ROY S. NELSON PLANT

2018 Annual Groundwater Monitoring and Corrective Action Report

PREPARED IN COMPLIANCE WITH THE EPA FINAL RULE FOR THE DISPOSAL OF COAL COMBUSTION RESIDUALS TITLE 40 CODE OF FEDERAL REGULATIONS PART 257

January 2019

CCR UNIT
WESTLAKE, LA

2018 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

Prepared for
Entergy Services, Inc
639 Loyola Ave
Mail unit L-ENT 3D
New Orleans, LA 70113

Prepared By:

Pivotal Engineering LLC,
Eagle Environmental, and
TRC Solutions

January 2019

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1.0 INTRODUCTION

Entergy Louisiana LLC (Entergy), operates a Coal Ash Landfill (CCR Unit) for the disposal of coal combustion residuals (CCR) at the Roy S. Nelson Plant located in Westlake, Louisiana. The CCR Unit receives CCR generated from the combustion of coal at the Nelson Plant. Management of the CCRs at the CCR Unit is performed pursuant to national criteria established in Title 40 of the Code of Federal Regulations (40 CFR) Part 257 (CCR Rule), published by the United States Environmental Protection Agency (EPA) on April 17, 2015. Entergy has installed a groundwater monitoring system at the CCR Unit that is subject to the groundwater monitoring and corrective action requirements provided under §§257.90 through 257.98 of the CCR Rule. In accordance with §257.90(e) of the CCR Rule, Entergy must prepare an annual report that provides information regarding the groundwater monitoring and corrective action program at the CCR Unit. This document is intended to provide the required information.

This report is the second annual groundwater monitoring report required under the CCR Rule and is the summary and analysis of results from the 2018 groundwater monitoring sampling events. The first groundwater monitoring report was completed in January 2018.

2.0 GROUNDWATER MONITORING WELL NETWORK

Entergy's groundwater monitoring system consists of 14 monitoring wells as shown in Appendix A. Pursuant to §257.91(f) of the CCR Rule, a qualified professional engineer has certified that the groundwater monitoring system has been designed and constructed to meet the requirements of this section of §257.91.

3.0 INSTALLED OR DECOMMISSIONED MONITORING WELLS DURING 2018

No monitoring wells were installed or decommissioned during 2018 at the CCR Unit.

4.0 GROUNDWATER MONITORING DATA

In accordance with §257.90(e)(3), all the monitoring data obtained under §§257.90 through 257.98 are provided in Appendix B along with a summary of the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was collected as part of detection or assessment monitoring.

5.0 STATUS SUMMARY OF THE 2018 GROUNDWATER MONITORING PROGRAM

Groundwater monitoring was performed in accordance with the detection monitoring requirements of §257.94. A summary of activities related to groundwater detection monitoring performed during 2018 is provided below:

- In accordance with §257.94(b), detection monitoring sampling was performed during April, August, October and December for analysis of Appendix III parameters.

- Appendix IV parameters were collected in April, August, October and December 2018 to enhance the background data set for those constituents. Sample collection for Radium 226/228 was not performed as these constituents were not detected in any of the background data. As noted above, the April, August, October and December 2018 Appendix IV data were collected for background purposes and are not required by the rule for detection or assessment monitoring.

- Statistical evaluation of the detection monitoring data was performed in accordance with the statistical method certified by a qualified Louisiana-registered professional Engineer. The certified statistical method has been posted to Entergy's CCR Rule Compliance Data and Information website.

- In 2018, Entergy completed a successful alternate source demonstration (ASD) per §257.94 (e)(2) in response to statistically significant increases (SSIs) identified during the second half of 2017 detection monitoring event. The ASD was certified by a Louisiana-registered professional engineer and was placed into the facility's operating record. As required by §257.94(e)(2), a copy of the ASD is included as Appendix C. Based on the successful evaluation conducted and results presented in the ASD, Entergy continued with detection monitoring in accordance with §257.94.

- The first half 2018 detection monitoring sampling was performed during April 2018. Results confirmed SSIs for calcium.

- In 2018, Entergy completed a successful alternate source demonstration (ASD) per §257.94 (e)(2) in response to statistically significant increases (SSIs) identified during the first half of 2018 detection monitoring event. The ASD was certified by a Louisiana-registered professional engineer and was placed into the facility's operating record. As required by §257.94(e)(2), a copy of the ASD is included as Appendix C. Based on the successful evaluation conducted and results presented in the ASD, Entergy continued with detection monitoring in accordance with §257.94.

- The second half 2018 detection monitoring sampling was performed during October 2018. Results confirmed SSIs for calcium.

- No problems were encountered during 2018 with regard to the groundwater monitoring system. Therefore, no actions were required to modify the system.

- The facility remained in detection monitoring for the duration of 2018.

6.0 PROJECTED ACTIVITIES FOR 2019

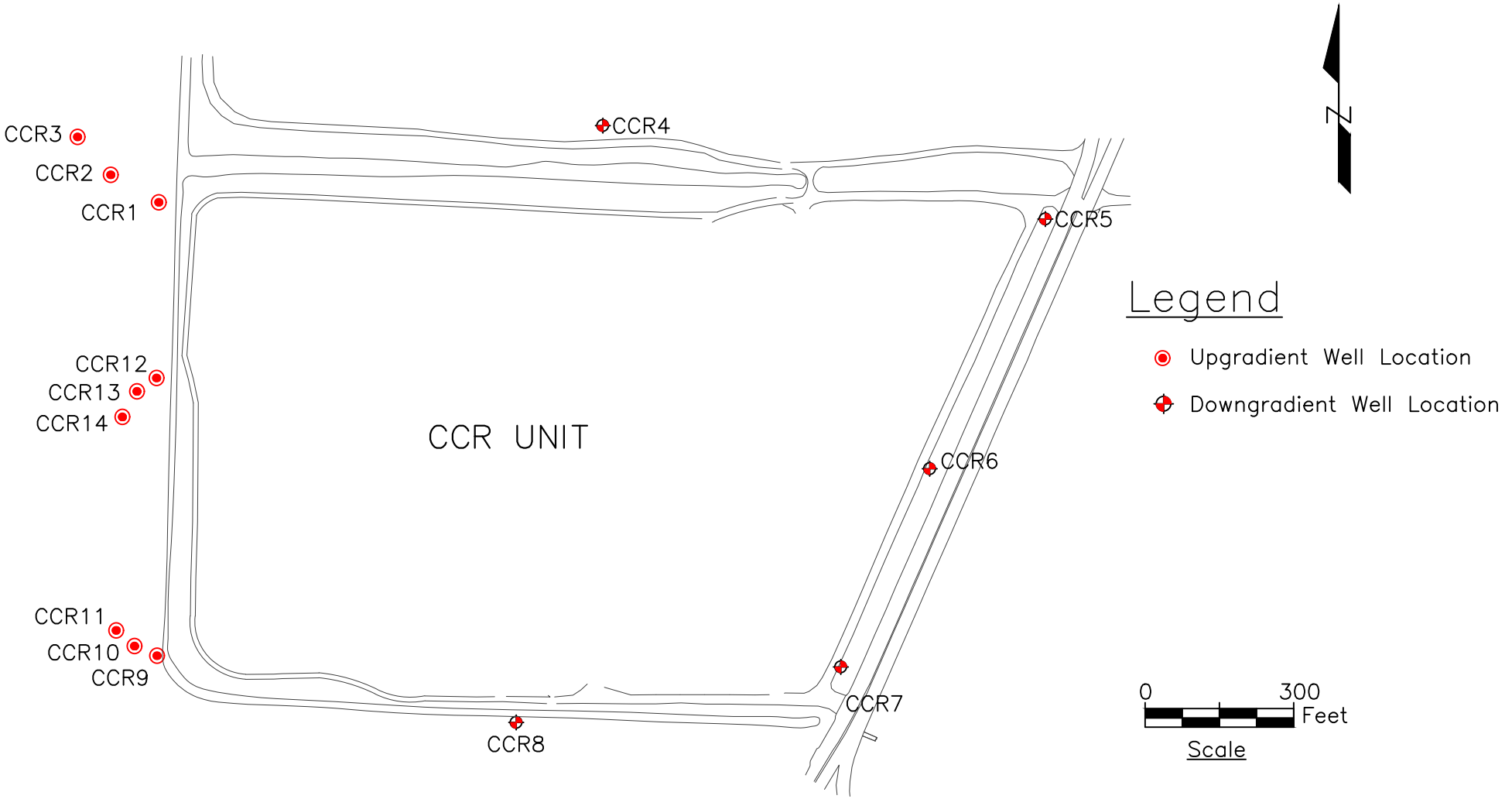
Planned activities for the CCR Unit's groundwater monitoring program during 2019 are listed below:

- Semi-annual detection monitoring events are planned for March and September 2019.

- Entergy is performing an ASD to evaluate the identified SSIs identified during the second half of 2018 monitoring period. Depending on the results of the ASD, Entergy will either continue with detection monitoring or implement assessment monitoring in accordance with §257.95.

APPENDIX A

SITE MAP



CCR UNIT
SITE MAP

ENTERGY LOUISIANA, LLC
ROY S. NELSON PLANT
HOUSTON RIVER ROAD, WESTLAKE, LOUISIANA

DATE	DESCRIPTION REVISIONS	BY

SCALE: AS NOTED	DRAWN BY: B.S.
DATE: JAN 06/16	CHECKED BY: T.E.

A
APPENDIX

APPENDIX B

SAMPLING SCHEDULE AND ANALYTICAL DATA

Detection Monitoring Sampling Dates

Entergy Louisiana LLC
Nelson Coal Ash Landfill
Westlake, LA

Well	CCR-1 (BG)	CCR-2 (BG)	CCR-3 (BG)	CCR-4	CCR-5	CCR-6	CCR-7	CCR-8	CCR-9 (BG)	CCR-10 (BG)	CCR-11 (BG)	CCR-12 (BG)	CCR-13 (BG)	CCR-14 (BG)
Date	4/2/18	4/2/18	4/2/18	4/2/18	4/2/18	4/3/18	4/3/18	4/2/18	4/1/18	4/1/18	4/1/18	4/2/18	4/2/18	4/2/18
40 CFR 257 Appendix III Parameters*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40 CFR 257 Appendix IV Parameters**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Date	8/16/18	8/16/18	8/16/18	8/17/18	8/15/18	8/15/18	8/15/18	8/17/18	8/15/18	8/15/18	8/15/18	8/16/18	8/16/18	8/16/18
40 CFR 257 Appendix III Parameters*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40 CFR 257 Appendix IV Parameters**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Date	10/29/18	10/29/18	10/29/18	10/31/18	10/31/18	10/31/18	10/31/18	10/30/18	10/30/18	10/30/18	10/30/18	10/30/18	10/30/18	10/30/18
40 CFR 257 Appendix III Parameters*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40 CFR 257 Appendix IV Parameters**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Date	12/17/18	12/17/18	12/17/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/17/18	12/17/18	12/17/18
40 CFR 257 Appendix III Parameters*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40 CFR 257 Appendix IV Parameters**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

*40 CFR 257 Appendix III Parameters collected on reference date and include Boron, Calcium, Chloride, Flouride, Sulfate, and Total Dissolved Solids. Laboratory reports to follow.
**40 CFR 257 Appendix IV Parameters collected on reference date and include Antimony, Arsenic, Barium, Beryillium, Cadmium, Chromium, Cobalt, Flouride, Lead, Lithium, Mercury, Molybdenum, Selenium and Thallium
Note: Detection monitoring results for pH are located on the next table.
Radium 226 and 228 combined were not analyzed in 2018 due to 100% non-detect in previous background analytical results

Detection Monitoring pH Results

Entergy Louisiana LLC
Nelson Coal Ash Landfill
Westlake, LA

Well	CCR-1 (BG)	CCR-2 (BG)	CCR-3 (BG)	CCR-4	CCR-5	CCR-6	CCR-7	CCR-8	CCR-9 (BG)	CCR-10 (BG)	CCR-11 (BG)	CCR-12 (BG)	CCR-13 (BG)	CCR-14 (BG)
Date	4/2/18	4/2/18	4/2/18	4/2/18	4/2/18	4/3/18	4/3/18	4/2/18	4/1/18	4/1/18	4/1/18	4/2/18	4/2/18	4/2/18
pH (S.U.)	6.82	6.62	6.73	6.68	6.88	6.95	7.14	6.48	6.92	6.78	7.01	6.40	7.02	6.61
Date	8/16/18	8/16/18	8/16/18	8/17/18	8/15/18	8/15/18	8/15/18	8/17/18	8/15/18	8/15/18	8/15/18	8/16/18	8/16/18	8/16/18
pH (S.U.)	6.78	6.54	6.59	6.88	6.77	6.67	6.67	6.52	7.08	6.92	6.98	6.31	6.80	6.53
Date	10/29/18	10/29/18	10/29/18	10/31/18	10/31/18	10/31/18	10/31/18	10/30/18	10/30/18	10/30/18	10/30/18	10/30/18	10/30/18	10/30/18
pH (S.U.)	6.96	6.77	6.87	6.78	7.03	7.06	7.03	6.45	7.21	7.10	7.23	6.48	6.85	6.69
Date	12/17/18	12/17/18	12/17/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/18/18	12/17/18	12/17/18	12/17/18
pH (S.U.)	6.80	6.56	6.70	6.70	6.92	6.92	6.91	6.41	7.16	7.03	7.21	6.20	6.67	6.49

S.U. - Standard Units

APPENDIX C

ALTERNATE SOURCE DEMONSTRATIONS

Alternate Source Demonstration

Entergy Roy S. Nelson Plant
Coal Ash Disposal Landfill
Westlake, Calcasieu Parish, Louisiana

April 2018

Alternate Source Demonstration

Entergy Roy S. Nelson Plant
Coal Ash Disposal Landfill
Westlake, Calcasieu Parish, Louisiana

April 2018

Prepared For
Entergy Louisiana, L.L.C.
Roy S. Nelson Plant
3500 Houston River Road
Westlake, Louisiana 70669

Tarek Elnaggar, P.E.
Principal

Jason S. House
Project Manager

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Executive Summary

Entergy Louisiana, L.L.C (Entergy) operates the Entergy Roy S. Nelson Plant (Plant), a coal fired power plant, to generate electricity. The Plant is located near Westlake, Calcasieu Parish, Louisiana, as shown in Figure 1.

Coal combustion residuals (CCR) are produced as part of the electrical generation operations which began for the Plant in 1960. Disposal of CCR has occurred since then in the on-site coal ash disposal landfill (landfill) that is approximately 31 acres in size (see Figure 2).

Entergy operates a Type I landfill under Louisiana Department of Environmental Quality (LDEQ) Solid Waste Permit No. P-0018-R1-M5. Entergy also manages CCR at the landfill as provided in the federal Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (CCR Rule), effective October 17, 2015.

Pursuant to the CCR Rule, Entergy has installed a groundwater monitoring network and has implemented groundwater monitoring at the landfill. The CCR certified groundwater monitoring network consists of 14 wells screened in the first continuous water bearing unit beneath the landfill (see Figure 3). A potentiometric map with water levels measured in September 2017 is shown in Figure 4.

The CCR Rule requires eight quarterly background groundwater monitoring events, pursuant to the CCR Rule, Entergy has performed nine background monitoring events between 2015 and 2017. The samples were analyzed for the Appendix III to Part 257 – Constituents for Detection Monitoring and the Appendix IV to Part 257 – Constituents for Assessment Monitoring parameters. Upon completion of the background sampling, the first semiannual detection monitoring event for the Appendix III constituents was performed in September 2017 and verification sampling was performed in both October and November 2017. Statistical analysis of these results relative to the background results was performed pursuant to 40 CFR 257.93(f) and the Statistical Analysis Plan (Pivotal 2017b). Based on the results of this statistical analysis, the concentrations of Appendix III constituents were within the interwell prediction limits for each constituent at each monitoring well except as follows:

- Calcium Statistically Significant Increase (SSI) in the groundwater at CCR-7

Pursuant to 40 CFR 257.94(e)(2), Entergy may demonstrate that a source other than the CCR management unit caused the SSI and SSL or that they resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The information provided in this report serves as Entergy's alternate source demonstration (ASD) prepared in accordance with 40 CFR 257.94(e)(2) and demonstrates that the SSI determined based on the first semiannual

detection monitoring event performed in 2017 is not due to leakage from the base of the landfill, but are due to the following:

- The source of the calcium SSI in groundwater at CCR-7 is natural variation in the groundwater quality. This conclusion is based on the following primary lines of evidence:
  - Boron concentrations in the groundwater at CCR-7 have been stable, and within the range of concentrations measured in the nine background monitoring wells, installed upgradient to the landfill. If the source of the calcium SSI was leachate leaking from the base of the landfill, the boron concentrations in the groundwater would be increasing as it migrated downgradient along with calcium to CCR-7; and
  - Calcium concentrations in the groundwater at CCR-7 have been stable since quarterly detection monitoring began in November 2015; and
  - Prior to the CCR Rule, LDEQ monitoring wells in the area of CCR-7 were sampled on a semiannual basis, and indicated calcium concentrations in the groundwater ranging from 19 mg/L to 119 mg/L. The SSI concentration for calcium in CCR-7 is 52 mg/L, within the range of historical calcium concentration trends at the site.
  - Soil leachate tests from samples collected at the site showed high levels of calcium in the soil (25.3 mg/kg to 1,250 mg/kg) at depths where the lower sand unit water bearing unit is present; and
  - The presence of a low hydraulic conductivity confining unit above the lower sand unit, hydraulically isolates the unit from overlying sources of water. Therefore, changes in groundwater constituent concentrations are likely derived from natural conditions within the aquifer unrelated to the presence of the landfill; and
  - An analysis of the major ion chemistry of the groundwater shows that groundwater at CCR-7 is not different from the groundwater at the other monitoring wells. The piper plot in Figure 7 demonstrates this point. The increase in calcium at CCR-7 is naturally occurring and the SSI is a result of the statistical analysis chosen.

Section 1
Introduction

1.1 Background

The Entergy Louisiana, L.L.C (Entergy) Roy S. Nelson Plant operates an on-site coal ash disposal landfill (landfill) located at 3500 Houston River Road in Westlake, Louisiana (Figure 1). The facility has been generating and disposing of coal combustion residuals (CCR) since it began operations in 1960.

Entergy operates a Type I landfill under Louisiana Department of Environmental Quality (LDEQ) Solid Waste Permit No. P-0018-R1-M5. Entergy also manages CCR at the landfill as provided in the federal Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (CCR Rule), effective October 17, 2015. Currently, four active disposal cells exist in the landfill and are regulated under the CCR rule. The areal extent of the landfill is shown in Figure 2.

The certified groundwater monitoring network at the landfill consists of 14 monitoring wells (CCR-1 through CCR-14), installed in accordance with the CCR Rule in the first continuous water bearing zone beneath the landfill, the Lower Sand unit. Pursuant to the CCR Rule, Entergy obtained certification by a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of 40 CFR 257.91 of the CCR Rule (Pivotal 2017a). Also, pursuant to CFR 257.93(f)(6) of the CCR Rule, statistical analysis of the monitoring results is performed in accordance with the Statistical Analysis Plan and Entergy obtained certification by a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area (Pivotal 2017b).

The CCR Rule requires eight quarterly background groundwater monitoring events, pursuant to the CCR Rule, Entergy has performed nine background monitoring events from the fourth quarter 2015 through the second quarter 2017. The samples were analyzed for the Appendix III to Part 257 – Constituents for Detection Monitoring and the Appendix IV to Part 257 – Constituents for Assessment Monitoring parameters. The first semiannual detection monitoring event for the Appendix III constituents as per the CCR Rule was performed in September 2017 and statistical analysis of these results relative to the background results was performed pursuant to the 40 CFR 257.93(f) and the Statistical Analysis Plan. Based on the results of this statistical analysis, the concentrations of Appendix III constituents in the Lower Sand unit were within the interwell prediction limits for each constituent at each monitoring well, except as follows:

- Calcium SSI (CCR-7)

1.2 Purpose

Pursuant to 40 CFR 257.93(h), an SSI and an SSL were determined for Appendix III constituents (calcium and pH) at monitoring wells screened in the geologic unit referred to as the Lower Sand. The SSIs were reported in the Groundwater Monitoring and Corrective Action 2017 Annual Report (Entergy, January 2018) which was also placed in the Plant's operating record and posted to Entergy's CCR web page. Pursuant to 40 CFR 257.94(e)(2), Entergy may demonstrate that a source other than the CCR management unit caused the SSI and SSL or that the SSI and SSL resulted from error in sampling analysis, statistical evaluation, or natural variation in groundwater quality. As per 40 CFR 257.94(e)(2), Entergy must complete the demonstration within 90 days of determination of the SSIs.

The objective of this report is to provide written documentation of the alternate source demonstration (ASD) for the SSI and SSL determined in the first semiannual detection monitoring event, as provided for in 40 CFR 257.94(e)(2) of the CCR Rule. Also, pursuant to 40 CFR(e)(2), this *ASD* report has been certified by a qualified Louisiana professional engineer verifying the accuracy of the information provided in this report.

1.3 Site Hydrogeology

Site investigations have identified two subsurface strata relevant to the CCR monitoring program, beneath the landfill:

- **Upper Clay** unit is the confining unit for the Lower Sand unit. The Upper Clay unit is composed of silty and sandy clays ranging in consistency from stiff to very stiff with low to medium plasticities. In-situ hydraulic conductivities in the Upper Clay unit ranged from 1.5×10^{-5} centimeters per second (cm/s) to 6.9×10^{-7} cm/s, with a general trend of decreasing hydraulic conductivity with depth. The base elevations of the Upper Clay are between -10 and -22 feet (TRC 2015)
- **Lower Sand** unit consists of clays, silts, and dense sands. The sand portion is generally clean and very fine sands that tend to be thinly laminated and graded. Lenses of silt, clay, and organics occur intermittently with organics increasing toward the base as sand grains become coarser. The base of the unit is characterized by a concentration of wood fragments. The Lower Sand unit ranges in thickness from 14.5 feet to 63 feet, with bottom elevations ranging from -27 feet to -86.5 feet. Calculated in-situ hydraulic conductivities in the Lower Sand unit range from 1.3×10^{-4} cm/s to 3.2×10^{-6} cm/s. All CCR Rule groundwater monitoring wells are screened in the Lower Sand unit because it is the first continuous water bearing unit beneath the landfill. A potentiometric map, with water levels measured in September 2017, of the Lower Sand unit is shown in Figure 4.

Section 2
Alternate Source Demonstration

Collection of the first semiannual detection monitoring event was completed in September 2017. Verification sampling was performed in November and October 2017. Eight background quarterly detection monitoring events were previously collected per 40 CFR 257.93(d) and 257.94(b). Statistical analysis of the first semiannual detection monitoring data was performed pursuant to 40 CFR 257.93(f) and (g), an in accordance with the Statistical Methods Certification (Pivotal, 2017b). Based on interwell statistical analysis, the following SSI was determined:

- Calcium SSI (CCR-7)

All other Appendix III constituents were within their interwell prediction limits in all the CCR Rule groundwater monitoring system wells. After identifying the SSI, verification sampling was completed in both October and November 2017. This verification sampling confirmed the SSI and SSL.

2.1 Calcium SSI at CCR-7

The SSI of calcium at CCR-7 is a result of natural variation in the groundwater quality. It is not a result of leachate leaking from the base of the landfill and subsequent migration of CCR constituents in the groundwater. The primary lines of evidence for this demonstration are as follows:

- **Primary Lines of Evidence:**
  - **Boron Time-Trend Analysis** – Boron is another Appendix III constituent monitored in the groundwater at the landfill. Both boron and calcium are found in CCR leachate. Boron is a conservative constituent, meaning it would more readily migrate through the Upper Sand unit than calcium, if leachate leaked from the base of the landfill. If CCR leachate was the source of the calcium SSI, an increase in boron concentration at CCR-7 would be expected to precede, or coincide with the increase in calcium concentration. As shown in Figures 5 and 6, the boron and calcium concentrations have both been stable since the beginning of the background quarterly detection monitoring in November 2015. Boron did not trigger an SSI at the semiannual detection monitoring event in September 2017, and it has consistently been within the range of boron concentrations measured in the groundwater at the sites nine background monitoring wells, upgradient of the landfill. This line of evidence indicates that the source of the calcium SSI at CCR-7 is not CCR leachate leaking from the base of the landfill.
  - **Stable Calcium Concentration Trends** – The calcium concentration in CCR-7 has exhibited a stable trend since the first sample was collected in November 2015. The

nine background quarterly detection monitoring samples collected at CCR-7 have been above the interwell prediction limit. The calcium concentrations did not start below the interwell prediction limit and then increase as a result of some calcium source (see Figure 5). This is a limitation of the statistical analysis and not evidence that calcium from leachate is affecting the groundwater.

- **Natural Variation in Groundwater Quality** – Pre-CCR rule monitoring wells, compliant to LDEQ standards for monitoring the landfill have since been abandoned, but sampling data from previous groundwater reports are available. These data from wells NEAL-3, NEAL-4, and NEAL-5 (well locations and data shown in Appendix A) provide evidence of natural variation in calcium concentrations ranging from 20 mg/L to 119 mg/L.
- **Soil Sample Leaching (SPLP) Tests** – Five investigative soil borings were advanced in locations downgradient of the landfill to determine the leachable calcium present in the natural soils. This study shows relatively high concentrations (25.3 mg/kg to 1,250 mg/kg) of leachable calcium exist in the soil between 37.5 feet below ground surface (bgs) and 62.5 feet bgs. This depth range is within the lower sand aquifer, where the CCR certified monitoring well network is screened.
- **Lower Sand Unit Hydraulic Isolation** – An upper sand unit is present beneath the landfill discontinuously across the site. The upper sand unit, where present, is located above the upper clay unit. As previously described the upper clay unit is present continuously above the lower sand unit across the site. Pumping tests demonstrated that the upper clay unit has sufficiently low hydraulic conductivity to confine the lower sand unit from the upper sand unit. Measurements taken in the pumping tests showed no draw down occurring in the upper sand when the lower sand was pumped (TRC, 2015). This hydraulic isolation of the lower sand unit, which is the upper most continuous water bearing unit at the site, provides evidence that changes in groundwater constituent concentrations are likely derived from natural conditions within the aquifer unrelated to the presence of the CCR unit.
- **Major Ion Groundwater Composition** – The major ion chemistry of the groundwater at all monitoring well locations is similar. The piper plot shown in Figure 7 provides evidence that CCR-7 groundwater has the same geochemical fingerprint as the other wells in the approved CCR certified monitoring network. The increase in calcium at CCR-7 is naturally occurring and does not make the groundwater at CCR-7 unique or different from the groundwater at the other monitoring wells. The SSI triggered as a result of the calcium increase is an artifact of the statistical method chosen for the analysis.

Section 3
Conclusions

The information provided in this report serves as the alternate source demonstration prepared in accordance with 40 CFR 257.94(e)(2) of the CCR Rule and demonstrates that the SSI determined based on the first semiannual detection monitoring event performed in 2017 is not due to leakage from the base of the active landfill, but are due to the following:

- The source of the calcium SSI in groundwater at CCR-7 is natural variation in the groundwater quality. This conclusion is based on the following primary lines of evidence:
  - Boron concentrations in the groundwater at CCR-7 have been stable, and within the range of concentrations measured in the nine background monitoring wells, installed upgradient to the landfill. If the source of the calcium SSI was leachate leaking from the base of the landfill, the boron concentrations in the groundwater would be increasing as it migrated downgradient along with calcium to CCR-7.
  - Calcium concentrations in the groundwater at CCR-7 have been stable since quarterly detection monitoring began in November 2015; and
  - Prior to the CCR Rule, LDEQ monitoring wells in the area of CCR-7 were sampled on a semiannual basis, and indicated calcium concentrations in the groundwater ranging from 19 mg/L to 119 mg/L. The SSI concentration for calcium in CCR-7 is 52 mg/L, within the range of historical calcium concentration trends at the site; and
  - Soil leachate tests from samples collected at the site showed high levels of calcium in the soil (25.3 mg/kg to 1,250 mg/kg) at depths where the lower sand unit water bearing unit is present; and
  - The presence of a low hydraulic conductivity confining unit above the lower sand unit, hydraulically isolates the unit from overlying sources of water. Therefore, changes in groundwater constituent concentrations are likely derived from natural conditions within the aquifer unrelated to the presence of the CCR unit; and
  - An analysis of the major ion chemistry of the groundwater shows that groundwater at CCR-7 is not different from the groundwater at the other monitoring wells. The piper plot in Figure 7 demonstrates this point. The increase in calcium at CCR-7 is naturally occurring and the SSI is a result of the statistical analysis chosen.

Therefore, based on the information provided in this *ASD* report, Entergy will continue to conduct detection monitoring as per 40 CFR 257.94 at the certified groundwater monitoring network. Based on the information provided, Entergy is not required to implement an assessment monitoring program pursuant to the CCR Rule during the second semiannual detection monitoring event scheduled for the first quarter 2018.

Section 4
Certification

I hereby certify that the alternative source demonstration presented within this document for the Independence Plant CCR unit has been prepared to meet the requirements of Title 40 CFR §257.94(e) 2 of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.94(e) 2.

Name: _____ **Date:** 4/23/18

Company: Pivotal Engineering, LLC

Section 5
References

Pivotal Engineering, LLC and TRC Environmental Corporation. 2017a. Groundwater Monitoring System Certification: Roy S. Nelson Generating Plant. Westlake, Louisiana. October 2017.

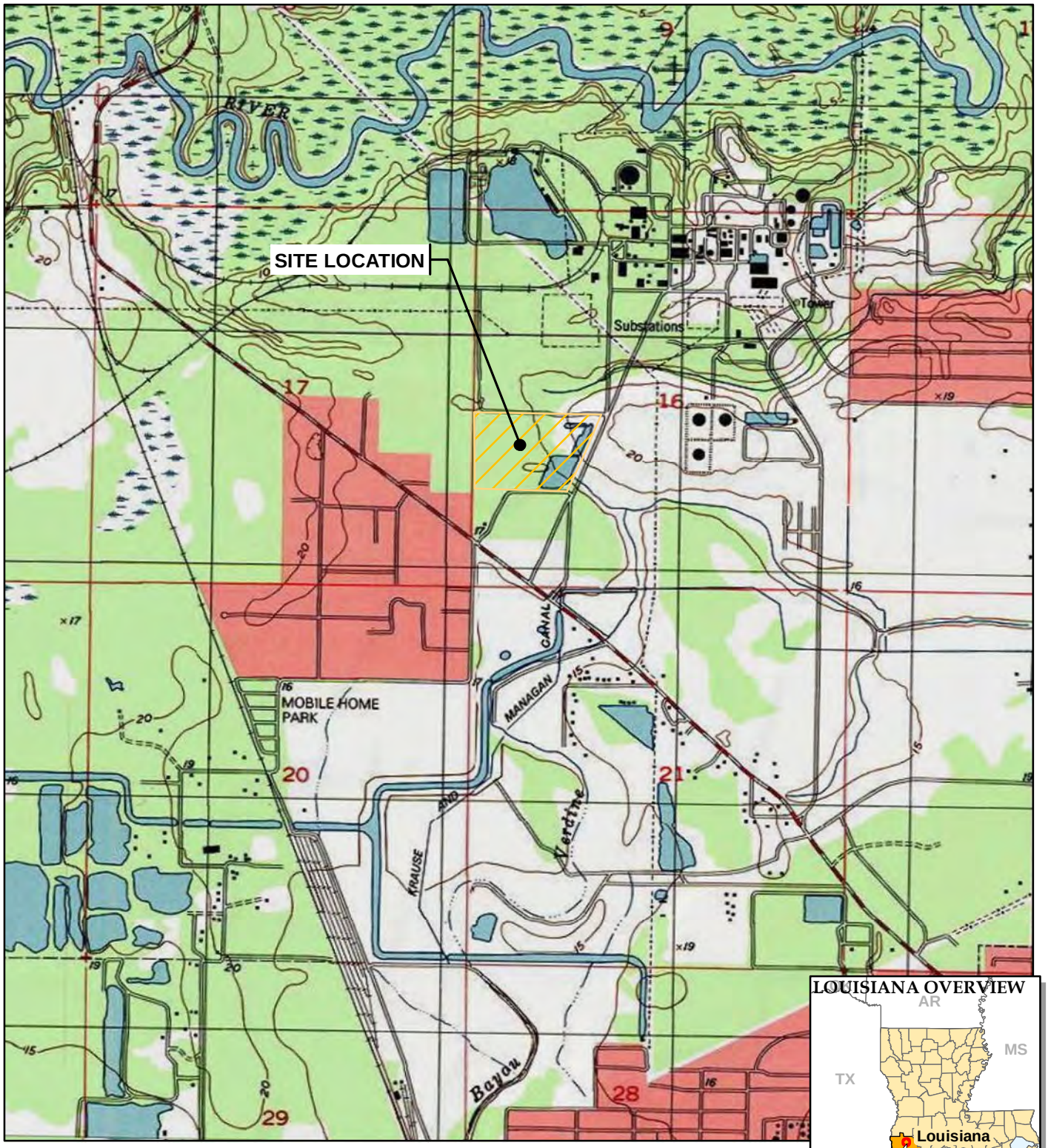
Pivotal Engineering, LLC and TRC Environmental Corporation. 2017b. Statistical Methods Certification: Roy S. Nelson Generating Plant. Westlake, Louisiana. October 2017.

TRC Environmental Corporation. 2015. Site Conceptual Model: Entergy Roy S. Nelson Coal Ash Landfill. Westlake, Calcasieu Parish, Louisiana. November 2015.

Table 1 Lower Sand Unit Groundwater Elevations (September 6, 2017)

Table 1
Lower Sand Groundwater Elevations (September 2017)

Well ID	GROUNDWATER ELEVATION (ft amal)
CCR-01	14.12
CCR-02	14.19
CCR-03	14.08
CCR-04	13.58
CCR-05	12.66
CCR-06	13.41
CCR-07	12.93
CCR-08	13.92
CCR-09	14.16
CCR-10	14.21
CCR-11	14.23
CCR-12	14.2
CCR-13	14.23
CCR-14	14.24



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,000 4,000
FEET

TRC

708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

TRC - GIS

PROJECT:

ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:

SITE LOCATION MAP

DRAWN BY:	S. MAJOR
CHECKED BY:	
APPROVED BY:	
DATE:	FEBRUARY 2018
PROJ. NO.:	253579
FILE:	253579-001slm.mxd

FIGURE 1

E:\Entergy\Louisiana\2018_253579\253579-001slm.mxd -- Saved By: SMAJOR on 2/19/2018, 14:44:11 PM

LEGEND

COAL ASH DISPOSAL LANDFILL

NOTES

1. BASE MAP IMAGERY FROM DIGIGLOBE , 2016.

0 700 1,400 Feet

1 " = 700 '

1:8,400

PROJECT:

ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:

ROY S. NELSON GENERATING PLANT FACILITY MAP

DRAWN BY:	S. MAJOR	PROJ. NO.:	253579
CHECKED BY:			
APPROVED BY:			
DATE:	FEBRUARY 2018		

FIGURE 2

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 253579-002.mxd

TRC - GIS
Coordinate System: NAD 1983 StatePlane Louisiana South FIPS 1702 Feet (Foot US)
Map Rotation: 0
Plot Date: 2/20/2018, 14:09:45 PM by SMAJOR -- LAYOUT: ANSI B (11"x17")
Path: E:\Entergy\Louisiana\2018_253579\253579-002.mxd

LEGEND

- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- COAL ASH DISPOSAL LANDFILL

NOTES

1. BASE MAP IMAGERY FROM DIGIGLOBE , 2016.

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:

ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:

MONITORING LOCATIONS
GROUNDWATER MONITORING NETWORK

DRAWN BY:	S. MAJOR	PROJ. NO.:	253579
CHECKED BY:			
APPROVED BY:			
DATE:	FEBRUARY 2018		

FIGURE 3

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 253579-003.mxd

Plot Date: 2/20/2018, 15:40:24 PM by SMAJOR -- LAYOUT: ANSI B (11"x17")
Path: E:\Entergy\Louisiana\2018_253579\253579-003.mxd

Coordinate System: NAD 1983 StatePlane Louisiana South FIPS 1702 Feet (Foot US)
Map Rotation: 0

TRC - GIS

LEGEND

- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- GROUNDWATER CONTOURS (SEPTEMBER 2017)
- COAL ASH DISPOSAL LANDFILL

NOTES

1. BASE MAP IMAGERY FROM DIGIGLOBE, 2016.
2. GROUNDWATER LEVELS MEASURED BY EAGLE ENVIRONMENTAL SERVICES IN SEPTEMBER 2017.

N

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:

ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:

LOWER SAND UNIT POTENIOMETRIC MAP (SEPTEMBER 2017)

DRAWN BY:	S. MAJOR	PROJ. NO.:	253579
CHECKED BY:			
APPROVED BY:			
DATE:	FEBRUARY 2018		

FIGURE 4

TRC

708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 253579-004.mxd

Plot Date: 2/20/2018, 15:43:55 PM by SMAJOR -- LAYOUT: ANSI B (11"x17")
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Coordinate System: NAD 1983 StatePlane Louisiana South FIPS 1702 Feet (Foot US)
Map Rotation: 0

TRC - GIS

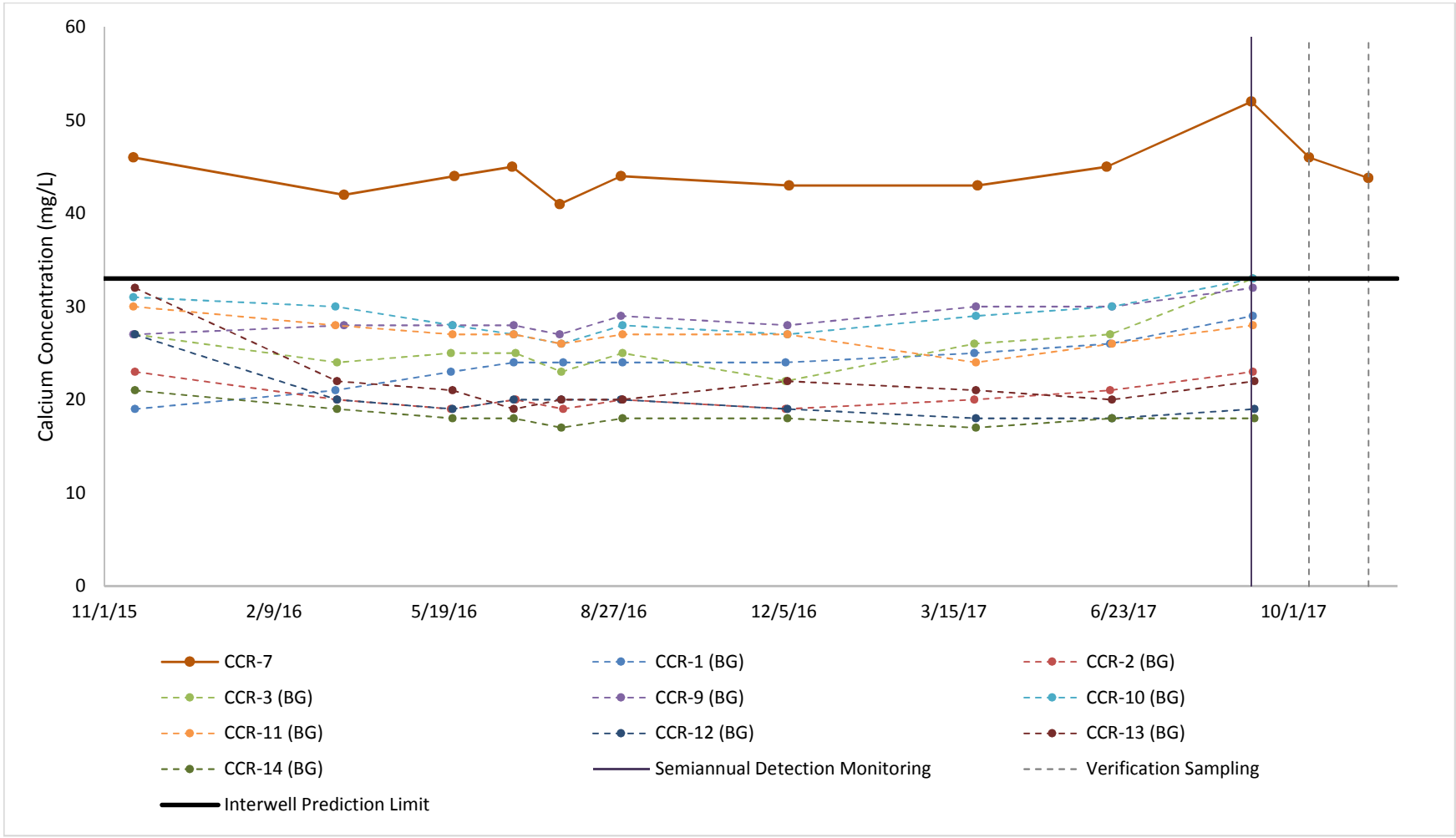


Figure 5: CCR background groundwater monitoring wells (dotted lines) and monitoring well CCR-7 (solid line) calcium concentration time trends.

Figure 5
Calcium Time-Trend Plot (CCR-7 SSI)

Prepared by: K. Barber (2/16/2018)
Checked by: L. Auner (3/20/2017)

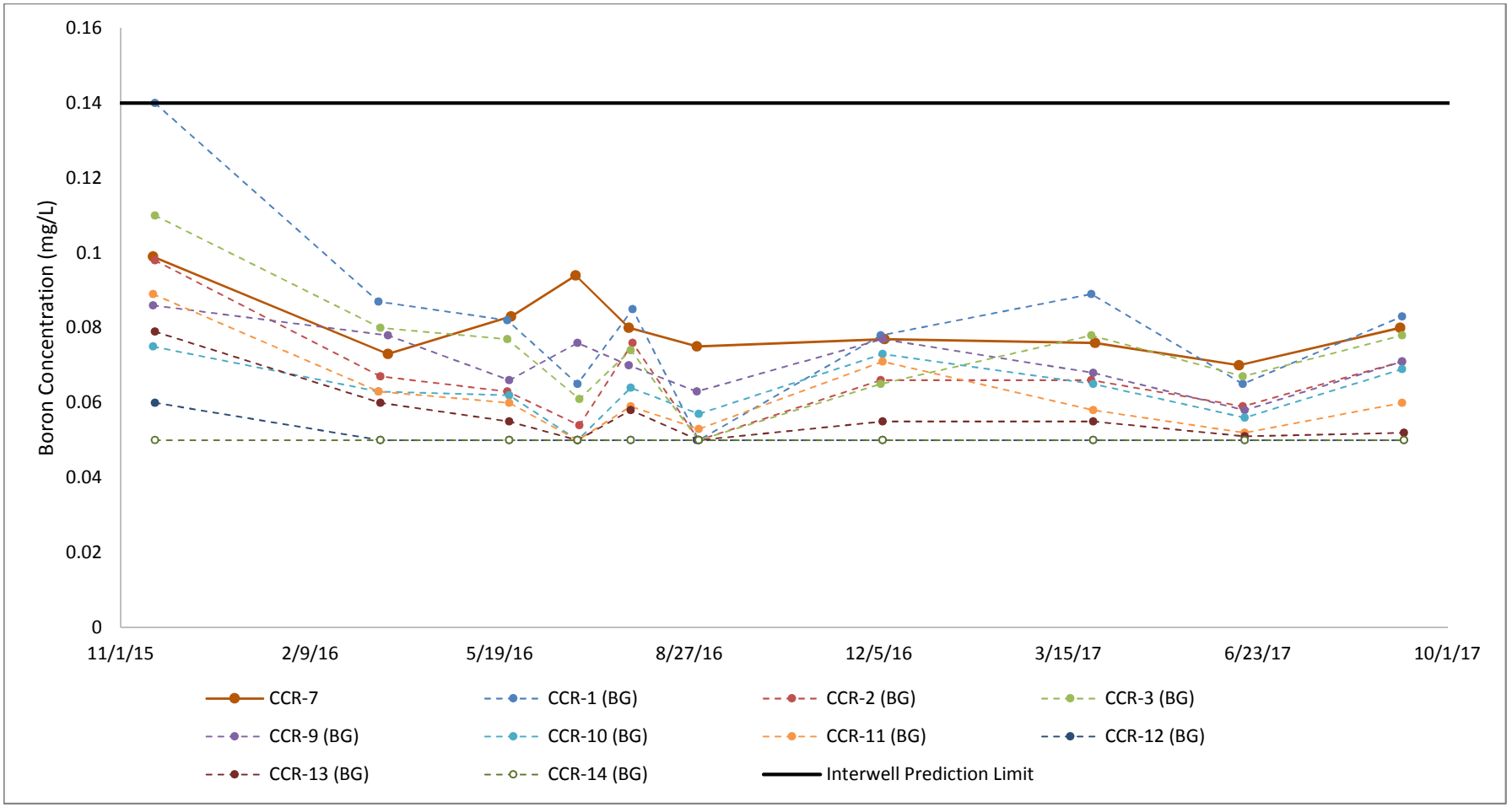


Figure 6: CCR background groundwater monitoring wells (dotted lines) and monitoring well CCR-7 (solid line) boron concentration time trends.

Figure 6
Boron Time-Trend Plot

Prepared by: K. Barber (2/16/2018)
Checked by: L. Auner (3/20/2018)

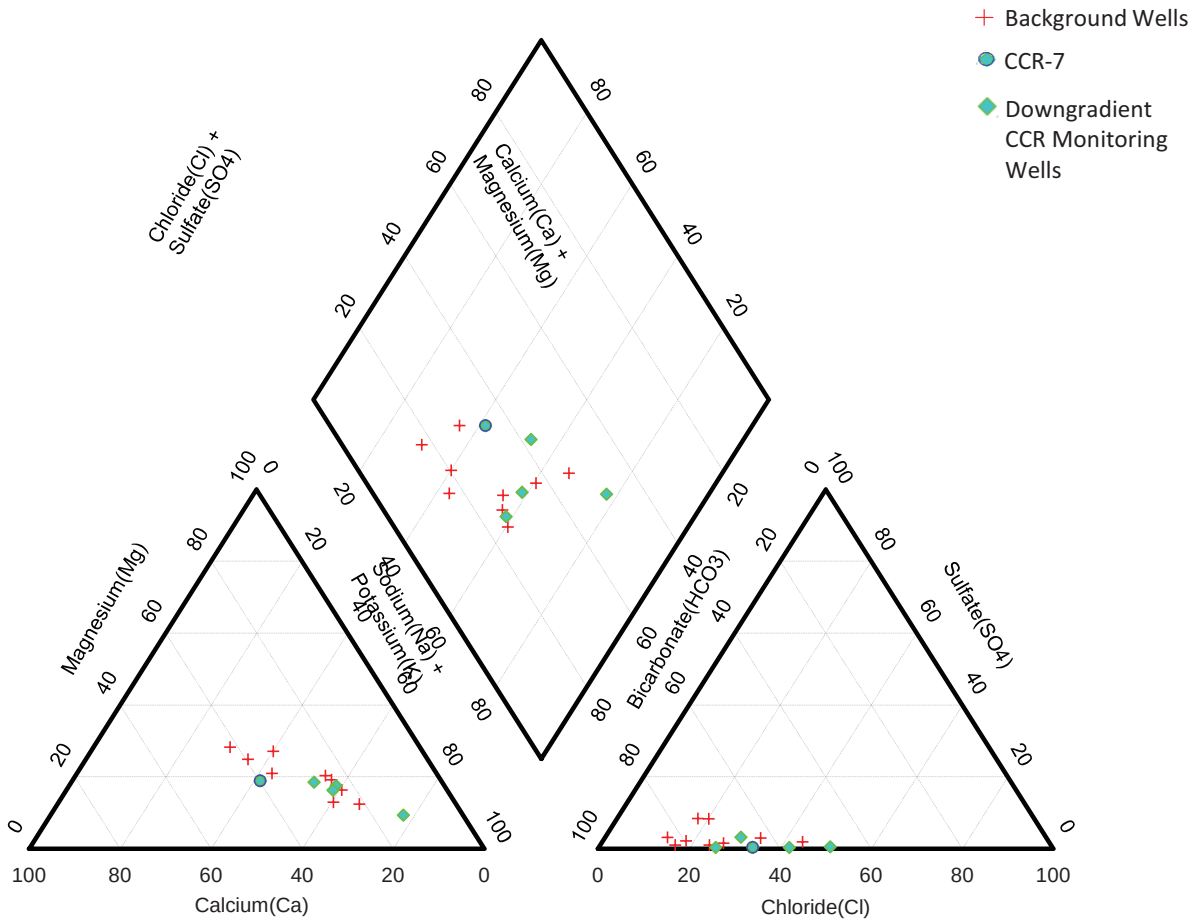


Figure 7
Piper Plot

Appendix A
LDEQ Calcium Groundwater Monitoring Data and Well Location Map

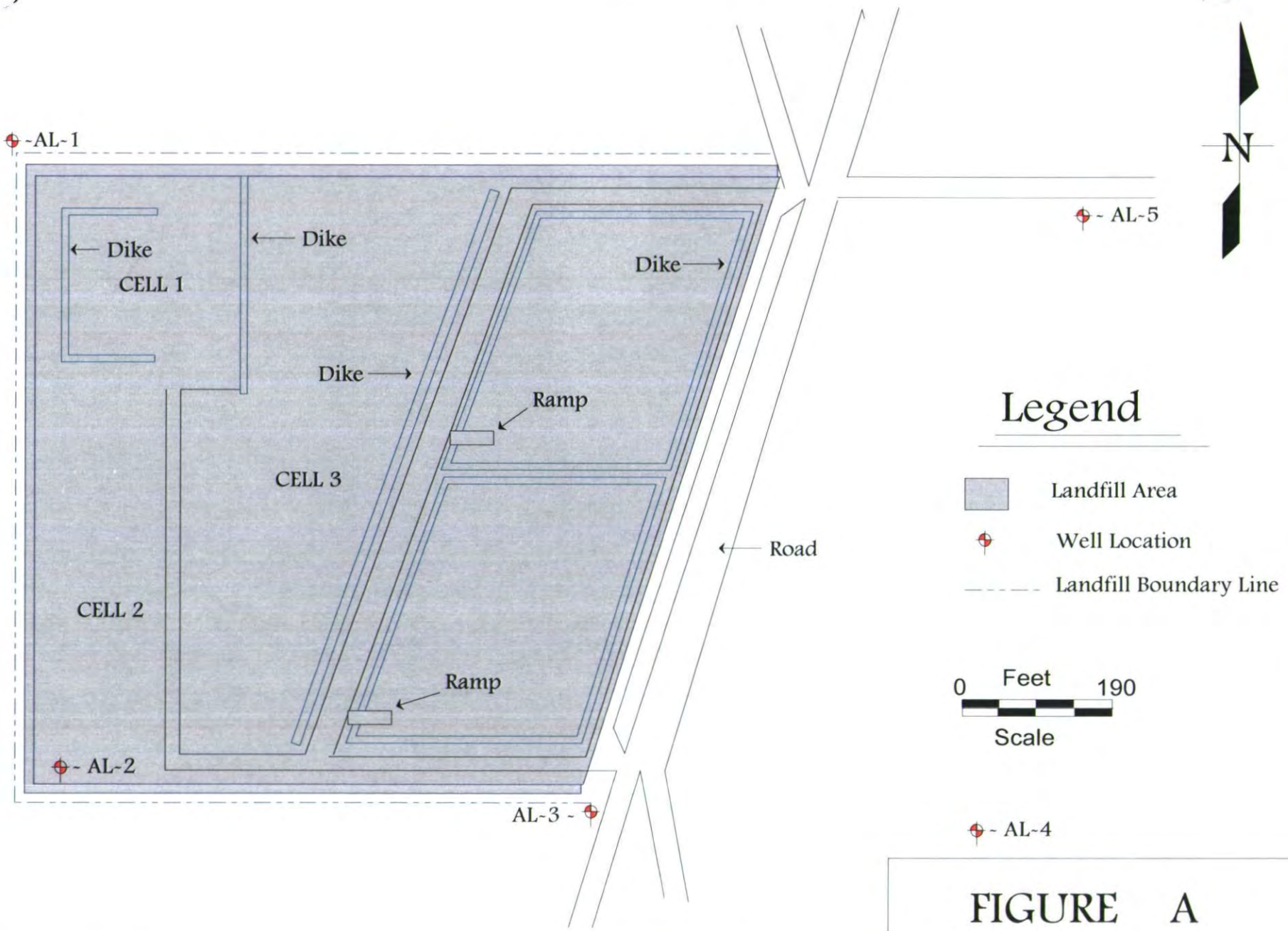
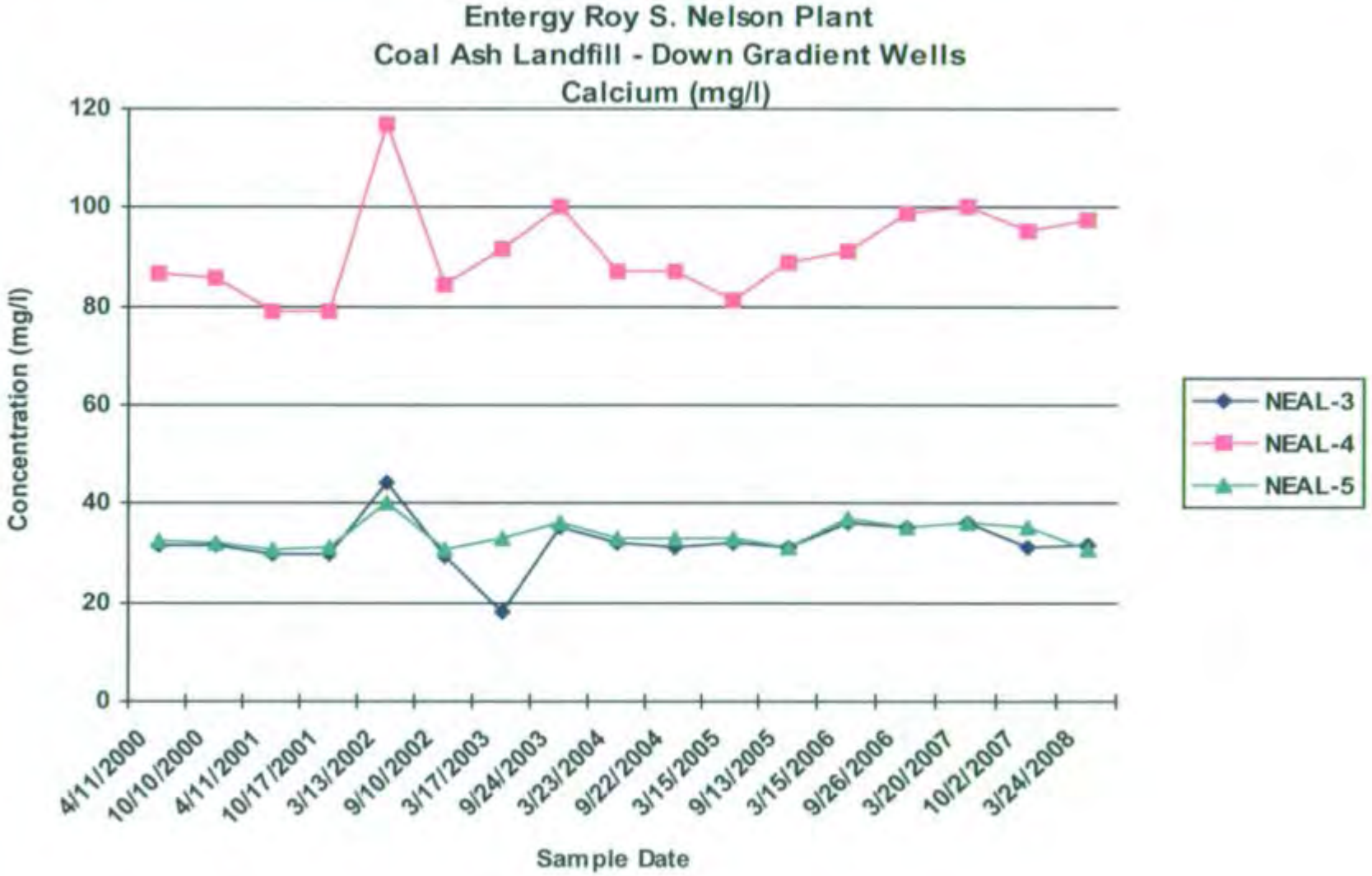


FIGURE A

09/24/2004 Date	File No.	Entergy Gulf States Louisiana, LLC	Roy S. Nelson Plant Houston River Road Westlake, Louisiana	Coal Ash Landfill Site Plan	CA-1 Figure No.
GVB Drawn By	RCL 8/2008 Chg. by				


Entergy Roy S. Nelson Plant
Coal Ash Landfill - Down Gradient Wells
Calcium (mg/l)
Concentration (mg/l)
120
100
80
60
40
20
0
4/11/2000
10/10/2000
4/11/2001
10/17/2001
3/13/2002
9/10/2002
3/17/2003
9/24/2003
3/23/2004
9/22/2004
3/15/2005
9/13/2005
3/15/2006
9/26/2006
3/20/2007
10/2/2007
3/24/2008
Sample Date
NEAL-3
NEAL-4
NEAL-5

Alternate Source Demonstration

1st Half 2018 Sampling Event

Entergy Roy S. Nelson Plant
Coal Ash Disposal Landfill
Westlake, Calcasieu Parish, Louisiana

October 2018

Alternate Source Demonstration

Entergy Roy S. Nelson Plant
Coal Ash Disposal Landfill
Westlake, Calcasieu Parish, Louisiana

October 2018

Prepared For
Entergy Louisiana, L.L.C.
Roy S. Nelson Plant
3500 Houston River Road
Westlake, Louisiana 70669

Tarek Elnaggar, P.E.
Principal

Jason S. House
Project Manager

Table of Contents

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List of Appendices

Executive Summary

Entergy Louisiana, L.L.C (Entergy) operates the Roy S. Nelson Plant (Plant), a coal fired power plant, to generate electricity. The Plant is located near Westlake, Calcasieu Parish, Louisiana, as shown in Figure 1.

Coal combustion residuals (CCR) are produced as part of the electrical generation operations which began for the Plant in 1960. Disposal of CCR has occurred since then in the on-site coal ash disposal landfill (landfill) that is approximately 31 acres in size (see Figure 2).

Entergy operates a Type I landfill under Louisiana Department of Environmental Quality (LDEQ) Solid Waste Permit No. P-0018-R1-M5. Entergy also manages CCR at the landfill as provided in the federal Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (CCR Rule), effective October 17, 2015.

Pursuant to the CCR Rule, Entergy has installed a groundwater monitoring network and has implemented groundwater monitoring at the landfill. The CCR certified groundwater monitoring network consists of 14 wells screened in the first continuous water bearing unit beneath the landfill (see Figure 3). A potentiometric map with water levels measured in April 2018 is shown in Figure 4.

Pursuant to the CCR Rule, Entergy performed nine background monitoring events between 2015 and 2017. The samples were analyzed for the Appendix III to Part 257 – Constituents for Detection Monitoring and the Appendix IV to Part 257 – Constituents for Assessment Monitoring parameters. Following background monitoring, the first semiannual detection monitoring event for the Appendix III constituents was performed in September 2017 and verification sampling was performed in October 2017, November 2017 and January 2018. Statistical analysis of these results relative to the background results was performed pursuant to 40 CFR 257.93(f) and the Statistical Analysis Plan (Pivotal 2017b). Based on the results of the statistical analysis, statistically significant increases (SSIs) were identified and evaluated in the Alternate Source Demonstration (ASD) report dated April 2018

Statistical analysis of the 1st half 2018 semiannual detection monitoring event results for the Appendix III constituents relative to the background results was performed pursuant to 40 CFR 257.93(f) and the Statistical Analysis Plan. Based on the results of the Statistical analysis, SSIs were identified as follows:

- Calcium Statistically Significant Increase (SSI) in the groundwater at CCR-7

The SSI for Calcium in CCR-7 is a result of exceedance of the interwell prediction limit.

Pursuant to 40 CFR 257.94(e)(2), Entergy may demonstrate that a source other than the CCR management unit caused the SSI or that it resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The information provided in this report serves as Entergy's alternate source demonstration (ASD) prepared in accordance with 40 CFR 257.94(e)(2) and demonstrates that the SSI determined based on the 1st half 2018 semiannual detection monitoring event is not due to leakage from the base of the landfill, but due to the following:

- The source of the calcium SSI in groundwater at CCR-7 is natural variation in the groundwater quality. This conclusion is based on the following primary lines of evidence:
  - Boron concentrations in the groundwater at CCR-7 have been stable, and within the range of concentrations measured in the nine background monitoring wells, installed upgradient to the landfill. If the source of the calcium SSI was leachate leaking from the base of the landfill, the boron concentrations in the groundwater would be increasing as it migrated downgradient along with calcium to CCR-7; and
  - Sulfate concentrations in the groundwater at CCR-7 have been stable, and within the range of concentrations measured in the nine background monitoring wells, installed upgradient to the landfill. If the source of the calcium SSI was leachate leaking from the base of the landfill, the sulfate concentrations in the groundwater would be increasing as it migrated downgradient along with calcium to CCR-7; and
  - Calcium concentrations in the groundwater at CCR-7 have been stable since quarterly detection monitoring began in November 2015; and
  - Prior to the CCR Rule, LDEQ monitoring wells in the area of CCR-7 were sampled on a semiannual basis, and indicated calcium concentrations in the groundwater ranging from 19 milligrams per liter (mg/L) to 119 mg/L. The SSI concentration for calcium in CCR-7 is 52 mg/L, within the range of historical calcium concentration trends at the site; and
  - Soil tests from samples collected at the site showed high levels of leachable calcium in the soil (25.3 mg/kg to 1,250 mg/kg) at depths where the lower sand unit water bearing unit is present; and
  - The presence of a low hydraulic conductivity confining unit above the lower sand unit, hydraulically isolates the unit from overlying sources of water. Therefore, changes in groundwater constituent concentrations are likely derived from natural conditions within the aquifer unrelated to the presence of the landfill; and
  - An analysis of the major ion chemistry of the groundwater shows that groundwater at CCR-7 is not different from the groundwater at the other monitoring wells. The piper plot in Figure 7 demonstrates this point. The increase in calcium at CCR-7 is naturally occurring and the SSI is a result of the statistical analysis chosen.

Section 1
Introduction

1.1 Background

The Entergy Louisiana, L.L.C (Entergy) Roy S. Nelson Plant operates an on-site coal ash disposal landfill (landfill) located at 3500 Houston River Road in Westlake, Louisiana (Figure 1). The facility has been generating and disposing of coal combustion residuals (CCR) since it began operations in 1960.

Entergy operates a Type I landfill under Louisiana Department of Environmental Quality (LDEQ) Solid Waste Permit No. P-0018-R1-M5. Entergy also manages CCR at the landfill as provided in the federal Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule (CCR Rule), effective October 17, 2015. Currently, four active disposal cells exist in the landfill and are regulated under the CCR rule. The areal extent of the landfill is shown in Figure 2.

The certified groundwater monitoring network at the landfill consists of 14 monitoring wells (CCR-1 through CCR-14), installed in accordance with the CCR Rule in the first continuous water bearing zone beneath the landfill, the Lower Sand unit. Pursuant to the CCR Rule, Entergy obtained certification by a qualified professional engineer stating that the groundwater monitoring system has been designed and constructed to meet the requirements of 40 CFR 257.91 of the CCR Rule (Pivotal 2017a). Also, pursuant to CFR 257.93(f)(6) of the CCR Rule, statistical analysis of the monitoring results is performed in accordance with the Statistical Analysis Plan and Entergy obtained certification by a qualified professional engineer stating that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area (Pivotal 2017b).

Pursuant to the CCR Rule, Entergy performed nine background monitoring events between 2015 and 2017. The samples were analyzed for the Appendix III to Part 257 – Constituents for Detection Monitoring and the Appendix IV to Part 257 – Constituents for Assessment Monitoring parameters. Following background monitoring, the first semiannual detection monitoring event for the Appendix III constituents was performed in September 2017 and verification sampling was performed in October 2017, November 2017 and January 2018. Statistical analysis of these results relative to the background results was performed pursuant to 40 CFR 257.93(f) and the Statistical Analysis Plan (Pivotal 2017b). Based on the results of the statistical analysis, statistically significant increases (SSIs) were identified and evaluated in the Alternate Source Demonstration (ASD) report dated April 2018

Statistical analysis of the 1st half 2018 semiannual detection monitoring event results for the Appendix III constituents relative to the background results was performed pursuant to 40 CFR

257.93(f) and the Statistical Analysis Plan. Based on the results of the Statistical analysis, SSIs were identified as follows:

- Calcium Statistically Significant Increase (SSI) in the groundwater at CCR-7

The SSI for Calcium in CCR-7 is a result of exceedance of the interwell prediction limit.

1.2 Purpose

Pursuant to 40 CFR 257.93(h), an SSI was determined for Appendix III constituent (calcium) at a monitoring well screened in the geologic unit referred to as the Lower Sand. Pursuant to 40 CFR 257.94(e)(2), Entergy may demonstrate that a source other than the CCR management unit caused the SSI or that the SSI resulted from error in sampling analysis, statistical evaluation, or natural variation in groundwater quality. As per 40 CFR 257.94(e)(2), Entergy must complete the demonstration within 90 days of determination of the SSI.

The objective of this report is to provide written documentation of the alternate source demonstration (ASD) for the SSI determined in the 1st half 2018 semiannual detection monitoring event, as provided for in 40 CFR 257.94(e)(2) of the CCR Rule. Also, pursuant to 40 CFR(e)(2), this *ASD* report has been certified by a qualified Louisiana professional engineer verifying the accuracy of the information provided in this report.

1.3 Site Hydrogeology

Site investigations have identified two subsurface strata relevant to the CCR monitoring program, beneath the landfill:

- **Upper Clay** unit is the confining unit for the Lower Sand unit. The Upper Clay unit is composed of silty and sandy clays ranging in consistency from stiff to very stiff with low to medium plasticities. In-situ hydraulic conductivities in the Upper Clay unit ranged from 1.5×10^{-5} centimeters per second (cm/s) to 6.9×10^{-7} cm/s, with a general trend of decreasing hydraulic conductivity with depth. The base elevations of the Upper Clay are between -10 and -22 feet (TRC 2015)
- **Lower Sand** unit consists of clays, silts, and dense sands. The sand portion is generally clean and very fine sands that tend to be thinly laminated and graded. Lenses of silt, clay, and organics occur intermittently with organics increasing toward the base as sand grains become coarser. The base of the unit is characterized by a concentration of wood fragments. The Lower Sand unit ranges in thickness from 14.5 feet to 63 feet, with bottom elevations ranging from -27 feet to -86.5 feet. Calculated in-situ hydraulic conductivities in the Lower Sand unit range from 1.3×10^{-4} cm/s to 3.2×10^{-6} cm/s. All CCR Rule groundwater monitoring wells are screened in the Lower Sand unit because it is the first continuous water bearing unit beneath the landfill. A potentiometric map, with water levels measured in September 2017, of the Lower Sand unit is shown in Figure 4.

Section 2
Alternate Source Demonstration

Collection of the 1st half 2018 semiannual detection monitoring event was completed in April 2018. Eight background quarterly detection monitoring events were previously collected per 40 CFR 257.93(d) and 257.94(b). Statistical analysis of the first semiannual detection monitoring data was performed pursuant to 40 CFR 257.93(f) and (g), an in accordance with the Statistical Methods Certification (Pivotal, 2017b). Based on interwell statistical analysis, the following SSI was determined:

- Calcium SSI (CCR-7)

All other Appendix III constituents were within their interwell prediction limits in all the CCR Rule groundwater monitoring system wells (Appendix C).

2.1 Calcium SSI at CCR-7

The SSI of calcium at CCR-7 is a result of natural variation in the groundwater quality. It is not a result of leachate leaking from the base of the landfill and subsequent migration of CCR constituents in the groundwater. The primary lines of evidence for this demonstration are as follows:

- **Primary Lines of Evidence:**
  - **Boron Time-Trend Analysis** – Boron is another Appendix III constituent monitored in the groundwater at the landfill. Both boron and calcium are found in CCR leachate. Boron is a conservative constituent, meaning it would more readily migrate through the Upper Clay unit than calcium, if leachate leaked from the base of the landfill. If CCR leachate was the source of the calcium SSI, an increase in boron concentration at CCR-7 would be expected to precede, or coincide with the increase in calcium concentration. As shown in Figures 5 and 6, the boron and calcium concentrations have both been stable since the beginning of the background quarterly detection monitoring in November 2015. Boron did not trigger an SSI at the semiannual detection monitoring event in April 2018, and it has consistently been within the range of boron concentrations measured in the groundwater at the sites nine background monitoring wells, upgradient of the landfill. This line of evidence indicates that the source of the calcium SSI at CCR-7 is not CCR leachate leaking from the base of the landfill.
  - **Sulfate Time-Trend Analysis** – Sulfate is another Appendix III constituent monitored in the groundwater at the landfill. Both sulfate and calcium are found in CCR leachate. Sulfate is a conservative constituent, meaning it would more readily migrate through the Upper Clay unit than calcium, if leachate leaked from the base

of the landfill. If CCR leachate was the source of the calcium SSI, an increase in sulfate concentration at CCR-7 would be expected to precede, or coincide with the increase in calcium concentration. As shown in Figures 5 and 7, the sulfate and calcium concentrations have both been stable since the beginning of the background quarterly detection monitoring in November 2015. Sulfate did not trigger an SSI at the semiannual detection monitoring event in April 2018, and it has consistently been within the range of sulfate concentrations measured in the groundwater at the sites nine background monitoring wells, upgradient of the landfill. This line of evidence indicates that the source of the calcium SSI at CCR-7 is not CCR leachate leaking from the base of the landfill.

- **Stable Calcium Concentration Trends** – The calcium concentration in CCR-7 has exhibited a stable trend since the first sample was collected in November 2015. The nine background quarterly detection monitoring samples collected at CCR-7 have been above the interwell prediction limit. The calcium concentrations did not start below the interwell prediction limit and then increase as a result of some calcium source (see Figure 5). This indicates that calcium is not affecting the groundwater.
- **Natural Variation in Groundwater Quality** – Pre-CCR rule monitoring wells, compliant to LDEQ standards for monitoring the landfill have since been abandoned, but sampling data from previous groundwater reports are available. These data from wells NEAL-3, NEAL-4, and NEAL-5 (well locations and data shown in Appendix A) provide evidence of natural variation in calcium concentrations ranging from 20 mg/L to 119 mg/L. The above noted was confirmed with calcium Non-Parametric Analysis of Variance (ANOVA) testing completed in the up-gradient background wells CCR-1 – CCR-3 and CCR-9 – CCR-14 located at the site and confirm the existence of natural variation/spatial variation. Therefore, natural variation can also occur in down gradient wells as evidenced by the detection of SSIs. Supporting documentation is attached in Appendix B
- **Soil Tests** – Five investigative soil borings were advanced in locations downgradient of the landfill to determine the leachable calcium present in the natural soils. This study shows high concentrations (25.3 mg/kg to 1,250 mg/kg) of leachable calcium exist in the soil between 37.5 feet below ground surface (bgs) and 62.5 feet bgs. This depth range is within the lower sand aquifer, where the CCR certified monitoring well network is screened.
- **Lower Sand Unit Hydraulic Isolation** – An upper sand unit is present beneath the landfill discontinuously across the site. The upper sand unit, where present, is located above the upper clay unit. As previously described the upper clay unit is present continuously above the lower sand unit across the site. Pumping tests demonstrated that the upper clay unit has sufficiently low hydraulic conductivity to confine the lower sand unit from the upper sand unit. Measurements taken in the pumping tests showed no draw down occurring in the upper sand when the lower

sand was pumped (TRC, 2015). This hydraulic isolation of the lower sand unit, which is the upper most continuous water bearing unit at the site, provides evidence that changes in groundwater constituent concentrations are likely derived from natural conditions within the aquifer unrelated to the presence of the CCR unit.

- **Major Ion Groundwater Composition** – The major ion chemistry of the groundwater at all monitoring well locations is similar. The piper plot shown in Figure 9 provides evidence that CCR-7 groundwater has the same geochemical fingerprint as the other wells in the approved CCR certified monitoring network. The increase in calcium at CCR-7 is naturally occurring and does not make the groundwater at CCR-7 unique or different from the groundwater at the other monitoring wells. The SSI triggered as a result of the calcium increase is an artifact of the statistical method chosen for the analysis.

Section 3
Conclusions

The information provided in this report serves as the alternate source demonstration prepared in accordance with 40 CFR 257.94(e)(2) of the CCR Rule and demonstrates that the SSI determined based on the 1st half 2018 semiannual detection monitoring event performed in April 2018 is not due to leakage from the base of the active landfill, but are due to the following:

- The source of the calcium SSI in groundwater at CCR-7 is natural variation in the groundwater quality. This conclusion is based on the following primary lines of evidence:
  - Boron concentrations in the groundwater at CCR-7 have been stable, and within the range of concentrations measured in the nine background monitoring wells, installed upgradient to the landfill. If the source of the calcium SSI was leachate leaking from the base of the landfill, the boron concentrations in the groundwater would be increasing as it migrated downgradient along with calcium to CCR-7.
  - Sulfate concentrations in the groundwater at CCR-7 have been stable, and within the range of concentrations measured in the nine background monitoring wells, installed upgradient to the landfill. If the source of the calcium SSI was leachate leaking from the base of the landfill, the Sulfate concentrations in the groundwater would be increasing as it migrated downgradient along with calcium to CCR-7.
  - Calcium concentrations in the groundwater at CCR-7 have been stable since quarterly detection monitoring began in November 2015.
  - Prior to the CCR Rule, LDEQ monitoring wells in the area of CCR-7 were sampled on a semiannual basis, and indicated calcium concentrations in the groundwater ranging from 19 mg/L to 119 mg/L. The SSI concentration for calcium in CCR-7 is 52 mg/L, within the range of historical calcium concentration trends at the site Non-Parametric ANOVA testing completed in the up-gradient back ground wells CCR-1 – CCR-3 and CCR-9 – CCR-14 located at the site and confirm the existence of natural variation/spatial variation. Therefore, natural variation can also occur in down gradient wells as evidenced by the detection of SSIs. ; and
  - Soil tests from samples collected at the site showed high levels of calcium in the soil (25.3 mg/kg to 1,250 mg/kg) at depths where the lower sand unit water bearing unit is present; and
  - The presence of a low hydraulic conductivity confining unit above the lower sand unit, hydraulically isolates the unit from overlying sources of water. Therefore, changes in groundwater constituent concentrations are likely derived from natural conditions within the aquifer unrelated to the presence of the CCR unit; and

- An analysis of the major ion chemistry of the groundwater shows that groundwater at CCR-7 is not different from the groundwater at the other monitoring wells. The piper plot in Figure 7 demonstrates this point. The calcium concentrations observed at CCR-7 are naturally occurring and the SSI is a result of the statistical analysis chosen.

Therefore, based on the information provided in this *ASD* report, Entergy will continue to conduct detection monitoring as per 40 CFR 257.94 at the certified groundwater monitoring network. Based on the information provided, Entergy is not required to implement an assessment monitoring program pursuant to the CCR Rule during the second half 2018 semiannual detection monitoring event scheduled for September 2018.

Section 4
Certification

I hereby certify that the alternate source demonstration presented within this document for the Roy S. Nelson Plant CCR unit has been prepared to meet the requirements of Title 40 CFR §257.94(e) 2 of the Federal CCR Rule. This document is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of Title 40 CFR §257.94(e) 2.

Name: _____ **Expiration Date:** 11/20/19

Company: Pivotal Engineering, LLC. **Date:** 11/20/18

Section 5
References

Pivotal Engineering, LLC and TRC Environmental Corporation. 2017a. Groundwater Monitoring System Certification: Roy S. Nelson Generating Plant. Westlake, Louisiana. October 2017.

Pivotal Engineering, LLC and TRC Environmental Corporation. 2017b. Statistical Methods Certification: Roy S. Nelson Generating Plant. Westlake, Louisiana. October 2017.

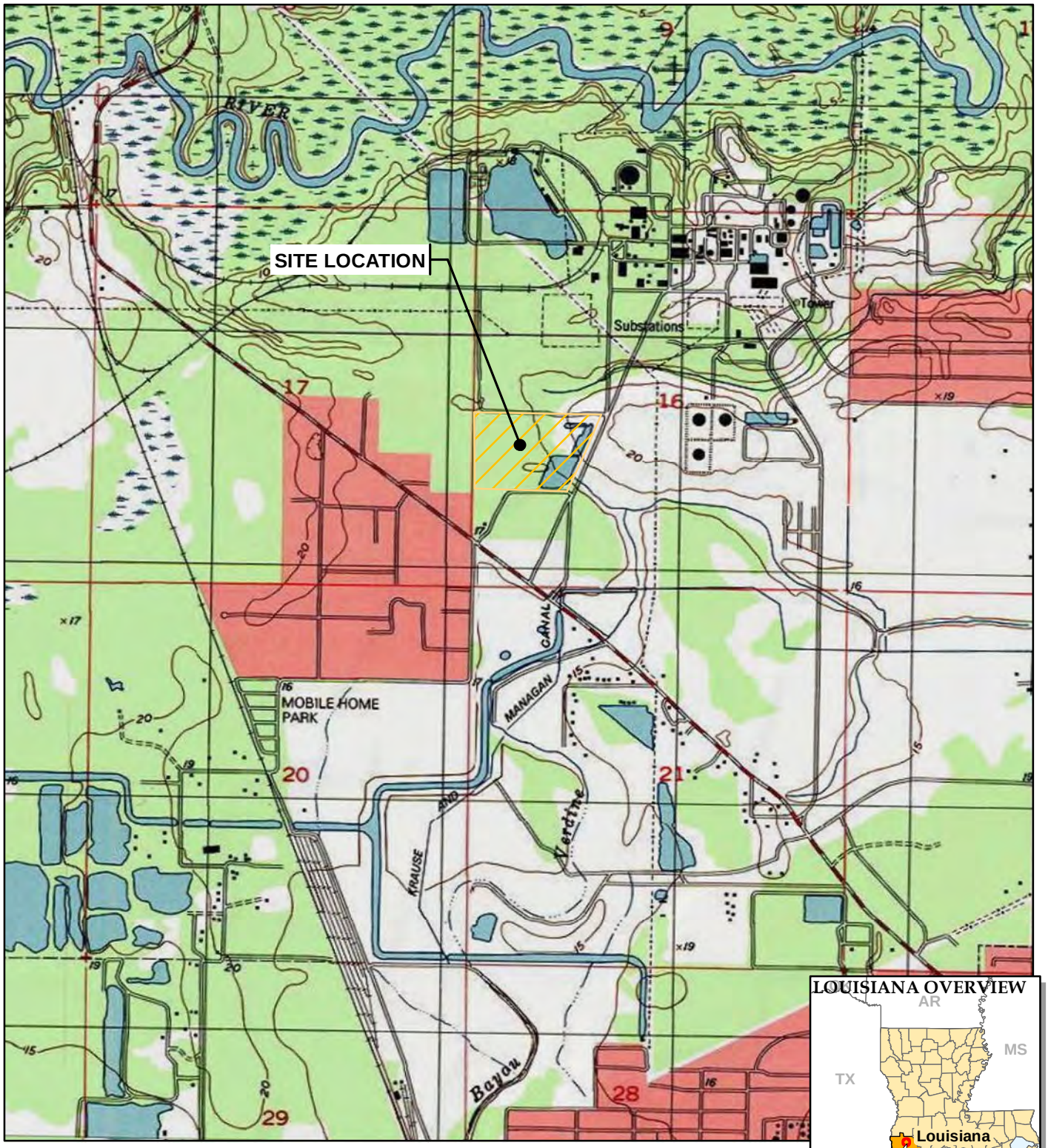
TRC Environmental Corporation. 2015. Site Conceptual Model: Entergy Roy S. Nelson Coal Ash Landfill. Westlake, Calcasieu Parish, Louisiana. November 2015.

Table 1 Lower Sand Unit Groundwater Elevations (April 2, 2018)

Table 1
Lower Sand Unit Groundwater Elevations (April 2018)

WELL ID	GROUNDWATER ELEVATION (ft amsl)
CCR-01	13.41
CCR-02	13.46
CCR-03	13.4
CCR-04	12.32
CCR-05	11.26
CCR-06	12.04
CCR-07	11.3
CCR-08	12.8
CCR-09	13.61
CCR-10	13.71
CCR-11	13.81
CCR-12	13.64
CCR-13	13.68
CCR-14	13.68

Prepared by: J.House (10/09/2018)
Checked by:



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,000 4,000
FEET

TRC

708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

TRC - GIS

PROJECT:

ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:

SITE LOCATION MAP

DRAWN BY:	S. MAJOR
CHECKED BY:	J. HOUSE
APPROVED BY:	
DATE:	OCTOBER 2018
PROJ. NO.:	253579
FILE:	253579-001slm.mxd

FIGURE 1

E:\Entergy\Louisiana\2018_253579\253579-001slm.mxd -- Saved By: SMAJOR on 10/16/2018, 11:54:36 AM

LEGEND

COAL ASH DISPOSAL LANDFILL

NOTES

1. BASE MAP IMAGERY FROM DIGIGLOBE , 2016.

0 700 1,400
Feet

1 " = 700 '
1:8,400

PROJECT:
ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:
ROY S. NELSON GENERATING PLANT FACILITY MAP

DRAWN BY:	S. MAJOR	PROJ. NO.:	253579
CHECKED BY:	J. HOUSE		
APPROVED BY:			
DATE:	OCTOBER 2018		

FIGURE 2

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 253579-002.mxd

Plot Date: 10/16/2018, 12:00:15 PM by SMAJOR -- LAYOUT: ANSI B (11"X17")
Path: E:\Entergy\Louisiana\2018_253579\253579-002.mxd
Coordinate System: NAD 1983 StatePlane Louisiana South FIPS 1702 Feet (Foot US)
Map Rotation: 0

TRC - GIS

LEGEND

- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- COAL ASH DISPOSAL LANDFILL

NOTES

1. BASE MAP IMAGERY FROM DIGIGLOBE, 2016.

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:

ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:

MONITORING WELL LOCATIONS FOR CCR GROUNDWATER MONITORING NETWORK

DRAWN BY:	S. MAJOR	PROJ. NO.:	253579
CHECKED BY:	J. HOUSE		
APPROVED BY:			
DATE:	OCTOBER 2018		

FIGURE 3

TRC
708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 253579-003.mxd

Plot Date: 10/16/2018, 12:03:25 PM by SMAJOR -- LAYOUT: ANSI B (11"x17")
Path: E:\Entergy\Louisiana\2018_253579\253579-003.mxd

Coordinate System: NAD 1983 StatePlane Louisiana South FIPS 1702 Feet (Foot US)
Map Rotation: 0

TRC - GIS

LEGEND

- CCR MONITORING WELL
- CCR BACKGROUND MONITORING WELL
- GROUNDWATER CONTOURS (APRIL 2018)
- COAL ASH DISPOSAL LANDFILL
- *(11.25)* GROUNDWATER ELEVATION (FT AMSL)

NOTES

1. BASE MAP IMAGERY FROM DIGIGLOBE, 2016.
2. GROUNDWATER LEVELS MEASURED BY PIVOTAL ENGINEERING IN APRIL 2018.

N

0 200 400 Feet

1 " = 200 '

1:2,400

PROJECT:

ENTERGY ROY S. NELSON PLANT
3500 HOUSTON RIVER RD
WESTLAKE, LA

TITLE:

LOWER SAND UNIT POTENTIOMETRIC MAP (APRIL 2018)

DRAWN BY:	S. MAJOR	PROJ. NO.:	253579
CHECKED BY:	J. HOUSE		
APPROVED BY:			
DATE:	OCTOBER 2018		

FIGURE 4

TRC

708 Heartland Trail
Suite 3000
Madison, WI 53717
Phone: 608.826.3600

FILE NO.: 253579-006.mxd

TRC - GIS

Coordinate System: NAD 1983 StatePlane Louisiana South FIPS 1702 Feet (Foot US)
Map Rotation: 0

Plot Date: 10/16/2018, 13:25:10 PM by SMAJOR -- LAYOUT: ANSI B(11"x17")
Path: E:\Entergy\Louisiana\2018_253579\253579-006.mxd

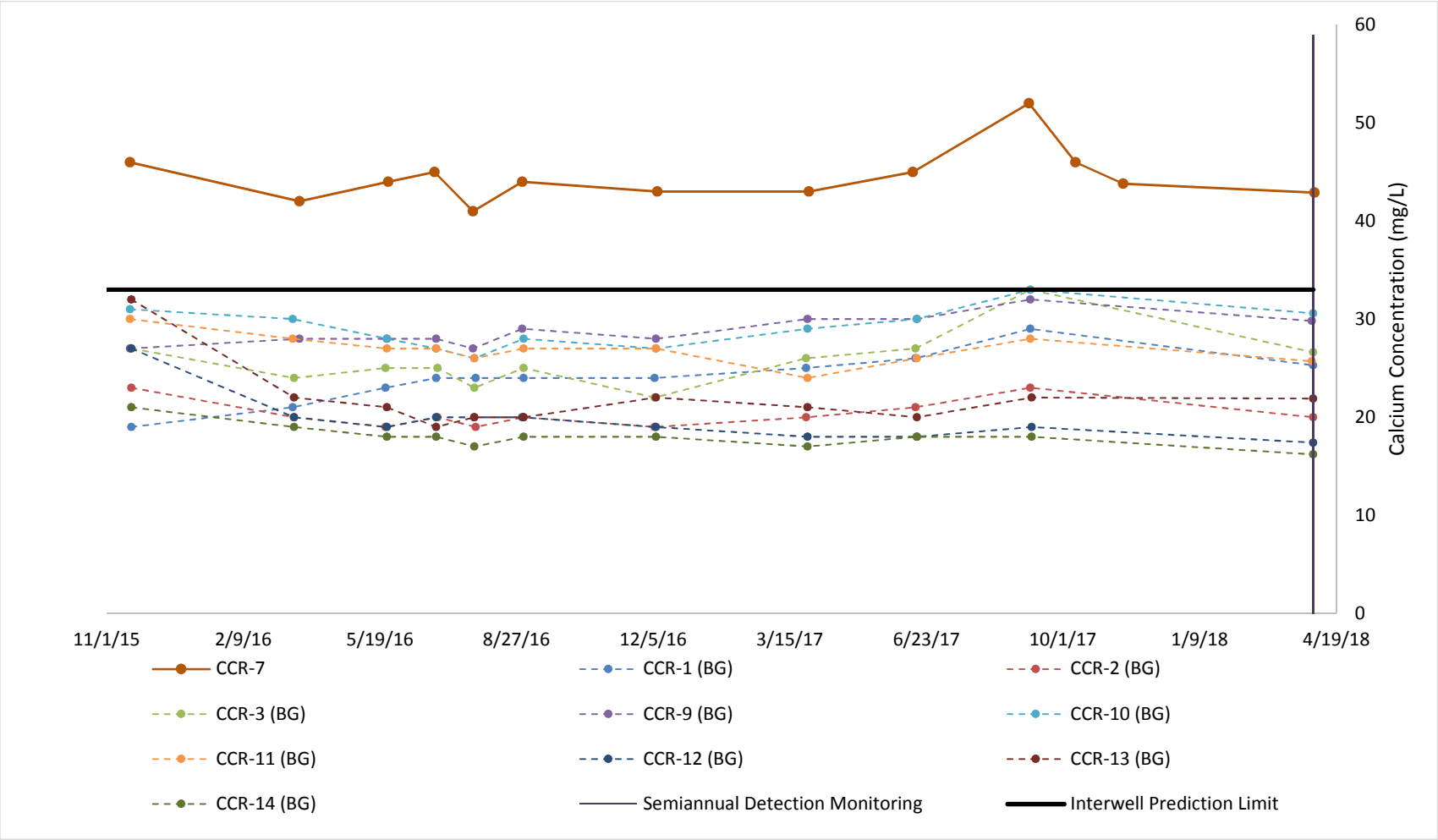


Figure 5: CCR background groundwater monitoring wells (dotted lines) and monitoring well CCR-7 (solid line) calcium concentration time trends.

Figure 5
Calcium Time-Trend Plot (CCR-7 SSI)

Prepared by: J. House (10/09/2018)
Checked by:

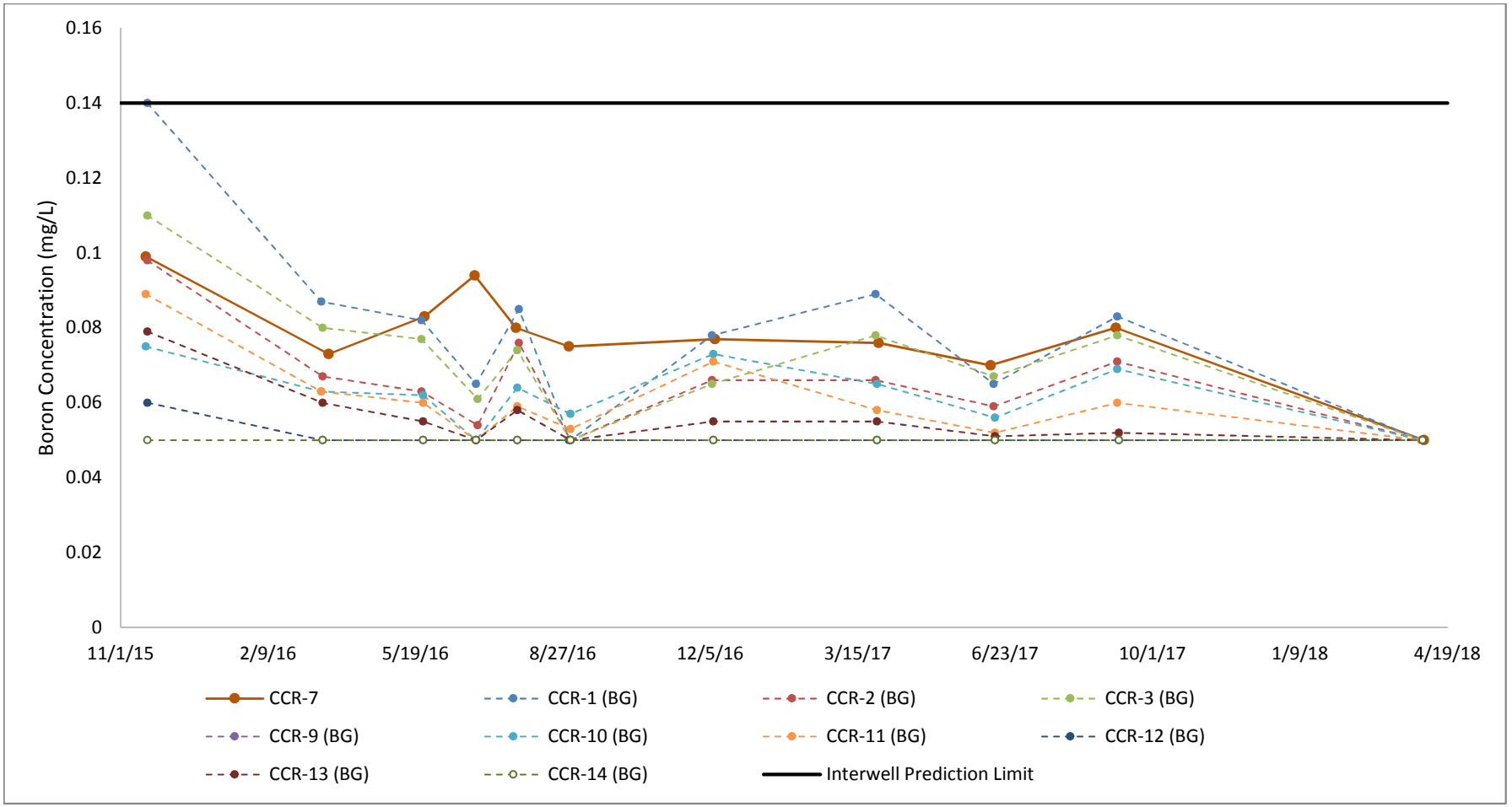


Figure 6: CCR background groundwater monitoring wells (dotted lines) and monitoring well CCR-7 (solid line) boron concentration time trends.

Figure 6
Boron Time-Trend Plot

Prepared by: J. House (10/09/2018)
Checked by:

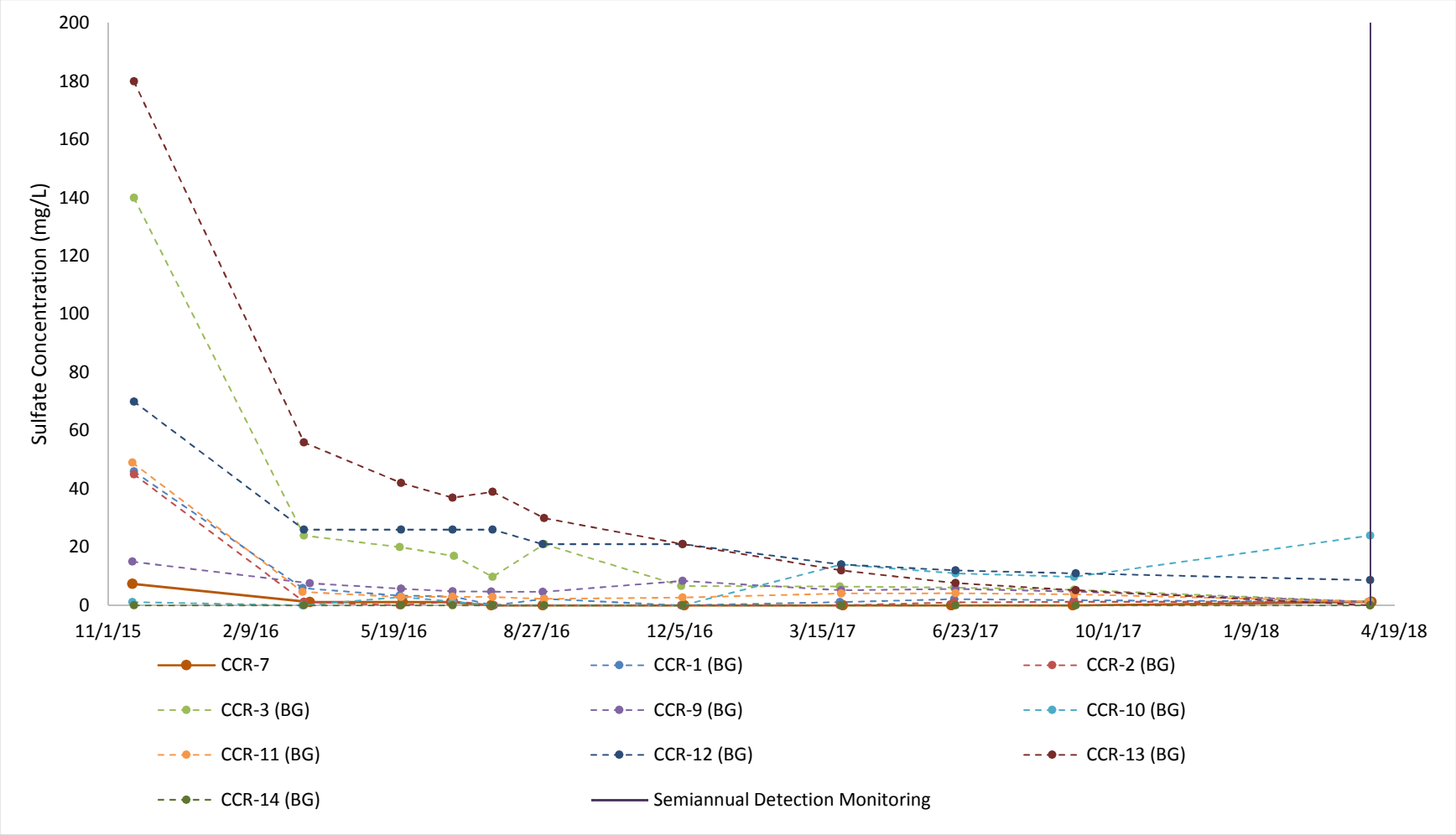
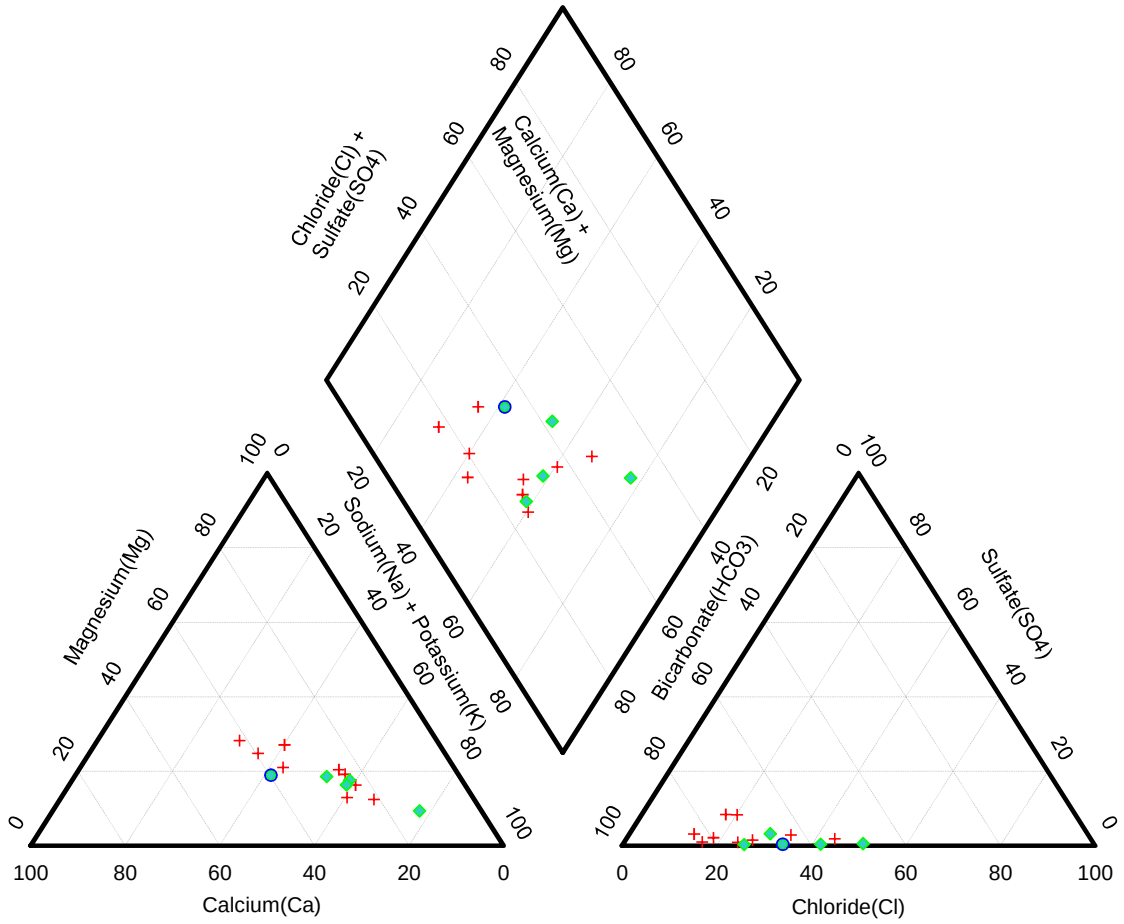


Figure 7: CCR background groundwater monitoring wells (dotted lines) and monitoring well CCR-7 (solid line) sulfate concentration time trends.

Figure 7
Sulfate Time-Trend Plot (CCR-7 SSI)

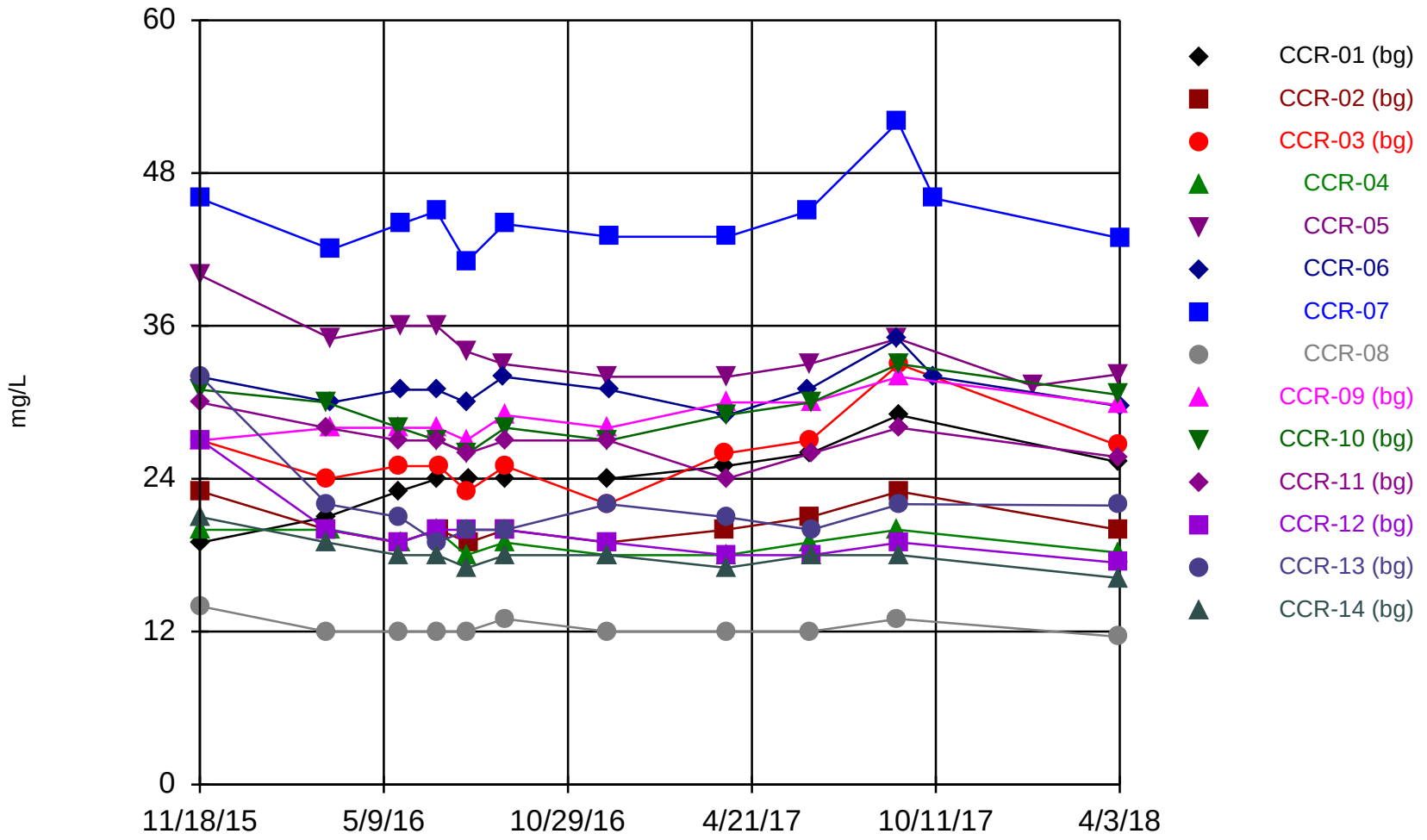
Prepared by: J. House (10/09/2018)
Checked by:

Figure 8


Chloride(Cl) + Sulfate(SO4)
Calcium(Ca) + Magnesium(Mg)
Sodium(Na) + Potassium(K)
Bicarbonate(HCO3)
Magnesium(Mg)
Calcium(Ca)
Chloride(Cl)
Sulfate(SO4)

Appendix A
LDEQ Calcium Groundwater Monitoring Data

Time Series



Constituent: Calcium Analysis Run 11/15/2018 15:48

Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

Appendix B
Non-Parametric ANOVA Results

Non-Parametric ANOVA

Constituent: Calcium Analysis Run 11/15/2018 15:50

Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

For observations made between 11/18/2015 and 4/2/2018, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 75.97

Tabulated Chi-Squared value = 15.507 with 8 degrees of freedom at the 5% significance level.

There were 16 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 75.54
Adjusted Kruskal-Wallis statistic (H') = 75.97

Appendix C
Interwell Prediction Limit Results

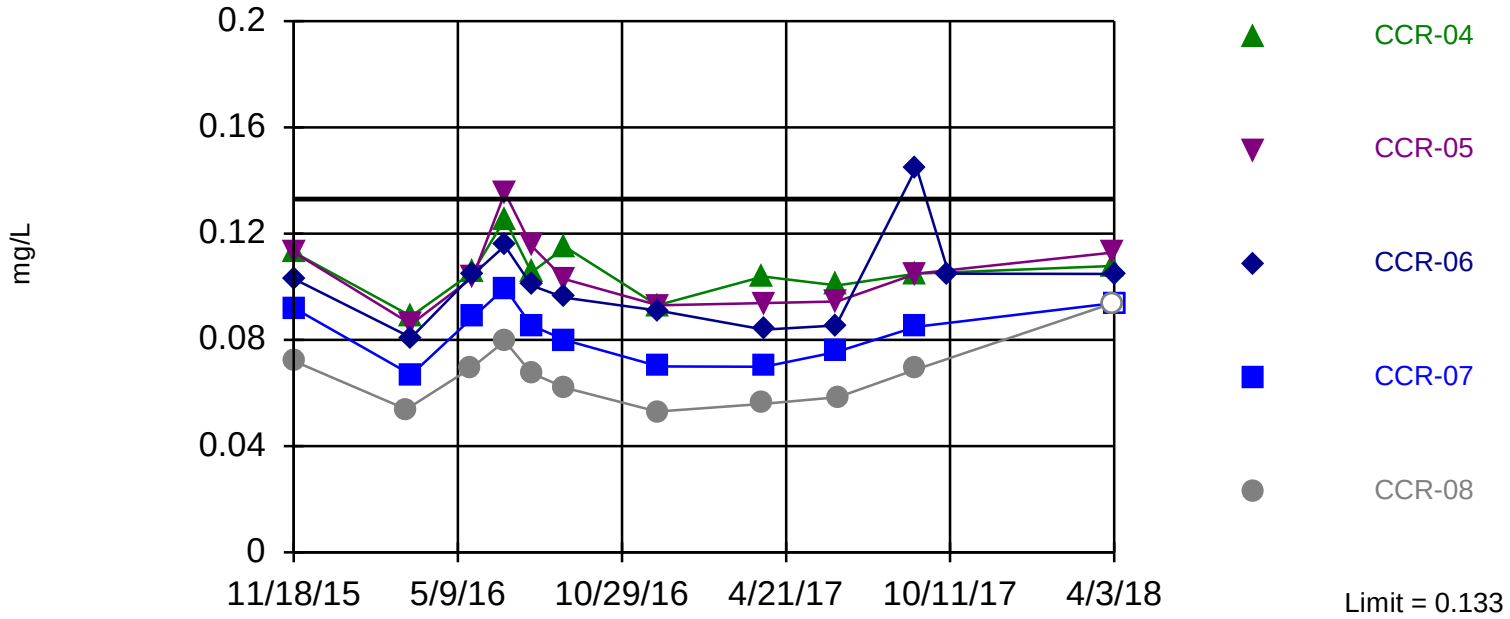
Parameter	2017 Interwell Limit		2017 SSI	4/18 Interwell Limit		4/18 SSI
Boron (mg/l)	Non-parametric	0.14		Non-parametric	0.133	
Calcium (mg/l)	Non-parametric	33	CCR-7: 46	Non-parametric	33	CCR-7: 42.9
Chloride (mg/l)	Non-parametric	110		Non-parametric	115	
Fluoride (mg/l)	Non-parametric	0.93		Non-parametric	0.93	
pH - Low (S.U.)	Parametric	6.47		Parametric	6.44	
pH - High (S.U.)	Parametric	7.7		Parametric	7.68	
Sulfate (mg/l)	Non-parametric	42		Non-parametric	42	
TDS (mg/l)	Parametric	453.6		Parametric	458.6	

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 99 background values. 35.35% NDs. Annual per-constituent alpha = 0.001976. Individual comparison alpha = 0.0001978 (1 of 2). Comparing 5 points to limit. Data were deseasonalized.

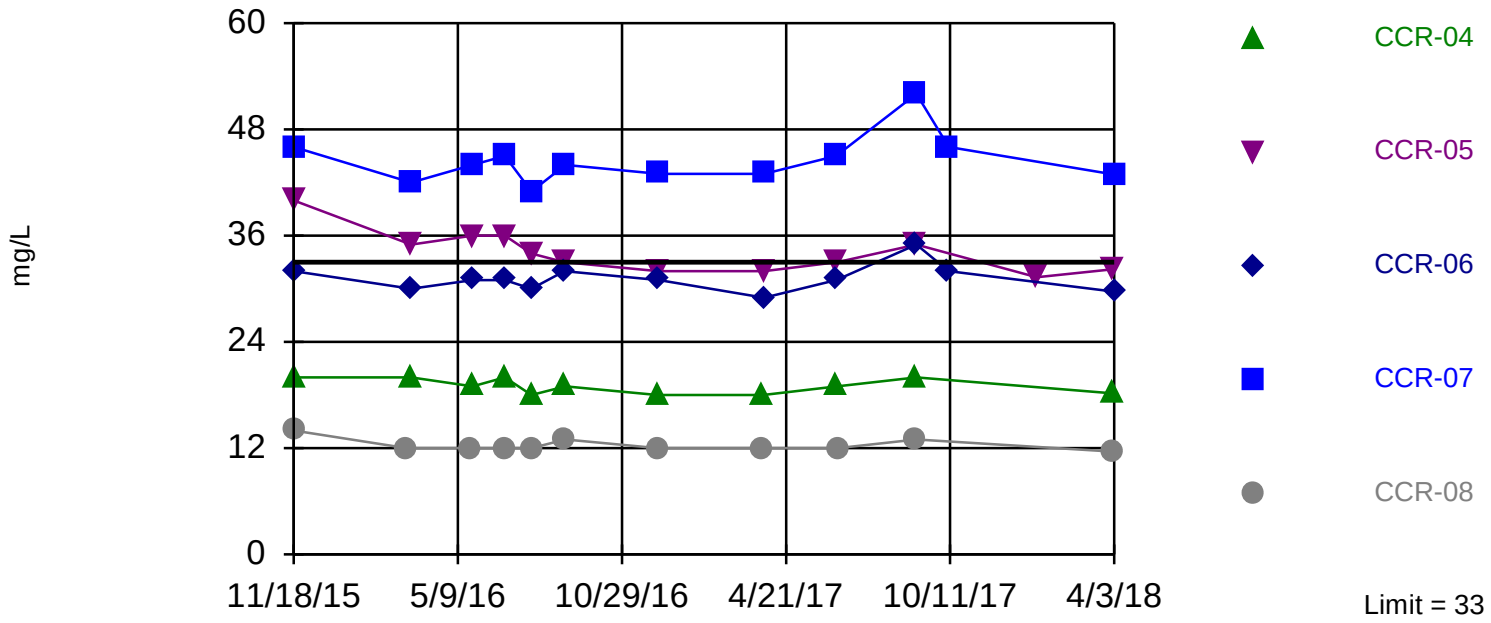
Constituent: Boron Analysis Run 5/31/2018 8:53 AM

Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

Exceeds Limit: CCR-07

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 99 background values. Annual per-constituent alpha = 0.001976. Individual comparison alpha = 0.0001978 (1 of 2). Comparing 5 points to limit. Seasonality was not detected with 95% confidence.

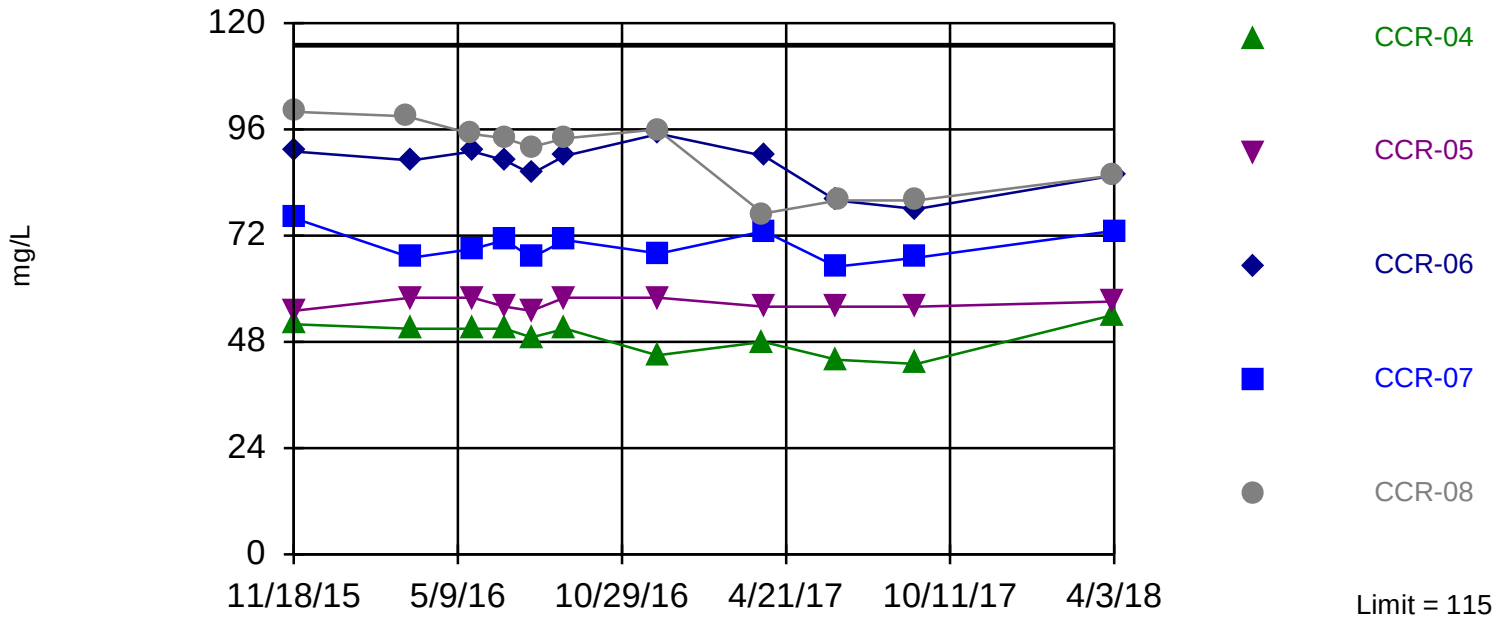
Constituent: Calcium Analysis Run 5/31/2018 8:53 AM

Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 99 background values. Annual per-constituent alpha = 0.001976. Individual comparison alpha = 0.0001978 (1 of 2). Comparing 5 points to limit. Seasonality was not detected with 95% confidence.

Constituent: Chloride Analysis Run 5/31/2018 8:53 AM

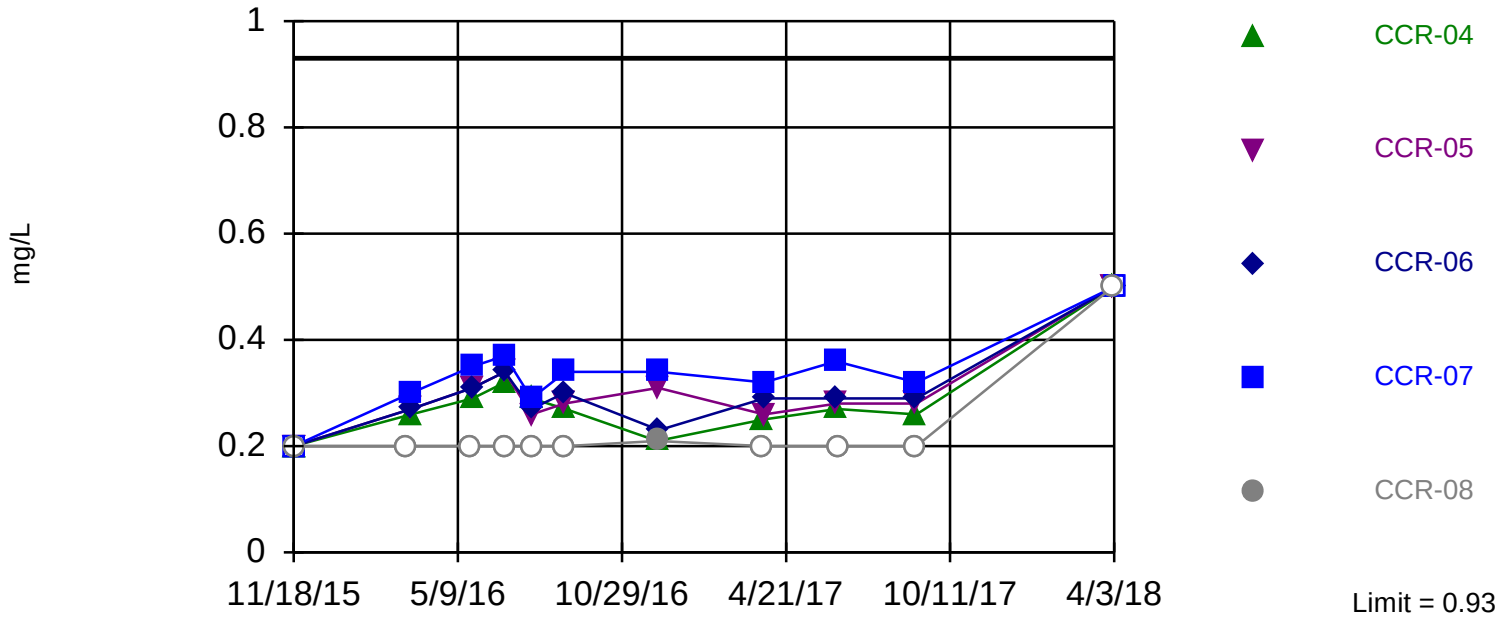
Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 99 background values. 22.22% NDs. Annual per-constituent alpha = 0.001976. Individual comparison alpha = 0.0001978 (1 of 2). Comparing 5 points to limit. Seasonality was not detected with 95% confidence.

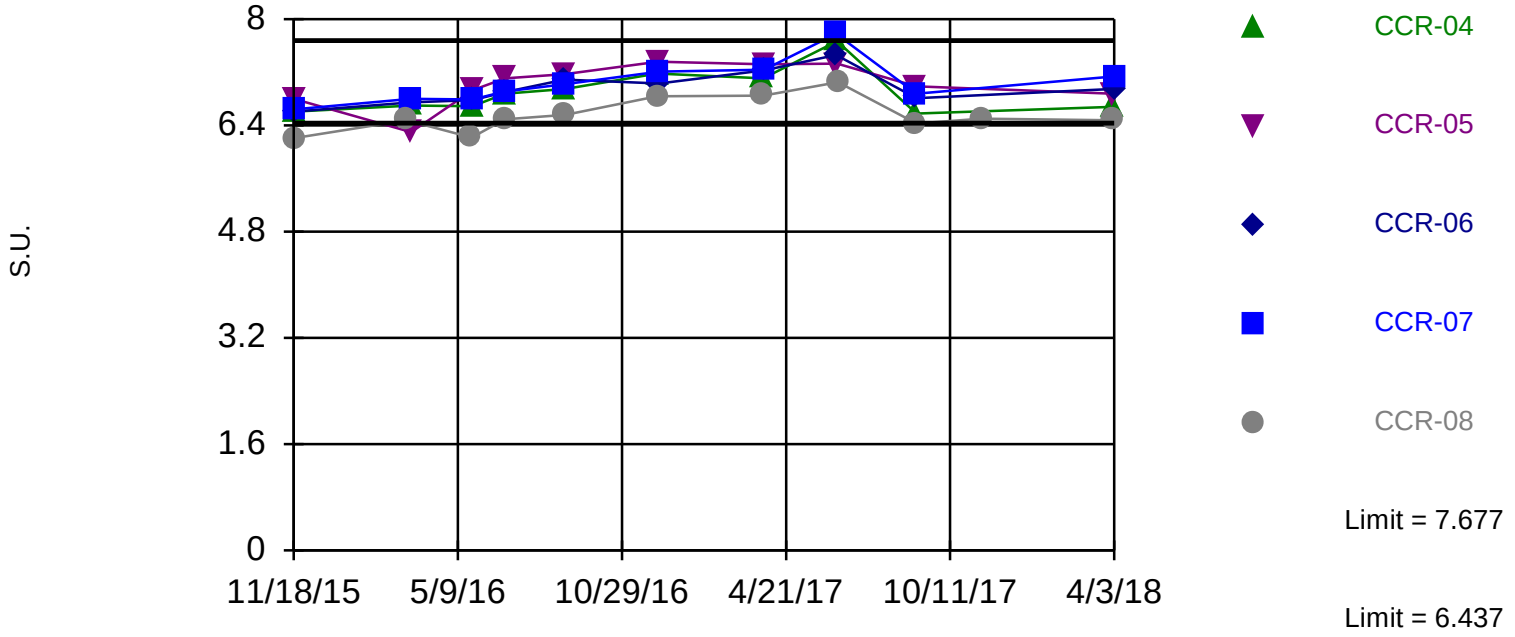
Constituent: Fluoride Analysis Run 5/31/2018 8:53 AM

Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

Within Limits

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=7.057, Std. Dev.=0.3429, n=90. Seasonality was not detected with 95% confidence. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9867, critical = 0.961. Kappa = 1.808 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.000752. Comparing 5 points to limit.

Constituent: pH Analysis Run 5/31/2018 8:53 AM

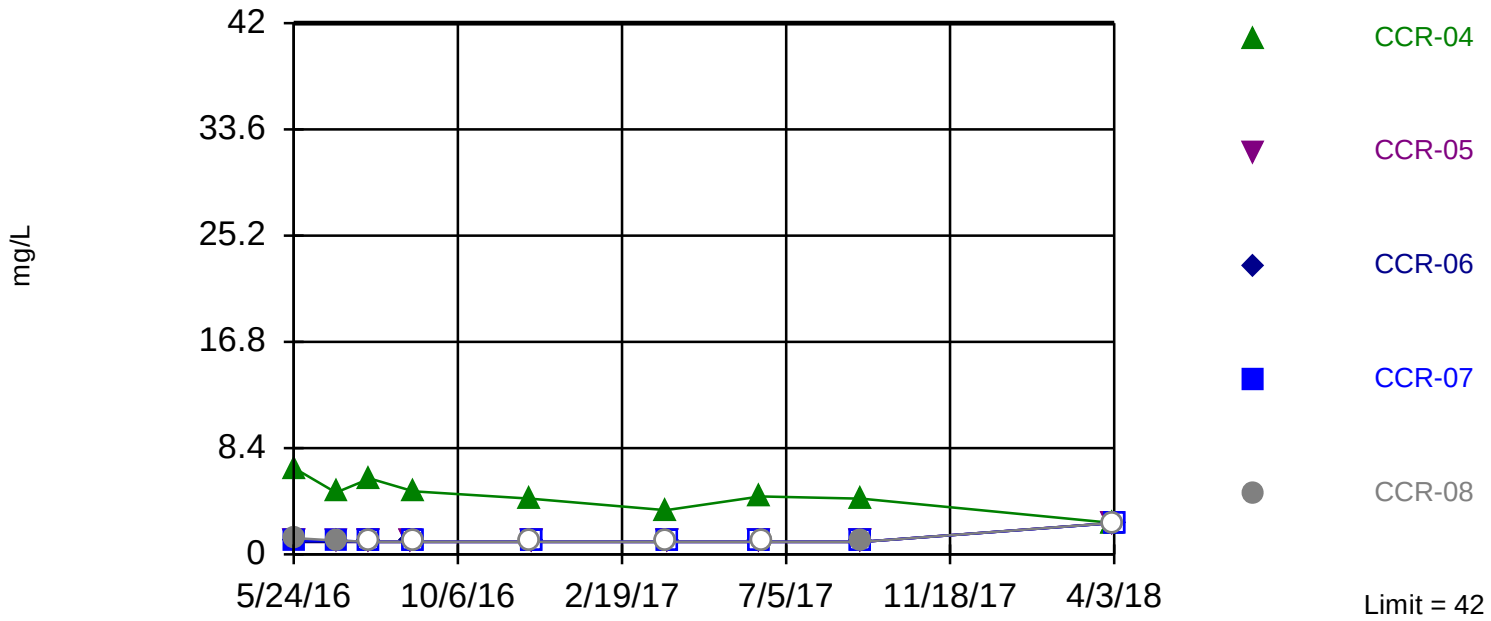
Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 81 background values. 30.86% NDs. Annual per-constituent alpha = 0.002927. Individual comparison alpha = 0.000293 (1 of 2). Comparing 5 points to limit. Seasonality was not detected with 95% confidence.

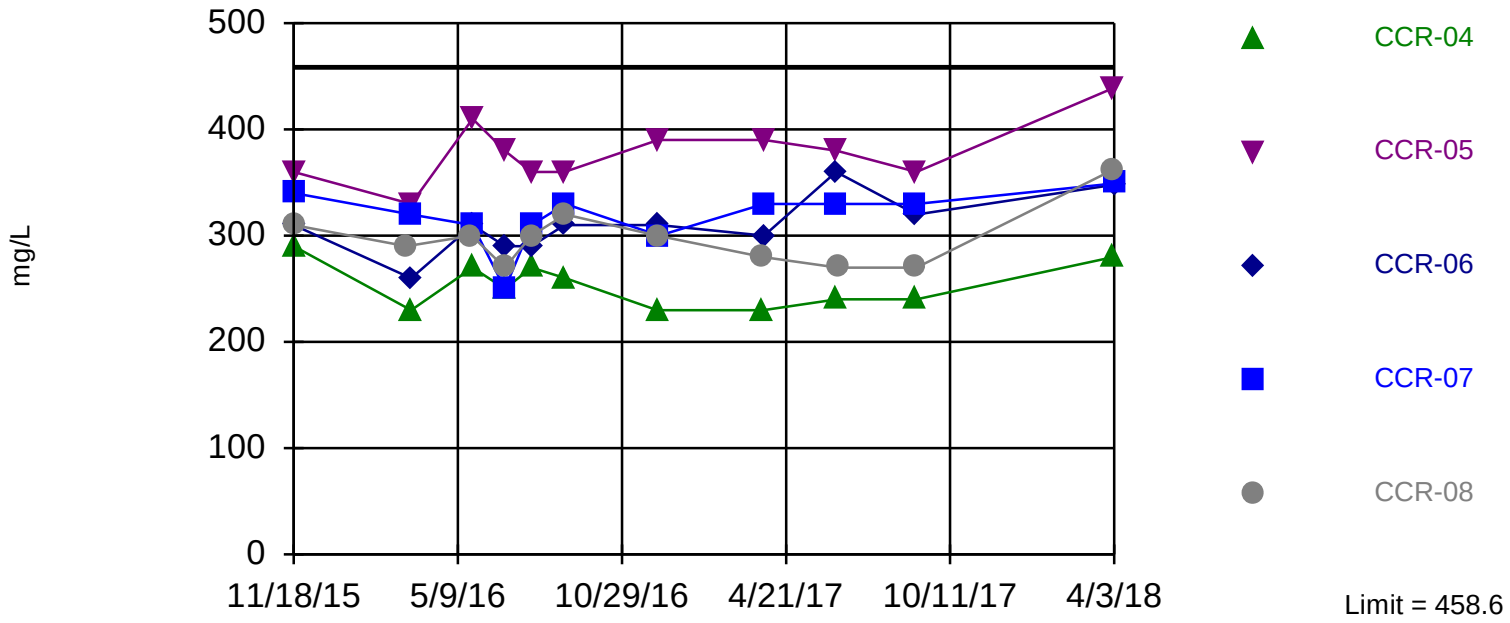
Constituent: Sulfate Analysis Run 5/31/2018 8:55 AM

Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR

Within Limit

Prediction Limit

Interwell Parametric



Background Data Summary (based on square root transformation): Mean=16.47, Std. Dev.=2.734, n=99. Seasonality was not detected with 95% confidence. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.982, critical = 0.967. Kappa = 1.808 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001504. Comparing 5 points to limit.

Constituent: Total Dissolved Solids Analysis Run 5/31/2018 8:53 AM

Nelson - Coal Ash Landfill Client: Entergy Gulf States Louisiana, LLC Data: Entergy Nelson CCR