

DRAFT

January 2026  
Port of Tacoma – Tru-Grit Site



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# Interim Action Plan

Prepared for the Port of Tacoma

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## ABBREVIATIONS

µg/kg	microgram per kilogram
bml	below mudline
BT	bioaccumulation trigger
CanAm	CanAm Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMCRP	Compliance Monitoring and Contingency Response Plan
CMMP	Comprehensive Maintenance and Mitigation Program
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CQAP	Construction Quality Assurance Plan
CSL	cleanup screening level
cy	cubic yard
CZMA	Coastal Zone Management Act
DAHP	Washington State Department of Archaeology and Historic Preservation
DMMP	Dredged Material Management Program
DMMU	dredged material management unit
DNS	Determination of Nonsignificance
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
feasibility boundary	FNC boundary identified by USACE in the FS phase
FNC	federal navigation channel
FS	feasibility study
H:V	horizontal to vertical (ratio)
IAP	Interim Action Plan
JARPA	Joint Aquatic Resources Permit Application
Lower Slope	lower slope of the Tru-Grit Site
Martinolich	Martinolich Shipbuilding Corporation
MLLW	mean lower low water
MTCA	Model Toxics Control Act
ng/kg	nanogram per kilogram
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PDR	<i>Preliminary Data Report for the Blair Waterway Side Slopes – Tru-Grit Subarea</i>
PDS	Planning and Development Services
PIF	project information form
Port	Port of Tacoma

Powers	A.H. Powers
RI	remedial investigation
RMC	residuals management cover
SCO	sediment cleanup objective
SCR	<i>Sediment Characterization Report, Port of Tacoma – Tru-Grit</i>
SEPA	State Environmental Protection Act
Site	Tru-Grit Site
SL	screening level
SMS	Sediment Management Standards
SQAPP	Sampling and Quality Assurance Project Plan
TEQ	toxic equivalent quotient
the Services	National Marine Fisheries Service and U.S. Fish and Wildlife Service
Tru-Grit	Tru-Grit Abrasives, Inc.
UCL	upper confidence level
Upper Slope	upper slope of the Tru-Grit Site
USACE	U.S. Army Corps of Engineers
USACE FNC Deepening Project	Project by USACE to deepen the FNC in the Blair Waterway to -57 feet MLLW plus a 2-foot overdredge
USEPA	U.S. Environmental Protection Agency
UTL	upper tolerance limit
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQC	Water Quality Certification
WQMP	water quality monitoring plan

# 1 Introduction

## 1.1 Site Description

This Interim Action Plan (IAP) for the Tru-Grit Abrasives, Inc. (Tru-Grit) Site (Site) was prepared by Anchor QEA on behalf of the Port of Tacoma (Port). The IAP presents the proposed Interim Action for cleanup of the Tru-Grit Site.

The Site is located on the northeastern side of the Blair Waterway in Tacoma, Washington, with the upland address at 1110 East Alexander Avenue, Tacoma, Washington (Figure 1-1). The Site includes areas of contaminated marine sediment along the shoreline and nearshore of Tru-Grit and Graymont Inc. facility to the east, as well as within a portion of side slopes of the proposed federal navigation channel (FNC) in the Blair Waterway.

## 1.2 Purpose and Scope

The main state law that governs the cleanup of contaminated sites is the Washington State Model Toxics Control Act (MTCA). When contaminated sediment is involved, the cleanup levels and other procedures are also regulated by the Sediment Management Standards (SMS; Chapter 173-204 Washington Administrative Code [WAC]). MTCA regulations specify criteria for the evaluation and conduct of a State cleanup action. SMS regulations dictate the standards for cleanup of sediment. Under both laws, cleanup must protect human health and the environment, meet environmental standards in other laws that apply, and provide for monitoring to confirm compliance with site cleanup standards.

The U.S. Army Corps of Engineers (USACE) is currently planning to deepen the FNC in the Blair Waterway to -57 feet mean lower low water (MLLW) plus a 2-foot overdredge (final elevation to -59 feet MLLW; USACE FNC Deepening Project). The sampling described in the *Sampling and Quality Assurance Project Plan* (SQAPP; Anchor QEA 2024) and SQAPP addenda (Anchor QEA 2025a, 2025b) was intended to delineate the extent of Site-associated contaminated sediments that could potentially be impacted (i.e., disturbed by sloughing) by that deepening project.

The Port plans to implement an Interim Action in advance of the USACE FNC Deepening Project. That Interim Action will remove Site-associated contaminated sediments from the lower slope of the Tru-Grit Site (Lower Slope) that could potentially be destabilized by the USACE FNC Deepening Project. The Interim Action is expected to provide a final cleanup for the Lower Slope area.

Additional actions may be required in the future to address contaminated sediment located in the upper slope of the Tru-Grit Site (Upper Slope). Sediments located in the Upper Slope area are outside the influence of the USACE FNC Deepening Project.

This IAP relies on extensive sediment quality data that has been collected by the Port. Those data are summarized in the *Preliminary Data Report for the Blair Waterway Side Slopes – Tru-Grit Subarea* (PDR; Anchor QEA 2025c) and *Sediment Characterization Report, Port of Tacoma – Tru-Grit* (SCR; Anchor QEA 2026).

This IAP describes the proposed Interim Action for the Site. Consistent with the requirements of WAC 173-340-380, this document provides the following information:

- Summary of Site background and current conditions (Section 2)
- A description of the proposed Interim Action (Section 3), including the proposed work; a description of the types, levels, and amounts of hazardous substances and/or other deleterious substances that will remain on Site following the Interim Action; the measures that will be used to prevent migration and contact with those substances; compliance monitoring; and potential contingency actions
- A description of how the Interim Action will be implemented (Section 4), including design, permitting, implementation, and schedule

## 2 Site Background

This section describes background information relevant to the cleanup of the Site. Information presented in this section includes the following:

- **Site History and Background:** Section 2.1 describes the history of the Site and vicinity, including a summary of previous Site activities and current land use.
- **Previous Investigations:** Section 2.2 describes previous investigations and other nearby cleanup sites.
- **Current Site Conditions:** Section 2.3 provides a summary of the environmental information presented in the SQAPP (Anchor QEA 2024), PDR (Anchor QEA 2025c), and SCR (Anchor QEA 2026).
- **Effects of the USACE FNC Deepening Project:** Section 2.4 discusses the USACE FNC Deepening Project and its relationship to the Tru-Grit Site.

Figure 2-1 shows the physical setting of the Tru-Grit Site inclusive of property boundaries and adjacent ownership. The floor of the FNC near the Site is owned by the Port of Tacoma.

### 2.1 Site History and Background

Table 2-1 provides a summary of Site history, focusing on dates and activities relevant to the Site's physical conditions and the release of Site-associated contaminants.

Prior to the 1950s, the Blair Waterway was known as the Wapato Waterway, and its head was located at 11th Street. The Site was located adjacent to a tidal inlet located south of 11th Street. The Site and adjacent areas were owned by the Tacoma Harbor Lumber Company.

In 1953, the Blair Waterway bridge was constructed at 11th Street. The waterway was then lengthened southward to Lincoln Avenue and renamed the Port Industrial Waterway. The waterway was deepened to approximately 30 feet. The Site remained vacant at that time.

In 1966, the Port received federal funding for lengthening and deepening of the Blair Waterway. The waterway was dredged southward to the turning basin, and the waterway was deepened to a depth of 51 feet. The waterway was subsequently renamed in 1969 after Archie Blair, a Port of Tacoma commissioner.

The Site was first developed for shipyard activity by the Martinolich Shipbuilding Corporation (Martinolich) between 1968 and 1976. The shipyard used a marine railway to launch vessels and a wooden pier structure to service them. Several shipyard buildings were constructed in the uplands. A drydock was acquired by 1973 and moored between the wooden dock and the former Blair 11th Street bridge. The Martinolich shipyard entered bankruptcy in 1976, and the original drydock was removed.

Shipyard activity at the Site resumed in 1976 under a different company, Sextant Marine. Sextant Marine leased a 1,000-ton drydock from the U.S. Navy. It was installed following a dredging event in roughly the same location as the former Martinolich drydock. Sextant Marine then changed its name to Sea-Tac Alaska Shipbuilding. The company continued operations until 1982, when it entered bankruptcy and the drydock was removed.

A.H. Powers (Powers) was a marine contractor incorporated in 1964. By the 1970s, the company was operating at the Site, using a former T-shaped dock located in the vicinity of the current Powers dock as shown in Figure 2-2. In 1978, Powers acquired ownership of the Site.

The Powers dock and the metal sheet-pile bulkhead were constructed in 1978. The dock structure was a portion of a former concrete barge salvaged by the company. The dock structure was installed in its current location following construction of the bulkhead and dredging of waterway sediments from the current dock footprint. The dock was subsequently used to support moorage and maintenance of Powers' barges and marine construction equipment. In 2007, the entire Powers property, including the two dock structures, was acquired by the Port.

Tru-Grit began operations in approximately 1990 as a tenant of Powers. Tru-Grit continued operations at the Site under a lease with the Port after 2007. The parent company of Tru-Grit is CanAm Materials (CanAm).

Between 1990 and 2013, Tru-Grit operations included receiving and offloading grit shipments and processing and packaging grit for resale. The offloading occurred at the Tru-Grit dock using a hopper and conveyor system that has since been removed. The barges being unloaded were moored in the same approximate location as the former shipyard drydocks, which had been removed by this time.

The CanAm/Tru-Grit material consists of a copper-smelting byproduct that undergoes preliminary processing before being shipped to the Site. It was sold to roofing manufacturers and sandblasters under the names Tru-Grit Abrasives and Tru-Grit Roofing Granules. The CanAm grit material was rich in copper and zinc but not arsenic.

The Tru-Grit product differed from many of the grit products manufactured from other metallurgical slags that were commonly used as abrasive blast grit in marine shipyards throughout this period. Locally, many blasting grits were derived from the slag produced at the ASARCO metals smelter in Tacoma (Landau 2021). In contrast to the Tru-Grit products, the ASARCO slag-derived grits contained elevated concentrations of arsenic, antimony, and lead in addition to copper and zinc.

Grit shipments were received by the facility two to three times a year, offloaded from barges using a series of ship-to-shore conveyors, and stored in an outdoor area surrounded by 8-foot-high concrete block walls. Grit was also temporarily stored on the southeastern portion of the upland property between 2005 and 2007, until Tru-Grit expanded their on-Site containment area. After 2013, barge

offloading operations ceased, and Tru-Grit operations only encompassed the upland storage and processing of grit materials. During this period, grit was trucked from a nearby Tru-Grit facility (Landau 2021).

As described in Section 2.2, the extent of the Tru-Grit Site investigated under the Agreed Order (No. DE-8978; Ecology 2012) included only the areas of Tru-Grit's operations. It did not include the area around the Powers dock. As described in the SCR (Anchor QEA 2026), heavy metals contamination extended from the Tru-Grit area of operations east around the Powers dock. The 2024–2025 investigations confirmed the boundary of the Site as defined for all Site-associated contaminants.

The most recent use of the Tru-Grit and Powers docks was by Orion Marine, a marine contractor and Port tenant. The dock and uplands were used for staging of their barges and marine construction equipment.

As of 2025, the Site and adjacent upland areas of the former Powers property are vacant except for intermittent use for trailer storage by Port tenants.

## 2.2 Previous Investigations

Previous investigations at the Site have included both upland and in-water areas, as summarized below. Figure 2-2 shows historical features of the Site as well as historical sampling locations.

### 2.2.1 *Blair Waterway Cleanup and Delisting*

In 1985, the Commencement Bay Nearshore/Tideflats remedial investigation (RI) collected sediment samples from eight potentially impacted areas in Commencement Bay, including the Blair Waterway. This study detected polycyclic aromatic hydrocarbons (PAHs), metals (i.e., copper and lead), polychlorinated biphenyls (PCBs), phenols, and phthalate esters concentrated around the Lincoln Avenue Drain and reaching the former 11th Street bridge (Landau 2021; Tetra Tech 1985).

Cleanup of the Blair Waterway sediments was conducted in the early 1990s. Contaminated sediments were removed by dredging and were disposed in the Milwaukee Waterway nearshore confined disposal facility. The Blair Waterway was removed from the National Priorities List in 1996 following completion of that cleanup.

### 2.2.2 *Tru-Grit Site Investigations*

Investigation of the Site was previously conducted under an Agreed Order (No. DE-8978; Ecology 2012) executed between the Washington State Department of Ecology (Ecology) and CanAm. CanAm was identified by Ecology as a potentially liable party under MTCA due to releases of the company's grit material containing elevated concentrations of copper and zinc. Work completed up to 2024 by CanAm includes a RI (Landau 2021) and draft feasibility study (FS; Landau 2019).

Investigations completed by Landau Associates provide an understanding of heavy metals distribution in surface and subsurface sediments near the former Tru-Grit operations. These studies documented the presence and distribution of grit material and associated metals in surface and shallow subsurface sediments. Available chemical data from these investigations are included as Appendix B of the SCR (Anchor QEA 2026). The Landau investigations did not include testing for contaminants other than heavy metals.

Surface samples collected between 2008 and 2018 had concentrations of arsenic, copper, and zinc exceeding SMS numeric sediment cleanup objective (SCO) values. Exceedances of SMS interpretive criteria were also observed during confirmational bioassays. The highest percentages of grit content encountered were west of the Tru-Grit dock within a relatively flat bathymetric area and coinciding with the Tru-Grit ship-to-shore conveyance system area. Concentrations of heavy metals decreased with distance from the pier. Background locations showed either low or no grit and lower metals concentrations, though some exceedances of screening levels (SLs) did occur in the background samples.

Taken together, the Landau investigation results indicated that the heavy metals associated with Tru-Grit operations (copper and zinc) are spatially concentrated around the Tru-Grit dock area and diminish outward, with vertical distribution generally limited to the upper several feet of sediment where Tru-Grit materials were deposited (Landau 2009, 2019, 2021). Grit and heavy metals contamination containing arsenic from historical operations not associated with Tru-Grit were present generally at deeper sediment intervals.

As discussed in Section 2.2 and in the SCR (Anchor QEA 2026), the nature and extent of other Site-associated contaminants was determined during later 2024–2025 testing. That testing included the full suite of SMS contaminants. That testing also documented the nature and extent of dioxin/furans within and adjacent to the Site. As discussed in Section 2.3, dioxin/furans are a regional contaminant that is present sporadically throughout portions of the outer, middle, and head of the Blair Waterway.

The 2021 Tru-Grit RI report largely delineated the areas and volumes of copper and zinc contamination that appeared to be associated with past releases of the Tru-Grit products. However, a full delineation of the Site, including other co-located contaminants from past shipyard and marine contractor operations was not conducted.

The 2019 Tru-Grit draft FS considered potential remedial alternatives to address the overlying Tru-Grit product but did not address the cleanup of the entire Site or antidegradation requirements associated with the cleanup of the Tru-Grit materials. The FS also did not fully consider the impacts of potential FNC deepening. These limitations were later addressed by the testing performed on behalf of the Port during 2025 and in the development of this IAP.

### 2.2.3 2024–2025 Sediment Testing

This IAP was developed following completion of several additional rounds of sediment testing performed on behalf of the Port. This includes both testing throughout the Blair Waterway in support of planned waterway deepening and targeted investigation of the Tru-Grit Site sediments, as follows:

- **2024–2025 Tru-Grit Sediment Testing:** Anchor QEA conducted sediment testing throughout the Tru-Grit Site during 2024 and 2025 on behalf of the Port. The purpose of that work was to characterize the nature and extent of all Site-related contamination to support cleanup planning for the Site and to inform planned deepening of the FNC. The work was conducted in accordance with a SQAPP (Anchor QEA 2024) and SQAPP addenda (Anchor QEA 2025a, 2025b).
  - The results of the 2024 and 2025 testing are presented in the SCR (Anchor QEA 2026), which is being submitted concurrently with this IAP. The results of follow-up testing of several archived samples will be summarized in an SCR Addendum (Anchor QEA [forthcoming]).
  - Figure 2-3 shows the recent sampling locations from the 2024 and 2025 Tru-Grit investigations, broken out by location in the Upper Slope (area not expected to be impacted by the USACE FNC Deepening Project) and the Lower Slope (area adjacent to the side slopes of the USACE FNC Deepening Project). Adjacent sampling locations within the FNC from the 2025 FNC investigation are also shown in Figure 2-3.
  - Table 2-2 summarizes the chemical parameters analyzed as part of the 2024 and 2025 Site investigations.
- **Testing in Support of Waterway Deepening:** Several rounds of subsurface sediment testing have been performed on behalf of the Port and the USACE in support of planned waterway deepening. For characterization of waterway conditions in the vicinity of the Site and for definition of background waterway sediment quality, this IAP incorporates sediment data collected during 2025 as part of those efforts.
  - Subsurface sediment testing within the Blair Waterway FNC and side slopes was conducted to collect data to support dredge design, dredged material management, and disposal at a Dredged Material Management Program (DMMP) open-water disposal site or for beneficial use. The results of the 2025 samples collected from this investigation are presented in the *Blair Waterway Federal Navigation Channel Sediment Characterization Report* (Anchor QEA 2025d), and relevant results within the vicinity of Tru-Grit are included in the Tru-Grit SCR (Anchor QEA 2026).
  - Investigation in the vicinity of the Lincoln Avenue Ditch was conducted to refine the extent of upland contaminants associated with the Lincoln Avenue Ditch Site and supplement historical analytical data from previous investigations. This investigation was conducted to support development of a new marine terminal on the Blair Waterway, which is being coordinated between the Port and the Puyallup Tribe of Indians and

which will include cutting back the existing shoreline to accommodate berthing areas for the new terminal. The results of the 2025 samples collected from this investigation are presented in the *Supplemental Investigation Report* (Maul Foster Alongi 2025).

## 2.3 Current Site Conditions

This section provides a brief overview of the current Site conditions based on the recent sediment testing data and applicable SLs.

### 2.3.1 Sediment Screening Levels

Table 2-2 lists the SLs for the Site. These SLs consider both SMS and DMMP requirements. The SMS requirements are applicable to the investigation and cleanup of the sediments at the Site. DMMP open-water disposal criteria area (DMMP 2025) were also considered given the planned USACE FNC Deepening Project, as follows:

- **Protection of Benthic Organisms:** The primary environmental receptors applicable to the Site consist of sediment-dwelling organisms. These benthic and epibenthic invertebrates are located near the base of the food chain and are important indicators of overall environmental health.
  - The SMS include two sets of numeric values for the protection of benthic organisms, including the SCO and the cleanup screening level (CSL). For most contaminants, these are provided on a dry weight basis. For non-polar organic compounds, organic carbon normalized SCO and CSL values are also provided.
  - Where the numeric SCO has been exceeded, confirmational bioassay testing can be used under the SMS to confirm or refute the presence of benthic toxicity.
  - The DMMP SLs for most contaminants are the same as the SMS SCO, as most were derived from the same underlying bioassay data set. The SMS SCO for the protection of benthic organisms is also used under the DMMP to evaluate projects for antidegradation; for chemicals without SCO values (e.g., dioxin and tributyltin), the DMMP SLs are used to evaluate antidegradation.
  - The DMMP maximum levels are higher than both the SCO and DMMP SLs and are provided for information purposes and to inform if dredge material removed during a cleanup action is suitable for open-water disposal.
  - SLs associated with benthic protection are typically applied to sediments on a point-by-point basis.
- **Assessing the Impacts of Bioaccumulative Contaminants:** The SLs listed in Table 2-2 also consider the potential impacts of bioaccumulative compounds.
  - Under the SMS, bioaccumulative compounds are assessed for their potential to accumulate in the food web and affect human or environmental receptors. For concentrations exceeding natural background or regional background concentrations,

this can involve risk assessment. Table 2-2 incorporates Ecology's natural background concentrations for Puget Sound surface sediments as defined in Ecology guidance.

- SLs associated with bioaccumulative contaminants are typically applied to sediments on an area-wide basis, because average exposures from within a Site tend to drive potential risks.
- The DMMP incorporates bioaccumulation testing in its dredge disposal decisions. Sediments proposed for open-water disposal are required to perform bioaccumulation testing of the respective DMMP bioaccumulation trigger (BT) is exceeded. Current DMMP BT values are included in Table 2-2.

Dioxin/furans are not associated with the contaminant releases that resulted in the Tru-Grit Site, but they are present throughout the Blair Waterway at concentrations above natural background levels. Refer to Section 2.3.3 for further discussion of these compounds.

SMS and DMMP SLs were applied to the Site data. Samples with confirmed exceedances are included Table 2-3a and are discussed further in Section 2.3.2. Section 2.3.2 also discusses detected bioaccumulative compounds. Samples where no exceedances occurred are shown in Table 2-3b.

### *2.3.2 Nature and Extent of Site-Associated Contaminants*

The nature and extent of sediment contamination at the Site was delineated through sediment testing performed in 2024 to 2025, along with the heavy metals data generated during the previous Tru-Grit RI/FS investigations. The 2024 and 2025 testing was more extensive and defined the lateral and vertical distribution of Site-associated contaminants in both the Upper Slope and the Lower Slope areas, including in the areas around the Powers dock that were not investigated during the previous studies.

As described in this section, the Preliminary Site Boundary was initially estimated based on the lateral distribution of heavy metals SCO exceedances at any depth in any of the 2024 and 2025 sediment cores and surface sediment samples. That boundary was then adjusted, as shown in Figure 2-4, to incorporate the following: 1) historical heavy metals sampling data; 2) SLs for bioaccumulative metals (arsenic, cadmium, lead, and mercury); and 3) the distribution of other Site-associated contaminants.

The Preliminary Site Boundary so established, as shown in Figure 2-4, generally follows the principal Site features and surrounds the Tru-Grit dock, the Powers dock, and the former marine railway.

Key findings regarding the nature and extent of Site-associated contaminants are summarized below and in Figures 2-4 through 2-6 and Tables 2-3a, 2-3b, and 2-4:

- **Heavy Metals:**

- Exceedances of SLs for heavy metals are summarized in Table 2-3a. The primary heavy metals associated with the Site include arsenic, copper, and zinc. These contaminants are present in shipyard-associated wastes (all three metals) and in the Tru-Grit materials

- (copper and zinc only). Other heavy metals present at the Site above SLs include antimony, chromium, and lead, but at much lower frequencies than arsenic, copper, and zinc.
- Figure 2-4 shows the distribution of SCO exceedances for all heavy metals detected at any depth in both surface and subsurface sediment data. These Site-associated heavy metals are present in both the Upper Slope and the Lower Slope and in areas surrounding the Tru-Grit dock and the Powers dock. No SCO or DMMP SL exceedances were detected in any of the core locations located within the FNC.
  - The depth of heavy metals contamination detected in the 2024 and 2025 sediment cores varies throughout the Site. The heavy metals exceedances extend to depths of 4 to 5 feet below mudline (bml) near the Tru-Grit dock and to deeper depths of up to 8 feet in the areas offshore of the Powers dock.
  - Outside of the Preliminary Site Boundary shown in Figure 2-4, the average concentrations of the four bioaccumulative metals (arsenic, cadmium, lead, and mercury) are currently below Ecology-estimated natural background concentrations for Puget Sound surface sediments. This analysis was performed conservatively by: 1) calculating the 95% upper confidence level (UCL) around the mean for each contaminant in each of the 2024 and 2025 samples and the adjacent cores from the Blair Waterway investigations as shown in Figure 2-4; and 2) representing each core location by only the maximum detected value of each heavy metal. The 95% UCLs are included in Table 2-4, which were calculated using ProUCL 5.2. The ProUCL output is included in Appendix A-1.
- **PCB Aroclors:**
    - Total PCB Aroclors were detected above the SCO at four sampling stations surrounding the Powers dock and three locations around the Tru-Grit dock, as shown in Figure 2-5a. No SCO or DMMP SL exceedances were detected in surface or subsurface sediments located outside of the Preliminary Site Boundary.
    - Using the same methodology applied for heavy metals, the 95% UCL was calculated for total PCB Aroclors for the 2024 and 2025 sampling locations located just outside of the Preliminary Site Boundary (35 micrograms per kilogram [ $\mu\text{g}/\text{kg}$ ] dry weight). This concentration was less than the current Blair Waterway background concentrations (37  $\mu\text{g}/\text{kg}$  dry weight) for shallow subsurface sediments. The Blair Waterway background concentrations for shallow subsurface sediments were estimated by calculating the 90/90 upper tolerance limit (UTL) for total PCB Aroclors throughout the Blair Waterway using all of the available PCB data generated for surface dredged material management units (DMMUs) from the 2025 Blair Waterway sediment characterization activities after excluding samples located within or adjacent to the Tru-Grit Site and after removal of higher-concentration outliers. This methodology is aligned with Ecology's approach for determining surface sediment regional background concentrations in surface sediments. The 90/90 UTL calculations for the Blair Waterway

indicate that the distribution of potentially significant Site-associated total PCB Aroclor concentrations is limited to areas within the Preliminary Site Boundary. The 90/90 UTLs are included in Table 2-4 and were calculated using ProUCL 5.2 and following *Sediment Cleanup User's Manual (SCUM): Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC* (Ecology 2025) for development of regional background values. The ProUCL output is included in Appendix A-2.

- **Tributyltin:** The tributyltin SL was exceeded only in three surface sediment samples located in the immediate vicinity of the Powers dock and one sample adjacent to the Tru-Grit dock (Figure 2-5b). There were no tributyltin exceedances located outside of the Preliminary Site Boundary.
- **PAH Compounds:**
  - Several PAH compounds were detected in excess of the SCO and the DMMP SL at stations located inside the Preliminary Site Boundary. As shown in Table 2-3a, these include benzo(a)anthracene, chrysene, fluoranthene, and pyrene, as well as the sum of high-molecular-weight PAH compounds.
  - No exceedances of the SCO or the DMMP SL were detected at locations sampled outside of the Preliminary Site Boundary.
- **Total Carcinogenic Polycyclic Aromatic Hydrocarbon (cPAH) Toxic Equivalent Quotient (TEQ):**
  - The concentration of cPAH TEQ was elevated at several locations within the Preliminary Site Boundary, with a maximum detected concentration of 1,230 µg/kg dry weight. Higher concentrations of cPAH TEQ contamination were generally co-located with elevated heavy metals contamination.
  - There are no benthic SCO or DMMP SL values for total cPAH TEQ.
  - Using the same methodology applied for heavy metals and PCBs, the 95% UCL was calculated for cPAH TEQ for the 2024 and 2025 sampling locations located just outside of the Preliminary Site Boundary (57 µg/kg dry weight). This concentration was less than the current Blair Waterway background concentrations (59 µg/kg dry weight) for shallow subsurface sediments. The Blair Waterway background concentrations in shallow subsurface sediments were estimated by calculating the 90/90 UTL for cPAH TEQ throughout the Blair Waterway using all of the available cPAH data generated for surface DMMUs from the 2025 Blair Waterway sediment characterization activities after excluding samples located within or adjacent to the Tru-Grit Site and after removal of high-concentration outliers. These calculations indicate that the distribution of potentially significant Site-associated cPAH TEQ concentrations is limited to areas within the Preliminary Site Boundary.
- **Other Sporadically Detected Contaminants:** Other contaminants were sporadically detected within the Site, including 1,2-dichlorobenzene (three detections, one SCO exceedance),

1,4-dichlorobenzene (six detections, one SCO exceedance), and 4,4'-DDT (seven detections, two DMMP SL exceedances). Exceedances for these contaminants occurred only in the Upper Slope area near the Tru-Grit dock; no exceedances for these contaminants occurred in the Lower Slope area.

Results of the recent testing and statistical evaluations demonstrate that the distribution of Site-associated contamination is limited to the areas within the Preliminary Site Boundary. Remediation of the areas within the Preliminary Site Boundary would eliminate all detected SCO exceedances and would reduce levels of Site-associated bioaccumulative contaminants to background levels.

### 2.3.3 *Distribution of Regional Contaminants*

Dioxin/furan compounds have been detected during previous dredge material characterization events in the outer Blair Waterway (e.g., at the Husky Terminal), within the Middle Blair Waterway (e.g., at the Georgia-Pacific Gypsum berth area and within the Lincoln Avenue ditch areas), and within the head of the Blair Waterway (e.g., at the Pierce County Terminal). These observations suggested that dioxin/furans may be present as a regional contaminant throughout the Blair Waterway.

The presence of dioxin/furans as a regional contaminant were confirmed more recently during the 2025 sediment testing performed in support of the USACE FNC Deepening Project. That testing confirmed that dioxin/furans were sporadically present at elevated concentrations within certain waterway side slope/berth areas and throughout much of the Blair Waterway turning basin. The distribution of dioxin/furan suggests the influence of historical and regional source inputs, with reductions in concentrations associated with past cleanup and navigation dredging efforts.

Figure 2-6 summarizes the distribution of dioxin/furan TEQ concentrations in surface and subsurface sediments near the Site within the middle reach of the Blair Waterway, as follows:

- Dioxin/furan TEQ concentrations were less than 10 nanograms per kilogram (ng/kg) dry weight in all of the 2024–2025 Tru-Grit investigation sediment cores collected within the FNC, except for one sample (TG-SC22) within DMMU D118, which had a concentration of 10.1 ng/kg TEQ in the 0-to-2-foot interval but which had a concentration of 0.498 ng/kg TEQ in the 2-to-4-foot interval, resulting in an average concentration of 5.3 ng/kg TEQ across the 0-to-4-foot interval. That average is similar to the DMMU D118 concentration (3.03 ng/kg from D118CS-A [BW-SC81]) from the Blair Waterway testing. The FNC was historically dredged during the cleanup performed in the early 1990s.
- Dioxin/furan TEQ concentrations were detected at concentrations exceeding 10 ng/kg sporadically in sediments within both the Upper Slope and the Lower Slope areas at the Tru-Grit Site. The detected concentrations in most samples ranged from less than 10 ng/kg to 82 ng/kg. One sample contained a detected concentration of 270 ng/kg. The distribution of

dioxin/furan TEQ exceedances did not correlate with concentrations of heavy metals and in some cases were present at deeper depths.

- The range of dioxin/furan TEQ concentrations within the Site were similar to those detected during dredge material characterizations performed in the adjacent Graymont berth areas during 2025 (maximum concentration of 219 ng/kg at DMMU D120; BW-SC94) and in the prior characterization of sediments located within the Georgia-Pacific Gypsum berth areas prior to the 2016 dredging of that area (dioxin/furan TEQ concentration of 110 ng/kg in the shallow DMMU1 composite prior to dredging) and in berth areas across the Blair Waterway from the former Lincoln Avenue ditches (dioxin/furan TEQ concentrations of 61.7 ng/kg and 160 ng/kg in shallow DMMUs D147 [BW-SC142] and D148 [BW-SC143], respectively).
- The recent Site investigations confirm that dioxin/furans are present within the Site as within adjacent waterway berth and slope areas. The presence of these regional compounds will impact dredging and Site remediation decisions and have been considered in development of this IAP.

## 2.4 Effects of the USACE FNC Deepening Project

The USACE FNC Deepening of the Blair Waterway to -57 feet MLLW plus a 2-foot overdredge (final elevation to -59 feet MLLW) is projected to begin in 2028. This IAP considers the potential impacts of that work on the stability of contaminated sediments located within the Site.

Figure 2-7 shows the USACE FNC Deepening Project's DMMUs located adjacent to the Tru-Grit Site. Those DMMUs were developed conservatively in considering how the deepening of the channel might impact adjacent side slope areas by causing sediment sloughing during or following completion of the work, as follows:

- The potential FNC slough area was calculated using a contingency 10-foot buffer landward of the FNC boundary identified by USACE in the FS phase (feasibility boundary) and a 2H:1V (horizontal to vertical [ratio]) slope.<sup>1</sup> The 10-foot adjustment considers the potential for lateral overdredging that could potentially occur during dredging. A full 2-foot overdredge allowance was also incorporated into the DMMUs, causing them to reach further shoreward within the Blair Waterway side slopes.
- Three of the USACE FNC Deepening Project's DMMUs overlap with the Tru-Grit Preliminary Site Boundary as shown in Figure 2-7. These include portions of DMMUs D117 (BW-SC75), D118 (BW-SC81), and D119 (BW-SC88).

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<sup>1</sup> For remediation planning, the use of the feasibility boundary with a 10-foot offset is conservative and likely over-estimates the area of sediments that may be destabilized (i.e., that may slough) as a result of the FNC deepening. The feasibility boundary assumes a wider navigation channel closer to the Tru-Grit Site, though the preliminary engineering and design evaluations by USACE may result in a narrower FNC boundary that is farther from the Site. The estimated slough area also incorporates a 10-foot offset from the feasibility boundary, a full 2-foot overdredge assumption and a 2H:1V side slope. Actual FNC dredge extents may be less and overdredge depths may be shallower. Also, the final side-slopes may be steeper than the assumed 2H:1V.

In developing this IAP, the removal of contaminated sediment from the Lower Slope areas of the Site has been prioritized. The planned work for this area to be conducted during the Interim Action is described in Section 3. Upper Slope areas of the Site will not be destabilized by the proposed deepening. The need for cleanup of the Upper Slope areas will be addressed through separate future cleanup action planning.

### 3 Proposed Interim Action

This section describes the proposed Interim Action for the Site. Information summarized in this section includes the following:

- Purpose of the Interim Action (Section 3.1)
- Interim Action description (Section 3.2)
- Basis for selecting the proposed Interim Action (Section 3.3)
- Compliance monitoring and associated contingency measures (Section 3.4)
- Reporting (Section 3.5)
- Preliminary engineer's cost estimate for the proposed Interim Action (Section 3.6)
- Final cleanup considerations (Section 3.7)

#### 3.1 Purpose of Interim Action

The purpose of the Interim Action is to remove contaminated sediments, consistent with MTCA and SMS requirements, in the Lower Slope area of the Tru-Grit Site prior to the USACE FNC Deepening Project to prevent them from sloughing into the FNC during or after waterway deepening.

The Interim Action is expected to provide a final cleanup action for the Lower Slope area of the Site. This includes remediating all Lower Slope areas containing SCO exceedances. The proposed remediation will also reduce levels of bioaccumulative contaminants in the Lower Slope to appropriate background-based concentrations listed in Table 3-1.

The Interim Action will not remediate the Upper Slope area of the Site. Additional actions may be required in the future to address remaining contaminated sediment in the Upper Slope area of the Tru-Grit Site.

#### 3.2 Interim Action Description

The Interim Action will be completed in advance of the USACE FNC Deepening Project. The proposed Interim Action is shown in plan-view in Figure 3-1 and in cross-section view in Figures 3-2 and 3-3. Performance standards are listed in Table 3-1.

The Interim Action will remove contaminated sediments from the Lower Slope area of the Site. Planned removal areas are identified as Area A and Area B on Figure 3-1. These include both areas of SCO exceedances and areas with elevated concentrations of potentially bioaccumulative contaminants.

The contaminated sediments will be removed by mechanical dredging and will be disposed of at a permitted upland Subtitle D landfill site. Following confirmation of contaminated sediment removal, clean residuals management cover (RMC) will be placed throughout the dredging area on the post-project surface.

The Interim Action work area includes two sediment removal areas:

- Area A is located offshore of the Tru-Grit dock and overlaps with portions of USACE FNC Deepening Project DMMUs D117 and D118 (also subsurface DMMUs D506 and D507). The depth of sediments exceeding the Table 3-1 Performance Standards is 4 feet bml based on metals and PCB contamination in Tru-Grit cores TG-SC14, TG-SC15, TG-SC-16, TG-SC17, and TG-SC18. D/F contamination is also co-located at this depth. Preliminary estimates of removal volumes are summarized in Table 3-2 and include a conservative 2-foot overdredge allowance and estimated side slope volumes calculated using a 2H:1V side slope assumption. The estimated removal volumes for Area A are between 5,767 cubic yards (cy; no overdredge allowance) and 9,062 cy (full 2-foot overdredge allowance). These volumes do not include contingency redredging, which is discussed in Section 3.4.
- Area B is located offshore of the Powers dock and overlaps with portions of USACE FNC Deepening Project DMMU D119 (also subsurface DMMU D507). The depth of sediments exceeding the Table 3-1 Performance Standards is 8 feet bml based on metals contamination in Tru-Grit core TG-SC26. D/F contamination is also co-located at this depth. Preliminary estimates of removal volumes are summarized in Table 3-2 and range between 2,723 cy (no overdredge allowance) and 3,637 cy (full 2-foot overdredge allowance). These volumes do not include contingency redredging, which is discussed in Section 3.4.

A preliminary geotechnical analysis was conducted to evaluate whether the proposed dredging of Area A or Area B could adversely impact the stability of the Tru-Grit dock or the Powers dock. That analysis indicated that the dredging would not cause destabilization of these structures under static conditions. Further evaluation of slope stability will be performed during remedial design. The outputs of those evaluations may affect final dredge prisms and sediment removal volumes.

The final extent of dredging in small portions of Area A is affected by physical obstructions. These include the navigational tower located near TG-SC14 and subsurface utilities located near the western portion of Area A. The approach for dredging in these areas will be refined during remedial design. Any residual contamination that is impracticable to remove will be covered with RMC.

Transloading of dredged material is planned to occur at the Port's West Hylebos Log Dock facility located on the Hylebos Waterway. This facility has existing stormwater infrastructure. A temporary transload facility will be constructed to support Tru-Grit dredge material management, as well as the USACE FNC Deepening Project. Tru-Grit dredge material will be dewatered and solidified sufficiently for acceptance at a landfill for upland disposal.

Performance monitoring will be performed as described in Section 3.4 within the dredge areas to confirm that the Table 3-1 Performance Standards have been met. If missed inventory (residual

contaminated sediment) is identified in that testing, then contingency redredging may be required of affected areas.

After performance testing and any associated contingency redredging, a 6-inch minimum layer of RMC material will be placed over the entire dredged area (both Action Areas A and B). To stay in place, RMC material requires a maximum slope grade of approximately 3H:1V. There, in areas where the post-dredge slope grade is steeper than 3H:1V, the RMC material thickness will need to be increased to reduce the final slope grade to 3H:1V or shallower. Table 3-3 includes a preliminary minimum volume estimate of 1,052 cy for the RMC placement based on a 6-inch minimum lift. Actual RMC material placement volumes will be higher than those values due to over-placement allowance and the need to provide additional material to stabilize the RMC material on the upper side slopes. The final RMC material placement volumes will be determined during remedial design.

Compliance monitoring will be performed as described in Section 3.4 following RMC material placement. This monitoring will confirm that the Table 3-1 Performance Standards have been met.

### 3.3 Basis for Interim Action Selection

The proposed Interim Action was selected following a screening of potential remedial approaches and consideration of the following evaluation criteria:

- Ability of the remedial approach to remove contaminated sediments from those areas of the Lower Slope that could potentially be destabilized by the planned deepening of the FNC
- Ability of the remedial approach to provide a final cleanup for the Lower Slope areas of the Site
- Ability of the remedial approach to comply with the Interim Action Performance Standards listed in Table 3-1, including both SMS SCO values and background-based performance standards for bioaccumulative contaminants
- Use of remedial technologies and methods that have been proven effective during the cleanup of similar contaminated sediment sites
- The use of remedial approaches that are permanent to the maximum extent practicable as defined under MTCA and SMS remedy selection requirements
- Alignment of the remedy with MTCA preferences for cleanup action selection as defined in WAC 173-340-370
- Preference for the use of remedial approaches that can be implemented in a timely manner in advance of the planned deepening of the FNC

The proposed Interim Action includes full removal to the extent practicable for all contaminated sediments (those that exceed the Table 3-1 Performance Standards) in the Lower Slope areas of the Site. Removal and upland disposal of these sediments represents a permanent remedy for these Lower Slope areas under the MTCA and SMS regulations. The work can be implemented prior to

planned deepening of the FNC in 2028, removing potential interference with the proposed USACE FNC Deepening Project.

### 3.4 Compliance Monitoring and Contingency Responses

Compliance monitoring will be performed as part of the Interim Action. Both a water quality monitoring plan (WQMP) and a compliance monitoring plan will be developed during final remedial design. Monitoring activities during the project will include each of the following:

- **Protection Monitoring:** Protection monitoring will include water quality monitoring to document water quality protection within the Site during dredging.
- **Performance Monitoring:** Performance monitoring will be performed after dredging but before RMC placement to confirm that the sediment removal has met performance criteria.
- **Confirmation Monitoring:** Confirmation monitoring will be performed after dredging and RMC placement are complete to document compliance of final surface sediment quality with Interim Action Performance Standards listed in Table 3-1.

Detailed monitoring requirements (i.e., sample locations, monitoring parameters) will be defined as part of remedial design and permitting.

### 3.5 Reporting

An Interim Action Completion Report will be drafted and submitted at the completion of the Interim Action. The report will summarize project construction and monitoring activities including any deviations from this plan or final design documents. The Interim Action Completion Report will be submitted to Ecology, the U.S. Environmental Protection Agency (USEPA), and USACE within 120 days following completion of RMC placement.

Collected monitoring data will be uploaded to Ecology's Electronic Information Management database at the time the report is submitted to Ecology.

### 3.6 Preliminary Engineer's Cost Estimate (Opinion of Probable Cost)

A Preliminary Engineer's Cost Estimate (Opinion of Probable Cost) is included in Table 3-4. This estimate is a sum of direct costs, indirect costs, and a 40% contingency. Direct costs include mobilization and demobilization, Site preparation, surveys, structural work, dredging, transloading, transportation, disposal, material placement, and environmental controls. Including 40% contingency and sales tax, the preliminary estimate of total direct costs is \$7,756,000. Indirect costs include engineering support services, construction quality assurance, and testing and reporting. Including 40% contingency, the preliminary estimate of total indirect costs is \$486,000. The preliminary estimate of total project costs to implement the Interim Action is \$8,242,000.

### **3.7 Final Cleanup Considerations**

The proposed Interim Action is expected to provide a final cleanup for the Lower Slope areas of the Site. With removal of the contaminated sediments from those areas, the USACE FNC Deepening Project can proceed unencumbered. The need for cleanup of remaining contaminated sediments located in the Upper Slope areas of the Site will be addressed through separate future cleanup action planning.

## 4 Implementation of the Interim Action

This section describes the anticipated schedule for design and implementation of the proposed Interim Action for the Lower Slope areas of the Site.

### 4.1 Design

Design activities are to be conducted in early 2026. This will include development of the following deliverables:

- Project plans and technical specifications
- Engineer's Cost Estimate
- Definition of proposed best management practices for use in construction
- Construction Quality Assurance Plan (CQAP)
- Compliance Monitoring and Contingency Response Plan (CMCRP)
- WQMP

Development of the current Interim Action approach included a preliminary geotechnical analysis to evaluate dredging the Lower Slope areas and the effects of dredging on the static stability of the slope. This analysis utilized existing geotechnical data from surrounding sites to inform the stratigraphy and for development of the slope stability model. Results from this model indicate that the current approach for implementation of the Interim Action dredging activities will result in stable static slope conditions. Further analyses should be completed during the design phase to verify these results and to also consider seismic slope stability as that condition was not evaluated as part of this initial effort.

### 4.2 Permitting

Table 4-1 provides a summary of permits and approvals that are anticipated to be required for the Interim Action. The information in Table 4-1 assumes that the Interim Action will qualify for programmatic permits issued under the Port's Comprehensive Repair and Maintenance Program approvals as a beneficial activity. Individual permits will be attained to demonstrate compliance with Hydraulic Project Approval (Washington Department of Fish and Wildlife [WDFW]) and Shoreline Substantial Development Permit (City of Tacoma Planning and Development Services [PDS] Department) permitting.

The Port will coordinate with representatives from the Puyallup Tribe of Indians, USACE, USEPA, National Marine Fisheries Service and U.S. Fish and Wildlife Service (the Services), Ecology, the Washington State Department of Archaeology and Historic Preservation (DAHP), WDFW, and the City of Tacoma PDS Department.

**Table 4-1  
Anticipated Permits for Tru-Grit Interim Action**

Approvals	Agency	Trigger	Notes
Clean Water Act Sections 404/10 Permit (under CMMP: NWS-2024-446-WRD)	USACE	Discharge of dredged or fill material into waters of the United States	A JARPA form and JARPA plan set will be prepared and submitted to USACE along with a PIF to confirm coverage under the Port's CMMP.
Section 408 Permit	USACE	Proposed alteration(s) to a federally authorized project	Section 408 permission will be confirmed by USACE via the PIF and additional supporting materials if requested.
CERCLA Coordination	USEPA	Location of project within Commencement Bay Superfund Site	CERCLA coordination with USEPA will be conducted via the PIF and by USACE as part of the USACE permit confirmation process.
Antidegradation Determination	DMMP	Evaluation of leave-surface sediment quality	USACE will coordinate with the Ecology site manager and DMMP as part of the USACE permit confirmation process to document exposed surface sediment quality is protective.
ESA Compliance (under CMMP: WCRO-2024-02448 & FWS/R1/2025-0000930)	The Services	Potential impacts to ESA-listed species and critical habitat	Supplemental information may be requested by the Services to confirm consultation coverage under the CMMP as a beneficial activity. ESA habitat conservation credits/debits will be calculated using the Port calculator.
National Historic Preservation Act Section 106 Compliance	DAHP	Potential impacts to archaeological, cultural, or historic resources	Cultural resources monitoring requirements will be determined based on the Port's programmatic Cultural Resources Plan developed with the Puyallup Tribe.
Clean Water Act Section 401 WQC (under CMMP: 23740)	Ecology	Potential water quality impacts from dredging and material placement	A project-specific WQMP demonstrating compliance with Washington State Water Quality Standards will be prepared and submitted to Ecology and USACE with the PIF, as required under the CMMP.
CZMA Compliance (under CMMP: 143975)	Ecology	Federally permitted, licensed, or funded projects affecting coastal resources in one or more of Washington's 15 coastal counties	Coverage under the CMMP CZMA will be confirmed by Ecology via the PIF.
Hydraulic Project Approval	WDFW	Activities occurring within waters of the state	Application materials will be submitted online to WDFW.
SEPA Determination (under CMMP) Public notice for DNS issued 4/21/2025	Port of Tacoma	Activities requiring environmental review in the Port of Tacoma	Public notice for DNS issued 4/21/2025

Approvals	Agency	Trigger	Notes
Shoreline Substantial Development Permit	City of Tacoma PDS Department	Dredging	A written narrative will be submitted to the City of Tacoma PDS Department, describing how the project meets each criterion for approval.

### 4.3 Implementation

Implementation of the proposed Interim Action will occur as follows:

- Interim Action Construction:** Following design and permitting activities, the Interim Action will be constructed. Timing of most in-water work activities will be limited by permit-specified “fish windows” to appropriate time periods when those activities are least likely to affect migrating juvenile salmonids and other aquatic species. These time limitations will affect the amount of work that can be completed within a given construction season and will particularly affect the overall time required to complete dredging and RMC material placement activities. Other work does not require in-water activity (e.g., upland sediment staging/transport) but is subject to other logistical constraints. Interim Action construction is reasonably expected to be performed in a single construction season.
- Compliance Monitoring:** Compliance monitoring will occur during and following construction, in accordance with the CQAP, CMCRP, and WQMP that are prepared as part of design and permitting activities.

### 4.4 Schedule

Construction of the Interim Action is proposed for implementation during the 2026/2027 fish window (July 15, 2026, to February 15, 2027) in advance of the USACE FNC Deepening Project.

In order to meet this timeline, design permitting and procurement activities will need to be completed between January 2026 and June 2026, with submittal of the JARPA and related permitting materials during mid-2026. Construction is estimated to take 3 months and is targeted to occur between December 2026 and February 2027.

The Completion Report will be submitted within 120 days of completion of construction.

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Prepared for the Washington State Department of Ecology and U.S. Environmental Protection  
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# Tables

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**Table 2-1**  
**Summary of Site History**

Date	Historical Uses
1940s	The site and vicinity are owned by the Tacoma Harbor Lumber Company.
1949	Wapato Waterway terminates at 11th Street with shallow tidal basin in front of site.
1950	The upland property is vacant and undeveloped. Wapato Waterway terminates just south of the 11th Street bridge.
1953	The original 11th Street bridge is constructed across head of Wapato Waterway.
Late 1950s	Wapato Waterway is extended to Lincoln Avenue with a water depth of approximately 30 feet and renamed the Port Industrial Waterway.
1966–1969	Federal funding is approved for the project to extend the Waterway past Lincoln Avenue to the turning basin and deepen it to 51 feet. Port Industrial Waterway is renamed “Blair Waterway” in 1969 after Port Commissioner Archie Blair.
1968–1976	Martinolich Shipbuilding Corp. operates at the site using a dock, marine railway, and a drydock (drydock added by 1973) at the site.
1973	The drydock is present just northwest of the Tru-Grit dock; a T-shaped float system is present in the location of the Powers dock.
1976	Martinolich enters bankruptcy; the original drydock is removed. Sextant Marine Shipbuilding takes over operations; a new 1,000-ton drydock is leased from U.S. Navy; berth dredging is performed by Sextant Marine Shipbuilding to install a new drydock.
1976–1982	Sextant Marine Shipbuilding is renamed “Sea-Tac Alaska Shipbuilding” and continues operations focusing on both federal maintenance work and fishing/crabbing vessel construction.
1978	A.H. Powers salvages a former concrete barge and modifies and installs a portion of that vessel, creating the Powers concrete dock; dredging and bulkhead construction are conducted as part of concrete dock installation.
1979	A.H. Powers acquires ownership of the property; the southeastern portion of the concrete dock is located in easement with Tacoma Lime (predecessor to Graymont).
1982	Sea-Tac Alaska Shipbuilding enters bankruptcy; the U.S. Navy drydock is removed; A.H. Powers uses the site as the home port for A.H. Powers construction company.
1990	Tru-Grit begins operations, offloading abrasive materials containing elevated levels of copper and zinc (but not arsenic).
1993–1995	Blair Waterway remediation is completed by the Port of Tacoma.
1996	Blair Waterway is removed from the CERCLA National Priorities List.
2007	The Port of Tacoma acquires property from A.H. Powers, including the Graymont easement for the concrete dock.
2012	Tru-Grit receives a PLP letter and enters Ecology Agreed Order to develop an RI/FS for cleanup of Tru-Grit abrasives.
2013	Tru-Grit barge offloading activities cease.
2019–2021	The Tru-Grit RI Report is completed. Presence of deeper arsenic-containing grit materials (in addition to Tru-Grit abrasive materials) is identified during testing.
2019	Tru-Grit Draft FS is completed.

Notes:

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act

Ecology: Washington State Department of Ecology

FS: feasibility study

PLP: potentially liable party

RI: remedial investigation

**Table 2-2**  
**Testing Parameters and Screening Levels**

Sediment Testing Parameter	Method	Benthic Screening Levels					Bioaccumulation Screening Levels		Other
		DMMP	SMS				DMMP	SMS	DMMP
		DMMP SL	SMS SCO	SMS CSL	AET SCO	AET CSL	DMMP BT	SMS Natural Background (or PQL) <sup>a</sup>	DMMP ML
<b>Conventional Parameters (pct)</b>									
Total organic carbon	SW9060AM								
Total solids	D2216								
Total solids	SM2540G								
Total volatile solids	PSEP-TV5								
<b>Metals (mg/kg)</b>									
Antimony	SW6020	150							200
Arsenic	SW6020	57	57	93	57	93	507.1	11	700
Cadmium	SW6020	5.1	5.1	6.7	5.1	6.7		0.8	14
Chromium	SW6020	260	260	270	260	270			
Copper	SW6020	390	390	390	390	390			1300
Lead	SW6020	450	450	530	450	530	975	21	1200
Mercury	SW7471B	0.41	0.41	0.59	0.41	0.59	1.5	0.2	2.3
Selenium	SW6020						3		
Silver	SW6020	6.1	6.1	6.1	6.1	6.1			8.4
Zinc	SW6020	410	410	960	410	960			3800
<b>Organometals (µg/kg)</b>									
Tributyltin (ion)	SW8270ESIM						73		
<b>Semivolatile Organics (mg/kg-OC)</b>									
1,2,4-Trichlorobenzene	SW8270ESIM		0.81	1.8					
1,2-Dichlorobenzene	SW8270ESIM		2.3	2.3					
1,4-Dichlorobenzene	SW8270ESIM		3.1	9					
Bis(2-ethylhexyl)phthalate	SW8270E		47	78					
Butylbenzyl phthalate	SW8270ESIM		4.9	64					
Di-n-butyl phthalate	SW8270E		220	1700					
Di-n-octyl phthalate	SW8270E		58	4500					
Diethyl phthalate	SW8270ESIM		61	110					
Dimethyl phthalate	SW8270ESIM		53	53					
Hexachlorobenzene	SW8270ESIM		0.38	2.3					
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	SW8270ESIM		3.9	6.2					
n-Nitrosodiphenylamine	SW8270ESIM		11	11					
Pentachlorophenol	SW8270ESIM								

**Table 2-2**  
**Testing Parameters and Screening Levels**

Sediment Testing Parameter	Method	Benthic Screening Levels					Bioaccumulation Screening Levels		Other
		DMMP	SMS				DMMP	SMS	DMMP
		DMMP SL	SMS SCO	SMS CSL	AET SCO	AET CSL	DMMP BT	SMS Natural Background (or PQL) <sup>a</sup>	DMMP ML
<b>Semivolatile Organics (µg/kg)</b>									
1,2,4-Trichlorobenzene	SW8270ESIM	31			31	51			64
1,2-Dichlorobenzene	SW8270ESIM	35			35	50			110
1,4-Dichlorobenzene	SW8270ESIM	110			110	110			120
2,4-Dimethylphenol	SW8270ESIM	29	29	29	29	29			210
2-Methylphenol (o-Cresol)	SW8270ESIM	63	63	63	63	63			77
4-Methylphenol (p-Cresol)	SW8270ESIM	670	670	670	670	670			3600
Benzoic acid	SW8270ESIM	650	650	650	650	650			760
Benzyl alcohol	SW8270ESIM	57	57	73	57	73			870
Bis(2-ethylhexyl)phthalate	SW8270E	1300			1300	1900			8300
Butylbenzyl phthalate	SW8270ESIM	63			63	900			970
Di-n-butyl phthalate	SW8270E	1400			1400	1400			5100
Di-n-octyl phthalate	SW8270E	6200			6200	6200			6200
Diethyl phthalate	SW8270ESIM	200			200	1200			1200
Dimethyl phthalate	SW8270ESIM	71			71	160			1400
Hexachlorobenzene	SW8270ESIM	22			22	70	168		230
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	SW8270ESIM	11			11	120			270
n-Nitrosodiphenylamine	SW8270ESIM	28			28	40			130
Pentachlorophenol	SW8270ESIM	400	360	690	360	690	504		690
Phenol	SW8270ESIM	420	420	1200	420	1200			1200

**Table 2-2  
Testing Parameters and Screening Levels**

Sediment Testing Parameter	Method	Benthic Screening Levels					Bioaccumulation Screening Levels		Other
		DMMP	SMS				DMMP	SMS	DMMP
		DMMP SL	SMS SCO	SMS CSL	AET SCO	AET CSL	DMMP BT	SMS Natural Background (or PQL) <sup>a</sup>	DMMP ML
<b>Polycyclic Aromatic Hydrocarbons (mg/kg-OC)</b>									
2-Methylnaphthalene	SW8270E		38	64					
Acenaphthene	SW8270E		16	57					
Acenaphthylene	SW8270E		66	66					
Anthracene	SW8270E		220	1200					
Benzo(a)anthracene	SW8270E		110	270					
Benzo(a)pyrene	SW8270E		99	210					
Benzo(b,j,k)fluoranthenes	SW8270E								
Benzo(g,h,i)perylene	SW8270E		31	78					
Carbazole	SW8270E								
Chrysene	SW8270E		110	460					
Dibenzo(a,h)anthracene	SW8270ESIM		12	33					
Dibenzofuran	SW8270E		15	58					
Fluoranthene	SW8270E		160	1200					
Fluorene	SW8270E		23	79					
Indeno(1,2,3-c,d)pyrene	SW8270E		34	88					
Naphthalene	SW8270E		99	170					
Phenanthrene	SW8270E		100	480					
Pyrene	SW8270E		1000	1400					
Total Benzofluoranthenes (b,j,k) (U = 0 max limit)	Calculated		230	450					
Total HPAH (SMS) (U = 0 max limit)	Calculated		960	5300					
Total LPAH (SMS) (U = 0 max limit)	Calculated		370	780					

**Table 2-2  
Testing Parameters and Screening Levels**

Sediment Testing Parameter	Method	Benthic Screening Levels					Bioaccumulation Screening Levels		Other
		DMMP	SMS				DMMP	SMS	DMMP
		DMMP SL	SMS SCO	SMS CSL	AET SCO	AET CSL	DMMP BT	SMS Natural Background (or PQL) <sup>a</sup>	DMMP ML
<b>Polycyclic Aromatic Hydrocarbons (µg/kg)</b>									
2-Methylnaphthalene	SW8270E	670			670	670			1900
Acenaphthene	SW8270E	500			500	500			2000
Acenaphthylene	SW8270E	560			1300	1300			1300
Anthracene	SW8270E	960			960	960			13000
Benzo(a)anthracene	SW8270E	1300			1300	1600			5100
Benzo(a)pyrene	SW8270E	1600			1600	1600			3600
Benzo(b,j,k)fluoranthenes	SW8270E								
Benzo(g,h,i)perylene	SW8270E	670			670	720			3200
Carbazole	SW8270E								
Chrysene	SW8270E	1400			1400	2800			21000
Dibenzo(a,h)anthracene	SW8270ESIM	230			230	230			1900
Dibenzofuran	SW8270E	540			540	540			1700
Fluoranthene	SW8270E	1700			1700	2500	4600		30000
Fluorene	SW8270E	540			540	540			3600
Indeno(1,2,3-c,d)pyrene	SW8270E	600			600	690			4400
Naphthalene	SW8270E	2100			2100	2100			2400
Phenanthrene	SW8270E	1500			1500	1500			21000
Pyrene	SW8270E	2600			2600	3300	11980		16000
Total Benzofluoranthenes (b,j,k) (U = 0 max limit)	Calculated	3200			3200	3600			9900
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 0 max limit)	Calculated								
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2 max limit)	Calculated							21	
Total HPAH (DMMP) (U = 0 max limit)	Calculated	12000			12000	17000			69000
Total LPAH (DMMP) (U = 0 max limit)	Calculated	5200			5200	5200			29000

**Table 2-2  
Testing Parameters and Screening Levels**

Sediment Testing Parameter	Method	Benthic Screening Levels					Bioaccumulation Screening Levels		Other
		DMMP	SMS				DMMP	SMS	DMMP
		DMMP SL	SMS SCO	SMS CSL	AET SCO	AET CSL	DMMP BT	SMS Natural Background (or PQL) <sup>a</sup>	DMMP ML
<b>Pesticides (mg/kg-OC)</b>									
2,4'-DDD (o,p'-DDD)	SW8081B								
2,4'-DDE (o,p'-DDE)	SW8081B								
2,4'-DDT (o,p'-DDT)	SW8081B								
4,4'-DDD (p,p'-DDD)	SW8081B								
4,4'-DDE (p,p'-DDE)	SW8081B								
4,4'-DDT (p,p'-DDT)	SW8081B								
Aldrin	SW8081B								
Chlordane, alpha- (Chlordane, cis-)	SW8081B								
Chlordane, beta- (Chlordane, trans-)	SW8081B								
Dieldrin	SW8081B								
Endrin ketone	SW8081B								
Heptachlor	SW8081B								
Hexachlorocyclohexane (BHC), beta-	SW8081B								
Nonachlor, cis-	SW8081B								
Nonachlor, trans-	SW8081B								
Oxychlordane	SW8081B								
Total Chlordane (DMMP) (U = 0 max limit)	Calculated								
<b>Pesticides (µg/kg)</b>									
2,4'-DDD (o,p'-DDD)	SW8081B								
2,4'-DDE (o,p'-DDE)	SW8081B								
2,4'-DDT (o,p'-DDT)	SW8081B								
4,4'-DDD (p,p'-DDD)	SW8081B	16							
4,4'-DDE (p,p'-DDE)	SW8081B	9							
4,4'-DDT (p,p'-DDT)	SW8081B	12							
Aldrin	SW8081B	9.5							
Chlordane, alpha- (Chlordane, cis-)	SW8081B								
Chlordane, beta- (Chlordane, trans-)	SW8081B								
Dieldrin	SW8081B	1.9							1700
Endrin ketone	SW8081B								
Heptachlor	SW8081B	1.5							270
Hexachlorocyclohexane (BHC), beta-	SW8081B								
Nonachlor, cis-	SW8081B								
Nonachlor, trans-	SW8081B								
Oxychlordane	SW8081B								
Sum 4,4 DDT, DDE, DDD (U = 0 max limit)	Calculated						50		69
Total Chlordane (DMMP) (U = 0 max limit)	Calculated	2.8					37		
Total DDx (U = 0 max limit)	Calculated								

**Table 2-2  
Testing Parameters and Screening Levels**

Sediment Testing Parameter	Method	Benthic Screening Levels					Bioaccumulation Screening Levels		Other
		DMMP	SMS				DMMP	SMS	DMMP
		DMMP SL	SMS SCO	SMS CSL	AET SCO	AET CSL	DMMP BT	SMS Natural Background (or PQL) <sup>a</sup>	DMMP ML
<b>Dioxin Furans (ng/kg)</b>									
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	E1613B								
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	E1613B								
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	E1613B								
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	E1613B								
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	E1613B								
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B								
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	E1613B								
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B								
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	E1613B								
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B								
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	E1613B								
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	E1613B								
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	E1613B								
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	E1613B								
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	E1613B								
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	E1613B								
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	E1613B								
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0 max limit)	Calculated								
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2 max limit)	Calculated	4 <sup>b</sup>					10	4.0	
Total Heptachlorodibenzo-p-dioxin (HpCDD)	E1613B								
Total Heptachlorodibenzofuran (HpCDF)	E1613B								
Total Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B								
Total Hexachlorodibenzofuran (HxCDF)	E1613B								
Total Pentachlorodibenzo-p-dioxin (PeCDD)	E1613B								
Total Pentachlorodibenzofuran (PeCDF)	E1613B								
Total Tetrachlorodibenzo-p-dioxin (TCDD)	E1613B								
Total Tetrachlorodibenzofuran (TCDF)	E1613B								

**Table 2-2  
Testing Parameters and Screening Levels**

Sediment Testing Parameter	Method	Benthic Screening Levels					Bioaccumulation Screening Levels		Other
		DMMP	SMS				DMMP	SMS	DMMP
		DMMP SL	SMS SCO	SMS CSL	AET SCO	AET CSL	DMMP BT	SMS Natural Background (or PQL) <sup>a</sup>	DMMP ML
<b>PCB Aroclors (mg/kg-OC)</b>									
Aroclor 1016	SW8082A								
Aroclor 1221	SW8082A								
Aroclor 1232	SW8082A								
Aroclor 1242	SW8082A								
Aroclor 1248	SW8082A								
Aroclor 1254	SW8082A								
Aroclor 1260	SW8082A								
Aroclor 1262	SW8082A								
Aroclor 1268	SW8082A								
Total PCB Aroclors (DMMP and SMMS Marine 2019) (U = 0 max limit)	Calculated		12	65			38		
Total PCB Aroclors (DMMP and SMMS Marine 2019) (U = 1/2 max limit)	Calculated								
<b>PCB Aroclors (µg/kg)</b>									
Aroclor 1016	SW8082A								
Aroclor 1221	SW8082A								
Aroclor 1232	SW8082A								
Aroclor 1242	SW8082A								
Aroclor 1248	SW8082A								
Aroclor 1254	SW8082A								
Aroclor 1260	SW8082A								
Aroclor 1262	SW8082A								
Aroclor 1268	SW8082A								
Total PCB Aroclors (DMMP and SMMS Marine 2019) (U = 0 max limit)	Calculated	130			130	1000			3100
Total PCB Aroclors (DMMP and SMMS Marine 2019) (U = 1/2 max limit)	Calculated							12 to 14 PQL <sup>c</sup>	

Notes:

- a. SMS natural background values are presented for bioaccumulative compounds only.
- b. The value representing the DMMP SL for Total Dioxin/Furan TEQ is the Disposal Site Management Objective.
- c. Ecology has not defined a natural background value for PCB Aroclors. SCUM (Ecology 2025) includes a total PCB congener-based natural background value of 3.5 µg/kg. However, PCB congener data are not available for the Site or the Blair Waterway. Appendix D of SCUM does define PQL values for PCB Aroclors, with PQLs of 12 to 14 µg/kg for individual Aroclors. Three different Aroclors (Aroclors 1248, 1254, and 1260) were detected at the Site.


<b>DMMP:</b> Dredged Material Management Program	<b>HPAH:</b> high-molecular-weight polycyclic aromatic hydrocarbon	<b>PQL:</b> practical quantitation limit
<b>blank cell:</b> not applicable	<b>LPAH:</b> low-molecular-weight polycyclic aromatic hydrocarbon	<b>SCO:</b> sediment cleanup objective
<b>µg/kg:</b> microgram per kilogram	<b>mg/kg:</b> milligrams per kilogram	<b>SCUM:</b> Sediment Cleanup User's Manual
<b>AET:</b> apparent effects threshold	<b>ML:</b> maximum level	<b>SL:</b> screening level
<b>BT:</b> bioaccumulation trigger	<b>ng/kg:</b> nanograms per kilogram	<b>SMS:</b> Sediment Management Standards
<b>cPAH:</b> carcinogenic polycyclic aromatic hydrocarbon	<b>OC:</b> organic carbon	<b>TBT:</b> tributyltin
<b>CSL:</b> cleanup screening level	<b>PCB:</b> polychlorinated biphenyl	<b>TEQ:</b> toxic equivalency quotient
	<b>pct:</b> percent	<b>U:</b> Compound analyzed for, but not detected above detection limit

**Table 2-3a**  
**Summary of Detected DMMP and SMS Exceedances**

Chemical	Method	Max Detected Value	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	AET Marine SCO	AET Marine CSL
<b>Metals (mg/kg)</b>									
Antimony	SW6020 / SW6020B	160	150		200				
Arsenic	SW6020 / SW6020B	1620	57	507.1	700			57	93
Chromium	SW6020 / SW6020B	488	260					260	270
Copper	SW6020 / SW6020B	1260	390		1300			390	390
Lead	SW6020 / SW6020B	1290	450	975	1200			450	530
Zinc	SW6020 / SW6020B	2970	410		3800			410	960
<b>Organometals (µg/kg)</b>									
Tributyltin (ion)	SW8270E / SW8270ESIM	243		73					
<b>Semivolatile Organics (mg/kg-OC)</b>									
1,2-Dichlorobenzene	SW8270E / SW8270ESIM	29.1				2.3	2.3		
1,4-Dichlorobenzene	SW8270E / SW8270ESIM	16.5				3.1	9		
<b>Semivolatile Organics (µg/kg)</b>									
1,2-Dichlorobenzene	SW8270E / SW8270ESIM	215	35		110				
1,4-Dichlorobenzene	SW8270E / SW8270ESIM	122	110		120				
<b>Polycyclic Aromatic Hydrocarbons (mg/kg-OC)</b>									
Benzo(a)anthracene	SW8270E / SW8270ESIM	280				110	270		
Chrysene	SW8270E / SW8270ESIM	407				110	460		
Fluoranthene	SW8270E / SW8270ESIM	2070				160	1200		
Pyrene	SW8270E / SW8270ESIM	1210				1000	1400		
Total HPAH (SMS) (U = 0 max limit)		4600				960	5300		
<b>Polycyclic Aromatic Hydrocarbons (µg/kg)</b>									
Benzo(a)anthracene	SW8270E / SW8270ESIM	1540	1300		5100				
Chrysene	SW8270E / SW8270ESIM	2240	1400		21000				
Fluoranthene	SW8270E / SW8270ESIM	11400	1700	4600	30000				
Pyrene	SW8270E / SW8270ESIM	6670	2600	11980	16000				
Total HPAH (DMMP) (U = 0 max limit)		25000	12000		69000				
<b>Dioxin/Furans (ng/kg)</b>									
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0 max limit)		270	4	10					
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2 max limit)		270	4	10					
<b>PCB Aroclors (mg/kg-OC)</b>									
Total PCB Aroclors (DMMP) (U = 0 max limit)		136		38					
Total PCB Aroclors (SMS Marine 2019) (U = 0 max limit)		61.3				12	65		
<b>PCB Aroclors (µg/kg)</b>									
Total PCB Aroclors (DMMP) (U = 0 max limit)		529	130		3100				
Total PCB Aroclors (SMS Marine 2019) (U = 0 max limit)		529						130	1000

**Table 2-3a**  
**Summary of Detected DMMP and SMS Exceedances**

Notes:

 Detected concentration is greater than any listed screening level

blank cell: not applicable

µg/kg: microgram per kilogram

AET: apparent effects threshold

BT: bioaccumulation trigger

CSL: cleanup screening level

DMMP: Dredged Material Management Program

HPAH: high-molecular-weight polycyclic aromatic hydrocarbon

ID: identification

mg/kg: milligram per kilogram

ML: maximum level

ng/kg: nanogram per kilogram

OC: organic carbon

PCB: polychlorinated biphenyl

SCO: sediment cleanup objective

SL: screening level

SMS: Sediment Management Standards

TEQ: toxic equivalency quotient

U: Compound analyzed for, but not detected above detection limit

**Table 2-3b**  
**Contaminants with No Detected Exceedances**

Chemical	Method	Max Detected Value	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	AET Marine SCO	AET Marine CSL
<b>Conventional Parameters (pct)</b>									
Total organic carbon	SW9060AM	5.30							
Total solids	D2216	84.06							
Total solids	SM2540G	91.86							
Total volatile solids	PSEP-TVS	13.30							
<b>Metals (mg/kg)</b>									
Cadmium	SW6020 / SW6020B	1.48	5.1		14	5.1	6.7	5.1	6.7
Mercury	SW7471B	0.344	0.41	1.5	2.3	0.41	0.59	0.41	0.59
Selenium	SW6020 / SW6020B	2.26		3					
Silver	SW6020 / SW6020B	0.92	6.1		8.4	6.1	6.1	6.1	6.1
<b>Organometals (mg/kg-OC)</b>									
Tributyltin (ion)	SW8270E / SW8270ESIM	35.7		73					
<b>Semivolatile Organics (mg/kg-OC)</b>									
1,2,4-Trichlorobenzene	SW8270E / SW8270ESIM	--				0.81	1.8		
Bis(2-ethylhexyl)phthalate	SW8270E / SW8270ESIM	72.1				47	78		
Butylbenzyl phthalate <sup>a</sup>	SW8270E / SW8270ESIM	5.99 <sup>a</sup>				5.99 <sup>a</sup>	64 <sup>a</sup>		
Diethyl phthalate	SW8270E / SW8270ESIM	11.2				61	110		
Dimethyl phthalate	SW8270E / SW8270ESIM	7.08				53	53		
Di-n-butyl phthalate	SW8270E / SW8270ESIM	23.4				220	1700		
Di-n-octyl phthalate	SW8270E / SW8270ESIM	98.6				58	4500		
Hexachlorobenzene	SW8270E / SW8270ESIM	--				0.38	2.3		
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	SW8270E / SW8270ESIM	--				3.9	6.2		
n-Nitrosodiphenylamine	SW8270E / SW8270ESIM	--				11	11		
Pentachlorophenol	SW8270E / SW8270ESIM	23.1							

**Table 2-3b**  
**Contaminants with No Detected Exceedances**

Chemical	Method	Max Detected Value	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	AET Marine SCO	AET Marine CSL
<b>Semivolatile Organics (µg/kg)</b>									
1,2,4-Trichlorobenzene	SW8270E / SW8270ESIM	--	31		64			31	51
2,4-Dimethylphenol	SW8270E / SW8270ESIM	--	29		210	29	29	29	29
2-Methylphenol (o-Cresol)	SW8270E / SW8270ESIM	5.0	63		77	63	63	63	63
4-Methylphenol (p-Cresol)	SW8270E / SW8270ESIM	160	670		3600	670	670	670	670
Benzoic acid	SW8270E / SW8270ESIM	142	650		760	650	650	650	650
Benzyl alcohol	SW8270E / SW8270ESIM	--	57		870	57	73	57	73
Bis(2-ethylhexyl)phthalate	SW8270E / SW8270ESIM	261	1300		8300			1300	1900
Butylbenzyl phthalate <sup>a</sup>	SW8270E / SW8270ESIM	49.1 <sup>a</sup>	63		970			63 <sup>a</sup>	900 <sup>a</sup>
Diethyl phthalate	SW8270E / SW8270ESIM	149	200		1200			200	1200
Dimethyl phthalate	SW8270E / SW8270ESIM	52.4	71		1400			71	160
Di-n-butyl phthalate	SW8270E / SW8270ESIM	187	1400		5100			1400	1400
Di-n-octyl phthalate	SW8270E / SW8270ESIM	365	6200		6200			6200	6200
Hexachlorobenzene	SW8270E / SW8270ESIM	--	22	168	230			22	70
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	SW8270E / SW8270ESIM	--	11		270			11	120
n-Nitrosodiphenylamine	SW8270E / SW8270ESIM	--	28		130			28	40
Pentachlorophenol	SW8270E / SW8270ESIM	63.0	400	504	690	360	690	360	690
Phenol	SW8270E / SW8270ESIM	152	420		1200	420	1200	420	1200
<b>Polycyclic Aromatic Hydrocarbons (mg/kg-OC)</b>									
1-Methylnaphthalene	SW8270E / SW8270ESIM	3.54							
2-Methylnaphthalene	SW8270E / SW8270ESIM	6.44				38	64		
Acenaphthene	SW8270E / SW8270ESIM	26.4				16	57		
Acenaphthylene	SW8270E / SW8270ESIM	12.0				66	66		
Anthracene	SW8270E / SW8270ESIM	42.7				220	1200		
Benzo(a)pyrene <sup>a</sup>	SW8270E / SW8270ESIM	146 <sup>a</sup>					99 <sup>a</sup>	210 <sup>a</sup>	
Benzo(g,h,i)perylene <sup>a</sup>	SW8270E / SW8270ESIM	87.1 <sup>a</sup>					31 <sup>a</sup>	78 <sup>a</sup>	
Benzo(b,j,k)fluoranthenes	SW8270E / SW8270ESIM	391							
Carbazole	SW8270E / SW8270ESIM	20.9							
Dibenzo(a,h)anthracene <sup>a</sup>	SW8270E / SW8270ESIM	15.0 <sup>a</sup>				12 <sup>a</sup>	33 <sup>a</sup>		
Dibenzofuran	SW8270E / SW8270ESIM	6.65				15	58		
Fluorene	SW8270E / SW8270ESIM	8.63				23	79		
Indeno(1,2,3-c,d)pyrene <sup>a</sup>	SW8270E / SW8270ESIM	69.5 <sup>a</sup>				34 <sup>a</sup>	88 <sup>a</sup>		
Naphthalene	SW8270E / SW8270ESIM	8.06				99	170		
Phenanthrene	SW8270E / SW8270ESIM	97				100	480		
Total Benzofluoranthenes (b,j,k) (U = 0 max limit) <sup>a</sup>		391 <sup>a</sup>				230 <sup>a</sup>	450 <sup>a</sup>		
Total HPAH (SMS) (U = 1/2 max limit)		4600							
Total LPAH (SMS) (U = 0 max limit)		140				370	780		
Total LPAH (SMS) (U = 1/2 max limit)		200							

**Table 2-3b**  
**Contaminants with No Detected Exceedances**

Chemical	Method	Max Detected Value	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	AET Marine SCO	AET Marine CSL
<b>Polycyclic Aromatic Hydrocarbons (µg/kg)</b>									
1-Methylnaphthalene	SW8270E / SW8270ESIM	28.3							
2-Methylnaphthalene	SW8270E / SW8270ESIM	42.8	670		1900			670	670
Acenaphthene	SW8270E / SW8270ESIM	211	500		2000			500	500
Acenaphthylene	SW8270E / SW8270ESIM	69.5	560		1300			1300	1300
Anthracene	SW8270E / SW8270ESIM	235	960		13000			960	960
Benzo(a)pyrene	SW8270E / SW8270ESIM	1060	1600		3600			1600	1600
Benzo(b,j,k)fluoranthenes	SW8270E / SW8270ESIM	2150							
Benzo(g,h,i)perylene	SW8270E / SW8270ESIM	505	670		3200			670	720
Carbazole	SW8270E / SW8270ESIM	121							
Dibenzo(a,h)anthracene	SW8270E / SW8270ESIM	84.0	230		1900			230	230
Dibenzofuran	SW8270E / SW8270ESIM	53.2	540		1700			540	540
Fluorene	SW8270E / SW8270ESIM	69.0	540		3600			540	540
Indeno(1,2,3-c,d)pyrene	SW8270E / SW8270ESIM	403	600		4400			600	690
Naphthalene	SW8270E / SW8270ESIM	64.5	2100		2400			2100	2100
Phenanthrene	SW8270E / SW8270ESIM	653	1500		21000			1500	1500
Total Benzofluoranthenes (b,j,k) (U = 0 max limit)		2150	3200		9900			3200	3600
Total Benzofluoranthenes (b,j,k) (U = 1/2 max limit)		2150							
Total LPAH (DMMP) (U = 0 max limit)		1030	5200		29000				
Total LPAH (DMMP) (U = 1/2 max limit)		1030							
Total LPAH (SMS) (U = 0 max limit)		1030						5200	5200
Total LPAH (SMS) (U = 1/2 max limit)		1030							
<b>Pesticides (mg/kg-OC)</b>									
2,4'-DDD (o,p'-DDD)	SW8081B	0.101							
2,4'-DDE (o,p'-DDE)	SW8081B	0.153							
2,4'-DDT (o,p'-DDT)	SW8081B	0.680							
4,4'-DDD (p,p'-DDD)	SW8081B	0.422							
4,4'-DDE (p,p'-DDE)	SW8081B	0.721							
4,4'-DDT (p,p'-DDT)	SW8081B	3.29							
Aldrin	SW8081B	--							
Chlordane, alpha- (Chlordane, cis-)	SW8081B	0.082							
Chlordane, beta- (Chlordane, trans-)	SW8081B	0.35							
Dieldrin	SW8081B	0.215							
Endrin ketone	SW8081B	0.342							
Heptachlor	SW8081B	--							
Hexachlorocyclohexane (BHC), beta-	SW8081B	0.085							
Nonachlor, cis-	SW8081B	0.12							
Nonachlor, trans-	SW8081B	--							
Oxychlordane	SW8081B	--							
Total Chlordane (DMMP) (U = 1/2 max limit)		0.97							

**Table 2-3b**  
**Contaminants with No Detected Exceedances**

Chemical	Method	Max Detected Value	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	AET Marine SCO	AET Marine CSL
<b>Pesticides (µg/kg)</b>									
2,4'-DDD (o,p'-DDD)	SW8081B	1.01							
2,4'-DDE (o,p'-DDE)	SW8081B	1.53							
2,4'-DDT (o,p'-DDT)	SW8081B	6.80							
4,4'-DDD (p,p'-DDD)	SW8081B	3.59	16						
4,4'-DDE (p,p'-DDE)	SW8081B	6.07	9						
4,4'-DDT (p,p'-DDT)	SW8081B	3.38	12						
Aldrin	SW8081B	--	9.5						
Chlordane, alpha- (Chlordane, cis-)	SW8081B	0.82							
Chlordane, beta- (Chlordane, trans-)	SW8081B	0.99							
Dieldrin	SW8081B	1.59	1.9		1700				
Endrin ketone	SW8081B	1.81							
Heptachlor	SW8081B	--	1.5		270				
Hexachlorocyclohexane (BHC), beta-	SW8081B	0.33							
Nonachlor, cis-	SW8081B	0.80							
Nonachlor, trans-	SW8081B	--							
Oxychlordane	SW8081B	--							
Sum 4,4 DDT, DDE, DDD (U = 0 max limit)		32.3		50	69				
Sum 4,4 DDT, DDE, DDD (U = 1/2 max limit)		32.3							
Total Chlordane (DMMP) (U = 0 max limit)		0.99	2.8	37					
Total Chlordane (DMMP) (U = 1/2 max limit)		2.7							
Total DDx (U = 0 max limit)		41.6							
Total DDx (U = 1/2 max limit)		41.6							

Notes:

a. Low TOC sample exceeded the SMS SCO on an OC-normalized basis, but did not exceed the dry weight AET. Therefore, this is not considered an exceedance under SMS.

-- : not detected in any sample

ML: maximum level

blank cell: not applicable

ng/kg: nanogram per kilogram

µg/kg: microgram per kilogram

OC: organic carbon

AET: apparent effects threshold

pct: percent

BT: bioaccumulation trigger

SCO: sediment cleanup objective

CSL: cleanup screening level

SL: screening level

DMMP: Dredged Material Management Program

SMS: Sediment Management Standards

ID: identification

TEQ: toxic equivalency quotient

LPAH: low-molecular-weight polycyclic aromatic hydrocarbon

U: Compound analyzed for, but not detected above detection limit

mg/kg: milligram per kilogram

**Table 2-4  
Detected Bioaccumulative Compounds**

Chemical	Max Detected Concentration Within Site (at any depth) <sup>1</sup>	DMMP BT	SMS Natural Background <sup>2</sup>	95% UCL Excluding Sample Locations Within Site <sup>1</sup> (at any depth)	Blair Waterway Background (90/90 UTL) <sup>3</sup>	Max Detect Sample ID
<b>Metals (mg/kg)</b>						
Arsenic	1620	507.1	11	< 11	-- <sup>4</sup>	TG-SC15-00-02-241113
Cadmium	1.48	--	0.8	< 0.8	-- <sup>4</sup>	TG-SC10-04-5.2-241112
Lead	1290	--	21	< 21	-- <sup>4</sup>	TG-SC15-00-02-241113
Mercury	0.344	1.5	0.2	< 0.2	-- <sup>4</sup>	TG-SC15RE-02-04-250328
<b>Organometals (µg/kg)</b>						
Tributyltin (ion)	243	73	-- <sup>5</sup>	< 73	--	TG-SG12-250826
<b>Polycyclic Aromatic Hydrocarbons (µg/kg)</b>						
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2 max limit)	1230	--	21	57	59	TG-SG06-250826
<b>PCB Aroclors (µg/kg)</b>						
Total PCB Aroclors (U = 0 max limit)	529	--	-- <sup>6</sup>	35	37	TG-SC27-04-06-250512

Notes:

Chemical concentrations are listed on a dry weight basis.

1. Calculations for maximum and 95% UCL concentrations include 2024–2025 Tru-Grit surface and subsurface data, along with immediately adjacent 2025 Blair Waterway cores. For 95% UCL calculations, the data from within the Preliminary Site Boundary were excluded, and each core was represented by only the maximum concentration in that core.
2. Natural background values for Puget Sound were taken from Ecology's Sediment Cleanup Users Manual (Ecology 2025).
3. Waterway background concentrations were developed for shallow subsurface waterway sediments using the same methodology as described in Ecology guidance for derivation of regional background concentrations in surface sediments (i.e., calculation of a 90/90 upper tolerance limit after removal of outliers and samples associated with cleanup sites or specific point sources).
4. Waterway background concentrations of these metals were equal to or less than Ecology-defined natural background concentrations for Puget Sound surface sediments.
5. Ecology has not defined a natural background concentration for tributyltin. This compound is typically elevated near shipyards and boat maintenance areas.
6. Ecology defined a natural background concentration for total PCB congeners (3.5 µg/kg dry weight) but not for total PCB Aroclors. The 3.5 µg/kg value is below the practical quantitation limit for PCB Aroclors.

µg/kg: microgram per kilogram

BT: bioaccumulation trigger

cPAH: carcinogenic polycyclic aromatic hydrocarbon

DMMP: Dredged Material Management Program

Ecology: Washington State Department of Ecology

mg/kg: milligrams per kilogram

**Table 3-1  
Interim Action Performance Standards**

Analyte	Performance Standards for Benthic Protection (Applied on a Point-by-Point Basis)			Performance Standards for Human Health Protection (Applied on an Area-Wide Basis)		
	Criteria	Unit <sup>1</sup>	Derivation	Criteria	Unit <sup>1</sup>	Derivation
<b>PART 1: SITE-ASSOCIATED HAZARODUS SUBSTANCES</b>						
<b>Metals (mg/kg)</b>						
Antimony	150	mg/kg	DMMP SL	--	--	--
Arsenic	57	mg/kg	SMS SCO / DMMP SL	11	mg/kg	SMS Natural Background
Cadmium	5.1	mg/kg	SMS SCO / DMMP SL	0.8	mg/kg	SMS Natural Background
Chromium	260	mg/kg	SMS SCO / DMMP SL	--	--	--
Copper	390	mg/kg	SMS SCO / DMMP SL	--	--	--
Lead	450	mg/kg	SMS SCO / DMMP SL	21	mg/kg	SMS Natural Background
Mercury	0.41	mg/kg	SMS SCO / DMMP SL	0.2	mg/kg	SMS Natural Background
Zinc	410	mg/kg	SMS SCO / DMMP SL	--	--	--
<b>Organometals (µg/kg)</b>						
Tributyltin (ion)	73	µg/kg	DMMP BT	73	µg/kg	DMMP BT
<b>Semivolatile Organics (µg/kg)</b>						
1,2-Dichlorobenzene	35	µg/kg	SMS AET	--	--	--
1,4-Dichlorobenzene	110	µg/kg	SMS AET	--	--	--
<b>Polycyclic Aromatic Hydrocarbons (µg/kg)</b>						
Benzo(a)anthracene	1,300	µg/kg	SMS SCO / DMMP SL	--	--	--
Chrysene	1,400	µg/kg	SMS SCO / DMMP SL	--	--	--
Fluoranthene	1,700	µg/kg	SMS SCO / DMMP SL	--	--	--
Pyrene	2,600	µg/kg	SMS SCO / DMMP SL	--	--	--
Total HPAH (DMMP) (U = 0 max limit)	12,000	µg/kg	SMS SCO / DMMP SL	--	--	--
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 1/2 max limit)	--	--	--	59	µg/kg	Blair Waterway 90/90 UTL <sup>2</sup>
<b>PCB Aroclors (µg/kg)</b>						
Total PCB Aroclors (U = 0)	130	µg/kg	SMS SCO / DMMP SL			
Total PCB Aroclors (U = 1/2 max limit)	--	--	--	37	µg/kg	Blair Waterway 90/90 UTL <sup>2</sup>
<b>PART 2: REGIONAL CONTAMINANTS</b>						
<b>Dioxin Furans (ng/kg)</b>						
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 1/2 max limit)	--	--	--	10	ng/kg	DMMP BT <sup>3</sup>

Notes:

- Performance standards for benthic protection are listed on a dry weight basis, under the assumption that most sediments tested as part of the interim action will contain total organic carbon contents below 0.5%. For non-ionizable organic
- The 90/90 UTL was calculated for shallow subsurface sediments using the same methodologies recommended by Ecology in SCUM (Ecology 2025) for calculating a regional background value in surface sediment.
- The interim action will remediate dioxin/furans in the Lower Slope sediments to below the DMMP BT value (10 ng/kg) on a point-by-point basis to avoid potential impacts of residual sediment on the planned deepening of the federal navigation channel

--: not applicable  
µg/kg: microgram per kilogram (dry weight basis)  
AET: apparent effects threshold  
BT: bioaccumulation trigger  
cPAH: carcinogenic polycyclic aromatic hydrocarbon  
DMMP: Dredged Material Management Program

Ecology: Washington State Department of Ecology  
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon  
mg/kg: milligram per kilogram (dry weight basis)  
mg/kg-OC: milligram per kilogram organic carbon normalized  
n/a: not applicable  
ng/kg: nanogram per kilogram

SCO: sediment quality objective  
SCUM: Sediment Cleanup User's Manual  
SL: screening level  
SMS: Sediment Management Standards  
TEQ: toxic equivalent quotient  
U: Compound analyzed for, but not detected above detection limit  
UTL: upper tolerance limit

**Table 3-2**  
**Estimated Sediment Removal Quantities**

<b>Dredge Area Name</b>	<b>Design Depth (ft below mudline)</b>	<b>Neatline Volume (cy)</b>	<b>Side Slope Volume (cy)</b>	<b>Total Volume (cy)</b>	<b>Maximum Allowable Overdredge Depth (ft below mudline)</b>	<b>Neatline Volume with Maximum Allowable Overdredge (cy)</b>	<b>Side Slope Volume with Maximum Allowable Overdredge (cy)</b>	<b>Total Volume with Maximum Allowable Overdredge (cy)</b>
<b>Area A</b>	4	4,935	832	5,767	6	7,403	1,659	9,062
<b>Area B</b>	8	1,805	918	2,723	10	2,256	1,381	3,637
<b>Total</b>	n/a	6,740	1,750	8,490	n/a	9,659	3,040	12,699

Notes:

cy: cubic yard

ft: foot

n/a: not applicable

**Table 3-3**  
**Estimated RMC Placement Quantities**

<b>Dredge Area</b>	<b>Surface Area (sf)</b>	<b>Minimum Estimated RMC<sup>1</sup> Volume (cy)</b>
<b>Area A</b>	44,483	824
<b>Area B</b>	12,347	229
<b>Total</b>	56,830	1,052

Notes:

1. RMC is designed to be 6-inch-thick layer of material. RMC requires an approximately 3H:1V slope to remain in place and prevent sloughing down the slope; therefore, in some areas the RMC layer may be greater than 6 inches thick as shown on Cross Sections A-A' and B-B' in Figures 3-2 and 3-3, respectively. The precise volume of RMC required will be determined at the design stage once the RMC material is selected and the minimum required slope to stay in place is determined.

cy: cubic yard

H:V: horizontal to vertical (ratio)

RMC: residuals management cover

sf: square foot

**Table 3-4  
Preliminary Engineer's Cost Estimate (Opinion of Probable Cost)**

Task ID	Task Description	Probable Total Cost (\$)
		Interim Action
1	Mobilization/Demobilization	\$ 710,000.00
2	Site Preparation	\$ 250,000.00
3	Surveys	\$ 142,000.00
4	Structural Work	\$ -
5	Dredging, Transloading, Transportation, and Disposal	\$ 3,579,000.00
6	Material Placement	\$ 142,000.00
7	Environmental Controls	\$ 200,000.00
<b>Direct Construction Costs Subtotal</b>		<b>\$ 5,023,000.00</b>
8	Direct Construction Contingency (40.0%)	\$ 2,009,000.00
<b>Direct Construction Cost Subtotal with Contingency</b>		<b>\$ 7,032,000.00</b>
9	Sales Tax (10.3%)	\$ 724,000.00
<b>Total Direct Construction Costs (with Contingency and Sales Tax) - Rounded</b>		<b>\$ 7,756,000.00</b>
10	Engineering Support Services	\$ 105,000.00
11	Construction Quality Assurance	\$ 42,000.00
12	Testing and Reporting	\$ 200,000.00
<b>Indirect Construction Costs Subtotal</b>		<b>\$ 347,000.00</b>
13	Indirect Construction Contingency (40.0%)	\$ 139,000.00
<b>Total Indirect Construction Costs (with Contingency) - Rounded</b>		<b>\$ 486,000.00</b>
<b>14</b>	<b>TOTAL PROJECT COSTS</b>	<b>\$ 8,242,000.00</b>

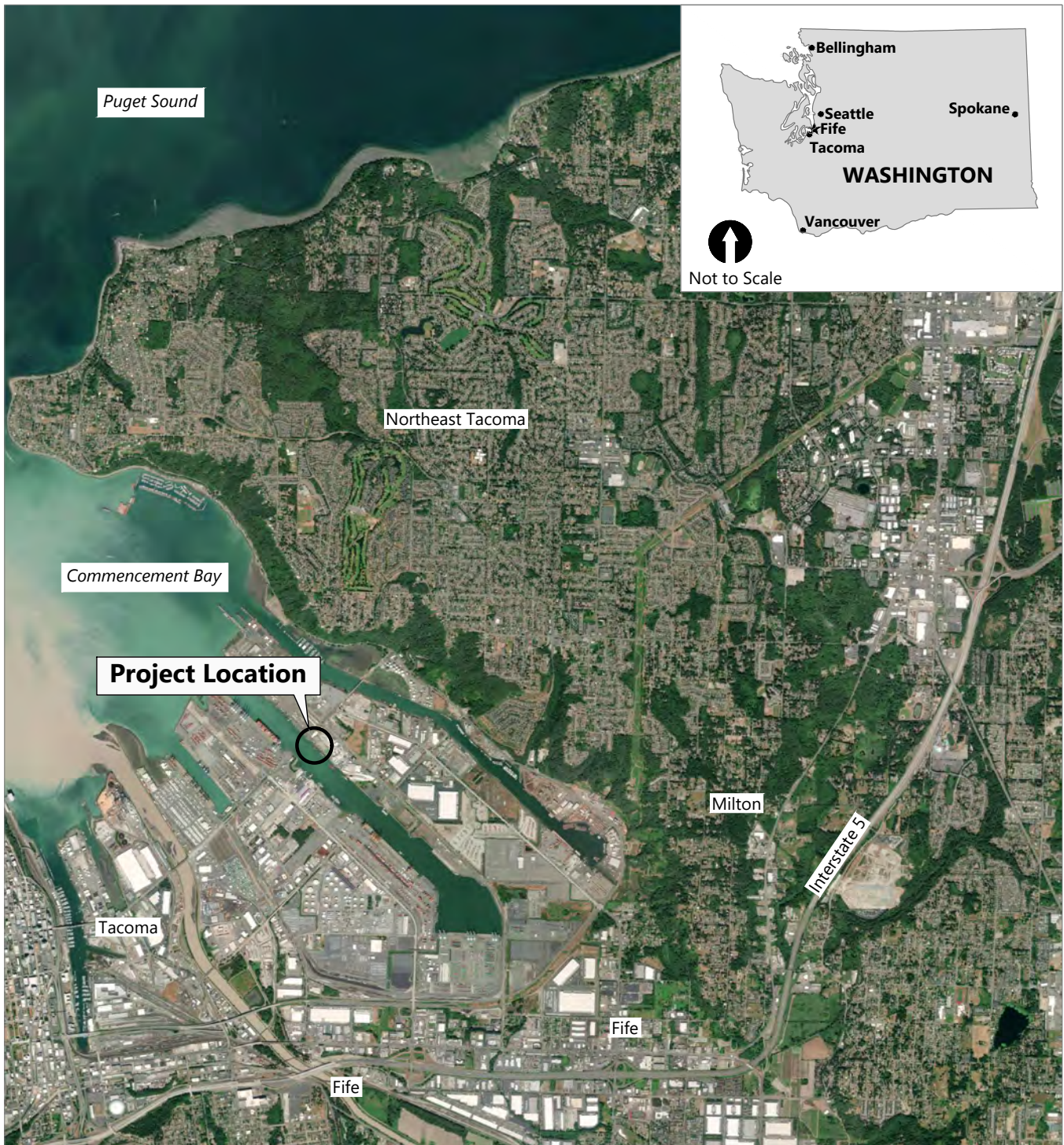
Notes:

1. In providing this Engineer's Cost Estimate (Opinion of Probable Cost), the Client understands that the Consultant (Anchor QEA) has no control over the cost or availability of labor, equipment, or materials, or over market condition or the Contractor's method of pricing, and the Consultant's Engineer's construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, express or implied, that the bids or the negotiated cost of the work will not vary from the Consultant's Engineer's construction costs.
2. Costs are presented in present-day United States dollars (i.e., 2025).
3. Sales tax is included at 10.3% (to account for Washington State [6.5%] and the City of Tacoma [3.8%] taxes).
4. A 40% contingency is applied to both total direct construction and total indirect construction costs, based on consideration of potential cost uncertainty associated with the level of information currently available and engineering best professional judgement. Due to the nature of the project, additional factors that cannot be forecasted at this time—such as scope unknowns (i.e., significant changes in site conditions or quantities), price uncertainty (i.e., varying market conditions, increasing inflation, fuel, and labor changes), or any other unforeseen circumstances (i.e., additional design requirements)—may influence contractor bidding prices and impact the final project costs outside, in excess, or below this contingency.

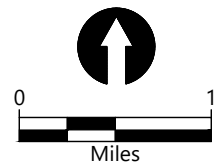
## Figures

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DRAFT



**SOURCE:** Aerial by Global Mapper  
**HORIZONTAL DATUM:** Washington State Plane South Zone, NAD83, U.S. Survey Feet



Publish Date: 2026/01/13 11:46 AM | User: dholmer  
Filepath: K:\Projects\0092-Port of Tacoma\Dredged Material Characterization for Tru-Grit Sediment Investigation\0092-RP-001 (Vicinity Map-IAP).dwg Figure 1-1 (Interim Action Plan)



**Figure 1-1**  
**Vicinity Map**

Interim Action Plan  
Port of Tacoma – Tru-Grit Site



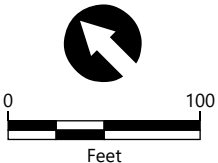
**LEGEND:**

- Feasibility Study Navigation Channel Boundary
- Parcel Boundary
- Easement Boundary For Concrete Dock (Graymont)
- Underwater Communications Crossing
- Underwater Watermain Crossing
- Navigation Tower
- Navigational Aid

**NOTES:**

1. Aerial imagery: Esri (2025)
2. Horizontal Datum: NAD83 State Plane Washington South, U.S. feet
3. Navigational aids source: Port of Tacoma 2003. Locations of navigational aids are approximate and will be verified during design.

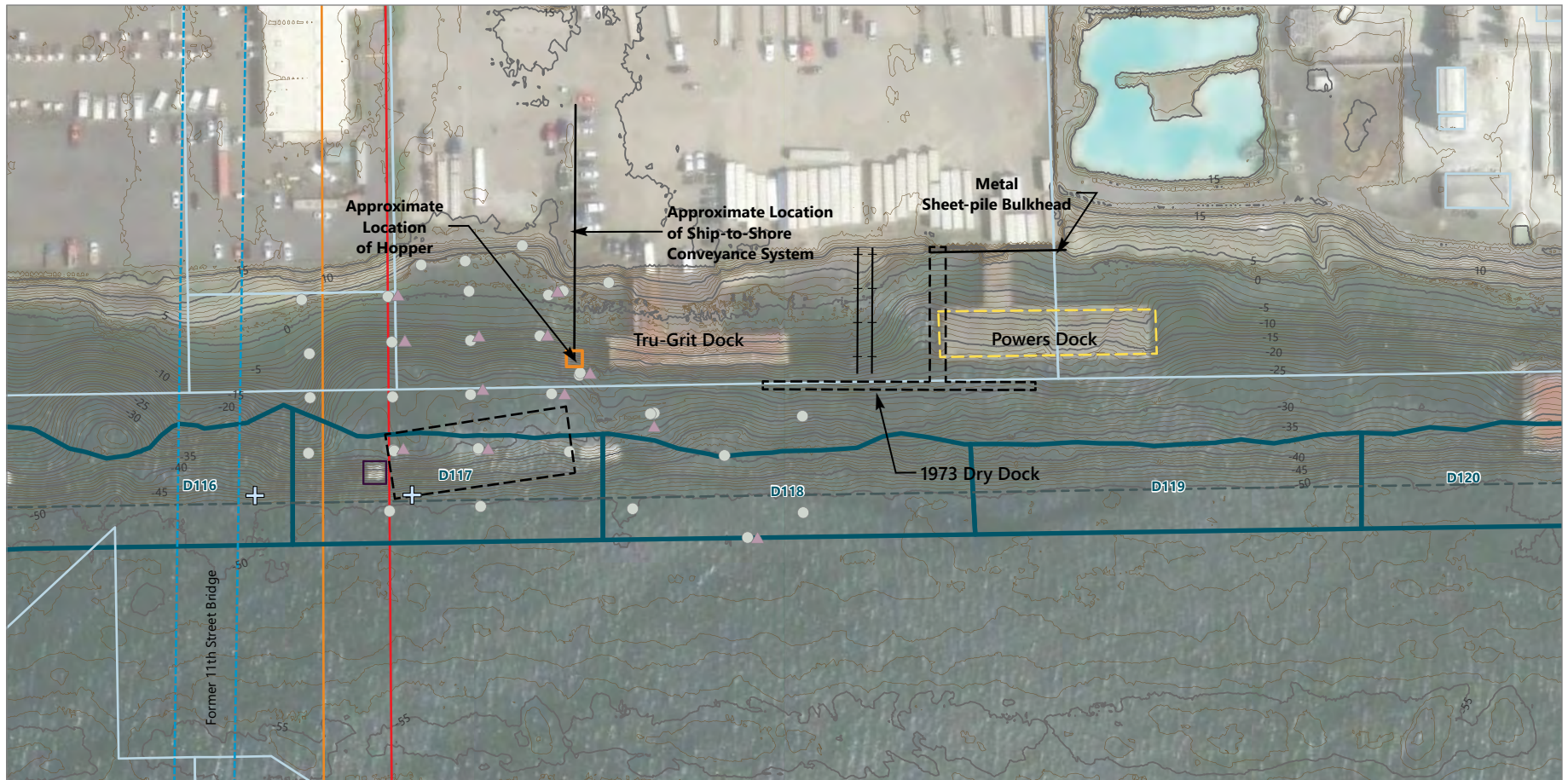
NAD83: North American Datum of 1983



Publish Date: 2026/01/14, 10:08 AM | User: thartmann  
 Filepath: \\GSTFile01\GIS\Jobs\PortofTacoma\_0092\Tru-Grit\_Site\_Project\_D\Maps\Interim\_Action\_Plan\AQ\_PoT\_Trugrit\_InterimActionPlan.aprx | Trugrit\_InterimActionPlan\_Fig2\_1\_SitePhysicalSetting



**Figure 2-1**  
**Site Physical Setting**  
 Interim Action Plan  
 Port of Tacoma – Tru-Grit Site



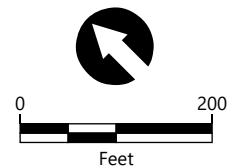
**LEGEND:**

- |  |  |                                 |                           |
|--|--|---------------------------------|---------------------------|
|  | Feasibility Study Navigation Channel Boundary  |                                 | Former 11th Street Bridge |
|  | Parcel Boundary                                |                                 | Navigation Tower          |
|  | Upper DMMU Boundary                            |                                 | Hopper                    |
|  | Easement Boundary For Concrete Dock (Graymont) |                                 | Navigational Aid          |
|  | Former Dry Dock                                | <b>Previous Sample Location</b> |                           |
|  | Elevation (MLLW, 5-Foot Interval)              |                                 | Subsurface Sediment       |
|  | Underwater Communications Crossing             |                                 | Surface Sediment          |
|  | Underwater Watermain Crossing                  |                                 |                           |
|  | Former Marine Railway                          |                                 |                           |

**NOTES:**

1. Aerial imagery: Esri (2025)
2. Contour Source: Survey by USACE, dated October 27, 2021, and David Evans Associates Inc., dated May 27, 2022, with data gaps filled from survey by USACE dated November 14, 2022
3. Horizontal Datum: NAD83 State Plane Washington South, U.S. feet
4. Vertical Datum: MLLW, feet
5. The later dry dock was located in approximately the same position.
6. Navigational aids source: Port of Tacoma 2003. Locations of navigational aids are approximate and will be verified during design.

DMMU: dredged material management unit  
 MLLW: mean lower low water  
 NAD83: North American Datum of 1983  
 USACE: U.S. Army Corps of Engineers



Publish Date: 2026/01/14, 10:06 AM | User: thartmann

Filepath: \\GSTFile01\GIS\Jobs\PortofTacoma\_0092\Tru-Grit\_Site\_Project\_D\Maps\Interim\_Action\_Plan\AQ\_PoT\_Trugrit\_InterimActionPlan.aprx | TruGrit\_InterimActionPlan\_Fig2\_2\_PreviouseSampling



**Figure 2-2**  
**Historical Features and Previous Sampling Locations**

Interim Action Plan  
 Port of Tacoma – Tru-Grit Site



**LEGEND:**

▭ Feasibility Study Navigation Channel Boundary

▭ Upper DMMU Boundary

**Upper Slope Sample Location**

▲ Core (Subsurface Sediment)

● Grab (Surface Sediment)

**Lower Slope Sample Location**

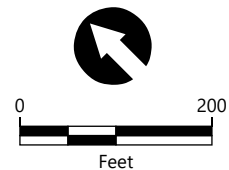
▲ Core (Subsurface Sediment)

● Grab (Surface Sediment)

**NOTES:**

1. Aerial imagery: Esri (2025)

DMMU: dredged material management unit



Publish Date: 2026/01/14, 9:53 AM | User: thartmann

Filepath: \\GSTFile01\GIS\Jobs\PortofTacoma\_0092\Tru-Grit\_Site\_Project\_D\Maps\Interim\_Action\_Plan\AQ\_PoT\_Trugrit\_InterimActionPlan.aprx | TruGrit\_InterimActionPlan\_Fig2\_3\_UpperLowerSlopeSampling





**Figure 2-3**  
**2024-2025 Upper Slope and Lower Slope Sampling Locations**



Interim Action Plan  
Port of Tacoma – Tru-Grit Site





**LEGEND:**

-  Feasibility Study Navigation Channel Boundary
-  Preliminary Site Boundary

**Sample Location**

-  Core (Subsurface Sediment)
-  Grab

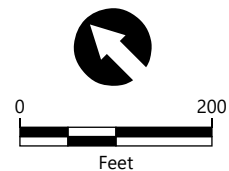
**SCO Exceedance**

-  No SCO Exceedance
-  SCO Exceedance

**NOTES:**

1. Aerial imagery: Esri (2025)
2. Site boundary is based on the distribution of SCO exceedances at any depth. See Sections 2 and 3 of the Interim Action Plan for discussion.

SCO: sediment cleanup objective



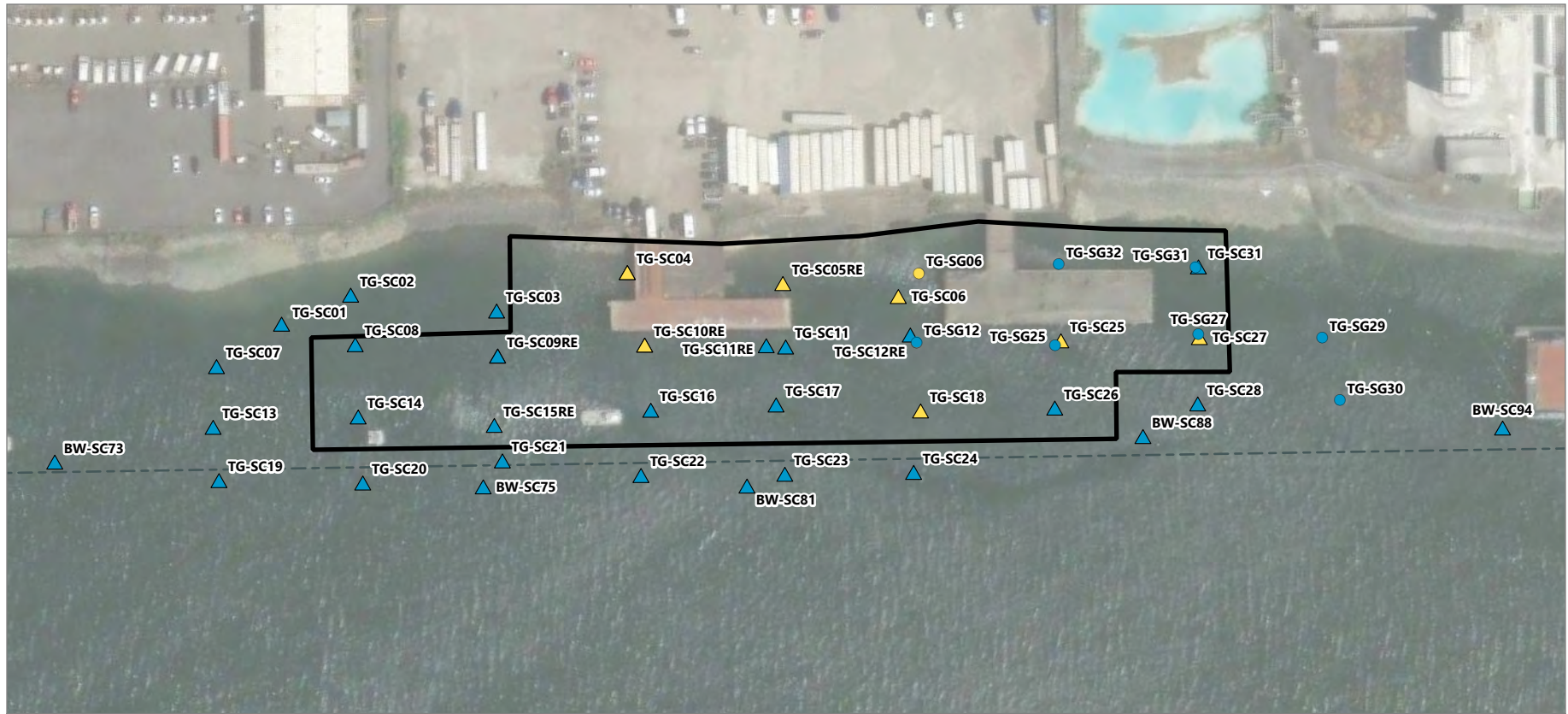
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**Figure 2-4**  
**Extent of Site-Associated Heavy Metals Contaminants**

Interim Action Plan  
Port of Tacoma – Tru-Grit Site



**LEGEND:**

Feasibility Study Navigation Channel Boundary

Preliminary Site Boundary

**Sample Location**

- Core (Subsurface Sediment)
- Grab

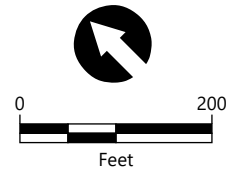
**Total PCB Exceedance**

- No SCO Exceedance
- SCO Exceedance

**NOTES:**

1. Aerial imagery: Esri (2025)
2. Screening criteria for Total PCB Aroclors 130 µg/kg based on the DMMP Screening Level and AET Marine SCO from SCUM.
3. Maximum sample concentration within each core is displayed, regardless of sample depth.
4. Metals SCO Exceedance Boundary was calculated using the five metals analyzed for the Tru-Grit Site and their associated SMS/DMMP screening levels: arsenic (57 mg/kg), chromium (260 mg/kg), copper (390 mg/kg), lead (450 mg/kg), and zinc (410 mg/kg).

µg/kg: microgram per kilogram  
 AET: apparent effects threshold  
 DMMP: Dredged Material Management Program  
 mg/kg: milligram per kilogram  
 PCB: polychlorinated biphenyl  
 SCO: sediment cleanup objective  
 SCUM: Sediment Cleanup User's Manual (WA State Dept. of Ecology, 2025)



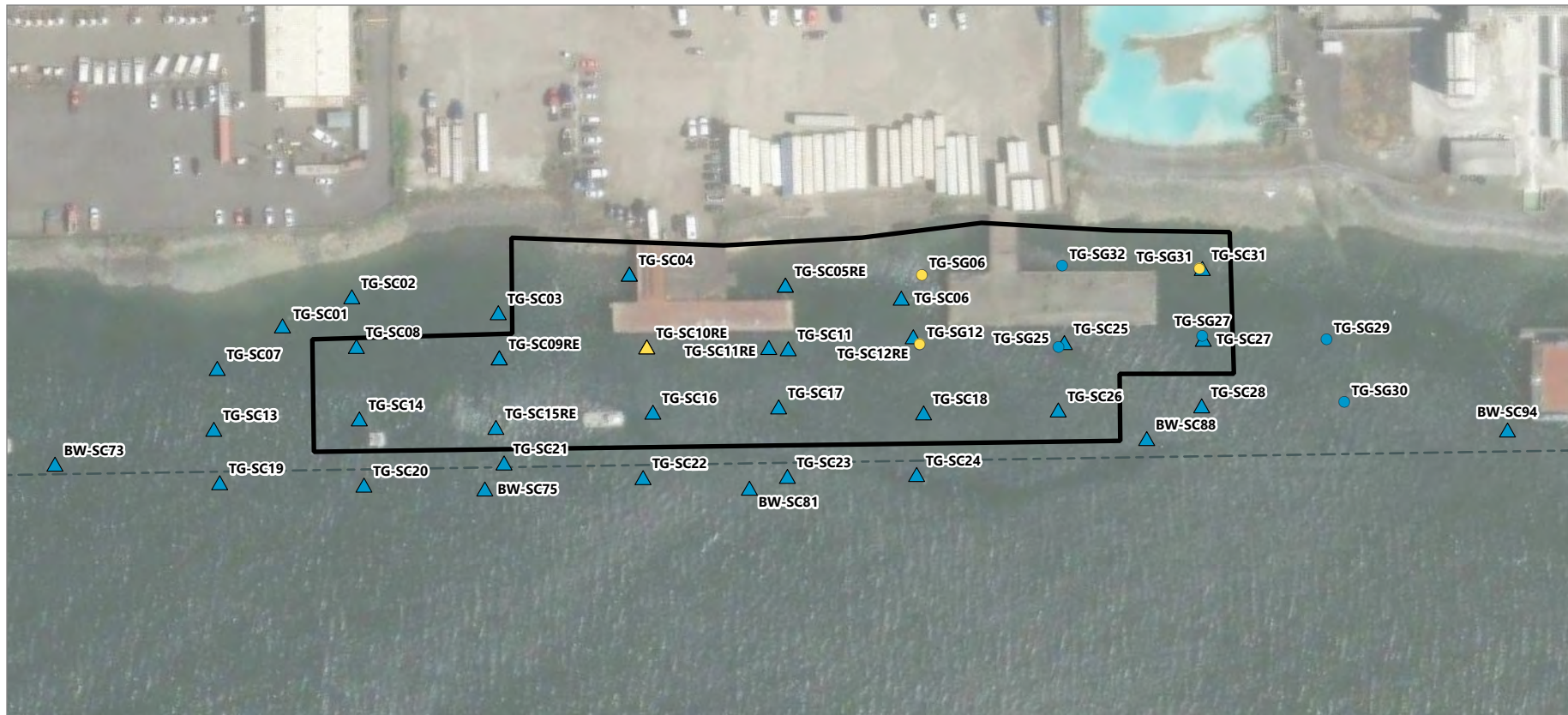
Publish Date: 2026/01/22, 2:44 PM | User: eiverson

Filepath: \\gstfile01\GIS\Jobs\PortofTacoma\_0092\Tru-Grit\_Site\_Project\_D\Maps\Interim\_Action\_Plan\AQ\_PoT\_Trugrit\_InterimActionPlan.aprx | TruGrit\_InterimActionPlan\_Fig2\_5a\_tPCB



**Figure 2-5a**  
**Distribution of Other Site-Associated Contaminants: Total PCB Aroclors**

Interim Action Plan  
 Port of Tacoma – Tru-Grit Site



**LEGEND:**

Feasibility Study Navigation Channel Boundary

Preliminary Site Boundary

**Sample Location**

Core (Subsurface Sediment)

Grab

**Tributyltin Exceedance**

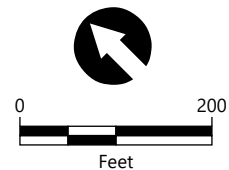
No SCO Exceedance

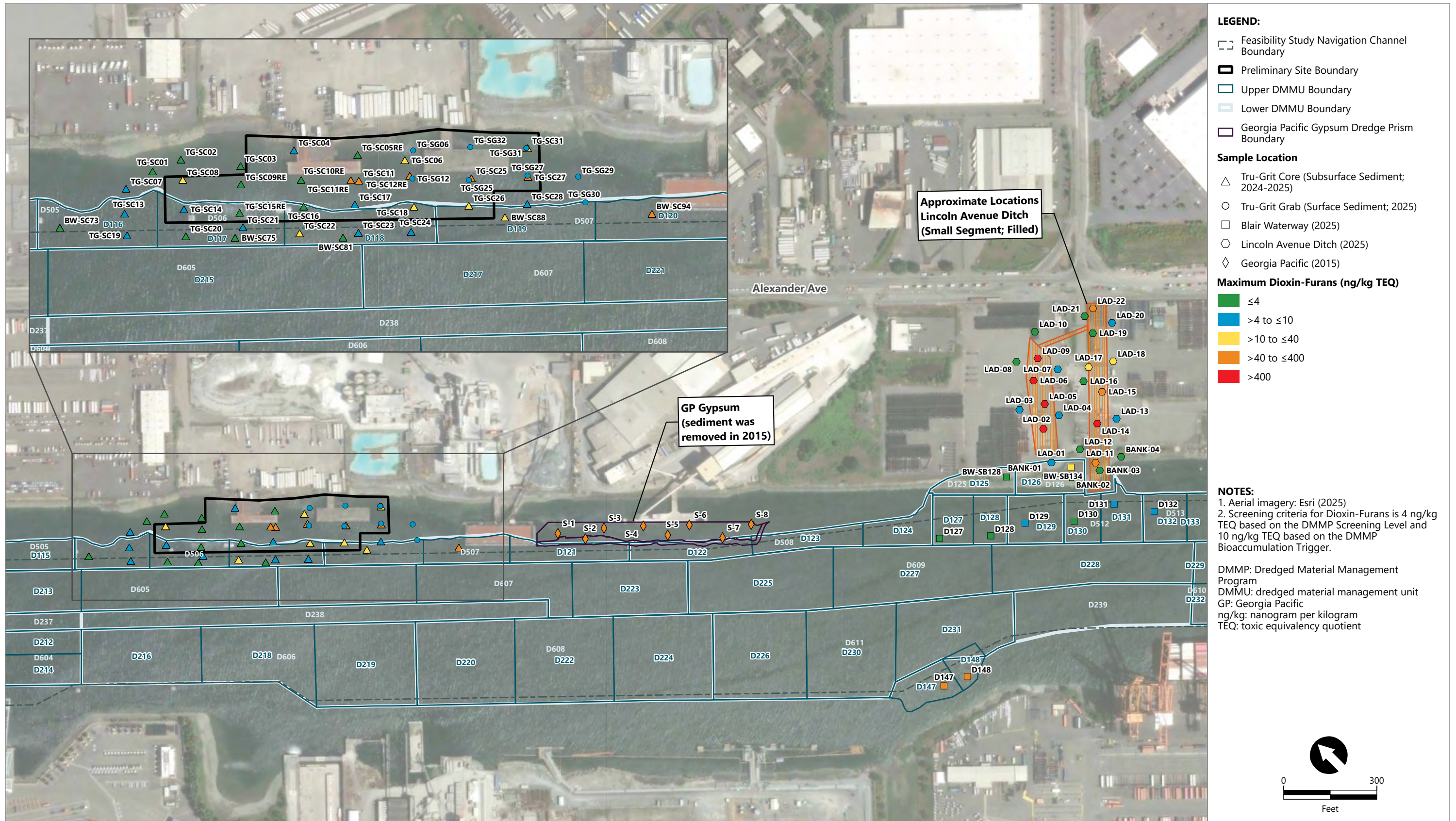
SCO Exceedance

**NOTES:**

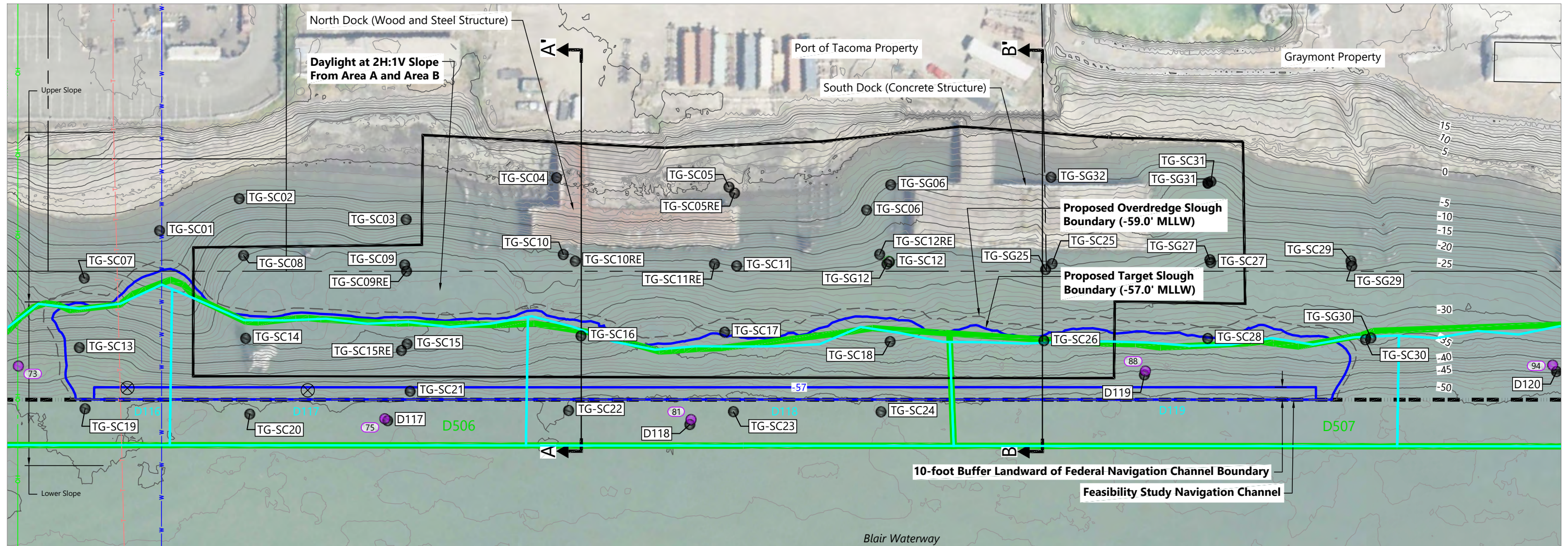
1. Aerial imagery: Esri (2025)
2. Screening criteria for Tributyltin is 73 µg/kg based on the DMMP Bioaccumulation Trigger.
3. Maximum sample concentration within each core is displayed, regardless of sample depth.
4. Metals SCO Exceedance Boundary was calculated using the five metals analyzed for the Tru-Grit Site and their associated SMS/DMMP screening levels: arsenic (57 mg/kg), chromium (260 mg/kg), copper (390 mg/kg), lead (450 mg/kg), and zinc (410 mg/kg).

µg/kg: microgram per kilogram  
 DMMP: Dredged Material Management Program  
 mg/kg: milligram per kilogram  
 SCO: sediment cleanup objective  
 SMS: Sediment Management Standards





Publish Date: 2026/01/14, 9:55 AM | User: thartmann  
 Filepath: \\GSTFile01\GIS\Jobs\PortofTacoma\_0092\Tru-Grit\_Site\_Project\_D\Maps\Interim\_Action\_Plan\AQ\_PoT\_Trugrit\_InterimActionPlan.aprx | TruGrit\_InterimActionPlan\_Fig2\_6\_RegionalContaminants\_DF



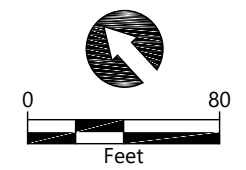
**SOURCES:** Bathymetric survey by eHydro dated 11/14/22; Aerial image from World Imagery: Esri, Maxar, Earthstar Geographics, and the GIS User community.  
**HORIZONTAL DATUM:** Washington State Plane South Zone, NAD83, U.S. Survey Feet  
**VERTICAL DATUM:** MLLW

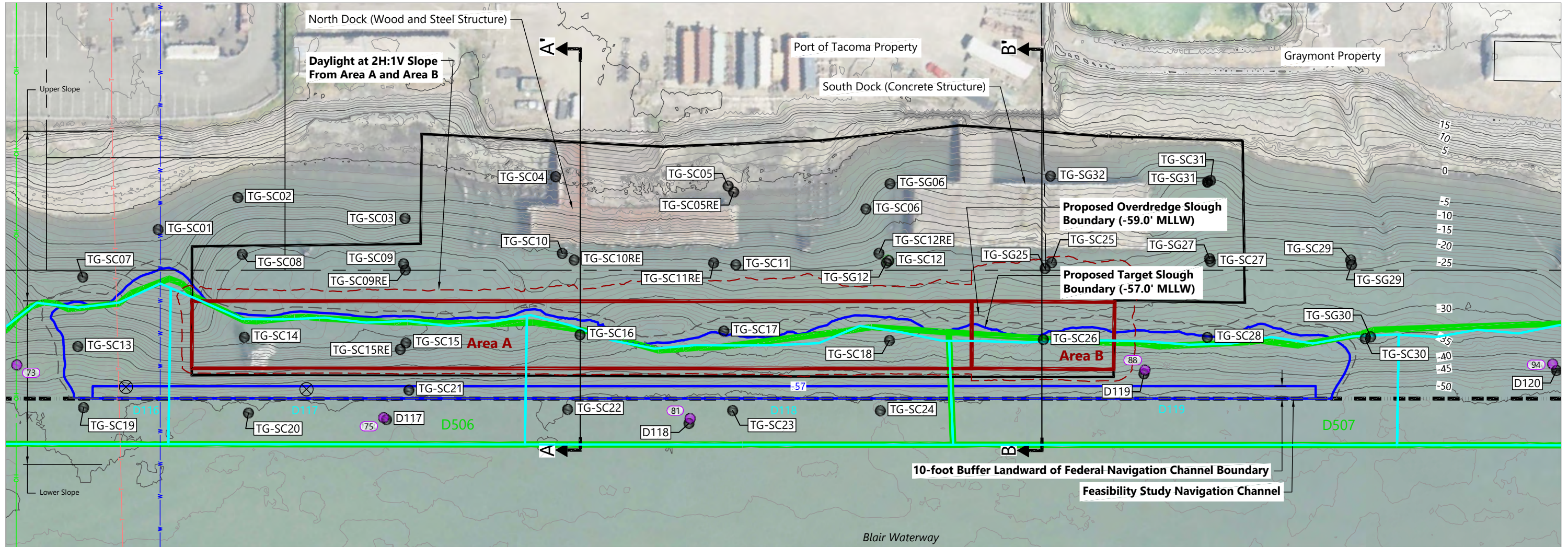
**NOTE:**  
 FNC deepening project along federal navigation channel boundary, and up to the 10-foot lateral buffer landward of the federal navigation channel boundary, will cause material above it to slough at approximately 2H:1V slope. Slough material will be subsequently dredged.

**ABBREVIATIONS:**  
 DMMU: Dredged Material Management Unit  
 FNC: federal navigation channel  
 H:V: horizontal to vertical ratio  
 MLLW: mean lower low water  
 NAD83: North American Datum of 1983

**LEGEND:**

- Existing Contours (USACE 2022, 1' and 5' Interval)
- FNC Deepening Project Design Elevation Slough Boundary in Tru-Grit Area (-57.0' MLLW)
- FNC Deepening Project Allowable Overdredge Slough Boundary in Tru-Grit Area (-59.0' MLLW)
- Feasibility Study Navigation Channel
- Property Line
- Preliminary Site Boundary
- Actual Core Sampling Location
- Channel Deepening Sideslope Vibracore Location
- Channel Deepening Lower DMMU Boundary
- Channel Deepening Upper DMMU Boundary
- Navigational Aid
- Overhead Power
- Underwater Crossing Communication
- Underwater Crossing Watermain





**SOURCES:** Bathymetric survey by eHydro dated 11/14/22; Aerial image from World Imagery; Esri, Maxar, Earthstar Geographics, and the GIS User community.  
**HORIZONTAL DATUM:** Washington State Plane South Zone, NAD83, U.S. Survey Feet  
**VERTICAL DATUM:** MLLW

**NOTE:**  
 FNC deepening project along federal navigation channel boundary, and up to the 10-foot lateral buffer landward of the federal navigation channel boundary, will cause material above it to slough at approximately 2H:1V slope. Slough material will be subsequently dredged.

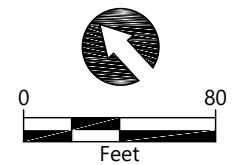
**ABBREVIATIONS:**  
 DMMU: Dredged Material Management Unit  
 FNC: federal navigation channel  
 H:V: horizontal to vertical ratio  
 MLLW: mean lower low water  
 NAD83: North American Datum of 1983

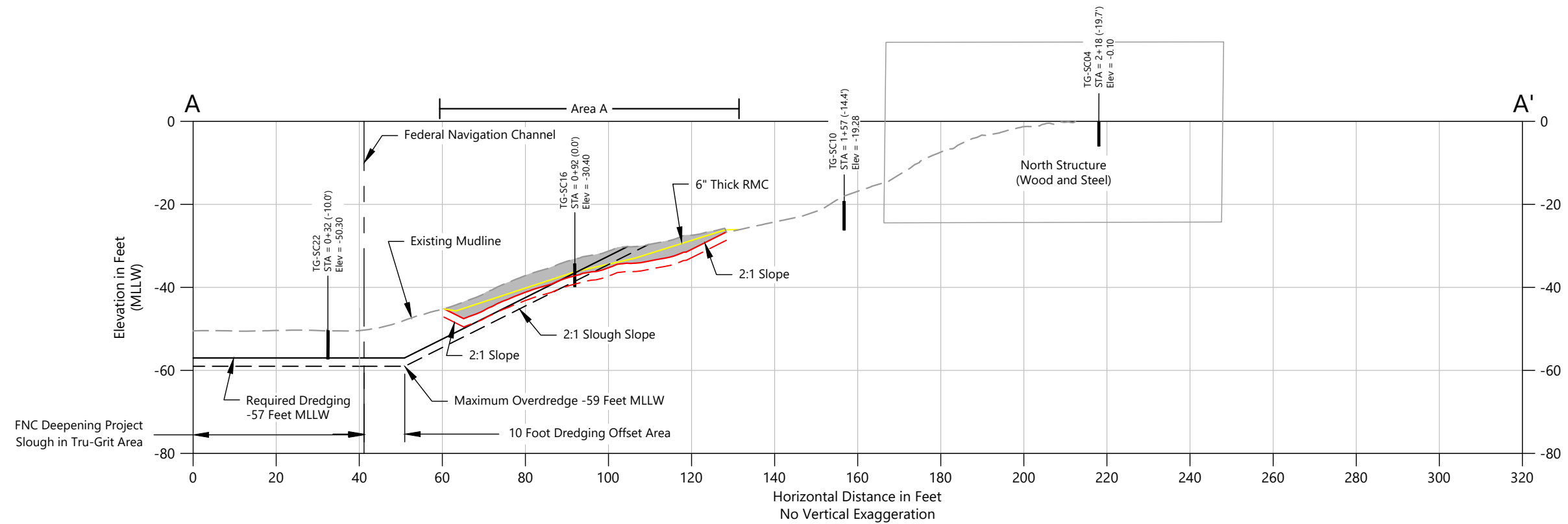
**LEGEND:**

- Existing Contours (USACE 2022, 1' and 5' Interval)
- FNC Deepening Project Design Elevation Slough Boundary in Tru-Grit Area (-57.0' MLLW)
- FNC Deepening Project Allowable Overdredge Slough Boundary in Tru-Grit Area (-59.0' MLLW)
- Feasibility Study Navigation Channel
- Property Line
- Preliminary Site Boundary
- Actual Core Sampling Location
- Channel Deepening Sideslope Vibracore Location

- Channel Deepening Lower DMMU Boundary
- Channel Deepening Upper DMMU Boundary
- Proposed Dredge Area Daylight Slope
- Dredge Area A, Lower Slope  
4' Dredge Depth + 2' Over-Dredge  
(Confirmed Contamination within Slough Area)
- Dredge Area B, Lower Slope  
8' Dredge Depth + 2' Over-Dredge  
(Confirmed Contamination within Slough Area)

- Navigational Aid
- Overhead Power
- Underwater Crossing Communication
- Underwater Crossing Watermain

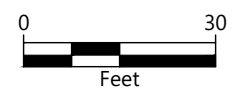


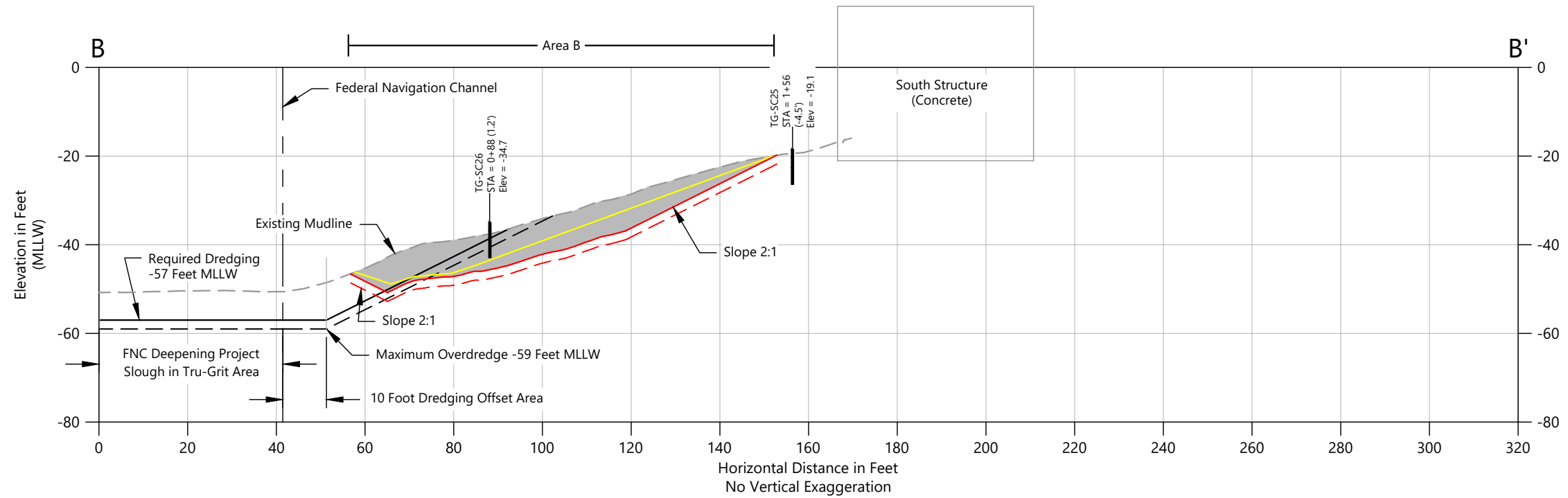


**NOTE:**  
 FNC deepening project along FNC boundary, and up to the 10-foot lateral buffer landward of the FNC boundary, will cause material above it to slough at approximately 2H:1V slope. Slough material will be subsequently dredged. Proposed dredge areas in the Tru-Grit lower slope (area A and area B) will be dredged prior to FNC deepening project, to mitigate the sloughing of Tru-Grit contaminated material into the FNC project area.

**ABBREVIATIONS:**  
 FNC: federal navigation channel  
 H:V: horizontal to vertical (ratio)  
 MLLW: mean lower low water  
 RMC: residuals management cover

- LEGEND:**
- Required FNC Dredging, -57 Feet MLLW
  - - - Maximum FNC Overdredge, -59 Feet MLLW
  - - - Existing Mudline
  - Dredge Area A Design Depth, 4' Depth Cut
  - - - Dredge Area A 2' Allowable Overdredge
  - RMC Placement
  - █ Lower Slope Dredge Area

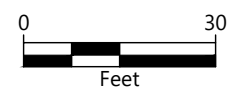




**NOTE:**  
 FNC deepening project along FNC boundary, and up to the 10-foot lateral buffer landward of the FNC boundary, will cause material above it to slough at approximately 2H:1V slope. Slough material will be subsequently dredged. Proposed dredge areas in the Tru-Grit lower slope (area A and area B) will be dredged prior to FNC deepening project, to mitigate the sloughing of Tru-Grit contaminated material into the FNC project area.

**ABBREVIATIONS:**  
 FNC: federal navigation channel  
 H:V: horizontal to vertical (ratio)  
 MLLW: mean lower low water  
 RMC: residuals management cover

- LEGEND:**
- Required FNC Dredging, -57 Feet MLLW
  - - - Maximum FNC Overdredge, -59 Feet MLLW
  - - - Existing Mudline
  - Dredge Area A Design Depth, 8' Depth Cut
  - - - Dredge Area B 2' Allowable Overdredge
  - RMC Placement
  - █ Lower Slope Dredge Area



# Appendix A

## ProUCL Outputs

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**Appendix A-1**  
**ProUCL Output – 95% Upper Confidence Levels**

**UCL Statistics for Data Sets with Non-Detects**

User Selected Options  
 Date/Time of Computation ProUCL 5.2 12/15/2025 2:08:30 PM  
 From File Data for hilltopping 20251215.xls  
 Full Precision OFF  
 Confidence Coefficient 95%  
 Number of Bootstrap Operations 2000

**Max\_per\_loc\_avg\_dups (arsenic;mg/kg;remaining after removal of sc-08 sc-05 sg-32)**

<b>General Statistics</b>			
Total Number of Observations	19	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	4.21	Mean	7.307
Maximum	14.6	Median	6.56
SD	2.876	Std. Error of Mean	0.66
Coefficient of Variation	0.394	Skewness	1.558

<b>Normal GOF Test</b>		<b>Shapiro Wilk GOF Test</b>	
Shapiro Wilk Test Statistic	0.829	Data Not Normal at 1% Significance Level	
1% Shapiro Wilk Critical Value	0.863		
Lilliefors Test Statistic	0.212	<b>Lilliefors GOF Test</b>	
1% Lilliefors Critical Value	0.229	Data appear Normal at 1% Significance Level	

**Data appear Approximate Normal at 1% Significance Level**

<b>Assuming Normal Distribution</b>			
<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	8.451	95% Adjusted-CLT UCL (Chen-1995)	8.644
		95% Modified-t UCL (Johnson-1978)	8.49

<b>Gamma GOF Test</b>		<b>Anderson-Darling Gamma GOF Test</b>	
A-D Test Statistic	0.614	Detected data appear Gamma Distributed at 5% Significance Level	
5% A-D Critical Value	0.742		
K-S Test Statistic	0.159	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.199	Detected data appear Gamma Distributed at 5% Significance Level	

**Detected data appear Gamma Distributed at 5% Significance Level**

<b>Gamma Statistics</b>			
k hat (MLE)	8.352	k star (bias corrected MLE)	7.068
Theta hat (MLE)	0.875	Theta star (bias corrected MLE)	1.034
nu hat (MLE)	317.4	nu star (bias corrected)	268.6
MLE Mean (bias corrected)	7.307	MLE Sd (bias corrected)	2.748
		Approximate Chi Square Value (0.05)	231.6
Adjusted Level of Significance	0.0369	Adjusted Chi Square Value	228.6

<b>Assuming Gamma Distribution</b>			
95% Approximate Gamma UCL	8.472	95% Adjusted Gamma UCL	8.584

**Appendix A-1**

**ProUCL Output – 95% Upper Confidence Levels**

<b>Lognormal GOF Test</b>			
Shapiro Wilk Test Statistic	0.934	<b>Shapiro Wilk Lognormal GOF Test</b>	
10% Shapiro Wilk Critical Value	0.917	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.137	<b>Lilliefors Lognormal GOF Test</b>	
10% Lilliefors Critical Value	0.18	Data appear Lognormal at 10% Significance Level	
<b>Data appear Lognormal at 10% Significance Level</b>			

<b>Lognormal Statistics</b>			
Minimum of Logged Data	1.437	Mean of logged Data	1.928
Maximum of Logged Data	2.681	SD of logged Data	0.346

<b>Assuming Lognormal Distribution</b>			
95% H-UCL	8.504	90% Chebyshev (MVUE) UCL	9.035
95% Chebyshev (MVUE) UCL	9.833	97.5% Chebyshev (MVUE) UCL	10.94
99% Chebyshev (MVUE) UCL	13.12		

**Nonparametric Distribution Free UCL Statistics**  
**Data appear to follow a Discernible Distribution**

<b>Nonparametric Distribution Free UCLs</b>			
95% CLT UCL	8.392	95% BCA Bootstrap UCL	8.755
95% Standard Bootstrap UCL	8.392	95% Bootstrap-t UCL	9.186
95% Hall's Bootstrap UCL	10.29	95% Percentile Bootstrap UCL	8.453
90% Chebyshev(Mean, Sd) UCL	9.286	95% Chebyshev(Mean, Sd) UCL	10.18
97.5% Chebyshev(Mean, Sd) UCL	11.43	99% Chebyshev(Mean, Sd) UCL	13.87

<b>Suggested UCL to Use</b>	
95% Student's-t UCL	8.451

When a data set follows an approximate distribution passing only one of the GOF tests, it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness using results from simulation studies. However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Max\_per\_loc\_avg\_dups (arsenic;mg/kg;removed with removal of sc-08 sc-05 sg-32)**

<b>General Statistics</b>			
Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	9.04	Mean	171.8
Maximum	1620	Median	75.7
SD	366.5	Std. Error of Mean	86.38
Coefficient of Variation	2.133	Skewness	4.053

<b>Normal GOF Test</b>		<b>Shapiro Wilk GOF Test</b>	
Shapiro Wilk Test Statistic	0.392	Data Not Normal at 1% Significance Level	
1% Shapiro Wilk Critical Value	0.858		

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

Lilliefors Test Statistic	0.391	<b>Lilliefors GOF Test</b>
1% Lilliefors Critical Value	0.235	Data Not Normal at 1% Significance Level

**Data Not Normal at 1% Significance Level**

#### Assuming Normal Distribution

##### 95% Normal UCL

95% Student's-t UCL 322.1

##### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 402.1

95% Modified-t UCL (Johnson-1978) 335.8

#### Gamma GOF Test

A-D Test Statistic 1.626

5% A-D Critical Value 0.777

K-S Test Statistic 0.235

5% K-S Critical Value 0.211

#### Anderson-Darling Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

#### Kolmogorov-Smirnov Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

#### Gamma Statistics

k hat (MLE) 0.773

Theta hat (MLE) 222.3

nu hat (MLE) 27.83

MLE Mean (bias corrected) 171.8

Adjusted Level of Significance 0.0357

k star (bias corrected MLE) 0.681

Theta star (bias corrected MLE) 252.2

nu star (bias corrected) 24.52

MLE Sd (bias corrected) 208.2

Approximate Chi Square Value (0.05) 14.25

Adjusted Chi Square Value 13.5

#### Assuming Gamma Distribution

95% Approximate Gamma UCL 295.7

95% Adjusted Gamma UCL 312.1

#### Lognormal GOF Test

Shapiro Wilk Test Statistic 0.923

10% Shapiro Wilk Critical Value 0.914

Lilliefors Test Statistic 0.144

10% Lilliefors Critical Value 0.185

#### Shapiro Wilk Lognormal GOF Test

Data appear Lognormal at 10% Significance Level

#### Lilliefors Lognormal GOF Test

Data appear Lognormal at 10% Significance Level

**Data appear Lognormal at 10% Significance Level**

#### Lognormal Statistics

Minimum of Logged Data 2.202

Maximum of Logged Data 7.39

Mean of logged Data 4.375

SD of logged Data 1.083

#### Assuming Lognormal Distribution

95% H-UCL 294.7

95% Chebyshev (MVUE) UCL 306.1

99% Chebyshev (MVUE) UCL 524.1

90% Chebyshev (MVUE) UCL 253.1

97.5% Chebyshev (MVUE) UCL 379.7

#### Nonparametric Distribution Free UCL Statistics

**Data appear to follow a Discernible Distribution**

#### Nonparametric Distribution Free UCLs

95% CLT UCL 313.9

95% Standard Bootstrap UCL 307.4

95% Hall's Bootstrap UCL 840.3

95% BCA Bootstrap UCL 440.9

95% Bootstrap-t UCL 958.5

95% Percentile Bootstrap UCL 336.5

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

90% Chebyshev(Mean, Sd) UCL	430.9	95% Chebyshev(Mean, Sd) UCL	548.3
97.5% Chebyshev(Mean, Sd) UCL	711.3	99% Chebyshev(Mean, Sd) UCL	1031

#### Suggested UCL to Use

95% H-UCL 294.7

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.

Please verify the data were collected from random locations.

If the data were collected using judgmental or other non-random methods,  
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

#### Max\_per\_loc\_avg\_dups (cadmium;mg/kg;remaining after removal of sc-08 sc-05 sg-32)

General Statistics			
Total Number of Observations	19	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.1	Mean	0.152
Maximum	0.26	Median	0.14
SD	0.0453	Std. Error of Mean	0.0104
Coefficient of Variation	0.298	Skewness	1.219

Normal GOF Test		Shapiro Wilk GOF Test	
Shapiro Wilk Test Statistic	0.872	Data appear Normal at 1% Significance Level	
1% Shapiro Wilk Critical Value	0.863	Lilliefors GOF Test	
Lilliefors Test Statistic	0.203	Data appear Normal at 1% Significance Level	
1% Lilliefors Critical Value	0.229	<b>Data appear Normal at 1% Significance Level</b>	

Assuming Normal Distribution		95% UCLs (Adjusted for Skewness)	
<b>95% Normal UCL</b>		95% Adjusted-CLT UCL (Chen-1995)	
95% Student's-t UCL	0.17	95% Modified-t UCL (Johnson-1978)	0.172
			0.171

Gamma GOF Test		Anderson-Darling Gamma GOF Test	
A-D Test Statistic	0.563	Detected data appear Gamma Distributed at 5% Significance Level	
5% A-D Critical Value	0.741	Kolmogorov-Smirnov Gamma GOF Test	
K-S Test Statistic	0.168	Detected data appear Gamma Distributed at 5% Significance Level	
5% K-S Critical Value	0.198	<b>Detected data appear Gamma Distributed at 5% Significance Level</b>	

Gamma Statistics			
k hat (MLE)	13.56	k star (bias corrected MLE)	11.45
Theta hat (MLE)	0.0112	Theta star (bias corrected MLE)	0.0133
nu hat (MLE)	515.1	nu star (bias corrected)	435.1
MLE Mean (bias corrected)	0.152	MLE Sd (bias corrected)	0.0449

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

Adjusted Level of Significance	0.0369	Approximate Chi Square Value (0.05)	387.8
		Adjusted Chi Square Value	383.9

#### Assuming Gamma Distribution

95% Approximate Gamma UCL	0.171	95% Adjusted Gamma UCL	0.172
---------------------------	-------	------------------------	-------

#### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.936	<b>Shapiro Wilk Lognormal GOF Test</b>
10% Shapiro Wilk Critical Value	0.917	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.15	<b>Lilliefors Lognormal GOF Test</b>
10% Lilliefors Critical Value	0.18	Data appear Lognormal at 10% Significance Level

**Data appear Lognormal at 10% Significance Level**

#### Lognormal Statistics

Minimum of Logged Data	-2.303	Mean of logged Data	-1.921
Maximum of Logged Data	-1.347	SD of logged Data	0.274

#### Assuming Lognormal Distribution

95% H-UCL	0.171	90% Chebyshev (MVUE) UCL	0.181
95% Chebyshev (MVUE) UCL	0.194	97.5% Chebyshev (MVUE) UCL	0.212
99% Chebyshev (MVUE) UCL	0.248		

#### Nonparametric Distribution Free UCL Statistics

**Data appear to follow a Discernible Distribution**

#### Nonparametric Distribution Free UCLs

95% CLT UCL	0.169	95% BCA Bootstrap UCL	0.172
95% Standard Bootstrap UCL	0.169	95% Bootstrap-t UCL	0.177
95% Hall's Bootstrap UCL	0.181	95% Percentile Bootstrap UCL	0.17
90% Chebyshev(Mean, Sd) UCL	0.183	95% Chebyshev(Mean, Sd) UCL	0.197
97.5% Chebyshev(Mean, Sd) UCL	0.217	99% Chebyshev(Mean, Sd) UCL	0.255

#### Suggested UCL to Use

95% Student's-t UCL	0.17
---------------------	------

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

#### Max\_per\_loc\_avg\_dups (cadmium;mg/kg;removed with removal of sc-08 sc-05 sg-32)

General Statistics			
Total Number of Observations	18	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.18	Mean	0.466
Maximum	1.48	Median	0.36
SD	0.346	Std. Error of Mean	0.0815
Coefficient of Variation	0.742	Skewness	2.069

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

<b>Normal GOF Test</b>			
Shapiro Wilk Test Statistic	0.732	<b>Shapiro Wilk GOF Test</b>	
1% Shapiro Wilk Critical Value	0.858	Data Not Normal at 1% Significance Level	
Lilliefors Test Statistic	0.294	<b>Lilliefors GOF Test</b>	
1% Lilliefors Critical Value	0.235	Data Not Normal at 1% Significance Level	
<b>Data Not Normal at 1% Significance Level</b>			
<b>Assuming Normal Distribution</b>			
<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	0.608	95% Adjusted-CLT UCL (Chen-1995)	0.643
		95% Modified-t UCL (Johnson-1978)	0.615
<b>Gamma GOF Test</b>			
A-D Test Statistic	0.89	<b>Anderson-Darling Gamma GOF Test</b>	
5% A-D Critical Value	0.747	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.209	<b>Kolmogorov-Smirnov Gamma GOF Test</b>	
5% K-S Critical Value	0.205	Data Not Gamma Distributed at 5% Significance Level	
<b>Data Not Gamma Distributed at 5% Significance Level</b>			
<b>Gamma Statistics</b>			
k hat (MLE)	2.857	k star (bias corrected MLE)	2.418
Theta hat (MLE)	0.163	Theta star (bias corrected MLE)	0.193
nu hat (MLE)	102.9	nu star (bias corrected)	87.06
MLE Mean (bias corrected)	0.466	MLE Sd (bias corrected)	0.3
		Approximate Chi Square Value (0.05)	66.55
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	64.83
<b>Assuming Gamma Distribution</b>			
95% Approximate Gamma UCL	0.61	95% Adjusted Gamma UCL	0.626
<b>Lognormal GOF Test</b>			
Shapiro Wilk Test Statistic	0.92	<b>Shapiro Wilk Lognormal GOF Test</b>	
10% Shapiro Wilk Critical Value	0.914	Data appear Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.165	<b>Lilliefors Lognormal GOF Test</b>	
10% Lilliefors Critical Value	0.185	Data appear Lognormal at 10% Significance Level	
<b>Data appear Lognormal at 10% Significance Level</b>			
<b>Lognormal Statistics</b>			
Minimum of Logged Data	-1.715	Mean of logged Data	-0.948
Maximum of Logged Data	0.392	SD of logged Data	0.585
<b>Assuming Lognormal Distribution</b>			
95% H-UCL	0.62	90% Chebyshev (MVUE) UCL	0.651
95% Chebyshev (MVUE) UCL	0.74	97.5% Chebyshev (MVUE) UCL	0.864
99% Chebyshev (MVUE) UCL	1.107		
<b>Nonparametric Distribution Free UCL Statistics</b>			
<b>Data appear to follow a Discernible Distribution</b>			
<b>Nonparametric Distribution Free UCLs</b>			

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

95% CLT UCL	0.6	95% BCA Bootstrap UCL	0.651
95% Standard Bootstrap UCL	0.597	95% Bootstrap-t UCL	0.761
95% Hall's Bootstrap UCL	1.209	95% Percentile Bootstrap UCL	0.603
90% Chebyshev(Mean, Sd) UCL	0.711	95% Chebyshev(Mean, Sd) UCL	0.822
97.5% Chebyshev(Mean, Sd) UCL	0.975	99% Chebyshev(Mean, Sd) UCL	1.277

#### Suggested UCL to Use

95% H-UCL 0.62

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

#### Max\_per\_loc\_avg\_dups (lead;mg/kg;remaining after removal of sc-08 sc-05 sg-32)

##### General Statistics

Total Number of Observations	19	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	5.98	Mean	14.29
Maximum	62.5	Median	9.6
SD	13.88	Std. Error of Mean	3.183
Coefficient of Variation	0.971	Skewness	2.866

##### Normal GOF Test

Shapiro Wilk Test Statistic	0.573
1% Shapiro Wilk Critical Value	0.863
Lilliefors Test Statistic	0.353
1% Lilliefors Critical Value	0.229

##### Shapiro Wilk GOF Test

Data Not Normal at 1% Significance Level

##### Lilliefors GOF Test

Data Not Normal at 1% Significance Level

**Data Not Normal at 1% Significance Level**

##### Assuming Normal Distribution

##### 95% Normal UCL

95% Student's-t UCL 19.81

##### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 21.76  
95% Modified-t UCL (Johnson-1978) 20.16

##### Gamma GOF Test

A-D Test Statistic	2.112
5% A-D Critical Value	0.751
K-S Test Statistic	0.282
5% K-S Critical Value	0.201

##### Anderson-Darling Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

##### Kolmogorov-Smirnov Gamma GOF Test

Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

##### Gamma Statistics

k hat (MLE)	2.262	k star (bias corrected MLE)	1.94
Theta hat (MLE)	6.317	Theta star (bias corrected MLE)	7.366
nu hat (MLE)	85.95	nu star (bias corrected)	73.72
MLE Mean (bias corrected)	14.29	MLE Sd (bias corrected)	10.26
		Approximate Chi Square Value (0.05)	54.94
Adjusted Level of Significance	0.0369	Adjusted Chi Square Value	53.53

**Appendix A-1**  
**ProUCL Output – 95% Upper Confidence Levels**

**Assuming Gamma Distribution**

95% Approximate Gamma UCL	19.17	95% Adjusted Gamma UCL	19.68
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<b>Lognormal GOF Test</b>			
Shapiro Wilk Test Statistic	0.801	<b>Shapiro Wilk Lognormal GOF Test</b>	
10% Shapiro Wilk Critical Value	0.917	Data Not Lognormal at 10% Significance Level	
Lilliefors Test Statistic	0.235	<b>Lilliefors Lognormal GOF Test</b>	
10% Lilliefors Critical Value	0.18	Data Not Lognormal at 10% Significance Level	

**Data Not Lognormal at 10% Significance Level**

<b>Lognormal Statistics</b>			
Minimum of Logged Data	1.788	Mean of logged Data	2.422
Maximum of Logged Data	4.135	SD of logged Data	0.608

<b>Assuming Lognormal Distribution</b>			
95% H-UCL	18.38	90% Chebyshev (MVUE) UCL	19.31
95% Chebyshev (MVUE) UCL	21.99	97.5% Chebyshev (MVUE) UCL	25.7
99% Chebyshev (MVUE) UCL	32.98		

**Nonparametric Distribution Free UCL Statistics**

**Data do not follow a Discernible Distribution**

<b>Nonparametric Distribution Free UCLs</b>			
95% CLT UCL	19.53	95% BCA Bootstrap UCL	22.98
95% Standard Bootstrap UCL	19.53	95% Bootstrap-t UCL	37.16
95% Hall's Bootstrap UCL	45.87	95% Percentile Bootstrap UCL	20.07
90% Chebyshev(Mean, Sd) UCL	23.84	95% Chebyshev(Mean, Sd) UCL	28.17
97.5% Chebyshev(Mean, Sd) UCL	34.17	99% Chebyshev(Mean, Sd) UCL	45.96

**Suggested UCL to Use**

95% Student's-t UCL	19.81
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. Recommendations are based upon data size, data distribution, and skewness using results from simulation studies. However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Max\_per\_loc\_avg\_dups (lead;mg/kg;removed with removal of sc-08 sc-05 sg-32)**

<b>General Statistics</b>			
Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	26	Mean	183.7
Maximum	1290	Median	82
SD	292.6	Std. Error of Mean	68.97
Coefficient of Variation	1.593	Skewness	3.542

<b>Normal GOF Test</b>			
Shapiro Wilk Test Statistic	0.514	<b>Shapiro Wilk GOF Test</b>	

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

1% Shapiro Wilk Critical Value	0.858	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.321	<b>Lilliefors GOF Test</b>
1% Lilliefors Critical Value	0.235	Data Not Normal at 1% Significance Level

#### Data Not Normal at 1% Significance Level

#### Assuming Normal Distribution

<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	303.7	95% Adjusted-CLT UCL (Chen-1995)	358.7
		95% Modified-t UCL (Johnson-1978)	313.3

#### Gamma GOF Test

A-D Test Statistic	1.195	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.766	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.22	<b>Kolmogorov-Smirnov Gamma GOF Test</b>
5% K-S Critical Value	0.209	Data Not Gamma Distributed at 5% Significance Level

#### Data Not Gamma Distributed at 5% Significance Level

#### Gamma Statistics

k hat (MLE)	1.017	k star (bias corrected MLE)	0.884
Theta hat (MLE)	180.7	Theta star (bias corrected MLE)	207.8
nu hat (MLE)	36.59	nu star (bias corrected)	31.83
MLE Mean (bias corrected)	183.7	MLE Sd (bias corrected)	195.4
		Approximate Chi Square Value (0.05)	19.94
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	19.03

#### Assuming Gamma Distribution

95% Approximate Gamma UCL	293.3	95% Adjusted Gamma UCL	307.2
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#### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.932	<b>Shapiro Wilk Lognormal GOF Test</b>
10% Shapiro Wilk Critical Value	0.914	Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.134	<b>Lilliefors Lognormal GOF Test</b>
10% Lilliefors Critical Value	0.185	Data appear Lognormal at 10% Significance Level

#### Data appear Lognormal at 10% Significance Level

#### Lognormal Statistics

Minimum of Logged Data	3.258	Mean of logged Data	4.647
Maximum of Logged Data	7.162	SD of logged Data	0.96

#### Assuming Lognormal Distribution

95% H-UCL	301.3	90% Chebyshev (MVUE) UCL	279
95% Chebyshev (MVUE) UCL	333.2	97.5% Chebyshev (MVUE) UCL	408.3
99% Chebyshev (MVUE) UCL	555.8		

#### Nonparametric Distribution Free UCL Statistics

#### Data appear to follow a Discernible Distribution

#### Nonparametric Distribution Free UCLs

95% CLT UCL	297.2	95% BCA Bootstrap UCL	393
95% Standard Bootstrap UCL	292.9	95% Bootstrap-t UCL	554.7

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

95% Hall's Bootstrap UCL	678.6	95% Percentile Bootstrap UCL	308.2
90% Chebyshev(Mean, Sd) UCL	390.6	95% Chebyshev(Mean, Sd) UCL	484.3
97.5% Chebyshev(Mean, Sd) UCL	614.4	99% Chebyshev(Mean, Sd) UCL	869.9

#### Suggested UCL to Use

95% H-UCL 301.3

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.

Please verify the data were collected from random locations.

If the data were collected using judgmental or other non-random methods,  
then contact a statistician to correctly calculate UCLs.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

#### Max\_per\_loc\_avg\_dups (mercury;mg/kg;remaining after removal of sc-08 sc-05 sg-32)

General Statistics			
Total Number of Observations	19	Number of Distinct Observations	19
Number of Detects	17	Number of Non-Detects	2
Number of Distinct Detects	17	Number of Distinct Non-Detects	2
Minimum Detect	0.00984	Minimum Non-Detect	0.0323
Maximum Detect	0.194	Maximum Non-Detect	0.0335
Variance Detects	0.0019	Percent Non-Detects	10.53%
Mean Detects	0.0515	SD Detects	0.0435
Median Detects	0.0391	CV Detects	0.846
Skewness Detects	2.478	Kurtosis Detects	7.269
Mean of Logged Detects	-3.218	SD of Logged Detects	0.722

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.731	<b>Shapiro Wilk GOF Test</b>
1% Shapiro Wilk Critical Value	0.851	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.265	<b>Lilliefors GOF Test</b>
1% Lilliefors Critical Value	0.241	Detected Data Not Normal at 1% Significance Level

Detected Data Not Normal at 1% Significance Level

#### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0483	KM Standard Error of Mean	0.00974
90KM SD	0.0411	95% KM (BCA) UCL	0.0647
95% KM (t) UCL	0.0652	95% KM (Percentile Bootstrap) UCL	0.0654
95% KM (z) UCL	0.0643	95% KM Bootstrap t UCL	0.0834
90% KM Chebyshev UCL	0.0775	95% KM Chebyshev UCL	0.0908
97.5% KM Chebyshev UCL	0.109	99% KM Chebyshev UCL	0.145

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.465	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.167	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.212	Detected data appear Gamma Distributed at 5% Significance Level

**Appendix A-1**  
**ProUCL Output – 95% Upper Confidence Levels**

**Detected data appear Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	2.144	k star (bias corrected MLE)	1.805
Theta hat (MLE)	0.024	Theta star (bias corrected MLE)	0.0285
nu hat (MLE)	72.9	nu star (bias corrected)	61.37
Mean (detects)	0.0515		

**Gamma ROS Statistics using Imputed Non-Detects**

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs  
 GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)  
 For such situations, GROS method may yield incorrect values of UCLs and BTVs  
 This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00984	Mean	0.0474
Maximum	0.194	Median	0.0381
SD	0.0428	CV	0.903
k hat (MLE)	1.885	k star (bias corrected MLE)	1.623
Theta hat (MLE)	0.0251	Theta star (bias corrected MLE)	0.0292
nu hat (MLE)	71.63	nu star (bias corrected)	61.66
Adjusted Level of Significance ( $\beta$ )	0.0369		
Approximate Chi Square Value (61.66, $\alpha$ )	44.6	Adjusted Chi Square Value (61.66, $\beta$ )	43.33
95% Gamma Approximate UCL	0.0655	95% Gamma Adjusted UCL	0.0674

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	0.0483	SD (KM)	0.0411
Variance (KM)	0.00169	SE of Mean (KM)	0.00974
k hat (KM)	1.384	k star (KM)	1.201
nu hat (KM)	52.61	nu star (KM)	45.64
theta hat (KM)	0.0349	theta star (KM)	0.0402
80% gamma percentile (KM)	0.0765	90% gamma percentile (KM)	0.106
95% gamma percentile (KM)	0.136	99% gamma percentile (KM)	0.203

**Gamma Kaplan-Meier (KM) Statistics**

Approximate Chi Square Value (45.64, $\alpha$ )	31.14	Adjusted Chi Square Value (45.64, $\beta$ )	30.09
95% KM Approximate Gamma UCL	0.0708	95% KM Adjusted Gamma UCL	0.0733

**Lognormal GOF Test on Detected Observations Only**

Shapiro Wilk Test Statistic	0.966	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk Critical Value	0.91	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.139	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.19	Detected Data appear Lognormal at 10% Significance Level

**Detected Data appear Lognormal at 10% Significance Level**

**Lognormal ROS Statistics Using Imputed Non-Detects**

Mean in Original Scale	0.0481	Mean in Log Scale	-3.293
SD in Original Scale	0.0423	SD in Log Scale	0.717
95% t UCL (assumes normality of ROS data)	0.0649	95% Percentile Bootstrap UCL	0.0651
95% BCA Bootstrap UCL	0.0708	95% Bootstrap t UCL	0.0802
95% H-UCL (Log ROS)	0.0702		

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

#### Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.292	KM Geo Mean	0.0372
KM SD (logged)	0.712	95% Critical H Value (KM-Log)	2.235
KM Standard Error of Mean (logged)	0.173	95% H-UCL (KM -Log)	0.0697
KM SD (logged)	0.712	95% Critical H Value (KM-Log)	2.235
KM Standard Error of Mean (logged)	0.173		

#### DL/2 Statistics

##### DL/2 Normal

Mean in Original Scale	0.0478
SD in Original Scale	0.0425
95% t UCL (Assumes normality)	0.0647

##### DL/2 Log-Transformed

Mean in Log Scale	-3.312
SD in Log Scale	0.736
95% H-Stat UCL	0.0708

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

#### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Gamma Distributed at 5% Significance Level**

#### Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.0733	95% GROS Adjusted Gamma UCL	0.0674
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

#### Max\_per\_loc\_avg\_dups (mercury;mg/kg;removed with removal of sc-08 sc-05 sg-32)

#### General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	0.0235	Mean	0.155
Maximum	0.344	Median	0.132
SD	0.106	Std. Error of Mean	0.0249
Coefficient of Variation	0.682	Skewness	0.743

#### Normal GOF Test

Shapiro Wilk Test Statistic	0.872
1% Shapiro Wilk Critical Value	0.858
Lilliefors Test Statistic	0.159
1% Lilliefors Critical Value	0.235

#### Shapiro Wilk GOF Test

Data appear Normal at 1% Significance Level

#### Lilliefors GOF Test

Data appear Normal at 1% Significance Level

**Data appear Normal at 1% Significance Level**

#### Assuming Normal Distribution

##### 95% Normal UCL

95% Student's-t UCL	0.199
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##### 95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.201
95% Modified-t UCL (Johnson-1978)	0.199

#### Gamma GOF Test

A-D Test Statistic	0.422
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#### Anderson-Darling Gamma GOF Test

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

5% A-D Critical Value 0.751 Detected data appear Gamma Distributed at 5% Significance Level

K-S Test Statistic 0.144 **Kolmogorov-Smirnov Gamma GOF Test**

5% K-S Critical Value 0.206 Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

#### Gamma Statistics

k hat (MLE)	2.194	k star (bias corrected MLE)	1.866
Theta hat (MLE)	0.0707	Theta star (bias corrected MLE)	0.0832
nu hat (MLE)	78.99	nu star (bias corrected)	67.16
MLE Mean (bias corrected)	0.155	MLE Sd (bias corrected)	0.114
		Approximate Chi Square Value (0.05)	49.3
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	47.83

#### Assuming Gamma Distribution

95% Approximate Gamma UCL	0.211	95% Adjusted Gamma UCL	0.218
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#### Lognormal GOF Test

Shapiro Wilk Test Statistic	0.946	<b>Shapiro Wilk Lognormal GOF Test</b>
10% Shapiro Wilk Critical Value	0.914	Data appear Lognormal at 10% Significance Level

Lilliefors Test Statistic 0.12 **Lilliefors Lognormal GOF Test**

10% Lilliefors Critical Value 0.185 Data appear Lognormal at 10% Significance Level

**Data appear Lognormal at 10% Significance Level**

#### Lognormal Statistics

Minimum of Logged Data	-3.751	Mean of logged Data	-2.108
Maximum of Logged Data	-1.067	SD of logged Data	0.756

#### Assuming Lognormal Distribution

95% H-UCL	0.247	90% Chebyshev (MVUE) UCL	0.249
95% Chebyshev (MVUE) UCL	0.291	97.5% Chebyshev (MVUE) UCL	0.348
99% Chebyshev (MVUE) UCL	0.46		

#### Nonparametric Distribution Free UCL Statistics

**Data appear to follow a Discernible Distribution**

#### Nonparametric Distribution Free UCLs

95% CLT UCL	0.196	95% BCA Bootstrap UCL	0.204
95% Standard Bootstrap UCL	0.196	95% Bootstrap-t UCL	0.209
95% Hall's Bootstrap UCL	0.201	95% Percentile Bootstrap UCL	0.198
90% Chebyshev(Mean, Sd) UCL	0.23	95% Chebyshev(Mean, Sd) UCL	0.264
97.5% Chebyshev(Mean, Sd) UCL	0.311	99% Chebyshev(Mean, Sd) UCL	0.403

#### Suggested UCL to Use

95% Student's-t UCL 0.199

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Max\_per\_loc\_avg\_dups (total cpah teq (7 minimum caepa 2005) (u = 1/2 max limit);ug/kg;remaining after removal of sc-08 sc-05 sg-32)**

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

General Statistics			
Total Number of Observations	19	Number of Distinct Observations	16
Number of Detects	17	Number of Non-Detects	2
Number of Distinct Detects	15	Number of Distinct Non-Detects	1
Minimum Detect	15.3	Minimum Non-Detect	20
Maximum Detect	106	Maximum Non-Detect	20
Variance Detects	889.5	Percent Non-Detects	10.53%
Mean Detects	48.5	SD Detects	29.82
Median Detects	47	CV Detects	0.615
Skewness Detects	0.437	Kurtosis Detects	-0.994
Mean of Logged Detects	3.671	SD of Logged Detects	0.702

Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.914	<b>Shapiro Wilk GOF Test</b>	
1% Shapiro Wilk Critical Value	0.851	Detected Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.155	<b>Lilliefors GOF Test</b>	
1% Lilliefors Critical Value	0.241	Detected Data appear Normal at 1% Significance Level	
<b>Detected Data appear Normal at 1% Significance Level</b>			

#### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	45.08	KM Standard Error of Mean	6.889
90KM SD	29.13	95% KM (BCA) UCL	56.27
95% KM (t) UCL	57.03	95% KM (Percentile Bootstrap) UCL	56.62
95% KM (z) UCL	56.42	95% KM Bootstrap t UCL	59.47
90% KM Chebyshev UCL	65.75	95% KM Chebyshev UCL	75.11
97.5% KM Chebyshev UCL	88.11	99% KM Chebyshev UCL	113.6

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.566	<b>Anderson-Darling GOF Test</b>	
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.155	<b>Kolmogorov-Smirnov GOF</b>	
5% K-S Critical Value	0.211	Detected data appear Gamma Distributed at 5% Significance Level	
<b>Detected data appear Gamma Distributed at 5% Significance Level</b>			

#### Gamma Statistics on Detected Data Only

k hat (MLE)	2.527	k star (bias corrected MLE)	2.121
Theta hat (MLE)	19.19	Theta star (bias corrected MLE)	22.87
nu hat (MLE)	85.93	nu star (bias corrected)	72.1
Mean (detects)	48.5		

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs  
 GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)  
 For such situations, GROS method may yield incorrect values of UCLs and BTVs  
 This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	12.28	Mean	45.17
Maximum	106	Median	41.2
SD	29.87	CV	0.661

**Appendix A-1**

**ProUCL Output – 95% Upper Confidence Levels**

k hat (MLE)	2.303	k star (bias corrected MLE)	1.974
Theta hat (MLE)	19.62	Theta star (bias corrected MLE)	22.88
nu hat (MLE)	87.5	nu star (bias corrected)	75.02
Adjusted Level of Significance ( $\beta$ )	0.0369		
Approximate Chi Square Value (75.02, $\alpha$ )	56.07	Adjusted Chi Square Value (75.02, $\beta$ )	54.64
95% Gamma Approximate UCL	60.44	95% Gamma Adjusted UCL	62.02

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	45.08	SD (KM)	29.13
Variance (KM)	848.5	SE of Mean (KM)	6.889
k hat (KM)	2.395	k star (KM)	2.052
nu hat (KM)	91.03	nu star (KM)	77.99
theta hat (KM)	18.82	theta star (KM)	21.97
80% gamma percentile (KM)	67.29	90% gamma percentile (KM)	87.15
95% gamma percentile (KM)	106.1	99% gamma percentile (KM)	148

**Gamma Kaplan-Meier (KM) Statistics**

Approximate Chi Square Value (77.99, $\alpha$ )	58.64	Adjusted Chi Square Value (77.99, $\beta$ )	57.18
95% KM Approximate Gamma UCL	59.95	95% KM Adjusted Gamma UCL	61.49

**Lognormal GOF Test on Detected Observations Only**

Shapiro Wilk Test Statistic	0.893	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk Critical Value	0.91	Detected Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.149	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.19	Detected Data appear Lognormal at 10% Significance Level

**Detected Data appear Approximate Lognormal at 10% Significance Level**

**Lognormal ROS Statistics Using Imputed Non-Detects**

Mean in Original Scale	45.29	Mean in Log Scale	3.587
SD in Original Scale	29.74	SD in Log Scale	0.71
95% t UCL (assumes normality of ROS data)	57.12	95% Percentile Bootstrap UCL	56.54
95% BCA Bootstrap UCL	57.12	95% Bootstrap t UCL	58.15
95% H-UCL (Log ROS)	67.56		

**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**

KM Mean (logged)	3.576	KM Geo Mean	35.74
KM SD (logged)	0.701	95% Critical H Value (KM-Log)	2.222
KM Standard Error of Mean (logged)	0.166	95% H-UCL (KM -Log)	65.96
KM SD (logged)	0.701	95% Critical H Value (KM-Log)	2.222
KM Standard Error of Mean (logged)	0.166		

**DL/2 Statistics**

<b>DL/2 Normal</b>		<b>DL/2 Log-Transformed</b>	
Mean in Original Scale	44.45	Mean in Log Scale	3.527
SD in Original Scale	30.63	SD in Log Scale	0.79
95% t UCL (Assumes normality)	56.63	95% H-Stat UCL	71.69

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

**Nonparametric Distribution Free UCL Statistics**

**Detected Data appear Normal Distributed at 1% Significance Level**

**Appendix A-1**  
**ProUCL Output – 95% Upper Confidence Levels**

**Suggested UCL to Use**

95% KM (t) UCL 57.03

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Max\_per\_loc\_avg\_dups (total cpah teq (7 minimum caepa 2005) (u = 1/2 max limit);ug/kg;removed with removal of sc-08 sc-05 sg-32)**

**General Statistics**

Total Number of Observations	18	Number of Distinct Observations	16
Number of Detects	15	Number of Non-Detects	3
Number of Distinct Detects	14	Number of Distinct Non-Detects	2
Minimum Detect	9.84	Minimum Non-Detect	13.2
Maximum Detect	1230	Maximum Non-Detect	14.2
Variance Detects	171204	Percent Non-Detects	16.67%
Mean Detects	276.5	SD Detects	413.8
Median Detects	82.7	CV Detects	1.496
Skewness Detects	1.66	Kurtosis Detects	1.309
Mean of Logged Detects	4.477	SD of Logged Detects	1.647

**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic	0.67	<b>Shapiro Wilk GOF Test</b>
1% Shapiro Wilk Critical Value	0.835	Detected Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.327	<b>Lilliefors GOF Test</b>
1% Lilliefors Critical Value	0.255	Detected Data Not Normal at 1% Significance Level

**Detected Data Not Normal at 1% Significance Level**

**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**

KM Mean	232.1	KM Standard Error of Mean	92.27
90KM SD	378.2	95% KM (BCA) UCL	388.7
95% KM (t) UCL	392.6	95% KM (Percentile Bootstrap) UCL	390.2
95% KM (z) UCL	383.9	95% KM Bootstrap t UCL	497.3
90% KM Chebyshev UCL	508.9	95% KM Chebyshev UCL	634.3
97.5% KM Chebyshev UCL	808.3	99% KM Chebyshev UCL	1150

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	0.792	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.79	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.168	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.233	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data follow Appr. Gamma Distribution at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	0.547	k star (bias corrected MLE)	0.482
Theta hat (MLE)	505.7	Theta star (bias corrected MLE)	573.9
nu hat (MLE)	16.4	nu star (bias corrected)	14.46
Mean (detects)	276.5		

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	230.5
Maximum	1230	Median	55.05
SD	390.2	CV	1.693
k hat (MLE)	0.281	k star (bias corrected MLE)	0.271
Theta hat (MLE)	819.2	Theta star (bias corrected MLE)	849
nu hat (MLE)	10.13	nu star (bias corrected)	9.773
Adjusted Level of Significance ( $\beta$ )	0.0357		
Approximate Chi Square Value (9.77, $\alpha$ )	3.8	Adjusted Chi Square Value (9.77, $\beta$ )	3.45
95% Gamma Approximate UCL	592.7	95% Gamma Adjusted UCL	652.9

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	232.1	SD (KM)	378.2
Variance (KM)	143039	SE of Mean (KM)	92.27
k hat (KM)	0.377	k star (KM)	0.351
nu hat (KM)	13.56	nu star (KM)	12.63
theta hat (KM)	616.3	theta star (KM)	661.5
80% gamma percentile (KM)	367.7	90% gamma percentile (KM)	670
95% gamma percentile (KM)	1008	99% gamma percentile (KM)	1872

#### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (12.63, $\alpha$ )	5.646	Adjusted Chi Square Value (12.63, $\beta$ )	5.203
95% KM Approximate Gamma UCL	519.3	95% KM Adjusted Gamma UCL	563.5

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.913	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.187	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 10% Significance Level

**Detected Data appear Lognormal at 10% Significance Level**

#### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	231.1	Mean in Log Scale	3.958
SD in Original Scale	389.7	SD in Log Scale	1.918
95% t UCL (assumes normality of ROS data)	391	95% Percentile Bootstrap UCL	384.7
95% BCA Bootstrap UCL	429.1	95% Bootstrap t UCL	482.3
95% H-UCL (Log ROS)	2287		

#### Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.112	KM Geo Mean	61.04
KM SD (logged)	1.666	95% Critical H Value (KM-Log)	3.72
KM Standard Error of Mean (logged)	0.407	95% H-UCL (KM -Log)	1100
KM SD (logged)	1.666	95% Critical H Value (KM-Log)	3.72
KM Standard Error of Mean (logged)	0.407		

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

DL/2 Statistics			
DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	231.6	Mean in Log Scale	4.053
SD in Original Scale	389.5	SD in Log Scale	1.784
95% t UCL (Assumes normality)	391.3	95% H-Stat UCL	1548

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

**Nonparametric Distribution Free UCL Statistics**  
**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**

**Suggested UCL to Use**  
 95% KM Adjusted Gamma UCL 563.5

The calculated UCLs are based on assumptions that the data were collected in a random and unbiased manner.  
 Please verify the data were collected from random locations.  
 If the data were collected using judgmental or other non-random methods,  
 then contact a statistician to correctly calculate UCLs.

When a data set follows an approximate distribution passing only one of the GOF tests,  
 it is suggested to use a UCL based upon a distribution passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.  
 Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.  
 However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Max\_per\_loc\_avg\_dups (total pcb aroclors (dmmp) (u = 1/2 max limit);ug/kg;remaining after removal of sc-08 sc-05 sg-32)**

General Statistics			
Total Number of Observations	19	Number of Distinct Observations	14
Number of Detects	8	Number of Non-Detects	11
Number of Distinct Detects	8	Number of Distinct Non-Detects	6
Minimum Detect	20	Minimum Non-Detect	3.5
Maximum Detect	81.9	Maximum Non-Detect	20.5
Variance Detects	488.6	Percent Non-Detects	57.89%
Mean Detects	49.9	SD Detects	22.1
Median Detects	46.5	CV Detects	0.443
Skewness Detects	0.358	Kurtosis Detects	-1.075
Mean of Logged Detects	3.816	SD of Logged Detects	0.477

Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.941	<b>Shapiro Wilk GOF Test</b>	
1% Shapiro Wilk Critical Value	0.749	Detected Data appear Normal at 1% Significance Level	
Lilliefors Test Statistic	0.173	<b>Lilliefors GOF Test</b>	
1% Lilliefors Critical Value	0.333	Detected Data appear Normal at 1% Significance Level	

**Detected Data appear Normal at 1% Significance Level**  
**Note GOF tests may be unreliable for small sample sizes**

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
KM Mean	23.12	KM Standard Error of Mean	6.509
90KM SD	26.51	95% KM (BCA) UCL	37.92

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

95% KM (t) UCL	34.4	95% KM (Percentile Bootstrap) UCL	36.36
95% KM (z) UCL	33.82	95% KM Bootstrap t UCL	34.95
90% KM Chebyshev UCL	42.64	95% KM Chebyshev UCL	51.49
97.5% KM Chebyshev UCL	63.76	99% KM Chebyshev UCL	87.88

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.215	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.719	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.15	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.295	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

**Note GOF tests may be unreliable for small sample sizes**

#### Gamma Statistics on Detected Data Only

k hat (MLE)	5.487	k star (bias corrected MLE)	3.513
Theta hat (MLE)	9.094	Theta star (bias corrected MLE)	14.2
nu hat (MLE)	87.8	nu star (bias corrected)	56.21
Mean (detects)	49.9		

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	21.92
Maximum	81.9	Median	3.5
SD	28.22	CV	1.287
k hat (MLE)	0.239	k star (bias corrected MLE)	0.236
Theta hat (MLE)	91.75	Theta star (bias corrected MLE)	92.78
nu hat (MLE)	9.08	nu star (bias corrected)	8.979
Adjusted Level of Significance ( $\beta$ )	0.0369		
Approximate Chi Square Value (8.98, $\alpha$ )	3.315	Adjusted Chi Square Value (8.98, $\beta$ )	3.02
95% Gamma Approximate UCL	59.39	95% Gamma Adjusted UCL	65.19

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	23.12	SD (KM)	26.51
Variance (KM)	703	SE of Mean (KM)	6.509
k hat (KM)	0.76	k star (KM)	0.675
nu hat (KM)	28.88	nu star (KM)	25.66
theta hat (KM)	30.41	theta star (KM)	34.24
80% gamma percentile (KM)	38.04	90% gamma percentile (KM)	58.52
95% gamma percentile (KM)	79.71	99% gamma percentile (KM)	130.5

#### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (25.66, $\alpha$ )	15.11	Adjusted Chi Square Value (25.66, $\beta$ )	14.41
95% KM Approximate Gamma UCL	39.24	95% KM Adjusted Gamma UCL	41.16

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.957	<b>Shapiro Wilk GOF Test</b>
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## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

10% Shapiro Wilk Critical Value	0.851	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.127	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.265	Detected Data appear Lognormal at 10% Significance Level

**Detected Data appear Lognormal at 10% Significance Level**

**Note GOF tests may be unreliable for small sample sizes**

#### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	27.61	Mean in Log Scale	2.991
SD in Original Scale	24.04	SD in Log Scale	0.815
95% t UCL (assumes normality of ROS data)	37.17	95% Percentile Bootstrap UCL	36.6
95% BCA Bootstrap UCL	37.7	95% Bootstrap t UCL	39.65
95% H-UCL (Log ROS)	43.69		

#### Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.34	KM Geo Mean	10.39
KM SD (logged)	1.297	95% Critical H Value (KM-Log)	3.058
KM Standard Error of Mean (logged)	0.319	95% H-UCL (KM -Log)	61.33
KM SD (logged)	1.297	95% Critical H Value (KM-Log)	3.058
KM Standard Error of Mean (logged)	0.319		

#### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	25.91	Mean in Log Scale	2.756
SD in Original Scale	25.26	SD in Log Scale	1.103
95% t UCL (Assumes normality)	35.96	95% H-Stat UCL	59.28

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

#### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Normal Distributed at 1% Significance Level**

#### Suggested UCL to Use

95% KM (t) UCL	34.4
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

#### Max\_per\_loc\_avg\_dups (total pcb aroclors (dmmp) (u = 1/2 max limit);ug/kg;removed with removal of sc-08 sc-05 sg-32)

#### General Statistics

Total Number of Observations	18	Number of Distinct Observations	17
Number of Detects	10	Number of Non-Detects	8
Number of Distinct Detects	10	Number of Distinct Non-Detects	7
Minimum Detect	30.5	Minimum Non-Detect	13
Maximum Detect	536	Maximum Non-Detect	19.9
Variance Detects	28022	Percent Non-Detects	44.44%
Mean Detects	187.4	SD Detects	167.4
Median Detects	128.5	CV Detects	0.893
Skewness Detects	1.449	Kurtosis Detects	1.195
Mean of Logged Detects	4.879	SD of Logged Detects	0.922

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

#### Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.803	<b>Shapiro Wilk GOF Test</b>
1% Shapiro Wilk Critical Value	0.781	Detected Data appear Normal at 1% Significance Level
Lilliefors Test Statistic	0.301	<b>Lilliefors GOF Test</b>
1% Lilliefors Critical Value	0.304	Detected Data appear Normal at 1% Significance Level

**Detected Data appear Normal at 1% Significance Level**

#### Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	109.9	KM Standard Error of Mean	36.45
90KM SD	146.7	95% KM (BCA) UCL	171.7
95% KM (t) UCL	173.3	95% KM (Percentile Bootstrap) UCL	172
95% KM (z) UCL	169.9	95% KM Bootstrap t UCL	234.2
90% KM Chebyshev UCL	219.3	95% KM Chebyshev UCL	268.8
97.5% KM Chebyshev UCL	337.5	99% KM Chebyshev UCL	472.6

#### Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.396	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.195	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.271	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

#### Gamma Statistics on Detected Data Only

k hat (MLE)	1.555	k star (bias corrected MLE)	1.155
Theta hat (MLE)	120.5	Theta star (bias corrected MLE)	162.2
nu hat (MLE)	31.1	nu star (bias corrected)	23.11
Mean (detects)	187.4		

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	104.1
Maximum	536	Median	32.75
SD	155	CV	1.488
k hat (MLE)	0.187	k star (bias corrected MLE)	0.193
Theta hat (MLE)	557.5	Theta star (bias corrected MLE)	540.4
nu hat (MLE)	6.724	nu star (bias corrected)	6.937
Adjusted Level of Significance ( $\beta$ )	0.0357		
Approximate Chi Square Value (6.94, $\alpha$ )	2.136	Adjusted Chi Square Value (6.94, $\beta$ )	1.89
95% Gamma Approximate UCL	338.2	95% Gamma Adjusted UCL	382.3

#### Estimates of Gamma Parameters using KM Estimates

Mean (KM)	109.9	SD (KM)	146.7
Variance (KM)	21524	SE of Mean (KM)	36.45
k hat (KM)	0.561	k star (KM)	0.505
nu hat (KM)	20.2	nu star (KM)	18.17

## Appendix A-1

### ProUCL Output – 95% Upper Confidence Levels

theta hat (KM)	195.8	theta star (KM)	217.8
80% gamma percentile (KM)	180.6	90% gamma percentile (KM)	296.8
95% gamma percentile (KM)	420.8	99% gamma percentile (KM)	725.5

#### Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.17, $\alpha$ )	9.513	Adjusted Chi Square Value (18.17, $\beta$ )	8.916
95% KM Approximate Gamma UCL	209.9	95% KM Adjusted Gamma UCL	224

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.936	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk Critical Value	0.869	Detected Data appear Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.161	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.241	Detected Data appear Lognormal at 10% Significance Level

Detected Data appear Lognormal at 10% Significance Level

#### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	109.7	Mean in Log Scale	3.822
SD in Original Scale	151.1	SD in Log Scale	1.396
95% t UCL (assumes normality of ROS data)	171.6	95% Percentile Bootstrap UCL	170.3
95% BCA Bootstrap UCL	186	95% Bootstrap t UCL	226.9
95% H-UCL (Log ROS)	364.9		

#### Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.85	KM Geo Mean	47.01
KM SD (logged)	1.322	95% Critical H Value (KM-Log)	3.136
KM Standard Error of Mean (logged)	0.328	95% H-UCL (KM -Log)	307.7
KM SD (logged)	1.322	95% Critical H Value (KM-Log)	3.136
KM Standard Error of Mean (logged)	0.328		

#### DL/2 Statistics

<b>DL/2 Normal</b>		<b>DL/2 Log-Transformed</b>	
Mean in Original Scale	108.1	Mean in Log Scale	3.674
SD in Original Scale	152.2	SD in Log Scale	1.542
95% t UCL (Assumes normality)	170.5	95% H-Stat UCL	480.9

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

#### Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 1% Significance Level

#### Suggested UCL to Use

95% KM (t) UCL	173.3
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness using results from simulation studies.

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

**Background Statistics for Data Sets with Non-Detects**

**User Selected Options**

Date/Time of Computation ProUCL 5.2 12/15/2025 3:58:11 PM  
 From File 20251125\_Blair\_Main\_Channel\_Flat\_File\_D100-300\_added\_chems.xls  
 Full Precision OFF  
 Confidence Coefficient 90%  
 Coverage 90%  
 Different or Future K Observations 1  
 Number of Bootstrap Operations 2000

result\_value1 (arsenic)

**General Statistics**

Total Number of Observations	100	Number of Distinct Observations	90
Minimum	1.18	First Quartile	2.555
Second Largest	12.1	Median	3.55
Maximum	131	Third Quartile	4.793
Mean	5.145	SD	12.85
Coefficient of Variation	2.498	Skewness	9.675
Mean of logged Data	1.275	SD of logged Data	0.609

**Critical Values for Background Threshold Values (BTVs)**

Tolerance Factor K (For UTL)	1.467	d2max (for USL)	3.024
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**Normal GOF Test**

Shapiro Wilk Test Statistic 0.198  
 1% Shapiro Wilk P Value 0  
 Lilliefors Test Statistic 0.396  
 1% Lilliefors Critical Value 0.103

**Normal GOF Test**

Data Not Normal at 1% Significance Level  
**Lilliefors GOF Test**  
 Data Not Normal at 1% Significance Level

**Data Not Normal at 1% Significance Level**

**Background Statistics Assuming Normal Distribution**

90% UTL with 90% Coverage	23.99	90% Percentile (z)	21.62
90% UPL (t)	21.81	95% Percentile (z)	26.28
90% USL	44.01	99% Percentile (z)	35.04

**Gamma GOF Test**

A-D Test Statistic 7.946  
 5% A-D Critical Value 0.77  
 K-S Test Statistic 0.189  
 5% K-S Critical Value 0.0911

**Anderson-Darling Gamma GOF Test**

Data Not Gamma Distributed at 5% Significance Level

**Kolmogorov-Smirnov Gamma GOF Test**

Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics**

k hat (MLE)	1.522	k star (bias corrected MLE)	1.483
Theta hat (MLE)	3.38	Theta star (bias corrected MLE)	3.469
nu hat (MLE)	304.4	nu star (bias corrected)	296.6
MLE Mean (bias corrected)	5.145	MLE Sd (bias corrected)	4.225

**Background Statistics Assuming Gamma Distribution**

90% Wilson Hilferty (WH) Approx. Gamma UPL	9.626	90% Percentile	10.75
90% Hawkins Wixley (HW) Approx. Gamma UPL	8.992	95% Percentile	13.45
90% WH Approx. Gamma UTL with 90% Coverage	10.66	99% Percentile	19.56
90% HW Approx. Gamma UTL with 90% Coverage	9.95		
90% WH USL	23.74	90% HW USL	22.69

**Lognormal GOF Test**

Shapiro Wilk Test Statistic 0.884  
 10% Shapiro Wilk P Value 8.070E-11  
 Lilliefors Test Statistic 0.0813  
 10% Lilliefors Critical Value 0.0813

**Shapiro Wilk Lognormal GOF Test**

Data Not Lognormal at 10% Significance Level

**Lilliefors Lognormal GOF Test**

Data appear Lognormal at 10% Significance Level

**Data appear Approximate Lognormal at 10% Significance Level**

**Appendix A-2**  
**ProUCL Output – 90/90 Upper Tolerance Limits**

<b>Background Statistics assuming Lognormal Distribution</b>			
90% UTL with 90% Coverage	8.748	90% Percentile (z)	7.814
90% UPL (t)	7.886	95% Percentile (z)	9.751
90% USL	22.6	99% Percentile (z)	14.77

**Nonparametric Distribution Free Background Statistics**  
**Data appear Approximate Lognormal at 10% Significance Level**

<b>Nonparametric Upper Limits for Background Threshold Values</b>			
Order of Statistic, order	95	90% UTL with 90% Coverage	7.43
Approx, f used to compute achieved CC	1.492	Approximate Actual Confidence Coefficient achieved by UTL	0.883
		Approximate Sample Size needed to achieve specified CC	91
90% Percentile Bootstrap UTL with 90% Coverage	7.223	90% BCA Bootstrap UTL with 90% Coverage	7.223
90% UPL	6.722	90% Percentile	6.578
90% Chebyshev UPL	43.89	95% Percentile	7.431
95% Chebyshev UPL	61.44	99% Percentile	13.29
90% USL	131		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20. Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

result\_value1 (cadmium)

<b>General Statistics</b>			
Total Number of Observations	100	Number of Missing Observations	0
Number of Distinct Observations	19	Number of Non-Detects	48
Number of Detects	52	Number of Distinct Non-Detects	4
Number of Distinct Detects	18	Minimum Non-Detect	0.11
Minimum Detect	0.06	Maximum Non-Detect	2
Maximum Detect	0.37	Percent Non-Detects	48%
Variance Detected	0.00467	SD Detected	0.0683
Mean Detected	0.121	SD of Detected Logged Data	0.469
Mean of Detected Logged Data	-2.228		

**Critical Values for Background Threshold Values (BTVs)**

Tolerance Factor K (For UTL)	1.467	d2max (for USL)	3.024
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**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic	0.796
1% Shapiro Wilk P Value	2.9818E-9
Lilliefors Test Statistic	0.2
1% Lilliefors Critical Value	0.141

**Normal GOF Test on Detected Observations Only**

Data Not Normal at 1% Significance Level

**Lilliefors GOF Test**

Data Not Normal at 1% Significance Level

Data Not Normal at 1% Significance Level

**Kaplan Meier (KM) Background Statistics Assuming Normal Distribution**

KM Mean	0.103	KM SD	0.0549
90% UTL90% Coverage	0.183	90% KM UPL (t)	0.174
90% KM Percentile (z)	0.173	95% KM Percentile (z)	0.193
99% KM Percentile (z)	0.23	90% KM USL	0.269

**DL/2 Substitution Background Statistics Assuming Normal Distribution**

Mean	0.13	SD	0.188
90% UTL90% Coverage	0.405	90% UPL (t)	0.373
90% Percentile (z)	0.37	95% Percentile (z)	0.438
99% Percentile (z)	0.566	90% USL	0.697

DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons

**Gamma GOF Tests on Detected Observations Only**

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

A-D Test Statistic	1.665	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.167	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.124	Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	4.337	k star (bias corrected MLE)	4.1
Theta hat (MLE)	0.028	Theta star (bias corrected MLE)	0.0296
nu hat (MLE)	451.1	nu star (bias corrected)	426.4
MLE Mean (bias corrected)	0.121		
MLE Sd (bias corrected)	0.06	90% Percentile of Chisquare (2kstar)	13.63

**Gamma ROS Statistics using Imputed Non-Detects**

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs  
 GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)  
 For such situations, GROS method may yield incorrect values of UCLs and BTVs  
 This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0198	Mean	0.102
Maximum	0.37	Median	0.0882
SD	0.0576	CV	0.565
k hat (MLE)	4.06	k star (bias corrected MLE)	3.945
Theta hat (MLE)	0.0251	Theta star (bias corrected MLE)	0.0259
nu hat (MLE)	812	nu star (bias corrected)	789
MLE Mean (bias corrected)	0.102	MLE Sd (bias corrected)	0.0514
90% Percentile of Chisquare (2kstar)	13.21	90% Percentile	0.171
95% Percentile	0.199	99% Percentile	0.258

**The following statistics are computed using Gamma ROS Statistics on Imputed Data**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW		WH	HW
90% Approx. Gamma UTL with 90% Coverage	0.183	0.184	90% Approx. Gamma UPL	0.171	0.171
90% Gamma USL	0.326	0.341			

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	0.103	SD (KM)	0.0549
Variance (KM)	0.00302	SE of Mean (KM)	0.00589
k hat (KM)	3.495	k star (KM)	3.397
nu hat (KM)	699	nu star (KM)	679.3
theta hat (KM)	0.0294	theta star (KM)	0.0302
80% gamma percentile (KM)	0.144	90% gamma percentile (KM)	0.177
95% gamma percentile (KM)	0.208	99% gamma percentile (KM)	0.274

**The following statistics are computed using gamma distribution and KM estimates**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW		WH	HW
90% Approx. Gamma UTL with 90% Coverage	0.172	0.17	90% Approx. Gamma UPL	0.161	0.16
90% KM Gamma Percentile	0.16	0.159	90% Gamma USL	0.287	0.291

**Lognormal GOF Test on Detected Observations Only**

Shapiro Wilk Approximate Test Statistic	0.915	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk P Value	0.00106	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.141	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.112	Data Not Lognormal at 10% Significance Level

**Data Not Lognormal at 10% Significance Level**

**Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects**

Mean in Original Scale	0.104	Mean in Log Scale	-2.356
SD in Original Scale	0.0547	SD in Log Scale	0.414
90% UTL90% Coverage	0.174	90% BCA UTL90% Coverage	0.19
90% Bootstrap (%) UTL90% Coverage	0.19	90% UPL (t)	0.162
90% Percentile (z)	0.161	95% Percentile (z)	0.187

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

99% Percentile (z) 0.248 90% USL 0.331

**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**

KM Mean of Logged Data	-2.371	90% KM UTL (Lognormal)	90% Coverage	0.168
KM SD of Logged Data	0.398	90% KM UPL (Lognormal)		0.157
90% KM Percentile Lognormal (z)	0.156	90% KM USL (Lognormal)		0.311

**Background DL/2 Statistics Assuming Lognormal Distribution**

Mean in Original Scale	0.13	Mean in Log Scale	-2.391
SD in Original Scale	0.188	SD in Log Scale	0.659
90% UTL	90% Coverage	90% UPL (t)	0.215
90% Percentile (z)	0.213	95% Percentile (z)	0.271
99% Percentile (z)	0.424	90% USL	0.672

**DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.**

**Nonparametric Distribution Free Background Statistics**

**Data do not follow a Discernible Distribution**

**Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)**

Order of Statistic, r	94	90% UTL with	90% Coverage	0.33
Approx, f used to compute achieved CC	1.492	Approximate Actual Confidence Coefficient achieved by UTL		0.883
Approximate Sample Size needed to achieve specified CC	91	90% UPL		0.19
90% USL	2	90% KM Chebyshev UPL		0.268

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20. Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

**result\_value1 (lead)**

**General Statistics**

Total Number of Observations	100	Number of Missing Observations	0
Number of Distinct Observations	95	Number of Non-Detects	2
Number of Detects	98	Number of Distinct Non-Detects	2
Number of Distinct Detects	94	Minimum Non-Detect	2.15
Minimum Detect	1.15	Maximum Non-Detect	3.39
Maximum Detect	36.4	Percent Non-Detects	2%
Variance Detected	29.67	SD Detected	5.447
Mean Detected	5.498	SD of Detected Logged Data	0.711
Mean of Detected Logged Data	1.41		

**Critical Values for Background Threshold Values (BTVs)**

Tolerance Factor K (For UTL) 1.467 d2max (for USL) 3.024

**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic 0.678  
 1% Shapiro Wilk P Value 0  
 Lilliefors Test Statistic 0.225  
 1% Lilliefors Critical Value 0.104

**Normal GOF Test on Detected Observations Only**

Data Not Normal at 1% Significance Level  
**Lilliefors GOF Test**  
 Data Not Normal at 1% Significance Level

**Data Not Normal at 1% Significance Level**

**Kaplan Meier (KM) Background Statistics Assuming Normal Distribution**

KM Mean	5.43	KM SD	5.386
90% UTL	90% Coverage	90% KM UPL (t)	12.41
90% KM Percentile (z)	12.33	95% KM Percentile (z)	14.29
99% KM Percentile (z)	17.96	90% KM USL	21.72

**DL/2 Substitution Background Statistics Assuming Normal Distribution**

Mean	5.416	SD	5.422
90% UTL	90% Coverage	90% UPL (t)	12.45

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

90% Percentile (z)	12.37	95% Percentile (z)	14.34
99% Percentile (z)	18.03	90% USL	21.81

**DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons**

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	3.578	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.767	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.143	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.0917	Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	1.849	k star (bias corrected MLE)	1.799
Theta hat (MLE)	2.973	Theta star (bias corrected MLE)	3.056
nu hat (MLE)	362.4	nu star (bias corrected)	352.7
MLE Mean (bias corrected)	5.498		
MLE Sd (bias corrected)	4.099	90% Percentile of Chisquare (2kstar)	7.177

**Gamma ROS Statistics using Imputed Non-Detects**

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs  
 GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)  
 For such situations, GROS method may yield incorrect values of UCLs and BTVs  
 This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	5.404
Maximum	36.4	Median	3.39
SD	5.433	CV	1.005
k hat (MLE)	1.589	k star (bias corrected MLE)	1.548
Theta hat (MLE)	3.401	Theta star (bias corrected MLE)	3.491
nu hat (MLE)	317.8	nu star (bias corrected)	309.6
MLE Mean (bias corrected)	5.404	MLE Sd (bias corrected)	4.344
90% Percentile of Chisquare (2kstar)	6.402	90% Percentile	11.18
95% Percentile	13.93	99% Percentile	20.14

**The following statistics are computed using Gamma ROS Statistics on Imputed Data**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW	WH	HW
90% Approx. Gamma UTL with 90% Coverage	12.06	12.19	90% Approx. Gamma UPL	10.89
90% Gamma USL	26.97	29.59		

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	5.43	SD (KM)	5.386
Variance (KM)	29.01	SE of Mean (KM)	0.541
k hat (KM)	1.016	k star (KM)	0.992
nu hat (KM)	203.2	nu star (KM)	198.5
theta hat (KM)	5.343	theta star (KM)	5.472
80% gamma percentile (KM)	8.744	90% gamma percentile (KM)	12.53
95% gamma percentile (KM)	16.31	99% gamma percentile (KM)	25.1

**The following statistics are computed using gamma distribution and KM estimates**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW	WH	HW
90% Approx. Gamma UTL with 90% Coverage	11.69	11.57	90% Approx. Gamma UPL	10.44
90% KM Gamma Percentile	10.5	10.35	90% Gamma USL	25.33

**Lognormal GOF Test on Detected Observations Only**

Shapiro Wilk Approximate Test Statistic	0.946	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk P Value	0.00115	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.104	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.0821	Data Not Lognormal at 10% Significance Level

**Data Not Lognormal at 10% Significance Level**

**Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects**

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

Mean in Original Scale	5.429	Mean in Log Scale	1.396
SD in Original Scale	5.414	SD in Log Scale	0.712
90% UTL90% Coverage	11.47	90% BCA UTL90% Coverage	13.22
90% Bootstrap (%) UTL90% Coverage	13.22	90% UPL (t)	10.16
90% Percentile (z)	10.05	95% Percentile (z)	13.02
99% Percentile (z)	21.15	90% USL	34.75

**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**

KM Mean of Logged Data	1.396	90% KM UTL (Lognormal)90% Coverage	11.41
KM SD of Logged Data	0.708	90% KM UPL (Lognormal)	10.12
90% KM Percentile Lognormal (z)	10.01	90% KM USL (Lognormal)	34.39

**Background DL/2 Statistics Assuming Lognormal Distribution**

Mean in Original Scale	5.416	Mean in Log Scale	1.388
SD in Original Scale	5.422	SD in Log Scale	0.721
90% UTL90% Coverage	11.54	90% UPL (t)	10.21
90% Percentile (z)	10.1	95% Percentile (z)	13.13
99% Percentile (z)	21.46	90% USL	35.5

**DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.**

**Nonparametric Distribution Free Background Statistics  
Data do not follow a Discernible Distribution**

**Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)**

Order of Statistic, r	94	90% UTL with90% Coverage	15.3
Approx, f used to compute achieved CC	1.492	Approximate Actual Confidence Coefficient achieved by UTL	0.883
Approximate Sample Size needed to achieve specified CC	91	90% UPL	12.29
90% USL	36.4	90% KM Chebyshev UPL	21.67

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20. Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

result\_value1 (mercury)

**General Statistics**

Total Number of Observations	100	Number of Missing Observations	0
Number of Distinct Observations	91	Number of Non-Detects	6
Number of Detects	94	Number of Distinct Non-Detects	6
Number of Distinct Detects	86	Minimum Non-Detect	0.0238
Minimum Detect	0.00716	Maximum Non-Detect	0.03
Maximum Detect	0.391	Percent Non-Detects	6%
Variance Detected	0.00246	SD Detected	0.0496
Mean Detected	0.0363	SD of Detected Logged Data	0.755
Mean of Detected Logged Data	-3.694		

**Critical Values for Background Threshold Values (BTVs)**

Tolerance Factor K (For UTL)	1.467	d2max (for USL)	3.024
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**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic	0.515
1% Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.318
1% Lilliefors Critical Value	0.106

**Normal GOF Test on Detected Observations Only**

Data Not Normal at 1% Significance Level  
**Lilliefors GOF Test**  
Data Not Normal at 1% Significance Level

**Data Not Normal at 1% Significance Level**

**Kaplan Meier (KM) Background Statistics Assuming Normal Distribution**

KM Mean	0.0351	KM SD	0.0481
90% UTL90% Coverage	0.106	90% KM UPL (t)	0.0974
90% KM Percentile (z)	0.0967	95% KM Percentile (z)	0.114

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

99% KM Percentile (z) 0.147 90% KM USL 0.18

**DL/2 Substitution Background Statistics Assuming Normal Distribution**

Mean	0.0349	SD	0.0484
90% UTL/90% Coverage	0.106	90% UPL (t)	0.0976
90% Percentile (z)	0.0969	95% Percentile (z)	0.114
99% Percentile (z)	0.147	90% USL	0.181

**DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons**

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	5.553	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.771	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.197	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.0941	Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	1.471	k star (bias corrected MLE)	1.431
Theta hat (MLE)	0.0247	Theta star (bias corrected MLE)	0.0253
nu hat (MLE)	276.5	nu star (bias corrected)	269
MLE Mean (bias corrected)	0.0363		
MLE Sd (bias corrected)	0.0303	90% Percentile of Chisquare (2kstar)	6.032

**Gamma ROS Statistics using Imputed Non-Detects**

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs  
 GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)  
 For such situations, GROS method may yield incorrect values of UCLs and BTVs  
 This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00716	Mean	0.0347
Maximum	0.391	Median	0.0204
SD	0.0485	CV	1.395
k hat (MLE)	1.445	k star (bias corrected MLE)	1.408
Theta hat (MLE)	0.024	Theta star (bias corrected MLE)	0.0247
nu hat (MLE)	289	nu star (bias corrected)	281.7
MLE Mean (bias corrected)	0.0347	MLE Sd (bias corrected)	0.0293
90% Percentile of Chisquare (2kstar)	5.96	90% Percentile	0.0735
95% Percentile	0.0924	99% Percentile	0.135

**The following statistics are computed using Gamma ROS Statistics on Imputed Data**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW	WH	HW
90% Approx. Gamma UTL with 90% Coverage	0.0783	0.0762	90% Approx. Gamma UPL	0.0703
90% Gamma USL	0.182	0.188		0.0681

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	0.0351	SD (KM)	0.0481
Variance (KM)	0.00231	SE of Mean (KM)	0.00483
k hat (KM)	0.534	k star (KM)	0.524
nu hat (KM)	106.7	nu star (KM)	104.9
theta hat (KM)	0.0658	theta star (KM)	0.067
80% gamma percentile (KM)	0.0578	90% gamma percentile (KM)	0.0941
95% gamma percentile (KM)	0.133	99% gamma percentile (KM)	0.227

**The following statistics are computed using gamma distribution and KM estimates**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW	WH	HW
90% Approx. Gamma UTL with 90% Coverage	0.0781	0.0761	90% Approx. Gamma UPL	0.0703
90% KM Gamma Percentile	0.0696	0.0674	90% Gamma USL	0.179
				0.185

**Lognormal GOF Test on Detected Observations Only**

Shapiro Wilk Approximate Test Statistic	0.923	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk P Value	8.2261E-6	Data Not Lognormal at 10% Significance Level

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

Lilliefors Test Statistic	0.115	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.0838	Data Not Lognormal at 10% Significance Level
<b>Data Not Lognormal at 10% Significance Level</b>		

**Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects**

Mean in Original Scale	0.0351	Mean in Log Scale	-3.715
SD in Original Scale	0.0483	SD in Log Scale	0.737
90% UTL90% Coverage	0.0718	90% BCA UTL90% Coverage	0.0904
90% Bootstrap (%) UTL90% Coverage	0.0904	90% UPL (t)	0.0633
90% Percentile (z)	0.0626	95% Percentile (z)	0.0818
99% Percentile (z)	0.135	90% USL	0.226

**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**

KM Mean of Logged Data	-3.72	90% KM UTL (Lognormal)90% Coverage	0.0718
KM SD of Logged Data	0.741	90% KM UPL (Lognormal)	0.0633
90% KM Percentile Lognormal (z)	0.0626	90% KM USL (Lognormal)	0.228

**Background DL/2 Statistics Assuming Lognormal Distribution**

Mean in Original Scale	0.0349	Mean in Log Scale	-3.73
SD in Original Scale	0.0484	SD in Log Scale	0.746
90% UTL90% Coverage	0.0717	90% UPL (t)	0.0631
90% Percentile (z)	0.0624	95% Percentile (z)	0.0819
99% Percentile (z)	0.136	90% USL	0.229

**DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.**

**Nonparametric Distribution Free Background Statistics**

**Data do not follow a Discernible Distribution**

**Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)**

Order of Statistic, r	94	90% UTL with90% Coverage	0.105
Approx, f used to compute achieved CC	1.492	Approximate Actual Confidence Coefficient achieved by UTL	0.883
Approximate Sample Size needed to achieve specified CC	91	90% UPL	0.0838
90% USL	0.391	90% KM Chebyshev UPL	0.18

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20. Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

**result\_value1 (total cpah teq (7 minimum caepa 2005) (u = 1/2 max limit))**

**General Statistics**

Total Number of Observations	100	Number of Missing Observations	0
Number of Distinct Observations	65	Number of Non-Detects	41
Number of Detects	59	Number of Distinct Non-Detects	19
Number of Distinct Detects	50	Minimum Non-Detect	13.7
Minimum Detect	3.7	Maximum Non-Detect	20
Maximum Detect	788	Percent Non-Detects	41%
Variance Detected	10291	SD Detected	101.4
Mean Detected	39.37	SD of Detected Logged Data	0.796
Mean of Detected Logged Data	3.11		

**Critical Values for Background Threshold Values (BTVs)**

Tolerance Factor K (For UTL)	1.467	d2max (for USL)	3.024
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**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic	0.264
1% Shapiro Wilk P Value	0
Lilliefors Test Statistic	0.363
1% Lilliefors Critical Value	0.133

**Normal GOF Test on Detected Observations Only**

Data Not Normal at 1% Significance Level

**Lilliefors GOF Test**

Data Not Normal at 1% Significance Level

**Data Not Normal at 1% Significance Level**

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

**Kaplan Meier (KM) Background Statistics Assuming Normal Distribution**

KM Mean	28.81	KM SD	78.32
90% UTL90% Coverage	143.7	90% KM UPL (t)	130.4
90% KM Percentile (z)	129.2	95% KM Percentile (z)	157.6
99% KM Percentile (z)	211	90% KM USL	265.6

**DL/2 Substitution Background Statistics Assuming Normal Distribution**

Mean	27.1	SD	79.05
90% UTL90% Coverage	143	90% UPL (t)	129.6
90% Percentile (z)	128.4	95% Percentile (z)	157.1
99% Percentile (z)	211	90% USL	266.1

**DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons**

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	6.184	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.779	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.244	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.119	Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	1.022	k star (bias corrected MLE)	0.982
Theta hat (MLE)	38.52	Theta star (bias corrected MLE)	40.12
nu hat (MLE)	120.6	nu star (bias corrected)	115.8
MLE Mean (bias corrected)	39.37		
MLE Sd (bias corrected)	39.74	90% Percentile of Chisquare (2kstar)	4.541

**Gamma ROS Statistics using Imputed Non-Detects**

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs  
 GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)  
 For such situations, GROS method may yield incorrect values of UCLs and BTVs  
 This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	24.54
Maximum	788	Median	14
SD	79.83	CV	3.253
k hat (MLE)	0.269	k star (bias corrected MLE)	0.268
Theta hat (MLE)	91.12	Theta star (bias corrected MLE)	91.6
nu hat (MLE)	53.87	nu star (bias corrected)	53.59
MLE Mean (bias corrected)	24.54	MLE Sd (bias corrected)	47.41
90% Percentile of Chisquare (2kstar)	1.599	90% Percentile	73.25
95% Percentile	116.3	99% Percentile	229.9

**The following statistics are computed using Gamma ROS Statistics on Imputed Data**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW		WH	HW
90% Approx. Gamma UTL with 90% Coverage	74.31	82.41	90% Approx. Gamma UPL	61.61	65.69
90% Gamma USL	279.1	422.3			

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	28.81	SD (KM)	78.32
Variance (KM)	6134	SE of Mean (KM)	7.905
k hat (KM)	0.135	k star (KM)	0.138
nu hat (KM)	27.06	nu star (KM)	27.58
theta hat (KM)	212.9	theta star (KM)	208.9
80% gamma percentile (KM)	29.14	90% gamma percentile (KM)	84.27
95% gamma percentile (KM)	161	99% gamma percentile (KM)	387.7

**The following statistics are computed using gamma distribution and KM estimates**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW		WH	HW
90% Approx. Gamma UTL with 90% Coverage	62.57	58.03	90% Approx. Gamma UPL	55.88	51.8

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

90% KM Gamma Percentile 55.31 51.28 90% Gamma USL 150.2 144.6

**Lognormal GOF Test on Detected Observations Only**

Shapiro Wilk Approximate Test Statistic	0.873	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk P Value	1.5002E-6	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.166	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.105	Data Not Lognormal at 10% Significance Level

**Data Not Lognormal at 10% Significance Level**

**Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects**

Mean in Original Scale	28.81	Mean in Log Scale	2.883
SD in Original Scale	78.74	SD in Log Scale	0.702
90% UTL90% Coverage	50.03	90% BCA UTL90% Coverage	53.6
90% Bootstrap (%) UTL90% Coverage	53.5	90% UPL (t)	44.39
90% Percentile (z)	43.93	95% Percentile (z)	56.69
99% Percentile (z)	91.49	90% USL	149.3

**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**

KM Mean of Logged Data	2.887	90% KM UTL (Lognormal)90% Coverage	49.83
KM SD of Logged Data	0.697	90% KM UPL (Lognormal)	44.26
90% KM Percentile Lognormal (z)	43.8	90% KM USL (Lognormal)	147.5

**Background DL/2 Statistics Assuming Lognormal Distribution**

Mean in Original Scale	27.1	Mean in Log Scale	2.753
SD in Original Scale	79.05	SD in Log Scale	0.748
90% UTL90% Coverage	47.02	90% UPL (t)	41.4
90% Percentile (z)	40.94	95% Percentile (z)	53.72
99% Percentile (z)	89.45	90% USL	150.7

**DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.**

**Nonparametric Distribution Free Background Statistics**

**Data do not follow a Discernible Distribution**

**Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)**

Order of Statistic, r	94	90% UTL with90% Coverage	59
Approx, f used to compute achieved CC	1.492	Approximate Actual Confidence Coefficient achieved by UTL	0.883
Approximate Sample Size needed to achieve specified CC	91	90% UPL	47.12
90% USL	788	90% KM Chebyshev UPL	264.9

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20. Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.

**result\_value1 (total pcb aroclors (sms marine 2019) (u = 1/2 max limit))**

<b>General Statistics</b>			
Total Number of Observations	100	Number of Missing Observations	0
Number of Distinct Observations	28	Number of Non-Detects	80
Number of Detects	20	Number of Distinct Non-Detects	9
Number of Distinct Detects	19	Minimum Non-Detect	2.8
Minimum Detect	15	Maximum Non-Detect	4
Maximum Detect	330	Percent Non-Detects	80%
Variance Detected	5004	SD Detected	70.74
Mean Detected	55.4	SD of Detected Logged Data	0.778
Mean of Detected Logged Data	3.637		

**Critical Values for Background Threshold Values (BTVs)**

Tolerance Factor K (For UTL)	1.467	d2max (for USL)	3.024
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**Normal GOF Test on Detects Only**

**Appendix A-2**

**ProUCL Output – 90/90 Upper Tolerance Limits**

Shapiro Wilk Test Statistic	0.548	<b>Shapiro Wilk GOF Test</b>
1% Shapiro Wilk Critical Value	0.868	Data Not Normal at 1% Significance Level
Lilliefors Test Statistic	0.335	<b>Lilliefors GOF Test</b>
1% Lilliefors Critical Value	0.223	Data Not Normal at 1% Significance Level

**Data Not Normal at 1% Significance Level**

**Kaplan Meier (KM) Background Statistics Assuming Normal Distribution**

KM Mean	13.32	KM SD	37.33
90% UTL90% Coverage	68.06	90% KM UPL (t)	61.72
90% KM Percentile (z)	61.15	95% KM Percentile (z)	74.72
99% KM Percentile (z)	100.2	90% KM USL	126.2

**DL/2 Substitution Background Statistics Assuming Normal Distribution**

Mean	12.61	SD	37.72
90% UTL90% Coverage	67.93	90% UPL (t)	61.52
90% Percentile (z)	60.95	95% Percentile (z)	74.65
99% Percentile (z)	100.4	90% USL	126.7

**DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons**

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	1.302	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.219	<b>Kolmogorov-Smirnov GOF</b>
5% K-S Critical Value	0.198	Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	1.468	k star (bias corrected MLE)	1.281
Theta hat (MLE)	37.73	Theta star (bias corrected MLE)	43.23
nu hat (MLE)	58.73	nu star (bias corrected)	51.25
MLE Mean (bias corrected)	55.4		
MLE Sd (bias corrected)	48.94	90% Percentile of Chisquare (2kstar)	5.55

**Gamma ROS Statistics using Imputed Non-Detects**

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs  
 GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)  
 For such situations, GROS method may yield incorrect values of UCLs and BTVs  
 This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	11.09
Maximum	330	Median	0.01
SD	38.16	CV	3.442
k hat (MLE)	0.144	k star (bias corrected MLE)	0.146
Theta hat (MLE)	76.91	Theta star (bias corrected MLE)	75.68
nu hat (MLE)	28.83	nu star (bias corrected)	29.3
MLE Mean (bias corrected)	11.09	MLE Sd (bias corrected)	28.97
90% Percentile of Chisquare (2kstar)	0.866	90% Percentile	32.76
95% Percentile	61.3	99% Percentile	144.5

**The following statistics are computed using Gamma ROS Statistics on Imputed Data**

**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**

	WH	HW		WH	HW
90% Approx. Gamma UTL with 90% Coverage	24.67	19.91	90% Approx. Gamma UPL	19.13	14.62
90% Gamma USL	131.1	158.7			

**Estimates of Gamma Parameters using KM Estimates**

Mean (KM)	13.32	SD (KM)	37.33
Variance (KM)	1393	SE of Mean (KM)	3.83
k hat (KM)	0.127	k star (KM)	0.13
nu hat (KM)	25.46	nu star (KM)	26.03
theta hat (KM)	104.6	theta star (KM)	102.3
80% gamma percentile (KM)	12.74	90% gamma percentile (KM)	38.51
95% gamma percentile (KM)	75.14	99% gamma percentile (KM)	184.8

## Appendix A-2

### ProUCL Output – 90/90 Upper Tolerance Limits

The following statistics are computed using gamma distribution and KM estimates  
Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods

	WH	HW		WH	HW
90% Approx. Gamma UTL with 90% Coverage	33.24	30.42	90% Approx. Gamma UPL	28.48	25.85
90% KM Gamma Percentile	28.09	25.47	90% Gamma USL	103.3	105.6

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.901	<b>Shapiro Wilk GOF Test</b>
10% Shapiro Wilk Critical Value	0.92	Data Not Lognormal at 10% Significance Level
Lilliefors Test Statistic	0.143	<b>Lilliefors GOF Test</b>
10% Lilliefors Critical Value	0.176	Detected Data appear Lognormal at 10% Significance Level

**Detected Data appear Approximate Lognormal at 10% Significance Level**

#### Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects

Mean in Original Scale	13.38	Mean in Log Scale	1.105
SD in Original Scale	37.59	SD in Log Scale	1.707
90% UTL90% Coverage	36.91	90% BCA UTL90% Coverage	45.4
90% Bootstrap (%) UTL90% Coverage	45.4	90% UPL (t)	27.61
90% Percentile (z)	26.91	95% Percentile (z)	50.03
99% Percentile (z)	160.1	90% USL	526.8

#### Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean of Logged Data	1.551	90% KM UTL (Lognormal)90% Coverage	23.56
KM SD of Logged Data	1.097	90% KM UPL (Lognormal)	19.55
90% KM Percentile Lognormal (z)	19.23	90% KM USL (Lognormal)	129.9

#### Background DL/2 Statistics Assuming Lognormal Distribution

Mean in Original Scale	12.61	Mean in Log Scale	1.247
SD in Original Scale	37.72	SD in Log Scale	1.25
90% UTL90% Coverage	21.75	90% UPL (t)	17.59
90% Percentile (z)	17.26	95% Percentile (z)	27.18
99% Percentile (z)	63.69	90% USL	152.3

**DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.**

#### Nonparametric Distribution Free Background Statistics

**Data appear to follow a Discernible Distribution**

#### Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)

Order of Statistic, r	94	90% UTL with90% Coverage	49
Approx, f used to compute achieved CC	1.492	Approximate Actual Confidence Coefficient achieved by UTL	0.883
Approximate Sample Size needed to achieve specified CC	91	90% UPL	35.31
90% USL	330	90% KM Chebyshev UPL	125.9

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20. Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers and consists of observations collected from clean unimpacted locations.

The use of USL tends to provide a balance between false positives and false negatives provided the data represents a background data set and when many onsite observations need to be compared with the BTV.