STORMWATER INTERIM REMEDIAL MEASURES FOCUSED FEASIBILITY STUDY REPORT

Arkema Portland Facility

Draft

Prepared for
Legacy Site Services LLC
486 Thomas Jones Way
Exton, PA 19341

Prepared by

integral consulting inc.

319 SW Washington Street
Suite 1150
Portland, OR 97204

July 3, 2008

CONTENTS

LIST OF FIGURES ..... **iv**
LIST OF TABLES ..... **v**
ACRONYMS AND ABBREVIATIONS ..... **vi**

1 INTRODUCTION **1-1**
1.1 PURPOSE 1-1
1.2 REPORT ORGANIZATION 1-1

2 SITE CHARACTERIZATION **2-1**
2.1 SITE DESCRIPTION 2-1
2.2 STORMWATER DRAINAGE 2-2

3 SITE INVESTIGATION ACTIVITIES AND INTERIM REMEDIAL MEASURES **3-1**
3.1 SUMMARY OF PREVIOUS INVESTIGATIONS 3-1
3.1.1 Historical Investigation Summary 3-2
3.1.2 2006 to 2007 Investigation Summary 3-4
3.2 SUMMARY OF PREVIOUS REMEDIAL ACTIONS AND BEST MANAGEMENT PRACTICES 3-7
3.2.1 Remedial Actions 3-7
3.2.2 Best Management Practices 3-7
3.2.3 Performance of Remedial Actions and Best Management Practices 3-8

4 SITE CONCEPTUAL MODEL **4-1**
4.1 JOINT SOURCE CONTROL STRATEGY SCREENING EVALUATION 4-1
4.1.1 Description of Data Evaluated 4-1
4.1.2 Joint Source Control Strategy Screening Results 4-3
4.1.3 Weight-of-Evidence Evaluation 4-5
4.1.4 Chemicals of Potential Concern 4-10
4.1.5 DDx Concentration Comparison to Standard DEQ Screening Levels 4-11
4.2 NATURE, EXTENT, AND SOURCES OF CHEMICALS OF POTENTIAL CONCERN 4-12
4.2.1 Surface Soil 4-12
4.2.2 Catch Basin Sediment and Stormwater (Lots 3 and 4) 4-12
4.2.3 Potential Sources and Migration Pathways 4-13

4.3 CHEMICAL OF POTENTIAL CONCERN LOADING FROM STORMWATER TO THE WILLAMETTE RIVER 4-13

5 IDENTIFICATION OF SOURCE CONTROL MEASURE OBJECTIVES 5-1

5.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS 5-1

5.2 STORMWATER REMEDIAL ACTION OBJECTIVES 5-1

6 IDENTIFICATION AND ANALYSIS OF INTERIM REMEDIAL MEASURES ALTERNATIVES 6-1

6.1 IDENTIFICATION OF STORMWATER TREATMENT PROCESS OPTIONS 6-1

6.1.1 Existing Stormwater Collection System 6-1

6.1.2 Surface Soil Treatment 6-1

6.1.3 Stormwater Infiltration 6-2

6.1.4 Stormwater Treatment at Ground Surface 6-2

6.1.5 In-Ground Stormwater Treatment 6-2

6.2 EVALUATION AND SCREENING OF STORMWATER TREATMENT PROCESS OPTIONS 6-2

6.2.1 Collection System Decommissioning/Outfall Consolidation 6-2

6.2.2 Collection System Cleaning/Lining 6-3

6.2.3 Surface Soil Capping 6-4

6.2.4 Stormwater Infiltration 6-4

6.2.5 Stormwater Treatment at Ground Surface 6-6

6.2.6 In-ground Stormwater Treatment 6-8

6.3 DEVELOPMENT OF STORMWATER INTERIM REMEDIAL MEASURE ALTERNATIVES 6-9

6.3.1 Alternative 1. Surface Soil Capping and Collection System Decommissioning/Outfall Consolidation with Channelized Overland Flow. 6-10

6.3.2 Alternative 2. Surface Soil Capping of "Hot Spots," Collection System Decommissioning/Outfall Consolidation, and Replacement with a New Sewer System with In-Ground Treatment 6-11

6.3.3 Alternative 3. Collection System Decommissioning/Outfall Consolidation, Surface Soil Capping of "Hot Spots," and Enhanced Stormwater Infiltration and Treatment Prior to Discharge 6-12

6.4 EVALUATION OF STORMWATER INTERIM REMEDIAL MEASURES ALTERNATIVES 6-13

6.4.1 Evaluation Criteria 6-14

6.4.2 Alternative 1. Surface Soil Capping and Collection System Decommissioning/Outfall Consolidation with Channelized Overland Flow 6-14

6.4.3 Alternative 2. Surface Soil Capping of "Hot Spots," Collection System Decommissioning/Outfall Consolidation, and Replacement with a New Sewer System with In-Ground Treatment 6-15

6.4.4 Alternative 3. Collection System Decommissioning/Outfall Consolidation, Surface Soil Capping of "Hot Spots," and Enhanced Stormwater Infiltration and Treatment Prior to Discharge. 6-16

7 RECOMMENDED ALTERNATIVE 7-1

8 REFERENCES 8-2

Appendix A. Surface Soil, Catch Basin Sediment, and Stormwater Data Screening Tables

Appendix B. Infiltration Basin Soils Recontamination Analysis with Stormwater Sediment

Appendix C. Design Basis and Detailed Cost Estimates

Appendix D. Figures from Previous Reports

LIST OF FIGURES

Figure 2-1. Vicinity Site Map
Figure 2-2. Aerial Photograph and Adjacent Properties
Figure 2-3. Topographic Map of the Site
Figure 2-4. Outfall and Catch Basin Locations
Figure 2-5. Existing Drainage Analysis
Figure 4-1. Surface Soil Sample Locations
Figure 4-2. DDx Concentrations in Surface Soil (0-1 ft)
Figure 6-1. Preliminary Screening of Treatment Options
Figure 6-2. Preliminary Plan View of Alternative 1 Interim Remedial Measure
Figure 6-3. Preliminary Plan View of Alternative 2 Interim Remedial Measure
Figure 6-4. Preliminary Plan View of Alternative 3 Interim Remedial Measure
Figure 7-1. Implementation Schedule Interim Remedial Measure

LIST OF TABLES

Table 2-1. Drainage Area Statistics

Table 2-2. Average Annual Stormwater Discharge by Drainage Area

Table 3-1. Reduction in DDx Concentrations as a Result of IRMs

Table 3-2. DDT, DDD, DDE and Total DDx Concentrations in Catch Basin and Filter Sock Sediment Samples

Table 3-3. Reduction in DDx Concentrations as a Result of BMPs

Table 4-1. Summary of Source Control Screening for Surface Soils

Table 4-2. Summary of Source Control Screening for Catch Basin Sediments

Table 4-3. Summary of Source Control Screening for Stormwater

Table 4-4. Comparison of DDx Concentrations with Standard DEQ Screening Levels

Table 4-5. Stormwater COPC Loading from Lots 3 and 4

Table 4-6. Upstream DDx Loads in the Willamette River

Table 5-1. Preliminary Project ARARs for the Arkema Stormwater IRM

Table 6-1. Detailed Comparison of Retained Treatment Alternatives

ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirement
Arkema	Arkema Inc.
bgs	below ground surface
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
COPC	chemical of potential concern
COI	chemical of interest
DDD	4,4′-dichloro-diphenyl-dichloroethane
DDE	4,4′-dichloro-diphenyl-dichloroethene
DDT	4,4′-dichloro-diphenyl-trichloroethane
DDx	total of 4,4′-DDT, -DDD, and -DDE
DEQ	Oregon Department of Environmental Quality
ECSI	Environmental Cleanup Site Information
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
FFS	focused feasibility study
FS	feasibility study
GLISP	Guild Lake Industrial Sanctuary Plan
IRM	interim remedial measure
Integral	Integral Consulting Inc.
JSCS	joint source control strategy
LSS	Legacy Site Services LLC
LWG	Lower Willamette Group
MCB	monochlorobenzene
MCL	maximum contaminant level
NAVD	North American Vertical Datum
NPDES	National Pollutant Discharge Elimination System

NTCRA	non-time critical removal action
O&M	operation and maintenance
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
Site	Arkema Inc. Portland, Oregon facility
RI	remedial investigation
RM	river mile
RAO	remedial action objective
RP/SLLI	Rhone-Poulenc/Starlink Logistics, Inc.
SVOC	semivolatile organic compound
SLV	screening level value
TDS	total dissolved solids
TSS	total suspended solids
VOC	volatile organic compound

1 INTRODUCTION

This stormwater interim remedial measure (IRM) focused feasibility study (FFS) report has been prepared for the former Arkema Inc. (Arkema) Portland, Oregon facility (Site). The stormwater IRM FFS was prepared in conjunction with the Arkema Site Remedial Investigation (RI) and Feasibility Study (FS) that is being conducted under the Oregon Department of Environmental Quality (DEQ) Voluntary Cleanup Program.[1] This FFS has been developed in general accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Engineering Evaluation/Cost Analysis (EE/CA) process (USEPA 1993) as an IRM to implement stormwater source control at the Site. This evaluation process is consistent with the Portland Harbor Joint Source Control Strategy (JSCS) that was developed by DEQ and the U.S. Environmental Protection Agency (EPA) (DEQ 2005). The source control action that is implemented as a result of this process will be approved by DEQ in accordance with Oregon state regulations and in consultation with EPA.

The stormwater IRM is one of several source control actions that have either been completed or are being evaluated for implementation as IRMs for soil, groundwater, stormwater, and sediment at the Site. These source control actions are implemented as IRMs to effectively and sequentially address short-term source control needs in a manner that is, to the greatest extent practical, compatible with the evaluation and implementation of a final site remedy. Integral Consulting Inc. (Integral) is conducting this work under contract with Legacy Site Services LLC (LSS), agent for Arkema.

1.1 PURPOSE

The purpose of this FFS is to identify a source control action that reduces the migration of chemicals of potential concern (COPCs) in stormwater at the Site to the Willamette River. The implementation of the stormwater source control IRM should be coordinated with any sediment remediation conducted as part of the non-time critical removal action (NTCRA). The Stormwater IRM should also be coordinated with the implementation of the groundwater source control IRM. The stormwater IRM can be implemented after DEQ has approved the preferred alternative for stormwater source control.

1.2 REPORT ORGANIZATION

This stormwater IRM FFS generally follows the outline presented in Appendix F of the stormwater IRM field sampling and data report (Integral 2007a). DEQ and EPA provided comments on the outline in letters dated November 27 and December 6, 2007 (McClincy 2007b

[1] Voluntary Agreement for Remedial Investigation/Feasibility Study, DEQ No. ECVC-WMCVC-NWR-97-14 (Voluntary Agreement).

and 2007c). LSS responded to comments provided by DEQ and EPA in a letter dated March 18, 2008 (LSS 2008a). This report takes into consideration comments provided by DEQ and EPA, as responded to by LSS.

The remaining sections and appendices of this stormwater IRM FFS are described briefly below.

- **Section 2, Site Characterization**—describes the physical setting of the Site, including stormwater drainage.
- **Section 3, Site Investigation Activities and IRMs**—summarizes previous investigations and IRMs that have been conducted at the Site.
- **Section 4, Site Conceptual Model**—presents the JSCS screening results and weight-of-evidence analysis, nature and extent of contamination, and potential source of contamination to stormwater.
- **Section 5, Identification of Source Control Measure Objectives**—describes the applicable or relevant and appropriate requirements (ARARs), IRM objectives, and design criteria for this IRM evaluation.
- **Section 6, Identification and Analysis of IRM Alternatives**—presents and evaluates IRM alternatives.
- **Section 7, Recommended Alternative**—presents the recommended IRM alternative.
- **Section 8, References**—lists documents cited in the FFS.
- **Appendix A, Surface Soil, Catch Basin Sediment, and Stormwater Data Screening Tables**
- **Appendix B, Infiltration Basin Soils Recontamination Analysis with Stormwater Sediment**
- **Appendix C, Design Basis and Detailed Cost Estimates.**
- **Appendix D, Figures from Previous Reports.**

2 SITE CHARACTERIZATION

The following sections describe the physical characteristics of the Site.

2.1 SITE DESCRIPTION

The Site is located along the southwest bank of the Willamette River between approximately River Mile (RM) 6.9 and 7.6 at 6400 NW Front Avenue in Portland, Oregon (Figures 2-1 and 2-2). The property lies within the Guild Lake Industrial Sanctuary Plan (GLISP) (formerly the Northwest Portland Industrial Sanctuary; Integral 2008b). The Site is zoned and designated "IH" for heavy industrial use, which precludes it from most nonindustrial uses (Portland Development Commission 2004). The purpose of the GLISP is to maintain and protect this land as a dedicated area for heavy and general industrial uses. Therefore, while future use of the facility is unknown, it will remain heavy industrial.

The Site occupies approximately 54 acres with surface elevations between 20 and 42 feet (North American Vertical Datum [NAVD] 1988; Figure 2-3). An approximately 20-ft bluff borders the eastern side of the property, forming the west bank of the Willamette River (Tract "A"). Above the bank, Site surface elevations are generally flat and range between 34 and 42 ft NAVD 88. This portion of the Site (uplands) is composed of four lots (Figure 2-3). Lots 3 and 4 comprise approximately 40 acres and are the part of the Site where chemical manufacturing and processing occurred (Refer to Section 2.2 of *Upland Level II Screening Ecological Risk Assessment* [Integral 2008b] for details regarding Site operational and ownership history). Lots 1 and 2, at the northeast end of the Site, are undeveloped compared to Lots 3 and 4. Lots 1 and 2 are covered by a mixture of grasses, bare soil, and scrub-shrub vegetation that are characteristic of opportunistic colonization of idle industrial soil.

The Site is bordered to the east by the Willamette River and to the south by CertainTeed Roof Product Manufacturing (Figure 2-2).[2] The Willbridge Bulk Fuel Storage Terminal (Environmental Cleanup Site Information [ECSI] 1549) and Kinder Morgan (ECSI 2104) sites are located immediately to the south of CertainTeed. Front Avenue borders the Site to the north and west. Five cleanup sites are located to the west of Front Avenue, upgradient of the Site. The sites include Starlink (Rhône-Poulenc; ECSI 155), Gould Industries, Doane Lake (ECSI 36), ESCO (ECSI 397), and Kinder Morgan (ECSI 2104; southwest of the Site). The Siltronics Inc. site (ECSI 183) is located immediately north of Front Avenue. Additional details on the adjacent properties can be found in DEQ's ECSI database.[3]

[2] GS Roofing Products; DEQ's Environmental Cleanup Site Information (ECSI) database 117
[3] http://www.deq.state.or.us/lq/ecsi/ecsiquery.asp

Heavy industrial land use surrounds the Site, isolating it from parks and residential areas. The nearest residential structures are located approximately 0.3 mile west of the facility. Forest Park, a large forested public park, is located 0.5 mile to the west of the facility (ERM 2005).

2.2 STORMWATER DRAINAGE

The layout of the inactive Acid Plant's existing stormwater sewer system is shown in Figure 2-4. Much of the existing stormwater sewer system on the Site has been in place since at least the mid-1950s and was primarily designed to carry very large volumes (i.e., millions of gallons per day) of industrial noncontact cooling water and secondarily to handle stormwater drainage. The existing stormwater sewer system was also designed to drain building basements and process sumps and, therefore, is rather deep (up to 12 feet below ground surface [bgs] in certain locations [Integral 2008a]).

The stormwater collection system for Lots 3 and 4 previously had been divided into four smaller drainage sub-basins based on Site topography before building demolition (Figure 2-4). Figure 2-5 presents a revised and updated evaluation of existing stormwater drainage at the Site, and Table 2-1 presents statistics for the catchments utilizing the previously defined basins as reference points. The existing stormwater collection in each of the four previously defined drainage areas is connected to a separate large concrete Parshall flume and discharge pipe (identified as Outfalls 001 through 004) located on the riverbank (ERM 2005). As shown in Figure 2-4, the Parshall flumes for Outfalls 001, 002, and 003 are located between the southernmost dock (Salt Dock) and the northernmost dock (No. 2 Dock), whereas Outfall 004 is located approximately 400 ft north of the No. 2 Dock. Discharge pipes and diffusers extend out into the river from each Parshall flume (ERM 2005). Parshall flumes were historically used to measure process water discharge flow rates. However, because existing stormwater discharge is a small fraction of the historic process water discharge, the Parshall flumes are currently oversized and not particularly useful for measuring stormwater flow.

Stormwater from Lots 3 and 4 that does not infiltrate, enters the Site stormwater system and is discharged through the four outfalls under National Pollutant Discharge Elimination System (NPDES) permit No. 100752. No process water has been discharged from the Site since the Acid Plant closed in 2001. Since issuance of the stormwater NPDES permit in January 2004 (issued solely for discharge of stormwater), all permit water quality discharge benchmarks have been met except for pH in samples collected from Outfall 004 during 2007 (Integral 2008a). During 2008, there were occasional pH exceedances in other outfalls.

Stormwater drainage from areas outside of the drainage basins for Outfalls 001, 002, 003, and 004 either ponds and infiltrates on site (i.e., large portions of Lots 1 and 2), flows overland from Lots 1 and 2 to Outfall 004, or during some heavy rainfall events flows overland and discharges

as a non-point source to the Willamette River. Statistics for drainage from the four drainage basins on Lots 3 and 4 and Lots 1 and 2 are presented in Table 2-1.

The Simple Method (Schueler 1987) was used to estimate discharge and COPC loading from the Site (see Section 4.3 for loading calculations). In the Simple Method, site discharge (in volume per time; gallons per year) can be computed as follows:

$$R = P \times R_v \times P_j \times A \times \text{Unit Conversions}$$

Where:

P = rainfall depth over the desired time interval (36 in./year; BES 2004)

R_v = runoff coefficient, which was calculated as 0.05 + 0.009 x % Impervious

P_j = fraction of rainfall events that produce runoff, estimated to be 0.9

A = area of the site

Table 2-2 presents the calculated stormwater discharge based on the defined subbasins in Table 2-1. Based on these calculations, an estimated 18.7 million gallons are discharged from the Site on an annual basis. Of this total discharge, approximately 96 percent is discharged from the four outfalls.

There are several reasons why the discharge estimated using the Simple Method are likely overestimates of actual stormwater discharge from the site. The 90 percent rainfall fraction that produces runoff (Pj) is a commonly-used default value that is typically used for urban areas that are designed to drain water (i.e., urban areas that are sufficiently sloped and have sufficient catch basins to drain water without ponding). The Site, however, is very flat and during storm events water ponds frequently in both pervious and impervious areas throughout the Site (as shown by the elevations on Figure 2-5). Also, a number of catch basins were plugged during plant demolition activities, the sodium persulfate injection work, and catch basin sediment cleaning activities associated with the stormwater IRM (Integral 2007a). Stormwater that flows to these plugged catch basins ponds, eventually infiltrates into the soil in unpaved areas, or evaporates. Other areas of the Site pond water because they are impervious closed basins (i.e., the former salt pads). In these latter areas, ponded water either evaporates, is pumped to surrounding drains as necessary, or overflows after prolonged rainfall events.

Other evidence that discharge calculations may overpredict actual stormwater flow is that a significant amount of precipitation is required before flow will occur at the stormwater outfalls. This phenomenon was observed during the 2007 stormwater sampling events where rainfall events of short duration or of low magnitude and longer frequency did not produce sufficient water to create flow to the stormwater outfalls.

3 SITE INVESTIGATION ACTIVITIES AND INTERIM REMEDIAL MEASURES

The following is a chronology of site investigations and IRMs related to stormwater that have been conducted at the Site.

- January 1999 to March 2001: Stormwater samples were collected from manholes SW-01 and SW-02 in the Acid Plant area as part of the Site remedial investigation.
- September and November 2000: Phase I Soil IRM was completed in the Acid Plant Area, including stormwater conveyance improvements, soil excavation and disposal, and temporary capping activities.
- November 2001: Phase II Soil IRM was completed in the Acid Plant Area, including soil excavation and disposal, capping, and the installation of a storm drain to collect stormwater drainage.
- February 2004 to March 2005: Stormwater samples were collected from Outfalls 001, 002, 003, and 004 during building demolition activities for the NPDES stormwater discharge permit.
- March 2005: Expanded stormwater sampling was conducted from manholes on Outfall 001, 002, 003, and 004 sewer systems to collect further information for the NPDES stormwater discharge permit.
- October 2006: Catch basin and filter sock sediment samples were collected in Lots 3 and 4 for the Stormwater IRM FFS.
- October to December 2006: Best management practices (BMPs) were implemented including catch basin cleaning and installation of new filter socks and biobags and sealing pipes in catch basins that were not needed after the Acid Plant was demolished (Lots 3 and 4).
- February to June 2007: Stormwater sampling was conducted from Outfalls 001, 002, 003, and 004 for the Stormwater IRM FFS.
- August 2007: utility pole and manhole water samples were collected (Lot 3) for the Stormwater IRM FFS.

The results of each of these previous investigations and IRMs are briefly described below in the following sections.

3.1 SUMMARY OF PREVIOUS INVESTIGATIONS

Both historical (1999 to 2005) and recent (2007) stormwater investigations have been conducted at the Site. Historical investigations were conducted as part of a multi-phase RI that was

conducted between September 1998 and March 2005. Arkema and DEQ entered into a Voluntary Agreement in August 1998 to address impacts to environmental media associated with the manufacture of DDT in the Acid Plant Area (the area of former pesticide manufacturing operations) (ERM 2005). One of the pathways (and its potential chemicals of interest [COIs]: pesticides, metals, volatile organic compounds [VOCs], semivolatile organic compounds [SVOCs], perchlorate, and chloride) investigated was the stormwater drain system (ERM 2005).

Additional investigations were conducted from 2006 to 2007 to address ongoing detections of COIs in stormwater at the Site. For the more recent investigations, a multi-phased approach was used consisting of enhancing existing BMPs in conjunction with catch basin inspection, cleaning, and sediment sampling. Following this effort, COIs and additional analytes were analyzed in stormwater during four stormwater sampling events in accordance with the stormwater IRM work plan (Integral 2006a).

3.1.1 Historical Investigation Summary

Results of the previous stormwater investigative work, through the completion of the monthly stormwater sampling in March 2005, is presented in the RI report. Fifty-five stormwater samples were collected to evaluate stormwater quality across the Site. Stormwater samples were collected from Manholes SW-1 and SW-02 in 1999 and 2001 and Outfalls 001 through 004 in 2004 and 2005 (Figure 2-4) (ERM 2005).

3.1.1.1 Stormwater Manhole Sampling

Stormwater grab samples were collected from manholes in 1999 and 2001 prior to plant shut down (SW-01 and SW-02; Figure 2-4) associated with two storm drain systems within the Acid Plant Area to evaluate potential COI impact to the stormwater. Samples were collected from each drain system at its point of entry to the manhole prior to mixing with non-contact cooling water discharge. Sample SW-01 was collected from a manhole located adjacent to the former manufacturing process residue trench within the Acid Plant Area, and sample SW-02 was collected from a manhole location north and downgradient of the Acid Plant Area (ERM 2005).

Stormwater samples were collected from SW-01 and SW-02 during four sampling events (January 22, November 11, and December 17, 1999; and March 27, 2001). Samples were analyzed for total and dissolved organochlorine pesticides. Key findings are summarized below:

- Dissolved DDT[4] was detected in five of eight stormwater samples collected in the Acid Plant Area in 1999.

[4] Note that DDT, DDD, and DDE all have low aqueous solubilities and have a high affinity for particulate surfaces (i.e., soil grains and organic matter). In these and other stormwater samples, analytical results are reported as either

- Dissolved 4,4′-dichloro-diphenyl-dichloroethane (DDD) and 4,4′-dichloro-diphenyl-dichloroethene (DDE) were not detected in any of the eight samples.
- Total DDT, DDD, and/or DDE were detected in all but one of the eight stormwater samples, suggesting that pesticide-containing particulate material was present in the stormwater samples.

Significant reductions in total 4,4′-DDT, 4,4′-DDE, and 4,4′-DDD (DDx) concentrations in stormwater were observed after the Phase I and II Soil IRMs were completed (see Table 3-1; Section 3.2). Post-IRM concentrations of total DDx in manhole SW-01 were approximately one-half to two-thirds lower than what had been observed previously, and total DDx concentrations in manhole SW-02 decreased by approximately an order of magnitude (ERM 2005).

3.1.1.2 2004 to 2005 Stormwater Outfall Sampling

DEQ issued Arkema a new NPDES stormwater discharge permit for stormwater drainage on January 22, 2004. A condition of the permit required Arkema to conduct stormwater characterization for legacy and 303(d) constituents for a 1-year period and to submit a report to DEQ summarizing the sampling procedures and results (ERM 2005). The stormwater characterization work consisted of monthly monitoring of stormwater in Outfalls 001, 002, 003, and 004 (Figure 2-4). Stormwater samples were analyzed for: total dissolved solids (TDS), metals (iron, manganese, mercury, and hexavalent chromium), DDT, DDD, DDE, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), monochlorobenzene (MCB), pentachlorophenol, perchlorate, and chloride.

Samples were collected monthly from February 2004 through March 2005, with the exception of June and July 2004 and February 2005, due to dry weather and lack of adequate stormwater flows. The stormwater sampling for the January 2004 NPDES permit is discussed further in the *Storm Water Characterization Report* (Arkema 2005).

The following constituents were detected in one or more of the monthly samples: DDT, DDD, DDE, iron, manganese, mercury, hexavalent chromium, perchlorate, and chloride. The analytical results indicate that low levels of total DDT, DDD, DDE, and iron were present in samples collected from all four stormwater outfalls at concentrations above the preliminary screening levels[5] of 0.001, 0.001, 0.001, and 1,000 ug/L, respectively (ERM 2005). Concentrations of hexavalent chromium, and chloride were generally higher in samples collected from Outfall 004, and perchlorate concentrations were generally higher in samples collected from Outfall

---

total (unfiltered) or dissolved (filtered). In stormwater samples that have been analyzed for both total and dissolved materials, DDT, DDD, and DDE are generally much more abundant in the total sample than the dissolved sample which is an indication of its affinity for the particulate phase. It should be noted that "dissolved" material is defined by a 0.45 μm filter size; however, DDT, DDD, and DDE can also be associated with fine particles (e.g., colloids) that are small enough to pass through the 0.45 μm filter.

[5] National Recommended Water Quality Criteria, Freshwater, Chronic (US EPA 1994) preliminary screening levels were used in Table 5-30 of the RI report.

001. Plant demolition activities were being carried out concurrently with the monthly monitoring. Several constituents (perchlorate, chloride, TDS, and hexavalent chromium) exhibited temporary increases during this period, and decreased after demolition activities were completed (ERM 2005). Mercury was only detected in one sample collected from Outfall 002, and was below the preliminary screening value (ERM 2005).

3.1.1.3 March 2005 Sewer Sampling

Because DDx and/or hexavalent chromium were detected in all of the outfalls, Arkema collected additional stormwater data in an effort to delineate the source of DDx and hexavalent chromium in the outfall samples (ERM 2005). During the March 2005 outfall sampling event, sampling was expanded to include three to five additional samples per drain system in upstream manholes. The additional stormwater sample locations and analytical results are shown on Figure 3 in Appendix D.

Total DDT was detected in all of the manhole water samples. As noted on Figure 3 in Appendix D, some of the samples collected were visibly turbid. The range of total DDT concentrations within each sewer system is shown below (Arkema 2005):

- No. 1 sewer system (0.051 to 1.6 μg/L)
- No. 2 sewer system (0.47 to 4.9 μg/L)
- No. 3 sewer system (0.089 to 0.25 μg/L)
- No. 4 sewer system (0.063 to 1.9 μg/L).

Hexavalent chromium was detected within the No. 4 sewer at concentrations ranging from 14.5 to 25.8 μg/L. The highest concentration of hexavalent chromium was obtained from a turbid water sample collected from a manhole on the upgradient portion of the sewer line.

3.1.2 2006 to 2007 Investigation Summary

BMPs and subsequent stormwater sampling were conducted to further assess chemical concentrations in areas that might need to be addressed by a stormwater IRM. After the removal of catch basin sediments and implementation of BMPs in 2006 (Section 3.2), four rounds of stormwater samples were collected.

Catch basin and stormwater samples were collected between October 16, 2006 and June 5, 2007 as reported in the *Stormwater Interim Remedial Measures Field Sampling and Data Report* (Integral 2007a). Catch basin and filter sock sediment samples were collected from October 16 to 20, 2006. Stormwater samples were collected on February 15, March 2, March 19, and June 5, 2007. Samples collected on March 19 and June 5, 2007 were first flush events initiated shortly after the beginning of the storm. Outfalls 003 and 004 were not sampled on June 5, 2007 due to a

short-duration storm event with little stormwater flow (Integral 2007a). A brief description of the sample results is presented below.

3.1.2.1 Catch Basin and Filter Sock Sediment Sampling

A total of 19 catch basin and 17 filter sock sediment samples were collected in October 2006 and analyzed for: grain size, PCBs, PAHs, hexavalent chromium, manganese, perchlorate, DDx (DDT, DDD, DDE), pentachlorophenol (PCP), phthalates, and dioxins and furans (selected samples only). Analytical results are provided in Appendix A.

Sampled catch basins were active (i.e., outlet pipes were not plugged), except for Catch Basins CB-001-02 and CB-002-01 (Figure 2-4). The sediment in these latter catch basins is representative of material near the catch basin, including erodible soils and some residual demolition materials such as sawdust from cut utility poles that can be transported to catch basins by stormwater, even though water that flows to these catch basins no longer discharges to the outfalls (Integral 2007a).

In general, individual DDT, DDD, DDE and total DDx concentrations were 2 to 10 times lower in filter sock sediment than in catch basin sediments. The catch basin samples are a mixture of sediment that accumulated in the catch basins before, during, and after building demolition. The filter sock material accumulated after building demolition was completed in 2005, and therefore represents only recently accumulated particulate material from the Site. In some cases the filter sock sediment includes demolition materials (i.e., demolition sawdust, soil, and other debris) transported to the catch basin after demolition was completed. Note also that the filter socks do not capture particulates of all sizes; therefore, some finer-grained material could have passed through the filter socks and been deposited in the catch basin sediment even after demolition was completed.

The highest DDx concentrations in catch basin and filter sock sediments were detected in catch basins in the Acid Plant area, which are part of the Outfall 002 sewer system (Table 3-2). The average DDx concentration in the Outfall 002 drainage basin, 53.9 mg/kg total DDx, was approximately 7 times the average DDx concentration in the Outfall 001 drainage basin. DDx concentrations in drainage basins for Outfalls 003 and 004 are two to three orders of magnitude lower than DDx concentrations in Outfall 002. With the exception of Outfall 004, filter sock sediment generally has average DDx concentrations two to seven times lower than catch basin sediment suggesting that IRMs and post-demolition BMPs have been effective at reducing DDx sediment concentrations. In the Outfall 004 drainage area, filter sock and catch basin DDx concentrations are very low compared to the other drainage basins and are within a factor of two to three to each other.

Pentachlorophenol concentrations detected in catch basin and filter sock sediment ranged from 1.34 to 31.4 mg/kg. The highest PCP concentrations were detected in catch basins associated with the Outfall 003 sewer system. When both catch basin and filter sock sediments were

analyzed for a given station, the highest PCP concentration was detected in the filter sock sample, indicating the PCP was from demolition or post-demolition activities. A utility pole wood sample was collected to determine if the poles were a potential source of the PCP. The sampling results are presented in Section 3.1.2.3.

3.1.2.2 Stormwater Sampling

A total of four rounds of stormwater samples were collected from each of the four outfalls between February 15 and June 5, 2007, and analyzed for: pH (March 2 and 19, and June 5, 2007), total suspended solids (TSS), hexavalent chromium (total), manganese (total and dissolved), perchlorate (total), PAHs (total), DDx (DDT, DDD, DDE [total and dissolved]), and PCP (Outfalls 001, 003, and 004). PCP was analyzed only in the Outfall 002 sample during the first sampling event because PCP was not detected in sediment samples collected from the Outfall 002 catch basins).

DDT, DDD, DDE, hexavalent chromium, and perchlorate were detected in the stormwater samples. DDT, DDD, DDE were detected in samples collected from every outfall (Integral 2008a). The highest concentrations of DDT were in Outfall 002. Of the four outfalls sampled, the highest hexavalent chromium concentrations were detected in samples collected from Outfall 004, and the highest perchlorate concentrations were detected in samples collected from Outfalls 001 and 002. Analytical results are provided in Appendix A.

Stormwater sampling of the No. 4 sewer during 2007 has shown pH ranges from 9.2 to 10.2. These results were submitted to DEQ in the quarterly NPDES monitoring reports. After consultation with DEQ and in response to the elevated pH, LSS investigated the No. 4 sewer system and found the source of the high pH to be in the area of the former chlorine cell room. This area is where salt brine was placed into electrolytic cells and converted to chlorine gas, hydrogen gas, and dilute sodium hydroxide during plant operation. This entire area has been decommissioned. All buildings, tanks, and concrete foundations have been removed. Based on the investigation, it appears that rain falling on this area may react with residual sodium hydroxide in the soil, drain to the storm sewer, and cause elevated pH levels in outfall samples (LSS 2007). During 2008, there were occasional pH exceedances in other outfalls. LSS is following up on these latter results to understand the potential implications for ongoing stormwater monitoring and discharge.

3.1.2.3 Other Related Sampling Activities

On August 14, 2007, a wood sample was collected from two utility poles located near Catch Basin CB-003-02. The purpose of collecting this sample was to determine whether the poles were a potential source of the PCP detected in the sediment sample collected from the filter sock in Catch Basin CB-003-02. PCP was not manufactured or used at the Site (Integral 2007a). The wood chip sample was analyzed for PAHs, PCP, and dioxins and furans. High concentrations of PAHs and pentachlorophenol (percent levels), and dioxin and furans (parts per billion levels)

were detected in the utility pole wood sample. Analytical results are presented in the stormwater IRM field sampling and data report (Integral 2007a).

On August 14, 2007, a sample was also collected from the invert of a manhole on the upgradient end of the No. 4 sewer system. The sample was collected during dry weather and thus represents groundwater infiltration into this sewer system. The visually estimated flowrate was minimal (i.e., a trickle). The water sample was collected to estimate the concentrations of chemicals in groundwater infiltrating into the sewer system and discharging to Outfall 004 (Integral 2007a). The water sample was analyzed for: organochlorine DDx (total and dissolved), VOCs, SVOCs (including PCP), metals (total and dissolved), chlorinated herbicides (total and dissolved), and dioxins and furans. Low levels of selected metals, DDx, SVOCs, and VOCs were detected in the sample. Many of the analytes detected in the water sample are preliminary COPCs for the Rhone-Poulenc/Starlink Logistics, Inc. (RP/SLLI) site, which indicates contaminated groundwater from the RP/SLLI site is migrating onto Arkema property in the vicinity of the manhole. Analytical results for the water sample are presented in the stormwater IRM field sampling and data report (Integral 2007a).

3.2 SUMMARY OF PREVIOUS REMEDIAL ACTIONS AND BEST MANAGEMENT PRACTICES (BMPS)

Since 1989, Arkema has conducted several source control measures and BMPs to improve soil, stormwater, groundwater, and sediment quality at the Site (Integral 2008b).

3.2.1 Remedial Actions

Phase I and II soil IRMs were conducted to remove DDT-contaminated soils in and around the Acid Plant area (Appendix D, Figure 7-1). The Phase I IRM (September and November 2000) included stormwater conveyance system upgrades, excavation and disposal of approximately 3,800 tons of surface and subsurface soil, and placement of a temporary cap over a large unpaved area east of the Acid Plant (ERM 2005). The Phase II IRM (November 2001) included excavation and disposal of approximately 915 tons of surface soils, paving in the former Acid Plant area to minimize the potential for contamination from stormwater drainage, and installation of a storm drain and associated piping west of the former Acid Plant Control House (Figure 2-4) to collect stormwater drainage (ERM 2005). Additional details on IRMs conducted at the Site can be found in the Phase I and II soil IRM reports and the Upland RI Report (ERM 2001, 2002, and 2005).

3.2.2 Best Management Practices

Recent stormwater BMPs were implemented between October 16 and November 1, 2006 (Integral 2007a). BMPs included removing sediment from each catch basin, rinsing the catch

basin with potable water, and pumping the water out of the catch basin with a sump pump. After catch basin cleaning, additional BMPs were implemented, including installing filter socks in the active catch basins and placing biobags on or adjacent to the catch basin grates (October 16 to November 1, 2006). In addition, a number of catch basin pipes that were not integral to the stormwater system were decommissioned (sealed with concrete or expandable plugs) (Integral 2007a).

On December 19, 2006, a vacuum truck was used to clean the deep catch basins and vaults connected to Outfalls 001, 003, and 004 including Pit 16 and Catch Basins 1-11, 1-19, 3-2, 3-3, and CB-003-01; Figure 2-4). One catch basin, Catch Basin 1-11, was also sealed with concrete (Integral 2007a).

3.2.3 Performance of Remedial Actions and Best Management Practices

The Phase I and II remedial actions were effective in removing soil containing DDT and chlorobenzene, and reduced the potential for transport of constituents in shallow soil (ERM 2005). Pre- and post-IRM DDx concentrations in Acid Plant area stormwater are presented in Table 3-1. After implementation of the Phase I and II remedial actions, concentrations of DDT, DDD, DDE in stormwater decreased by 2 to 35 times. In samples from manhole SW-01, DDT, DDD, DDE, decreased by approximately one-half to two-thirds below pre-IRM concentrations. In the SW-02 manhole sample, DDT and metabolite concentrations decreased by approximately an order of magnitude (Table 3-1). In the latter area, the placement of a temporary cap over previously unpaved soils effectively reduced DDT and metabolite concentrations in stormwater by more than 90 percent. In most of the pre- and post-IRM stormwater samples, more than 90 percent of the DDT, DDD, DDE were associated with the particulate fraction (i.e., greater than 0.45 μm).

Pre- and post- BMP concentrations of DDT, DDD, DDE from the Parshall Flumes at Outfalls 001, 002, 003, and 004 are presented in Table 3-3 and Figures 5-7 in Appendix D . BMPs implemented in 2006 (catch basin sediment cleaning and installation of filter socks and biobags) did not significantly reduce DDT, DDD, and DDE concentrations in outfall stormwater samples below concentrations already achieved by Phase I and II IRMs (Figures 5-7, Appendix D). As shown in Table 3-3, post-BMP concentrations of total DDx are approximately an order of magnitude higher than dissolved concentrations, indicating that DDx is primarily being transported in the particulate phase. This suggests that the source of DDx to stormwater discharged at the Site is fine-grained sediment loads being transported within the stormwater conveyance system that can include erodible soils transported to the catch basins that are not captured by the filter socks. These findings are discussed further in Section 4.2 and addressed in the IRM alternatives presented in Section 6.

4 SITE CONCEPTUAL MODEL

This section summarizes the JSCS screening and identification of COPCs for evaluation in this FFS. The nature and extent, potential sources, and loading of COPCs from stormwater to the Willamette River are also summarized in this section.

4.1 JOINT SOURCE CONTROL STRATEGY SCREENING EVALUATION

This stormwater source control evaluation follows the JSCS guidance document (DEQ 2005). The primary objective of the JSCS is to identify and evaluate sources of COPCs that may impact the Willamette River (DEQ 2005). The JSCS guidance includes the groundwater, stormwater, and erodible soil pathways to the river. This evaluation is directed at the stormwater and erodible soils pathways to the river.

On December 15, 2006, LSS submitted to DEQ a source control memorandum that provided the outline and rationale for completing the screening and source control evaluation pursuant to the December 2005 Portland Harbor JSCS for the Arkema Portland Plant (Integral 2006b). DEQ provided comments on the memorandum in a letter dated January 22, 2007 (McClincy 2007a) and during a meeting held between DEQ and LSS on April 3, 2007. This source control evaluation generally addresses the comments from DEQ and also follows JSCS guidance[6] (DEQ 2005). Riverbank soil sampling data that were generated in 2007 are not part of this analysis because these areas are not directly connected to the upland stormwater system that is the subject of this FFS. The bank erosion pathway will be addressed, if needed, in other source control evaluations, or for those portions that fall within the RAA boundary, in the EE/CA for the in-water portion of the Site.

4.1.1 Description of Data Evaluated

The following sections briefly describe the data screened against the highly conservative screening level values (SLVs) listed in the JSCS guidance document (DEQ 2005).

4.1.1.1 Surface Soils

A total of 103 surface soil (0 to 1 ft bgs) sample results were included in the JSCS screening (Figure 4-1). These data were collected in support of the upland remedial investigation and

[6] As noted in the Joint Source Control Strategy (DEQ 2005), "The information contained in this document should be interpreted and used in a manner that is fully consistent with the State's and EPA's environmental cleanup laws and implementing rules. This document does not constitute rulemaking by the Oregon Environmental Quality Commission or by EPA, and may not be relied upon to create a right or benefit, substantive or procedural, enforceable in law or equity, by any person, including the DEQ or EPA. DEQ or EPA may take action at variance with this document."

IRMs. Soils collected beneath pavement were included in the screening evaluation because redevelopment of the Site may expose the soils and make them transportable to the river; however, most of the surface soils screened in this JSCS evaluation are not presently exposed or available to be potentially eroded and transported to the river. These soil samples were collected during a number of Site investigations from 1994 to 2005. Additional information on the surface soil samples is presented in the upland RI report (ERM 2005).

4.1.1.2 Catch Basin Sediment

A total of 19 catch basin and 17 filter sock sediment samples were collected in October 2007 (Figure 2-4). The filter socks were installed following demolition activities, which were conducted between 2003 and January 2005 (ERM 2005). The sediment in the filter socks includes demolition debris and surface soils deposited after January 2005 (completion of demolition activities) and October 2006. The sediment in the catch basins includes material that was deposited prior to initiation of demolition activities (2003) but could also include material not captured by the filter socks after demolition activities were completed. The results of the catch basin and filter sock sediment sampling demonstrated that filter sock sediment DDx concentrations were generally much lower than catch basin sediment indicating that IRMs and post-demolition BMPs were effective at reducing DDx sediment concentrations. Additional analyses of these data are presented in Section 3.1.2.1. Additional details on the samples are presented in the stormwater IRM field sampling and data report (Integral 2007a).

4.1.1.3 Stormwater

Four rounds of stormwater samples collected from the outfall Parshall flumes between February and June 2007 were included in the JSCS screening (Figure 2-4). The samples included both filtered and unfiltered samples for selected analytes. These stormwater samples were chosen for the screening because they are representative of current site conditions (i.e., post plant closure and demolition). Two of the stormwater sampling events were "first flush" events (i.e., samples were collected near the beginning of the storm event). Outfalls 003 and 004 were not sampled during the second first flush event due to a short-duration storm. The results of the 2007 stormwater sampling are briefly presented in Section 3.1.2.2. Additional information is presented in the stormwater IRM field sampling and data report (Integral 2007a).

In addition to the samples collected by LSS, four rounds of composite samples and one set of grab samples were collected by the Lower Willamette Group (LWG) from the Parshall flume at Outfall 002 between March and November 2007. The LWG samples were collected from the flume using ISCO® automatic samplers. Additional details on the LWG sampling methods are presented in the Round 3A stormwater field sampling report (LWG 2007).

4.1.2 Joint Source Control Strategy Screening Results

Surface soil, catch basin sediment, and stormwater analytical results were compared to the highly conservative SLVs provided in the JSCS guidance document. An exceedance of an SLV does not necessarily indicate the upland source of contamination poses an unacceptable risk to human or ecological receptors, but instead requires only further consideration using a weight-of-evidence approach (DEQ 2005). A weight-of-evidence approach is used to evaluate the magnitude of the priority for each medium or area of the Site where source control actions are being considered. If warranted, based on the weight–of-evidence evaluation, COPCs are then proposed to be carried forward into the RI/FS process for subsequent evaluations, and in this specific case, for evaluation in the stormwater FFS.

Screening tables for surface soils, catch basin sediments, and stormwater analytical results are presented in Appendix A. For comparison purposes, the screening table for the LWG stormwater data only includes constituents analyzed in samples collected by LSS. Summaries of JSCS screening results for surface soils, catch basin/filter sock sediments, and stormwater samples collected by LSS are presented in Tables 4-1, 4-2, and 4-3, respectively. The following sections briefly describe the JSCS screening results for each media.

4.1.2.1 Surface Soils

Detected surface soil concentrations exceeded the highly conservative SLVs for one PCB chemical (Aroclor® 1248), one SVOC (indeno[1,2,3-cd]pyrene), three metals (arsenic, chromium, and zinc), and pesticides.

PCB Aroclor® 1248 was detected in six of 29 samples analyzed, with a maximum detected value of 4.6 mg/kg. All six detections exceeded the highly conservative SLV. Indeno[1,2,3-cd]pyrene was detected in five of 13 samples analyzed, with a maximum detected value of 0.194 mg/kg.

Arsenic was detected in all 13 samples analyzed with a maximum detected concentration of 76.1 mg/kg. Of the 13 detections, only 15 percent exceeded the highly conservative SLV. Chromium and zinc were both detected in all 14 samples analyzed, with maximum detected concentrations of 195 and 392 mg/kg, respectively. All of the zinc concentrations exceeded the highly conservative SLV, but only 14 percent of the chromium concentrations exceeded the SLV.

Endrin was detected in one of 58 samples analyzed with a maximum detected concentration of 1.5 mg/kg, which exceeded the highly conservative SLV. Gamma-HCH was also detected in one of 58 samples analyzed at a concentration of 0.01 mg/kg, which exceeded the highly conservative SLV. DDT, DDD, DDE were detected in 75 of 77 samples analyzed, with a maximum detected concentration of 12,300 mg/kg. All of the detected sample concentrations exceeded the highly conservative SLVs.

4.1.2.2 Catch Basin/Filter Sock Sediments (Lots 3 and 4)

Detected catch basin/filter sock sediment concentrations exceeded the highly conservative SLVs for 17 dioxin/furans, manganese, 11 PAHs, DDT, DDD, and DDE, pentachlorophenol, and two phthalates (bis(2-ethylhexyl) and dibutyl). A brief description of the detected constituents that exceeded the highly conservative SLVs is presented below and in Table 4-2.

The maximum detected concentrations of dioxins and furans ranged from 0.0003 mg/kg (2,3,7,8-tetrachlorodibenzo-*p*-dioxin, exceeding the highly conservative SLV in 83 percent of samples) to 1.5 mg/kg (octachlorodibenzo-*p*-dioxin, exceeding the highly conservative SLV in 72 percent of samples) in catch basin and filter sock sediments collected at the Site. Detected concentrations of manganese exceeded the highly conservative SLV in 3 percent of samples with a maximum concentration of 1,720 mg/kg. The maximum detected PAH concentrations ranged from 0.192 mg/kg (fluorene, exceeding the highly conservative SLV in 3 percent of samples) to 2.86 mg/kg (pyrene, exceeding the highly conservative SLV in 56 percent of samples). The maximum detected concentrations of 4,4'-DDT, -DDE, and -DDD were 128, 8.01, and 44.8 mg/kg, respectively. DDT, DDD, and DDE exceeded the highly conservative SLVs for all samples analyzed. Detected pentachlorophenol concentrations exceeded the highly conservative SLVs in 19 percent of samples with a maximum concentration of 31.4 mg/kg. Detected concentrations of dibutyl phthalate and bis(2-ethylhexyl) phthalate exceeded the highly conservative SLVs in 47 and 61 percent of samples, respectively, with maximum concentrations of 15.3 and 65.7 mg/kg, respectively.

Although the analyte lists for catch basin sediments and surface soils differ, a comparison of surface soil and catch basin sediment summary tables (Tables 4-1 and 4-2) reveals significantly lower DDT and metabolite concentrations detected in catch basin sediment compared to surface soil samples. A PCB Aroclor® was detected in several surface soil samples, but none was detected in catch basin sediment samples. Detected pentachlorophenol and selected PAH constituent concentrations, however, were higher in catch basin sediments than surface soils. This finding is discussed further in Section 4.1.3.1 of the weight-of-evidence evaluation.

4.1.2.3 Stormwater (Lots 3 and 4)

Detected stormwater concentrations exceeded the highly conservative SLVs for hexavalent chromium, manganese, perchlorate, six PAHs, pentachlorophenol, and DDT, DDD, and DDE. A brief description of the detected constituents that exceeded the highly conservative SLVs is presented below and in Table 4-3.

Detected total hexavalent chromium concentrations exceeded the highly conservative SLV in 36 percent of samples with a maximum concentration of 0.038 mg/L. Detected total manganese concentrations exceeded the highly conservative SLV in 29 percent of samples with a maximum concentration of 0.157 mg/L. Detected perchlorate concentrations exceeded the highly conservative SLV in 14 percent of samples with a maximum detected concentration of 0.125 mg/L. The maximum detected PAH concentrations ranged from 0.00001073 mg/L

(dibenzo[a,h]anthracene, exceeding the highly conservative SLV in 7 percent of samples) to 0.00009335 mg/L (chrysene, exceeding the highly conservative SLV in 7 percent of samples). Pentachlorophenol detections exceeded the highly conservative SLV in 91 percent of samples analyzed with a maximum concentration of 0.00728 mg/L. The maximum detected total concentrations of 4,4'-DDT, -DDE, and -DDD were 0.00248, 0.002, and 0.000133 mg/L, respectively, and exceeded the highly conservative SLVs in 100, 86, and 71 percent of samples, respectively.

Total concentrations of DDT, DDD, and DDE are approximately an order of magnitude higher than their dissolved counterparts, indicating that the majority of DDx is transported in particulate form. Similarly, total concentrations of manganese are greater than dissolved concentrations by a factor of approximately 3.

A comparison of the screening results for the LSS and LWG samples collected from Outfall 002 shows that PAH and DDT, DDD, and DDE concentrations are generally similar (Appendix A). The LWG collected an ISCO® grab sample on June 5, 2007, the same day stormwater grab samples were collected by LSS. A comparison of the June 5 data reveals a relatively close match between the two data sets for DDT, DDD, DDE. Dissolved concentrations of DDT, DDD, DDE, however, are approximately an order of magnitude higher in the ISCO® grab samples than the LSS grab samples. The reason for the difference in dissolved concentrations is not known; however, differences between the two sampling methods included different filter materials (the ISCO® samples were reportedly filtered using 0.2 μm glass fiber filters, and the LSS samples were filtered using 0.45 μm polyethersulfone filters) and possibly different periods of time between sampling and filtering.

4.1.3 Weight-of-Evidence Evaluation

The JSCS guidance document lists weight-of-evidence elements that can be considered for each media. The JSCS guidance also allows other lines of evidence, even ones not listed in the JSCS guidance document, to be considered.

The following sections provide a weight-of-evidence analysis for surface soils/catch basin sediments and stormwater at the Site.

4.1.3.1 Surface Soils and Catch Basin Sediments

JSCS guidance lists the following weight-of-evidence elements to be considered for surface soils (DEQ 2005):

- Presence of persistent bioaccumulative chemicals
- Contaminant concentrations (magnitude of exceedance above SLV)
- Regional background soil concentrations for naturally occurring chemicals (i.e., metals)

- Extent of contaminated soil (e.g., area of exposed and/or erodible soil)
- Proximity of source area soil to the river
- In-water sediment data in proximity to the source area
- Site surface conditions (e.g., exposed soil, paved areas, slope)
- Riverbank stability (e.g., potential for erosion under extreme rainfall events, potential for erosion under flood conditions, bank erosion rates)
- Soil properties (e.g., soil type, compaction, erodability, permeability)
- Stormwater management
- Proximity of source area soils to stormwater catch basins
- Evaluation of potential soil erosion and contaminant transport (e.g., modeling, quantitative erosion calculations)
- Estimate of potential contaminant loading to the river.

These and other lines of evidence deemed relevant for the surfaces soil to stormwater pathway are considered in this weight-of-evidence evaluation. The following discussion is broken into the developed (Lots 3 and 4) and undeveloped (Lots 1 and 2) portions of the Site due to the physical differences between these areas.

Lots 3 and 4

The majority of stormwater drainage from Lots 3 and 4 is discharged through Outfalls 001 through 004 (Figure 2-4). Approximately half of the surface soils on Lots 3 and 4 are covered with asphalt or building foundation concrete (Figure 2-4). Most of the surface soil samples collected from Lots 3 and 4 are from areas that are covered by asphalt or concrete building foundations that were left in place to serve as temporary caps. As a result, the soil sample results are not a good indicator of solids that may presently be transported to the river, but they must be considered if redevelopment activities are conducted in the future. The most relevant indicator of solids that may currently be transported to the river is the catch basin sediments. The particulate material observed in the catch basins and filter socks may be transported through the present sewer conveyance system and to the river. According to the JSCS guidance, erodible soils are defined as soils within 100 ft of a catch basin or within 100 ft of the top of the riverbank (DEQ 2005). Although soils more than 100 ft from a catch basin or top of riverbank are not likely to be eroded and transported to the river, they may be transportable to the river if Site conditions change (i.e., redevelopment or changes to the stormwater conveyance system). Figure 2-4 shows 100 ft "capture zones" around each active catch basin.

Detected concentrations of PAHs and PCP were higher in catch basin/filter sock sediments than surface soils. In addition, dioxins and furans were detected in catch basin/filter sock sediment samples. At these locations, these constituents probably originated from a number of treated

utility poles that were cut and removed from the Site during demolition activities. Secondarily, atmospheric deposition of dioxin/furans is widely known in industrial and urban settings and the Site is located directly across from the RP facility, a known local source of dioxin/furans. In August 2007, LSS collected a composite sample of two utility poles located within the stormwater capture zone of Catch Basin CB-003-02. High concentrations of PAHs and pentachlorophenol (percent levels), and dioxin and furans (parts per billion levels) were detected in the utility pole wood sample (Integral 2007a). The source of these constituents to catch basins was probably sawdust created during demolition cutting activities that likely transported to the catch basins during subsequent storm events. Treated utility pole sawdust was observed at the Site during only a short period during building demolition. Because building demolition was completed 3 years ago and BMPs have removed sediments (including sawdust) from the catch basins, these constituents are no longer considered active sources in the stormwater system and are therefore not considered COPCs.

Detected concentrations of two phthalates (bis(2-ethylhexyl) and dibutyl) exceeded the most conservative JSCS SLVs in catch basin/filter sock samples. The maximum exceedance quotient for dibutyl phthalate and bis(2-ethylhexyl) phthalate was 255 and 199, respectively. There is no known historical use of phthalates as raw materials (or in finished goods) at the Site. The phthalates are likely from demolition activities (the use of plastic sheeting; cutting plastic pipe and other materials). Demolition activities are completed; therefore, phthalates are no longer a source of contamination at the Site. Because building demolition was completed 3 years ago and BMPs have removed sediment from the catch basins, these constituents are no longer considered active sources in the stormwater system and are therefore not considered COPCs.

Manganese was only detected in one of 36 catch basin or filter sock sediment samples analyzed at a concentration that exceeded the most conservative JSCS SLV. The exceedance quotient for this sample was only 1.6. There is no known historical use of manganese as a raw material (or in finished goods) at the Site. Because manganese is a naturally occurring metal that only marginally exceeded the SLV in only one sample (3 percent of samples analyzed), manganese is not considered a COPC at the Site.

Concentrations of DDT, DDD, and DDE were detected above the conservative JSCS SLVs in catch basin and filter sock sediment samples and are not attributable to demolition activities. These constituents are COPCs that are addressed by the stormwater IRM alternatives presented in Section 6.

The pathway from erodible surface soils to catch basins is complete in the areas of exposed soil that are within the capture zones of the catch basins (Figure 2-4). The stormwater to river pathway is currently complete, but the existing stormwater system will be significantly modified as part of the stormwater IRM (Section 6). The windblown soil pathway to the river is complete, but is likely insignificant since the portions of Lots 3 and 4 with elevated COI

concentrations are in impervious paved or covered areas. Lots 3 and 4 are relatively flat, so the potential for soil erosion is low (Figure 2-3).

Lots 1 and 2

Lots 1 and 2 are undeveloped and are not paved. There is no stormwater conveyance system on this portion of the Site. During light storm events, water will undergo infiltration and evapotranspiration. During heavy storm events in addition to infiltration and evapotranspiration, stormwater may first pond in low areas, and if there is enough rainfall, stormwater may discharge directly to the river in the eastern portion of Lots 1 and 2 or to Front Avenue in the western portion of the lots. The topography on Lots 1 and 2 is relatively flat, so erosion is unlikely to be significant (Figure 2-3). Additional discussion on the drainage of Lots 1 and 2 is presented in Section 6.

Arsenic, chromium, and zinc concentrations detected in surface soil samples on Lots 1 and 2 exceeded the highly conservative JSCS SLVs (SS stations; Appendix A). Detected arsenic and chromium concentrations are above average background soil concentrations in Oregon (7 and 42 mg/kg, respectively; DEQ 2002). The maximum detected arsenic and chromium concentrations, however, only minimally exceeded the most conservative JSCS SLVs (2.3x and 1.8x, respectively; Appendix A). The maximum detected zinc concentration was 85x the most conservative JSCS SLV but was only approximately 3x higher than the average background zinc concentration in Oregon (86 mg/kg; DEQ 2002). There are no known historical uses of arsenic or zinc as raw materials (or in finished goods) on Lots 1 and 2 at the Site. These metals may have originated from historical dredge spoils that were placed on Lots 1 and 2. Based on this information, arsenic, chromium, and zinc are not considered COPCs at the Site.

Detected concentrations of DDT, DDD, and DDE exceeded the conservative JSCS SLVs in most of the surface soil samples collected from Lots 1 and 2 (SS stations; Appendix A). No DDT manufacturing occurred on Lots 1 and 2; however in the 1990s, a trench that was used to dispose of DDT-residue was discovered on Lot 1. In 1994, the contents of the trench, approximately 1,700 tons of soil, were removed and disposed of at a Subtitle C landfill in Arlington, Oregon. Confirmation sampling demonstrated that the cleanup met industrial and residential[7] soil cleanup levels. Note that the current DEQ residential risk-based concentration for DDT in soil (1.7 mg/kg) exceeds the highly conservative JSCS SLV for catch basin sediment and erodible soils by more than 5,000 times. Clean backfill was used to replace the excavated soil from the trench and therefore no residual impact from the former DDT trench is expected (ERM 2005). The origin of DDT on Lots 1 and 2 could have come from the placement of historical dredge spoils placed in these areas. DDT, DDD, and DDE are COPCs that are addressed by the stormwater IRM alternatives presented in Section 6.

[7] With the exception of one confirmation sample that exceeded DEQ's residential standard but met the industrial cleanup standard.

Detected concentrations of the PCB Aroclor® 1248 exceeded the most conservative JSCS SLV in four of 13 soil samples collected from Lot 2 (stations SS1-1, SS1-2, SS2-2 and SS2-3; Figure 4-1). The maximum exceedance quotient was 199. Transformers or other PCB source materials were not historically used on this portion of the Site. The source of the PCBs may have originated from historical dredge spoils placed on this portion of the Site. Based on this information, PCB Aroclor® 1248 is not considered a COPC at the Site.

The pathway from erodible surface soils to the river is likely complete during the heaviest storm events. The windblown soil pathway to the river is complete, but is likely not significant due to vegetation present on Lots 1 and 2. The Site is relatively flat, so the potential for soil erosion is low (Figure 2-3).

4.1.3.2 Stormwater (Lots 3 and 4)

JSCS guidance lists the following weight-of-evidence elements to be considered for stormwater (DEQ 2005):

- Identification and characterization of potential sources of contaminants
- Magnitude of stormwater and stormwater sediment exceedance at each sampling point and proximity of sampling point to the river
- Regional background soil concentrations of naturally occurring chemicals
- Presence of bioaccumulative chemicals
- Site hydrology including consideration of but not limited to the following:
  - Site conditions
  - Size of drainage
  - Location and estimate size of discharge
- Stormwater system design and management
- Maintenance and condition of conveyance system
- Contaminant fate and transport
- Estimate of potential contaminant loading to the Willamette river.

Small amounts of water have been observed flowing through the Parshall flume on the No. 4 sewer during dry periods of the year. The water observed flowing through the sewer system during the dry periods of the year likely represents groundwater infiltration. Low levels of selected metals, DDx, SVOCs, and VOCs were detected in a sample of the infiltrating groundwater. Many of the analytes detected in the water sample are preliminary COPCs for the Rhone-Poulenc/Starlink Logistics, Inc. (RP/SLLI) site, which indicates contaminated groundwater from the RP/SLLI site is migrating onto Arkema property on Lot 3 in a sewer

lateral that intercepts the RP/SLLI plume. LSS prepared a plan to abandon the portion of the No. 4 sewer system where groundwater infiltration is occurring (LSS 2008b). The plan was approved by DEQ (McClincy 2008) and was implemented by LSS in June 2008.

Detected manganese concentrations in stormwater samples exceeded the secondary maximum contaminant level (MCL) by factors of up to 3. The secondary MCL for manganese is based on aesthetics (i.e., taste and staining) rather than toxicity. None of the samples exceeded the tap water preliminary remediation goal (PRG) for manganese, which is 1.70 mg/l (DEQ 2005). Therefore manganese is not considered a COPC at the Site.

Hexavalent chromium and perchlorate concentrations detected in stormwater at the Site exceeded the most conservative JSCS SLVs by factors of 3.5 and 5.1, respectively. These exceedance factors are relatively low and therefore are not considered COPCs at the Site.

The maximum detected PCP concentration in stormwater exceeded the most conservative JSCS SLV by a factor of 13. The source of the PCP is likely from utility poles that were cut off during demolition activities. The cut-off utility poles that remain at the Site will be addressed in Section 6. PCP is not considered a COPC at the Site.

A total of six PAHs exceeded the most conservative JSCS SLVs in stormwater at the Site (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene; Table 4-3). The maximum SLV exceedance quotients for these PAHs ranged from 1.2 to 7.0. All of the exceedance quotients are relatively low. One possible source of PAHs in stormwater is from asphalt paving that is present in much of the Site. Another possible source of the PAHs is from utility poles that were cut off during demolition activities. The cut-off utility poles that remain at the Site will be addressed in Section 6. PAHs are not considered a CPOC at the Site.

Concentrations of DDT, DDD, and DDE were detected above the conservative JSCS SLVs in the majority of the stormwater samples collected. These constituents are COPCs that will be addressed in Section 6.

The stormwater to river pathway is currently complete, but the existing stormwater system will be significantly modified as evaluated in the alternatives presented in Section 6.

4.1.4 Chemicals of Potential Concern

COPCs for stormwater at the Site were derived through the JSCS weight-of-evidence analysis presented in Section 4.1.3. The weight-of-evidence analysis was based on multiple lines of evidence that included the following:

- Background concentrations

- SLV exceedance quotients
- Historical use of the chemicals
- Likely sources of the chemicals
- Frequency of exceedances.

DDT, DDD, and DDE were identified as COPCs in surface soil, catch basin/filter sock sediment, and stormwater. DDx will be addressed in the IRM alternatives presented in Section 6.

4.1.5 DDx Concentration Comparison to Standard DEQ Screening Levels

DDx concentrations in stormwater, surface soils, and catch basin sediments were compared to standard DEQ screening level values (Table 4-4). These values included tap water preliminary remediation goals (PRGs) for stormwater and occupational and residential risk-based concentrations (RBCs) for surface soils and catch basin sediments. In stormwater samples, dissolved DDT, DDD, and DDE were not detected above the PRGs of 0.2, 0.2, and 0.28 μg/L, respectively, in any of the of the samples analyzed. Total DDD was also not detected above the PRG. Total DDT and DDE were detected above the tap water PRGs in 43 and 50 percent of the samples analyzed, respectively. Maximum exceedances of Total DDT and DDE above tap water PRGs were 10 times and 12 times, respectively.

In surface soil samples, DDT was detected above the residential RBC of 1.7 mg/Kg in 71 percent of the samples and detected above the occupational RBC of 7.7 mg/Kg in 58 percent of the samples analyzed. DDD was detected above the residential RBC of 2.4 mg/Kg in 19 percent of the samples and was detected above the occupational RBC of 11 mg/Kg in 12 percent of the samples analyzed. DDE was detected above the residential RBC of 1.7 mg/Kg in 27 percent of the samples and detected above the occupational RBC of 7.7 mg/Kg in 16 percent of the samples analyzed. In catch basin sediments, DDT was detected above the residential and occupational RBCs in 25 percent and 11 percent of the samples analyzed, respectively. DDD was detected above the residential and occupational RBCs in 8 percent and 3 percent of the samples analyzed, respectively. DDE was detected above the residential and occupational RBCs in 17 percent and 3 percent of the samples analyzed, respectively.

Based upon screening against more appropriate and accepted DEQ risk-based screening level values, DDx only exceeds tap water PRGs in 50 percent or less of the samples and at limited levels of exceeded (up to 12.4 times for DDT). DEQ risk-based tap water PRGs are not exceedance for dissolved DDx in stormwater. For soils, DEQ risk-based residential and/or occupational screening level values are exceeded in typically less than 50% of the samples and are much lower for occupational exposures, the most appropriate screening level for the Site. For catch basin sediments, DEQ risk-based residential and/or occupational screening level values are exceeded in less than 25% of the samples and are much lower (i.e., less than 11 percent) for occupational exposures. Using these DEQ standards, the Arkema Site would be

ranked as a low-priority site for further evaluation for cleanup for stormwater, a low- to medium- (however most of these soils are already capped in the Acid Plant area) priority site for surface soils, and a low-priority site for catch basin sediments.

4.2 NATURE, EXTENT, AND SOURCES OF CHEMICALS OF POTENTIAL CONCERN

The nature and extent of DDx in surface soils, catch basin/filter sock sediment, and stormwater is presented below. The discussion of catch basin sediments and stormwater applies to Lots 3 and 4. Lots 1 and 2 are undeveloped and do not have a stormwater conveyance system; however, sources of DDx on these lots are also summarized below because modifications to site drainage as a result of this FFS could affect the migration of stormwater from Lots 1 and 2 into a modified stormwater conveyance and treatment system.

4.2.1 Surface Soil

The nature and extent of DDx is presented below. Additional details for these constituents can be found in the upland RI report (ERM 2005).

Figure 4-2 shows DDx concentrations in surface soils at the Site. The highest concentrations of DDx at the Site are in the Acid Plant area where historic DDT manufacturing occurred. DDx concentrations in this area range from less than 1 mg/kg to 12,300 mg/kg (station GA-SB05). The footprint of DDx-impacted soil is generally bounded north-south by Docks 1 and 2, and east-west by the Willamette River and the former Caustic Process Building (ERM 2005). Presently, the majority of these DDx-impacted soils in the Acid Plant area are beneath asphalt paving or concrete building foundations. Lower concentrations of DDx ranging from 0.45 mg/kg (station SS2-6) to 147 mg/kg (station SS1-3) were detected on Lots 1 and 2 (Figure 4-2).

4.2.2 Catch Basin Sediment and Stormwater (Lots 3 and 4)

The following section briefly discusses the nature and extent of DDx in catch basin sediment and stormwater sampling results from 2006 to 2007. Additional details for these and other constituents can be found in the stormwater IRM field sampling and data report (Integral 2007a).

DDx concentrations detected in catch basin sediment and stormwater samples are presented in Appendix D, Figure 2. The highest DDx concentrations in catch basin and filter sock sediments were detected in catch basins in the Acid Plant area. The catch basins in the Acid Plant area are part of the Outfall 002 sewer system, which has the highest DDx stormwater concentrations. Total DDx concentrations detected in the stormwater samples are generally an order of

magnitude higher than the associated dissolved concentrations, indicating that most of the DDx is being transported in particulate form.

4.2.3 Potential Sources and Migration Pathways

The following is a brief description of potential sources and migration pathways of DDx in stormwater. These potential sources and pathways will be addressed by the IRM alternatives presented in Section 6.

The potential sources of DDx to the stormwater conveyance system on Lots 3 and 4 include the following:

- Erodible soils that are transported by overland flow or wind to the catch basin capture zones. Particulates that are too small to be removed by the filter socks installed in the catch basins are potential sources of DDx. Erodible soils in the former Acid Plant area would be expected to have the highest concentration of DDx relative to the other outfall subbasins. This is considered to be the primary ongoing source of DDx to stormwater.
- Sediment that has been deposited in the stormwater conveyance system since the plant shutdown in 2001. Sediments in the Outfall 002 sewer system would be expected to have higher concentrations of DDx than the other Outfall sewers. This is considered to be a potential source of DDx to stormwater; however, the magnitude of this source is probably minor.
- Subsurface particulates that infiltrate the storm sewer system where there are holes or breaks in the conveyance system, including locations where sewer pipes were sheared off during plant demolition activities. Dredge fill material and other historical fill materials could be sources of DDx in subsurface particulates. This pathway is difficult to quantify but is assumed to be a less significant source of DDx to stormwater than the other potential sources.

Erodible soils are a potential source of DDx in stormwater that is transported to the river by overland flow. Overland flow is only expected to be significant during the heaviest storm events, which are uncommon. The effect of wind is expected to be insignificant because the majority of soils on Lots 3 and 4 are covered with asphalt or concrete foundations, and most areas on Lots 1 and 2 are vegetated.

4.3 CHEMICAL OF POTENTIAL CONCERN LOADING FROM STORMWATER TO THE WILLAMETTE RIVER

The Simple Method can be used to calculate DDx discharge (L, as mass per time) as follows:

$$L = R \times C \times \text{Units Conversions}$$

Where:

R = site discharge, calculated in Section 2.2

C = flow weighted mean COPC concentration in mass per volume

Table 4-5 presents the results for DDx detected during the IRM sampling and analysis based on the defined sub-basins in Table 2-1. Flow rates and concentrations of non-point source stormwater discharge (i.e., overland flow) from Lots 1 and 2 have not been measured at the Site; therefore, loading from these potential sources was not calculated. However, given the relatively flat nature of these parts of the Site, the existence of depressions which will allow for enhanced infiltration and evaporation, the existence of vegetation, and the relatively low concentrations of DDx in Lots 1 and 2, loading to the Willamette River from these areas will be negligible except during infrequent, large storm events. Based on these calculations, approximately 0.0572 lbs (less than 1 ounce) of DDx discharges to the river in a year. Nearly all of the DDx mass being discharged from the Site is generated within the four drainage basin areas (Lots 3 and 4) and most of that is from the Outfall 001 area because of the larger volume of stormwater discharge from the drainage basin for this Outfall.

For comparison, current DDx loading in the Willamette River upstream of the Site should be considered. DDx concentration and river discharge data from eight Willamette River water sampling events (at River Mile 11 [RM11] approximately four miles upstream of the Site) were used to determine comparative baseline loads of DDx in the river at RM 11 (Table 4-6; Integral 2006c, 2006d, 2007b, 2007c, 2007d). Willamette River surface water samples were collected from 2004-2007 during river flows ranging from 6,000 to 169,000 cubic feet per second (cfs). The 169,000 cfs flow represents an extreme high-river event that may or may not occur in a given year. Therefore, in this analysis (to be conservative), all but the highest river flow (169,000 cfs) were used. The DDx base load (calculated as the river DDx concentration x river flow during a sample event) ranges from 0.0025 to 0.5324 lbs/day (0.91 to 194 lbs/yr) of DDx (Table 4-6). The average annual DDx base load flux calculated based on all but the highest extreme Willamette River flow event is at least 13.4 lbs/year.

Consequently, the annual DDx flux in stormwater from the Site is minimal in comparison (approximately 1 ounce on average versus at least 13.4 lbs on average) of the annual base load of DDx in the Willamette River as calculated at RM 11.

5 IDENTIFICATION OF SOURCE CONTROL MEASURE OBJECTIVES

This section presents a summary of the ARARs and remedial action objectives (RAOs) for the Arkema Stormwater IRMs. RAOs are chemical- and media-specific goals for the interim remedial action that are protective of human health and the environment.

5.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

A preliminary list of statutes and regulations that may be considered as potential ARARs for the project is included in Table 5-1. These ARARs can be generally categorized as chemical-, action- or location-specific. The list of ARARs in Table 5-1 includes both federal and State of Oregon rules and regulations that are considered relevant for a stormwater IRM at the Site. The ARARs will be finalized in consultation with DEQ prior to implementation of the stormwater IRM.

5.2 STORMWATER REMEDIAL ACTION OBJECTIVES

Three RAOs were previously identified in the *Stormwater Interim Remedial Measures Field Sampling and Data Report* (Integral 2007a) for stormwater remedial action at the Site:

- Reduce and/or mitigate the migration of aqueous phase COPCs in stormwater to the Willamette River that are at or above acceptable risk-based concentrations
- Reduce and/or mitigate the migration of COPCs in sediment that is transported in stormwater to the Willamette River that are at or above acceptable risk-based concentrations.
- Reduce flux of COPCs from the upland areas of the Former Site (i.e., Site) via stormwater drainage that may recontaminate any sediment or sediment caps.

Because DEQ and EPA have clarified that upland land owners along the Willamette River are not to complete site-specific, in-water risk assessments in the Portland Harbor (USEPA 2005), site-specific, risk-based cleanup levels for stormwater, which would be based upon potential in-water risks, have not yet been developed for the Site. As a result of the lack of risk-based concentrations, interim RAOs that reduce the flux of COPCs commonly referred to as a "mass reduction" approach are considered appropriate until a final risk assessment is completed by LWG and incorporated into a final site remedy. The proposed interim RAO for this stormwater IRM is listed below:

- Reduce the total mass of DDx in stormwater discharged from the Site to the Willamette River to less than 1 ounce of DDx annually.

This interim RAO applies only to the interim remedial measure for stormwater contemplated in this FFS and is not intended as an RAO for the final site remedy.

6 IDENTIFICATION AND ANALYSIS OF INTERIM REMEDIAL MEASURES ALTERNATIVES

This section identifies and evaluates stormwater process options (Section 6.1 and 6.2) that are then used to develop and screen three stormwater IRM alternatives (Section 6.3 and 6.4).

6.1 IDENTIFICATION OF STORMWATER TREATMENT PROCESS OPTIONS

To develop stormwater treatment IRM alternatives, potentially applicable treatment process options were identified to address potential sources of COPCs in stormwater as described in the following sections.

6.1.1 Existing Stormwater Collection System

A stormwater collection system currently exists at the Site. Since the facility closure in 2001 and subsequent demolition activities and the cessation of large volumes of process water discharges in the system, potential sources of entrained sediment within this system could be a source of discharge of DDx in stormwater. Two options were identified to address this potential source of DDx:

A. **Collection System Decommissioning/Outfall Consolidation**—This option would consist of abandoning the current stormwater collection system; however, if abandoned, an alternate method for stormwater collection would be required. Non-point discharge of stormwater from the Site (i.e., allowing stormwater drainage from the Site to flow overland and to the Willamette River) would probably not be allowed. Thus, if abandoned, the stormwater collection system would need to be replaced, either with channelized, overland flow to a point discharge to the Willamette River or with a new, shallow stormwater collection system and point discharge.

B. **Sewer Cleaning/Lining**—This option would consist of first cleaning the existing stormwater collection system and then lining it with a new material such as cast-in-place pipe.

6.1.2 Surface Soil Treatment

This option would consist of capping surface soils with an asphalt cap, topsoil, and/or vegetation to physically stabilize or isolate these soils from stormwater drainage and eliminate the potential for contaminated surface particulates to be entrained within stormwater discharges. This option could be either implemented site-wide or on a more focused basis to address erodible surface soils with the highest concentrations of DDx.

6.1.3 Stormwater Infiltration

This option would consist of routing Site drainage to an infiltration basin. Given the amount of precipitation during extreme precipitation events and groundwater elevation, it is unlikely that all site stormwater could be infiltrated.

6.1.4 Stormwater Treatment at Ground Surface

This option would consist of routing stormwater drainage to treatment areas, which could include one or more of the following proven technologies:

1. Vegetated/grassy swales
2. Rock-filled ditches (i.e., Rock Filters)
3. Wetponds or wetlands
4. Sedimentation basins
5. Aboveground sand/sand-carbon filters.

6.1.5 In-Ground Stormwater Treatment

This option would consist of installing treatment systems as a part of the existing or new stormwater collection systems. These systems could be installed either just prior to discharge, from one or more points of the collection system, or at each of the individual catch basins prior to entering the collection system. This option could include one or more of the following:

1. Hydrodynamic separators
2. Cartridge (multi-media) filter systems
3. In-vault or linear sand, sand and carbon, or multi-media filters
4. Structural detention facilities.

6.2 EVALUATION AND SCREENING OF STORMWATER TREATMENT PROCESS OPTIONS

This section evaluates and screens each of the above stormwater treatment process options based upon site specific conditions. Results of the evaluation are presented in Figure 6-1.

6.2.1 Collection System Decommissioning/Outfall Consolidation

Collection system decommissioning would consist of filling pipelines with sand or cement grout and plugging them with grout at manholes to assure that the pipes will not be a potential

pathway for DDx migration within the subsurface. All manholes and catch basins would then be filled with pea gravel, compacted and capped with concrete to a depth of 1 foot below grade. Discharges from the Site could be consolidated into one outfall, Outfall 004 (see below).

Decommissioning the collection system would eliminate the pathway for potential subsurface sources of DDx to current Site discharges. The current stormwater collection system is significantly aged, and the age of the collection system, as well as activities associated with the decommissioning former plant, may have compromised the structural integrity of the collection system. Structural defects could allow contaminated stormwater to infiltrate into the system during wet periods and contaminated soil particles to "fall" into the collection system. These pathways may be a source of DDx to stormwater discharges. Further, the collection system was designed to handle both stormwater and process water when the former plant was in operation. Thus, the collection system is oversized for current stormwater flows, and sedimentation could be occurring since plant operations have ceased. Sediment, if it has settled within the pipes, could be resuspended during a heavy precipitation event and be a potential source of DDx to stormwater discharges.

To evaluate the potential DDx sources settled in stormwater pipes, data from catch basin and filter sock sampling were evaluated. Average concentrations of DDx compounds measured within catch basin sediments (i.e., below filter socks) during the 2006 sampling event were generally higher than concentrations measured within sediments captured in filter socks (designed to capture contributing sediment from surface soils). These data suggest that historical sediment accumulation may have higher concentrations of DDx than sediments that accumulated more recently since building demolition. Further, BMPs designed to reduce the contribution of surface sources, including the placement of biofilter bags around catch basins and the installation of new filter socks within all active catch basins, had little effect on reducing DDx concentrations in stormwater discharges (Integral 2007a). While other explanations are possible, they could also indicate that BMPs were ineffective at capturing DDx compounds that are associated with very small particles in stormwater or that the filter socks were simply ineffective (e.g., they could have filled with sediment very rapidly and then were bypassed by subsequent precipitation events).

This treatment option has the potential to effectively reduce mass loading. Also, the collection systems that discharge to Outfalls 001, 002, and 003 will require decommissioning as part of the installation of the groundwater cut-off wall that is being incorporated with the groundwater source control IRM at the Site. Therefore, the sewer abandonment alternative has been retained for further analysis.

6.2.2 Collection System Cleaning/Lining

Sewer cleaning and lining would consist of flushing the collection system and capturing and disposing of the sediment and treating the water prior to discharge. Subsequent to cleaning, the

existing sewer system could then be lined to mitigate potential subsurface DDx sources to stormwater.

During plant operation, approximately 25 million gallons per day of noncontact cooling water flowed through the larger diameter sewer pipes at the Site, which likely kept the pipes free of sediment. The majority of the sewer pipes have not been cleaned since the plant closed in 2001. In addition, it is likely that some of the downspout and floor drain pipes were sheared off during plant demolition activities. As a result, it would be impossible to find the upper ends of the pipes for cleaning and lining activities. Finally, because abandonment of the collection system is already required for drainage to three of the four outfalls, collection system cleaning and lining has been screened from further analysis.

6.2.3 Surface Soil Capping

The surface soil capping option would consist of physically isolating potentially contaminated surface soils from stormwater drainage, thus eliminating their ability to be entrained within stormwater discharges. Physical isolation could be accomplished with either an asphalt or soil cap. As indicated by surface soil data generated during the RI, as well as stormwater discharge data and catch basin sediment data generated during the stormwater IRM investigation, DDx compounds are found at low concentrations in surface soils throughout the drainage basins to all four existing outfalls. The highest DDx concentrations are found in surface soils (and thus in catch basin sediment and ultimately in stormwater discharge) within the drainage basin for Outfall 002.

A soil cap would require vegetation to minimize erosion that could compromise the cap's integrity. Maintenance of the cap would include semi-annual inspections to insure that the cap has not been compromised. All areas that are capped with topsoil and vegetation would require annual mowing or vegetation trimming to facilitate inspections. It is further anticipated that some portion of a vegetated cap would require annual maintenance.

This treatment option has been retained and will be evaluated as a stand-alone alternative (i.e., addressing all contaminated surface soils) as well as a component of an active stormwater management and treatment alternative (i.e., addressing only "hot spots" in the drainage basin for Outfall 002).

6.2.4 Stormwater Infiltration

Stormwater infiltration would consist of development of a stormwater detention basin with a large surface area, shallow depth, and permeable bottom layer. As stormwater infiltrates into the subsurface, Site COPCs would be sorbed onto the vadose and saturated zones soil matrix. Stormwater drainage would require routing to the infiltration basin via surface vegetated/ grassy or rock swales.

A groundwater cut-off wall between the Willamette River and former plant area in Lots 3 and 4 has been proposed for the groundwater source control IRM (ERM 2008). To avoid the potential for groundwater mounding behind the cut-off wall, the stormwater detention basin would be placed away from the cut off wall in Lots 1 or 2. Modeling conducted in support of the GWSC IRM demonstrated that placement of an infiltration basin on Lots 1 or 2 would not have an adverse impact on the performance of the hydraulic control component of the GWSC IRM. The most feasible location for an enhanced stormwater infiltration basin is on the eastern edge of Lot 2. Soils in this area are dominated by fill materials from Willamette River dredge spoils, plant organic material, and other miscellaneous debris (ERM 2003). The fill material consists of sands with intermittent thin layers of silt and clay. Review of boring logs in the area of interest (RP-10-97 and ARK-09, AMEC 2006) indicate that soils consist primarily of medium dense, brown, fine sand between 4 and 15 ft below ground surface, which should provide for adequate infiltration rates for detention basin design. A geotechnical evaluation as well as infiltration testing will be required during remedial design and prior to final siting of the infiltration basin.

Consideration has been given for potential stormwater infiltration effects on groundwater. Given the low solubility of DDx, the majority of the DDx compounds will be associated with the particulate phase and will be filtered out or sorbed within the first few inches within the bottom of the basin. Even the portion of DDx compounds labeled "dissolved" may actually be associated with very small solids or colloidal material and will be filtered out within the vadose zone. DDx compounds that are actually dissolved within the stormwater will also be removed. Constituents with soil-water partition coefficients (K_d) greater than 100 are considered to have very low mobility (Pitt et al. 1996). K_d values can be calculated by $K_d = K_{oc} \times f_{oc}$, where K_{oc} is the octanol-water coefficient of the compounds and f_{oc} is the fraction of organic carbon in the soil (units of gram/gram). Assuming a design of $K_d>100$, the minimum necessary organic carbon content of the soil beneath the infiltration basin can be calculated for each DDx compound as follows:

- DDD, $K_{oc} = 1.00 \times 10^6$ L/kg, $f_{oc} = 0.0001$ or 0.01 percent
- DDE, $K_{oc} = 4.47 \times 10^6$ L/kg, $f_{oc} = 0.000022$ or 0.002 percent
- DDT, $K_{oc} = 2.63 \times 10^6$ L/kg, $f_{oc} = 0.000038$ or 0.004 percent.

The above calculations show that only a small amount of organic carbon is necessary for sorption of DDx compounds in stormwater, indicating that DDx compounds are extremely unlikely to reach groundwater. In addition to sorption, particulates with DDx compounds may become physically entrained and immobilized within the filter material. Any vegetation within the basin will have to be maintained, including the removal and replacement of dead vegetation, mowing grass within the basin, and the removal of any trees that interfere with the operation of the basin.

This alternative has been retained for further analysis given the restraints discussed in this section.

6.2.5 Stormwater Treatment at Ground Surface

This option would consist of diverting stormwater to drainage treatment areas, which could include one or all of the structures described below:

Vegetated or grassy swales—Vegetated/grassy swales are long narrow landscaped depressions used to collect and convey stormwater drainage, allowing DDx compounds to settle and filter out as the water infiltrates into the ground or flows from one area to the next through the facility. Treatment within the swales would include minimal infiltration of stormwater (Section 6.2.4) and filtration by vegetation; however, these treatment processes within the swales will be somewhat effective at removing Site contaminants. Vegetated or grassy swales would be highly effective for transport of water across the Site.

An additional biological treatment component that would be realized by using a grassy swale is the microbial degradation of DDx. A proven remedial technology for DDx compounds involves the sequential cycling of indigenous microbial communities from aerobic to anaerobic conditions (the Daramend Process[8]). While not as highly engineered, by its design the grassy swale will be periodically inundated with water promoting anaerobic conditions, while at other times the swale will be dry promoting aerobic conditions. This natural cycling of the microbial community conditions within the swale in conjunction with the entrapment of DDx within the fines settled in the bottom of the swale provide the optimal conditions for enhancing the natural degradation of DDx.

Operation and maintenance requirements for vegetated swales include maintaining the vegetation within the swales, removal and replacement of dead vegetation, mowing grass within the swales, and the removal of any trees that interfere with the operation of the swales. Also, the side slopes of the swales will require maintenance to prevent erosion. Finally, any areas that have a large buildup of sediment or debris will have to be cleaned out to minimize the potential of a large "flush" of DDx or other debris during very large storm events.

Given that swales will have some treatment effectiveness for DDx, they have been retained, but are not planned to be utilized as a primary treatment process. Vegetated or grassy swales will be utilized primarily for stormwater transport at the Site.

Rock-filled ditches—Rock-filled ditches are long, narrow ditches used to convey stormwater and allow DDx to settle and filter out as the stormwater flows between the rocks. The primary advantage to rock-filled ditches is that they allow for additional filtration and thus treatment.

[8] Reference Guide to Non-Combustion Technologies for Remediation of Persistent Organic Pollutants in Stockpiles and Soil, USEPA Office of Solid Waste and Emergency Response, December, 2005. http://www.clu-in.org/POPs

The primary disadvantage to using rock-filled ditches is that they would need to be significantly larger than swales to convey equivalent stormwater flows, and would therefore require a significantly larger excavation volume. Based on this disadvantage, rock-filled ditches have been retained only as a potential alternative to grassy/vegetated swales that would be evaluated and/or implemented as needed during the Remedial Design/Remedial Action phase.

Wetponds or wetlands—Wetponds/wetlands are constructed with a permanent pool of water. Stormwater drainage enters the pond at one end and displaces water from the permanent pool. DDx compounds are removed from stormwater through gravitational settling and biologic processes. Given that the permanent pool of water located within these structures will be an "attractive nuisance" for wildlife at the Site, they have been screened from further analysis.

Sedimentation basins—Sedimentation basins are designed to fill during storm events and slowly release the water over a number of hours to promote settling/sedimentation of larger particles transported during rainfall events. While some of the DDx will be associated with larger particles, it is anticipated that the majority of the DDx mass is associated with small particles within the stormwater discharge. Therefore, this technology will have limited effectiveness on the removal of DDx from stormwater discharges. Given this limitation and the fact that the slow release of water may allow the basin to have a semipermanent pool between precipitation events during the rainy season, this alternative has only been retained for further analysis as a potential pretreatment and flow control device prior to other stormwater technologies (e.g., infiltration basins).

Aboveground sand/sand-carbon filters—Aboveground sand filters reduce DDx as water filters through the sand and achieves flow control by slowing the discharge rate. DDx compounds are relatively insoluble in water and thus are most likely associated with suspended solids within stormwater drainage. Sand filters have been shown to reduce stormwater TSS concentrations by 70 to 90 percent (Claytor and Schuler 1996; USEPA 1999; Hatt et al. 2008). Sand filter TSS removal efficiencies typically decrease with decreasing influent concentration and, as typically designed for stormwater treatment, may not remove particles smaller than 10 μm. "Ripening" (the accumulation of sediment on the surface of sand filters) will actually increase the efficiency of these filters to remove smaller particles. Sand filters have been shown to remove 50 percent of colloidal (i.e., <1 μm) particles (USEPA 1999). Carbon (typically as peat moss or activated carbon) can be added to create a multi-media filter and increase sorption of aqueous phase organics as stormwater flows through the devices, similar to filtration systems found in drinking water plants. Limited studies have been conducted to determine the effectiveness of sand filters on removing DDx from stormwater discharges.

Organic sand filters (i.e., filters with a 50/50 mix of sand and either activated carbon or peat) have been shown to increase the removal efficiency of organic constituents, up to 90 percent for hydrocarbons (Claytor and Schuler 1996), 80 to 90 percent (influent concentrations from 1.2mg/L to 3.1 mg/L) for total petroleum hydrocarbons (USEPA 1999), and ~70 percent for

Dieldrin (USEPA 1999). Studies did not show any significant removal of DDT in several different filtering media types, including organic sand filters; however, influent concentrations in these studies were several orders of magnitude (~0.006 μg/L) lower than concentrations at the Site (USEPA 1999).

Proper operation of sand filters requires regular inspection and maintenance for clogging of the sand filter. Given the potential for build up and discharge of DDx on the surface of the filter media, the surface layer would be replaced on a regularly scheduled interval to minimize clogging. Other maintenance requirements include removing of debris and sediment buildup within inlet and outlet structures to maintain proper performance, vegetation that inhibits the operation of the sand filter, and dead vegetation within the sand filter.

This treatment option has been retained for further analysis.

6.2.6 In-ground Stormwater Treatment

This option would consist of installing underground treatment systems as part of the existing or a new stormwater collection system. These systems could be installed either just prior to discharge, at one or more points within the collection system, or at each of the individual catch basins prior to entering the sewer system. The following in-ground treatment systems have been evaluated.

Hydrodynamic separators—Hydrodynamic separators consist of cylindrical vessels with tangential inlet flow which spirals down the perimeter, thus causing the heavier particles to settle. This technology uses the vortex-enhanced settling mechanism (swirl-concentration) to capture settable solids, floatables, and oil and grease. The Washington State Department of Ecology has completed assessments of several types of hydrodynamic separators that can be found at http://www.ecy.wa.gov/programs/wq/stormwater/newtech. In general these systems were found to remove 80 percent of TSS of 50 μm or larger and have Washington State General Use Level Designation for pretreatment ahead of infiltration or to protect and extend the maintenance cycle of downstream treatment devices. These systems require periodic removal of trapped sediments typically using a vacuum truck.

Given that these systems will not remove the smaller sediment particles within the stormwater that will contain the highest mass of DDx, they have been screened from further analysis, except as a potential pretreatment system prior to infiltration or media filtration.

Cartridge filter systems—This technology consists of placing media in filter cartridges (typically vertical cartridges) and amending the media with materials that will improve effectiveness, including leaf compost, pleated fabric, activated charcoal, perlite, and zeolite. The system functions by routing the stormwater through the filtering or sorbing medium, which traps particulates and/or dissolved DDx. The type of media as well as the design flow through

rate and media particle size can be adjusted to achieve very high removal rates of DDx. Reported removal efficiencies for these systems can vary widely depending on the type of filter media used, the flowrate through individual cartridges, and influent concentrations. Typical reported removal efficiencies are similar to those for carbon-sand filters discussed above; however, media type and flowrate can be modified to meet very stringent removal requirements.

This treatment option is retained for further analysis.

In-vault or linear sand and/or multi-med filters—This system is similar to the aboveground sand/carbon filters with the only exception that filtration media is stored within a vault below the ground surface. Design parameters and treatment efficiencies are similar to those of an above ground system. This treatment option is retained for further analysis.

Structural detention facilities—Structural detention facilities such as tanks, vaults, and oversized pipes provide underground storage of stormwater as part of a drainage flow control system. These facilities must be designed not only for their function, but also to withstand the subsurface environment, including potential groundwater submersion, potentially corrosive chemical and/or electrochemical soil conditions, and surface loadings. Given the potential size of these facilities to control stormwater flows and the need to excavate large quantities of soils for their installation, these facilities have been screened from further analysis. Their use may be considered on a limited/local basis for flow control during the design process.

6.3 DEVELOPMENT OF STORMWATER INTERIM REMEDIAL MEASURE ALTERNATIVES

Treatment of DDx in Site stormwater will require the combination of multiple treatment options. The primary retained stormwater treatment process options include abandonment/replacement of existing storm sewer system, soil capping, enhanced stormwater infiltration, and multi-media filters (sand, sand-carbon, and/or cartridges) that could be located either above ground or in-ground. Several process options were retained on a limited basis for potential pre-treatment. These options include sedimentation basins, hydrodynamic separators, and structural detention facilities. The retained treatment options were combined into three Site-wide alternatives:

- Alternative 1. Surface Soil Capping and Collection System Decommissioning/Outfall Consolidation with Channelized Overland Flow.
- Alternative 2. Surface Soil Capping of "Hot Spots," Collection System Decommissioning/Outfall Consolidation and Replacement with a New Sewer System with In-Ground Treatment

- Alternative 3. Collection System Decommissioning/Outfall Consolidation, Surface Soil Capping of "Hot Spots," and Enhanced Stormwater Infiltration and Treatment Prior to Discharge.

The development of the Site-wide alternatives includes a feasibility-level design of each alternative for the given design storm. While early efforts in stormwater management have typically focused on flood events ranging from the 2- to 100-year storm, there is increasing recognition that small storms dominate watershed hydrologic parameters typically associated with water quality management issues (EPA/600/R-04/121 *Stormwater Best Management Practice Design Guide*). Further, while large storms may contain significant chemical constituent loads, their contribution to the average annual chemical load is quite small due to their infrequent nature. Thus, designing water quality treatment for these large storm events is not reasonable for the Stormwater IRM. The selected IRM, however, must be able to accommodate larger stormwater flow volumes without failing. For these reasons, the design storm used for water quality treatment is different from the design storm used for hydrologic control in this FFS as described below.

For water quality treatment design, the City of Portland design guidelines (BES 2004) will be used to treat roughly 90 percent of the average annual runoff. Flow rate-based pollution reduction facilities will be designed to treat runoff generated by a rainfall intensity of 0.19 in. per hour (depending on the time of concentration). Flow volume-based facilities will be designed to treat runoff generated by 0.83 in. of rainfall over 24 hours.

For hydraulic design, each of the IRM FFS alternatives considered will be designed to accommodate the 25-year, 24-hour design storm of 3.9 in. (BES 2004).

6.3.1 Alternative 1. Surface Soil Capping and Collection System Decommissioning/Outfall Consolidation with Channelized Overland Flow.

Alternative 1 consists of the following components (Figure 6-2).

Abandonment of the existing stormwater system—Approximately 14,000 LF of the existing stormwater collection system would be abandoned in general accordance with the City of Portland's Sewer Drainage and Design Manual requirements for the abandonment of public collection systems and the City of Portland's standard specifications for municipal construction. The system would be abandoned in place by filling pipelines with sand and plugging them with grout at manholes. All manholes will be filled with pea gravel and compacted. The abandonment would deviate from the City of Portland's requirements in that catch basins and manholes would not be removed to a minimum of 3 ft below finished grade in order to minimize the disturbance of soils. In lieu of this requirement, all structures would be filled with concrete to a depth of 1 ft below grade.

Surface transport of stormwater drainage—Several vegetated swales will be used to collect and transport stormwater from the Site to the Willamette River in Lots 3 and 4 (Figure 6-2). Swales will be designed to convey the 25-year, 24-hour design storm (Appendix C-1 provides preliminary design calculations). It is anticipated that stormwater discharge from these lots will not require treatment prior to discharge.

Further, soil berms (approximately 1 ft in height) will be located on the southern boundaries of the existing defined drainage basins for Outfalls 001 through 004. These berms will be located to minimize overland flow off-site.

Stormwater will either be discharged utilizing new, rip-rap protected outfalls, or would be routed to existing outfalls for discharge.

Soil stabilization and on-site disposal—Approximately 2,500 yd^3 of soil would be excavated to construct the vegetated swales utilized for stormwater transport. Excavated soil would be contained on-site by stock piling within the pervious areas that will be capped with topsoil and vegetated (see below). Stockpiles will have 2 percent slope to minimize erosion but allow drainage.

Surface soil capping—All pervious areas within the current drainage basins for outfalls 001, 002, 003, and 004 will be capped with 6 in. of topsoil and vegetated. Impervious areas would undergo maintenance, including the sealing of any cracks within the asphalt and potentially repaving severely deteriorated areas.

As part of the adaptive management approach, if stormwater discharges do not meet anticipated mass loading reductions, sedimentation basins and/or hydrodynamic separators followed by sand/sand-carbon or cartridge filters could be installed at the downgradient portion of the swales to enhance stormwater treatment. Existing stormwater outfalls could then be utilized to discharge treated stormwater. The addition of these latter contingency items was not considered in the evaluation of the cost of Alternative 1.

Appendix C-1 presents preliminary design calculations for this system.

6.3.2 Alternative 2. Surface Soil Capping of "Hot Spots," Collection System Decommissioning/Outfall Consolidation, and Replacement with a New Sewer System with In-Ground Treatment

Alternative 2 consists of the following components (Figure 6-3).

Abandonment of the existing stormwater system—A portion of the existing stormwater collection system would be abandoned as described in Alternative 1. Some components of the existing stormwater collection system would be incorporated into the new stormwater collection system.

Replacement with a new, shallow system—Existing catch basins would be used to capture stormwater, and approximately 8,000 LF of new stormwater collection system would be installed to replace the abandoned stormwater collection system. Stormwater collection systems discharging to Outfalls 001, 002, and 003 would be rerouted to discharge to Outfall 004. Figure 6-3 presents a conceptual layout of the new stormwater collection system. This system would require the excavation of approximately 2,500 yd^3 of soil. Soil would be contained on-site by stockpiling with a 2 percent slope to minimize erosion and allow drainage, placing a geotextile over the stock pile for demarcation and capping with 6 in. of compacted soil.

Further, soil berms (approximately 1 ft in height) will be located on the southern boundaries of the existing defined drainage basins for Outfalls 001 through 004. These berms will be located to minimize overland flow off site.

"Hot Spot" surface soil capping—All areas within the current drainage basins for outfalls 002 and a portion of the drainage basin discharging to Outfall 001 would be capped with new asphalt (pervious areas) or will undergo maintenance, including the sealing of any cracks within the asphalt and potential re-paving of severely deteriorated areas.

In-ground treatment—Stormwater collected from the former plant area would undergo in-ground treatment. Conceptually stormwater treatment would be located at multiple points throughout the collection system (Figure 6-3). It is anticipated that in addition to flow control with structural detention vaults, all stormwater would pass through a sand/sand-carbon filter followed by a polishing cartridge filter system. To minimize the size of the polishing cartridge filter system, it would not be sized to treat the entire water quality design storm.

The treatment systems would require the excavation of approximately 6,000 yd^3 of soil. Soil would be contained on-site by stockpiling with a 2 percent slope to minimize erosion and allow for drainage, placing a geotextile over the stock pile for demarcation, and capping with 6 in. of compacted soil.

Appendix C-2 presents preliminary design calculations for this system.

6.3.3 Alternative 3. Collection System Decommissioning/Outfall Consolidation, Surface Soil Capping of "Hot Spots," and Enhanced Stormwater Infiltration and Treatment Prior to Discharge

Alternative 3 consists of the following components (Figure 6-4).

Abandonment of the existing stormwater system—The existing stormwater collection system would be abandoned as described in Alternative 1. Although Outfall 004 would be retained as the discharge outfall.

Vegetated swales—Several vegetated swales would be used to collect and transport stormwater drainage from the Lots 3 and 4 to Lot 2 where treatment would occur (Figure 6-4). The swales would require the excavation of approximately 3,500 yd^3 of soils. These soils would be contained on-site by stockpiling with a 2 percent slope to minimize erosion and allow for drainage, placing a geotextile over the stockpile for demarcation and capping with 6 in. of compacted soil.

Further, soil berms (approximately 1 ft in height) will be located on southern boundaries of the existing defined drainage basins for Outfalls 001 through 004. These berms will be located to minimize overland flow off site.

Infiltration basin—A portion of the stormwater would be infiltrated at the eastern edge of Lot 2. Based on preliminary estimates (Appendix C-3), approximately 90 percent of the Site water quality treatment volume (determined by the water quality design storm) could be infiltrated at the Site. This system would require the excavation of approximately 12,000 yd^3 of soils. These soils would be contained on-site by stockpiling with a 2 percent slope to minimize erosion and allow for drainage, placing a geotextile over the stockpile for demarcation and capping with 6 in. of compacted soil.

"Hot Spot" capping—Hot spot capping will be conducted as described in Alternative 2.

Above ground treatment—The remaining water from the water quality design storm (post-infiltration) would receive treatment via sand/sand-carbon filtration (either above or below ground) similar to the sand/sand-carbon filtration as described in Alternative 2. This system would require the excavation of approximately 200 yd^3 of soil. These soils would be contained on-site by stockpiling with a 2 percent slope to minimize erosion and allow for drainage, placing a geotextile over the stockpile for demarcation and capping with 6 in. of compacted soil.

Appendix C-3 presents preliminary design calculations for this system.

6.4 EVALUATION OF STORMWATER INTERIM REMEDIAL MEASURES ALTERNATIVES

Per the JSCS, this FFS has been developed in general accordance with the CERCLA EE/CA process (USEPA 1993) as an IRM to implement source control at the Site. EPA's *Conducting Non-Time-Critical Removal Actions Under CERCLA* sets forth the following criteria to be used to evaluate remedial action alternatives. Table 6-1 presents a summary of the evaluation.

6.4.1 Evaluation Criteria

6.4.1.1 Effectiveness

This factor evaluates the alternative's ability to meet RAOs. This evaluation considers the magnitude of risk from untreated waste or treatment residuals, incorporating their volume, toxicity, mobility, and tendency to bioaccumulate or degrade. It also addresses the adequacy of engineering and institutional controls needed to manage the potential risk, and assesses the time until the treatment objectives would be met.

6.4.1.2 Implementability

This factor evaluates the practical, technical, and legal feasibility of constructing and operating the alternatives. It also addresses the ease of implementation, monitoring considerations, and the availability of required goods and services. Consistency with governmental requirements and the need for appropriate authorization are also considered.

6.4.1.3 Reasonableness of Cost

This factor evaluates the capital and operation and maintenance (O&M) costs of each alternative. Direct capital costs could include construction, equipment, land and site development, buildings, services, relocation expenses, and disposal. Indirect capital costs could include engineering expenses, license or permit fees, and start-up and contingency allowances. Annual O&M costs could include operating labor, maintenance materials and labor, auxiliary materials and energy, disposal of residues, purchased services, administration, insurance, taxes, licensing, maintenance reserve and contingency funds, rehabilitation, and periodic review requirements and performance monitoring. The costs for each alternative used a 10-year time frame as a consideration that this is an IRM, and a final site remedy should, at a maximum, be implemented within the next 10 years.

6.4.2 Alternative 1. Surface Soil Capping and Collection System Decommissioning/Outfall Consolidation with Channelized Overland Flow

Alternative 1 consists of capping with soil, revegetating all of the pervious areas, and repairing the asphalt cap on all of the impervious areas in the drainage basins that discharge through the existing four outfalls at the Site. The existing stormwater collection system would be abandoned and replaced with surface vegetated swales that would route stormwater drainage to the Willamette River. Annual O&M would include mowing the vegetated portion of the cap, inspecting of the structural integrity of all capped areas and repairing any structural defects. Stormwater discharge monitoring would also be conducted to assess the performance of the IRM.

Effectiveness

This alternative would be effective at meeting the Site RAOs set for the stormwater IRM. The potential source of subsurface DDx in the current stormwater system would be eliminated by the abandonment of the existing stormwater collection system. Potential surface sources of DDx to stormwater within the four previously defined drainage basins would be reduced by physically isolating potentially DDx-containing soils within these areas from stormwater drainage.

Implementability

The technology to implement this alternative is readily available. The soil and asphalt cap could be compromised during later construction activities, and therefore may not be compatible with the final site remedy and site use. Also, surface swales may limit access to portions of the site during the implementation of the final site remedy.

Cost

The capital cost for this alternative is approximately $2.1 million. The annual O&M cost for this alternative is approximately $50,000. The 10-year present value for this alternative is approximately $2.5 million. Detailed costs are presented in Appendix C-4.

6.4.3 Alternative 2. Surface Soil Capping of "Hot Spots," Collection System Decommissioning/Outfall Consolidation, and Replacement with a New Sewer System with In-Ground Treatment

Alternative 2 consists of capping with soil and revegetating and repairing the asphalt cap in the areas with the highest DDx concentrations in drainage basins that discharge through Outfalls 001 and 002 at the Site. The existing stormwater collection system would be abandoned and replaced with a new collection system that discharges following treatment through existing Outfall 004. Discharged stormwater would undergo flow control via detention vaults and treatment via an in-ground sand-carbon (peat or activated carbon) filter vault. Annual O&M would include mowing the vegetated portion of the cap; inspecting the structural integrity of all capped areas and repairing any structural defects; replacing cartridge filters; and removing, disposing of, and replacing the top 6 in. of the sand/sand-carbon filters. Stormwater discharge monitoring would also be conducted to assess the performance of the IRM.

6.4.3.1 Effectiveness

This alternative would be moderately effective at meeting the Site RAOs set for the stormwater IRM. The potential source of subsurface DDx in the current stormwater system would be eliminated by the abandonment of existing stormwater collection system. A portion of the potential surface sources would be eliminated by physically isolating surface soils from stormwater drainage in the areas containing the highest concentrations of DDx. The remainder

of stormwater drainage potentially containing Site DDx would be treated with a combination of structural detention basins, sand-carbon filters, and cartridge filters.

Implementability

The technology to implement this alternative is readily available. The installation of collection and treatment systems will require a large amount of soil excavation. Column tests could be conducted with Site stormwater and potential filtration media for refinement of the design of the sand-carbon filters.

Cost

The capital cost for this alternative is approximately $1.9 million. The annual O&M cost for this alternative is approximately $40,000, but it increases to approximately $55,000 every 2 years to replace the top 6 in. of the sand-carbon filters. The 10-year present value for this alternative is approximately $2.3 million. Detailed costs are presented in Appendix C-4.

6.4.4 Alternative 3. Collection System Decommissioning/Outfall Consolidation, Surface Soil Capping of "Hot Spots," and Enhanced Stormwater Infiltration and Treatment Prior to Discharge.

Alternative 3 consists of capping with soil and revegetating and repairing the asphalt cap in the areas with the highest DDx concentrations in drainage basins that discharge through Outfalls 001 and 002. The existing stormwater collection system would be abandoned and replaced with a surface swale collection system. A portion of the stormwater would be infiltrated, while the remaining stormwater would undergo treatment via an above-or below ground sand-carbon (peat or activated carbon) filter and discharge through existing Outfall 004. Annual O&M would include mowing the vegetated portion of the cap, inspecting the structural integrity of all capped areas, and repairing any structural defects.

A preliminary conservative evaluation was conducted to evaluate the possibility of DDx build up within the infiltration basin and possible effects on groundwater (Appendix B). Based on EPA's soil screening guidance migration to ground pathway (USEPA 1996), the earliest topsoil replacement could potentially occur is after 40+ years of basin operation. However, performance of the infiltration basin would include monitoring which could include stormwater discharge monitoring and, sampling of a monitoring well downgradient of the infiltration basin to ensure DDx is not adversely impacting groundwater quality.

6.4.4.1 Effectiveness

This alternative would be effective at meeting the Site RAOs set for the stormwater IRM. The potential source of subsurface DDx in the current stormwater system would be eliminated by the abandonment of existing stormwater collection system. A portion of the potential surface sources would be eliminated by physically isolating surface soils from stormwater drainage in

the areas containing the highest concentrations of DDx. Also, a substantial portion of stormwater drainage could be infiltrated. The remaining stormwater drainage, potentially containing DDx, would be treated with a combination of sand, sand-carbon filters, and/or cartridge filters.

6.4.4.2 Implementability

The technology to implement this alternative is readily available. The siting and sizing of the infiltration basin will require a geotechnical evaluation and infiltration testing. This could lead to either an increase or decrease in the size of the infiltration basin, and ultimately to the amount of water that could be infiltrated. Column tests could be conducted with Site stormwater and potential filtration media for refinement of the design of the sand-carbon filters.

Cost

The capital cost for this alternative is approximately $1.2 million. The annual O&M cost for this alternative is approximately $42,000 and increases to approximately $43,000 every 2 years to removed, dispose, and replace the top 6 in. of the sand/carbon filters. Also, assuming the top 12-inches of the infiltration basin must be removed, disposed of, and replaced every 5 years, the 5 year and 10 year annual costs increase to $55,000 and $56,000, respectively. The 10-year present value for this alternative is approximately $1.6 million. Detailed costs are presented in Appendix C-4.

7 RECOMMENDED ALTERNATIVE

Based upon the results of the evaluation in Section 4.3 and absent the need to modify the existing stormwater collection system in advance of the EE/CA, the Arkema Site is a low priority Site in terms of the need to implement stormwater source control measures. The Arkema Site contributes less than 1 ounce of DDx per year to the Willamette River via the stormwater pathway. Whereas, at least 13.4 pounds on average of DDx as calculated at RM 11 is transported by the Willamette River annually past the Arkema Site as its base load. Nonetheless, based on the need to reconfigure Arkema's stormwater system in advance of the EE/CA and results of the screening in Section 6.4, Alternative 3 is selected as the recommended alternative. Alternative 3 provides a high level of effectiveness, is easily implementable, and is the most cost effective alternative.

This alternative could be implemented in advance or in conjunction with the implementation of the planned groundwater IRM. The existing stormwater collection system would be abandoned prior to the installation of the groundwater cut-off wall, while new stormwater conveyances and treatment systems could be constructed prior to the installation to the groundwater IRM or on a parallel track with the installation of the groundwater IRM. Both the groundwater IRM and the stormwater IRM would be implemented prior to the implementation of any sediment remedial actions performed under the EE/CA.

Figure 7-1 presents a preliminary schedule for the implementation of the IRM. A modification of the current NPDES permit may be required; however, permitting requirements may be alleviated somewhat given that an existing stormwater outfall (Outfall 004) would continue to be utilized for stormwater discharge. This alternative is also amenable to an adaptive management approach and could be fairly easily modified by adding or modifying treatment.

Alternative 3 could be easily integrated into the final site remedy as the infiltration basin and/or the filtration basin could be incorporated into stormwater management for the final remedy. Further, this alternative minimizes the area of surface soils that would require either capping (Alternative 1) or containment (Alternative 2). The final site remedy may require further management of these soils to meet overall site RAOs. Thus, this alternative also minimizes the amount of rehandling and management of potentially contaminated soils and duplicative efforts and costs.

8 REFERENCES

AMEC. 2006. Stage 1 Source Control Evaluation Technical Memorandum. Prepared by AMEC Earth & Environmental, Inc. Submitted to Oregon Department of Environmental Quality, May 19, 2006.

Arkema. 2005. Stormwater Characterization Report, Portland Plant. Arkema Inc., 6400 NW Front Ave., Portland, OR.

BES. 2004. City of Portland Stormwater Management Manual. City of Portland, Bureau of Environmental Services. Adopted July 1, 1999; revised September 1, 2004.

Claytor, R. A. and T. R. Schueler. 1996. Design of Stormwater Filtering Systems. http://www.mckenziewaterquality.org/documents/sotmrwater_filtering_system_design.pdf. Prepared for Chesapeake Research Consortium, Inc. with supplemental funding by EPA, Region 5.

DEQ. 2002. Default background concentrations for metals. Internal DEQ memorandum from the Toxicology Workgroup to DEQ Cleanup Project Managers. October 28, 2002.

DEQ. 2005. Portland Harbor joint source control strategy, final December 2005. http://www.deq.state.or.us/lq/cu/nwr/PortlandHarbor/jointsource.htm. Prepared by Oregon Department of Environmental Quality and U.S. Environmental Protection Agency, Portland, OR. December 2005.

ERM. 2001. Interim Remedial Measures Implementation Report, ATOFINA Facility, Portland, Oregon. Prepared for ATOFINA Inc., Portland, OR. ERM-West, Inc., Portland, OR.

ERM. 2002. Phase II Soil Interim Remedial Measure, Arkema, Inc., 6400 NW Front Street, Portland, Oregon. Prepared for Arkema, Inc., Portland, OR. ERM-West, Inc., Portland, OR.

ERM. 2003. Environmental Summary Report, Lots 1 and 2, ATOFINA Chemicals, Inc., Portland, OR. Prepared for ATOFINA Inc., Portland, OR. ERM-West, Inc., Bellevue, WA.

ERM. 2005. Upland Remedial Investigation Report Lots 3 & 4 and Tract A - Revision 1. Prepared for Arkema Inc., Portland, OR. ERM-West, Portland, OR.

ERM. 2008. Groundwater Source Control Interim Remedial Measure, DRAFT Focused Feasibility Study. Prepared for Legacy Site Services, LLC. ERM-West, Inc., Portland, OR. May 2008.

Hatt, B.E., Fletcher, T.D., and A. Deletic. 2008. Hydraulic Pollutant Removal Performance of Finer Media Filtration Systems. *Environ. Sci. Technol.* 42(7): 2535–2541.

Integral. 2006a. Stormwater interim remedial measure work plan, former Arkema Portland Facility, Portland, Oregon. Prepared for Legacy Site Services, Exton, PA. Integral Consulting Inc., Broomfield, CO.

Integral. 2006b. JSCS document outline and rationale technical memorandum. Prepared for Legacy Site Services, Exton, PA. Integral Consulting Inc., Portland, OR.

Integral. 2006c. Portland Harbor RI/FS. Round 3 January 2006 High-Flow Surface Water Field Sampling Report. Prepared for the Lower Willamette Group, Portland, OR. Integral Consulting Inc., Portland, OR. March 27, 2006.

Integral. 2006d. Portland Harbor RI/FS. Round 2A Surface Water Site Characterization Summary Report. Prepared for the Lower Willamette Group. Integral Consulting Inc., Portland, OR. April 24, 2006.

Integral. 2007a. Stormwater Interim Remedial Measures Field Sampling and Data Report. Prepared for Legacy Site Services LLC. Integral Consulting Inc., Portland, OR.

Integral. 2007b. Portland Harbor RI/FS. Round 3A Fall 2006 Stormwater Surface Water Event Field Sampling Report. Prepared for the Lower Willamette Group, Portland, OR. Integral Consulting Inc., Portland, OR. January 15, 2007.

Integral. 2007c. Portland Harbor RI/FS. Round 3A Low-Flow and Stormwater-Impacted Surface Water Data Report. Prepared for the Lower Willamette Group, Portland, OR. Integral Consulting Inc., Portland, OR. May 21, 2007.

Integral. 2007d. Portland Harbor RI/FS. Round 3A Winter 2007 High-Flow Surface Water Data Report. Prepared for the Lower Willamette Group, Portland, OR. Integral Consulting Inc., Portland, OR. October 15, 2007.

Integral. 2008a. DRAFT Human Health Risk Assessment Arkema Site: Upland Areas. Prepared for Legacy Site Services LLC. Integral Consulting Inc., Portland, OR.

Integral. 2008b. DRAFT Arkema Upland Level II Screening Ecological Risk Assessment. Prepared for Legacy Site Services LLC. Integral Consulting Inc., Portland, OR.

LSS. 2007. Personal communication (letter to Bob McCoy, Oregon Department of Environmental Quality, Portland, Oregon, dated December 14, 2007, regarding NPDES Permit No. 100752 at the Arkema Portland Site). Legacy Site Services LLC, Exton, PA.

LSS. 2008a. Personal communication (letter to Matt McClincy, Oregon Department of Environmental Quality, Portland, Oregon, dated March 18, 2008, regarding response to DEQ

and EPA comments on the stormwater FFS outline at the Arkema Portland Site). Legacy Site Services LLC, Exton, PA.

LSS. 2008b. Personal communication (letter to Matt McClincy, Oregon Department of Environmental Quality, Portland, Oregon, dated March 25, 2008, regarding the No. 4 storm sewer manhole abandonment at the former Arkema Portland Plant). Legacy Site Services LLC, Exton, PA.

LWG. 2007. Round 3A Upland Stormwater Sampling, Field Sampling Report, Portland Harbor RI/FS, Portland, OR. Prepared by Lower Willamette Group, Portland, OR.

McClincy, M. 2007a. Personal communication (letter to Todd Slater, Legacy Site Services, Inc., Exton, PA, dated January 22, 2007, regarding comments on technical memorandum prepared by Integral Consulting Inc. for the JSCS screening document outline for the Arkema Portland Plant). Oregon Department of Environmental Quality, Portland, OR.

McClincy, M. 2007b. Personal communication (letter to Todd Slater, Legacy Site Services, Inc., Exton, PA, dated November 27, 2006, regarding DEQ comments on the stormwater IRM FFS outline provided in Appendix F of the stormwater IRM field sampling and data report prepared by Integral Consulting Inc for the Arkema Portland Plant). Oregon Department of Environmental Quality, Portland, OR.

McClincy, M. 2007c. Personal communication (letter to Todd Slater, Legacy Site Services, Inc., Exton, PA, dated December 6, 2007, regarding EPA comments on the stormwater IRM FFS outline provided in Appendix F of the stormwater IRM field sampling and data report prepared by Integral Consulting Inc for the Arkema Portland Plant). Oregon Department of Environmental Quality, Portland, OR.

McClincy, M. 2008. Personal communication (letter to Todd Slater, Legacy Site Services, Inc., Exton, PA, dated May 2, 2008, regarding the No. 4 sewer manhole abandonment for the Arkema Portland Plant). Oregon Department of Environmental Quality, Portland, OR

Pitt, R., S. Clark, K. Parmert, and R. Field. 1996. *Groundwater Contamination from Stormwater Infiltration*. Ann Arbor Press, Inc. Chelsea, MI. 1996.

Portland Development Commission. 2004. Willamette industrial urban renewal report. Portland Development Commission, Portland, OR. 18 pp. October 27, 2004.

Schueler, T. 1987. *Controlling urban runoff, a practical manual for planning and designing urban best management practices.* Prepared for the Metropolitan Washington Council of Governments, Washington, DC.

USEPA. 1993. Conducting non-time-critical removal action under CERLCA. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Publication 9360.0-32-FS. EPA/540/F-94/009. December 1993.

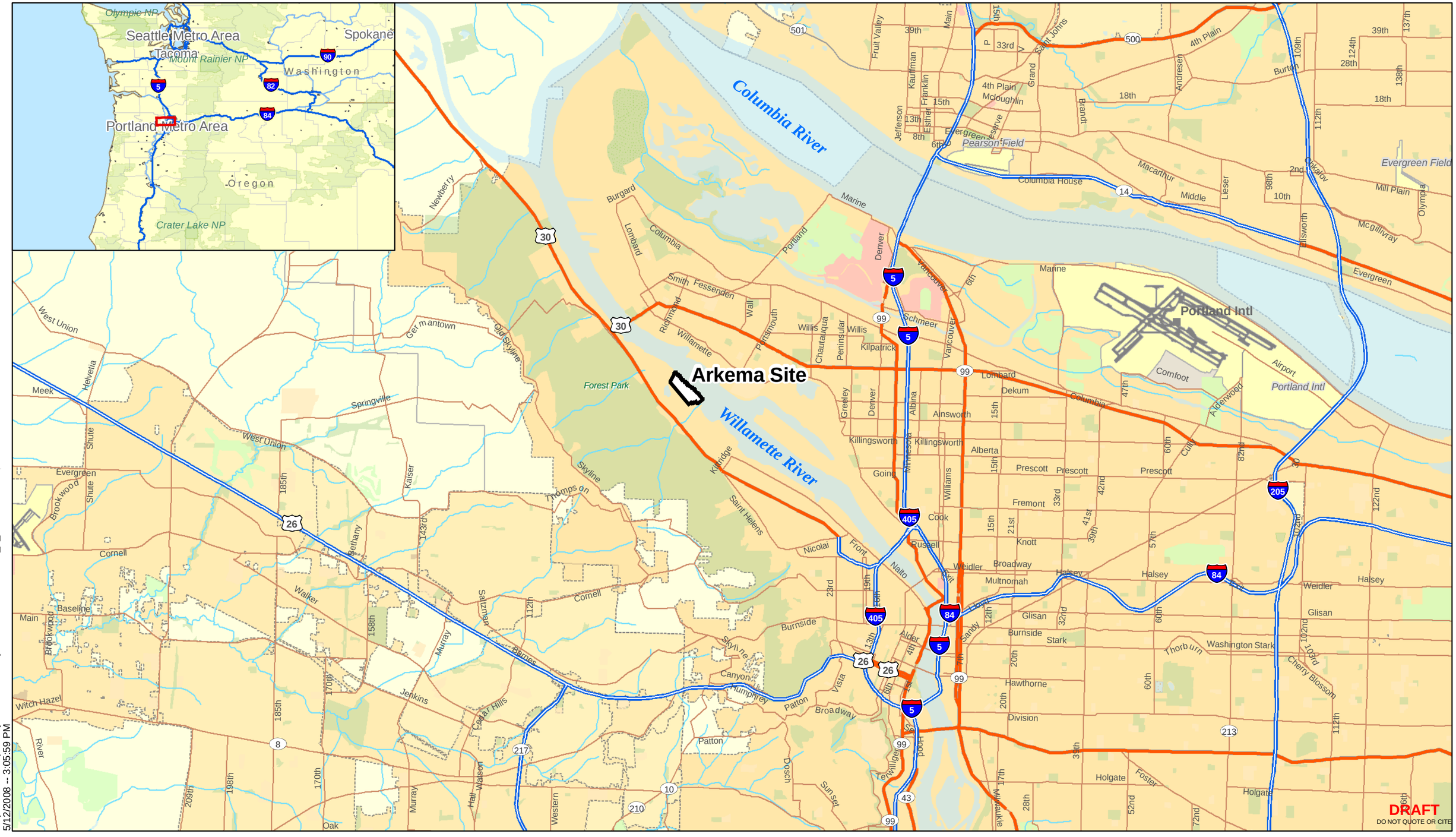
USEPA. 1996. Soil screening guidance: User's guide. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Publication 9355.4-23. July 1996.

USEPA. 1999. Stormwater treatment at critical areas, evaluation of filtration media. U.S. Environmental Protection Agency. Publication EPA/600/R-00/010. July 1999.

USEPA. 2005. Personal communication (letter to Jim McKenna and Bob Wyatt regarding Portland Harbor Superfund site; administrative order on consent for remedial investigation and feasibility study; Docket No. CERCLA-10-2001-0240 Conceptual Site Model Update). U.S. Environmental Protection Agency, Portland, OR.

USEPA. 2008. Storm water management model, Version 5.0. U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Water Supply and Water Resource Division. EPA/600/R-05/040. (http://www.epa.gov/ednnrmrl/models/swmm/index.htm)

FIGURES



Map Document: (P:\Projects\Arkema-Oly\stormwater\mxd\FIG2_1_05122008.mxd)
5/12/2008 -- 3:05:59 PM

integral consulting inc.

N

0 0.5 1 2
Miles

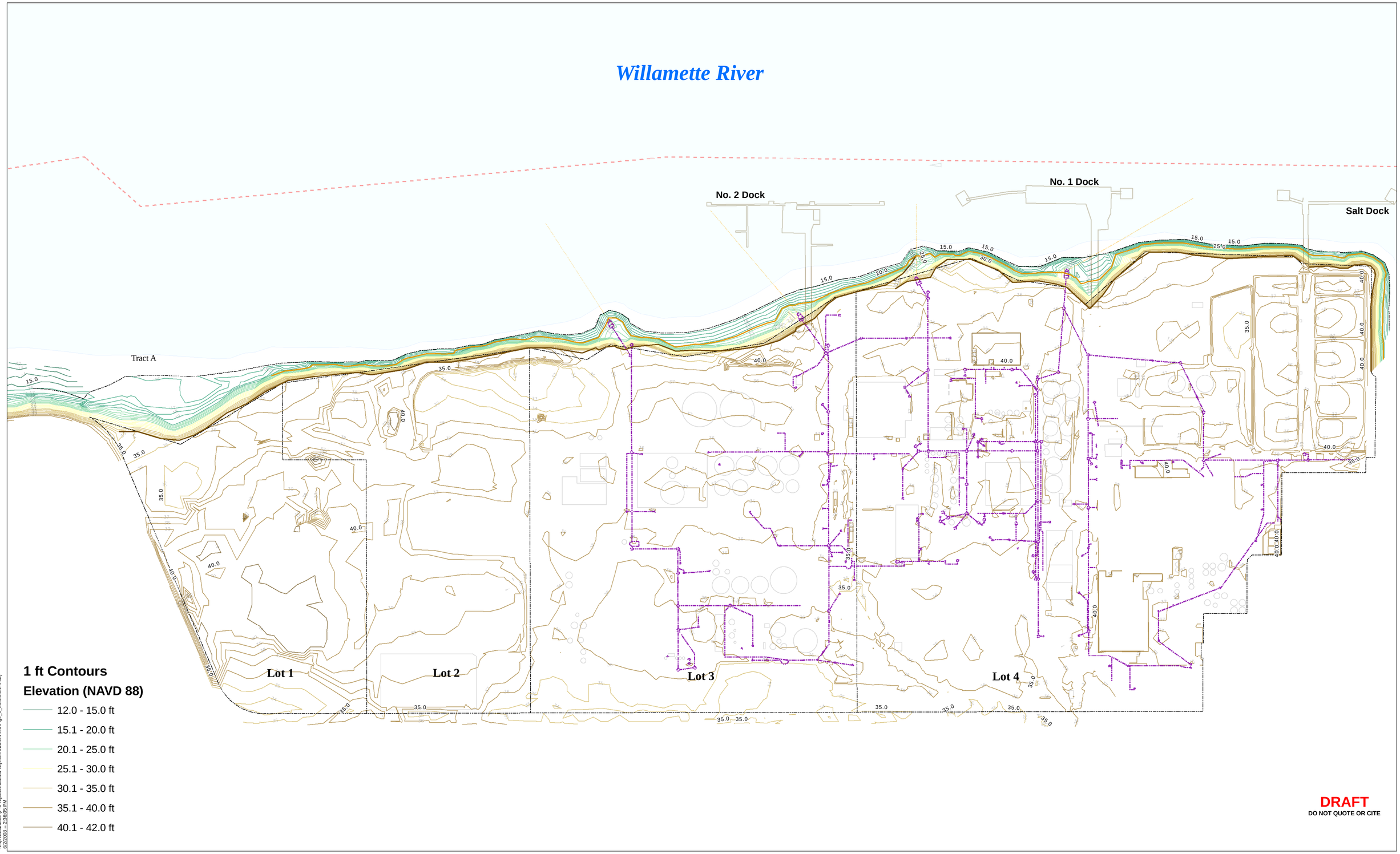
Figure 2-1
Vicinity Site Map

Map Document: (P:\Projects\Arkema-Oly\stormwater\mxd\StormWater_05062008\Fig2_2_20080512.mxd)
5/27/2008 -- 2:34:05 PM

integral consulting inc.

0 0.1 0.2
Miles

Figure 2-2
Aerial Photograph and Adjacent Properties



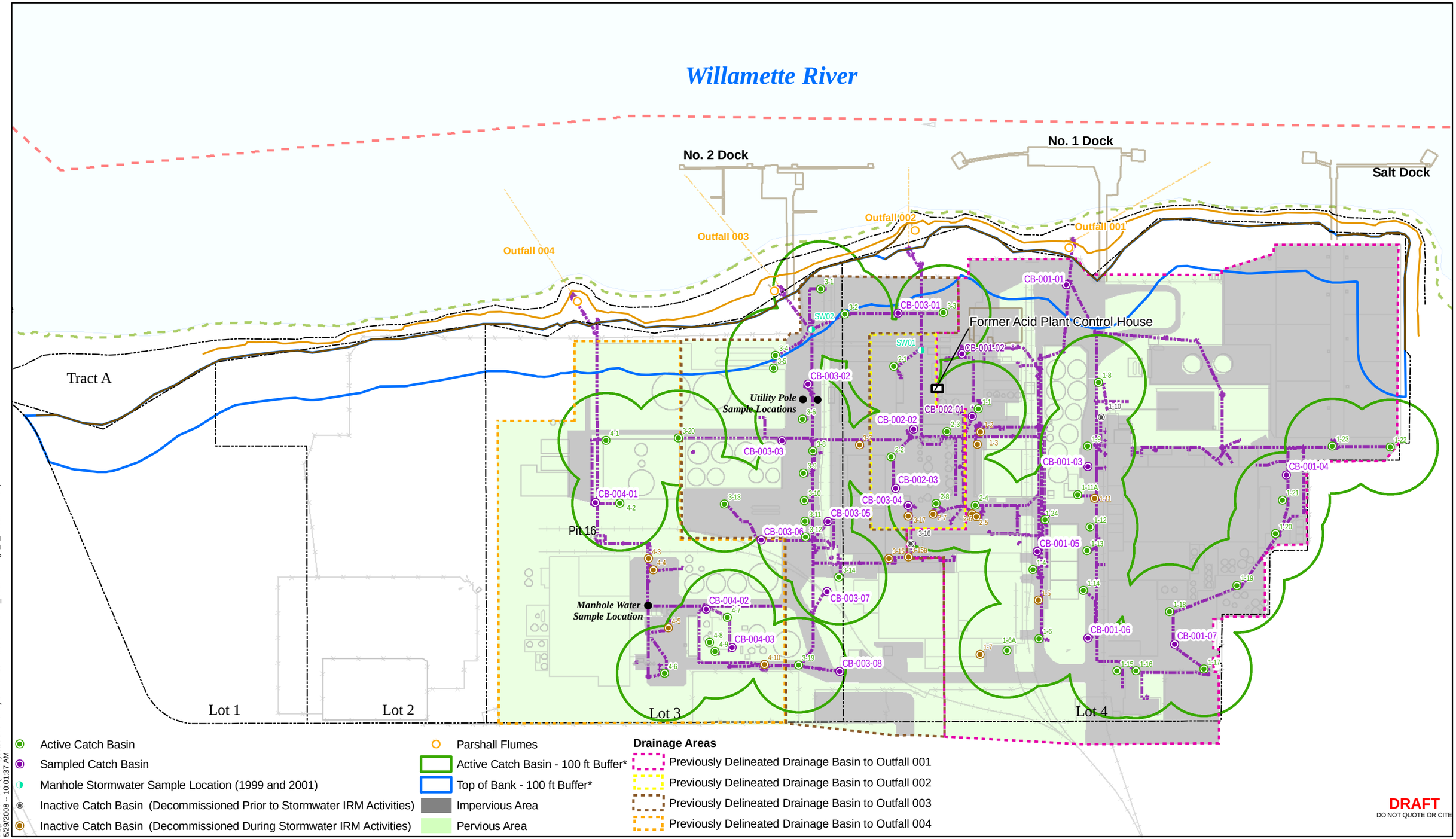
integral consulting inc.

N

0 80 160 320
Feet

River
Ordinary High Water (20.46 ft NAVD)
Top of Bank
Existing Stormwater Sewer System
Navigation Channel
Property and Lot Boundaries

Figure 2-3
Topographic Map of the Site



integral consulting inc.

0 100 200
Feet

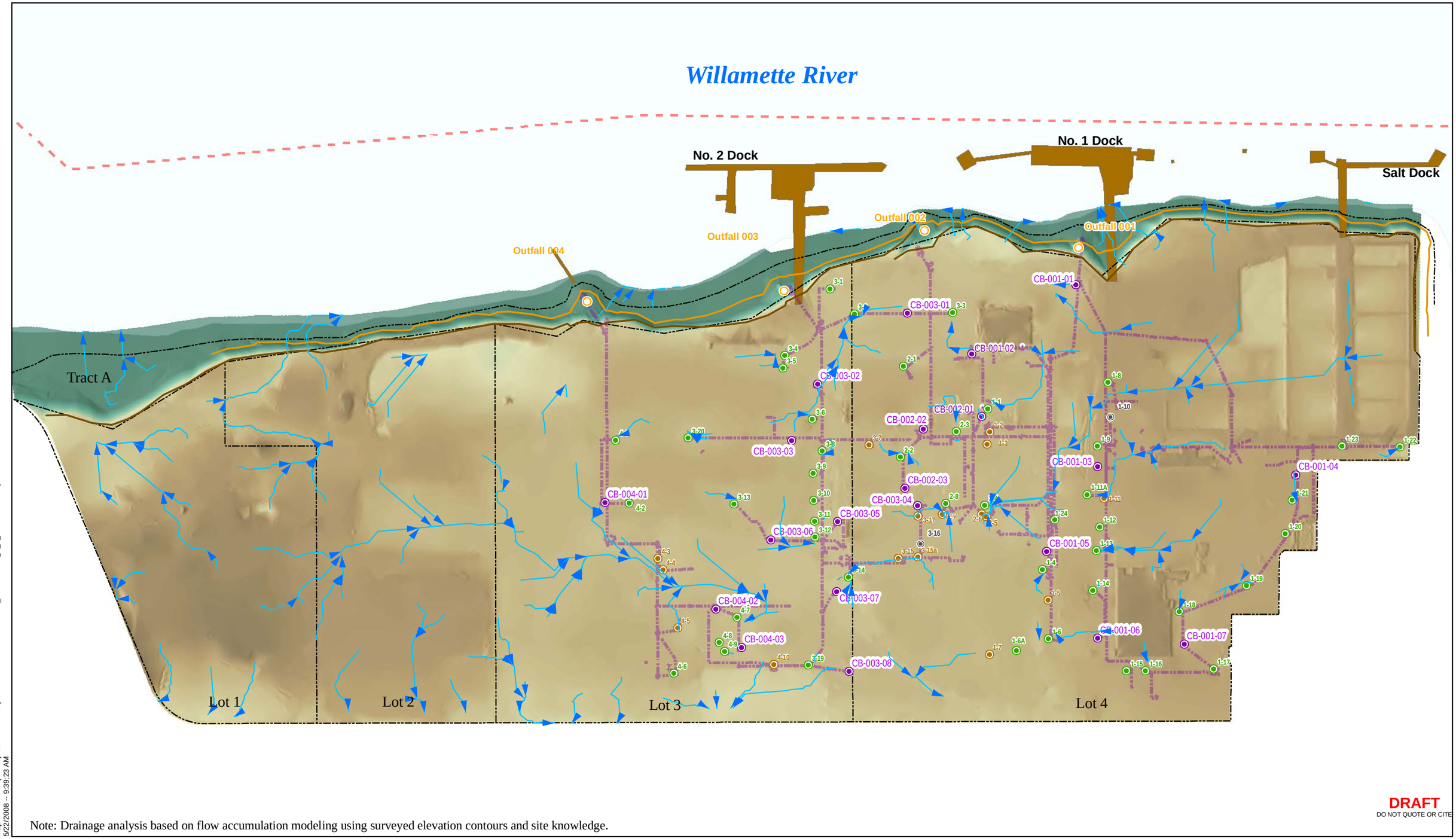
Existing Stormwater Sewer System
Existing Stormwater Discharge Diffusers
12 ft Contour
Navigation Channel
River
Ordinary High Water
Top of Bank

*Buffer Zone is per JSCS guidance document (DEQ 2005).

Catch Basin Sampled
Outfall Number
CB-004-01
CB-004-01
Station
* Sampled Catch Basin Inactive (Outlet Pipes Plugged Prior to Stormwater IRM Activities)

Catch Basin Not Sampled
Outfall Number
3-12
Station

Figure 2-4
Outfall and Catch Basin Locations



Map Document: (P:\Projects\Arkema-Oly\stormwater\mxd\StormWater_05062008\Fig2_4_20080522.mxd)
5/22/2008 -- 9:39:23 AM

Note: Drainage analysis based on flow accumulation modeling using surveyed elevation contours and site knowledge.

integral consulting inc.

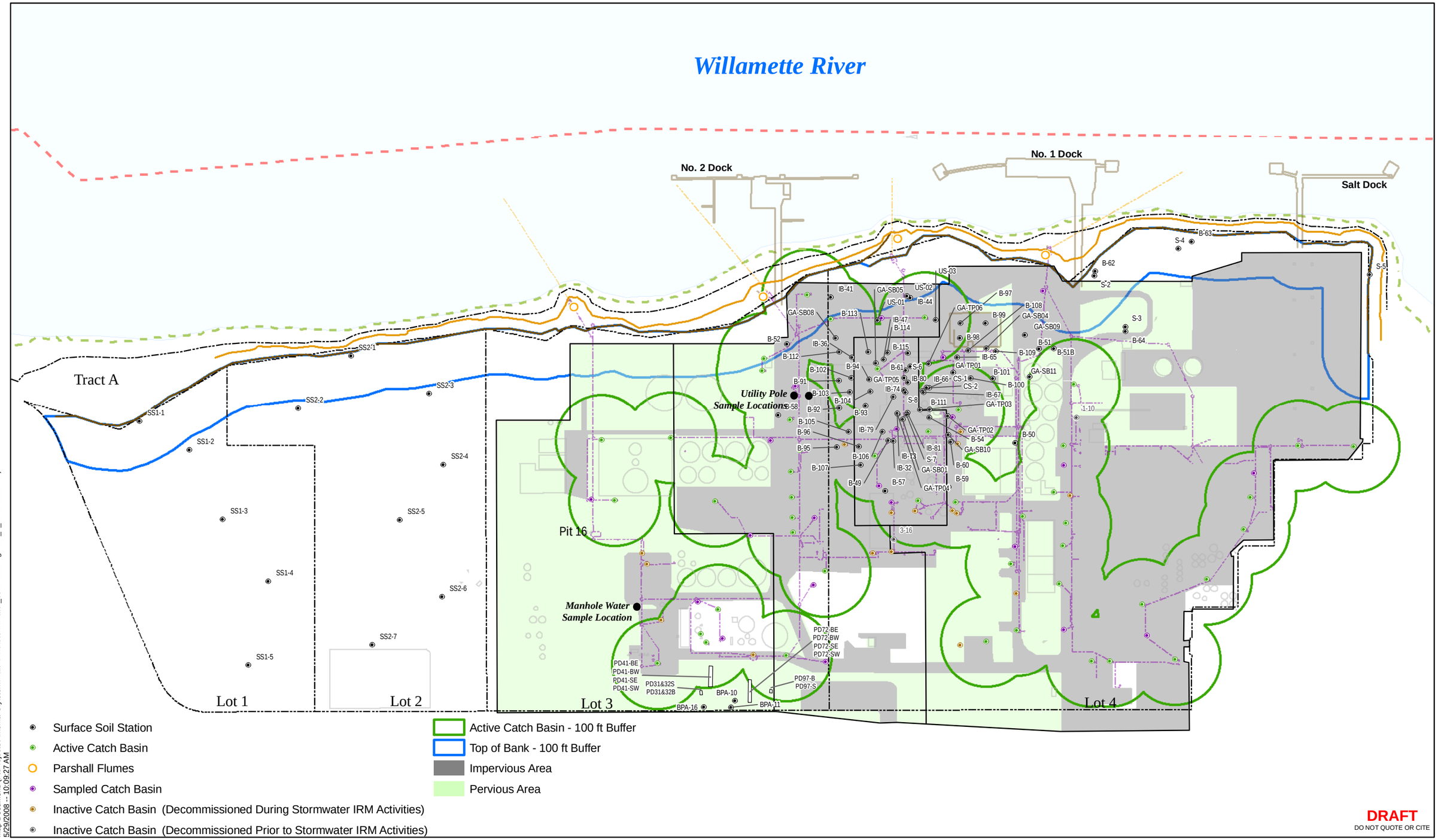
0 100 200
Feet

- Active Catch Basin
- Inactive Catch Basin (Decommissioned Prior to Stormwater IRM Activities)
- Inactive Catch Basin (Decommissioned During Stormwater IRM Activities)
- Parshall Flumes
- Sampled Catch Basin
- Existing Drainage

Elevation ft (NAVD)
Value
High : 42.565
Low : 9.7343

- Existing Stormwater Sewer System
- Navigation Channel
- River
- Ordinary High Water
- Top of Bank

Figure 2-5
Existing Drainage Analysis



Map Document: (P:\Projects\Arkema-Olystormwater\mxd\StormWater_05062008\Figure 4_1_05122008.mxd)
5/29/2008 -- 10:09:27 AM

integral consulting inc.

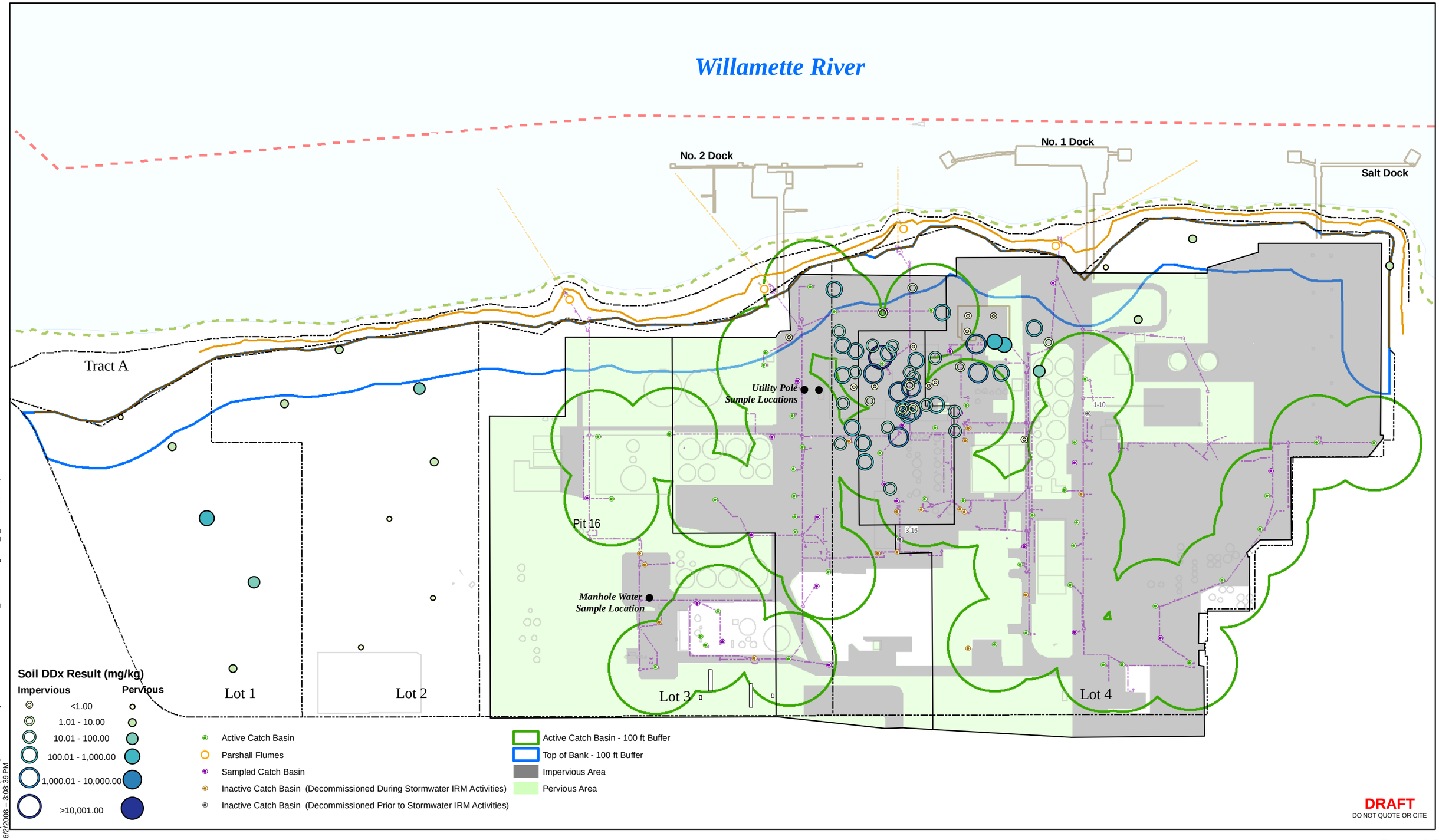
0 100 200
Feet

E-Sewer-L
Storm Drain
12 ft Contour
Navigation Channel
River
Drainage Area
Ordinary High Water
Top of Bank
Property and Lot Boundaries

Catch Basin Sampled
Outfall Number
CB-004-01
CB-004-01
Station
* Sampled Catch Basin Inactive (Outlet Pipes Plugged Prior to Stormwater IRM Activities)

Catch Basin Not Sampled
Outfall Number
3-12
Station

Figure 4-1
Surface Soil Sample Locations



Map Document: (P:\Projects\Arkema-Oly\stormwater\mxd\Storm\Water_05062008\Figure 4_2_05292008.mxd)
6/2/2008 -- 3:08:39 PM

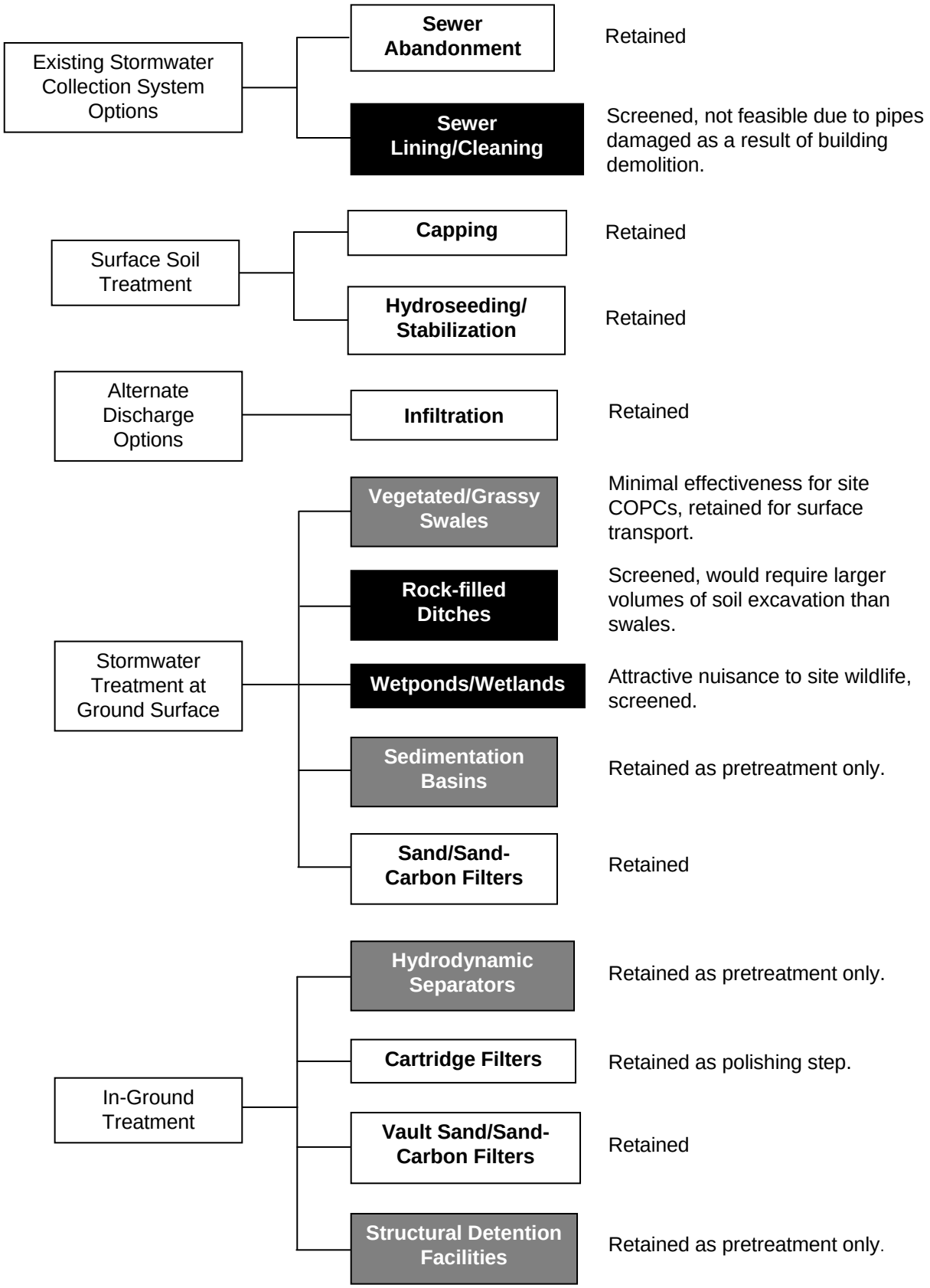
integral consulting inc.

0 100 200
Feet

E-Sewer-L
Storm Drain
12 ft Contour
Navigation Channel
River
Ordinary High Water
Top of Bank
Drainage Area
Property and Lot Boundaries

DDx = Total of 4,4'-DDD, -DDE, -DDT

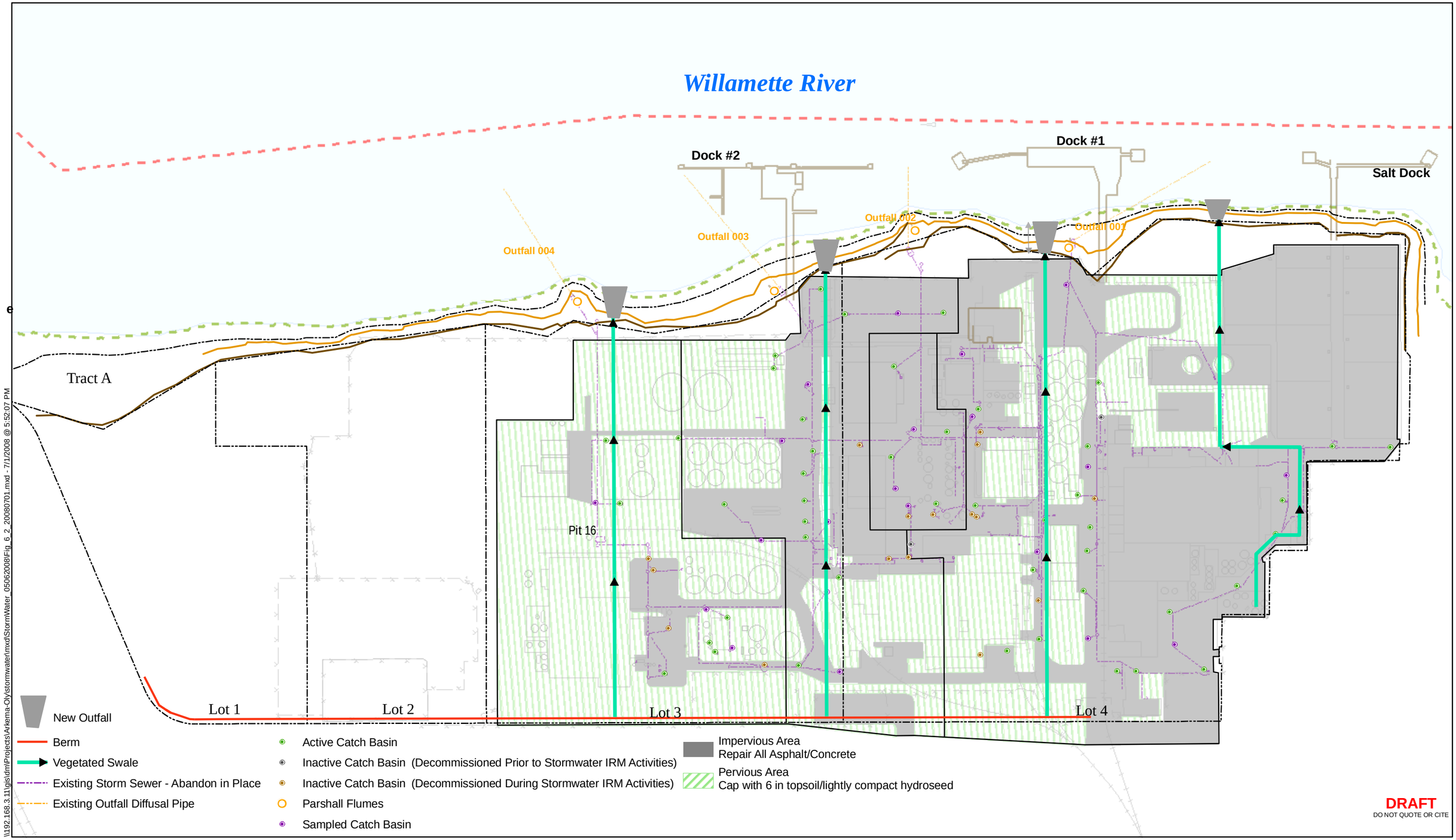
Figure 4-2
DDx Concentrations in Surface Soil (0-1 ft)



integral consulting inc.

Remediation Process Retained
Remediation Process Screened Out
Remediation Process Retained as Pretreatment Only

Figure 6-1.
Preliminary Screening of Treatment Options

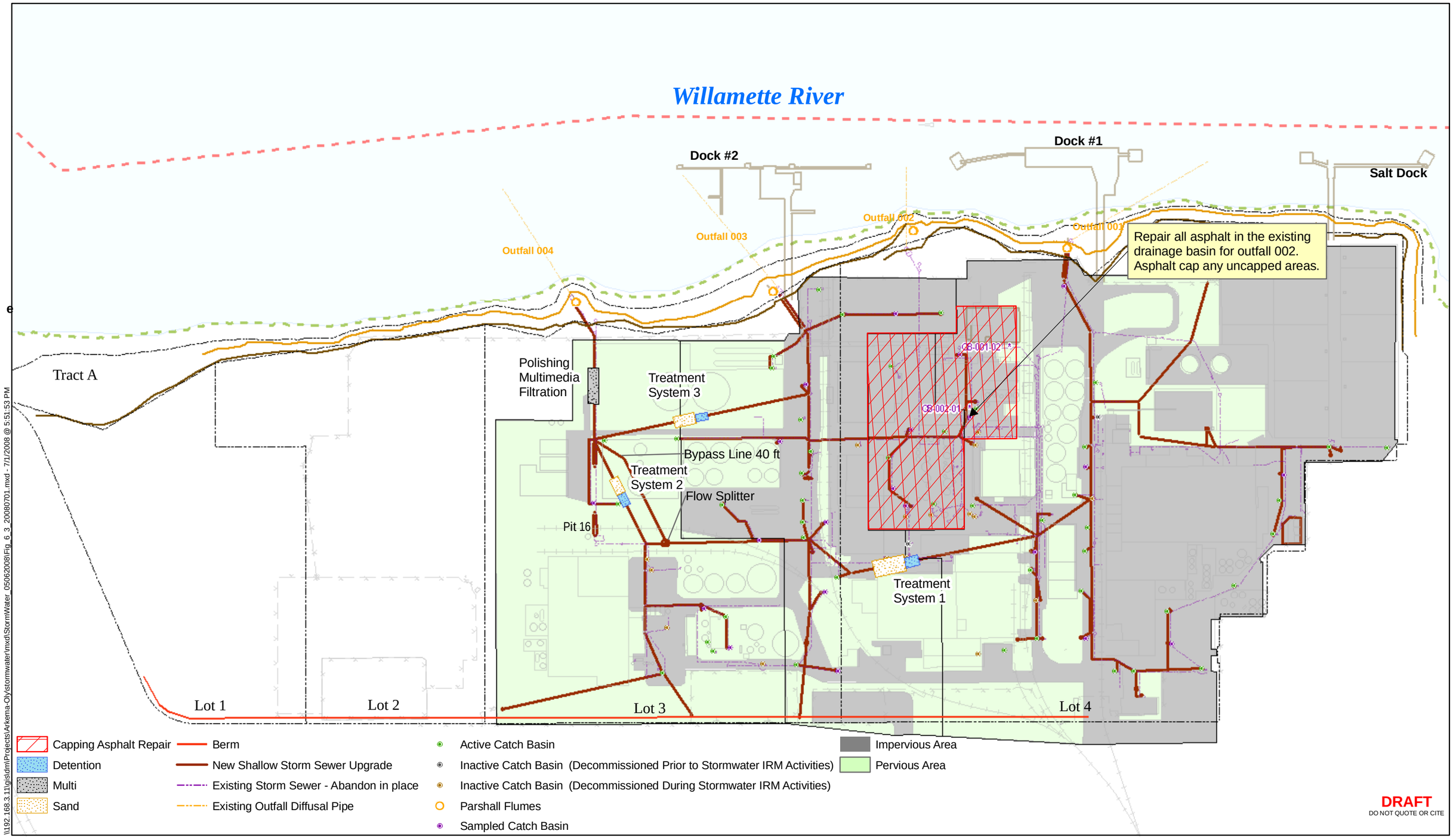


integral consulting inc.

0 100 200
Feet

Top of Bank
Ordinary High Water
12 ft Contour
Navigation Channel
River
Existing Drainage Area
Property and Lot Boundaries

Figure 6-2
Preliminary Plan View of Alternative 1
Interim Remedial Measure

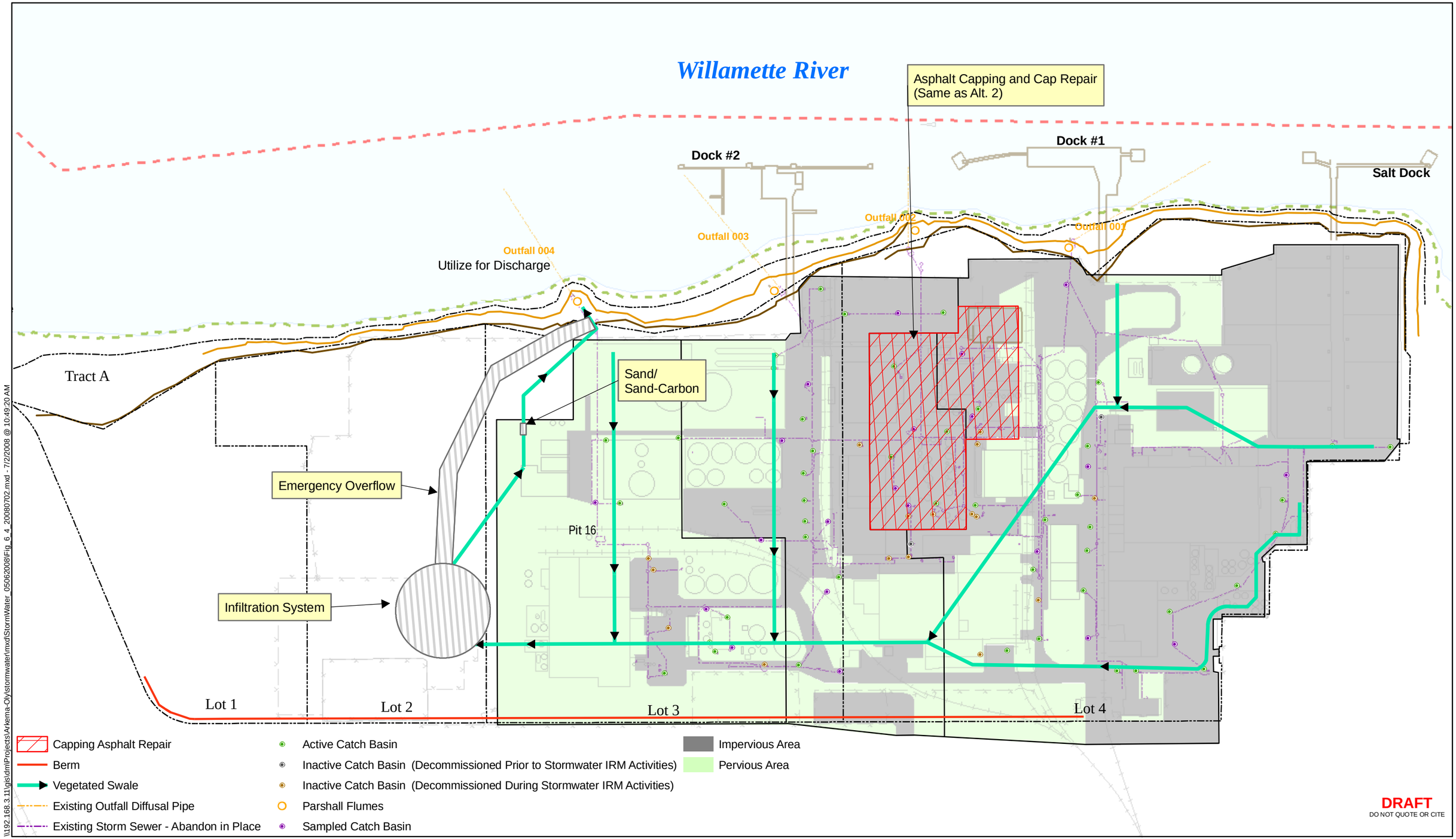


integral consulting inc.

0 100 200
Feet

Top of Bank
Ordinary High Water
12 ft Contour
Navigation Channel
River
Existing Drainage Area
Property and Lot Boundaries

Figure 6-3
Preliminary Plan View of Alternative 2
Interim Remedial Measure



\\192.168.3.11\gis\dm\Projects\Arkema-Oly\stormwater\mxd\StormWater_05062008\Fig_6_4_20080702.mxd - 7/2/2008 @ 10:49:20 AM

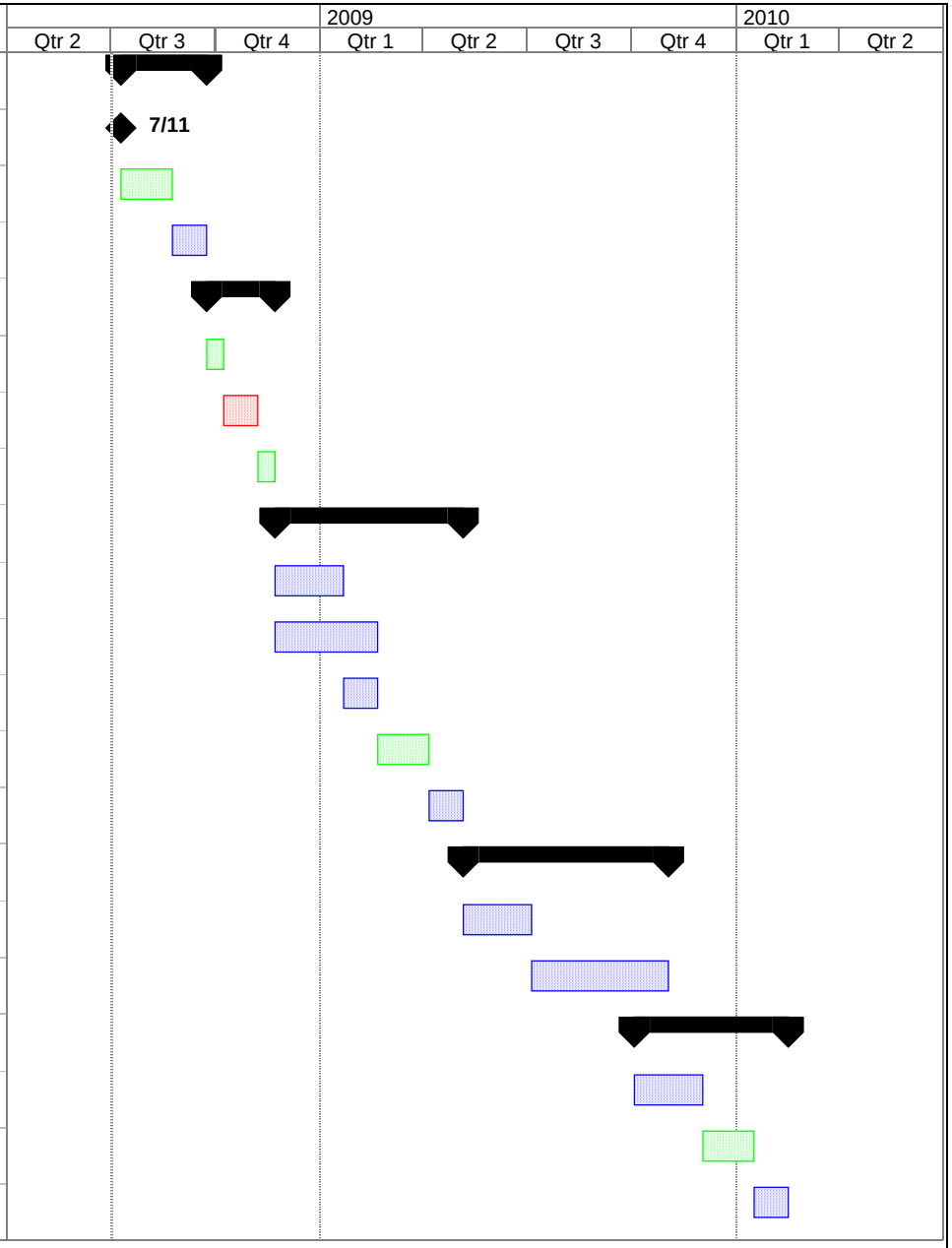
integral consulting inc.

0 100 200
Feet

12 ft Contour
Navigation Channel
River
Existing Drainage Area
Property and Lot Boundaries
Ordinary High Water
Top of Bank

Figure 6-4
Preliminary Plan View of Alternative 3
Interim Remedial Measure

ID	Task Name	Duration	Start	Finish
1	**Stormwater IRM FFS**	**75 days**	**7/11/08**	**9/23/08**
2	Submit Draft FFS	1 day	7/11/08	7/11/08
3	DEQ Review	45 days	7/11/08	8/24/08
4	Finalize FFS	30 days	8/25/08	9/23/08
5	**Finalization of IRM**	**60 days**	**9/24/08**	**11/22/08**
6	DEQ Public Notice/Staff Report	15 days	9/24/08	10/8/08
7	Public Comment	30 days	10/9/08	11/7/08
8	Finalize Agreed Action	15 days	11/8/08	11/22/08
9	**Remedial Design Phase**	**165 days**	**11/23/08**	**5/6/09**
10	RD Field Work	60 days	11/23/08	1/21/09
11	Plans & Specifications	90 days	11/23/08	2/20/09
12	Draft RD Report	30 days	1/22/09	2/20/09
13	DEQ Review	45 days	2/21/09	4/6/09
14	Finalize RD Report & Bid Package	30 days	4/7/09	5/6/09
15	**Remedial Action Phase**	**180 days**	**5/7/09**	**11/2/09**
16	Contractor Bidding	60 days	5/7/09	7/5/09
17	Construction	120 days	7/6/09	11/2/09
18	**Implementation Report**	**135 days**	**10/4/09**	**2/15/10**
19	Draft Implementation Report	60 days	10/4/09	12/2/09
20	DEQ Review	45 days	12/3/09	1/16/10
21	Finalize Implement Report	30 days	1/17/10	2/15/10



integral consulting inc.

Figure 7-1
Implementation Schedule
Interim Remedial Measure

TABLES

Table 2-1. Drainage Area Statistics

Description	Area		Pervious Area		Impervious Area	
	square feet	Acres	%	Type	%	Type
Lots 3 and 4 Drainage Basins						
Previouly delineated drainage to Outfall 001	796,000	18.3	30%	Urban Open Space, <50% Cover	70%	Urban, Parking Lot
Previously delineated drainage to Outfall 002	75,000	1.7	0%	NA	100%	Urban, Parking Lot
Previously delineated drainage to Outfall 003	347,000	8.0	43%	Urban Open Space, <50% Cover	57%	Urban, Parking Lot
Previously delineated drainage to Outfall 004	376,000	8.6	88%	Urban Open Space, <50% Cover	12%	Urban, Parking Lot
Other Areas of Lots 3 & 4[a]						
Lot 3 (overland flow to Willamette)	75,000	1.7	100%	Urban Open Space, 50 - 75% Cover	0%	NA
Lot 4 (overland flow to Willamette)	75,000	1.7	100%		0%	NA
Lot 1	267,000	6.1	100%	Urban Open Space, 50 - 75% Cover	0%	NA
Lot 2	360,000	8.3	100%	Urban Open Space, 50 - 75% Cover	0%	NA
Portion of Lot 2[b] that drains to Lot 3 and (through Outfall 004) to the Willamette	152,000	3.5	100%	Urban Open Space, 50 - 75% Cover	0%	0
Remainder of drainage	208,000	4.8	100%	Urban Open Space, 50 - 75% Cover	0%	NA
Total:	2,371,000	54.4	63%		37%	

Notes:

[a] Area within Lots 3 & 4 that are outside of the current drainage to Outfalls 001, 002, 003, and 004 and discharge as non-point source to the Willamette River.

[b] A small amount of stormwater from Lot 1 flows to Lot 3 and ultimately to the Willamette River through Outfall 004 (Figure 2-5).

Table 2-2. Average Annual Stormwater Discharge by Drainage Area

Description	Area (square feet)	Area (acres)	Pervious Area (%)	Impervious Area (%)	Fraction of Precipitation That Produces Runoff[a]	Runoff Coefficient[b]	Discharge[c] (gallons/yr)
Lots 3 and 4 Drainage Basins							
Drainage to Outfall 001	796,000	18.3	30%	70%	0.9	0.68	10,900,000
Drainage to Outfall 002	75,000	1.7	0%	100%	0.9	0.95	1,400,000
Drainage to Outfall 003	347,000	8.0	43%	57%	0.9	0.56	4,000,000
Drainage to Outfall 004 (including from Lot 2)	528,000	12.1	88%	12%	0.9	0.16	1,700,000
Lots 3 & 4[d]					0.9		
Lot 3	75,000	1.7	100%	0	0.9	0.05	100,000
Lot 4	75,000	1.7	100%	0	0.9	0.05	100,000
Lot 1 - Total	267,000	6.1	100%	0	0.9	0.05	300,000
Lot 2 (minus drainage to Outfall 004)	208,000	4.8	100%	0	0.9	0.05	200,000
Total Area:	2,371,000	54.4					

Total Point Source Discharge from Outfalls 1, 2, 3, and 4:	18,000,000	=	96%
Total Non-Point Source Discharge:	700,000	=	4%
Total Discharge:	18,700,000		

Notes:

[a] Default value.

[b] Runoff Coefficient utilizing "The Simple Method", *Urban Stormwater Hydrology, A Guide to Engineering Calculations*. CRC Press. 1993. Rv = 0.05 + 0.009x(percent impervious).

[c] Discharge = Area (Acres) x Fraction of Precipitation producing runoff x Runoff Coefficient x 27153.4 (Unit Conversion Factor)

[d] Area within Lots 3 & 4 that is outside of the current drainage to Outfalls 001, 002, 003, and 004 and discharge as non-point source to the Willamette River.

[e] A small amount of stormwater from Lot 1 flows to Lot 3 and ultimately to the Willamette River through Outfall 004 (Figure 2-5).

[f] Approximatley 3.5 acres of runoff from Lot 2 flows to Lot 3 and ultimately to the Willamette River through Outfall 004. This acerage is counted in the drainage to Outfall 004.

Table 3-1. Reduction in DDx Concentrations as a Result of IRMs

Analyte		Pre-IRM Concentration (µg/L)[a,b] Min	Max	Mean[d]	Post-IRM Concentration (µg/L) 3/27/2001	Percent Reduction[c,d]
Station SW01						
4,4'-DDT	(total)	5.15	28.5 J	13.9 J	8	42%
	(dissolved)	0.040 U	0.35 J	0.185 J	0.090	51%
	Percent particulates:			99%	99%	
4,4'-DDD	(total)	0.25 J	1.1	0.68 J	0.2 U	85%
	(dissolved)	0.04 U	0.04 UJ	0.02 UJ	0.020 U	--
	Percent particulates:[d]			97%	90%	
4,4'-DDE	(total)	0.55 J	1.55 J	0.97 J	0.5	48%
	(dissolved)	0.040 U	0.04 UJ	0.02 UJ	0.020 U	--
	Percent particulates:[d]			98%	98%	
Station SW02						
4,4'-DDT	(total)	19	32	24	0.28 J	99%
	(dissolved)	0.08 J	0.31 J	0.20 J	0.020 UJ	
	Percent particulates:[d]			99%	96%	
4,4'-DDD	(total)	0.55	2.5	1.28	0.0820 J	94%
	(dissolved)	0.040 U	0.04 UJ	0.02 UJ	0.020 UJ	--
	Percent particulates:[d]			98%	88%	
4,4'-DDE	(total)	0.8	0.9	0.85	0.0230 J	97%
	(dissolved)	0.040 U	0.04 UJ	0.02 UJ	0.020 UJ	--
	Percent particulates:[d]			98%	57%	

Notes:
-- Data not available or cannot be calculated.
J - Estimated.
U - Undetected at detection limit shown.
[a] Pre-IRM concentrations include averages of samples and sample duplicates for individual events.
[b] Pre-IRM samples were collected on 1/22/1999, 11/11/1999, and 12/17/1999.
[c] Percent reduction calculated using mean of pre-IRM stormwater samples versus the post-IRM sample form March 2001.
[d] One-half the detection limit was used for sample concentrations below the detection limit.

Table 3-2. DDT, DDD, DDE and Total DDx Concentrations in Catch Basin and Filter Sock Sediment Samples

	Catch Basin Material (mg/kg)			Filter Sock Material (mg/kg)			Catch Basin:Filter Sock Ratio		
Pesticides	min	max	mean	min	max	mean	min	max	mean
All Outfalls	*n=19*			*n=17*					
4,4'-DDD	0.00739	44.6	3.282	0.0119	1.33	0.301	0.62	33.53	10.90
4,4'-DDE	0.00875	8.01	1.098	0.013	3.02	0.508	0.67	2.65	2.16
4,4'-DDT	0.0191	128	8.377	0.0291	16.1	2.016	0.66	7.95	4.15
Total of 4,4'-DDD, -DDE, -DDT	0.0521	146	12.738	0.0654	20	2.829	0.80	7.30	4.50
Outfall 001	*n=7*			*n=6*					
4,4'-DDD	0.0296	44.6	5.920	0.0119	1.33	0.314	2.49	33.53	18.84
4,4'-DDE	0.0427	5.48	1.091	0.0244	0.767	0.269	1.75	7.14	4.05
4,4'-DDT	0.0191	5.37	1.163	0.0291	2.48	0.641	0.66	2.17	1.82
Total of 4,4'-DDD, -DDE, -DDT	0.111	55.5	8.181	0.0654	4.58	1.224	1.70	12.12	6.68
Outfall 002	*n=3*			*n=3*					
4,4'-DDD	0.636	10.4	3.961	0.314	1.24	0.798	2.03	8.39	4.96
4,4'-DDE	0.48	8.01	3.597	0.284	3.02	1.988	1.69	2.65	1.81
4,4'-DDT	0.708	128	46.469	0.204	16.1	7.831	3.47	7.95	5.93
Total of 4,4'-DDD, -DDE, -DDT	2.03	146	53.877	0.802	20	10.634	2.53	7.30	5.07
Outfall 003	*n=6*			*n=5*					
4,4'-DDD	0.00739	2.78	0.590	0.0139	0.278	0.128	0.53	10.00	4.60
4,4'-DDE	0.00875	1.1	0.296	0.013	0.335	0.153	0.67	3.28	1.94
4,4'-DDT	0.0919	7.93	1.878	0.0473	2.81	1.111	1.94	2.82	1.69
Total of 4,4'-DDD, -DDE, -DDT	0.108	11.1	2.767	0.0742	3.39	1.392	1.46	3.27	1.99
Outfall 004	*n=3*			*n=3*					
4,4'-DDD	0.018	0.0995	0.054	0.0218	0.124	0.066	0.83	0.80	0.82
4,4'-DDE	0.0113	0.0571	0.041	0.0221	0.153	0.098	0.51	0.37	0.42
4,4'-DDT	0.0228	0.352	0.144	0.0604	0.728	0.461	0.38	0.48	0.31
Total of 4,4'-DDD, -DDE, -DDT	0.0521	0.509	0.240	0.104	1.01	0.627	0.50	0.50	0.38

Table 3-3. Reduction in DDx Concentrations as a Result of BMPs

Analyte		Pre-BMP Concentration (mg/L)[a,b] Min	Max	Mean[e]	Post-BMP Concentration (mg/L)[a,c] Min	Max	Mean[e]	Percent Reduction[d]
Outfall 001								
4,4'-DDT	(total)	0.000039 U	0.00072	0.00029185	0.000132 J	0.00018 J	0.0001575 J	46%
	(dissolved)	--	--	--	0.00000338 U	0.0000215	0.0000108 J	--
	Percent particulates:			--			93%	
4,4'-DDD	(total)	0.0000098 U	0.000077	0.00003189	0.0000333 J	0.0000592 U	0.000036275 J	-14%
	(dissolved)	--	--	--	0.00000202 UJ	0.0000071	4.1525E-06 J	--
	Percent particulates:			--			89%	
4,4'-DDE	(total)	0.000018	0.00076	0.00018035	0.0000928 J	0.000228	0.0001712 J	5%
	(dissolved)	--	--	--	0.000005 U	0.0000224 U	7.5775E-06 U	--
	Percent particulates:			--			98%	
Outfall 002								
4,4'-DDT	(total)	0.00019	0.00087	0.000504	0.000373 J	0.000138	0.00111025 J	-120%
	(dissolved)	--	--	--	0.000012 U	0.00248	0.00005118 J	--
	Percent particulates:			--			98%	
4,4'-DDD	(total)	0.000014	0.000082	0.0000298	0.0000429	0.000226 U	0.00008573 J	-188%
	(dissolved)	--	--	--	0.00000195 J	0.00000827	0.00000461 J	--
	Percent particulates:			--			95%	
4,4'-DDE	(total)	0.000044	0.00028	0.0001904	0.000147 J	0.002	0.00065625 J	-245%
	(dissolved)	--	--	--	0.0000057 U	0.000101	0.00003171 J	--
	Percent particulates:			--			95%	
Outfall 003								
4,4'-DDT	(total)	0.000063	0.0013	0.0004093	0.000188 J	0.000214 J	0.00020133 J	51%
	(dissolved)	--	--	--	0.0000114 J	0.0000218 J	0.00001773 J	--
	Percent particulates:			--			96%	

Table 3-3. Reduction in DDx Concentrations as a Result of BMPs

Analyte		Pre-BMP Concentration (mg/L)[a,b]			Post-BMP Concentration (mg/L)[a,c]			Percent
		Min	Max	Mean[e]	Min	Max	Mean[e]	Reduction[d]
4,4'-DDD	(total)	0.000011	0.00005	0.0000257	0.0000244 J	0.0000304	0.00002290 J	11%
	(dissolved)	--	--	--	0.00000214 J	0.00000634	0.00000470 J	--
	Percent particulates:			--			79%	
4,4'-DDE	(total)	0.000039 U	0.00031	0.0000925	0.000108 U	0.000275	0.00018967 J	-105%
	(dissolved)	--	--	--	0.0000122 J	0.0000161 J	0.00001197 J	--
	Percent particulates:			--			94%	
Outfall 004								
4,4'-DDT	(total)	0.000058	0.00068	0.0002633	0.0000843	0.000127	0.0001111 J	58%
	(dissolved)	--	--	--	0.00000261 U	0.00000991	0.00000433	--
	Percent particulates:			--			96%	
4,4'-DDD	(total)	0.0000096	0.000082	0.00003151	0.0000409 U	0.0000634	0.00004612 J	-46%
	(dissolved)	--	--	--	0.00000213	0.00000785	0.00000389	--
	Percent particulates:			--			92%	
4,4'-DDE	(total)	0.000029	0.00024	0.00007585	0.0000843 U	0.000157	0.00011105	-46%
	(dissolved)	--	--	--	0.00000398 U	0.0000138	0.00000691	--
	Percent particulates:			--			94%	

Notes:
-- Data not available or cannot be calculated.
J - Estimated.
U - Undetected at detection limit shown.
[a] Concentrations include averages of sample and sample duplicates for individual events.
[b] A total of 10 pre-BMP samples were collected between 3/30/04 and 3/29/05.
[c] Post-BMP samples were collected on 2/15/07, 3/2/07, 3/19/07, and 6/5/07 (Outfalls 003 and 004 were not sampled on 6/5/07 due to a short duration storm event).
[d] Percent reduction was calculated using mean of pre-BMP stormwater samples versus the post-BMP samples. Negative values indicate increased concentrations.
[e] One-half the detection limit was used to calculate the mean for samples below the detection limit.

Table 4-1. Summary of Source Control Screening for Surface Soils

Analyte	CAS #	Max Detected Result (mg/kg)	Mean Detected Result (mg/kg)	# Samples	# Detected Results	% of Detected Results	% of Detected Exceedances[a]	Max Detected Exceedance Result[a]	Min SLV[a] (mg/kg)	Min SLV Pathway	Max SLV Exceedance Factor[b]
Aroclor 1016	12674-11-2	--	--	29	0	0	0	--	0.42	Bioaccumulation	--
Aroclor 1221	11104-28-2	--	--	29	0	0	--	--	--	--	--
Aroclor 1232	11141-16-5	--	--	29	0	0	--	--	--	--	--
Aroclor 1242	53469-21-9	--	--	29	0	0	0	--	0.002	Bioaccumulation	--
Aroclor 1248	12672-29-6	4.6	1.30	29	6	21	21	4.6	0.004	Bioaccumulation	1150
Aroclor 1254	11097-69-1	--	--	29	0	0	0	--	0.01	Bioaccumulation	--
Aroclor 1260	11096-82-5	0.17	0.15	29	3	10	0	--	0.24	Toxicity	--
Aroclors	12767-79-2	4.6	0.92	29	9	31	10	4.6	0.676	Toxicity	6.80
Arsenic (total)	7440-38-2	76.1	16.94	13	13	100	15	76.1	33	Toxicity	2.31
Cadmium (total)	7440-43-9	--	--	14	0	0	0	--	0.003	Bioaccumulation	--
Chromium (total)	7440-47-3	195	50.24	14	14	100	14	195	111	Toxicity	1.76
Lead (total)	7439-92-1	56.3	32.98	14	14	100	0	--	128	Toxicity	--
Zinc (total)	7440-66-6	392	142.26	14	14	100	100	392	3	Bioaccumulation	131
2-Methylnaphthalene	91-57-6	--	--	13	0	0	0	--	0.201	Toxicity	--
Acenaphthene	83-32-9	--	--	13	0	0	0	--	0.29	Toxicity	--
Acenaphthylene	208-96-8	--	--	13	0	0	0	--	0.16	Toxicity	--
Anthracene	120-12-7	0.0898	0.09	13	1	8	0	--	0.845	Toxicity	--
Benz(a)anthracene	56-55-3	0.288	0.17	13	7	54	0	--	1.05	Toxicity	--
Benzo(a)pyrene	50-32-8	0.37	0.22	13	8	62	0	--	1.45	Toxicity	--
Benzo(b)fluoranthene	205-99-2	0.347	0.22	13	8	62	--	--	--	--	--
Benzo(g,h,i)perylene	191-24-2	0.218	0.18	13	5	38	0	--	0.3	Toxicity	--
Benzo(k)fluoranthene	207-08-9	0.359	0.22	13	8	62	0	--	13.4	Toxicity	--
Chrysene	218-01-9	0.532	0.28	13	8	62	0	--	1.29	Toxicity	--
Dibenz(a,h)anthracene	53-70-3	0.0749	0.07	13	1	8	0	--	1.3	Toxicity	--
Fluoranthene	206-44-0	0.523	0.26	13	4	31	0	--	2.23	Toxicity	--
Fluorene	86-73-7	--	--	13	0	0	0	--	0.536	Toxicity	--
Indeno(1,2,3-cd)pyrene	193-39-5	0.194	0.16	13	5	38	31	0.194	0.1	Toxicity	1.94
Naphthalene	91-20-3	--	--	28	0	0	0	--	0.561	Toxicity	--
Phenanthrene	85-01-8	0.234	0.16	13	3	23	0	--	1.17	Toxicity	--
Pyrene	129-00-0	0.621	0.20	13	8	62	0	--	1.52	Toxicity	--
4,4'-DDD	72-54-8	260	11.99	77	46	60	58	260	0.0003	Bioaccumulation	866,667
4,4'-DDE	72-55-9	190	9.45	77	50	65	60	190	0.0003	Bioaccumulation	633,333
4,4'-DDT	50-29-3	12,000	512.78	77	74	96	86	12,000	0.0003	Bioaccumulation	40,000,000
Aldrin	309-00-2	--	--	58	0	0	0	--	0.04	Toxicity	--
alpha-Endosulfan	959-98-8	--	--	58	0	0	--	--	--	--	--
alpha-Hexachlorocyclohexane	319-84-6	--	--	58	0	0	--	--	--	--	--
beta-Endosulfan	33213-65-9	--	--	58	0	0	--	--	--	--	--
beta-Hexachlorocyclohexane	319-85-7	--	--	58	0	0	--	--	--	--	--
Chlordane (*cis* and *trans*)	57-74-9	--	--	58	0	0	0	--	0.0176	Toxicity	--
Chlordane (technical)	12789-03-6	--	--	13	0	0	--	--	--	--	--
cis-Chlordane	5103-71-9	--	--	51	0	0	--	--	--	--	--
delta-Hexachlorocyclohexane	319-86-8	--	--	58	0	0	--	--	--	--	--
Dieldrin	60-57-1	--	--	58	0	0	0	--	0.0618	Toxicity	--
Endosulfan sulfate	1031-07-8	--	--	58	0	0	--	--	--	--	--

Table 4-1. Summary of Source Control Screening for Surface Soils

Analyte	CAS #	Max Detected Result (mg/kg)	Mean Detected Result (mg/kg)	# Samples	# Detected Results	% of Detected Results	% of Detected Exceedances[a]	Max Detected Exceedance Result[a]	Min SLV[a] (mg/kg)	Min SLV Pathway	Max SLV Exceedance Factor[b]
Endrin	72-20-8	1.5	1.50	58	1	2	2	1.5	0.207	Toxicity	7.25
Endrin aldehyde	7421-93-4	--	--	58	0	0	--	--	--	--	--
Endrin ketone	53494-70-5	--	--	51	0	0	--	--	--	--	--
gamma-Hexachlorocyclohexane	58-89-9	0.01	0.01	58	1	2	2	0.01	0.00499	Toxicity	2.00
Heptachlor	76-44-8	--	--	58	0	0	0	--	0.01	Toxicity	--
Heptachlor epoxide	1024-57-3	--	--	58	0	0	0	--	0.016	Toxicity	--
Methoxychlor	72-43-5	0.0073	0.01	58	1	2	--	--	--	--	--
Total of 4,4'-DDD, -DDE, -DDT	PP_DDT3ISO	12,300	519.65	77	75	97	94	12,300	0.0003	Bioaccumulation	41,000,000
Toxaphene	8001-35-2	--	--	58	0	0	--	--	--	--	--
trans -Chlordane	5103-74-2	--	--	51	0	0	--	--	--	--	--
Diesel Range Hydrocarbons	DRH	14,000	1,365.64	29	17	59	--	--	--	--	--
Gasoline Range Hydrocarbons	GRH	3.28	1.50	13	10	77	--	--	--	--	--
Heavy oil	8001-58-9	1,270	297.91	13	13	100	--	--	--	--	--
Residual Range Hydrocarbons	RRH	3,300	1,055.00	16	4	25	--	--	--	--	--
2,4,5-Trichlorophenol	95-95-4	--	--	13	0	0	--	--	--	--	--
2,4,6-Trichlorophenol	88-06-2	--	--	13	0	0	--	--	--	--	--
2,4-Dichlorophenol	120-83-2	--	--	13	0	0	--	--	--	--	--
2,4-Dimethylphenol	105-67-9	--	--	13	0	0	--	--	--	--	--
2,4-Dinitrophenol	51-28-5	--	--	13	0	0	--	--	--	--	--
2-Chlorophenol	95-57-8	--	--	13	0	0	--	--	--	--	--
2-Methylphenol	95-48-7	--	--	13	0	0	--	--	--	--	--
2-Nitrophenol	88-75-5	--	--	13	0	0	--	--	--	--	--
3- and 4-Methylphenol Coelution	C_3+4MPHN	--	--	13	0	0	--	--	--	--	--
4,6-Dinitro-2-methylphenol	534-52-1	--	--	13	0	0	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	--	--	13	0	0	--	--	--	--	--
4-Nitrophenol	100-02-7	--	--	13	0	0	--	--	--	--	--
Pentachlorophenol	87-86-5	--	--	13	0	0	0	--	1	Toxicity	--
Phenol	108-95-2	--	--	13	0	0	0	--	0.048	Toxicity	--
Bis(2-ethylhexyl) phthalate	117-81-7	--	--	13	0	0	0	--	0.33	Bioaccumulation	--
Butylbenzyl phthalate	85-68-7	--	--	13	0	0	--	--	--	--	--
Dibutyl phthalate	84-74-2	--	--	13	0	0	0	--	0.11	Toxicity	--
Diethyl phthalate	84-66-2	--	--	13	0	0	0	--	0.63	Toxicity	--
Dimethyl phthalate	131-11-3	--	--	13	0	0	--	--	--	--	--
Di-*n* -octyl phthalate	117-84-0	--	--	13	0	0	--	--	--	--	--
1,2,4-Trichlorobenzene	120-82-1	--	--	28	0	0	0	--	9.2	Toxicity	--
1,2-Dichlorobenzene	95-50-1	--	--	28	0	0	0	--	0.34	Toxicity	--
1,3-Dichlorobenzene	541-73-1	--	--	28	0	0	0	--	1.7	Toxicity	--
1,4-Dichlorobenzene	106-46-7	--	--	28	0	0	0	--	0.35	Toxicity	--
2,4-Dinitrotoluene	121-14-2	--	--	13	0	0	--	--	--	--	--
2,6-Dinitrotoluene	606-20-2	--	--	13	0	0	--	--	--	--	--
2-Chloronaphthalene	91-58-7	--	--	13	0	0	--	--	--	--	--
2-Nitroaniline	88-74-4	--	--	13	0	0	--	--	--	--	--
3,3'-Dichlorobenzidine	91-94-1	--	--	13	0	0	--	--	--	--	--
3-Nitroaniline	99-09-2	--	--	13	0	0	--	--	--	--	--

Table 4-1. Summary of Source Control Screening for Surface Soils

Analyte	CAS #	Max Detected Result (mg/kg)	Mean Detected Result (mg/kg)	# Samples	# Detected Results	% of Detected Results	% of Detected Exceedances[a]	Max Detected Exceedance Result[a]	Min SLV[a] (mg/kg)	Min SLV Pathway	Max SLV Exceedance Factor[b]
4-Bromophenyl phenyl ether	101-55-3	--	--	13	0	0	--	--	--	--	--
4-Chloroaniline	106-47-8	--	--	13	0	0	--	--	--	--	--
4-Chlorophenyl phenyl ether	7005-72-3	--	--	13	0	0	--	--	--	--	--
4-Nitroaniline	100-01-6	--	--	13	0	0	--	--	--	--	--
Benzoic acid	65-85-0	--	--	13	0	0	--	--	--	--	--
Benzyl alcohol	100-51-6	--	--	13	0	0	--	--	--	--	--
Bis(2-chloro-1-methylethyl) ether	108-60-1	--	--	13	0	0	--	--	--	--	--
Bis(2-chloroethoxy) methane	111-91-1	--	--	13	0	0	--	--	--	--	--
Bis(2-chloroethyl) ether	111-44-4	--	--	13	0	0	--	--	--	--	--
Dibenzofuran	132-64-9	--	--	13	0	0	--	--	--	--	--
Hexachlorobenzene	118-74-1	--	--	13	0	0	0	--	0.1	Toxicity	--
Hexachlorobutadiene	87-68-3	0.0008	0.0008	28	1	4	0	--	0.55	Toxicity	--
Hexachlorocyclopentadiene	77-47-4	--	--	13	0	0	0	--	0.44	Toxicity	--
Hexachloroethane	67-72-1	--	--	13	0	0	--	--	--	--	--
Isophorone	78-59-1	--	--	13	0	0	--	--	--	--	--
Nitrobenzene	98-95-3	--	--	13	0	0	--	--	--	--	--
N-Nitrosodiphenylamine	86-30-6	--	--	13	0	0	--	--	--	--	--
N-Nitrosodipropylamine	621-64-7	--	--	13	0	0	--	--	--	--	--
1,1,1,2-Tetrachloroethane	630-20-6	--	--	15	0	0	--	--	--	--	--
1,1,1-Trichloroethane	71-55-6	--	--	15	0	0	--	--	--	--	--
1,1,2,2-Tetrachloroethane	79-34-5	--	--	15	0	0	--	--	--	--	--
1,1,2-Trichloroethane	79-00-5	--	--	15	0	0	--	--	--	--	--
1,1-Dichloroethane	75-34-3	--	--	15	0	0	--	--	--	--	--
1,1-Dichloroethene	75-35-4	--	--	15	0	0	--	--	--	--	--
1,1-Dichloropropene	563-58-6	--	--	15	0	0	--	--	--	--	--
1,2,3-Trichlorobenzene	87-61-6	--	--	15	0	0	--	--	--	--	--
1,2,3-Trichloropropane	96-18-4	--	--	15	0	0	--	--	--	--	--
1,2,4-Trimethylbenzene	95-63-6	--	--	15	0	0	--	--	--	--	--
1,2-Dibromo-3-chloropropane	96-12-8	--	--	15	0	0	--	--	--	--	--
1,2-Dichloroethane	107-06-2	--	--	15	0	0	--	--	--	--	--
1,2-Dichloropropane	78-87-5	--	--	15	0	0	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	--	--	15	0	0	--	--	--	--	--
1,3-Dichloropropane	142-28-9	--	--	15	0	0	--	--	--	--	--
2,2-Dichloropropane	594-20-7	--	--	15	0	0	--	--	--	--	--
2-Butanone	78-93-3	--	--	12	0	0	--	--	--	--	--
2-Chlorotoluene	95-49-8	--	--	15	0	0	--	--	--	--	--
2-Hexanone	591-78-6	--	--	15	0	0	--	--	--	--	--
4-Chlorotoluene	106-43-4	--	--	15	0	0	--	--	--	--	--
4-Methyl-2-pentanone	108-10-1	--	--	12	0	0	--	--	--	--	--
Acetone	67-64-1	0.13	0.09	12	2	17	--	--	--	--	--
Benzene	71-43-2	--	--	15	0	0	--	--	--	--	--
Bromobenzene	108-86-1	--	--	15	0	0	--	--	--	--	--
Bromochloromethane	74-97-5	--	--	15	0	0	--	--	--	--	--
Bromodichloromethane	75-27-4	--	--	15	0	0	--	--	--	--	--

Table 4-1. Summary of Source Control Screening for Surface Soils

Analyte	CAS #	Max Detected Result (mg/kg)	Mean Detected Result (mg/kg)	# Samples	# Detected Results	% of Detected Results	% of Detected Exceedances[a]	Max Detected Exceedance Result[a]	Min SLV[a] (mg/kg)	Min SLV Pathway	Max SLV Exceedance Factor[b]
Bromoform	75-25-2	--	--	15	0	0	--	--	--	--	--
Bromomethane	74-83-9	--	--	15	0	0	--	--	--	--	--
Carbon disulfide	75-15-0	--	--	15	0	0	--	--	--	--	--
Carbon tetrachloride	56-23-5	--	--	15	0	0	--	--	--	--	--
Chlorobenzene	108-90-7	0.021	0.010	15	4	27	--	--	--	--	--
Chlorodibromomethane	124-48-1	--	--	15	0	0	--	--	--	--	--
Chloroethane	75-00-3	--	--	15	0	0	--	--	--	--	--
Chloroform	67-66-3	--	--	15	0	0	--	--	--	--	--
Chloromethane	74-87-3	--	--	15	0	0	--	--	--	--	--
cis -1,2-Dichloroethene	156-59-2	--	--	15	0	0	--	--	--	--	--
cis -1,3-Dichloropropene	10061-01-5	--	--	15	0	0	--	--	--	--	--
Dibromomethane	74-95-3	--	--	15	0	0	--	--	--	--	--
Dichlorodifluoromethane	75-71-8	--	--	15	0	0	--	--	--	--	--
Ethylbenzene	100-41-4	--	--	15	0	0	--	--	--	--	--
Ethylene dibromide	106-93-4	--	--	15	0	0	--	--	--	--	--
Isopropylbenzene	98-82-8	--	--	15	0	0	--	--	--	--	--
m,p -Xylene	179601-23-1	--	--	15	0	0	--	--	--	--	--
Methylene chloride	75-09-2	--	--	15	0	0	--	--	--	--	--
n -Butylbenzene	104-51-8	--	--	15	0	0	--	--	--	--	--
n -Propylbenzene	103-65-1	--	--	15	0	0	--	--	--	--	--
o -Xylene	95-47-6	--	--	15	0	0	--	--	--	--	--
p -Cymene	99-87-6	--	--	15	0	0	--	--	--	--	--
Sec-butylbenzene	135-98-8	--	--	15	0	0	--	--	--	--	--
Styrene	100-42-5	--	--	15	0	0	--	--	--	--	--
tert -Butylbenzene	98-06-6	--	--	15	0	0	--	--	--	--	--
Tetrachloroethene	127-18-4	0.0019	0.0013	15	2	13	0	--	0.53	Toxicity	--
Toluene	108-88-3	0.043	0.022	15	2	13	--	--	--	--	--
Total xylenes	1330-20-7	--	--	15	0	0	--	--	--	--	--
trans -1,2-Dichloroethene	156-60-5	--	--	15	0	0	--	--	--	--	--
trans -1,3-Dichloropropene	10061-02-6	--	--	15	0	0	--	--	--	--	--
Trichloroethene	79-01-6	--	--	15	0	0	0	--	2.1	Toxicity	--
Trichlorofluoromethane	75-69-4	--	--	15	0	0	--	--	--	--	--
Vinyl chloride	75-01-4	--	--	15	0	0	--	--	--	--	--

Notes:

SLV - Screening Level Value

These data were originally screened and submitted to DEQ in April 2006. The SLVs are from the 2006 version of Table 3-1 of the JSCS Guidance Document (DEQ 2005).

The following stations were removed from the dataset screened in April 2006 because their locations are unkown or they are located below top of bank: B050, SLTEST, E-SETCON, PD100-B, PS-1, PS-2, S-1, VES5, and the RB stations.

[a] Minimum of DEQ 2007 Bioaccumulative Sediment SLVs, and MacDonald probable effects concentration or other sediment quality value (Toxicity).

[b] Detected results only

Table 4-2. Summary of Source Control Screening for Catch Basin Sediments

Analyte	CAS #	Max Detected Result (mg/kg)	Mean Detected Result (mg/kg)	# Samples	# Detected Results	% of Detected Results	% of Detected Exceedances[a]	Max Detected Exceedance[a]	Min SLV[a] (mg/kg)	Min SLV Pathway	Max SLV Exceedance Factor[b]
Aroclor 1016	12674-11-2	--	--	36	0	0	0	--	0.53	Toxicity	--
Aroclor 1221	11104-28-2	--	--	36	0	0	--	--	--	--	--
Aroclor 1232	11141-16-5	--	--	36	0	0	--	--	--	--	--
Aroclor 1242	53469-21-9	--	--	36	0	0	--	--	--	--	--
Aroclor 1248	12672-29-6	--	--	36	0	0	0	--	1.5	Toxicity	--
Aroclor 1254	11097-69-1	--	--	36	0	0	0	--	0.3	Toxicity	--
Aroclor 1260	11096-82-5	--	--	36	0	0	0	--	0.2	Toxicity	--
Total Aroclors	12767-79-2	--	--	36	0	0	0	--	0.00039	Bioaccumulation	--
Heptachlorodibenzofuran homologs	38998-75-3	0.08	0.01	18	18	100	--	--	--	--	--
Heptachlorodibenzo-*p*-dioxin homologs	37871-00-4	0.31	0.03	18	18	100	--	--	--	--	--
Hexachlorodibenzofuran homologs	55684-94-1	0.026	0.003	18	18	100	--	--	--	--	--
Hexachlorodibenzo-*p*-dioxin homologs	34465-46-8	0.027	0.003	18	18	100	--	--	--	--	--
Octachlorodibenzofuran	39001-02-0	0.063	0.007	18	18	100	6	0.063	0.023	Bioaccumulation	2.74
Octachlorodibenzo-*p*-dioxin	3268-87-9	1.5	0.1	18	18	100	72	1.5	0.023	Bioaccumulation	65.2
Pentachlorodibenzofuran homologs	30402-15-4	0.0053	0.0012	18	18	100	--	--	--	--	--
Pentachlorodibenzo-*p*-dioxin homologs	36088-22-9	0.0012	0.0002	18	17	94	--	--	--	--	--
Tetrachlorodibenzofuran homologs	30402-14-3	0.004	0.001	18	18	100	--	--	--	--	--
Tetrachlorodibenzo-*p*-dioxin homologs	41903-57-5	0.000088	0.000026	18	18	100	--	--	--	--	--
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	0.02	0.002	18	18	100	72	0.02	0.00069	Bioaccumulation	29.0
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	35822-46-9	0.19	0.02	18	18	100	94	0.19	0.00069	Bioaccumulation	275
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	0.0018	0.0003	18	18	100	6	0.0018	0.00069	Bioaccumulation	2.61
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	0.0035	0.0007	18	18	100	94	0.0035	0.0000027	Bioaccumulation	1296
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	39227-28-6	0.0019	0.0002	18	18	100	94	0.0019	0.0000027	Bioaccumulation	704
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	0.0009	0.0002	18	18	100	94	0.0009	0.0000027	Bioaccumulation	333
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	57653-85-7	0.0072	0.0007	18	18	100	89	0.0072	0.0000027	Bioaccumulation	2667
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	0.000038	0.000015	18	13	72	61	0.000038	0.0000027	Bioaccumulation	14.1
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	19408-74-3	0.004	0.0004	18	18	100	94	0.004	0.0000027	Bioaccumulation	1481
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	0.0022	0.0004	18	18	100	94	0.0022	0.0000026	Bioaccumulation	846
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	40321-76-4	0.00061	0.0001	18	17	94	83	0.00061	0.00000027	Bioaccumulation	2259
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	0.00053	0.00009	18	17	94	83	0.00053	0.0000027	Bioaccumulation	196
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	0.00084	0.00018	18	18	100	100	0.00084	0.00000003	Bioaccumulation	28000
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	0.0031	0.0006	18	18	100	100	0.0031	0.00000077	Bioaccumulation	4026
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	1746-01-6	0.00003	0.00001	18	16	89	83	0.00003	9.1E-09	Bioaccumulation	3297
TEQ WHO98	TEQ_DIOXIN	0.0045976	0.00069	18	18	100	100	0.0045976	9.1E-09	Bioaccumulation	505231
Chromium hexavalent (total)	18540-29-9	0.554	0.231	36	14	39	0	--	64	Region 9 Ind	--
Manganese (total)	7439-96-5	1,720	386	36	36	100	3	1720	1100	Toxicity	1.56
Perchlorate	14797-73-0	3.34	0.53	36	7	19	0	--	100	Region 9 Ind	--
1-Methylnaphthalene	90-12-0	--	--	36	0	0	--	--	--	--	--
2-Methylnaphthalene	91-57-6	--	--	36	0	0	0	--	0.2	Toxicity	--
Acenaphthene	83-32-9	0.267	0.141	36	2	6	0	--	0.3	Toxicity	--
Acenaphthylene	208-96-8	0.0403	0.0219	36	2	6	0	--	0.2	Toxicity	--
Anthracene	120-12-7	0.432	0.087	36	12	33	17	0.432	0.0572	TEC	7.55

Table 4-2. Summary of Source Control Screening for Catch Basin Sediments

Analyte	CAS #	Max Detected Result (mg/kg)	Mean Detected Result (mg/kg)	# Samples	# Detected Results	% of Detected Results	% of Detected Exceedances[a]	Max Detected Exceedance[a]	Min SLV[a] (mg/kg)	Min SLV Pathway	Max SLV Exceedance Factor[b]
Benzo(a)anthracene	56-55-3	0.939	0.257	35	19	54	37	0.939	0.108	TEC	8.69
Benzo(a)pyrene	50-32-8	0.76	0.28	36	26	72	44	0.76	0.15	TEC	5.07
Benzo(b+k)fluoranthene	BKBFLANTH	1.91	0.61	36	30	83	--	--	--	--	--
Benzo(g,h,i)perylene	191-24-2	1.06	0.25	36	22	61	19	1.06	0.3	Toxicity	3.53
Chrysene	218-01-9	1.83	0.46	36	27	75	56	1.83	0.166	TEC	11.0
Dibenzo(a,h)anthracene	53-70-3	0.406	0.167	36	5	14	8	0.406	0.033	TEC	12.3
Fluoranthene	206-44-0	2.8	0.5	36	36	100	36	2.8	0.423	TEC	6.62
Fluorene	86-73-7	0.192	0.057	36	5	14	3	0.192	0.0774	TEC	2.48
Indeno(1,2,3-cd)pyrene	193-39-5	0.543	0.287	36	13	36	28	0.543	0.1	Toxicity	5.43
Naphthalene	91-20-3	--	--	36	0	0	0	--	0.176	TEC	--
Phenanthrene	85-01-8	1.77	0.28	36	25	69	28	1.77	0.204	TEC	8.68
Pyrene	129-00-0	2.86	0.60	36	36	100	56	2.86	0.195	TEC	14.7
4,4'-DDD	72-54-8	44.6	1.9	36	36	100	100	44.6	0.00033	Bioaccumulation	135,152
4,4'-DDE	72-55-9	8.01	0.82	36	36	100	100	8.01	0.00033	Bioaccumulation	24,273
4,4'-DDT	50-29-3	128	5.4	36	36	100	100	128	0.00033	Bioaccumulation	387,879
Total of 4,4'-DDD, -DDE, -DDT	E966176	146	8	36	36	100	94	146	0.00033	Bioaccumulation	442,424
Pentachlorophenol	87-86-5	31.4	7.0	36	10	28	19	31.4	0.25	Bioaccumulation	126
Bis(2-ethylhexyl) phthalate	117-81-7	65.7	19.8	36	22	61	61	65.7	0.33	Bioaccumulation	199
Butylbenzyl phthalate	85-68-7	3.7	1.3	36	4	11	0	--	100,000	Region 9 Ind	--
Dibutyl phthalate	84-74-2	15.3	1.1	36	20	56	47	15.3	0.06	Bioaccumulation	255
Diethyl phthalate	84-66-2	--	--	36	0	0	0	--	0.6	Toxicity	--
Dimethyl phthalate	131-11-3	3.23	0.60	36	24	67	0	--	100,000	Region 9 Ind	--
Di-*n*-octyl phthalate	117-84-0	2.69	0.98	36	8	22	0	--	25,000	Region 9 Ind	--

Notes:

SLV - Screening Level Value

TEC - Threshold Effects Concentration

These data were originally screened and submitted to DEQ in November 2007. The SLVs are from the 2007 version of Table 3-1 of the JSCS Guidance Document (DEQ 2005).

[a] - Minimum of DEQ 2007 Bioaccumulative Sediment SLVs, and MacDonald probable effects concentration or other sediment quality value (Toxicity).

[b] - Detected results only

Table 4-3. Summary of Source Control Screening for Stormwater

Analyte	CAS #	Max Detected Result (mg/l)	Mean Detected Result (mg/l)	# Samples	# Detected Results	% of Detected Results	% of Detected Exceedances[a]	Max Detected Exceedance[a]	Min SLV (mg/l)	Min SLV Pathway	Max SLV Exceedance Factor[b]
Chromium hexavalent (total)	18540-29-9	0.038	0.016	14	7	50	36	0.0383	0.011	Eco	3.48
Manganese (dissolved)	7439-96-5	0.068	0.013	14	9	64	7	0.0681425	0.05	MCL	1.36
Manganese (total)	7439-96-5	0.157	0.043	14	14	100	29	0.157425	0.05	MCL	3.1
Perchlorate	14797-73-0	0.125	0.031	14	10	71	14	0.125	0.0245	PRG	5.10
1-Methylnaphthalene	90-12-0	0.0000262	0.0000101	14	10	71	--	--	--	--	--
2-Methylnaphthalene	91-57-6	0.000128	0.000128	14	1	7	0	--	0.0002	MCL	--
Acenaphthene	83-32-9	0.0000225	0.0000186	14	2	14	0	--	0.0002	MCL	--
Acenaphthylene	208-96-8	0.00002045	0.00000937	14	5	36	0	--	0.0002	MCL	--
Anthracene	120-12-7	0.00001265	0.00000601	14	14	100	0	--	0.0002	MCL	--
Benzo(a)anthracene	56-55-3	0.00004505	0.00003063	14	2	14	7	0.00004505	0.000018	Fish	2.5
Benzo(a)pyrene	50-32-8	0.000065	0.000022	14	4	29	14	0.000065	0.0000092	PRG	7.1
Benzo(b)fluoranthene	205-99-2	0.0000198	0.0000144	4	4	100	25	0.0000198	0.000018	Fish	1.1
Benzo(g,h,i)perylene	191-24-2	0.0000531	0.0000085	14	14	100	0	--	0.0002	MCL	--
Benzo(k)fluoranthene	207-08-9	0.00000574	0.00000454	4	4	100	0	--	0.000018	Fish	--
Benzofluoranthenes	56832-73-6	0.0001354	0.0000207	10	10	100	--	--	--	--	--
Chrysene	218-01-9	0.00009335	0.00001450	14	12	86	7	0.00009335	0.000018	Fish	5.2
Dibenzo(a,h)anthracene	53-70-3	0.00001073	0.00000628	14	5	36	7	0.00001073	0.0000092	PRG	1.17
Fluoranthene	206-44-0	0.000132	0.000026	14	13	93	0	--	0.0002	MCL	--
Fluorene	86-73-7	0.0000366	0.0000143	14	4	29	0	--	0.0002	MCL	--
Indeno(1,2,3-cd)pyrene	193-39-5	0.0000442	0.0000133	14	6	43	7	0.0000442	0.000018	Fish	2.5
Naphthalene	91-20-3	0.0000639	0.0000639	14	1	7	0	--	0.0002	MCL	--
Phenanthrene	85-01-8	0.00008655	0.00003586	14	4	29	0	--	0.0002	MCL	--
Pyrene	129-00-0	0.000114	0.000026	14	12	86	0	--	0.0002	MCL	--
4,4'-DDD	72-54-8	0.000133	0.000052	14	10	71	71	0.000133	0.00000031	Fish	429
4,4'-DDD (dissolved)	72-54-8	0.00000827	0.00000484	14	12	86	86	0.00000827	0.00000031	Fish	27
4,4'-DDE	72-55-9	0.002	0.0003	14	12	86	86	0.002	0.00000022	Fish	9,091
4,4'-DDE (dissolved)	72-55-9	0.000101	0.000025	14	7	50	50	0.000101	0.00000022	Fish	459
4,4'-DDT	50-29-3	0.00248	0.00043	14	14	100	100	0.00248	0.00000022	Fish	11,273
4,4'-DDT (dissolved)	50-29-3	0.000138	0.000030	14	10	71	71	0.000138	0.00000022	Fish	627
Total 4,4'-DDD, -DDE, -DDT	E966176	0.00448	0.00076	14	14	100	93	0.00448	0.0002	PRG	22.4
Total 4,4'-DDD, -DDE, -DDT (dissolved)	E966176	0.000247	0.000042	14	13	93	7	0.000247	0.0002	PRG	1.24
Pentachlorophenol	87-86-5	0.00728	0.00182	11	11	100	91	0.00728	0.00056	PRG	13.0

Notes:

MCL - Maximum Contaminant Level

PRG - Preliminary Remediation Goal

SLV - Screening Level Value

These data were originally screened and submitted to DEQ in November 2007. The SLVs are from the 2007 version of Table 3-1 of the JSCS Guidance Document (DEQ 2005).

[a] Minimum SLV

[b] Detected results only

Table 4-4. Comparison of DDx Concentrations with Standard DEQ Screening Levels

Storm Water Summary.

Analyte	CAS #	Units	Max Detected Result	Mean of Detected Results	# Samples	# Detected Results	% of Detected Results	# Detected Results Exceed PRG	% of Detected Exceedances	Drinking Water PRG	Quotient
4,4'-DDD	72-54-8	mg/l	0.000133	0.0001	14	10	71	0	0	0.00028	--
4,4'-DDD (dissolved)	72-54-8	mg/l	8.27E-06	4.84E-06	14	12	86	0	0	0.00028	--
4,4'-DDE	72-55-9	mg/l	0.002	0.000343	14	12	86	7	50	0.0002	10
4,4'-DDE (dissolved)	72-55-9	mg/l	0.000101	0.0000255	14	7	50	0	0	0.0002	--
4,4'-DDT	50-29-3	mg/l	0.00248	0.000429	14	14	100	6	43	0.0002	12.4
4,4'-DDT (dissolved)	50-29-3	mg/l	0.000138	0.0000303	14	10	71	0	0	0.0002	--

Surface Soil Summary.

								DEQ Occupational RBCs				DEQ Residential RBCs			
Analyte	CAS #	Units	Max Detected Result	Mean of Detected Results	# Samples	# Detected Results	% of Detected Results	# Detected Results Exceed SLV	% of Detected Exceedances	SLV	Quotient	# Detected Results Exceed SLV	% of Detected Exceedances	SLV	Quotient
4,4'-DDD	72-54-8	mg/kg	260	11.99	77	46	60	9	12	11	24	15	19	2.4	108
4,4'-DDE	72-55-9	mg/kg	190	9.448	77	50	65	12	16	7.7	25	21	27	1.7	112
4,4'-DDT	50-29-3	mg/kg	12000	512.8	77	74	96	45	58	7.7	1558	55	71	1.7	7059

Catch Basin Sediments Summary.

								DEQ Occupational RBCs				DEQ Residential RBCs			
Analyte	CAS #	Units	Max Detected Result	Mean of Detected Results	# Samples	# Detected Results	% of Detected Results	# Detected Results Exceed SLV	% of Detected Exceedances	SLV	Quotient	# Detected Results Exceed SLV	% of Detected Exceedances	SLV	Quotient
4,4'-DDD	72-54-8	mg/kg	44.6	1.875	36	36	100	1	3	11	4	3	8	2.4	19
4,4'-DDE	72-55-9	mg/kg	8.01	0.8195	36	36	100	1	3	7.7	1	6	17	1.7	5
4,4'-DDT	50-29-3	mg/kg	128	5.373	36	36	100	4	11	7.7	17	9	25	1.7	75

Notes:
SLV - Screening Level Value

Table 4-5. Stormwater COPC Loading from Lots 3 and 4.

COPC	Outfall 001 (mg/L)	Outfall 002 (mg/L)	Outfall 003 (mg/L)	Outfall 004 (mg/L)
4,4'-DDD				
02/15/07	3.74E-05	4.29E-05	5.92E-05 U	6.34E-05
03/02/07	4.48E-05 J	5.40E-05 J	3.33E-05 J	5.45E-05 J
03/19/07	5.92E-05 U	5.92E-05 U	2.78E-05 U	4.09E-05 U
06/05/07	3.33E-05 J	3.33E-05 J	NS	NS
Average Concentration[a]	4.51E-05	4.00E-05	0.00E+00 [b]	4.61E-05
Annual Discharge Quantity (gal)	10,900,000	1,400,000	4,000,000	1,700,000
Average Annual Mass (lb)	4.10E-03	4.67E-04	0.00E+00	6.54E-04
Total Loading (lbs):	0.0052			
4,4'-DDE				
02/15/07	1.48E-04	2.29E-04	2.28E-04	8.43E-05 U
03/02/07	2.16E-04	2.49E-04	9.28E-05	1.34E-04
03/19/07	2.28E-04	2.28E-04	2.40E-04 J	1.57E-04
06/05/07	9.28E-05 J	9.28E-05 J	NS	NS
Average Concentration[a]	1.71E-04	2.00E-04	1.87E-04	1.11E-04
Annual Discharge Quantity (gal)	10,900,000	1,400,000	4,000,000	1,700,000
Average Annual Mass (lb)	1.56E-02	2.33E-03	6.24E-03	1.58E-03
Total Loading (lbs):	0.0257			

Table 4-5. Stormwater COPC Loading from Lots 3 and 4.

COPC	Outfall 001 (mg/L)	Outfall 002 (mg/L)	Outfall 003 (mg/L)	Outfall 004 (mg/L)
4,4'-DDT				
02/15/07	1.32E-04 J	3.73E-04 J	1.57E-04	8.43E-05
03/02/07	1.61E-04 J	4.78E-04 J	1.80E-04 J	1.22E-04 J
03/19/07	1.57E-04	1.57E-04	2.14E-04 J	1.27E-04
06/05/07	1.80E-04 J	1.80E-04 J	NS	NS
Average Concentration[a]	1.58E-04	2.97E-04	1.84E-04	1.11E-04
Annual Discharge Quantity (gal)	10,900,000	1,400,000	4,000,000	1,700,000
Average Annual Mass (lb)	1.43E-02	3.47E-03	6.13E-03	1.58E-03
Total Loading (lbs):	0.0262			
Total DDx Loading (lbs):	0.0572			

Notes:

[a] Averages were calculated using 1/2 the detection limit for undetected constituents. If all concentrations were below detection limits, averages were not calculated.

[b] If analyte was not detected in a given area, average concentration was assumed to be zero.

U - undetected at detection limit shown
J - estimated concentration
NA - not applicable
NS - not sampled

Table 4-6. Upstream DDx[a] Loads in the Willamette River.

Sample Date	Upstream DDx Concentration (pg/L)[b]	Willamette River Flow (cfs)	DDx Load at RM 11	
			lbs/day	lbs/year
Nov-04	43.1	20,000	0.0046	1.70
Mar-05	46	10,000	0.0025	0.91
Jul-05	86.9	9,000	0.0042	1.54
Jan-06	584	169,000	0.5324	194.32
Sep-06	96.2	6,000	0.0031	1.14
Nov-06	91.4	16,000	0.0079	2.88
Mar-07	563.6	65,000	0.1976	72.13
		Mean (w/o highest flow event):	0.0367	13.3807

Notes:

[a] DDx is sum of 2,4' and 4,4- isomers of DDT, DDD, and DDE. Concentration is an average of the east, west, and mid-river samples. One-half the detection limit was used for concentrations below the detection limit.

[b] Upstream samples collected at RM 11.

pg/L = picogram/liter
CFS = cubic feet per second

Table 5-1. Preliminary Project ARARs for the Arkema Stormwater IRM

ARAR and Citation	Description	Applicability
Federal		
Federal Water Pollution Control Act/Clean Water Act (CWA) [33 USC Sections 1313, 1314, and 1341; 40 CFR Parts 131, 230]	The CWA establishes the basic structure for regulation of discharges of pollutants into waters of the United States. Section 401(33 USC Section 1341) requires state certification that a discharge will not violate state water quality standards.	The implementing regulations of the CWA are applicable.
Resource Conservation and Recovery Act (RCRA) [42 USC Section 6921; 40 CFR Parts 260, 261]	RCRA provides standards for the identification and management of solid and hazardous waste.	These regulations are potentially applicable if soil contains a listed or characteristic waste that could be subject to RCRA requirements for storage, treatment, and disposal.
Hazardous Materials Transportation Act [49 USC Section 15101 *et seq.*; 49 CFR Section 171-177]	Regulations provide for packaging, documentation, and transportation of hazardous waste (some RCRA requirements also apply).	This regulation is potentially applicable if any soil excavated as part of the removal action is identified as hazardous waste and requires shipment for treatment or disposal.
State		
Oregon Water Quality Law (WQL) [ORS 468b.005 – 468b.095 (surface water) and ORS 468B.150-190 (groundwater); Oregon Water Quality Standards and Criteria, OAR Chapter 340, Divisions 40 and 41]	The WQL designates beneficial uses of water bodies and water quality standards and criteria necessary to protect those uses. In particular, OAR 340-041-0340 provides the beneficial water uses that shall be protected in the Willamette Basin. OAR 340-041-0442 through 340-041-0445 provide water quality standards for the State of Oregon. With respect to groundwater, OAR 340-0404-020 and 340-0404-0303(3)(b) define an "…antidegradation policy to emphasize the prevention of groundwater pollution and to control waste discharges to groundwater so that the highest possible water quality is maintained."	This regulation is applicable because the beneficial use of groundwater and the Willamette River must be protected.

Table 5-1. Preliminary Project ARARs for the Arkema Stormwater IRM

ARAR and Citation	Description	Applicability
Oregon Regulations pertaining to NPDES and water pollution control facility (WPCF) Permits [OAR Chapter 340, Division 45]	The Oregon NPDES regulations establish discharge limits and monitoring requirements for direct discharges to surface waters.	The requirements of this regulation are potentially applicable to any direct discharges of treated or untreated water to the Willamette River.
Oregon Solid Waste Management Act (SWMA) [ORS 459.005 *et seq*.; OAR 340-094-0040]	The SWMA provides standards for the management and handling of solid wastes in Oregon.	This regulation is potentially applicable because nonhazardous materials may be disposed of at a Subtitle D landfill.
Hazardous Waste Regulations [ORS 466.005-466.225; OAR Chapter 340-101-0033]	Hazardous waste regulations provide standards for the identification and management of hazardous wastes in Oregon.	This regulation is applicable if any soil excavated as part of the removal action is identified as hazardous waste and requires shipment for treatment or disposal in Oregon.
Cleanup Standards [OAR 340-122-0040(2)(a), (4) and (6]	The cleanup standards provide hazardous substance remedial action levels and requirements.	This regulation is applicable to the establishment of cleanup levels and other requirements for the removal action.
Indian Graves and Protected Objects (IGPO) [ORS 97.740 *et seq.*]	The IGPO protects human remains, funerary objects, sacred objects, and objects of cultural patrimony.	This regulation is applicable only if Native American remains or funerary objects are at the site, which, based on current information, is considered very unlikely.
Archaeological Objects Site [ORS 358.905 *et seq.*]	The archaeological objects laws protect archaeological objects and sites; requires notice upon discovery of artifacts.	This regulation is unlikely to be applicable, because the site has not been shown to be an archaeological resource.

Table 5-1. Preliminary Project ARARs for the Arkema Stormwater IRM

ARAR and Citation	Description	Applicability
Air Quality [OAR 340-226-0100]	The air quality laws provide general emissions standards for fugitive emissions of air contaminants and require the highest and best practicable treatment of control of such emissions.	This regulation is applicable only if a removal action generates fugitive emissions of air contaminants, which is considered unlikely.
Visible Air Contaminant Limitations [OAR 340-208-0110]	The visible air contaminant limitations prohibit the emission of any air contaminant from a new source for a period or periods aggregating more than 3 minutes in any 1 hour that is equal to or greater than 20% opacity. These rules are for "special control areas," including Multnomah County.	This regulation is applicable only if a removal action generates visible air emissions of air contaminants, which is considered unlikely.
Fugitive Emission Requirements (FER) [OAR 340-208-0200, 0210]	The FER prohibits any handling, transporting, or storage of materials, use of a road, or any equipment to be operated, without taking reasonable precautions to prevent particulate matter from becoming airborne. These rules are for "special control areas," including Multnomah County.	This regulation is potentially applicable if excavated soil requires shipment, which is considered unlikely.
City of Portland Requirements for Greenway overlay zones [City of Portland Zoning Code Chapter 33.440]	The City of Portland has established Greenway overlay zones adjacent to the Willamette River to conserve natural, scenic, historical, economic, and recreational qualities and to promote public access, flood protection, and aesthetic factors. The regulations for Greenway overlays require that proposed development not be detrimental to the use and function of the river and abutting lands and must conserve, enhance, and maintain scenic qualities and natural habitat.	This regulation is potentially applicable to remedial activities at the site, as portions of the site are located within a Greenway overlay.
Certification of Compliance with Water Quality Requirements and Standards (CCWQ) [ORS 468b.035; OAR Chapter 340, Division 48]	The CCWQ requirements describe procedures for processing applications for certification pursuant to Section 401 of the CWA.	This regulation is potentially applicable because a water quality monitoring program and performance standards will be required for the preferred removal action alternative.

Table 6-1. Detailed Comparison of Retained Treatment Alternatives.

Alternative	Effectiveness	Implementability	Cost
Alternative 1. Surface Soil Capping and Abandonment of the Existing Sewer System with Channelized Overland Flow.	Anticipated to have a very high removal of Site COPCs from stormwater discharge.	Readily available technology. Cap may be compomrised by final site remedy. Surface swales may inhibit access during the implementation of the final site remedy.	Capital - $2,100,000 10-yr Present Value-$2,500,000
Alternative 2. Surface Soil Capping of "Hot Spots". Abandonment of the Existing Sewer System and Replacement with a New Sewer System with In-Ground Treatment	Anticipated to have an average to high removal of Site COPCs from stormwater discharge.	Readily available technology.; however, requires excavation of subsurface soils in potentially contaminated areas for installation of the collection and treatment system. Column tests should be conducted.	Capital - $1,900,000 10-yr Present Value-$2,300,000
Alternative 3. Abandonment of the Existing Sewer System, Surface Soil Capping of "Hot Spots," Enhanced Stormwater Infiltration and Treatment Prior to Discharge.	Antcipated to have a high removal of Site COPCs from stormwater discharge.	Readily available technology. Geotechnical evaluation and infiltration testing will be required prior to siting of the infiltration basin. Column tests should be conducted.	Capital - $1,200,000 10-yr Present Value-$1,600,000