

## **4.9 Groundwater Protection**

Ref: 40 CFR Part 270.28  
40 CFR Part 270.14(c)

The Permittee must develop, conduct and maintain applicable groundwater monitoring and response programs for the closed impoundment to detect the possibility of post closure escape of hazardous constituents. According to 40 CFR Part 264.91, the required groundwater monitoring program must consist of a detection monitoring program per 40 CFR 264.98; a compliance monitoring program per 40 CFR 264.99; or a corrective action program per 40 CFR 264.100.

Whenever hazardous constituents under 40 CFR Part 264.93 from a regulated unit exceed concentration limits under 40 CFR Part 264.94 in groundwater between the compliance point under 40 CFR Part 264.95 and the down gradient facility property boundary, the owner or operator must institute a corrective action program under 40 CFR Part 264.100

### **4.9.1 PREVIOUS POST CLOSURE MONITORING ACTIVITIES**

#### **4.9.1.1 Former Detection Monitoring Program**

The detection monitoring program originally consisted of six (6) Point of Compliance wells (MW-1, MW-2, MW-3, MW-4, MW-5 and MW-6) located near the down gradient, outside toe of the dike of the closed impoundment (east and northeast side of the impoundment), and two (2) monitoring wells (MW-7 and MW-8) installed on the west, up gradient side from the closed impoundment (see Retired Wells in Figure 6). The Point of Compliance wells and the up-gradient monitoring wells were completed in general accordance with the requirements of 40 CFR 264.97 as previously described in the Groundwater Monitoring section of the Post-Closure Permit approved in 1993.

Based on a statistical comparison of analytical results of groundwater samples collected from the up-gradient wells and the Point of Compliance wells, the groundwater protection standard was exceeded in the Point of Compliance wells and reported to the Oklahoma State Department of Health [OSDH; currently Oklahoma Department of Environmental Quality (ODEQ)] in 1987.

Due to the detected exceedance of the groundwater protection standards at the Point of Compliance, the routine detection monitoring program was suspended, and a compliance monitoring program was implemented.

Beginning with Term 2 of the permit (issued September 12, 2008) the detection monitoring wells were sampled annually. Due to persistent exceedance of select Groundwater Protection Standards, monitoring of MW-1 through MW-6 was discontinued. This action was based upon meetings and correspondence culminating in a letter from the ODEQ to GCD dated April 3, 2018 authorizing discontinuation of sampling of wells MW-1 through MW-6 due primarily to their location within the source area. See correspondence in Appendix A.

#### 4.9.1.2 Former Compliance Monitoring Program

The compliance monitoring program originally consisted of four (4) Remedial Action wells (RM-101, RM-102, RM-103 and RM-104) located approximately 1,200 feet east and southeast of the impoundment (see Figure 7). The Remedial Action wells were completed in general accordance with the requirements of 40 CFR 264.97 as previously described in the Groundwater Monitoring section of the Post-Closure Permit approved in 1993.

Starting in November 1988, groundwater samples were collected on a quarterly basis from the Remedial Action wells and analyzed for: cadmium, chlorides, manganese, sodium, selenium, zinc, sulfate, TOC, and TOX. The pH and conductivity parameters were also measured and recorded in the field during purging of the monitoring wells.

Beginning with the second term of the permit (issued September 12, 2008) the compliance monitoring wells were sampled semi-annually. The previous 10 years of Post Closure monitoring data indicated well RM-104 was side gradient of the groundwater flow beneath the closed impoundment. For this reason, one well (designated RM-102b) was added between RM-102 and RM-103 to more precisely detect any potential post closure release of hazardous constituent(s) from the closed impoundment. Monitoring well installation was completed on July 30, 2008 in general accordance with installation standards provided in the SAP in effect at the time. Upon installation of RM-102b, RM-104 was retired (see Retired Wells in Figure 6), sampling was discontinued, and the well was used solely for purposes of determining the groundwater potentiometric surface.

Based upon meetings and correspondence culminating in a letter from the ODEQ to GCD dated April 3, 2018, parameters analyzed in RM well samples were reduced to pH, specific conductance, manganese, and cadmium due to a historic lack of permit-required parameters detected above their respective regulatory limits. See correspondence in Appendix A.

#### 4.9.1.3 Former Corrective Action Program

After confirmation that the groundwater protection standard was exceeded in the Point of Compliance wells in 1987, and in association with investigation of the former discharge pond as a SWMU, corrective action was implemented. A Corrective Measure Study (CMS) was submitted in November 1989. Essential elements of that CMS were permitted in the Post Closure Permit as a Corrective Action Plan (CAP). That CAP called for:

- ❑ Surface drainage modifications;
- ❑ Removal of contaminated soil;
- ❑ Soil capping contaminated areas;
- ❑ Installation of a bentonite slurry wall;
- ❑ Installation of four wells (RP-1 through 4) to monitor the effectiveness of the slurry wall;
- ❑ Monitoring of RP-1 through 4; and
- ❑ Continued compliance (aka plume/remedial action) monitoring

In accordance with the CAP, a soil/bentonite slurry wall was installed in 1994, approximately 20 feet down gradient from the defined contaminant plume along the east and north sides of the former impoundment. Also, four (4) corrective action wells (RP-1, RP-2, RP-3 and RP-4) were located approximately 50 feet down gradient (north, east and southeast sides) from the slurry wall (see Figure 7). The RP monitoring wells were completed in general accordance with the requirements of 40 CFR 264.97.

Compliance monitoring has progressed throughout the post closure period (in accordance with Permit Section IV.H.) in order to determine if the facility could return to detection monitoring. Under the terms of compliance monitoring and the corrective action plan, the former owner/operator (Eagle Picher) performed:

- ❑ quarterly groundwater elevation determination for wells RM-101 through RM-104
- ❑ quarterly sampling of wells RM-101 through RM-104
- ❑ quarterly groundwater elevation determination for wells RP-1 through RP-4
- ❑ quarterly sampling of wells RP-1 through RP-4
- ❑ weekly groundwater elevation determination for wells MW-1 through MW-8
- ❑ weekly pumping and sample collection from MW-1 through MW-6
- ❑ monthly analysis of a composite sample from MW-1 through MW-6
- ❑ annual Appendix IX sampling and analysis of MW-1 through MW-6
- ❑ annual well depth measurements

Beginning with the second term of the permit (issued September 12, 2008) the corrective action wells RP-1 through RP-4 were sampled semi-annually. Annual and semi-annual groundwater monitoring reports submitted to the ODEQ contain a complete summary of all sample dates and data. Based upon meetings and correspondence culminating in a letter from the ODEQ to GCD dated April 3, 2018, parameters analyzed in RP well samples were refined based upon past detections. See correspondence in Appendix A.

#### 4.9.1.4 Evaluation of the Efficacy of the Corrective Action Program

GCD must use existing groundwater monitoring data to ascertain whether the Corrective Action Program has been effective. Per Section IV.I.4.e., the permit allows the facility to return to detection monitoring if data from three consecutive years demonstrates that there has been no exceedance of the groundwater protection standard. This demonstration is based upon empirical data and statistical analysis of the data collected from the monitoring network.

GCD has conducted that evaluation and has found the following:

##### *Slurry Trench*

Potentiometric mapping shows that the hydraulic gradient across the slurry wall (as measured by ground water elevations up-gradient and down-gradient of the slurry wall) is moving toward equilibrium. This is best observed by examining the potentiometric maps supplied with the previous annual groundwater reports. These maps indicate that although the effect is less evident with time, the trench continues to have a beneficial impact by impeding groundwater flow and chemical diffusion across the slurry trench. For this reason, the trench continues to benefit groundwater quality down gradient of the closed impoundment.

### *Dewatering*

During the Term 1 of the permit (1994-2003) the former owner/operator (Eagle Picher) has collected 31,562 gallons of ground water from the MW wells under the dewatering program. Using average concentrations, it was estimated that less than 20 pounds of regulated constituents had been removed from the groundwater at a cost of \$10,000's of dollars. The removal rate was determined to be very inefficient and the dewatering program was becoming more ineffective with time due to decreasing concentrations of regulated constituents in the ground water. Dewatering was discontinued based upon renewal of the original permit (Term 2, issued September 12, 2008).

### *Groundwater Monitoring*

Certain wells and certain parameters meet the criteria for returning to detection monitoring, and certain wells and certain parameters continue to exceed the limits imposed by the Groundwater Protection Standard and/or statistical methods. However, the validity of the statistical comparison was called into question for two reasons:

- the up-gradient and down-gradient groundwater quality data was not contemporaneous; and
- All up-gradient wells in use at the time did not represent background conditions. Specifically, MW-7, MW-8 and BG01a did not appear to represent background conditions (see Retired Wells in Figure 6).

With these doubts, the statistical evaluation was halted, and the monitoring program was revised significantly in April 2018.

***Based upon decades of experience with post closure monitoring and evaluation by the ODEQ, GCD recommends the following groundwater monitoring plan for Term 3 of the permit:***

## **4.9.2 PROPOSED TERM 3 GROUNDWATER MONITORING PLAN**

### 4.9.2.1 Point of Compliance

The point of compliance will remain: MW-1, MW-2, MW-3, MW-4, MW-5 and MW-6. Groundwater monitoring in this source area will be discontinued; however, the wells will not be closed at this time. Well closure will be subject to agreement between ODEQ and GCD, and the appropriate permit modification.

### 4.9.2.2 Groundwater Protection Standard

The Groundwater Protection Standard will remain the concentration limits for the constituents specified in Table 2, unless modified at a later date. Those standards have been updated to reflect current MCL/SMCLs.

#### 4.9.2.3 Compliance Monitoring

Based upon the existing data, the Groundwater Protection Standard has been exceeded beyond the point of compliance (not all wells or all parameters). As a result, the facility cannot return to detection monitoring; therefore, compliance monitoring and corrective action monitoring will continue.

#### 4.9.2.4 Constituents of Concern

Tables 1 and 2 identify the constituents and parameter of concern. This list is a subset of the constituents of concern identified in the previous post closure permits (Terms 1 and 2), based upon persistence and concentrations over the term of previous monitoring. As discussed later in this document, and seen in Table 1, not all Table 2 constituents and parameters will be tested in all wells each monitoring event.

#### 4.9.2.5 Groundwater Sampling and Analysis

The monitoring program will include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide a reliable indication of groundwater quality up gradient and down gradient of the waste management area.

The groundwater sampling will be conducted in general accordance with the following protocol:

Prior to sample collection, trained field personnel will measure (gauge) the static water level in each active well using an electronic water level indicator.

Following gauging activities, each active monitoring well will be sampled using a low-flow methodology. Field measurements of temperature, pH, and conductivity will be performed at recorded intervals to confirm well recharge stabilization. Once stabilization is confirmed field parameters will be collected and groundwater samples will be collected in laboratory-provided, pre-preserved sample containers.

The sample containers will be properly labeled, and a chain-of-custody form will be completed for transfer of the collected samples to the laboratory. The sampler will retain a copy of the signed chain-of-custody showing when and to whom samples were relinquished. Collected samples will be analyzed for one or more of the parameters specified in Table 2. This sampling protocol is detailed in the Sampling and Analysis plan (SAP) provided in Appendix D.

#### 4.9.2.6 Background Water Quality Determination

##### *Up gradient Wells*

Currently, the facility operates in the compliance monitoring mode based upon the fact that certain parameters in certain down gradient wells continue to exceed the Groundwater Protection Standard as measured by the empirical data and/or statistical methods applied to the groundwater data.

BG-01: Well BG-01 was installed near the southwest corner of the former Eagle Picher property close to municipal water tanks along Highway 69A. Although not located on

GCD-owned property, GCD has access to this location. This well is positioned up-gradient of the closed impoundment and should be unaffected by nearby Ceradyn and Umicore manufacturing operations. For this reason, water samples collected from BG-01 would be representative of the local groundwater quality<sup>1</sup> and may be used to provide background water quality data.

MW-7 and MW-8: During Terms 1 and 2 of the permit, samples from monitoring wells MW-7 and MW-8 were used to represent background water quality based upon their up-gradient position relative to the closed impoundment. While it is true samples from MW-7 and MW-8 represent groundwater quality up-gradient of the closed impoundment, they do not clearly represent background water quality due to their proximity to the source, and they may they have been impacted by manufacturing operations (Umicore) immediately up-gradient of their location.

GCD will:

1. Utilize BG-01 to monitor background water quality on an annual basis. See Figure 7 and Table 1.
2. Discontinue use of MW-7 and MW-8 due to their proximity to manufacturing operations. MW-7 and MW-8 are traditionally hydraulically up-gradient of the closed impoundment, but, are close to the source area and have not been found to be representative of background water quality. See Retired Wells in Figure 6.

#### 4.9.2.7 Point of Compliance (POC) Monitoring

To date, ground water monitoring data indicates the POC wells MW-1 through MW-6 have been impacted by a release from the closed impoundment. POC wells are also a significant distance from the down gradient property line and are situated up-gradient of two other sets of groundwater monitoring wells (RPs and RMs). Furthermore, MW-1 through MW-6 are within the source area. For these reasons, they do not provide critical data. Sampling and analysis will be discontinued; however, the wells will not be closed at this time. Well closure will be subject to agreement between ODEQ and GCD, and the appropriate permit modification.

GCD will:

1. Discontinue monitoring MW-1 through MW-6.
2. Not close wells MW-1 through MW-6 without permission from the ODEQ.

#### 4.9.2.8 Slurry Wall Monitoring (RP) Wells

The RP wells (RP-1 through RP-4) provide data regarding the performance of the slurry trench and down gradient movement of any impact identified in the POC wells. For these reasons they are predictive of important factors such as natural or engineered attenuation, contaminant degradation and the rate of contaminant travel. RP wells are also a significant distance from the down gradient property line and are situated up gradient of one other set of groundwater monitoring wells (RMs). They therefore, provide important data and warrant regular monitoring. Ultimately, the RP wells may be used to demonstrate source containment.

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<sup>1</sup> Local groundwater quality has been affected by historic lead and zinc mining operations.

GCD will:

1. Monitor RP-1 through RP-4 on an annual basis. See Figure 7 and Table 1.

#### 4.9.2.9 Remedial Action Monitoring (RM) Wells

The RM wells (RM-101, RM-102, RM-102B and RM-103) provide data regarding down gradient movement of any impact identified in the POC and RP wells. For these reasons they are predictive of important factors such as natural or engineered attenuation, contaminant degradation, the rate of contaminant travel and any potential off-site impact. Ultimately, the RM wells may be used to demonstrate source containment.

Although the RM wells are not located on the downgradient property line, there are no other monitoring wells down gradient of the RM wells. They therefore, provide important data and warrant regular monitoring.

GCD will:

1. Monitor RM-101, RM-102, RM-102B and RM-103 on an annual basis. See Figure 7 and Table 1.

#### 4.9.2.10 Appendix IX Surveillance

Appendix IX to Part 264 contains a master list of groundwater monitoring constituents. During Terms 1 and 2 of the permit Appendix IX surveillance was used to determine whether additional hazardous constituents from the Appendix IX list were actually present in the uppermost aquifer and, if so, at what concentration. To accomplish this, GCD conducted enhanced sampling, herein referred to as surveillance. If the surveillance indicated that Appendix IX constituents were present in the ground water that had not already been identified in the permit as monitoring constituents in Table 2, GCD was required to resample within one month and repeat the analysis. If the second analysis confirmed the presence of new constituents, GCD reported the concentration of these additional constituents to the ODEQ within fourteen days after receipt of data from the second analysis and added them to the monitoring list.

The value of Appendix IX surveillance decreased over time as the plume stabilized. No new constituents have been added as a result of this analysis since the Q4 2013 sampling event. For this reason, Appendix IX surveillance will be discontinued.

GCD will:

1. Discontinue Appendix IX surveillance.

#### 4.9.2.11 Analyte Removal

Monitoring constituents not detected above the laboratory reporting limit for at least 3 consecutive years may be removed from the groundwater monitoring list.

#### 4.9.2.12 Well Retirement

With the exception of RM wells, GCD may petition that a well be retired from the monitoring plan if there has been no exceedance of the groundwater protection standard

identified in Table 2 for all analytes in the last 3 consecutive years. A data summary will accompany any request for a well retirement. In the event the petition is approved, the well will remain in place; however, samples will no longer be collected and evaluated with the following exception. The groundwater elevation in the retired well may be established to enhance the potentiometric surface mapping.

#### 4.9.2.13 Reporting

On an annual basis, GCD will submit a groundwater monitoring report that contains:

1. a summary of the results of the sampling and analysis conducted the previous 12 months;
2. results from the required statistical evaluation, if any;
3. potentiometric maps depicting the groundwater surface from each annual monitoring event from the previous year;
4. an isoconcentration map for any analyte detected above the groundwater protection standard identified in Table 2.
5. a discussion regarding analyte removal and well retirement per Sections 4.9.2.11 and 4.9.2.12 above; and
6. an evaluation of the previous year's data.

#### 4.9.2.14 Further Corrective Action

40 CFR Part 264.100 allows an owner/operator a reasonable time period to implement a corrective action program. At the Quapaw facility, corrective action has been previously implemented in conjunction with post closure activities, as described in Section 4.9.1.3 above. GCD recognizes that additional corrective action may be required if post closure escape of constituents threatens human health or the environment. Presently, RM wells have demonstrated on-site containment of constituents of concern.

GCD believes it is reasonable to proceed as described because a corrective action program has already been implemented at the facility during the initial stages of post closure; and because there is no reason to believe there is any threat to human health or the environment beyond the facility boundary. In addition, the ODEQ has available alternative enforcement mechanisms in the event an unreasonable threat to human health or the environment is identified.

### 4.9.3 SUMMARY

Previous monitoring plans were developed at the confluence of a ground water assessment, impoundment closure, enforcement-driven corrective measures and a RCRA Facility Investigation. As a result, two different monitoring programs (compliance and plume) were developed and then merged into a single permitted facility-wide monitoring program. To accomplish this, collection of background data was expedited to formulate and quickly implement the monitoring plan. Through out the first 10 years of Post Closure monitoring (Term 1), the monitoring proved out the beneficial effects of the corrective actions taken, but, did not definitively define the limits or significance of an advancing plume (that is, whether a groundwater protection standard has been met or exceeded).

The Term 2 ground water monitoring plan leveraged the existing data and filled data gaps necessary to determine the significance of potential exceedances identified during the initial stages of post-closure with the intent of defining the plume and determining if further corrective action is required. Appendix IX surveillance was added as a mechanism to ensure the list of constituents monitored was representative of any potential advancing contaminants. Well BG-01a was added, and ultimately closed, and the value of background data collected from MW7 and MW-8 was evaluated. RM-102b was added to replace RM-104 which was found to be side-gradient. The statistical evaluation of data was critically evaluated, and contingent plans were added to replace or remove wells as necessary to achieve the monitoring objectives. Also, the frequency of analysis was modified to focus on down gradient monitoring to ensure protection of human health and the environment.

The proposed Term 3 ground water monitoring plan is informed by more than two decades of monitoring, a stabilized plume that is contained on-site, and ODEQ input (see Appendix A). It includes the following features to streamline monitoring; detect the potential post-closure escape of hazardous constituents from the closed impoundment; and be more protective of human health and the environment:

- Eliminates monitoring at the point of compliance where exceedances are known to occur close to the source. Monitoring of MW-1 through MW-8 will be discontinued;
- Limits the collection of background data to BG-01;
- Discontinues Appendix IX analysis (surveillance) based upon stabilized conditions;
- Allows for the retirement of wells where no exceedances are occurring for 3 consecutive years (modeled after Corrective Action requirements);
- Retains RM wells as sentinel-wells close to the downgradient property line;
- Establishes RP and RM wells as the focal point of monitoring; and
- Provides an opportunity to demonstrate on-site containment, or lack of risk to receptors, for final closure.

The ground water monitoring plan is summarized in the following Table 1:

**TABLE 1  
GROUNDWATER MONITORING PLAN SUMMARY (TERM 3)  
GCD RESOURCES, LLC  
QUAPAW, OKLAHOMA**

WELLS	PROPOSED MONITORING REQUIREMENTS	
	ANALYTE(S)	FREQUENCY
<b>BG-01</b>  Background Well see 4.9.2.6	As, Ba, Cd, Cl-, Co, Cr, F-, Hg, Mn, Na, Ni, Pb, Sb, Se, SO4, Zn, pH, SC  Static Water Elevation	Annual  Each sampling event
<b>RP</b>  Slurry Wall Wells see 4.9.2.8 and 4.9.2.10	As, Ba, Cd, Cl-, Co, Cr, F-, Hg, Mn, Na, Ni, Pb, Sb, Se, SO4, Zn, pH, SC  Static Water Elevation	Annual  Each sampling event
<b>RM</b>  Remedial Action Wells see 4.9.2.9	Cd, Mn, pH, SC  Static Water Elevation	Annual  Each sampling Event

**Abbreviations:**

As/Arsenic  
 Ba/Barium  
 Cd/Cadmium  
 Cl-/Chloride  
 Co/Cobalt  
 Cr/Chromium  
 F-/Fluoride  
 Hg/Mercury  
 Mn/Manganese

Na/Sodium  
 Ni/Nickel  
 Pb/Lead  
 Sb/Antimony  
 Se/Selenium  
 SO4/Sulfate  
 Zn/Zinc  
 pH/pH  
 SC/Specific Conductance

**TABLE 2  
GROUNDWATER PROTECTION STANDARD  
GCD RESOURCES, LLC  
QUAPAW, OKLAHOMA**

<b>Constituents and Parameter of Concern</b>	<b>Concentration of Concern (mg/L)</b>	<b>Source of Standard<sup>2</sup></b>
Arsenic (As)	0.01	MCL <sup>3</sup>
Barium (Ba)	2.0	MCL
Cadmium (Cd)	0.005	MCL
Chloride (Cl-)	250	SMCL <sup>4</sup>
Cobalt (Co)	386	Regional Screening Levels <sup>5</sup>
Chromium (Cr)	0.1	MCL
Fluoride (F-)	4.0	MCL
Mercury (Hg)	0.002	MCL
Manganese (Mn)	0.05	SMCL
Sodium (Na)	390.66	Upper background limit <sup>6</sup>
Nickel (Ni)	0.14	OWRB <sup>7</sup>
Lead (Pb)	0.015	MCL
Antimony (Sb)	0.006	MCL
Selenium (Se)	0.05	MCL
Sulfate (SO <sub>4</sub> )	250	SMCL
Zinc (Zn)	5	SMCL
pH	6.5 – 8.5 (standard units)	SMCL
Specific Conductance (SC)	5610.22	Upper background limit <sup>5</sup>

<sup>2</sup> The statistical upper limit or other appropriate value will be used when MCL or SMCL values are not published, or background levels exceed the MCL or SMCL.

<sup>3</sup> Maximum Contaminant Level (MCL) for Primary Drinking Water Regulations

<sup>4</sup> Secondary MCL from Secondary Drinking Water Regulations

<sup>5</sup> Regional Screening Levels for Chemical Contaminants at Superfund Sites: Outdoor Worker exposure to Soil DAF=1

<sup>6</sup> Based upon last statistical analysis of GCD groundwater data (2011)

<sup>7</sup> OAC Title 785 Chapter 45 Appendix I Criteria for Groundwater Protection (*Unofficial*)