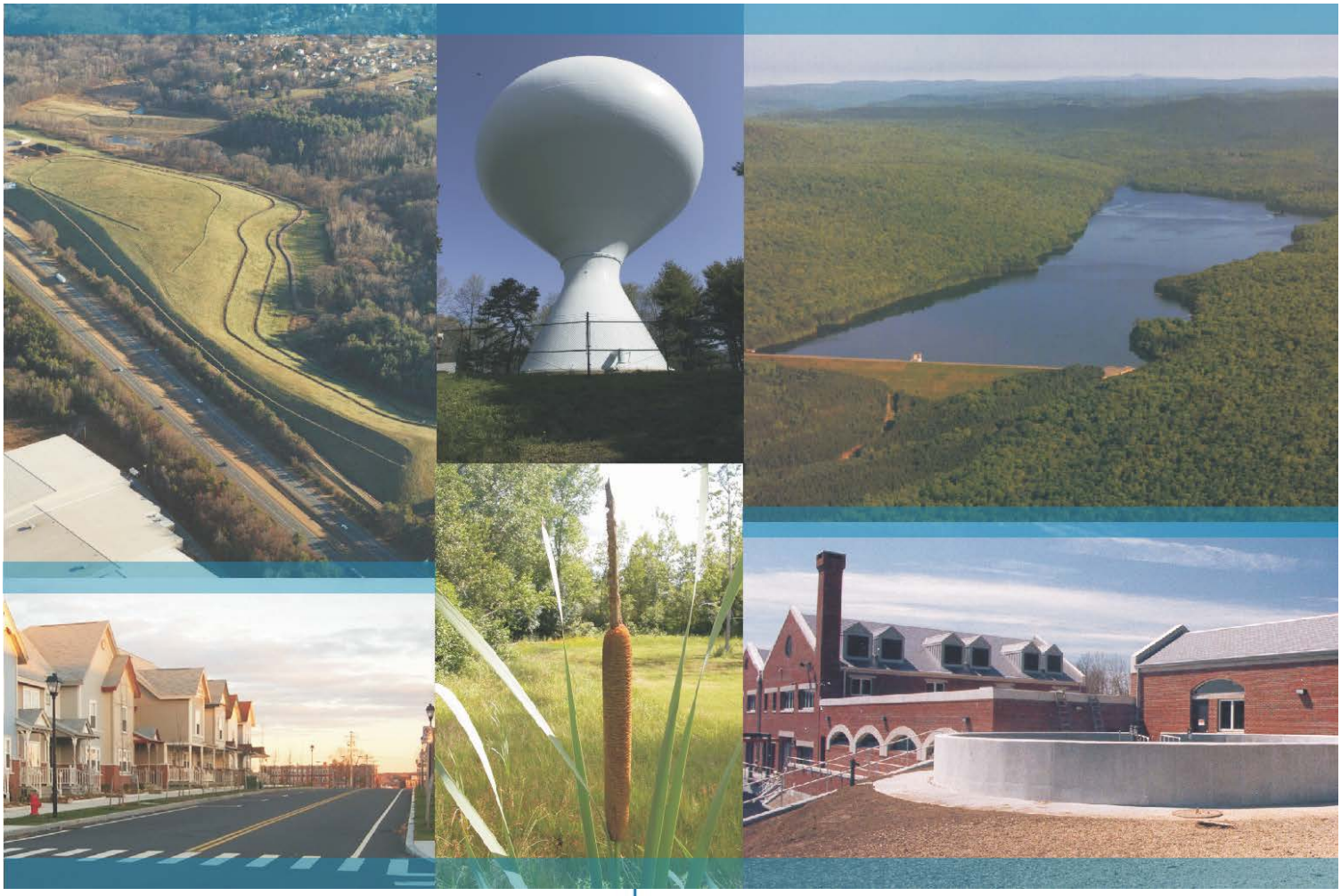

Tighe&Bond

United Illuminating – English Station
Grand Avenue
New Haven, Connecticut

Bulkhead Inspection Report

Prepared For:

United Illuminating
Orange, Connecticut

December 27, 2017

CONFIDENTIAL

Section 1
Introduction

The former English Station power generation facility is located on Ball Island in New Haven harbor, south of the Grand Avenue bridges. The project involves a Routine Inspection of the steel bulkhead along the shoreline of the facility extending from the western bridge to the eastern bridge a distance of approximately 2,525 linear feet.

1.1 Scope of Work

On October 9-10, 2017, Tighe & Bond with commercial divers from Pepperrell Cover Marine were on site at the English Station site in New Haven, Connecticut to perform an inspection of the sheet pile bulkhead. This included in-water visual inspections of the bulkhead from the mudline to the water level, and boat based inspection from the water level to the top of the bulkhead. Topside walk around inspection was also performed on be the ground surface immediately behind the bulkhead. In addition, ultrasonic thickness testing of the sheet piles to determine thickness of the sheets was performed periodically along the bulkhead focused on typical high corrosion zones.

1.2 Existing Conditions

English Station is located on Ball Island to the south of Grand Avenue. The shoreline on the property consists of steel sheet pile bulkhead. On the east side of the island is the East Branch of Mill River, and to the west is the West Branch of Mill River. There are federal navigation channels on both sides of the island with those channels in relatively close proximity to the bulkhead. The federal channels have authorized depths of 12 feet below mean lower low water (MLLW) datum, however the existing depths are typically less around Ball Island as illustrated by the shaded portions of Figure 1.

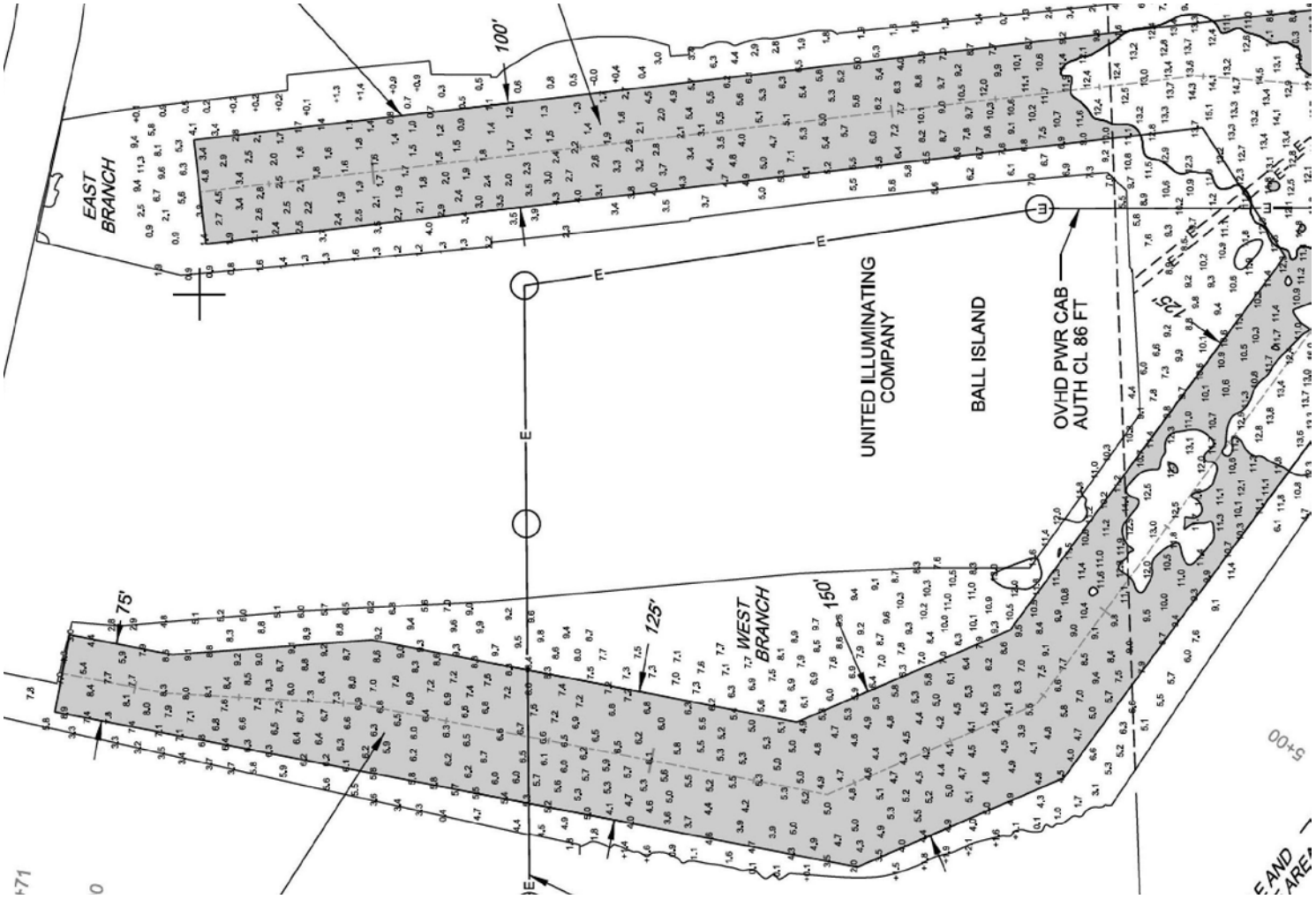

Figure 1 Water depths in feet, Army Corps of Eng. July 2017 survey, MLLW datum 1983-2001 tidal epoch

Archive soil boring data were reviewed typically indicating fill near the surface, over soft organic soils from about 15 to 35 feet down (on the island), over sands of varying grain size and density to at least a depth of 70 feet, and 100 feet in a few borings with refusal not encountered.

The existing sheet pile bulkhead was built in three phases between 1998 and 2003, consisting of several different types of construction, varied based on soil conditions, bulkhead height, and existing structures on the site.

The Phase 1 bulkhead begins at the northwest corner of the site near the southwest corner of the existing warehouse building. There is a short section of sheet pile bulkhead that runs around the corner from Grand Avenue, which was part of Phase 2. The Phase 1 bulkhead starts at the corner with this bulkhead and runs approximately 510 feet to the south.

The Phase 2 bulkhead is in two different areas on the site. The larger of the sections is on the opposite side of the site from Phase 1, and runs approximately 640 feet from the Grand Avenue bridge over the east Mill River channel to the south. The smaller section of bulkhead is on the opposite side of the site and runs from the Grand Avenue bridge

over the west Mill River channel, approximately 170 feet to the intersection with the Phase 1 bulkhead.

And finally, in Phase 3, the bulkhead was extended around the southern end of the site, connecting the Phase 1 and Phase 2 bulkheads. The bulkhead built in Phase 3 is approximately 1,185 feet.

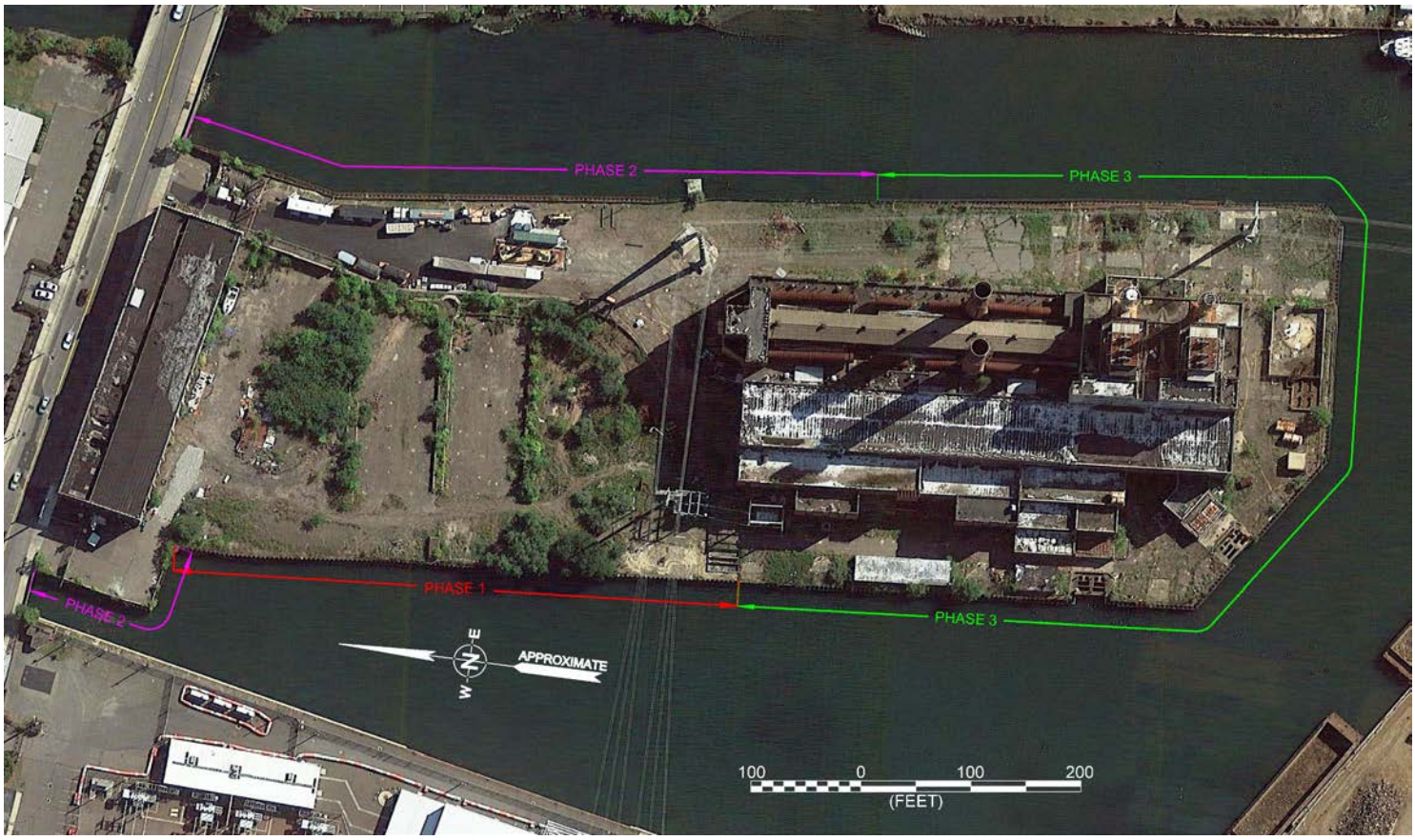

Figure 2 Bulkhead Construction Phases, 1998 to 2003 construction

Section 2
Inspection

2.1 Methods

Two different types of inspection were performed: visual and ultrasonic testing. The visual inspection was performed long the entire bulkhead, above and underwater, and was a structural assessment to look for defects or deterioration not consistent with the bulkhead design or performance. The ultrasonic testing (UT) to determine the thickness of the sheet pile from the outside, without the need for coating removal (Cygnus underwater UT gauge). The UT's were performed every 50' along the length of the bulkhead and at three different spots vertically: at the mudline, low tide level and the water level.

2.2 General Observations

Overall, the sheet pile was observed to be in good condition. This finding is expected since the bulkhead was built within the past 20 years. The coating on the sheets is showing some deterioration, with some slight bubbling and warping in isolated spots. Based on the UT thickness testing results, the bulkhead has not corroded enough to be measured in most places (0.001" precision) and other spots showing very minimal, up to 0.005" of corrosion loss, however this thickness difference from theoretical could just be steel mill rolling tolerance. There is some onset of corrosion in the isolated locations where the coating has been lost. The As-Built construction drawings indicate the steel coating was Bar-Rust 235 Epoxy in Phase 1 and 3 with manufacturer data indicating typical 4 to 8 mil dry film thickness per coat and a recommended SSPC-10 near white metal grit blast preparation on new steel. Phase 1 drawings indicated two coats with a minimum 15 mil total coating thickness.

The wale and tie rod/ground anchor system, which also appears to be in good condition, shows similar levels of isolated coating loss and corrosion onset as observed with the sheet piles. The ground anchor heads are typically covered with grease filled caps to resist corrosion. The handling holes in the tops of the sheet piles are typically covered with through bolt and fender washers (epoxy coated)

Inspection of the ground surface behind the bulkhead also indicates the finding of the bulkhead in good condition. There was no visually apparent evidence of soil loss through the bulkhead, such as tension cracking of the soil or sinkholes. Furthermore, looking down the length of the bulkhead, there was no obvious sign of bending failure or off-shore failure, since the sheets were found to be relatively straight with no excessive displacement in any direction.

2.3 Phase 1

The Phase 1 bulkhead was constructed in two different ways. Most of the length of bulkhead consists of new AZ26 sheet pile with a wale connecting the sheet piles to the new ground anchors that are angled at 40°, downward, inshore. The anchors and double channel wale are located at about mean high water level, below the typical high corrosion splash zone. The ground anchor heads are covered with grease filled caps to resist corrosion. A small section, approximately 63' long with some overlap on either

end, utilizes an existing reinforced concrete deadman connected to the new sheet piles via new tie-backs. There was no evidence of failure for either section of bulkhead.

As was mentioned in 2.2 above, the coating showed some signs of localized coating loss in isolated areas, as expected for a structure of this age in a marine environment.

Photo 1 Phase 1 Bulkhead, minor coating deterioration inshore face

Photo 2 Phase 1 Bulkhead, minor coating deterioration offshore face

2.4 Phase 2

There are two different areas of bulkhead that were built as part of Phase 2. The bulkhead on the west side of the island near the bridge over the west Mill River channel is in considerably better condition than the bulkhead along the east Mill River channel. The West Bulkhead has a hard 90° corner where the sheets are tied together across the corner with tie rods at 45° to the bulkhead, located at mid tide level. To the north of the corner, the sheets are tied back to another buried sheet pile bulkhead. The West Bulkhead shows no signs of structural failure or coating failure.

Photo 3 Phase 2 West, corner

Photo 4 Phase 2 West at Grand Avenue

The East Bulkhead, however, has some bulkhead coating loss in the tidal and splash zones. There are more widespread coating losses, especially in the area closest to Grand Avenue.

Photo 5 Phase 2 East at Grand Avenue, note coating deterioration on wale

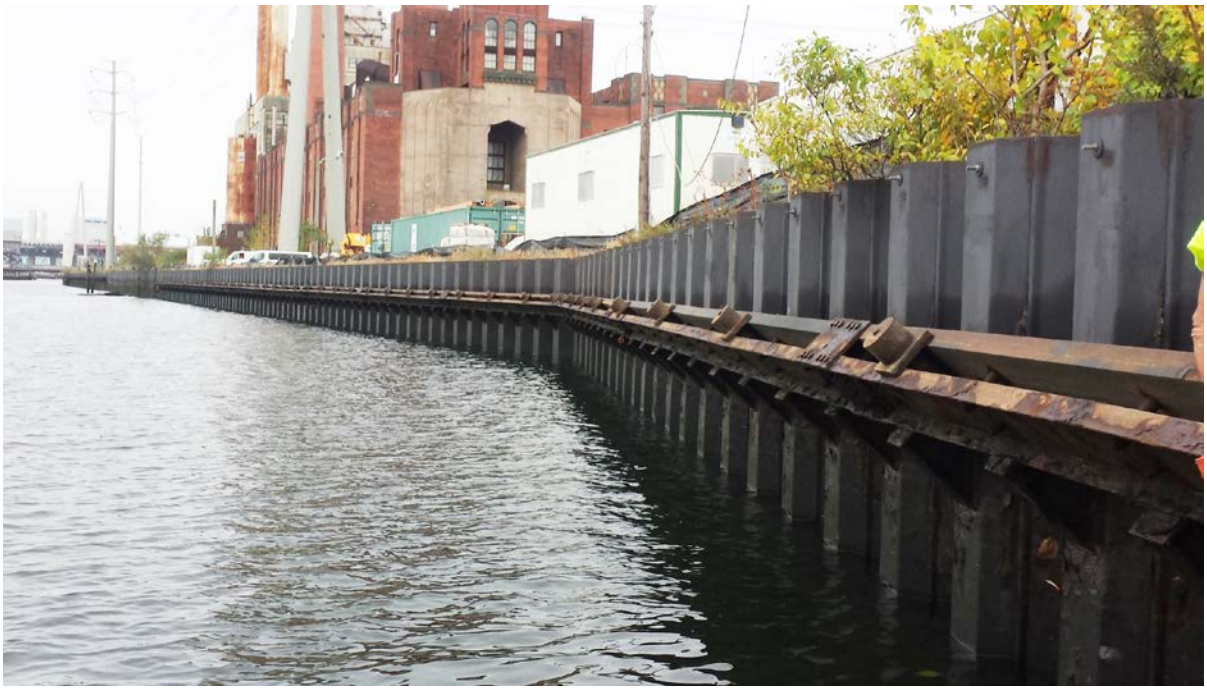

Photo 6 Phase 2 East looking south, note coating deterioration on wale

The Phase 2 East Bulkhead is supported with tiebacks, which are typically angled down at 40° through a prior concrete relieving platform except for the bulkhead in front of the

foundation for the high-tension wires and continuing to the L.P. Discharge Channel, where horizontal tiebacks connect to the relieving platform that was strengthened in some areas. There is no evidence of failure along the length of the Phase 2 East Bulkhead, but the wale coating shows signs of deterioration. Based on the UT thickness tests, the sheet piles are still very close to full sectional area.

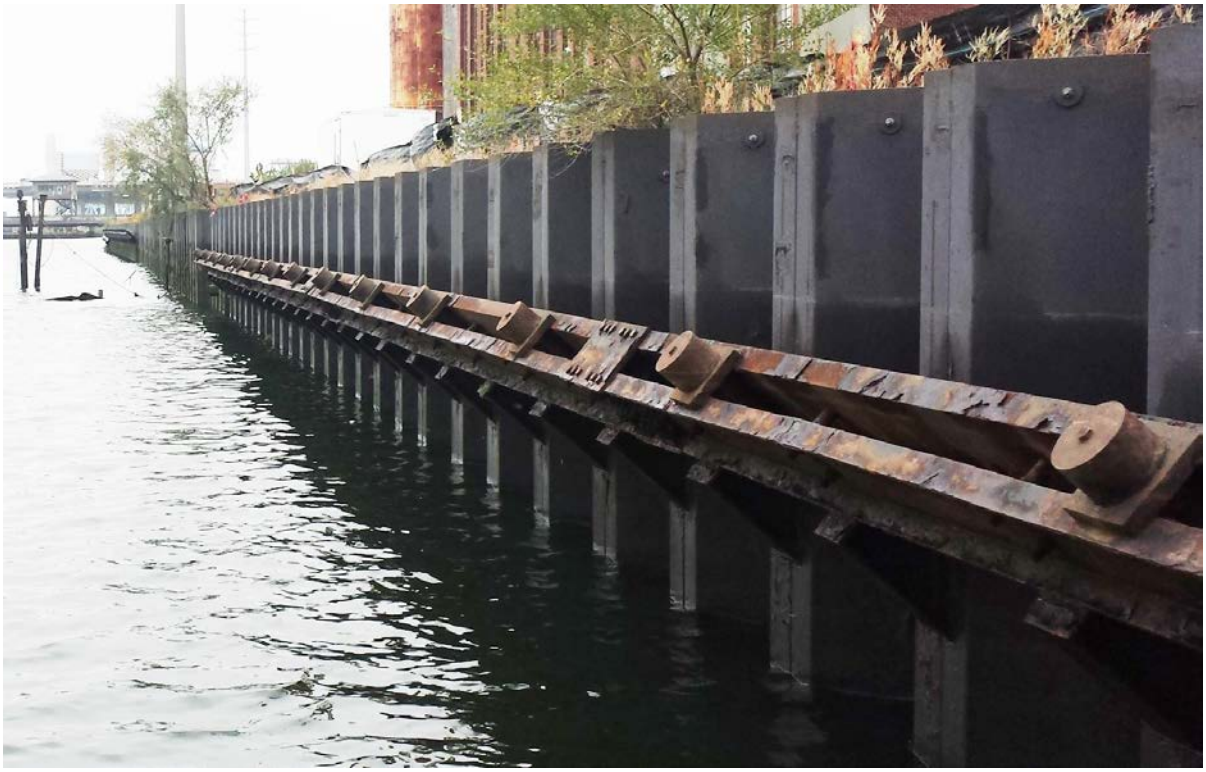

Photo 7 Phase 2 East, looking south, note coating deterioration on wale

Photo 8 Phase 2 East, south end with sunken boat adjacent to bulkhead

2.5 Phase 3

The sheet pile bulkhead constructed in Phase 3 is similar in construction to the Phase 2 bulkheads. Most of the Phase 3 sheet piles are tiebacks, which are typically angled down at 40° through a prior concrete relieving platform (existing modified, or new).

Photo 9 Typical Phase 3 angles down ground anchors with Phase 3 grease caps

The central area on the south bulkhead utilizes HZ cantilevered piles (Phase 3 Zone D).

Three areas have steel sheet piling that spans over buried under channel cable crossings that utilize steel pipe piles and wales to support the non-driven sheet piling.

The condition of the coating in the Phase 3 bulkhead is similar to the rest of the bulkhead with localized coating deterioration and onset of corrosion on the sheet piling, wales and tiebacks to vary degrees, primarily in the tidal and splash zones. There are small isolated areas of coating loss and slight corrosion, but the UT thickness testing shows full sectional area.

Photo 10 Phase 3 East typical coating deterioration localized in the splash zone, primarily at field welds with coating touch-ups

Photo 11 Phase 3 East, typical coating deterioration localized in the splash zone, primarily at field welds with coating touch-ups

Photo 12 Typical Phase 3 bulkhead coating deterioration and corrosion onset in the tidal and splash zones – note horizontal tiebacks at southeastern high tension pole area do not have corrosion protection end caps

Photo 13 Phase 3 Southeastern area with varying configurations and degrees of coating deterioration, Unit 8 discharge area bulkhead (right side) appears to have had minimal coating with more extensive coating loss

The short length of bulkhead in between Unit 7 and Unit 8 discharge structures has a wale missing splice plates. Observation of the wale coating suggests the wale splice plates were never installed. The wale is welded to the angled mounting brackets on both sides of the splice, and this is not noted in the As-Built drawings, suggesting it was accepted by the engineer of record.

Photo 14 Phase 3 wale missing splice plates between Unit 7 and 8 discharge structures

Photo 15 Phase 3 wale missing splice plates between Unit 7 and 8 discharge structures

On the south facing bulkhead, there are 2 locations along the section of cantilevered HZ-piles where the interlocks have split. At the top, the interlocks are touching, but are not threaded together. At the bottom near the mudline, the interlocks have been pushed out of alignment by approximately 12". This most likely happened during construction, perhaps when the pile was being driven, there may have been an obstruction that caused the pile tip to kick out of alignment. Review of the archive As-Built drawings indicated that HZ piles D44, D45 and D53 encountered refusal or were terminated above design tip elevations with D53 being the most extreme with actual tip elevation of -26.3' versus a design tip elevation of -66.5'. The interlock separations found, do not correspond with the early terminated HZ piles noted, and the As-Built notes do not mention separated interlocks or field repairs. The diver reached into the interlock separations and found hard surfaces, not soil, it appears that repairs were inserted into the web pockets between these piles. The easternmost HZ pile, D1, was driven slightly outward and overlapping pile D2, but the gap had been sealed and may have just been an end termination transition fit.

Photo 16 Phase 3 Southern bulkhead cantilevered HZ piles with separated interlocks at two locations

Photo 17 Phase 3 Separated interlock at water surface between piles D7 and D8

The western length of Phase 3 bulkhead has similar conditions with localized coating deterioration and onset of corrosion on the sheet piling, wales and tiebacks to vary degrees, primarily in the tidal and splash zones. There are small isolated areas of coating loss and slight corrosion, but the UT thickness testing shows full sectional area.

Photo 18 Phase 3 Western bulkhead at intake tunnel with localized coating deterioration and corrosion onset in the tidal and splash zones

Photo 19 Phase 3 Western bulkhead at underwater cable crossing area (wales at the top of the bulkhead)

Section 3
Assessments & Recommendations

3.1 Assessments

Based on the visual above and underwater observations the English Station bulkhead appears to be structurally sound with only some minor localized deterioration. The separated HZ pile interlocks are not noted on As-Built drawings but likely did happen during pile driving. The Phase 3 wale missing splice plates is atypical. These do not appear to be structural issues, or an apparent soil loss issue, however follow ups with the contractor and/or engineer of record might provide additional insight into the construction assessment and field repairs performed.

The coating deterioration observed is localized in the tidal and splash zones, primarily at locations of field welding and field coating touch up. Corrosion has started at these areas, but has not progressed to the point where measurable steel losses can be established. This coating deterioration is consistent with the age of the bulkhead and the location in the upper tidal zone and splash zone. Currently, the sheet piles are at, or close to, full original thickness and it is expected that the piles were selected with some additional steel thickness as a corrosion allowance. Confirmation with the engineer of record, or from a basis of design document, may be possible if available.

3.2 Recommendations

The separated HZ pile interlocks are not noted on As-Built drawings but likely did happen during pile driving. Follow ups with the contractor and/or engineer of record might provide additional insight into the construction assessment and field repairs performed. If repairs are needed to eliminate these gaps, this might be performed with welded plates and web pocket grouting.

The Phase 3 wale missing splice plates is atypical, but easily repaired with a custom fabricated set of splice plates to fit the misaligned wale bolt holes.

The localized coating deterioration is an ongoing maintenance item. With the coating deterioration and onset of corrosion occurring in the upper tide zone to splash zone, cathodic protection is not an option. The best approach would be grit blasting the affected areas and recoating with a surface tolerant epoxy within the same low tide cycle. Due to environmental permitting considerations, we expect this would be performed from a float or platform fit to the bulkhead to catch the grit and coating debris, and a natural organic blast grit, such as walnut shells, may be necessary. Mechanical tool surface preparation would be a lesser alternative if grit blasting is not permitted.