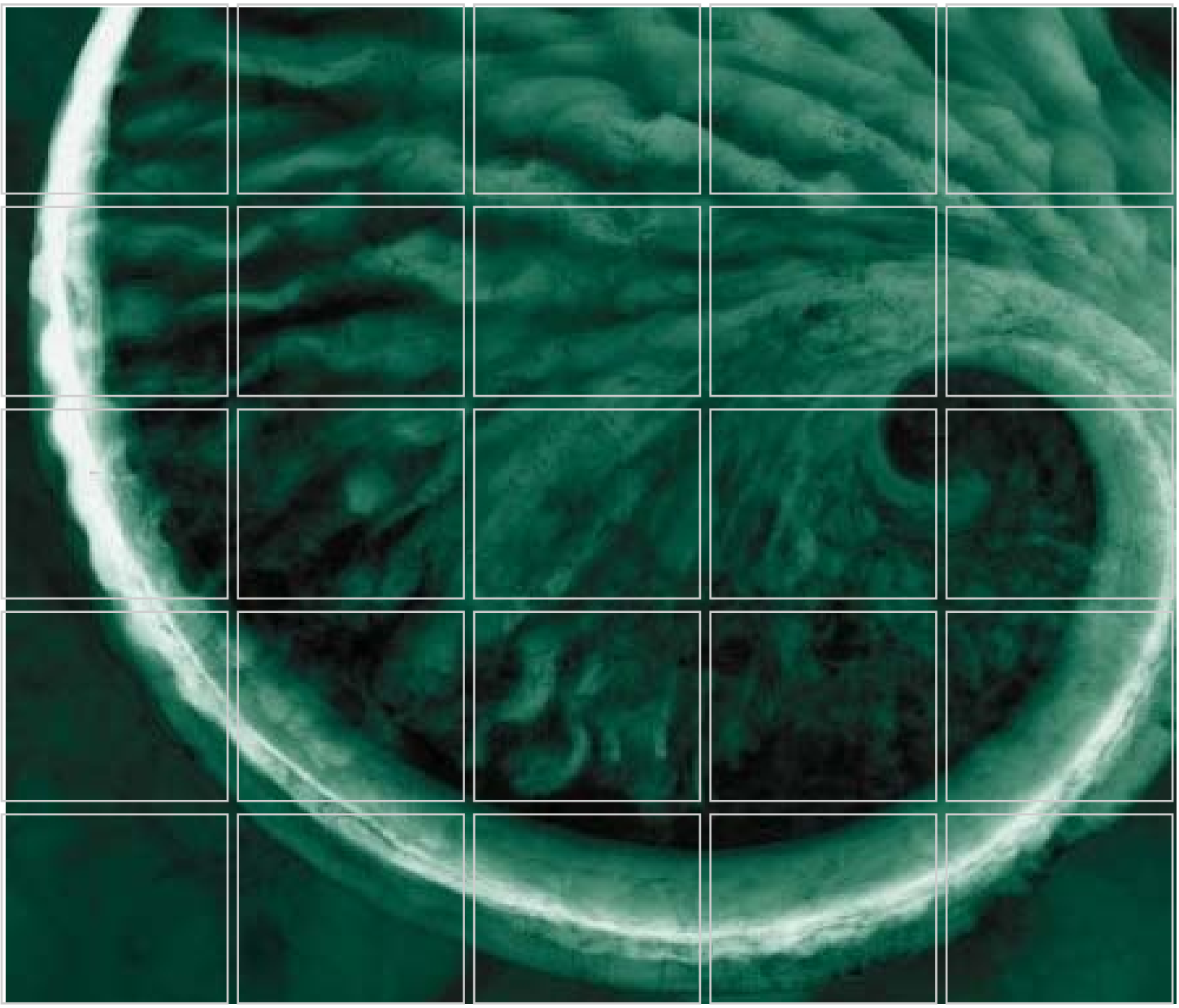

Performance Monitoring Plan – Groundwater Source Control Measure

Arkema Inc. Facility
Portland, Oregon

Prepared for:
Legacy Site Services LLC

January 2011

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Project No. 114849

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LIST OF ACRONYMS

Consent Order	Order on Consent DEQ No. LQVC-NWR-08-04
COPC	Constituent of potential concern
DDT	Dichloro diphenyl trichloroethane
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 actions
ODEQ	Oregon Department of Environmental Quality
PDR	Preliminary Design Report
PMP	Performance Monitoring Plan
PVC	Polyvinyl Chloride
USEPA	United States Environmental Protection Agency
VFD	Variable Frequency Drive

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 (the site) located at 6400 NW Front Avenue in Portland, Oregon (Figure 1-1). This PMP has been prepared pursuant to the Order on Consent requiring source control measures 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). This PMP has been prepared in accordance with the *Scoping Technical Memorandum, Groundwater Source Control Interim Remedial Measure*, (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* (ERM 2010b); and associated comments and approvals received from the ODEQ and United States Environmental Protection Agency (USEPA).

1.1 BACKGROUND

1.1.1 Site History

Inorganic chemicals were manufactured at the site from 1941 until 2001, when the facility was closed and chemical manufacturing was discontinued. For most of the site's history, chemical activities involved electrolytic decomposition of brine solutions to manufacture inorganic chemicals, including sodium chlorate, chlorine, sodium hydroxide, hydrogen, and hydrochloric acid. Other chemical manufacturing processes during the site's operational history included the production of dichloro diphenyl trichloroethane (DDT) from 1947 to 1954, and ammonium perchlorate from 1958 to 1962 (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.

Arkema (formerly known as ATOFINA Chemicals Inc., Elf Atochem North America Inc., and the Pennwalt Corporation) has conducted investigations and performed a number of interim remedial measures (also referred to as SCMs) in the upland portion of the site since 1994. These historical investigations and SCMs were conducted under the ODEQ Voluntary Cleanup Program. Results of the historical investigations were presented in the *Upland Remedial Investigation Report Lots 3 & 4 and Tract A – Revision 1*, which was submitted to ODEQ in December 2005 (ERM 2005). Results of the SCMs implemented between 2000 and 2006 have been presented to the ODEQ and were summarized in the FFS (ERM 2008b).

A groundwater source control evaluation was submitted to the ODEQ in 2007 (Integral 2007) and an addendum was submitted in 2008 (Integral 2008). The source control screening evaluation concluded that implementation of a GW SCM would significantly reduce contaminant flux to the Willamette River in accordance with the Joint Source Control Strategy (JSCS)[1]. In May 2008, LSS submitted the FFS in support of the GW SCM at the site (ERM 2008b). The FFS provided an evaluation of remedial alternatives and selected the preferred alternative for the GW SCM (additional details regarding the FFS are presented in Section 1.1.2 below). On 23 February 2009, ODEQ approved the general approach for the GW SCM. This approach includes installation of a groundwater barrier wall (GWBW) and a groundwater extraction and treatment (GWET) system, with treated water being discharged to the Willamette River.

Arkema and ODEQ entered into the Consent Order for the upland portion of the site on 31 October 2008. The upland Consent Order requires submittal of various documents in support of upland SCMs (groundwater, storm water, and erodible soil) and the site-wide upland FS. The current

[1] *The Portland Harbor Joint Source Control Strategy* prepared by the Oregon Department of Environmental Quality and the United States Environmental Protection Agency (ODEQ 2005) is a framework for making upland source control decisions at the Portland Harbor Superfund Site.

phase of work has been implemented under the 2009 Work Plan (ERM 2009b), a document required by the Consent Order.

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 Arkema 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 draft Scoping Technical Memorandum (ERM 2006) was prepared to identify and outline the general concepts necessary to complete a GW SCM. ODEQ provided comments on this memorandum in January 2007, which 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 (RAOs):

- 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.
- 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 (ERM 2008b) 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 (groundwater extraction and treatment) 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 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 (ERM 2008b) submitted to 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 four 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, 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.

ODEQ conditionally approved the FFS (ERM 2008b) 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, ODEQ recommended alternatives for the primary components of the GW SCM. A proposed layout of the recommended GW SCM is presented on Figure 1-2. A conceptual cross section of the GW SCM is presented on Figure 1-3.

The recommended barrier wall component of the GW SCM will require construction of a GWBW along the top of the river bank extending to the top of the basalt using conventional slurry wall technology. 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.

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 GW SCM Work Plan (ERM 2009b) was prepared following the FFS, as required by the Consent Order.

The *Preliminary Design Report – Groundwater Source Control Measure* (ERM 2010a) (PDR) was submitted to 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. This PMP is a document required under the Work Plan, the PDR, and the GWBW Pre-Final Design. Following this PMP, the next submittal to ODEQ will be the GWET System Pre-Final Design, which will include specific design details of the GWET system, and draft versions of additional planning documents. The Pre-Final Design package will form the basis for the preparation of vendor and contractor bid documents.

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 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 Zone and Deep Zone. The conceptual design of the GW SCM is shown on Figure 1-3.

The layout of the GW SCM is presented on Figure 2-1, including the Target Capture Zone. 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 2010a).

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 if necessary.

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, and 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 installation and operation of a GWET system.

The lateral extent of the Target Capture Zone shown on Figure 2-1 was based on the historical and current (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.

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 of capture zone extent and numerical modeling.

The purpose of treatment system sampling described in Section 3 is to meet the potential compliance monitoring requirements of the as yet to be determined NDPES 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 based on this analysis.

2.2 *WATER LEVEL MONITORING*

The purpose of water level monitoring is to provide sufficient data to determine an inward hydraulic gradient across the GWBW and evaluate the actual capture zone of the GW SCM. The capture zone analysis will be performed using water level measurement data from selected piezometers throughout the target capture zone to generate potentiometric surface maps. The evaluation of inward hydraulic gradient will be performed using water level measurement data from select groups of piezometers located upgradient and down gradient of the GWBW.

2.2.1 *Potentiometric Surface and Water Level Difference Maps*

Water level data will be collected using a combination of transducer and manual measurements. The proposed potentiometric surface monitoring points are listed in Table 2-1. Figures 2-2, 2-3, and 2-4 present the locations of the proposed monitoring points in the Shallow, Intermediate, and Deep Zones, respectively. The proposed monitoring points consist of existing monitoring wells and proposed new piezometers. The proposed new piezometers include piezometers that will replace monitoring wells scheduled to be abandoned as part of the GWBW installation.

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. This analysis will be used to determine areas of upward flow. Specific clusters of monitoring points will be used to evaluate vertical flow areas.

As described below, selected monitoring points will have water level sensors installed to allow real-time monitoring of water levels in critical locations, as listed in Table 2-1. These wells are likely to be influenced by the seasonal and tidal fluctuations of the river. The transducer data will allow for frequent water level measurement in these critical wells. 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 needed to optimize the 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.

2.2.2 *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 2.2.1. 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. The monitoring points within each cluster are presented in Table 2-2.

The water levels within each piezometer in the clusters will be monitored automatically using water level sensors and fed back to an on-site computer. These groundwater level measurements of critical wells will be monitored remotely on a real-time basis via a network connection.

The extraction rates from the individual recovery wells will be adjusted in order to maintain an inward hydraulic gradient, as measured within each six gradient control point cluster. The proposed extraction pumps will be variable frequency drive (VFD) pumps fitted with water level sensors connected to the networked computer on-site. Flow adjustments to individual wells will be made remotely through the on-site computer.

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. In order to provide an accurate value for the calculation of the long-term hydraulic gradient, the transducer measurements will be averaged over a period of 1 week. A minimum target gradient of 0.005 will be used to control the initial operation of the recovery wells. 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. These target gradients will be presented in the 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. This data will be used for high/low cutoff switches on the extraction pumps and to monitor the efficiencies of the individual recovery wells over time. 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. Water level data from recovery wells will not be used in the evaluation of actual capture zone.

2.2.4 *Piezometer Installation*

Approximately 17existing monitoring wells will require abandonment as part of the installation of the GWBW. The specific wells scheduled for abandonment are listed in Table 2-1. The replacement piezometers and the additional proposed GWET system monitoring network piezometers are presented in Table 2-1.

The monitoring wells will be abandoned in accordance with Section 690-240-0510 of the Oregon Administrative Rules (OAR), Abandonment of Monitoring Wells. The abandonment procedures were presented in the *Arkema Portland Groundwater Source Control Measure Groundwater Barrier Wall Pre-Final Design* (ERM 2010c) and the response to ODEQ comments letter dated 22 December 2010 (ERM 2010d). These procedures include over-drilling the existing well and backfilling the borehole with bentonite grout.

The piezometers will be constructed from nominal one-inch diameter Schedule 40 polyvinyl chloride (PVC) casing with a five-foot long, pre-packed 0.010-inch slotted screen. The piezometer seals will consist of a two-foot thick bentonite chip (Puregold® or equivalent) seal placed above the filter pack. The piezometer will then be sealed to approximately 2 feet below ground surface with a high solids bentonite grout (PureGold® Grout or equivalent) pumped from the bottom up via tremie pipe. The piezometers will be completed with traffic-rated flush mount vault boxes set in concrete.

New and replacement piezometers will be installed using direct push dual-tube drilling methods. The specific drilling method to be used in each aquifer zone is described below.

2.2.4.1 *Shallow Zone Piezometers*

The Shallow Zone boreholes will be advanced to the top of the Shallow-Intermediate Silt horizon using nominal 3-1/4-inch internal diameter (ID) casing. Soil samples will be collected every five feet to a depth of 30 feet bgs and continuously thereafter, until the silt horizon is identified. All soil samples will be logged and described by a geologist familiar with the site geology. The shallow zone piezometer will be installed at the contact with the Shallow-Intermediate Silt.

2.2.4.2 *Intermediate and Deep Zone Piezometers*

For the Intermediate and Deep Zone piezometer installations in the area delineated as having potential dense non-aqueous phase liquid (DNAPL) chlorobenzene, a conductor casing step-down across the Shallow-Intermediate Silt is required in order to ensure that DNAPL from the Shallow Zone is not dragged down during installation.

A borehole will be advanced to the top of the underlying Shallow-Intermediate Silt horizon using 4-1/4-inch ID casing. Soil cores will be collected every five feet to a depth of 30 feet bgs and continuously thereafter, until the silt horizon is identified. Once the silt horizon is identified, a temporary conductor casing will be installed within the augers in the borehole and will be backfilled with approximately five feet of hydrated bentonite chips. The borehole will then be advanced to the installation depth through the conductor casing and step-down seal using nominal 3-1/4-inch ID casing. Soil core collection will resume at a frequency of every five feet below the Shallow-Intermediate Silt.

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 NDPES 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, 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) following treatment in the FBR, from the effluent as a polishing step.
- 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 A.

3.2 *COMPLIANCE MONITORING*

The purpose of compliance monitoring is to evaluate the performance of the treatment system in meeting the discharge effluent limits required under the as yet to be determined 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 consist of collecting monthly samples 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 are will be performed in accordance with the most recent site Quality Assurance Project Plan (QAPP), 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 the QAPP, included as Appendix A of this PMP.

4.0 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 performance monitoring reporting scope and schedule. The reporting phase is intended to fulfill Steps 5 and 6 of the evaluation of capture zones.

4.1 PERFORMANCE MONITORING REPORTING

The results of GW SCM performance monitoring will be reported to ODEQ monthly for the first twelve months of GWET system operation. These monthly reports will include water levels, potentiometric surface maps, head difference maps, and 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 ODEQ before modifying the reporting frequency.

In the event that the GWET system does not operate 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 period of no pumping is expected to occur between GWBW installation and GWET system start up. LSS remains committed to working with DEQ to minimize this period through agency cooperation and a phased approach in construction of the GWBW and GWET system.

5.0 REFERENCES

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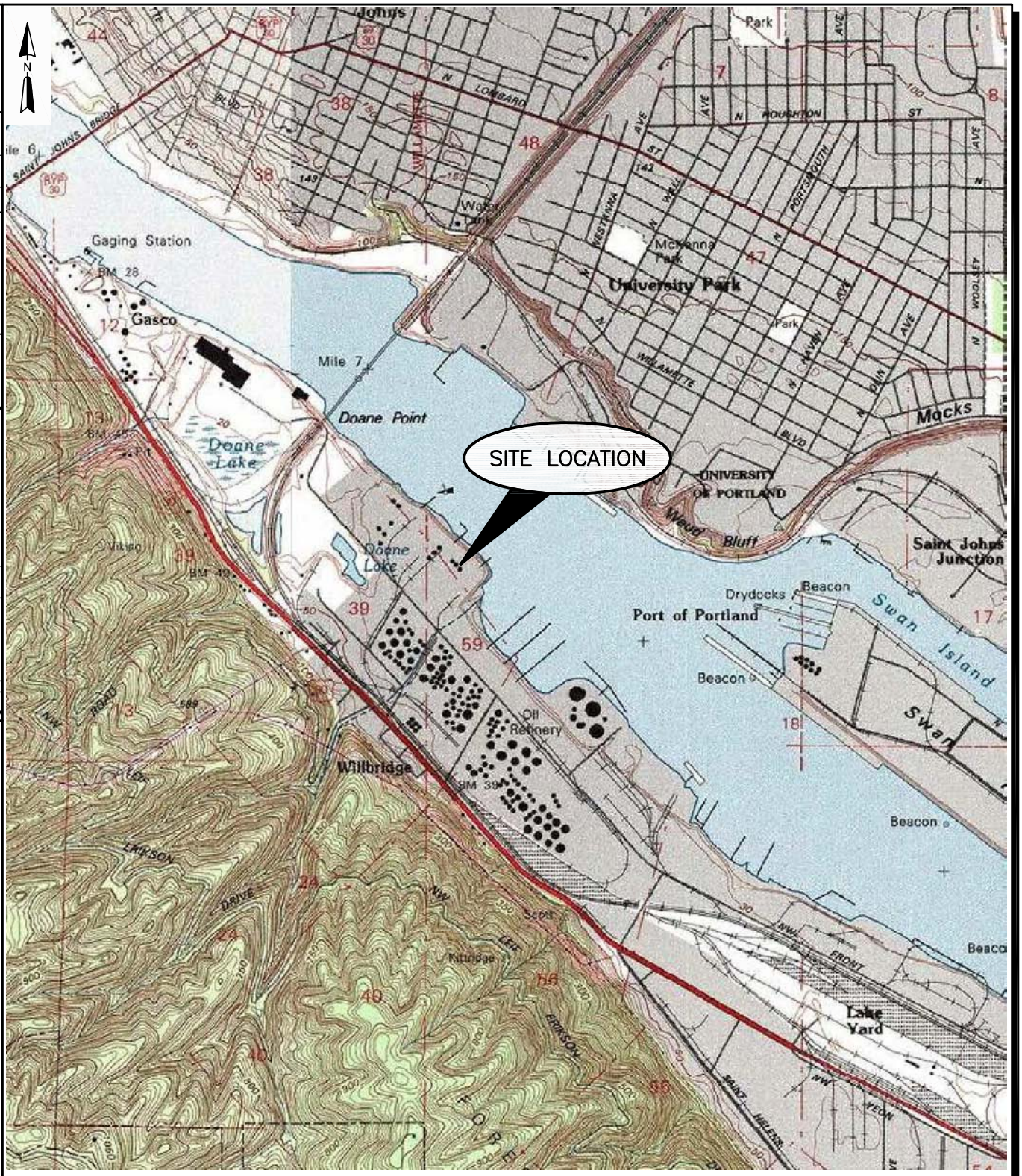
Figures

Project No. 0114849.01

Date: 05/05/10

Drawn By: R. Olson

CAD File: g:\\0114849\01\01148901-01.dwg



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1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

Figure 1-1

Site Location

Preliminary Design Report

Groundwater Source Control Measure

Arkema, Inc.

Portland, Oregon

References:
TOPO!® Software
U.S.G.S. 7.5 Minute Series (Topographic) Quadrangle,
Linnton, OR Version: 1990; Current: 1990
Portland, OR WA Version: 1990; Current: 1990

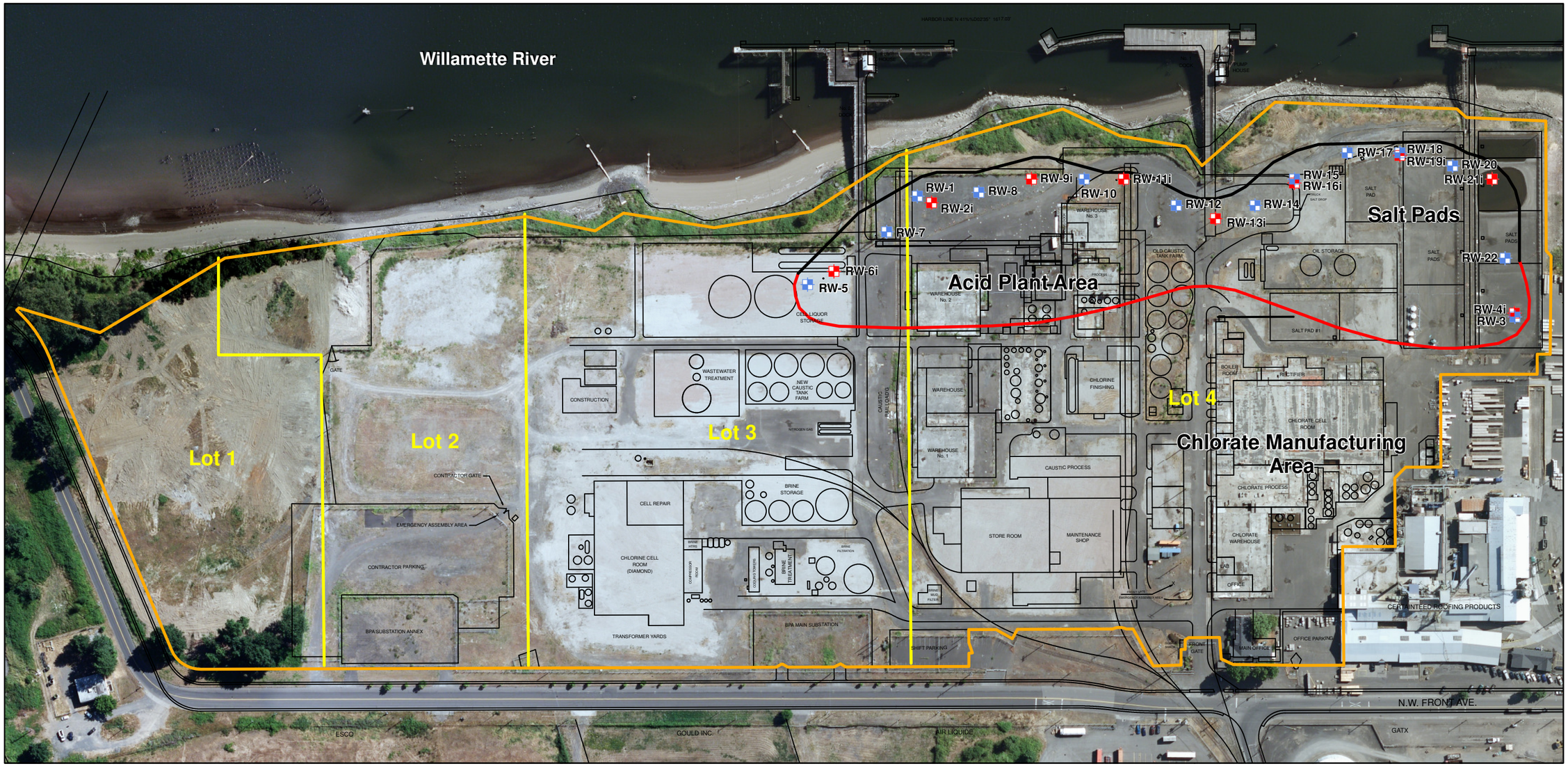
ERM *05/10*

Project: 0093634.05

Date: 01/04/2011

Drawn By: TFC

F:\RM106\A\Arkema\0057055 Groundwater Modeling\ArcGis\Figure 3-4 Preliminary GWET System Layout.mxd



Legend

- Shallow Zone Recovery Well
- Intermediate Zone Recovery Well
- Proposed Barrier Wall Alignment
- Target Capture Zone
- Lot Boundary
- Site Boundary

N

0 200 400 Feet

Aerial Photo: City of Portland, July 2009

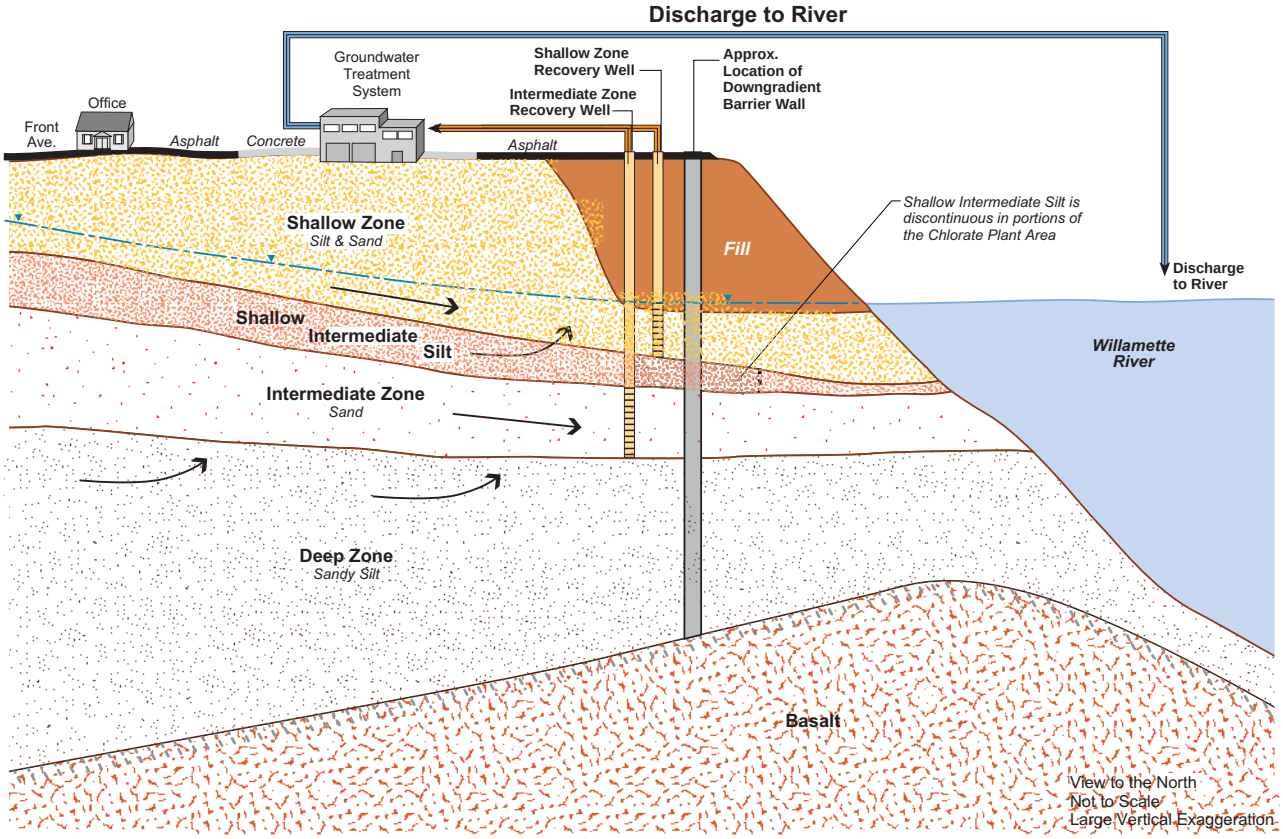
Figure 1-2
Site Layout
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc.
Portland, Oregon

ERM 01/11

Project No. 114849

Date: 1-4-11

Drawn By: EJK



Conceptual Groundwater Flow Direction

Figure 1-3

Groundwater Source Control Measure Conceptual Design
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc.
Portland, Oregon

ERM *FIG 1-3 1-4-11*

Project: 0093634.05

Date: 01/12/2011

Drawn By: TFC

F:\RM106\A\Arkema\0057055 Groundwater Modeling\ArcGis\Figure 3-4 Preliminary GWET System Layout.mxd

Legend

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

N

0 150 300 Feet

Aerial Photo: City of Portland, July 2009

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

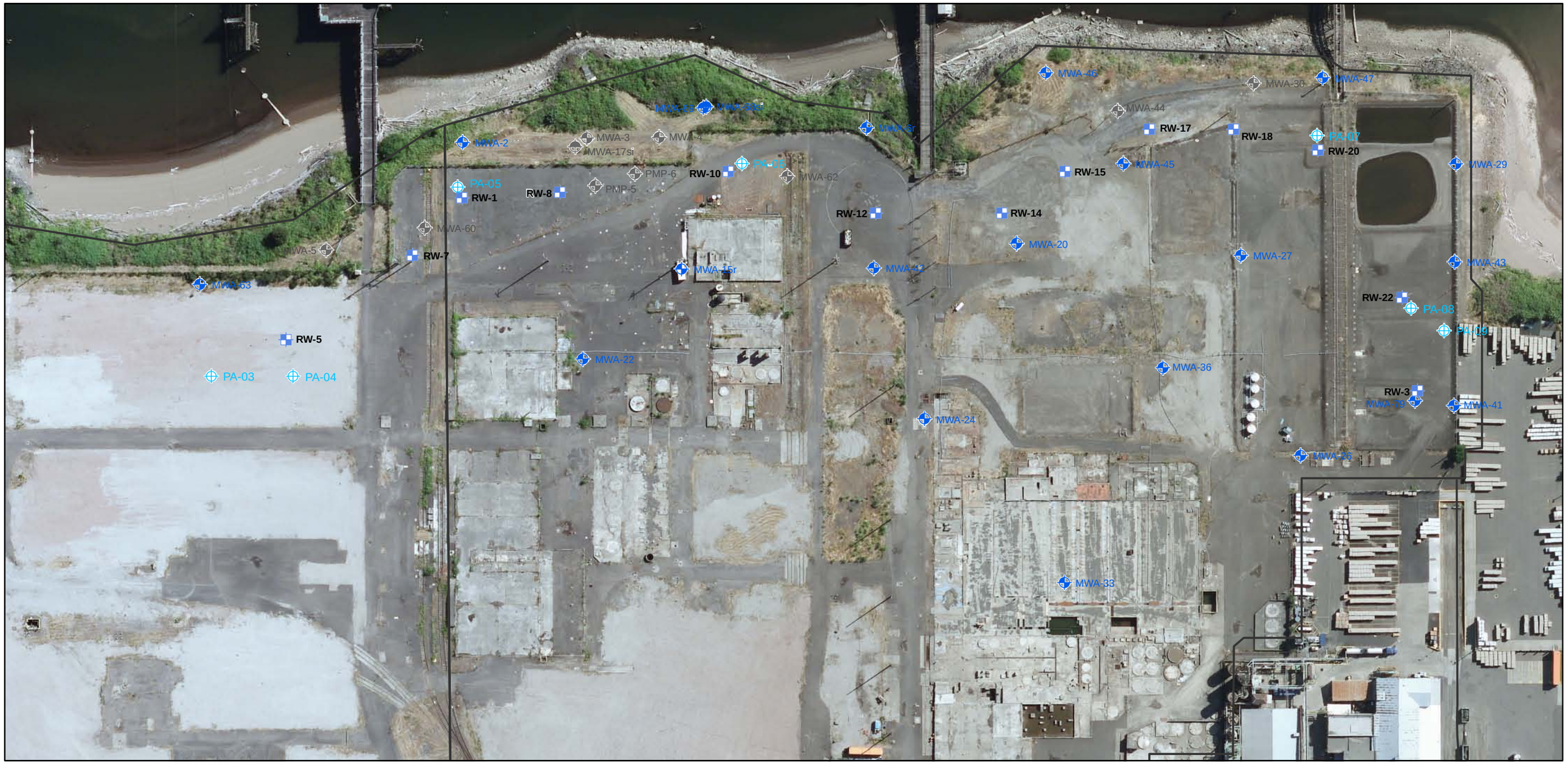
ERM 01/11

Project: 0114849

Date: 01/14/2011

Drawn By: mike.appel

File: D:\Arkema\0114849 GWET Design GW SCM\Performance Monitoring Plan\Figure 2-2 (Shallow WL).mxd



Legend

- Proposed Shallow Zone Piezometer
- Shallow Zone Recovery Well
- Existing Shallow Zone Monitoring Well
- Shallow Zone Monitoring Well to be Abandonded
- Existing Shallow-Intermediate Zone Monitoring Well
- Shallow-Intermediate Zone Monitoring Well to be Abandonded
- Proposed Barrier Wall Alignment
- Target Capture Zone
- Parcel and Property Boundaries

N

0 150 300 Feet

Aerial Photo: City of Portland, July 2009

Figure 2-2

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

ERM 01/11

Project: 0093634.05

Date: 01/14/2011

Drawn By: mike.appel

File: D:\Arkema\0114849 GWET Design GW SCM\Performance Monitoring Plan\Figure 2-3 (Intermediate WL).mxd

Legend

- Proposed Intermediate Zone Piezometer
- Intermediate Zone Recovery Well
- Existing Intermediate Zone Monitoring Well
- Intermediate Zone Monitoring Well to be Abandoned
- Target Capture Zone
- Proposed Barrier Wall Alignment
- Parcel and Property Boundaries

N

0 150 300 Feet

Aerial Photo: City of Portland, July 2009

Figure 2-3

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

ERM 01/11

Project: 0114849

Date: 01/14/2011

Drawn By: mike.appel

File: D:\Arkema\0114849 GWET Design GW SCM\Performance Monitoring Plan\Figure 2-4 (Deep WL).mxd

Legend

- Proposed Deep Zone Piezometer
- Existing Deep Zone Monitoring Well
- Deep Zone Monitoring Well to be Abandoned
- Target Capture Zone
- Proposed Barrier Wall Alignment
- Parcel and Property Boundaries

N

0 150 300 Feet

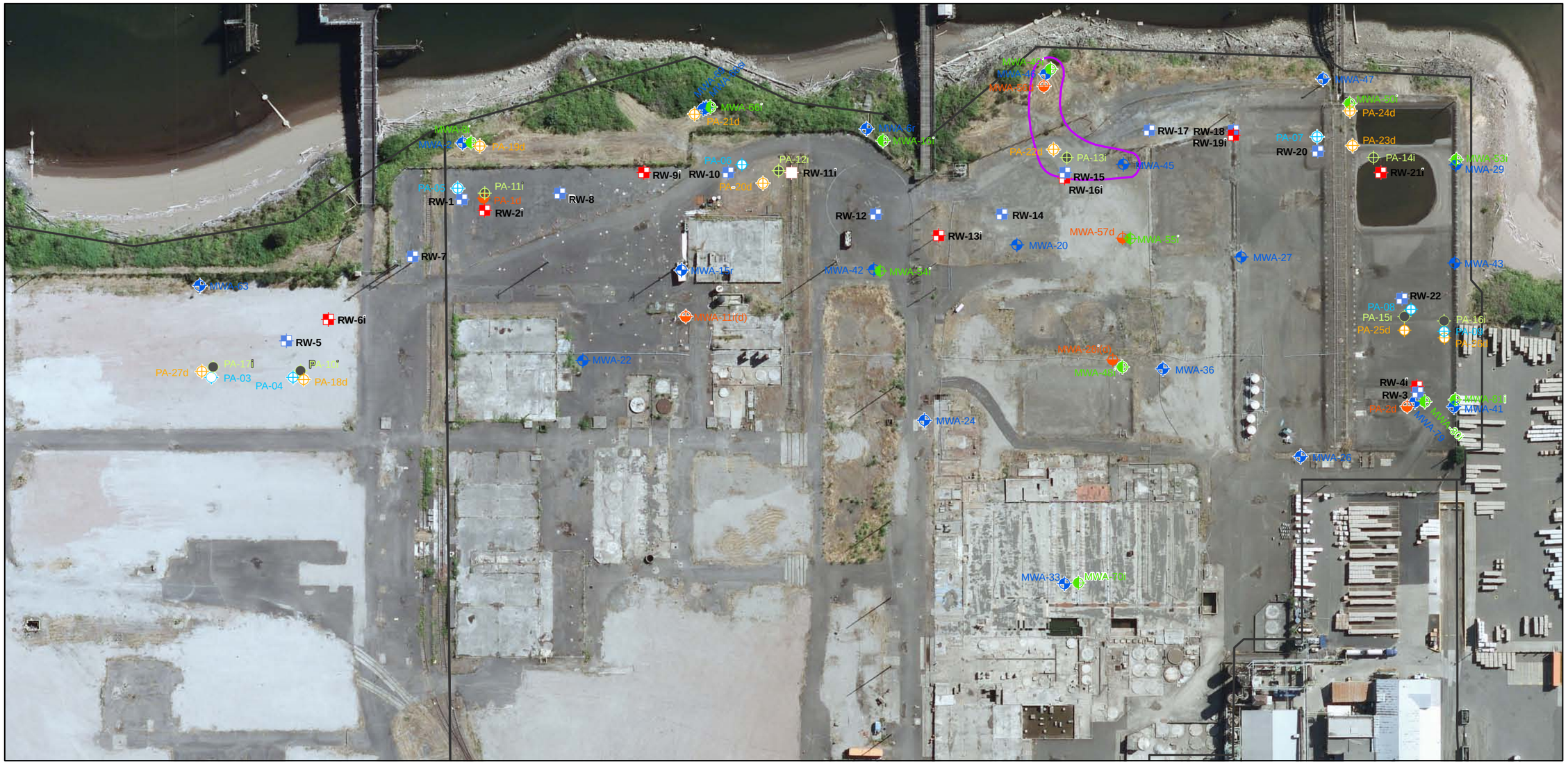
Aerial Photo: City of Portland, July 2009

Figure 2-4

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

ERM 01/11

Project: 0114849
Date: 01/14/2011
Drawn By: mike.appel
File: D:\Arkema\0114849 GWET Design GW SCM\Performance Monitoring Plan\Figure 2-5 (Head Difference).mxd



Legend

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

N

0 150 300 Feet

Aerial Photo: City of Portland, July 2009

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

ERM 01/11

Tables

Table 2-1
Water Level Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc. Facility
Portland, Oregon

Monitoring Point	Status	Aquifer Classification	Scheduled for Abandonment	Capture Zone Monitoring Point	Gradient Control Points		Real-time Monitoring
					Gradient Calculation Point	Comparison Point	
MWA-2	Active	Shallow		Y	Y	PA-5	Y
MWA-3	Active	Shallow	Y	NA	NA		
MWA-4	Active	Shallow	Y	NA	NA		
MWA-5	Active	Shallow	Y	NA	NA		
MWA-6r	Active	Shallow		Y	N		N
MWA-8i	Active	Intermediate		Y	Y	PA-11i	Y
MWA-9i	Active	Intermediate	Y	NA	NA		
MWA-10i	Active	Intermediate	Y	NA	NA		
MWA-	Active	Deep		Y	N		N
MWA-	Active	Deep		Y	N		N
MWA-13d	Active	Deep	Y	NA	NA		
MWA-	Active	Deep	Y	NA	NA		
MWA-16i	Active	Intermediate		Y	N		N
MWA-17si	Active	Shallow	Y	NA	NA		
MWA-20	Active	Shallow		Y	N		N
MWA-21b	Abandoned	Basalt		NA	NA		
MWA-22	Active	Shallow		Y	N		N
MWA-24	Active	Shallow		Y	N		N
MWA-26	Active	Shallow		Y	N		N
MWA-27	Active	Shallow		Y	N		N
MWA-28i(d)	Active	Deep		Y	N		N
MWA-29	Active	Shallow		Y	N		N
MWA-33	Active	Shallow		Y	N		N
MWA-36	Active	Shallow		Y	N		N
MWA-41	Active	Shallow		Y	N		N
MWA-42	Active	Shallow		Y	N		N
MWA-43	Active	Shallow		Y	N		N
MWA-44	Active	Shallow	Y	NA	NA		
MWA-45	Active	Shallow		Y	Y	MWA-46	Y
MWA-46	Active	Shallow		Y	Y	MWA-45	Y
MWA-47	Active	Shallow		Y	Y	PA-15	Y
MWA-48i	Active	Intermediate		Y	N		N
MWA-49i	Active	Intermediate		Y	Y	PA-13i	Y
MWA-50i	Active	Intermediate		Y	Y	PA-14i	Y
MWA-53i	Active	Intermediate		Y	N		N
MWA-54i	Active	Intermediate		Y	N		N
MWA-55i	Active	Intermediate		Y	N		N
MWA-56d	Active	Deep		Y	Y	PA-22d	Y
MWA-57d	Active	Deep		Y	N		N

Table 2-1
Water Level Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc. Facility
Portland, Oregon

Monitoring Point	Status	Aquifer Classification	Scheduled for Abandonment	Capture Zone Monitoring Point	Gradient Control Points		Real-time Monitoring
					Gradient Calculation Point	Comparison Point	
MWA-59d	Active	Deep	Y	NA	NA		
MWA-60	Active	Shallow	Y	NA	NA		
MWA-62	Active	Shallow	Y	NA	NA		
MWA-63	Active	Shallow		Y	N		N
MWA-65i	Active	Intermediate	Y	NA	NA		
MWA-66i	Active	Intermediate		Y	Y	PA-12i	Y
MWA-69	Active	Shallow		Y	Y	PA-6	Y
MWA-78i	Active	Intermediate	Y	NA	NA		
MWA-79	Active	Shallow		Y	N		N
MWA-80i	Active	Intermediate		Y	N		N
MWA-81i	Active	Intermediate		Y	N		N
NMP-3D	Active	Shallow	Y	NA	NA		
PA-1d	Active	Deep		Y	Y	PA-19d	N
PA-2d	Active	Deep		Y	N		N
PA-3	Proposed	Shallow		Y	Y	PA-4	Y
PA-4	Proposed	Shallow		Y	Y	PA-3	Y
PA-5	Proposed	Shallow		Y	Y	MWA-2	Y
PA-6	Proposed	Shallow		Y	Y	MWA-69	Y
PA-7	Proposed	Shallow		Y	Y	MWA-47	Y
PA-8	Proposed	Shallow		Y	Y	PA-9	Y
PA-9	Proposed	Shallow		Y	Y	PA-8	Y
PA-10i	Proposed	Intermediate		Y	Y	PA-17i	Y
PA-11i	Proposed	Intermediate		Y	Y	MWA-8i	Y
PA-12i	Proposed	Intermediate		Y	Y	MWA-66i	Y
PA-13i	Proposed	Intermediate		Y	Y	MWA-49i	Y
PA-14i	Proposed	Intermediate		Y	Y	MWA-50i	Y
PA-15i	Proposed	Intermediate		Y	Y	PA-16i	Y
PA-16i	Proposed	Intermediate		Y	Y	PA-15i	Y
PA-17i	Proposed	Intermediate		Y	Y	PA-10i	Y
PA-18d	Proposed	Deep		Y	Y	PA-27d	Y
PA-19d	Proposed	Deep		Y	Y	PA-1d	Y
PA-20d	Proposed	Deep		Y	Y	PA-21d	Y
PA-21d	Proposed	Deep		Y	Y	PA-20d	N
PA-22d	Proposed	Deep		Y	Y	PA-56d	Y
PA-23d	Proposed	Deep		Y	Y	PA-24d	Y
PA-24d	Proposed	Deep		Y	Y	PA-23d	Y
PA-25d	Proposed	Deep		Y	Y	PA-26d	Y
PA-26d	Proposed	Deep		Y	Y	PA-25d	Y
PA-27d	Proposed	Deep		Y	Y	PA-18d	Y

Table 2-1
Water Level Monitoring Locations
Performance Monitoring Plan
Groundwater Source Control Measure
Arkema Inc. Facility
Portland, Oregon

Monitoring Point	Status	Aquifer Classification	Scheduled for Abandonment	Capture Zone Monitoring Point	Gradient Control Points		Real-time Monitoring
					Gradient Calculation Point	Comparison Point	
PMP-5	Active	Shallow	Y	NA	NA		
PMP-6	Active	Shallow	Y	NA	NA		

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-1d	X	X
MWA-2	MWA-8i	PA-18d	X	X
MWA-69	MWA-66i	PA-21d	X	X
MWA-46	MWA-49i	MWA-56d	X	X
PA-6	PA-12i	PA-20d	X	X
MWA-45	PA-13i	PA-22d	X	X
MWA-46	MWA-49i	MWA-56d	X	X
PA-7	PA-14i	PA-23d	X	X
MWA-47	MWA-50i	PA-24d	X	X
PA-8	PA-15i	PA-25d	X	X
PA-9	PA-16i	PA-26d	X	X

Table 3-1
NDPES 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	<10
Nitrogen, Ammonium	1	
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

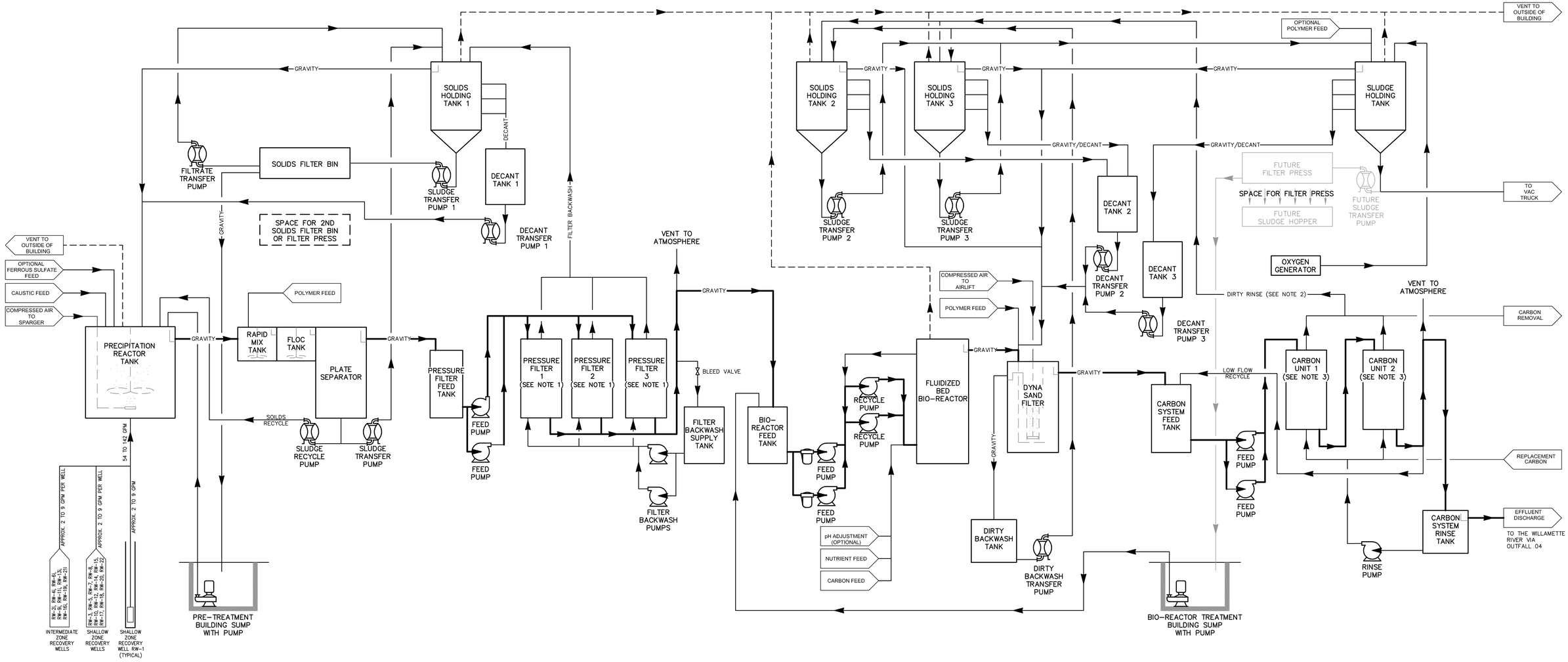
(1) - Estimated effluent concentrations based on approximately 90% removal efficiency for liquid-phase granular activated carbon (LPGAC).

(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
GWET System Process Flow Diagram



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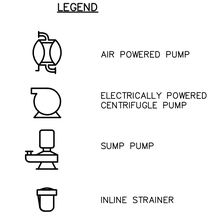

NOTES:

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)

REV.	DATE	DESCRIPTION	BY	CHK
0	01/12/11	ISSUED FOR CLIENT REVIEW	LAG	BR

DRAWN BY RMK | CADD Review FGB | CHECKED BY LG-Rol

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SEAL

GROUNDWATER SOURCE CONTROL MEASURE

ARKEMA, INC.
PORTLAND, OREGON

GWET SYSTEM PROCESS FLOW DIAGRAM

SCALE	PROJECT NUMBER	SHEET	REV.
AS NOTED	0114849	PFD-01	0
DATE 11/10/2010			

REVISIONS TO BE MADE ON THE CADD FILE ONLY

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Appendix B
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

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