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Technical Memorandum

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From: Chris Greene – Geosyntec Consultants, Inc.

Subject: Orrington Remediation Site – Changed Site Conditions which support leaving Plant Area Native Soils and Select Underground Piping (other than the Industrial Sewer) In Place

This Technical Memorandum provides site data and information which supports the Petition for Modification of BEP August 19, 2010 Order.

As described in the Petition, significant new information has been collected which shows a change in conditions and improved understanding of the impacts in the Plant Area since the Board issued the BEP Order in 2014. Additional work has been performed to evaluate the changed conditions and to support leaving certain deep native soils in place with mercury concentrations above the MPS, which are not a significant source of mercury to groundwater, are not a risk to potential receptors and/or are technically impractical to remove. This new information also supports leaving selected segments of underground piping, other than the Industrial Sewer, in place where the pipes are deeper than or outside of the excavation limits (horizontally or vertically). A limited segment of the Industrial Sewer is also proposed to be left in place in one specific area where health and safety concerns are present due to the presence of chloropicrin and the depth of the excavation to remove the pipe in this area.

The approach to leave native soils with mercury concentrations above the MPS in place in the Plant Area is consistent with the approach allowed in the April 2014 Maine Board of Environmental Protection (BEP) court order (the Order) for Landfill 1. The majority of the mercury in the Plant Area soils is located in the fill material with mercury concentrations above the MPS. Removal of this fill will eliminate both human and ecological exposure pathways. Furthermore, unlike at Landfill 1, there are no disposal areas or listed waste soils within the Plant Area, therefore the approach allowed in the Order for Landfill 1 should be technically applicable to the Plant Area as well. The native soils in the Plant Area are physically similar to those in the Landfill 1 Area and the potential for the Plant Area native soils to leach mercury to groundwater is low and similar to the Landfill 1 native soils. Mercury remaining in the native soils with the potential to leach to groundwater will be captured by the groundwater extraction system resulting in an environmentally protective remedy.

The Maine regulations allow a BEP Order to be revised if new information resulting in a changed condition is available. The changed conditions are summarized below.

- The finding of the BEP Order were based on samples from 116 borings, only 42 of which were deeper than 2 feet below ground surface (bgs). Since the BEP Order was issued, an additional 197 borings were conducted with 2,014 additional samples collected. **Figure 1** shows the sampling locations at the time of the BEP Order was issued and locations of additional sampling since completed.)
- Since the BEP Order was issued, an additional 68 new monitoring wells and piezometers monitoring groundwater conditions were installed.
- The BEP Order was based on data resulting in a total volume of soil with mercury concentrations over the MPS within the Plant Area totaled approximately 59,920 CY. Based on the new data from over 2,000 additional samples, the revised volume of soil with mercury concentrations over the MPS totals 164,000 CY, a nearly three-fold increase which is a significant change in conditions.
- While these additional soils are a significant volume increase, the soils themselves have low concentrations of mercury and are thus low risk to human health and the environment.
- The BEP Order was based on the data showing the maximum depth of soils with concentrations above the MPS to be approximately 12 feet below grade. The new data from the additional samples, the maximum depth of soils with concentrations above the MPS is now approximately 26 feet below grade in certain areas, well below the groundwater table and 2 to 3 times deeper than originally expected resulting in a significant change in conditions. In general, the mercury concentrations in these deeper native soils have lower concentrations than the fill.
- The new soil borings, monitoring wells and piezometers provide an increased understanding of the Site geology and subsurface conditions. The presence of a mantle of gravel and sandy soils beneath the Plant Area had been presumed based on historical investigations, and this has not been observed in many of the recent explorations.
- A three-dimensional numerical model of Site groundwater has been completed and approved by the Maine DEP. The model provides the ability to run detailed scenarios showing where groundwater flows under various conditions including capture zones.
- At the time the BEP Order was finalized, the Maine DEP expected various COCs other than mercury to be found in the Site soils throughout the Plant Area, however the new borings and analysis verify that mercury is the primary Site contaminant of concern. Chloropicrin is present in a well-defined area, and other non-mercury COCs are not present above the MPS in the Plant Area. This new understanding of contaminants is also a changed condition from that which was expected at the time of the BEP Order.
- When the BEP Order was issued, the expectation was that mercury concentrations would be high across the entire Plant Area, however the new data indicates this assumption was incorrect. Of the native soils being proposed to be left in place, 99.6% have mercury concentrations less than the residential RAG of 51 mg/kg.
- Furthermore, the Maine DEP assumed that visible mercury and recoverable mercury would be present throughout the Site, however based on over 2,000 additional soil samples, microbeads of visible mercury were only found in two borings from the Cell Building Area and an area immediately adjacent to the Cell Building. This new understanding of contaminants is also a changed condition from that which was expected at the time of the BEP Order.

These changed conditions and new facts support a modification to the BEP Order.

After evaluating the significant amount of new data collected at the Site as described above, it is clear the understanding of the conditions at the Orrington Remediation Site have changed.
This new data technically supports the requested modifications to the Order for the following reasons:

- The soil MPS of 2.2 mg/kg was established to be protective of potential receptors in the Penobscot River that could be impacted by soil erosion and transport via surface flow. The removal of fill materials and placement of a clean cover on top of the native soils will prevent surficial contact and erosion which will remove the mechanism for soils with mercury concentrations above 2.2 mg/kg to be transported to the river.
- Groundwater mercury concentrations in the Plant Area are generally below or close to the MPS of 2 µg/L and are generally showing declining trends in mercury concentrations, The fill material with mercury concentrations above the MPS of 2.2 mg/kg in the Plant Area will all be removed and once this is completed, the already low groundwater mercury concentrations are expected to decrease further.
- The groundwater extraction system in the Landfill 1 Area will capture groundwater from the Plant Area.
- Visible mercury was not identified in the general Plant Area and was only observed in locations within and adjacent to the Cell Building footprint. Both fill and native soil materials containing visual mercury identified during the pre-design activities or during excavation, will be removed.
- Mercury sequential extraction data shows that mercury in the native soils outside of the Cell Building Area is primarily in less soluble fractions, and therefore less likely to leach to groundwater. Groundwater concentrations in the Cell Building Area are currently low and are expected to decrease further when the fill material and soils with visible mercury are removed.
- There are no identified historical disposal areas or units within the limits of the Plant Area, no listed waste is present in this area, and mercury impacts to soil within the Plant Area are from incidental contact with mercury-containing material from former manufacturing operations.
- Waste characterization samples collected to date show that the soils to be removed during the Plant Area CMI are characteristically non-hazardous with the exception of one sample at the former Retort Building. Additional waste characterization sampling will be performed for soils to be disposed off-site and any areas identified as hazardous waste will be excavated and managed separately and disposed of at appropriate disposal facilities.
- A Piping Evaluation Criteria will be developed by Mallinckrodt and submitted to the Maine DEP for approval which can be used in the field in consultation with the on-site Maine DEP representative.

RISK EVALUATION

A risk assessment was performed in 1998 and a soil MPS of 60 mg/kg was proposed based on the Maine DEP residential Remedial Action Guideline (RAG) at the time (CDM, 1998). After extensive negotiations with the agencies, in a 2002 letter to Maine DEP and the US EPA, Mallinckrodt proposed a sediment and soil MPS of 3.2 mg/kg which was based on the federal fish tissue standard of 0.3 ppm (Mallinckrodt, 2002; EPA, 2003) because of Maine DEP's concerns regarding potential impacts to fish in the Penobscot River. This proposed MPS was developed to protect humans and wildlife that may consume fish from the river. A sediment concentration of 3.2 mg/kg or less would keep the mercury concentration in fish tissue below the EPA standard of 0.3 ppm. Maine DEP argued that soils from the upland areas of the Site could travel via erosion carried by surface runoff into the river. While Mallinckrodt did not agree with this premise due to other control mechanisms installed to address erosion, in order to move the project forward Mallinckrodt proposed the MPS of 3.2 mg/kg apply to both sediment and soil. After a period of public comment, the US EPA and Maine DEP provided a final sediment and soil MPS of 2.2 mg/kg based on the new Maine DEP fish tissue standard of 0.2 ppm (EPA, 2003; Maine DEP, 2008). Throughout this process, extensive discussions regarding constructability and the inability to remove deep fill material were held with Maine DEP.

As part of the Plant Area remediation, fill materials with mercury above 2.2 mg/kg will be removed and replaced with clean fill. This includes all surficial soils, defined as the top 18 inches of soil (CDM 1998) within the Plant Area. The native soils with mercury concentrations above the MPS to remain in place will be covered with clean soils with an average thickness of 7 feet and up to a thickness of 20 ft in some locations. The clean fill will be stabilized with vegetation or pavement thus eliminating any exposure pathways in the Plant Area. With this remedial design, there is not a mechanism for native soils with mercury above 2.2 mg/kg remaining in place in the Plant Area to erode and/or be transported into the river via surface runoff which was the basis for the conservative MPS of 2.2 mg/kg.

A deed notice will remain in place on the property to prevent potential future residential development. This deed notice documents the conditions which maybe be encountered during future construction activities or industrial development. The two potential future exposure scenarios are a construction worker potentially digging in the soils and a commercial worker. The mercury soil construction worker and soil commercial worker RAGs are 930 mg/kg and 510 mg/kg, respectively. Based on data from over 1,000 samples collected during the pre-design activities, the maximum mercury concentration to be left in place is well below both RAGs. Furthermore, approximately 99% of the samples from native soils being left in place had mercury concentrations less than the residential RAG of 51 mg/kg and 92% have mercury concentrations less than the MPS.

Because there is almost no methyl mercury or organic mercury in the sequential extraction samples within the Cell Building Area and across the Plant Area, the Maine RAGs for the two most likely future exposure scenarios discussed above (Soil Construction Worker and Soil Commercial Worker) are appropriate for a comparison to amounts of mercury remaining at depth in the Plant Area.

GROUNDWATER

The understanding of the Site groundwater has significantly changed since the BEP Order was issued in 2014. An additional 68 new monitoring wells and piezometers have been installed across the Site. The new soil borings, monitoring wells and piezometers provided an increased understanding of the Site geology and subsurface conditions. In particular, the Plant Area appears to be underlain by relatively shallow, impermeable basal till covered by sandy and clayey outwash soils and fill soils of various composition. In some regions of the Plant Area, impermeable glacial till is within several feet of the ground surface. Vertical groundwater migration is limited by the low permeable glacial till, and lateral groundwater migration is generally westward. The presence of a mantle of gravel and sandy soils beneath the Plant Area had been presumed based on historical investigations, and this has not been observed in many of the recent explorations.

Furthermore, since 2014, a three-dimensional numerical model of Site groundwater has been completed and approved by the Maine DEP in September 2017. This model incorporates data gathered since 2014 and provides the ability to run detailed scenarios showing where groundwater flows under various conditions. The additional sampling has also shown that mercury groundwater concentrations in the Plant Area are generally near or below the MPS except at two locations, which is also new information since the Order was issued in 2014. The Plant Area is underlain by a low-permeability, clayey glacial till formation. Sand and/or clay outwash of varying thickness (between 2 and 45 feet) overlies the till. The till resists downward seepage of groundwater. Therefore, groundwater in the outwash soils primarily migrates laterally, in an overall westerly direction, toward Landfill 1 (SME, 2016; SME, 2017). Based on water level elevation data, groundwater contours show overall groundwater movement to the west and the groundwater model simulations, using groundwater particle tracking, support this interpretation (SME, 2016). Groundwater emanating from the Plant Area, including mercury dissolved in the groundwater around the former Cell Building, therefore, will migrate west and be collected by the extraction system in the Landfill 1 Area. The simulation of groundwater movement from the former Cell Building and former Chlorate Building areas, using the Maine DEP approved Site groundwater model, shows that groundwater will be captured by the two interim groundwater extraction wells (EW-3 and EW-5) that will operate during the Landfill 1 remediation. The interim system that will be in place after the Landfill 1 Area CMI is commenced will continue to capture groundwater from the Plant Area until the final extraction system is installed. The Final Groundwater Extraction System design has been approved in concept by Maine DEP and the final system will be installed upon completion of the Landfill 1 CMI in fall 2018. Groundwater model simulations confirm that the groundwater from the Plant Area will be captured under the Final Groundwater Extraction System.

In summary, both the groundwater extraction system that will operate during the Landfill 1 CMI, and the final groundwater extraction system capture groundwater from the Plant Area, including any mercury impacted groundwater resulting from the native soils that remain in place.

Mercury groundwater concentrations in the Plant Area are generally near or below the MPS of 2 µg/L except at PZ-PA-44 and the Chlorate Building Manhole. Water quality monitoring was conducted of piezometers and monitoring wells in the Plant Area vicinity in June and July 2017.

Ten monitoring points were sampled, of which five were below MPS in July, and three others had single-digit ug/L detections near the MPS. With the exception of the Chlorate Building Manhole and PZ-PA-44, the maximum concentrations in this vicinity range from <0.2 to 10.7 ug/L. Additionally, mercury concentrations in groundwater in the Plant Area have been dropping over time. Fill material above the MPS and the Chlorate Building underdrain system will be removed as part of the Plant Area CMI and these remedial measures are expected to reduce groundwater concentrations in this area. PZ-PA-44 is in the Cell Building Area and fill material above the MPS is being removed from this area. In addition, visible mercury was noted in soil boring SB-PA-44 immediately adjacent to PZ-PA-44 and as a result native soils above the MPS around this location are also being removed. Neighboring monitoring points do not show a groundwater mercury plume emanating from the Cell Building Area. Mercury that is mobilized in the groundwater moves west and is captured by the groundwater extraction system in the Landfill 1 area, as discussed above.

Mercury is more likely to dissolve in the groundwater in the presence of elevated salinity. Based on specific conductance values measured across the Plant Area during years of monitoring events, salinity of the groundwater in the Plant Area is substantially the same as background values indicating there are no geochemical reasons for mercury remaining in native soils in the Plant Area to preferentially leach to groundwater.

At the former Cell Building Area, dissolved mercury in the groundwater is primarily from spills and incidental contact with elemental mercury and general plant processes (CDM, 1998). Visible mercury has been observed in soil samples retrieved from the outwash soils beneath the former Cell Building which is discussed in more detail below. Thus, with the exception of the elevated mercury at PZ-PA-44 which is near the area where visible mercury was identified during the PD activities, aqueous mercury concentrations throughout the Plant Area are below or near to the MPS. The proposed Plant Area approach includes removal of both fill and native soils with visible mercury which will remove the source of the mercury contributing to elevated groundwater concentrations at PZ-PA-44, greatly reducing the potential source of mercury to the rest of the Plant Area groundwater and further reducing the already low concentrations downgradient from the Cell Building Area.

NATIVE SOILS TO BE LEFT IN PLACE

The current understanding of the Site soils with mercury concentrations above the MPS is very different than what was known at the time the BEP Order was issued in 2014. At that time, a total of 116 borings had been completed at the site, only 42 of which were deeper than 2 feet bgs. Since 2014, an additional 197 borings have been conducted with 2,014 additional samples collected. **Figure 1** shows the sampling locations at the time of the BEP Order was issued and locations of additional sampling since completed.

At the time the Order was issued, the maximum depth of soils with concentrations above the MPS in the Plant Area was assumed to be approximately 12 feet below grade. The new data indicates the maximum depth of soils with concentrations above the MPS is now approximately 26 feet below grade, well below the groundwater table and three times deeper than originally expected.

While the BEP Order assumed the volume of soils to be removed from the Plant was approximately 59,920 CY, the additional delineation and increased depth profile results in a revised volume of Plant Area soil with mercury concentrations over the MPS of 164,000 CY, a nearly three-fold increase. In short, conditions in the Plant Area are significantly different than what was expected in 2014 when the Order was issued. For this reason, the proposed approach to leave low risk native soils at depth (below the fill) with mercury concentrations above the MPS in place is a reasonable remediation approach.

These increased depth and higher volumes of soil above the MPS in the Plant Area do **not** however indicate widespread high levels of mercury contamination. Of the native soils being proposed to be left in place, all are well below both the Construction Worker and Commercial Worker soil RAGs. Furthermore, approximately 99% of the samples from native soils proposed to be left in place have mercury concentrations less than the residential RAG of 51 mg/kg.

Similar to the approach in the final Landfill 1 CMI Plan – Rev2, Mallinckrodt is proposing to excavate certain native soils in the Plant Area that have higher levels of mercury and which can be removed without added technical complexities such as sheeting and shoring or working at depths well below the groundwater table. Specifically, native soils at SB-PA-93 have mercury concentrations from 166 mg/kg to 240 mg/kg, native soils at SB-PA-54 and SB-PA-30 have mercury concentrations of 80 mg/kg and 187 mg/kg respectively and native soils at SB-PA-110 have 52 mg/kg mercury from one to two feet below the fill. Although all of these concentrations are below the Commercial and Industrial RAGs, the native soils in each of these locations will be removed during the excavation of the fill in these areas. A mercury concentration of 229 mg/kg is also present at SB-PA-46 at 4 feet below the fill and these native soils will also be removed.

Furthermore, portions of concrete subsurface structures that are located within the native soils to be left in place will remain. These deeper concrete sections are at depths such that they will not interfere with any future activities at the Site and a deed restriction will be placed on the entire Site limiting usage for industrial/commercial purposes. Concrete foundations or other structures that are within the fill or native soils that meet the MPS will also be left in place.

COLUMN TESTING AND LEACHABILITY RESULTS

In accordance with the Order requirements for Landfill 1, a Column Test Study (Study) was conducted to determine the capacity of soils to leach mercury and other constituents in concentrations that would exceed the MPS. The purpose of the Study was to predict the concentrations of mercury in groundwater that would result if native soils with mercury concentrations above the MPS were left in place. The results showed that the mercury species in the soil remaining in place post remediation have low percentages of soluble fractions available to leach to the groundwater. The results also showed that the fractions leaching to groundwater are predicted to be below or close to the MPS value after remediation of the Landfill 1 Area. These Study results indicated that sequential extraction data are a good predictor of the leaching potential of mercury.

The Maine DEP and its consultants reviewed the Study and how the results of the Study were applied to the Landfill 1 remedial design. In a memo dated March 28, 2018, the Maine DEP

described the conclusions, the variability in assumptions and how the variability in the parameters were addressed in the design. The memo also states that the Maine DEP agrees the study shows there is a relationship between the sequential data and the subsequent leachability of mercury from site soils.

Once it became known that conditions in the Plant Area were significantly changed from what was expected when the Order was issued, the approach as outlined in the Order for the Landfill 1 Area was applied to the Plant Area.

An additional investigation was conducted to assess the potential for leaving native soils with mercury concentrations above the MPS in place in the Plant Area. This investigation primarily focused on assessing the potential for mercury to leach from native soils that would be left in place with concentrations above the MPS by taking samples at several locations throughout the Plant Area (**Figure 2**) for mercury sequential extraction analysis. These samples were taken in different locations to capture any potential differences across the Plant Area. The Column Test Study conducted in Landfill 1 indicated that sequential extraction data are a good predictor of the leaching potential of mercury.

Samples from these locations where native soils with mercury concentrations above the MPS are proposed to be left in place were analyzed for mercury speciation at Eurofins Laboratory using sequential extraction analysis via EPA method 1631. Three locations, SB-PA-220, SB-PA-221, and SB-PA-226, were collected from within or near the Cell Building footprint. Borings SB-PA-219 and SB-PA-222 were collected in areas away from the Cell Building Area to look at speciation results in the rest of the Plant Area soils.

The results of the mercury sequential extraction tests are shown on **Figure 3**. Locations outside of the Cell Building Area indicated lower percentages of soluble fractions (e.g. F1 and F2) of mercury than within or near the former Cell Building. Specifically, samples analyzed outside of the Cell Building Area have 74% or more of the mercury not in the leachable F1 and F2 fractions. These results indicate that mercury that would be left in place outside of the Cell Building Area, is primarily in less soluble fractions and therefore unlikely to leach into the groundwater. This data is strongly correlated with the low mercury concentrations in groundwater outside of the Cell Building Area as discussed above. The combination of the sequential extraction data and groundwater data indicate limited mercury may leach from the soils left behind in the Plant Area outside of the Cell Building Area.

The three locations within or near the former Cell Building have 29% to 44% of the mercury in the less soluble (non F1 or F2) fractions. Though a higher percentage of the mercury in the native soils beneath the Cell Building are in lower fractions, the Plant Area groundwater results discussed above show that little mercury is currently leaching to the groundwater.

The excavation proposed for the Plant Area would remove approximately 65% of the soils above the MPS in the Cell Building Area. The estimated total volume of soils (fill and native) with mercury concentrations above the MPS in the Cell Building Area is 37,000 CY, 24,000 CY of which will be removed. The average mercury concentration of the soils planned to be removed is

17.5 mg/kg. Therefore, though concentrations of mercury currently leaching from the Cell Building Area are currently low, they are expected to drop further after excavation of 24,000 CY of soil in this area. The native soils remaining below the bottom of excavation in the Plant Area are well characterized with over 1,000 samples of these soils already collected.

Additionally, as discussed above, the Site Groundwater Model and capture zone analyses illustrates that the groundwater extraction system (current and future) will capture any mercury that may leach to the groundwater from native soils remaining in place above the MPS across the Site.

In summary, the Column Testing Study and sequential data results provide strong technical support to leave native soils containing mercury concentrations greater than the MPS of 2.2 mg/kg in place in the Plant Area while using the groundwater extraction system to control potential migration of mercury in groundwater.

SOILS CONTAINING VISIBLE MERCURY

As shown in **Figure 1**, 197 borings were conducted on an approximately 50-foot grid throughout the Plant Area. A mercury sample was generally collected every foot of depth in each boring resulting in a total of 2,014 samples; providing a high density of data to characterize the Plant Area soils. Each sample was visually inspected for mercury both before removal from the boring sleeve and during preparation for analysis. Within the Plant Area excavation boundaries, visible mercury was only observed in locations within and adjacent to the Cell Building footprint and in one location adjacent to the former Retort Building. Visible mercury was encountered in five borings and in surficial soils in one limited area. Soils with non-recoverable visible mercury will be removed, stockpiled separately from other soils, and transported to the Stablex facility in Canada where they will be processed and disposed of in accordance with the disposal facility's permit for such soils. Because the waste profile for such soils will include the fact that visual mercury is present in the soils, further waste characterization is not required for these soils. Excavations in the areas where visible mercury was identified are designed to remove materials containing visible mercury regardless of whether the materials are fill or native soils. Native soils containing visible mercury will not remain in place and are not subject to the technical rationale for leaving soils in place in the Plant Area.

The high density of data points taken during the pre-deign activities demonstrates that visible mercury is unlikely to be located in the Plant Area outside of the Cell Building Area. To further confirm that soils with visible mercury are being removed from the Plant Area, the bottoms and side walls in each excavation area will be visually inspected for visible mercury. These inspections will follow the procedures described in the Visual Mercury Inspection Protocol(Protocol) approved by the Maine DEP, and the inspections will be recorded in the CQA documentation. If visible mercury is identified, the Protocol outlines specific procedures on determining the area to be excavated, segregation and management of the removed soils, as well as follow-up inspections of the bottoms and side walls of the additional excavation area.

WASTE CHARACTERIZATION

Samples for Phase I excavation waste characterization analysis were collected from 45 locations within and two locations just outside of the Plant Area excavation boundaries as shown on **Figure 4**. These samples included multiple locations within and immediately surrounding the Cell Building and Chlorate Building footprints where higher mercury concentrations were detected during the pre-design activities.

Analytical results from each of these locations, except TP-PA-02, indicate that the soils within the Plant Area are characteristically non-hazardous as shown on **Figure 4**. The analytical results for TP-PA-02 (located in the area of the Former Retort Building) indicated that the soil sample was characteristically hazardous for mercury and these excavated soils will be managed as hazardous waste.

Prior to beginning the Plant Area Phase 2 CMI, additional waste characterization will be performed at a frequency of 1 sample per 500 tons as required by the waste disposal facilities for non-hazardous waste. Based on the current excavation approach, approximately 260 additional waste characterization samples will be collected, resulting in a total of over 300 samples being collected from across the Plant Area. If future waste characterization samples demonstrate hazardous characteristics in a particular location, the fill material with mercury above the MPS within the immediate vicinity of the sample will be removed, segregated from other excavated soils, and disposed of as hazardous waste. Depending on the volume of native soils underlying the hazardous fill, additional waste characterization sampling will be performed to characterize the native soils proposed to be left in place.

CLEAN CONTACT COVER

Native soils to remain in place above the MPS will have a clean contact cover installed over them. The contact cover will consist of an average thickness of 7 feet of cover with a minimum of 2 feet of clean soil in all areas. The cover will prevent surficial contact with soils and be stabilized with vegetation or pavement to present erosion. The contact cover will eliminate the overland runoff pathway for soils above the MPS to reach the river and will be protective of fish in the river and humans that may eat the fish, thus satisfying the underlying objectives that lead to the development of the soil MPS of 2.2 mg/kg.

UNDERGROUND PIPING

The approach to the Plant Area Phase 2 CMI proposes to address the underground piping at the Site by a combination of removal and abandonment in place.
A camera survey of portions of the Industrial Sewer was conducted on August 25, 2015. Observations during the survey of the accessible portions of the sewer included its condition, inflows, areas of standing water and locations of debris accumulation. Surveyed sections of the sewer appeared to be in generally good condition, with no large cracks or other significant structural damage observed. This included the segment of the sewer in the Chloropicrin Area.

Occasional evidence of debris, standing water, and algal growth were observed. Observations of the camera survey do not indicate the presence of visible mercury in the Industrial Sewer.
The entire Industrial Sewer will be removed with the one exception of the segment of the sewer which is present in the Chloropicrin Area. The soils within the Chloropicrin Area have mercury concentrations less than the MPS and the chloropicrin levels in the soils are being treated in situ due to health and safety concerns associated with excavating soils impacted with high concentrations of chloropicrin. The concentrations of mercury in soil within the Chloropicrin Area are already below 2.2 mg/kg therefore when the in-situ chloropicrin remediation is complete this area will be in compliance with the MPS. Removing the Industrial Sewer piping is this area would require excavations of approximately 20 feet below the existing ground surface. To remove this limited segment of deep piping would present new health and safety issues associated with construction at depth. Trench boxes or excessive benching and sloping would be required to maintain a safe excavation, all of which should be unnecessary to remove a buried piping that is located within clean soils. For these health and safety reasons both before and after the chloropicrin is remediated, the Industrial Sewer line will be removed except for the segment of pipe between the manhole just north of the Chloropicrin Area and the manhole to the east of the Chloropicrin Area. The sewer pipe will be cut at both of these intersection points and the sewer pipe within the chloropicrin area will be filled with flowable fill. The Industrial Sewer to be removed, and the limited segment to remain in place, is shown on **Figure 5**.

For piping other than the Industrial Sewer, where the bottom of excavation elevation is lower than the crown elevation of the underground piping, such piping will be removed and stockpiled for off-site disposal. In addition, the Chlorate Building underdrains will all be removed regardless of the elevation of the excavations in this area. In areas where the bottom of excavation is above the crown elevation or the underground piping is horizontally outside of the excavation limits, the underground piping will be addressed by evaluation of historical usage of the piping, condition of the piping and risks from the piping remaining in place, followed by agreement and approval by the Maine DEP.

The results of the pre-design investigation indicate that there is no pattern linking the underground piping to mercury concentrations above the MPS and the pipes that were video inspected are in good condition.

The portions of the underground piping that will be left in place will be surveyed to provide a record of piping to be left in place. The piping will then be flushed clean and the flushed-out material collected and disposed of properly. Free water will also be removed prior to abandonment. The piping to be left in place will then be abandoned by completely filling with flowable fill. This abandonment procedure will ensure that the piping will not act as a pathway for future groundwater flow.

Based on the camera survey that shows the underground piping to be in generally good condition and the lack of co-location between mercury concentrations above the MPS and the underground piping, abandoning certain segments of the underground piping in place will result in a protective remedy.

CONCLUSION

As presented above, there is a significant amount of new information that supports a modification to the BEP Order allowing a remedy that incorporates leaving native soils with mercury concentrations above the MPS at depth in place in the Plant Area as well as certain segments of underground piping and concrete at depth in place in the Plant Area. The human and ecological exposure pathways will be eliminated by removing the fill material which contains the majority of mercury in the Plant Area soils and covering the native soils to remain in place with clean fill. The clean fill will be stabilized with vegetation or pavement to prevent erosion of soils and act as a cap of the soils remaining in place with mercury concentrations above the MPS.

Current groundwater concentrations in the Plant Area are already near or below the groundwater MPS except in the one piezometer in the Cell Building Area. Removal of fill material in the Plant Area above the MPS as well as soils with visible mercury will cause further reductions of mercury concentrations in groundwater. Mercury sequential extraction results indicate that the mercury in the majority of the Plant Area is unlikely to leach to groundwater; and this data correlates well with the existing low mercury concentrations in the Plant Area groundwater. Mercury remaining in the native soils that could potentially impact groundwater will be captured by the groundwater extraction system in the Landfill 1 Area.

Waste characterization results to date show that soils within the Plant Area are non-hazardous. If future characterization indicates otherwise, hazardous soils will be managed separately and disposed off-site as hazardous waste. Soils identified to contain visible mercury will not remain in place as part of the Plant Area remedy.

Results from the pre-design activities indicate that mercury concentrations in soils adjacent to underground piping to be left in place shows that there is no correlation between the piping location and mercury concentrations above the MPS. Piping will be flushed prior to abandonment and the material flushed out of the piping collected and disposed of properly. The piping will then be abandoned with flowable fill to prevent the piping from being a future groundwater pathway.

Together the new information presented in these multiple lines of evidence show that leaving native material with mercury concentrations above the MPS and abandoning limited segments of underground piping in place in the Plant Area is a remedy protective of human health and the environment.

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FIGURES

Figure 1 – Plant Area Investigation Locations Before and After BEP Order
Figure 2 – Plant Area Mercury Sequential Extraction Locations
Figure 3 – Plant Area Mercury Sequential Extraction Results
Figure 4 - Plant Area Waste Characterization Results
Figure 5 – Industrial Sewer Removal Plan

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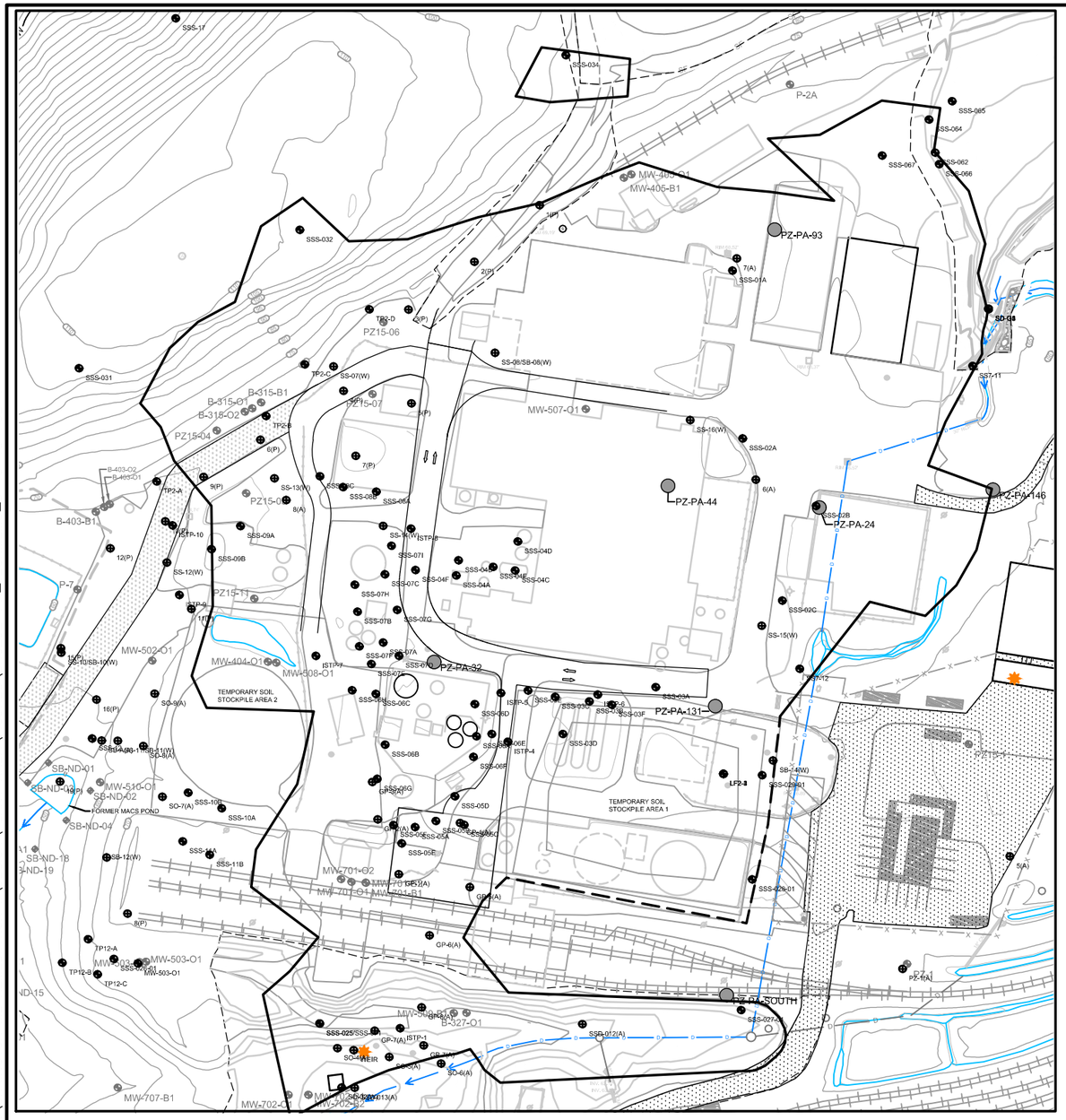

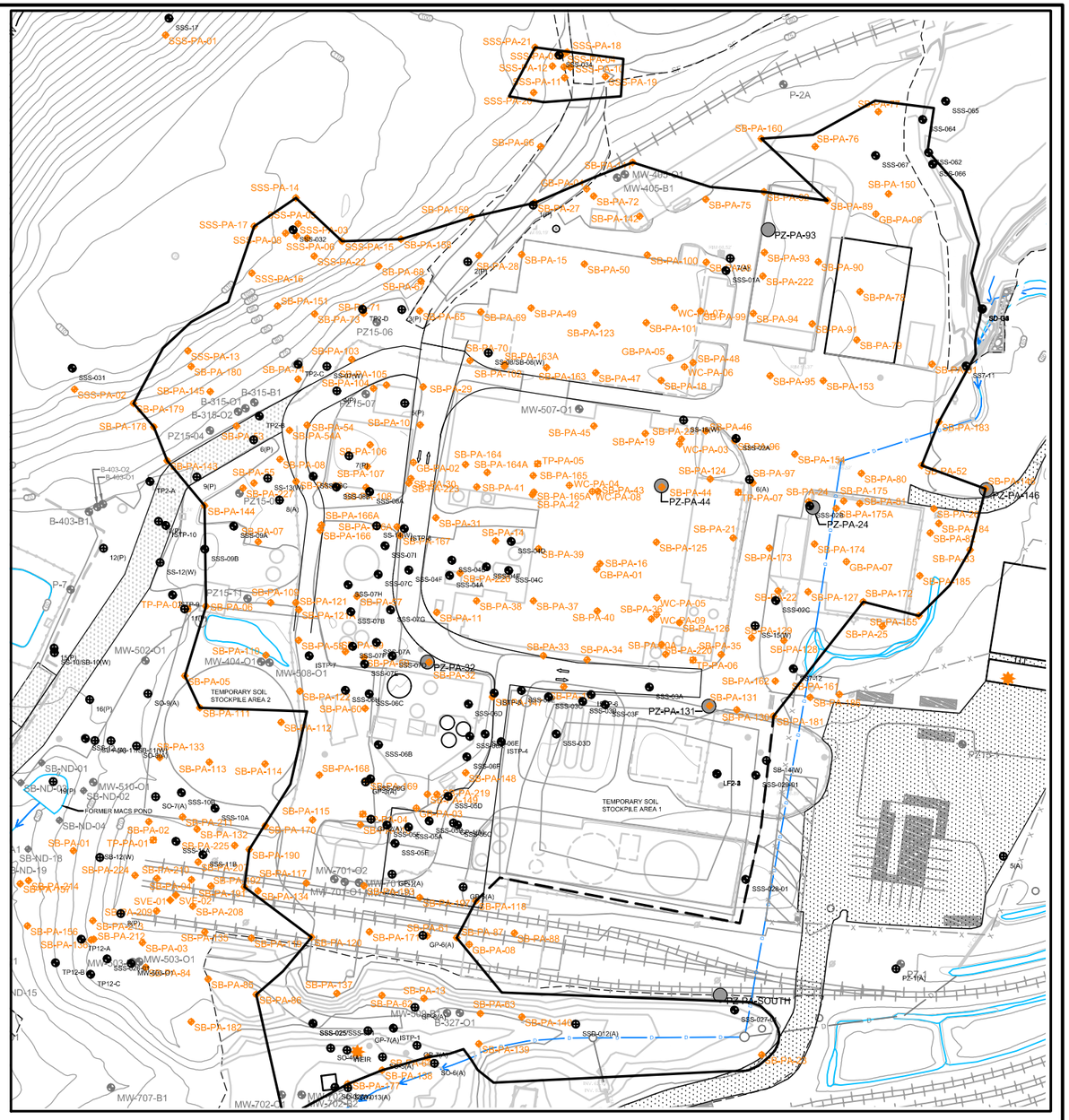

LEGEND

- 30 — EXISTING GROUND ELEVATION (FEET)
- MONITORING WELL LOCATION
- PRE-DESIGN TEST PIT
- PRE-DESIGN GEOTECHNICAL BORING
- PRE-DESIGN SOIL BORING
- PRE-DESIGN PIEZOMETER LOCATION
- HISTORICAL SAMPLE LOCATION
- PLANT AREA EXCAVATION BOUNDARY

NOTES

1. EXISTING TOPOGRAPHY AND SITE FEATURES ARE BASED ON A SURVEY CONDUCTED BY THE JAMES W. SEWALL COMPANY IN 2003 AND PROVIDED IN CDMSMITH DRAWING "38410C_MASTER-SURVEY.DWG". THE HORIZONTAL DATUM IS NAD83 (NORTH AMERICAN DATUM 1983 MAINE STATE PLANE EAST ZONE AND THE VERTICAL DATUM IS NAVD 88 NORTH AMERICAN VERTICAL DATUM 1988.
2. PRE-DESIGN INVESTIGATION LOCATIONS OBTAINED BY CES INC OF BANGOR MAINE BETWEEN THE DATES OF JUNE 2015 AND MAY 2017.
3. HISTORICAL INVESTIGATION LOCATIONS PROVIDED BY WOODARD AND CURRAN IN DRAWING "ACADr2010-213894X00C.DWG" WHICH IS PART OF DRAWING "21389400-DED FIG 1-1 J 2014".

N

0 120'

SCALE IN FEET

PLANT AREA INVESTIGATION LOCATIONS BEFORE AND AFTER BEP ORDER

ORRINGTON REMEDIATION PROJECT
ORRINGTON, MAINE

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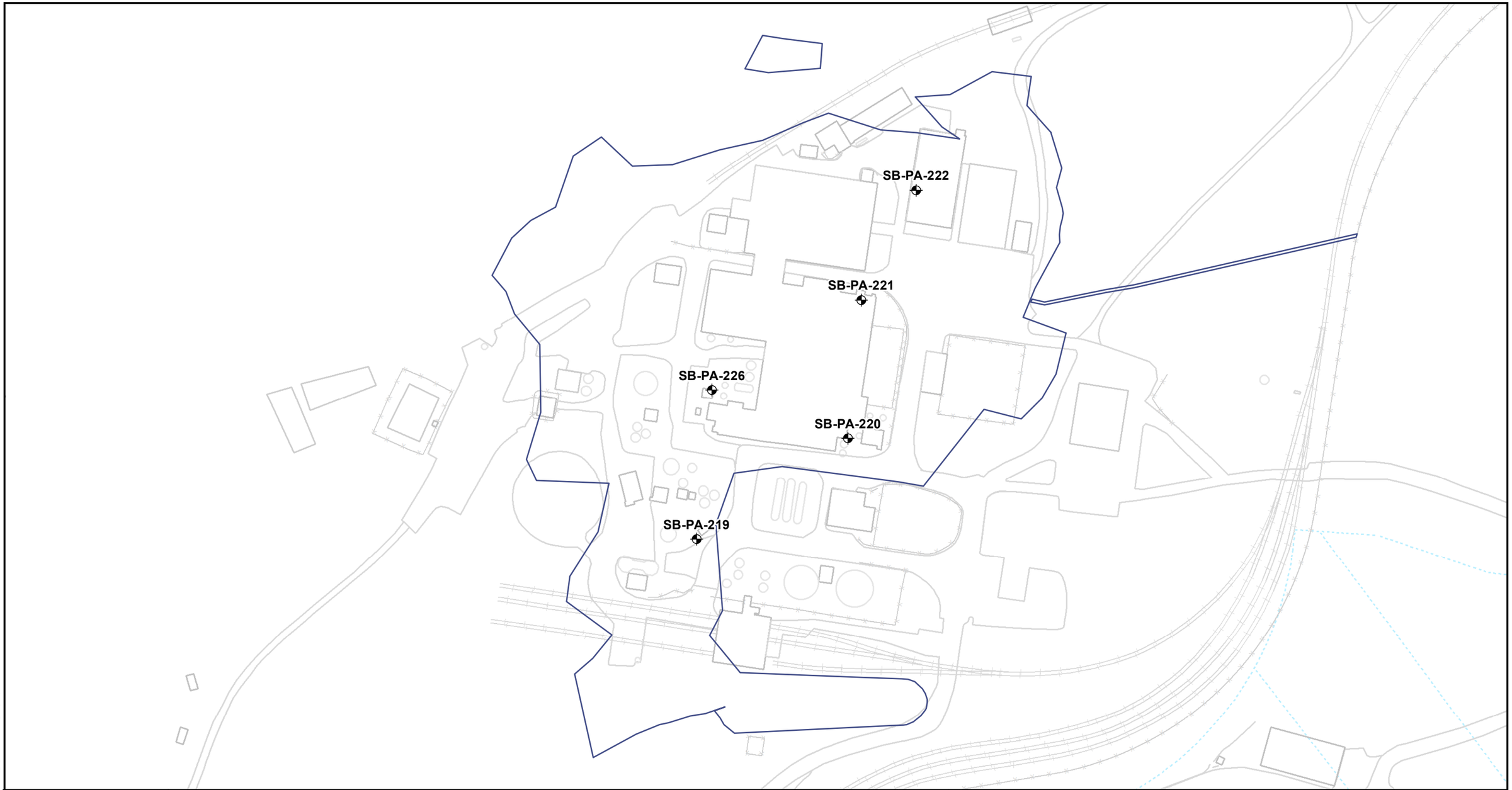
Figure: 1



LEGEND

- MERCURY SEQUENTIAL EXTRACTION BORINGS
- PLANT AREA EXCAVATION BOUNDARY

N

0 150'

SCALE IN FEET

PLANT AREA
MERCURY SEQUENTIAL EXTRACTION LOCATIONS
ORRINGTON REMEDIATION SITE
ORRINGTON, MAINE

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FIGURE 2

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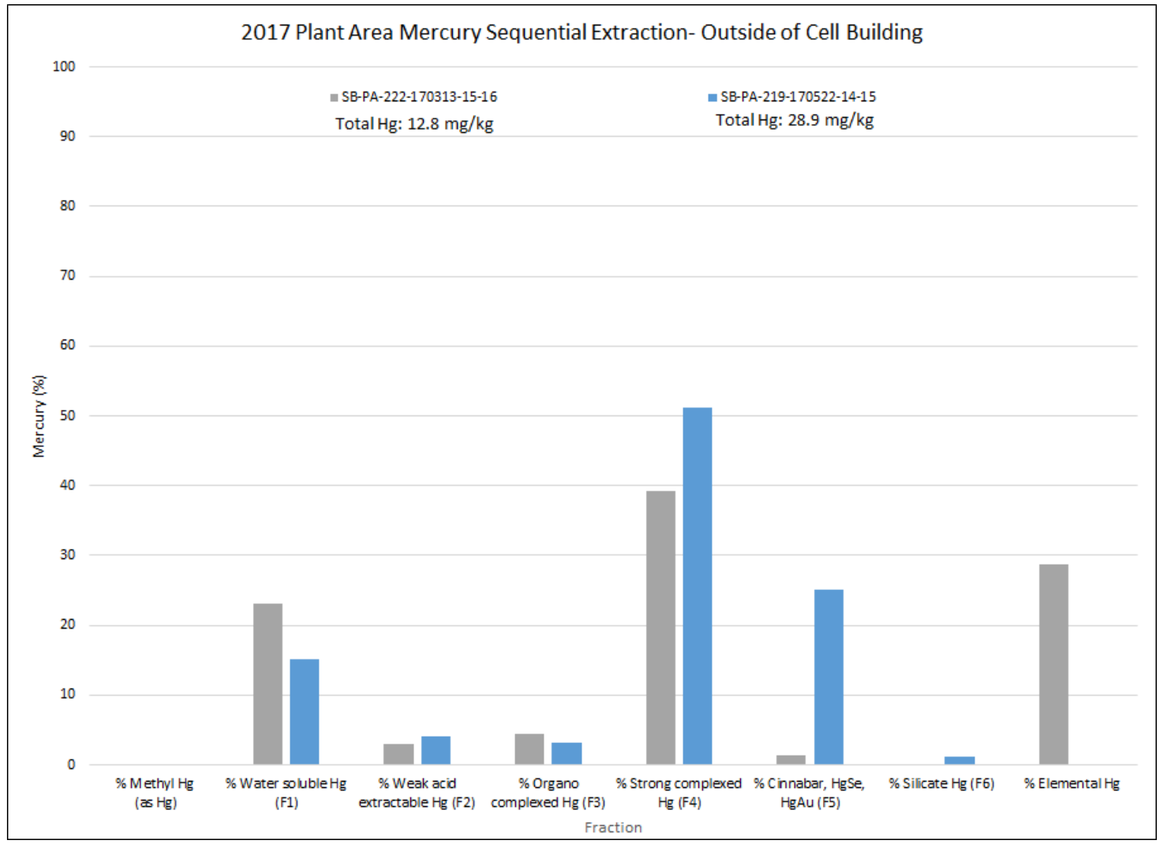
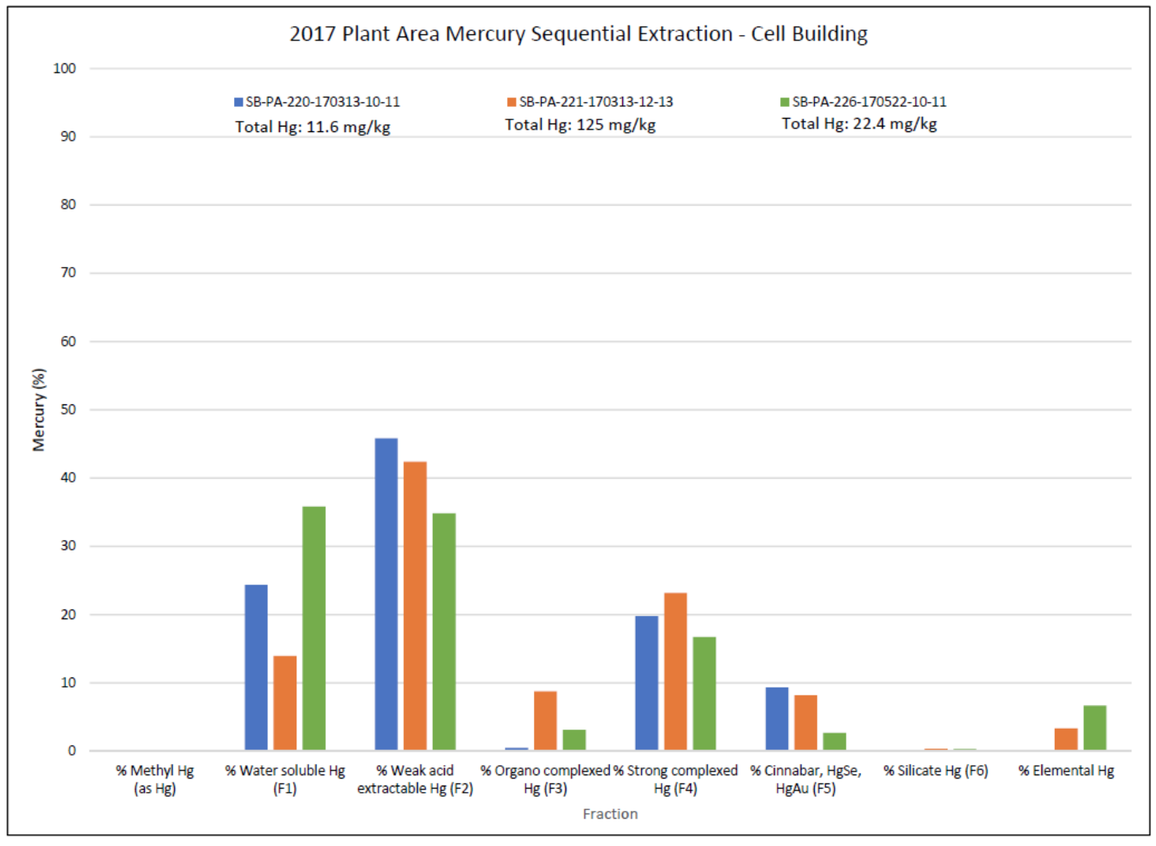
(Q:\\ = \\boston-01\GIS$\) Q:\GIS\Projects\BR0282_Orrington\MEMXD\Mercury_Figures\PA\COCs\Fig 2 Hg SequentialExtraction.mxd author: ACaiazzo; 6/13/2018





NOTES:
1. Plant Area sequential extraction locations are shown on Figure 4.

PLANT AREA
MERCURY SEQUENTIAL EXTRACTION RESULTS
ORRINGTON REMEDIATION SITE
ORRINGTON, MAINE

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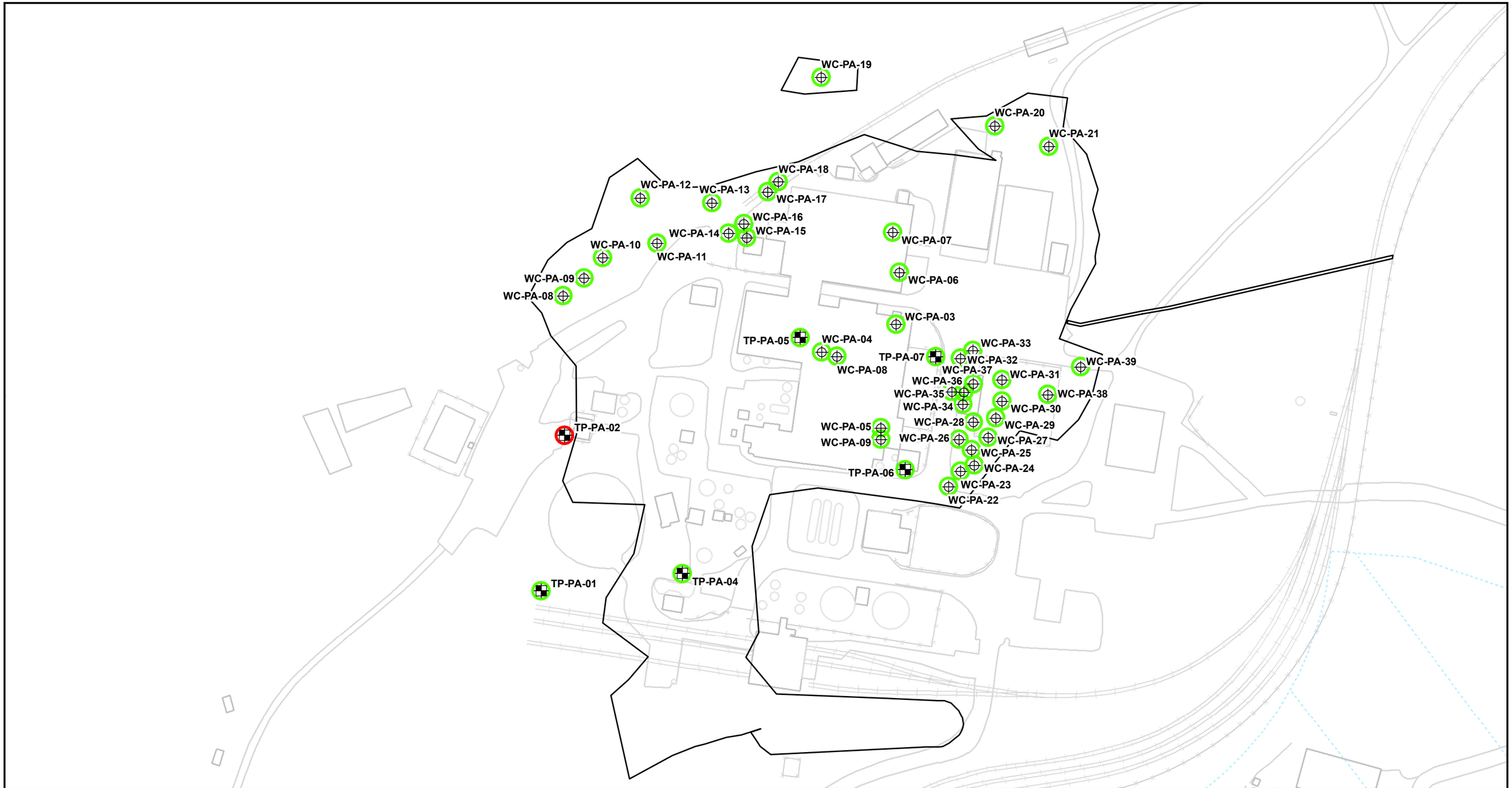
FIGURE
3



LEGEND

- PRE-DESIGN TEST PIT
- WASTE CHARACTERIZATION SOIL BORING
- PLANT AREA EXCAVATION BOUNDARY
- CHARACTERISTIC NON-HAZARDOUS FOR MERCURY
- CHARACTERISTIC HAZARDOUS FOR MERCURY

N

0 150'

SCALE IN FEET

PLANT AREA
WASTE CHARACTERIZATION RESULTS
ORRINGTON REMEDIATION SITE
ORRINGTON, MAINE

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FIGURE 4

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(Q:\ = \\boston-d1\GIS$) Q:\GIS\Projects\BR0292_Orrington\MEMXD\Mercury_Figures\PA\COCs\Fig 6 Waste Characterization Jul17.mxd; author: ACalazzo; 6/13/2018

T:\PROJECTS_CADD\O\ORRINGTON\ORRINGTON ME REMEDIATION II\DESIGN\PLANT AREA\FIGURES\BR0292-PA_INDUST PIPE REMOVAL

PENOBSCOT RIVER

LIMIT OF SCRAP METAL YARD AS-BUILT SURVEY

LIMIT OF WORK

PA 1

PA 2

PA 3

PA 4

PA 5

MAINTENANCE BUILDING

PA 6

PA 7

PA 8

PA 9

PA 10

CHLORATE BUILDING UNDERDRAIN COLLECTION MANHOLE

CHLORATE MANHOLE

CATCH BASIN 2 FILLED WITH CONCRETE

PLUGGED 18" PIPE

LIMIT OF SOUTHERLY STREAM AS-BUILT SURVEY

INVERT EL = 57.0 FT

TOP OF HIGHEST PIPE - THP

TOP OF PIPE AT SPILL OVER POINT - 53.20' BOT OM OF SPILL OVER PIPE AT ANGLED SWEEP POINT - 51.96'

"V" NOTCH IN TOP CENTER OF WALL - 50.62'

WEIR HOUSE

OUTFALL FLOOR - 47.62'

PAVED SUMP

GROUNDWATER EXTRACTION SYSTEM UTILITY CORRIDOR APPROXIMATE LOCATION

GROUNDWATER TREATMENT PLANT

MW-405-O1
MW-405-B1
MW-507-O1
B-315-B1
B-315-O1
B-315-O2
B-403-O1
B-403-O2
B-403-B1
MW-501-O1
MW-502-O1
MW-404-O1
MW-508-O1
MW-510-O1
MW-402-O1
B-316-O1
B-316-B1
MW-503-B1
MW-503-O1
MW-708-B1
MW-708-B2
MW-708-01
MW-707-B1
MW-701-O1
MW-702-B1
MW-702-B2
MW-701-O2
MW-701-B2
MW-701-B1
MW-509-B1
B-327-O1

LEGEND

- UTILITY POLE LOCATION
- APPROXIMATE PIPE LOCATION
- HISTORIC MONITORING WELL/SOIL BORING TO BE MAINTAINED (THERE MAY BE A CLUSTER OF WELLS IN SOME LOCATIONS)
- CHLOROPICRIN TREATMENT AREA
- 2016 SURVEYED SCRAP METAL YARD AND SOUTHERLY STREAM BOUNDARY LIMITS
- INDUSTRIAL SEWER PIPE
- CHLORATE BUILDING UNDERDRAIN PIPE
- INDUSTRIAL SEWER PIPE TO BE ABANDONED IN PLACE (NOTE 1)
- INDUSTRIAL SEWER PIPE TO BE REMOVED
- EXCAVATION BOUNDARY

NOTES:

1. THE INDUSTRIAL SEWER PIPES IN THE CHLOROPICRIN AREA WILL BE ABANDONED IN PLACE BECAUSE THE CHLOROPICRIN CONCENTRATION INSOIL IN HTIS AREA IS A SAFETY CONCERN FOR WORKERS.

N

0 50' 100'

SCALE IN FEET

INDUSTRIAL SEWER REMOVAL PLAN

ORRINGTON REMEDIATION SITE
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Figure: 5