

MEMO

TO	Katie Daugherty, ODEQ
FROM	Brendan Robinson, PE, ERM; Todd Slater, LSS
DATE	2 July 2025
REFERENCE	0773823.204
SUBJECT	Groundwater Source Control Measure Monthly Performance Monitoring Report

1. INTRODUCTION

The Oregon Department of Environmental Quality (ODEQ), in its letter dated 31 May 2019 and in the subsequent meeting with Legacy Site Services LLC (LSS) and Environmental Resources Management, Inc. (ERM) on 2 July 2019, requested that LSS initiate monthly status reports associated with the onsite groundwater source control measure (GW SCM) at the Arkema site (Site) consistent with the Performance Monitoring Plan (PMP; ERM 2014¹) beginning July 2019. The Site is located at 6400 NW Front Avenue in Portland, Oregon, and the Site location is shown on Figure 1. The 2014 PMP was prepared pursuant to the Order on Consent issued by ODEQ, signed on 31 October 2008 (ODEQ No. LQVC-NWR-08-04; Consent Order). The purpose of the PMP was to present the monitoring, reporting, and adaptive management processes used during implementation of the GW SCM. On 30 November 2021, ODEQ directed LSS that following the October 2021 Monthly Performance Monitoring Report (MPR), subsequent MPRs would be suspended pending the implementation of the Groundwater Extraction Enhancement (GEE) project in 2022. During that time, ODEQ requested monthly schedule updates in lieu of MPRs. The trench wells installed as part of the GEE project were started on 27 November 2022, and MPR writing restarted in December 2022. The purpose of the GEE project was to install new extraction capacity to achieve the Capture Zone Objectives.

On 6 June 2024, ODEQ requested that LSS and ERM reduce the scope of future MPRs to facilitate faster review. On 11 September 2024, ODEQ agreed for the first amended MPR to be the August 2024 MPR submitted in October 2024.

¹ ERM-West, Inc. 2014. *Revised Final Performance Monitoring Plan – Groundwater Source Control Measure, Arkema Inc. Facility, Portland, Oregon*. July 2014.

2. GWET SYSTEM PERFORMANCE

The average influent flow rate was 44.00 gallons per minute (gpm) for the entire month of April 2025, and the average operational influent flow during operational periods was 45.52 gpm.

Extraction wells, pumps, and conveyance lines become fouled with accumulated solids over time. A proactive pump removal and maintenance program is in place to address pump fouling. Regularly scheduled redevelopment is anticipated to maintain the productivity of the groundwater extraction trenches and recovery wells. Conveyance line cleaning will be conducted as needed based on analysis of backpressure.

Compared to March 2025, the April 2025 average system influent flow rate was 1.95 gpm higher. During this same time period, the average Shallow Zone groundwater elevation increased by 2.56 feet, and the average Intermediate Zone groundwater elevation increased by 0.53 feet, as shown on Attachments A-1 and A-2.

River elevations are shown over time on Attachments A-1 and A-2, and in an inset on the potentiometric surface maps (Figures 2 through 4). The river elevation has generally been trending upward since a seasonal low was observed in October 2024. The river elevation in April 2025 had an average elevation of 11.28 feet North American Vertical Datum of 1988 (NAVD88) with a minimum elevation of 8.72 feet NAVD88 and a maximum elevation of 15.66 feet NAVD88. The average river elevation had a slight increase of 0.03 feet NAVD88 compared to March 2025.

LSS is continuing to optimize extraction rates within the system to increase flow rates at each operational well until either the extraction rates specified in the *Groundwater Extraction Enhancement Final Design Report* (ERM 2022²) are achieved, the wells are producing the maximum quantity of water possible, or until the Capture Zone Objectives are met.

Actions taken in April 2025 to optimize flow rates included the following:

- Redevelopment of the horizontal screen section at underperforming trenches 4, 5, and 6 began in February, and continued through April 2025.
- Cleaning of the conveyance line was performed.

2.1 GWET PLANT OPERATIONS

The GWET plant operated within permit conditions during the reporting period. There was one shutdown during April 2025:

- 22 April 2025: The wellfield was shut down for 1 day due to conveyance line jetting.

² ERM-West, Inc. 2022. *Final Design Report, Arkema Inc. Facility, Portland, Oregon*. May 2022.

3. CAPTURE ZONE EVALUATION

As described in the PMP, the purpose of hydraulic monitoring (i.e., groundwater elevation data) is to provide sufficient data to demonstrate an inward hydraulic gradient across the groundwater barrier wall (GWBW) and to evaluate the effective hydraulic capture produced by the GW SCM.

3.1 GROUNDWATER ELEVATION MONITORING

Groundwater elevation monitoring was completed on 11 April 2025. The Serfes (1991)³ method was used to account for tidal variations of groundwater and river elevations as described in the PMP. Horizontal and vertical gradients were calculated and plotted over time as shown in Attachments B-1 and B-2. Groundwater elevations, horizontal gradients, and vertical gradients from 11 April 2025 are tabulated in Attachment B-3 and Attachment B-4.

3.2 POTENTIOMETRIC SURFACE, GROUNDWATER ELEVATION DIFFERENCE MAPS, AND GROUNDWATER FLOW DIRECTIONS

Groundwater elevation data collected on 11 April 2025 was used to prepare potentiometric surface maps based on manual measurements and averaged transducer groundwater elevations (Figures 2 through 4) and vertical gradient difference maps (Figures 5 and 6).

The generalized flow direction indicated by the potentiometric surface maps shows groundwater flow from upgradient toward the GBWW. Potentiometric surface maps (Figures 2, 3, and 4) show generalized groundwater movement to the extraction trenches in the Shallow, Intermediate, and Deep Zones due to GW SCM pumping, and cones of depression are apparent around the groundwater extraction trenches in the Shallow and Intermediate Zones. Horizontal gradient in the Shallow Zone at gradient control cluster 2 (GCC 2) was inward in April 2025, nearly zero at GCC 1, GCC 3 and GCC 6, and outward at GCC 4, GCC 5, as shown in Attachments B-1 and B-3.

Vertical gradients were calculated for each vertical well pair and are plotted on Figures 5 and 6. Vertical groundwater gradients and trend lines are shown in Attachments B-2 and B-4. Vertical groundwater gradients exterior to the GBWW were largely neutral to slightly downward between the Shallow and Intermediate Zones and between the Intermediate and Deep Zones.

Vertical gradients interior to the GBWW between the Shallow Zone and Intermediate Zone were upward at GCC 2, nearly neutral at GCC 3, and downward at GCC 6, GCC 5, GCC 4, and GCC 1. Note that the vertical gradient for GCC 1 is exaggerated as a result of the localized pressure zone where soils are tight, and water is relatively immobile. Vertical gradients interior to the GBWW between the Intermediate Zone and Deep Zone were upward at GCC 6, GCC 5 and GCC 2, nearly neutral at GCC 3, and downward at GCC 1 and GCC 4.

³ Serfes, Michael. 1991. "Determining the Mean Hydraulic Gradient of Ground Water Affected by Tidal Fluctuations." *Groundwater* 29(4): July–August.

4. CONCLUSIONS

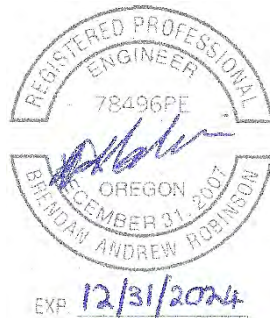
Analysis of horizontal gradients over time indicate that the extraction wells are performing better than the historical recovery wells, and horizontal gradients are periodically inward, and the magnitude of outward gradients are decreasing over time, as shown on Attachment B-1. The extraction rates throughout the GWET system will continue to be optimized to meet Target Capture Objectives. Conveyance line cleaning took place in March and April 2025. Redevelopment of underperforming trenches 1, 4, 5, and 6 began in February 2025 and continued in March and April 2025 to mitigate accumulation of silt in the filter pack in both the vertical and horizontal sections using impulse redevelopment techniques, and resonant technology. LSS will continue to optimize new extraction wells, including pump maintenance and upgrades. Additional modifications to the system, if needed to progress toward capture objectives, will be included in subsequent MPRs. The project schedule provided as Attachment C summarizes planned activities.

Attachment D shows the average influent groundwater flow rate from April 2019 through April 2025. As shown on this figure, the extraction trenches are removing approximately three times more water than the legacy system and achieving lower horizontal gradients over time.

Regards,



Brendan Robinson, PE
Partner



ATTACHMENTS

FIGURE 1 – SITE LAYOUT

FIGURE 2 – SHALLOW ZONE GROUNDWATER CONTOURS

FIGURE 3 – INTERMEDIATE ZONE GROUNDWATER CONTOURS

FIGURE 4 – DEEP ZONE GROUNDWATER CONTOURS

FIGURE 5 – SHALLOW TO INTERMEDIATE ZONE VERTICAL HEAD DIFFERENCE MAPS

FIGURE 6 – INTERMEDIATE TO DEEP ZONE VERTICAL HEAD DIFFERENCE MAPS

ATTACHMENT A-1 – OPERATIONAL PUMPING RATE GRAPH

ATTACHMENT A-2 – AVERAGE MONTHLY PUMPING RATE GRAPH

ATTACHMENT A-3 – GWET SYSTEM GROUNDWATER EXTRACTION RATES TABLE

ATTACHMENT B-1 – HORIZONTAL GRADIENTS SUMMARY GRAPH

ATTACHMENT B-2 – VERTICAL GRADIENTS SUMMARY GRAPH

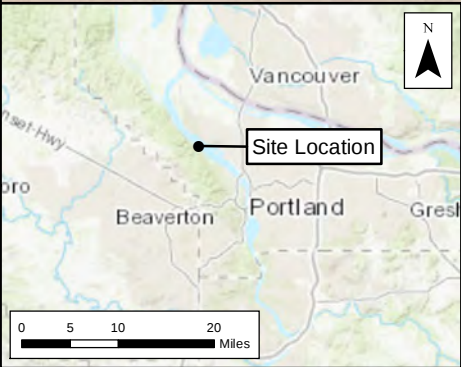
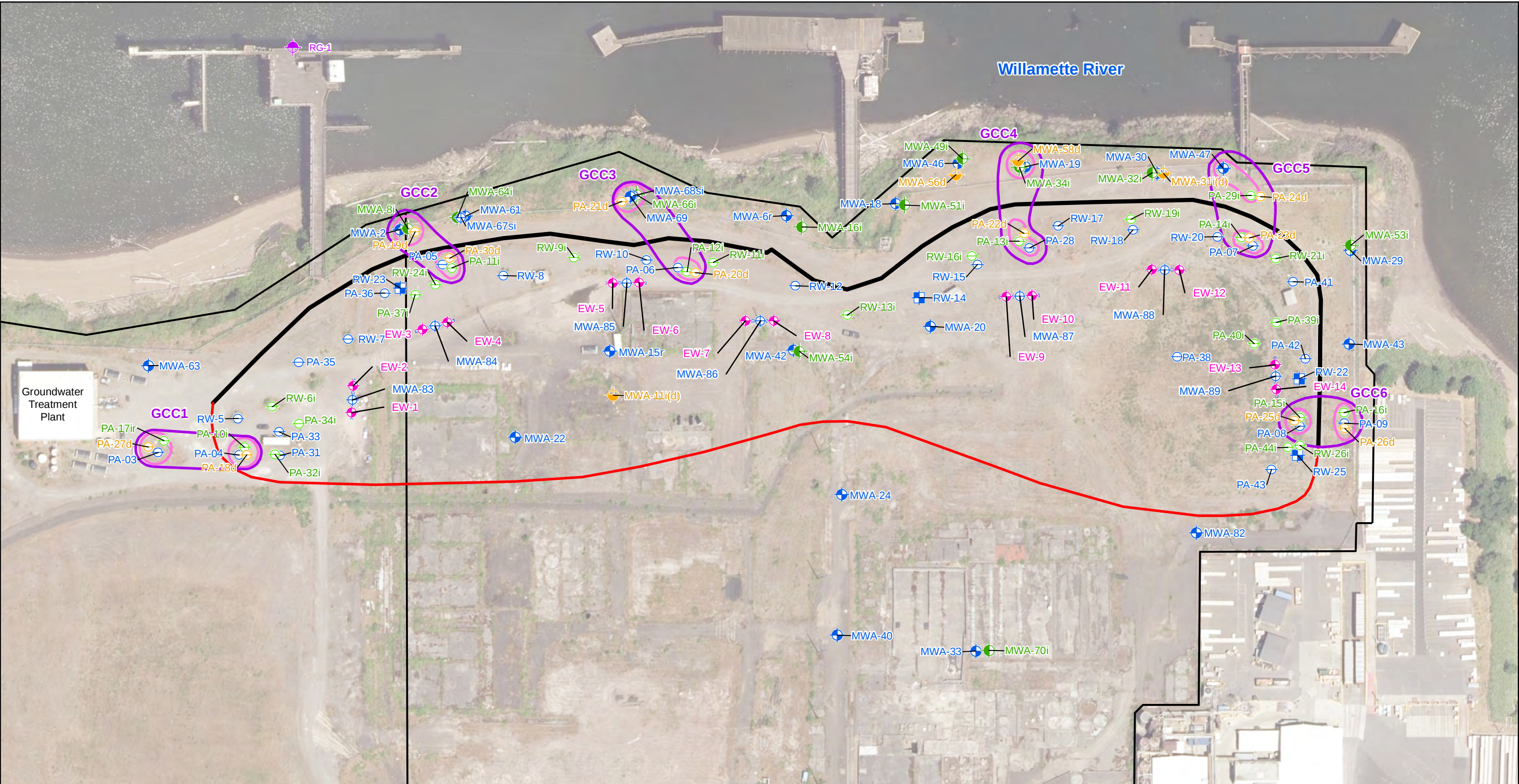
ATTACHMENT B-3 – WATER LEVELS AND HORIZONTAL GRADIENTS TABLE

ATTACHMENT B-4 – WATER LEVELS AND VERTICAL GRADIENTS TABLE

ATTACHMENT C – PROJECT SCHEDULE

ATTACHMENT D – AVERAGE GROUNDWATER EXTRACTION RATE GRAPH

MAUS\Projects\S-U\Total\Arkema - Portland\Groundwater Source Control\maps\MP\GWET_PMP_202212\Figure 1 Site Layout for MPR .mxd. REVISED: 02/06/2023. SCALE: 1:1,440 when printed at 11x17
DRAWN BY: Jake Sullivan



Legend

- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Shallow-Intermediate Zone Monitoring Well
- Deep Zone Monitoring Well
- Shallow Zone Piezometer
- Intermediate Zone Piezometer
- Deep Zone Piezometer
- Shallow Zone Recovery Well
- River Gauge
- Trench Extraction Well
- Target Capture Zone
- Barrier Wall Alignment
- Parcel and Property Boundaries

GradientClusters

Type

- Gradient Control Cluster
- Vertical Flow Cluster
- Extraction Trench

Figure 1

Site Layout

Monthly Progress Report

Groundwater Source Control Measure

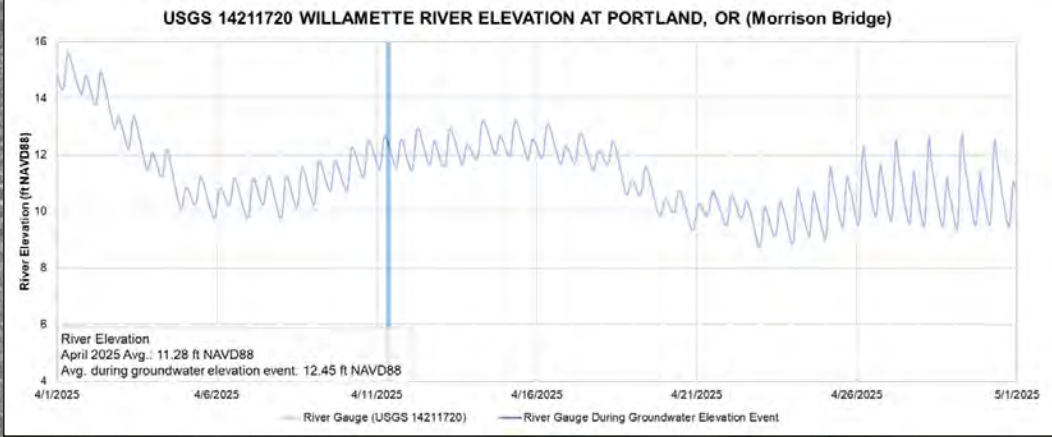
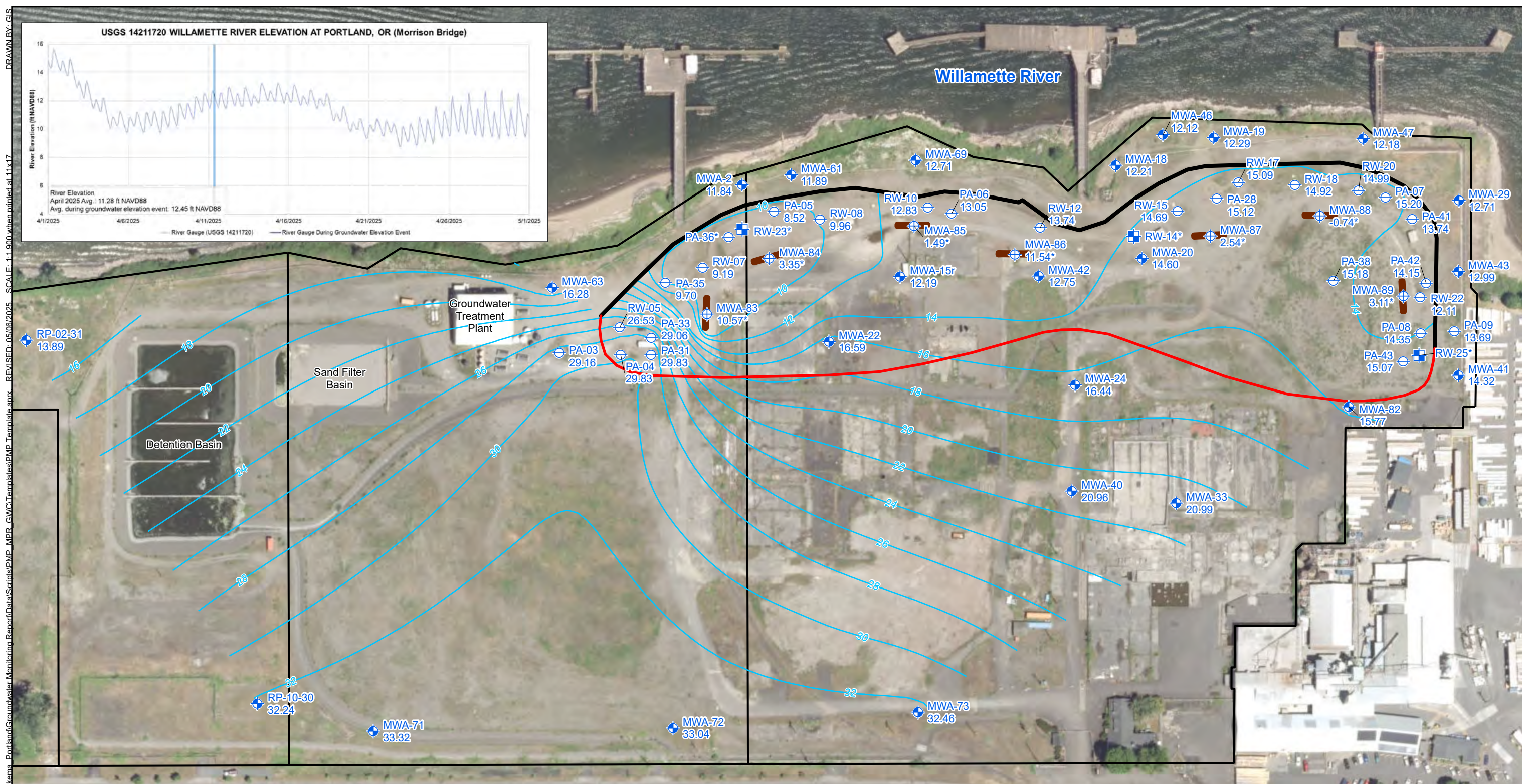
Arkema Inc.

Portland, Oregon

Environmental Resources Management

www.erm.com

ERM



Legend

- Shallow Zone Piezometer
- Shallow Zone Monitoring Well
- Active Recovery Well;
Not Used During Contouring
- Shallow-Intermediate Zone Monitoring Well
- 27.70 Groundwater Elevation (ft NAVD88)
- Shallow Zone Groundwater Contours
(ft NAVD88) Dashed where Inferred
- Target Capture Zone
- Barrier Wall Alignment
- Extraction Trench (Not To Scale)

Notes:
* Value not used for contouring.
Water levels collected April, 2025.
ft NAVD88: feet North American Vertical Datum
of 1988.
Aerial Photo: City of Portland, Summer 2017.

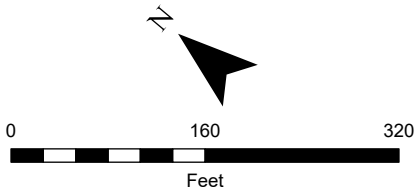
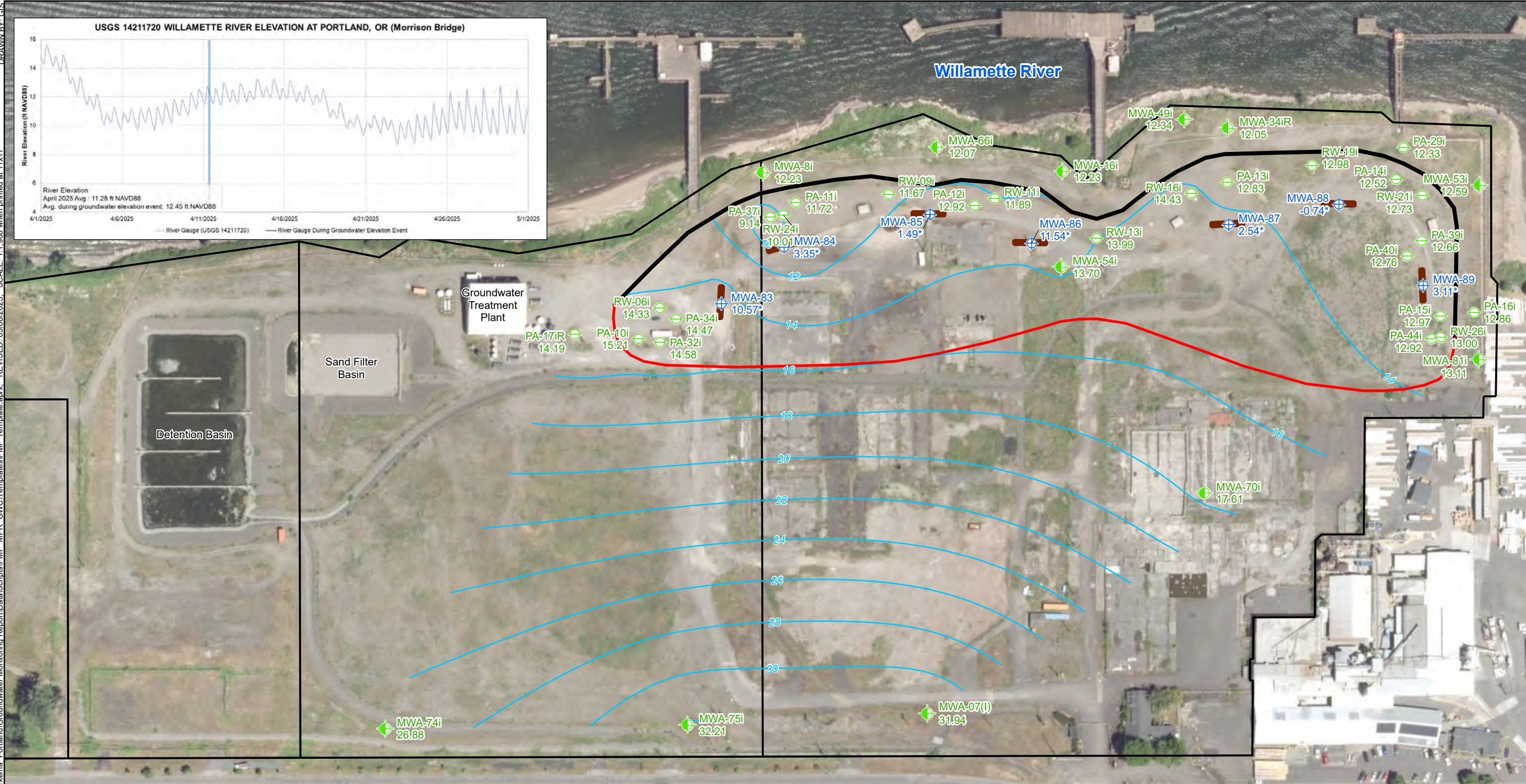


Figure 2
April 2025 Shallow Zone Groundwater Contours
Monthly Progress Report
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

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Legend

- Intermediate Zone Piezometer
- Intermediate Zone Monitoring Well
- Shallow-Intermediate Zone Monitoring Well
- 27.70 Groundwater Elevation (ft NAVD88)
- Intermediate Zone Groundwater Contours (ft NAVD88) Dashed where Inferred
- Target Capture Zone
- Barrier Wall Alignment
- Extraction Trench (Not To Scale)

Notes:

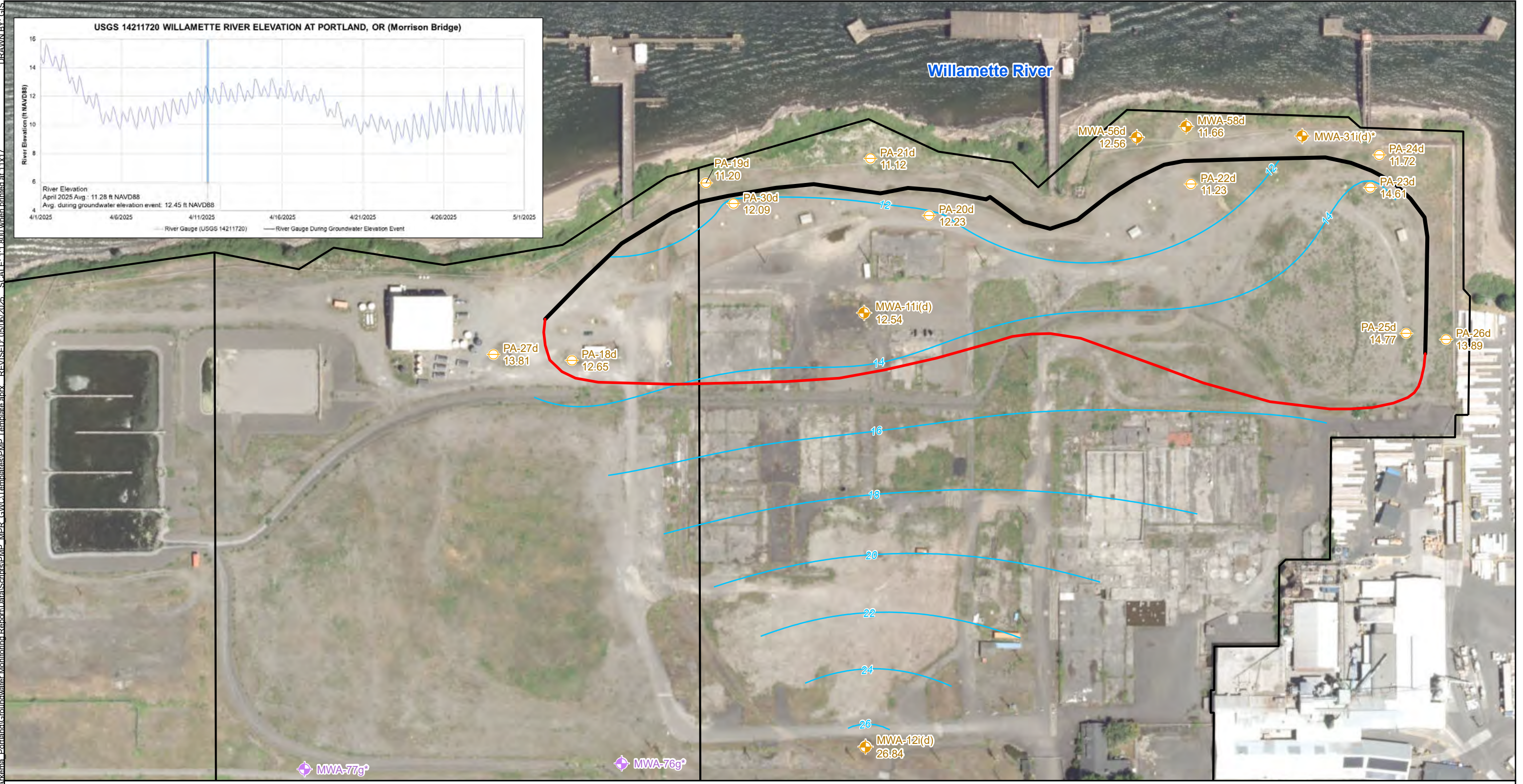
- * Value not used for contouring.
- Water levels collected April, 2025.
- ft NAVD88: feet North American Vertical Datum of 1988.
- Aerial Photo: City of Portland, Summer 2017.

Figure 3

April 2025 Intermediate Zone Groundwater Contours
Monthly Progress Report
Groundwater Source Control Measures
Arkema Inc.
Portland, Oregon

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Legend

Intermediate Zone Monitoring Well	Trench Extraction Well	Downward Gradient
Deep Zone Monitoring Well	Active Recovery Well	Upward Gradient
Intermediate Zone Piezometer	Target Capture Zone	Barrier Wall Alignment
Deep Zone Piezometer	Extraction Trench	
Shallow-Intermediate Zone Monitoring Well		

Notes:
Brown gradient: Downward gradient.
Green gradient: Upward gradient.
Vertical gradient calculated as intermediate zone minus deep zone potentiometric surfaces.
Water levels collected April, 2025.
Aerial Photo: City of Portland, Summer 2017.

0 130 260
Feet

Figure 6

April 2025 Intermediate to Deep Zone Vertical Head Difference
Monthly Progress Report
Groundwater Source Control Measures
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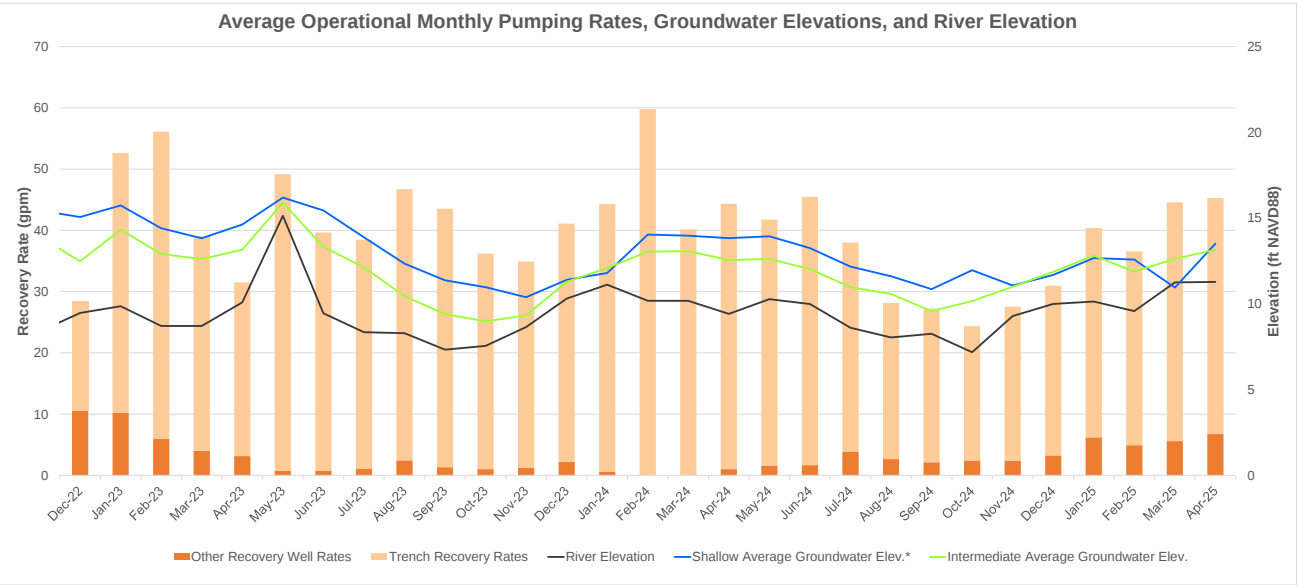


ATTACHMENT A-1

OPERATIONAL PUMPING RATE GRAPH

Attachment A-1

Operational Pumping Rate Graph
Arkema Inc. Facility
Portland, Oregon



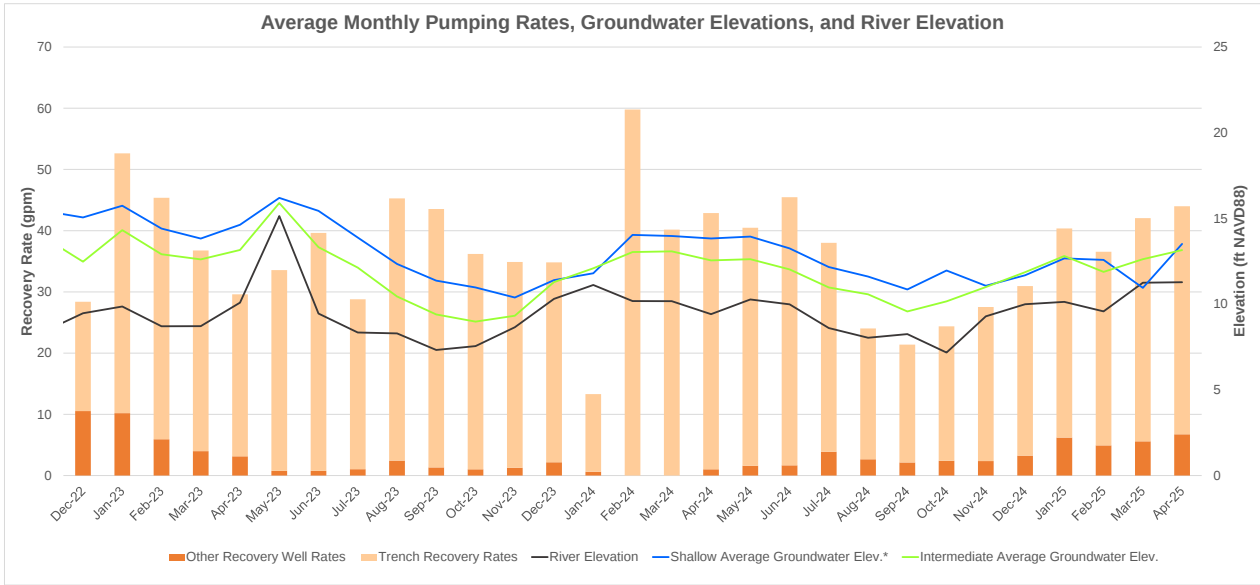


ATTACHMENT A-2

AVERAGE MONTHLY PUMPING RATE
GRAPH

Attachment A-2

Average Pumping Rate Graph
Arkema Inc. Facility
Portland, Oregon





ATTACHMENT A-3

GWET SYSTEM GROUNDWATER
EXTRACTION RATES TABLE

Attachment A-3

GWET System Groundwater Extraction Rates Table Arkema Inc. Facility Portland, Oregon

Recovery Well	April 2025 Average Operational Pumping Rate (gpm)	April 2025 Average Monthly Pumping Rate (gpm)
RW-14	1.72	1.66
RW-22	1.34	1.30
RW-23	2.01	1.94
RW-25	1.90	1.83
EW-01	2.04	1.97
EW-02*	0.00	0.00
EW-03	8.97	8.67
EW-04	0.17	0.16
EW-05	2.34	2.26
EW-06*	1.32	1.27
EW-07	0.10	0.09
EW-08	3.56	3.44
EW-09	0.00	0.00
EW-10	5.42	5.23
EW-11	4.45	4.30
EW-12*	0.00	0.00
EW-13	6.01	5.81
EW-14	4.18	4.04
Total	45.52	44.00

* = Recovery well not in service during reporting period

gpm = gallon per minute



ATTACHMENT B-1

HORIZONTAL GRADIENTS SUMMARY GRAPH

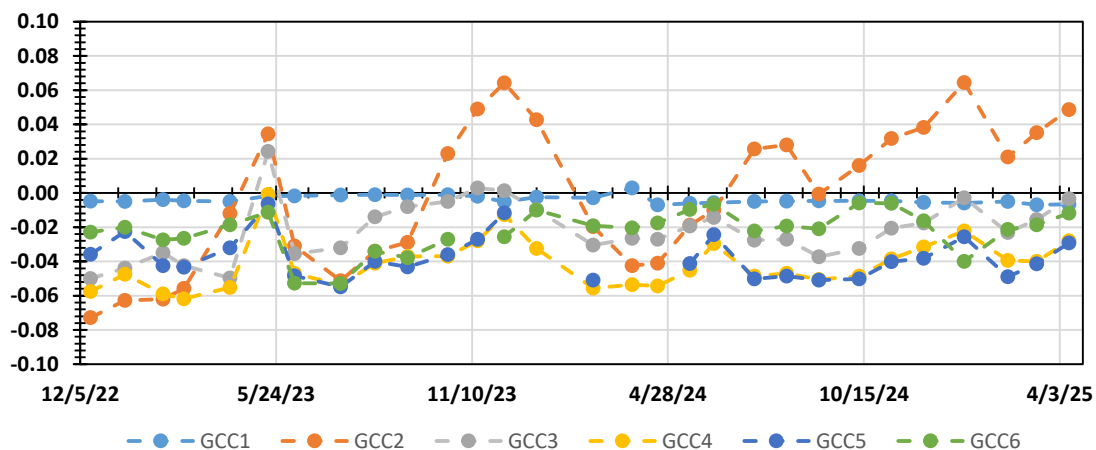
Attachment B-1

Horizontal Gradients Summary: April 2025

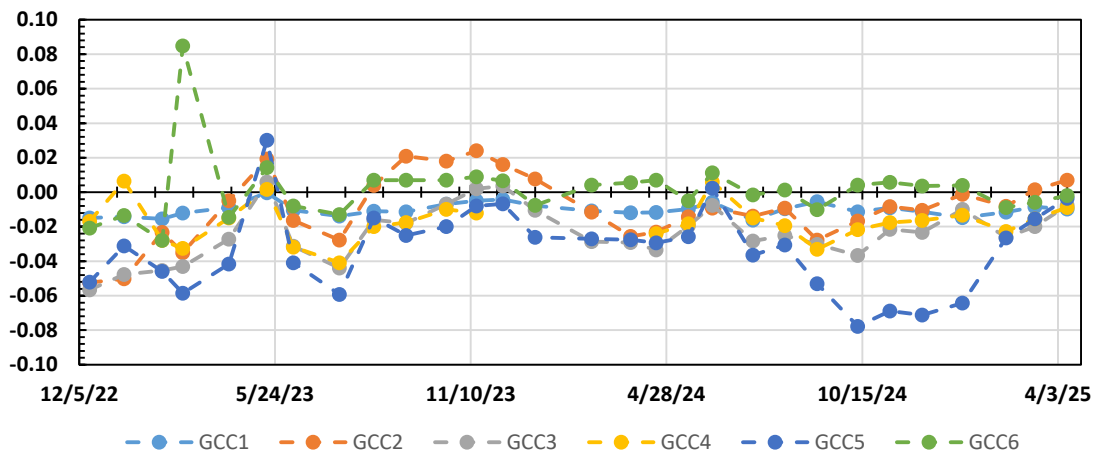
Arkema Inc. Facility

Portland, Oregon

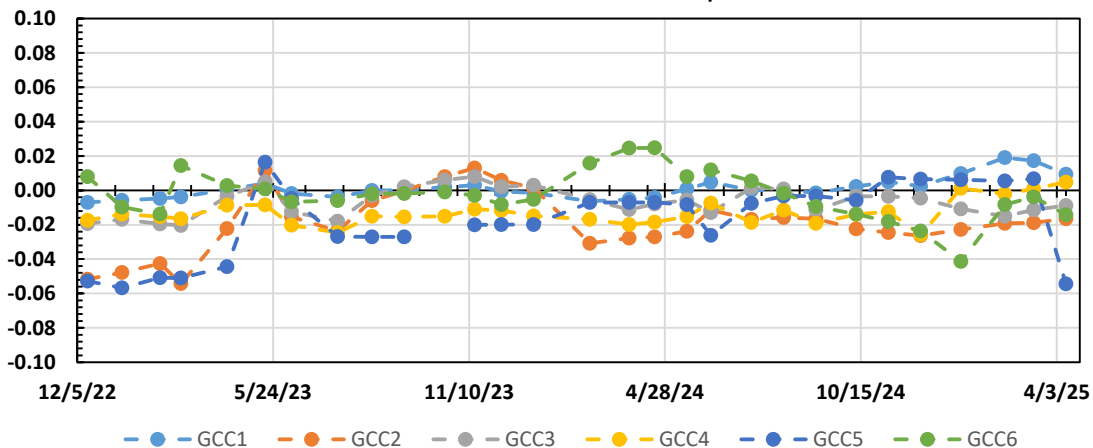
Horizontal Gradients - Shallow Zone



Horizontal Gradients - Intermediate Zone



Horizontal Gradients - Deep Zone



Positive horizontal gradient indicates an inward hydraulic gradient across the GWBW.



ATTACHMENT B-2

VERTICAL GRADIENTS SUMMARY
GRAPH

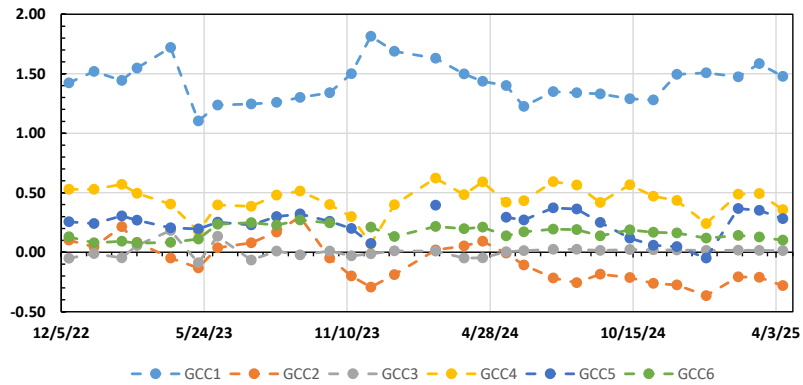
Attachment B-2

Vertical Gradients Summary: April 2025

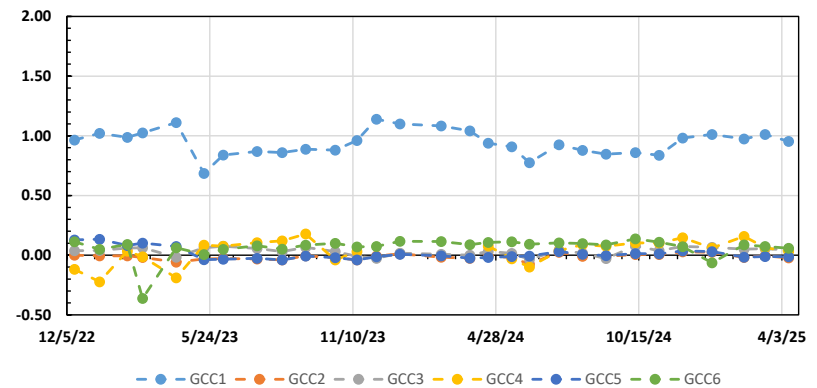
Arkema Inc. Facility

Portland, Oregon

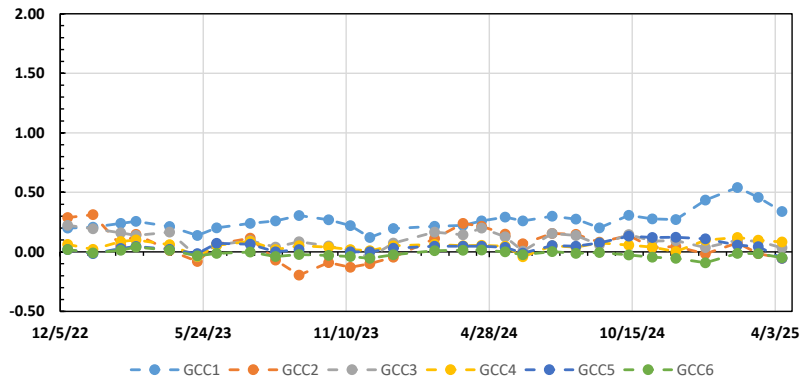
Vertical Gradients - Interior SZ-IZ



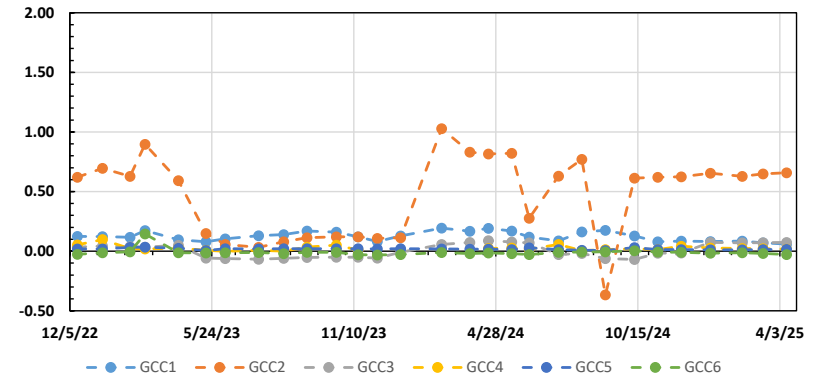
Vertical Gradients - Exterior SZ-IZ



Vertical Gradients - Interior IZ-DZ



Vertical Gradients - Exterior IZ-DZ





ATTACHMENT B-3

WATER LEVELS AND HORIZONTAL
GRADIENTS TABLE

Attachment B-3

Water Levels and Horizontal Gradients Table Arkema Inc. Facility Portland, Oregon

Gradient Cluster	Well Pair Zone	Exterior Well	Water Elevation (ft NAVD88)	Interior Well	Water Elevation (ft NAVD88)	Horizontal Gradient (ft / ft)
GCC1	Shallow	PA-03	29.16	PA-04	29.83	-0.007
	Intermediate	PA-17iR	14.19	PA-10i	15.21	-0.010
	Deep	PA-27d	13.81	PA-18d	12.65	0.009
GCC2	Shallow	MWA-2	11.84	PA-05	8.52	0.049
	Intermediate	MWA-8i	12.23	PA-11i	11.72	0.007
	Deep	PA-19d	11.20	PA-30d	12.09	-0.016
GCC3	Shallow	MWA-69	12.71	PA-06	13.05	-0.003
	Intermediate	MWA-66i	12.07	PA-12i	12.92	-0.008
	Deep	PA-21d	11.12	PA-20d	12.23	-0.009
GCC4	Shallow	MWA-19	12.29	PA-28	15.12	-0.028
	Intermediate	MWA-34iR	12.05	PA-13i	12.83	-0.009
	Deep	MWA-58d	11.66	PA-22d	11.23	0.005
GCC5	Shallow	MWA-47	12.18	PA-07	15.20	-0.029
	Intermediate	PA-29i	12.33	PA-14i	12.52	-0.003
	Deep	PA-24d	11.72	PA-23d	14.61	-0.054
GCC6	Shallow	PA-09	13.69	PA-08	14.35	-0.012
	Intermediate	PA-16i	12.86	PA-15i	12.97	-0.002
	Deep	PA-26d	13.89	PA-25d	14.77	-0.014

Positive horizontal gradient indicates an inward hydraulic gradient across the GWBW.

Horizontal gradient calculated as (Exterior Elevation – Interior Elevation) / Horizontal distance.

* = anomalous groundwater elevation

** = horizontal gradient cannot be calculated due to anomalous elevation reading

ft NAVD88 = feet North American Vertical Datum of 1988

^M = manual groundwater elevation measurement



ATTACHMENT B-4

WATER LEVELS AND VERTICAL
GRADIENTS TABLE

Attachment B-4

Water Levels and Vertical Gradients Table Arkema Inc. Facility Portland, Oregon

Region	Pair	Gradient Cluster	Upper Well	Water Elevation (ft NAVD88)	Lower Well	Water Elevation (ft NAVD88)	Vertical Gradient (ft / ft)
Interior	SZ-IZ	GCC1	PA-04	29.83	PA-10i	15.21	1.48
		GCC2	PA-05	8.52	PA-11i	11.72	-0.28
		GCC3	PA-06	13.05	PA-12i	12.92	0.01
		GCC4	PA-28	15.12	PA-13i	12.83	0.36
		GCC5	PA-07	15.20	PA-14i	12.52	0.28
		GCC6	PA-08	14.35	PA-15i	12.97	0.10
	IZ-DZ	GCC1	PA-10i	15.21	PA-18d	12.65	0.34
		GCC2	PA-11i	11.72	PA-30d	12.09	-0.05
		GCC3	PA-12i	12.92	PA-20d	12.23	0.04
		GCC4	PA-13i	12.83	PA-22d	11.23	0.08
		GCC5	PA-14i	12.52	PA-23d	14.61	-0.05
		GCC6	PA-15i	12.97	PA-25d	14.77	-0.05
Exterior	SZ-IZ	GCC1	PA-03	29.16	PA-17iR ^M	14.19	0.95
		GCC2	MWA-2	11.84	MWA-8i	12.23	-0.02
		GCC3	MWA-69	12.71	MWA-66i	12.07	0.04
		GCC4	MWA-19	12.29	MWA-34iR	12.05	0.03
		GCC5	MWA-47	12.18	PA-29i	12.33	-0.01
		GCC6	PA-09	13.69	PA-16i	12.86	0.06
	IZ-DZ	GCC1	PA-17iR ^M	14.19	PA-27d	13.81	0.06
		GCC2	MWA-8i	12.23	PA-19d	11.20	0.66
		GCC3	MWA-66i	12.07	PA-21d	11.12	0.07
		GCC4	MWA-34iR	12.05	MWA-58d	11.66	0.02
		GCC5	PA-29i	12.33	PA-24d	11.72	0.02
		GCC6	PA-16i	12.86	PA-26d	13.89	-0.03

Positive vertical gradient indicates an downward hydraulic gradient.

Vertical gradient calculated as (Upper Elevation – Lower Elevation) / Screen Midpoint distance.

* = anomalous groundwater elevation

** = vertical gradient cannot be calculated due to anomalous elevation reading

DZ = Deep Zone

ft NAVD88 = feet North American Vertical Datum of 1988

IZ = Intermediate Zone

^M = manual groundwater elevation measurement

SZ = Shallow Zone



ATTACHMENT C

PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish
1	Quarterly GW Monitoring			
2	4th Quarter 2024 Groundwater Monitoring	48 days	Sun 12/8/24	Tue 2/11/25
7	1st Quarter 2025 Groundwater Monitoring	73 days	Mon 2/24/25	Wed 6/4/25
12	2nd Quarter 2025 Groundwater Monitoring *	71 days	Mon 5/12/25	Mon 8/18/25
13	Sample Wells	5 days	Mon 5/12/25	Fri 5/16/25
14	Obtain Analytical Data	1 day	Mon 6/2/25	Mon 6/2/25
15	Data Validation	1 day	Tue 6/17/25	Tue 6/17/25
16	Report Completed	1 day	Mon 8/18/25	Mon 8/18/25
17	Monthly Progress Reports	197 days	Sat 2/15/25	Mon 11/17/25
18	December 2024 MPR	1 day	Sat 2/15/25	Sat 2/15/25
19	January 2025 MPR	1 day	Mon 3/17/25	Mon 3/17/25
20	February 2025 MPR	1 day	Tue 4/15/25	Tue 4/15/25
21	March 2025 MPR	1 day	Thu 6/19/25	Thu 6/19/25
22	April 2025 MPR	1 day	Wed 7/2/25	Wed 7/2/25
23	May 2025 MPR	1 day	Tue 7/15/25	Tue 7/15/25
24	June 2025 MPR	1 day	Fri 8/15/25	Fri 8/15/25
25	July 2025 MPR	1 day	Mon 9/15/25	Mon 9/15/25
26	August 2025 MPR	1 day	Wed 10/15/25	Wed 10/15/25
27	September 2025 MPR	1 day	Mon 11/17/25	Mon 11/17/25
28	GWET Shutdown	1 day	Mon 9/15/25	Mon 9/15/25
29	Data Gaps	371 days	Tue 4/1/25	Tue 9/1/26
30	Data Gaps Phase I	65 days	Tue 4/1/25	Mon 6/30/25
31	Workplan	32 days	Mon 6/2/25	Tue 7/15/25
32	ODEQ Review	23 days	Wed 7/16/25	Fri 8/15/25
33	Data Gaps Phase I Investigations (August 2025 Mobilization)	42 days	Fri 8/1/25	Mon 9/29/25
34	IRAM 1 and 4 - Acid Plant Area Soil & GW ISS *	1241 days	Mon 4/1/24	Fri 12/29/28
52	IRAM 2-Enhanced ISCR Perchlorate & CrVI In Chlorate Plant Area, if needed	891 days	Fri 8/1/25	Fri 12/29/28
58	IRAM 3-Remove Human Health Direct Contact Hot Spots, if needed (Summer 2028 implementation)	718 days	Wed 4/1/26	Fri 12/29/28

Arkema Portland
Monthly Progress Report Attachment C

Task

Milestone

Summary

Split

Project Summary

Inactive Task

Inactive Milestone

Inactive Summary

Manual Task

Duration-only

Manual Summary Rollup

Manual Summary

External Tasks

External Milestone

Deadline

Progress

Manual Progress

Page 1



ATTACHMENT D

AVERAGE GROUNDWATER
EXTRACTION RATE GRAPH

Attachment D

Average Groundwater Extraction Rate Graph
Arkema Inc. Facility
Portland, Oregon

