girders and piles are described in Table 3.2 and shown on Figure 3.2.

***Table 3.1 Damage Rating for Reinforced Concrete Elements - ASCE 130***

| Damage Rating | Existing Damage |
|---|---|
| Not Inspected | Not inspected, inaccessible, or passed by |
| No Defects | Good original hard surface, hard material, sound |
| Minor | Mechanical abrasion or impact spalls up to 1-in in depth<br>Occasional corrosion stains or small pop-out corrosion spalls<br>General cracks up to 1/16" in width |
| Moderate | Structural cracks up to 1/16" in width<br>Corrosion cracks up to 1/4" in width |

| Damage Rating | Existing Damage |
|---|---|
| | Chemical deterioration: Random cracks up to 1/16” in width; “Soft” concrete and/or rounding of corners up to 1” deep<br>Mechanical abrasion or impact spalls greater than 1” in depth |
| Major | Structural cracks 1/16” to 1/4” in width and partial breakage (through section cracking with structural spalls)<br>Corrosion cracks wider than 1/4” and open or closed corrosion spalls (excluding pop-outs)<br>Multiple cracks and disintegration of surface layer due to chemical deterioration<br>Mechanical abrasion or impact spalls exposing the reinforcing |
| Severe | Structural cracks wider than 1/4” or complete breakage<br>Complete loss of concrete cover due to corrosion of reinforcing steel with more than 30% of diameter loss for any main reinforcing bar<br>Loss of bearing and displacement at connections<br>Loss of concrete cover (exposed steel) due to chemical deterioration<br>Loss of more than 30% of cross-section due to any cause |

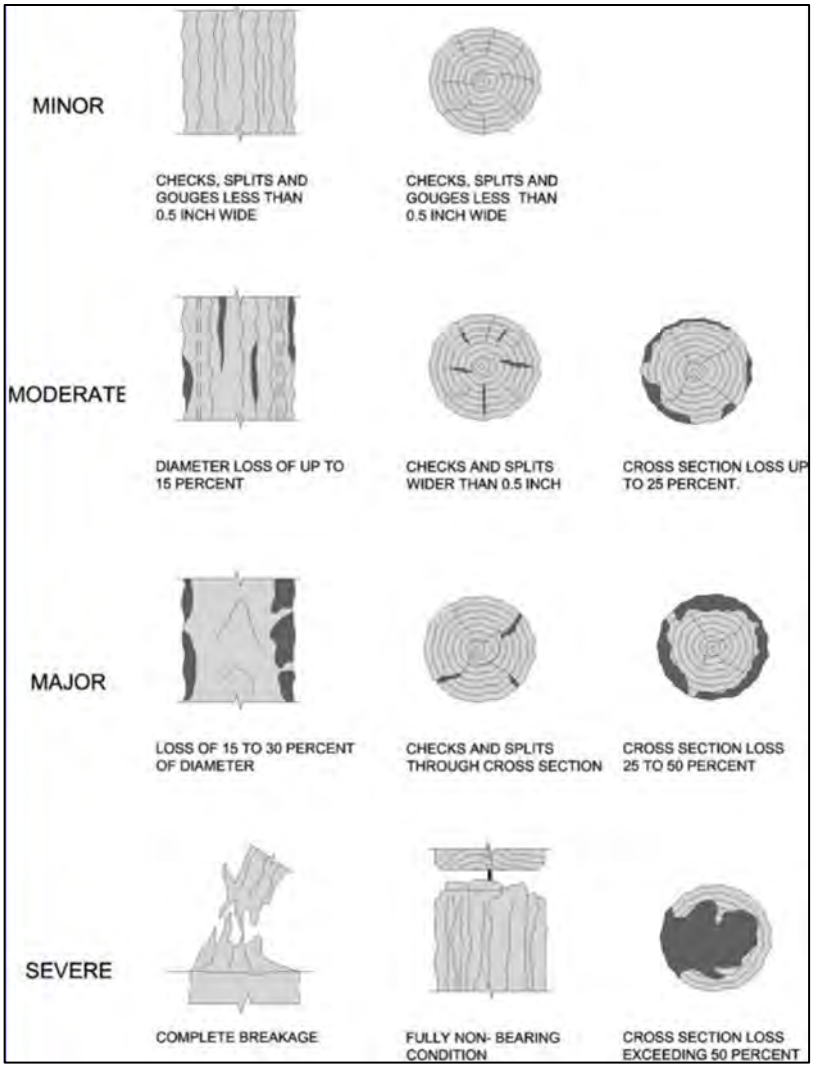



*Figure 3.1 Damage Ratings Sketches for Reinforced Concrete Elements*

*Table 3.2 Damage Rating for Prestressed Concrete Elements*

| Damage Rating | Existing Damage |
|---|---|
| Not Inspected | Not inspected, inaccessible, or passed by |
| No Defects | Good original hard surface, hard material, sound |
| Minor | Minor mechanical or impact spalls up to 0.5” deep |
| Moderate | Structural cracks up to 1/32” in width<br>Chemical deterioration: Random cracks up to 1/32” in width |
| Major | Structural cracks 1/32” to 1/8” in width<br>Any corrosion cracks generated by strands or cables<br>Chemical deterioration: cracks wider than 1/8”<br>“Softening” of concrete up to 1” deep |
| Severe | Structural cracks wider than 1/8” and at least partial breakage or loss of bearing<br>Corrosion spalls over any prestressing steel<br>Exposed prestressing steel<br>Partial spalling and loss of cross section due to chemical deterioration |

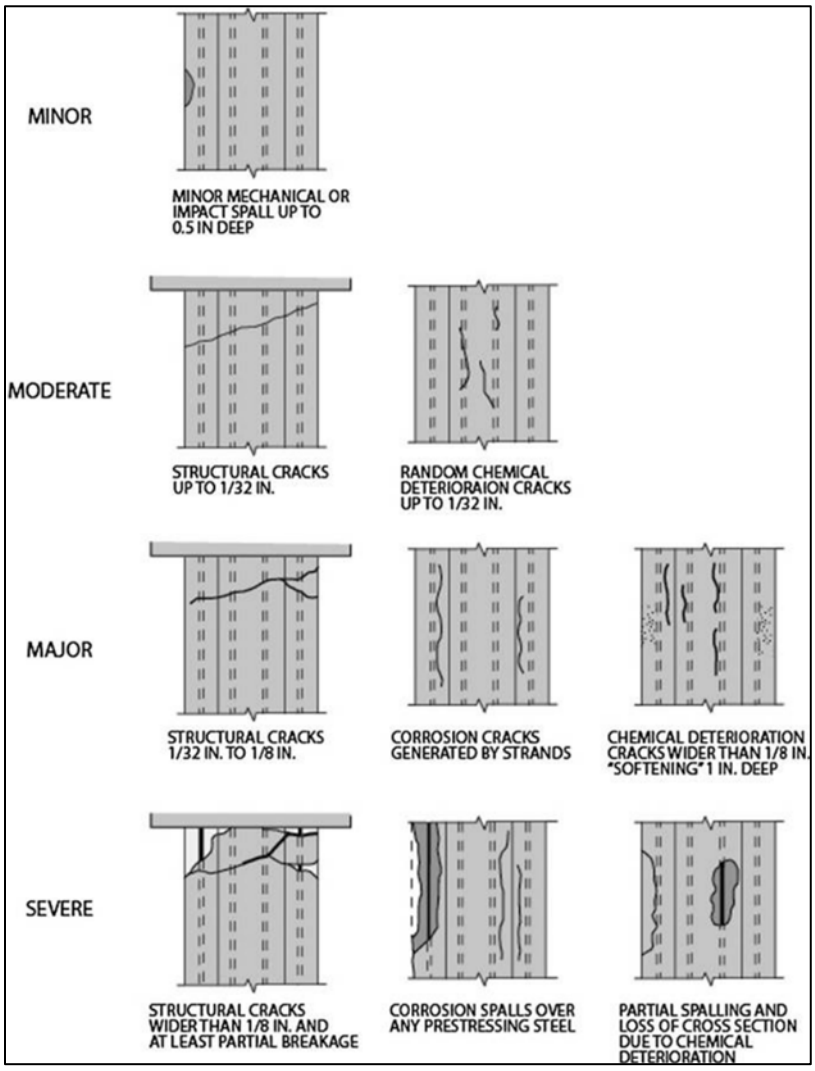



*Figure 3.2 Damage Ratings Sketches for Prestressed Concrete Elements*

## 3.4 Condition Assessment Rating

After completion of the inspection of individual structural elements a Condition Assessment Rating is assigned to the structure based on observed damages (both reinforced concrete and precast prestressed concrete elements), impact of the damages to the intended use, functionality, stability, and strength of the structure. The Condition Assessment Rating can be considered an overall rating for the structure and is impacted by the importance of a particular element to the function and integrity of the entire structure, e.g., secondary structures such as light poles, benches, water fountains may be noted to have critical damage or maybe non-functional, but they have minimal impact on the overall Condition Rating of the Pier.

The excerpt of various ratings from ASCE 130 is provided in Table 3.3.

*Table 3.3 Condition Rating*

| Rating | Description |
|---|---|
| Good | No visible damage or only minor damage noted.<br>Structural elements may show very minor deterioration, but no overstressing observed.<br>No repairs are required. |
| Satisfactory | Limited minor to moderate defects or deterioration observed but no overstressing observed.<br>No repairs are required. |
| Fair | All primary structural elements are sound but minor to moderate defects or deterioration observed.<br>Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure.<br>Repairs are recommended, but the priority of the recommended repairs is low. |
| Poor | Advanced deterioration or overstressing observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure.<br>Repairs may need to be carried out with moderate urgency. |
| Serious | Advanced deterioration, overstressing, or break age may have significantly affected the load-bearing capacity of primary structural components.<br>Local failures are possible, and loading restrictions may be necessary.<br>Repairs may need to be carried out on a high-priority basis with urgency. |
| Critical | Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components.<br>More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary.<br>Repairs may need to be carried out on a very high-priority basis with strong urgency. |

# 4. Condition Assessment Observations

The Pier structure and abutment are exposed to harsh marine environments, which include high wind and high wave loads. Continuous exposure to seawater or marine spray with recurring wet and dry conditions are detrimental to the concrete structure and leads to black/green algae growth in concrete, causing discoloration and formation of cracks. Cracks in concrete allow seawater to access the reinforcement, initiating corrosion. As corrosion expands around the circumference of the reinforcement, the bond between concrete and reinforcement weakens and results in delamination. The progressive delamination eventually leads to concrete breaking off from the reinforcement (spalling). Progressive spalling exposes prestressed/reinforced concrete steel and increases corrosion, which leads to reduced section capacity or permanent failure of that element (broken cross section).

# 4.1 Pier Abutment

The Pier abutment has several minor to moderate visible cracks on the deck surface, as shown on Figure 4.1. These cracks do not affect the structure and should be monitored over time. As cracks widen, they may cause localized spalls and/or tripping hazards for pedestrians.


*Figure 4.1 Visible Cracks on Abutment 1-A - Main Pier Entrance*

The abutment was drilled through at ten (10) locations around the Chit-Chat Café building. Drilling started from the south side of the building, coring holes at approximately 15' intervals, and ended on the north side entrance. The drill locations were labeled B-1 through B-10 as shown in Figure 4.2, to document the observations.

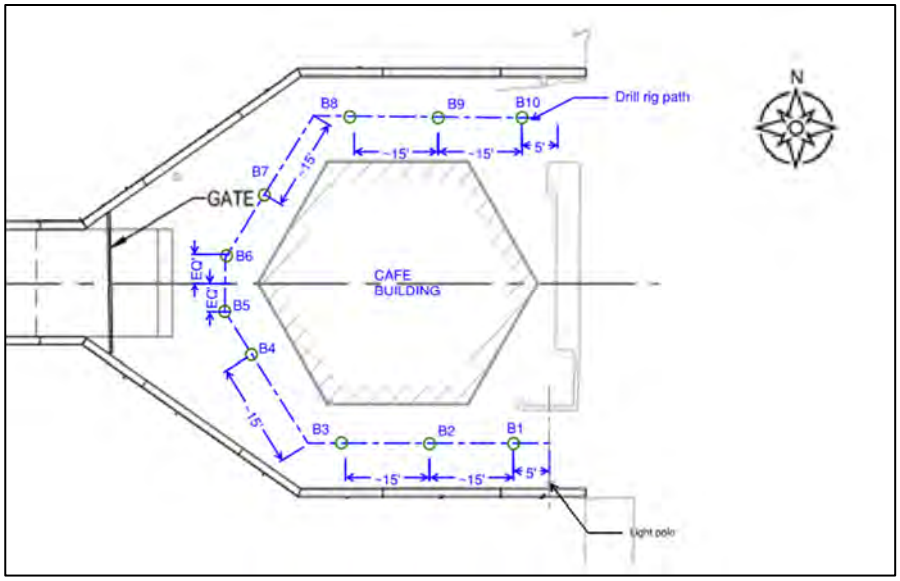



*Figure 4.2 Plan View of Drill Rig Path and Borehole Locations*

Initially, a high-pressure cutting machine (coring machine) extracted approximately 1' thick core of the concrete deck at each location; followed by the drill rig to drill through that hole until a hard pan founding layer was penetrated or approximately 25' to 30' depth below the concrete deck. At the end of drilling, the spoils i.e., fill material from the holes, were used to fill the hole and the top 1' was filled with cementitious grout.

Drill locations B-1 through B-9 all showed no voids in the abutment, as summarized in Table 4.1. Drilling location B-10 showed a 4" to 8" deep void directly below the concrete deck. In several locations, the coring cut through the deck reinforcement (0.5" bar) but should not affect the structural integrity of the deck supported on grade. Detailed field notes are provided in Appendix A.1

*Table 4.1 Summary of Drilling Findings*

| Core ID | Drilled Depth (ft) | Comments |
|---|---|---|
| B-1 | 30 | No Rebar was noted in the core sample and no void in the abutment |
| B-2 | 30 | No Rebar was noted in the core sample and no void in the abutment |
| B-3 | 15 | 0.5" Rebar was noted in the core sample and no void in the abutment |
| B-4 | 25 | No Rebar was noted in the core sample and no void in the abutment |
| B-5 | 22 | 0.5" Rebar was noted in the core sample and no void in the abutment |
| B-6 | 25 | 0.5" Rebar was noted in the core sample and no void in the abutment |
| B-7 | 25 | 0.5" Rebar was noted in the core sample and no void in the abutment |
| B-8 | 25 | 0.5" Rebar was noted in the core sample and no void in the abutment. Water in core hole drained quickly, indicating no signs of water accumulation behind the wall |
| B-9 | 25 | No Rebar was noted in the core sample and no void in the abutment |
| B-10 | 20 | No Rebar was noted in the core sample and 4"-8" void was found directly under concrete deck. |

The observed damage along the pier is summarized in Table 4.2. All images and detailed observation from the inspection are provided in Appendix A.1.

*Table 4.2 Damage Ratings - Pier Abutment*

| Structural Element | Bent ID | General Observation | Rating |
|---|---|---|---|
| Abutment | NA | – Rust bleed stains around sheet pile/abutment concrete cap interface, abutment concrete cap and handrails connection<br>– Loss of steel sheet piles<br>– Minor cracks on reinforced concrete retaining wall<br>– Minor to moderate cracks on abutment concrete cap<br>– Minor to moderate corrosion and structural spalls on abutment concrete cap<br>– Discoloration of concrete (black/green algae) | Moderate |

The old gate at the entrance broke due to high winds on 02/14/2023 and replaced by the time the deck delamination survey was performed (04/12/2023), as shown in Figure 4.3 and Figure 4.4, respectively.

*Figure 4.3 Main Pier Entrance Gate - Damaged*

*Figure 4.4 Main Pier Entrance Gate - Replaced*

# 4.2 Pier

The Pier structure inspection included deck, handrails, exterior faces of box girders, bent caps, and piles.

## 4.2.1 Handrails

The deck handrails were previously evaluated in June 2022, and the observed damages were documented in a technical memorandum “Condition Assessment of Pier Handrails” (August 2022). The memorandum is provided in Appendix C.

Handrail panels with damage at or extending towards the deck were assigned severe and major damage ratings as the damage typically weakened the connection to the deck. Elements rated with severe damage included completely broken panels, severely corroded reinforcement, cracks, spalls, and rust stains at the deck level; major ratings included damage extending towards the deck level.

Minor and moderate damage ratings included damage at the top to around mid-height of the panel. Damages with open spalls, rust stains, and visible corroded rebar were rated as moderate; other visible damages like cracks with no spalls and rust stains were rated as minor.

The collapsed panels were recommended to be temporarily replaced with chain link fences until new concrete panels were installed.

A total of 164 panels were assessed on site in June 2022 and the corresponding damage rating for the panels have been summarized in Table 4.3. Some panel ratings were revised accounting for the condition noted in the previous years' assessment and relative change over the year.

*Table 4.3 Summary of Assessment – Damage Ratings*

| Assessment | Year 2022 | Year 2021 |
|---|---|---|
| No Damage | 13 | 25 |
| Minor Damage | 29 | 29 |
| Moderate Damage | 29 | 30 |
| Major Damage | 56 | 36 |
| Severe Damage | 37 | 44 |

### 4.2.2 Deck, Sides and Soffit

The deck surface was inspected for visible damage. Typically, damage observed on the deck were cracks, uneven surface due to broken concrete, rust stains, and spalls. Most of the damage was found on the prestressed box girder ends of the deck cross section, likely due to the water from high waves splashing against piles and handrails and entering the deck through scupper openings in the handrails.

A chain drag survey to identify the areas of delamination in the concrete deck was performed on February 13 and April 12, 2023. A delaminated section of concrete produces a different frequency sound than an intact section of concrete. Delaminated locations as identified by the "drummy" sound were recorded. After identifying the general area of delamination on the deck, a hammer was used to sound the concrete and determine the extent of delamination.

The locations of the delaminated areas are marked as A1 through A127 in Appendix A.2. Representative delaminated locations are shown on Figure 4.5. Based on the survey, there is approximately 14,316 SF of delaminated area i.e., more than 50% of the deck area showed signs of delamination.

The condition of the Pier exterior sides and soffits were assessed from the images captured by the drone. The images were reviewed by GHD's engineers to identity damages such as discoloration from algae growth, rust stains, cracks, and spalls. Typical damages on the sides and soffits of the deck and bent caps are shown in Figure 4.6 through


*Figure 4.5 Delaminated Areas at Bent 4 - N-S Extension Pier*

*Figure 4.6 Deck Moderate Rating (Bent 1C)*

*Figure 4.7 Deck Major Rating (Bent 1F)*

*Figure 4.8 Deck Severe Rating (Bent 3)*

*Figure 4.9 Bent Major Rating (Bent 1B)*

*Figure 4.10 Bent Severe Rating (Bent 3)*

The observed damage along the pier is summarized in Table 4.4. All images and detailed observation from the inspection are provided in Appendix A.3. Overall, most of the deck and bent cap have damage ranging from major to severe.

*Table 4.4 Damage Ratings - Deck*

| Structural Element | Bent ID | General Observation | Rating |
|---|---|---|---|
| Deck | Bent 1C | – Discoloration of concrete (black/green algae)<br>– Rust bleed stains around and underside of deck and handrail connection<br>– Minor to moderate corrosion and structural spalls<br>– Minor to moderate cracks | Moderate |
| | Bents 1F, 1G, 1H, 1I, IJ, 1K. 1L, 1M, 1N, 1P | – Discoloration of concrete (black/green algae)<br>– Rust bleed stains around and underside of deck and handrail connection<br>– Moderate to major corrosion and structural spalls<br>– Moderate to major cracks | Major |
| | Bents 1B, 1D, 1E, 1O, 1Q, 1R, 2, 3, 4 | – Discoloration of concrete (black/green algae)<br>– Rust bleed stains around and underside of deck and handrail connection<br>– Moderate to severe corrosion and structural spalls with visible rebar<br>– Moderate to severe cracks and rust bleed stains around deck underside edges | Severe |

| | | | |
|---|---|---|---|
| Bent | Bents 1B, 1C, 1F, 1H, 1I, 1J, 1K, 1N, 2 | – Discoloration of concrete (black/green algae) on bent<br>– Rust bleed stains around connections and underside edges of bent and bearing plate<br>– Moderate to major corrosion and structural spalls on Bent<br>– Moderate to major cracks and rust bleed stains around bent underside edges | Major |
| | Bents 1D, 1E, 1G, 1L, 1M, 1O, 1P, 1Q, 1R, 3, 4 | – Discoloration of concrete (black/green algae) on bent<br>– Rust bleed stains around connections and underside edges of bent and bearing plate<br>– Moderate to severe corrosion and structural spalls on Bent with visible rebar<br>– Moderate to severe cracks and rust bleed stains around bent underside edges | Severe |

### 4.2.3 Piles

The pile inspection was performed by New Age Aerials and Sea Engineering (below water only).

New Age Aerials used the drone to perform a visual inspection above water for all the piles and the ROV for 5 piles below water (3 on Main Pier, 2 on Pier Extension). Sea Engineering's divers performed Level I and Level II underwater inspection of the precast prestressed concrete piles.

All the piles inspected below the water line are noted in Figure 4.11. The piles showed no signs of damage below the MHW water line and minimal scouring was observed around the piles at seabed. The damage rating for the piles as noted in Figure 4.12 was governed by the conditions observed above the waterline.

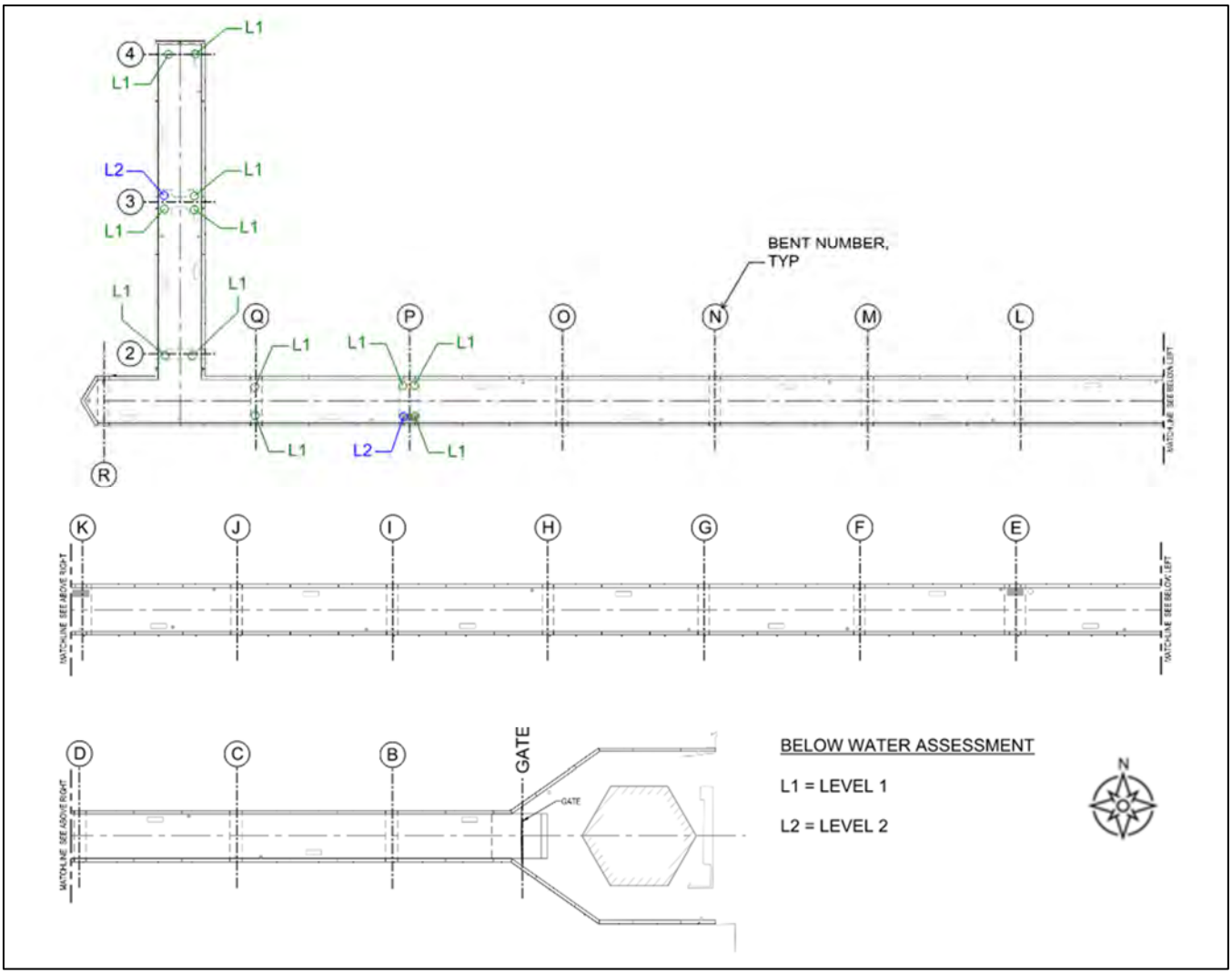



*Figure 4.11 Underwater Pile Inspection Locations – Sea Engineering Report*

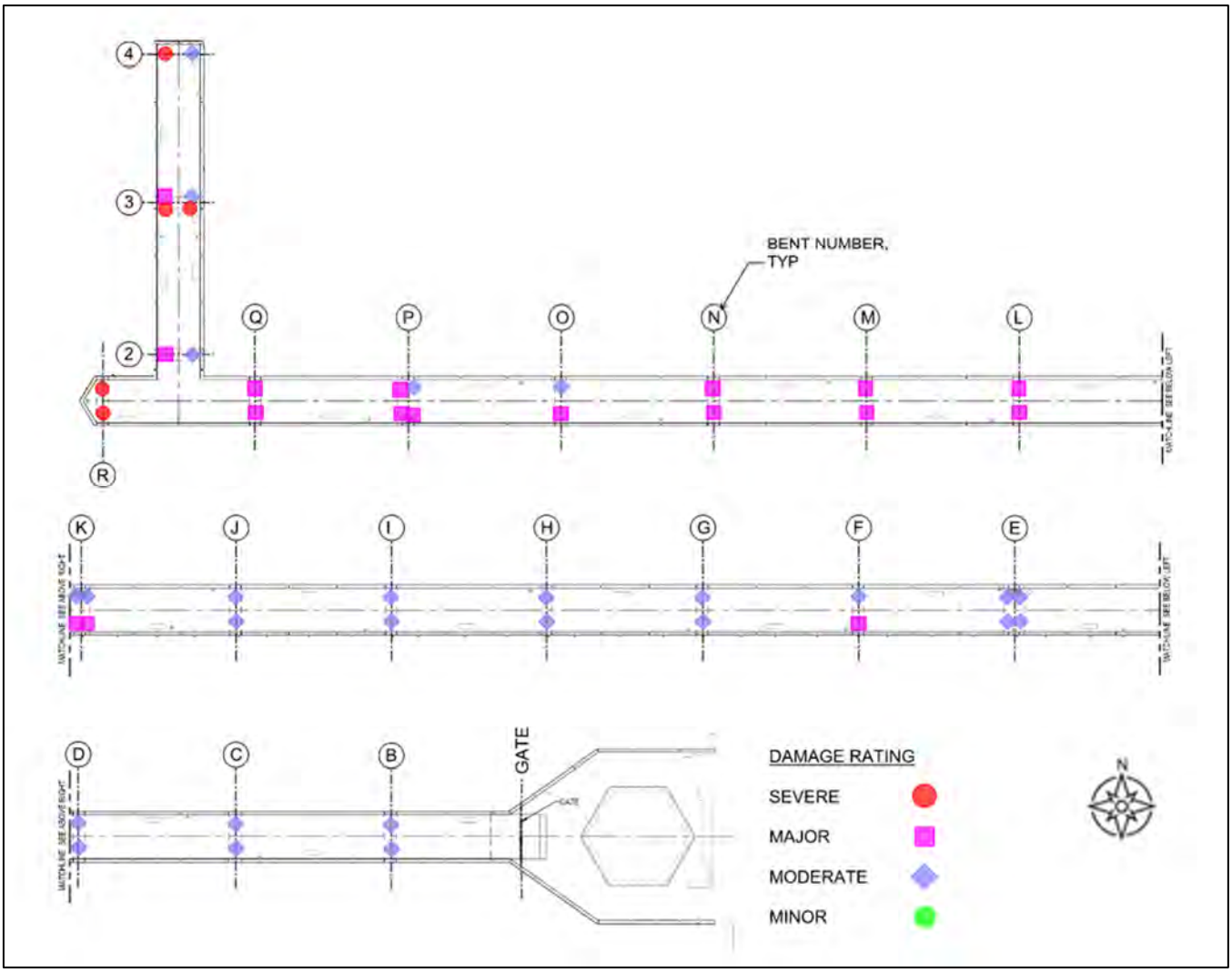



*Figure 4.12 Damage Ratings – Piles (Combined Above and Below Water Condition)*

### 4.2.3.1 Level I Assessment

Typical observations from the inspection as shown in Figure 4.13 through Figure 4.16 include:

- Marine growth around the shoreside of piles. The marine growth was most dense for approximately 8’ along the pile.
- From mudline to +8’ no marine growth was observed. From +8’ to +18’ above mudline marine growth was observed. Approximately 75% marine growth included a mixture of soft corals, sea stars, hard mussels, and barnacles. From 18ft above mudline to MHW marine growth was also observed. This marine growth included 100% of 6” thick barnacles and mussels with fishing line, ropes, and fishing tackle.
- No scour was observed. The seabed approximately 30’ away from Bent 1P looked even.
- Concrete spall on sides exposed to most direct wind and waves. The spiral reinforcement is exposed to continued corrosion and impacts the load carrying capacity of the piles.
- Discoloration of concrete.
- No broken piles.

*Figure 4.13 Pier Extension - Bent 4 Piles*

*Figure 4.14 Pile Damage Rating - Moderate (Bent 1G)*

*Figure 4.15 Pile Damage Rating - Major (Bent 1K)*

*Figure 4.16 Pile Damage Rating - Severe (Bent 1R)*

A summary of Level I assessment is provided in Table 4.5. Most of the piles have a damage rating of moderate to major. The damage is likely caused by the constant impact of waves and strong winds against piles.

*Table 4.5 Damage Ratings - Piles*

| Description | Bent ID | General Observation | Rating |
|---|---|---|---|
| Pile | Bents 1B, 1C, 1D, 1E, 1F, 1G, 1H, 1I, 1J, 1K, 1O, 1P, 2, 3 | – Rust stains and moderate cracks on piles<br>– Abrasion on piles<br>– Minor impact spalls on piles | Moderate |
| | Bents 1F, 1K, 1L, 1M, 1N, 1O, 1P, 1Q, 2, 3 | – Rust stains and moderate to major cracks on piles<br>– Abrasion on piles<br>– Minor impact to Major corrosion and structural spalls on piles | Major |
| | Bents 1R, 3, 4 | – Rust stains and moderate to major cracks on piles<br>– Abrasion on piles<br>– Major to severe corrosion and structural spalls on piles and visible rebar | Severe |

### 4.2.3.2 Level II Assessment

Level II observations are documented at three elevations along the length of the pile - at mudline, mid-water, and tidal zone. The piles were chosen based on the conditions observed in the field. All piles were observed to have some sort of damage.

– North-west pile at Bent 3 on Pier Extension. South-west pile at Bent 3 was noted to be in severe condition above MHW water level.
– South-west pile at Bent P on E-W Main Pier as it appeared to have some damage as seen in drone images.

– South-west pile at Bent K on E-W Main Pier because divers found a crack on pile near MHW level close to marine growth.

The divers noted no damages on the piles after removing the marine growth, as shown in Figure 4.17. Appendix B provides detailed information on the inspection observations by Sea Engineering. In general, the observations included the following:

- Abrasion on piles
- Discoloration of concrete
- Typical marine growth
- No Damage

Overall Rating of Piles below MHW Level are Minor.

*Figure 4.17 Typical Pile Condition – Level II Inspection*

# 5. Overall Assigned Condition Rating

Based on the observations and condition assessment of individual components of the Pier, the overall condition ratings for different segments of the Pier are as follows:

– Main Pier starting from Abutment to Bent 1-Q is rated as Poor.
– Main Pier between Bent 1-Q to Bent 1-R is rated as Serious.
– Pier Extension is rated as Serious.

The Pier segments rated as Poor are based on the following observations:

– Major to severe structural and corrosion cracks mostly concentrated on prestressed concrete box girder sections in between bents and on bent caps, below deck line and on the exterior wings of the deck cross section.
– Major to severe structural and corrosion spalls with visible rebar/prestressing steel concentrated on prestressed concrete box girder sections in between bents and on bent caps, below deck line and on the exterior wings of the deck cross section.
– Moderate to major damage on piles (no visible rebar/prestressing steel).

The Pier segments rated as Serious are based on the following observations:

– For deck and bent caps – same observation as noted for segments rated as Poor.
– Severe damage on piles with visible rebar/prestressing steel expected to reduce the load bearing capacity, and local failures may occur in extreme events.

Figure 5.1 shows the limits for pier abutment and pier structure condition rating.

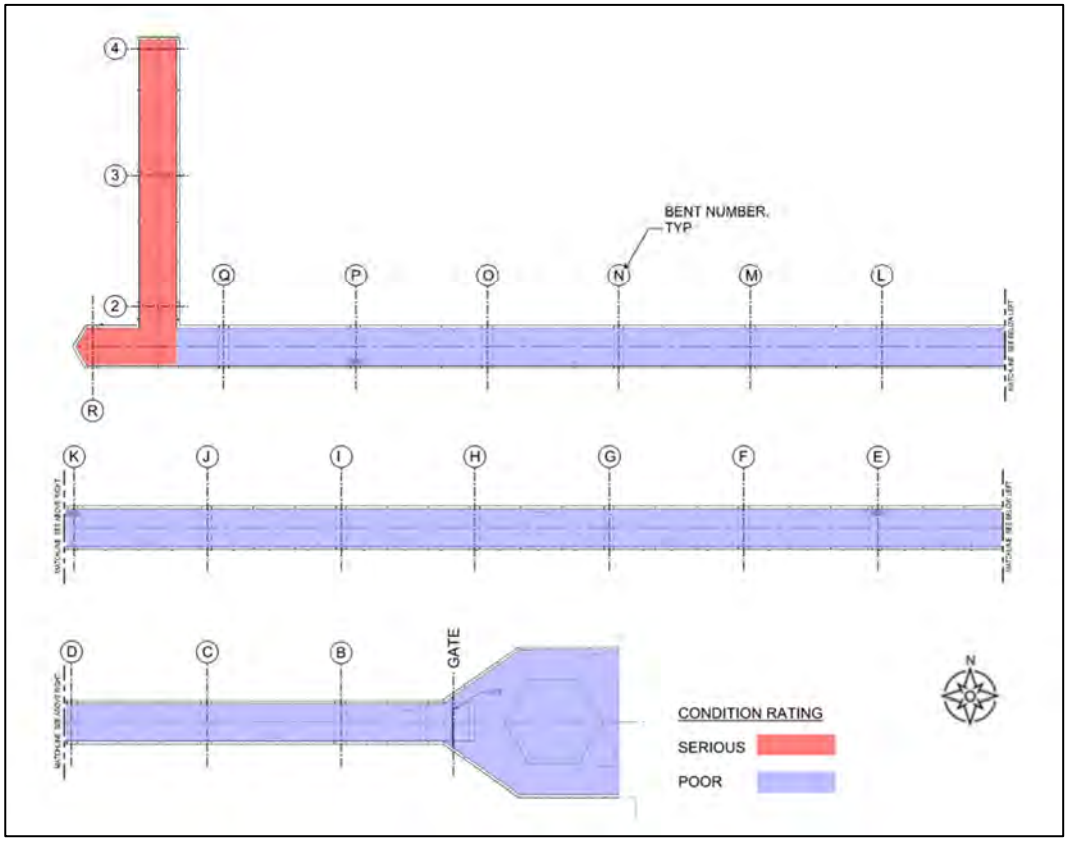



*Figure 5.1 Structure Condition Rating*

# 6. Recommendations

## 6.1 Reduced Loading

Based on the observed conditions, it is recommended to reduce the overall loading on the Pier. The Pier may continue to be used as a recreational fishing pier, however, it is recommended to reduce live load rating to 50-psf, see Figure 6.1. Vehicle access should also be limited to a single work truck (GVWR 11500-lbs, similar to Ford F-250 truck) at a given time and access should be prohibited at the offshore end of the Main Pier and on the East-West Pier until the piles are repaired. The Pier should be closed for all public access before and during anticipated storm events that can subject the piles to high winds, swells, and large waves and reopened after a condition assessment.

| 50 psf | 100 psf | 150 psf |
|---|---|---|

*Figure 6.1 Live Load Graphical Representation – AASHTO Pedestrian Bridge Code*

## 6.2 Conceptual Repairs

The conceptual repairs are intended to slow the rate of continued deterioration, restoring as-built capacity, and strengthening of the existing structural elements as needed. The methods and type of repairs are based on damage observed during the field surveys and use of repairs in similar conditions on other projects. These repairs are considered maintenance and serve to extend the service life of the pier, typically 10 to 15 years.

### 6.2.1 Deck Repairs

There are two types of concrete spalls: closed and open.

Closed spalls may appear as cracks in the concrete, but underneath a section of the concrete may have separated from the rebar. The deteriorated concrete is removed and replaced with new concrete that bonds with the reinforcement steel.

Open spalls are where a layer of concrete has completely separated, typically due to rebar corrosion. This causes the steel to expand, pushing the concrete away from the reinforcement. The damaged area would be sawcut and then chipped out to expose the sound concrete. The corroded reinforcing steel would be blasted clean before placement of new concrete. If there is significant section loss, additional reinforcing steel will be installed to restore the structural capacity. Where reinforcing bars are exposed during repairs, galvanic anodes for full extent of spall repair should be installed. The area would then be filled with a self-leveling epoxy or cementitious grout and provided a smooth finish suitable for walking surfaces. See Figure 6.2 for sketch of typical deck spall repair detail.

In critical conditions, the rebar has suffered significant or complete section loss, thereby not providing any tensile strength to the concrete. In such instances, new rebar would be doweled in to replace the corroded rebar before adding new concrete.

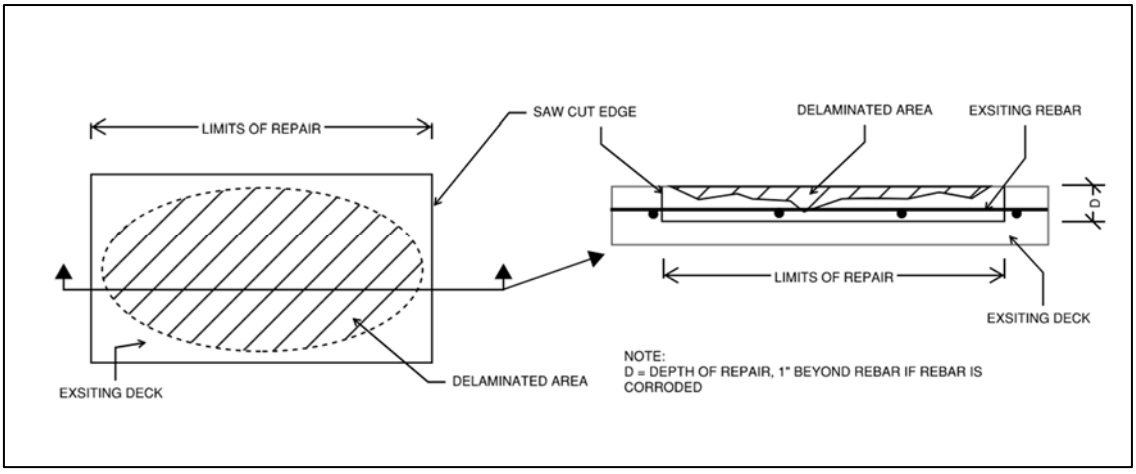



*Figure 6.2 Delamination Repair – Top Deck*

## 6.2.2 General Spall Repairs

Damage along the bottom and sides of the Pier is due to delamination of the concrete and corrosion of the reinforcing steel. The recommended repair as shown in  is similar to the deck repairs. The spalled and loose concrete is first removed and then the concrete surrounding the existing reinforcing is chipped away. The exposed reinforcing steel is cleaned of rust and scale, and an epoxy coating is applied to protect the reinforcing and increase bonding for the concrete.

If the reinforcing is found to have deteriorated to the point where a significant percentage of the original section has been lost, additional reinforcing will be doweled into the concrete and spliced with the existing steel. Alternatively, the damaged reinforcing may be cut out and a new section attached using mechanical connectors. The new reinforcing may be of a smaller diameter with less spacing to reduce the lap lengths required. Where reinforcing bars are exposed during repairs, galvanic anodes for full extent of spall repair should be installed.

Alternatively, instead of forming the sides and bottom of the deck to install new concrete, shotcrete may be applied directly to the surface after repairing the reinforcing bars. However, this alternative will require additional measures to catch any material that may not adhere to the Pier. The repair materials are prohibited from being discharged into the open waters.

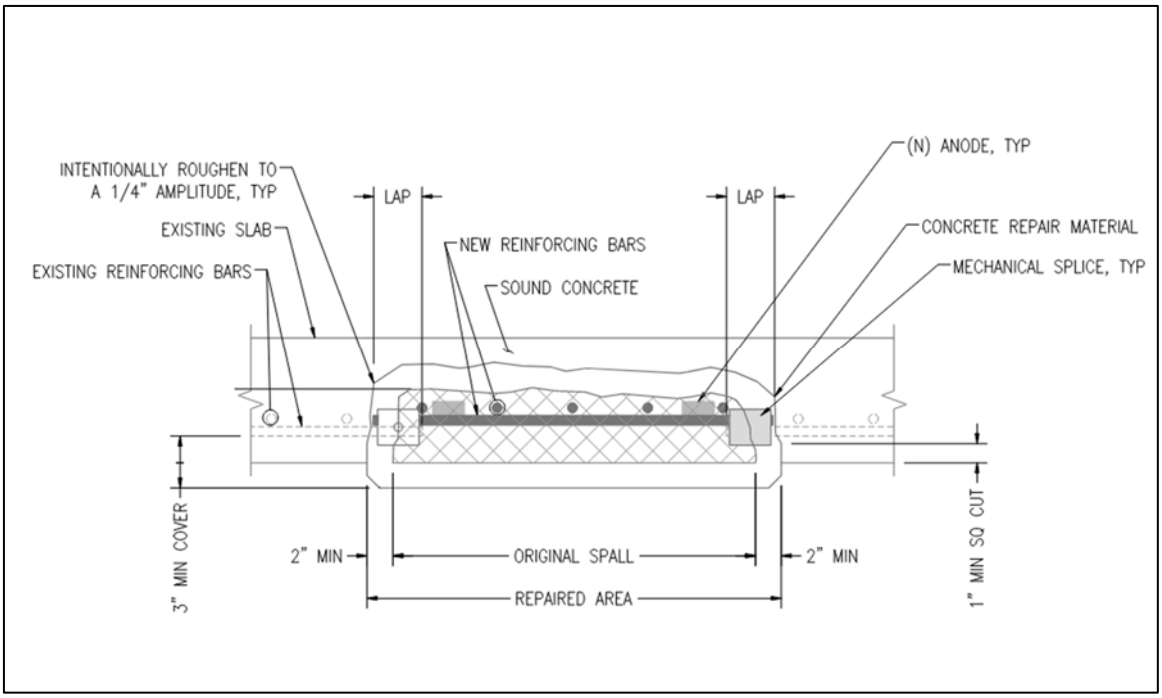



*Figure 6.3 Concrete Spall Repairs – Sides and Soffit*

## 6.2.3 Crack Repairs

Typical concrete crack repairs consist of filling the cracks with cementitious grout or injectable epoxy mixture. The cracks are widened to provide a clean adhering surface to installing sealant ports approximately every 6” along the crack, and then sequentially injecting epoxy into each port. This fills in the crack and mitigates moisture intrusion that may corrode the embedded reinforcing steel. A typical crack repair detail is shown in Figure 6.4. If areas around cracks indicate delamination or spalls, they can be repaired similar to spall repairs.

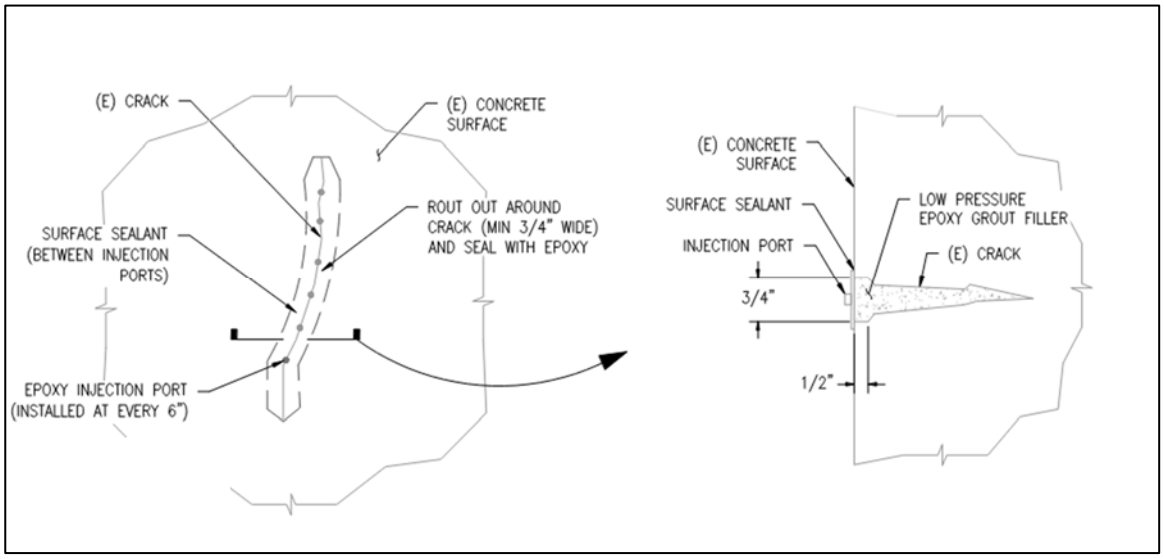



*Figure 6.4 Epoxy Injection Crack Repair Details*

## 6.2.4 Pile Repairs

The piles showing concrete cover loss, exposed rebar within the tidal zone or below water line can be repaired with the use of fiberglass (FRP) jackets. This repair has been used extensively for the repair of timber, steel and concrete piles that have suffered damage and deterioration and is well-suited for marine construction. The FRP jacket should extend above and below the high and low waterlines to cover the splash zone. The jackets can be extended to mudline if the damages are near the mudline.

The repairs can be accomplished from floating or fixed platforms under the pier and may need diver assistance for in-water work. The concrete surface is prepared by removing marine growth from the pile. The jackets are placed in position on the piles using spacers and reinforcing is placed within the annulus between the piles and jackets, if required to restore the structural capacity. Cementitious grout is then pumped into place in the annulus through ports in the shell, bonding with the existing concrete and preventing further deterioration of the section. The FRP jackets remain in place on the piles and offer abrasion resistance and provide a typical service life of 10 to 15 years. A sketch of this repair detail is shown below in Figure 6.5.

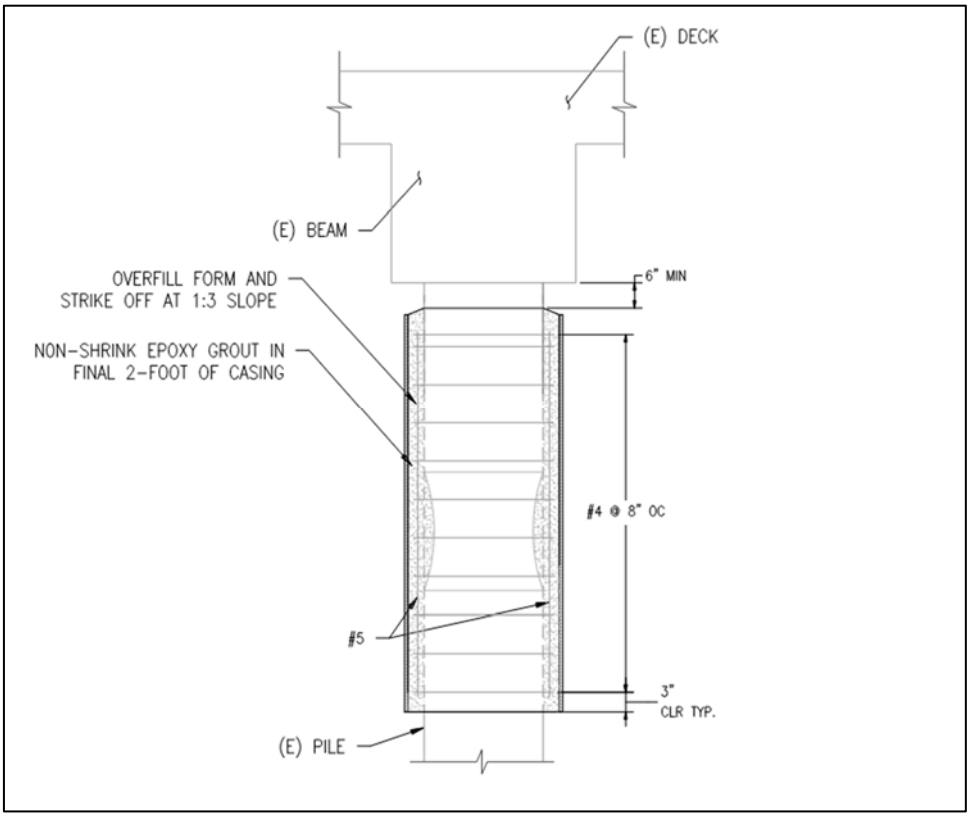



***Figure 6.5 Pile Repair near Waterline – FRP Jackets***

Repair of damaged piles near the deck or outside the areas impacted by water can be repaired similar to spall repairs. The concrete surface is prepared by chipping and removing the loose and unsound concrete and removing concrete from around the reinforcing steel. The exposed reinforcing steel is cleaned of rust and scale, and an epoxy coating is applied to protect the reinforcing and increase bonding for the concrete. If the reinforcing is found to have deteriorated to the point where a significant percentage of the original section has been lost, additional reinforcing will be doweled into the concrete and spliced with the existing steel. Alternatively, the damaged reinforcing may be cut out and a new section attached using mechanical connectors. Where reinforcing bars are exposed during repairs, galvanic anodes for full extent of spall repair should be installed.

Proper curing methods are then used to ensure that excessive shrinkage does not occur in the repair area. A sketch of the conceptual repair is shown in Figure 6.6.

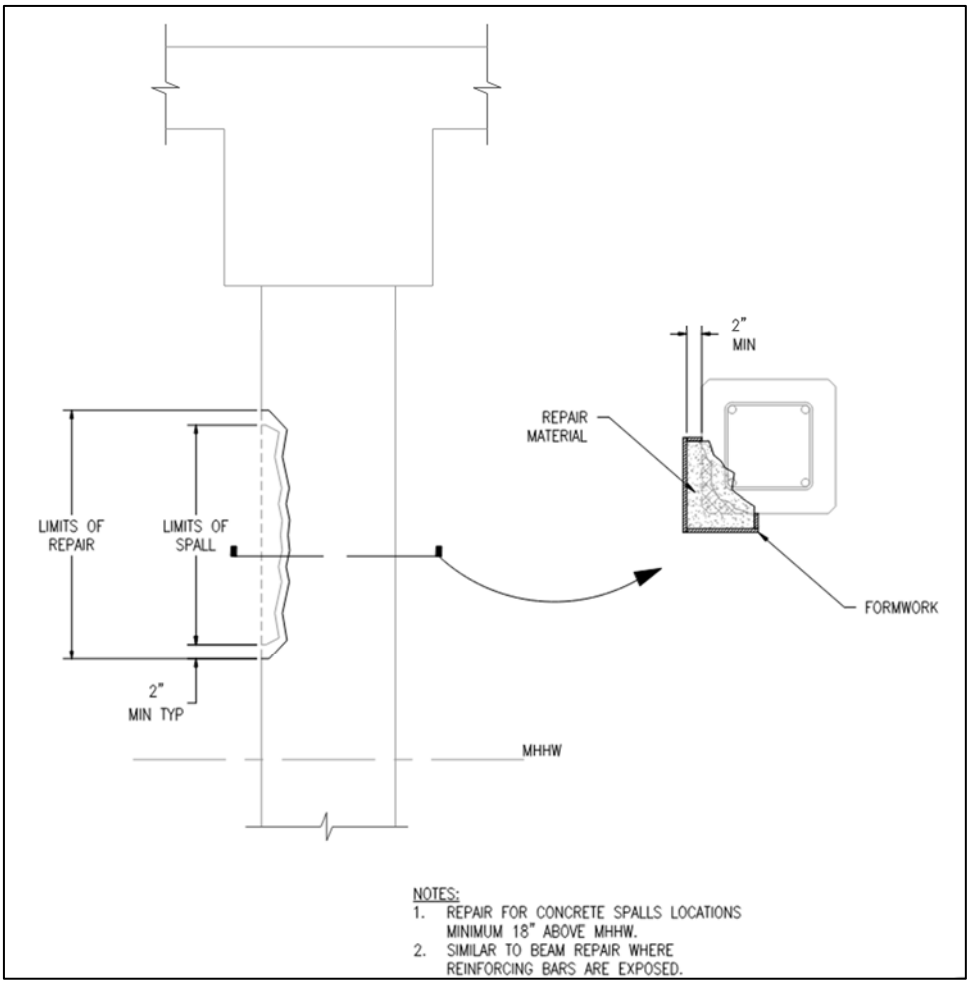



*Figure 6.6 Pile Repairs Outside Water*

### 6.2.5 Handrail Repairs

Various alternatives for the repair and replacement of existing handrails are provided in GHD's report titled "Condition Assessment of Pier Handrails – 2022" (August 2022) and in the construction drawings developed for the handrail replacement project in August 2022.

## 6.3 Future Assessments

ASCE 130 provides guidance for recommending level of assessment and frequency of assessment of the structure based on the condition ratings (Table 6.1). The maximum interval between inspections may be revised considering the extent of deterioration, implementation of repairs and rate of deterioration of elements that are not repaired.

– Routine Inspections:

It is recommended that a routine inspection of the entire Pier be undertaken annually. The piles and areas of the box girder that are not accessible from the deck can be assessed using a drone. The focus will be on estimating progress of damages over and the current condition of the Pier can be used as baseline for continued comparison.

– Post-Event Inspections:

The handrail panels, especially the ones parallel to shore, and the piles should be visually assessed before opening the pier after a major storm or seismic event. The recent storm events in December to January have brought significantly large waves and swells to the site. The structure should be assessed after swells of 15-ft and 12-second

period or greater. The assessment can be performed using a drone, focusing on visually observed spall, exposed rebar, broken elements etc.

The Routine Inspections can be scheduled at end of the storm season to combine the two inspections.

*Table 6.1 Recommended Inspection Schedule*

| Condition Rating | Maximum Interval (Years) |
|---|---|
| Good | 5 |
| Satisfactory | 5 |
| Fair | 4 |
| Poor | 4 |
| Serious | 2 |
| Critical | 0.5 |

# 7. ROM Cost Estimate

A Rough Order of Magnitude (ROM) cost-estimate is prepared based on the observed condition and proposed repairs. As the entire structure is rated as Serious condition, the repairs should be undertaken in a timely manner to maintain the current functionality and use of the structure. However, if the City requires undertaking repairs over time, the repairs can be prioritized as following:

Priority Level 1: Severe to Critical damages, require repairs within 0 to 1 year.

Priority Level 2: Moderate to Major damages, require repairs within 1 to 2 years and may be deferred with additional review.

Priority Level 3: Moderate to Major damages, require repairs within 1 to 5 years and may be deferred with additional review.

It is important to note the following assumptions in using the ROM cost-estimate.

– The costs shown are Rough Order of Magnitude (ROM) and may be used for budgeting purposes with appropriate contingencies. The time of bid solicitation, the number of interested bidders, mobilization cost, cost of contractual and insurance / bond requirements, cost of impact mitigation requirements outlined in project permits, cost of fuel, material supply chain, and available labor can significantly affect the project bids. Such factors are not captured in this estimate.
– The repair quantities are approximate based on the condition assessment and available data from aerial imagery for the structure that were not physically accessible (e.g. piles above water, underside of the pier etc.). Actual quantities may increase significantly during design development and construction. A resident engineer and/or construction manager should represent the Owner to verify areas of repair prior to beginning work and again verify quantities periodically.
– The unit rates used to calculate Low and High Cost are estimated rates based on limited bid data available to GHD from projects requiring repair in and over water bodies. However, an additional cost-estimate closer to the time of bid and based on the construction plans must be used to develop the project budget.
– Costs are based on the proposed conceptual repair details where typical construction methods can be utilized to complete the repairs. It is probable that some unique construction methodologies or repairs may be required after an engineering evaluation.

*Table 7.1 ROM Cost-Estimate*

| ID | Description | Priority Level | Location | Estimated Quantity | Quantity Unit | Low Cost | High Cost |
|---|---|---|---|---|---|---|---|
| 1 | Box girder spall repair, assume 4" thick | Level 1 | 8 | 2150 | SF | $ 1,700,000 | $ 2,200,000 |
| 2 | Concrete bent spall repair, assume 4" thick | Level 1 | 10 | 1700 | SF | $ 900,000 | $ 1,400,000 |
| 3 | Pile repair - FRP Jacket | Level 1 | 5 | 300 | LF | $ 400,000 | $ 500,000 |
| 4 | Box girder spall repair, assume 4" thick | Level 2 | 9 | 575 | SF | $ 500,000 | $ 600,000 |
| 5 | Concrete bent crack repair | Level 2 | 1 | 75 | LF | $ 100,000 | $ 100,000 |
| 6 | Concrete bent spall repair, assume 4" thick | Level 2 | 9 | 375 | SF | $ 200,000 | $ 300,000 |
| 7 | Pile repair - FRP Jacket | Level 2 | 1 | 60 | LF | $ 100,000 | $ 100,000 |
| 8 | Deck delamination | Level 3 | 127 | 14500 | SF | $ 1,100,000 | $ 1,900,000 |
| 9 | Concrete abutment crack repair | Level 3 | 1 | 30 | LF | $ 100,000 | $ 100,000 |
| 10 | Concrete abutment spall repair, assume 4" thick | Level 3 | 1 | 275 | SF | $ 200,000 | $ 300,000 |
| 11 | Box girder crack repair | Level 3 | 19 | 650 | LF | $ 500,000 | $ 600,000 |
| 12 | Box girder spall repair | Level 3 | 2 | 50 | SF | $ 100,000 | $ 100,000 |
| 13 | Concrete bent crack repair | Level 3 | 15 | 250 | LF | $ 200,000 | $ 300,000 |
| | **BASE COST** | | | | | $ 6,100,000 | $ 8,500,000 |
| | **RECOMMENDED CONTINGENCY %** | | | | | 50% | 30% |
| | **TOTAL COST (JAN 2024)** | | | | | **$ 9,150,000** | **$ 11,050,000** |

# Appendices

# Appendix A

## Condition Assessment - Details

A.1 Pier Abutment

A.2 Pier Structure – Deck Delamination Survey

A.3 Pier Structure – UAV (Drone) Imagery

A.4 Pier Structure – Damage Rating

# A.1. Pier Abutment - Drilling

### Field Notes for Drill Location B1

The concrete core extracted from deck showed no rebar and there was no void directly under deck.

*Table A.1-1 B1 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 0-3 | Coarse Aggregate Base |
| 3-11 | Sand/Cement and Rock |
| 11-16 | Crushed Rock - Soft |
| 16-21 | Cementitious - Hard |
| 21-25 | Cementitious- Hard |
| 25-30 | Clayey/Silty Sand/Gravel |
| 30 | Gravel and Clay |

### Field Notes for Drill Location B2

The concrete core extracted from deck showed no rebar and there was no void directly under deck.

*Table A.1-2 B2 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 0-3 | Coarse Aggregate Base |
| 3-11 | Sand/Cement and Rock |
| 11-16 | Crushed Rock - Soft |
| 16-21 | Cementitious - Hard |
| 21-25 | Cementitious- Hard |
| 25-30 | Clayey/Silty Sand/Gravel |
| 30 | Gravel and Clay |

### Field Notes for Drill Location B3

The concrete core extracted from deck showed 0.5” rebar and there was no void directly under deck.

*Table A.1-3 B3 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 0-7 | Dry Sand |
| 7-15 | Sandy/Loose Material |
| 15 | Hard pan - Metallic |

### Field Notes for Drill Location B4

The concrete core extracted from deck showed no rebar and there was no void directly under deck.

*Table A.1-4 B4 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 0-3 | Soft Sand |
| 3-6 | Gravel and Sand |
| 6-10 | Cement and Sand - Soft |
| 10-20 | Cement and Sand - Soft |
| 20-25 | Soft Clay |

**Field Notes for Drill Location B5**

B5 was in front of the gate, on the south side of the café building. The concrete core extracted from deck showed 0.5” rebar and there was no void directly under deck.

*Table A.1-5 B5 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 1-9 | Gravel/Crushed Rock and Sand |
| 9-12 | Cement Slurry - Medium Hard |
| 12-18 | Cement Slurry - Medium Hard |
| 18-20 | Cement Slurry - Hard |
| 20-21 | Cement Slurry - Hard |
| 21-22 | Hard pan layer – Rock (Broken Drill Bitt) |

**Field Notes for Drill Location B6**

B6 was in front of the gate, on the north side of the café building. The concrete core extracted from deck showed 0.5” rebar and there was no void directly under deck.

*Table A.1-6 B6 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 1-6 | Sand |
| 6-16 | Concrete Slurry |
| 16-19 | Cement and Sand - Softer |
| 19-22 | Cement and Sand - Hard |
| 22-25 | Clay and wood shavings |

**Field Notes for Drill Location B7**

B7 was located on the north side near the café exit door. The concrete core extracted from deck showed 0.5” rebar and there was no void directly under deck.

*Table A.1-7 B7 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 0-6 | Sand |
| 6-20 | Sand Slurry Gravel |
| 20-25 | Clay |

**Field Notes for Drill Location B8**

B8 is located on the north side near the café window, in front of second full handrail panel. – Material Observation The concrete core extracted from deck showed 0.5” rebar and there was no void directly under deck. Water in the core hole drained quickly, indicating no signs of water accumulation behind the wall.

*Table A.1-8 B8 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 1-4 | Sand |
| 4-17 | Slurry |
| 17-19 | Sand - Soft |
| 19-25 | Clay |

**Field Notes for Drill Location B9**

The concrete core extracted from deck showed no rebar and there was no void directly under deck.

*Table A.1-9 B9 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 1-3 | Sand |
| 3-17 | Slurry |
| 17-25 | Clay |

**Field Notes for Drill Location B10**

The concrete core extracted from deck showed no rebar and there was approximately 4” to 8” void directly under deck. The void may be due to deck’s uneven concrete thickness which can be possibly due to grout. The deck on the north side is relatively thicker. The void is not anticipated to have any impact on the structural performance of the pier abutment.

*Table A.1-10 B10 – Material Observation*

| Depth (ft) | Material Description |
|---|---|
| 1-7 | Slurry |
| 7-10 | Sand |
| 10-14 | Crushed Rock |
| 14-20 | Clay |


*Figure A.1-1 Drill Rig*


*Figure A.1-2 Coring Machine*

*Figure A.1-3 B1 Location*

*Figure A.1-4 B1 Core Sample*

*Figure A.1-5 B2 Location*

*Figure A.1-6 B2 Core Sample*

*Figure A.1-7 B3 Location*


*Figure A.1-8 B3 Core Sample*

*Figure A.1-9 B4 Location*

*Figure A.1-10 B4 Core Sample*

*Figure A.1-11 B5 location*


*Figure A.1-12 B5 Core Sample*

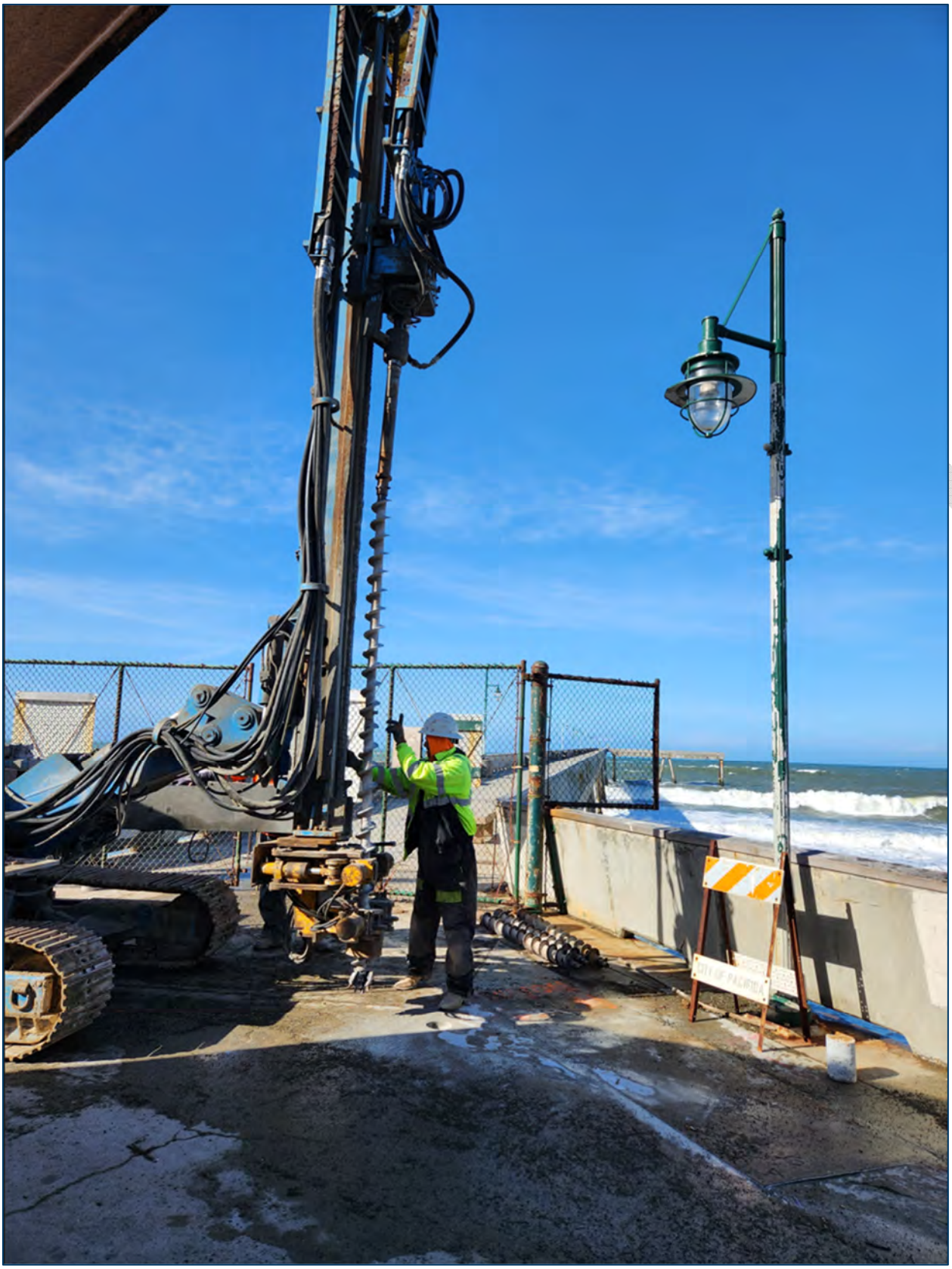


*Figure A.1-13 B6 location*


*Figure A.1-14 B6 Core Sample*

*Figure A.1-15 Wood Shavings at B6 Location*

*Figure A.1-16 B7 Location*


*Figure A.1-17 B7 Core Sample*


*Figure A.1-18 B8 Location*


*Figure A.1-19 B8 Core Sample*

*Figure A.1-20 B9 Location*

*Figure A.1-21 B9 core sample*


*Figure A.1-22 B10 Location*

*Figure A.1-23 B10 Core Sample*

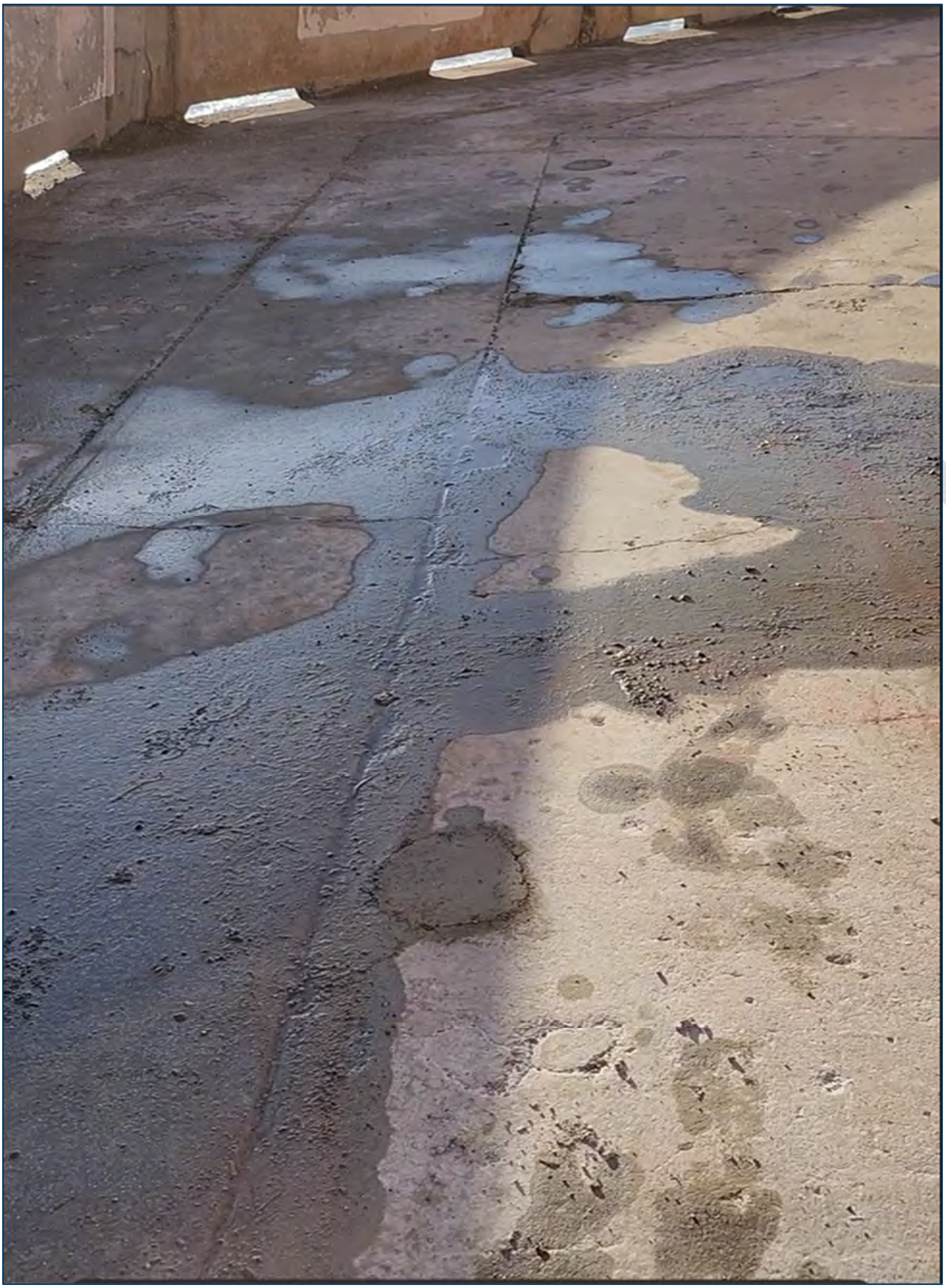


*Figure A.1-24 Typical photo of hole filled after drilling*

# A.2. Pier Structure - Deck Delamination Survey


*Figure A.2-1 Delaminated Areas at Bent 4 - N-S Extension Pier*

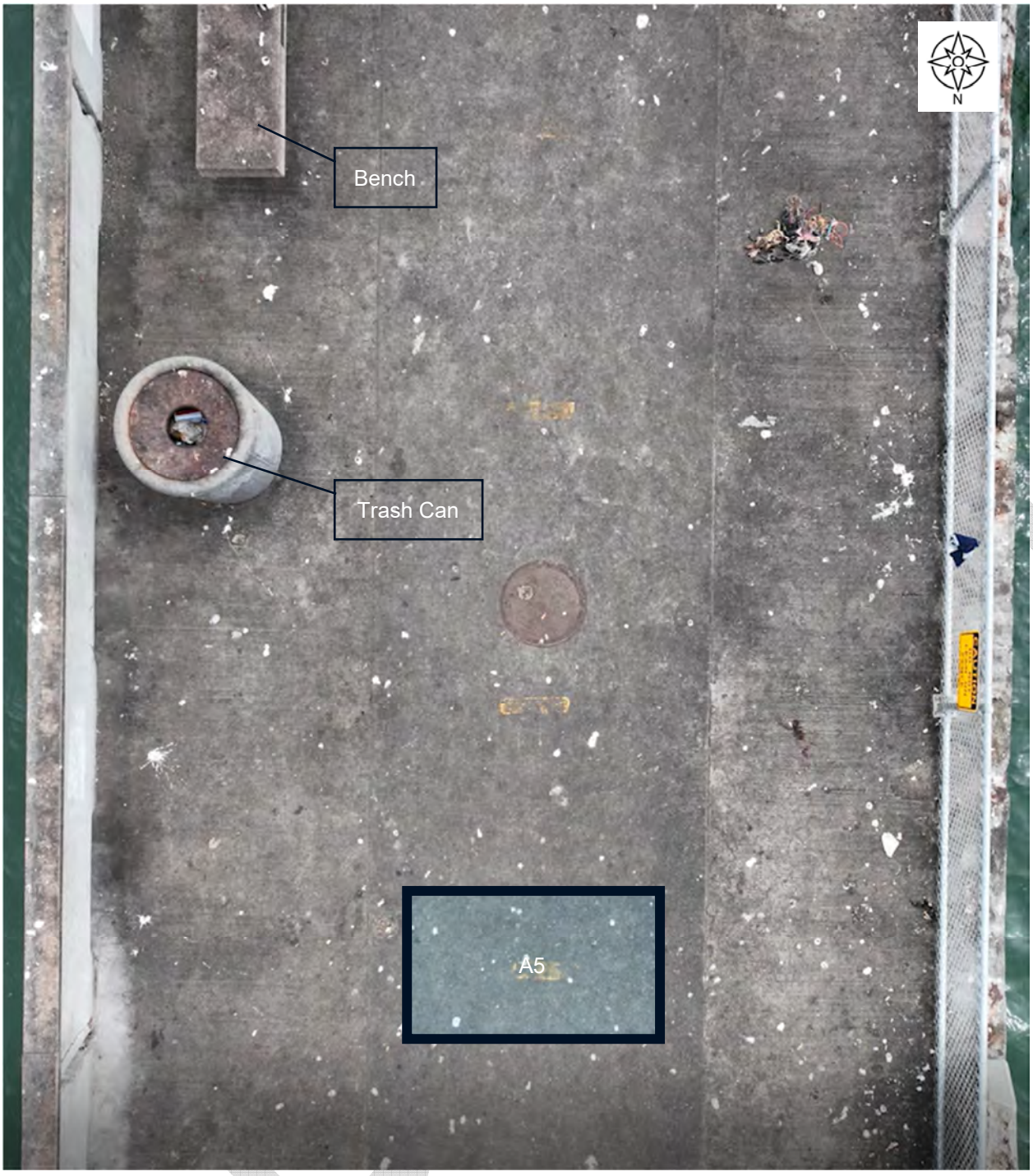



*Figure A.2-2 Delaminated Area between Bent 4 and Bent 3 - N-S Extension Pier*


*Figure A.2-3 Delaminated Areas Between Bent 4 and Bent 3 - N-S Extension Pier*


*Figure A.2-4 Delaminated Areas at Bent 3 - N-S Pier Extension*

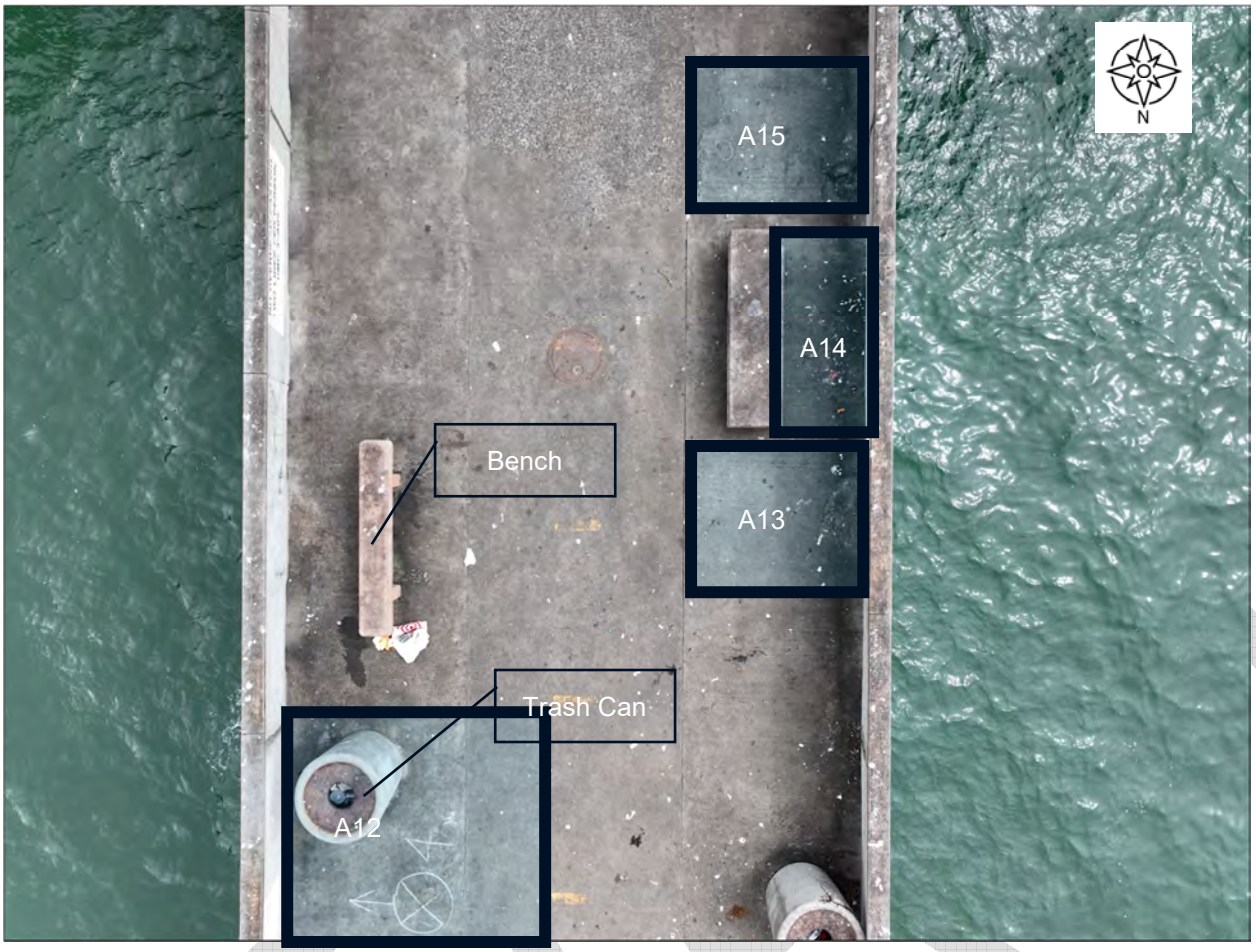



*Figure A.2-5 Delaminated Areas between Bent 3 and Bent 2 - N-S Pier Extension*

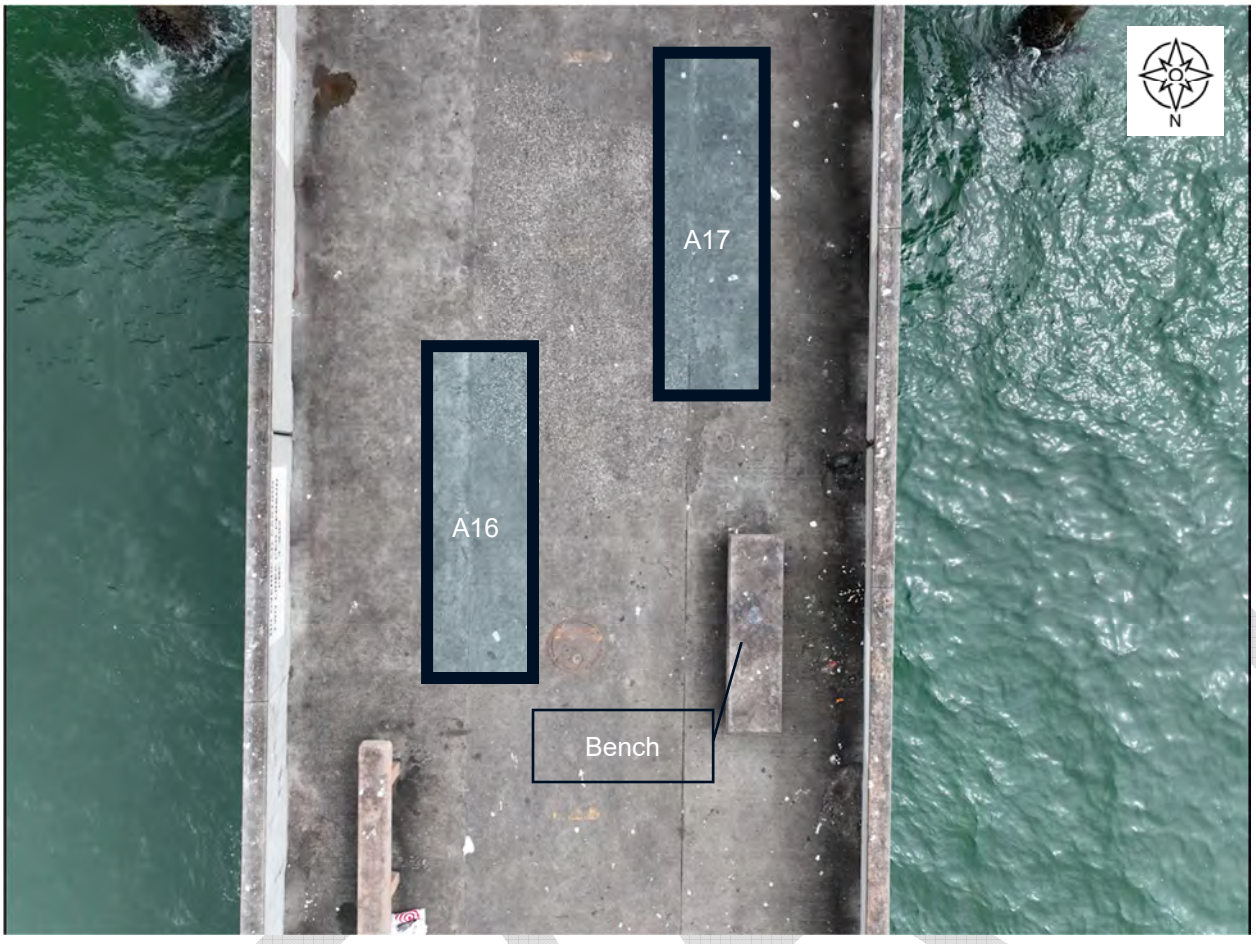



*Figure A.2-6 Delaminated Areas between Bent 3 and Bent 2 - N-S Pier Extension*

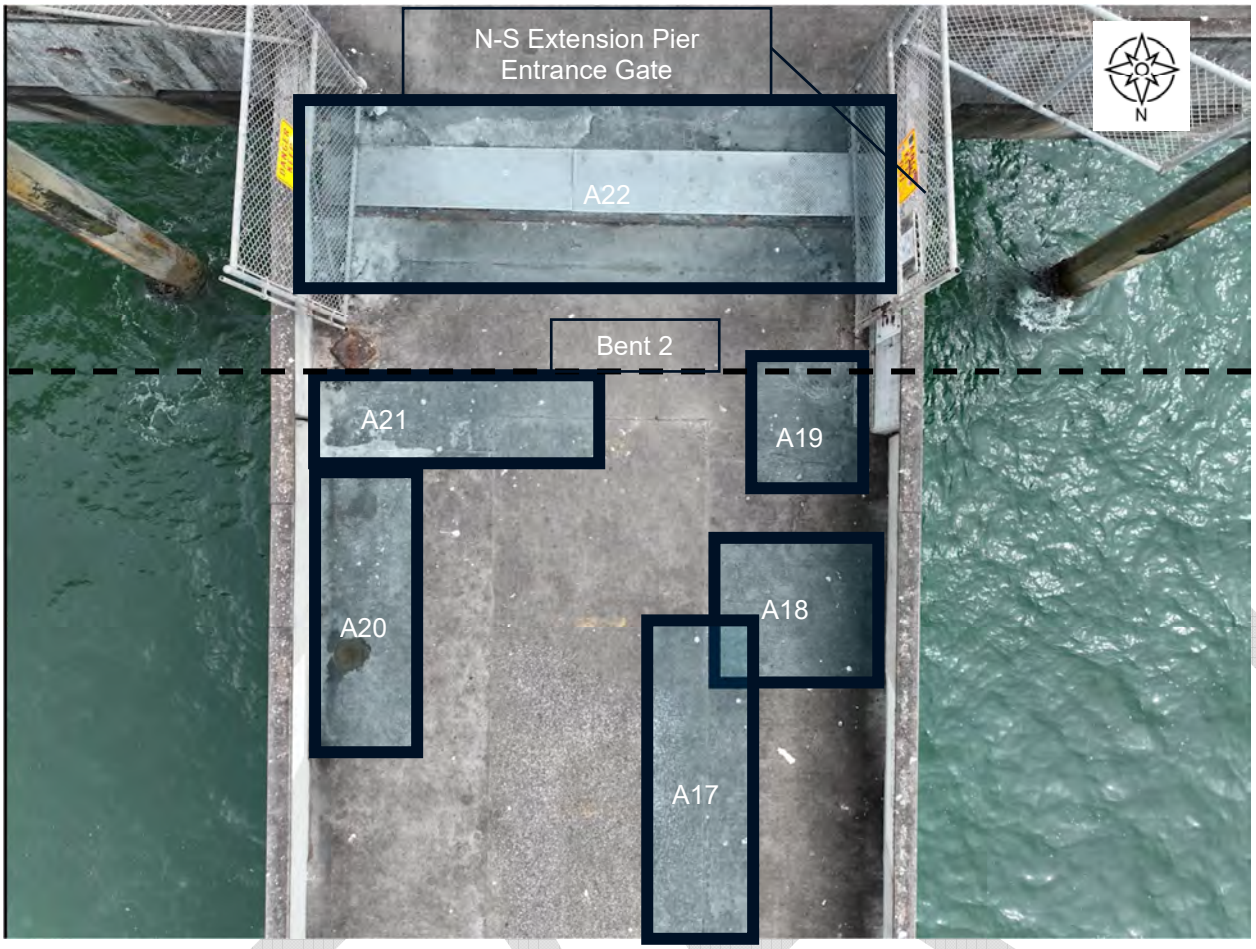



*Figure A.2-7 Delaminated Areas at Bent 2 - N-S Extension Pier Entrance*

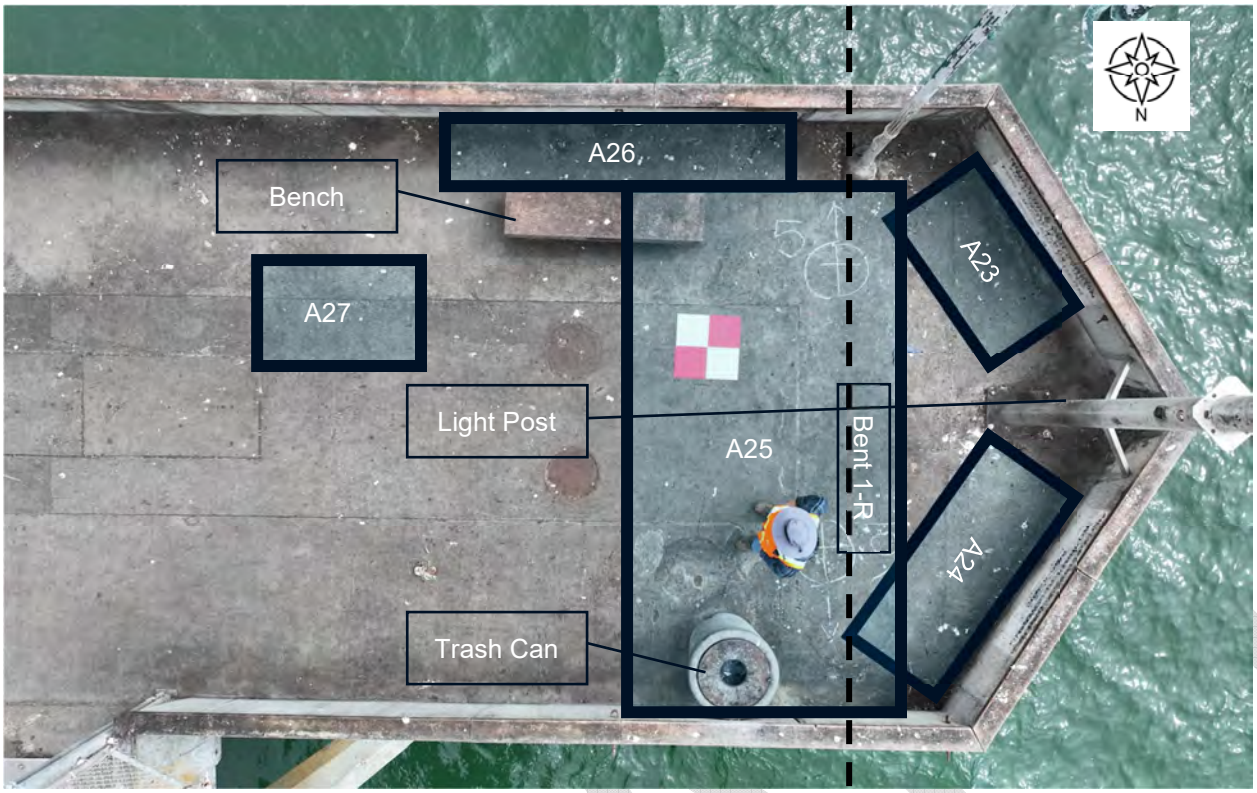



*Figure A.2-8 Delaminated Areas at Bent 1-R - E-W Main Pier*

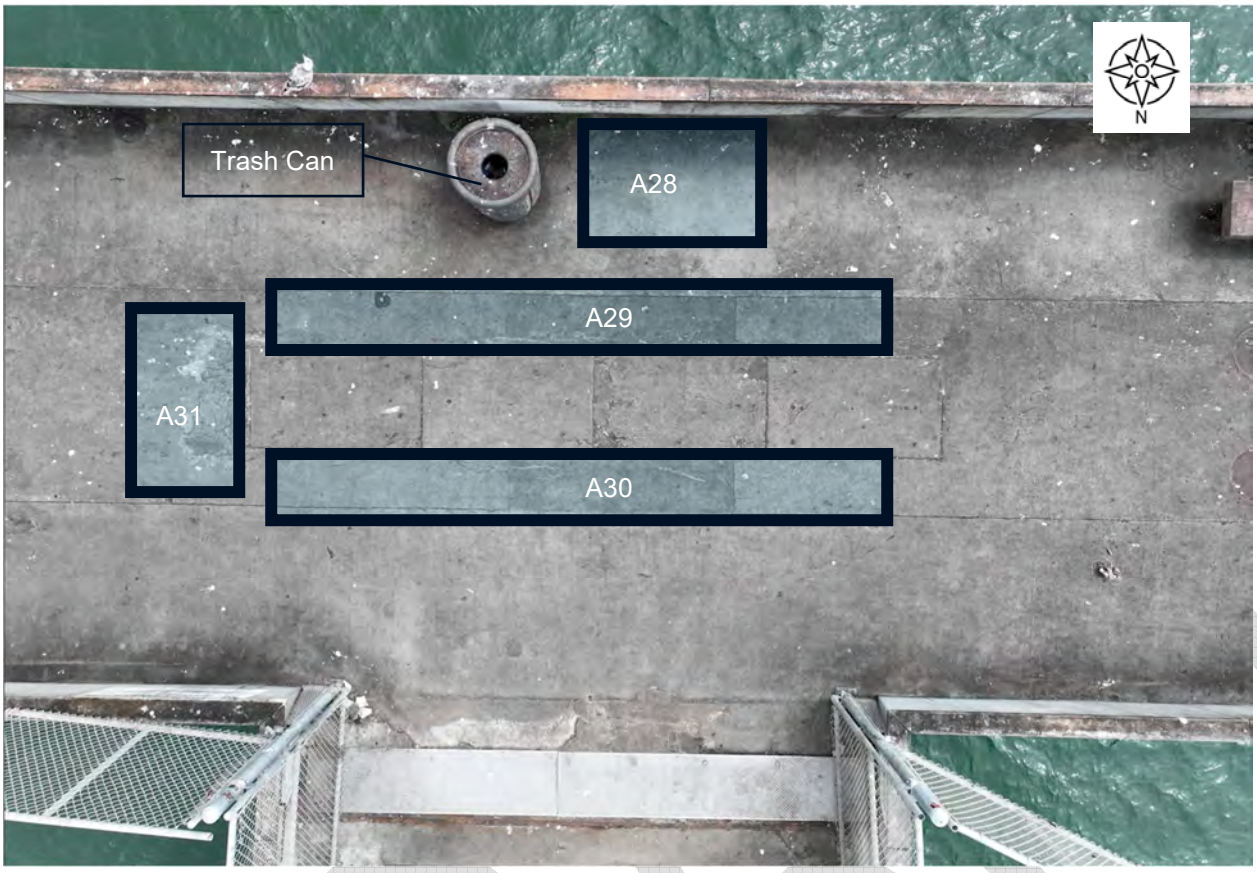



*Figure A.2-9 Delaminated Areas between Bent 1-R and Bent 1-Q - E-W Main Pier*


*Figure A.2-10 Delaminated Areas at Bent 1-Q - E-W Main Pier*

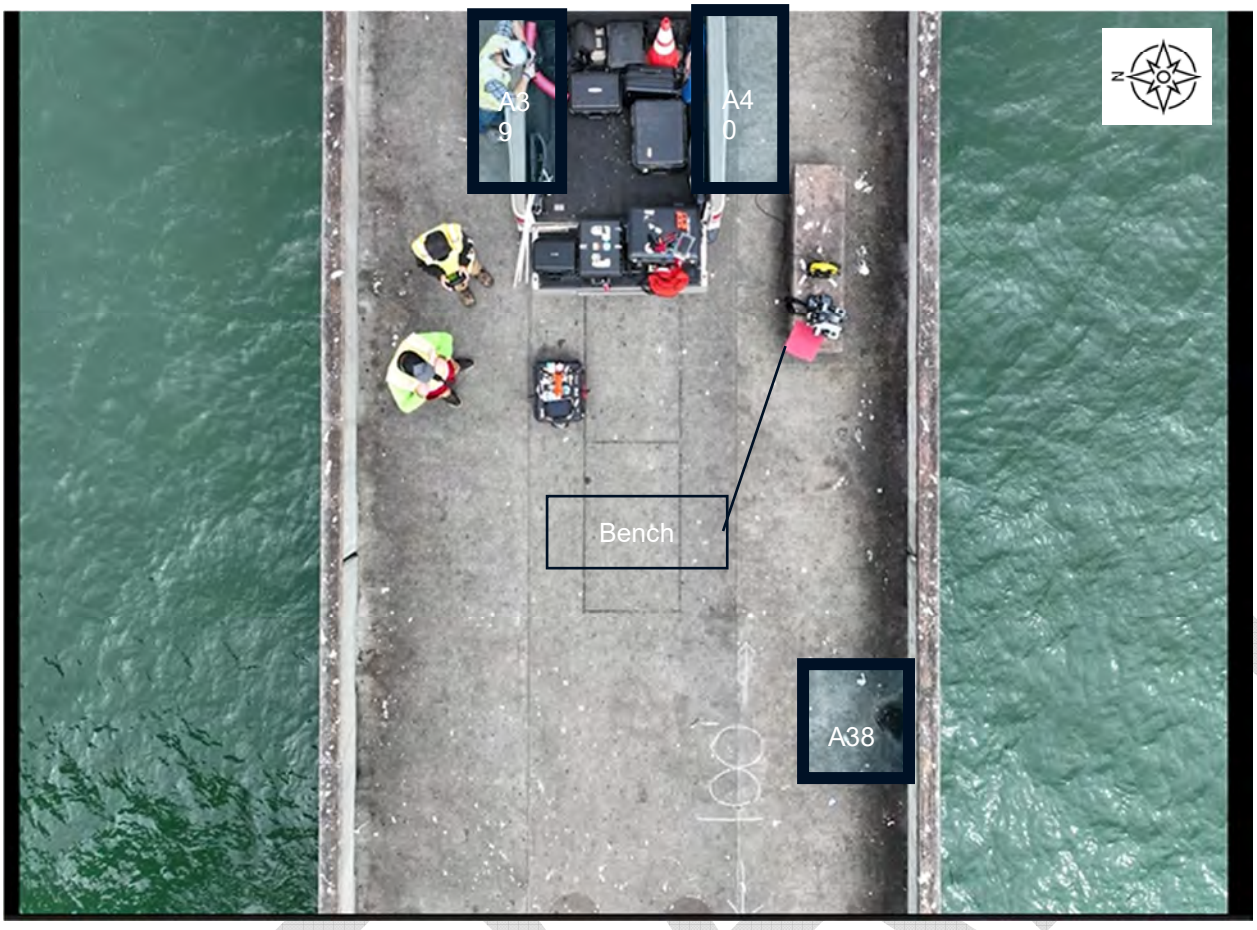



*Figure A.2-11 Delaminated Areas between Bent 1-Q and Bent 1-P - E-W Main Pier*

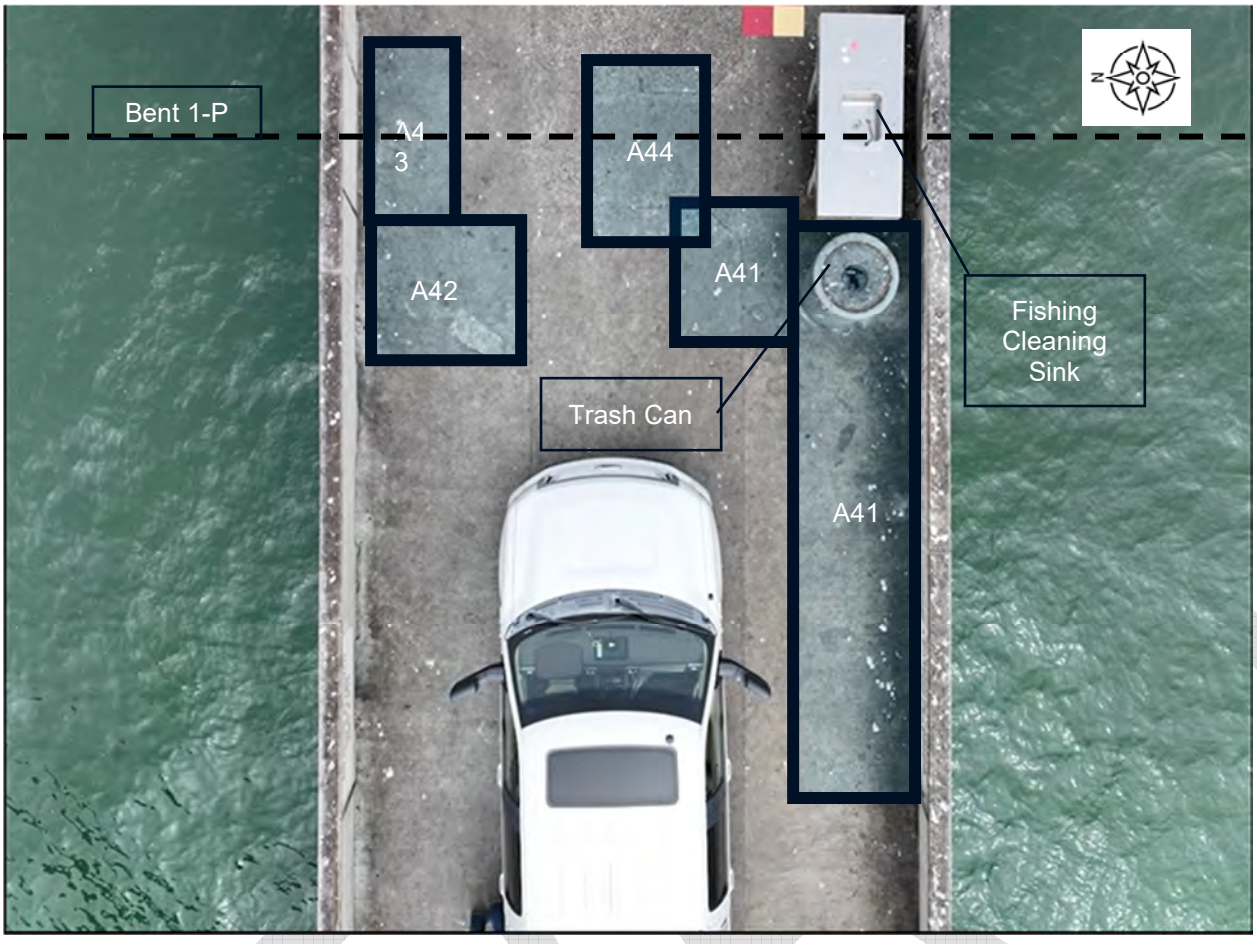



*Figure A.2-12 Delaminated Areas at Bent 1-P - E-W Main Pier*

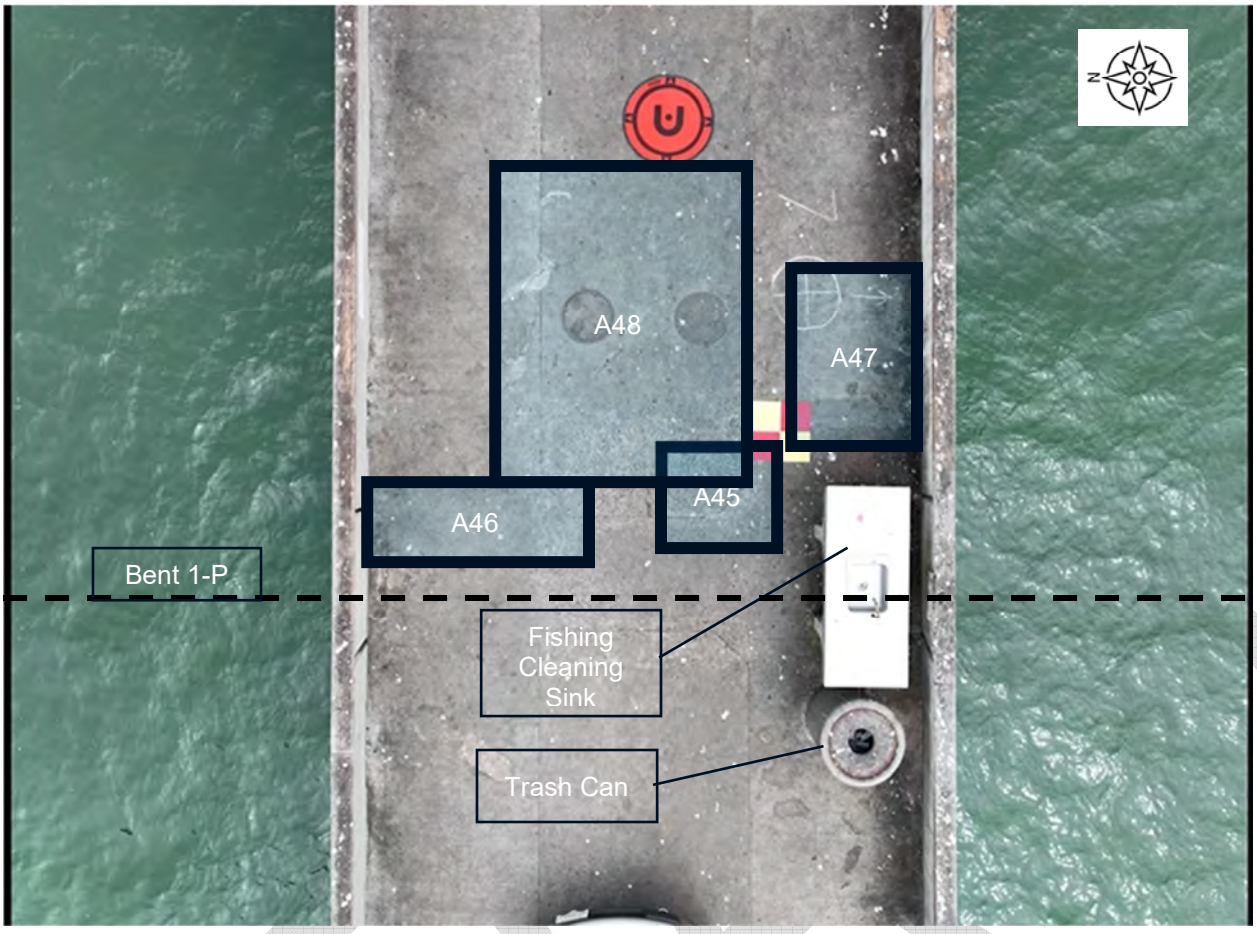



*Figure A.2-13 Delaminated Areas between Bent 1-P and Bent 1-O - E-W Main Pier*

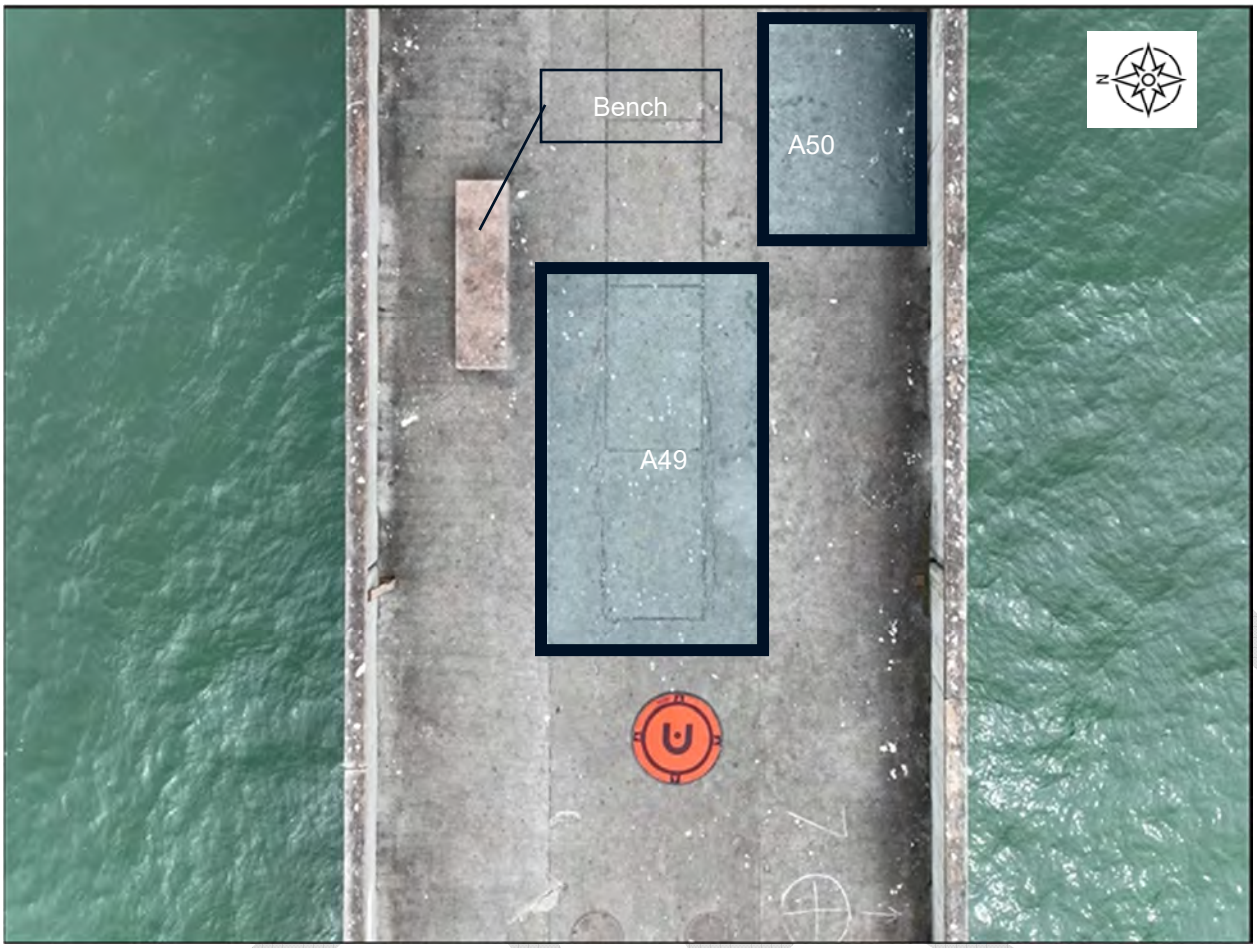



*Figure A.2-14 Delaminated Areas between Bent 1-P and Bent 1-O - E-W Main Pier*

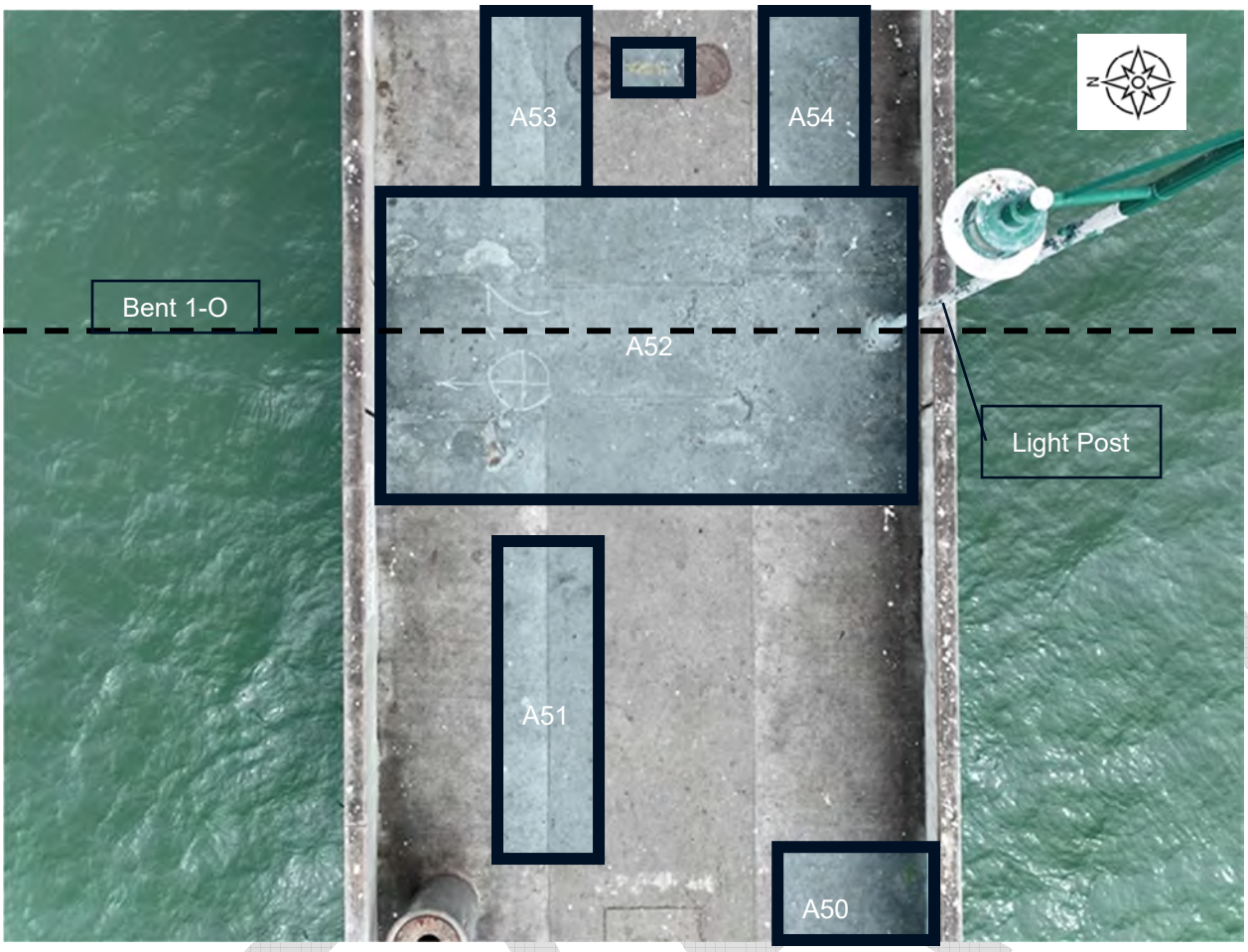



*Figure A.2-15 Delaminated Areas at Bent 1-O - E-W Main Pier*

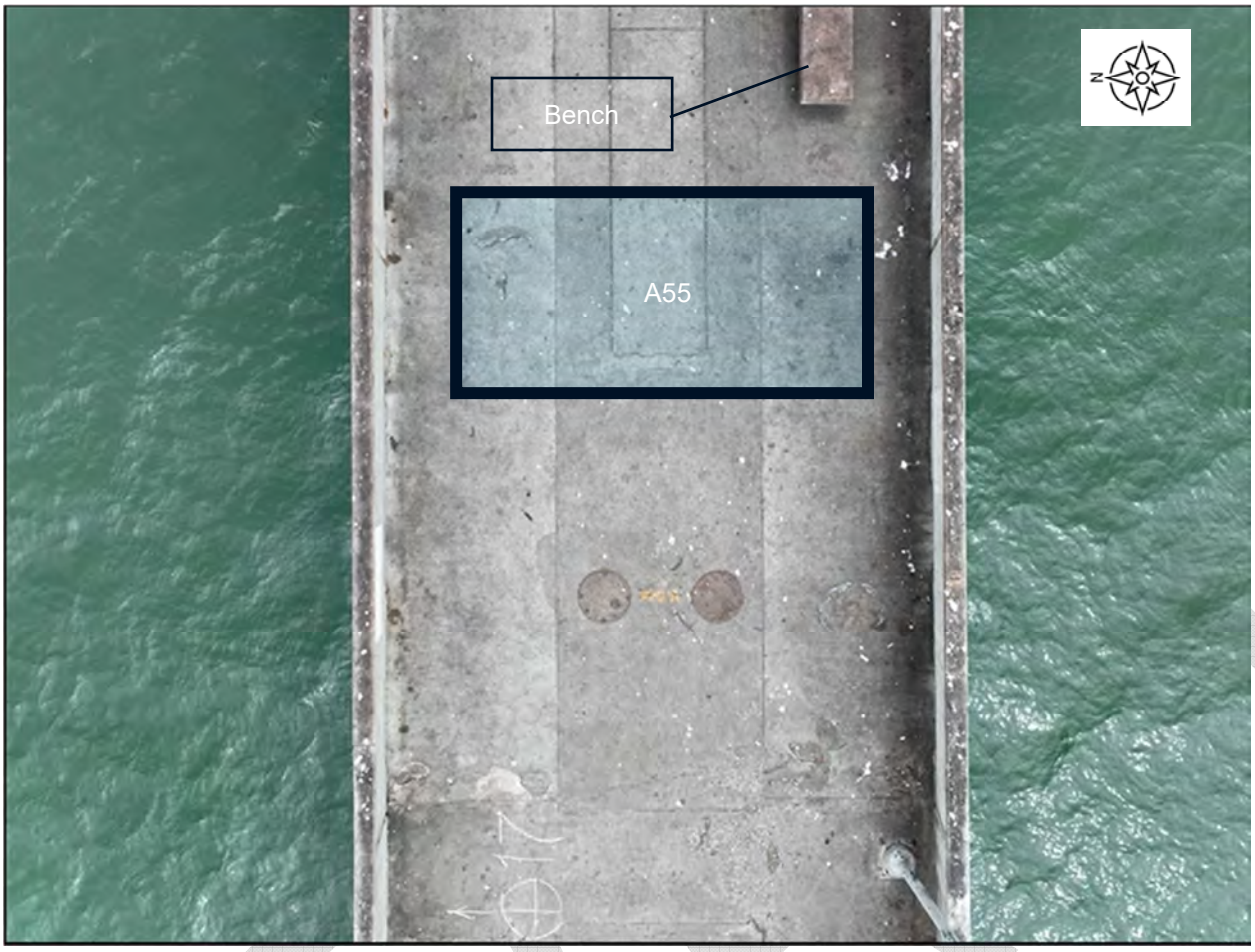



*Figure A.2-16 Delaminated Areas between Bent 1-O and Bent 1-N - E-W Main Pier*

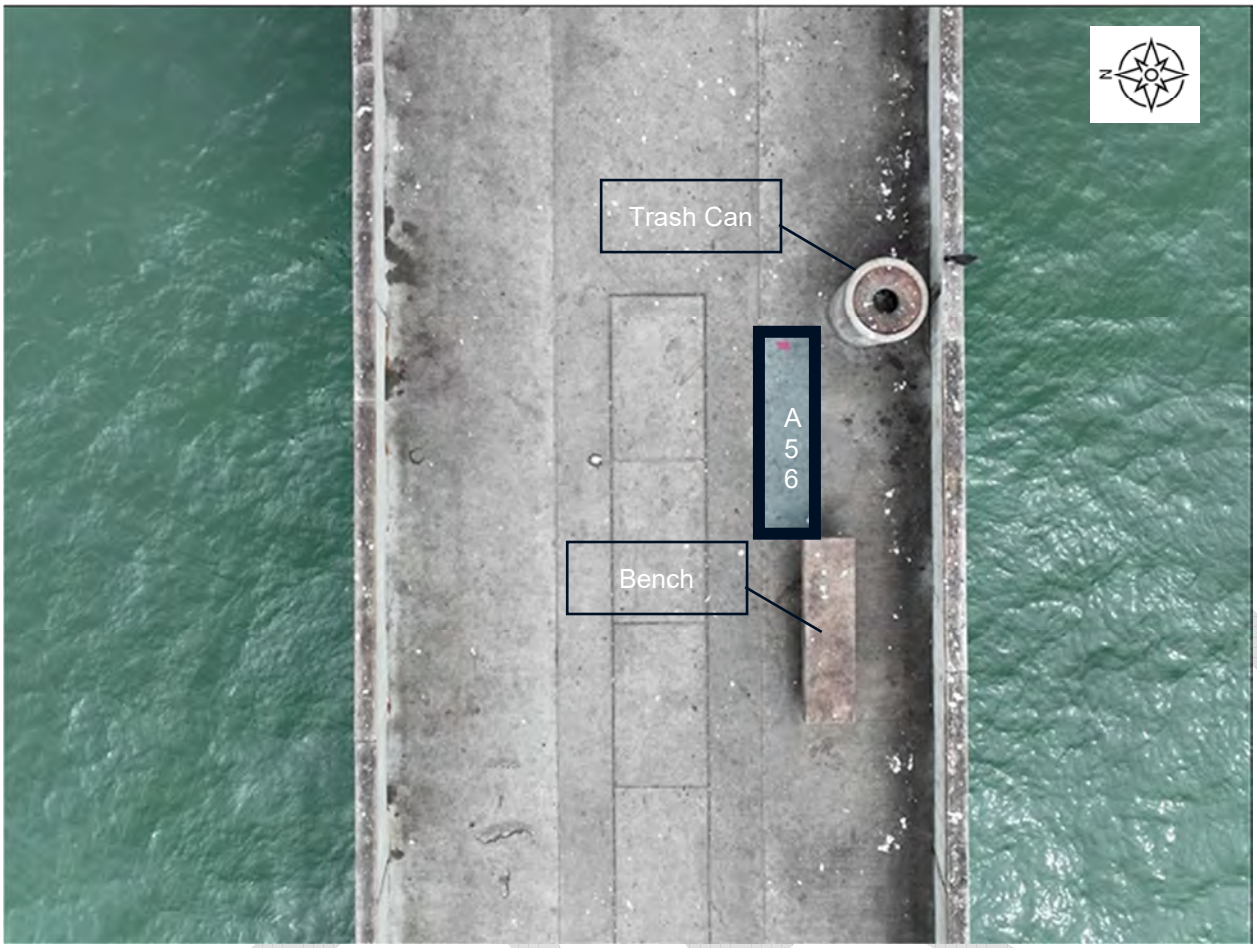



*Figure A.2-17 Delaminated Areas between Bent 1-O and Bent 1-N - E-W Main Pier*

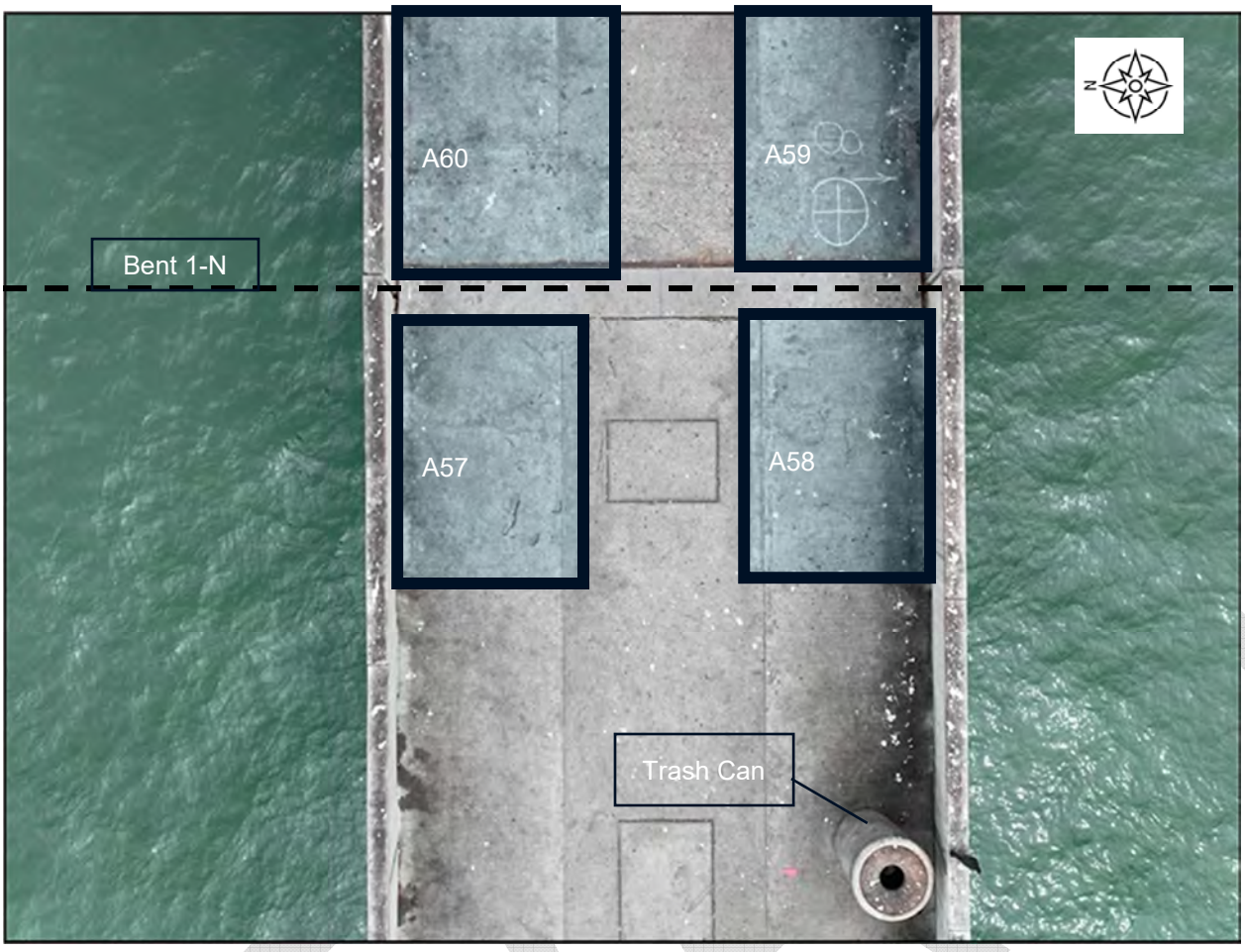



*Figure A.2-18 Delaminated Areas at Bent 1- N – E-W Main Pier*


*Figure A.2-19 Delaminated Areas between Bent 1-N and Bent 1- M – E-W Main Pier*


*Figure A.2-20 Delaminated Areas at Bent 1- M – E-W Main Pier*

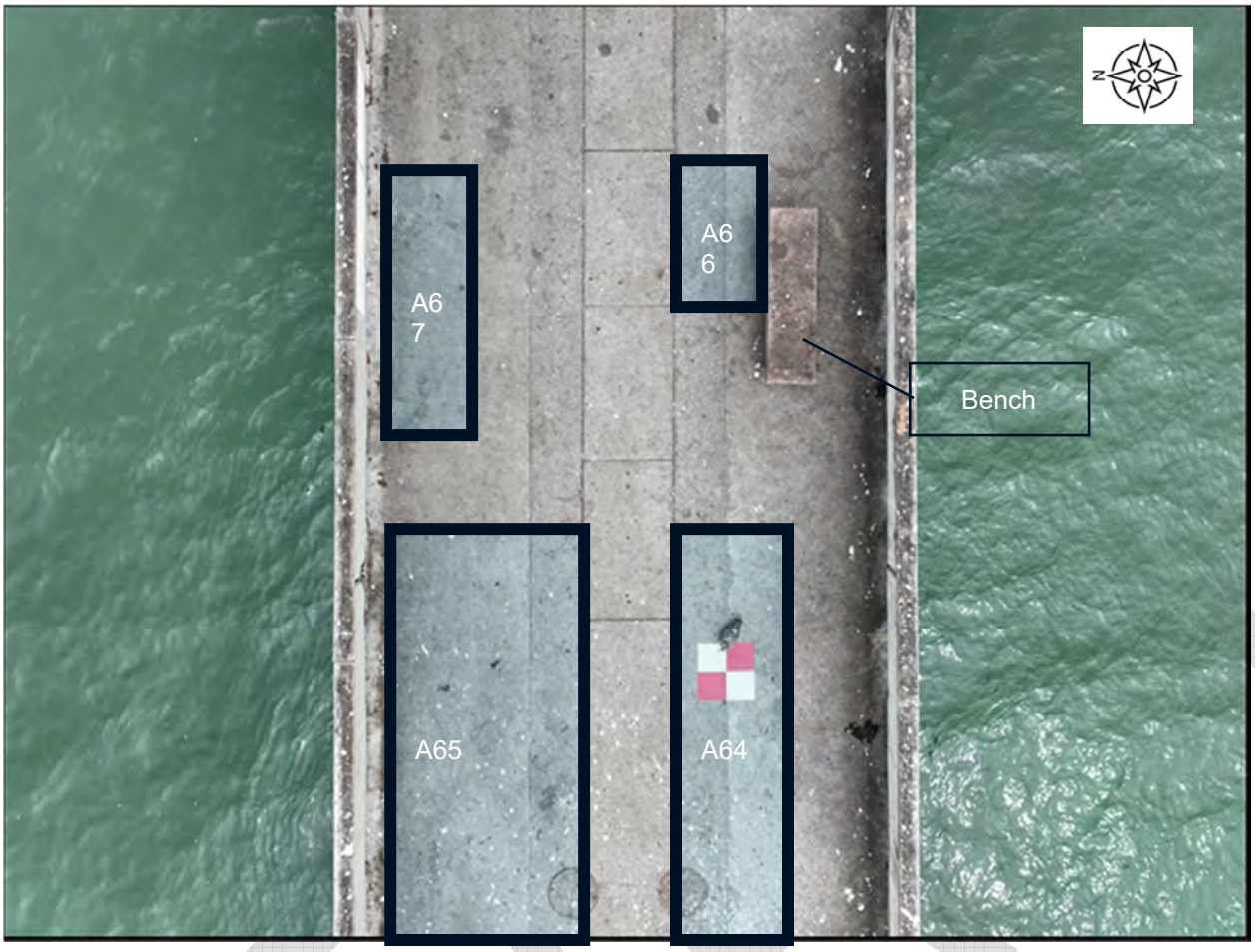



*Figure A.2-21 Delaminated Areas between Bent 1-M and Bent 1-L – E-W Main Pier*

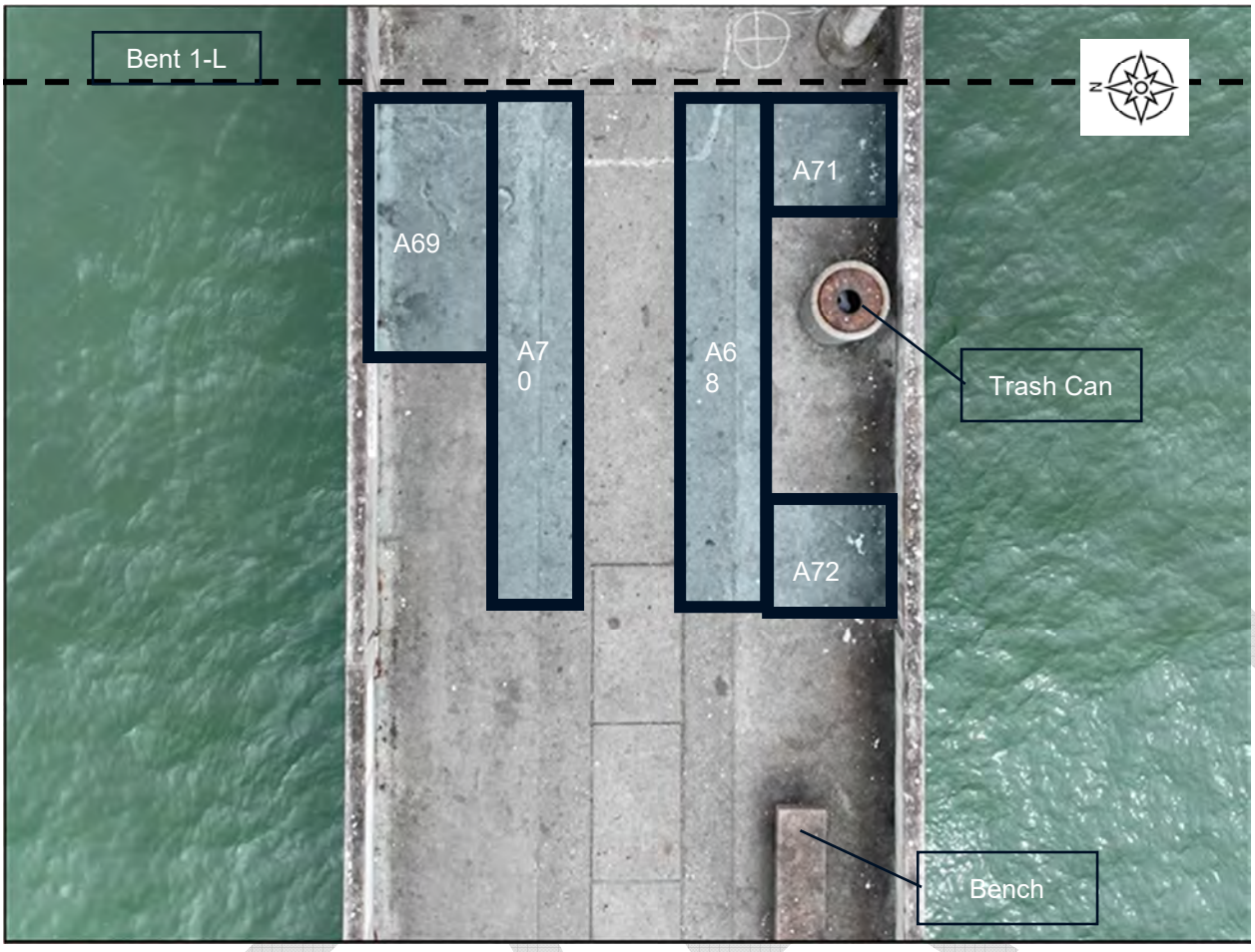



*Figure A.2-22 Delaminated Areas between Bent 1-M and Bent 1-L – E-W Main Pier*

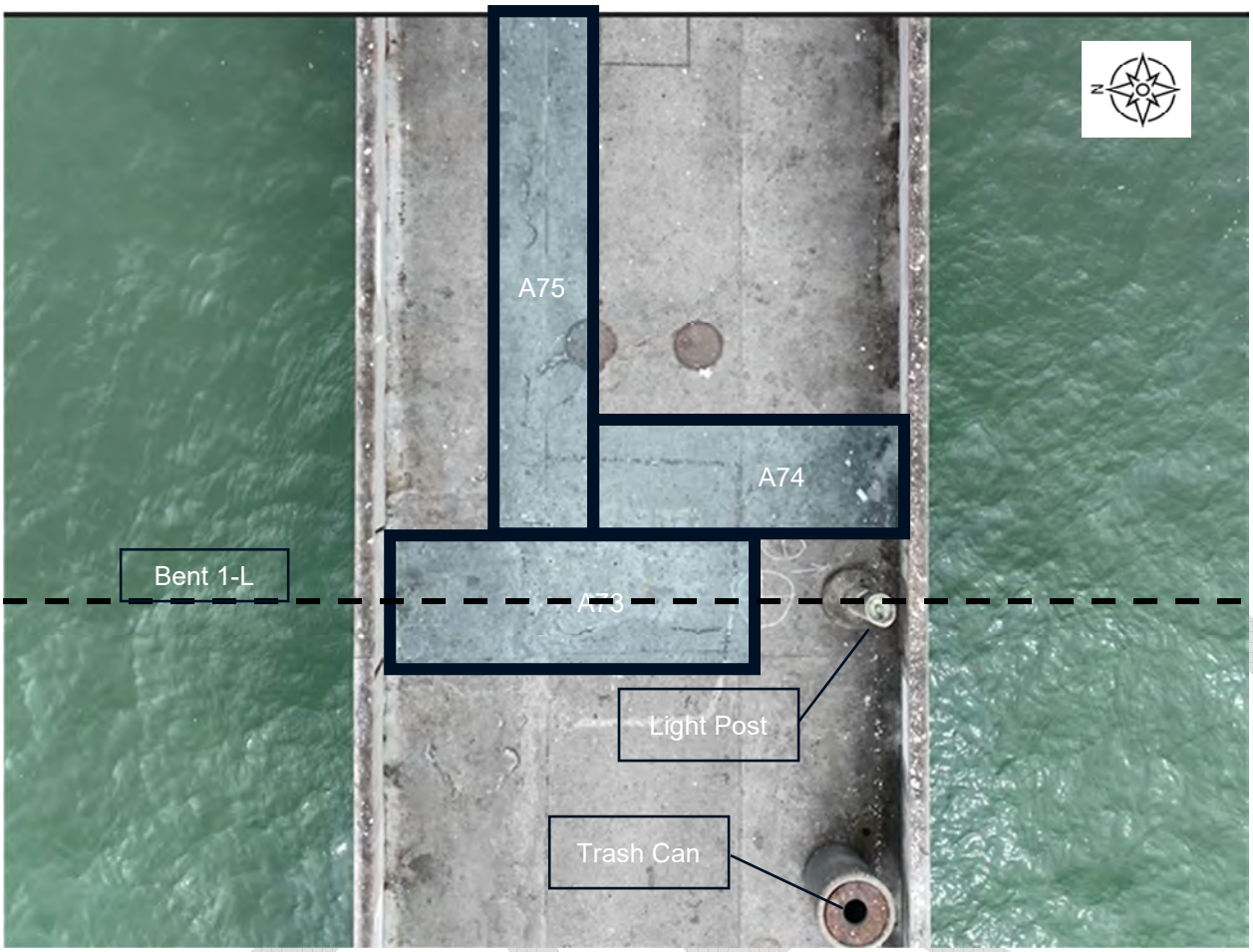



*Figure A.2-23 Delaminated Areas at Bent 1- L – E-W Main Pier*


*Figure A.2-24 Delaminated Areas between Bent 1-L and Bent 1-K – E-W Main Pier*

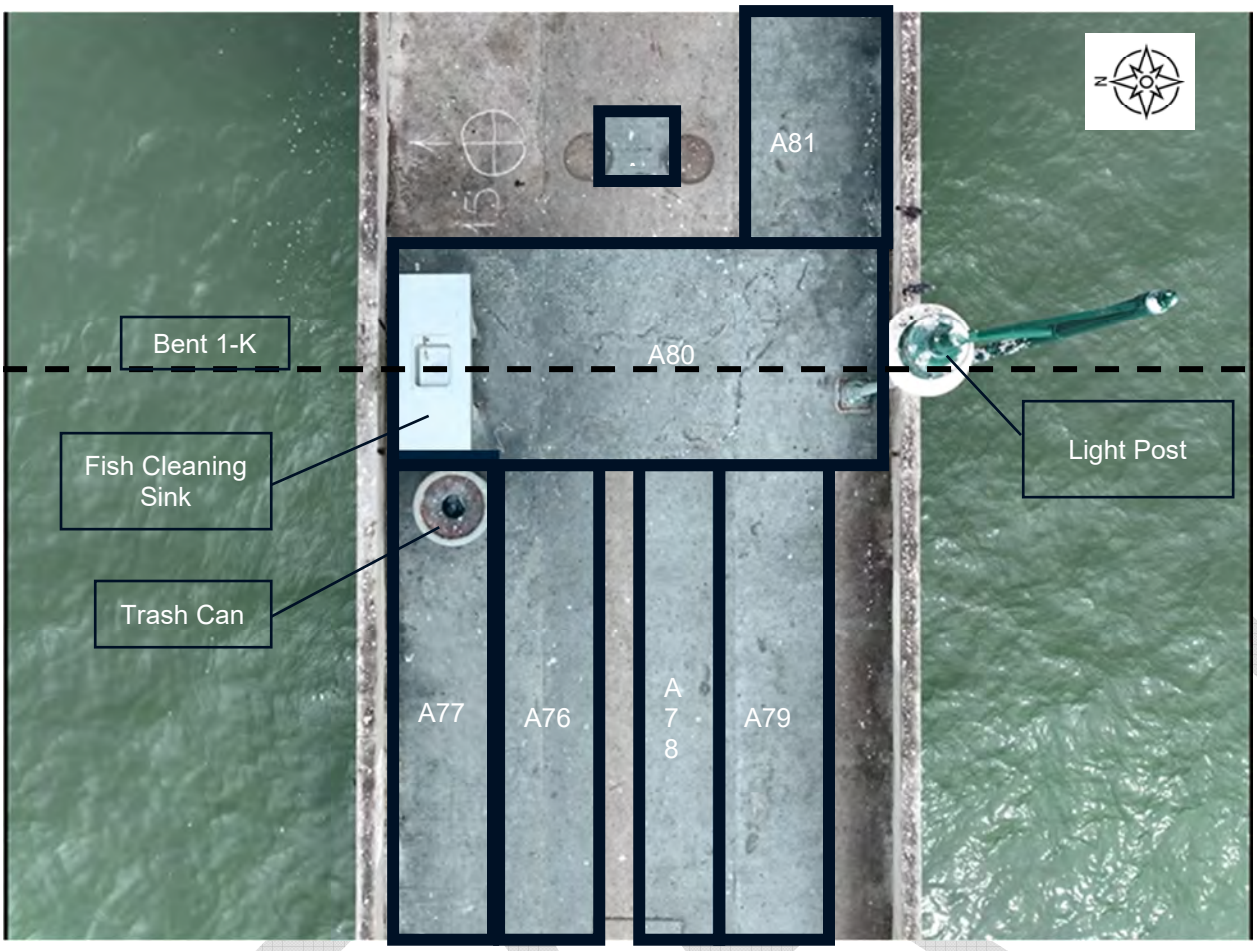



*Figure A.2-25 Delaminated Areas at Bent 1-K – E-W Main Pier*

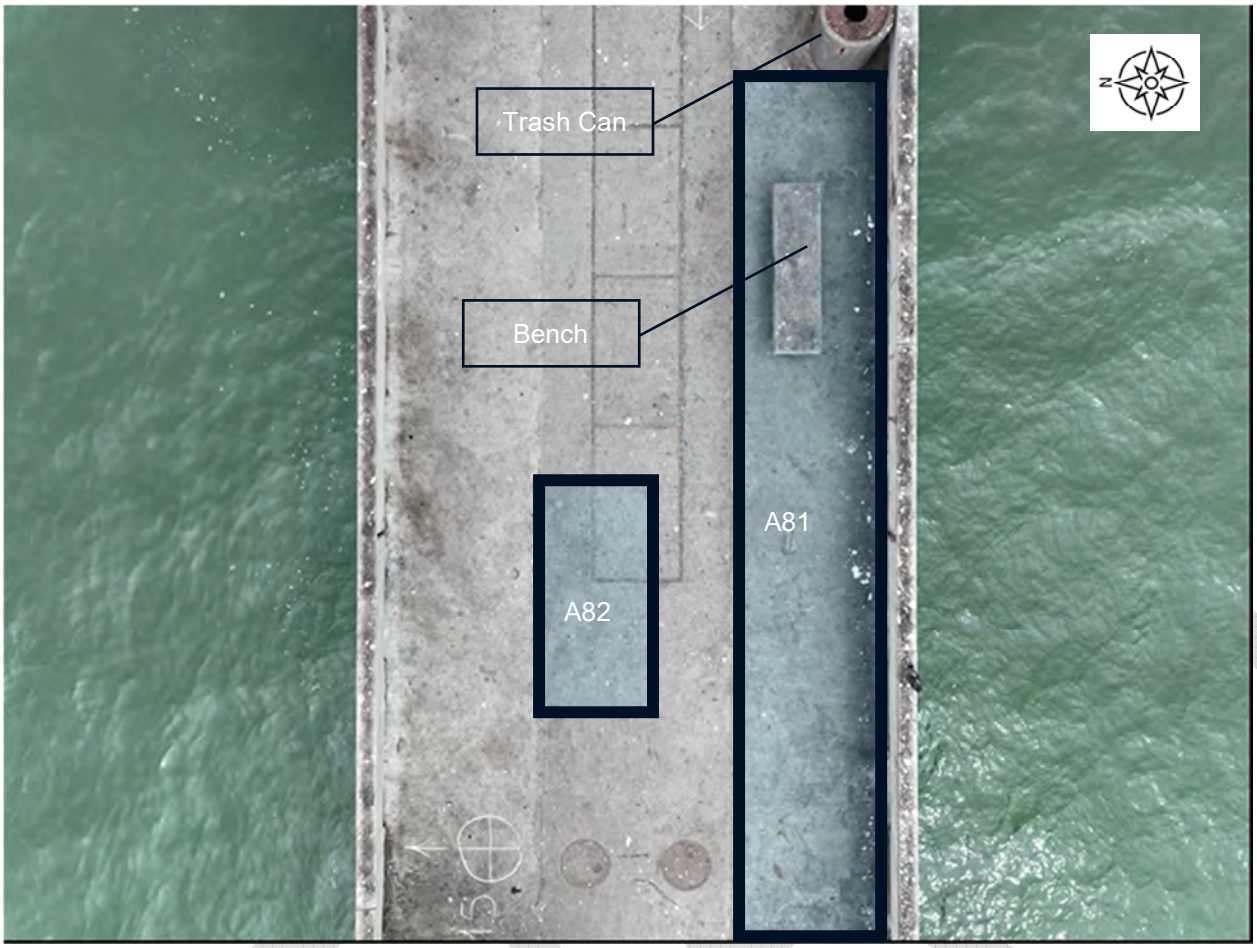



*Figure A.2-26 Delaminated Areas between Bent 1-K and Bent 1-J – E-W Main Pier*

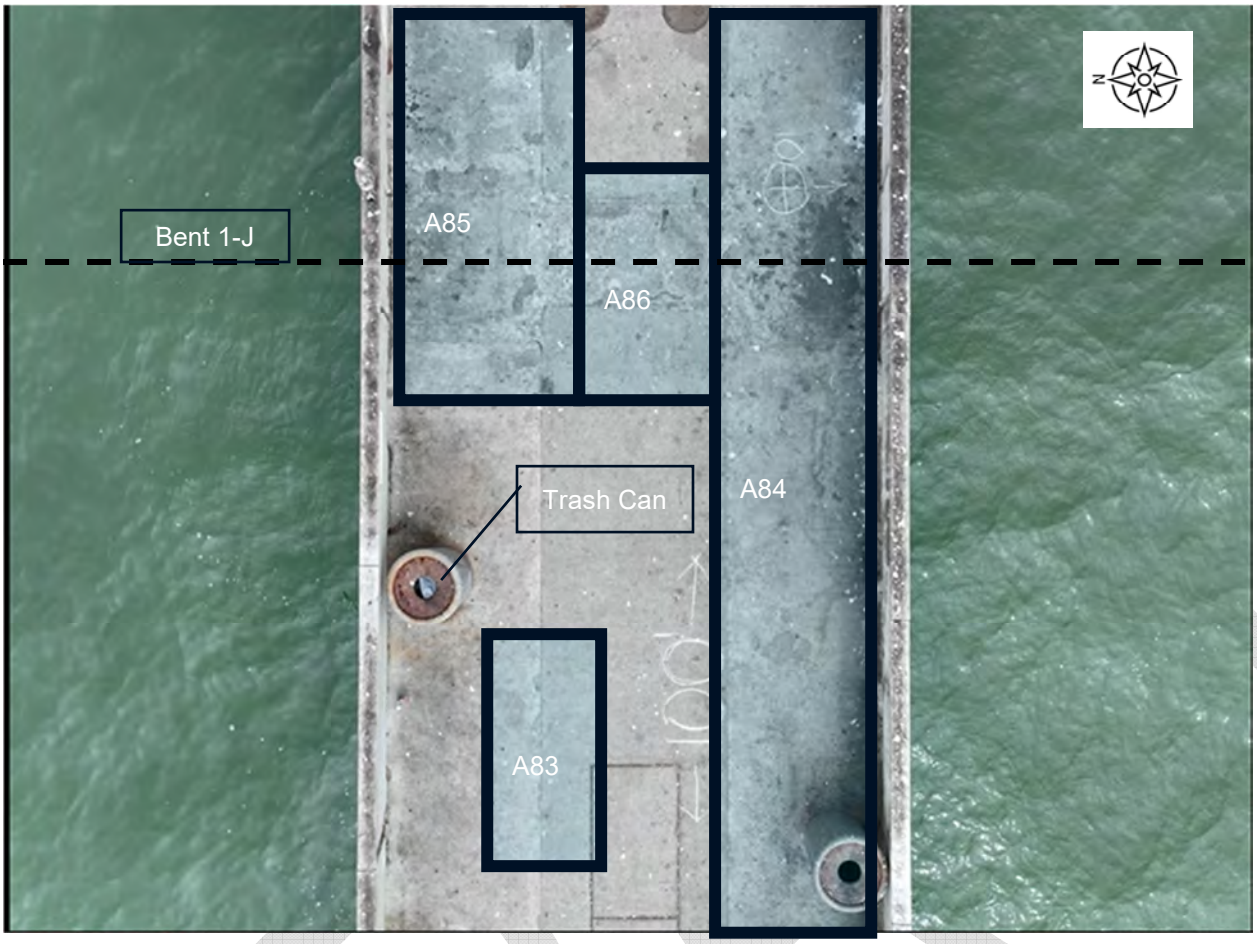



*Figure A.2-27 Delaminated Areas at Bent 1-J – E-W Main Pier*


*Figure A.2-28 Delaminated Areas between Bent 1-J and Bent 1-I – E-W Main Pier*

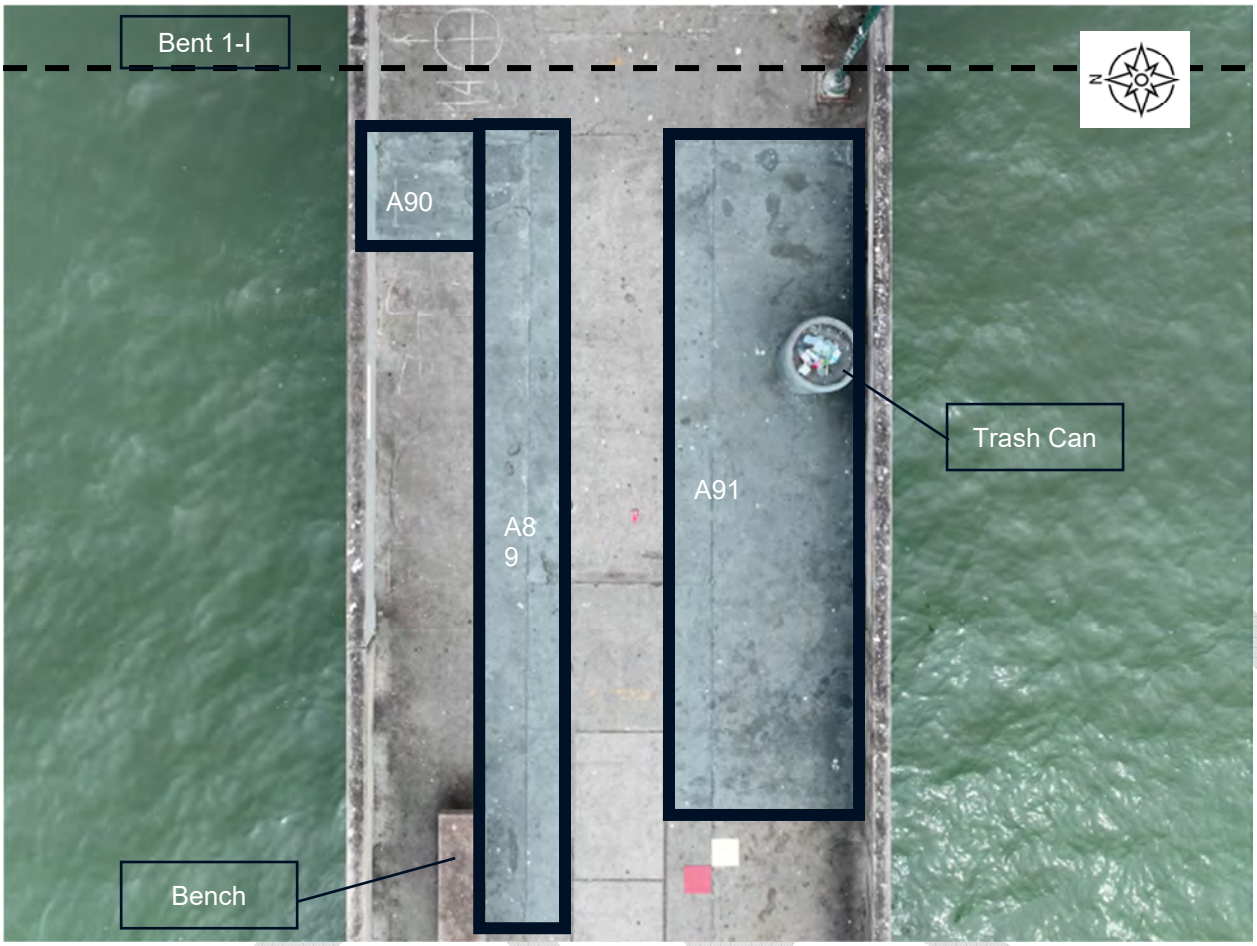



*Figure A.2-29 Delaminated Areas between Bent 1-J and Bent 1-I – E-W Main Pier*


*Figure A.2-30 Delaminated Areas at Bent 1-I – E-W Main Pier*

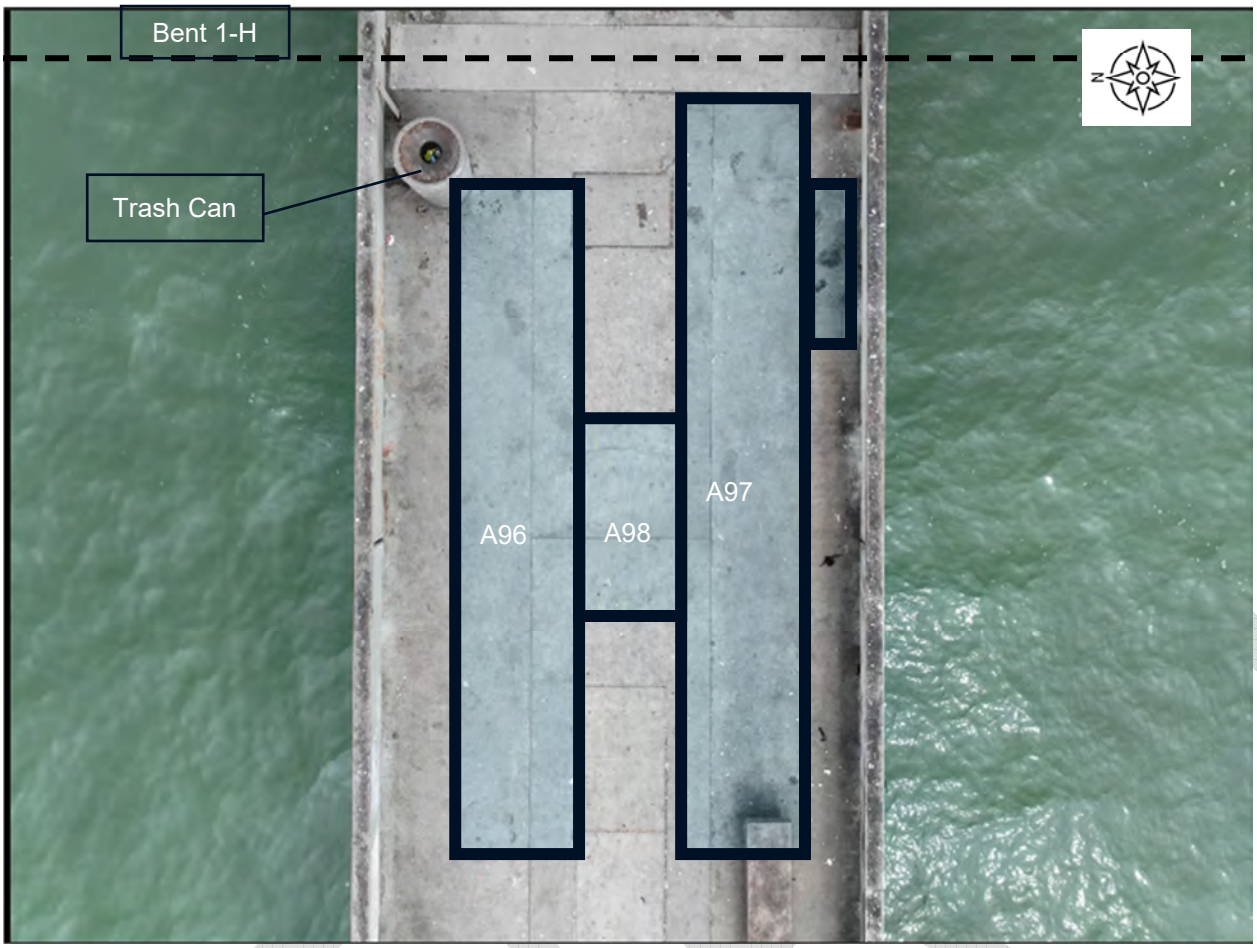



*Figure A.2-31 Delaminated Areas between Bent 1-I and Bent 1-H – E-W Main Pier*

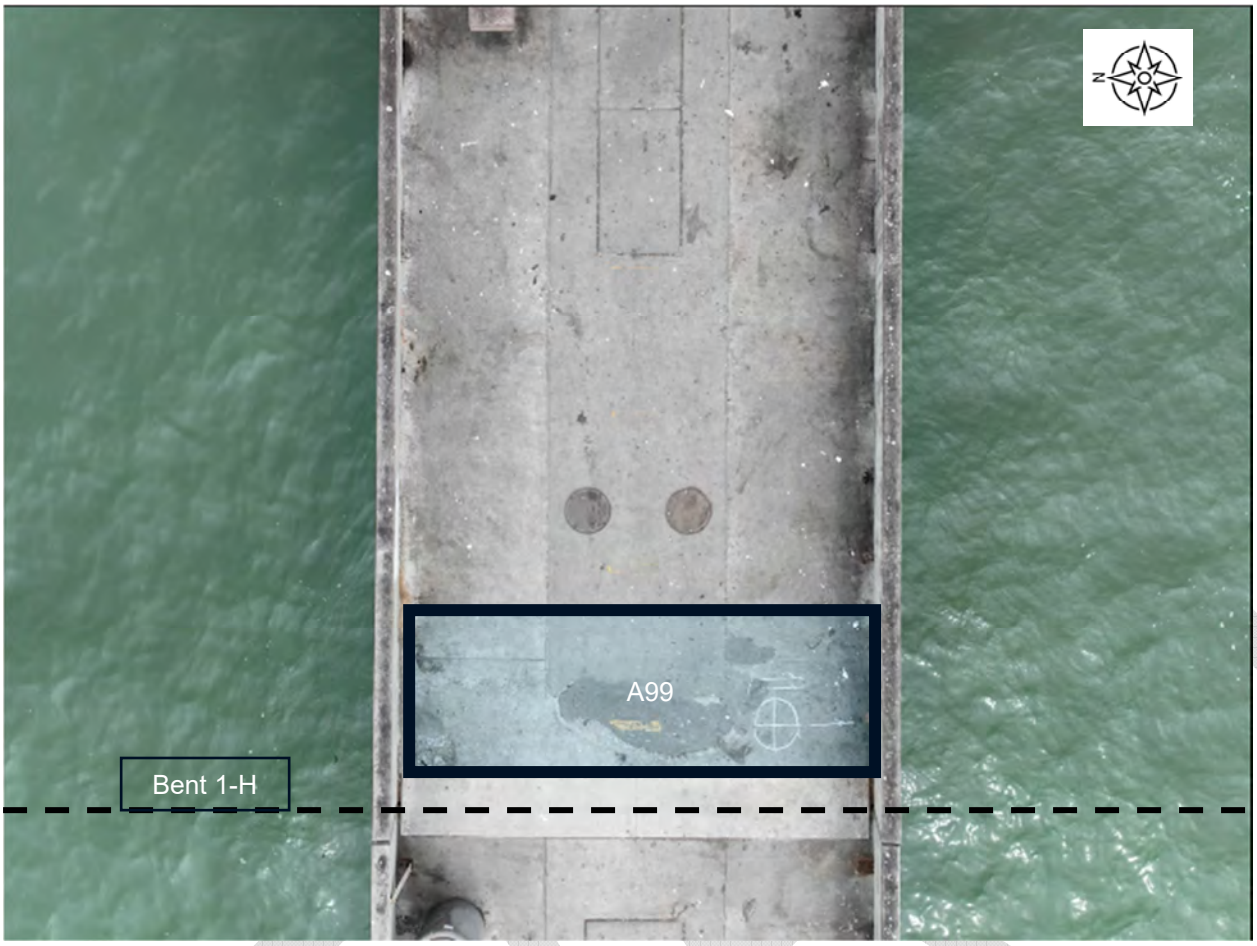



*Figure A.2-32 Delaminated Areas at Bent 1-H – E-W Main Pier*


*Figure A.2-33 Delaminated Areas between Bent 1-G and Bent 1-H – E-W Main Pier*


*Figure A.2-34 Delaminated Areas around Bent 1-G – E-W Main Pier*

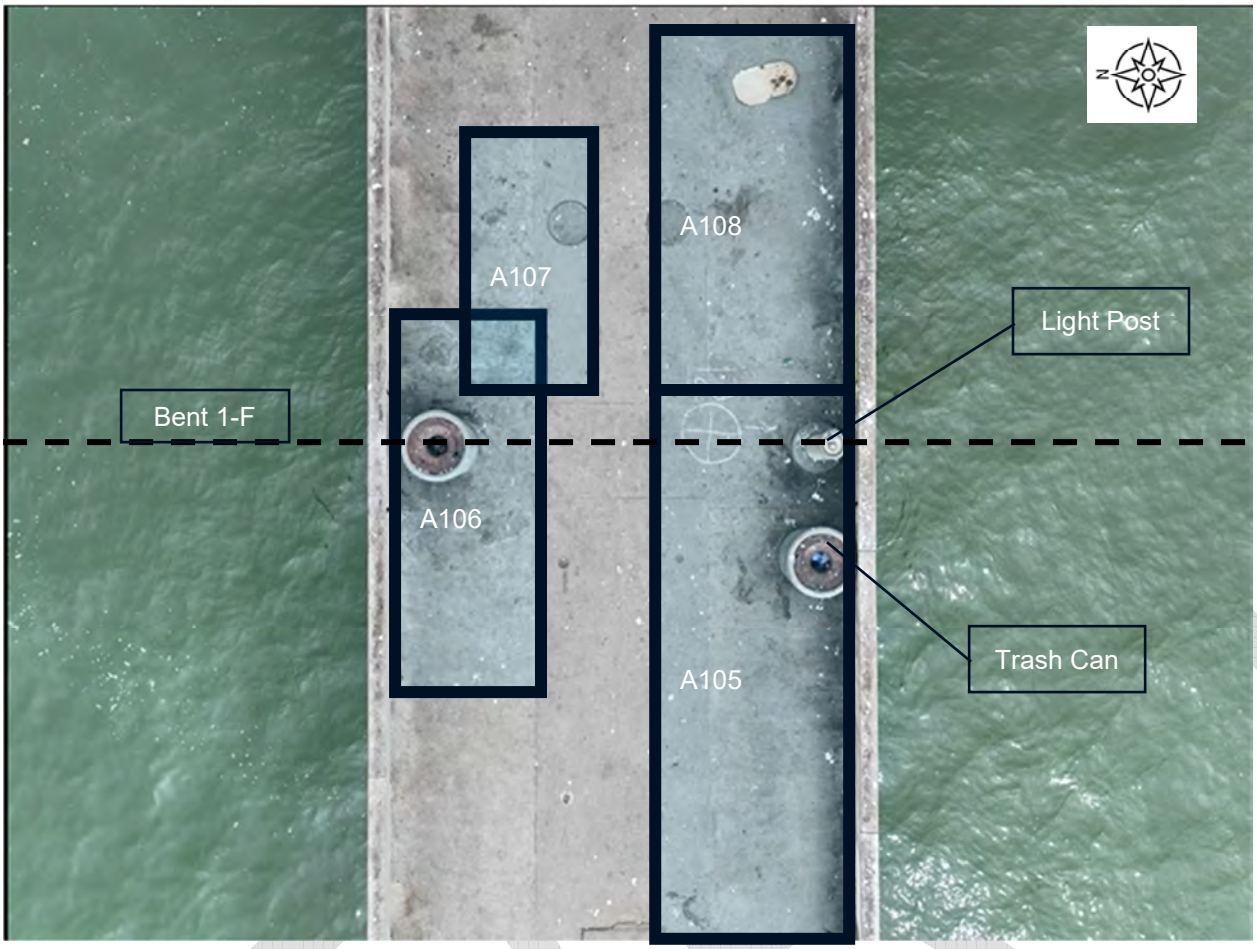



*Figure A.2-35 Delaminated Areas around Bent 1-F – E-W Main Pier*

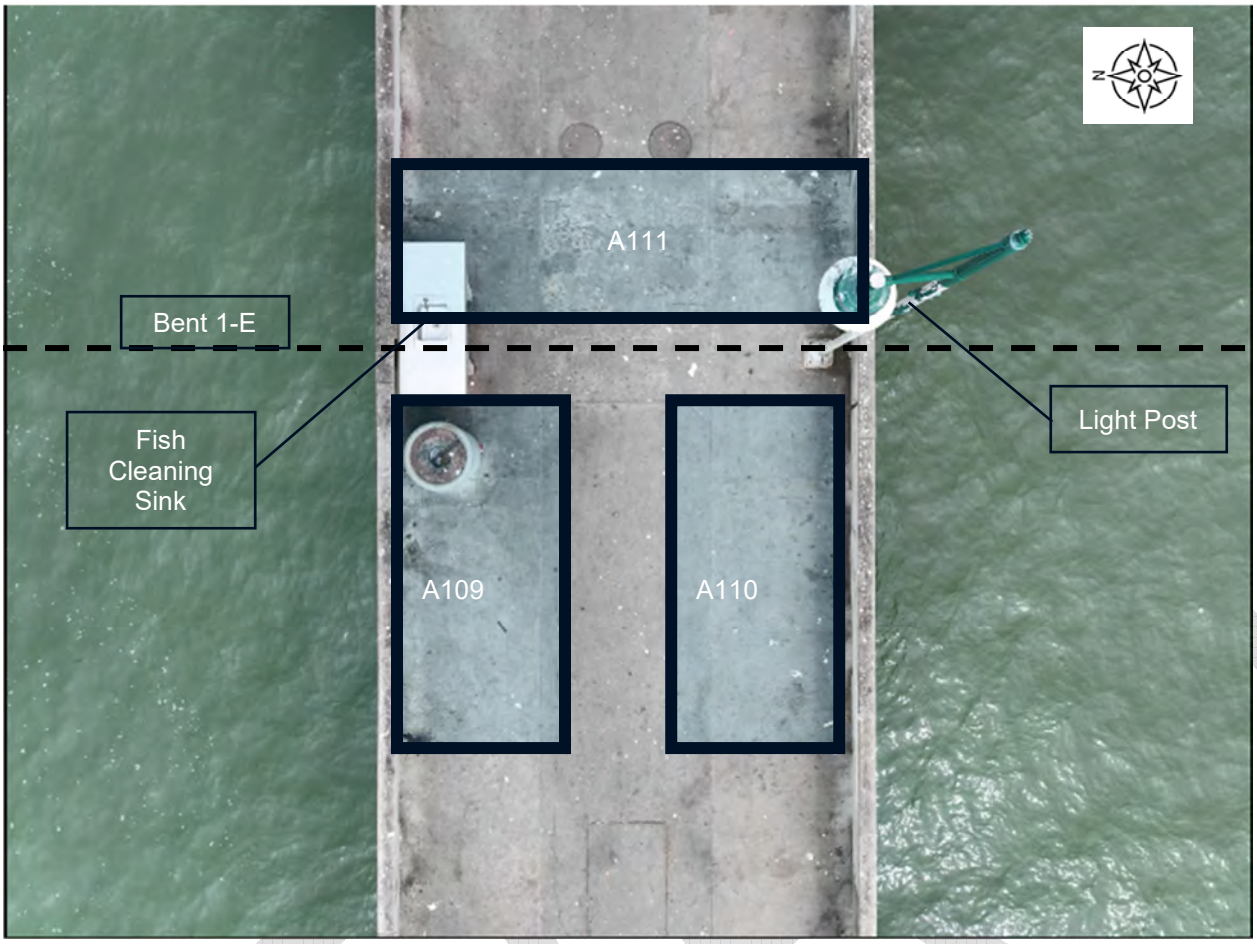



*Figure A.2-36 Delaminated Areas around Bent 1-E – E-W Main Pier*


*Figure A.2-37 Delaminated Areas between Bent 1-E and Bent 1-D – E-W Main Pier*

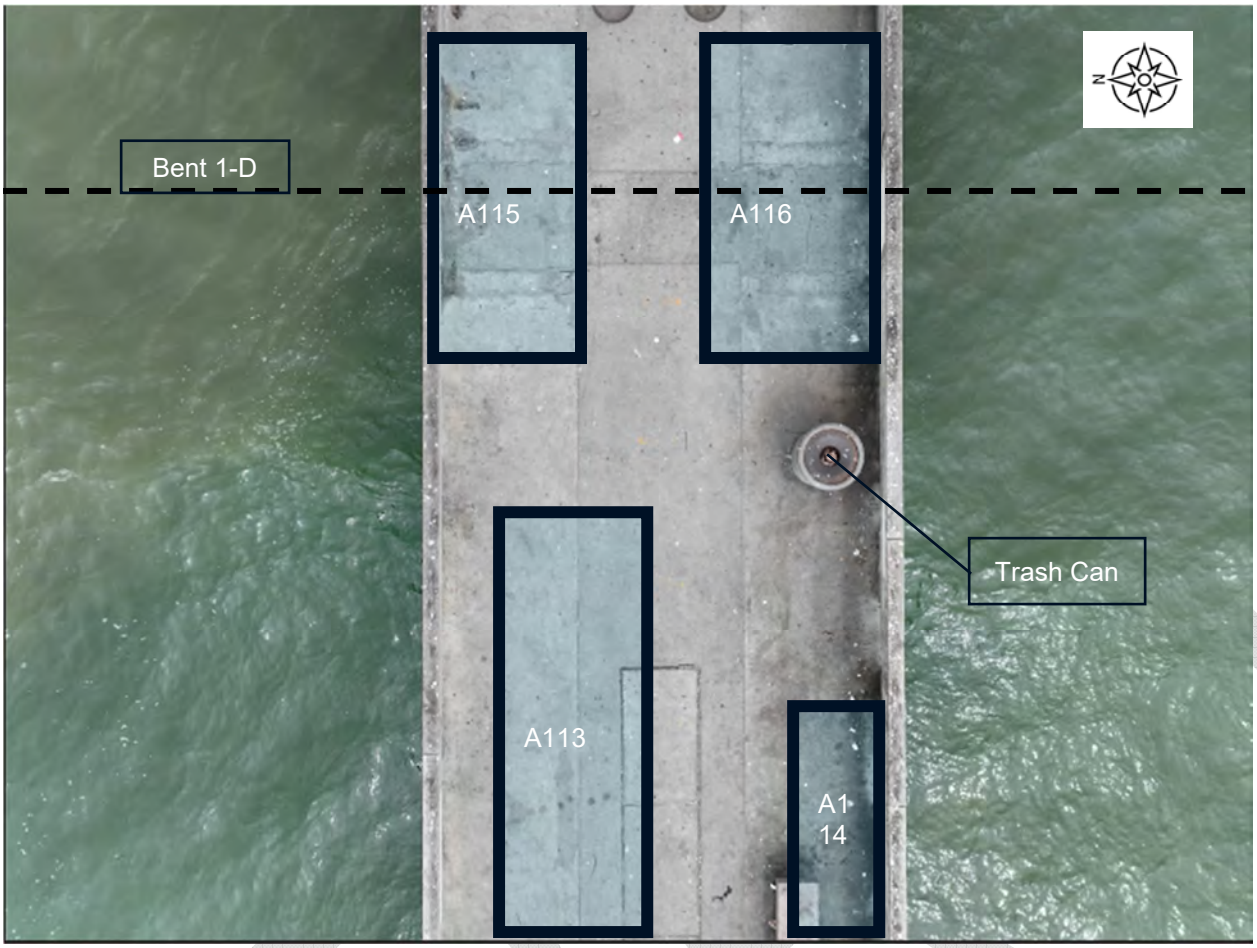



*Figure A.2-38 Delaminated Areas around Bent 1-D – E-W Main Pier*


*Figure A.2-39 Delaminated Areas between Bent 1-C and Bent 1-D – E-W Main Pier*


*Figure A.2-40 Delaminated Areas around Bent 1-C – E-W Main Pier*

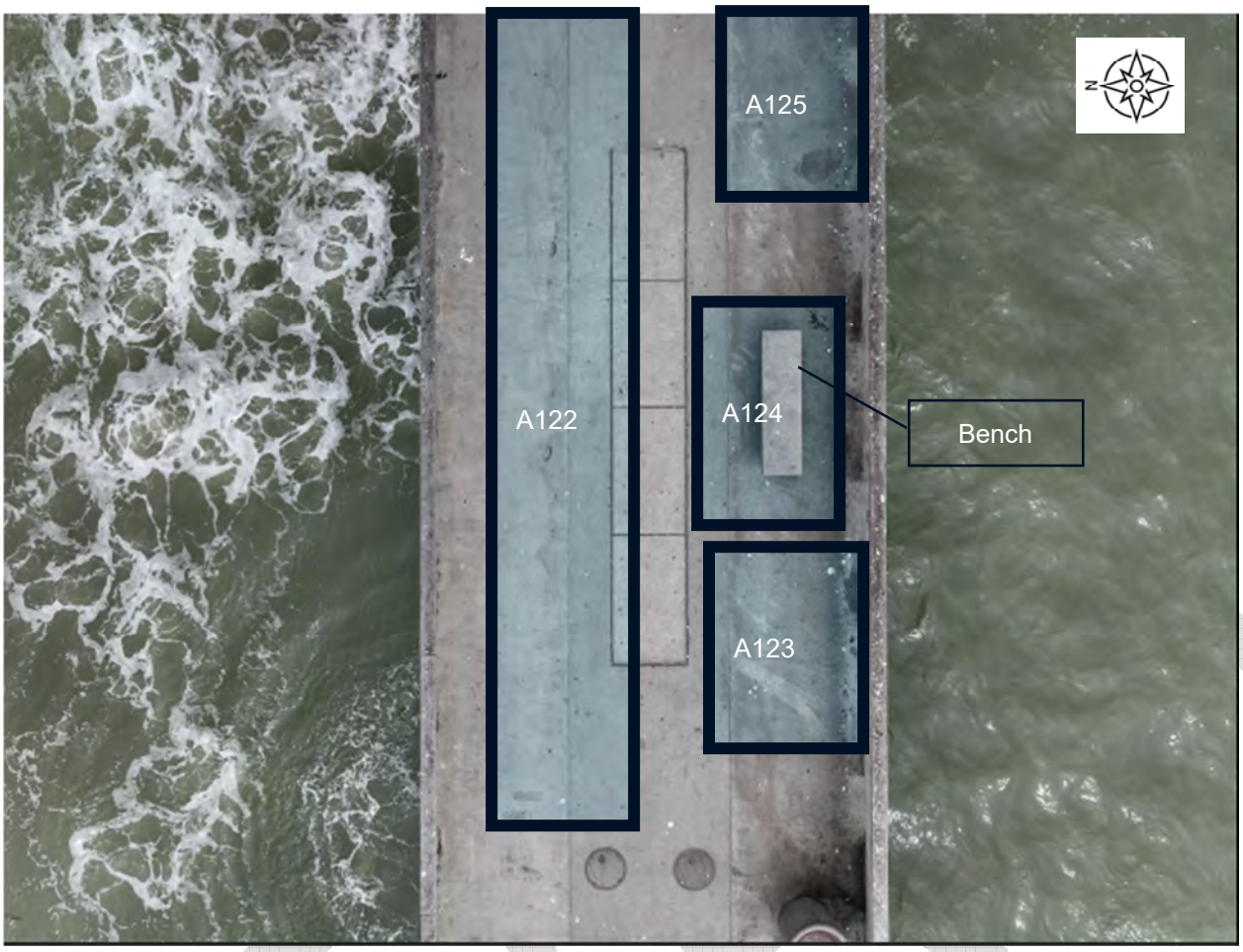



*Figure A.2-41 Delaminated Areas between Bent 1-C and Bent 1-B – E-W Main Pier*

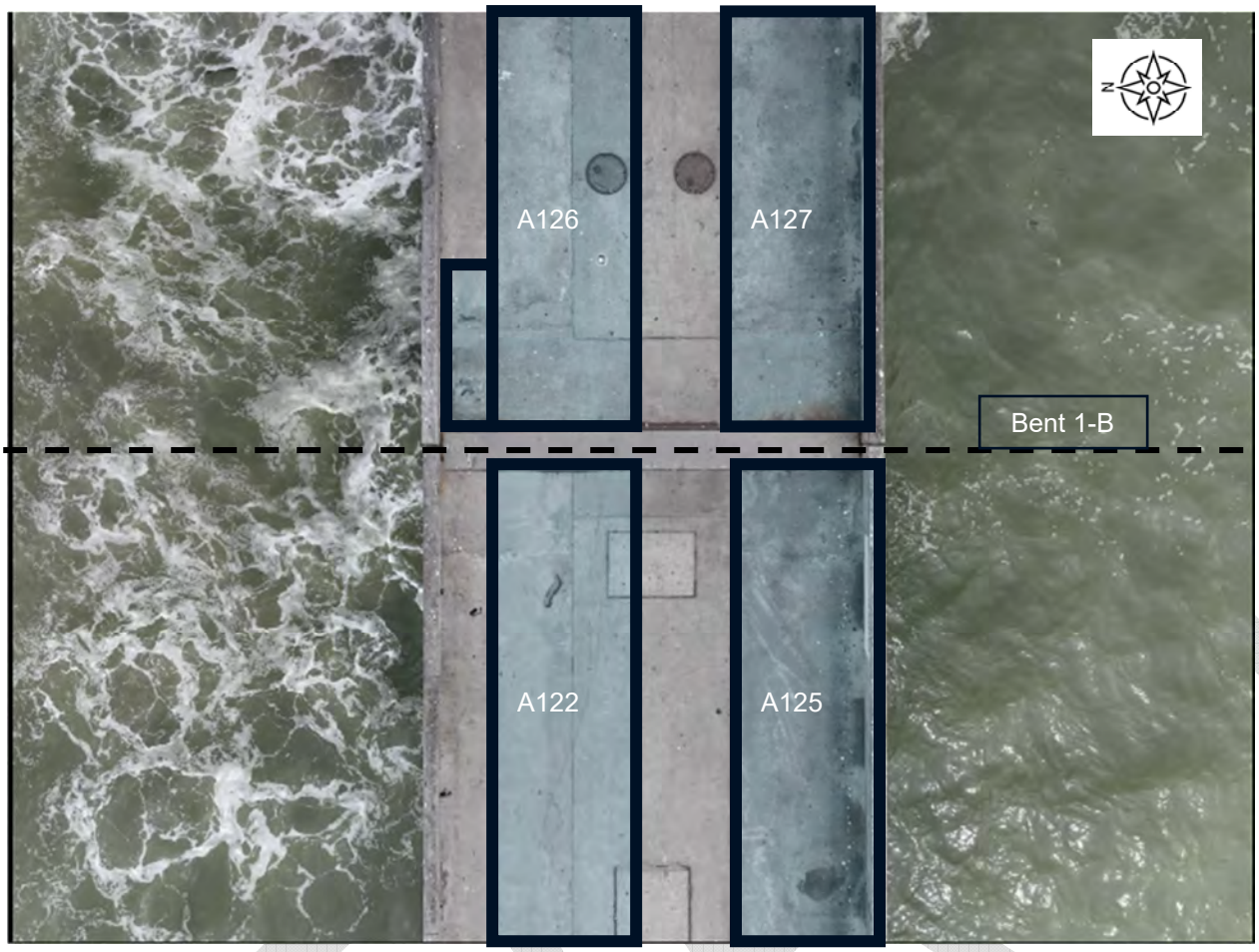



*Figure A.2-42 Delaminated Areas around Bent 1-B – E-W Main Pier*


*Figure A.2-43 Delaminated Areas around Abutment 1-A*

# A.3. Pier Structure - UAV (Drone) Imagery

**Deck Exterior at Pier Abutment**

The existing Pier abutment steel sheet piles have 100% section loss. In 1993 a reinforced concrete wall was installed behind the steel sheet piles, which is now exposed to the seawater.

Observations:

- Rust bleed stains around sheet pile/abutment concrete cap interface, abutment concrete cap and handrails connection
- Loss of steel sheet piles
- Minor to Moderate cracks on abutment concrete cap
- Minor to Moderate corrosion and structural spalls on abutment concrete cap
- Discoloration of concrete (black/green algae)
- Overall rating – Moderate

*Figure A.3-1 Deck Exterior from Pier Abutment to Bent 1B – North Face*

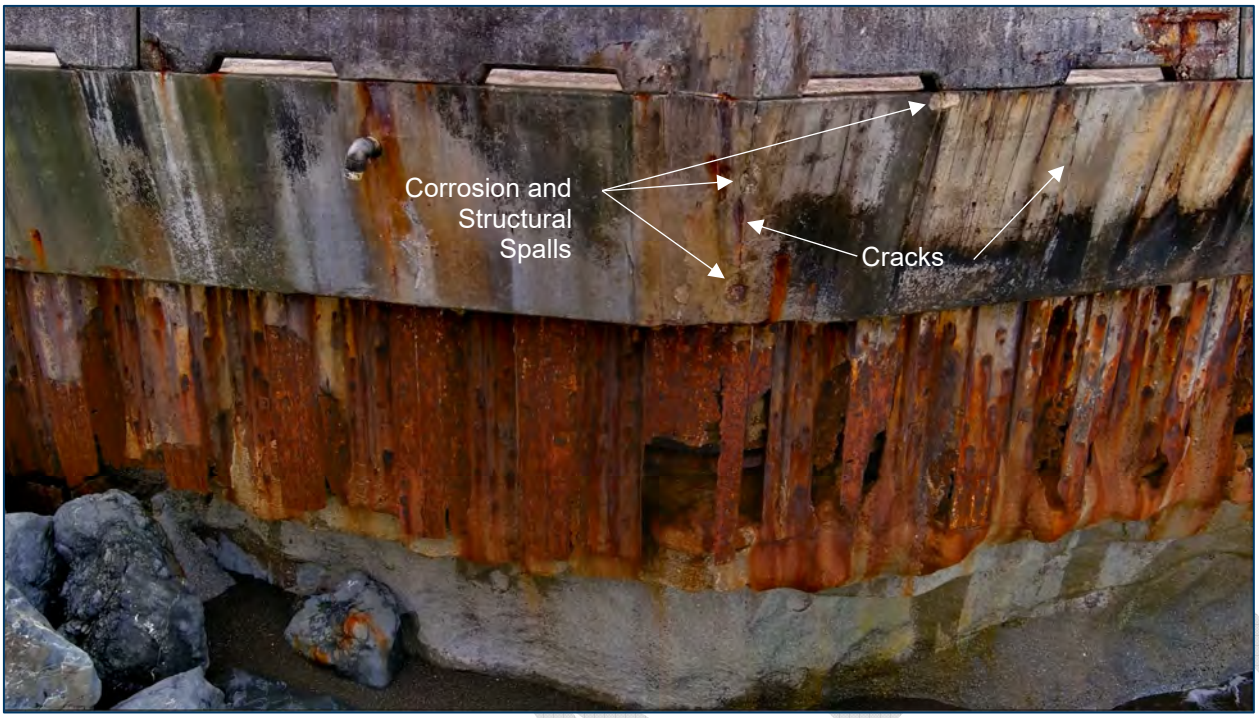



*Figure A.3-2 Pier Abutment, Handrail and Concrete Cap – North Face*

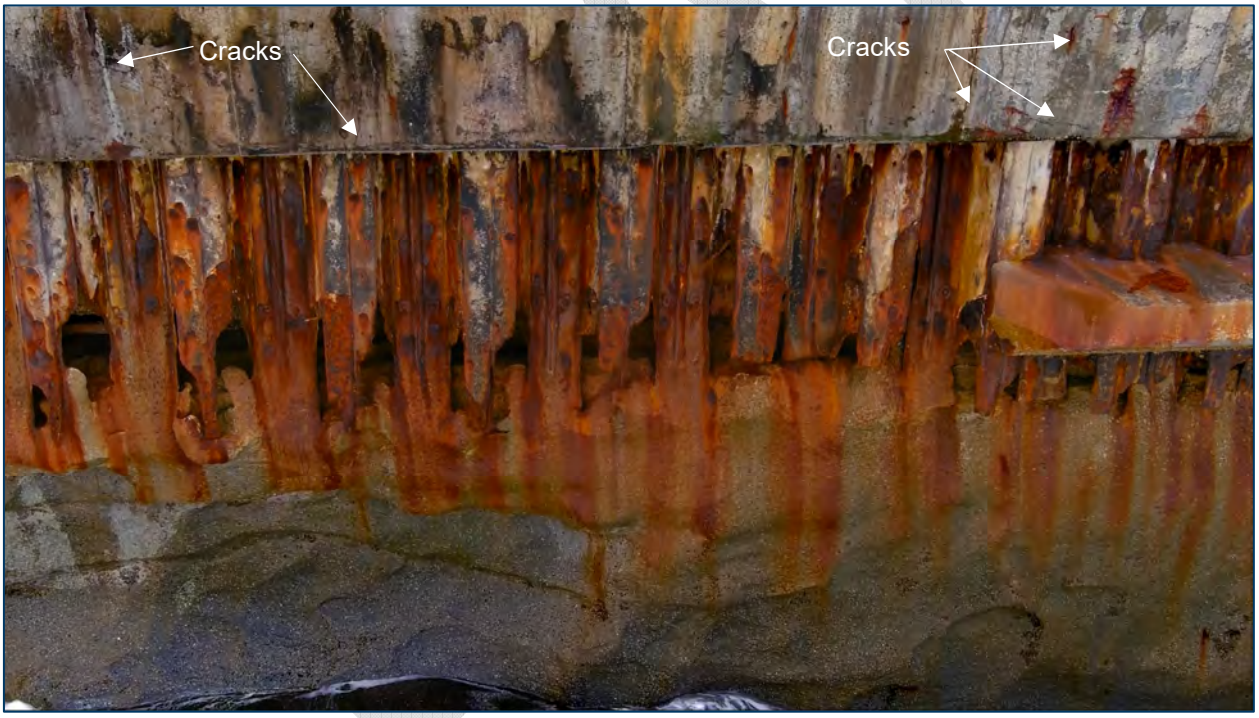



*Figure A.3-3 Pier Abutment Wall – North Face*


*Figure A.3-4 Pier Abutment Wall and Concrete Cap – North Face*

**Deck Exterior between Pier Abutment and Bent 1B**

Observations:

- Unattended broken wiring coming out of the deck underside.
- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection
- Moderate to Severe corrosion and structural spalls with visible rebar
- Moderate to Major cracks and rust bleed stains around deck underside edges
- Overall rating of deck – Severe


*Figure A.3-5 Deck Exterior between Pier Abutment and Bent 1B – North Face*

*Figure A.3-6 Deck Exterior between Pier Abutment and Bent 1B – South Face*

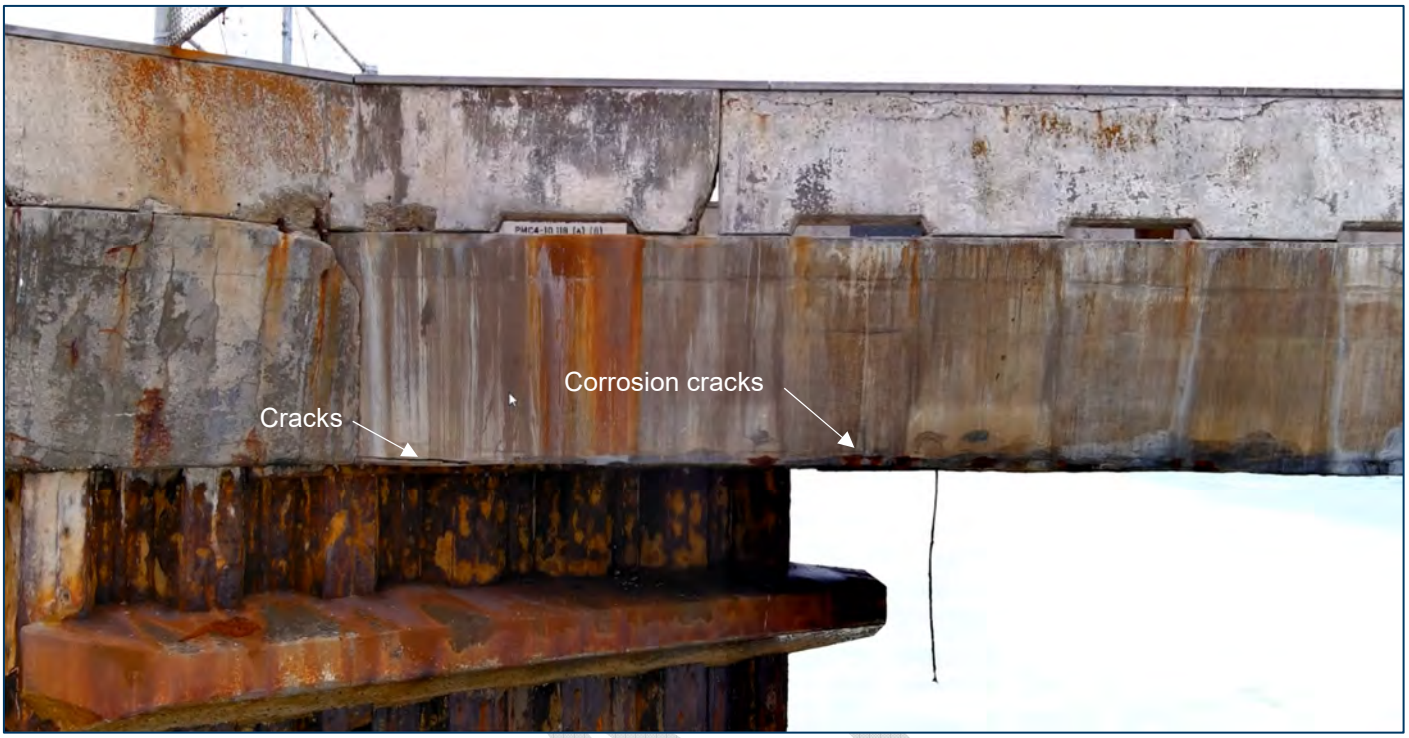



*Figure A.3-7 Deck Exterior between Pier Abutment and Bent 1B – North Face*


*Figure A.3-8 Deck Exterior between Pier Abutment and Bent 1B – North Face*

**Deck Exterior at Bent 1B**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection, deck, and bent connection (around bearing plate)
- Moderate to Major corrosion and structural spalls

- Moderate to Major cracks and rust bleed stains around bent underside edges
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Bent – Major
- Overall rating for Pile - Moderate


*Figure A.3-9 Deck Exterior between Pier Abutment and Bent 1B – South Face*

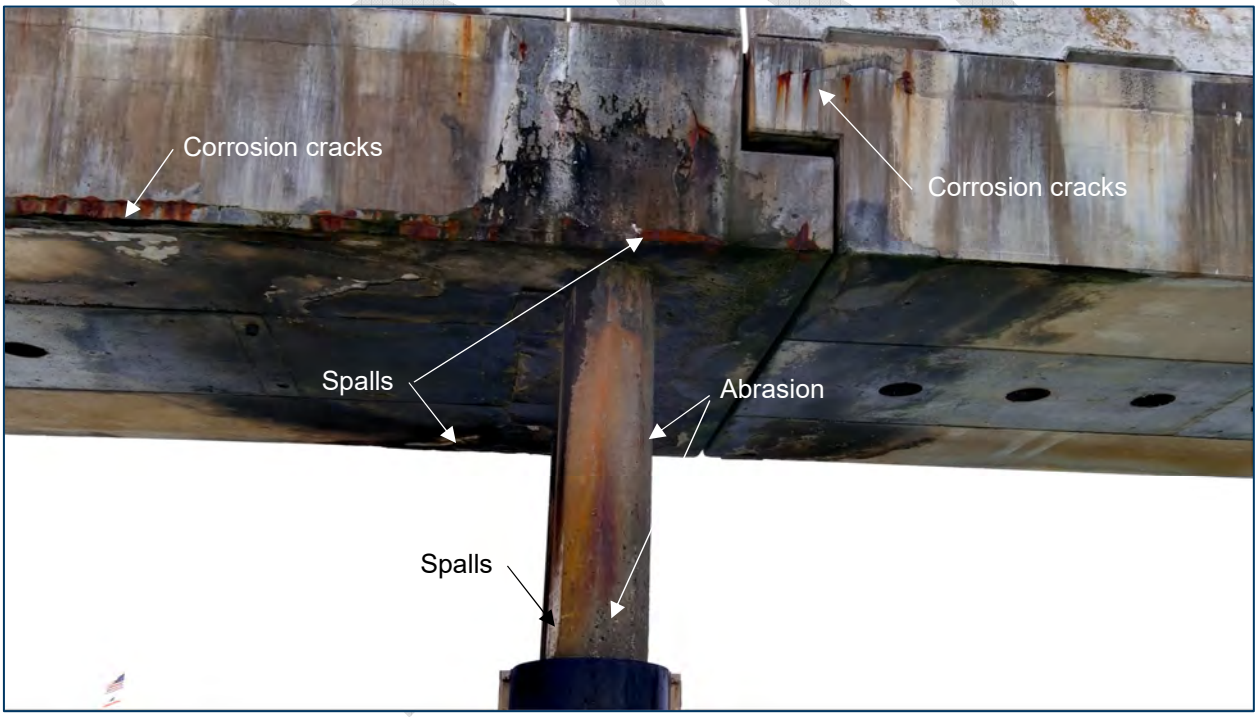



*Figure A.3-10 Deck Exterior at Bent 1B – North Face*

**Deck Exterior around Bent 1C**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck, and bent connection
- Minor to Moderate corrosion and structural spalls on deck between Bent 1B and 1C
- Moderate to Major corrosion and structural spalls around and under Bent 1C
- Moderate to Major cracks around and under Bent 1C
- Minor to Moderate cracks on deck between Bent 1B and 1C
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Deck – Moderate
- Overall rating for Bent – Major
- Overall rating for Pile - Moderate

*Figure A.3-11 Deck Exterior from Bent 1B to Bent 1C – North Face*

*Figure A.3-12 Deck Exterior between Bent 1C and Pier Abutment – South Face*

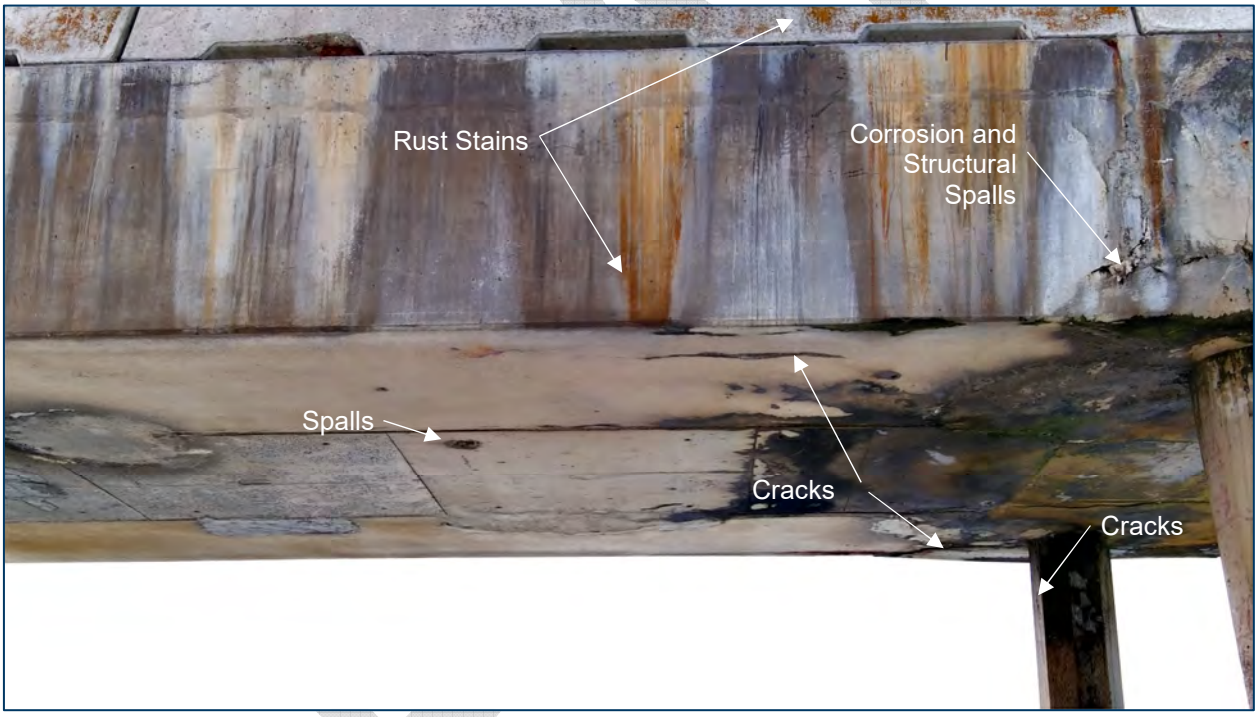



*Figure A.3-13 Deck Exterior at Bent 1C – North Face*


*Figure A.3-14 Deck Exterior at Bent 1C – South Face*

**Deck Exterior around Bent 1D**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Moderate to Severe corrosion and structural spalls on deck between Bent 1C and 1D – Visible rebar
- Moderate to Severe corrosion and structural spalls around Bent 1D
- Moderate to Major cracks around and under Bent 1D
- Moderate cracks between on deck Bent 1C and 1D
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Deck – Severe
- Overall rating for Bent - Severe
- Overall rating for Pile - Moderate

*Figure A.3-15 Deck Exterior around Bent 1D – North Face*

*Figure A.3-16 Deck Exterior around Bent 1D – South Face*

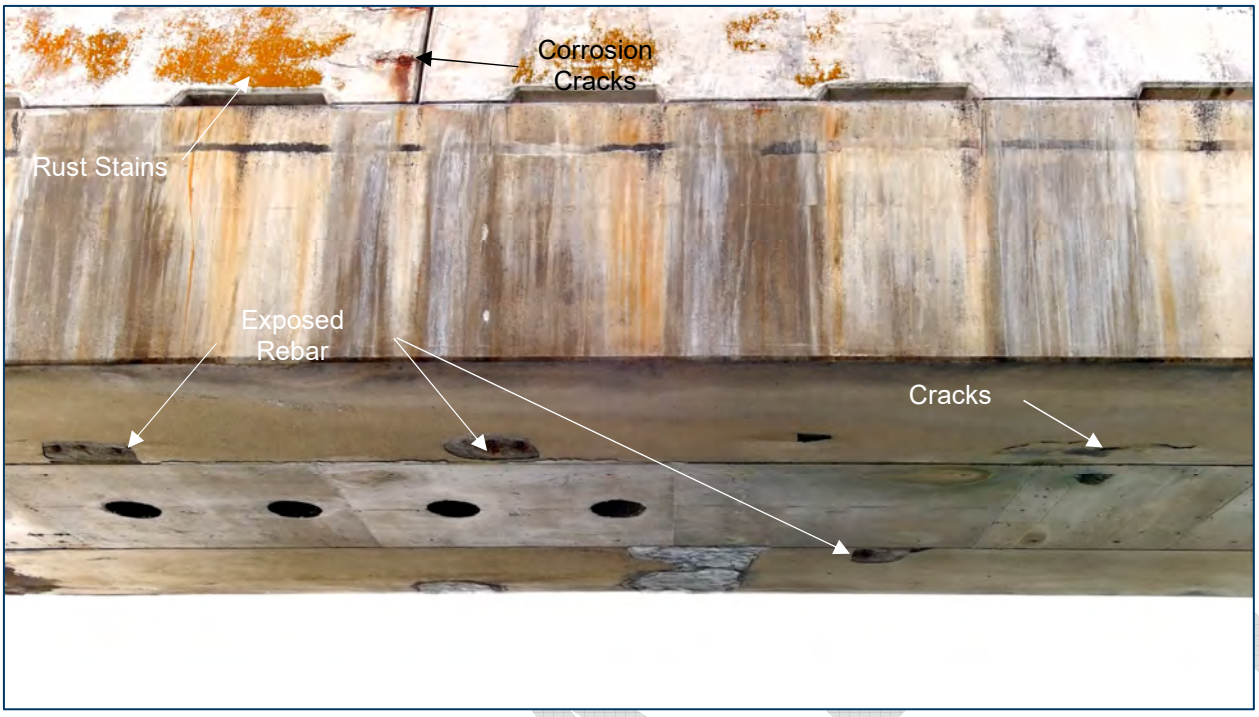



*Figure A.3-17 Deck Exterior between Bent 1C and 1D – North Face*

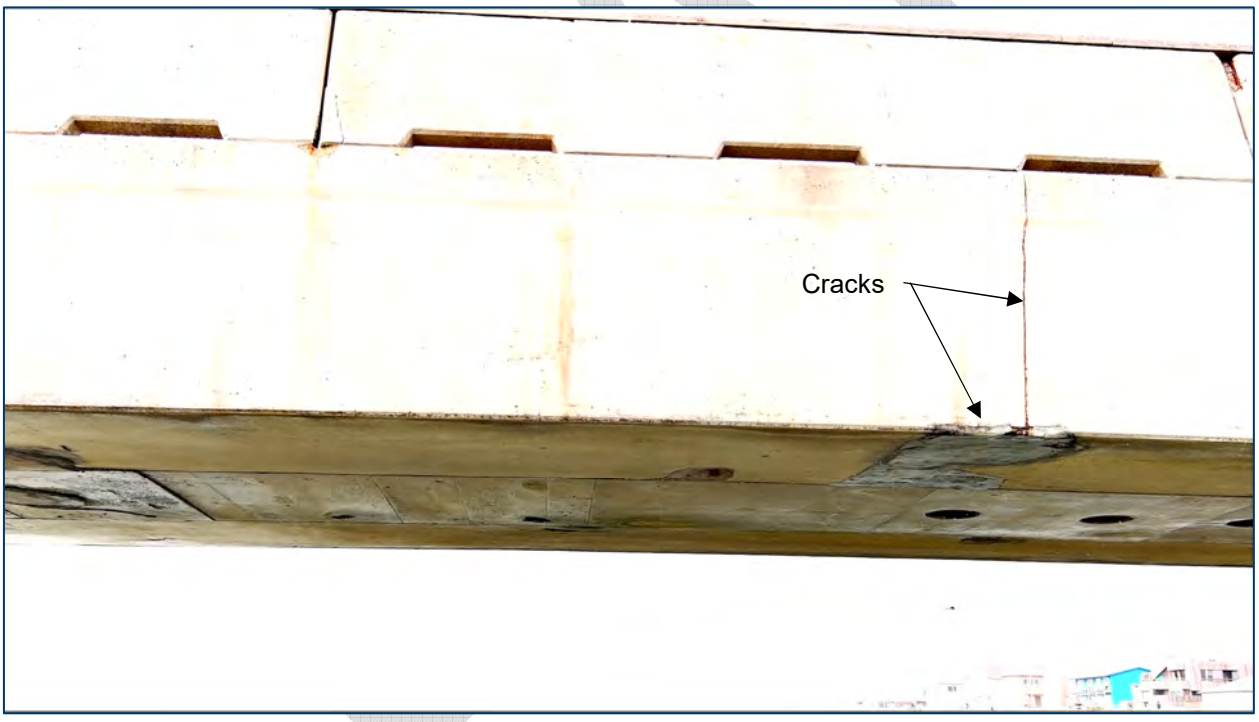



*Figure A.3-18 Deck Exterior between Bent 1D and 1C – South Face*

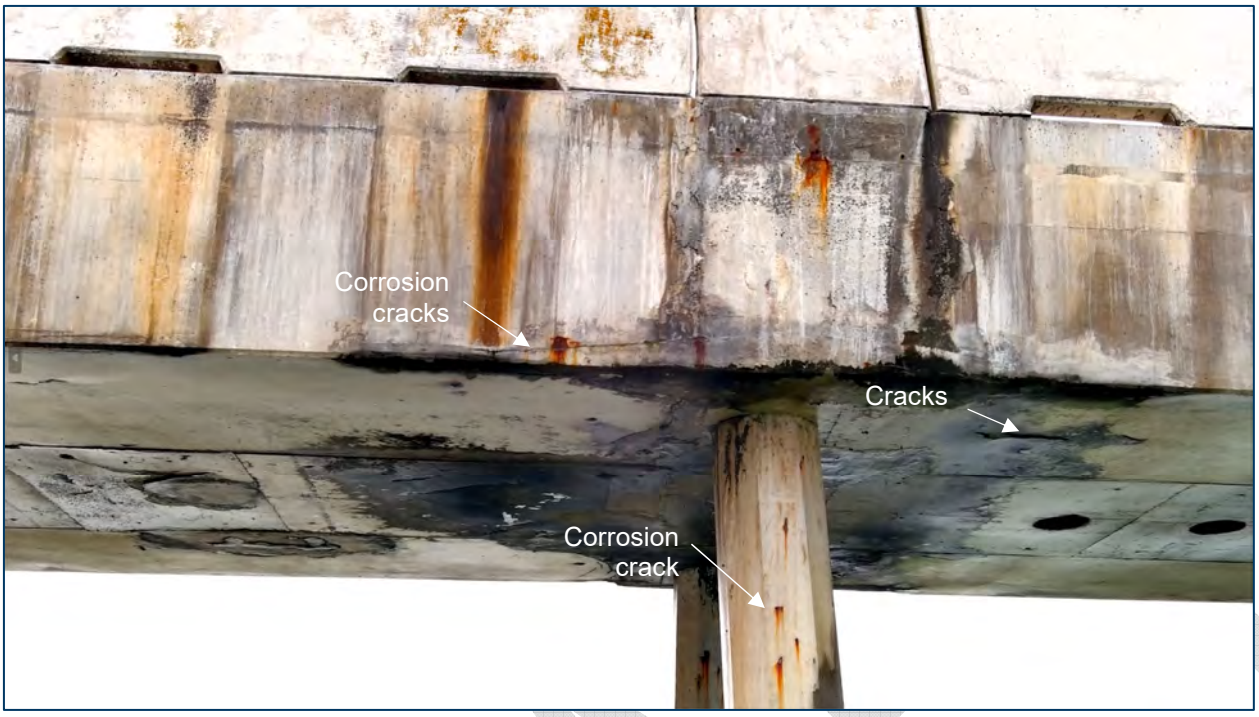



*Figure A.3-19 Deck Exterior at Bent 1D – North Face*

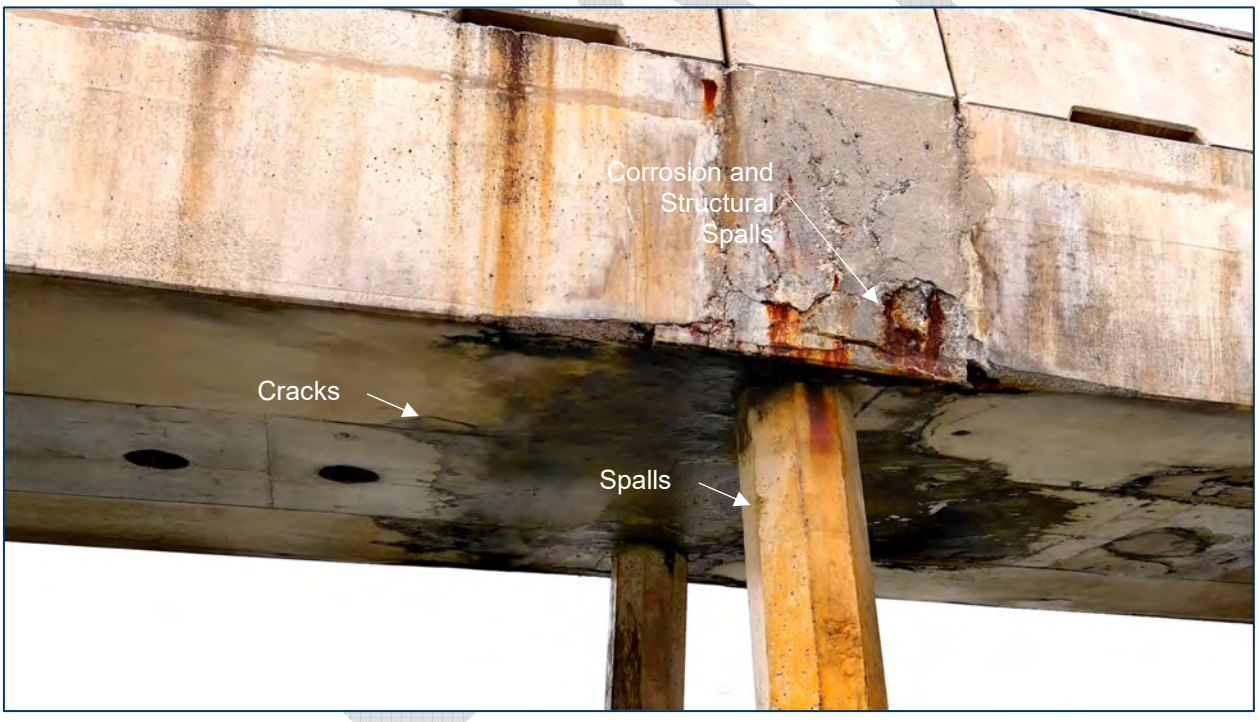



*Figure A.3-20 Deck Exterior at Bent 1D – South Face*

**Deck Exterior around Bent 1E**

Observations:

- Discoloration of concrete (black/green algae)

- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Moderate to Severe corrosion and structural spalls on deck between Bent 1D and 1E – Visible rebar
- Moderate to Major cracks around and under Bent 1E
- Moderate cracks on deck between Bent 1D and 1E
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Deck – Severe
- Overall rating for Bent - Major

Overall rating for Pile - Moderate

*Figure A.3-21 Deck Exterior around Bent 1E and Bent 1F – North Face*

*Figure A.3-22 Deck Exterior around Bent 1E – South Face*

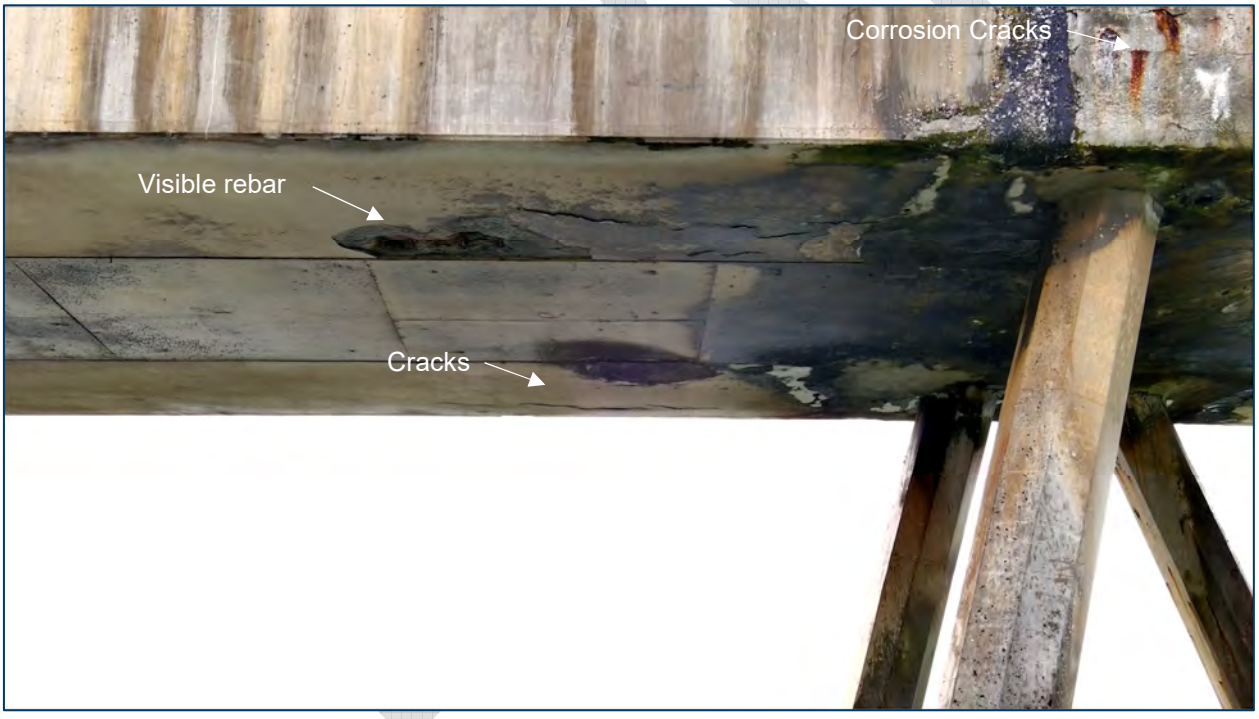



*Figure A.3-23 Deck Exterior around Bent 1E – North Face*


*Figure A.3-24 Deck Exterior at Bent 1E – North Face*


*Figure A.3-25 Deck Exterior at Bent 1E – South Face*

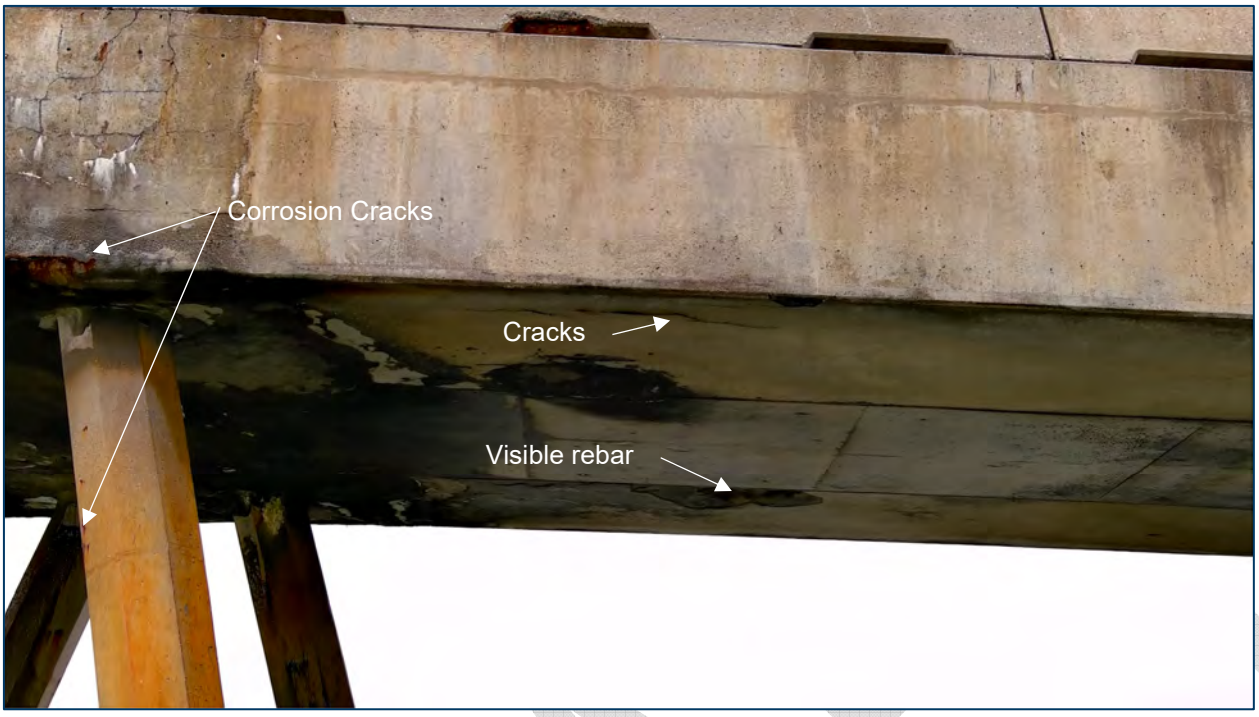



*Figure A.3-26 Deck Exterior between Bent 1E and 1D – South Face*

**Deck Exterior around Bent 1F**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Moderate to Major corrosion and structural spalls on deck between Bent 1E and 1F
- Moderate to Major corrosion and structural spalls around Bent 1F
- Moderate to Major cracks around and under Bent 1E
- Moderate to Major cracks between Bent 1E and 1F
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Major
- Overall rating for Pile – Bent F-N – Moderate, Bent F-S - Major

*Figure A.3-27 Deck Exterior around Bent 1F – South Face*


*Figure A.3-28 Deck Exterior at Bent 1F – North Face*


*Figure A.3-29 Deck Exterior at Bent 1F – South Face*

**Deck Exterior around Bent 1G**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck, and bent connection
- Moderate to Major corrosion and structural spalls on deck between Bent 1F and 1G
- Moderate to Severe corrosion and structural spalls around Bent 1G
- Moderate to Major cracks around and under Bent 1G
- Moderate to Major cracks between Bent 1F and 1G
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Severe
- Overall rating for Pile - Moderate

*Figure A.3-30 Deck Exterior around Bent 1G – North Face*

*Figure A.3-31 Deck Exterior around Bent 1H and 1G – South Face*

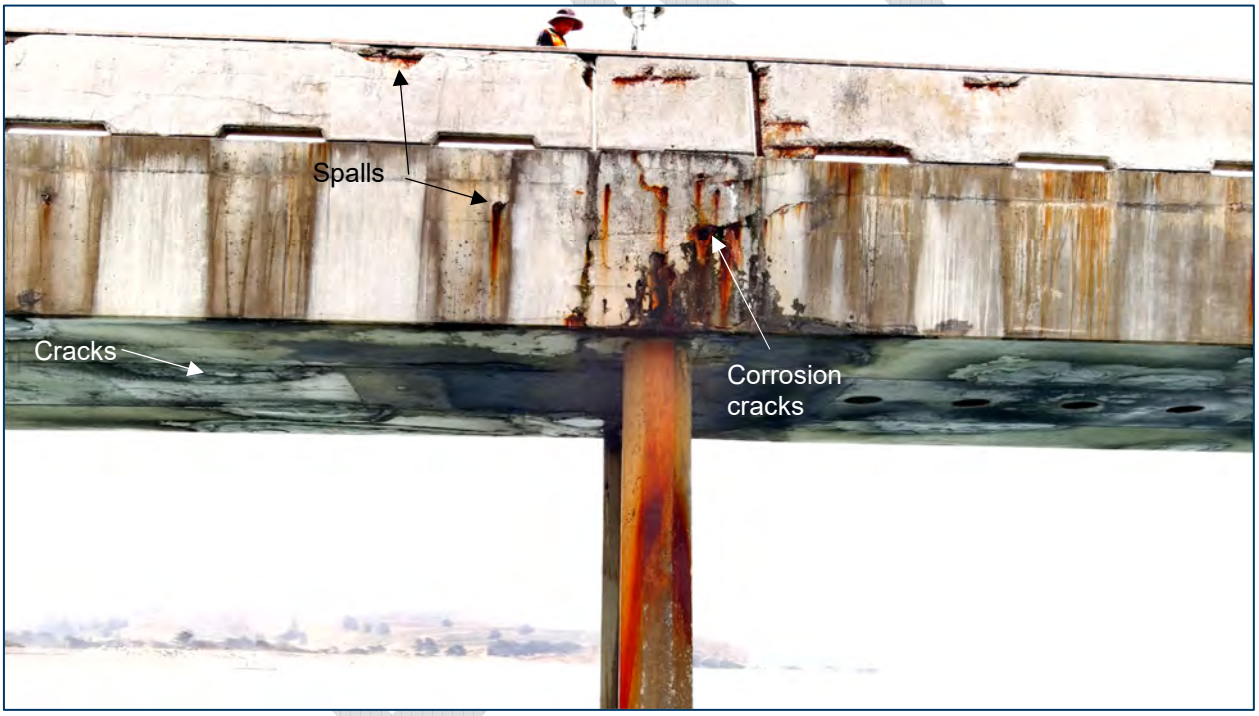



*Figure A.3-32 Deck Exterior at Bent 1G – North Face*


*Figure A.3-33 Deck Exterior at Bent 1G – South Face*

**Deck Exterior around Bent 1H**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection (bearing plate connection)
- Moderate corrosion and structural spalls between Bent 1G and 1H
- Moderate corrosion and structural spalls around Bent 1H
- Moderate to Major cracks around and under Bent 1H
- Moderate to Major cracks between Bent 1G and 1H
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Major
- Overall rating for Pile - Moderate

*Figure A.3-34 Deck Exterior around Bent 1H – North Face*

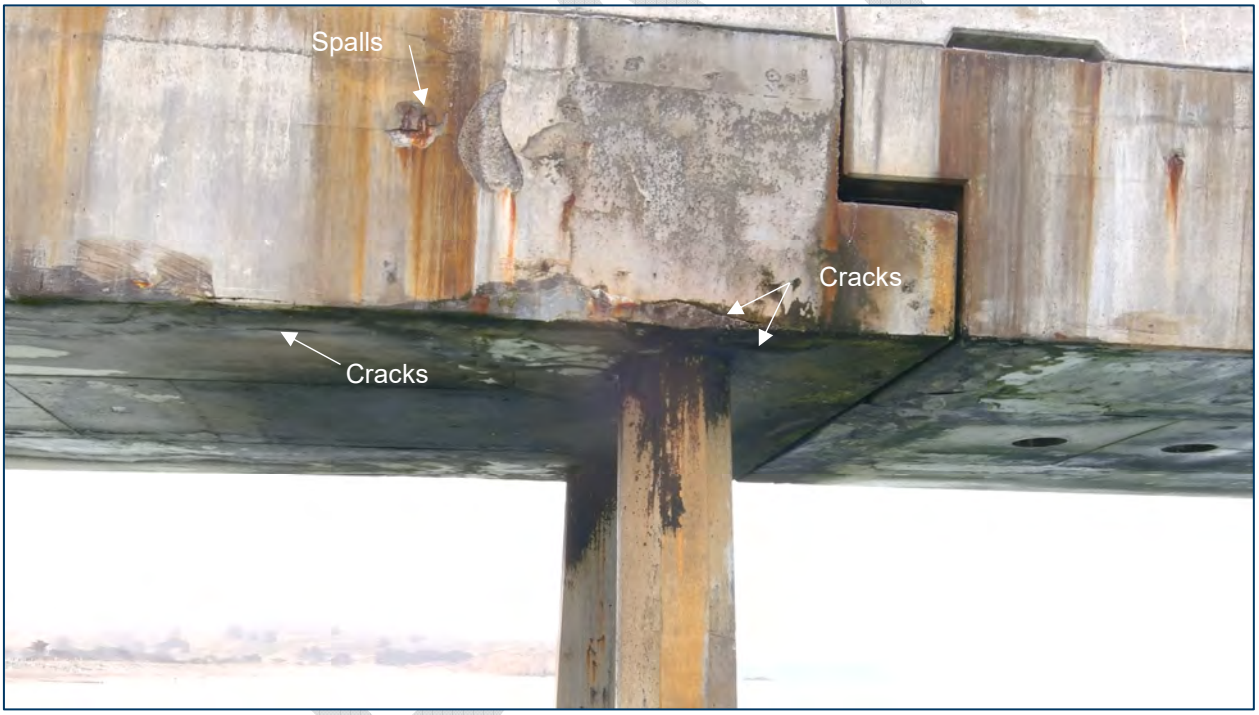



*Figure A.3-35 Deck Exterior at Bent 1H – North Face*


*Figure A.3-36 Deck Exterior at Bent 1H – South Face*

**Deck Exterior around Bent 1I**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection (bearing plate connection)
- Minor impact spalls between Bent 1H and 1I
- Moderate to Major corrosion and structural spalls around Bent 1I
- Moderate to Major cracks around and under Bent 1I
- Minor to Moderate cracks between Bent 1H and 1I
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Deck – Moderate
- Overall rating for Bent - Major
- Overall rating for Pile - Moderate

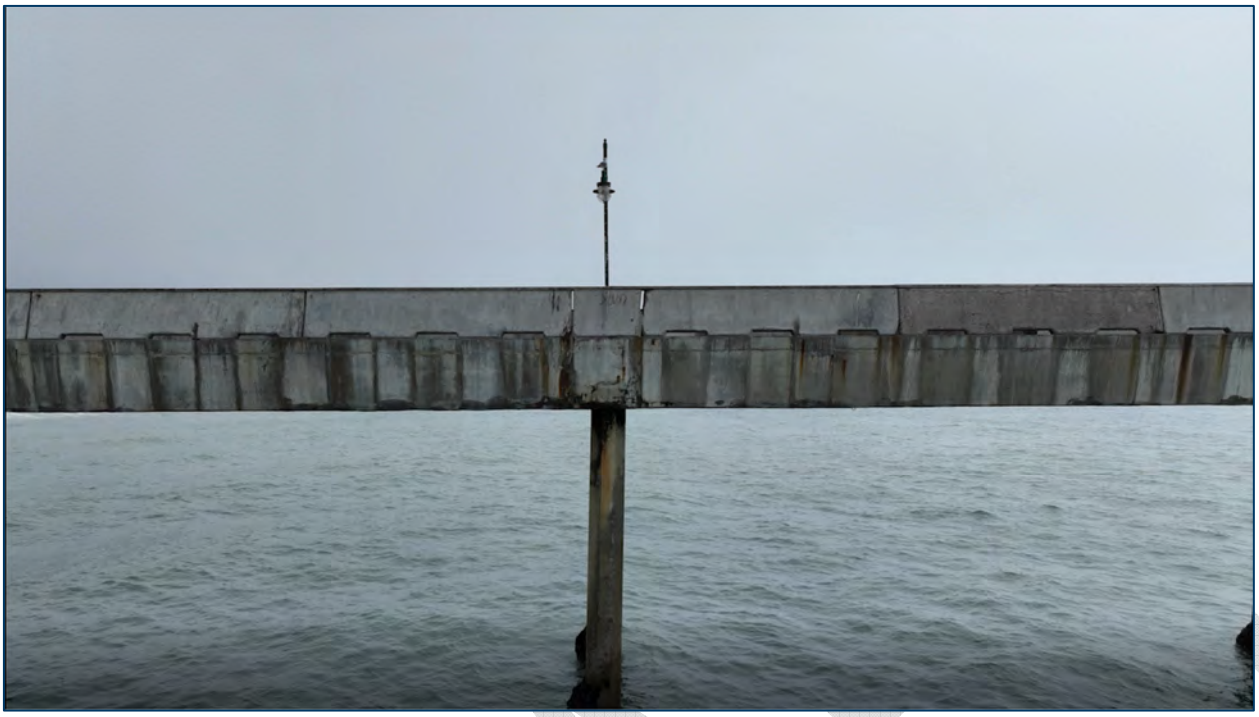


*Figure A.3-37 Deck Exterior around Bent 1I – North Face*

*Figure A.3-38 Deck Exterior around Bent 1I - South Face*

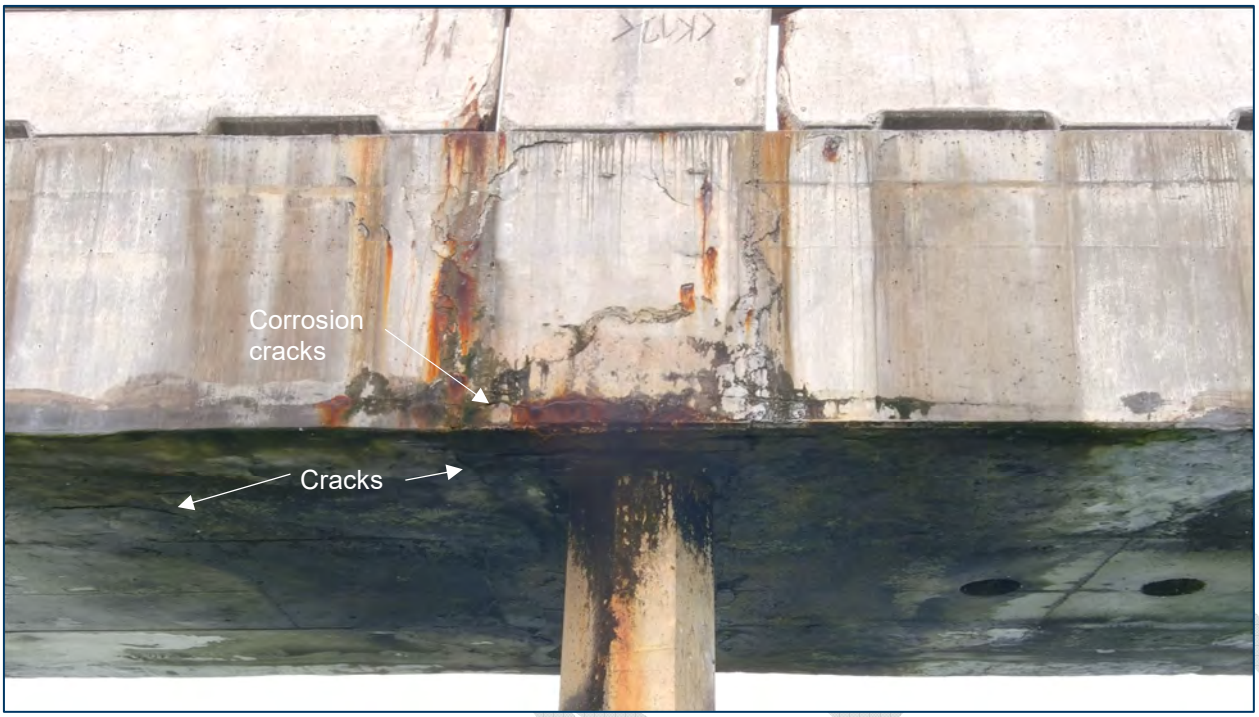



*Figure A.3-39 Deck Exterior at Bent 1I – North Face*


*Figure A.3-40 Deck Exterior at Bent 1I – South Face*

**Deck Exterior around Bent 1J**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Minor spalls between Bent 1I and 1J
- Moderate to Major corrosion and structural spalls around Bent 1J
- Moderate to Major cracks around and under Bent 1I
- Moderate to Major cracks between Bent 1I and 1J
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Major
- Overall rating for Pile – Moderate

*Figure A.3-41 Deck Exterior around Bent 1J - North Face*

*Figure A.3-42 Deck Exterior between Bent 1K and 1J – South Face*

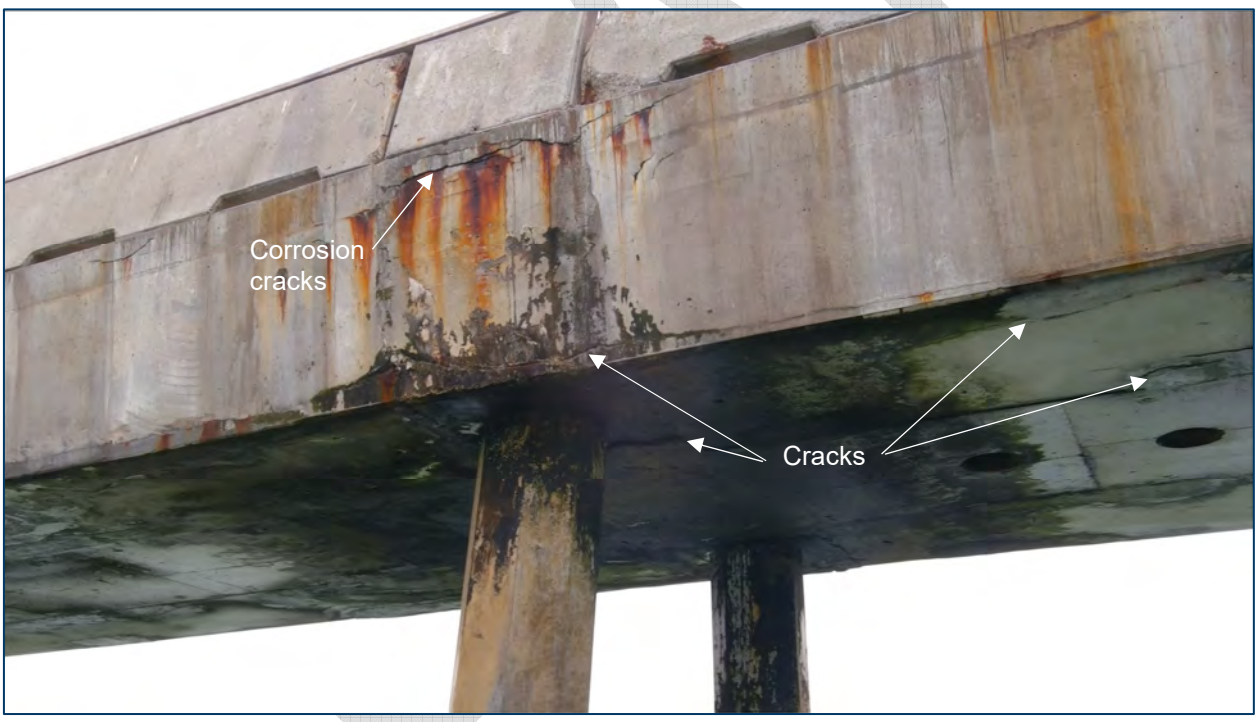



*Figure A.3-43 Deck Exterior at Bent 1J – North Face*


*Figure A.3-44 Deck Exterior at Bent 1J - South Face*

**Deck Exterior around Bent 1K**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Minor spalls between Bent 1J and 1K
- Moderate to Major corrosion and structural spalls around Bent 1K
- Moderate to Major cracks around and under Bent 1K
- Moderate to Major cracks between Bent 1J and 1K
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Major
- Overall rating for Pile – Bent K-NE - Moderate, Bent K-NW - Moderate, Bent K-SE - Major, Bent K-SW - Major

*Figure A.3-45 Deck Exterior around Bent 1K and 1L- North Face*

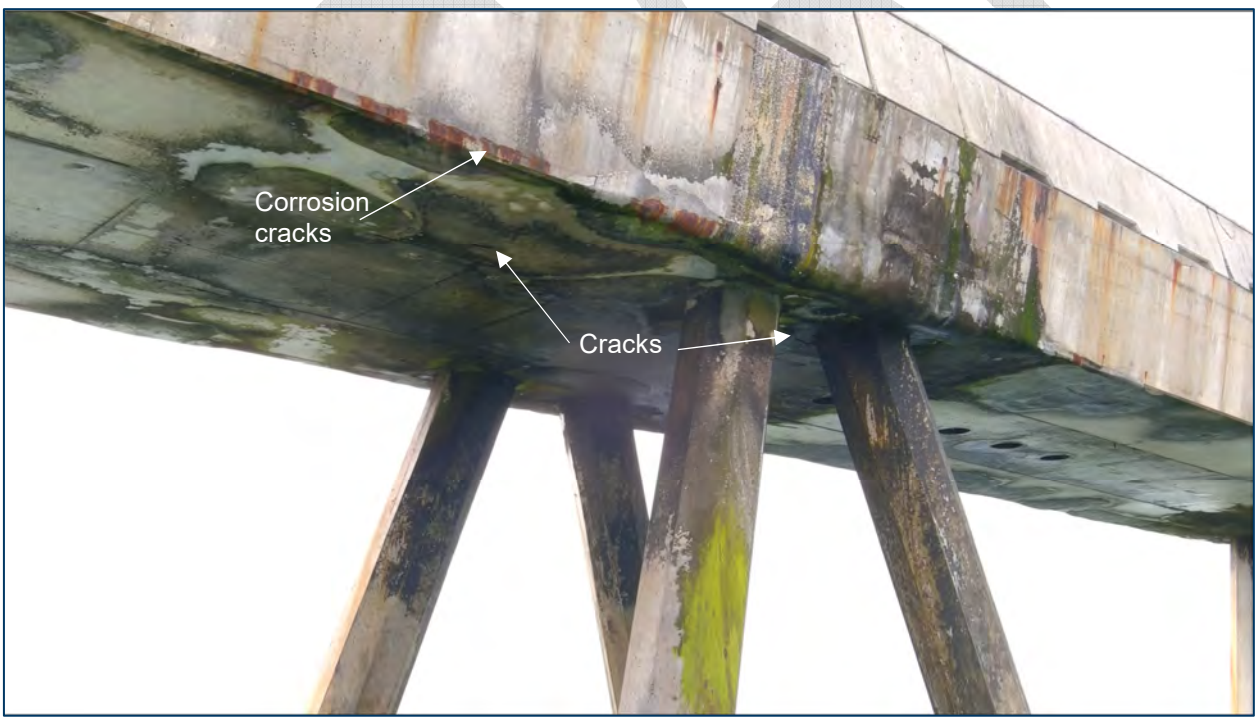



*Figure A.3-46 Deck Exterior at Bent 1K – North Face*

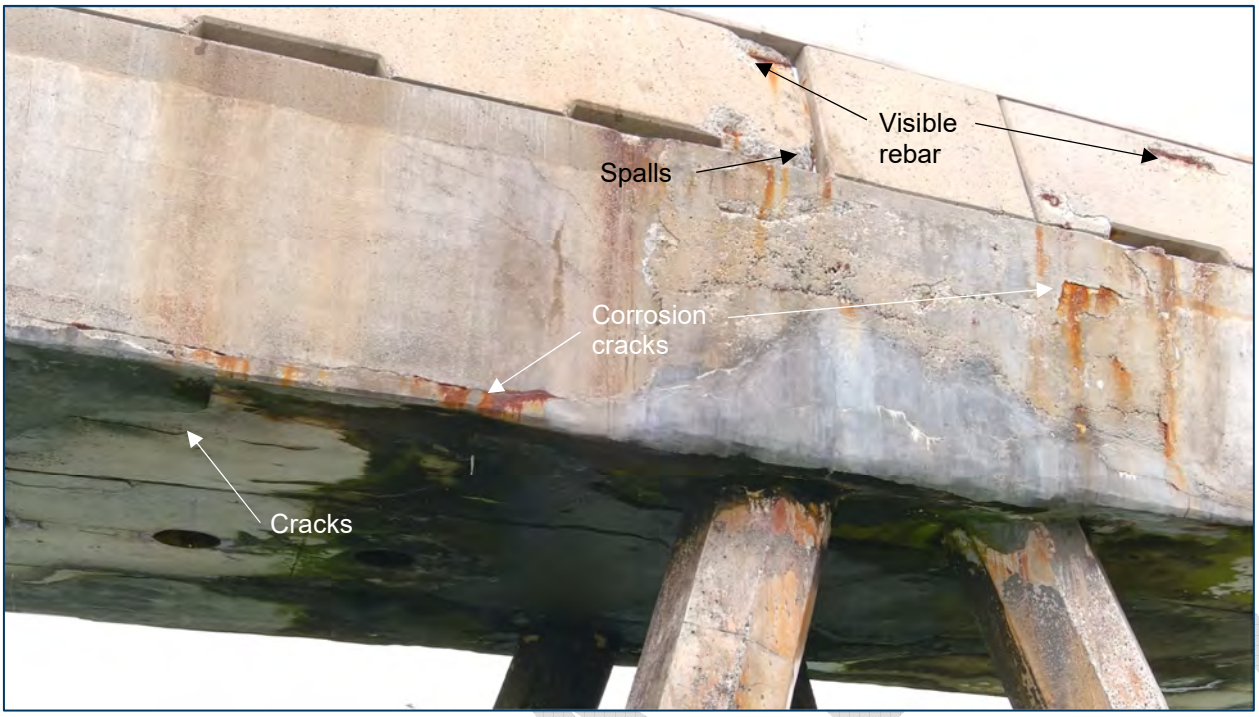



*Figure A.3-47 Deck Exterior at Bent 1K – South Face*

**Deck Exterior around Bent 1L**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Moderate to Major corrosion and structural spalls between Bent 1K and 1L
- Moderate to Severe corrosion and structural spalls around Bent 1L
- Moderate to Major cracks around and under Bent 1L
- Moderate to Major cracks between Bent 1K and 1L
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Severe
- Overall rating for Pile – Major

*Figure A.3-48 Deck Exterior between Bent 1M and 1L – South Face*


*Figure A.3-49 Deck Exterior at Bent 1L – North Face*


*Figure A.3-50 Deck Exterior at Bent 1L – South Face*

**Deck Exterior around Bent 1M**

Observations:

- Discoloration of concrete (black/green algae)

- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Minor spalls between Bent 1L and 1M
- Moderate to Severe corrosion and structural spalls around Bent 1M – Visible Rebar
- Moderate to Major cracks around and under Bent 1M
- Moderate to Major cracks between Bent 1L and 1M
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Severe
- Overall rating for Pile – Bent M-N - Major, Bent M-S - Moderate

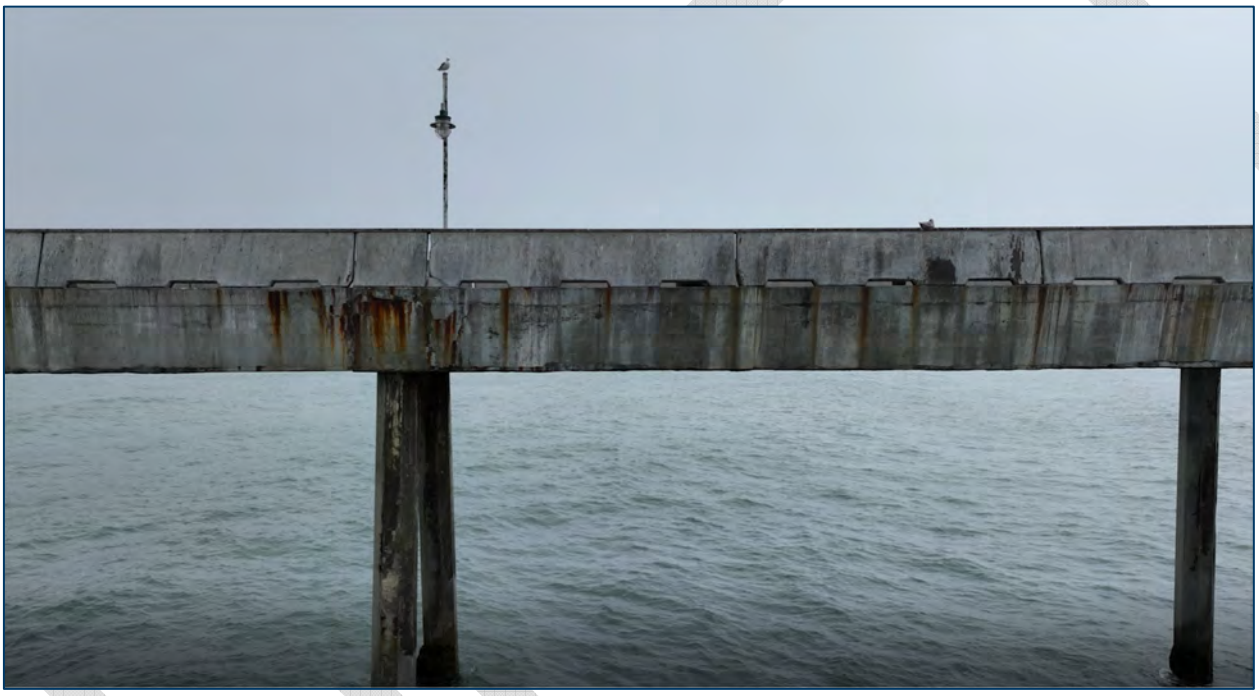


*Figure A.3-51 Deck Exterior around Bent 1M – North Face*


*Figure A.3-52 Deck Exterior at Bent 1M – North Face*

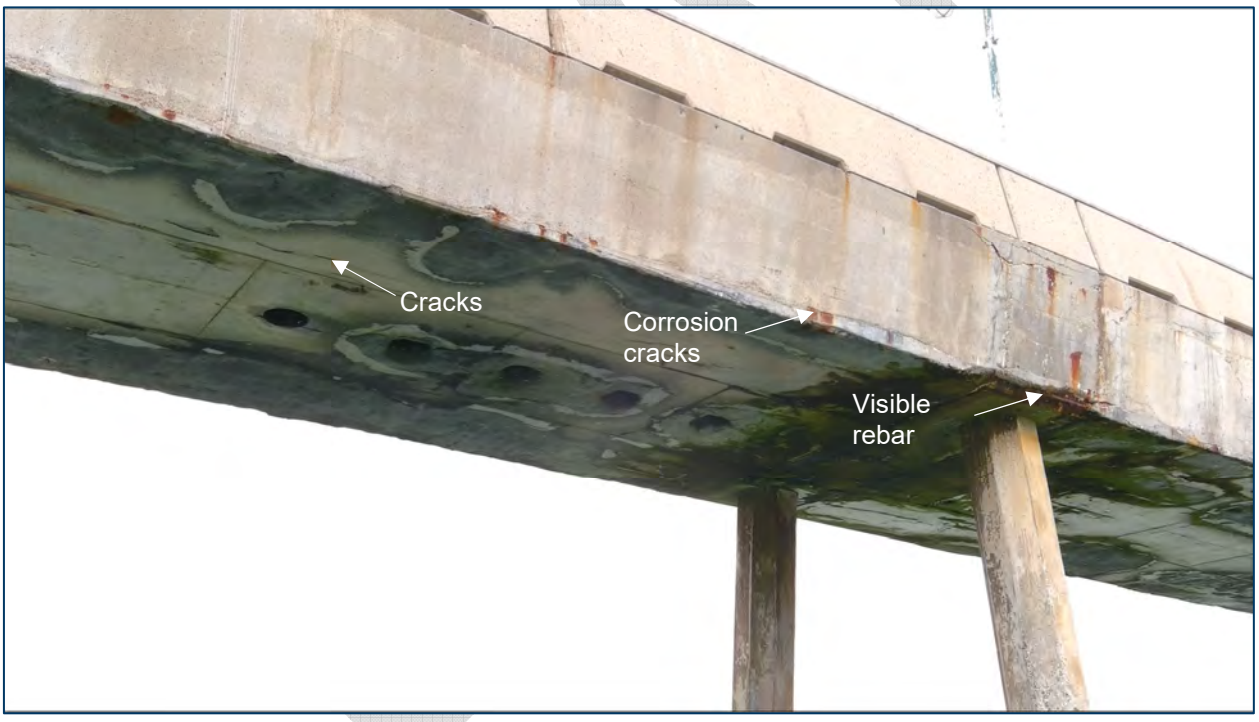



*Figure A.3-53 Deck Exterior at Bent 1M – South Face*

**Deck Exterior around Bent 1N**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection

- Minor spalls between Bent 1M and 1N
- Moderate to Major spalls around Bent 1N
- Moderate to Major cracks around and under Bent 1N
- Moderate to Major cracks between Bent 1M and 1N
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Major
- Overall rating for Pile – Major

*Figure A.3-54 Deck Exterior around Bent 1N - North Face*


*Figure A.3-55 Deck Exterior between Bent 1O and 1N – South Face*


*Figure A.3-56 Deck Exterior at Bent 1N – North Face*


*Figure A.3-57 Deck Exterior at Bent 1N - South Face*

### Deck Exterior around Bent 1O

Observations:

- Discoloration of concrete (black/green algae)

- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Moderate to Severe corrosion and structural spalls between Bent 1N and 1O – Corroded Visible Rebar
- Moderate to Severe corrosion and structural spalls around Bent 1O – Corroded Visible Rebar, Significant section loss
- Moderate to Major cracks around and under Bent 1O
- Moderate cracks between Bent 1N and 1O
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Severe
- Overall rating for Bent - Severe
- Overall rating for Pile – Bent O-N Moderate, Bent O-S Major

*Figure A.3-58 Deck Exterior around Bent 1O - North Face*


*Figure A.3-59 Deck Exterior between Bent 1O and 1N – South Face*

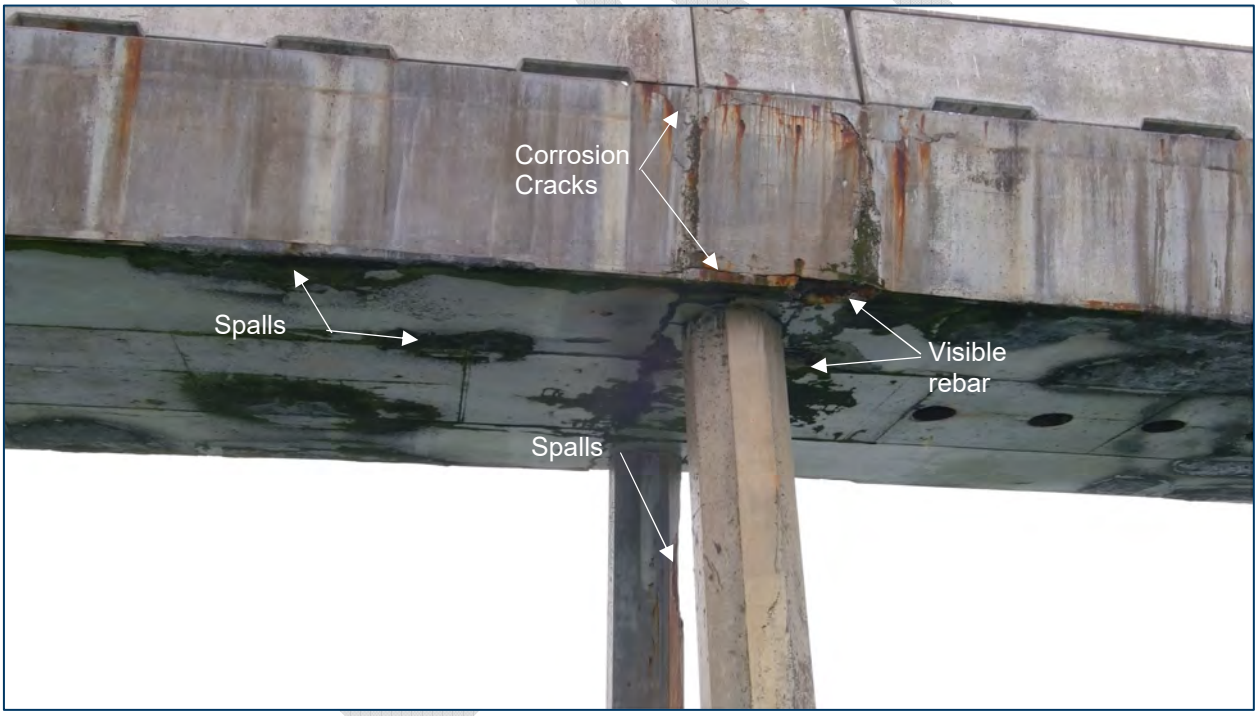



*Figure A.3-60 Deck Exterior at Bent 1O - North Face*


*Figure A.3-61 Deck Exterior at Bent 1O – South Face*

**Deck Exterior around Bent 1P**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck, and bent connection
- Minor spalls between Bent 1O and 1P
- Moderate to Severe corrosion and structural spalls around Bent 1P – Corroded Visible Rebar
- Moderate to Major cracks around and under Bent 1P
- Moderate to Major cracks between Bent 1O and 1P
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Major
- Overall rating for Bent - Severe
- Overall rating for Pile – Bent P-NE - Moderate, Bent P-NW - Major, Bent P-SE - Major, Bent P-SW - Major

*Figure A.3-62 Deck Exterior around Bent 1P - North Face*

*Figure A.3-63 Deck Exterior around Bent 1P - North Face*

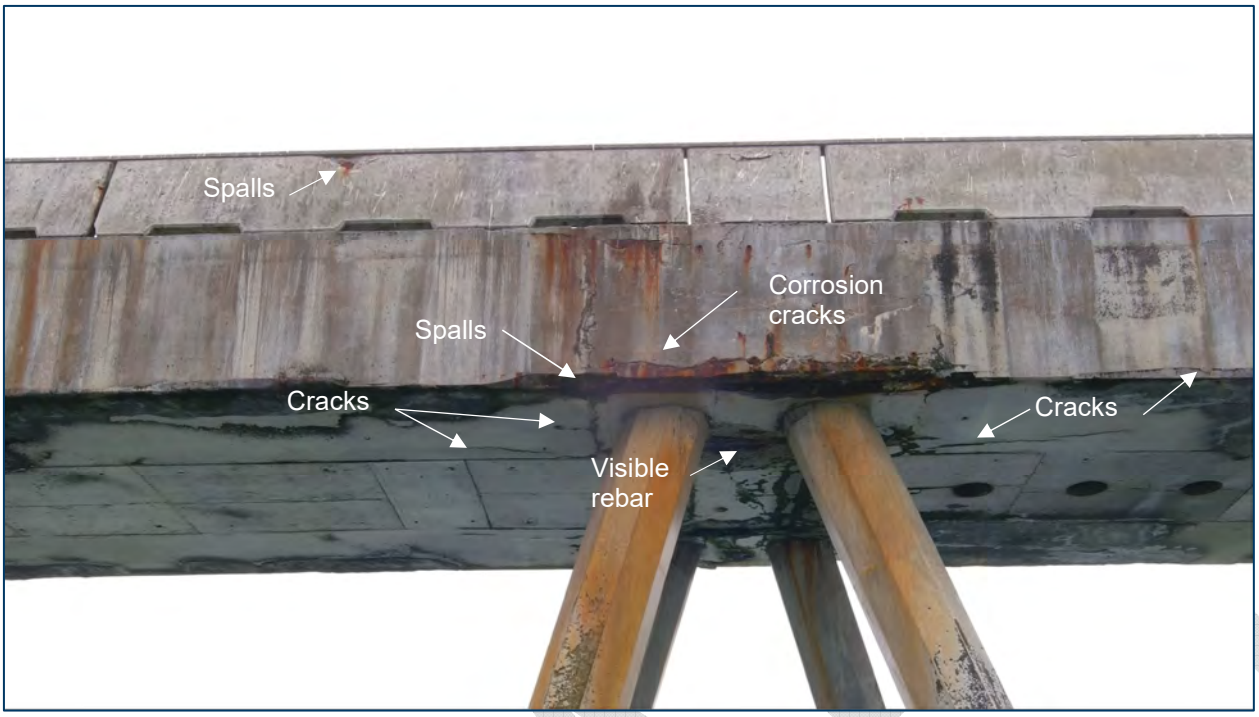
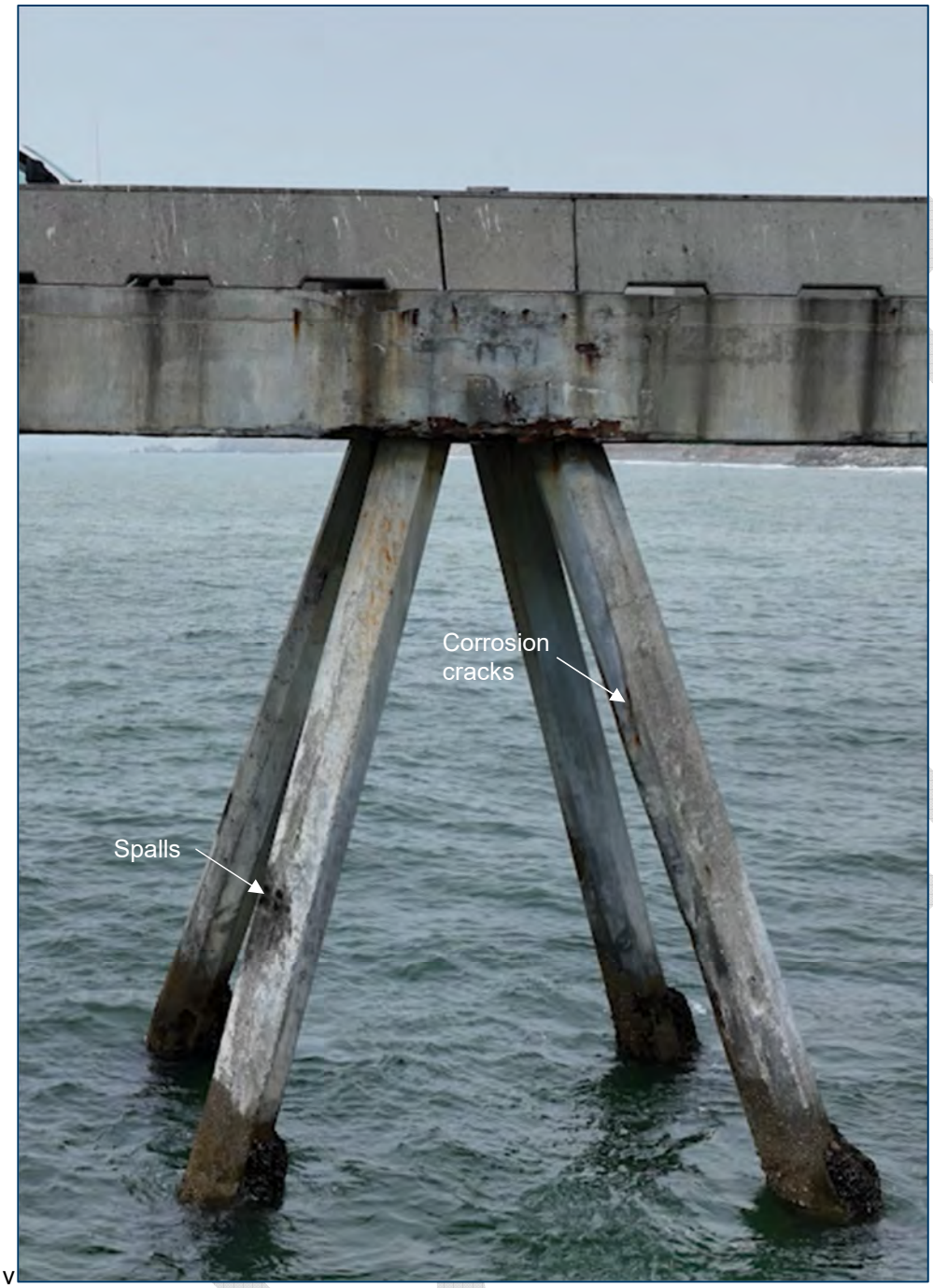



*Figure A.3-64 Deck Exterior at Bent 1P - North Face*

*Figure A.3-65 Deck Exterior at Bent 1P – South Face*




v

*Figure A.3-66: Deck Exterior at Bent 1P – South Face*

**Deck Exterior around Bent 1Q**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Moderate to Severe corrosion and structural spalls between Bent 1P and 1Q – Visible Corroded Rebar
- Moderate to Severe corrosion and structural spalls around Bent 1Q – Visible Corroded Broken Rebar, Significant section loss around bent edges

- Moderate cracks around and under Bent 1Q
- Moderate cracks between Bent 1P and 1Q
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Severe
- Overall rating for Bent - Severe
- Overall rating for Pile – Major


*Figure A.3-67 Deck Exterior between Bent 1P and 1Q – North Face*


*Figure A.3-68 Deck Exterior between Bent 1Q and 1P – South Face*

*Figure A.3-69 Deck Exterior around Bent 1Q - North Face*

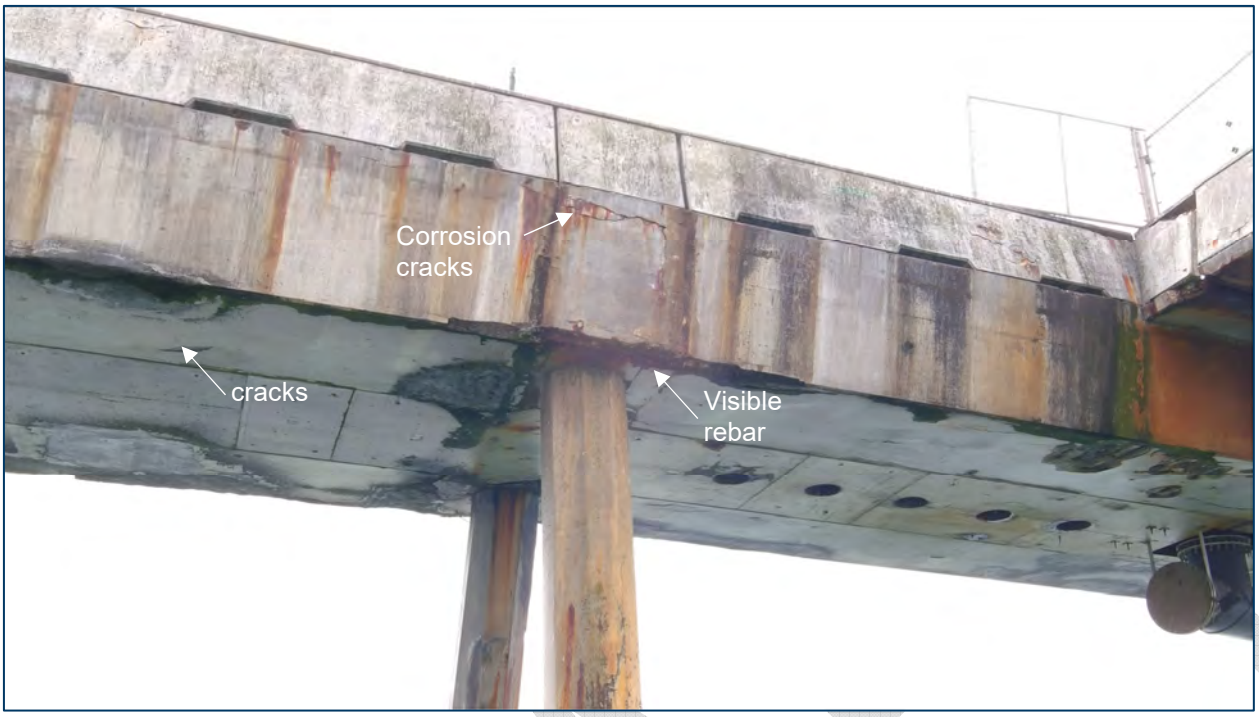



*Figure A.3-70 Deck Exterior at Bent 1Q – North Face*


*Figure A.3-71 Deck Exterior at Bent 1Q – South Face*

**Deck Exterior between Bent 1Q and 1R**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection, bent face towards water
- Major to Severe corrosion and structural spalls between Bent 1Q and 1R – Visible Corroded Rebar, Significant section loss around bent edges
- Moderate to Major corrosion and structural spalls around E-W main pier and N-S Extension Pier Connection
- Moderate to Major cracks around E-W main pier and N-S Extension Pier Connection
- Moderate to Major cracks between Bent 1Q and 1R
- Major to Severe corrosion and structural spalls around Bent 1R – Visible Corroded Rebar, Significant section loss around one of the piles and bent edges, Broken chunks of concrete around bent and deck edges
- Moderate to Severe cracks around and under Bent 1R
- Moderate to Severe cracks between Bent 1Q and 1R
- Rust stains and moderate to major cracks on piles
- Abrasion on piles
- Minor impact to Severe corrosion/structural spalls on piles – Visible corroded rebar
- Overall rating for Deck – Severe
- Overall rating for Bent - Severe
- Overall rating for Piles - Severe

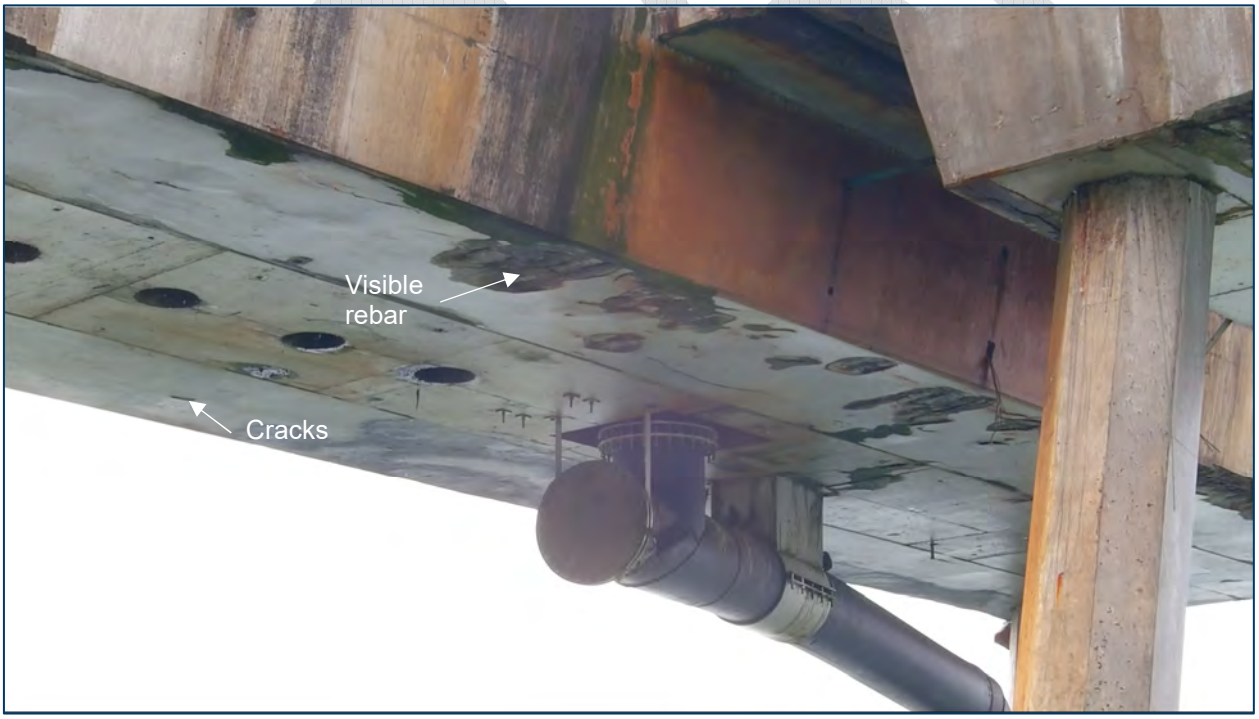



*Figure A.3-72 Deck Exterior between Bent 1Q and 1R - North Face*

*Figure A.3-73 Deck Exterior at N-S Extension Pier joint*

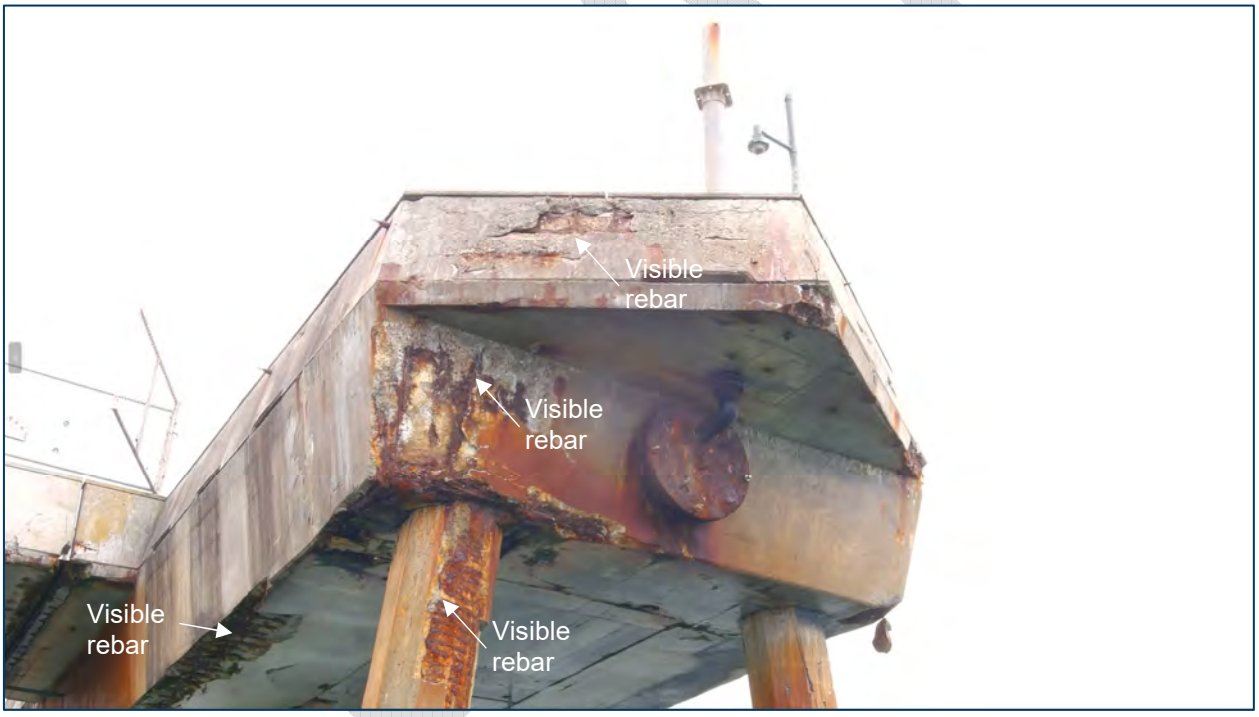



*Figure A.3-74 Deck Exterior at Bent 1R and N-S Pier Extension Joint – North - West Face*


*Figure A.3-75 Deck Exterior at Bent 1R – West Face*

*Figure A.3-76 Deck Exterior around Bent 1R – South Face*

*Figure A.3-77 Deck Exterior at Bent 1R – South Face*

**Deck Exterior around Bent 2 – N/S Extension Pier**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Major to Severe corrosion and structural spalls between Bent 2 and 3 – Visible Corroded Rebar, Significant section loss around bent edges
- Moderate to Major corrosion and structural spalls around Bent 2
- Moderate to Major cracks around and under Bent 2
- Moderate to Severe cracks between Bent 2 and 3
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Major corrosion/structural spalls on piles
- Overall rating for Deck – Severe
- Overall rating for Bent - Major
- Overall rating for Pile No – Bent 2W – Major, Bent 2E - Moderate


*Figure A.3-78 Deck Exterior around Bent 2 and 3 – East Face*


*Figure A.3-79 Deck Exterior at & around Bent 2 - East Face*


*Figure A.3-80 Deck Exterior at Bent 2 and N-S Pier Extension Joint – West Face*

*Figure A.3-81 Deck Exterior around Bent 2 and 1R – West Face*

**Deck Exterior around Bent 3 – N/S Extension Pier**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Major to Severe corrosion and structural spalls between Bent 3 and 4 – Visible Corroded Rebar, Significant section loss around bent edges
- Major to Severe corrosion and structural spalls around Bent 3
- Moderate to Severe cracks around and under Bent 3
- Moderate to Severe cracks between Bent 3 and 4
- Rust stains and moderate cracks on piles
- Abrasion on piles
- Minor impact to Severe corrosion/structural spalls on piles – Visible corroded rebar in some piles
- Overall rating for Deck – Severe
- Overall rating for Bent - Severe
- Overall rating for Pile No – Bent 3NE - Moderate, Bent 3NW – Major, Bent 3SE - Severe, Bent 3SW - Severe

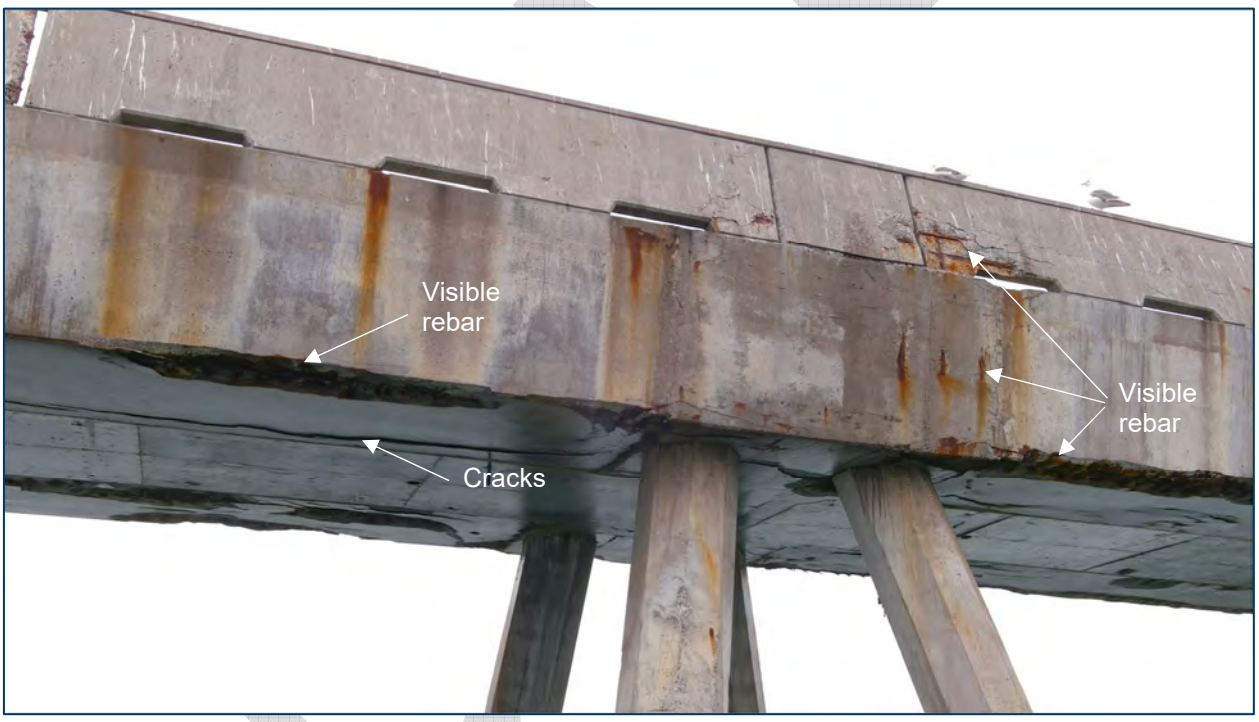



*Figure A.3-82 Deck Exterior at Bent 3 – East Face*


*Figure A.3-83 Deck Exterior at Bent 3 – West Face*


*Figure A.3-84 Deck Exterior around Bent 3 – East Face*


*Figure A.3-85 Deck Exterior around Bent 3 and 4 - East Face*

*Figure A.3-86 Deck Exterior around Bent 4 and 3 – West Face*

**Deck Exterior around Bent 4 – N/S Extension Pier**

Observations:

- Discoloration of concrete (black/green algae)
- Rust bleed stains around deck and handrail connection at some places, deck and bent connection
- Major to Severe corrosion and structural spalls between Bent 3 and 4 – Visible Corroded Rebar, Significant section loss around bent edges
- Major to Severe corrosion and structural spalls around Bent 3 – Visible Corroded Rebar, Broken rebar around bent edge, Significant section loss in between piles and around pile-deck connection (Visible corroded spiral reinforcement)
- Moderate to Severe cracks around and under Bent 4
- Moderate to Severe cracks between Bent 3 and 4
- Rust stains and moderate to major cracks on piles
- Abrasion on piles
- Minor impact to Severe corrosion/structural spalls on piles – Visible corroded rebar in some piles
- Overall rating for Deck – Severe
- Overall rating for Bent - Severe
- Overall rating for Pile No – Bent 4E – Moderate, Bent 4W - Severe


*Figure A.3-87 Deck Exterior between Bent 4 and 3 – West Face*

*Figure A.3-88 Deck Exterior around Bent 4 – West Face*


*Figure A.3-89 Deck Exterior at Bent 4 – North Face*

**Bearing Plate**

Observations:

- Rust bleed stains around deck and bent connection with bearing plates can be probably due to corroded bearing plates


*Figure A.3-90 Bearing Plate at Deck and Bent Connection*

# A.4. Pier Structure – Damage Rating

The damage ratings for the abutment, deck, and piles are provided along with the recommended priority level based on the observations.

| Damage Rating | Repair Priority |
|---|---|
| Severe | 1 |
| Major | 2 |
| Moderate | 3 |
| Minor | 4 |

## A.4.1. Pier Deck

| Pier Deck Location | Damage Rating |
|---|---|
| At Abutment | Moderate |
| Deck between Abutment & Bent 1B | Severe |
| Bent 1B | Major |
| Deck between Bent 1B and 1C | Moderate |
| Bent 1C | Major |
| Deck between Bent 1C and 1D | Severe |
| Bent 1D | Severe |
| Deck between Bent 1D and 1E | Severe |
| Bent 1E | Major |
| Deck between Bent 1E and 1F | Major |
| Bent 1F | Major |
| Deck between Bent 1F and 1G | Major |
| Bent 1G | Severe |
| Deck between Bent 1G and 1H | Major |
| Bent 1H | Major |
| Deck between 1H and 1I | Moderate |
| Bent 1I | Major |
| Deck between Bent 1I and 1J | Major |
| Bent 1J | Major |
| Deck between Bent 1J and 1K | Major |
| Bent 1K | Major |
| Deck between Bent 1K and 1L | Major |
| Bent 1L | Severe |
| Deck between Bent 1L and 1M | Major |
| Bent 1M | Severe |
| Deck between Bent 1M and 1N | Major |

| Pier Deck Location | Damage Rating |
|---|---|
| Bent 1N | Major |
| Deck between Bent 1N and 1O | Severe |
| Bent 1O | Severe |
| Deck between Bent 1O and 1P | Major |
| Bent 1P | Severe |
| Deck between Bent 1P and 1Q | Severe |
| Bent 1Q | Severe |
| Deck between Bent 1Q and 1R | Severe |
| Bent 1R | Severe |
| Bent 2 | Major |
| Deck between Bent 2 and 3 | Severe |
| Bent 3 | Severe |
| Deck between Bent 3 and 4 | Severe |
| Bent 4 | Severe |

## A.4.2. Pier Piles

| Pile Location | Damage Rating |
|---|---|
| Bent 1B - N | Moderate |
| Bent 1B - S | Moderate |
| Bent 1C - N | Moderate |
| Bent 1C - S | Moderate |
| Bent 1D - N | Moderate |
| Bent 1D - S | Moderate |
| Bent 1E - NE | Moderate |
| Bent 1E - SE | Moderate |
| Bent 1E - NW | Moderate |
| Bent 1E - SW | Moderate |
| Bent 1F - N | Moderate |
| Bent 1F - S | Major |
| Bent 1G - N | Moderate |
| Bent 1G - S | Moderate |
| Bent 1H - N | Moderate |
| Bent 1H - S | Moderate |
| Bent 1I - N | Moderate |
| Bent 1I - S | Moderate |
| Bent 1J - N | Moderate |

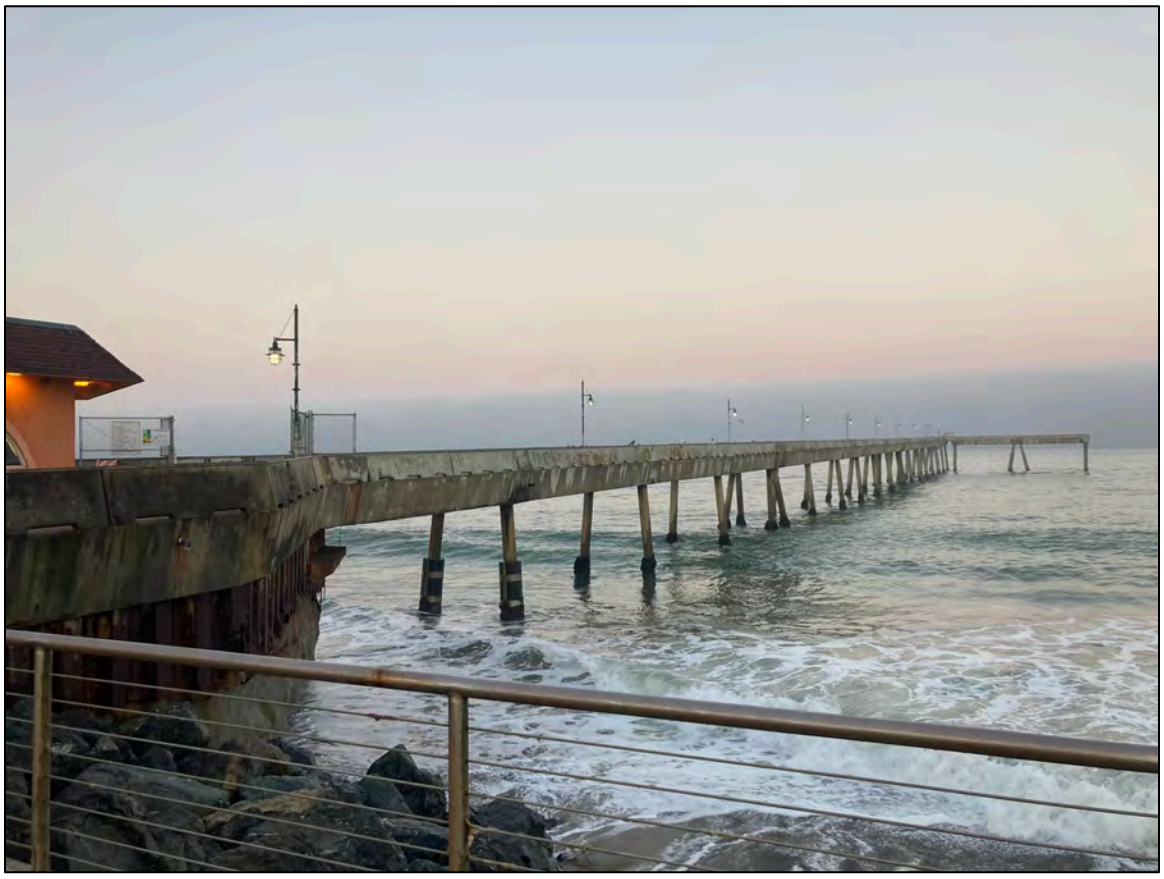
| Pile Location | Damage Rating |
|---|---|
| Bent 1J - S | Moderate |
| Bent 1K - NE | Moderate |
| Bent 1K - SE | Major |
| Bent 1K - NW | Moderate |
| Bent 1K - SW | Major |
| Bent 1L - N | Major |
| Bent 1L - S | Major |
| Bent 1M - N | Major |
| Bent 1M - S | Major |
| Bent 1N - N | Major |
| Bent 1N - S | Major |
| Bent 1O - N | Moderate |
| Bent 1O - S | Major |
| Bent 1P - NE | Moderate |
| Bent 1P - SE | Major |
| Bent 1P - NW | Major |
| Bent 1P - SW | Major |
| Bent 1Q - N | Major |
| Bent 1Q - S | Major |
| Bent 1R - N | Severe |
| Bent 1R - S | Severe |
| Bent 2 - E | Moderate |
| Bent 2 - W | Major |
| Bent 3 - NE | Moderate |
| Bent 3 - SE | Severe |
| Bent 3 - NW | Major |
| Bent 3 - SW | Severe |
| Bent 4 - E | Moderate |
| Bent 4 - W | Severe |

# Appendix B

## Sea Engineering Report

SEA ENGINEERING, INC.

# City of Pacifica Municipal Pier Underwater Inspection Report



**9/13/2023**

***Sea Engineering, Inc.***
200 Washington Street, Suite 107
Santa Cruz, CA 95060
PH 831-421-0871 FX 831-421-0875
www.seaengineering.com

**VIA ELECTRONIC MAIL**

September 13, 2023

GHD
505 Montgomery Street
San Francisco, CA 94111
(415)283-4970

Attention: Satish Chilka, PE (satish.chilka@ghd.com)

Subject: City of Pacifica, CA – Municipal Pier – Underwater Inspection Report

Dear Mr. Chilka,

Sea Engineering, Inc. (SEI) is pleased to present the following Underwater Inspection report to GHD for the City of Pacifica, CA (the city) Municipal Pier in Pacifica, CA. SEI prepared this report at the request of GHD and the city following the completion of the underwater inspection of the Pacifica Pier piles. The inspections were executed by an SEI team consisting of a dive team led by a PE diver. SEI personnel who performed the inspection produced this report and its appendices.

The following report includes an executive summary, descriptions of the piles inspected at Pacifica Pier, an account of the conditions observed during the inspection, evaluation and assessment of the inspected elements, and recommended follow-up actions. Condition plans, inspection notes, photographs (above water and underwater), and reference material are included in appendices to the report.

## 1. Executive Summary

SEI performed the underwater inspection of the piles at Pacifica Municipal Pier over two days between August 24 and August 25, 2023. The inspected portion of Pacifica Municipal Pier comprises piles on the main pier and the finger pier (Appendix 1). SEI inspected the prestressed concrete piles from the mudline to the Mean High Water (MHW) line.

The underwater portions of the inspected Pacifica Municipal Pier prestressed concrete piles are in **Good** condition due to no damage observed. There are no underwater repair recommendations for the inspected piles.

## 2. Introduction

### 2.1. Site Description

Pacifica Municipal Pier is located just off the shore of Pacifica, CA, at the end of Santa Rosa St. (Photograph 1). The project site consists of battered prestressed concrete piles supporting the prestressed concrete superstructure. The Pacifica Municipal Pier has been open to public access since 1973. The pier is used for pedestrian access to the waterfront for fishing and public views of the Pacific Ocean.

### 2.2. Inspection Scope and Methodology

The scope of the underwater inspection consists of Level I visual & tactile inspection of 28 preselected battered prestressed concrete piles (out of 48 visible piles) from the mudline to the splash zone, as well as Level II cleaning and close visual & tactile inspection at three underwater elevations (mudline, mid-water, & tidal zone) on five piles. However, due to weather shutdowns and public interference, SEI was able to complete Level I inspections on 20 Piles and Level II inspections on three piles. SEI assigned ratings to inspected piles utilizing a condition rating system which follows requirements found in the American Society of Civil Engineers (ASCE) Waterfront Facilities Inspection and Assessment Standard Practice Manual (Appendix 4). SEI's inspection notes also provide descriptions of observed damage, including damage type, approximate elevation, location, and extent. Underwater photographs were taken of typical pile conditions.

SEI completed the underwater inspection of Pacifica Municipal Pier utilizing Surface Supplied Diving (SSD) techniques and equipment, which include hardwired communication between the diving inspector and note taker, a continuous low pressure (LP) air supply from a topside diving compressor, as well as back up and emergency high pressure (HP) air. Inspection notes were recorded electronically by the topside note taker during diving operations. Due to water depths of less than 35 feet of seawater (fsw), SEI utilized No Decompression (No "D") dive tables and a three-person dive team for the underwater inspection. The dive team was led by Paul Roberts of SEI, a California Registered Professional Engineer (P.E.) and commercially trained and ADCI-certified diver, who performed approximately 50% of the inspection. Ian Squier of SEI, an Engineer Diver E.I.T. and ADCI-certified diver, completed 50% of the inspection. Diving operations were staged from pickup trucks on the deck of Pacifica Municipal Pier. Diver ingress/egress was from an all-terrain crane and dive stage (Photograph 2)

Following a thorough review of the inspection findings, SEI assigned overall condition ratings to the battered prestressed concrete piles using a rating system found in the ASCE Manual 130 (Appendix 4). Pile damage ratings from the inspection and condition ratings for the piles are provided in the Observed Conditions (Section 4) of this report.

## 3. Description of Structures

### 3.1. Prestressed Concrete Piles

Pacifica Municipal Pier's prestressed concrete deck slabs are supported by 48 prestressed concrete piles arranged in 20 bents. 17 bents run from inshore to offshore, lettered B-R. At the offshore end of the pier, there is a single pile bent (Bent 1) and three bents that run from south to north, numbered 2-4. Typical prestressed concrete piles are octagonal in cross-section and measure 30 inches in diameter.

## 4. Observed Conditions

### 4.1. Prestressed Concrete Piles

The underwater portions of the inspected Pacifica Municipal Pier prestressed concrete piles are in **Good** condition, with no damage observed. However, it should be noted that the overall condition of the piles is downgraded when considering damage above MHW and outside of the underwater inspection. Numerous open spalls with exposed reinforcement, closed spalls, cracks, and evidence of corrosion exist above MHW (out of scope). Two piles have above-water cracks that extend to the top of the marine growth; however, underwater, no evidence of the crack could be found. One of these cracks is located on Pile K-SW, where a Level II

underwater inspection cleaning was done. No evidence of the crack was found on the cleaned portion of the pile below water.

Table 4.1 below summarizes the quantity and percentage of Pacifica Municipal Pier prestressed concrete piles observed with each damage type.

**Table 4.1 Prestressed Concrete Piles– Damage Summary**

| | Damage Type |
|---|---|
| | No Damage |
| Percentage of Piles (%)* | 100% |
| Number of Piles (#)* | 20 |

* Percentage and total numbers of piles based on 20 Piles inspected

Level II inspections were completed at Piles 3-NW, P-SW, and K-SW. See Photographs 3-12 for a representation of Level II cleaning areas.

Table 4.2 below summarizes the Damage Ratings for the underwater portions of the inspected Pacifica Municipal Pier prestressed concrete piles (MN = Minor/No Damage, MD = Moderate, MJ = Major, SV = Severe). Guidelines for Condition Assessment Ratings and Prestressed Concrete Pile Damage Ratings can each be found in Appendix 4. See Figure 1, Pacifica Municipal Pier Pile Condition plans, for a visual representation of the pile damage rating locations. Detailed notes for each prestressed concrete pile inspected can be found in Appendix 3.

**Table 4.2 Prestressed Concrete Piles – Damage Rating Summary**

| | Pile Damage Rating | | | | |
|---|---|---|---|---|---|
| | No Damage (ND) | Minor (MN) | Moderate (MD) | Major (MJ) | Severe (SV) |
| # of Piles (20 Inspected) | 20 | 0 | 0 | 0 | 0 |
| % of Piles | 100% | 0% | 0% | 0% | 0% |

## 5. Evaluation and Assessment

### 5.1. Prestressed Concrete Piles

The prestressed concrete piles exhibited no damage below MHW, and the underwater portions of the piles are in **Good** condition. There is a stark contrast between the condition of the piles above and below water. Above water (out of scope), the piles show generalized major to severe damage from corrosion of reinforcement and prestressing strands.

## 6. Recommendations

### 6.1. Prestressed Concrete Piles

There are no underwater repair recommendations for the inspected piles.

If you have any questions, please don't hesitate to contact me.

Very truly yours,

**SEA ENGINEERING, INC.**

Paul L. Roberts, P.E.
West Coast Vice President - Civil Engineer/Diver
proberts@seaengineering.com
(831) 421-0871

# APPENDIX 1:
# CONDITION PLAN

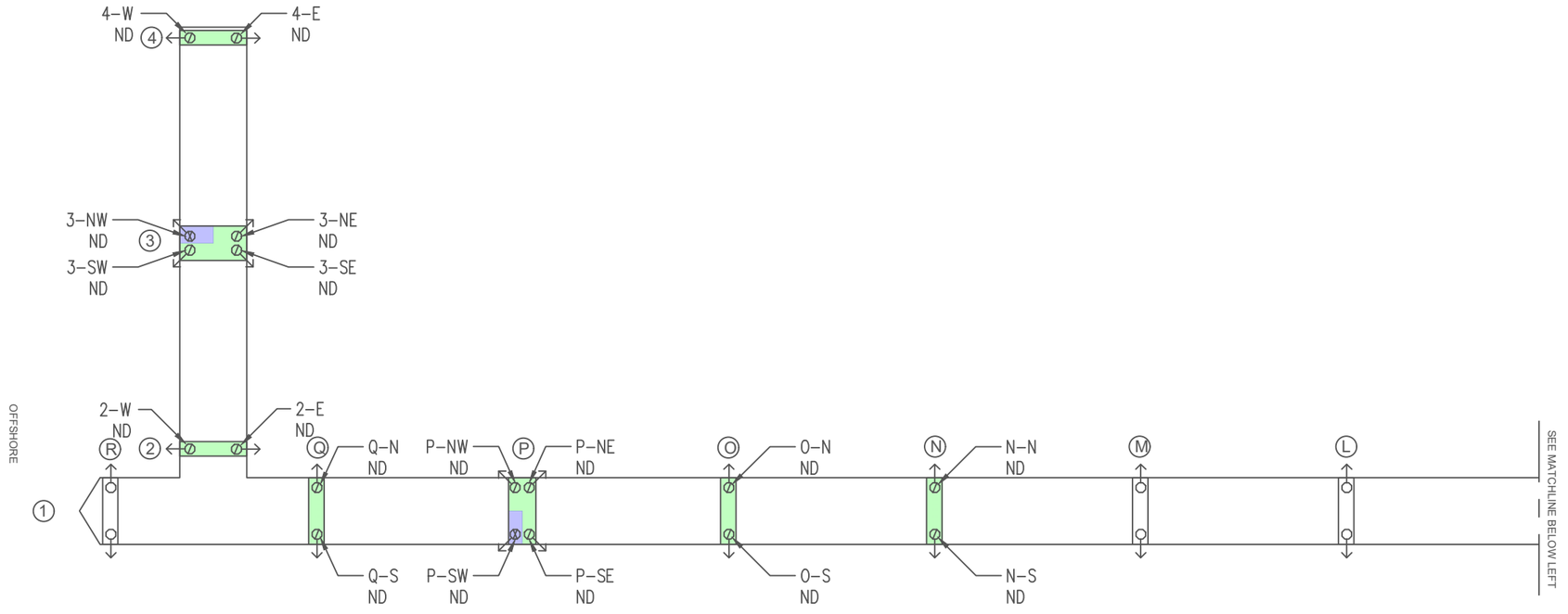
LEGEND

Pile ID and Damage Rating — 4–E ND

Level I Inspected Pile

Level II Inspected Pile

| Damage Ratings | |
|---|---|
| ND | No Damage |
| MN | Minor |
| MD | Moderate |
| MJ | Major |
| SV | Severe |





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FAX 808.536.3703


NOTES:

N

# PACIFICA MUNICIPAL PIER
## CITY OF PACIFICA
## UNDERWATER INSPECTION
## AUGUST 25, 2023

| | |
|---|---|
| PROJECT NUMBER: | 35313 |
| PROJECT ENGINEER: | PR |
| DRAWN BY: | IS |
| CHECKED BY: | PR |
| SCALE: | NTS |
| DATE: | AUGUST 25, 2023 |

CONDITION PLAN

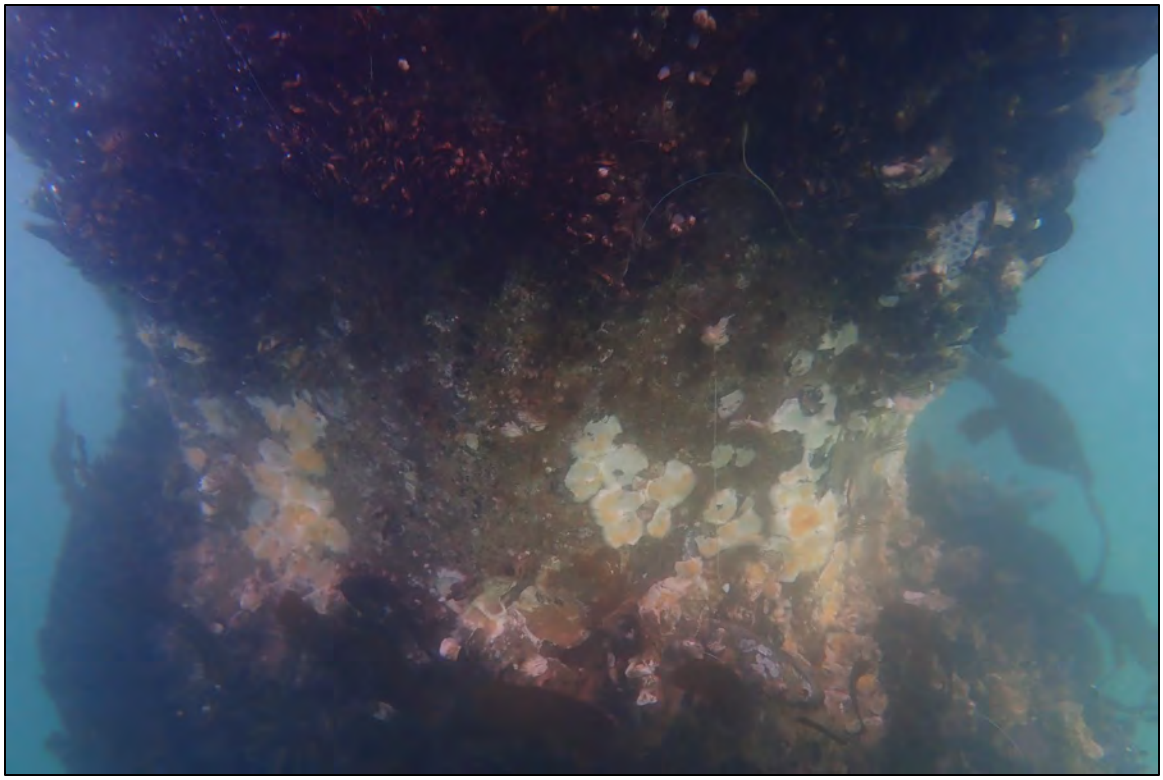
SHEET: 1

RING: 1/1

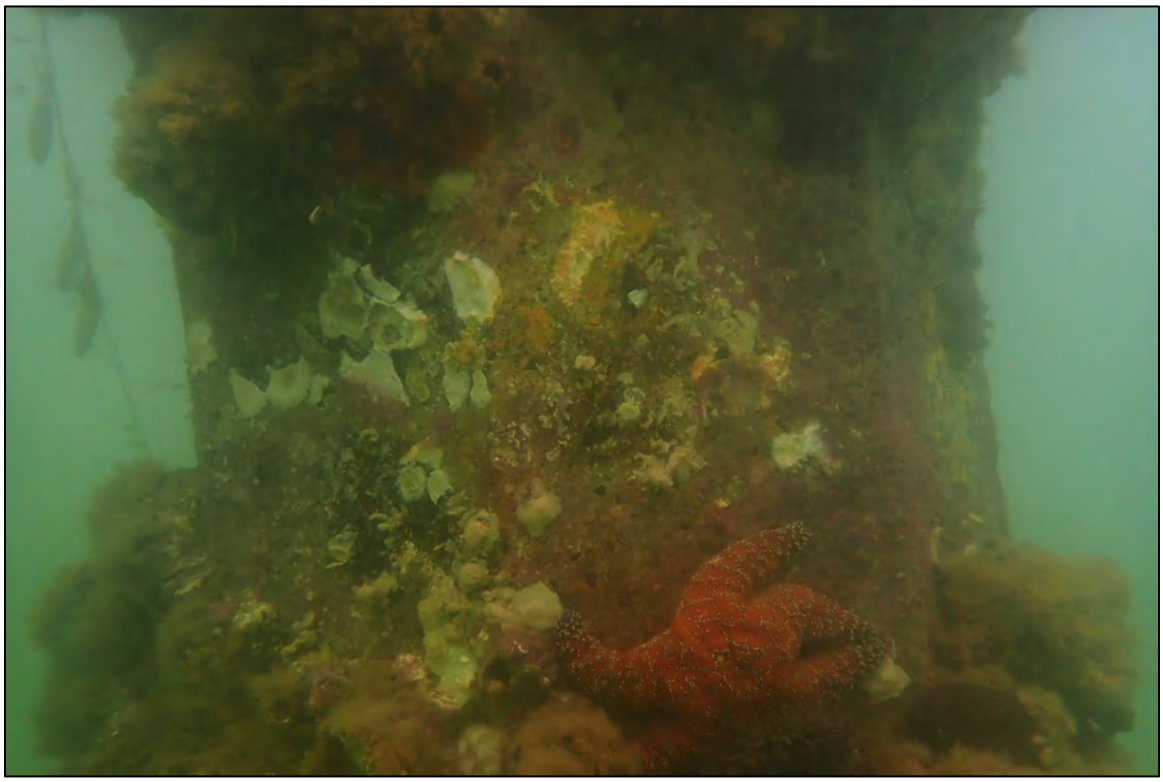
# APPENDIX 2:
# PHOTOGRAPHS

**PHOTOGRAPH 1:** Pacifica Municipal Pier (view from the northeast)

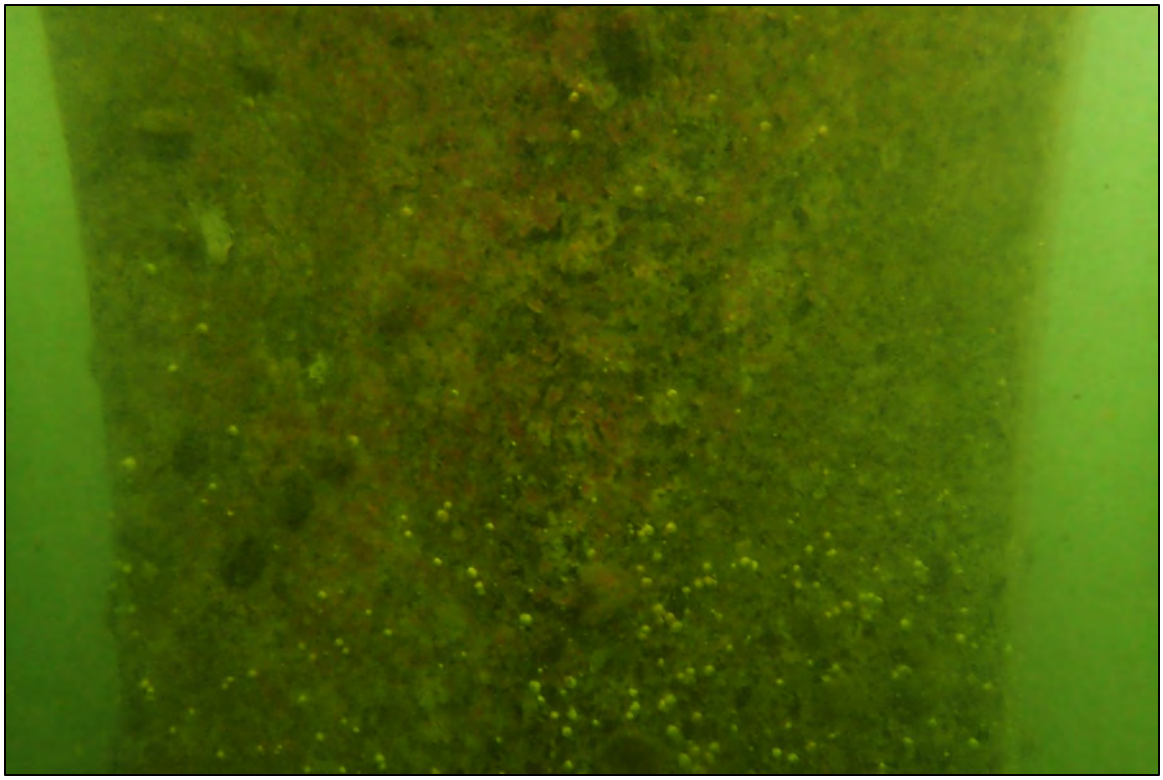
**PHOTOGRAPH 2:** Diver entering the water in crane lifted dive stage



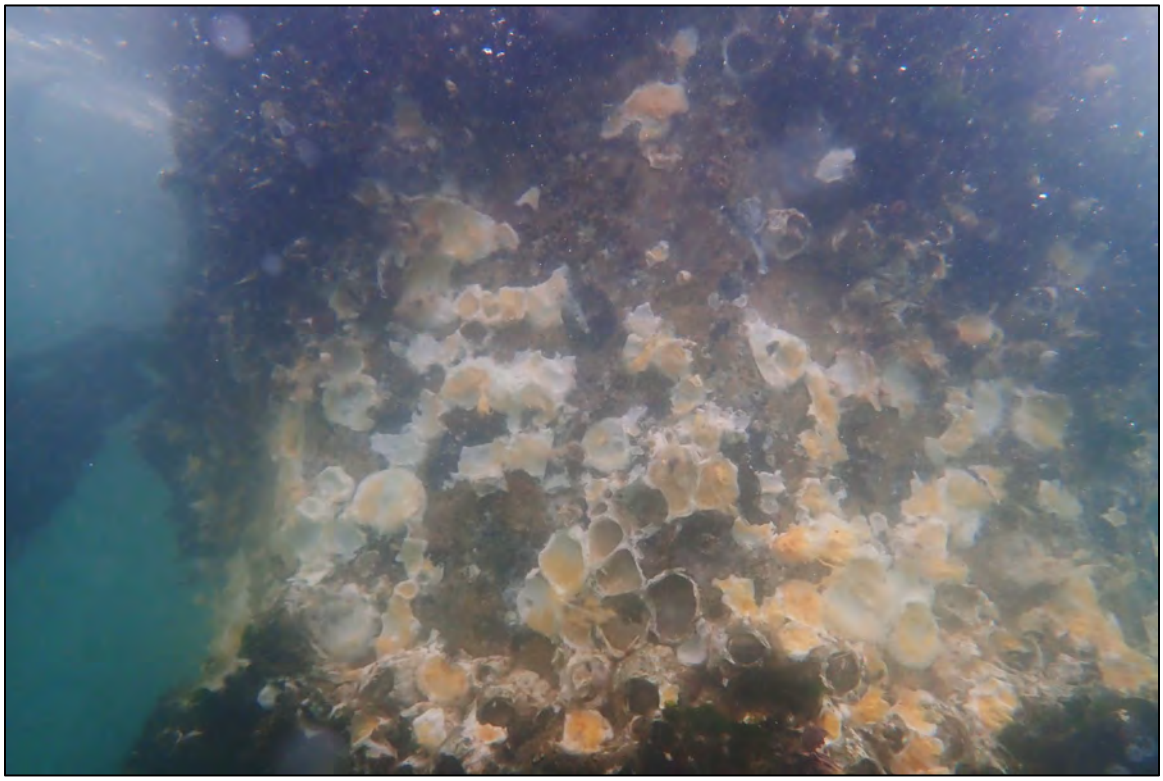
**PHOTOGRAPH 3:** Pile 3-NW Level II tidal zone



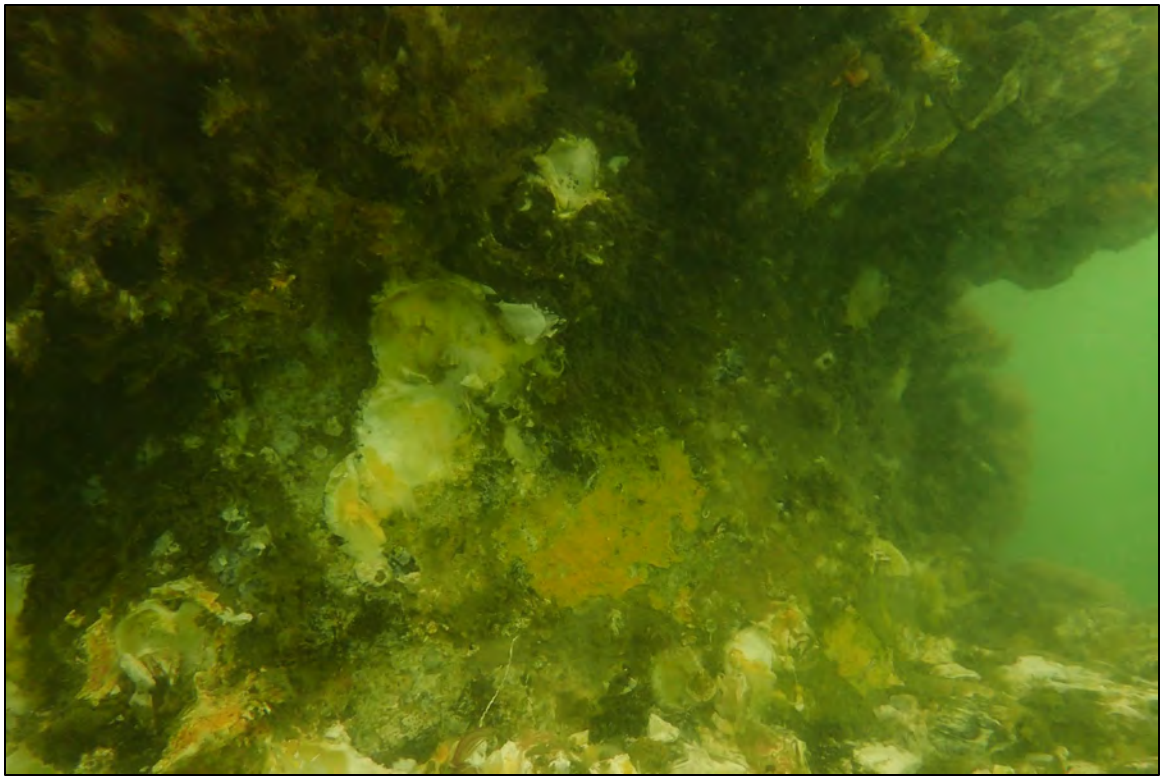
**PHOTOGRAPH 4:** Pile 3-NW Level II midwater



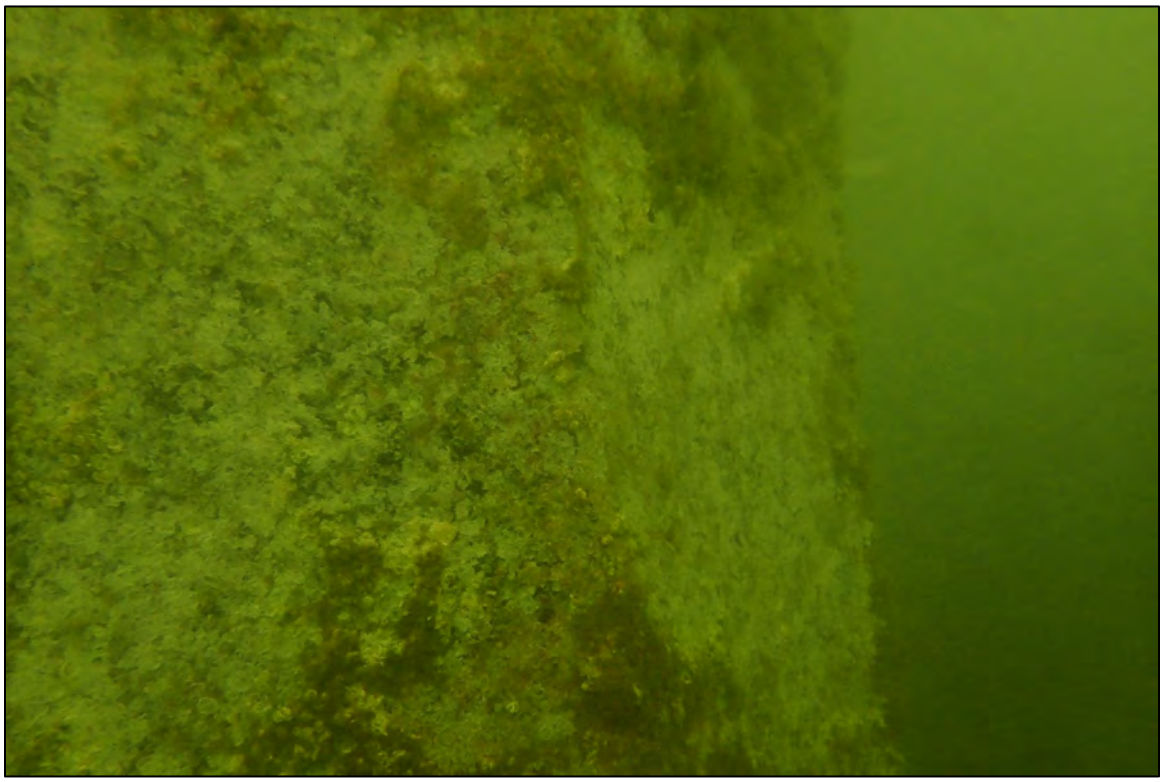
**PHOTOGRAPH 5:** Pile 3-NW Level II mudline



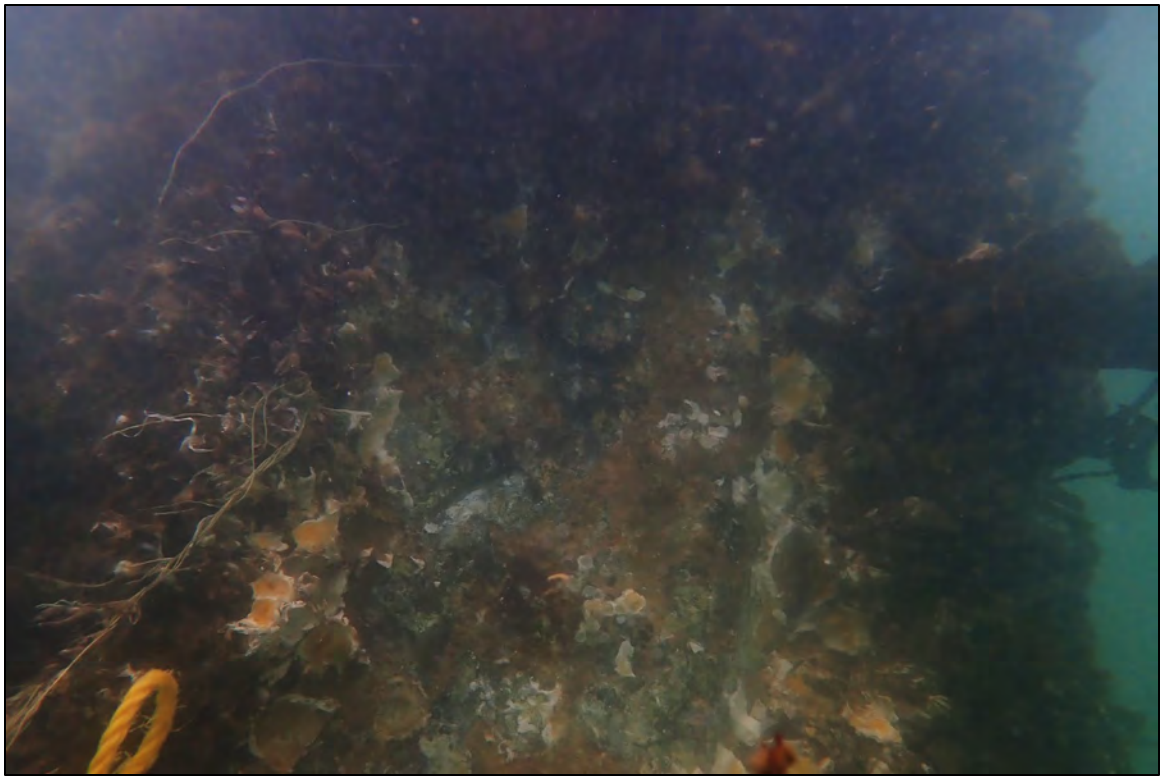
**PHOTOGRAPH 6:** Pile P-SW Level II tidal zone



**PHOTOGRAPH 7:** Pile P-SW Level II midwater

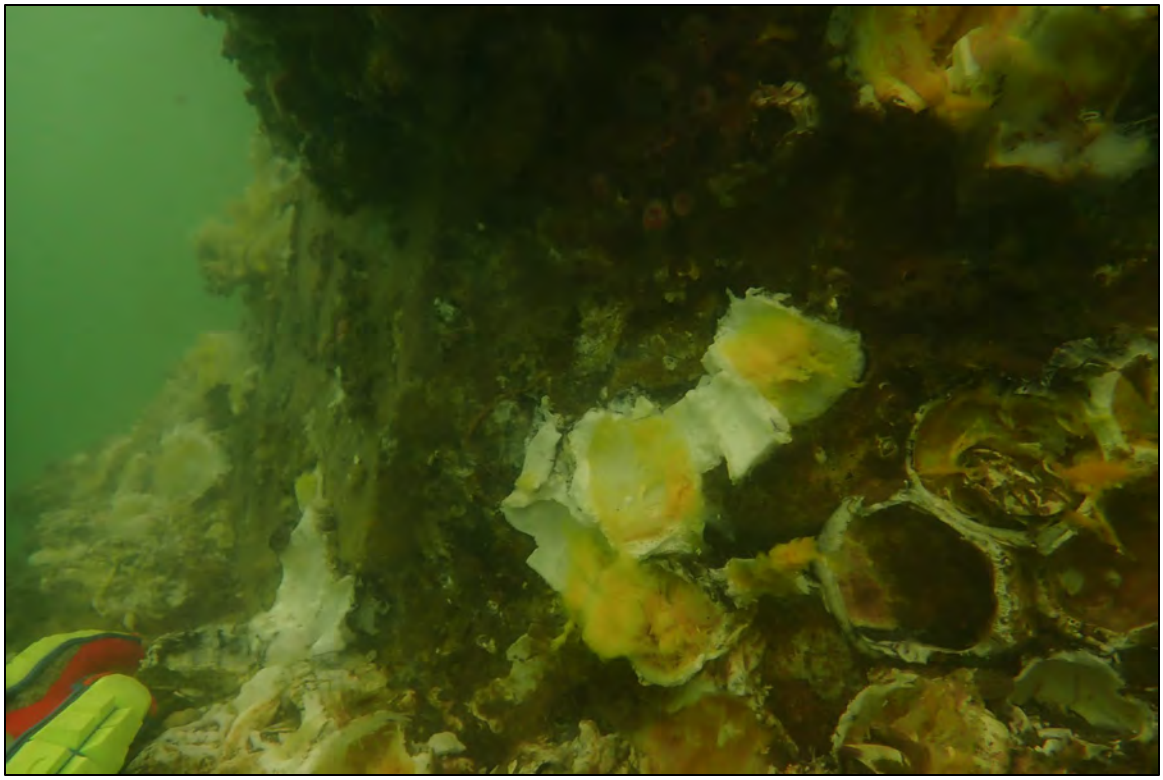


**PHOTOGRAPH 8:** Pile P-SW Level II mudline

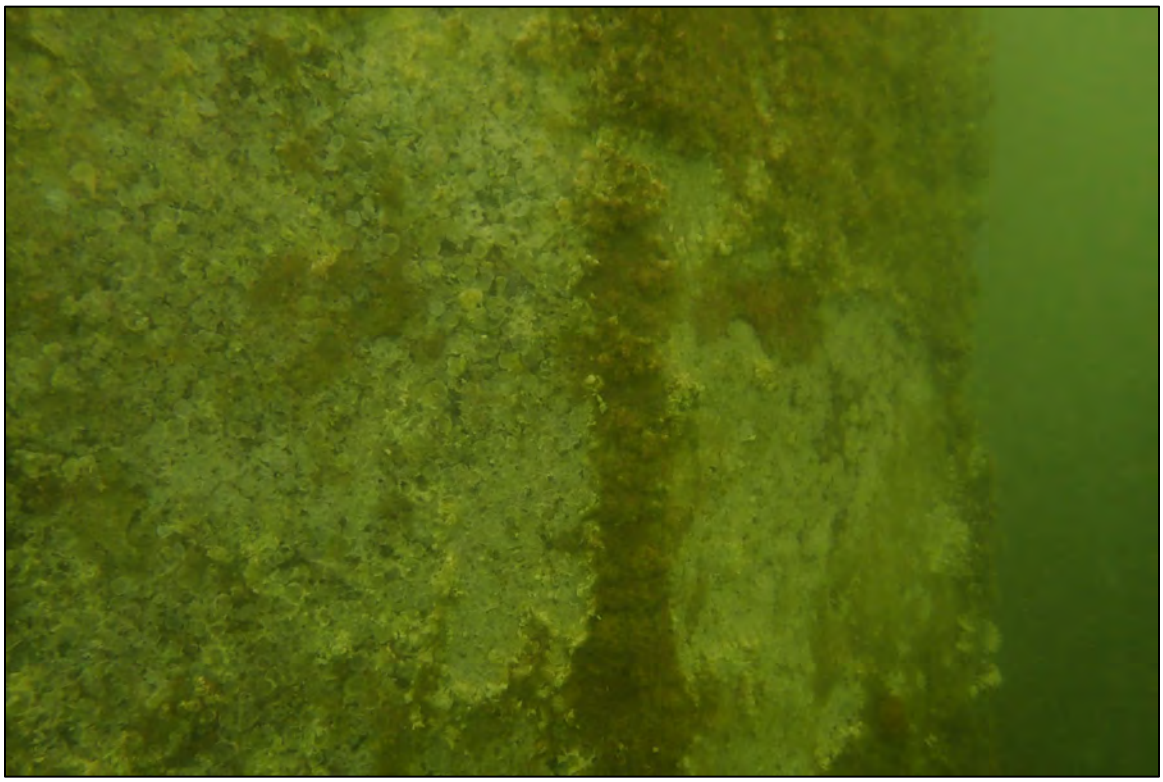


**PHOTOGRAPH 9:** Pile K-SW Level II tidal zone

**PHOTOGRAPH 10:** Pile K-SW Level II tidal zone closeup



**PHOTOGRAPH 11:** Pile K-SW Level II midwater



**PHOTOGRAPH 12:** Pile K-SW Level II mudline

# APPENDIX 3:
# UNDERWATER PILE INSPECTION NOTES

| ELEMENT ID # | LOCATION | CONDITION OBSERVED | LEVEL II | Notes | PNEUMO | DATE TIME | DIVER |
|---|---|---|---|---|---|---|---|
| 4-W | BELOW WATER | ND | | NO DAMAGE, FROM ML TO +8FT NO MARINE GROWTH, ABOVE 8FT FROM ML 75% MG MIXTURE OF SOFT CORALS AND SEASTARS AND HARD MUSSELS AND BARNACLES, 18FT AND ABOVE FROM ML 100% OF 6 IN THICK BARNACLES AND MUSSELS WITH FISHING LINE, ROPES, AND FISHING TACKLE. TYPICAL MARINE GROWTH CONDITION. | | | PR |
| 4-E | BELOW WATER | ND | | NO DAMAGE | | | PR |
| 3-NW | BELOW WATER | ND | X | NO DAMAGE | 32 | 1045 8/24/23 | PR |
| 3-NW | TIDAL ZONE | ND | X | NO DAMAGE, TYPICAL MG | | | PR |
| 3-NW | MIDWATER | ND | X | NO DAMAGE, TYPICAL MG | | | PR |
| 3-NW | MUDLINE | ND | X | NO DAMAGE | | | PR |
| 3-NE | BELOW WATER | ND | | NO DAMAGE | | | PR |
| 3-SE | BELOW WATER | ND | | NO DAMAGE | | | PR |
| 3-SW | BELOW WATER | ND | | NO DAMAGE | | | PR |
| 2-W | BELOW WATER | ND | | NO DAMAGE | | | PR |
| 2-E | BELOW WATER | ND | | NO DAMAGE | | | PR |
| Q-N | BELOW WATER | ND | | NO DAMAGE | | | PR |
| Q-S | BELOW WATER | ND | | NO DAMAGE | | | IS |
| P-SW | BELOW WATER | ND | | NO DAMAGE | | | IS |
| P-SW | TIDAL ZONE | ND | X | NO DAMAGE, HEAVY BARNACLE AND MUSSEL GROWTH, REQUIRED OVER AN HOUR TO CLEAN FOR LVL II WITH ROCK HAMMER | | | IS |
| P-SW | ML | ND | X | NO DAMAGE, TYPICAL MG | 29 | 1048 8/25/2023 | IS |
| P-SW | MW | ND | X | NO DAMAGE, TYPICAL MG | | | IS |
| P-NW | BELOW WATER | ND | | NO DAMAGE | | | IS |
| P-SE | BELOW WATER | ND | | NO DAMAGE | | | IS |
| P-NE | BELOW WATER | ND | | NO DAMAGE | | | IS |
| O-N | BELOW WATER | ND | | NO DAMAGE | | | IS |
| O-S | BELOW WATER | ND | | NO DAMAGE | | | IS |
| N-N | BELOW WATER | ND | | NO DAMAGE | | | IS |
| N-S | BELOW WATER | ND | | NO DAMAGE | | | IS |
| K-NW | BELOW WATER | ND | | NO DAMAGE | | | IS |
| K-SW | MUDLINE | ND | X | NO DAMAGE, 100% COVER SM BARNACLES | 22 | 1214 8/25/2023 | IS |
| K-SW | MIDWATER | ND | X | NO DAMAGE, TYPICAL MG | | | IS |
| K-SW | TIDAL ZONE | ND | X | NO DAMAGE, TYPICAL MG, 2 FT X 2 FT SQ CLEAN, DIVER OUT OF TIME | | | IS |
| K-SW | BELOW WATER | ND | | NO DAMAGE | | | IS |

# APPENDIX 4:
# REFERENCES

Table 2-7. Damage Ratings for Prestressed Concrete Elements

| Damage Rating | | Existing Damage[a] | Exclusions [Defects Requiring Elevation to the Next Higher Damage Rating(s)] |
|---|---|---|---|
| NI | Not Inspected | • Not inspected, inaccessible, or passed by[b] | |
| ND | No Defects | • Good original hard surface, hard material, sound | |
| MN | Minor | • Minor mechanical or impact spalls up to 0.5 in. deep | Minor damage not appropriate if<br>• Structural damage<br>• Corrosion damage<br>• Chemical deterioration[c]<br>• Cracks of any type or size |
| MD | Moderate | • Structural cracks up to 1/32 in. in width<br>• Chemical deterioration: Random cracks up to 1/32 in. in width | Moderate damage not appropriate if<br>• Structural breakage and/or spalls<br>• Corrosion cracks<br>• Loss of cross section in any form<br>• "Softening" of concrete |

*(Continued)*

Table 2-7. Damage Ratings for Prestressed Concrete Elements *(Continued)*

| Damage Rating | | Existing Damage[a] | Exclusions [Defects Requiring Elevation to the Next Higher Damage Rating(s)] |
|---|---|---|---|
| MJ | Major | • Structural cracks 1/32 in. to 1/8 in. in width<br>• Any corrosion cracks generated by strands or cables<br>• Chemical deterioration: cracks wider than 1/8 in.<br>• "Softening" of concrete up to 1 in. deep | Major damage not appropriate if<br>• Exposed prestressing steel |
| SV | Severe | • Structural cracks wider than 1/8 in. and at least partial breakage or loss of bearing<br>• Corrosion spalls over any prestressing steel<br>• Partial spalling and loss of cross section due to chemical deterioration | |

[a]Any defect listed below is sufficient to identify relevant damage grade.
[b]If not inspected due to inaccessibility or passed by, note as such.
[c]Chemical deterioration: Sulfate attack, alkali-silica reaction, alkali-aggregate reaction, alkali-carbonate reaction ettringite distress, or other chemical/concrete deterioration.

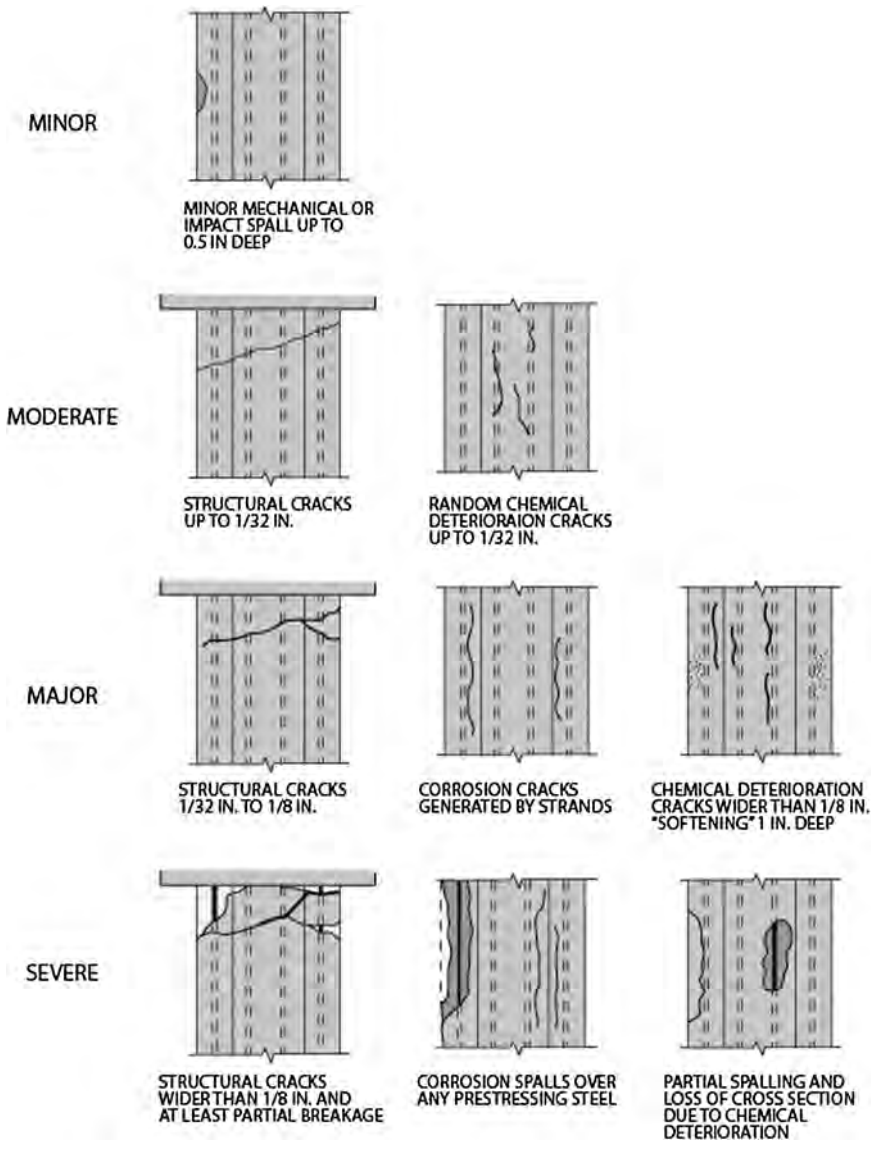



*Fig. 2-5. Damage ratings for prestressed concrete elements*
*Source: Courtesy of CH2M HILL, Inc. and COWI, Inc., reproduced with permission.*

Table 2-14. Condition Assessment Ratings

| 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 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. |

### 2.6.2 Condition Assessment Ratings

The Condition Assessment Rating should be assigned upon completion of the routine inspection and remain associated with the structural unit (as defined in Section 3.1.1) until the structure is rerated following a quantitative engineering evaluation and repairs, or upon completion of the next

# Appendix C

## Condition Assessment of Pier Handrails, 2022

# Technical Memorandum

**August 25, 2022**

| | | | |
|---|---|---|---|
| **To** | Ryan Marquez, City of Pacifica | **Contact No.** | 925 849 1019 |
| **Copy to** | Paul Henderson | **Email** | satish.chilka@ghd.com |
| **From** | Satish Chilka PE | **Project No.** | 11223688 |
| **Project Name** | Pacifica Pier Handrail Repairs | | |
| **Subject** | Condition Assessment of Pier Handrails - 2022 | | |

## 1. Introduction

The Pacifica Municipal Pier, located at 2100 Beach Blvd. Pacifica, CA 94044, is an L-shaped concrete pier supported on concrete piles (Figure 1.1). The pier functioned to support an outfall extending from Beach Boulevard into the ocean. The pier deck are prestressed concrete box girders with cast-in-place concrete handrails.

GHD Inc. conducted a condition assessment of the concrete handrails in March 2021 and developed repair options for damaged handrails along the pier. The collapse of handrails along the pier extension had resulted in the portion of the pier remaining closed to the public. The findings of the assessment were documented in a technical memorandum (March 2021) and included as Attachment A.

The City of Pacifica is evaluating options to undertake priority-based repairs of the handrails with the available funds i.e., repair handrails with severe damage. A revised condition assessment was performed for the handrails in June 2022 to review the current condition and progress of deterioration, and update the quantities required to be repaired in the near-term. The revised assessment utilized the observations from the previous assessment in Year 2021 as baseline in providing the revised ratings and recommended timeline for undertaking repairs.

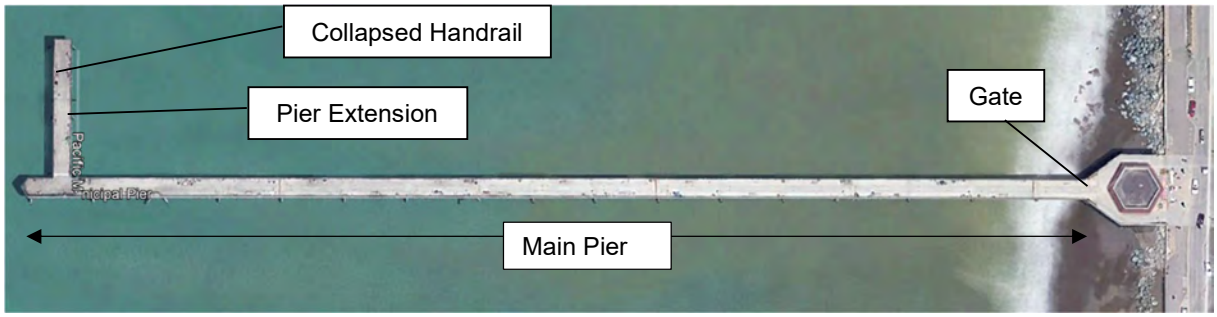



*Figure 1.1 Pacifica Municipal Pier Layout*

## 2. Methodology

The methodology was consistent with the condition assessment performed in Year 2021.

## 2.1 Observation methods

A visual observation of inside and outside faces of concrete handrails and deck surfaces was performed to assess current condition, identify areas of significant damage. At locations of observed damage, a 16-oz hammer was used to sound the concrete and determine extent of delamination and closed spall. Photographs and a handwritten record of observed damages were compiled. Results are tabulated with panels numbered starting at the Pier Abutment, with panel #1 being the first full panel starting beyond the gate.

The pier deck (box girder) was not accessible beyond visual observations in some locations, to evaluate the condition of the side walls that will affect the connection of the handrails.

## 2.2 Damage Ratings

The observed conditions of the guardrails are categorized in conformance with ASCE 130: Waterfront Facilities Inspection and Assessment. For reinforced concrete elements, damage can be described as either minor, moderate, major, or severe as described in Table 2.1.

*Table 2.1: Damage Rating for Reinforced Concrete Elements - ASCE 130*

| Damage Rating | Existing Damage |
|---|---|
| Not Inspected | – Not inspected, inaccessible, or passed by |
| No Defects | – Good original hard surface, hard material, sound |
| Minor | – Mechanical abrasion or impact spalls up to 1-in in depth<br>– Occasional corrosion stains or small pop-out<br>– corrosion spalls<br>– General cracks up to 1/16-in in width |
| Moderate | – Structural cracks up to 1/16-in in width<br>– Corrosion cracks up to 1/4-in in width<br>– Chemical deterioration: Random cracks up to 1/16-in in width; “Soft” concrete and/or rounding of corners up to 1-in deep<br>– Mechanical abrasion or impact spalls greater than 1-in in depth |
| Major | – Structural cracks 1/16-in to 1/4-in in width and partial breakage (through section cracking with structural spalls)<br>– Corrosion cracks wider than 1/4-in and open or closed corrosion spalls (excluding pop-outs)<br>– Multiple cracks and disintegration of surface layer due to chemical deterioration<br>– Mechanical abrasion or impact spalls exposing the reinforcing |
| Severe | – Structural cracks wider than 1/4-in or complete breakage<br>– Complete loss of concrete cover due to corrosion of reinforcing steel with more than 30% of diameter loss for any main reinforcing bar<br>– Loss of bearing and displacement at connections<br>– Loss of concrete cover (exposed steel) due to<br>– chemical deterioration<br>– Loss of more than 30% of cross-section due to any cause |

# 3. Condition Assessment

The existing handrails are cast-in-place concrete panels with reinforcement extending from the side walls of the pier deck (box girder) providing a connection between the deck and handrails.

The pier has continued experiences high wind in a harsh marine environment. There were no known instances of high surf (waves) reaching the pier deck or handrails since January 2021. Continuous exposure to seawater or marine spray with recurring wet and dry conditions are detrimental to the concrete structure. Cracks in concrete allow seawater to access the reinforcement, initiating corrosion. As corrosion expands around the circumference of the reinforcement, the bond between concrete and reinforcement weakens and results in delamination. The progressive delamination eventually leads to concrete breaking off from the reinforcement i.e., spalling.

## 3.1 Damaged Handrail

The pier experienced high surf and/or wind forces in January 2021. A 41-ft portion of the handrail on the west edge of pier extension (deck spanning north to south) collapsed inward onto the deck. The entire extension has remained closed to public access and the condition of handrails on this span were not assessed.

The collapsed panels were previously noted to have severely corroded reinforcement at the joint between the handrail panels and deck. The concrete panels did not show signs of exposed spall hence the weakened connection due to corroded reinforcement and potential delamination in the side walls of the pier deck were determined to be the main cause of failure. The pier deck was visibly damaged as the handrail reinforcement pulled out indicating spall in the pier deck.

*Figure 3.1 Collapsed Handrail, Photo 2021*

## 3.2 Typical Damage

The minor and moderate damages, characterized by cracks less than 1/16” in width and spalled concrete of less than 1” depth, are not expected to significantly impact the existing strength of the handrails. The primary cause for the collapsed handrail was due to weakened connection between the panel and deck. Hence, if cracks, spalls, or rust stains were observed along the length of bottom connection to deck, those damages are categorized as major or severe damage.

More substantial cracks and spalls of concrete result in a significant loss of area in the structural concrete at supports, and generally leave existing reinforcement exposed to weather and subject to corrosion. In several instances, large spalls and reinforcement corrosion at handrails was accompanied by visible corrosion and spalling extending into the concrete below deck level.

Figure 3.2 through Figure 3.5 show the typical damage in handrail panels associated with the damage ratings.

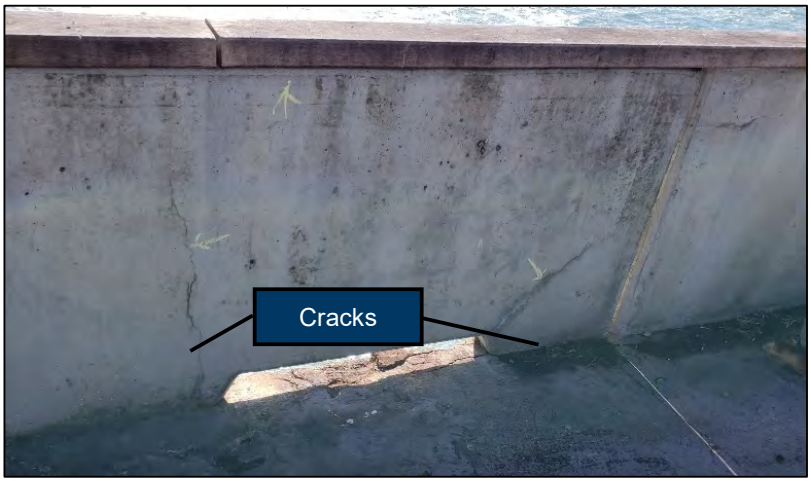



*Figure 3.2: Typical Damage Rated Minor*

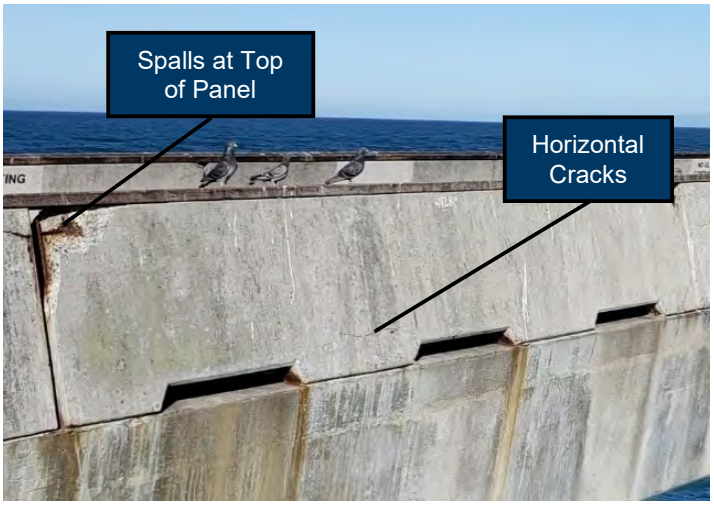



*Figure 3.3: Typical Damage Rated Moderate*

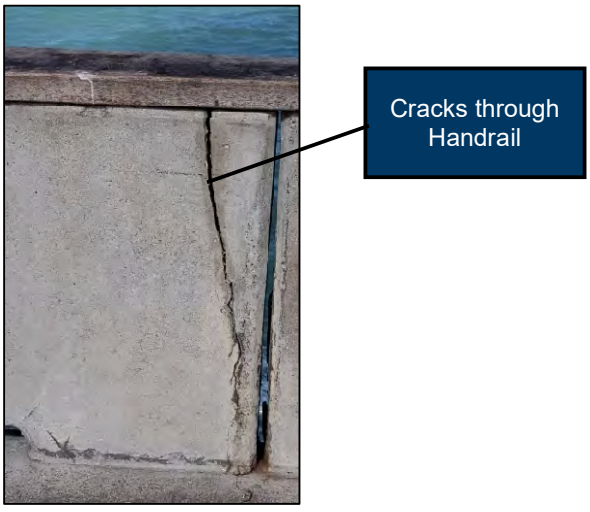



*Figure 3.4: Typical Damage Rated Major*


*Figure 3.5: Typical Damage Rated Severe*

A total of 164 panels were assessed on site and the corresponding damage rating for the panels have been summarized in Table 3.1, and include additional details in Attachment B. Some panel ratings were revised accounting for the condition noted in the previous years' assessment and relative change over the year.

*Table 3.1 Summary of Assessment – Damage Ratings*

| Assessment | Year 2022 | Year 2021 |
|---|---|---|
| No Damage | 13 | 25 |
| Minor Damage | 29 | 29 |
| Moderate Damage | 29 | 30 |
| Major Damage | 56 | 36 |
| Severe Damage | 37 | 44 |

# 4. Conclusions and Recommendations

The extent of damage suggests that the corrosion and spalling is concentrated in areas of the pier farthest from shore, and panels closer to shore as well. In handrail panels without major or severe damage, the presence of corrosion staining, minor spalling, and cracking suggests that corrosion of reinforcement has already begun and will continue to progress in current exposure conditions. Field observations and categorization of observed damages have been recorded in detail for each panel, as summarized in the attached Attachment B.

The revised timeline for undertaking the handrail repairs based on the rate of deterioration observed in the handrails is provided in Table 4.1. Year 0 is referenced to the year of assessment (2022). The recommended timeline may be revised with subsequent condition assessment to accommodate the most current condition of the handrails. The repair or replacement of panels rated severe should be prioritized, followed by major and moderate over time.

*Table 4.1 Recommended Timeline for Repairs*

| Damage Rating | Time (Years) |
|---|---|
| Severe | 0 to 2 |
| Major | 0 to 5 |
| Moderate | 0 to 10 |
| Minor | 0 to 15 |

The collapsed handrail at the pier extension should be replaced or the extension should remain closed to the public.

At handrail panels with severe and major damage extending across two or more supports, as well as at the fully collapsed panels, full replacement of the panels is recommended.

At panels with minor to moderate damage, patching superficial cracks and spalled concrete would mitigate further damage. Providing additional supports at panels to supplement existing corroded rebar would extend the life of the panels and reduce the likelihood of future collapses.

The City of Pacifica should undertake annual condition assessment of the handrails and above deck components until the handrails are repaired, as necessary. The condition of the pier deck (box girder) and supporting piles should also evaluated to assess the integrity of the handrail connections to the pier deck.

The pier should be closed to public when high wind and wave conditions are anticipated in the area. The handrail panels, especially the ones parallel to shore, should be visually checked before opening the pier.

# 5. Limitations

*This technical memorandum has been prepared by GHD for City of Pacifica. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.*

**Accessibility of documents**

*If this Technical Memorandum is required to be accessible in any other format this can be provided by GHD upon request and at an additional cost if necessary.*

*The opinions, conclusions and any recommendations in this memorandum are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

*Investigations undertaken in respect of this memorandum are constrained by the site conditions and location of the handrails limiting visual and physical access to all the handrail panels. As a result, not all relevant site features and conditions may have been identified in this memorandum.*

**Attachment A:** Memorandum – Assessment of Pacifica Pier Above Deck Components, March 2021.

**Attachment B:** Field Notes – Condition Assessment July 2022.

ATTACHMENT A

# Memorandum

03/29/2021

| | | | |
|---|---|---|---|
| To: | Sam Bautista | Ref. No.: | 11223688 |
| From: | Patrick Brutzman, Satish Chilka | Tel: | (925) 849-1000 |
| cc: | Paul Henderson, Craig Lewis | | |
| **Subject:** | **Assessment of Pacifica Pier Above-Deck Components - FINAL** | | |

## 1. Introduction

The Pacifica Municipal Pier, located at 2100 Beach Blvd. Pacifica, CA 94044. The structure is an L-shaped concrete pier supported by concrete piles. GHD has been asked to provide a condition assessment and develop repair options for damaged existing handrails at the far end of the pier. The damage to handrails has resulted in the pier being currently closed to the public.

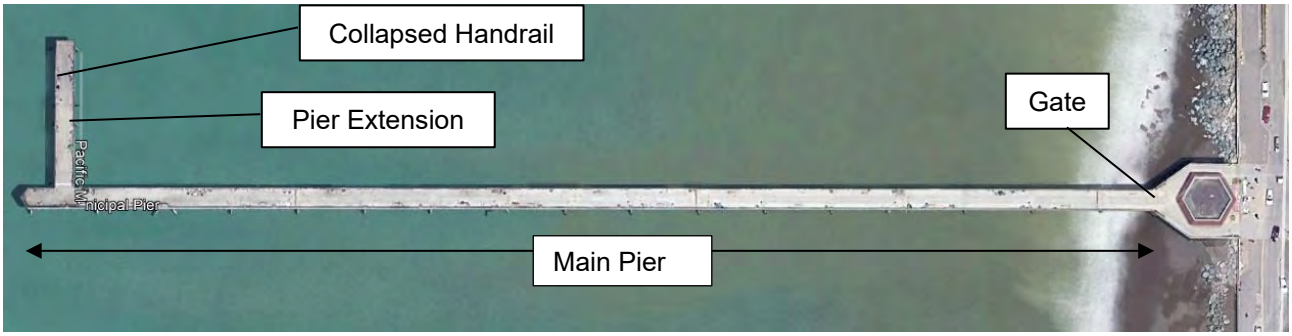



Figure 1: Pacifica Municipal Pier Layout

## 2. Background

Existing as-built drawings of the pier structure (dated 03/27/1972) are available as a reference for the original condition of the handrail. The handrail consists of cast-in-place concrete wall panels 6-1/2" thick and 42" tall, leaning inward over the deck. Panels are typically 18'-6" long, with shorter 4'-0" long panels occurring aligned with pile locations at 60'-0" on-center. The base of the typical panel has (3) 3'-0" openings with (2) 3'-0' supports between them, and the connection to the deck is reinforced with (2) #5 dowels at edge supports and (3) #5 dowels at interior supports. Refer to Figure 2 for a detail view of the existing handrail condition, and Figure 3 for an elevation view.

A condition assessment was performed by engineers from GHD on 2/12/2021 between 9:30 AM and 1:30 PM. Field observations were carried out to determine the current state of deterioration at all concrete

GHD
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guardrails and light post connections above the deck of the pier. At elements determined to be significantly damaged, measurements were taken in preparation for design of replacement and retrofit schemes.

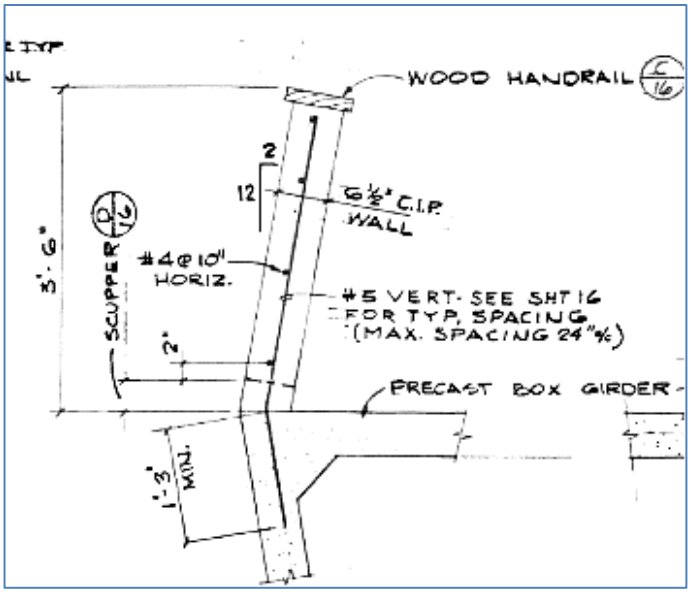


Figure 2: Existing Handrail Connection to Deck

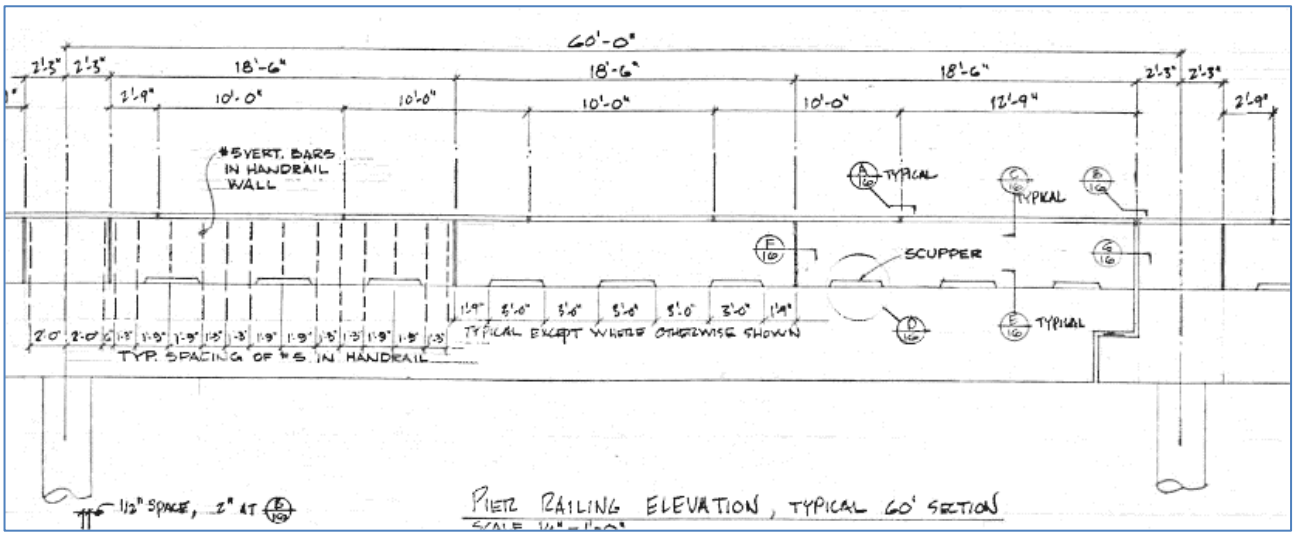


Figure 3: Existing Handrail Connection to Deck

# 3. Methodology

## 3.1 Observation methods

A visual observation of inside and outside faces of concrete handrails and deck surfaces was performed to assess current condition, identify areas of significant damage. At locations of observed damage, a 16-oz hammer was used to sound the concrete and determine extent of delamination and closed spall. Photographs and a handwritten record of observed damages were compiled. Results are tabulated with panels numbered starting at the Pier Abutment, with panel #1 being the first full panel starting beyond the gate.

## 3.2 Condition Assessment

The observed condition of the guardrails are categorized in conformance with ASCE 130: Waterfront Facilities Inspection and Assessment. For reinforced concrete elements, damage can be described as either minor, moderate, major, or severe as described in Table 3-1.

Table 3-1: Damage Rating for Reinforced Concrete Elements - ASCE 130

| Damage Rating | Existing Damage |
|---|---|
| Not Inspected | • Not inspected, inaccessible, or passed by |
| No Defects | • Good original hard surface, hard material, sound |
| Minor | • Mechanical abrasion or impact spalls up to 1-in in depth<br>• Occasional corrosion stains or small pop-out<br>• corrosion spalls<br>• General cracks up to 1/16-in in width |
| Moderate | • Structural cracks up to 1/16-in in width<br>• Corrosion cracks up to 1/4-in in width<br>• Chemical deterioration: Random cracks up to 1/16-in in width; “Soft” concrete and/or rounding of corners up to 1-in deep<br>• Mechanical abrasion or impact spalls greater than 1-in in depth |
| Major | • Structural cracks 1/16-in to 1/4-in in width and partial breakage (through section cracking with structural spalls)<br>• Corrosion cracks wider than 1/4-in and open or closed corrosion spalls (excluding pop-outs)<br>• Multiple cracks and disintegration of surface layer due to chemical deterioration<br>• Mechanical abrasion or impact spalls exposing the reinforcing |
| Severe | • Structural cracks wider than 1/4-in or complete breakage<br>• Complete loss of concrete cover due to corrosion of reinforcing steel with more than 30% of diameter loss for any main reinforcing bar<br>• Loss of bearing and displacement at connections<br>• Loss of concrete cover (exposed steel) due to<br>• chemical deterioration<br>• Loss of more than 30% of cross-section due to any cause |

## 4. Assessment Results

The pier experiences high wind and wave exposure in a harsh marine environment. Continuous exposure to seawater along with constant wet and dry conditions are detrimental to concrete structures. Cracks in concrete allow seawater access to the reinforcement, initiating corrosion. As corrosion expands the reinforcement, the bond between concrete and reinforcement weakens and causes spalling.

### 4.1 Damaged Handrail

At the pier extension, an approximately 41’ portion of west-facing handrail panels have collapsed inward onto the deck, probably resulting from high surf and/or wind forces sometime during January 2021. At the collapsed panels, the reinforcement is severely corroded at the joint between handrail panels and deck concrete, weakening the connection. Although the concrete panel itself did not show signs of spalls or delamination, the connections were the main cause of failure.

At the south end of the damaged panel, the reinforcement has pulled out of the concrete deck, indicating that there is a weakened bond within the deck concrete. The damage to handrails has also damaged the side wall of the deck. The underside of the deck was not accessible for further assessment during this inspection.

Figure 4: Photos of Collapsed Handrail

### 4.2 Typical Damage

A total of 164 panels were assessed on site and the corresponding damage rating for the panels have been summarized in Table 4-4-1, and include additional details in Appendix A.

Table 4-4-1: Damage Rating Summary

| Damage Rating | No Damage | Minor | Moderate | Major | Severe |
|---|---|---|---|---|---|
| No. of Panels | 25 | 29 | 30 | 36 | 44 |

The minor and moderate damage, characterized by cracks less than 1/16” in width and spalled concrete of less than 1” depth, is not expected to significantly impact the existing strength of the handrails. The primary cause for the collapsed handrail was due to weakened connection between the panel and deck. Hence, if cracks, spalls, or rust stains were observed along the length of bottom connection to deck, those damages are categorized as major or severe damage.

More substantial cracks and spalls of concrete result in a significant loss of area in the structural concrete at supports, and generally leave existing reinforcement exposed to weather and subject to corrosion. In several instances, large spalls and reinforcement corrosion at handrails was accompanied by visible corrosion and spalling extending into the concrete below deck level.

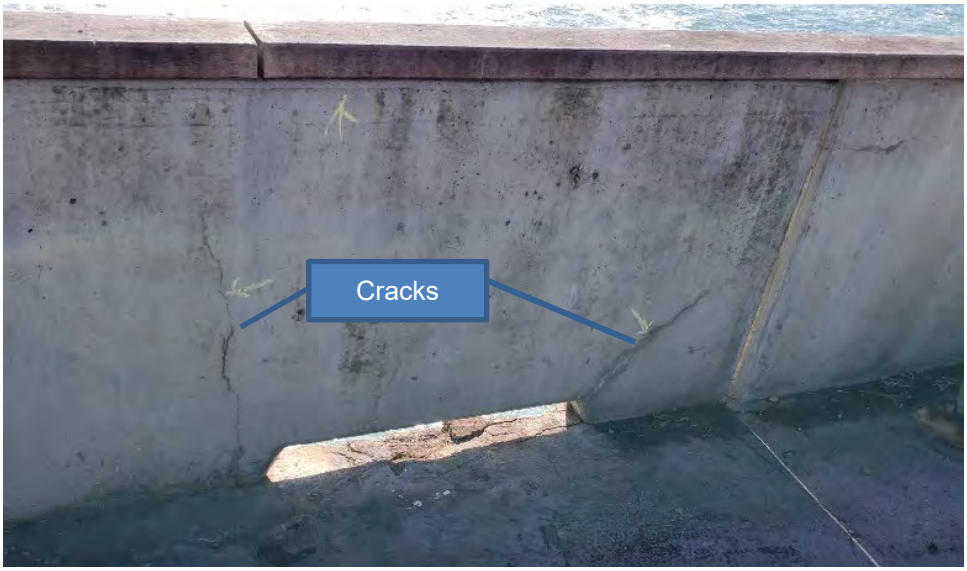


Figure 5: Typical Damage Rated Minor


Figure 6: Typical Damage Rated Moderate

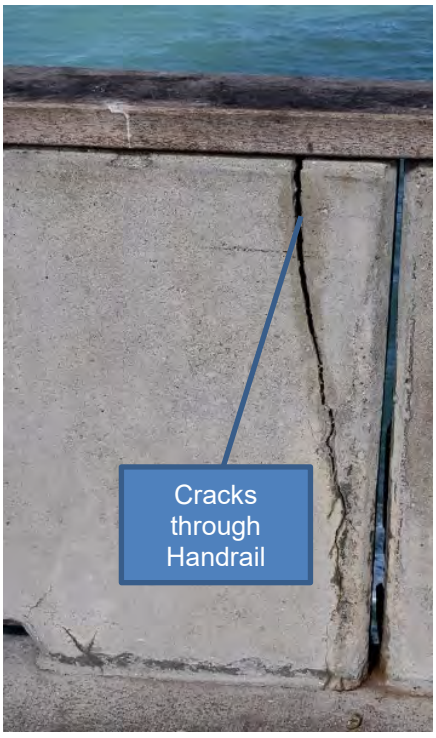


Figure 7: Typical Damage Rated Major


Figure 8: Typical Damage Rated Severe

### 4.3 Repaired Panel

One panel has been previously repaired. The exterior surface follows the profile of other panels, but the inside face is vertical, creating a wider base for stability. A galvanized steel angle section has been installed at the inside face, with anchors embedded into the panel and presumably into the deck to provide an improved connection.


Figure 10: Repaired Handrail Panel

### 4.4 Steel Brace Supports

Some panels have a 1/4” thick bent steel plate supports anchored at the inside face and at the deck to provide additional bracing. The anchors and hardware at these plate braces are significantly corroded, and at one location the plate has 100% section loss at mid-height.

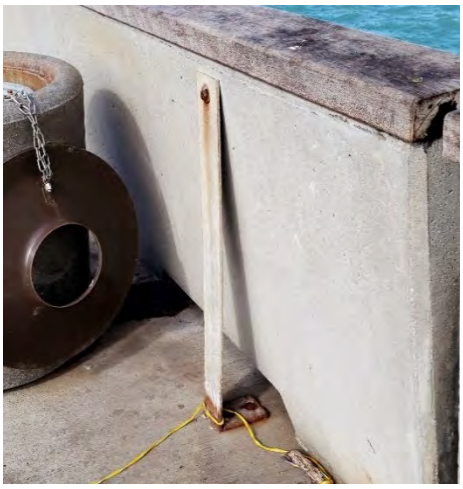

Figure 11: Steel Brace at Handrail

### 4.5 Connections of Light Post

The light posts on the pier are connected to the pier deck using 4 bolts and steel base plate. The base plate and anchor bolts show signs of corrosion. The nuts seem to be stainless steel material, showed some discoloration but didn’t show significant corrosion. There was no visible damage to the connections or grout pad around the base plate indicating movement of the light post due to a weakened connection.

Figure 9: Typical Light Post Foundation

### 4.6 Fish Cleaning Stations

The fish cleaning stations are concrete structures connected to the deck. The stations showed signs of deterioration and spalls. These damages start from the bottom connections due to corrosion of reinforcement and align well with the observations of similar deterioration at handrails.

## 5. Conclusions and Recommendations

The current extent of damage suggests that the corrosion observed in collapsed railing panels is widespread at areas of the pier farthest from shore, and present in the abutment panels closer to shore as well. In railing panels without major or severe damage, the presence of corrosion staining, minor spalling, and cracking suggests that corrosion of reinforcement has already begun and will continue to progress in current exposure conditions. Field observations and categorization of observed damages have been recorded in detail for each panel, as summarized in the attached Appendix A.

At railing panels with severe and major damage extending across two or more supports, as well as at fully collapsed panels, full replacement of the panels is recommended. At panels with major or severe damage concentrated at supports, a retrofit consisting of repairing damaged concrete, repairing corroded reinforcement, and providing additional support mechanism may be a feasible alternative to full replacement.

At panels with minor to moderate damage, patching superficial cracks and spalled concrete would mitigate further damage. Providing additional supports at panels to supplement existing corroded rebar would extend the life of the panels and reduce the likelihood of future collapses.

The collapsed handrail at the extension pier should be replaced or the extension closed to the public. The recommended timeline for other panels is provided in Table 5-1, referenced to Year 2021 as baseline i.e., Year 0.

It is also recommended to close the pier when high wind and wave conditions are anticipated in the area. The panels, especially the ones parallel to shore, should be visually checked before opening the pier.

Table 5-1: Recommended Timeline for Repairs

| Damage Rating | Time (Years) |
|---|---|
| Severe | 0 to 1 |
| Major | 0 to 2 |
| Moderate | 0 to 5 |
| Minor | 0 to 10 |

# Appendix A

## Field Observation Notes and Damage Rating Summary

ATTACHMENT A

**PROJECT** PACIFICA PIER HANDRAIL REPAIRS
**CLIENT** CITY OF PACIFICA
**SUBJECT** 2/12/2021 FIELD OBSERVATION REPORT - VISUAL AND SPALLING INSPECTION
**ENGINEER** PB **DATE** 2/15/2021
**CHECKED** SC **DATE** 2/18/2021

LEGEND

**PANEL ID INFO**

| | |
|---|---|
| **N/S/E/W** | SIDE OF PIER (NORTH/SOUTH/EAST/WEST) |
| **#** | PANEL COUNT FROM ENTRANCE OF PIER (Negative # indicates panels shoreside of the gate) |
| **S** | SHORT PANEL |
| **A** | ABUTMENT WALL |

**REPORT ITEM**

| | |
|---|---|
| **RAT** | DAMAGE RATING |
| **ND** | No Damage |
| **MN** | Minor Damage |
| **MJ** | Major Damage |
| **SV** | Severe Damage |


| | |
|---|---|
| **MC(##)** | MINOR CRACK NOT EXCEEDING 1/16" (TOTAL LENGTH OF CRACK, INCHES) |
| **MS(##x##)** | MINOR SPALLING (APPROX. AREA, INCHES) |
| **CR** | CRACKING WITH LOSS OF EFFECTIVE CONCRETE AREA AT SUPPORT |
| **SP** | SPALLING WITH LOSS OF EFFECTIVE CONCRETE AREA AND REINFORCEMENT COVER |
| **E** | DAMAGE LOCATED AT EDGE OF PANEL |
| **FW/FH** | DAMAGE SPREAD ACROSS FULL WIDTH / HEIGHT |
| **X#** | NUMBER OF INSTANCES OF DAMAGE |

**MAIN PIER STRUCTURE**

| | Side S | | | | Side N | | | |
|---|---|---|---|---|---|---|---|---|
| **PANEL ID** | **INSIDE S** | **OUTSIDE S** | **RAT S** | **REMARK S** | **INSIDE N** | **OUTSIDE N** | **RAT N** | **REMARK N** |
| **-5A** | | SP | MN | | CR(90) | FW-SP | SV | |
| **-4A** | | SP | MD | | CR | SP | MJ | |
| **-3A** | CR | SPX2 | MD | | | SP | MJ | |
| **-2A** | CR(60) | SP(24X30) | MD | | CR(48) | SP | SV | |
| **-1A** | E-SP | SP(3) | MJ | | CR(30) | E-SPX2 | MJ | |
| **0A** | MC, CR | FW-SP | SV | GATE OCCURS 4' FROM END | CR(60) | E-SP | MJ | GATE OCCURS 4' FROM END |
| **1** | MS(18X10)X2 | | MD | | | | ND | STEEL BRACKET |
| **2** | | E-MC | MN | | MC(42) | CR | MN | |
| **3** | | | ND | | | | ND | |
| **4S** | | | ND | | | SP | MD | |
| **5** | | | ND | | MC(42) | | MN | |
| **6** | | | ND | | | | ND | |
| **7** | MS(12X4) | | MN | | MS | | MN | |
| **8S** | MS | | MN | | | MC | MN | |
| **9** | MC(90), MS | SP | MD | | | MS(12X18)X2 | MD | |
| **10** | | CR, SP | SV | | | MS(12X12) | MD | |
| **11** | CR | MS | SV | | MS, MC(90) | MS | MD | |
| **12S** | | | ND | | | MS | MD | |
| **13** | | MS(12X24) | MD | SPALLING | MC(42) | MC | MD | |

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ATTACHMENT A

**PROJECT** PACIFICA PIER HANDRAIL REPAIRS
**CLIENT** CITY OF PACIFICA
**SUBJECT** 2/12/2021 FIELD OBSERVATION REPORT - VISUAL AND SPALLING INSPECTION
**ENGINEER** PB **DATE** 2/15/2021
**CHECKED** SC **DATE** 2/18/2021

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **14** | | | ND | | SP | MC | SV | |
| **15** | MC(90) | | MN | | MS(18X6), MC | | MJ | |
| **16S** | | | MN | CLEANING STA W/ SPALLING | | | ND | |
| **17** | | | ND | | MS, MC(30) | SP | MJ | |
| **18** | | MS(12X12) | MJ | CORRODED DECK | MC, SP | MS | MJ | |
| **19** | | MS(6X12)X2 | MD | | SP(24X8) | MS | SV | |
| **20S** | | MS | MD | | MS | | MN | |
| **21** | | SP,MC(42) | MJ | | | MS | MN | |
| **22** | MS | MS,CR | SV | | | SP | MN | |
| **23** | MC(30) | MS | MD | | CR, FW-MC | SP | MN | |
| **24S** | | MS | MD | | | | ND | |
| **25** | | MS | MD | | SP | SP | SV | |
| **26** | | SP | MJ | | SP | SP | MJ | |
| **27** | | MC | MN | | | | ND | |
| **28S** | | | ND | | | | ND | |
| **29** | | | ND | | | | ND | |
| **30** | | | MN | STEEL BRACKET LOST | | | ND | STEEL BRACKET |
| **31** | | SP | MD | | E-SP | MS,SP | SV | |
| **32S** | | SP | MD | | | MC,MS | MJ | |
| **33** | MC | FH-SP | SV | | E-SP | SP | SV | |
| **34** | E-SP,CR | | SV | | CR(300), SP | FH-CR | SV | |
| **35** | MC(30) | | MN | | | FH-SP | MJ | |
| **36S** | | MC(42) | MN | | | CR | MD | |
| **37** | MC(42), SP | | MN | | SP | MC | SV | |
| **38** | MC(42) | | MN | | SP | SP | SV | |
| **39** | MC(42) | MS | MJ | | | SP | MJ | |
| **40S** | | | ND | | | | ND | |
| **41** | SP | SP | SV | | SP(24X12) | E-SP,CR | SV | |
| **42** | E-SP, FW-SP | | SV | | E-SP | | MJ | |
| **43** | MC(42) | SP | MJ | | E-SP | | MJ | |
| **44S** | | E-SP | SV | | | | MN | |
| **45** | | E-SP | SV | | | E-SP | MJ | |
| **46** | | | ND | | FW-SP | SP | SV | |
| **47** | MC | | MN | | | | ND | |
| **48S** | | | ND | | | | ND | |
| **49** | | E-SP | SV | | | E-SP | SV | |
| **50** | MS(12X24)X2 | E-SP | SV | | | E-SP | SV | |
| **51** | | | MN | | | E-SP | MJ | |
| **52S** | | SP | MJ | | | SP | MJ | |
| **53** | CR | SP | SV | CORRODED DECK | CR | MS | SV | |
| **54** | | | MN | | | E-MS | MJ | |
| **55** | | SP | MJ | AT MID-PANEL | | E-SP | MJ | |

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ATTACHMENT A

**PROJECT** PACIFICA PIER HANDRAIL REPAIRS
**CLIENT** CITY OF PACIFICA
**SUBJECT** 2/12/2021 FIELD OBSERVATION REPORT - VISUAL AND SPALLING INSPECTION
**ENGINEER** PB **DATE** 2/15/2021
**CHECKED** SC **DATE** 2/18/2021

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **56S** | | MS | MN | | FW-CR | FW-CR | MD | |
| **57** | | E-SP | SV | | | SP | MD | |
| **58** | CR | E-SP | SV | | | E-SP | MJ | |
| **59** | CR | | MJ | STEEL BRACKET | CR | E-SP | SV | STEEL BRACKET |
| **60S** | CR | | SV | | CR | FW-CR | MD | |
| **61** | CR | | SV | | MC(42) | MS | MD | |
| **62** | | MS | MD | | | CR,MS | MJ | AT MID-PANEL |
| **63** | MC(60) | MS | MD | | | SP | MD | |
| **64S** | | | MN | | | | MN | |
| **65** | | E-SP | SV | | SP | | SV | DAMAGE CONCENTRATED AT CORNER |
| **66** | | FH-SP | SV | | | | ND | OPEN BAY |
| **67** | | E-SP | MJ | | CR | | MJ | AT CORNER |
| **68** | CR, SP | FW-SP | MJ | END WALL | CR, SP | FW-SP | SV | END WALL |

| | | | |
|---|---|---|---|
| SUBTOTAL | NO DAMAGE | 12 | |
| | MINOR | 17 | |
| | MODERATE | 15 | |
| | MAJOR | 11 | |
| | SEVERE | 19 | |

| | | | |
|---|---|---|---|
| SUBTOTAL | NO DAMAGE | 13 | |
| | MINOR | 10 | |
| | MODERATE | 12 | |
| | MAJOR | 21 | |
| | SEVERE | 18 | |

**PIER EXTENSION**

| | **Side W** | | | | **Side E** | | | |
|---|---|---|---|---|---|---|---|---|
| **PANEL ID** | **INSIDE W** | **OUTSIDE W** | **RAT W** | **REMARK W** | **INSIDE E** | **OUTSIDE E** | **RAT E** | **REMARK E** |
| **1S** | | | MN | NEW PANEL | MC | CR | MD | |
| **2** | CR(42) | SP, E-SP | MJ | | MC(42) | E-SP | SV | |
| **3** | | | MN | | | MC(30) | MD | |
| **4S** | | | SV | COLLAPSE | SP | SP | SV | |
| **5** | | | SV | COLLAPSE | CR | E-SP | SV | |
| **6** | | | SV | COLLAPSE | | E-SP | MJ | |
| **7** | SP | FW-SP | SV | | | E-SP | MJ | |
| **8** | | MS | MD | ENDPANEL | | SP(24X12)X2 | MJ | ENDPANEL |

| | | | |
|---|---|---|---|
| SUBTOTAL | NO DAMAGE | 0 | |
| | MINOR | 2 | |
| | MODERATE | 1 | |
| | MAJOR | 1 | |
| | SEVERE | 4 | |

| | | | |
|---|---|---|---|
| SUBTOTAL | NO DAMAGE | 0 | |
| | MINOR | 0 | |
| | MODERATE | 2 | |
| | MAJOR | 3 | |
| | SEVERE | 3 | |

| | | |
|---|---|---|
| TOTAL | NO DAMAGE | 25 |
| | MINOR | 29 |
| | MODERATE | 30 |
| | MAJOR | 36 |
| | SEVERE | 44 |

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ATTACHMENT B

| | |
|---|---|
| **PROJECT** | PACIFICA PIER HANDRAIL REPAIRS |
| **CLIENT** | CITY OF PACIFICA |
| **SUBJECT** | 7/5/2022 FIELD OBSERVATION NOTES - VISUAL CONDITION ASSESSMENT |
| **NOTES BY** | Satish Chilka PE, Derek Linsley PE |
| **COMPILED BY** | Ishan Goel, EIT |

**LEGEND**

***PANEL ID INFO***

| | |
|---|---|
| N/S/E/W | SIDE OF PIER (NORTH/SOUTH/EAST/WEST) |
| # | PANEL COUNT FROM ENTRANCE OF PIER (Negative # indicates panels shoreside of the gate) |
| S | SHORT PANEL |
| A | ABUTMENT WALL |


***REPORT ITEM***

| | |
|---|---|
| RAT | DAMAGE RATING |
| ND | NO DAMAGE |
| MN | MINOR DAMAGE |
| MD | MODERATE DAMAGE |
| MJ | MAJOR DAMAGE |
| SV | SEVERE DAMAGE |

| | |
|---|---|
| MC(##) | MINOR CRACK NOT EXCEEDING 1/16" (TOTAL LENGTH OF CRACK, INCHES) |
| MS(##x##) | MINOR SPALLING (APPROX. AREA, INCHES) |
| CR | CRACKING WITH LOSS OF EFFECTIVE CONCRETE AREA AT SUPPORT |
| SP | SPALLING WITH LOSS OF EFFECTIVE CONCRETE AREA AND REINFORCEMENT COVER |
| B | BOTTOM CONNECTION DAMAGED |
| E | DAMAGE LOCATED AT EDGE OF PANEL |
| FW/FH | DAMAGE SPREAD ACROSS FULL WIDTH / HEIGHT |
| X# | NUMBER OF INSTANCES OF DAMAGE |

**MAIN PIER STRUCTURE - REVISED RATINGS**

| | PIER SIDE - S | | | | PIER SIDE - N | | | |
|---|---|---|---|---|---|---|---|---|
| **PANEL ID** | **INSIDE** | **OUTSIDE** | **RAT** | **REMARK** | **INSIDE** | **OUTSIDE 2** | **RAT** | **REMARK** |
| **-5A** | | SP | MN | | CR(90) | FW-SP | SV | |
| **-4A** | | SP | MD | | CR | SP | MJ | B |
| **-3A** | CR | SPX2 | MD | | | SP | MJ | B |
| **-2A** | CR(60) | SP(24X30) | MJ | B, 11'-2" (INSIDE) | CR(48) | SP | SV | 11'-2" (INSIDE) |
| **-1A** | E-SP | SP(3) | MJ | B | CR(30) | E-SPX2 | SV | MJ-SV |
| **0A** | MC, CR | FW-SP | SV | GATE OCCURS 4' FROM END | CR(60) | E-SP | MJ | GATE OCCURS 4' FROM END |
| **1** | MS(18X10)X2 | | MJ | MJ-MD, STEEL BRACKET (7'-11") | | | MN | STEEL BRACKET (8'-3") |
| **2** | 42" CR | E-MC | MN | | MC(42) | CR | MN | |
| **3** | | | ND | | | | ND | |
| **4S** | | | ND | | | SP | MD | MD-MN |
| **5** | | | MN | DECK DAMAGED | MC(42) | | MN | |

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ATTACHMENT B

**PROJECT** PACIFICA PIER HANDRAIL REPAIRS
**CLIENT** CITY OF PACIFICA
**SUBJECT** 7/5/2022 FIELD OBSERVATION NOTES - VISUAL CONDITION ASSESSMENT
**NOTES BY** Satish Chilka PE, Derek Linsley PE
**COMPILED BY** Ishan Goel, EIT

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **6** | | | ND | | | | ND | |
| **7** | MS(12X4) | | MN | | MS | | MD | MD-MN |
| **8S** | MS | | MJ | MD-MJ | | MC | MN | |
| **9** | MC(90), MS | SP | MJ | MD-MJ, LARGE OPENING | | MS(12X18)X2 | MJ | MD-MJ, B |
| **10** | | CR, SP | MJ | MD-MJ, ENDS | | MS(12X12) | MD | |
| **11** | CR | MS | MJ | MD-MJ, TOP | MS, MC(90) | MS | MD | MD-MN |
| **12S** | | | ND | | | MS | MD | MD-MN |
| **13** | | MS(12X24) | MD | SPALLING | MC(42) | MC | MD | MD-MN |
| **14** | | | MN | | SP | MC | SV | SV-MJ, ENDS |
| **15** | MC(90) | | MN | | MS(18X6), MC | | MJ | MJ-MD |
| **16S** | | | ND | | | | ND | CLEANING STA W/ SPALLING |
| **17** | | | MD | CORRODED DECK | MS, MC(30) | SP | MJ | |
| **18** | | MS(12X12) | MD | | MC, SP | MS | MJ | MJ-MD |
| **19** | | MS(6X12)X2 | MD | | SP(24X8) | MS | SV | SV-MJ |
| **20S** | | MS | MN | | MS | | MN | MN-ND |
| **21** | | SP,MC(42) | MJ | MJ-MD | | MS | MD | MN-MD, B |
| **22** | MS | MS,CR | MJ | MD-MJ, ENDS | | SP | MJ | MD-MJ |
| **23** | MC(30) | MS | MJ | MD-MJ | CR, FW-MC | SP | SV | SV-MJ |
| **24S** | | MS | MD | DECK DAMAGE | | | MJ | MJ-MD |
| **25** | | MS | MN | | SP | SP | SV | |
| **26** | | SP | MJ | MJ-MD | SP | SP | MJ | MJ-MD |
| **27** | | MC | MD | | MC | | MN | ND-MN |
| **28S** | | | MN | MN-ND,NO JOINT GAP | | | ND | NO JOINT GAP |
| **29** | | | ND | STEEL BRACKET LOST | | | MN | ND-MN, CORRODED STEEL BRACKET |
| **30** | | | MD | MN-MD | | END LAND - SPALL | MJ | MD-MJ |
| **31** | | SP | MN | | E-SP | MS,SP | MJ | MD-MJ |
| **32S** | | SP | MD | | | MC,MS | MJ | MJ-MD |
| **33** | MC | FH-SP | MJ | MJ-MD | E-SP | SP | SV | SV-MJ, ENDS |
| **34** | E-SP,CR | | SV | | CR(300), SP | FH-CR | SV | |
| **35** | MC(30) | | MN | DECK CRACK | | FH-SP | MJ | |
| **36S** | | MC(42) | MN | | | CR | MD | WATERSIDE BASE DAMAGED |
| **37** | MC(42), SP | | MD | MN-MD | SP | MC | SV | |
| **38** | MC(42) | | MJ | MD-MJ | SP | SP | SV | |
| **39** | MC(42) | MS | MJ | | | SP | MJ | |
| **40S** | | | MN | ND-MN | | | ND | |
| **41** | SP | SP | SV | DECK DAMAGE | SP(24X12) | E-SP,CR | SV | SV-MJ, DECK DAMAGE - MD |
| **42** | E-SP, FW-SP | | SV | | E-SP | | SV | MJ-SV, ENDS |

DRAFT FOR REVIEW

**PROJECT** PACIFICA PIER HANDRAIL REPAIRS
**CLIENT** CITY OF PACIFICA
**SUBJECT** 7/5/2022 FIELD OBSERVATION NOTES - VISUAL CONDITION ASSESSMENT
**NOTES BY** Satish Chilka PE, Derek Linsley PE
**COMPILED BY** Ishan Goel, EIT

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **43** | MC(42) | SP | MJ | MJ-MD | E-SP | | MJ | MJ-MD |
| **44S** | | E-SP | SV | SV-MJ | | | MN | |
| **45** | | E-SP | MJ | MD-MJ | | E-SP | MJ | |
| **46** | | | ND | | FW-SP | SP | SV | |
| **47** | MC | | MD | MN-MD | | | SV | SV-MJ |
| **48S** | | | MN | | | | MN | ND-MN |
| **49** | | E-SP | MJ | MD-MJ | | E-SP | SV | SV-MJ, ENDS |
| **50** | MS(12X24)X2 | E-SP | MJ | MD-MJ | | E-SP | SV | SV-MJ |
| **51** | | | MD | MN-MD | | E-SP | MJ | MD-MJ |
| **52S** | | SP | MJ | MD-MJ | | SP | MJ | MD-MJ |
| **53** | CR | SP | MJ | CORRODED DECK | CR | MS | SV | SV-MJ, MD - DECK DAMAGE |
| **54** | | | MD | MN-MD | | E-MS | MJ | MJ-MD |
| **55** | | SP | MJ | MD-MJ, AT MID-PANEL | | E-SP | MJ | MJ-MD |
| **56S** | | MS | MN | | FW-CR | FW-CR | MD | |
| **57** | | E-SP | SV | SV-MJ | | SP | MJ | MD-MJ |
| **58** | CR | E-SP | SV | SV-MJ | | E-SP | MJ | |
| **59** | CR | | MD | MN-MD, STEEL BRACKET MISSING | CR | E-SP | SV | MJ-SV, STEEL BRACKET |
| **60S** | CR | | MN | | CR | FW-CR | MJ | MD-MJ |
| **61** | CR | | MJ | MD-MJ, DECK DAMAGE | MC(42) | MS | MJ | MD-MJ |
| **62** | | MS | MJ | MD-MJ | | CR,MS | MJ | AT MID-PANEL |
| **63** | MC(60) | MS | MJ | MD-MJ | | SP | MJ | MD-MJ |
| **64S** | | | MN | | | | MN | MN-ND |
| **65, L-SHAPE @ N** | | E-SP | SV | SV-MJ | SP | | SV | DAMAGE CONCENTRATED AT CORNER |
| **66** | | FH-SP | MJ | MJ-MD | | | ND | OPEN BAY, DECK DAMAGE |
| **67** | | E-SP | MD | | CR | | MD | AT CORNER |
| **68** | CR, SP | FW-SP | SV | SV-MJ, END WALL | CR, SP | FW-SP | SV | END WALL |

| | | | |
|---|---|---|---|
| SUBTOTAL | NO DAMAGE | 7 | |
| | MINOR | 17 | |
| | MODERATE | 16 | |
| | MAJOR | 25 | |
| | SEVERE | 9 | |

| | | |
|---|---|---|
| SUBTOTAL | NO DAMAGE | 6 |
| | MINOR | 10 |
| | MODERATE | 10 |
| | MAJOR | 27 |
| | SEVERE | 21 |

ATTACHMENT B

**PROJECT** PACIFICA PIER HANDRAIL REPAIRS
**CLIENT** CITY OF PACIFICA
**SUBJECT** 7/5/2022 FIELD OBSERVATION NOTES - VISUAL CONDITION ASSESSMENT
**NOTES BY** Satish Chilka PE, Derek Linsley PE
**COMPILED BY** Ishan Goel, EIT

**PIER N/S EXTENSION - CLOSED NO ACCESS - RATINGS NOT REVISED**

| | PIER SIDE - W | | | | PIER SIDE - E | | | |
|---|---|---|---|---|---|---|---|---|
| **PANEL ID** | **INSIDE** | **OUTSIDE** | **RAT** | **REMARK** | **INSIDE** | **OUTSIDE 2** | **RAT** | **REMARK** |
| **1S** | | | MN | NEW PANEL | MC | CR | MD | |
| **2** | CR(42) | SP, E-SP | MJ | | MC(42) | E-SP | SV | |
| **3** | | | MN | | | MC(30) | MD | |
| **4S** | | | SV | COLLAPSE | SP | SP | SV | |
| **5** | | | SV | COLLAPSE | CR | E-SP | SV | |
| **6** | | | SV | COLLAPSE | | E-SP | MJ | |
| **7** | SP | FW-SP | SV | | | E-SP | MJ | |
| **8** | | MS | MD | ENDPANEL | | SP(24X12)X2 | MJ | ENDPANEL |

| | | | |
|---|---|---|---|
| SUBTOTAL | NO DAMAGE | 0 | |
| | MINOR | 2 | |
| | MODERATE | 1 | |
| | MAJOR | 1 | |
| | SEVERE | 4 | |

| | | | |
|---|---|---|---|
| SUBTOTAL | NO DAMAGE | 0 | |
| | MINOR | 0 | |
| | MODERATE | 2 | |
| | MAJOR | 3 | |
| | SEVERE | 3 | |

**SUMMARY**

| | | |
|---|---|---|
| **TOTAL** | NO DAMAGE | 13 |
| | MINOR | 29 |
| | MODERATE | 29 |
| | MAJOR | 56 |
| | SEVERE | 37 |


GHD