SEDIMENT ACCEPTANCE CRITERIA TECHNICAL MEMORANDUM (CONCEPTUAL 30 PERCENT DESIGN DELIVERABLE)

TERMINAL 4 EARLY ACTION
PORT OF PORTLAND, PORTLAND, OREGON

DRAFT DOCUMENT: DO NOT QUOTE OR CITE

This document has not been reviewed or approved by USEPA and its federal, state and tribal partners and is subject to change in whole or in part.

Prepared for

Port of Portland

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August 2006

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1 INTRODUCTION

1.1 Project Description

The objective of this technical memorandum is to develop sediment acceptance criteria for placement of contaminated sediments in the Slip 1 confined disposal facility (CDF). The initial placement of contaminated sediments from the Terminal 4 Removal Action into the Slip 1 CDF, and the technical data supporting the suitability of this material for placement in the Slip 1 CDF, are described in the Design Analysis Report (DAR). The focus of this memorandum is to develop acceptance criteria for contaminated sediments from other cleanup sites in the Portland Harbor, subsequent to the placement of Terminal 4 sediments, as well as acceptance criteria for overlying imported fill and structural fill materials needed to bring the CDF elevation up to final grade.

1.1.1 CDF Fill Sequence (Elevation Control)

The CDF consists of a sand and gravel berm spanning the mouth of Slip 1 with an engineered fill sequence placed behind the berm and terminating at a final upland elevation. The fill sequence consists of the following (these will be confirmed during the Prefinal [60 percent] Design submittal):

Design Elevation (National Geodetic Vertical Datum [NGVD])	
Base of Slip 1	~-35.0 feet
Top of Terminal 4 Sediments	~XX feet
Top of Contaminated Sediments from Other Sites	XX feet
Top of Imported Fill	XX feet
Final Elevation	+33.2 feet

Contaminated materials from Terminal 4 and other sites in the Portland Harbor will be placed within the saturated zone of the CDF (i.e., below the water table) to minimize the leachability and mobility of contaminants. The elevation corresponding to the top of the saturated zone is XX feet (NGVD).

1.1.2 CDF Capacity and Excess Capacity

The total CDF capacity and the estimated volumes of various fill materials are listed below (this will be confirmed during the Prefinal [60 percent] Design submittal):

Fill Material Volume in Cubic Yards (cy)	
Terminal 4 Sediments	XX cy
Contaminated Sediments from Other Sites	XX cy
Imported Fill Material	XX cy
Structural Cap	XX cy
Total CDF Capacity	XX cy

1.1.3 Relationship to CDF Management Plan and OMMP

The CDF Management Plan (Appendix B of the DAR) describes the procedures that will be implemented to manage the placement of contaminated sediments, whether by hydraulic or mechanical means, into the Slip 1 CDF, as well as imported fill and structural fill materials; appropriate management practices to prevent the release of sediments and contaminants during and between placement events; and quality assurance procedures to ensure the CDF is constructed according to specifications.

The Operations, Maintenance, and Monitoring Plan (OMMP) describes the inspection and monitoring procedures that will be implemented after the CDF is filled and the final cover layer is placed, to ensure the structural integrity of the CDF is maintained, and to verify contaminants are adequately contained in the CDF. A key component of the OMMP will be a groundwater quality monitoring plan, which will include installation and sampling of "sentinel" groundwater monitoring wells in the CDF berm. The CDF Management Plan will be provided as an appendix to the Prefinal (60 percent) Design Analysis Report and the OMMP will be an appendix to the Final 100 percent Design Analysis Report.

1.2 Project Objectives

1.2.1 Protect Beneficial Uses of Willamette River

The primary objective of the Slip 1 CDF is to protect humans and ecological receptors in the Willamette River through removal and long-term confinement of contaminated sediments, thereby isolating these contaminants from the aquatic community.

1.2.2 Provide Safe and Secure Disposal Option for Portland Harbor Contaminated Sediment

For those areas where dredging or other removal actions constitute a preferred option for remediation of contaminated sediments in the Portland Harbor Superfund Site, the availability of viable and environmentally protective disposal options are limited. The Slip 1 CDF provides available capacity that can be used to confine and isolate contaminated sediments from other parts of the Harbor without unnecessarily tying up valuable regional landfill capacity. The use of regional landfills for disposal of municipal waste provides a higher value to the community.

2 SEDIMENT ACCEPTANCE CRITERIA

The general requirements of the sediment acceptance criteria for the Slip 1 CDF are outlined in Section 1(b)(iv) of the Action Memorandum for the Terminal 4 Removal Action (USEPA 2006a). The general requirements as specified by the U.S. Environmental Protection Agency (USEPA) are listed below, and where possible, more specific and implementable criteria are provided to guide sediment management decisions.

2.1 Sediments Derived from Portland Harbor Superfund Site

Only sediments from the Portland Harbor Superfund Site are eligible for placement in the saturated zone of the CDF (see Section 5.2). However, overlying imported fill materials required for construction of the CDF may be derived from outside sources (e.g., Columbia River channel dredge sands).

2.2 Sediment Exclusions

Without additional treatment to control high-risk sediments, the materials described below will be excluded from the CDF.

2.2.1 No Characteristic Hazardous Waste

No sediments designated as characteristic hazardous waste will be eligible for placement in the CDF. Hazardous waste designation will be determined using the USEPA Toxic Characteristic Leaching Procedure (TCLP) test. All sediments will be tested for TCLP metals. Testing requirements for TCLP organic constituents will be based on the results of bulk sediment chemical analysis. The TCLP analytical results will be compared to the hazardous waste criteria listed in 40 CFR-261.24. See Section 4.3.4 for further discussion.

2.2.2 No Free Oil

Sediments containing "free oil" are not eligible for placement in the CDF. "Free oil" is defined herein as greater than 1 percent total petroleum, based on the following:

- **Qualitative Criterion**. Field observations of core sections, with supporting photographic documentation, showing separate-phase petroleum product (i.e.,

oil globules, stringers, pockets, etc.) covering more than 1 percent of the cross-sectional area of the core

- **Quantitative Criterion**. Total petroleum hydrocarbon (NW-TPH) analysis resulting in greater than 1 percent TPH by weight (greater than 10,000 parts per million [ppm], sum of gasoline, diesel, and residual oil fractions)

2.3 Geotechnical Properties

The geotechnical properties of the fill materials must be of an acceptable quality such that they do not impact the long-term performance of the CDF and are able to support design loads for construction on the final upland surface. Geotechnical requirements will be further developed during the later stages of design.

2.4 Geochemical Properties and Leachability

2.4.1 Contaminated Sediment Criteria

The geochemical properties and leachability of the contaminated sediments must be shown to be protective of human health and the environment when allowance is made for mixing and attenuation of contaminants during subsurface transport through the fill materials and the berm. Acceptance of contaminated sediments based on their geochemical properties and leachability will be determined in consideration of the following:

- Bulk sediment chemical concentrations
- Pancake Column Leaching Test (PCLT) concentrations (Myers et al. 1996; USACE 2003)
- Predicted groundwater attenuation factors (see Section 3)

As an initial screening analysis to help focus subsequent leachate and elutriate testing requirements, contaminated sediments proposed for placement in the saturated zone of the CDF will be compared to the following sediment quality screening criteria:

- Portland Harbor Sediment Quality Guidelines (SQGs), at such time as they are adopted for use (Windward et al. 2006; currently in agency review)
- Probable Effects Levels (PECs; MacDonald et al. 2000), to be used in the interim period prior to the adoption of Portland Harbor SQGs

Considering the results of the bulk sediment screen, PCLT testing will be conducted on:

- Target metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, and Zn)
- Any organic constituents exceeding sediment quality screening criteria in bulk sediment
- Other site-specific target analytes as deemed appropriate by the USEPA and the Port

PCLT testing is discussed further in Section 4.3.5.

2.4.2 Imported Fill Criteria

To be considered for placement in the unsaturated zone of the CDF, imported fill material will be at or below the sediment quality screening criteria listed in Section 2.4.1, or Pacific Northwest background soil metals concentrations in Clark County (WDOE 1994), whichever is greater. Once potential material is selected, an analysis will be performed to ensure that the imported fill is suitable for use in construction of the CDF based on the design.

3 GROUNDWATER TRANSPORT ANALYSIS

3.1 Regulatory Framework

Protection of beneficial uses in the Willamette River will be evaluated based on achieving acceptable water quality standards in the receiving water adjacent to the CDF. National freshwater chronic water quality criteria (USEPA 2006b) are appropriate for evaluating long-term effects in surface water, if any, which may be caused by groundwater moving through the CDF.

Receiving water concentrations will be estimated using PCLT leachate results and groundwater attenuation factors, which describe the concentration reductions that occur as groundwater migrates through the fill material, the containment berm, and eventually into the river. Groundwater attenuation factors are estimated using a predictive computer model of the CDF (see Section 3.2).

Attainment of chronic water quality criteria in the receiving water is one of the evaluation criteria USEPA and the Port will use to determine the suitability of dredged material for placement in the CDF. If a preliminary assessment indicates these criteria may not be met, additional testing and/or sediment management options may need to be considered (e.g., placing material in a more isolated portion of the CDF, subdividing the material to isolate higher risk sediments, etc.). The evaluation process for suitability determinations will be described in the Prefinal (60 percent) Design submittal.

3.2 Groundwater Transport Model

The groundwater contaminant transport model used in the Engineering Evaluation/Cost Analysis (EE/CA; BBL 2005) will be updated and refined to simulate placement of additional contaminated sediments from other parts of the Portland Harbor and to characterize the potential mobility of a range of representative contaminants of concern (COCs) to the Willamette River. The model is a two-dimensional model (MODFLOW/MT3D) along the longitudinal flow path of the CDF from the Terminal 4 uplands through the CDF fill materials and the berm, and ultimately to the point of discharge to the Willamette River. Key model input parameters are listed in Table 1.

3.2.1 Sediment Leachability

Leaching of COCs from contaminated sediments provides the initial, maximum porewater concentrations at the point of placement in the CDF. The leachable porewater concentrations are estimated using PCLT results. The ratio of bulk sediment concentrations to leachate concentrations also provides an estimate of the chemical partitioning behavior of the sediments for use in the groundwater contaminant transport model.

3.2.2 Mixing and Attenuation Processes

Contaminants that are leached from the sediments are subsequently affected by mixing and attenuation processes as they are transported through the CDF fill materials and the berm before eventually being discharged to the river. The following processes help to reduce contaminant concentrations during subsurface transport in the CDF and thereby minimize the potential for exposures to aquatic life in the Willamette River:

- Hydraulic dispersion of leachate during groundwater transport
- Mixing of leachate with inflowing regional groundwater and incident rainfall that enters the CDF
- Adsorption of contaminants on the organic or clay fractions of the fill materials
- Subsurface biodegradation of contaminants
- Tidal dispersion in the berm caused by fluctuating water levels in the river

These processes will be incorporated in the groundwater contaminant transport model, as described below.

3.2.3 Groundwater Attenuation Factors

The results of the groundwater modeling effort will be used to calculate groundwater attenuation factors (GAFs). The GAFs quantify the concentration reductions that occur between the porewater in the contaminated fill material of the CDF and the surface water adjacent to the CDF. GAFs can then be used to determine acceptable PCLT leachate concentrations that will be able to meet chronic water quality criteria in the Willamette River and thus protect the beneficial uses of the river. GAFs will be

calculated individually for a representative list of Portland Harbor COCs spanning a range of geochemical properties and mobility characteristics.

It is anticipated that a range of GAFs will be calculated for different locations within the CDF, based on distance from the berm and elevation. For example, contaminants leaching from sediments placed in the head of the CDF and further removed from the river will undergo longer transport pathways and therefore more pronounced attenuation. As a result, the head of the CDF will be able to accommodate higher contaminant concentrations but still meet acceptable water quality criteria by the time these constituents reach the river. Similarly, the deeper portions of the contaminated fill sequence may also be able to accommodate sediments with higher concentrations, given that these sediments will be separated from the river by a thicker part of the berm.

3.2.4 Time Variability of Groundwater Quality

Groundwater concentrations at the point of discharge to the river are dynamic and time variable. Concentrations will rise and fall in response to competing transport and degradation processes, first rising as contaminants are transported through the CDF following their initial leaching, then declining in response to biodegradation and the progressive loss of leachable contaminants from the CDF over time. Model scenarios will be performed over a minimum 100-year period, or to the time at which the peak concentration leaves the berm, whichever is greater.

3.3 Groundwater Modeling Results

Initially, a preliminary groundwater screening evaluation will be conducted as part of this design process to develop estimated GAFs for typical Portland Harbor constituents and fill scenarios. Subsequently, a project-specific model run will be performed for candidate sediments once the exact placement location and elevation are known.

3.3.1 Preliminary Screening Evaluation

A technical memorandum describing the model structure, input parameters, data sources, time-variable model outputs, and a description of any refinements or updates

to the model subsequent to the EE/CA will be attached to this memo. The primary result of the groundwater modeling effort will be development of GAFs for representative Portland Harbor COCs based on the point of placement in the CDF (i.e., interior or exterior placement in the CDF, and elevation in the fill sequence). The generic GAFs will be used to conduct an initial screening evaluation of PCLT results of candidate sediments. Screening-level modeling scenarios will be completed as part of the Prefinal (60 percent) Design.

3.3.2 Project-Specific Evaluations

The Port will conduct a project-specific groundwater transport evaluation for each candidate project for any constituents or groups of constituents with PCLT leachate concentrations above chronic water quality criteria. The project-specific transport evaluation will utilize the data and analytical results presented in the Sediment Characterization Report (see Section 4.1.2). Project-specific GAFs will be calculated, considering the specific elevation and location of placement within the CDF, as well as the concentrations and locations of other fill materials that may have already been placed in the CDF up to that time.

In addition to conducting project-specific chemical concentration predictions for any material being considered for placement in the CDF, the Port and USEPA will have other qualitative factors that will be used to determine the acceptability of material. Some of these factors may be viewed as safety factors such as the overall protection of human health and the environment, the presence of principal threat compounds, the physical nature of the material, the form of the chemical component, and quantity of the material. In addition, the Port will consider factors that include long-term site liability, indemnification, and cost on a case-by-case basis before a final determination of acceptability is made. The process by which these other more qualitative factors are integrated into an overall management framework will be further defined in the Prefinal (60 percent) Design submittal version of this document and in the Prefinal (60 percent) Design submittal of Appendix B (Confined Disposal Sediment Management Plan) of the Design Analysis Report.

4 SUBMITTAL AND TESTING REQUIREMENTS

4.1 Required Submittals

Projects proposing to place contaminated sediments in the CDF must submit the following documentation for USEPA and Port review and approval.

4.1.1 Sampling and Analysis Plan

A Sampling and Analysis Plan (SAP) must be submitted that contains the following information:

- Plan map of proposed dredge prism, dredged material management units (DMMUs; see Section 4.2), and proposed core locations
- Summary of existing chemical and physical testing data
- Core depths and compositing scheme
- Analytical parameters, test methods, and detection limits
- Field and analytical quality assurance procedures and quality control limits
- Project team organization (i.e., project manager, analytical laboratory, coring contractor, etc.)

4.1.2 Sediment Characterization Report

A Sediment Characterization Report must be submitted that contains the following information:

- Plan map showing DMMUs and actual core locations
- Table(s) of core coordinates, water depths, penetration depths, recovery depths, and compositing intervals
- Deviations from SAP requirements, if any
- Core logs with geologic descriptions and sediment classifications, per American Society of Testing and Materials (ASTM)
- Assessment of "free oil" composition of the sediments based on field observations and core descriptions
- Tables of analytical results for bulk sediment, TCLP, and PCLT testing

- Data validation report evaluating laboratory quality assurance/quality control (QA/QC) performance according to National Functional Guidelines, and acceptability of data

4.1.3 Submittal Schedule

The SAP should be submitted at least 18 months in advance of the proposed dredging project. The Sediment Characterization Report should be submitted at least 1 year in advance of the proposed dredging project. These lead times are required to allow project proponents to obtain a final decision on acceptance of material for placement in the CDF, finalize dredging and disposal plans and bid documents, and secure a dredging contractor to perform the work. Port and agency review of both the SAP and the final report will be provided within 60 days of submittal.

4.2 Dredged Material Management Units

Given the CDF capacity for acceptance of up to 500,000 cy of additional contaminated sediments from the Portland Harbor, candidate dredge prisms should be subdivided into DMMUs that are 25,000 to 100,000 cy in size. This corresponds to approximately one DMMU for every 5 to 20 percent of the CDF capacity. Each DMMU would be analyzed for bulk sediment, TCLP, and PCLT leachate testing. Each DMMU analysis would be composited from 3 to 4 cores through a representative, volume-weighted section of the candidate dredge prism.

Higher testing frequencies, up to one sample per 25,000 cy, would be required for more highly contaminated and heterogeneous materials, especially materials that could potentially contain hazardous waste and/or free oil. The exact sampling frequencies will be determined on a case-by-case basis.

4.3 Chemical and Physical Testing Requirements

Each DMMU will be analyzed for bulk sediment chemistry, physical properties, TCLP, and PCLT, as listed below. Additional testing parameters may be required on a case-by-case

basis at the discretion of USEPA and the Port, based on project-specific considerations, such as current and historical industrial operations and land uses.

4.3.1 Tiered Testing Procedures

It is recommended that the analyses be tiered such that the results of the bulk sediment testing may be used to focus the analyte lists for TCLP and PCLT testing.

PCLT testing for metals will be required in all cases. PCLT testing will also be required for those organic constituents that exceed applicable sediment quality criteria in bulk sediment, as well as any additional contaminants that may be required by the USEPA or the Port on a case-by-case basis, including potentially bioaccumulative contaminants.

TCLP testing for Resource Conservation and Recovery Act (RCRA) metals will be required in all cases. TCLP testing will also be required for those organic constituents that exceed 20 times the hazardous waste criteria in bulk sediment.

4.3.2 Bulk Sediment Chemistry

Bulk sediments will be analyzed for the following chemical constituents:

- Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, and Zn) (USEPA 6000/7000 series)
- Semivolatile organic compounds (including polynuclear aromatic hydrocarbons [PAHs]) (USEPA 8270)
- Volatile organic compounds (USEPA 8260)
- Polychlorinated biphenyls (PCBs) (USEPA 8082)
- Chlorinated pesticides (including DDTs) (USEPA 8081)
- Total petroleum hydrocarbons (NW-TPH Method)

The following constituents will be analyzed on a case-by-case basis, depending on current and historical operations at the site and neighboring properties:

- Tributyltin (Krone)

4.3.3 Bulk Physical Properties

Bulk sediments will be analyzed for the following physical properties:

- Total organic carbon
- Grain size (ASTM)
- Atterberg limits

4.3.4 TCLP Testing

Bulk sediments will be extracted and analyzed for the following TCLP parameters:

- TCLP metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag)

The following are contingent analyses, depending on the results of the bulk sediment chemistry. TCLP tests will be conducted for those organic parameters that exceed 20 times the hazardous waste criteria in bulk sediments. Contingent TCLP tests include the following:

- TCLP Volatile Organics
- TCLP Semivolatile Organics
- TCLP Organochlorine Pesticides

4.3.5 PCLT Testing

PCLT testing will be conducted according to U.S. Army Corps of Engineers (USACE) Waterways Experiment Station procedures (Myers et al. 1996; USACE 2003). PCLT testing for metals will be required in all cases. PCLT testing will also be required for those organic constituents that exceed sediment quality criteria in bulk sediment. Additional parameters, including potentially bioaccumulative parameters, may be required on a case-by-case basis. See Section 2.4.1 for applicable sediment quality criteria.

PCLT testing will be conducted under anoxic conditions, representative of saturated subsurface conditions in the CDF. A minimum of 15 pore elutions will be analyzed. Alternate (i.e., odd and even) pore elutions may be analyzed for metals and organic constituents.

4.3.6 Other Testing Requirements

If material is proposed for hydraulic placement in the CDF, and the discharge rates and volumes and the remaining CDF capacity are such that overflow of the CDF weir is expected, causing return flow of dredging elutriate water to the Willamette River, the following additional tests will be required:

- Modified Elutriate Test (MET) per Palermo 1985
- Column Settling Test (CST) per Palermo and Thackston 1988

These tests will be used to evaluate the potential for short-term water quality effects during discharge to the CDF and overflow to the river.

5 OTHER CONSIDERATIONS

5.1 Sediment Treatment to Fix Oil or Leachable Hazardous Waste

No sediments designated as characteristic hazardous waste or containing "free oil" will be eligible for placement in the CDF, as described in Section 2.2. However, if such sediments are subjected to treatment processes that are shown to effectively fix or immobilize the oil and/or leachable hazardous constituents, they may be eligible for placement in the CDF after treatment.

Bench scale testing must be conducted using representative sediments, additives and mixing ratios (as appropriate), and sufficient engineering design must be performed to show that the treatment process is feasible and constructable. The treated sediments must then be analyzed according to the CDF testing requirements described in this memo, including bulk sediment, TCLP, and PCLT testing, to demonstrate the effectiveness of the treatment process at fixing or immobilizing the oil and/or leachable hazardous constituents. Close coordination with USEPA and the Port will be required to define project-specific bench-scale testing and engineering design requirements for determining the acceptability of treated sediments for placement in the CDF.

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TABLES

Table 1
Groundwater Transport Model Input Parameters
Terminal 4 Confined Disposal Facility

Input Parameter	Value	Unit
Fill Material		
Fraction organic carbon	--	%
Porosity	--	unitless
Hydraulic conductivity	--	cm/s
Bulk density	--	gm/cm^3
COPC concentrations	--	ug/L
COPC partition coefficients	--	L/kg
COPC degradation rates	--	1/yr
Cap Material		
Fraction organic carbon	--	%
Porosity	--	unitless
Hydraulic conductivity	--	feet/day
Bulk density	--	gm/cm^3
Berm Material		
Fraction organic carbon	--	%
Porosity	--	unitless
Hydraulic conductivity	--	feet/day
Bulk density	--	gm/cm^3
Aquifer Material and Properties		
Fraction organic carbon	--	%
Porosity	--	unitless
Hydraulic conductivity	--	feet/day
Horizontal hydraulic gradient	--	feet/feet
Vertical hydraulic gradient	--	feet/feet
Hydrologic Properties	--	
Average river stage	--	feet CRD
Average tidal fluctuation	--	feet
Annual Precipitation	--	in
Recharge Through Cap	--	in/yr
CDF Dimensions		
Berm width top (inside to outside)	--	feet
Berm width bottom (inside to outside)	--	feet
Fill material thickness (top to bottom)	--	feet
Fill material length (top)	--	feet
Fill material length (bottom)	--	feet
Cap material thickness	--	feet
Base of CDF elevation	--	feet CRD
Boundary Flow Conditions		
River - constant head	--	feet CRD
Groundwater - constant head	--	feet CRD
Dispersivity		
Longitudinal dispersivity - Fill	--	feet
Horizontal dispersivity - Fill	--	feet
Vertical dispersivity - Fill	--	feet
Longitudinal dispersivity - Berm	--	feet
Horizontal dispersivity - Berm	--	feet
Vertical dispersivity - Berm	--	feet