

CCR GROUNDWATER MONITORING SYSTEM CERTIFICATION – REVISION 1

UNIT 3 LANDFILL

Sherburne County (Sherco) Generating Plant
Becker, Minnesota

Prepared for:

Northern States Power Company, a Minnesota Corporation

January 23, 2023



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ENVIRONMENTAL \ ENGINEERING \ LAND SURVEYING

CCR GROUNDWATER MONITORING SYSTEM
CERTIFICATION – REVISION 1
Sherco Unit 3 Landfill
Becker, Minnesota

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Additionally, I certify that the groundwater monitoring system identified in this report has been designed and constructed to meet the requirements of § 257.91, Groundwater monitoring systems, as included in 40 CFR Part 257, Subpart D, Disposal of Coal Combustion Residuals from Electric Utilities.

Signature of Preparer:



Nicholas Bonow, P.E., P.G. #47510
Carlson McCain, Inc.

Date: January 23, 2023

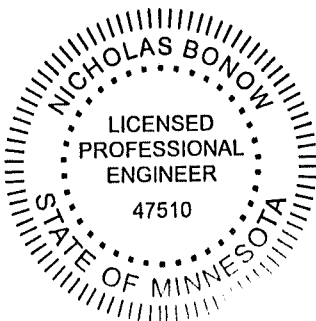


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1. INTRODUCTION

This report presents documentation and certification of the groundwater monitoring system for the Unit 3 Dry Ash Landfill (Landfill) at the Sherburne County Generating Plant (Sherco) located in Becker, Minnesota. The Sherco plant is owned and operated by Northern States Power Company, a Minnesota Corporation (NSPM). The Landfill location is shown on Figure 1 and an aerial photograph and site layout map for Landfill are shown on Figure 2.

The Landfill is an existing coal combustion residuals (CCR) landfill and is required to comply with provisions of the U.S. Code of Federal Regulations (CFR), Title 40, Parts 257 and 261 relating to disposal of coal combustion residuals from electric utilities. In particular, this report addresses the requirements of 40 CFR Section 257.91, Groundwater Monitoring Systems.

The CCR groundwater monitoring system was updated due to construction of Cell 4 at the Landfill. Former CCR groundwater monitoring system wells P-117, P-137A and P-138A were located within the footprint of the Cell 4 construction area and were sealed in June 2022 prior to construction of Cell 4. Replacement wells P-142, P-143A and P-144A were installed south of the planned location of Cell 4 in November 2020. The locations of the monitoring system wells that were sealed and the replacement wells are depicted on Figure 4. The drilling and installation of wells P-142, P-143A and P-144A is described in the Monitoring Well Installation Report (Carlson McCain, 2021a), which is included in the Landfill's operating record.

1.1 Groundwater Monitoring System §257.91(a)

According to §257.91(a), CCR units must comply with the following performance standard:

“The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that:

- (1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:*
 - (i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or*
 - (ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells; and*

- (2) *Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The down-gradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.*

Additionally, §257.91 includes specific requirements in subparts (b) through (g) relating to the development and implementation of the groundwater monitoring system, which must be satisfied in order to demonstrate compliance with the performance standard listed in subpart (a).

NSPM has installed a groundwater monitoring system at the Landfill as described in Table 1 and shown in Figure 5 that complies with the standard set forth in §257.91(a). The system includes twelve monitoring wells that monitor up-gradient, down-gradient and side-gradient locations.

The following sections describe the system in further detail, and address the requirements of subparts (b) through (g).

2. SITE CHARACTERIZATION

The hydrogeologic setting of the Landfill has been characterized in accordance with §257.91(b) which states *“The number, spacing, and depths of monitoring systems shall be determined based upon site specific technical information that must include thorough characterization of”*:

- (1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and*
- (2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.”*

Several hydrogeologic investigations and monitoring well installations have previously been performed at the Landfill that characterize the site’s hydrogeology for permitting and compliance with CCR and/or Minnesota Pollution Control Agency (MPCA) rules. Pertinent reports include the following:

- NSP, 1991a. SHERCO Plant, Unit 3 Dry Ash Landfill Site Expansion, Phase I Hydrogeologic Summary, January 1991;
- NSP, 1991b. SHERCO Plant, Unit 3 Dry Ash Landfill – Cell 2, Phase II Hydrogeologic Investigation, May 11, 1991;
- Xcel, 2007. SHERCO Unit #3 Dry Ash Landfill Expansion, Phase I Hydrogeologic Report and Phase II Work Plan, October 2007;
- NSP, 2008. Sherco Dry Ash Disposal Facility, Hydrogeologic Evaluation, Phase II – Field Investigation, prepared by Xcel Energy; March 2008;
- Xcel, 2009. SHERCO AQCS Landfill – Cell #3, Phase III Hydrogeologic Investigation – EMS Installation, November 16, 2009.
- Xcel, 2014. Sherco Unit 3 AQCS Solids Landfill Hydrogeologic Summary, prepared by Xcel Energy, August 2014.
- Carlson McCain, 2020. Monitoring Well Installation Work Plan, Sherco Unit 3 Landfill, prepared for Xcel Energy by Carlson McCain, Inc., September 25, 2020.
- Carlson McCain, 2021a. Monitoring Well Installation Report, Sherco Unit 3 Landfill, prepared for Xcel Energy by Carlson McCain, Inc., February 17, 2021.
- Carlson McCain, 2021b. Monitoring Well Replacement Report, Sherco Unit 3 Landfill, prepared for Xcel Energy by Carlson McCain, Inc., December 6, 2021.

Carlson McCain has reviewed these investigation and well installation reports in detail and the data and information contained in the reports has been adapted for use in this report.

2.1 Compliance with §257.91(b)(2) - Geology

General notes:

- 1) The requirements in §257.91(b)(2) will be discussed prior to §257.91(b)(1) in Sections 2.1 and 2.2 respectively since the geology and stratigraphy requirements in §257.91(b)(2) are generally the basis for the hydrogeologic requirements in §257.91(b)(1).
- 2) Of the reports listed in the previous section, the reports for Cell 2 (NSP, 1991b), the landfill expansion (NSP, 2008) and the hydrogeologic summary (Xcel, 2014) in particular discuss the geology, stratigraphy, and distinctive textural classifications of the stratigraphic units beneath the Landfill. For consistency in reading this section, the discussion in this section will reference data mainly from NSP (2008). In general, unless otherwise cited, specific data on soil types, thicknesses, spatial distribution, etc. are credited to NSP (2008).

Three major stratigraphic materials have been encountered at the Landfill and include, from top to bottom, outwash sand (alluvium), a discontinuous layer of glacial till, and granitic bedrock. The major stratigraphic materials encountered at the Landfill are illustrated on cross-sections from soil borings conducted during previous hydrogeologic investigations at the site.

2.1.1 Outwash Material (Alluvium)

Outwash material, or alluvium, is the upper-most stratigraphic unit at the Landfill. The alluvium generally extends from the ground surface to bedrock though it is interrupted by glacial till as described in Section 2.1.2. over a large portion of the site.

Description/Classification

The alluvium consists primarily of fine to coarse sand, densities of medium dense to very dense, typically less than 10% fines, and is well to poorly sorted. Soils are typically classified as SP or SP-SM under the United Soil Classification System (USCS). The sand color was primarily tan to brown in color. The texture and color of the material is fairly consistent across the site.

Spatial Distribution

The alluvium consists of the material between the ground surface extending to bedrock though, as discussed Sections 2.1 and 2.1.2, the alluvium is interrupted by a layer of glacial till that exists over a large portion of the site. The alluvium below the till has also been referred to as deep alluvium (Carlson McCain, 2016). The alluvium ranges from 30 to 75 feet thick with maximum thicknesses found in areas that the alluvial deposits extend uninterrupted from the ground surface to bedrock.

Grain Size and Permeability

Using the Hazen method (Fetter, 1994) and slug testing, the permeabilities for the alluvium beneath the Landfill ranges from 2.2×10^{-2} cm/sec to 7.7×10^{-2} cm/sec. The porosity of the alluvium was estimated to be 0.25.

2.1.2 Glacial Till

Grantsburg sublobe and Superior lobe glacial tills have been identified at the Landfill and have been characterized by their geologic origins in order to highlight their differences in classification, grain size and permeability. Since the permeability of the glacial tills are four to six orders of magnitude lower than the outwash, they have been mapped as a single unit on maps and cross-sections in previous reports.

Description/Classification

Grantsburg till is described to be from the Grantsburg sublobe glacial ice advancement, color is brown to gray, is classified as a clayey sand under the USCS, is calcareous in nature, and contains fragments of shale. Superior till is described to be from the Superior lobe glacial ice advancement, color is reddish-brown due to scouring of iron rich sandstones, and is classified as a silty sand under the USCS.

Spatial Distribution

The glacial till exists within the alluvium over a large portion of the Landfill site, and is typically present at elevations ranging from 923 to 937 feet above mean sea level (MSL). Although it was present in the majority of the borings advanced during the landfill expansion hydrogeologic investigation, discontinuities in the till were observed beneath the Landfill. Where present, the till thickness typically ranged from 1 to 12 feet thick, with a thicker area present beneath a portion of Cell 2.

Grain Size and Permeability

Using the Hazen method (Fetter, 1994) and slug testing, the permeabilities for the Grantsburg and Superior tills ranged from 1.0×10^{-6} to 3.4×10^{-8} cm/sec and from 1.1×10^{-7} to 8.5×10^{-7} cm/sec respectively. The porosity of the glacial till was estimated to be 0.15.

2.1.3 Bedrock

Nineteen borings were extended to bedrock during previous investigations and middle Precambrian granitic bedrock is the first bedrock encountered at the Landfill. The depth to bedrock ranged from 50 to 83 feet below ground surface (bgs) at elevations ranging from 896 to 919 feet MSL. The upper portion of bedrock was weathered to various degrees; however, the bedrock is considered impermeable beneath the weathered veneer.

2.2 Compliance with §257.91(b)(1) - Hydrogeology

2.2.1 Aquifer Thickness

The water table beneath the Landfill typically occurs above the top of the glacial till identified in Section 2.1.2. Therefore, the uppermost aquifer is the alluvium discussed in Section 2.1.1, which ranges from 30 to 75 feet thick.

2.2.2 Groundwater Elevation and Flow Direction

As shown in the hydrograph in Figure 3, the groundwater fluctuates between one and three feet on an annual basis and by as much as seven feet from a wet year to a drought year at the Landfill. The hydrograph also indicates that, from 1986 to the present, groundwater elevations at the facility have ranged from approximately 931.0 to 947.0 feet MSL and are typically five to ten feet above the glacial till described in Section 2.1.2.

Groundwater elevation contours at the Landfill during September 2022 are shown in Figure 4. The contours were derived from water levels that were obtained during the Fall 2022 monitoring event at the Landfill which included wells in the CCR monitoring system as well as additional wells and piezometers around the Landfill. As shown in Figure 4, groundwater flow direction beneath the Landfill is primarily to the south. This flow direction is generally consistent with historical data at the facility and is also consistent with the regional groundwater flow direction towards the Mississippi river.

2.2.3 Groundwater Flow Gradients

Based on the groundwater elevation contours shown in Figure 4, the average horizontal groundwater gradient at the Landfill was calculated at 0.003 (units of vertical feet per horizontal foot). The horizontal gradient appeared to be fairly consistent across the entire facility and is also consistent with values previously reported for the facility.

Vertical gradients were calculated from four nested well pairs (P-73A-2 and P-73B-1, P-76A- and P-76B-1, P-143A and P-143B and P-144A and P-144B) based on water level measurements collected during the spring and fall 2022 groundwater monitoring events. The average vertical gradient was calculated at 0.004 downward.

Because of the relatively small vertical distances over which the gradients are measured and the low magnitude of the differences in water elevations, a vertical gradient of 0.004 is considered insignificant and detection monitoring of the water table aquifer is sufficient to detect a potential release from the Landfill.

2.2.4 Groundwater Flow Velocity

Average linear groundwater flow velocity was calculated using Darcy's equation:

$$v = Kh \times i / ne$$

where Kh = horizontal hydraulic conductivity (length/time)
i = horizontal gradient (dimensionless)
ne = effective porosity

As discussed in Section 2.1.1, the outwash sand at the facility exhibited a range of average Kh values from 2.2×10^{-2} to 7.7×10^{-2} cm/sec and 0.25 for n_e (estimated). Section 2.2.3 indicated the value for i is 0.003 (calculated).

Resulting groundwater velocity values at the Site range from approximately 273 to 956 feet per year.

3. CONCEPTUAL MODEL AND MONITORING WELL LOCATIONS

§257.91(c) states that *“The groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section (discussed in Section 1.1 of this report), based on the site-specific information specified in paragraph (b) of this section (discussed in Section 2.0 of this report).”*

Section 3.1 below integrates existing data into a geologic and hydrogeologic framework, or conceptual model, for the Landfill site. The conceptual model offers a simplified representation of the geologic media and serves as the basis for identifying the primary monitoring units.

The conceptual model also facilitates a description of the fate and transport of a hypothetical release from the proposed facility. It provides a rationale for predicting the most likely flow paths that a release might follow and provides the basis for an effective monitoring network that can intercept the potential release.

Sections 3.2 and 3.3 below discuss the selection of monitoring well locations based on the rule requirements and the conceptual model for the Landfill site.

3.1 Conceptual Model

The conceptual model for the release of a constituent of concern (COC) from the Landfill focuses on groundwater as the transport mechanism. As discussed in Section 2.2.2, the water table beneath the Landfill is typically 5 to 10 feet above the glacial till layer identified in Section 2.1.2. Exfiltration from Landfill area is anticipated to move vertically downward from the base until it reaches the water table contact. No glacial till has been identified in the vadose zone, which would impede or redirect the infiltrating leachate. Upon reaching the water table, a COC will likely travel mainly horizontally toward the south toward the Mississippi River.

Based on this conceptual model, the groundwater monitoring network should target the water table as the primary monitoring zone; and downgradient wells should be located mainly on the south sides of the Landfill in order to detect a potential release.

3.2 Groundwater Monitoring System

As discussed in Section 1.1, NSPM has installed a groundwater monitoring system at the Landfill that complies with the standard set forth in §257.91(a). The system includes twelve water table monitoring wells that include up-gradient, down-gradient, and side-gradient wells as follows:

Up-Gradient	Down-Gradient	Side-Gradient
P-125, P-134, P-141	P-75-2, P-97-1, P-98-1, P-120, P-142, P-143A, P-144A	P-73A-2, P-74-2

Well locations relative to the Landfill are shown in Figure 5; and well construction data, including unique well number and installation date, are summarized in Table 1.

3.2.1 Compliance with §257.91(c)(1)

As described above in Section 3.2, seven monitoring wells are located down-gradient, three are up-gradient and two are side-gradient of the Landfill. This exceeds the minimums of one up-gradient and three down-gradient monitoring wells required in §257.91(c)(1).

3.2.2 Compliance with §257.91(c)(2)

Based on the conceptual model for the Landfill, monitoring wells in addition to the minimums described in Section 3.2.1 have been located in up-gradient, down-gradient and side-gradient locations at the Landfill. Monitoring well P-141 was installed in 2016 (Carlson McCain, 2016) to combine with previously existing wells P-125 and P-134 to accurately represent the background groundwater quality at the site. Other compliance monitoring wells are evenly spaced along the down-gradient and side-gradient edges of the Landfill and are well-situated to detect a potential release.

4. GROUNDWATER MONITORING SYSTEM PERFORMANCE

The Landfill is not a multi-unit facility and, therefore, compliance with §257.91(d) is not required. Given that, Section 4.1 below discusses compliance with §257.91(e) which states that *“Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the groundwater.”*

4.1 Compliance with §257.91(e)

Monitoring well completion logs that were reviewed indicate that wells included in the monitoring network have casings that are screened and packed with sand to enable collection of groundwater samples (NSP, 1991b, Xcel, 2008, Xcel, 2009, Carlson McCain, 2021a and Carlson McCain, 2021b). The monitoring well completion logs also indicate the annular spaces above the sand packs in the monitoring wells have been sealed to prevent contamination of samples and the groundwater. Further, previous sampling at all wells in the monitoring network have proven that the wells are sampleable and provide acceptable and consistent results.

4.1.1 Compliance with §257.91(e)(1)

As required in §257.91(e)(1):

1. The design, installation, development and decommissioning of any monitoring wells, piezometers, and any other measurement, sampling and analytical devices that are part of groundwater monitoring system will be kept as part of the operating record;
2. The operating record for the facility consists of electronic reports found on NSPM’s data network; and
3. Access to the operating record was provided for the completion of this groundwater monitoring system certification.

4.1.2 Compliance with §257.91(e)(2)

As required in §257.91(e)(2), monitoring wells, piezometers, and any other measurement, sampling and analytical devices that are part of the groundwater monitoring system will be operated and maintained so that they perform to the design specifications throughout the life of the monitoring program.

4.1.3 Groundwater Sampling and Analysis Plan

A Groundwater Sampling and Analysis Plan (SAP) and Statistical Methods Certification have been prepared for the wells in the CCR groundwater monitoring network at Landfill (Carlson McCain, 2023). The SAP provides the methods and procedures that will be used to collect, ship, analyze, and

report groundwater monitoring data from the facility is intended to comply the requirements of §257.93.

5. REVISION HISTORY

A history of revisions to this document as follows:

1. Revision 0 – Published October 17, 2017
2. Revision 1 – Published January 23, 2023, revised to reflect:
 - a. Abandonment and replacement of five monitoring system wells due to low water levels in 2021 at the facility.
 - b. Construction of Cell 4
 - i. Abandonment of three monitoring wells.
 - ii. Addition of three replacement monitoring wells to the monitoring system.

6. REFERENCES

Carlson McCain, 2016. Monitoring Well Installation Report, Unit #3 AQCS Landfill – Sherco Generating Plant, October 13, 2016.

Carlson McCain, 2021a. Monitoring Well Installation Report, Unit 3 Landfill – Sherco Generating Plant, prepared by Carlson McCain, Inc., February 17, 2021.

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NSP, 1991b. SHERCO Plant, Unit 3 Dry Ash Landfill – Cell 2, Phase II Hydrogeologic Investigation, May 11, 1991.

NSP - Minnesota, 2008. Sherco Dry Ash Disposal Facility, Hydrogeologic Evaluation, Phase II – Field Investigation, prepared by Xcel Energy; March 2008.

EPA, 2015. 40 CFR Parts 257 and 261; Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule, Federal Register vol. 80, no. 74. Environmental Protection Agency. April 17, 2015.

Xcel, 2007. SHERCO Unit #3 Dry Ash Landfill Expansion, Phase I Hydrogeologic Report and Phase II Work Plan. Xcel Energy, October, 2007.

Xcel, 2009. SHERCO AQCS Landfill – Cell #3, Phase III Hydrogeologic Investigation – EMS Installation. Xcel Energy, November 16, 2009.

Tables

Table 1
CCR Groundwater Monitoring System
Sherco Unit 3 Landfill

Well ID	Minnesota Unique Well ID	Date Installed	Location Site Coordinates (ft)		Elevation Top of Riser Pipe	Screen Length (ft)	Well Depth (ft)	Monitoring Status	Hydrologic Location
			Easting	Northing					
P-73A-2	863060	11/3/2021	2025348	872627	974.18	10	41.83	Routine Semiannual	Side-Gradient
P-74-2	863061	11/2/2021	2025238	870732	971.98	10	46.56	Routine Semiannual	Side-Gradient
P-75-2	863062	11/1/2021	2023947	871250	973.85	10	46.16	Routine Semiannual	Down-Gradient
P-97-1	863064	11/1/2021	2023990	870840	974.77	15	47.35	Routine Semiannual	Down-Gradient
P-98-1	863065	11/2/2021	2024684	870532	973.73	10	47.72	Routine Semiannual	Down-Gradient
P-120	474023	2/11/1991	2024299	870529	973.33	10	48.53	Routine Semiannual	Down-Gradient
P-125	517548	4/1/1993	2024679	873649	972.20	10	36.41	Routine Semiannual	Up-gradient
P-134	747065	12/6/2008	2022754	873698	973.85	10	37.52	Routine Semiannual	Up-gradient
P-141	822160	7/22/2016	2023787	873696	975.17	10	39.24	Routine Semiannual	Up-gradient
P-142	853115	11/24/2020	872150.1	2023900.2	972.60	10	40.80	Routine Semiannual	Down-Gradient
P-143A	853113	11/24/2020	872223.7	2023331.9	974.69	10	42.82	Routine Semiannual	Down-Gradient
P-144A	853111	11/23/2020	872223.8	2022876.5	972.45	10	39.66	Routine Semiannual	Down-Gradient

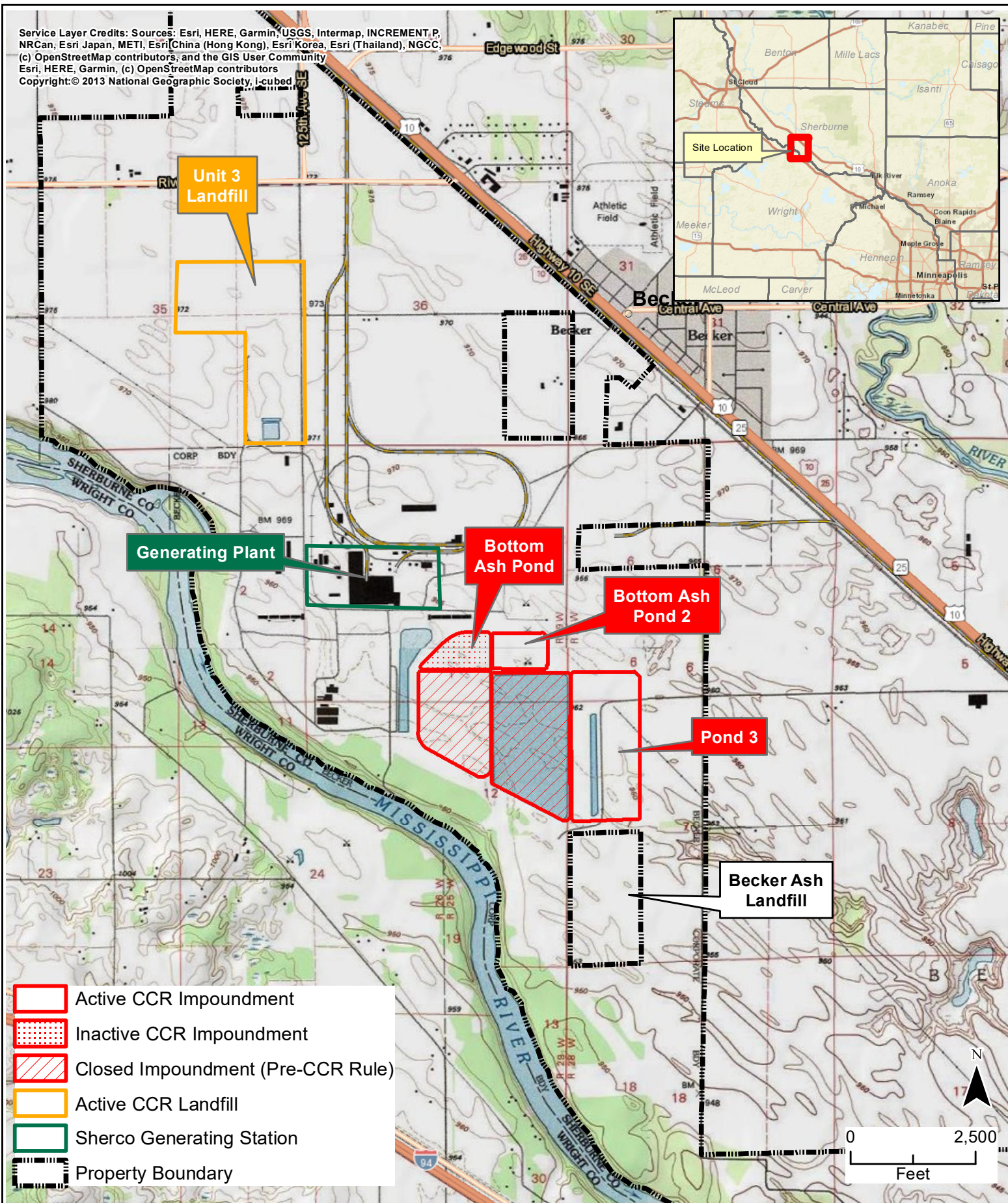
*Notes:

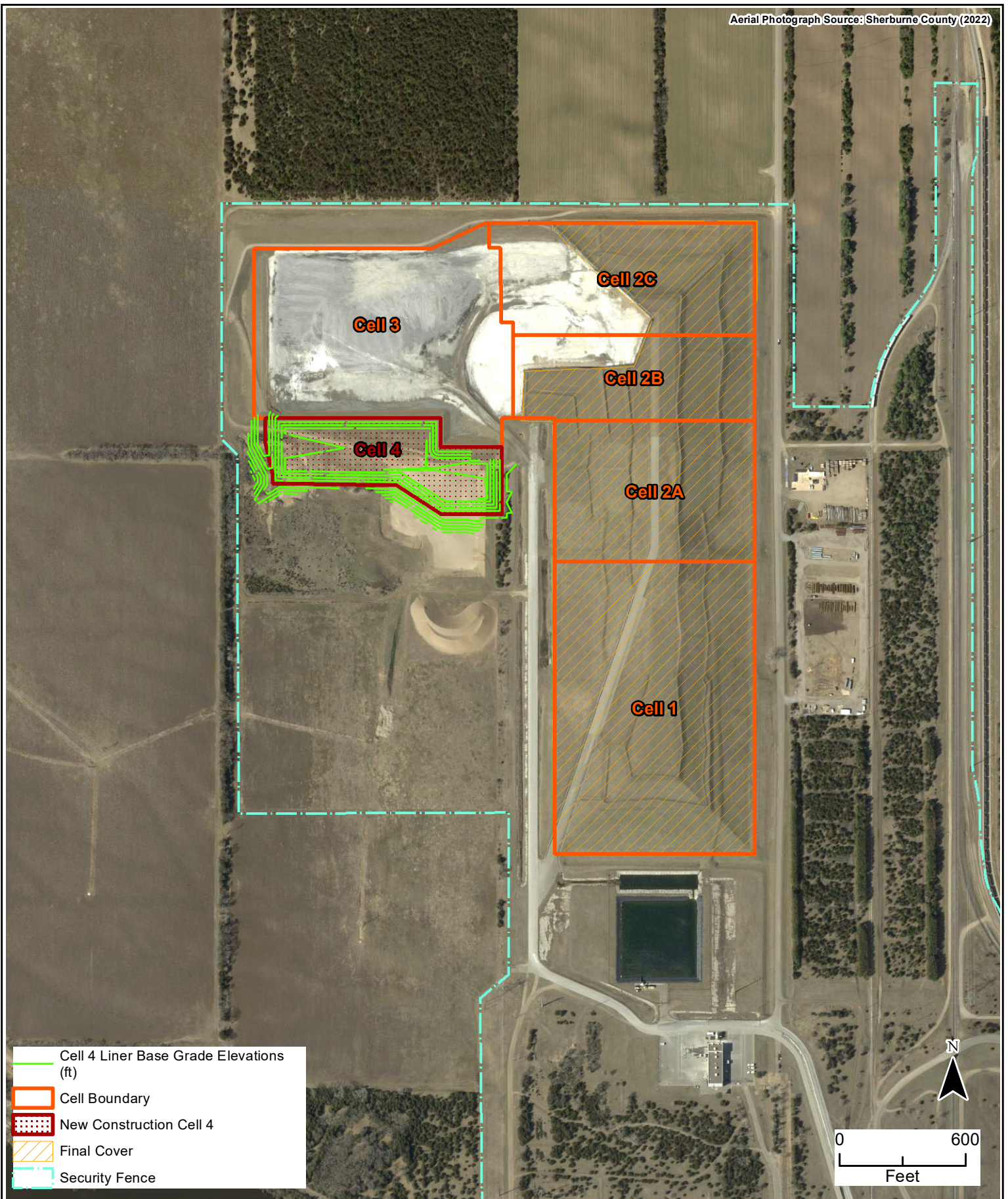
Elevation is feet above mean sea level

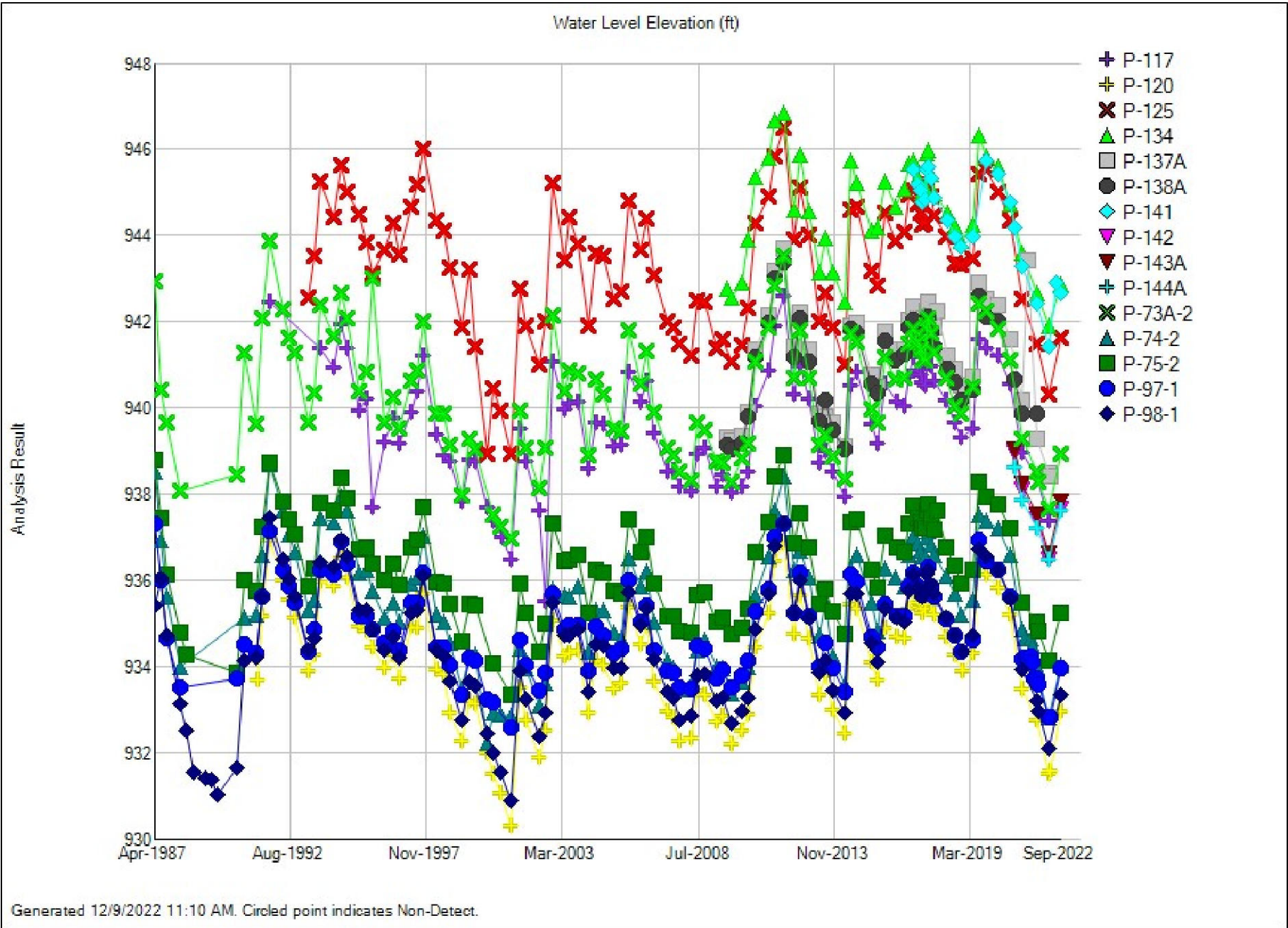
Wells P-117, P-137A and P-138A were abandoned in advance of Cell 4 construction on June 6, 2022.

Figures

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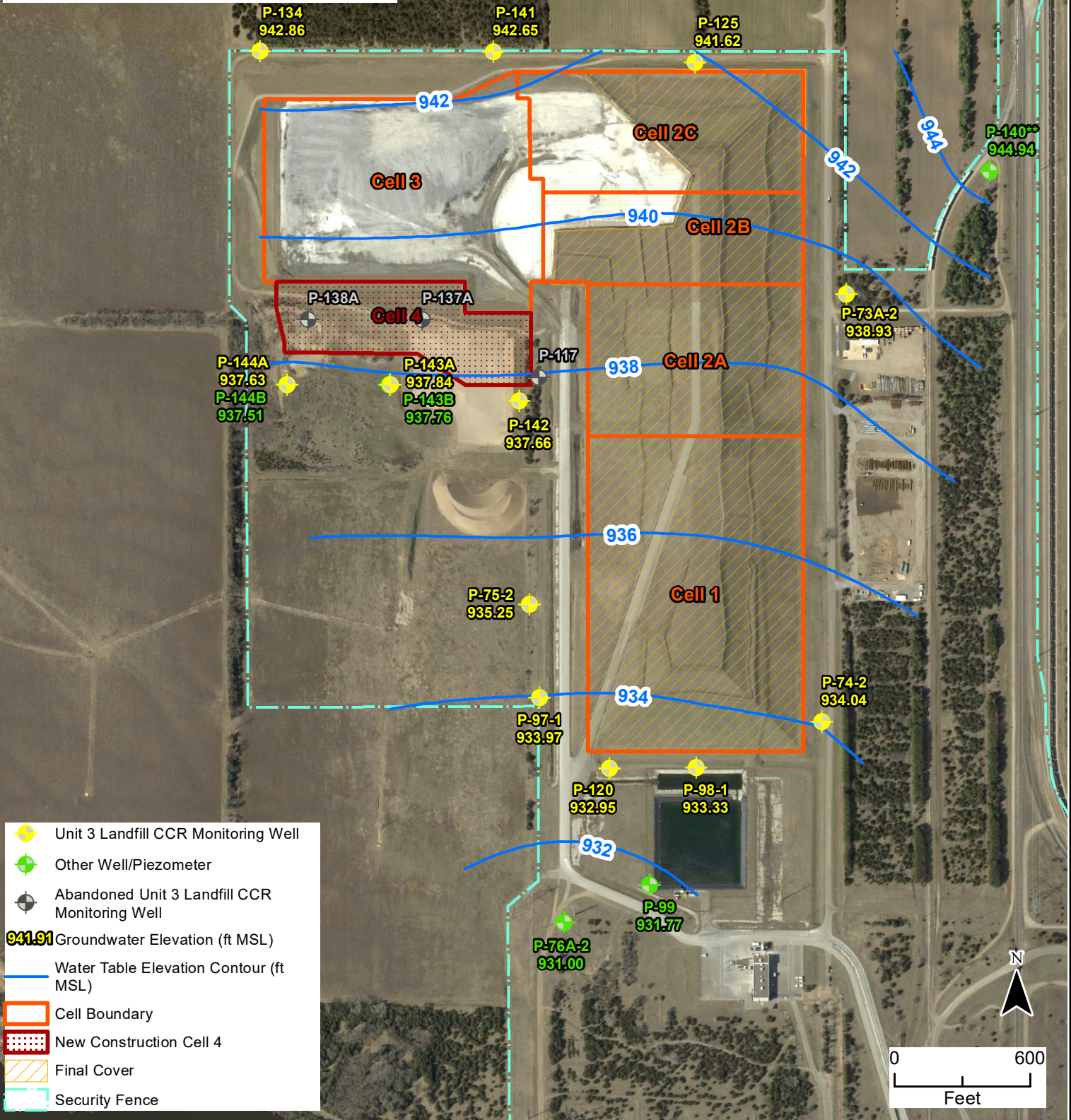






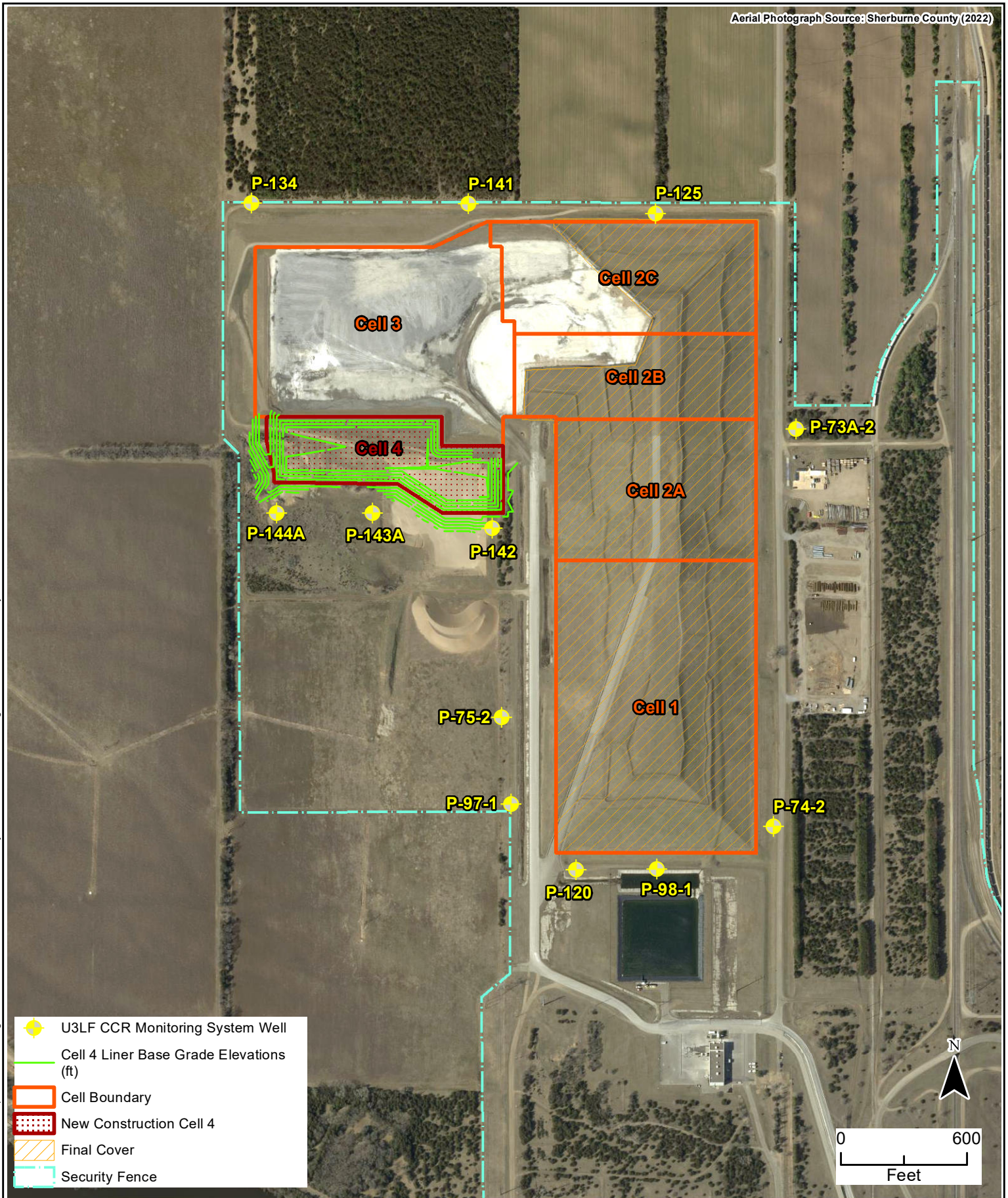
****NOTE**

The groundwater elevation at well P-140 is an estimate since the water level at the well was inadvertently not obtained at the well during the fall of 2022 monitoring event. An average increase in groundwater elevations 1.2 feet at the U3LF CCR monitoring wells between the spring and fall of 2022 monitoring events was calculated and added to the spring 2022 water level at well P-140.



**CCR GROUNDWATER MONITORING
SYSTEM CERTIFICATION - REV 1**
Unit 3 Landfill
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FIGURE 4
**WATER TABLE
ELEVATION CONTOUR
MAP (09/21-22/2022)**



**CCR GROUNDWATER MONITORING
SYSTEM CERTIFICATION - REV 1**
Unit 3 Landfill
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FIGURE 5
**CCR GROUNDWATER
MONITORING SYSTEM**