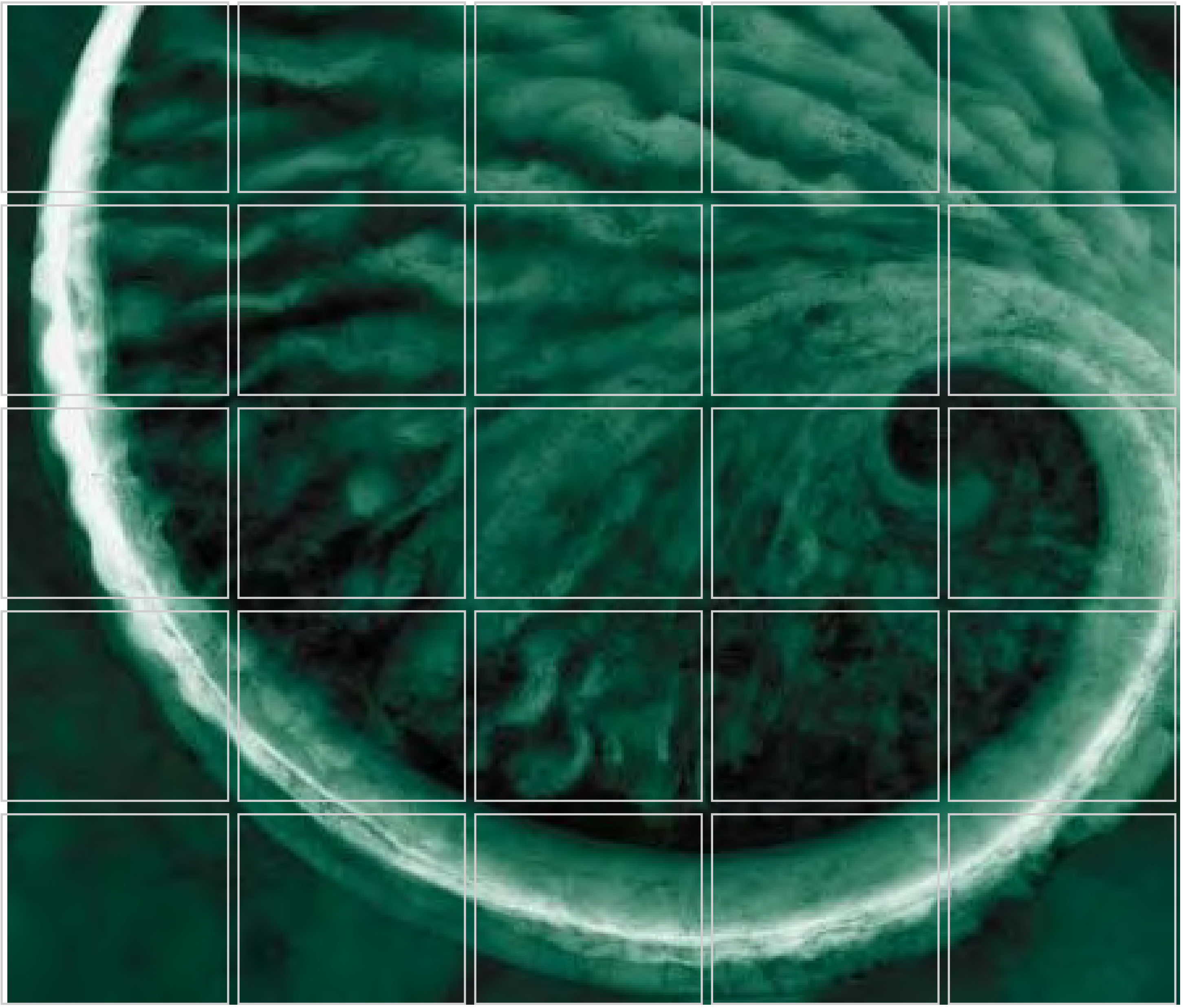

Final Performance Monitoring Plan – Groundwater Source Control Measure

Arkema Inc. Facility
Portland, Oregon

August 2013

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Prepared for:
Legacy Site Services LLC

ERM

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Arkema Inc. Facility, Portland, Oregon

August 2013

Project No. 180382

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LIST OF ACRONYMS

COPC	Constituent of potential concern
DDT	Dichlorodiphenyltrichloroethane
ERM	ERM-West, Inc.
FBR	Fluidized bed reactor
FFS	Focused feasibility study
FS	Feasibility study
GWBW	Groundwater barrier wall
GWET	Groundwater extraction and treatment
GW SCM	Groundwater source control measure
JSCS	Joint Source Control Strategy
LSS	Legacy Site Services LLC
NPDES	National Pollutant Discharge Elimination System
NTCRA	Non-time-critical removal action
ODEQ	Oregon Department of Environmental Quality
PDR	Preliminary Design Report
PMP	Performance Monitoring Plan
PVC	Polyvinyl chloride
SCM	Source control measure
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

On behalf of Legacy Site Services LLC (LSS), agent for Arkema Inc. (Arkema), ERM-West, Inc. (ERM) has prepared this Performance Monitoring Plan (PMP) for the former Arkema Portland Plant located at 6400 NW Front Avenue in Portland, Oregon (the site) (Figure 1-1). This PMP has been prepared pursuant to the Order on Consent requiring source control measures (SCMs) and a feasibility study (FS) issued by the Oregon Department of Environmental Quality (ODEQ), signed 31 October 2008 (DEQ No. LQVC-NWR-08-04) (Consent Order).

The purpose of this PMP is to present the monitoring requirements for the implementation of a groundwater source control measure (GW SCM). The PMP has been prepared in accordance with the following:

- *Scoping Technical Memorandum, Groundwater Source Control Interim Remedial Measure* (Scoping Memo) (ERM 2006);
- *Summary of Remedial Technology Alternatives Memorandum, Groundwater Source Control Interim Remedial Measure Focused Feasibility Study* (ERM 2008a);
- *Draft Focused Feasibility Study, Groundwater Source Control Interim Remedial Measure* (FFS) (ERM 2008b);
- *Draft Groundwater Source Control Measure Design and Implementation Work Plan* (Work Plan) (ERM 2009b);
- *Draft Preliminary Design Report – Groundwater Source Control Measure* (PDR) (ERM 2010b);
- *Groundwater Extraction and Treatment System Pre-Final Design* (ERM 2011b);
- *Groundwater Extraction and Treatment System Final Design* (Groundwater Extraction and Treatment [GWET] System Final Design) (ERM 2013); and
- Associated comments and approvals received from the ODEQ and United States Environmental Protection Agency (USEPA).

1.1 BACKGROUND

The Site is located at 6400 NW Front Avenue in the Northwest Industrial Area of Portland, Oregon. The Site is located in the heart of the Guild's

Lake Industrial Sanctuary, zoned and designated "IH" for heavy industrial use. The Site is bounded by Front Avenue on the north and west, the Willamette River on the east, and an asphalt roofing manufacturer on the south. The plant operated as a chemical manufacturing facility for over 50 years. Manufacturing activities at the facility were terminated in 2001, and the plant was decommissioned and dismantled in 2004. F

1.1.1 Site History

Starting in 1941, various chemicals were produced at the site, including: sodium chlorate, potassium chlorate, chlorine, sodium hydroxide, dichlorodiphenyltrichloroethane (DDT), sodium orthosilicate, sodium hydroxide, magnesium chloride hexahydrate, ammonia, ammonium perchlorate, sodium perchlorate, and hydrochloric acid. Most recently, the facility was an operating chlor-alkali plant until the plant shut down in 2001.

A detailed description of historical site activities and manufacturing processes was presented in the *Upland Remedial Investigation Report Lots 3 & 4 and Tract A – Revision 1* (RI Report) (ERM 2005).

Decommissioning and removal of the manufacturing infrastructure were completed in early 2005. The only remaining original structures are the office building located at the site entrance on Front Street and several concrete floor slabs left in place as environmental caps (Figure 1-2). Arkema maintains leases from the Oregon Department of State Lands for the docks in the Willamette River, which are not currently in use.

1.1.2 Regulatory Background

In 1998, Arkema entered into a Voluntary Agreement with the ODEQ under the Oregon Voluntary Cleanup Program to address impacts on environmental media associated with the manufacture of DDT in the Acid Plant Area and sediment in the Willamette River adjacent to the Site. The RI Report was conditionally approved by the ODEQ on 5 June 2006. Detailed information regarding environmental conditions at the Site is provided in the RI Report, which contains a site description, background information, and discussion of the nature and extent of contamination at the Site.

In June 2005, Arkema entered into a non-time-critical removal action administrative settlement with the United States Environmental

Protection Agency (USEPA) (Early Action)[1] to address impacts to near-shore sediment at the Site. The Statement of Work for the Early Action requires, among other things, the preparation and delivery of an Engineering Evaluation/Cost Analysis (EE/CA) Work Plan to identify and provide alternatives for addressing the primary chemicals of potential concern (COPCs) in the intertidal area and submerged lands on and adjacent to the Site. The draft EE/CA was submitted to the USEPA on 26 July 2012 (Integral 2012). Agency comments on the EE/CA were received on 11 February 2013. Responses were submitted on 28 March 2013.

In 2008, Arkema and the ODEQ entered into the Consent Order for the upland portion of the Site. The upland Consent Order requires submittal of various documents in support of upland source control (i.e., groundwater, stormwater, and erodible soil) and the upland FS (data gap investigation, risk assessment, hot spot evaluation, and FS Work Plan and FS).

A groundwater source control evaluation was submitted to the ODEQ in 2007 (Integral 2007a) and an addendum was submitted in 2008 (Integral 2008a). The source control screening evaluation concluded that implementation of the Groundwater SCM would prevent additional contaminant flux to the Willamette River, as required by the Joint Source Control Strategy (JSCS)[2]. In May 2008, LSS submitted the *Focused Feasibility Study, Groundwater Source Control Interim Remedial Measure* (FFS) in support of the Groundwater SCM at the Site (ERM 2008b). The FFS provided an evaluation of remedial alternatives and selected the preferred alternative for the Groundwater SCM.

On 23 February 2009, the ODEQ approved the general approach for the Groundwater SCM. This approach included installation of a groundwater barrier wall and a GWET system, with treated water discharged to the Willamette River. The ODEQ approved the *Groundwater Barrier Wall Final Design* (ERM 2012b) on 7 August 2012. Construction of the groundwater

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1 *Administrative Order on Consent for Removal Action*, USEPA Region 10, Docket No. CERCLA 10-20050191 (27 June 2005).

2 *The Portland Harbor Joint Source Control Strategy* prepared by the ODEQ and USEPA (ODEQ 2005) is a framework for making upland source control decisions at the Portland Harbor Superfund Site.

barrier wall began in May 2012 and was completed in December 2012. The ODEQ approved the *Arkema Portland Groundwater Source Control Measure Groundwater Extraction and Treatment System Final Design* (ERM 2013) on 2 April 2013. Construction of the GWET system began in December 2012 and is anticipated to be completed in September 2013.

Between September 2000 and November 2006, several stormwater IRMs—including soil removal, temporary capping, and Best Management Practices [BMPs]—were implemented at the Site to address stormwater (Integral 2007b). However, because the planned Groundwater SCM was going to require a substantial modification and rerouting of the existing stormwater system, LSS agreed to further enhance the stormwater BMPs. LSS subsequently began preparing a Stormwater SCM FFS (SW FFS) (Integral 2008b) to evaluate additional stormwater IRMs. Following negotiation and response to comments on the SW FFS, LSS began designing the Stormwater SCM with preparation of the Design Work Plan (Integral 2009). Subsequent to this submittal, the ODEQ and Arkema entered into the Memorandum of Agreement and Order (MAO), which was executed on 4 August 2010.

The *Final Design Report Stormwater Source Control Measures* (Integral 2011) was submitted on 30 September 2011 and conditionally approved by the ODEQ on 21 December 2011. Construction of the Stormwater SCM began in April 2012 and was substantially complete at the time of this Work Plan. The design and implementation of the Stormwater SCM are summarized in Section 3.6.2. Stormwater SCM performance monitoring began in January 2013. A Performance Monitoring Report for the Stormwater SCMs at the Arkema Portland Facility was submitted on 1 June 2013. These design reports and performance monitoring report were prepared pursuant to the Order on Consent requiring SCMs, issued by the ODEQ, signed 31 October 2008 (ODEQ No. LQVC-NWR-08-04), and the storm water MAO, No. WQ/I-NWR-10-175 executed by ODEQ and LSS, as agent for Arkema, on 4 August 2010.

1.1.2 Groundwater Source Control Measure Development

The JSCS is a guidance document that was developed by the ODEQ and USEPA to identify, evaluate, and control potential sources of contamination that may impact the Willamette River in a manner that is consistent with the objective and schedule for the Portland Harbor Superfund Site RI/FS (ODEQ 2005). LSS notes that, per statements from ODEQ and USEPA in the JSCS, screening levels are not intended to be cleanup levels or discharge limits. The goal of the JSCS is to achieve timely upland source control to prevent the risk of significant recontamination after the Portland Harbor cleanup is completed. The JSCS recommends that upland source control be substantially completed to the greatest extent practicable before or during any early removal actions, as well as non time-critical removal actions (NTCRAs), in order to reduce the potential for recontamination of river sediment.

Several innovative in situ interim remedial measures were implemented at the site between September 2000 and April 2006. Despite the success of those interim remedial measures, LSS did not believe an in situ remedial approach would be capable of meeting the source control objectives—many of which are not yet defined—in the USEPA-envisioned timeframe for the sediment NTCRA currently being planned at the site. Because of the NTCRA schedule, LSS has been required to pursue an alternative strategy of physical and hydraulic containment to achieve groundwater source control.

Following discussions with the ODEQ in September 2006, the Scoping Memo (ERM 2006) was prepared to identify and outline the general concepts necessary to complete a GW SCM. The ODEQ provided comments on this memo in January 2007, and these comments were addressed in a letter submitted by LSS in March 2007.

LSS subsequently commenced preparation of the FFS in April 2007 to evaluate the alternatives for a GW SCM to achieve the following remedial action objectives:

- Establish hydraulic control of groundwater constituents of potential concern (COPCs) at the site, and maintain an inward groundwater gradient toward the upland portion of the site, away from the Willamette River;
- Reduce the potential for recontamination of river sediments via the groundwater pathway following the Arkema NTCRA;
- Allow upland SCMs to proceed on an independent schedule from the NTCRA without impeding or compromising that work; and
- Implement a remedy, which, to the extent practicable, will complement and be compatible with potential final upland remedies for the site.

The GW SCM evaluated in the FFS consisted of the following primary components:

1. A containment barrier wall to physically separate the affected upland portions and in-water portions of the site.
2. Hydraulic control (GWET) to prevent groundwater containing unacceptable concentrations of COPCs from moving around, over, or under the containment barrier wall.
3. Management of treated groundwater from the ex situ treatment system, with treated effluent discharged to the Willamette River under a National Pollutant Discharge Elimination System (NPDES) Permit.

As requested by the ODEQ, LSS submitted the *Summary of Remedial Technology Alternatives Memorandum Groundwater Source Control Interim Remedial Measure Focused Feasibility Study* (ERM 2008a) in January 2008. This document provided a technology screening and summarized the range of remedial alternatives (i.e., proposed barrier wall alignments, treatment system options, and discharge options) being evaluated as part of the FFS (ERM 2008b).

Supporting studies and evaluations—including groundwater modeling, a GWBW geotechnical engineering analysis, slurry materials testing, and a groundwater treatability study—were completed between 2006 and 2008. Following the completion of this supporting work and the technology screening, a detailed evaluation and comparative analysis of the various remedial action alternatives was performed and presented in the FFS submitted to the ODEQ in May 2008.

The lateral and vertical extent of the GW SCM was primarily determined by the extent of four major COPCs in groundwater: hexavalent chromium, perchlorate, chlorobenzene, and DDT (and associated breakdown products DDD and DDE, collectively referred to as DDx). The historical interim remedial measures have focused on remediating one or more of these COPCs. Current and historical data indicate that the on-site sources of these compounds are limited to specific areas on Lots 3 and 4 (ERM 2005; ERM 2010a). Once an approved groundwater source control evaluation for the former Rhone Poulenc site is available, the ODEQ and LSS will evaluate the need for Rhone Poulenc to perform additional GW SCMs along Lots 1, 2, and the remainder of Lot 3.

The ODEQ conditionally approved the FFS and provided comments on the proposed GW SCM in a letter dated 29 July 2008. On 12 September 2008, LSS submitted responses to ODEQ comments on the FFS.

In a memorandum dated 20 February 2009, the ODEQ recommended alternatives for the primary components of the GW SCM. The layout of the GW SCM is presented as Figure 1-2. A conceptual cross section of the GW SCM is presented as Figure 1-3.

The recommended barrier wall component of the GW SCM required construction of a GWBW along the top of the river bank extending to the top of the basalt using conventional slurry wall technology. The GWBW construction was completed in December 2012. The recommended GWET system for the GW SCM consists of the following major components:

- Twenty-two groundwater recovery wells screened in the Shallow and Intermediate Zones;
- A chemical precipitation reactor with aeration and pH adjustment via sodium hydroxide;
- A solids handling system (i.e., clarifier with polymer feed, sludge holding tank, and associated equipment);
- A pH adjustment tank;
- An optional post-clarification solids filter, if required;
- A fluidized bed reactor (FBR) with a solids filter for biomass handling; and
- Two liquid-phase granular activated carbon vessels in series.

The recommended treated water discharge option consists of discharge to the Willamette River.

The ODEQ published a public notice on 9 March 2009 seeking public comments on the recommended remedial alternative. A public meeting was held on 14 April 2009 to present the GW SCM. The public comment period closed on 21 April 2009 and the ODEQ issued a response to public comments in a letter dated 21 May 2009. The Work Plan was prepared following the FFS, as required by the Consent Order.

The PDR was submitted to the ODEQ in May 2010. The *Groundwater Source Control Measure – Groundwater Barrier Wall Pre-Final Design* (ERM 2010b) was submitted to the ODEQ in October 2010. A recovery well and piezometer network design was submitted to the ODEQ in an email dated 11 December 2012. The final recovery well and piezometer network design was approved by ODEQ 14 March 2013. The GWET System Final Design was submitted to the ODEQ on 7 March 2013. The Final Design was approved by the ODEQ on 2 April 2013. This PMP is a document required under the Work Plan, the PDR, and the GWET System Final Design.

1.2 OBJECTIVES

The objectives of this PMP are to:

- Present the monitoring scope and rationale for evaluating the performance of the GW SCM in preventing the flux of contaminants in groundwater to the Willamette River; and
- Present an effluent discharge monitoring scope and rationale to evaluate compliance with as-yet-to-be-determined NPDES permit requirements.

1.3 REPORT ORGANIZATION

The remainder of the PMP is organized as follows:

- Section 2.0 presents the hydraulic containment system layout, target capture zone, water level monitoring locations, and evaluation of capture;
- Section 3.0 presents the groundwater treatment system summary, system performance monitoring scope, and proposed NPDES compliance monitoring scope;
- Section 4.0 presents the adaptive management process and reporting of performance monitoring results; and
- Section 5.0 lists the references cited in this PMP.

2.0 HYDRAULIC CONTAINMENT MONITORING

2.1 GROUNDWATER EXTRACTION SYSTEM MANAGEMENT

A key objective of the GW SCM is to achieve hydraulic containment of the alluvial sequence at the site, in order to prevent the flow of COPCs to the Willamette River. The alluvial sequence at the site consists of the Shallow Zone, Intermediate Zone, Shallow-Intermediate Silt, and the Deep Zone. The distribution of COPCs at the site is predominantly within the Shallow Zone, with decreasing impacts observed in the Intermediate and Deep Zones. The conceptual design of the GW SCM is shown on Figure 1-3.

The layout of the GW SCM, including the Target Capture Zone, is presented on Figure 2-1. A numerical groundwater model was used to determine the distribution of recovery wells required to achieve hydraulic capture using conservative extraction rates developed from site-specific pumping tests (ERM 2010b).

The hydraulic conditions of the site are variable and subject to both seasonal and daily tidal fluctuations. As noted in the PDR, there is additional inherent uncertainty associated with the results of numerical groundwater modeling. Because of this inherent uncertainty, an adaptive management approach will be used to control the operation of the groundwater extraction system to meet the objectives of the GW SCM (i.e., hydraulic capture of the alluvial sequence and maintaining an inward hydraulic gradient across the GWBW).

The principle of adaptive management is a systematic, iterative process of decision-making. The proposed approach will consist of regular monitoring of the hydraulic conditions of the GW SCM. The monitoring results will then be used to evaluate the performance of the GW SCM. Appropriate changes can be made to the operation of the extraction system to optimize the performance of the GW SCM. Subsequent monitoring will be used to evaluate the effectiveness of these operational changes and determine the need for additional, or alternative, measures.

The primary method for evaluating the performance of the GW SCM will be through evaluating the capture zone of the extraction system. The USEPA has published the guidance document *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (USEPA 2008) for the development of hydraulic containment performance monitoring programs; this guidance has been followed to develop the monitoring program described in this PMP. The guidance identifies six steps for systematic evaluation of capture zones:

1. Review site data, site conceptual model, and remedy objectives;
2. Define site-specific Target Capture Zone;
3. Interpret water levels using potentiometric surface maps (horizontal), water level difference maps (vertical), and water level pairs (gradient control points);
4. Perform calculations, including flow rate, capture zone width, and numerical modeling (simulate water levels, particle tracking, and/or transport modeling);
5. Evaluate concentration trends; and
6. Interpret actual capture and compare to Target Capture Zone, and assess uncertainties and data gaps.

The steps outlined above encompass an adaptive management approach evaluating the performance of the GW SCM and incorporating changes in the operation of the system.

Steps 1 and 2 have been performed as part of the development of the GW SCM. The current site data and conceptual model for the purpose of GW SCM design were presented most recently in the ODEQ-approved PDR. The objective of the GW SCM is to establish hydraulic control of groundwater at the Arkema site, and maintain an inward groundwater gradient towards the upland portion of the site, away from the Willamette River. The approved SCM consists of constructing a conventional slurry barrier wall, and installing and operating a GWET system.

The lateral extent of the Target Capture Zone shown on Figure 2-1 was based on the historical and current (as of August 2009) distribution of COPCs at the site, as presented in Appendix A of the PDR. The vertical extent of the Target Capture Zone includes the alluvial sequence, which consists of the Shallow Zone, Shallow-Intermediate Silt, Intermediate Zone, and the Deep Zone. The Basalt Zone is not included in the Target Capture Zone. However, some flow of groundwater from the Basalt Zone upwards into the actual capture zone will occur. A vertical profile of the recovery well and piezometers adjacent to the GWBW are presented in Appendix B.

The purpose of the monitoring described in this section is to provide sufficient data to perform Step 3, the interpretation of water levels, and

Step 4, the calculation and numerical modeling for verification of target capture zone extent.

The purpose of treatment system sampling described in Section 3 is to meet the ODEQ-approved design treatment objectives and the as-yet-to-be-determined compliance monitoring requirements of the NPDES industrial discharge permit.

The reporting described in Section 4 includes the comparison of actual capture to the Target Capture Zone and evaluation of system performance (i.e., Step 6).

The development of potential contingency measures, ranging from adjustment of extraction rates to installation of additional recovery wells, will be generally based on this analysis and applied as part of the adaptive management process described in Section 4.

2.2 *CAPTURE ZONE EVALUATION*

The purpose of water level monitoring is to provide sufficient data to demonstrate an inward hydraulic gradient across the GWBW and evaluate the actual capture zone of the GW SCM (i.e. Steps 3 and 4 described above).

Water level data will be collected using a combination of transducer and manual measurements. The proposed potentiometric surface monitoring points are listed in Table 2-2. Figures 2-2, 2-3, and 2-4 present the locations of the monitoring points in the Shallow, Intermediate, and Deep zones, respectively. The monitoring points consist of existing monitoring wells and piezometers installed between December 2012 and April 2013.

Select monitoring points will have water level transducers installed to allow real-time monitoring of groundwater elevations in designated locations at 15-minute intervals, as listed in Table 2-2. The groundwater elevations in these monitoring wells are likely to be influenced by seasonal and tidal fluctuations of the river.

The periodic manual water level measurements will be used evaluate the capture zone of the GW SCM and to confirm and recalibrate the transducers, as necessary.

Manual water level measurements will be completed monthly for the first year of operation to evaluate performance variability throughout the year and to make potential changes to optimize GW SCM performance. The appropriate long-term water level monitoring schedule will be determined based on this first year of system operation and optimization performance data. The long-term water level monitoring schedule will be presented in the Long-Term Operation and Maintenance Plan.

2.2.1 Potentiometric Surface and Water Level Difference Maps

Water level data will be used to prepare potentiometric surface maps (i.e., horizontal water level maps) of the Shallow, Intermediate, and Deep Zones. Flow lines can then be derived to determine the extent of horizontal capture of the GW SCM.

Vertical water level difference maps will be prepared by comparing the water levels in adjacent hydrogeological units. Specific clusters of monitoring points will be used to determine vertical gradient. This analysis will be used to determine areas of upward flow.

2.2.2 Gradient Control Points

One of the key measures of the performance of the GW SCM is the hydraulic gradient across the GWBW. By establishing an inward hydraulic gradient across the GWBW, a groundwater flux away from the Willamette River will be created.

Water level measurement and potentiometric surface mapping will be conducted periodically, as described in Section 2.3.1. The data collected as part of the potentiometric surface mapping will also be used to evaluate the hydraulic gradient across the GWBW within each hydrogeologic unit.

The hydraulic gradient across the GWBW will be continuously monitored in six areas (i.e., control point "clusters") along the GWBW alignment, as shown on Figure 2-5, to confirm that an inward hydraulic gradient across the GWBW is maintained between manual water level measurement events.

As noted in the PDR, the recovery well layout and anticipated extraction rates were iteratively adjusted in the groundwater model until particle-tracking results indicated that full capture of the alluvial sequence was achieved within the lateral extent of the Target Capture Zone. The particle tracking results and potentiometric surface maps are included as Appendix A.

The PDR presented the groundwater modeling design of the GW SCM and the steady-state results demonstrating hydraulic capture. The groundwater elevations estimated by the model at the compliance monitoring points were documented at this modeled steady state. The gradients were calculated as the difference in elevation between respective piezometer pairs divided by distance between the compliance cluster inside the wall and outside the wall. The model-predicted gradients between gradient control pairs are presented in Table 2-1.

There is inherent uncertainty and conservative assumptions used in the groundwater model to develop the recovery well system layout, including:

- 25-foot grid model resolution
- Complex interaction between the shallow and intermediate pumping well; and
- Rapid changes in the potentiometric surface adjacent to the GWBW and recovery wells.

These factors result in some of the modeled-predicted head differences and gradients being actually flat or outward across the barrier wall. Although there is an outward gradient observed across the GWBW in the individual aquifer zones, hydraulic control of the Target Capture Zone groundwater system was still achieved, as calculated by volumetric flow balance and particle tracking results. However, consistent with the conservative approach to GWET System design and operation, initial target gradient control set points will still be established at a minimum of 0.005 feet per feet inward across the GWBW. This will ensure that the conditions predicted by the model for achieving hydraulic control are met or exceeded during the initial operation of the GWET System. As described in Section 4, an adaptive management approach will be used to refine target gradient set points as GW SCM performance monitoring data is used to update the hydrogeologic model of the site.

2.2.2.1 Real Time Water Level Data Filtering

The water levels in the gradient control points outside of the GWBW are anticipated to fluctuate approximately 2 to 3 feet with the tides on a daily basis (ERM 2010b). The water levels inside the GWBW are anticipated to fluctuate with a much lower amplitude and significant time lag compared to the points closer to the Willamette River. The Willamette River experiences a tidal influence from the Pacific Ocean, which produces a progressive pressure wave that propagates inland, causing groundwater levels, and therefore hydraulic gradients, to fluctuate.

In a system with tidal fluctuations of groundwater levels, mathematic filtering methods are used more accurately determine groundwater elevations by filtering tidal fluctuations using a moving average of a three day moving average (Serfes 1991). In order to provide an accurate value for the calculation of the long-term hydraulic gradient, the Serfes filtering method will be applied. The Serfes filtering method applies the central limit theorem to groundwater elevation measurements collected on an hourly basis. Typically, diminishing return of accuracy is observed by increasing the number of points (i.e. shorter time intervals between measurements) included in a dataset. However, because groundwater level measurements of gradient control point pairs can be recorded by level transmitters and will be monitored remotely, readings will be taken every 15 minutes, on a real-time basis, via a network connection. These 15-minute interval readings will be used to calculate a mean hydraulic gradient. The Serfes filtering method, using a 3-day moving average, will be applied as follows:

1. Transmitters shall be calibrated to existing groundwater elevation conditions prior to beginning the 3-day moving average calculation.
2. The transmitters will be set to collect water level data every 15 minutes, at least 3 days prior to initiating the GW SCM system.
3. First moving average: A moving average will take an average of the first 24 hours of data collected (96 observation points).
4. Second moving average: A second moving average will take an average of 24 hours of the first running average (96 observation points).
5. Mean water level (third moving average): A third moving average will determine the mean water level. The third running average will take an average of 24 hours of the second running average. The first point of data will be at hour 36. The fourth point of data will be at hour 37.

The mean hydraulic gradient will be calculated between well pairs based on the calculated water levels, established by the moving average of a 3-day moving average and lateral distance between the well pairs.

The extraction rates from the individual recovery wells will be adjusted in order to maintain an inward hydraulic gradient, as measured within each of the six gradient control point clusters. The extraction pumps in the recovery wells are fitted with variable frequency drives and water level sensors connected to the networked computer on site. Flow adjustments at individual wells can be made manually and/or remotely through the on-site computer.

As noted in Section 2.3.1, unanticipated variations (i.e., too large or too small) in the real-time water level monitoring data will be confirmed by manual measurement of the water level. Spurious data, caused by water level sensor malfunction or calibration drift, will not be used for gradient evaluation. In these cases, the water level sensors will be replaced or repaired as necessary to monitoring the long-term hydraulic gradient.

The results of monthly potentiometric surface mapping and actual capture zone analysis will be used iteratively to develop specific target gradients and head differences for each well cluster during the first 12 months of operation, in accordance with the adaptive management plan presented in Section 4.1. These target gradients will be presented in the Long-Term Operation and Maintenance Plan that will be prepared following GWET system startup and optimization.

2.2.3 Recovery Well Efficiency

The groundwater extraction system will be operated to achieve a target head difference across the GWBW. Extraction rates from individual wells will be adjusted to maintain the inward hydraulic gradient.

As noted in the PDR, the well losses in recovery wells may be significant. Well losses are affected by well construction, well development, and long-term fouling of the screen. Excessive well losses can lead to insufficient available drawdown for proper pump operation or to meet the required extraction rate.

The water levels in the recovery wells will be monitored continuously using a water level sensor as part of the operation of the GWET system. Water level measurement data will be used to optimize operation of the pumps, to establish high/low shutoff switches on the extraction pump, and in coordination with feedback from piezometer water level measurements. This data will also be used to monitor the efficiencies of the individual recovery wells over time. Water level data from recovery wells will not be used in the evaluation of actual capture zone. If well inefficiency is affecting the ability to achieve the target flow rate in a well, mitigation measures, such as well redevelopment, will be implemented, as discussed in Section 4.1.

2.3 RECOVERY WELL PUMP TESTS AND GROUNDWATER MODEL UPDATE

The performance monitoring program described above has been designed to provide sufficient data to evaluate whether the actual capture zone during GWET System operation encompasses the Target Capture Zone. The assessment of the capture zone will rely on the evaluation of potentiometric surface mapping and modeled particle tracking. This evaluation will require a sufficiently reliable groundwater model. As noted by the ODEQ, the current groundwater model includes assumed aquifer parameters (e.g. hydraulic conductivity) that are based on a series of localized pump tests. In order to improve the estimates of aquifer parameters along the length of the GWBW, a series of pump tests of individual recovery wells will be conducted prior to full operation of the GWET System. The empirical data collected during these tests will be applied to recalibrate the model. Recalibration of the model will include recalculation of vertical and horizontal hydraulic conductivity around each recovery well to improve the accuracy of model prediction and subsequent particle tracking results.

These individual recovery well pump tests will achieve the following objectives:

- Refinement of localized aquifer properties and hydrogeologic conditions, and subsequent recalibration and update of the groundwater model;
- Provide an indication of the maximum potential yield of each recovery well; and
- Provide an indication of groundwater quality in each recovery well and allow determination of likely effluent quality and treatment system operation parameters (e.g., dosing requirements) prior to system startup.

The pump tests will be conducted once the pumping and level monitoring systems are completed (anticipated late September). The centralized pump control, water level monitoring system, and recovery pipeline, will allow for efficient implementation of the pump test. It is anticipated that multiple recovery well pump tests can be conducted simultaneously, and thus minimize any potential delays in full system start up. Samples of groundwater from selected individual wells will collected be analyzed for determine of system operation parameters. Purged groundwater generated during the pump test will be stored on site in frac-tanks for subsequent treatment in the GWET System.

Pump test procedures will generally follow the procedures used in previous pump tests described in the *Draft Data Gaps Assessment Work Plan* (ERM 2009). A specific pump test program work plan memorandum will be presented under separate cover.

3.0 GROUNDWATER TREATMENT SYSTEM PERFORMANCE MONITORING

The purpose of the groundwater treatment system is to treat the combined flow from the recovery wells and discharge the effluent to the Willamette River. The effluent discharge will be managed under an Individual NPDES Industrial Wastewater Permit.

3.1 GROUNDWATER TREATMENT SYSTEM

The recommended groundwater treatment system consists of the following components:

- A precipitation reactor with aeration and pH adjustment via sodium hydroxide to remove iron and other metals potentially present at concentrations exceeding their discharge limits in groundwater;
- A solids handling system (i.e., clarifier with polymer feed, sludge holding tank, filter press, and associated equipment) to dewater and prepare precipitated solids for off-site transportation and disposal;
- A pH adjustment tank to neutralize the groundwater pH prior to anaerobic biological treatment;
- An FBR to anaerobically biodegrade perchlorate and chlorate, and potentially biodegradable organics present in groundwater;
- A post-FBR sand filter to remove biomass potentially carried over into the FBR effluent;
- Two liquid-phase granular activated carbon units in series to remove remaining volatile organic compounds (e.g., chlorobenzene) and pesticides (e.g., DDT) from the effluent following treatment in the FBR, as a polishing step; and
- Discharges to the Willamette River through existing Outfall 4.

A general layout of the GWET system is shown on Figure 2-1. The process flow diagram of the treatment system is presented in Appendix C.

3.2 COMPLIANCE MONITORING

The purpose of compliance monitoring is to evaluate the performance of the treatment system in meeting the as-yet-to-be-determined discharge effluent limits required under the Individual NPDES Industrial Wastewater Permit. At the time of preparation of this PMP, the permit requirements have not been finalized; however, potential permit requirements for design purposes were presented in the PDR and include monthly sampling of the treatment system influent and effluent (Figure 3-1). The potential effluent quality objectives of the NPDES permit, based on discussions with the ODEQ, are presented in Table 3-1.

The composite flow samples will be collected using integrated flow samplers. These samplers will collect a composite sample proportional to the flow rate over a 24-hour period. The samples will be analyzed at an ODEQ-certified laboratory for the parameters listed in Table 3-1. Sample handling and labeling procedures will be performed in accordance with the most recent site Quality Assurance Project Plan, prepared as part of the *Draft Design Report Stormwater Source Control Measures* (Integral 2010). Data quality objectives for parameters not previously sampled at the site are provided in an addendum to the Quality Assurance Project Plan (Appendix D).

4.0 ADAPTIVE MANAGEMENT PROCESS AND REPORTING

LSS is committed to maintaining and documenting hydraulic containment of the alluvial sequence, and compliance with the NPDES permit requirements. This section describes the adaptive management process and performance monitoring reporting scope and schedule. The reporting phase is intended to fulfill Steps 5 and 6 of the evaluation of capture zones (see Section 2.1).

4.1 ADAPTIVE MANAGEMENT FLOW PROCESS

The GWET System component of the GW SCM will be operated and optimized to meet the remedial action objectives of the GW SCM. An adaptive management flow process has been established to verify the capture objectives are being achieved. The adaptive management flowchart is provided as Figure 4-1. The adaptive management flow chart distinguishes criteria for over- or underperformance of wells (maintaining hydraulic capture), design deficiencies, and maintenance issues (e.g. decreasing well efficiencies). Solutions to specific problems associated with equipment performance will be referred to in the Long Term Operation and Maintenance Plan

The adaptive management flow chart does not address issues with GWET System operation that are related to treatment system component operation and maintenance. These activities will be addressed in the Long Term Operation and Maintenance Plan.

4.2 PERFORMANCE MONITORING REPORTING

The results of GW SCM performance monitoring will be reported to the ODEQ monthly for the first 12 months of GWET system operation. These monthly reports will include water levels, potentiometric surface maps, head difference maps, capture zone evaluation, and recommendations for extraction system optimization. The results of monthly potentiometric surface mapping and actual capture zone analysis will be used iteratively to develop specific target gradients and head differences for each well cluster during the first 12 months of operation. The target gradients and long-term water level monitoring schedule will be presented in the Long-Term Operation and Maintenance Plan. Long-term monitoring requirements will be determined under an adaptive management approach. LSS will request approval from the ODEQ before modifying the reporting frequency.

In the event that the GWET system is not operational for an extended period of time (e.g., greater than 1 month), manual water level monitoring will be conducted on a monthly basis to confirm/calibrate electronic real-time measurements until system operation resumes.

The longest anticipated operational downtime is expected to occur between GWBW installation and GWET system startup. LSS remains committed to working with the ODEQ to minimize this period through agency cooperation and a phased approach during construction of the GWBW and GWET system.

5.0 *REFERENCES*

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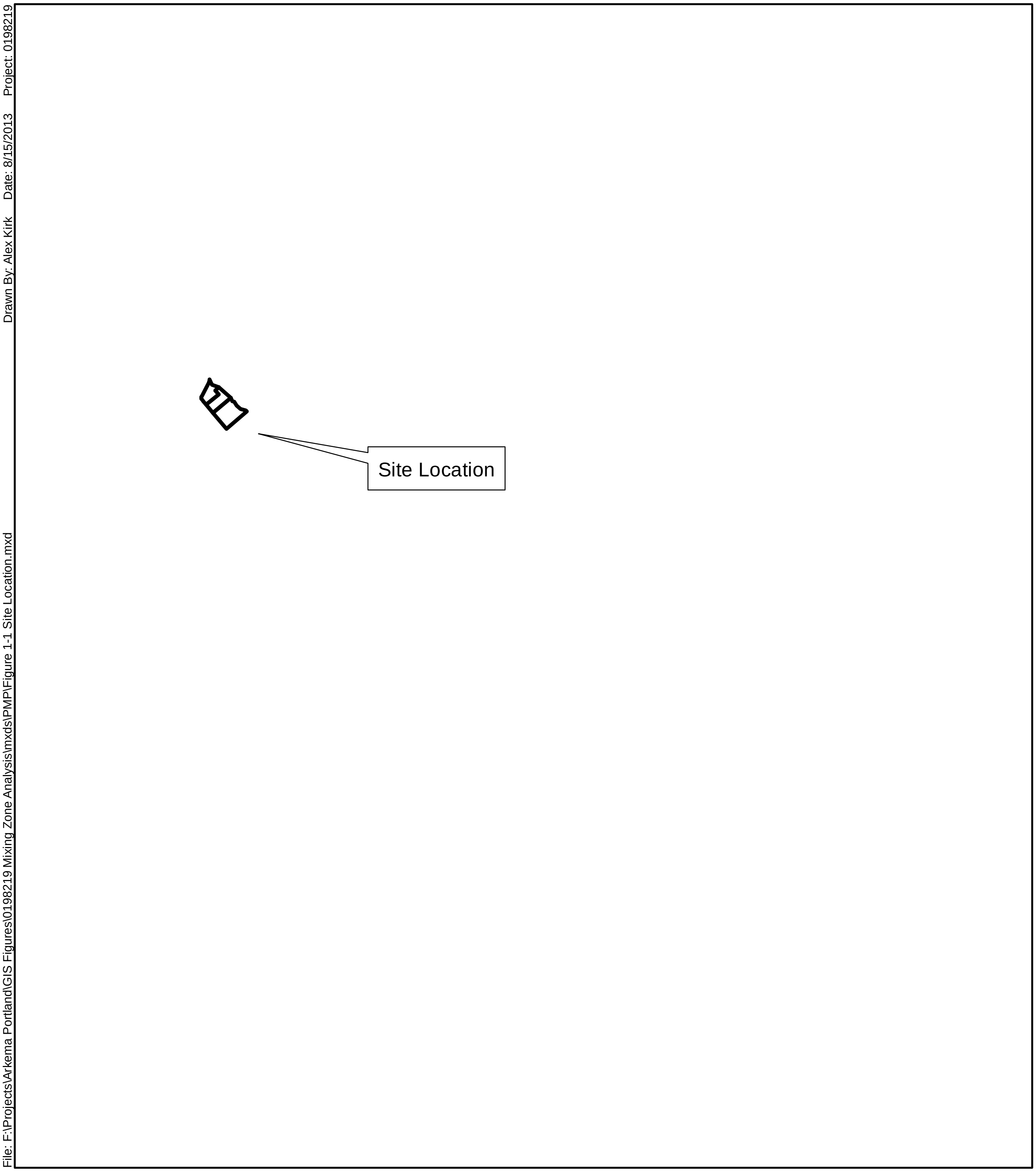
Figures

File: F:\Projects\Arkema Portland\GIS Figures\0198219 Mixing Zone Analysis\mxds\PMP\Figure 1-1 Site Location.mxd Drawn By: Alex Kirk Date: 8/15/2013 Project: 0198219



Legend

Parcel and Property Boundaries

0 0.5 1 2 Miles

Figure 1-1

Site Location
Performance Monitoring Plan
Arkema Inc.
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM

File: F:\Projects\Arkema Portland\GIS Figures\0198219 Mixing Zone Analysis\mxds\PMP\Figure 1-2 Site Layout.mxd   Drawn By: Alex Kirk   Date: 8/26/2013   Project: 0180382

Legend

- Shallow Zone Recovery Well
- Intermediate Zone Recovery Well
- Top of Bank
- 100-yr Flood Plain (32.5 feet NAVD88)
- Barrier Wall Alignment
- Western Berm
- Southern Berm
- Eastern Berm
- Eastern Stormwater Swale
- Western Stormwater Swale
- Underground Water Conveyance Piping
- Pond Boundary
- Areas to be Filled
- Former Site Infrastructure
- Parcel Boundaries
- Property Boundaries

0 100 200 400 Feet

1 inch : 200 feet

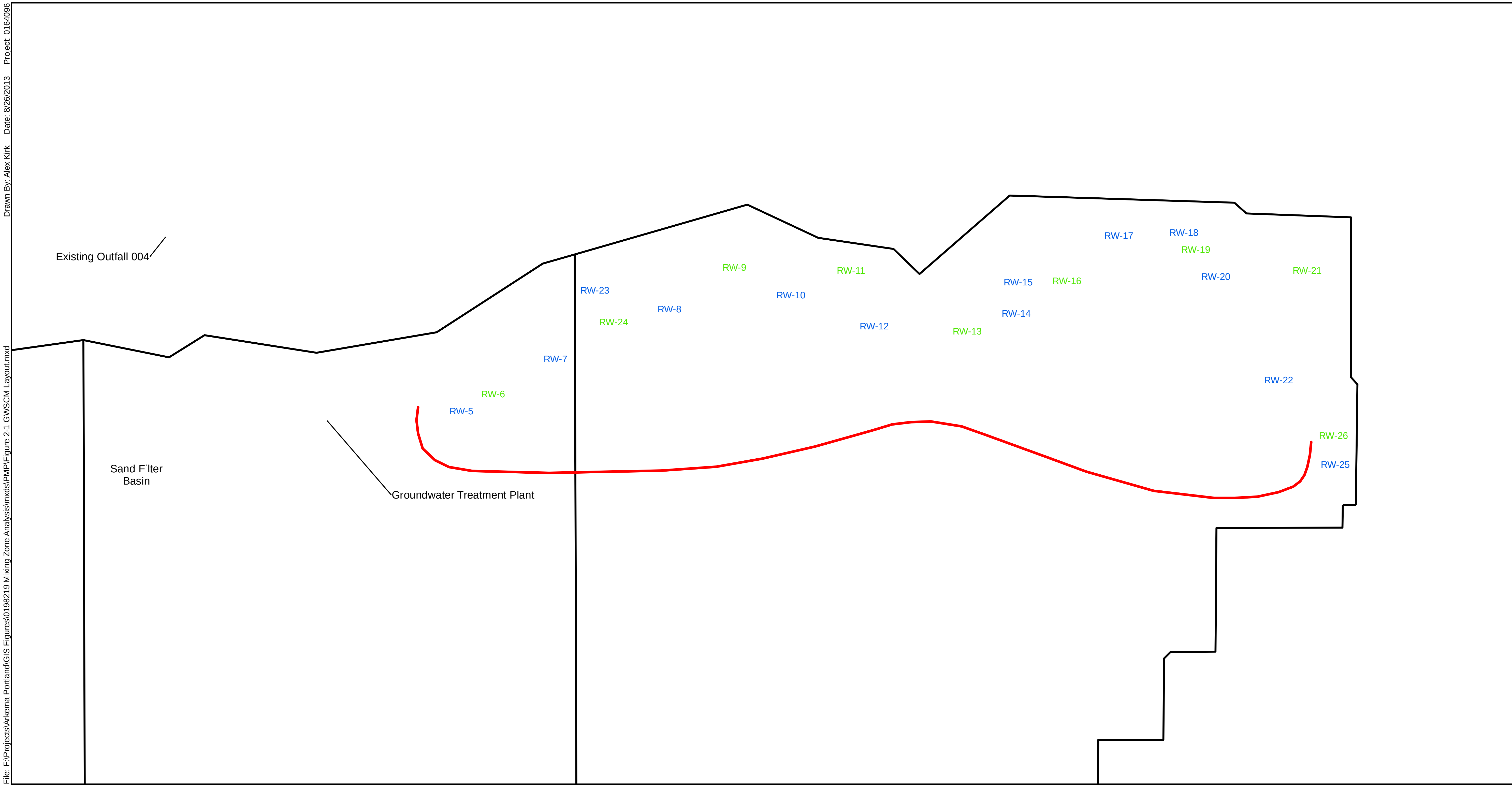
Aerial Photo: City of Portland, July 8, 2012

Note:
A number of the buildings and structures noted on this diagram have been demolished and/or removed.

Figure 1-2
Site Layout
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc.
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM.

File: F:\Projects\Arkema Portland\GIS Figures\0198219 Mixing Zone Analysis\mxds\PMP\Figure 2-1 GWSCM Layout.mxd
Drawn By: Alex Kirk Date: 8/26/2013 Project: 0164096



Legend

- Shallow Zone Recovery Well
- Intermediate Zone Recovery Well
- Barrier Wall Alignment
- Target Capture Zone
- Underground Groundwater Conveyance Piping

0 75 150 300 Feet

1 inch : 150 feet

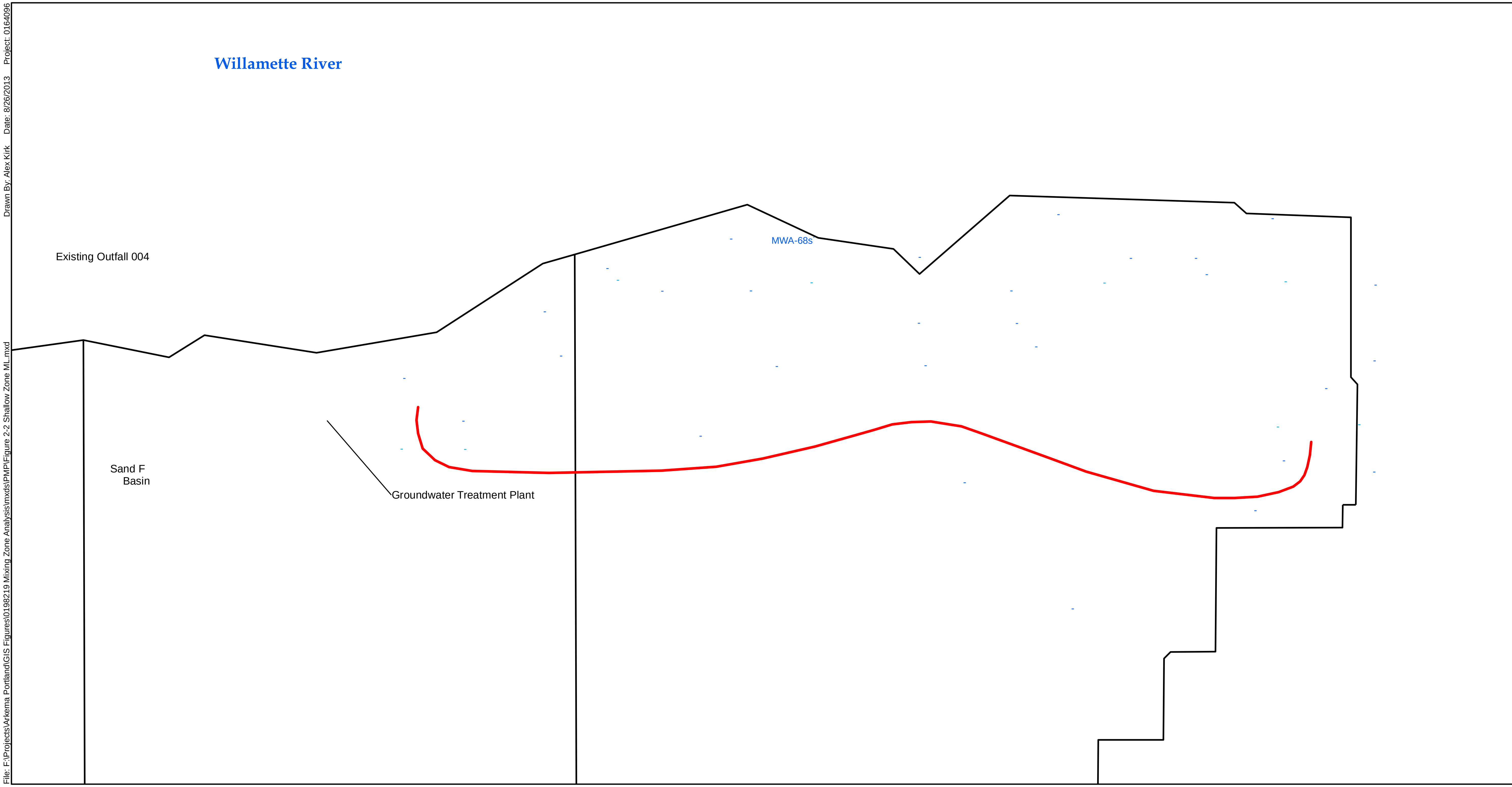
Aerial Photo: City of Portland, July 8, 2012

Figure 2-1

Groundwater Source Control Measures Layout
Performance Monitoring Plan
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM.

File: F:\Projects\Arkema Portland\GIS Figures\0198219 Mixing Zone Analysis\mxds\PMP\Figure 2-2 Shallow Zone ML.mxd Drawn By: Alex Kirk Date: 8/26/2013 Project: 0164096



Legend

- Shallow Zone Piezometer
- Shallow Zone Recovery Well
- Shallow Zone Monitoring Well
- Shallow-Intermediate Zone Monitoring Well
- Barrier Wall Alignment
- Target Capture Zone
- Parcel and Property Boundaries

0 75 150 300 Feet

1 inch : 150 feet

Aerial Photo: City of Portland, July 8, 2012

Figure 2-2

Shallow Zone Water Level Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM.

File: F:\Projects\Arkema Portland\GIS Figures\0198219 Mixing Zone Analysis\mxds\PMP\Figure 2-3 Intermediate Zone ML.mxd Drawn By: Alex Kirk Date: 8/26/2013 Project: 0164096

Legend

- Intermediate Zone Piezometer
- Intermediate Zone Extraction
- Intermediate Zone Monitoring Well
- Barrier Wall Alignment
- Target Capture Zone
- Parcel and Property Boundaries

0 75 150 300 Feet

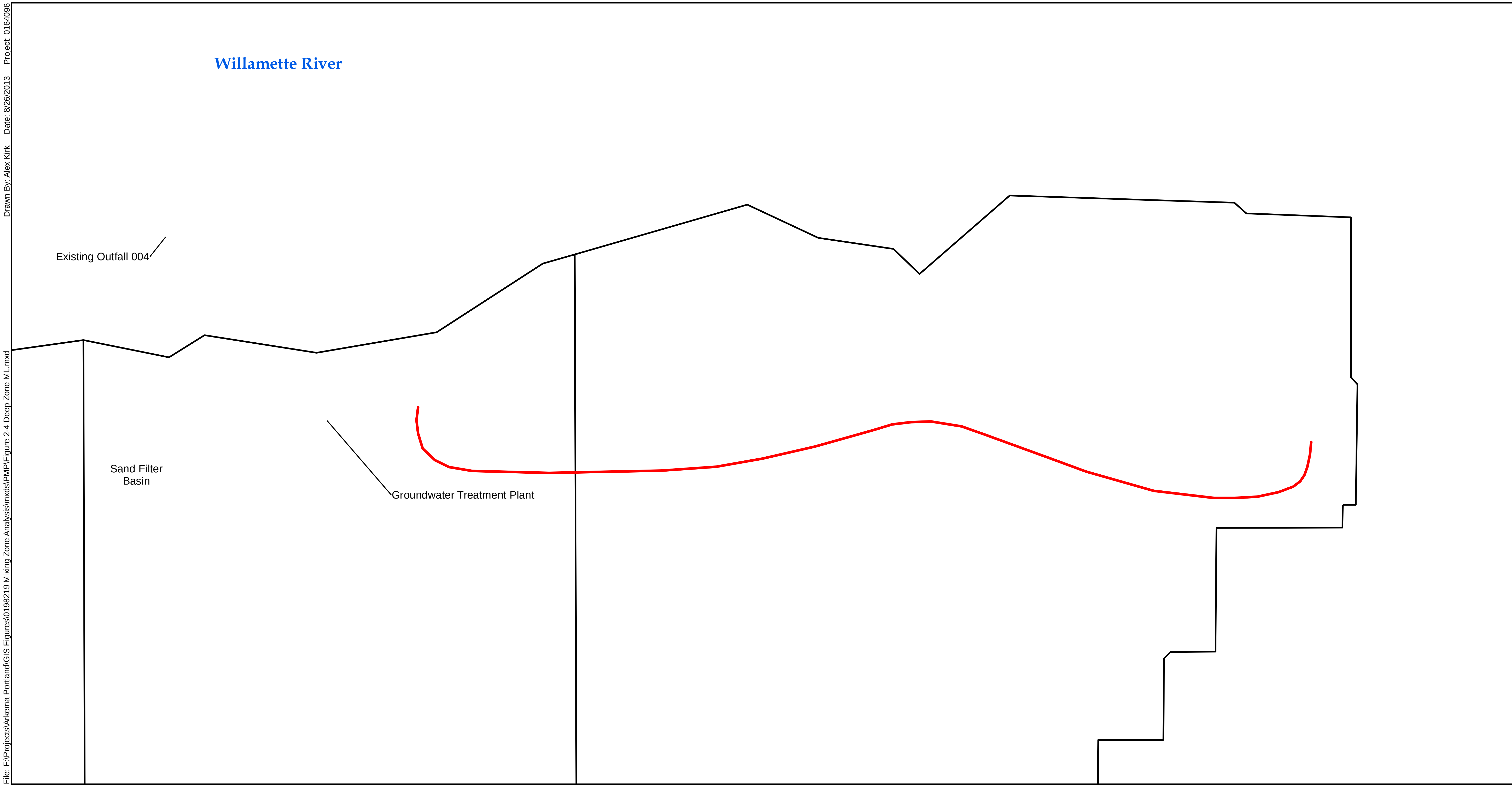
1 inch : 150 feet

Aerial Photo: City of Portland, July 8, 2012

Figure 2-3

Intermediate Zone Water Level Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM.



Legend

- Deep Zone Piezometer
- Deep Zone Monitoring Well
- Barrier Wall Alignment
- Target Capture Zone
- Parcel and Property Boundaries

0 75 150 300 Feet

1 inch : 150 feet

Aerial Photo: City of Portland, July 8, 2012

Figure 2-4

Deep Zone Water Level Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM.

Drawn By: Alex Kirk Date: 8/26/2013 Project: 0164096

File: F:\Projects\Arkema Portland\GIS Figures\0198219 Mixing Zone Analysis\mxds\PMP\Figure 2-5 GCM Locations.mxd

Legend

- Shallow Zone Recovery Well
- Intermediate Zone Recovery Well
- Shallow Zone Piezometer
- Intermediate Zone Piezometer
- Deep Zone Piezometer
- Shallow Monitoring Well
- Shallow-Intermediate Monitoring Well
- Intermediate Monitoring Well
- Existing Deep Zone Monitoring Well
- Barrier Wall Alignment
- Target Capture Zone
- Gradient Control Cluster
- Vertical Flow Cluster

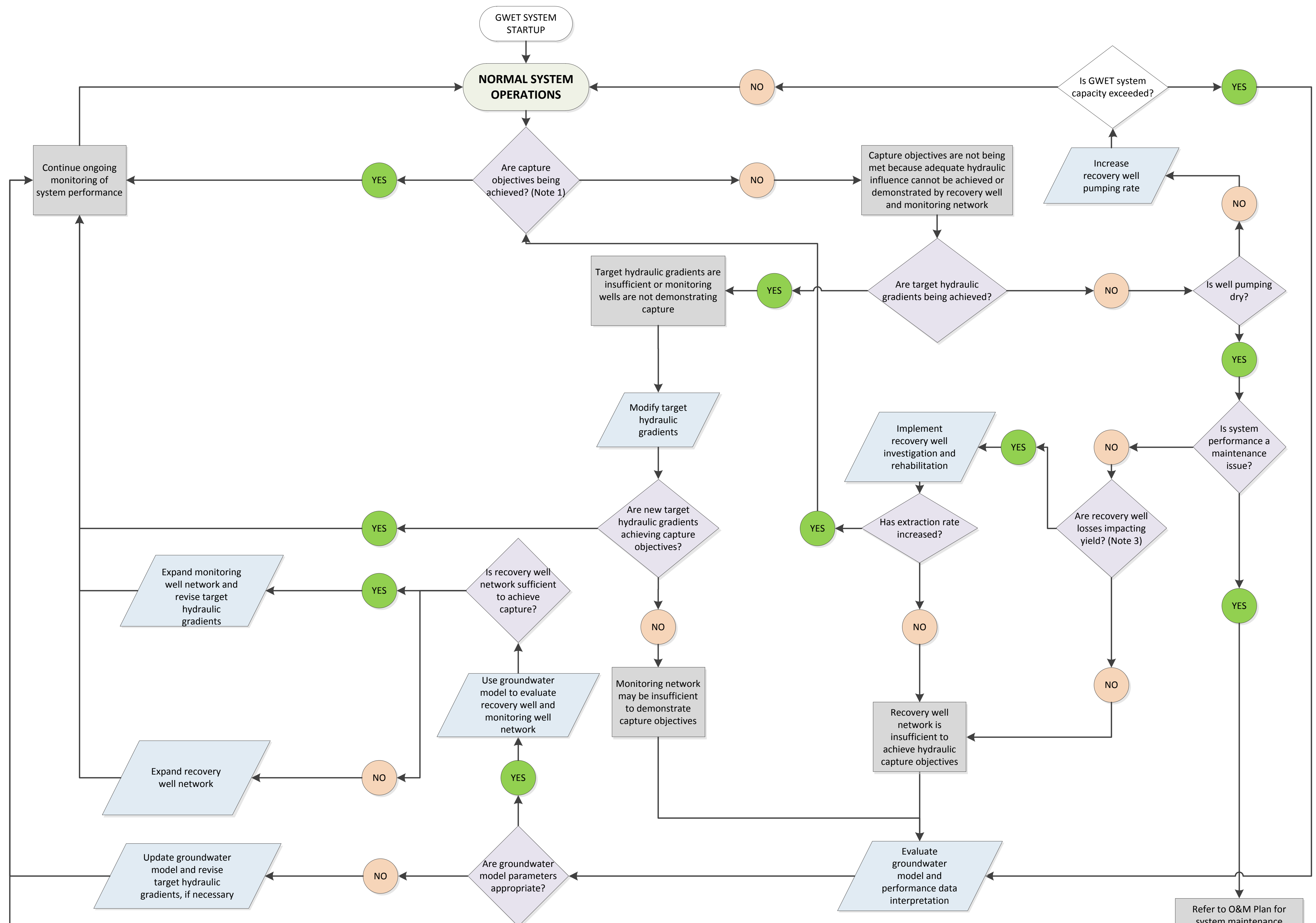
0 60 120 240 Feet

1 inch : 120 feet

Aerial Photo: City of Portland, July 8, 2012

Figure 2-5
Gradient Control Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc.
Portland, Oregon

Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204
ERM



Note 1: Capture objectives include inward hydraulic gradient, volumetric flow analysis and flow path analysis.
Note 2: Target hydraulic gradients are determined by target differences in water elevation between piezometers, as defined in Table 2-1
Note 3: Insufficient well yield factors can include inadequate well development, bio-fouling, well construction

ERM
Environmental Resources Management
1001 SW 5th St, Suite 1010
Portland, Oregon 97204

Figure 4-1
Adaptive Management Flow Process
Performance Monitoring Plan
Arkema Inc.
Portland, Oregon

Tables

FINAL

Table 2-1
Well Construction Details
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc. Facility
Portland, Oregon

Monitoring Point	Status	Northing	Easting	Aquifer Classification	Depth Drilled (ft)	Measuring Point Elevation (ft)	Ground Surface Elevation (ft)	Measuring Point Stickup (ft)	Well Depth (ft)	Screened Interval: Screen Length (ft)	Screened Interval: Screen Material	Screened Interval: Screen Slot Size (in)	Screened Interval: Sump Length (ft)	Screened Interval: Depth Below Surface Bottom (ft)	Screened Interval: Depth Below Surface Top (ft)	Screened Interval: Elevation Bottom (ft)	Screened Interval: Elevation Top (ft)	Sandpack Interval: Depth Below Surface Bottom (ft)	Sandpack Interval: Depth Below Surface Top (ft)	Sandpack Interval: Elevation Bottom (ft)	Sandpack Interval: Elevation Top (ft)	Sandpack Interval: Sandpack Thickness (ft)	Performance Monitoring: Capture Zone Monitoring	Performance Monitoring: Real-time Monitoring	Gradient Control: Gradient Calculation Point	Gradient Control: Comparison Point	Gradient Control: Model Predicted Head (ft)	Gradient Control: Distance Between Observation (ft)	Gradient Control: Model Predicted Target (ft)	Gradient Control: Selected Target Gradient (ft)	Gradient Control: Target Head Difference (ft)
MWA-2	Active	702507.29	7627621.41	Shallow	32.3	38.46	35.22	3.23	35.17	10.0	304 S.S.	0.010	0.5	31.5	21.5	3.7	13.7	32.3	18.5	2.9	16.7	13.8	Y	Y	Y	PA-5	-0.84	68.3	-0.012	-0.012	-0.84
MWA-6r	Active	702150.87	7627942.75	Shallow	34.0	36.46	36.75	-0.29	33.21	5.0	304 S.S.	0.010	0.3	33.2	28.2	3.6	8.6	33.5	25.5	3.3	11.3	8.0	Y	N	N						
MWA-7(i)	Active	701726.90	7627124.30	Intermediate	33.0	36.24	36.15	0.09	33.39	2.5	304 S.S.	0.010	0.3	33.0	30.5	3.2	5.7	33.3	28.0	2.9	8.2	5.3	N	N	N						
MWA-8i	Active	702500.54	7627628.33	Intermediate	47.3	38.09	35.43	2.66	49.60	5.0	304 S.S	0.010	0.3	47.0	42.0	-11.6	-6.6	47.3	39.8	-11.9	-4.4	7.5	Y	Y	Y	PA-11i	-1.12	73.4	-0.015	-0.015	-1.12
MWA-	Active	702172.18	7627634.01	Deep	51.0	36.49	36.62	-0.13	51.00	4.5	304 S.S	0.010	0.3	50.8	46.2	-14.2	-9.6	51.0	44.0	-14.4	-7.4	7.0	Y	N	N						
MWA-	Active	701735.80	7627117.50	Deep	52.0	35.86	36.15	-0.30	51.76	10.0	304 S.S	0.010	0.3	51.8	42.0	-15.6	-5.9	52.0	40.0	-15.9	-3.9	12.0	Y	N	N						
MWA-15r	Active	702211.10	7627673.20	Shallow	32.5	36.06	36.39	-0.34	29.21	10.0	304 S.S.	0.10	0.1	32.5	22.5	3.9	13.9	32.5	22.5	3.9	13.9	10.0	N	N	N						
MWA-16i	Active	702127.25	7627944.39	Intermediate	45.3	36.72	36.99	-0.27	44.23	5.0	304 S.S	0.010	0.3	44.2	39.2	-7.2	-2.2	45.3	37.2	-8.3	-0.2	8.1	Y	N	N						
MWA-18	Active	702056.87	7628041.35	Shallow	29.5	39.43	36.44	2.99	32.49	10.0	304 S.S.	0.010	0.3	29.2	19.2	7.2	17.2	29.5	17.0	6.9	19.4	12.5	N	N	N						
MWA-19	Active	701963.23	7628180.37	Shallow	35.5	39.90	37.42	2.48	31.98	10.0	304 S.S.	0.010	0.3	29.2	19.2	8.2	18.2	30.5	17.0	6.9	20.4	13.5	N	N	N						
MWA-20	Active	701925.54	7627952.11	Shallow	35.5	40.95	38.46	2.49	37.49	10.0	304 S.S.	0.010	0.3	34.7	24.7	3.8	13.8	35.5	22.5	3.0	16.0	13.0	Y	N	N						
MWA-22	Active	702232.00	7627516.00	Shallow	36.0	36.59	36.91	-0.31	34.69	10.0	304 S.S.	0.010	0.3	34.7	24.7	2.2	12.2	36.0	23.0	0.9	13.9	13.0	Y	N	N						
MWA-23	Active	701387.76	7627481.85	Shallow	26.0	36.81	37.10	-0.30	25.12	10.0	304 S.S.	0.010	0.3	25.2	15.2	11.9	21.9	26.0	13.5	11.1	23.6	12.5	N	N	N						
MWA-24	Active	701875.73	7627721.74	Shallow	36.0	37.58	37.94	-0.36	33.48	10.0	304 S.S.	0.010	0.3	34.0	24.0	3.9	13.9	36.0	22.0	1.9	15.9	14.0	Y	N	N						
MWA-29	Active	701587.00	7628359.88	Shallow	35.2	37.23	37.51	-0.28	33.70h	10.0	304 S.S.	0.010	0.3	34.9	24.9	2.6	12.6	35.2	22.9	2.3	14.6	12.3	Y	N	N						
MWA-30	Active	701832.68	7628278.84	Shallow	30.0	38.34	38.75	-0.41	29.25	10.0	304 S.S.	0.010	0.3	29.1	19.1	9.7	19.7	29.4	17.4	9.4	21.4	12.0	N	N	N						
MWA-31i(d)	Active	701826.17	7628283.95	Deep	60.0	38.36	38.74	-0.38	59.80	5.0	304 S.S	0.010	0.2	59.8	54.8	-21.1	-16.1	60.0	54.0	-21.3	-15.3	6.0	N	N	N						
MWA-32i	Active	701837.47	7628275.46	Intermediate	44.0	38.70	38.92	-0.22	41.98	5.0	304 S.S	0.010	0.2	42.0	37.0	-3.1	1.9	42.0	35.0	-3.1	3.9	7.0	N	N	N						
MWA-33	Active	701623.46	7627679.75	Shallow	30.0	37.26	37.75	-0.49	29.71	10.0	Sch 40 PVC	0.010	0.2	30.0	20.0	7.7	17.7	30.0	19.0	7.7	18.7	11.0	Y	N	N						
MWA-34i	Active	701968.03	7628174.50	Intermediate	38.0	39.92	37.33	2.59	39.79	5.0	304 S.S	0.010	0.2	37.0	32.0	0.3	5.3	37.5	31.5	-0.2	5.8	6.0	N	N	N						
MWA-39	Active	701532.86	7627527.05	Shallow	26.5	37.06	37.23	-0.17	25.00	9.25	Sch 40 PVC	0.010	0.7	24.3	15.1	12.9	22.2	26.0	13.0	11.2	24.2	13.0	N	N	N						
MWA-40	Active	701767.86	7627584.45	Shallow	31.0	36.96	37.18	-0.21	30.20	9.25	Sch 40 PVC	0.010	0.7	29.5	20.3	7.7	16.9	29.5	18.0	7.7	19.2	11.5	N	N	N						
MWA-41	Active	701404.34	7628138.42	Shallow	35.0	37.77	38.01	-0.24	35.00	9.25	Sch 40 PVC	0.010	0.7	34.3	25.1	3.7	13.0	35.0	23.0	3.0	15.0	12.0	Y	N	N						
MWA-42	Active	702036.96	7627820.55	Shallow	33.5	37.24	37.62	-0.38	31.50	9.25	Sch 40 PVC	0.010	0.7	30.8	21.6	6.8	16.1	31.8	19.1	5.8	18.5	12.7	Y	N	N						
MWA-43	Active	701513.44	7628269.72	Shallow	35.0	37.22	37.46	-0.24	35.00	9.25	Sch 40 PVC	0.010	0.7	34.3	25.1	3.2	12.4	35.0	23.0	2.5	14.5	12.0	Y	N	N						
MWA-46	Active	702029.70	7628129.61	Shallow	30.5	36.67	36.68	-0.01	29.70	9.25	Sch 40 PVC	0.010	0.7	29.0	19.8	7.7	16.9	28.5	17.3	8.2	19.4	11.2	Y	Y	Y	PA-28	0.97	137.0	0.007	-0.005	-0.69
MWA-47	Active	701773.75	7628336.57	Shallow	35.0	38.69	38.99	-0.30	35.00	9.25	Sch 40 PVC	0.010	0.7	34.3	25.1	4.7	13.9	35.0	23.0	4.0	16.0	12.0	Y	Y	Y	PA-07	1.58	103.7	0.015	-0.005	-0.52
MWA-49i	Active	702029.26	7628137.40	Intermediate	44.0	36.68	36.84	-0.16	44.00	4.45	Sch 40 PVC	0.010	0.7	43.3	38.9	-6.5	-2.0	43.0	36.6	-6.2	0.2	6.4	Y	Y	Y	PA-13i	1.40	124.3	0.011	-0.005	-0.62
MWA-51i	Active	702046.99	7628047.09	Intermediate	44.0	36.33	36.59	-0.26	42.50	4.45	Sch 40 PVC	0.010	0.7	41.8	37.4	-5.2	-0.8	42.5	35.2	-5.9	1.4	7.3	N	N	N						
MWA-53i	Active	701590.84	7628364.82	Intermediate	44.5	37.27	37.52	-0.25	44.40	4.45	Sch 40 PVC	0.010	0.7	43.7	39.3	-6.2	-1.7	43.5	36.3	-6.0	1.2	7.2	Y	N	N						
MWA-54i	Active	702030.36	7627823.95	Intermediate	41.5	37.31	37.72	-0.41	41.10	4.45	Sch 40 PVC	0.010	0.7	40.4	36.0	-2.7	1.8	41.1	35.3	-3.4	2.4	5.8	Y	N	N						
MWA-56d	Active	702022.47	7628117.01	Deep	61.0	36.68	36.82	-0.14	60.80	4.75	Sch 40 PVC	0.010	0.55	60.3	55.5	-23.4	-18.7	61.0	53.0	-24.2	-16.2	8.0	Y	Y	Y	PA-22d	1.12	100.2	0.011	-0.005	-0.50
MWA-58d	Active	701974.54	7628179.53	Deep	63.0	37.07	37.19	-0.12	60.50	4.75	Sch 40 PVC	0.010	0.55	60.0	55.2	-22.8	-18.0	61.5	52.8	-24.3	-15.6	8.7	N	N	N						
MWA-61	Active	702455.71	7627686.02	Shallow	33.5	36.21	36.15	0.06	32.50	10.0	Sch 40 PVC	0.010	0.0	32.1	22.3	4.1	13.9	32.5	21.0	3.7	15.2	11.5	N	N	N						
MWA-63	Active	702637.66	7627291.45	Shallow	30.5	36.29	36.38	-0.09	30.00	10.0	Sch 40 PVC	0.010	0.4	29.6	19.8	6.8	16.6	30.5	17.0	5.9	19.4	13.5	Y	N	N						
MWA-64i	Active	702462.46	7627678.56	Intermediate	49.0	35.84	36.17	-0.33	47.00	4.5	Sch 40 PVC	0.010	0.5	46.5	42.0	-10.3	-5.8	49.0	40.0	-12.8	-3.8	9.0	N	N	N						
MWA-66i	Active	702309.97	7627843.28	Intermediate	49.0	33.10	33.50	-0.40	42.50	4.5	Sch 40 PVC	0.010	0.1	42.4	37.6	-8.9	-4.1	43.5	35.8	-10.0	-2.3	7.7	Y	Y	Y	PA-12i	-0.86	114.1	-0.008	-0.008	-0.86
MWA-67si	Active	702458.92	7627681.48	Shallow	38.0	36.34	36.14	0.20	38.00	1.5	Sch 40 PVC	0.010	0.2	37.8	36.3	-1.7	-0.2	38.0	36.0	-1.9	0.1	2.0	N	N	N						
MWA-68si	Active	702312.58	7627839.61	Shallow	34.0	33.77	33.65	0.13	34.00	1.5	Sch 40 PVC	0.010	0.2	33.8	32.3	-0.2	1.3	34.0	32.0	-0.4	1.6	2.0	N	N	N						
MWA-69	Active	702314.52	7627836.40	Shallow	30.0	33.69	33.65	0.04	29.50	10.0	Sch 40 PVC	0.010	0.2	29.3	19.5	4.3	14.1	30.0	18.0	3.6	15.6	12.0	Y	Y	Y	PA-6	-1.05	109.1	-0.010	-0.010	-1.05
MWA-70i	Active	701611.69	7627691.20	Intermediate	46.5	37.62	37.84	-0.23	43.00	9.8	Sch 40 PVC	0.010	0.5	32.7	42.5	5.1	-4.7	32.5	43.0	5.3	-5.2	-10.5	N	N	N						
MWA-71	Active	702394.12	7626543.33	Shallow	23.0	34.82	35.23	-0.41	22.18	10.0	304 S.S	0.010	0.3	22.5	12.5	12.7	22.7	23.0	10.0	12.2	25.2	13.0	N	N	N						
MWA-72	Active	702019.73	7626864.10	Shallow	23.0	34.16	34.57	-0.41	22.34	10.0	304 S.S	0.010	0.3	22.0	12.0	12.6	22.6	23.0	10.0	11.6	24.6	13.0	N	N	N						
MWA-73	Active	701727.58	7627143.03	Shallow	22.0	36.01	36.37	-0.36	20.15	10.0	304 S.S	0.010	0.3	21.0	11.0	15.4	25.4	21.0	9.0	15.4	27.4	12.0	N	N	N						
MWA-74i	Active	702388.62	7626536.38	Intermediate	44.0	34.72	34.98	-0.26	72.78	5.0	304 S.S	0.010	0.3	43.0	38.0	-8.0	-3.0	43.0	35.5	-8.0	-0.5	7.5	N	N	N						

Table 2-1
Well Construction Details
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc. Facility
Portland, Oregon

Monitoring Point	Status	Northing	Easting	Aquifer Classification	Depth Drilled (ft)	Measuring Point Elevation (ft)	Ground Surface Elevation (ft)	Measuring Point Stickup (ft)	Well Depth (ft)	Screened Interval: Screen Length (ft)	Screened Interval: Screen Material	Screened Interval: Screen Slot Size (in)	Screened Interval: Sump Length (ft)	Screened Interval: Depth Below Surface: Bottom (ft)	Screened Interval: Depth Below Surface: Top (ft)	Screened Interval: Elevation: Bottom (ft)	Screened Interval: Elevation: Top (ft)	Sandpack Interval: Depth Below Surface: Bottom (ft)	Sandpack Interval: Depth Below Surface: Top (ft)	Sandpack Interval: Elevation: Bottom (ft)	Sandpack Interval: Elevation: Top (ft)	Sandpack Interval: Sandpack Thickness (ft)	Performance Monitoring: Capture Zone Monitoring	Performance Monitoring: Real-time Monitoring	Gradient Control: Gradient Calculation Point	Gradient Control: Comparison Point	Gradient Control: Model Predicted Head (ft)	Gradient Control: Distance Between Observation (ft)	Gradient Control: Model Predicted Target (ft)	Gradient Control: Selected Target Gradient (ft)	Gradient Control: Target Head Difference (ft)
MWA-75i	Active	702014.68	7626858.37	Intermediate	48.0	34.09	34.43	-0.34	39.88	15.0	304 S.S	0.010	0.3	40.0	25.0	-5.6	9.4	41.0	23.5	-6.6	10.9	17.5	N	N	N						
MWA-76g	Active	702010.18	7626853.34	Gravel	94.0	34.96	35.23	-0.26	94.12	5.0	304 S.S	0.010	0.3	94.0	89.0	-58.8	-53.8	94.0	87.5	-58.8	-52.3	6.5	N	N	N						
MWA-77g	Active	702382.88	7626528.75	Gravel	91.0	34.03	34.40	-0.37	90.20	5.0	304 S.S	0.010	0.3	90.5	85.5	-56.1	-51.1	91.0	83.5	-56.6	-49.1	7.5	N	N	N						
MWA-81i	Active	701408.82	7628145.87	Intermediate	48.0	37.50	37.96	-0.46	44.00	5.0	Sch 40 PVC	0.010	0.3	44.0	39.0	-6.0	-1.0	45.0	37.5	-7.0	0.5	7.5	Y	N	N						
NMP-1D	Active	702247.30	7627690.20	Shallow	36.0	35.82	36.18	-0.36	34.14	4.5	Sch 40 PVC	0.010	0.5	34.0	29.5	2.2	6.7	35.0	27.8	1.2	8.4	7.2	N	N	N						
NMP-1S	Active	702255.40	7627696.30	Shallow	30.5	35.90	36.11	-0.21	29.49	9.5	Sch 40 PVC	0.010	0.2	29.5	20.0	6.6	16.1	30.0	18.0	6.1	18.1	12.0	N	N	N						
NMP-2D	Active	702263.50	7627701.90	Shallow	37.0	35.56	35.97	-0.41	36.59	4.5	Sch 40 PVC	0.010	0.5	36.5	32.0	-0.5	4.0	37.0	30.0	-1.0	6.0	7.0	N	N	N						
NMP-2S	Active	702271.20	7627707.60	Shallow	30.5	35.75	35.88	-0.14	29.57	9.5	Sch 40 PVC	0.010	0.2	29.5	20.0	6.4	15.9	30.0	18.0	5.9	17.9	12.0	N	N	N						
NMP-3S	Active	702287.50	7627718.30	Shallow	30.5	35.68	36.02	-0.33	29.37	9.5	Sch 40 PVC	0.010	0.2	29.5	20.0	6.5	16.0	30.0	18.0	6.0	18.0	12.0	N	N	N						
NMP-4D	Active	702281.80	7627666.30	Shallow	36.0	35.63	35.91	-0.27	35.23	4.5	Sch 40 PVC	0.010	0.5	35.0	30.5	0.9	5.4	36.0	28.0	-0.1	7.9	8.0	N	N	N						
NMP-4S	Active	702290.70	7627672.40	Shallow	30.5	35.67	35.89	-0.22	29.48	9.5	Sch 40 PVC	0.010	0.2	29.5	20.0	6.4	15.9	30.0	18.0	5.9	17.9	12.0	N	N	N						
NMP-5D	Active	702273.20	7627684.40	Shallow	35.5	35.38	35.84	-0.47	33.54	4.5	Sch 40 PVC	0.010	0.5	33.5	29.0	2.3	6.8	34.5	27.0	1.3	8.8	7.5	N	N	N						
NMP-5S	Active	702281.50	7627689.70	Shallow	30.5	35.57	35.55	0.02	29.72	9.5	Sch 40 PVC	0.010	0.2	29.5	20.0	6.1	15.6	30.0	18.0	5.6	17.6	12.0	N	N	N						
NMP-6D	Active	702259.90	7627730.00	Shallow	36.0	36.08	36.27	-0.19	33.81	4.5	Sch 40 PVC	0.010	0.5	33.5	29.0	2.8	7.3	35.0	27.0	1.3	9.3	8.0	N	N	N						
NMP-6S	Active	702251.90	7627724.50	Shallow	30.5	35.94	36.23	-0.29	29.41	9.5	Sch 40 PVC	0.010	0.2	29.5	20.0	6.7	16.2	30.0	18.0	6.2	18.2	12.0	N	N	N						
PA-03	Active	7627216.44	702557.55	Shallow	27.5		36.00			5.0	Sch 40 PVC	0.010	0.3	27.5	22.5	8.5	13.5	27.5	20.5	8.5	15.5	7.0	Y	Y	Y	PA-4	-1.57	97.2	-0.016	-0.016	-1.57
PA-04	Active	7627278.72	702482.87	Shallow	32.0		36.00			5.0	Sch 40 PVC	0.010	0.3	32.0	27.0	4.0	9.0	32.0	25.0	4.0	11.0	7.0	Y	Y	Y	PA-3	--				
PA-05	Active	7627622.28	702439.04	Shallow	34.0		34.00			5.0	Sch 40 PVC	0.010	0.3	34.0	29.0	0.0	5.0	34.0	27.0	0.0	7.0	7.0	Y	Y	Y	MWA-2	--				
PA-06	Active	7627810.48	702208.51	Shallow	34.0		34.00			5.0	Sch 40 PVC	0.010	0.3	34.0	29.0	0.0	5.0	34.0	27.0	0.0	7.0	7.0	Y	Y	Y	MWA-69	--				
PA-07	Active	7628285.98	701683.25	Shallow	31.0		36.00			5.0	Sch 40 PVC	0.010	0.3	31.0	26.0	5.0	10.0	31.0	24.0	5.0	12.0	7.0	Y	Y	Y	MWA-47	--				
PA-08	Active	7628152.67	701494.83	Shallow	32.0		36.00			5.0	Sch 40 PVC	0.010	0.3	32.0	27.0	4.0	9.0	32.0	25.0	4.0	11.0	7.0	Y	Y	Y	PA-09	--				
PA-09	Active	7628190.77	701455.26	Shallow	32.0		36.00			5.0	Sch 40 PVC	0.010	0.3	32.0	27.0	4.0	9.0	32.0	25.0	4.0	11.0	7.0	Y	Y	Y	PA-08	0.03	54.9	0.000	-0.005	-0.27
PA-10i	Active	7627290.20	702481.40	Intermediate	42.0		36.00			5.0	Sch 40 PVC	0.010	0.3	42.0	37.0	-6.0	-1.0	42.0	35.0	-6.0	1.0	7.0	Y	Y	Y	PA-17i	--				
PA-11i	Active	7627625.25	702427.17	Intermediate	44.0		34.00			5.0	Sch 40 PVC	0.010	0.3	44.0	39.0	-10.0	-5.0	44.0	37.0	-10.0	-3.0	7.0	Y	Y	Y	MWA-8i	--				
PA-12i	Active	7627810.14	702200.79	Intermediate	41.0		34.00			5.0	Sch 40 PVC	0.010	0.3	41.0	36.0	-7.0	-2.0	41.0	34.0	-7.0	0.0	7.0	Y	Y	Y	MWA-66i	--				
PA-13i	Active	7628104.19	701909.50	Intermediate	44.0		36.00			5.0	Sch 40 PVC	0.010	0.3	44.0	39.0	-8.0	-3.0	44.0	37.0	-8.0	-1.0	7.0	Y	Y	Y	MWA-49i	--				
PA-14i	Active	7628284.93	701700.25	Intermediate	46.0		38.00			5.0	Sch 40 PVC	0.010	0.3	46.0	41.0	-8.0	-3.0	46.0	39.0	-8.0	-1.0	7.0	Y	Y	Y	PA-29i	--				
PA-15i	Active	7628161.26	701501.92	Intermediate	45.0		36.00			5.0	Sch 40 PVC	0.010	0.3	45.0	40.0	-9.0	-4.0	45.0	38.0	-9.0	-2.0	7.0	Y	Y	Y	PA-16i	--				
PA-16i	Active	7628200.47	701463.79	Intermediate	45.0		36.00			5.0	Sch 40 PVC	0.010	0.3	45.0	40.0	-9.0	-4.0	45.0	38.0	-9.0	-2.0	7.0	Y	Y	Y	PA-15i	-0.10	54.7	-0.002	-0.005	-0.27
PA-17i	Active	7627227.23	702563.89	Intermediate	42.0		36.00			5.0	Sch 40 PVC	0.010	0.3	42.0	37.0	-6.0	-1.0	42.0	35.0	-6.0	1.0	7.0	Y	Y	Y	PA-10i	-0.96	103.8	-0.009	-0.009	-0.96
PA-18d	Active	7627285.10	702471.91	Deep	49.0		36.00			5.0	Sch 40 PVC	0.010	0.3	49.0	44.0	-13.0	-8.0	49.0	42.0	-13.0	-6.0	7.0	Y	Y	Y	PA-27d	--				
PA-19d	Active	7627631.96	702489.77	Deep	48.0		34.00			5.0	Sch 40 PVC	0.010	0.3	48.0	43.0	-14.0	-9.0	48.0	41.0	-14.0	-7.0	7.0	Y	Y	Y	PA-30d	-0.40	52.9	-0.007	-0.007	-0.40
PA-20d	Active	7627817.79	702198.24	Deep	59.0		34.00			5.0	Sch 40 PVC	0.010	0.3	59.0	54.0	-25.0	-20.0	59.0	52.0	-25.0	-18.0	7.0	Y	Y	Y	PA-21d	--				
PA-21d	Active	7627824.81	702318.79	Deep	57.0		32.00			5.0	Sch 40 PVC	0.010	0.3	57.0	52.0	-25.0	-20.0	57.0	50.0	-25.0	-18.0	7.0	Y	Y	Y	PA-20d	-0.16	120.8	-0.001	-0.005	-0.60
PA-22d	Active	7628115.97	701922.28	Deep	63.0		38.00			5.0	Sch 40 PVC	0.010	0.3	63.0	58.0	-25.0	-20.0	63.0	56.0	-25.0	-18.0	7.0	Y	Y	Y	MWA-56d	--				

Monitoring Point	Status	Northing	Easting	Aquifer Classification	Depth Drilled	Measuring Point Elevation	Ground Surface Elevation	Measuring Point Stickup	Well Depth	Screened Interval								Sandpack Interval					Performance Monitoring		Gradient Control						
										Screen Length	Screen Material	Screen Slot Size	Sump Length	Depth Below Surface		Elevation		Depth Below Surface		Elevation		Sandpack	Capture Zone Monitoring	Real-time Monitoring	Gradient Calculation Point	Comparison Point	Model Predicted Head	Distance Between Observation	Model Predicted Target	Selected Target Gradient	Target Head Difference
														Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Thickness									
					(ft)	(ft)	(ft)	(ft)	(ft)	(ft)		(in)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)					(ft)	(ft)	(ft)	(ft)	(ft)
PA-23d	Active	7628285.33	701692.13	Deep	81.0		38.00			5.0	Sch 40 PVC	0.010	0.3	81.0	76.0	-43.0	-38.0	81.0	74.0	-43.0	-36.0	7.0	Y	Y	Y	PA-24d	-1.47	62.3	-0.024	-0.024	-1.47
PA-24d	Active	7628335.03	701727.31	Deep	81.0		38.00			5.0	Sch 40 PVC	0.010	0.3	81.0	76.0	-43.0	-38.0	81.0	74.0	-43.0	-36.0	7.0	Y	Y	Y	PA-23d	--				
PA-25d	Active	7628152.49	701506.80	Deep	79.0		38.00			5.0	Sch 40 PVC	0.010	0.3	79.0	74.0	-41.0	-36.0	79.0	72.0	-41.0	-34.0	7.0	Y	Y	Y	PA-26d	--				
PA-26d	Active	7628185.21	701450.16	Deep	79.0		38.00			5.0	Sch 40 PVC	0.010	0.3	79.0	74.0	-41.0	-36.0	79.0	72.0	-41.0	-34.0	7.0	Y	Y	Y	PA-25d	-0.73	65.4	-0.011	-0.011	-0.73
PA-27d	Active	7627214.29	702570.40	Deep	48.0		36.00			5.0	Sch 40 PVC	0.010	0.3	48.0	43.0	-12.0	-7.0	48.0	41.0	-12.0	-5.0	7.0	Y	Y	Y	PA-18d	-0.45	121.3	-0.004	-0.005	-0.61
PA-28	Active	7628105.84	701894.74	Shallow	31.0		36.00			5.0	Sch 40 PVC	0.010	0.3	31.0	26.0	5.0	10.0	31.0	24.0	5.0	12.0	7.0	Y	Y	Y	MWA-46	--				
PA-29i	Active	7628341.94	701738.56	Intermediate	45.0		36.00			5.0	Sch 40 PVC	0.010	0.3	45.0	40.0	-9.0	-4.0	45.0	38.0	-9.0	-2.0	7.0	Y	Y	Y	PA-14i	1.73	68.7	0.025	-0.005	-0.34
PA-30d	Active	7627633.26	702436.89	Deep	48.0		34.00			5.0	Sch 40 PVC	0.010	0.3	48.0	43.0	-14.0	-9.0	48.0	41.0	-14.0	-7.0	7.0	Y	Y	Y	PA-19d	--				
PMP-1	Active	702220.30	7627682.50	Shallow	35.0	36.36	36.35	0.02	34.00	10.0	304 S.S	0.010	0.0	34.0	24.0	2.3	12.3	35.0	22.5	1.3	13.8	12.5	N	N	N						
PMP-2	Active	702254.40	7627654.50	Shallow	35.0	36.36	36.32	0.05	33.80	10.0	304 S.S	0.010	0.0	33.8	23.8	2.5	12.5	35.0	21.0	1.3	15.3	14.0	N	N	N						
PMP-3	Active	702279.20	7627643.20	Shallow	35.0	36.17	36.14	0.03	35.00	10.0	304 S.S	0.010	0.0	35.0	25.0	1.1	11.1	35.0	22.8	1.1	13.3	12.2	N	N	N						
RW-05	Active	7627307.13	702516.89	Shallow	29.0		36.00			10.0	304 S.S	0.010	0.3	29.0	19.0	7.0	17.0	29.5	17.5	7.0	19.0	12.0	Y	Y	N						
RW-06i	Active	7627358.43	702494.65	Intermediate	41.0		36.00			5.0	304 S.S	0.010	0.3	41.0	36.0	-5.0	0.0	41.5	33.0	-5.0	3.5	8.5	Y	Y	N						
RW-07	Active	7627480.16	702466.26	Shallow	36.0		36.00			10.0	304 S.S	0.010	0.3	36.0	26.0	0.0	10.0	36.5	24.0	0.0	12.5	12.5	Y	Y	N						
RW-08	Active	7627650.10	702380.41	Shallow	35.0		35.00			10.0	304 S.S	0.010	0.3	35.0	25.0	0.0	10.0	39.0	26.4	0.0	12.6	12.6	Y	Y	N						
RW-09i	Active	7627733.53	702319.88	Intermediate	42.0		34.00			5.0	304 S.S	0.010	0.3	42.0	37.0	-8.0	-3.0	44.1	37.0	-8.0	-0.9	7.1	Y	Y	N						
RW-10	Active	7627796.06	702242.19	Shallow	34.0		34.00			10.0	304 S.S	0.010	0.3	34.0	24.0	0.0	10.0	37.0	24.2	0.0	12.8	12.8	Y	Y	N						
RW-11i	Active	7627840.09	702183.18	Intermediate	42.0		34.00			5.0	304 S.S	0.010	0.3	42.0	37.0	-8.0	-3.0	45.5	38.1	-8.0	-0.6	7.4	Y	Y	N						
RW-12	Active	7627871.99	702077.07	Shallow	31.0		35.00			10.0	304 S.S	0.010	0.3	31.0	21.0	4.0	14.0	31.0	18.0	4.0	17.0	13.0	Y	Y	N						
RW-13i	Active	7627901.05	702003.55	Intermediate	40.0		35.00			5.0	304 S.S	0.010	0.3	40.0	35.0	-5.0	0.0	42.0	33.5	-5.0	3.5	8.5	Y	Y	N						
RW-14	Active	7627968.41	701962.17	Shallow	30.0		35.00			10.0	304 S.S	0.010	0.3	30.0	20.0	5.0	15.0	32.5	20.0	5.0	17.5	12.5	Y	Y	N						
RW-15	Active	7628048.90	701930.66	Shallow	31.0		36.00			10.0	304 S.S	0.010	0.3	31.0	21.0	5.0	15.0	38.0	25.0	5.0	18.0	13.0	Y	Y	N						
RW-16i	Active	7628054.92	701936.85	Intermediate	42.0		36.00			5.0	304 S.S	0.010	0.3	42.0	37.0	-6.0	-1.0	49.0	36.0	-6.0	7.0	13.0	Y	Y	N						
RW-17	Active	7628150.24	701884.88	Shallow	31.0		36.00			10.0	304 S.S	0.010	0.3	31.0	21.0	5.0	15.0	34.0	21.0	5.0	18.0	13.0	Y	Y	N						
RW-18	Active	7628203.98	701810.54	Shallow	32.0		37.00			10.0	304 S.S	0.010	0.3	32.0	22.0	5.0	15.0	42.0	29.5	5.0	17.5	12.5	Y	Y	N						
RW-19i	Active	7628213.30	701818.09	Intermediate	45.0		37.00			5.0	304 S.S	0.010	0.3	45.0	40.0	-8.0	-3.0	50.0	42.7	-8.0	-0.7	7.3	Y	Y	N						
RW-20	Active	7628266.91	701723.11	Shallow	30.0		36.00			10.0	304 S.S	0.010	0.3	30.0	20.0	6.0	16.0	35.5	23.0	6.0	18.5	12.5	Y	Y	N						
RW-21i	Active	7628292.81	701650.87	Intermediate	46.0		38.00			5.0	304 S.S	0.010	0.3	46.0	41.0	-8.0	-3.0	53.0	36.1	-8.0	8.9	16.9	Y	Y	N						
RW-22	Active	7628197.13	701534.02	Shallow	31.0		38.00			10.0	304 S.S	0.010	0.3	31.0	21.0	7.0	17.0	33.0	20.0	7.0	20.0	13.0	Y	Y	N						
RW-23	Active	7627551.09	702466.07	Shallow	35.0		35.00			10.0	304 S.S	0.010	0.3	35.0	25.0	0.0	10.0	37.2	24.5	0.0		12.7	Y	Y	N						
RW-24i	Active	7627566.33	702443.43	Intermediate	42.0		35.00			5.0	304 S.S	0.010	0.3	42.0	37.0	-7.0	-2.0	45.0	37.5	-7.0	0.5	7.5	Y	Y	N						
RW-25	Active	7628122.95	701474.02	Shallow	33.0		36.00			10.0	304 S.S	0.010	0.3	33.0	23.0	3.0	13.0	38.5	25.0	3.0	16.5	13.5	Y	Y	N						
RW-26i	Active	7628130.55	701480.56	Intermediate	43.0		36.00			5.0	304 S.S	0.010	0.3	43.0	38.0	-7.0	-2.0	47.0	40.0	-7.0	0.0	7.0	Y	Y	N						

Notes:

Y = Yes
N = No
NA = Not applicable

Table 2-2
Head Difference Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc. Facility
Portland, Oregon

Aquifer Designation			Vertical Flow Calculation	
Shallow	**Intermediate**	**Deep**	**Shallow/Intermediate**	**Intermediate/Deep**
PA-3	PA-17i	PA-27d	X	X
PA-4	PA-10i	PA-18d	X	X
PA-5	PA-11i	PA-30d	X	X
MWA-2	MWA-8i	PA-19d	X	X
MWA-69	MWA-66i	PA-21d	X	X
PA-6	PA-12i	PA-20d	X	X
MWA-46	MWA-49i	MWA-56d	X	X
PA-28	PA-13i	PA-22d	X	X
PA-7	PA-14i	PA-23d	X	X
MWA-47	PA-29i	PA-24d	X	X
PA-8	PA-15i	PA-25d	X	X
PA-9	PA-16i	PA-26d	X	X

FINAL

Table 3-1
N3DES Permit Effluent Discharge Limits
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc.
Portland, Oregon

Parameter	MQL	Effluent Quality Objective
VOCs (ug/L)[1]		
Benzene	0.5	<0.7
Chlorobenzene	0.5	<200
Chloroform	0.5	<30
SVOCs (ug/L)[1]		
2-Chlorophenol	1	<5
Pesticides (ug/L)[1]		
DDD	0.05	<0.05
DDE	0.05	<0.05
DDT	0.05	<0.05
Metals (ug/L)[2]		
Arsenic	0.05	<10
Chromium, hexavalent	0.9	<16
Inorganics (mg/L)[3]		
Chlorate	NA	<0.015
Perchlorate	0.004	<0.015
pH (s.u.)	NA	5.5 to 9.0
Other Parameters (mg/L)[3]		
Nitrate as N	0.1	
Nitrogen, Ammonium	1	<10
Nitrogen, Total Kjeldahl	NA	
Phosphate, Total as P	0.01	<1
Total Organic Carbon	NA	<10
Total Suspended Solids	NA	<25
Total Volatile Solids	NA	<25

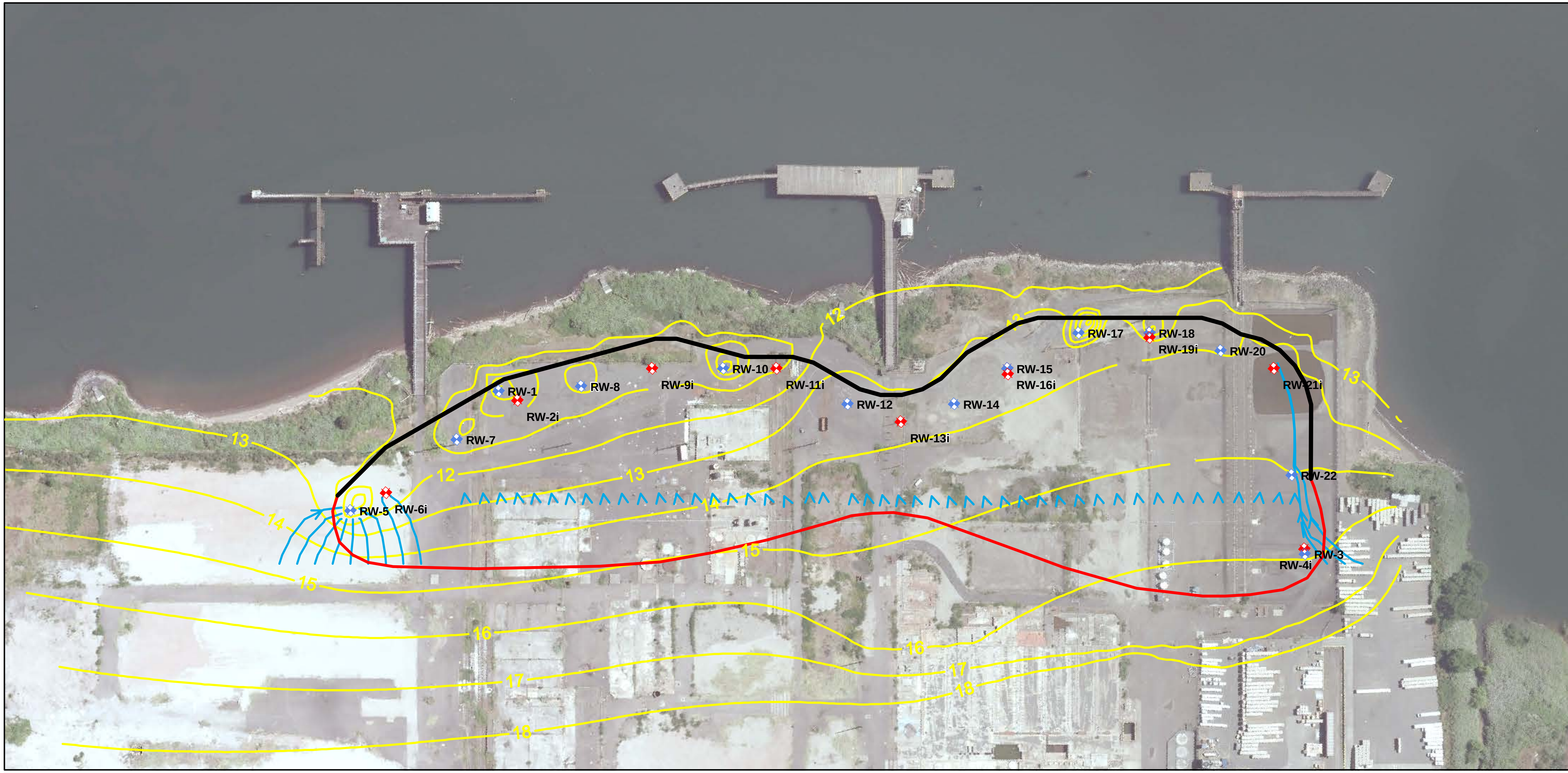
Notes

(1) - Estimated effluent concentrations based on approximately 90% removal efficiency for liquid-phase granular activated carbon (LPGAC).
(2) - Estimated effluent concentrations assume iron co-precipitation with clarifier and optional solids filtration.
(3) - Estimated effluent concentrations based on documented performance of fluidized bed reactor.

MDL = Method Detection Limit
mg/L = milligrams per liter
ug/L = micrograms per liter
s.u. = standard units
NA = data not available
VOC = Volatile Organic Compounds

SVOC = Semi-Volatile Organic Compounds
ODEQ = Oregon Department of Environmental Qu
DDD = dichloro diphenyl dichloroethane
DDE = dichloro diphenyl dichloroethylene
DDT = dichloro diphenyl trichloroethane

Appendix A
Potentiometric Surface and Particle Tracking Figures - Preliminary Design Report



Legend

- Shallow Zone Groundwater Flow Path
- Shallow Zone Head Solution (ft NAVD88)
- Shallow Zone Recovery Well
- Intermediate Zone Recovery Well
- Proposed Barrier Wall Alignment
- Target Capture Zone

N

0 150 300 Feet

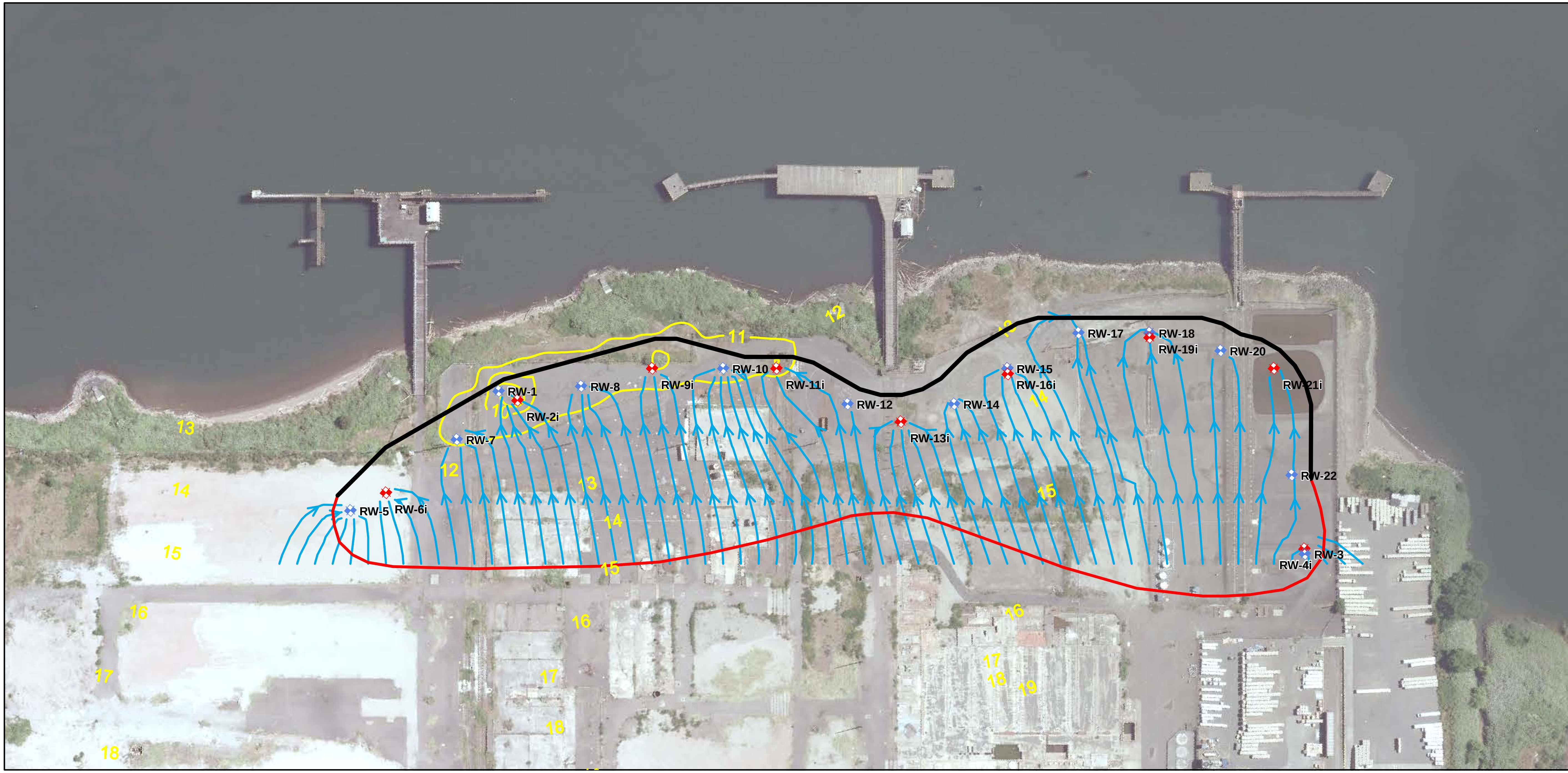
Data Sources: Aerial Photo: City of Portland, June 2008

Figure 3-1

Shallow Zone Groundwater Flow Path and Head Solution
Preliminary Design Report
Groundwater Source Control Measure
Arkema, Inc.
Portland, Oregon

ERM 05/11

Project: 0093634.05
Date: 05/02/2011
Drawn By: TFC
F:\RM106\A\Arkema\0057055 Groundwater Modeling\ArcGis\Arkema Preliminary Barrier Wall Design - Figure 3-1.mxd



Legend

- Intermediate Zone Groundwater Flow Path
- Intermediate Zone Head Solution (ft NAVD88)
- Proposed Barrier Wall Alignment
- Target Capture Zone
- Shallow Zone Withdrawal Well
- Intermediate Zone Withdrawal Well

N

0 150 300 Feet

Data Sources: Aerial Photo: City of Portland, June 2008

Figure 3-2
Intermediate Zone Groundwater Flow Path and Head Solution
Preliminary Design Report
Groundwater Source Control Measure
Arkema, Inc.
Portland, Oregon

ERM *05/11*

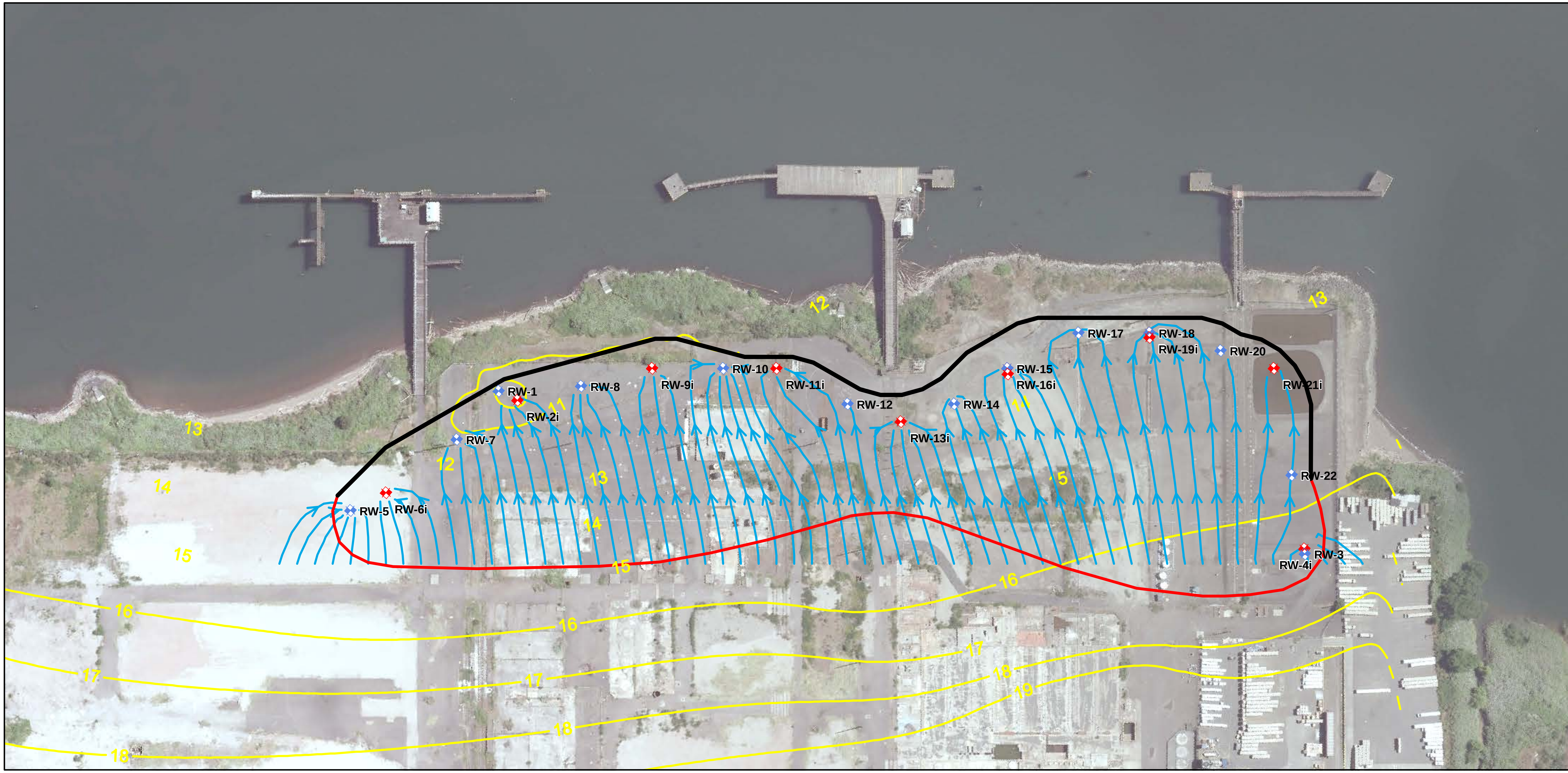
File: F:\RM106\A\Arkema\0057055 Groundwater Modeling\ArcGis\Arkema Preliminary Barrier Wall Design - Intermediate Zone.mxd

Drawn By: TFC

Date: 05/02/2011

Project: 0093634.05

File: F:\RM106\A\Arkema\0057055 Groundwater Modeling\ArcGis\Arkema Preliminary Barrier Wall Design - Deep Zone.mxd
Drawn By: TFC
Date: 05/02/2011
Project: 0093634.05



Legend

- Deep Zone Groundwater Flow Path
- Deep Zone Head Solution (ft NAVD88)
- Proposed Barrier Wall Alignment
- Target Capture Zone
- Shallow Zone Withdrawal Well
- Intermediate Zone Withdrawal Well

N

0 150 300 Feet

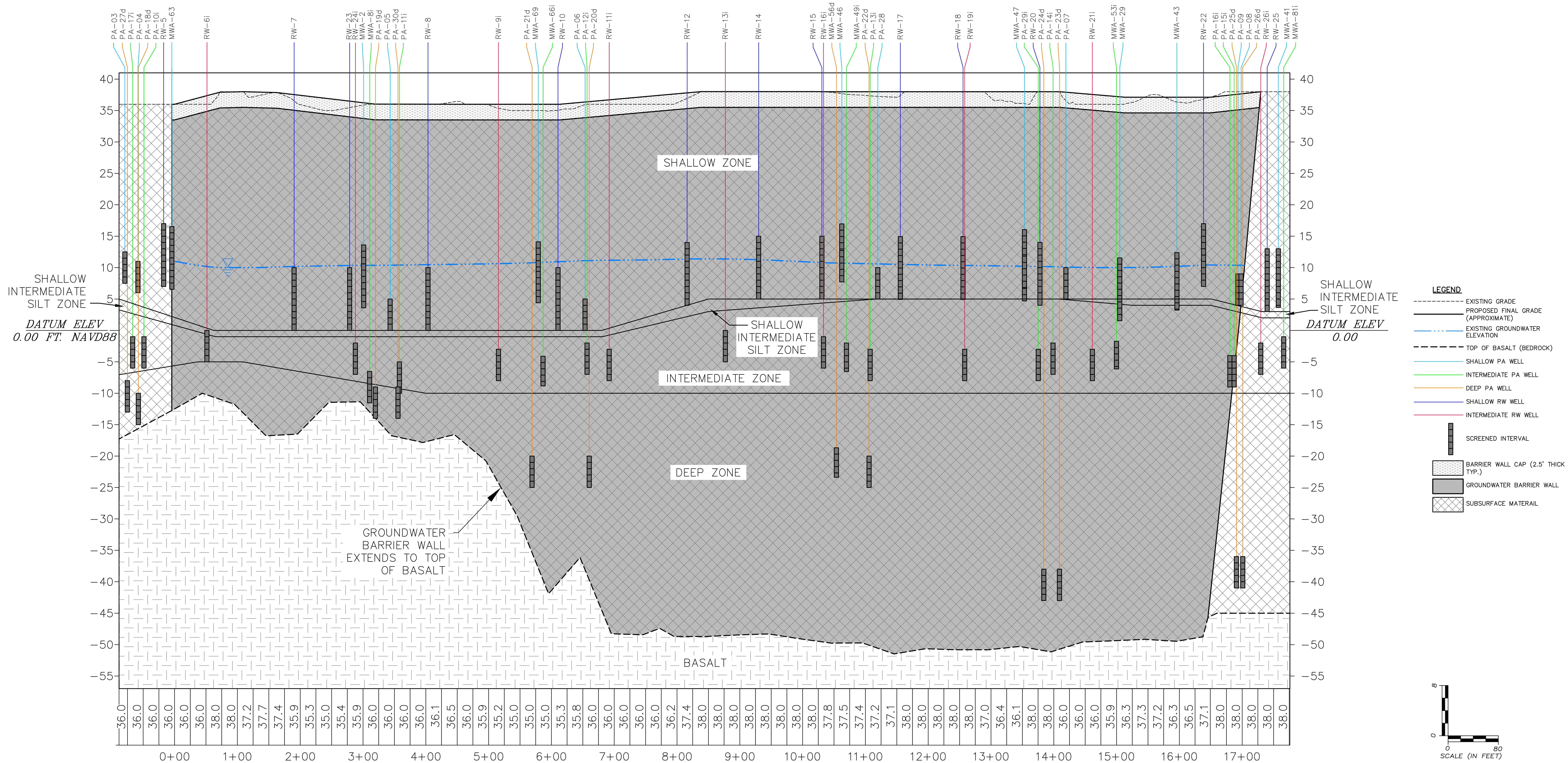
Data Sources: Aerial Photo: City of Portland, June 2008

Figure 3-3

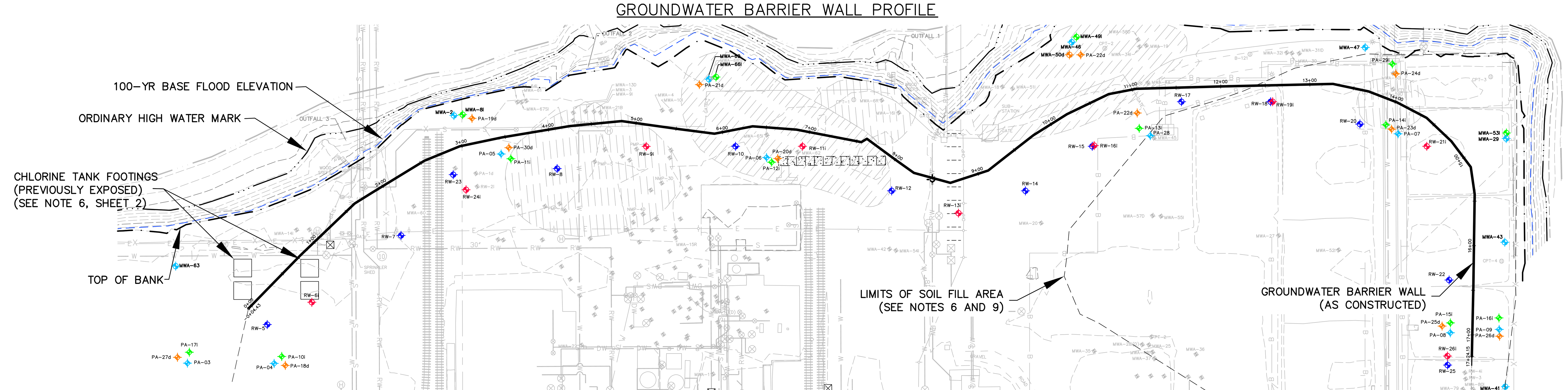
Deep Zone Groundwater Flow Path and Head Solution
Preliminary Design Report
Groundwater Source Control Measure
Arkema, Inc.
Portland, Oregon

ERM 05/11

Appendix B
Hydraulic Gradient Control Point Cross Section



GROUNDWATER BARRIER WALL PROFILE



GROUNDWATER BARRIER WALL PLAN

0 80 180
SCALE (IN FEET)

REV.	DATE	DESCRIPTION	BY	CHK
1	2/5/13	ADDRESS AGENCY COMMENTS	RK	BR

DRAWN BY RMK | CADD Review FGB | CHECKED BY SL-ANN

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SEAL

GROUNDWATER SOURCE CONTROL MEASURE
PERFORMANCE MONITORING SYSTEM
ARKEMA INC.
PORTLAND, OREGON

HYDRAULIC GRADIENT CONTROL POINT CROSS SECTION

SCALE	PROJECT NUMBER	SHEET	REV.
AS NOTED	0180382	6	1
DATE 07/20/2010			

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Appendix C GWET System Process Flow Diagram

NOTES:

1. TWO FILTER UNITS IN OPERATION WITH ONE UNIT IN BACKWASH/STANDBY.

2. AFTER PLACEMENT OF NEW CARBON IN THE CARBON UNITS, THEY ARE RINSED TO REMOVE FINES

3. THE CARBON UNITS ARE OPERATED IN SERIES (PRIMARY UNIT DISCHARGING TO THE SECONDARY UNIT DISCHARGING TO THE OUTFALL)

4. THE CARBON UNITS ARE OPERATED IN SERIES (PRIMARY UNIT DISCHARGING TO THE SECONDARY UNIT DISCHARGING TO ATMOSPHERE.)

ISSUED FOR AGENCY APPROVAL

REV.	DATE	DESCRIPTION	BY	CHK
B	01/25/13	ISSUED FOR AGENCY APPROVAL	LAG	BR
A	05/14/12	ISSUED FOR BIDS	LAG	BR
0	02/07/11	ISSUED FOR AGENCY REVIEW	LAG	BR

DRAWN BY RMK CADD Review FGB CHECKED BY LG-Rol

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Environmental Resources Management, Inc.

REGISTERED PROFESSIONAL ENGINEER 78496PE OREGON DECEMBER 31, 2007 BRENDAN ANDREW ROBINSON

EXP. 12/31/2014

GROUNDWATER SOURCE CONTROL MEASURE

ARKEMA, INC.
PORTLAND, OREGON

GWET SYSTEM PROCESS FLOW DIAGRAM

SCALE	PROJECT NUMBER	SHEET	REV.
AS NOTED	0180382	PFD-01	B
DATE 11/10/2010			

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Appendix D
Quality Assurance Project Plan Addendum

Introduction

This attachment will serve as an addendum to most recent site Quality Assurance Project Plan (QAPP), prepared as part of the *Draft Design Report Stormwater Source Control Measures* (Integral 2010). This document has been prepared to include additional treatment system effluent monitoring analytical requirements in the project scope.

Data Quality Objectives

Effluent samples collected for reporting requirements will be analyzed by Columbia Analytical Services in Kelso, Oregon, following quantitative data quality objectives provided in Table 1. Internal monitoring of effluent will be accomplished using field test methods.

Field quality control samples, including duplicates and blanks will be collected as per the QAPP at a frequency of at least 1 set of quality control samples for every 20 field samples.

Table 1
Laboratory Quality Objectives
Groundwater Source Control Measure
Arkema Inc.
Portland, Oregon

Parameter	Analytial Method	MQL	Effluent Quality Objective
Organochlorine Pesticides (ug/L)			
DDD	USEPA 625	0.05	<0.05
DDE	USEPA 625	0.05	<0.05
DDT	USEPA 625	0.05	<0.05
Metals (ug/L)			
Arsenic (total)	USEPA 200.8	0.1	<10
Chromium, hexavalent	USEPA 7195/6010B	0.9	<16
Inorganics (mg/L)			
Chlorate	USEPA 300.1	NA	<0.015
Perchlorate	USEPA 314	0.004	<0.015
pH (s.u.)	SM 4500H+ B	NA	5.5 to 9.0
Other Parameters (mg/L)			
Nitrogen, Ammonium	USEPA 350.1	1	<10
Nitrogen, Total Kjeldahl	USEPA 351	NA	
Phosphate, Total as P	USEPA 365.1	0.01	<1
Total Suspended Solids	SM 2540D	NA	<130
Total Volatile Solids	USEPA 160.4	NA	<25

Notes
mg/L = milligrams per liter
ug/L = micrograms per liter
s.u. = standard units
NA = data not available
USEPA = United States Environmental Protection Agency
SM = Standard method