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DRAFT TECHNICAL MEMORANDUM

To:	Kelly Madalinski, Jim McKenna, and Krista Koehl, Port of Portland	**Date:**	April 1, 2010
From:	Todd Thornburg, Anchor QEA Pete Townsend, NewFields	**Project:**	050332-01
Re:	Groundwater Model Input Parameter Memorandum Port of Portland Terminal 4 Confined Disposal Facility		

This memorandum presents the input parameters proposed for use in the groundwater model of the Terminal 4 confined disposal facility (T4 CDF). The selection of model input parameters builds on the collaborative work performed by the Port of Portland (Port) and U.S. Environmental Protection Agency (USEPA) during the informal dispute resolution (IDR) process in 2007, as summarized in Table 1. At the conclusion of the IDR process, the T4 CDF modeling work was put on hold until significant new information could be obtained by the Lower Willamette Group (LWG) as part of the Portland Harbor Remedial Investigation/Feasibility Study (RI/FS). This new RI/FS information includes a better understanding of Portland Harbor chemicals of concern (COCs) accounting for most of the estimated human health and ecological risk, a comprehensive suite of contaminant mobility tests from Portland Harbor areas of potential concern (AOPCs), progress toward developing a Portland Harbor chemical fate and transport model (QEA-FATE model), and achieving consistency between the T4 and LWG modeling efforts to the extent possible.

The following topics are discussed in more detail in the sections below:

- Representative AOPCs to be considered in the T4 CDF evaluation
- COCs to be evaluated
- Modeling overview (short-term and long-term approaches)
- Physical and chemical input parameters to be used

This memorandum does not focus on engineering design or operational parameters that may affect the T4 CDF performance, such as the physical configuration of the containment berm (in particular, the size of the training dikes), the finish surface of the cover layer (i.e., paved

or unpaved), or specific placement strategies (elevations and locations) for contaminated sediments from particular AOPCs. However, these engineering design or operational parameters may be evaluated during the modeling effort as necessary to optimize the protectiveness of the facility based on engineering constraints, construction experience, and input from the concurrent CDF design process.

REPRESENTATIVE AOPCS FOR T4 CDF EVALUATION

A key data input requirement of the T4 CDF groundwater model is the characterization of bulk sediment and leachate characteristics from a representative cross-section of potential dredging sites in Portland Harbor. The LWG collected and tested composite sediment samples from 11 AOPCs within Portland Harbor (LWG 2009) and subjected these sediment samples to sequential batch leachate tests (SBLT), a U.S. Army Corps of Engineers (USACE) laboratory procedure designed to simulate chemical leaching characteristics of sediments in a CDF (USACE 2003). Sediment and leachate tests performed by the Port at T4 were also included in the analysis. In all, bulk sediment and leachate data are available for the following AOPCs:

AOPC	River Mile	Bank	Site Vicinity
1	2.2	East	Evraz Oregon Steel
3	3.8	East	Schnitzer
6	4.3	East	Terminal 4
8	4.8	West	BP-Arco
9	6.3	West	Gasco
11	5.7	East	Mar Com Marine
13	6.8	East	Willamette Cove
14	7.1	West	Arkema
17	8.2	East	Cascade General Shipyard
17	9.0	East	Swan Island Lagoon
19	8.8	West	Gunderson
20	9.7	West	Fireboat Cove

The 12 AOPCs listed above are among the sites most likely to be addressed with active remediation, including the consideration of dredging. These AOPCs provide a representative cross-section of contaminated sediments throughout Portland Harbor; the sediment test sites

extend from River Mile (RM) 2.2 to RM 9.7 on both the east and west banks of the river, and include a wide spectrum of waterfront industries and COCs. Contaminated sediments from 10 of the 12 AOPCs are being evaluated for dredging and disposal in the T4 CDF.

Leachate test results from two of the AOPCs (Site 9 and Site 14, Gasco and Arkema, respectively) are not currently included in the T4 CDF modeling analysis because sediment from portions of these areas contains evidence of sheen or oily product, and USEPA has indicated such sediment may not be appropriate for placement in the CDF without treatment. Leachate concentrations of polycyclic aromatic hydrocarbons (PAHs) and DDT isomers from Gasco and Arkema samples, respectively, are two to four orders of magnitude higher than other AOPCs; these samples were generally collected in areas of highest concentration, potentially containing free product (see Attachment A). It may be appropriate that sediment in marginal areas from these two AOPCs with lower COC concentrations and no free product is suitable for evaluation. In addition, sediment containing higher COC concentrations and/or free product may later be evaluated for suitability if such sediment is first subjected to a treatment process such as stabilization. Additional leaching tests from these two AOPCs would need to be conducted on less-impacted areas and/or treated sediment according to the procedures that are ultimately developed in the Sediment Acceptance Criteria Memorandum to determine if they are suitable for placement in the CDF.

CONSTITUENTS OF CONCERN

A number of COCs are being considered for evaluation in the chemical fate and transport portion of the QEA-FATE model for Portland Harbor. A subset of key COCs from this list is proposed for evaluation in the T4 CDF groundwater model, as listed below.

COC for Portland Harbor Fate and Transport Model (QEA-FATE)	COC for T4 CDF Groundwater Model
Arsenic	
Copper	✓
Mercury	
Naphthalene	✓
Benzo(a)pyrene	✓
Bis(2-ethylhexyl)phthalate	
Tributyltin	
4,4'-DDD	
4,4'-DDE	
4,4'-DDT	
Total DDX	✓
PCB-77*	
PCB-126*	✓
Total PCBs	✓

Note:
* PCB congeners have been removed from consideration in QEA-FATE.

The rationale for selecting the COCs for the T4 CDF groundwater model is provided below.

Metals

Several metals are being evaluated as Portland Harbor COCs, including arsenic, copper, mercury, and tributyltin (TBT). Copper will be carried forward as a COC in the T4 CDF model because the upper percentile leachate concentrations in SBLT tests are above the chronic water quality criterion for the Willamette River. Arsenic will not be carried forward in the CDF model because all of the composited bulk sediment samples from Portland Harbor AOPCs are within the range of natural background concentrations in soil (i.e., all are less than 7 milligrams per kilogram [mg/kg]; WDOE 1994), and leachate concentrations are within the range of natural background concentrations in groundwater (USGS 1999), with the possible exception of AOPC 3. Mercury will not be carried forward because it was detected in only one out of 40 leachate samples (see Attachment A, Table 1). TBT will not be modeled because this parameter was not analyzed in LWG leachate samples, and because TBT is a relatively short-lived constituent, with an anaerobic half-life in sediment of only a few years (Champ and Seligman 1996; Dowson et al. 1996).

Semivolatile Organic Compounds

PAHs are one of the primary groups of COCs for Portland Harbor, and are derived from a variety of different sources. Two key PAHs—naphthalene and benzo(a)pyrene—will be carried forward in the T4 CDF model. These two compounds represent low molecular weight and high molecular weight PAHs, respectively, and bracket the range of chemical characteristics and mobilities of the PAHs. In addition, benzo(a)pyrene is one of the carcinogenic PAHs with the highest toxicity.

Bis(2-ethylhexyl)phthalate (BEHP) will not be carried forward because only three out of 40 leachate samples exceeded fish consumption criteria, and in every case the exceedance was an isolated anomaly not replicated in the other leachate cycles from the same AOPC. Note that there is no chronic criterion for BEHP because "BEHP is not toxic to aquatic organisms at or below its solubility limit" (see USEPA National Recommended Water Quality Criteria 2010). USEPA previously agreed to remove BEHP from further consideration in the CDF model (USEPA 2007).

DDT Isomers

T4 CDF modeling efforts will be focused on Total DDX (i.e., the sum of 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD). None of the 2,4'-DDX isomers were detected in LWG leachate samples outside of AOPC 14 (which is currently excluded from this modeling effort). Total DDX model predictions will be compared directly to aquatic life criteria, which are similarly expressed on a total basis. However, fish consumption criteria are evaluated on the basis of individual isomers. As an initial conservative screening evaluation, model predictions for Total DDX will be compared to the most stringent of the individual fish consumption criteria (i.e., fish consumption criteria for 4,4'-DDT and 4,4'-DDE are the same, both being more stringent than 4,4'-DDD). If the predicted Total DDX concentration is above the fish consumption criterion for 4,4'-DDT, then the relative contributions of the different isomers to the total DDX concentration will be assessed. A proportional allocation of the Total DDX to the individual isomers will be performed using the Harbor-wide leachate statistics. On average, DDT, DDE, and DDD comprise 15, 61, and 24 percent of the Total DDX concentration, respectively, based on the mean Harbor-wide leachate concentrations.

Polychlorinated Biphenyls

Initial polychlorinated biphenyl (PCB) modeling efforts will be focused on Total Aroclors to characterize the bulk composition of Portland Harbor sediments, and because most water quality criteria are expressed on the basis of Total PCBs. PCB-126, an important dioxin-like congener, will also be modeled and evaluated on the basis of its toxicity equivalency factor (TEF) relative to dioxin. PCB-77 will not be carried forward in the CDF model. Although PCB-77 leachate concentrations are about 10 times higher than PCB-126, modeling PCB-126 is more representative of potential risks because PCB-126 is 1,000 times more toxic than PCB-77, and both congeners have similar partitioning coefficients (see Attachment A).

OVERVIEW OF MODELING APPROACH

Two types of groundwater models are being developed for the T4 CDF. The short-term groundwater model is designed to evaluate short-term (i.e., days to weeks) transport of COCs in dredge elutriate water from a hydraulic slurry that would be discharged into the open pond behind the berm during CDF construction. The long-term groundwater model is designed to evaluate long-term (i.e., decades to centuries) transport of COCs in groundwater migrating through the contaminated sediment material after the CDF is constructed and filled.

Short-Term Groundwater Model

The short-term groundwater model is used to assess the initial filling of the CDF pond by hydraulic dredging. The hydraulic dredge slurry, which includes large quantities of sediment and entrained water, is temporarily ponded behind the berm. This creates a differential hydraulic head across the berm and causes dredge elutriate water to flow through the berm toward the river. In contrast, mechanical dredging and placement techniques, in which sediments are placed in the pond at near in situ water content, will cause very little head difference in the pond and will not induce any substantive flow through the berm. For example, mechanical disposal of a barge with a 2,000-cubic yard (cy) sediment load will cause approximately 0.1-foot of head rise in the pond, which is negligible compared to the typical 1- to 2-foot daily tidal fluctuation in the river.

USEPA and the Port reached agreement on the short-term groundwater modeling approach and model input parameters during IDR (see Table 1). Short-term groundwater modeling for

the T4 sediments was subsequently completed and results were submitted to USEPA in July 2007 (NewFields 2007a). The short-term model results indicated copper, lead, Total DDX, and Total PCBs would be over a million times lower than chronic criteria before groundwater enters the river, as summarized below:

Constituent	Chronic Criterion (µg/L)	Short-Term Groundwater Discharge Concentration (µg/L)
Copper	2.7	~1 E -17
Lead	0.54	~1 E -8
Total PCBs	0.014	~1 E -18
Total DDX	0.001	~1 E -14

Thus, water quality impacts during short-term filling of the CDF are expected to be negligible in a T4 hydraulic dredging scenario with conservatively high production rates. With the completion of the T4 Phase I Removal Action, less sediment requires dredging than previously assumed for the short-term groundwater model. Therefore, the short-term groundwater model results represent a worst-case scenario and will be used for the CDF design at this time. Short-term model results may be updated at later design stages based on the final T4 dredge prism.

Hydraulic dredging may not be a feasible option for most or all of the other AOPCs in Portland Harbor, given that most of the AOPCs are located a long distance from T4, and many are on the opposite bank of the river. AOPC 3 is located about a half mile downstream of the CDF, but the next nearest AOPCs on the same side of the river are about 1.4 miles upstream and 2.1 miles downstream of the CDF. Mechanical dredging, rather than hydraulic dredging, may be a more feasible option for removing Portland Harbor sediment and placing this material into the CDF. Further work on the short-term groundwater model would be more appropriately conducted on a site-specific basis during later phases of design, if hydraulic dredging is determined to be a practicable and cost-effective alternative for a particular AOPC. Therefore, short-term groundwater modeling will not be further developed for the T4 CDF design.

Long-Term Groundwater Model

The long-term groundwater model will be used to assess the ability of the CDF to provide long-term protection of surface water quality via groundwater migration to the river. To perform this analysis, the long-term groundwater modeling period must be defined. The long-term modeling period was selected to coincide with the longest applicable engineering design standard being applied to the CDF. The design seismic event, corresponding to a 10 percent probability of exceedance in 50 years, or a return period of 475 years, is the longest applicable design standard. Therefore, the long-term groundwater model will be run for 475 years.

Due to the extended simulation period, previous versions of the long-term groundwater model were performed using a simplified steady-state boundary condition at the river interface to streamline model computations and run times (Table 1). This model scenario is conservatively protective because it does not fully account for tidal dispersion and groundwater-surface water interactions in the shallow subsurface transition zone. If a higher level of accuracy is required, pending the outcome of initial steady-state model results, the effect of a more realistic transient boundary condition simulating diurnal tides and/or seasonal fluctuations in river levels may be incorporated in future long-term model evaluations.

PHYSICAL AND CHEMICAL MODEL INPUT PARAMETERS

Groundwater model input parameters, including the physical and hydraulic properties of CDF building materials, initial leachate concentrations in the confined sediment layer, and partitioning coefficients and biodegradation rates of COCs, are discussed in this section (see Tables 2 and 3). In addition, leachate concentrations and partitioning coefficients derived from Portland Harbor sediments are compared to other sites in Region 10 where sediments have been evaluated for placement in a CDF (see Table 4).

Material and Hydraulic Properties

USEPA and the Port reached agreement on a majority of the material and hydraulic properties of the CDF building materials, including the contaminated sediment fill material, the cover material, the regional aquifer, the import material for the berm, and the training dikes (quarry spalls) (see Table 1). Material and hydraulic input parameters and their

supporting data and rationale are summarized in Table 2. The only physical parameter to be updated since the IDR agreements is the organic carbon content of the contaminated sediment material. The organic carbon content (ranging from 1.0 to 1.8 percent, averaging 1.5 percent) was determined from the Harbor-wide bulk sediment analyses of Portland Harbor AOPCs (see Attachment A).

Initial Source Concentrations

SBLT data from Portland Harbor provide an estimate of the porewater concentrations that are expected to equilibrate with contaminated sediments in the T4 CDF. These data are used to initialize the source concentrations in the CDF. The source concentrations represent the potential for COCs to be mobilized in groundwater as the COCs move through the CDF (undergoing fate and transport processes) toward the river. The geometric mean, arithmetic mean, and 90th percentile leachate concentrations from Portland Harbor SBLT results (excluding leachate results from AOPCs 9 and 14; see Attachment A) provide the minimum, average, and maximum source concentrations, respectively, for setting the initial conditions in the long-term groundwater model. The initial source concentrations for the various groundwater COCs are compiled in Table 3.

Partitioning Coefficients

The ratio of the bulk sediment concentration to the SBLT leachate concentration is used to develop site-specific partitioning coefficients for contaminated sediment placed in the CDF. The partitioning coefficient describes how readily contaminants are desorbed from the sediments, dissolved in groundwater, and made available for transport through the CDF. The derivation of partitioning coefficients from SBLT tests on bulk sediment from Portland Harbor AOPCs is presented in Attachment A. Geometric mean partitioning coefficients for the various groundwater COCs are compiled in Table 3.

The initial source concentrations and the partitioning coefficients are dependent variables in that both are derived from SBLT leachate analyses; therefore, a sensitivity analysis should be conducted on only one or the other of these variables. The initial source concentrations, being the more direct measurement, will be for used in the sensitivity analysis.

The SBLT leachate results are applicable to the contaminated sediment material but are not representative of the geochemical environment in the berm. The physical properties (sand and gravel) and source characteristics (regional quarries) of the berm material are fundamentally different, as are the thermodynamic conditions in the berm (i.e., dominated by adsorption processes rather than desorption). Applicable partitioning coefficients for metals in the berm material were established in NewFields (2007b). Partitioning coefficients for organic constituents are adopted from the LWG RI Report, Table E6 (LWG 2009); these are the same partitioning coefficients proposed for use in the QEA-FATE model.

Biodegradation Rates

Published biodegradation rates were compiled and evaluated for use in the T4 CDF model. It is expected that anaerobic degradation processes will prevail in the confined contaminated sediments, whereas aerobic degradation processes will be more important in the berm. The proposed long-term model scenarios to be evaluated will include a range of conservatively protective biodegradation rates from the lower end of published literature values, (i.e., slower rates), with particular emphasis on field and regional studies. For DDX and PCBs, zero degradation will be evaluated as a worst-case scenario. Because of the significantly longer time period of the CDF model predictions (475 years) compared to the QEA-FATE simulation period (30 years), biodegradation is likely to be a more important attenuation process for contaminants in the CDF and should be carefully considered in the CDF evaluation (USACE 1996; M. Palermo, pers. comm.).

Proposed biodegradation rates (expressed as half-lives, in days) are presented in Table 3, along with supporting literature citations. These rates were selected in consideration of the following:

- Biodegradation rates compiled by the LWG for use in the chemical fate and transport portion of the QEA-FATE model, as well as ongoing updates/refinements of those rates, and in consideration of the significantly longer time period of the CDF simulations
- Biodegradation references and comments provided by USEPA to the Port on June 20 and July 18, 2007 (see Table 1)
- Other relevant literature studies of anaerobic sediment biodegradation with particular emphasis on field and regional studies, as referenced in Table 3.

In situations where biodegradation produces intermediate daughter products (e.g., DDE degrading to DDMU), the toxicity of those products will be considered in the analysis.

Comparison with Other Region 10 Sites

Leaching data for three key COCs at Portland Harbor—benzo(a)pyrene, Total PCBs, and Total DDX—are compared to data from other Region 10 CDF sites in Table 4. The other Region 10 CDF sites are predominantly marine sites in Puget Sound waterways. The elevated salinity at these sites is likely to have a pronounced effect on the partitioning behavior of metals, but less of an effect on the partitioning of organic contaminants such as the three COCs listed above.

The following general observations are evident from inspection of Table 4:

- The bulk sediment concentrations in Portland Harbor are typical and near the average of the bulk sediment concentrations at Puget Sound sites, which include sites with both higher and lower concentrations of all three COCs.
- The leachate concentrations from Portland Harbor are in many cases higher than those measured at Puget Sound sites, in spite of relatively similar bulk sediment concentrations.
- Because of the higher leachate concentrations, the calculated partitioning coefficients for Portland Harbor are typically about an order of magnitude lower than those calculated at Puget Sound sites.

The observed differences in leachate concentrations and partitioning coefficients between Portland Harbor and Puget Sound sites may be an artifact of using incomparable laboratory test procedures. The Portland Harbor leaching tests were conducted using the SBLT protocol, whereas the Puget Sound leaching tests, because of their marine salinity, required the use of pancake column leaching tests (PCLT; USACE 2003).

The PCLT is a sediment column test in which porewater is eluted slowly over a period of several weeks and months, whereas the SBLT is a sediment-water slurry subjected to 24-hour contact periods, then the leachate is centrifuged, decanted, and filtered. In the SBLT, metals are filtered through a 0.45-micron cellulose filter and organics are filtered through a 1-

micron glass fiber filter (USACE 2003). Very fine clay particles, as well as colloids, have the ability to pass through the filtration step of the SBLT, especially the 1-micron filter used for organic constituents. Laboratory observations of high turbidity levels in the filtered leachate support the interpretation that SBLT results may be biased high due to the inclusion of particulate matter. If the elevated leachate concentrations in the SBLT tests are caused by an inefficient filtration step in the laboratory, then the use of these results provides an additional element of conservatism in T4 CDF model predictions.

TABLES

Table 1 Status of Terminal 4 CDF Groundwater Model Input Parameters and Issues
Table 2 Physical and Hydraulic Properties of CDF Materials
Table 3 Geochemical Properties of CDF Chemicals of Concern
Table 4 Comparison of Leaching Test Data from Portland Harbor and Other Region 10 Sites

ATTACHMENT

Attachment A Derivation of Partitioning Coefficients from Portland Harbor Sequential Batch Leachate Tests

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TABLES

Table 1
Status of Terminal 4 CDF Groundwater Model Input Parameters and Issues

Model Input Parameter and Supporting Document(s)	Date of Document Submittal	Description	Status[1,2]
Long-Term Groundwater Model			
CDF Groundwater Modeling Period	12/6/2006	The proposed CDF groundwater modeling period is the longest of the applicable engineering design periods, corresponding to a design seismic event with a return period of 475 years (i.e., 10 percent probability of exceedance in 50 years).	Resolved: USEPA approval of the seismic performance standard proposed in the 60 Percent Design Analysis Report (Anchor 2006) without comment, as per comments provided on 1/15/07.
Physical Model Parameters (K, TOC, porosity, density)	3/30/2007	Specification of physical input parameters for characterizing groundwater flow and chemical exchange properties of import material (berm, cap, dikes) and CDF fill material from T4 and Portland Harbor.	Resolved: Initial agreement on physical model parameters and sensitivity ranges occurred in 3/30/07 Groundwater Modeling Meeting (see meeting notes). See also *Borrow Source Analytical Results* and *Dredged Material Permeability Evaluation,* below.
Borrow Source Analytical Results	6/8/2007	Laboratory analysis of TOC values from material collected at potential borrow source sites that could be used to construct the CDF berm.	Resolved: During the 6/8/07 IDR meeting, Port proposed a mean value of 0.06% TOC based on borrow source sampling results from two local quarries; USEPA agreed to the Port's approach.
Explanation of Effective Dispersion (NewFields 2007c)	4/20/2007	Compares the use of a steady-state versus transient groundwater flow solutions in long-term contaminant transport predictions. Similarities of approach are compared to previous CDF modeling studies, including St. Paul Waterway, Tacoma, Terminal 91, Seattle, and Blair Slip 1, Tacoma.	Resolved: Use of a steady-state flow solution for the long-term model is acceptable. A transient river boundary may be added to the long-term model if greater accuracy is required. A transient flow solution is appropriate for the short-term model. This approach was approved by USEPA during the 5/17/07 meeting (see meeting notes).
Dredged Material Permeability Evaluation (Anchor 2007a)	5/4/2007	Provide hydraulic conductivity (permeability) values for the long-term groundwater model for Portland Harbor material after it has been placed within the CDF and allowed to consolidate.	Resolved; 6/12/07 email from Sean Sheldrake.
Metal Partitioning Coefficients for Berm (NewFields and Anchor 2007)	6/20/2007	Provide partitioning coefficients for the berm for use in groundwater model.	Resolved; final comments from USEPA on 7/12/07 via email from Sean Sheldrake.
SAP for Terminal 4 SBLT (Palermo and Anchor 2007a)	6/15/2007	Sampling and analysis plan to obtain more representative leachate testing of Terminal 4 dredge prism.	Resolved; USEPA approval of SAP on 6/19/07. Test results (leachate concentrations and partitioning coefficients) are incorporated in Table 3 of this memorandum.
Portland Harbor Stats Summary	6/11/2007	Source concentrations for COPCs had previously been derived from statistical analysis of Portland Harbor sediment samples.	No longer relevant. Concentrations have been updated with new LWG SBLT and bulk sediment data from representative AOPCs.
Portland Harbor Leachate Evaluation (Metals)	6/11/2007	Partitioning coefficients for metals had previously been derived from paired sediment/porewater data from Portland Harbor (Portland Harbor Site Investigation, Weston 1998).	No longer relevant. Concentrations have been updated with new LWG SBLT and bulk sediment data from representative AOPCs.
Portland Harbor Leachate Evaluation (Organics)	6/11/2007	Partitioning coefficients for organics had previously been derived from Region 10 leachability test data for organic constituents at Puget Sound CDF sites.	No longer relevant. Concentrations have been updated with new LWG SBLT and bulk sediment data from representative AOPCs.
Response to USEPA June 20 Comments on PH Values	7/19/2007	Responses to USEPA's comments on proposed leachate values for metals and organics in Portland Harbor.	No longer relevant. Concentrations have been updated with new LWG SBLT and bulk sediment data from representative AOPCs.
Biodegradation Rate Summary	7/17/2007	Input parameters for long-term groundwater model.	Proposed updated values are provided in Table 3 of this memorandum, based on degradation rates developed for use in the Portland Harbor chemical fate and transport model (QEA-FATE), comments previously provided by USEPA (in 7/18/07 email), and other appropriate literature references.
T4 Biodegradation Comments	7/18/2007	Comments from USEPA on Biodegradation Values (not the same values as in the 7/17/07 document).	
Points of Compliance and Criteria	11/15/2007	Points of compliance and criteria necessary for evaluating model output.	Preliminary CDF performance criteria were provided by USEPA to LWG on 2/18/10. Further refinement and resolution of these criteria will occur through the harbor-wide RI/FS process.
Short-Term Groundwater Model			
Explanation of Effective Dispersion (NewFields 2007c)	4/20/2007	See description in Long-Term Groundwater Model.	The short-term groundwater modeling approach and input parameters for Terminal 4 were resolved during IDR. Summary report of short-term model results for Terminal 4 was submitted to USEPA on 7/30/07, based on the hydraulic dredging scenario under evaluation in 2007. Short-term model results indicate groundwater concentrations entering the river are many orders of magnitude lower than chronic criteria. With the completion of the T4 Phase I Removal Action, it is currently unknown whether hydraulic dredging remains a cost-effective option for Phase II dredging at Terminal 4. In addition, hydraulic dredging may not be a feasible option for most or all of the AOPCs identified in Portland Harbor. Further work on the short-term model should be conducted on a site-specific basis during later stages of design, if hydraulic dredging is shown to be feasible and cost-effective alternative for a particular AOPC. Therefore, short-term groundwater modeling will not be further developed for the T4 CDF 60 percent design.
Short-term CDF Hydraulic Boundary Condition (NewFields 2007d)	4/30/2007	Methodology to estimate the short-term hydraulic head boundary condition during and following the CDF filling operation; boundary condition is input to short-term water quality model.	
SAP for Additional MET (Palermo and Anchor 2007b)	5/25/2007	Sampling and analysis to obtain more representative elutriate testing of Terminal 4 dredge prism.	
Estimated Source Concentrations for Short-Term GW Model (Anchor and Palermo 2007)	4/27/07 revised 7/9/2007	Provide source concentrations for short-term groundwater model; subsequently updated with new MET data.	
T4 Kd Comments; New MET Comments	7/12/2007	USEPA's comments on Kd values and Short-term GW Source (MET).	
Short-Term Water Quality Modeling (NewFields 2007a)	7/30/2007	Summary report of short-term model results.	

Notes:
1. Status information was obtained from the T4 EA IDR Action Item Tracking spreadsheet dated July 10, 2007; IDR Meeting Summaries; the comment resolution table attached to the November 15, 2007 letter from USEPA to the Port; and project emails.
2. Specific performance standards for CDFs developed during the harbor-wide process will apply to the T4 CDF.

Table 2
Physical and Hydraulic Properties of CDF Materials

Material	Units	Proposed Material Property Values for Sensitivity Analysis			Data Source/Rationale
		Min.	Average	Max.	
Sediment Fill					
Fraction organic carbon	-	0.010	0.015	0.018	LWG (2009), Measured pH bulk sediment: 10% / Average / 90%
Porosity	-	-	0.35	-	Anchor (2006)
Hydraulic conductivity	ft/d	0.00017	0.00085	0.0028	Anchor (2007a); Consolidation tests from T4 and Region 10
Bulk density	g/cm^3	-	1.3	-	BBL (2005; Table 4-4); Consolidation tests from T4
Imported Fill					
Fraction organic carbon	-	0.0005	0.0006	0.0007	Anchor (2007b), Measured import from local quarries
Porosity	-	-	0.30	-	Anchor (2006)
Hydraulic conductivity	ft/d	-	28	-	Freeze and Cherry (1979; Table 2.2); clean sand
Bulk density	g/cm^3	-	2.0	-	Holz and Kovacs (1981; Table 2-1)
Berm Fill					
Fraction organic carbon	-	0.0005	0.0006	0.0007	Anchor (2007b), Measured import from local quarries
Porosity	-	-	0.30	-	Anchor (2006)
Hydraulic conductivity	ft/d	30	280	450	Hazen's approximation based on gradation specification for Select Fill
Bulk density	g/cm^3	-	2.0	-	Holz and Kovacs (1981; Table 2-1)
Dispersion - Horizontal	-	-	40	-	Anchor (2006); NewFields (2007c): Dynamic model calibration
Dispersion - Vertical	-	-	0.4	-	Anchor (2006); NewFields (2007c): Dynamic model calibration
Training Dikes					
Fraction organic carbon	-	-	0.00006	-	Assumed 10 percent of Berm Fill value
Porosity	-	-	0.30	-	Anchor (2006)
Hydraulic conductivity	ft/d	-	2,800	-	Freeze and Cherry (1979; Table 2.2); clean gravel
Bulk density	g/cm^3	-	2.2	-	Holz and Kovacs (1981; Table 2-1)
Aquifer					
Fraction organic carbon	-	-	0.003	-	BBL (2005); Average measured value in Slip 1 aquifer material
Porosity	-	-	0.30	-	Anchor (2006)
Hydraulic conductivity (K)	ft/d	-	65	-	Hart Crowser (2000); Pumping test results, as reported in BBL (2005)
Bulk Density	g/cm^3	-	2.0	-	Holz and Kovacs (1981; Table 2-1)

Table 3
Geochemical Properties of CDF Chemicals of Concern

Material	Units	Values for Sensitivity Analysis			Data Source/Rationale
		Min.	Average	Max.	
Initial Source Concentrations in Contaminated Sediment Pore Waters					
Copper	µg/L	4	8	14	LWG (2009); Geometric Mean, Arithmetic Mean, and 90th Percentile of SBLT results
Naphthalene	µg/L	0.04	0.07	0.15	LWG (2009); Geometric Mean, Arithmetic Mean, and 90th Percentile of SBLT results
Benzo(a)pyrene	µg/L	0.12	0.23	0.52	LWG (2009); Geometric Mean, Arithmetic Mean, and 90th Percentile of SBLT results
Total DDX	µg/L	0.014	0.058	0.076	LWG (2009); Geometric Mean, Arithmetic Mean, and 90th Percentile of SBLT results
Total PCB Aroclors	µg/L	0.22	0.87	2.17	LWG (2009); Geometric Mean, Arithmetic Mean, and 90th Percentile of SBLT results
PCB-126	ng/L	0.08	0.27	0.68	LWG (2009); Geometric Mean, Arithmetic Mean, and 90th Percentile of SBLT results
Metal Partitioning Coefficient [Kd]					
Copper [Sediment]	L/kg	-	8,900	-	LWG (2009); Geometric Mean of AOPCs; see Attachment A
Copper [Berm, Cap]	L/kg	100	165	-	NewFields (2007b)
Copper [Quarry Spall]	L/kg	1	20	-	USEPA (2005; Table 3); Minimum and 1st Percentile Kd
Log Organic Partitioning Coefficient [Koc] - Sediment					
Naphthalene	Log L/kg-OC	-	4.97	-	LWG (2009); Geometric Mean of AOPCs; see Attachment A
Benzo(a)pyrene	Log L/kg-OC	-	5.18	-	LWG (2009); Geometric Mean of AOPCs; see Attachment A
Total DDX	Log L/kg-OC	-	4.87	-	LWG (2009); Geometric Mean of AOPCs; see Attachment A
Total PCB Aroclors	Log L/kg-OC	-	4.86	-	LWG (2009); Linear Isotherm Model; see Attachment A
PCB-126	Log L/kg-OC	-	4.80	-	LWG (2009); Linear Isotherm Model; see Attachment A
Log Organic Partitioning Coefficient [Koc] - Berm					
Naphthalene	Log L/kg-OC	3.12	3.30	3.53	LWG RI Report Table E6 (2009)
Benzo(a)pyrene	Log L/kg-OC	5.68	6.01	6.67	LWG RI Report Table E6 (2009)
Total DDX	Log L/kg-OC	5.08	6.44	6.62	LWG RI Report Table E6 (2009); Geometric Mean of DDT, DDE, and DDD
Total PCB Aroclors	Log L/kg-OC	5.96	6.39	7.59	LWG RI Report Table E6 (2009); Geometric Mean of Ar-1254 and Ar-1260
PCB-126	Log L/kg-OC	6.27	6.57	6.88	LWG RI Report Table E6 (2009)
Biodegradation Half Life in Sediment [Anaerobic]					
Naphthalene	days	40	110	1,100	Mean, 95% UCL, and 0.1 x UCL, from Bach et al. (2005); Coates et al. (1996a, 1996b, 1997);
Benzo(a)pyrene	days	470	1,500	15,000	Chang et al. (2001); Heitkamp & Cerniglia (1987); Rothermich et al. (2002)
Total DDX	days	11,000	33,000	Infinite	Eganhouse et al. (2000a, 2000b)
Total PCB Aroclors	days	-	22,000	Infinite	Magar et al. (2005); van Dort et al. (1997); Mackay et al. (1994); Davis (2004)
PCB-126	days	2,400	3,700	Infinite	Sinkkonen & Paasivirta (2000); Beurskens & Stortelder (1995)

Table 4
Comparison of Leaching Test Data from Portland Harbor and Other Region 10 Sites

Material	Units	Portland Harbor AOPCs	Thea Foss Waterway			Hylebos – Segment 3/4	Duwamish – East Waterway
			Dredge Area	SSMA-7S	SSMA-7D		
Total Organic Carbon (TOC)							
Bulk Sediment	%	1.5	3.0	3.9	3.8	1.9	1.6
Benzo(a)pyrene							
Bulk Sediment	µg/kg	990	6,730	2,700	32,000	190	210
Mean Leachate	µg/L	0.23	0.23	0.03	0.80	< 1.1	NA
90th Percentile Leachate	µg/L	0.52	0.39	0.05	1.10	< 1.4	NA
Mean Koc	L/kg-OC	151,000	976,000	2,310,000	1,050,000	NC	NC
Total PCB Aroclors							
Bulk Sediment	µg/kg	650	61	420	540	350	1,290
Mean Leachate	µg/L	0.87	< 0.05	< 0.05	< 0.05	< 0.04	< 0.10
90th Percentile Leachate	µg/L	2.17	< 0.09	< 0.05	< 0.05	0.09	0.05
Mean Koc	L/kg-OC	72,000	NC	NC	NC	1,090,000	1,610,000
Total DDX							
Bulk Sediment	µg/kg	55	< 9	71	< 120	13	NA
Mean Leachate	µg/L	0.058	< 0.005	< 0.005	< 0.008	< 0.004	NA
90th Percentile Leachate	µg/L	0.076	0.003	0.006	< 0.010	< 0.006	NA
Mean Koc	L/kg-OC	74,000	NC	730,000	NC	NC	NA

Notes:
NA - Not Analyzed
NC - Not Calculated, due to lack of detected concentrations

ATTACHMENT

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ATTACHMENT A

DERIVATION OF PARTITIONING COEFFICIENTS FROM PORTLAND HARBOR SEQUENTIAL BATCH LEACHATE TESTS

The results and analysis of sequential batch leachate tests (SBLT; USACE 2003) conducted on sediments in areas of potential concern (AOPCs) in Portland Harbor are presented in this attachment. The AOPCs are being evaluated for remedial action in the Portland Harbor Feasibility Study. One of the remedial actions under consideration is dredging and placement of the dredged sediments in a nearshore confined disposal facility (CDF), such as the proposed CDF at the Port of Portland's (Port's) Terminal 4 (T4). SBLTs are laboratory tests specifically designed to evaluate the leaching characteristics of chemicals of concern (COCs) in dredged sediments placed in a CDF, and the potential for COCs to be mobilized in groundwater as it moves through the CDF toward the Willamette River.

One of the key results of the SBLTs is the estimation of chemical partitioning coefficients. Partitioning coefficients are an important input parameter for groundwater models currently being developed to characterize contaminant fate and transport in the T4 CDF. The partitioning coefficients developed from the SBLTs are appropriate for describing leaching (i.e., desorption) of COCs from contaminated sediments in a CDF.

Other methods must be used to estimate partitioning coefficients in the CDF berm, due to its significantly different material properties (i.e., the berm is comprised of import sand and gravel from local quarries) and thermodynamic conditions (i.e., adsorption-dominated processes rather than desorption; aerobic rather than anaerobic conditions). Partitioning coefficients applicable to the CDF berm have been adopted from the Portland Harbor Remedial Investigation Report (LWG 2009) and are compared with SBLT-derived coefficients later in this attachment.

SBLT SAMPLING AND ANALYSIS METHODS

SBLTs were conducted in 11 AOPCs by the Lower Willamette Group (LWG) in accordance with the methods described in the Portland Harbor RI/FS Sediment Chemical Mobility Testing Field Sampling Plan (LWG 2008) and U.S. Army Corps of Engineers protocols (USACE 2003). In addition, a SBLT conducted independently by the Port on sediment from T4 was also included in this evaluation (Palermo and Anchor 2007). In all, 12 SBLTs were conducted on composite sediment samples from the following AOPCs:

AOPC	River Mile[1]	Bank	Site Vicinity
1	2.2	East	Evraz Oregon Steel
3	3.8	East	Schnitzer
6	4.3	East	Terminal 4
8	4.8	West	BP-Arco
9	6.3	West	Gasco
11	5.7	East	Mar-Com Marine
13	6.8	East	Willamette Cove
14	7.1	West	Arkema
17	8.2	East	Cascade General Shipyard
17	9.0	East	Swan Island Lagoon
19	8.8	West	Gunderson
20	9.7	West	Fireboat Cove

Note:
[1] Approximate river mile at center of AOPC sampling area

Partitioning coefficients were calculated for each individual AOPC, and Harbor-wide coefficients were calculated using the compiled results from 10 of the AOPCs. The SBLT results for the remaining two AOPCs (sites 9 and 14, adjacent to Gasco and Arkema, respectively) were excluded from Harbor-wide calculations because portions of these AOPCs may contain free product, which increases the complexity of their leaching characteristics and is unrepresentative of other Harbor sediments. Sediments containing free product may require stabilization or some other form of treatment before they are considered suitable for placement in a CDF.

SBLT Chemicals of Concern

Partitioning coefficients were calculated for a comprehensive group of COCs, as listed below. This list is consistent with the COCs being considered for evaluation in related LWG modeling efforts (i.e., QEA-FATE model) for Portland Harbor. A more focused list of COCs will be selected for T4 CDF modeling.

- Metals:
  - Arsenic
  - Copper
  - Mercury
- Semivolatile Organic Compounds (SVOCs):
  - Naphthalene
  - Benzo(a)pyrene
  - Bis(2-ethylhexyl)phthalate
- Chlorinated Pesticides:
  - 4,4'-DDD
  - 4,4'-DDE
  - 4,4'-DDT
  - Total DDX
- Polychlorinated Biphenyls (PCBs):
  - Total PCB Aroclors
  - Total PCB Congeners
  - PCB-77
  - PCB-106/118
  - PCB-126
  - PCB-169

Chemical Partitioning Equations

The SBLT procedure results in extraction and analysis of four sequential leachate cycles from the test sediment. An initial chemical analysis of the composite bulk sediment sample is performed. For each leaching cycle, the mass of contaminant remaining in the sediment is adjusted to account for mass lost via leaching to the aqueous phase, using the principles of mass balance (USACE 2003, Appendix D):

$$C_{sed}(n) = C_{sed}(n-1) - 4 \times C_{leach}(n), \quad n = \text{cycles 1 through 4}$$

in which $C_{sed}(n)$ is the bulk sediment concentration associated with the nth leachate cycle [in mg/kg, µg/kg, or ng/kg], $C_{leach}(n)$ is the leachate concentration for the same cycle in consistent units [i.e., mg/L, µg/L, or ng/L, respectively], $C_{sed}(0)$ is the initial bulk sediment concentration prior to leaching, and the constant (4) represents the weight ratio of water-to-sediment (4-to-1) as specified in the SBLT procedure.

Partitioning coefficients [K_d in L/kg] are then calculated for each leaching cycle:

$$K_d = C_{sed}(n) / C_{leach}(n)$$

Metals partitioning coefficients are expressed as K_d values, as derived above. However, partitioning coefficients for organic compounds (including SVOCs, chlorinated pesticides, and PCBs) are normalized to the organic carbon content of the sediment, as follows:

$$K_{oc} = K_d / foc$$

in which K_{oc} is the organic carbon partitioning coefficient [L/kg-organic carbon] and foc is the unitless fraction of sedimentary organic carbon [kg-organic carbon/kg-sediment].

Treatment of Nondetects in SBLT Results

The occurrence of undetected analytical concentrations in either bulk sediment or leachate complicates the calculation of partitioning coefficients. The following general rules were observed when handling nondetects:

- **Nondetects in Bulk Sediment:** If a particular COC was not present at detectable concentrations in the initial bulk sediment phase in a particular AOPC, there is insufficient data to calculate a partitioning coefficient for that COC and AOPC. Such data were not included in Harbor-wide calculations.
- **Detections in Bulk Sediment; Partial Detections in Leachate:** If a particular COC was present at detectable concentrations in at least one of the four leaching cycles, partitioning coefficients were calculated and included in Harbor-wide partitioning calculations. Partitioning coefficients calculated using undetected leachate concentrations may actually be greater than the calculated value and therefore carry an associated “>” flag.

- **Detections in Bulk Sediment; Nondetects in Leachate:** If a particular COC was not detected in all four leaching cycles, the data were generally not included in Harbor-wide calculations, unless the level of "censoring" provides useful information to help bound the range of values. Specifically, if the calculated partitioning coefficients, based on undetected leachate concentrations, fall within the upper quartile of values observed at other sites in the Portland Harbor, such data can add value to the Harbor-wide summary statistics and were, therefore, retained in the Harbor-wide dataset.

In situations where partitioning coefficients were calculated using undetected leachate concentrations, one-half the detection limit of the leachate analysis was used in the calculation (i.e., in the denominator of the sediment-to-water ratio).

SBLT Partitioning Calculations

The analytical results of the SBLTs, calculated partitioning coefficients for individual AOPCs, and Harbor-wide summary statistics are compiled in Table A-1. This table includes the following information for each AOPC and COC:

- Initial measured bulk sediment COC concentrations, and calculated bulk sediment COC concentrations for each subsequent leaching cycle
- Measured fraction of organic carbon in bulk sediment (based on total organic carbon [TOC] analysis)
- Measured COC concentrations in each leachate extraction cycle
- Calculated partitioning coefficients for each leachate extraction cycle
- Geometric mean partitioning coefficients for each AOPC and COC, based on the central tendency of the four leachate cycles
- Harbor-wide summary statistics (including minimum, mean, maximum, and 10th and 90th percentile values of log partitioning coefficients) as derived from 10 AOPCs, excluding Sites 9 and 14

In developing recommended partitioning coefficients for Portland Harbor, four different calculation methods were considered, although not every method produced a reliable value in every AOPC, and one method (method 2) proved to be inapplicable to the Portland

Harbor dataset. The use of multiple methods helps to provide corroboration of model input values and improved reliability. The following calculation methods were evaluated:

1. Harbor-wide summary statistics of log K_d or log K_{oc} values
2. Partitioning isotherms derived from analysis of sequential leaching cycles
3. Linear isotherms derived from regression analysis of Harbor-wide data pairs
4. Freundlich isotherms derived from regression analysis of Harbor-wide data pairs

These various partitioning calculations are described in more detail below:

1. Harbor-Wide Summary Statistics of Log K_d and Log K_{oc} Values

In a large majority of cases, there were no consistent trends in leachate concentrations over the four cycles of the SBLT; therefore, the data were simply analyzed as four replicate measurements. Partitioning coefficients were calculated for each cycle, and a geometric mean partitioning coefficient was calculated for each AOPC by averaging the results of the four cycles. Harbor-wide summary statistics (including mean, minimum, maximum, and 10th and 90th percentile values) were then calculated over the 10 AOPCs (see Table A-1).

2. Partitioning Isotherms Derived from Analysis of Sequential Leaching Cycles

For some COCs, and in some environments, it is possible to develop partitioning isotherms based on the change in sediment and leachate concentrations that occur over the four leaching cycles of the SBLT (USACE 2003). However, Portland Harbor data are not amenable to this type of calculation for the following reasons (see Table A-1):

1) The COCs in Harbor sediments are moderately to strongly hydrophobic. As a result, very little mass is desorbed during each leaching cycle and the overall change in sediment concentration over the four-cycle test is negligible.

2) It is unusual to observe consistently decreasing leachate concentrations over the course of the four test cycles. More typically, concentrations rise and fall randomly from one cycle to the next with no apparent trend. This type of non-ideal behavior has also been observed in other SBLT tests in other parts of the country (M. Palermo, pers. comm.).

For these reasons, the analytical results from the four leachate cycles were treated as four replicate measurements, as described in the previous section.

3. Linear Isotherms Derived from Regression Analysis of Harbor-Wide Data Pairs

A linear isotherm model is a common way to describe chemical partitioning relationships (Tchobanoglous and Schroeder 1985). For this study, the partitioning relationships were developed using all of the Harbor-wide data to provide coverage over the entire range of observed sediment and leachate concentrations. Each AOPC is represented by a data pair consisting of the mean sediment concentration and mean leachate concentration averaged over the four SBLT cycles. The 10 data pairs from 10 AOPCs are posted in a scatterplot, and a least-squares linear regression is fit to this Harbor-wide dataset. The scatterplots and regression lines are shown on the left-hand panels of Figure A-1, and the linear regression statistics are summarized in Table A-2 for each COC. Note that a minimum of three valid data pairs (i.e., valid SBLT results from at least three AOPCs; see discussion under *Treatment of Nondetects in SBLT Results*) is required to fit a regression model.

The slope of the regression line is an estimate of the linear partitioning coefficient. A linear partitioning coefficient is constant over the range of observed sediment concentrations. The regression line for metals is allowed to intercept the y axis, indicating some amount of residual and un-leachable metal can be fixed in the mineral framework of the sediment and this fraction does not interact with porewater. The regression line for organic compounds is forced through the origin because these compounds cannot be mineralized and are assumed to be fully exchangeable.

4. Freundlich Isotherms Derived from Regression Analysis of Harbor-Wide Data Pairs

A Freundlich isotherm model is another common way to describe chemical partitioning relationships (Tchobanoglous and Schroeder 1985). Similar to the linear isotherm model, scatterplots of the 10 sediment-leachate pairs from the 10 AOPCs are fitted with a least-squares regression line. To derive the Freundlich isotherm coefficients, however, the data are modeled in logarithmic space. The logarithmic scatterplots are shown in the right-hand panels of Figure A-1, adjacent to their corresponding linear models. The

Freundlich coefficients [K_f] and [1/n] correspond to the slope and intercept of the logarithmic regression model, respectively.

METHOD COMPARISON AND RECOMMENDATIONS

The log K_d and log K_{oc} values for metals and organics, respectively, are summarized in Table A-2. For COCs that were amenable to all three calculation methods (primarily PCB aroclors and congeners), there is excellent agreement among the three estimates. The mean partitioning coefficient of the AOPCs (based on Harbor-wide summary statistics), the slope of the linear regression model, and the Freundlich coefficient [K_f] of the log regression model, differ by no more than one quarter to one half an order of magnitude for these constituents.

The recommended partitioning coefficients for use in the T4 CDF model were selected using the following decision logic:

1. The slope of the linear regression model is the preferred method for estimating the partitioning coefficient if a moderately strong correlation is observed (i.e., $0.78 < r^2 < 0.98$).
2. If a poor correlation is observed in the linear regression model, the mean of the log K_d or log K_{oc} values from the Harbor-wide summary statistics is used.
3. The Freundlich coefficients are not recommended for use because the Freundlich slope [1/n] is close to 1 in a majority of cases (i.e., it is not substantially different than the linear isotherm model). The added complexity of the Freundlich model is, therefore, not warranted.

In summary, the partitioning coefficients derived from the SBLT data are appropriate for characterizing the leaching (i.e., desorption) of COCs from contaminated sediments placed in the T4 CDF. The recommended sediment desorption coefficients for use in the T4 CDF groundwater model are summarized in Table A-2.

For comparison, partitioning coefficients recommended for use in the Portland Harbor chemical fate and transport model (component of QEA-FATE model) are also provided in Table A-2. These partitioning coefficients were derived from a survey of literature values (LWG 2009) and from the analysis of LWG water column monitoring data in the Willamette

River. They are more appropriate for characterizing surface water fate and transport processes in the Willamette River, as well as adsorptive processes and groundwater/surface water interactions in the CDF berm.

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Table A-1
Summary of Bulk Sediment and Leachate Results, AOPC and Harbor-Wide Partitioning Coefficients

				Bulk Sediment Concentrations					SBLT Leachate Concentrations				LOG Kd/Koc (L/kg) [1][2]				AOPC Summary Statistics [3]			Harbor-Wide LOG Kd/Koc Summary Stats [5]	
	Sediment Unit	Leachate Unit	Fraction TOC	Initial Concentration	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	GeoMean Sediment[4]	GeoMean Leachate[4]	Average LOG Kd/Koc		
Arsenic																					
Site 1: Evraz Oregon Steel	mg/kg	mg/l	0.0112	4.45 T	4.33	4.32	4.31	4.30	0.0310 T	0.0027 T	0.0015 T	0.0013 T	2.14	3.21	3.46	3.54	4.31	0.0035	3.09	Min	2.34
Site 3: Schnitzer	mg/kg	mg/l	0.0151	3.90 J	3.83	3.75	3.68	3.62	0.0173	0.0204	0.0178	0.0139 T	2.35	2.26	2.32	2.42	3.72	0.0172	2.34		
Site 6: Terminal 4	mg/kg	mg/l	0.0156	6.20	6.18	6.15	6.13	6.12	0.0060	0.0065	0.0038	0.0026	3.01	2.98	3.21	3.37	6.15	0.0044	3.14	10th %-tile	3.01
Site 8: BP-Arco	mg/kg	mg/l	0.0071	4.00 JT	3.99	3.99	3.99	3.98	0.0014	0.0008	0.0007	0.0010	3.46	3.70	3.76	3.60	3.99	0.0009	3.63		
Site 11: Mar Com Marine	mg/kg	mg/l	0.0135	2.40	2.38	2.37	2.37	2.37	0.0051	0.0025 T	0.0006 T	0.0005 T	2.67	2.98	3.60	3.72	2.37	0.0014	3.24	Mean	3.25
Site 13: Willamette Cove	mg/kg	mg/l	0.0290	5.10	5.09	5.08	5.07	5.04	0.0028 T	0.0021 T	0.0016 T	0.0094 JT	3.26	3.39	3.50	2.73	5.07	0.0030	3.22		
Site 17: Cascade General	mg/kg	mg/l	0.0119	3.10	3.09	3.09	3.07	3.06	0.0024 T	0.0012 T	0.0030 T	0.0023 T	3.11	3.43	3.01	3.12	3.08	0.0021	3.17	90th %-tile	3.65
Site 17: Swan Is. Lagoon	mg/kg	mg/l	0.0167	3.00	3.00	2.99	2.99	2.99	0.0010 T	0.0011 T	0.0007 T	0.0010 T	3.48	3.45	3.63	3.50	2.99	0.0009	3.51		
Site 19: Gunderson	mg/kg	mg/l	0.0170	5.60	5.60	5.59	5.59	5.59	0.0009 T	0.0011	0.0006	0.0007	3.79	3.71	3.97	3.90	5.59	0.0008	3.84	Max	3.84
Site 20: Fireboat Cove	mg/kg	mg/l	0.0102	2.75 T	2.74	2.73	2.73	2.73	0.0017 T	0.0027 T	0.0010 T	0.0007 T	3.21	3.01	3.46	3.59	2.73	0.0013	3.32		
Site 9: Gasco	mg/kg	mg/l	0.1060	2.70 J	2.70	2.69	2.68	2.67	0.0012 T	0.0018	0.0020	0.0018	3.35	3.17	3.13	3.17	2.68	0.0017	3.21		
Site 14: Arkema	mg/kg	mg/l	0.0199	3.70	3.69	3.68	3.66	3.63	0.0024	0.0030 T	0.0049 T	0.0068 T	3.19	3.09	2.88	2.73	3.66	0.0039	2.97		
Copper																					
Site 1: Evraz Oregon Steel	mg/kg	mg/l	0.0112	16.6 JT	16.4	16.4	16.4	16.4	0.0392 T	0.0037 T	0.0022 T	0.0048 T	2.62	3.65	3.88	3.53	16.42	0.0062	3.42	Min	3.42
Site 3: Schnitzer	mg/kg	mg/l	0.0151	33.6 J	33.5	33.5	33.5	33.5	0.0145	0.0110	0.0073	0.0044 T	3.36	3.48	3.66	3.88	33.49	0.0085	3.60		
Site 6: Terminal 4	mg/kg	mg/l	0.0156	48.9	48.83	48.72	48.70	48.69	0.0170	0.0271	0.0051	0.0023	3.46	3.25	3.98	4.33	48.74	0.0086	3.75	10th %-tile	3.58
Site 8: BP-Arco	mg/kg	mg/l	0.0071	121.0 JT	121.0	121.0	121.0	120.9	0.0035	0.0032	0.0030	0.0036	4.54	4.58	4.61	4.53	120.97	0.0033	4.56		
Site 11: Mar Com Marine	mg/kg	mg/l	0.0135	20.8 J	20.8	20.8	20.8	20.8	0.0025 U	0.0030 T	0.0016 T	0.0019 T	> 4.22	3.84	4.13	4.05	20.78	0.0018	4.06	Mean	3.95
Site 13: Willamette Cove	mg/kg	mg/l	0.0290	67.6 J	67.6	67.6	67.6	67.2	0.0026 T	0.0026 T	0.0030 T	0.0909 T	4.41	4.41	4.35	2.87	67.48	0.0066	4.01		
Site 17: Cascade General	mg/kg	mg/l	0.0119	67.8 J	67.8	67.7	67.7	67.7	0.0120 T	0.0041 T	0.0020 T	0.0019 T	3.75	4.22	4.53	4.56	67.73	0.0037	4.27	90th %-tile	4.30
Site 17: Swan Is. Lagoon	mg/kg	mg/l	0.0167	14.5 J	14.5	14.5	14.4	14.4	0.0028 T	0.0017 T	0.0134 JT	0.0023 T	3.72	3.93	3.03	3.81	14.45	0.0034	3.62		
Site 19: Gunderson	mg/kg	mg/l	0.0170	50.6	50.6	50.6	50.6	50.5	0.0036 T	0.0035	0.0033	0.0028	4.15	4.16	4.19	4.26	50.57	0.0033	4.19	Max	4.56
Site 20: Fireboat Cove	mg/kg	mg/l	0.0102	28.7 T	28.7	28.7	28.7	28.7	0.0034 T	0.0012 T	0.0042 T	0.0023 T	3.93	4.38	3.83	4.10	28.67	0.0025	4.06		
Site 9: Gasco	mg/kg	mg/l	0.1060	33.6 J	33.6	33.6	33.6	33.5	0.0025 T	0.0029	0.0069	0.0046	4.13	4.06	3.69	3.86	33.56	0.0039	3.94		
Site 14: Arkema	mg/kg	mg/l	0.0199	70.4	70.4	70.4	70.4	70.3	0.0014	0.0030 T	0.0068 T	0.0063 T	4.70	4.38	4.01	4.05	70.37	0.0036	4.29		
Mercury																					
Site 1: Evraz Oregon Steel	mg/kg	mg/l	0.0112	0.06 T	0.06	0.06	0.06	0.06	0.0001 UT	0.0001 UT	0.0001 UT	0.0001 UT	NC	NC	NC	NC	0.06	0.0001	NC	Min	ID
Site 3: Schnitzer	mg/kg	mg/l	0.0151	0.18	0.18	0.18	0.18	0.18	0.0001 U	0.0001 U	0.0001 U	0.0001 UT	NC	NC	NC	NC	0.18	0.0001	NC		
Site 6: Terminal 4	mg/kg	mg/l	0.0156	0.08	0.08	0.08	0.08	0.08	0.0001 U	0.0001 U	0.0001 U	0.0001 U	NC	NC	NC	NC	0.08	0.0001	NC	10th %-tile	ID
Site 8: BP-Arco	mg/kg	mg/l	0.0071	0.09 T	0.09	0.09	0.09	0.09	0.0001 U	0.0001 U	0.0001 U	0.0001 U	NC	NC	NC	NC	0.09	0.0001	NC		
Site 11: Mar Com Marine	mg/kg	mg/l	0.0135	0.06	0.06	0.06	0.06	0.06	0.0001 U	0.0001 UT	0.0001 UT	0.0001 UT	NC	NC	NC	NC	0.06	0.0001	NC	Mean	ID
Site 13: Willamette Cove	mg/kg	mg/l	0.0290	0.98	0.98	0.98	0.98	0.97	0.0001 UT	0.0001 UT	0.0001 UT	0.0017 JT	> 4.29	> 4.29	> 4.29	2.75	0.98	0.0001	3.91		
Site 17: Cascade General	mg/kg	mg/l	0.0119	0.06	0.06	0.06	0.06	0.06	0.0001 UT	0.0001 UT	0.0001 UT	0.0001 UT	NC	NC	NC	NC	0.06	0.0001	NC	90th %-tile	ID
Site 17: Swan Is. Lagoon	mg/kg	mg/l	0.0167	0.15	0.15	0.15	0.15	0.15	0.0001 UT	0.0001 UT	0.0001 UT	0.0001 UT	NC	NC	NC	NC	0.15	0.0001	NC		
Site 19: Gunderson	mg/kg	mg/l	0.0170	0.54	0.54	0.54	0.54	0.54	0.0001 UT	0.0001 U	0.0001 U	0.0001 U	NC	NC	NC	NC	0.54	0.0001	NC	Max	ID
Site 20: Fireboat Cove	mg/kg	mg/l	0.0102	0.11 T	0.11	0.11	0.11	0.11	0.0001 UT	0.0001 UT	0.0001 UT	0.0001 UT	NC	NC	NC	NC	0.11	0.0001	NC		
Site 9: Gasco	mg/kg	mg/l	0.1060	0.19	0.19	0.19	0.19	0.19	0.0001 UT	0.0001 U	0.0001 U	0.0001 U	NC	NC	NC	NC	0.19	0.0001	NC		
Site 14: Arkema	mg/kg	mg/l	0.0199	0.41	0.41	0.41	0.41	0.41	0.0001 U	0.0001 UT	0.0001 UT	0.0001 UT	NC	NC	NC	NC	0.41	0.0001	NC		

Table A-1
Summary of Bulk Sediment and Leachate Results, AOPC and Harbor-Wide Partitioning Coefficients

	Sediment Unit	Leachate Unit	Fraction TOC	Bulk Sediment Concentrations					SBLT Leachate Concentrations				LOG Kd/Koc (L/kg) [1][2]				AOPC Summary Statistics [3]			Harbor-Wide LOG Kd/Koc Summary Stats [5]	
				Initial Concentration	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	GeoMean Sediment[4]	GeoMean Leachate[4]	Average LOG Kd/Koc		
Benzo(a)pyrene																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	100	100	100	99	99	0.055 J	0.055	0.041	0.053	5.21	5.21	5.34	5.22	8,882	0.051	5.24	Min	4.42
Site 3: Schnitzer	ug/kg	ug/l	0.0151	460	459	458	456	455	0.180	0.410	0.410	0.220	5.23	4.87	4.87	5.14	30,265	0.286	5.03		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	7,900	7,899.60	7,899.20	7,898.80	7,898.40	0.100 UJ	0.100 UJ	0.100 UJ	0.100 UJ	> 7.01	> 7.01	> 7.01	> 7.01	506,378	0.050	7.01	10th %-tile	4.72
Site 8: BP-Arco	ug/kg	ug/l	0.0071	450	444	440	439	438	1.600	0.820	0.370	0.220	4.59	4.88	5.22	5.45	61,996	0.572	5.04		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	240 J	238	237	237	234	0.480	0.220	0.160	0.550 J	4.57	4.90	5.04	4.50	17,522	0.310	4.75	Mean	5.18
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	200 J	194	193	193	192	1.500	0.170	0.073	0.220	3.65	4.59	4.96	4.48	6,659	0.253	4.42		
Site 17: Cascade General	ug/kg	ug/l	0.0119	70	70	69	69	69	0.087	0.045	0.030	0.020	4.83	5.11	5.29	5.46	5,835	0.039	5.17	90th %-tile	5.48
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	74	74	73	73	73	0.044	0.090	0.085	0.019 J	5.00	4.69	4.71	5.36	4,393	0.050	4.94		
Site 19: Gunderson	ug/kg	ug/l	0.0170	72 J	72	71	71	71	0.075	0.089	0.031	0.028	4.75	4.67	5.13	5.17	4,197	0.049	4.93	Max	7.01
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	290	289	288	288	287	0.140 J	0.320	0.058	0.140	5.31	4.95	5.69	5.30	28,257	0.138	5.31		
Site 9: Gasco	ug/kg	ug/l	0.1060	200,000	199,970	199,746	199,482	198,202	7.4	56.0	66.0 J	320.0	5.41	4.53	4.46	3.77	1,880,653	54.391	4.54		
Site 14: Arkema	ug/kg	ug/l	0.0199	800 J	800	799	796	794	0.051	0.095	0.730	0.670	5.90	5.63	4.74	4.77	40,069	0.221	5.26		
Naphthalene																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	11	11	10	10	10	0.051 J	0.080	0.037 U	0.069	4.28	4.07	> 4.70	4.12	933	0.048	4.29	Min	4.22
Site 3: Schnitzer	ug/kg	ug/l	0.0151	150	150	150	150	150	0.013 U	0.010 U	0.038	0.046	> 6.18	> 6.30	5.42	5.33	9,923	0.015	5.81		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	250	249.60	249.20	248.80	248.40	0.100 U	0.100 U	0.100 U	0.100 U	> 5.51	> 5.51	> 5.50	> 5.50	15,994	0.050	5.50	10th %-tile	4.26
Site 8: BP-Arco	ug/kg	ug/l	0.0071	27	27	27	27	27	0.032	0.021 U	0.017 U	0.011 U	5.07	> 5.56	> 5.65	> 5.84	3,777	0.011	5.53		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	73	72	70	EX	EX	0.150	0.530	52.000	0.150 J	4.55	3.99	EX	EX	5,284	0.228	4.27	Mean	4.97
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	240 J	239	239	238	238	0.220	0.140	0.080	0.087	4.57	4.77	5.01	4.97	8,223	0.121	4.83		
Site 17: Cascade General	ug/kg	ug/l	0.0119	6	6	6	6	5	0.094 U	0.036	0.031 U	0.057 U	> 4.03	4.14	> 4.50	> 4.22	491	0.029	4.22	90th %-tile	5.58
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	35	35	35	34	34	0.052 U	0.069 U	0.030 U	0.034 U	NC	NC	NC	NC	2,081	0.022	NC		
Site 19: Gunderson	ug/kg	ug/l	0.0170	36	36	36	36	35	0.018	0.012	0.021	0.120	5.07	5.25	5.00	4.24	2,102	0.027	4.89	Max	5.81
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	65	65	64	64	64	0.071	0.086	0.012 U	0.022 U	4.95	4.87	> 6.02	> 5.76	6,317	0.025	5.40		
Site 9: Gasco	ug/kg	ug/l	0.1060	3,200,000	3,165,200	3,154,400	3,128,000	3,080,000	8,700	2,700	6,600 J	12,000	3.54	4.04	3.65	3.38	29,544,591	6,567.530	3.65		
Site 14: Arkema	ug/kg	ug/l	0.0199	190	176	164	162	160	3.500	2.900	0.630	0.500	3.40	3.45	4.11	4.21	8,313	1.337	3.79		
Bis(2-ethylhexyl)phthalate																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	21	ED	20	19	18	6.20 U	0.28 U	0.26 U	0.25 U	NC	NC	NC	NC	1,779	0.132	NC	Min	4.20
Site 3: Schnitzer	ug/kg	ug/l	0.0151	95	94	93	91	90	0.26	0.25 U	0.50	0.25 U	4.38	> 4.69	4.08	> 4.68	6,123	0.212	4.46		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	92 U	ND	ND	ND	ND	0.42 U	0.70 U	0.61 U	1.20 U	ND	ND	ND	ND	2,747	0.341	ND	10th %-tile	4.30
Site 8: BP-Arco	ug/kg	ug/l	0.0071	20 U	ND	ND	EX	EX	1.00 UJ	0.50	5.70	0.85	ND	ND	ND	ND	976	0.597	ND		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	36	35	31	30	26	0.25 U	1.00 UJ	0.25 U	1.00 U	NC	NC	NC	NC	2,460	0.250	NC	Mean	4.64
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	70	69	68	67	64	0.26 U	0.29 U	0.25 U	0.79 U	NC	NC	NC	NC	2,358	0.175	NC		
Site 17: Cascade General	ug/kg	ug/l	0.0119	340	335	325	321	317	1.30 UJ	2.40	1.00 U	1.00 U	> 4.64	4.06	> 4.74	> 4.74	27,618	0.790	4.54	90th %-tile	5.08
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	260	256	249	245	238	1.00 UJ	1.70 J	1.00 U	1.90 J	> 4.49	3.95	> 4.47	3.88	14,966	0.948	4.20		
Site 19: Gunderson	ug/kg	ug/l	0.0170	840	838	836	835	EX	0.54 U	0.37 U	0.25 U	44.00 J	> 5.26	> 5.43	> 5.60	EX	49,309	0.184	5.43	Max	5.43
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	280	269	264	260	259	2.70 J	1.40 J	1.00 U	0.27 U	3.99	4.27	> 4.71	> 5.28	25,867	0.711	4.56		
Site 9: Gasco	ug/kg	ug/l	0.1060	900 U	ND	ND	ND	ND	0.36	0.63	0.61	2.80	ND	ND	ND	ND	4,176	0.789	ND		
Site 14: Arkema	ug/kg	ug/l	0.0199	170	169	146	145	136	0.25 U	5.70 U	0.25 U	2.20	> 4.83	> 3.45	> 4.80	3.53	7,956	0.559	4.15		

Table A-1
Summary of Bulk Sediment and Leachate Results, AOPC and Harbor-Wide Partitioning Coefficients

	Sediment Unit	Leachate Unit	Fraction TOC	Bulk Sediment Concentrations					SBLT Leachate Concentrations				LOG Kd/Koc (L/kg) [1][2]				AOPC Summary Statistics [3]			Harbor-Wide LOG Kd/Koc Summary Stats [5]	
				Initial Concentration	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	GeoMean Sediment[4]	GeoMean Leachate[4]	Average LOG Kd/Koc		
PCB077																					
Site 1: Evraz Oregon Steel	ng/kg	ng/l	0.0112	542	517	504	499	493	6.19	3.26	1.28	1.45	3.87	4.14	4.54	4.48	44,944	2.474	4.26	Min	4.15
Site 3: Schnitzer	ng/kg	ng/l	0.0151	1,600	1,598	1,585	1,579	1,574	0.40	3.32	1.41	1.36	5.42	4.50	4.87	4.88	104,916	1.262	4.92		
Site 8: BP-Arco	ng/kg	ng/l	0.0071	9 U	ND	ND	ND	ND	0.17	0.06	0.02 U	0.01 U	ND	ND	ND	ND	499	0.024	ND	10th %-tile	4.21
Site 11: Mar Com Marine	ng/kg	ng/l	0.0135	48	46	46	45	45	0.45	0.24	0.11	0.12	3.88	4.14	4.47	4.46	3,365	0.194	4.24		
Site 13: Willamette Cove	ng/kg	ng/l	0.0290	116 T	110	109	108	108	1.47	0.26 J	0.19	0.07 J	3.41	4.16	4.29	4.73	3,755	0.266	4.15	Mean	4.43
Site 17: Cascade General	ng/kg	ng/l	0.0119	54	50	49	49	49	1.04	0.28 T	0.05	0.04	3.61	4.16	4.88	4.98	4,121	0.161	4.41		
Site 17: Swan Is. Lagoon	ng/kg	ng/l	0.0167	170	166	162	162	161	0.90	1.01	0.21	0.11 T	4.05	3.98	4.67	4.94	9,752	0.380	4.41	90th %-tile	4.67
Site 19: Gunderson	ng/kg	ng/l	0.0170	7,770	7,612	7,535	7,516	7,492	39.40	19.30	4.73	5.96	4.06	4.36	4.97	4.87	443,467	12.100	4.56		
Site 20: Fireboat Cove	ng/kg	ng/l	0.0102	414	389	380	378	376	6.23	2.27	0.59	0.34	3.79	4.22	4.80	5.04	37,325	1.295	4.46	Max	4.92
Site 9: Gasco	ng/kg	ng/l	0.1060	207 J	207	205	204	203	0.02 U	0.40 J	0.39	0.29	> 5.35	3.69	3.69	3.82	1,931	0.140	4.14		
Site 14: Arkema	ng/kg	ng/l	0.0199	3,350	3,349	3,342	3,303	3,268	0.29 T	1.72	9.80	8.67	5.77	4.99	4.23	4.28	166,597	2.540	4.82		
PCB106 & 118																					
Site 1: Evraz Oregon Steel	ng/kg	ng/l	0.0112	3,190	2,981	2,874	2,832	2,792	52.30	26.70	10.40	10.20	3.71	3.98	4.39	4.39	256,147	19.618	4.12	Min	4.07
Site 3: Schnitzer	ng/kg	ng/l	0.0151	323,000	322,646	319,970	318,462	316,934	88.50	669.00	377.00	382.00	5.38	4.50	4.75	4.74	21,158,679	303.874	4.84		
Site 8: BP-Arco	ng/kg	ng/l	0.0071	157	150	147	146	146	1.85	0.67	0.19	0.06 U	4.06	4.49	5.04	> 5.84	20,731	0.288	4.86	10th %-tile	4.08
Site 11: Mar Com Marine	ng/kg	ng/l	0.0135	707	669	649	640	629	9.46	5.00	2.41	2.52	3.72	3.98	4.29	4.27	47,900	4.117	4.07		
Site 13: Willamette Cove	ng/kg	ng/l	0.0290	2,230 T	2,092	2,067	2,049	2,044	34.60	6.13 J	4.50	1.30	3.32	4.07	4.20	4.73	71,132	5.935	4.08	Mean	4.36
Site 17: Cascade General	ng/kg	ng/l	0.0119	2,180	1,939	1,866	1,853	1,844	60.30	18.30 T	3.18	2.15	3.43	3.93	4.69	4.86	157,565	9.320	4.23		
Site 17: Swan Is. Lagoon	ng/kg	ng/l	0.0167	2,690	2,590	2,454	2,431	2,416	24.90	34.00	5.84	3.75 T	3.79	3.64	4.40	4.59	148,025	11.669	4.10	90th %-tile	4.85
Site 19: Gunderson	ng/kg	ng/l	0.0170	43,800	42,884	42,472	42,354	42,203	229.00	103.00	29.50	37.80	4.04	4.38	4.93	4.82	2,498,673	71.614	4.54		
Site 20: Fireboat Cove	ng/kg	ng/l	0.0102	7,500	6,968	6,751	6,699	6,679	133.00	54.20	13.00	4.97	3.71	4.09	4.70	5.12	664,065	26.124	4.41	Max	4.86
Site 9: Gasco	ng/kg	ng/l	0.1060	2,070	2,069	2,058	2,031	2,018	0.36	2.56	6.93	3.17	4.74	3.88	3.44	3.78	19,281	2.118	3.96		
Site 14: Arkema	ng/kg	ng/l	0.0199	19,200	19,192	19,139	18,819	18,535	2.06 T	13.10	80.20	71.00	5.67	4.87	4.07	4.12	950,713	19.799	4.68		
PCB126																					
Site 1: Evraz Oregon Steel	ng/kg	ng/l	0.0112	23.2	22.2	21.7	21.5	21.0	0.246	0.129	0.052	0.121 U	3.91	4.18	4.57	> 4.50	1,934	0.100	4.29	Min	3.99
Site 3: Schnitzer	ng/kg	ng/l	0.0151	1,100.0	1,098.7	1,090.2	1,085.2	1,080.2	0.319	2.120	1.270	1.240	5.36	4.53	4.75	4.76	72,090	1.016	4.85		
Site 8: BP-Arco	ng/kg	ng/l	0.0071	9.8 U	ND	ND	ND	ND	0.081	0.024 U	0.016 U	0.012 U	ND	ND	ND	ND	639	0.015	ND	10th %-tile	4.11
Site 11: Mar Com Marine	ng/kg	ng/l	0.0135	5.5 J	5.2	5.1	5.0	5.0	0.087 U	0.025 U	0.014 U	0.018 U	NC	NC	NC	NC	393	0.014	NC		
Site 13: Willamette Cove	ng/kg	ng/l	0.0290	12.0 JT	11.2	11.0	10.9	10.8	0.212 U	0.031 J	0.024 U	0.023 U	> 3.58	4.11	> 4.51	> 4.53	395	0.026	4.18	Mean	4.36
Site 17: Cascade General	ng/kg	ng/l	0.0119	10.0 J	9.1	8.8	8.8	8.7	0.219	0.074 JT	0.014 J	0.010 U	3.54	4.00	4.73	> 5.19	745	0.032	4.37		
Site 17: Swan Is. Lagoon	ng/kg	ng/l	0.0167	15.7	14.8	14.0	13.8	13.7	0.216	0.216	0.038	0.031 T	3.61	3.59	4.34	4.43	843	0.086	3.99	90th %-tile	4.61
Site 19: Gunderson	ng/kg	ng/l	0.0170	198.0	193.2	190.9	190.3	189.3	1.210	0.562	0.157	0.234	3.97	4.30	4.85	4.68	11,231	0.398	4.45		
Site 20: Fireboat Cove	ng/kg	ng/l	0.0102	45.3	43.0	42.1	41.8	41.5	0.577	0.222	0.066	0.096	3.86	4.27	4.79	4.62	4,127	0.169	4.39	Max	4.85
Site 9: Gasco	ng/kg	ng/l	0.1060	74.6 U	ND	ND	ND	ND	0.009 U	0.282 J	0.100 U	0.125 U	ND	ND	ND	ND	342	0.045	ND		
Site 14: Arkema	ng/kg	ng/l	0.0199	119.0	118.9	118.7	117.1	115.6	0.014 JT	0.072	0.398	0.371	5.62	4.92	4.17	4.19	5,907	0.111	4.73		

Table A-1
Summary of Bulk Sediment and Leachate Results, AOPC and Harbor-Wide Partitioning Coefficients

				Bulk Sediment Concentrations					SBLT Leachate Concentrations				LOG Kd/Koc (L/kg) [1][2]				AOPC Summary Statistics [3]			Harbor-Wide LOG Kd/Koc Summary Stats [5]	
	Sediment Unit	Leachate Unit	Fraction TOC	Initial Concentration	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	GeoMean Sediment[4]	GeoMean Leachate[4]	Average LOG Kd/Koc		
PCB169																					
Site 1: Evraz Oregon Steel	ng/kg	ng/l	0.0112	2.4 U	ND	ND	ND	ND	0.019 U	0.009 U	0.012 U	0.055 U	ND	ND	ND	ND	98	0.009	ND	Min	ID
Site 3: Schnitzer	ng/kg	ng/l	0.0151	23.3 U	ND	ND	ND	ND	0.021 U	0.025 U	0.024 U	0.021 U	ND	ND	ND	ND	764	0.011	ND		
Site 8: BP-Arco	ng/kg	ng/l	0.0071	5.3 U	ND	ND	ND	ND	0.077	0.016 J	0.015 U	0.017 U	ND	ND	ND	ND	316	0.017	ND	10th %-tile	ID
Site 11: Mar Com Marine	ng/kg	ng/l	0.0135	2.9 U	ND	ND	ND	ND	0.075 U	0.059 U	0.015 U	0.011 U	ND	ND	ND	ND	88	0.015	ND		
Site 13: Willamette Cove	ng/kg	ng/l	0.0290	4.8 UT	ND	ND	ND	ND	0.087 U	0.021 UJ	0.016 U	0.012 U	ND	ND	ND	ND	75	0.012	ND	Mean	ID
Site 17: Cascade General	ng/kg	ng/l	0.0119	2.6 U	ND	ND	ND	ND	0.036 U	0.019 UT	0.005 U	0.012 U	ND	ND	ND	ND	100	0.007	ND		
Site 17: Swan Is. Lagoon	ng/kg	ng/l	0.0167	7.0 U	ND	ND	ND	ND	0.093 J	0.069 U	0.007 U	0.007 UT	ND	ND	ND	ND	181	0.014	ND	90th %-tile	ID
Site 19: Gunderson	ng/kg	ng/l	0.0170	22.7 U	ND	ND	ND	ND	0.119 U	0.036 U	0.016 U	0.031	ND	ND	ND	ND	648	0.023	ND		
Site 20: Fireboat Cove	ng/kg	ng/l	0.0102	10.1 U	ND	ND	ND	ND	0.032 U	0.035 U	0.021 U	0.089	ND	ND	ND	ND	472	0.023	ND	Max	ID
Site 9: Gasco	ng/kg	ng/l	0.1060	83.6 U	ND	ND	ND	ND	0.010 U	0.340 J	0.058 U	0.114 J	ND	ND	ND	ND	383	0.048	ND		
Site 14: Arkema	ng/kg	ng/l	0.0199	71.4 U	ND	ND	ND	ND	0.010 UT	0.020 U	0.103	0.063 UJ	ND	ND	ND	ND	1,779	0.020	ND		
Total PCBs Congeners																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	185 T	172	165	163	160	3.31 JT	1.72 T	0.66 JT	0.72 JT	3.67	3.93	4.34	4.30	14,727	1.282	4.06	Min	3.91
Site 3: Schnitzer	ug/kg	ug/l	0.0151	4,962 T	4,956	4,914	4,890	4,867	1.50 JT	10.57 T	6.03 JT	5.74 T	5.34	4.49	4.73	4.75	324,956	4.840	4.83		
Site 8: BP-Arco	ug/kg	ug/l	0.0071	7 JT	7	6	6	6	0.10 JT	0.04 JT	0.01 JT	0.01 JT	3.96	4.40	4.87	5.17	910	0.023	4.60	10th %-tile	3.97
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	25 JT	23	22	22	21	0.48 JT	0.24 JT	0.12 JT	0.12 JT	3.55	3.84	4.14	4.12	1,632	0.199	3.91		
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	86 T	79	78	77	77	1.65 JT	0.28 JT	0.21 JT	0.06 JT	3.22	3.99	4.10	4.63	2,681	0.279	3.98	Mean	4.28
Site 17: Cascade General	ug/kg	ug/l	0.0119	47 JT	41	39	39	39	1.53 JT	0.44 T	0.07 JT	0.05 JT	3.35	3.88	4.66	4.82	3,314	0.220	4.18		
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	107 T	103	97	96	95	1.01 JT	1.46 JT	0.24 T	0.14 T	3.79	3.60	4.38	4.60	5,838	0.473	4.09	90th %-tile	4.64
Site 19: Gunderson	ug/kg	ug/l	0.0170	2,371 JT	2,318	2,298	2,292	2,286	13.12 JT	4.98 JT	1.48 JT	1.59 JT	4.02	4.43	4.96	4.93	135,212	3.520	4.58		
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	851 T	779	749	742	740	17.88 JT	7.56 JT	1.66 JT	0.65 T	3.63	3.99	4.64	5.04	73,760	3.483	4.33	Max	4.83
Site 9: Gasco	ug/kg	ug/l	0.1060	95 JT	95	94	93	93	0.01 JT	0.11 JT	0.21 JT	0.13 JT	5.04	3.89	3.62	3.81	884	0.072	4.09		
Site 14: Arkema	ug/kg	ug/l	0.0199	1,013 JT	1,013	1,010	995	982	0.15 T	0.69 T	3.77 JT	3.27 JT	5.53	4.87	4.12	4.18	50,246	1.063	4.67		
Total Aroclors																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	109	106	104	103	102	0.64	0.50	0.26	0.22	4.17	4.27	4.55	4.61	9,279	0.366	4.40	Min	4.32
Site 3: Schnitzer	ug/kg	ug/l	0.0151	4,520	4,510	4,488	4,462	4,453	2.56	5.48	6.45	2.22	5.07	4.73	4.66	5.12	296,567	3.763	4.90		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	46	--	45.13	--	44.97	--	0.19	--	0.04	--	4.18	--	4.85	2,888	0.089	4.51	10th %-tile	4.37
Site 8: BP-Arco	ug/kg	ug/l	0.0071	10 UN	ND	ND	ND	ND	0.04	0.01 UN	0.01 UN	0.01 UN	ND	ND	ND	ND	661	0.009	ND		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	10 UN	ND	ND	ND	ND	0.13	0.07	0.05	0.05	ND	ND	ND	ND	292	0.070	ND	Mean	4.55
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	77	76	75	75	75	0.27	0.20	0.08	0.04 UN	3.99	4.11	4.52	> 5.11	2,588	0.095	4.44		
Site 17: Cascade General	ug/kg	ug/l	0.0119	50	49	48	48	48	0.30	0.17	0.04	0.04	4.14	4.39	5.06	5.06	4,039	0.088	4.66	90th %-tile	4.81
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	69	68	66	66	65	0.22	0.39	0.10	0.08	4.26	4.01	4.60	4.68	3,967	0.163	4.39		
Site 19: Gunderson	ug/kg	ug/l	0.0170	1,358	1,348	1,341	1,336	1,334	2.52	1.66	1.28	0.56	4.50	4.68	4.79	5.15	78,812	1.315	4.78	Max	4.90
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	281	274	254	250	249	1.51	5.00	1.01	0.27	4.25	3.70	4.39	4.96	25,194	1.192	4.32		
Site 9: Gasco	ug/kg	ug/l	0.1060	120 UN	ND	ND	ND	ND	0.03 UN	0.05	0.10 UN	0.12	ND	ND	ND	ND	562	0.044	ND		
Site 14: Arkema	ug/kg	ug/l	0.0199	990 UN	ND	ND	ND	ND	0.90 UN	5.00 UN	15.00 UN	10.00 UN	ND	ND	ND	ND	23,371	2.549	ND		

Table A-1
Summary of Bulk Sediment and Leachate Results, AOPC and Harbor-Wide Partitioning Coefficients

	Sediment Unit	Leachate Unit	Fraction TOC	Bulk Sediment Concentrations					SBLT Leachate Concentrations				LOG Kd/Koc (L/kg) [1][2]				AOPC Summary Statistics [3]			Harbor-Wide LOG Kd/Koc Summary Stats [5]	
				Initial Concentration	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	GeoMean Sediment[4]	GeoMean Leachate[4]	Average LOG Kd/Koc		
4,4'-DDD																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	1.9 U	ND	ND	ND	ND	0.010 U	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	80	0.005	ND	Min	4.29
Site 3: Schnitzer	ug/kg	ug/l	0.0151	10.0 U	ND	ND	ND	ND	0.010 U	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	328	0.005	ND		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	23.0 UJ	--	--	ND	--	--	--	0.004 J	--	--	--	ND	--	736	0.004	ND	10th %-tile	4.40
Site 8: BP-Arco	ug/kg	ug/l	0.0071	2.0 U	ND	ND	ND	ND	0.010 UJ	0.010 U	0.011 U	0.010 U	ND	ND	ND	ND	134	0.005	ND		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	1.9 U	ND	ND	ND	ND	0.032 J	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	59	0.008	ND	Mean	5.11
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	8.5 J	8.3	8.2	8.1	8.1	0.054 J	0.031 J	0.010 U	0.010 U	3.72	3.96	> 4.75	> 4.75	282	0.014	4.29		
Site 17: Cascade General	ug/kg	ug/l	0.0119	2.0 U	ND	ND	ND	ND	0.010 UJ	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	80	0.005	ND	90th %-tile	5.94
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	1.9 U	ND	ND	ND	ND	0.011 U	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	54	0.005	ND		
Site 19: Gunderson	ug/kg	ug/l	0.0170	78.0 NJ	77.4	76.9	76.7	76.6	0.160 J	0.120	0.049	0.025	4.45	4.58	4.96	5.26	4,522	0.070	4.81	Max	6.22
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	85.0 J	85.0	84.9	84.9	84.8	0.010 U	0.010 U	0.010 U	0.010 U	> 6.22	> 6.22	> 6.22	> 6.22	8,328	0.005	6.22		
Site 9: Gasco	ug/kg	ug/l	0.1060	99.0 U	ND	ND	ND	ND	0.010 UJ	0.010 UJ	0.100 UJ	0.010 UJ	ND	ND	ND	ND	466	0.009	ND		
Site 14: Arkema	ug/kg	ug/l	0.0199	16,000	15,981	15,845	15,489	15,089	4.7	34.0	89.0	100.0	5.23	4.37	3.94	3.88	783,786	34.534	4.36		
4,4'-DDE																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	1.9 U	ND	ND	ND	ND	0.010 U	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	80	0.005	ND	Min	4.59
Site 3: Schnitzer	ug/kg	ug/l	0.0151	10.0 U	ND	ND	ND	ND	0.040 U	0.010 U	0.010 U	0.032 U	ND	ND	ND	ND	323	0.009	ND		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	16.0 UJ	--	--	ND	--	--	--	0.006 J	--	--	--	ND	--	511	0.006	ND	10th %-tile	ID
Site 8: BP-Arco	ug/kg	ug/l	0.0071	2.0 U	ND	ND	ND	ND	0.010 UJ	0.010 U	0.011 U	0.010 U	ND	ND	ND	ND	134	0.005	ND		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	1.9 U	ND	ND	ND	ND	0.010 U	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	67	0.005	ND	Mean	5.56
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	4.9 U	ND	ND	ND	ND	0.028 U	0.015 U	0.010 U	0.010 U	ND	ND	ND	ND	81	0.007	ND		
Site 17: Cascade General	ug/kg	ug/l	0.0119	2.0 U	ND	ND	ND	ND	0.010 UJ	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	80	0.005	ND	90th %-tile	ID
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	1.9 U	ND	ND	ND	ND	0.011 U	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	54	0.005	ND		
Site 19: Gunderson	ug/kg	ug/l	0.0170	150	147	145	145	145	0.770	0.410	0.110	0.068 J	4.05	4.32	4.89	5.10	8,553	0.220	4.59	Max	6.52
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	170.0	170.0	169.9	169.9	169.8	0.010 U	0.010 U	0.010 U	0.010 U	> 6.52	> 6.52	> 6.52	> 6.52	16,662	0.005	6.52		
Site 9: Gasco	ug/kg	ug/l	0.1060	99.0 U	ND	ND	ND	ND	0.010 UJ	0.078 UJ	0.100 UJ	0.054 UJ	ND	ND	ND	ND	464	0.023	ND		
Site 14: Arkema	ug/kg	ug/l	0.0199	2,000 U	ND	ND	ND	ND	0.10 U	1.00 U	5.00 U	5.00 U	ND	ND	ND	ND	49,787	0.629	ND		
4,4'-DDT																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	6.1 U	ND	ND	ND	ND	0.010 U	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	268	0.005	ND	Min	4.24
Site 3: Schnitzer	ug/kg	ug/l	0.0151	10.0 U	ND	ND	ND	ND	0.054 U	0.010 U	0.010 U	0.044 U	ND	ND	ND	ND	321	0.011	ND		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	20.0 UJ	--	--	ND	--	--	--	0.003 UJ	--	--	--	ND	--	641	0.001	ND	10th %-tile	ID
Site 8: BP-Arco	ug/kg	ug/l	0.0071	2.0 U	ND	ND	ND	ND	0.010 UJ	0.010 U	0.011 U	0.010 U	ND	ND	ND	ND	134	0.005	ND		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	4.2	4.0	4.0	3.9	3.8	0.039 J	0.022 NJ	0.019 J	0.010 U	3.89	4.12	4.18	> 4.76	291	0.017	4.24	Mean	4.42
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	5.8	5.8	5.7	5.7	5.6	0.010 U	0.010 U	0.010 U	0.010 U	> 4.60	> 4.60	> 4.60	> 4.60	198	0.005	4.60		
Site 17: Cascade General	ug/kg	ug/l	0.0119	2.0 U	ND	ND	ND	ND	0.010 UJ	0.010 U	0.010 U	0.010 U	ND	ND	ND	ND	80	0.005	ND	90th %-tile	ID
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	1.9 U	ND	ND	ND	ND	0.011 U	0.010 U	0.010 U	0.010 UJ	ND	ND	ND	ND	54	0.005	ND		
Site 19: Gunderson	ug/kg	ug/l	0.0170	20.0 U	ND	ND	ND	ND	0.034 U	0.031 U	0.010 U	0.010 U	ND	ND	ND	ND	581	0.009	ND	Max	4.60
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	19.0 U	18.7	18.2	18.1	18.0	0.081 U	0.120 U	0.029 U	0.015 U	ND	ND	ND	ND	894	0.023	ND		
Site 9: Gasco	ug/kg	ug/l	0.1060	99.0 U	ND	ND	ND	ND	0.010 UJ	0.010 UJ	0.100 UJ	0.010 UJ	ND	ND	ND	ND	466	0.009	ND		
Site 14: Arkema	ug/kg	ug/l	0.0199	29,000	28,999	28,983	28,915	28,791	0.21 J	4.00	17.00	31.00	6.84	5.56	4.93	4.67	1,453,369	4.587	5.50		

Table A-1
Summary of Bulk Sediment and Leachate Results, AOPC and Harbor-Wide Partitioning Coefficients

				Bulk Sediment Concentrations					SBLT Leachate Concentrations				LOG Kd/Koc (L/kg) [1][2]				AOPC Summary Statistics [3]			Harbor-Wide LOG Kd/Koc Summary Stats [5]	
	Sediment Unit	Leachate Unit	Fraction TOC	Initial Concentration	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 1	Cycle 2	Cycle 3	Cycle 4	GeoMean Sediment[4]	GeoMean Leachate[4]	Average LOG Kd/Koc		
Total DDx[6]																					
Site 1: Evraz Oregon Steel	ug/kg	ug/l	0.0112	6.1 UN	ND	ND	ND	ND	0.010 UN	0.010 UN	0.010 UN	0.010 UN	ND	ND	ND	ND	268	0.005	ND	Min	4.23
Site 3: Schnitzer	ug/kg	ug/l	0.0151	10.0 UN	ND	ND	ND	ND	0.054 UN	0.010 UN	0.010 UN	0.044 UN	ND	ND	ND	ND	321	0.011	ND		
Site 6: Terminal 4	ug/kg	ug/l	0.0156	23.0 UN	ND	ND	ND	ND	--	--	0.011	--	--	--	ND	--	734	0.011	ND	10th %-tile	4.32
Site 8: BP-Arco	ug/kg	ug/l	0.0071	2.0 UN	ND	ND	ND	ND	0.010 UN	0.010 UN	0.011 UN	0.010 UN	ND	ND	ND	ND	134	0.005	ND		
Site 11: Mar Com Marine	ug/kg	ug/l	0.0135	6.1	5.8	5.7	5.6	5.5	0.076	0.032	0.029	0.010 UN	3.75	4.12	4.15	> 4.91	417	0.024	4.23	Mean	4.87
Site 13: Willamette Cove	ug/kg	ug/l	0.0290	16.8	16.5	16.3	16.2	16.2	0.073	0.044	0.010 UN	0.010 UN	3.89	4.11	> 5.05	> 5.05	562	0.017	4.53		
Site 17: Cascade General	ug/kg	ug/l	0.0119	2.0 UN	ND	ND	ND	ND	0.010 UN	0.010 UN	0.010 UN	0.010 UN	ND	ND	ND	ND	80	0.005	ND	90th %-tile	5.64
Site 17: Swan Is. Lagoon	ug/kg	ug/l	0.0167	1.9 UN	ND	ND	ND	ND	0.011 UN	0.010 UN	0.010 UN	0.010 UN	ND	ND	ND	ND	54	0.005	ND		
Site 19: Gunderson	ug/kg	ug/l	0.0170	238.0	234.2	232.0	231.4	231.0	0.947	0.546	0.164	0.098	4.16	4.40	4.92	5.14	13,656	0.302	4.66	Max	6.06
Site 20: Fireboat Cove	ug/kg	ug/l	0.0102	264.5	264.2	263.7	263.6	263.5	0.081 UN	0.120 UN	0.029 UN	0.015 UN	> 5.81	> 5.64	> 6.25	> 6.54	25,894	0.023	6.06		
Site 9: Gasco	ug/kg	ug/l	0.1060	99.0 UN	ND	ND	ND	ND	0.010 UN	0.078 UN	0.100 UN	0.054 UN	ND	ND	ND	ND	464	0.023	ND		
Site 14: Arkema	ug/kg	ug/l	0.0199	46,000					4.96	38.05	108.50	133.50	5.67	4.78	4.32	4.23	2,287,107	40.662	4.75		

Notes:
[1] Partitioning of metals is expressed as Kd; Partitioning of organics is expressed as Koc.
[2] If leachate is not always detected, Kd/Koc values are based on 1/2 the detection limit for nondetects.
[3] GeoMean sediment concentrations are carbon normalized for organic compounds.
[4] GeoMean concentrations are based on 1/2 the detection limit for nondetects.
[5] Sites 9 and 14 are excluded from Harbor-wide summary statistics.
[6] Total DDx is defined as the sum of 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE.

Outlier concentration excluded (EX) from Kd/Koc calculations due to mass balance violations and/or anomalous and unconfirmed leachate results
NC = Not calculated because chemical of concern is not detected in any leachate cycles
ND = Not calculated because chemical of concern is not detected in bulk sediment
ED = Not calculated because of elevated detection limit in leachate
ID = Insufficient data; less than 3 valid data pairs
> = Kd/Koc value may be higher than indicated due to undetected leachate concentrations

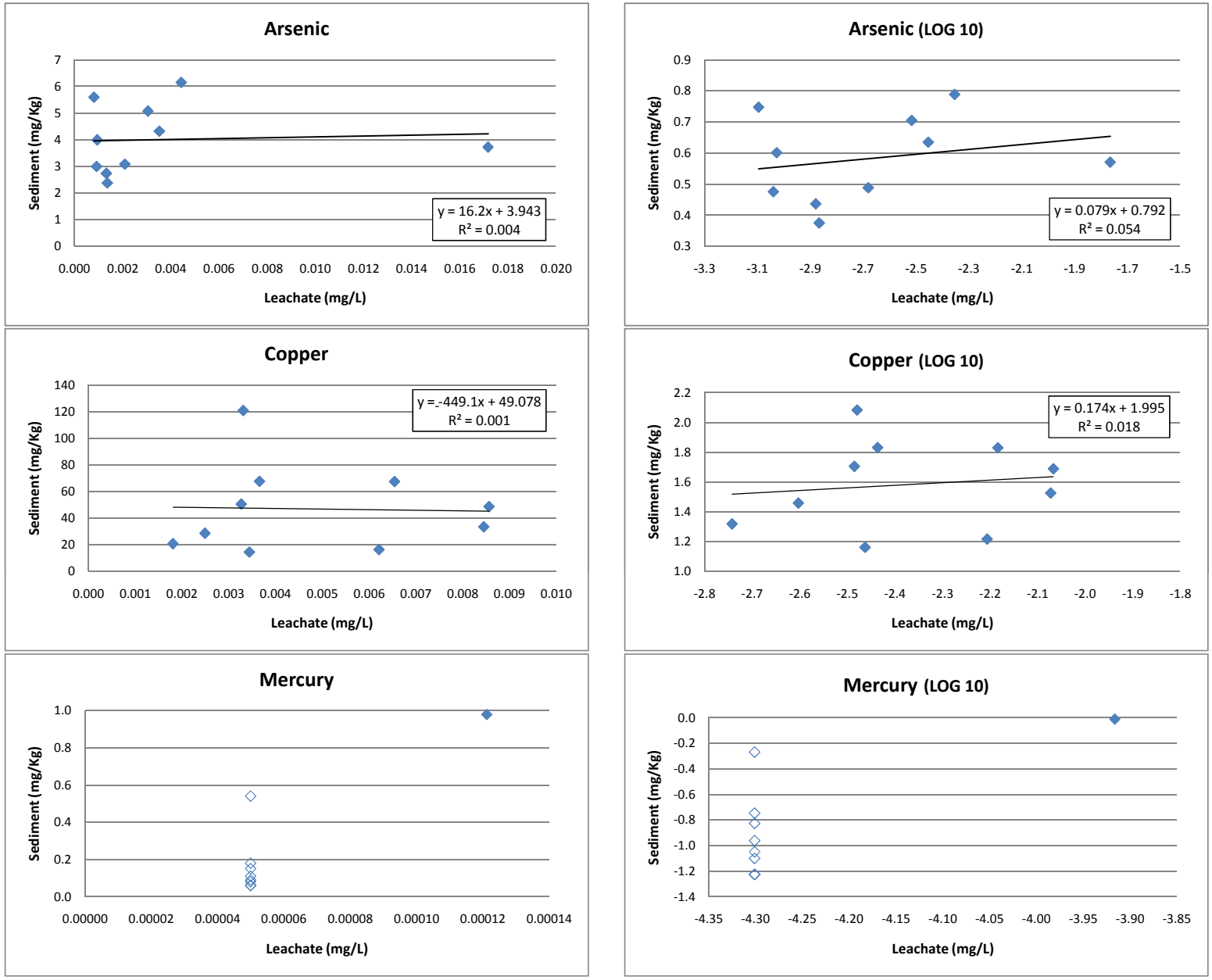
Table A-2
Compilation of Log Partitioning Coefficients (Log Kd/Log Koc) for T4 CDF Confined Sediments and Berm

		LEACHING COEFFICIENTS FOR CONFINED SEDIMENTS [SBLT RESULTS]											PARTITIONING COEFFICIENTS FOR CDF BERM							
		Harbor-Wide Summary Statistics of Log Kd/Log Koc Values [Method 1]						Linear Isotherm Model [Method 3]		Freundlich Isotherm Model [Method 4]			Literature Values [RI Table E6]			LWG Water Column Data				
		Number Data Pairs	Min	10th Percentile	Mean	90th Percentile	Max	LOG Regression Slope	Regression Coefficient [r^2]	Freundlich Coefficient [K_f]	Freundlich Slope [1/n]	Regression Coefficient [r^2]	Min	Mean	Max	Number Data Pairs	Min	Mean	Max	St Dev
Arsenic	**Kd**	10	2.34	3.01	3.25	3.65	3.84	PC	0.004	PC	PC	0.054	1.6	2.4	4.3	74	3.39	4.34	4.85	0.23
Copper	**Kd**	10	3.42	3.58	3.95	4.30	4.56	PC	0.001	PC	PC	0.018	0.7	3.5	6.2	92	3.94	4.93	5.44	0.28
Mercury	**Kd**	1	Insufficient Data					Insufficient Data		Insufficient Data			3.8	4.9	6.0	Insufficient Data				
Benzo(a)pyrene	**Koc**	10	4.42	4.72	5.18	5.48	7.01	PC	-0.158	PC	PC	0.055	5.68	6.01	7.85	10	7.08	7.73	8.5	0.49
Naphthalene	**Koc**	9	4.22	4.26	4.97	5.58	5.81	PC	-0.763	PC	PC	0.019	2.96	3.30	3.71	3	4.93	5.31	5.79	0.44
Bis(2-ethylhexyl)phthalate	**Koc**	5	4.20	4.30	4.64	5.08	5.43	PC	-1.022	PC	PC	0.005	3.52	7.42	9.52	7	5.72	6.35	6.7	0.36
PCB-077	**Koc**	8	4.15	4.21	4.43	4.67	4.92	4.56	0.964	4.44	1.16	0.921	5.52	6.39	7.74	43	6.13	6.75	7.85	0.4
PCB-106 & 118	**Koc**	9	4.07	4.08	4.36	4.85	4.86	4.83	0.977	4.32	1.04	0.882	6.13	6.69	7.29	48	6.23	6.75	7.77	0.32
PCB-126	**Koc**	7	3.99	4.11	4.36	4.61	4.85	4.80	0.918	4.68	1.35	0.951	6.27	6.57	6.88	6	6.58	6.89	7.22	0.27
PCB-169	**Koc**	0	Insufficient Data					Insufficient Data		Insufficient Data			6.89	7.18	7.49	Insufficient Data				
Total PCB Congeners	**Koc**	9	3.91	3.97	4.28	4.64	4.83	4.67	0.777	4.31	1.12	0.888	Not Evaluated			Not Evaluated				
Total PCB Aroclors	**Koc**	8	4.32	4.37	4.55	4.81	4.90	4.86	0.931	4.62	1.16	0.943	Not Evaluated			Not Evaluated				
4,4'-DDD	**Koc**	3	4.29	4.40	5.11	5.94	6.22	PC	-0.984	PC	PC	0.003	4.74	5.95	6.22	32	4.24	6.32	7.44	0.62
4,4'-DDE	**Koc**	2	4.59	ID	5.56	ID	6.52	Insufficient Data		Insufficient Data			4.21	6.78	6.84	TO BE DETERMINED				
4,4'-DDT	**Koc**	2	4.24	ID	4.42	ID	4.60	Insufficient Data		Insufficient Data			3.91	6.61	8.17	31	5.98	6.89	7.72	0.43
Total DDx	**Koc**	4	4.23	4.32	4.87	5.64	6.06	PC	-0.378	PC	PC	0.247	Not Evaluated			Not Evaluated				

Notes:
Partitioning coefficients for organics are carbon normalized (Koc); metals are not (Kd)
PC = Regression parameters not reported due to poor correlation
ID = Insufficient Data (less than 3 valid data pairs)

Recommended Log Kd/ Log Koc values for confined sediments
Recommended Log Kd/ Log Koc values for CDF berm

Figure A-1
Linear and Log (Freundlich) Regressions of Harbor-Wide Partitioning Data



Key:
- ◆ Valid AOPC sediment-leachate data pair
- ◇ Invalid data pair excluded from regression model

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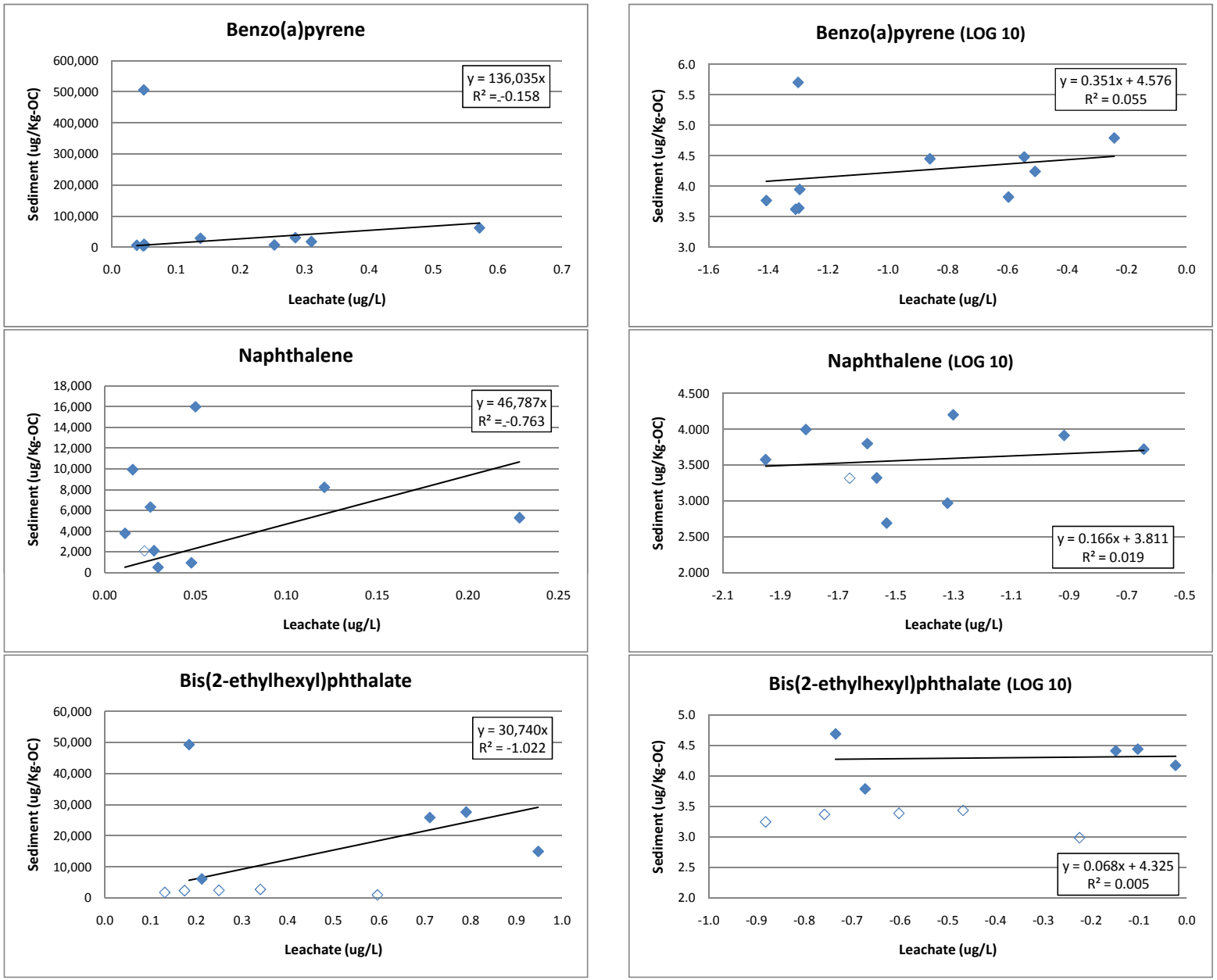
Linear and Log (Freundlich) Regressions of Harbor-Wide Partitioning Data



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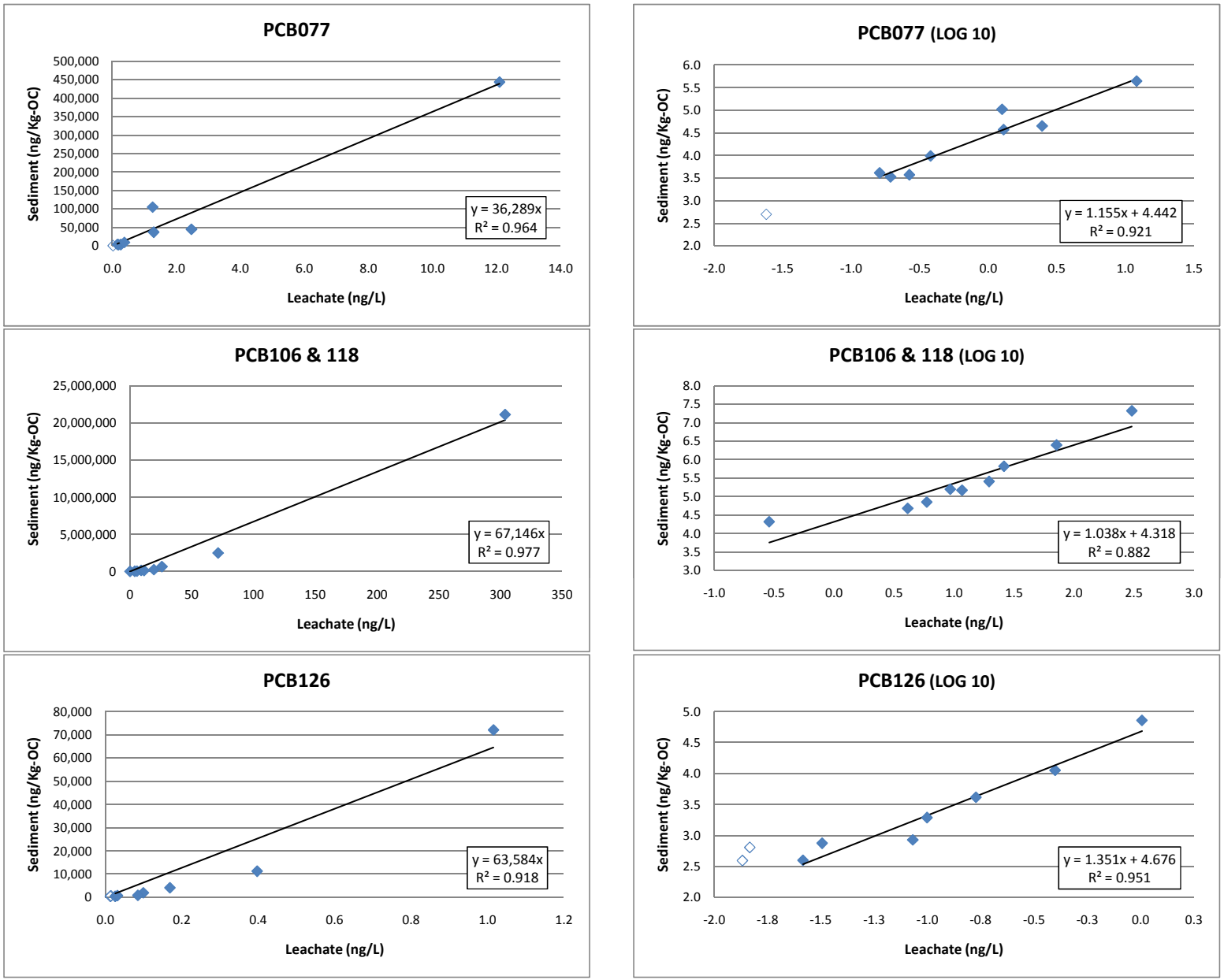

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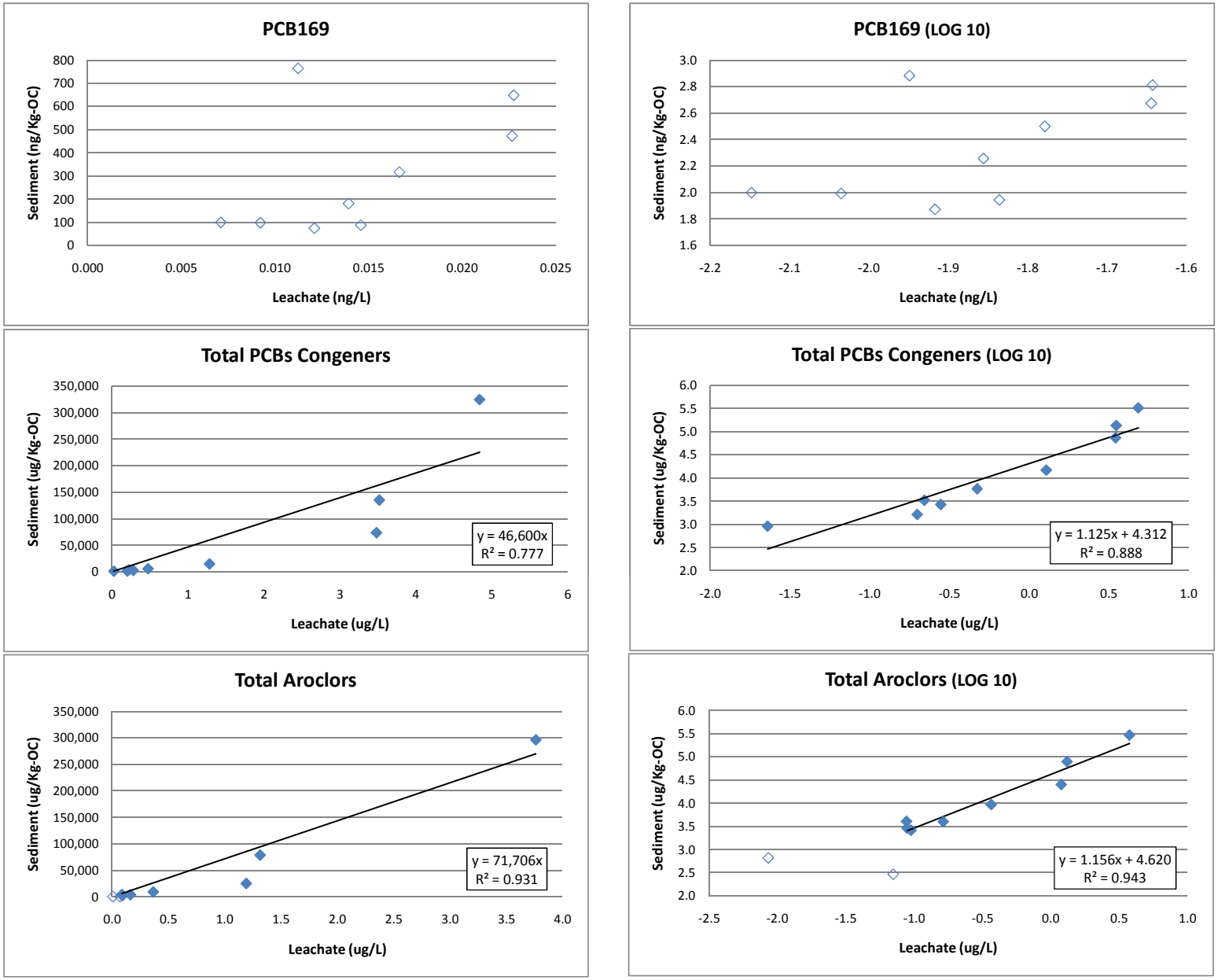

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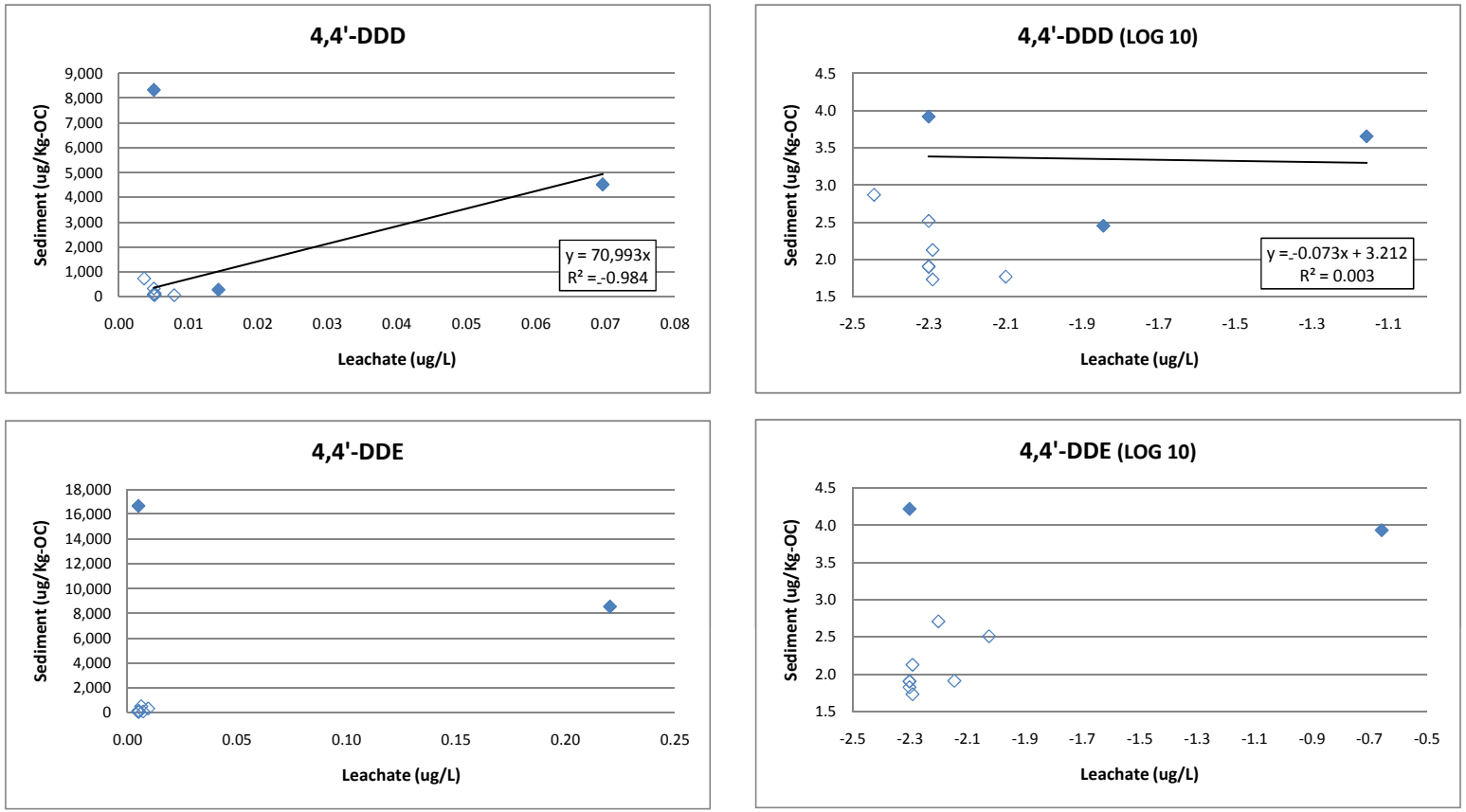

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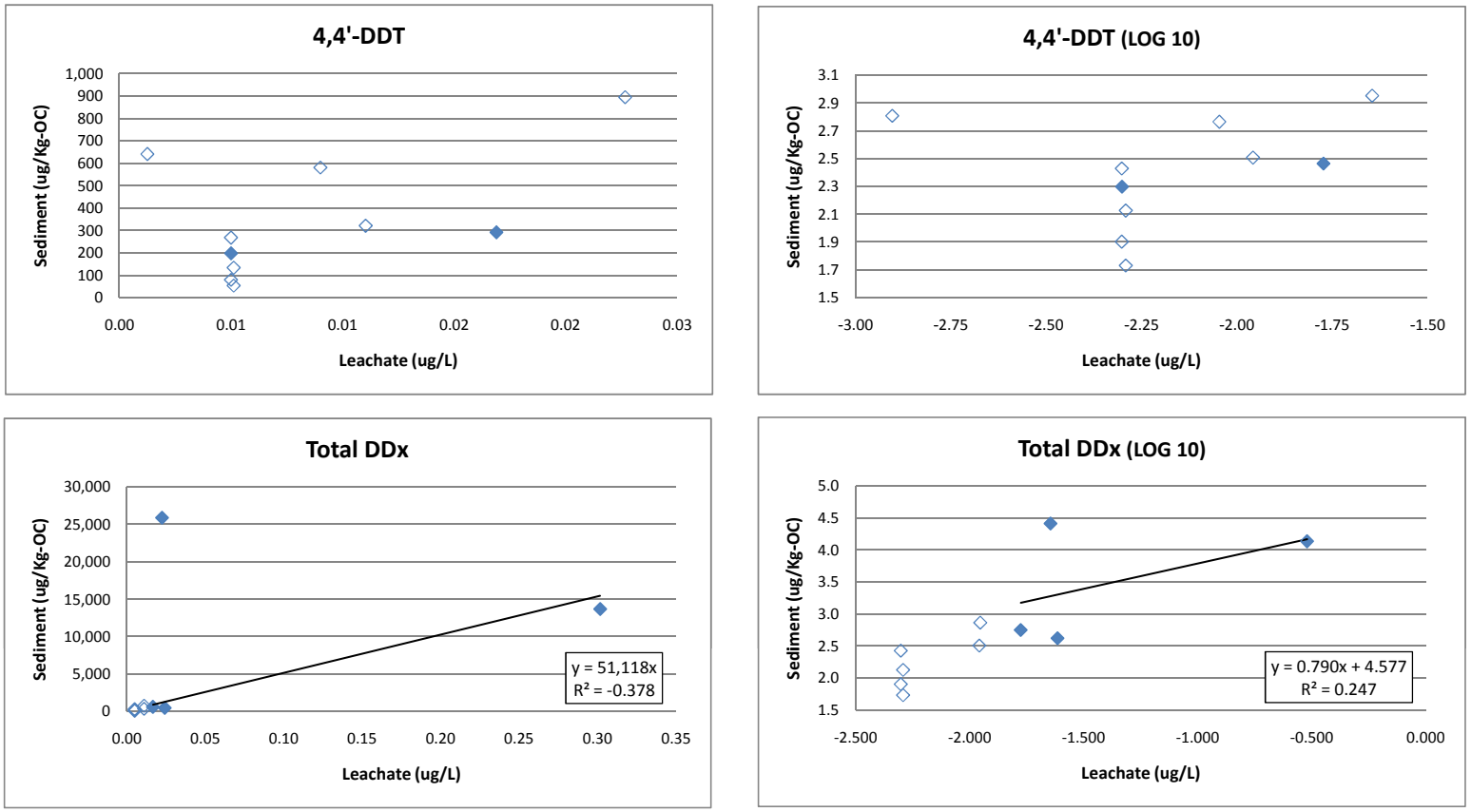

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