EMID-700088

Department of Energy

Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

RECEIVED
SEP 26 2018
NMED
Hazardous Waste
Bureau

SEP 26 2018

Mr. John E. Kieling
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Dear Mr. Kieling:

Subject: Submittal of the Annual Progress Report on Chromium Plume Control Interim Measure Performance

Enclosed please find two hard copies with electronic files of the Annual Progress Report on Chromium Plume Control Interim Measure Performance. This progress report presents data and results from the initial start-up in January 2017 through July 2018. This report is being submitted to fulfill Fiscal Year 2018 Milestone 9 in Appendix B of the 2016 Compliance Order on Consent (Consent Order).

Pursuant to Section XXIII.C of the Consent Order, a pre-submission review meeting was held with the U.S. Department of Energy Environmental Management Los Alamos Field Office (EM-LA); Newport News Nuclear BWXT – Los Alamos, LLC (N3B); and the New Mexico Environment Department (NMED) on June 20, 2018, to discuss NMED's comments on the performance monitoring work plan. EM-LA and N3B defined what would be included in the annual progress report in response to the comments.

If you have any questions, please contact Steve White at (505) 309-1370 (steve.white@em-la.doe.gov) or Cheryl Rodriguez at (505) 665-5330 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Arturo Q. Duran
Designated Agency Manager
Environmental Management
Los Alamos Field Office

Enclosures:
1. Annual Progress Report on Chromium Plume Control Interim Measure Performance (EM2018-0028)

cc (letter with enclosure[s]):
S. White, N3B
C. Rodriguez, EM-LA

cc (letter with electronic enclosure[s]):
L. King, EPA Region 6, Dallas, TX
R. Martinez, San Ildefonso Pueblo, NM
D. Chavarria, Santa Clara Pueblo, NM
S. Yanicak, NMED
emla.docs@em.doe.gov
N3B Records
Public Reading Room (EPRR)
PRS Database

cc (letter emailed without enclosure[s]):
F. Johns, N3B
D. Katzman, N3B
J. Legare, N3B
F. Lockhart, N3B
N. Lombardo, N3B
B. Robinson, N3B
A. Duran, EM-LA
D. Nickless, EM-LA
D. Rhodes, EM-LA

EM-LA-20AD-00309

September 2018
EM2018-0028

Annual Progress Report on Chromium Plume Control Interim Measure Performance

N3B Los Alamos

EM2018-0028

Annual Progress Report on Chromium Plume Control Interim Measure Performance

September 2018

Responsible program director:

Printed Name	Signature	Title	Organization	Date
Bruce Robinson		Program Director	Water Program	9/18/2018

Responsible N3B representative:

Printed Name	Signature	Title	Organization	Date
Joseph A. Legare		Program Manager	N3B Environmental Remediation Program	9/18/18

Responsible DOE-EM-LA representative:

Printed Name	Signature	Title	Organization	Date
Arturo Q. Duran		Designated Agency Manager	Office of Quality and Regulatory Compliance	9/25/18

CONTENTS

Figures

Tables

Appendix

1.0 INTRODUCTION

This progress report on chromium plume control interim measure (IM) performance presents data and results related to IM activities between initial start-up in January 2017 through July 2018. This report is prepared to satisfy reporting outlined in the April 2018 "Chromium Plume Control Interim Measure Performance Monitoring Work Plan" (LANL 2018, 603010) and additional reporting commitments made to the New Mexico Environment Department (NMED) in subsequent technical team meetings. The work plan included the monitoring and reporting that will be conducted to evaluate performance of the IM conducted under the May 2015 "Interim Measures Work Plan for Chromium Plume Control" (IMWP) (LANL 2015, 600458).

The principle objective of the IM is to achieve and maintain the 50-ppb downgradient chromium plume edge within the Los Alamos National Laboratory (LANL or the Laboratory) boundary with a specific metric of reduction of chromium concentrations at monitoring well R-50 to the 50-µg/L New Mexico groundwater standard or less over a period of approximately 3 yr. A secondary objective is to hydraulically control plume migration in the eastern downgradient portion of the plume.

The current IM operations consist of pumping from three extraction wells, CrEX-1, CrEX-2, and CrEX-3; treatment at a centralized treatment facility; and injection of treated water into injection wells CrIN-3, CrIN-4, and CrIN-5 (Figure 1.0-1). This initial operational configuration addresses the southern downgradient portion of the plume and is considered the initial element of the IM. The second element of the IM will address the eastern portion of the plume after the final configuration of the remaining components of the IM infrastructure is in place and operational. Characterization data from newly drilled CrIN-6 led to an evaluation of the optimal operational configuration to meet the IM objectives. The results of the CrIN-6 evaluation are presented in the "Evaluation of Chromium Plume Control Interim Measure Operational Alternatives for Injection Well CrIN-6" submitted to NMED in April 2018 (LANL 2018, 603032). NMED provided a response on June 6, 2018, that approved proceeding with the recommendation to convert CrIN-6 from an injection well to an extraction well (CrEX-5) (NMED 2018, 700011). Two injection wells, CrIN-1 and CrIN-2, are currently not operating because of uncertainty whether continuous injection in those two wells, without concurrent extraction from CrEX-5 (reconfigured CrIN-6), would push the plume to the north of CrIN-1 and thus not achieve complete hydraulic control of the eastern portion of the plume. The fourth extraction well, CrEX-4, has been used for short-term extraction testing but is not being used for continuous pumping at this time.

This report presents operational information through June 2018 and analytical data available through July 2018.

2.0 INTERIM MEASURE OPERATIONS

The IM discussion on IM operations are presented below by year.

2.1 2017 Operations and Testing

Table 2.1-1 presents significant operational and maintenance activities for 2017 through July 2018. Figure 2.1-1 presents a timeline for IM activities from design through start-up and operation.

2.1.1 2017 System Operations

The only significant operational activity that directly relates to implementation of the IM involved extraction from CrEX-1 and injection into CrIN-4 and CrIN-5 from January 6, 2017, through June 26, 2017.

Interruptions in pumping and injection occurred during that period, including a full shutdown from the period between April 27 and May 30, but the pumping was otherwise mostly continuous. The pumping rate at CrEX-1 during the January through June period was approximately 70 gallons per minute (gpm), and injection varied slightly around approximately 35 gpm into each of the two injection wells. This activity was a manual operation before automated control of the system came online. Extraction at CrEX-1 and injection into CrIN-4 and CrIN-5 was terminated in late June 2017 to enable construction of additional infrastructure.

Brief, 4-day to 10-day hydraulic and system functional testing also took place during November and December 2017 but are not considered to be sustained IM operations. These events are described in section 2.1.2 below.

2.1.2 2017 Hydraulic Testing

A very short-duration injection test was conducted at CrIN-6 on October 31, 2017, followed by a 6-day pumping test conducted from November 1 through 7, 2017. The injection test was conducted over a 2-hr duration at flow rates varying between 10 and 130 gpm to demonstrate system functionality. A 6-d pumping test was also conducted at 90 gpm continuously at CrIN-6. Sampling was conducted at the CrIN-6 wellhead during the 6-day test according to the analyte suite and schedule provided to NMED by email on October 27, 2017. Water generated during the 6-day test was treated at the well head, piped directly to the storage basins, and land-applied under Discharge Permit 1793 (DP-1793). Analyses and results from the pumping test were documented in the "Evaluation of Chromium Plume Control Interim Measure Operational Alternatives for Injection Well CrIN-6" (LANL 2018, 603032).

Aquifer testing was conducted in groups of injection wells in an alternating-well configuration. The first 10-day cross-hole aquifer test involved continuous injection into CrIN-1, CrIN-3, and CrIN-5 from November 13 through 22, 2017, at a nominal rate of 70 gpm at each well. The second 10-day test was conducted from November 27 through December 6, 2017, and involved injection into CrIN-2 and CrIN-4 at a nominal rate of 70 gpm at each well. A third 4-day test was conducted at CrIN-3, CrIN-4, and CrIN-5 from December 11 through 14, 2017, at varying injection rates. Extraction wells CrEX-1, CrEX-2, and CrEX-3 were pumping during all of these injection tests.

2.1.3 2017 Tracer Testing

In May 2017, tracers were introduced into CrIN-4 and CrIN-5 to characterize the groundwater pathways and the rate of migration of treated (and traced) water away from the injection wells. Tracers were introduced with injection water in accordance with the January 19, 2017, notice of intent from the U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office (EM-LA)/ Los Alamos National Security, LLC (LANS) and the response letter from the NMED Groundwater Quality Bureau dated February 20, 2017, stating that no permit is required for deployment of tracers (LANL 2017, 602984; NMED 2017, 602983). On May 18, 2017, 50 kg of the tracer sodium-1,5 naphthalene disulfonate was deployed into CrIN-4; and on May 23, 2017, 50 kg of sodium-1,6 naphthalene disulfonate was deployed into CrIN-5. For each of these two tracer deployments, 50 kg of tracer was mixed with 15,000 gal. of potable water and injected during work hours over a 2-day period. The CrIN-4 and CrIN-5 tracer deployments occurred approximately 1 mo before the June 2017 cessation of injection into CrIN-4 and CrIN-5. Neither of these two tracers was detected in monthly monitoring that was conducted at wells R-50 and SIMR-2, possibly because injection into CrIN-4 and CrIN-5 was not sufficiently continuous after tracer deployment to push the tracers to the monitoring points. The deployment of tracers into the remaining four CrIN wells has not been conducted. DOE EM-LA/Newport News Nuclear BWXT – Los Alamos, LLC (N3B) will be redeploying tracer into CrIN-4 and CrIN-5 and conducting first-time deployment into CrIN-3 in September 2018. Redeployment in CrIN-4 and CrIN-5 will use different tracers than the two used in

May 2017. Tracers will also be deployed into remaining injection wells once the second element of the system start-up occurs.

2.1.4 2017 Routine and Non-Routine Activities

IM infrastructure well drilling and installation was completed during 2017. Extraction wells CrEX-2 and CrEX-4 and injection well CrIN-6 were completed and tied into the treatment infrastructure. Of these three infrastructure wells, only CrEX-2 is currently operational.

2.2 2018 Operations and Testing

Table 2.1-1 presents significant operational and maintenance activities for 2017 through July 2018. Figure 2.1-1 presents a timeline for IM activities from design through start-up and operation.

2.2.1 2018 System Operations

Several short-duration functional testing events were conducted in February 2018 after CrEX-4 was connected to the treatment system infrastructure. All of these were less than 1-day events. A 72-hr functional test was conducted between March 5 and March 8, 2018. All four CrEX wells were pumped and all of the CrIN wells with the exception of CrIN-6 received injection flow during the February and March 2018 testing. Extraction and injection rates were intentionally variable during these testing events.

The first element of the IM and the first fully integrated, sustained operation of the treatment system and pipeline and infrastructure network started on March 20, 2018. This element included pumping at CrEX-1, CrEX-2, and CrEX-3 with injection occurring at CrIN-3, CrIN-4, and CrIN-5. Extraction and injection rates were intentionally variable during this period while tuning adjustments were continually made. Operational parameters such as individual well optimal flow rates and pipeline pressures became better established and system control elements better understood during this period. One brief shutdown occurred on April 9 and 10 for a routine alarm at CrEX-2. Following the restart of the system on April 10, all six wells were operated at a nominal flow rate of 60 gpm with a total treatment volume of 180 gpm. Operations were stopped on April 23 ahead of the DOE EM-LA contract transition.

The system did not operate between April 23 and May 22, 2018, during the contract transition and was restarted on May 23, 2018. The system was thoroughly checked and operational procedures were reviewed to ensure that the restart of the system was performed in a safe and reliable manner. Flow rates at all locations have been maintained at the nominal 60 gpm through June 30, 2018. The extraction wells were shut down for less than 1 hr on June 14 and June 19, 2018, for routine ion exchange vessel changeouts. The injection wells continued operating during these events. Sustained operations have proven reliable.

2.2.2 2018 Routine and Non-Routine Activities

Pumping events will be part of ongoing routine maintenance at the CrIN wells as the wells age and are exposed to long-term injection cycles. Maintenance pumping was conducted at CrIN-3, CrIN-4, and CrIN-5 during April 2018. Pumping occurred at CrIN-5 on April 5, 2018, (15,000 gal.) and again on April 19, 2018 (3000 gal.). Pumping occurred at CrIN-4 on April 10 (12,000 gal.) and again on April 18 (4000 gal.). Pumping occurred at CrIN-3 on April 11, 2018 (14,000 gal.).

In the case of the April maintenance event, only CrIN-4 and CrIN-5 had experienced much sustained injection, but all three wells had experienced multiple functional testing events with variable flow rates. Gaining an understanding of the function and relationship between the downhole flow control valves in the wells and other flow control mechanisms within the piping network also likely resulted in some entrained air being released to the injection well screens and filter packs. The maintenance pumping resulted in comparative performance improvements between before-and-after water levels for given injection rates.

2.2.3 Injection Well Performance

CrIN-3, CrIN-4, and CrIN-5 are the only injection wells to have undergone enough sustained service to evaluate. Their general performance has been and continues to be good. Learning each well's optimal operating range and system flow control mechanisms has taken some time but has been key to achieving satisfactory results. Figure 2.2-1 presents water level and flow rates for each of the three CrIN wells between April 1 through the end of July 2018. The contract transition period in April and May is evident with zero flow and static water level conditions. Since restarting the system in May, stable injection flow and slowly rising water levels have indicated reliable and predictable performance. Water levels were anticipated to rise within the wells because of minor plugging of the filter pack and formation with entrained air and other minor foulants. The slowly and consistently rising water levels indicate that there are no serious problems related to injection well fouling.

2.2.4 Chromium Mass Removal

Table 2.2-1 presents estimates for chromium mass removal for 2017 and 2018. Although mass removal rates and efficiency are not directly related to IM performance, they may provide insights into observed plume response.

3.0 PERFORMANCE MONITORING RESULTS

The IMWP (LANL 2015, 600458) states that performance monitoring will be conducted to evaluate plume response associated with IM operations and guide adjustments in operational strategies. Water quality and water level results are presented in this section.

3.1 Sampling

Sampling under the "Chromium Plume Control Interim Measure Performance Monitoring Work Plan" (LANL 2018, 603010) effectively began in February 2017 with monthly monitoring of wells R-50 (screens 1 and 2) and SIMR-2 because of their proximity to the operations that were conducted at CrEX-1, CrIN-4, and CrIN-5 in 2017. Monthly monitoring at R-44 (screens 1 and 2), R-45 (screens 1 and 2), and R-61 began in October 2017, largely to collect baseline information on temporal variations at those wells that can be compared with trends that may occur in association with eventual IM operations in those areas. Additional wells (R-35a, R-35b, and R-11) have since been added to the performance monitoring. All performance monitoring wells are sampled monthly, and five piezometers (CrPZ-1, CrPZ-2a, CrPZ-3, CrPZ-4, and CrPZ-5) are sampled quarterly under the work plan. Figure 3.1-1 shows the locations of the wells in the chromium plume area and also shows which monitoring wells and piezometers are sampled under the work plan. Sampling at these monitoring wells is conducted in a manner consistent with the sampling protocol used for the Interim Facility-Wide Groundwater Monitoring Plan (IFGMP) (LANL 2017, 602406). A purge protocol for the piezometers is being developed to optimize data quality.

The analyte suite for sampling at performance monitoring wells focuses on a subset of key indicator constituents in the intervening monthly samples than for the quarterly samples collected for the same wells under the IFGMP. Table 3.1-1 shows the performance monitoring wells and piezometers and the sample frequency for each constituent category.

3.2 Monitoring Results

Time-series plots are provided for the set of performance monitoring wells and piezometers (Figures 3.2-1 through 3.2-20). The period of record for the plots varies based on the period that information is available. For each performance monitoring well or piezometer, two plots are provided that each include a subset of key constituents (perchlorate, nitrate, sulfate, tritium, and chloride) also found within the chromium plume. Each plot also shows the hydrograph of water levels at that location for context. A full data set from the performance monitoring wells for the period of record evaluated for this report (January 2009 through July 2018) is provided as Appendix A. Over time the relation between water levels (e.g., drawdown or mounding) and changes in chromium and other key constituents in the plume may provide insights into performance of the IM.

Several tracers that have been used in the project area are also monitored. As discussed in section 2.1.3, an additional tracer deployment into CrIN-3, CrIN-4, and CrIN-5 will be a key component of the IM to characterize the nature of potential changes in chromium concentrations over time in performance monitoring wells. Those tracers will be included in time-series plots in future performance monitoring reports.

The time-series data collected to date show little indication of decreasing chromium concentrations in response to the IM. Significant temporal variability is observed in many of the wells (e.g., R-50 screen 1), making short-term changes in chromium concentrations difficult to assign specifically to IM performance at this time. This is likely attributable to the limited continuous periods of IM operations conducted from 2017 to 2018 (see discussion in sections 2.1.1 and 2.2.1). More detailed time-series plots that focus only on the 2017 to 2018 time period are shown for R-50 screens 1 and 2 (Figures 3.2-21 and 3.2-22) to facilitate an evaluation of whether injection in CrIN-4 and CrIN-5 caused water-level responses in either screen in R-50. Although not definitive, there may be some subtle indication that R-50 screen 1 shows a slight increase in pressure associated with the injection periods.

3.3 Water-Table Map

A water-table map (Figure 3.3-1) using May 2018 groundwater elevation data is presented as an additional line of evidence in evaluating IM performance and interpreting potential changes in concentrations of key constituents in performance monitoring wells and piezometers. Long-term pumping and injection at IM infrastructure wells may affect the structure of the water table over time in the form of drawdown around extraction wells and mounding around injection wells. The relation of changes in the water table, chromium concentrations, and potential tracer breakthrough will provide insights into overall IM performance and inform adaptive management of IM operations if necessary.

4.0 DISCUSSION

Multiple lines of evidence are being used to evaluate the performance of the IM and the cause for effectiveness. These same data can also be used to inform adaptive management strategies that may need to be considered if the IM objectives are not being met. The primary line of evidence for IM performance will be trends in chromium concentrations in performance monitoring wells under the IM that indicate hydraulic capture compared with the long-term trend before IM operations. Additional lines of evidence that will help interpret changes in chromium concentration include water-level data and tracer data from the injection well tracer tests. These data will also provide key insights that support continuous refinements of the conceptual model for the regional aquifer.

It was stated in the IMWP (LANL 2015, 600458) that it may require up to 1 yr of continuous IM operation to see clear indication of plume response at performance monitoring wells. Based on the trends in chromium and related constituents in performance monitoring wells, the IM operations have not run sufficiently long to have caused discernable changes in concentrations beyond those related to natural variability and long-term trends.

5.0 RECOMMENDATIONS

There are no indications at this point that any aspect of the operational approach of the IM should be changed. Reconfiguration of CrIN-6 to CrEX-5 and tie-in to the central treatment system is expected to occur in the spring 2019 time frame and will enable start-up of the entire IM. A new monitoring well, R-70, will also be installed in the spring 2019 time frame and will be added to the list of performance monitoring wells sampled on a monthly basis for a suite consistent with other wells sampled monthly. The same tracers sampled at R-45 S1 and S2 and at R-11 will be monitored at R-70.

6.0 REFERENCES AND MAP DATA SOURCES

6.1 References

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

LANL (Los Alamos National Laboratory), May 2015. "Interim Measures Work Plan for Chromium Plume Control," Los Alamos National Laboratory document LA-UR-15-23126, Los Alamos, New Mexico. (LANL 2015, 600458)

LANL (New Mexico Environment Department), January 19, 2017. "Notice of Intent to Conduct a Tracer Study at Los Alamos National Laboratory," to M. Hunter (NMED) from J. Bretzke (LANL), and C. Rodriguez (DOE-EM). (LANL 2017, 602984)

LANL (Los Alamos National Laboratory), May 2017. "Interim Facility-Wide Groundwater Monitoring Plan for the 2018 Monitoring Year, October 2017–September 2018," Los Alamos National Laboratory document LA-UR-16-24070, Los Alamos, New Mexico. (LANL 2017, 602406)

LANL (Los Alamos National Laboratory), April 2018. "Chromium Plume Control Interim Measure Performance Monitoring Work Plan," Los Alamos National Laboratory document LA-UR-18-23082, Los Alamos, New Mexico. (LANL 2018, 603010)

LANL (Los Alamos National Laboratory), April 2018. “Evaluation of Chromium Plume Control Interim Measure Operational Alternatives for Injection Well CrIN-6,” Los Alamos National Laboratory document LA-UR-18-23385, Los Alamos, New Mexico. (LANL 2018, 603032)

NMED (New Mexico Environment Department), February 20, 2017. “Response to Notice of Intent to Discharge; DP-1835; Los Alamos National Laboratory,” New Mexico Environment Department letter to J. Bretzke (LANL), and C. Rodriguez (DOE-EM) from M. Hunter (NMED), Santa Fe, New Mexico. (NMED 2017, 602983)

NMED (New Mexico Environment Department), June 6, 2018. “Evaluation of Chromium Plume Control Interim Measure Operational Alternatives,” New Mexico Environment Department letter to D. Hintze (DOE-EM-LA) and J. Legare (N3B) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2018, 700011)

6.2 Map Data Sources

Hillshade; Los Alamos National Laboratory, ER-ES, As published; \\slip\gis\Data\HYP\LiDAR\2014\Bare_Earth\BareEarth_DEM_Mosaic.gdb; 2014.

Unpaved roads; Los Alamos National Laboratory, ER-ES, As published, GIS projects folder; \\slip\gis\GIS\Projects\14-Projects\14-0062\project_data.gdb\digitized_site_features\digitized_roads; 2017.

Drainage channel; Los Alamos National Laboratory, ER-ES, As published, GIS projects folder; \\slip\gis\GIS\Projects\15-Projects\15-0080\project_data.gdb\correct_drainage; 2017.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 29 November 2010.

Paved Road Arcs; Los Alamos National Laboratory, FWO Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 29 November 2010.

Chromium plume > 50 ppb; Los Alamos National Laboratory, ER-ES, As published; \\slip\gis\GIS\Projects\13-Projects\13-0065\shp\chromium_plume_2.shp; 2018.

Regional groundwater contour May 2017, 4-ft interval; Los Alamos National Laboratory, ER-ES, As published; \\slip\gis\GIS\Projects\16-Projects\16-0027\project_data.gdb\line\contour_wl2017may_2ft; 2017.

Regional groundwater contour November 2017, 2-ft interval; Los Alamos National Laboratory, ER-ES, As published; \\slip\gis\GIS\Projects\16-Projects\16-0027\project_data.gdb\line\contour_wl2017nov_2ft; 2017.

Point features; As published; EIM data pull; 2017.

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 13 August 2010.

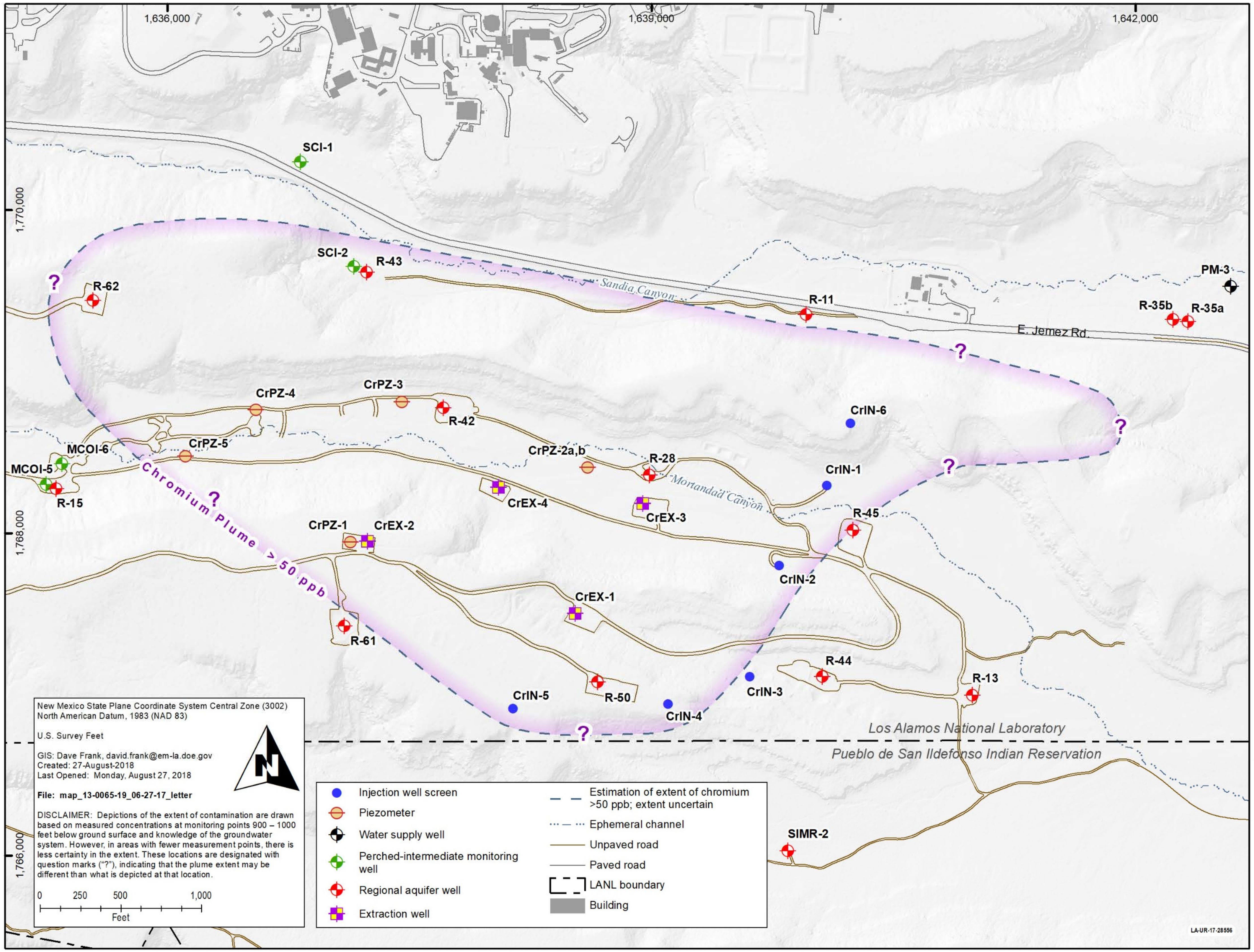


Figure 1.0-1 Chromium project area map

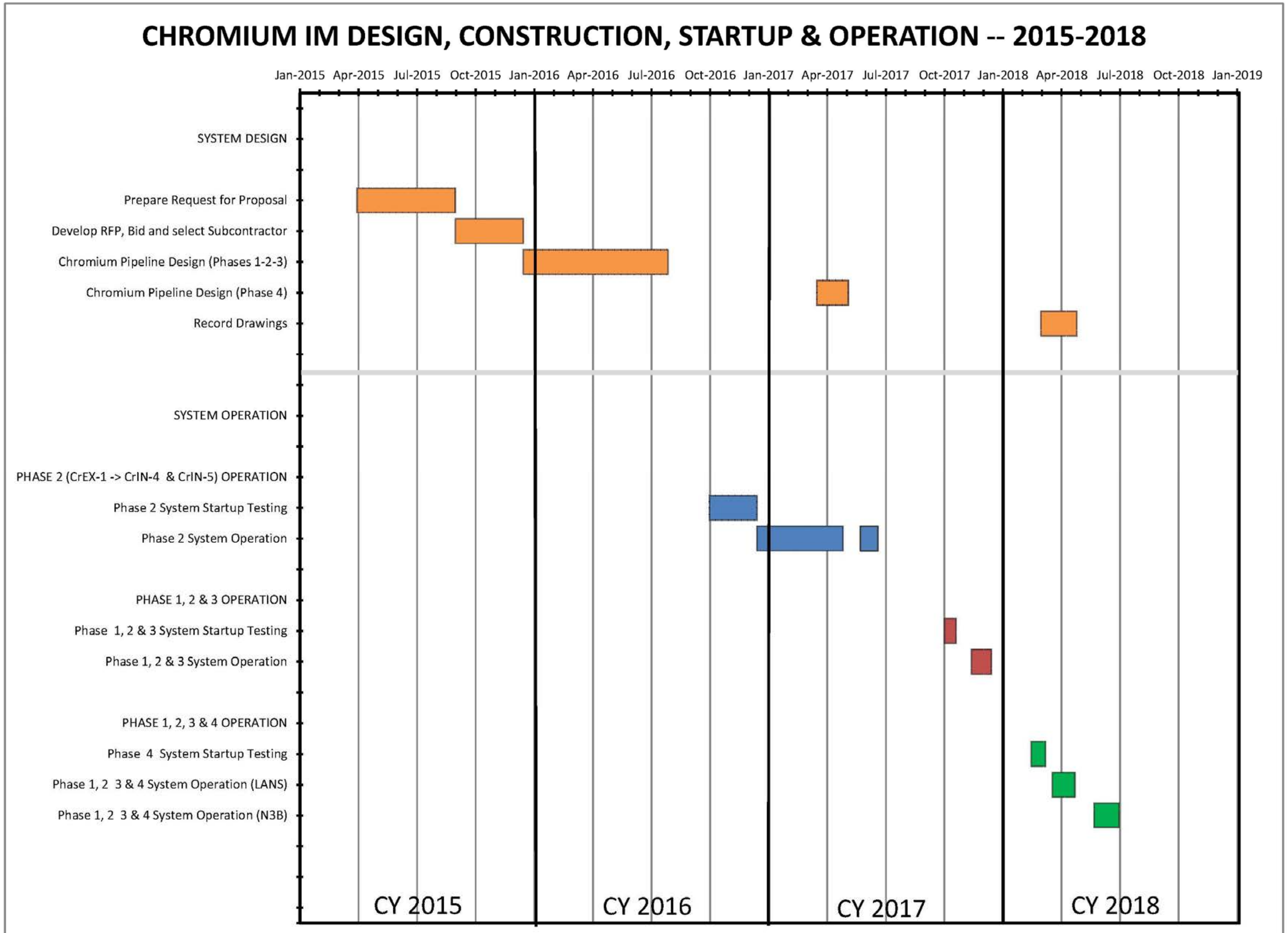
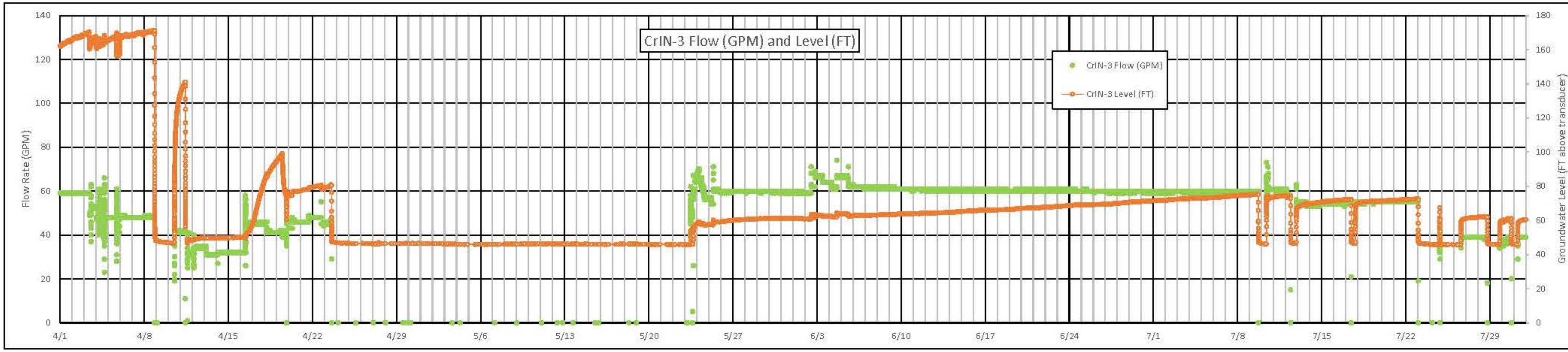


Figure 2.1-1 Timeline for chromium IM activities from design through start-up and operation



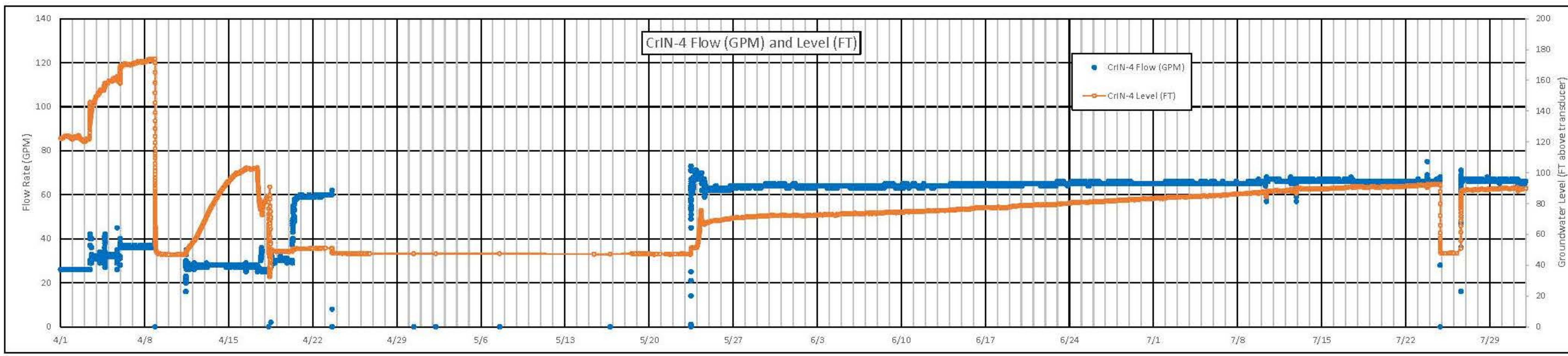


Figure 2.2-1 **Injection well flow rates and water levels for CrIN-3, CrIN-4, and CrIN-5**

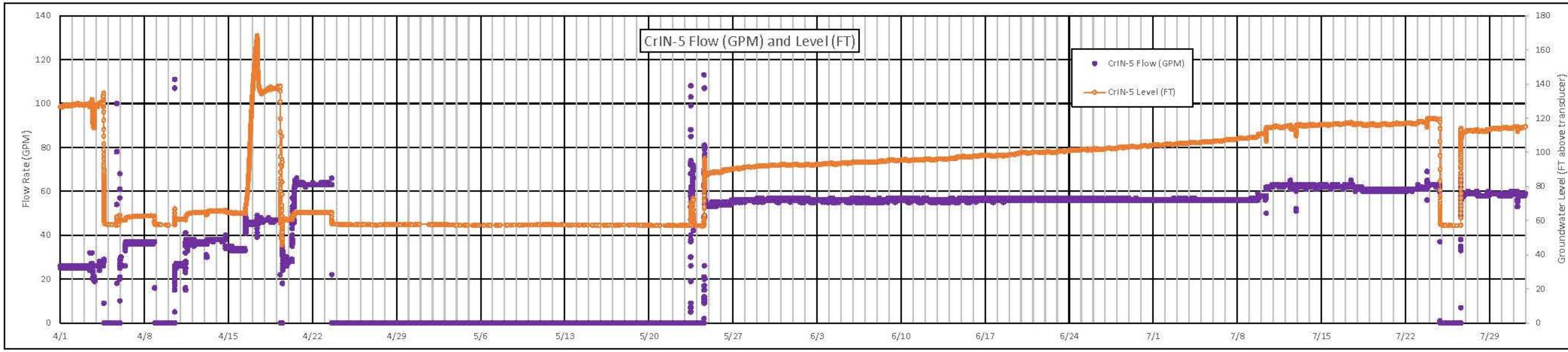


Figure 2.2-1 (continued) **Injection well flow rates and water levels for CrIN-3, CrIN-4, and CrIN-5**

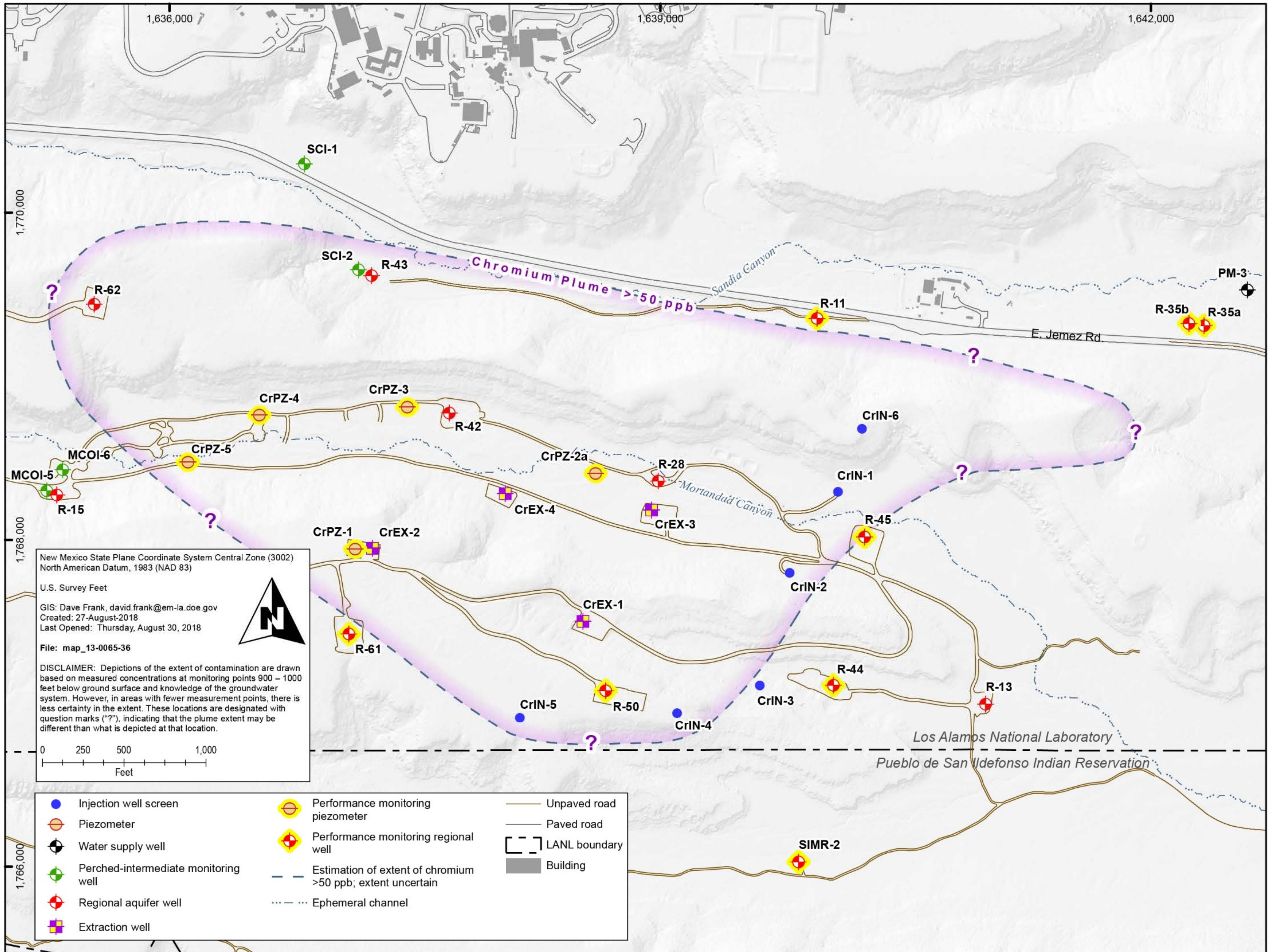


Figure 3.1-1 Locations of all wells in the chromium plume area, including performance monitoring wells and piezometers

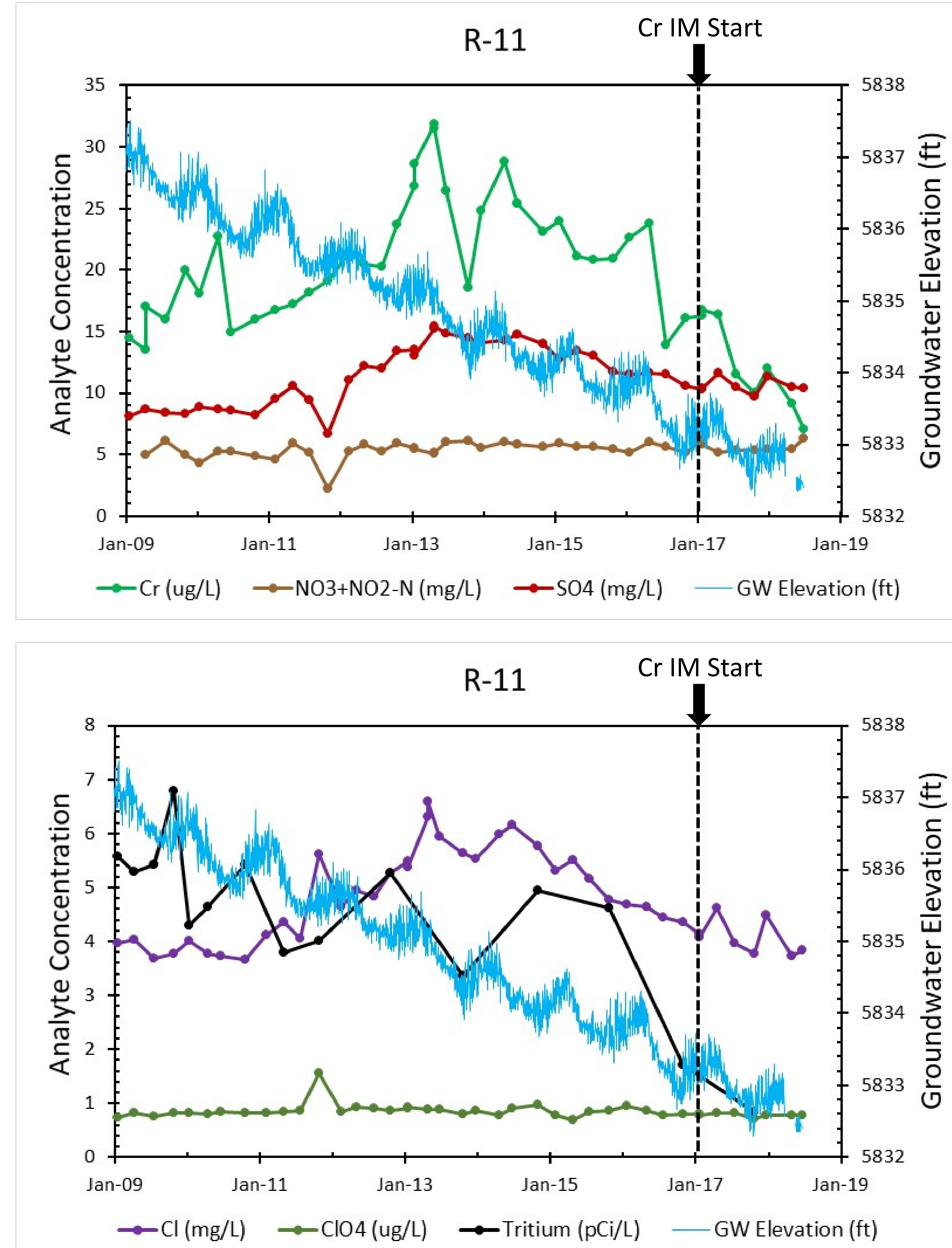
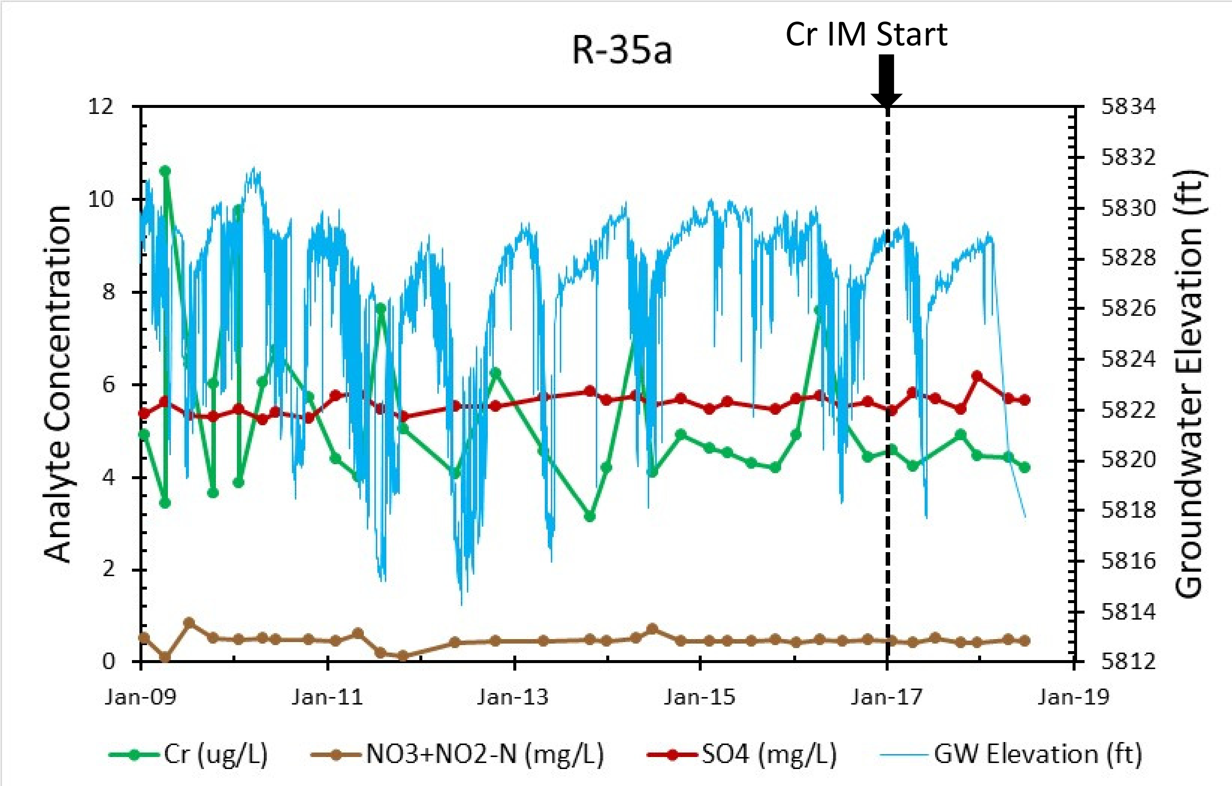
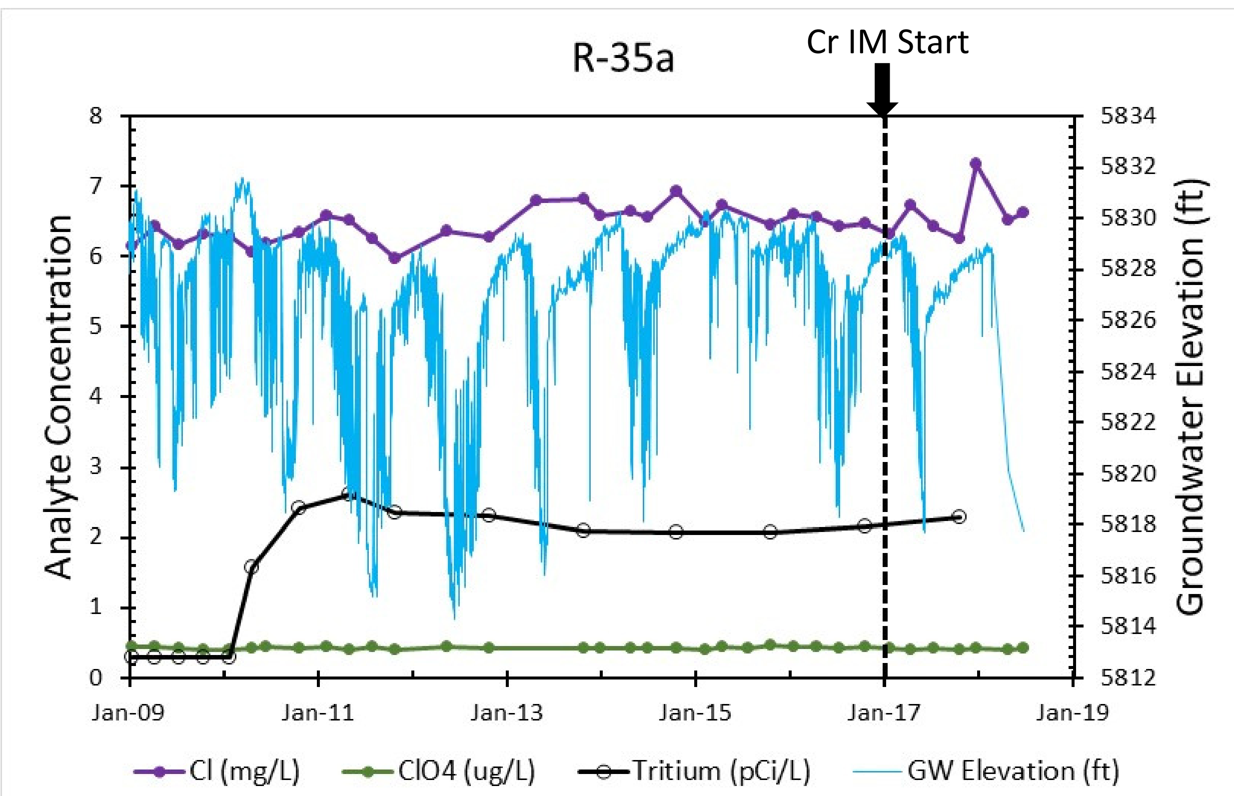


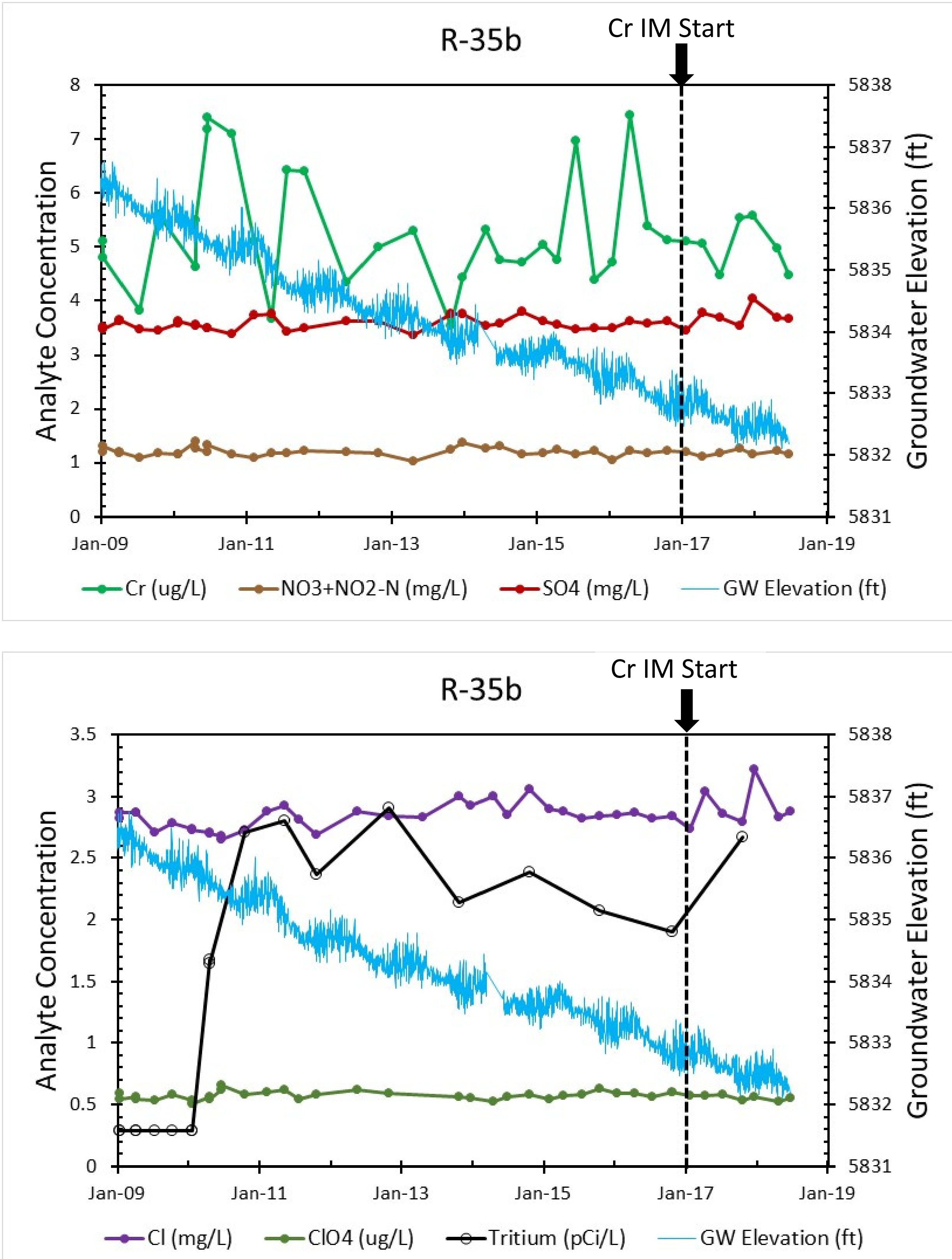
Figure 3.2-1 Time-series plots for R-11





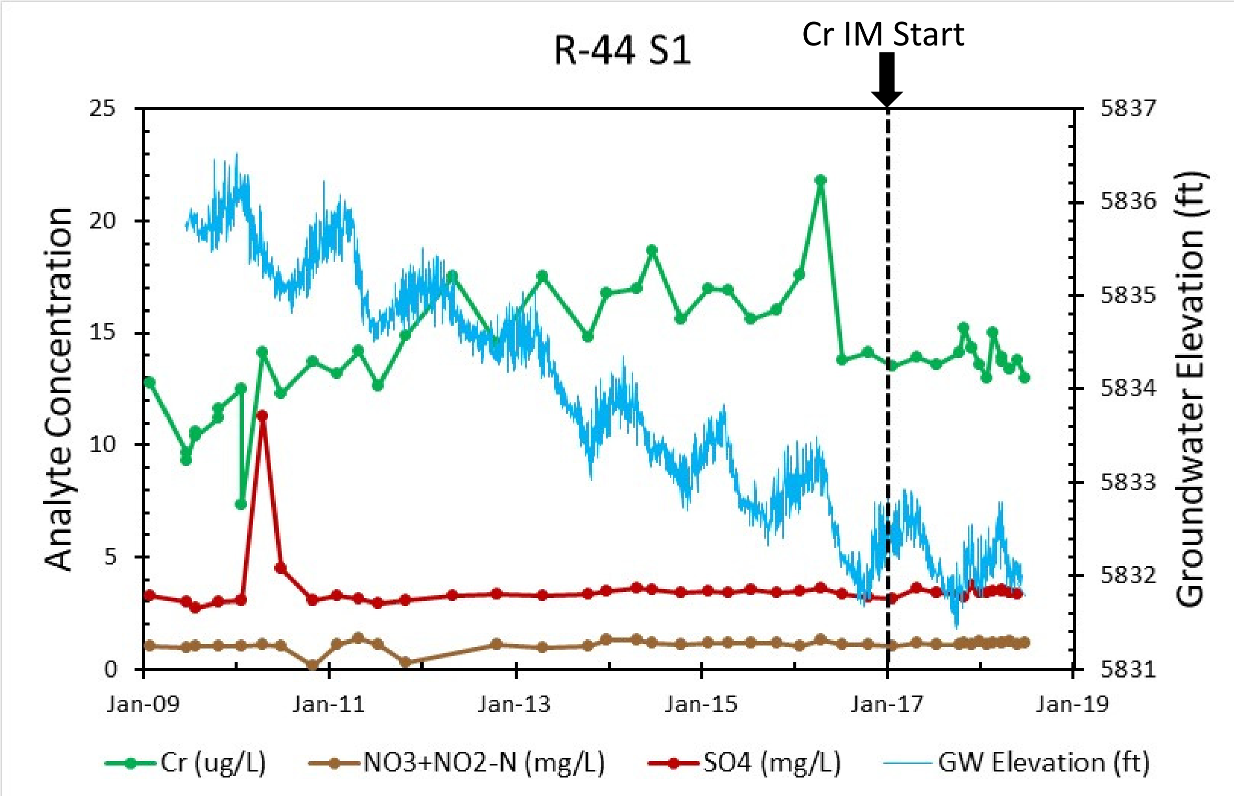
Note: Data represented by open circles are nondetect at the plotted value.

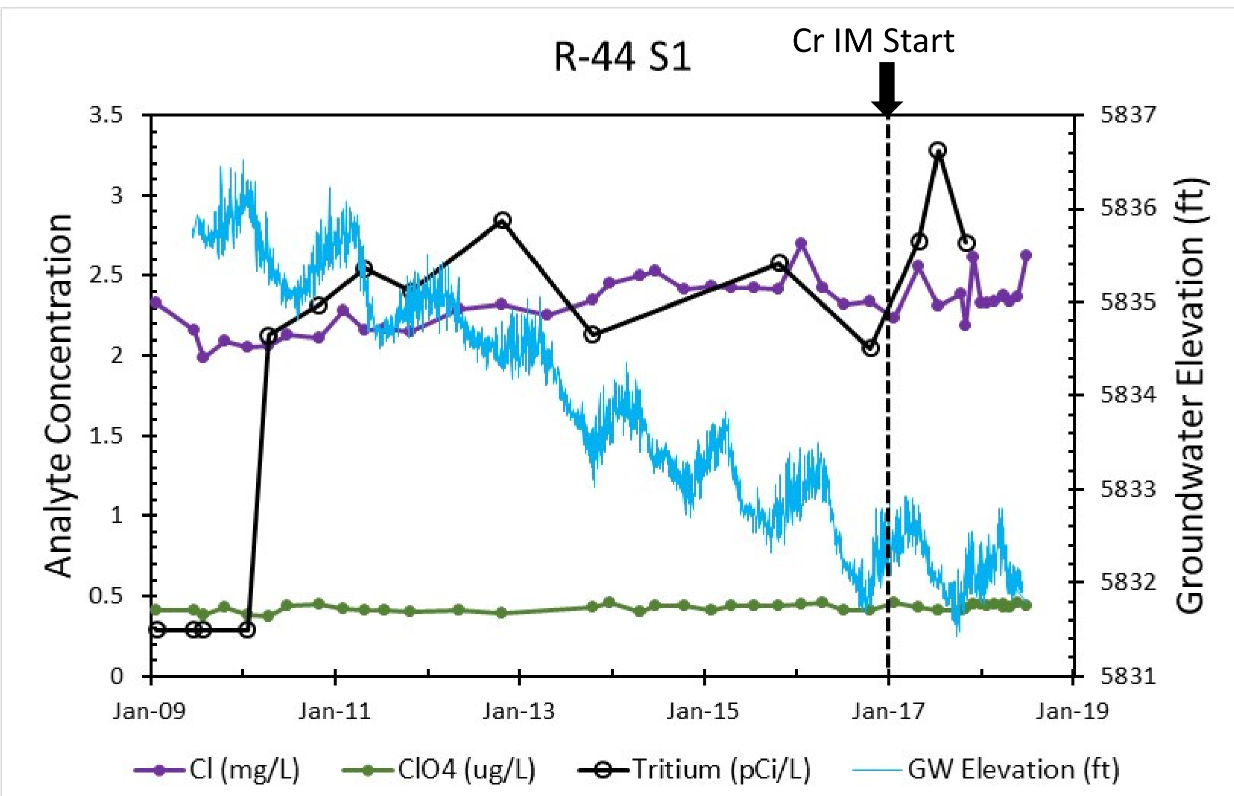
Figure 3.2-2 Time-series plots for R-35a



Note: Data represented by open circles are nondetect at the plotted value.

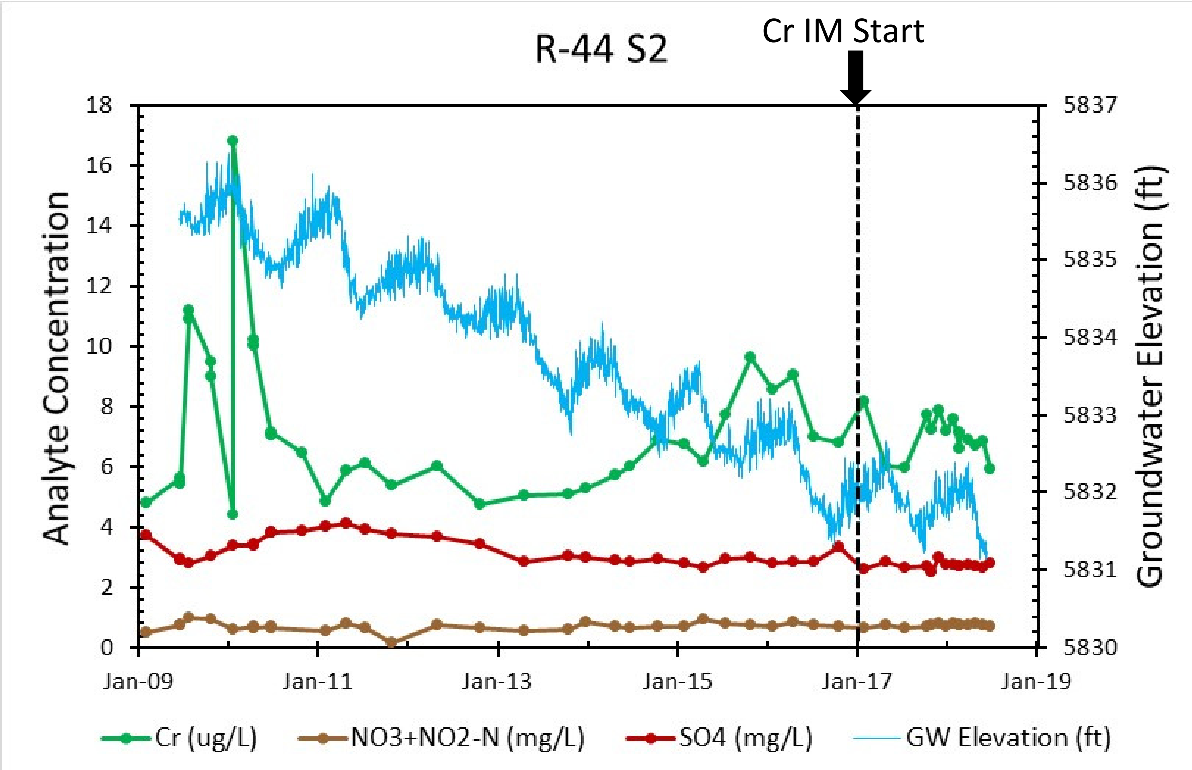
Figure 3.2-3 Time-series plots for R-35b

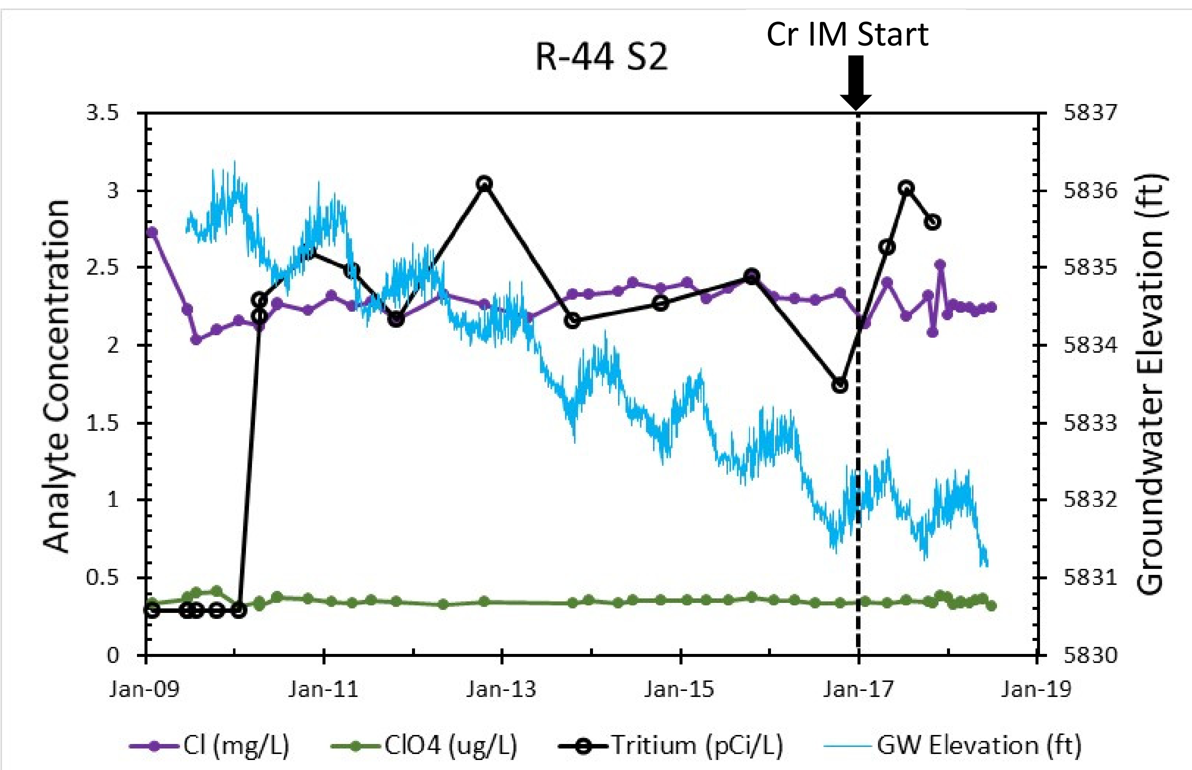




Note: Data represented by open circles are nondetect at the plotted value.

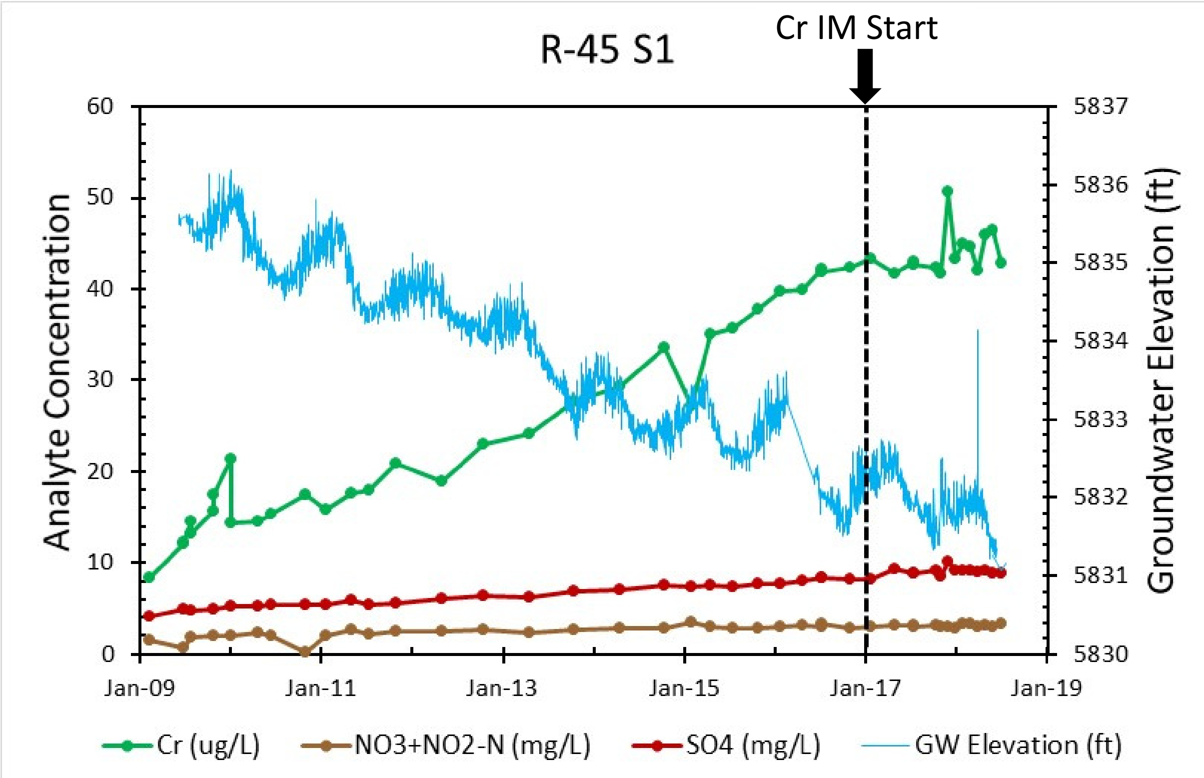
Figure 3.2-4 Time-series plots for R-44 S1

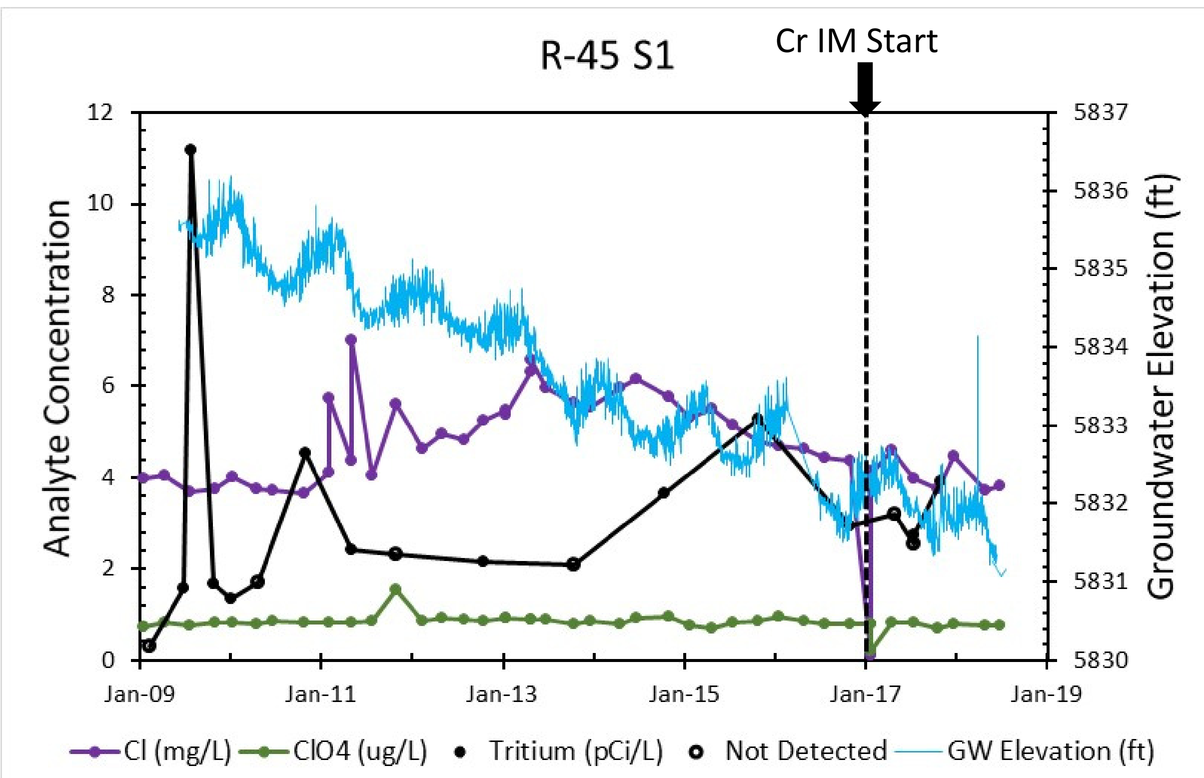




Note: Data represented by open circles are nondetect at the plotted value.

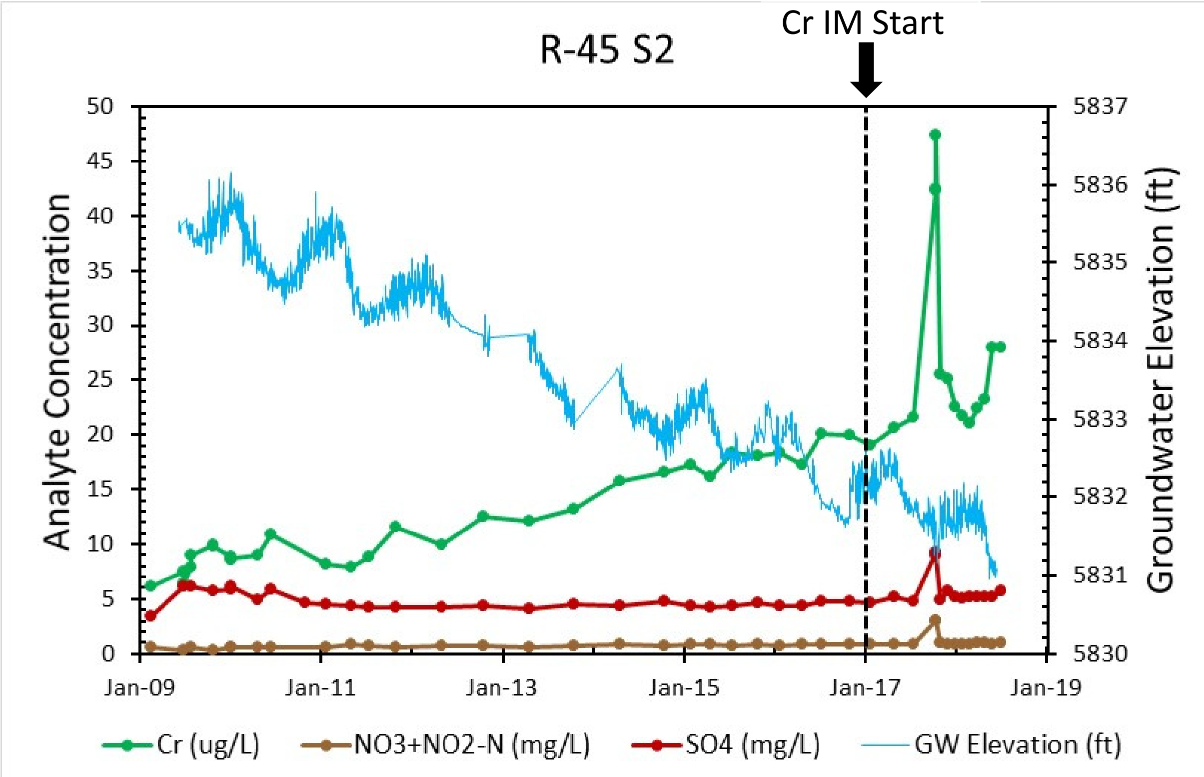
Figure 3.2-5 Time-series plots for R-44 S2

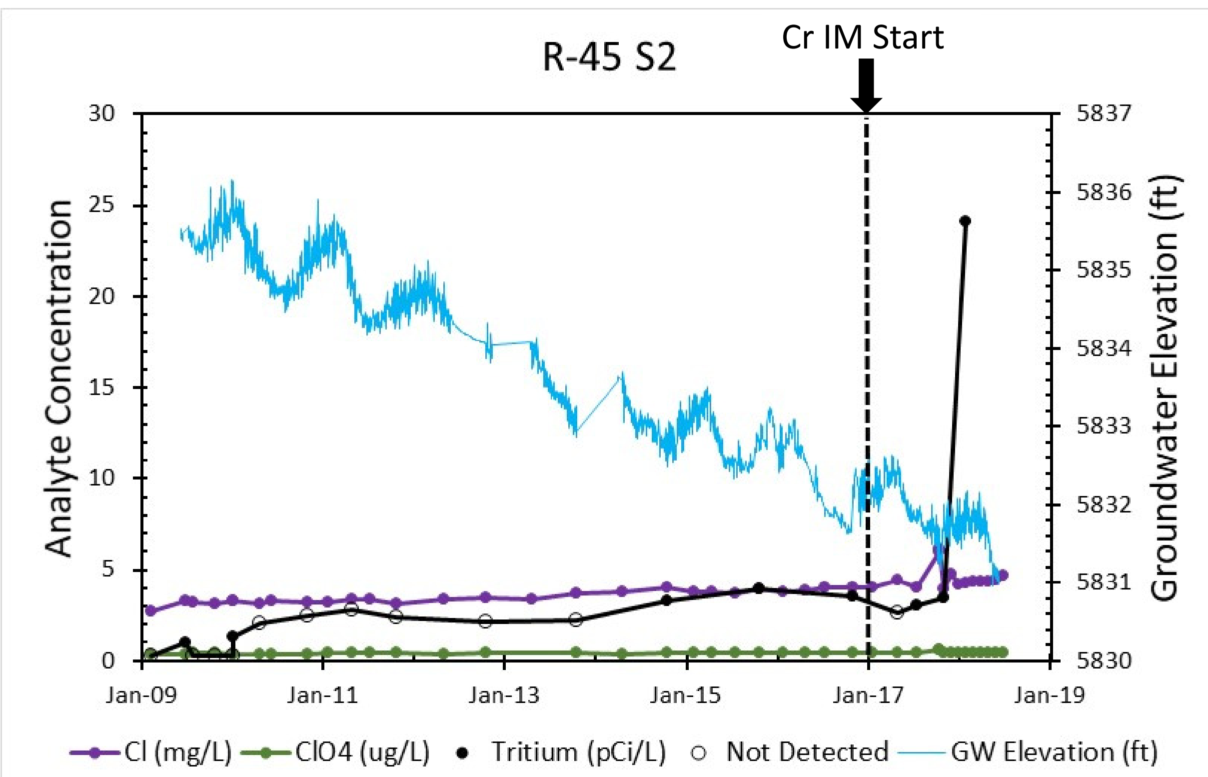




Note: Data represented by open circles are nondetect at the plotted value.

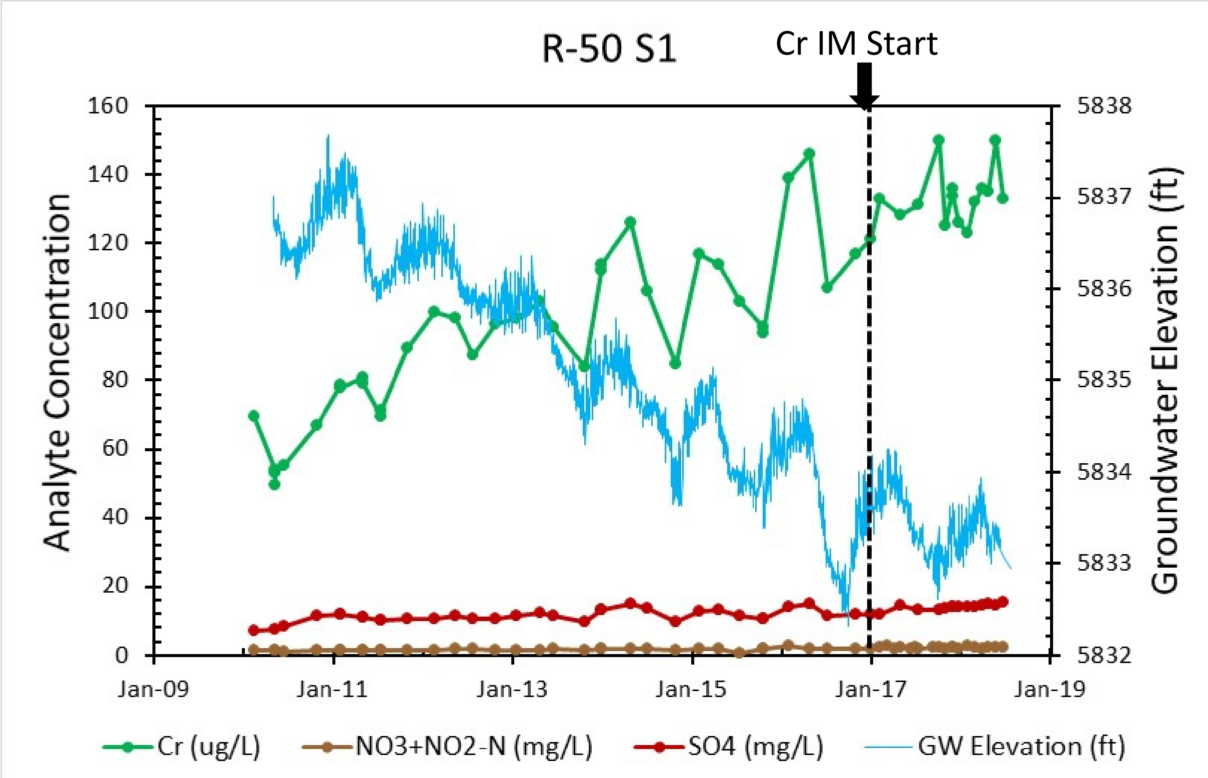
Figure 3.2-6 Time-series plots for R-45 S1





Note: Data represented by open circles are nondetect at the plotted value.

Figure 3.2-7 Time-series plots for R-45 S2



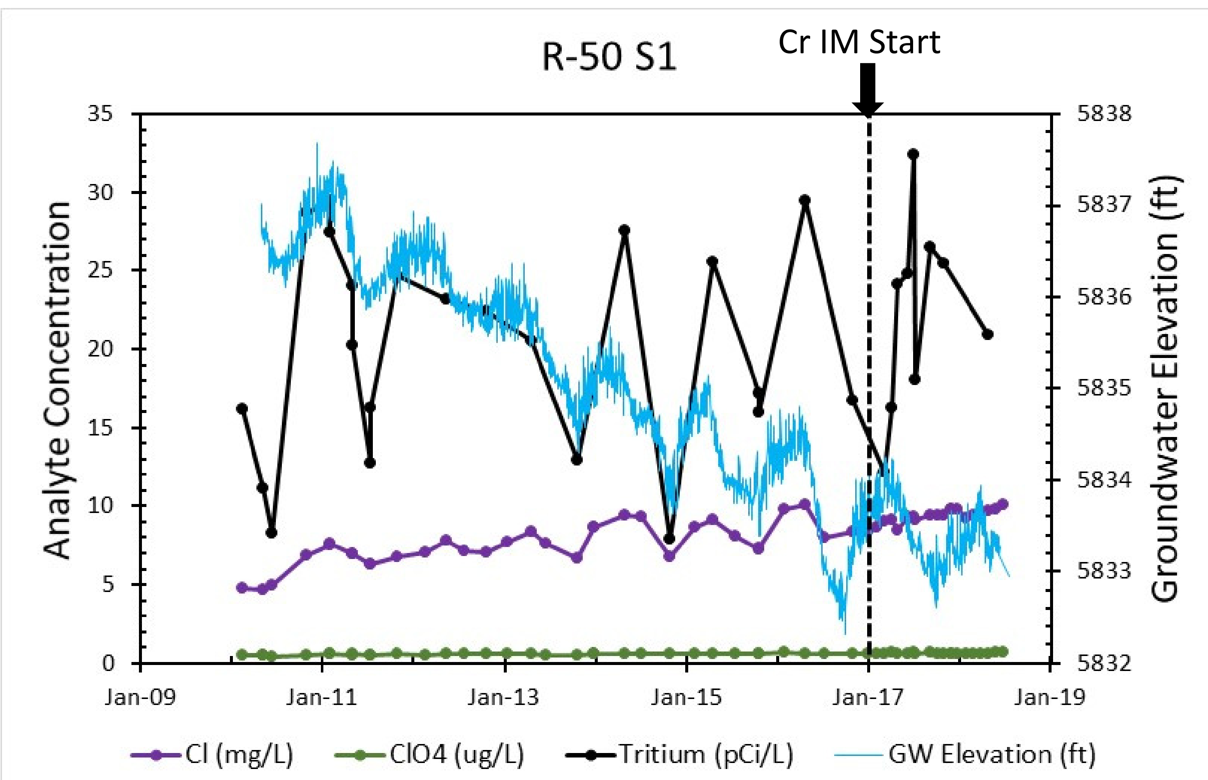
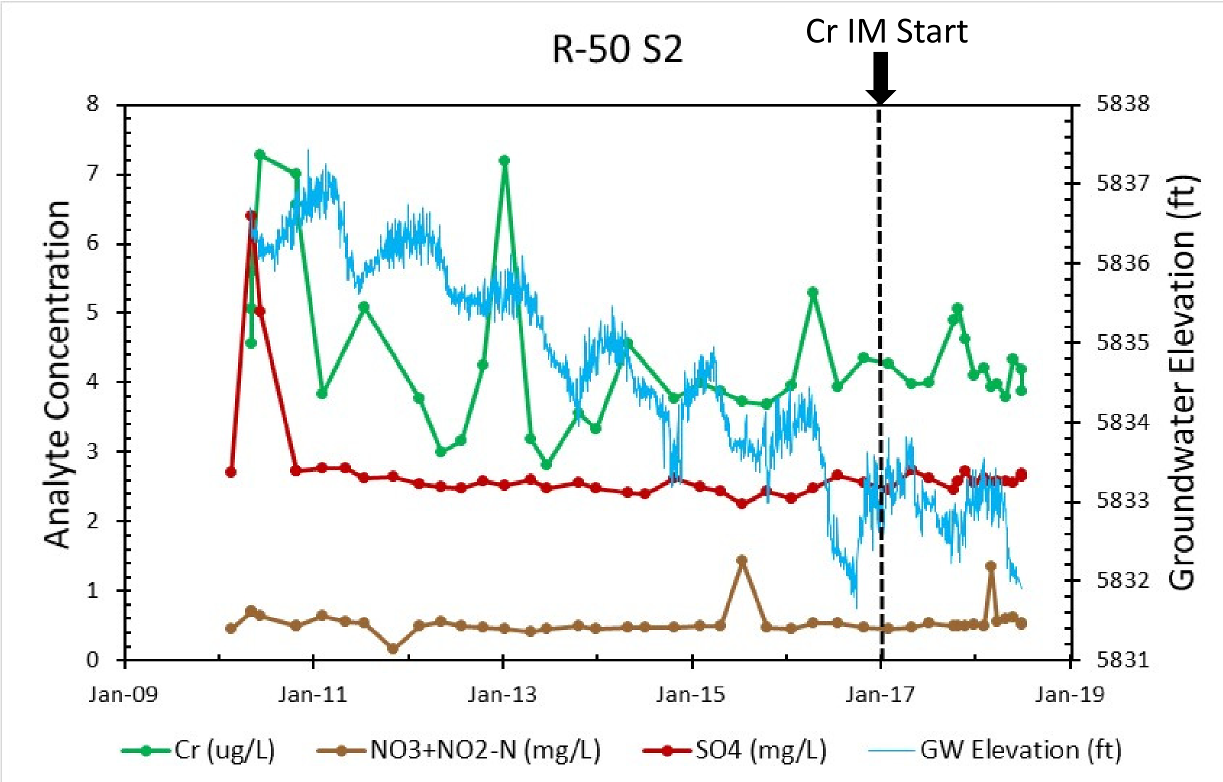
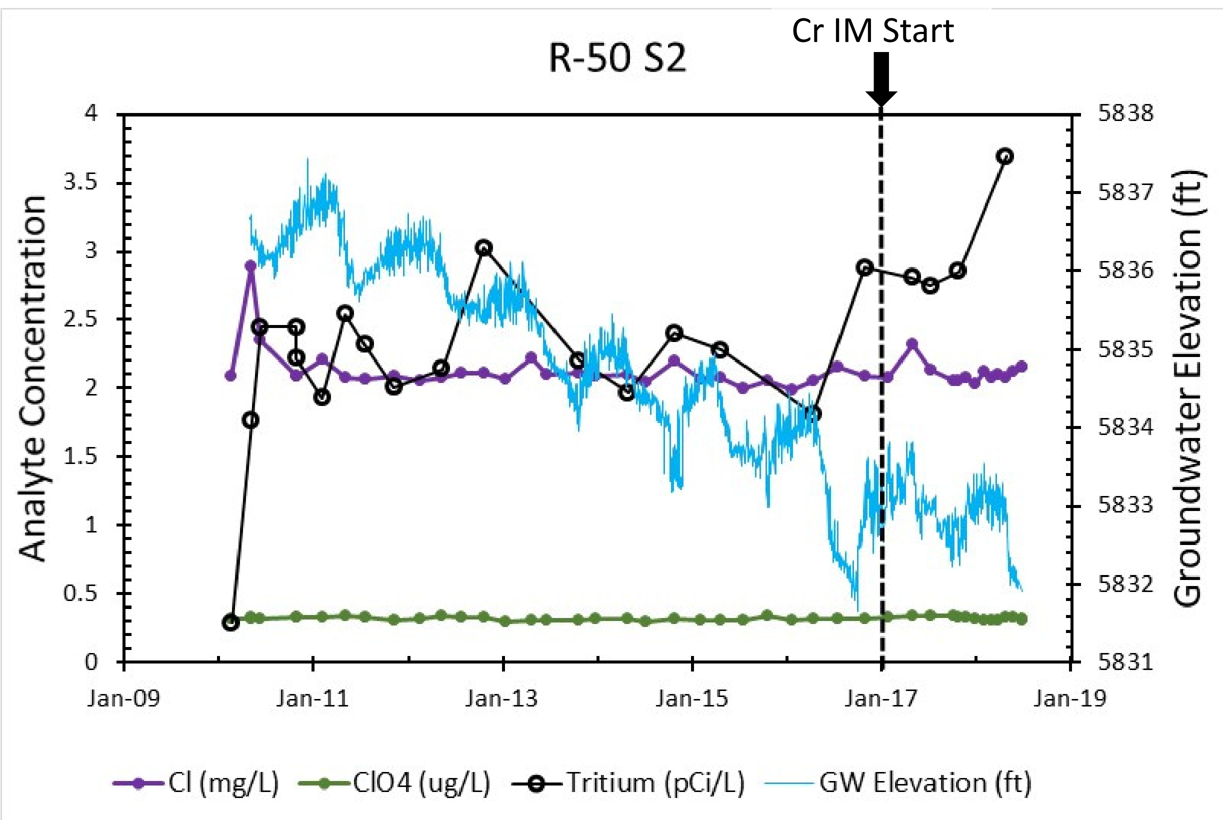


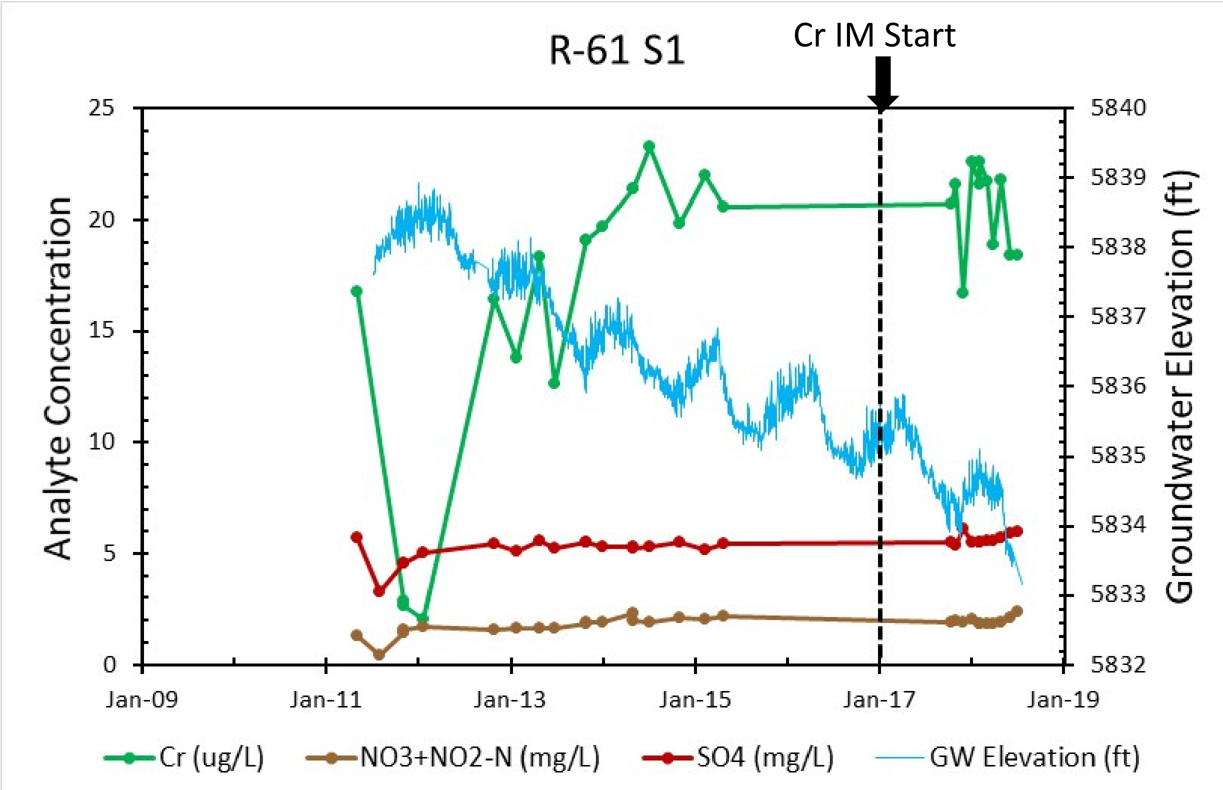
Figure 3.2-8 Time-series plots for R-50 S1

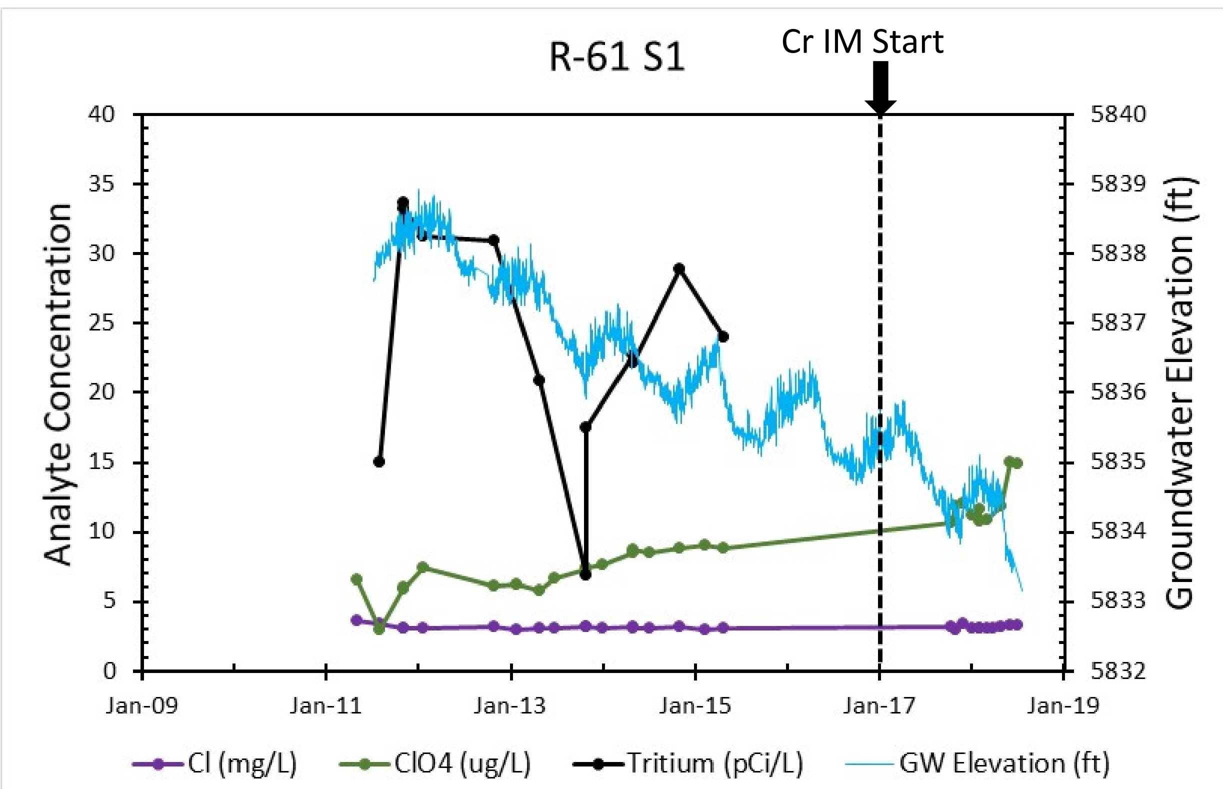




Note: Data represented by open circles are nondetect at the plotted value.

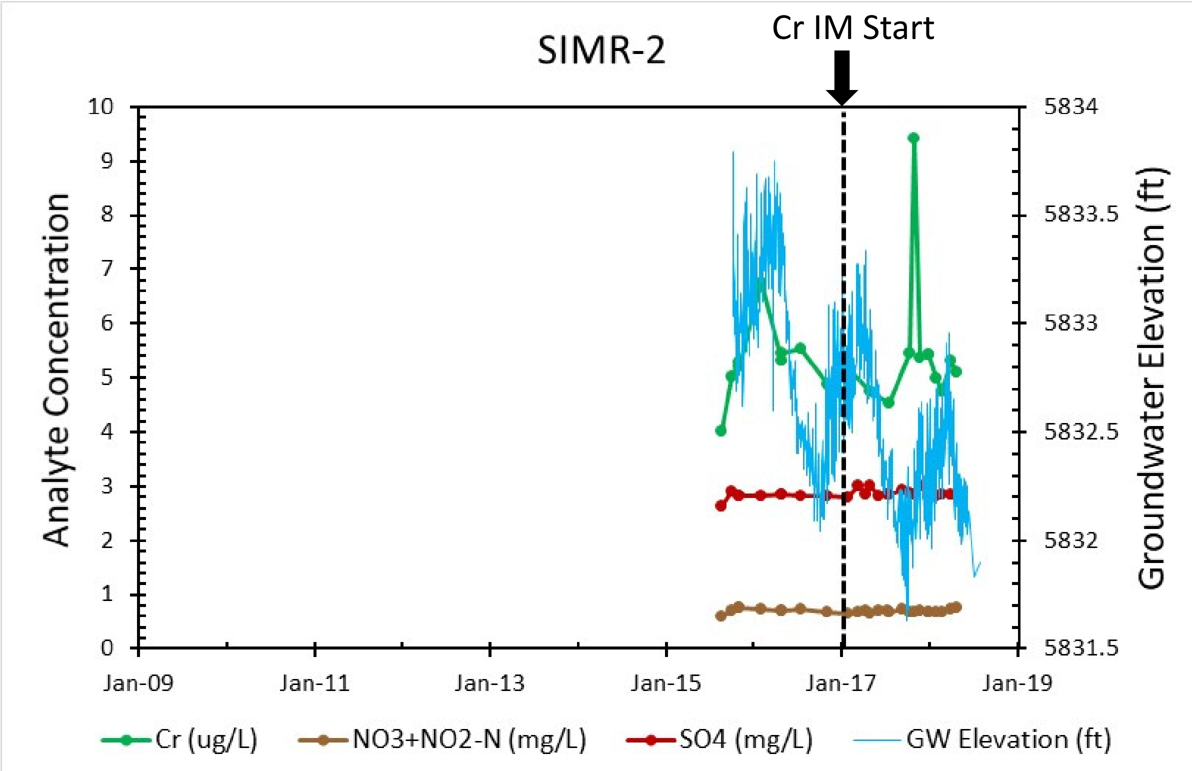
Figure 3.2-9 Time-series plots for R-50 S2

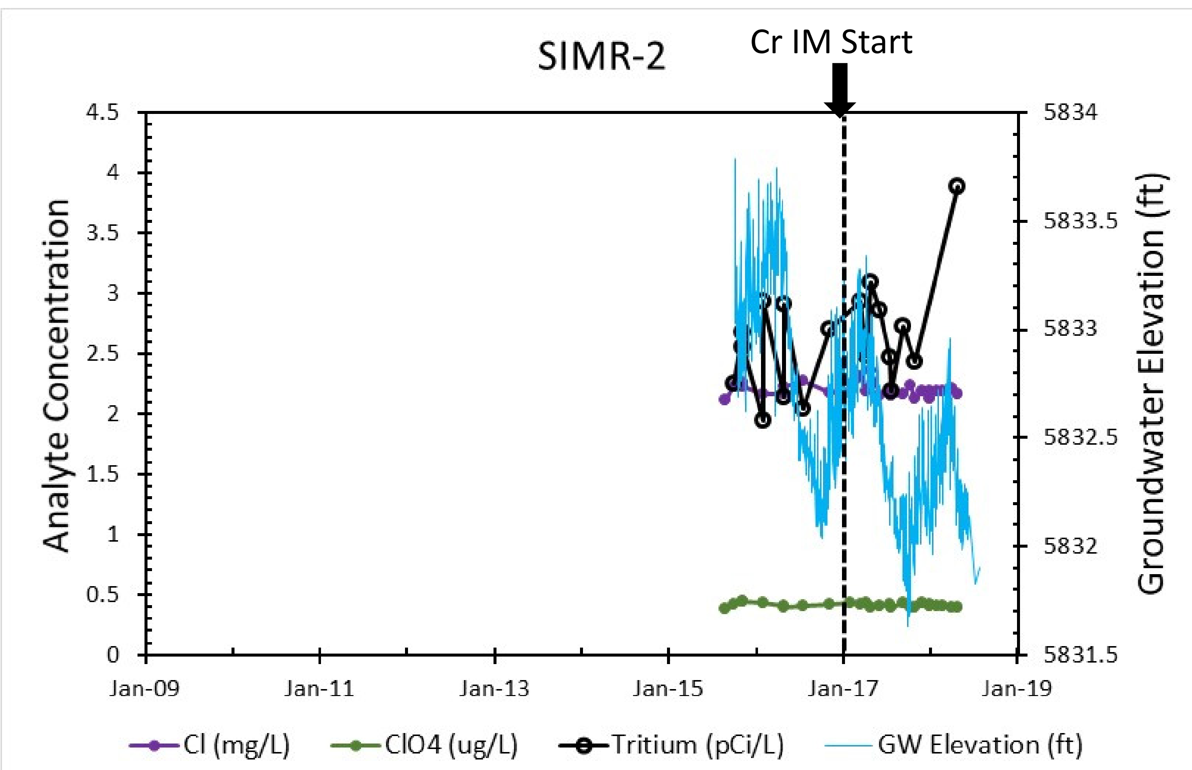




Note: Data for certain constituents at R-61 S1 have historically been non-representative of aquifer conditions because of locally reducing conditions around the well. Current data are considered useful for the purposes of this performance monitoring report.

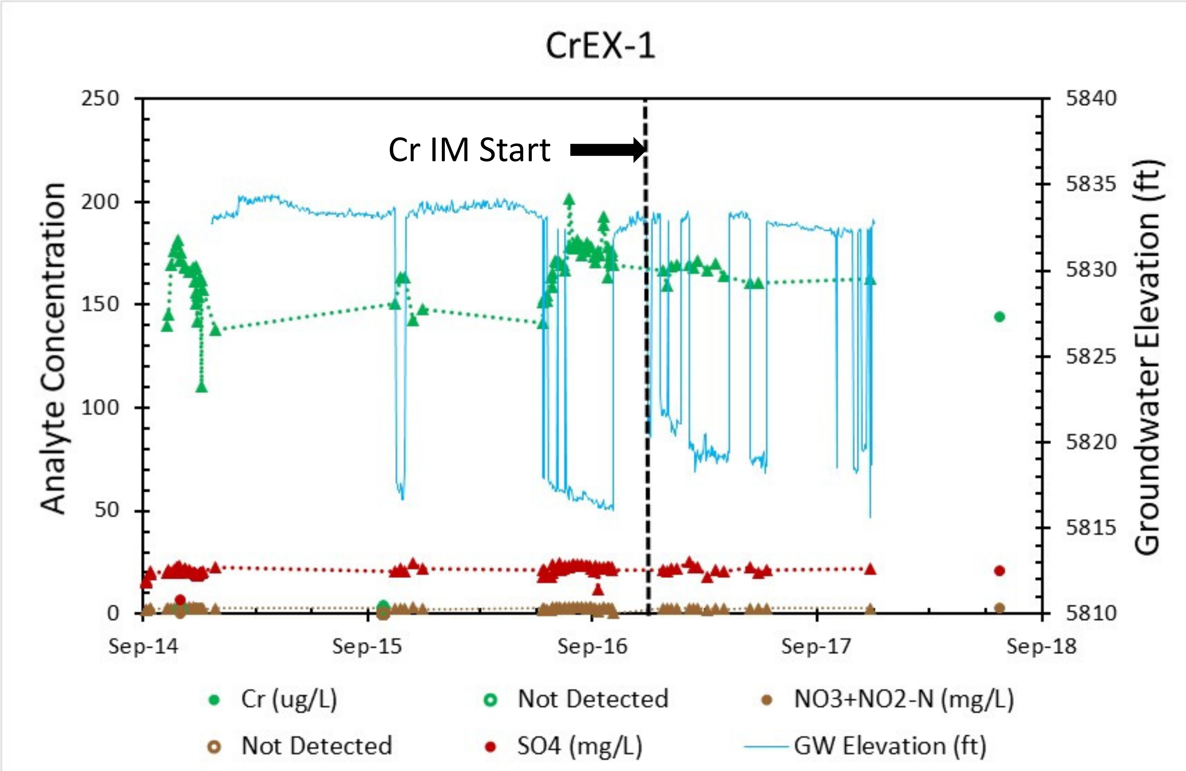
Figure 3.2-10 Time-series plots for R-61 S1

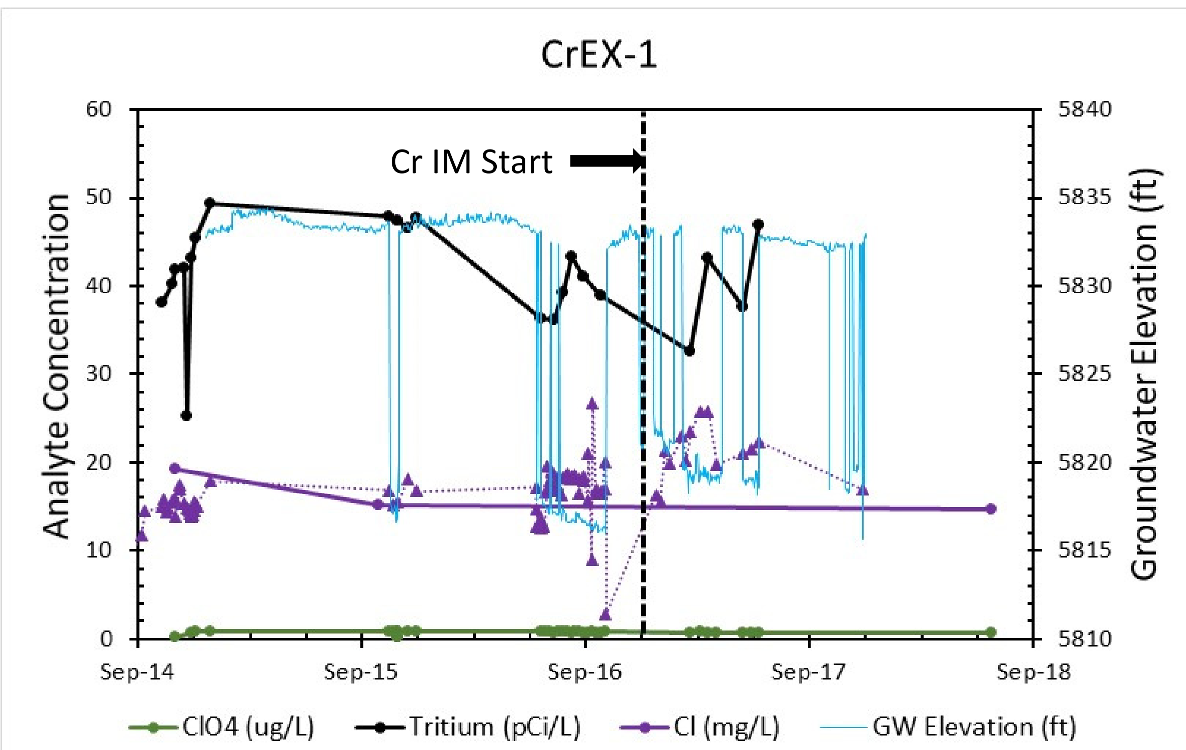




Note: Data represented by open circles are nondetect at the plotted value.

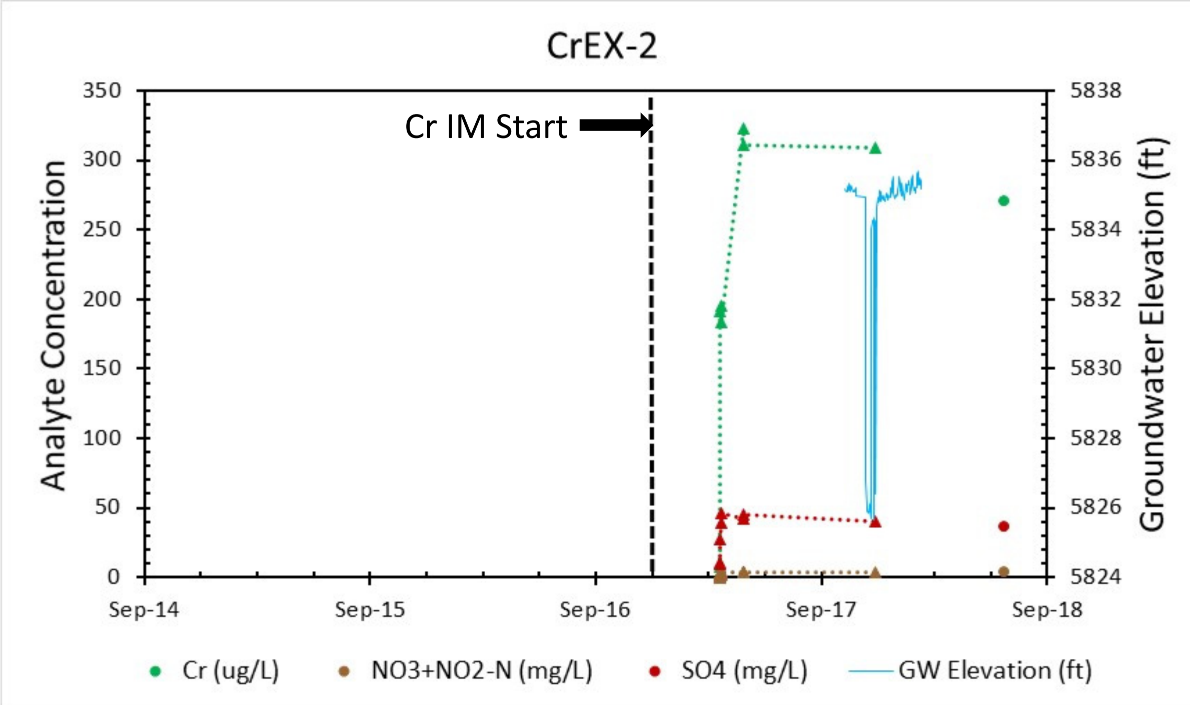
Figure 3.2-11 Time-series plots for SIMR-2

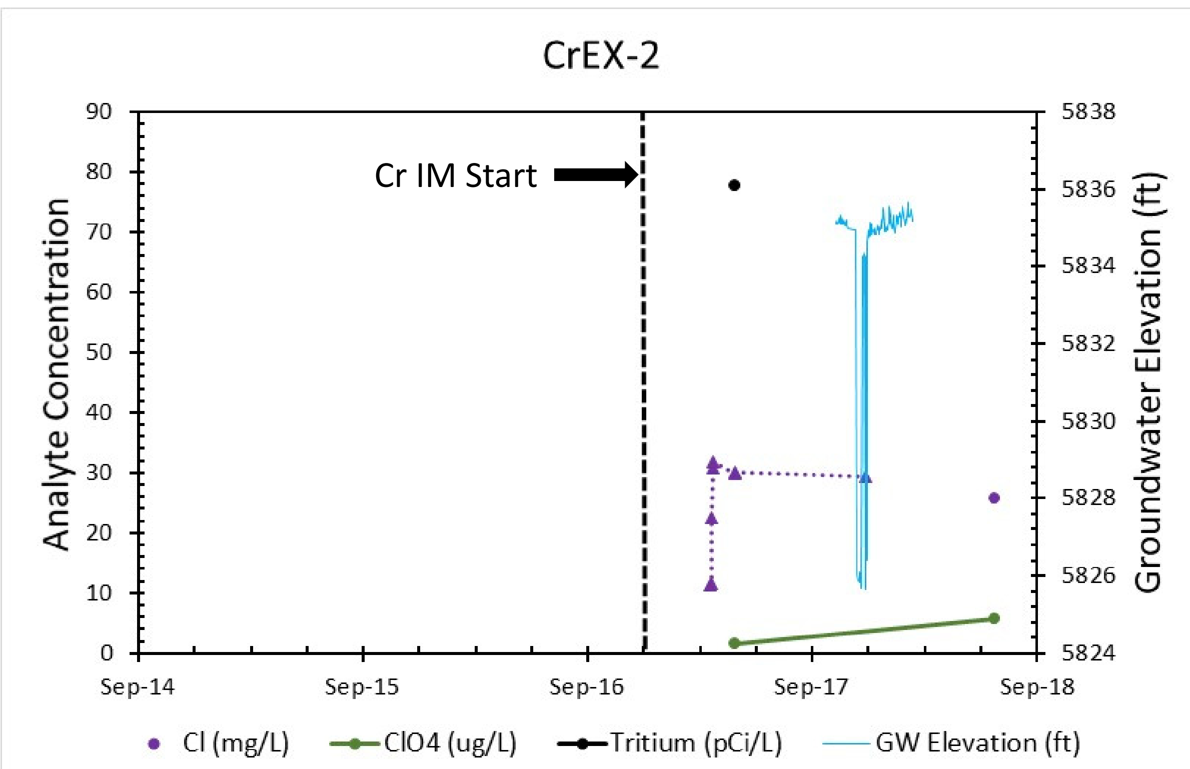




Notes: Data represented by triangles and dashed lines are from screening level analyses. Data represented by open circles are nondetect at the plotted value.

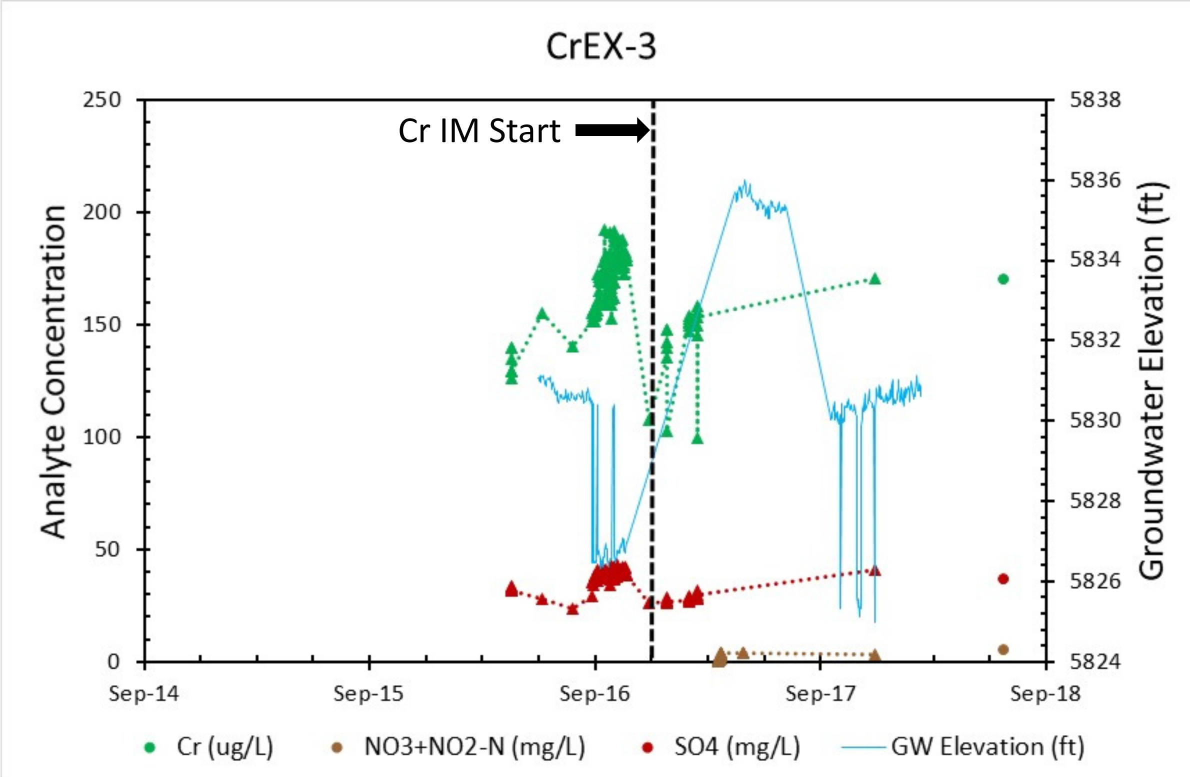
Figure 3.2-12 Time-series plots for CrEX-1

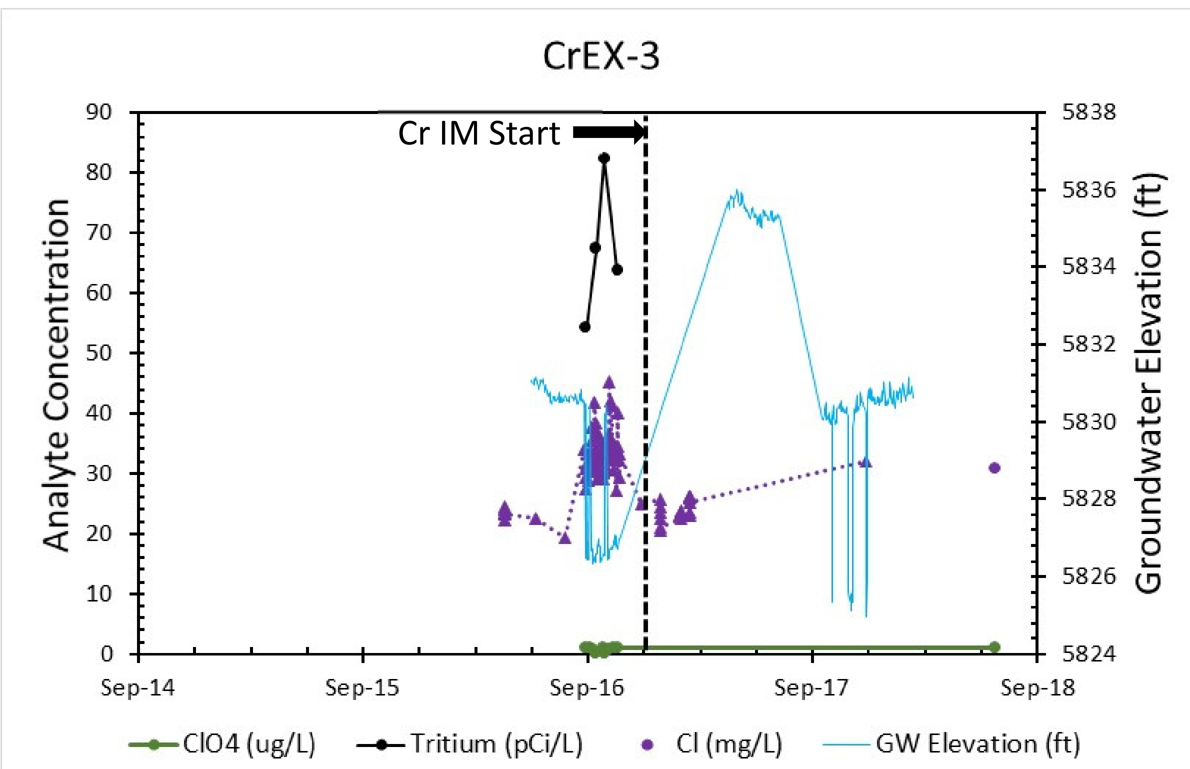




Note: Data represented by triangles and dashed lines are from screening level analyses.

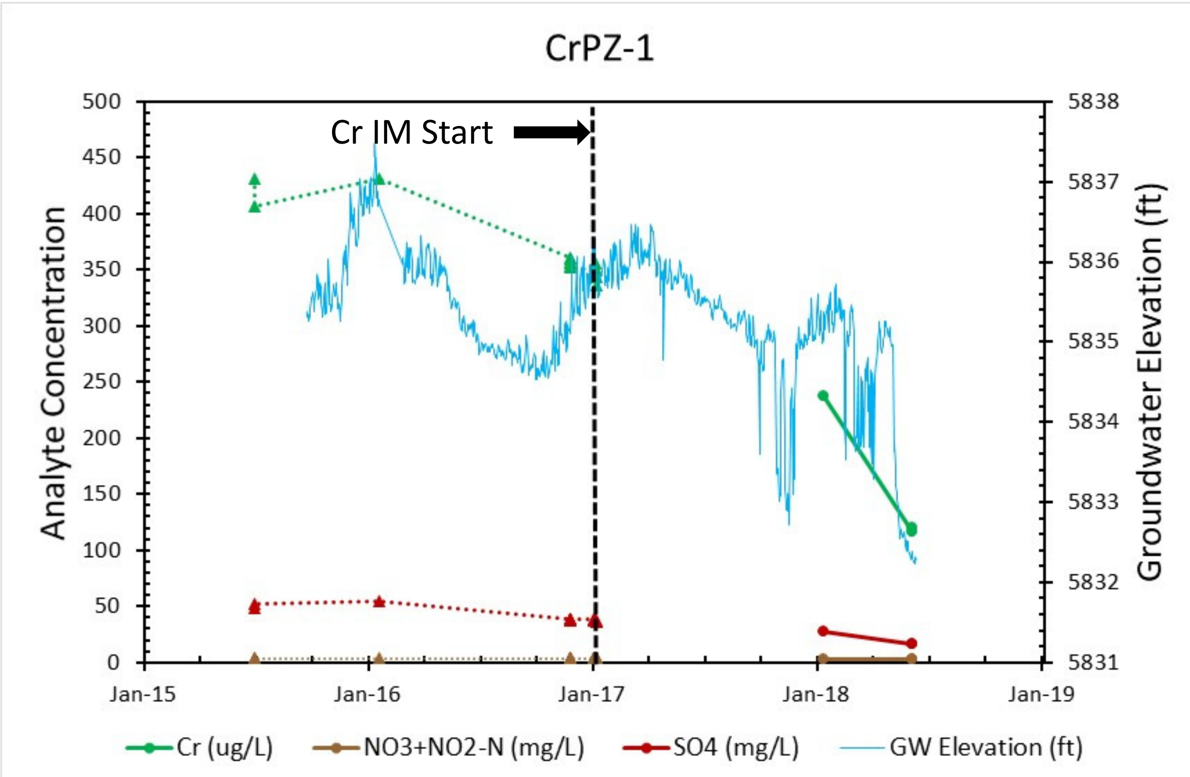
Figure 3.2-13 Time-series plots for CrEX-2

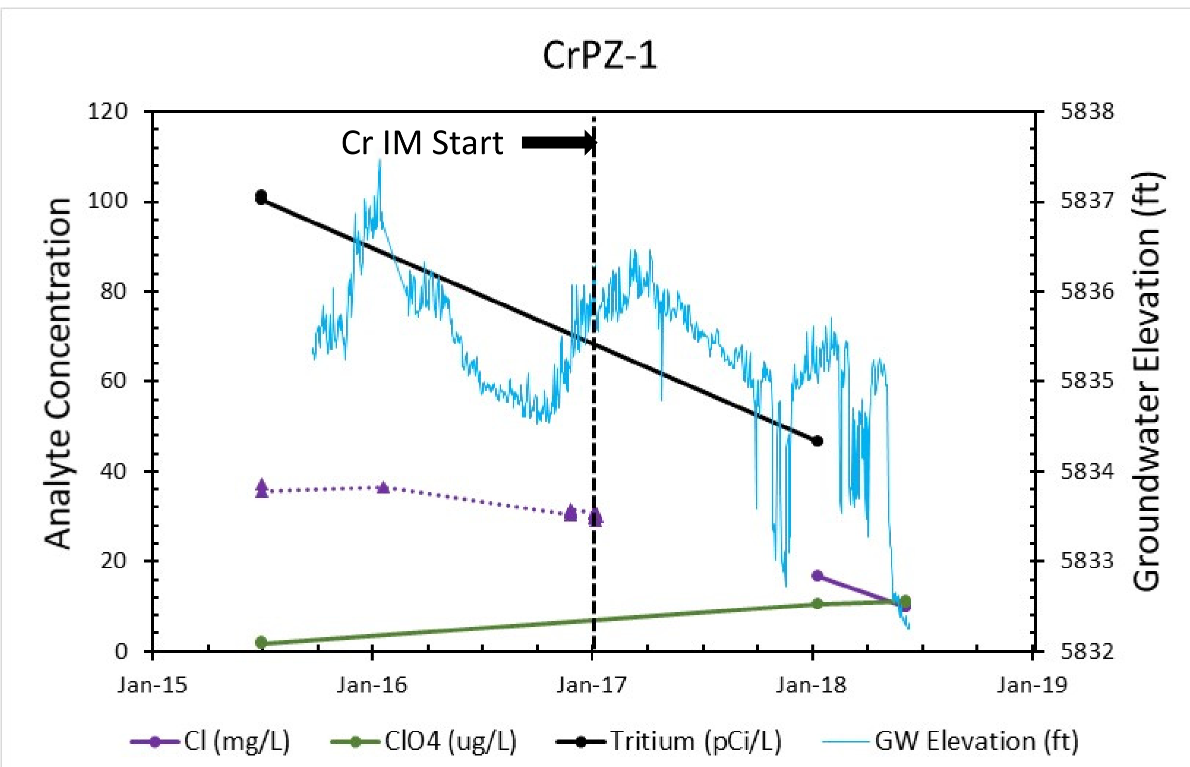




Note: Data represented by triangles and dashed lines are from screening level analyses.

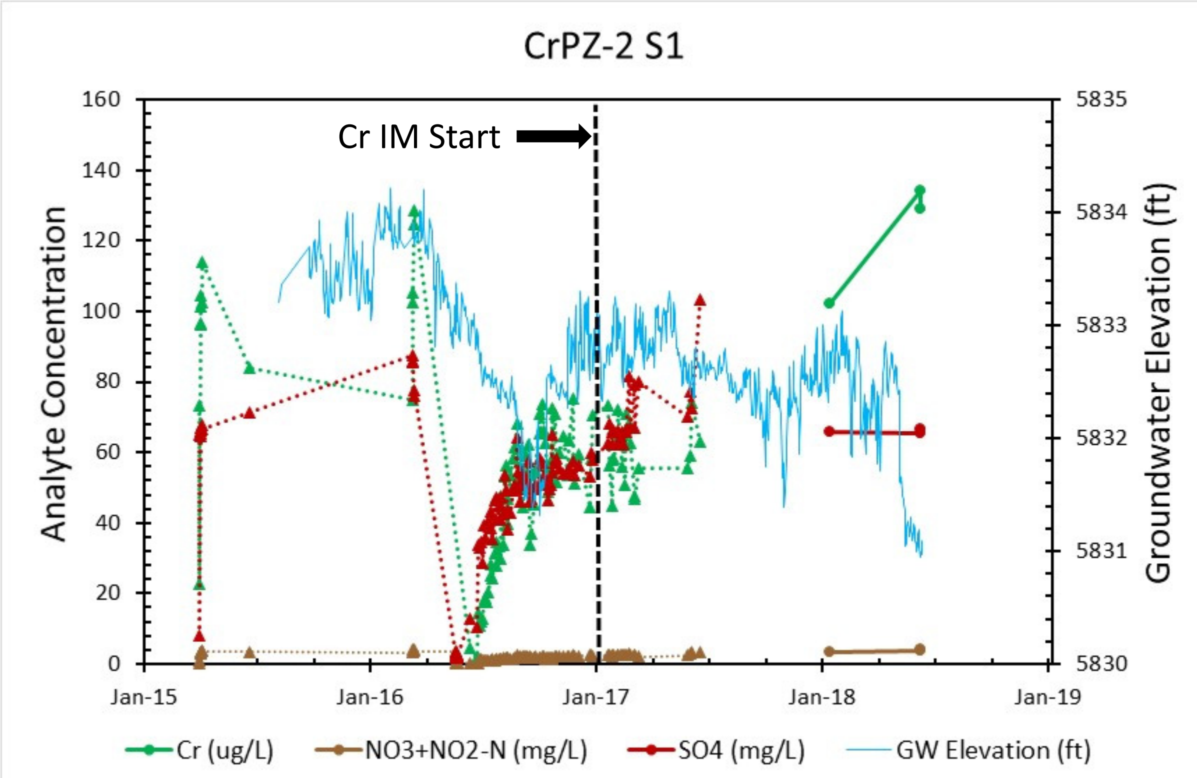
Figure 3.2-14 Time-series plots for CrEX-3

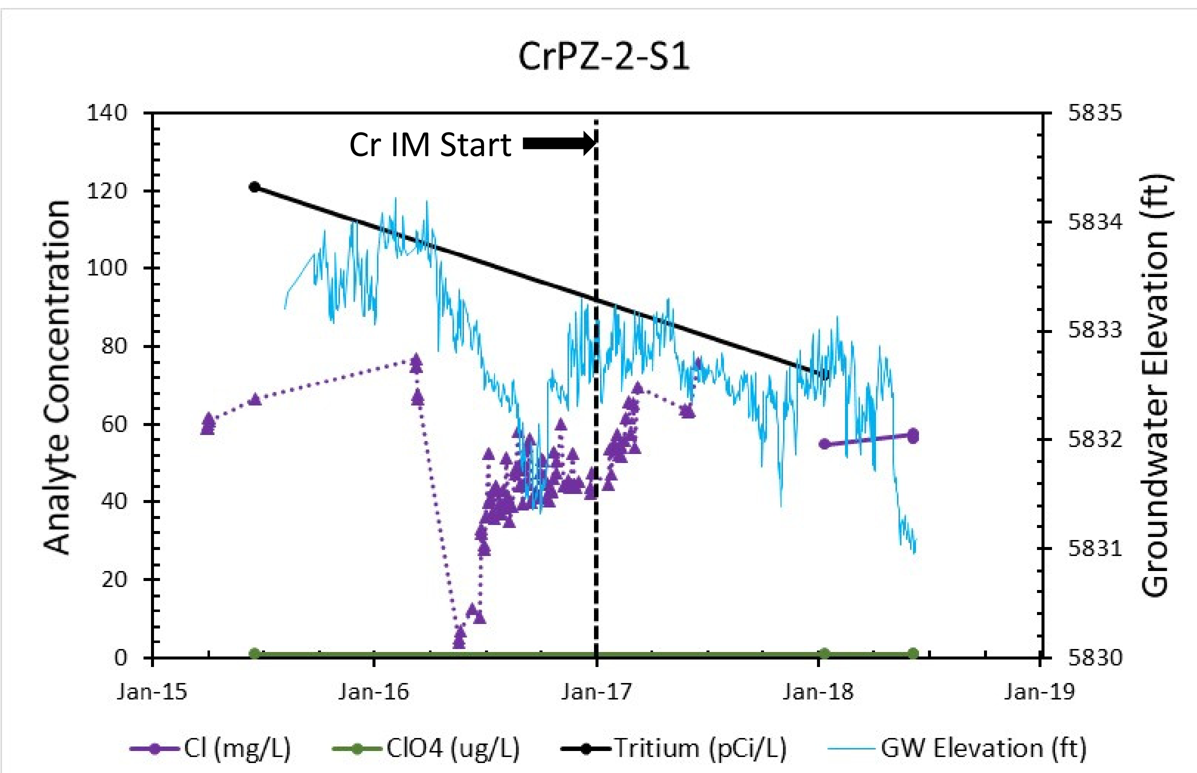




Note: Data represented by triangles and dashed lines are from screening level analyses.

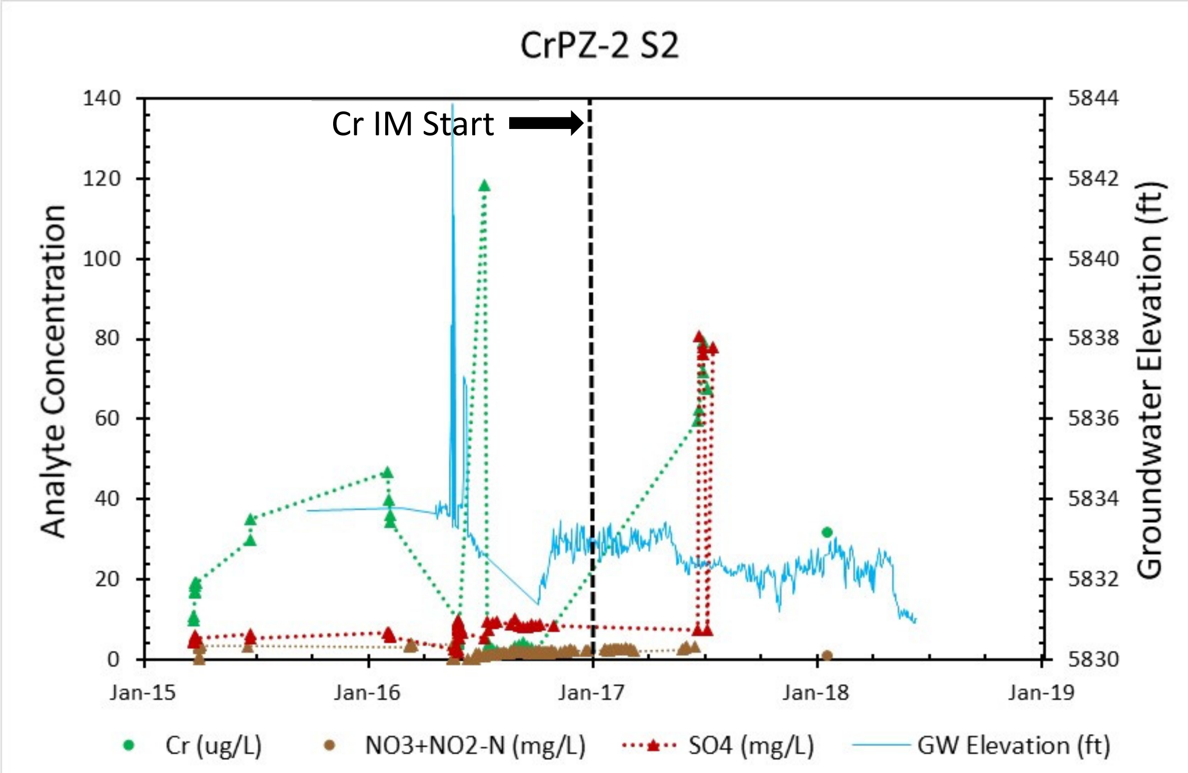
Figure 3.2-15 Time-series plots for CrPZ-1

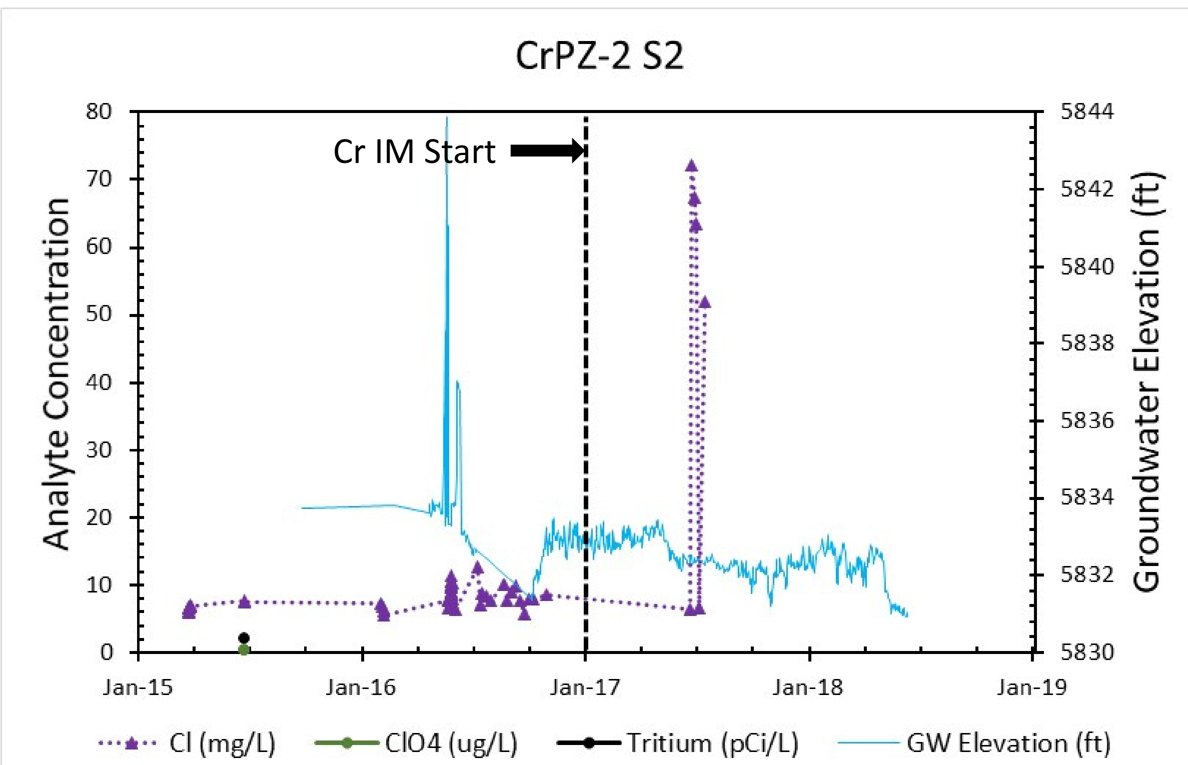




Note: Data represented by triangles and dashed lines are from screening level analyses.

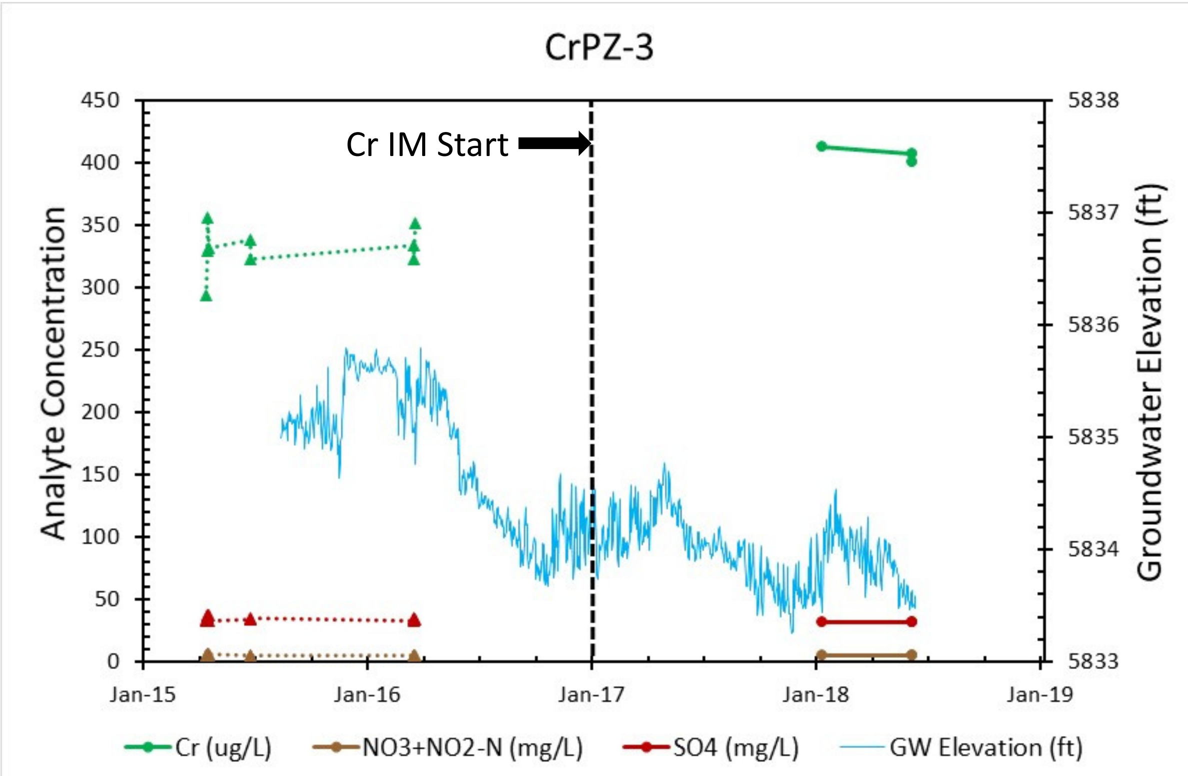
Figure 3.2-16 Time-series plots for CrPZ-2-S1

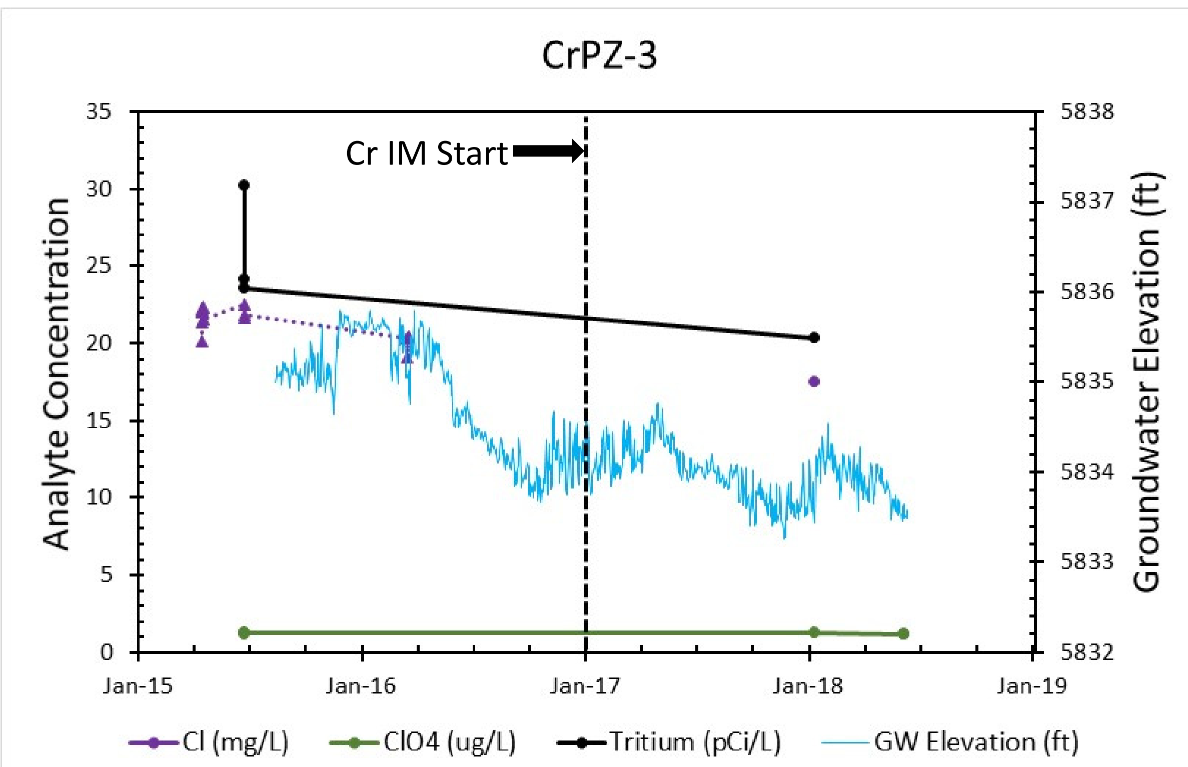




Note: Data represented by triangles and dashed lines are from screening level analyses.

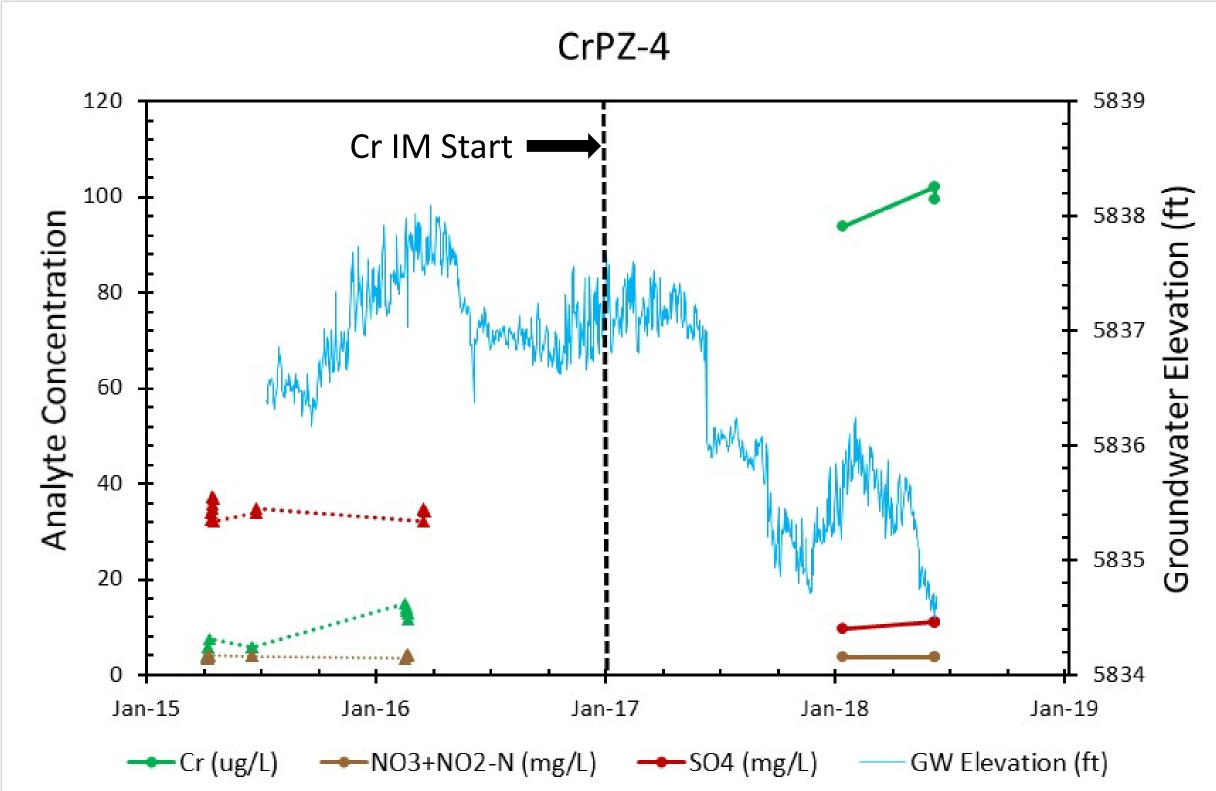
Figure 3.2-17 Time-series plots for CrPZ-2-S2

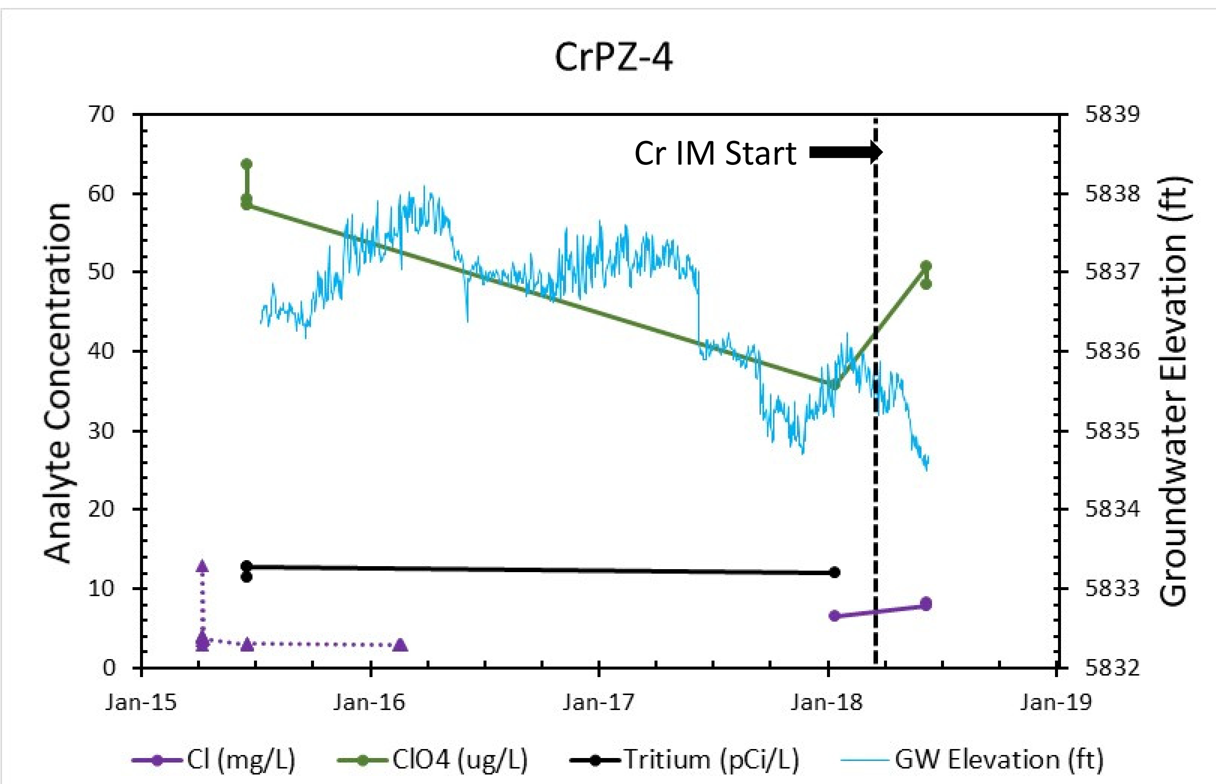




Note: Data represented by triangles and dashed lines are from screening level analyses.

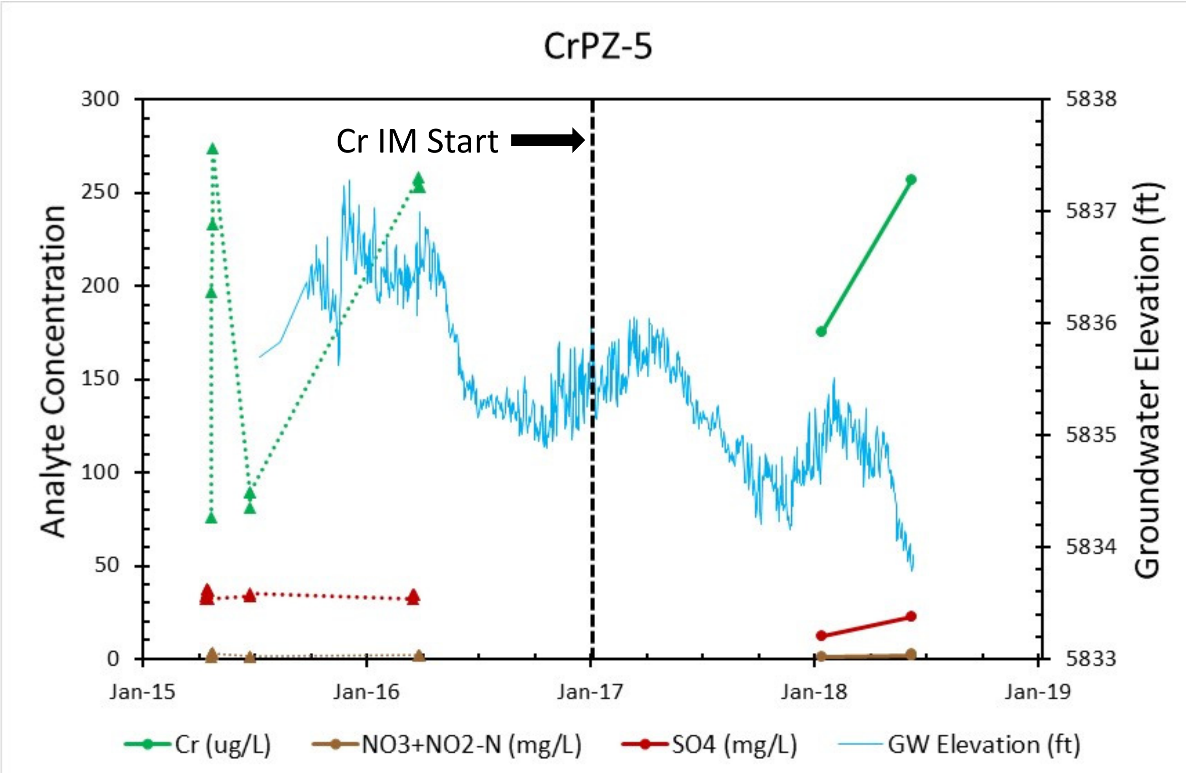
Figure 3.2-18 Time-series plots for CrPZ-3

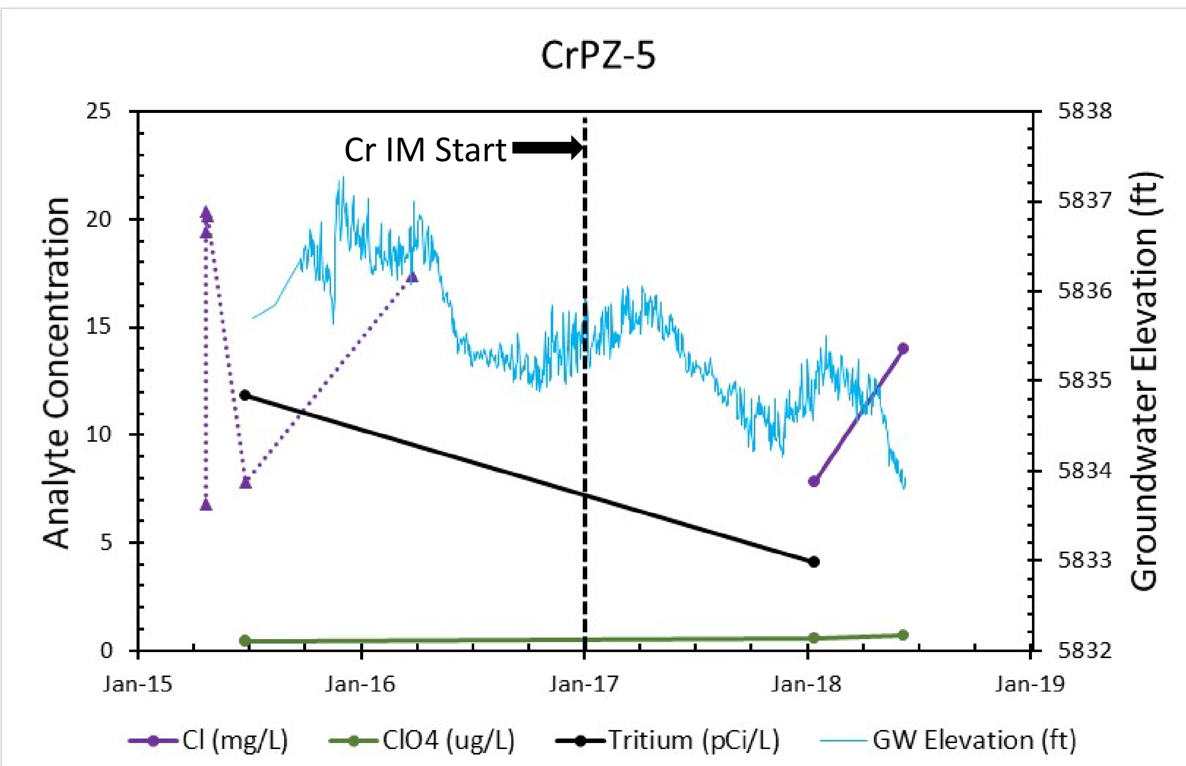




Note: Data represented by triangles and dashed lines are from screening level analyses.

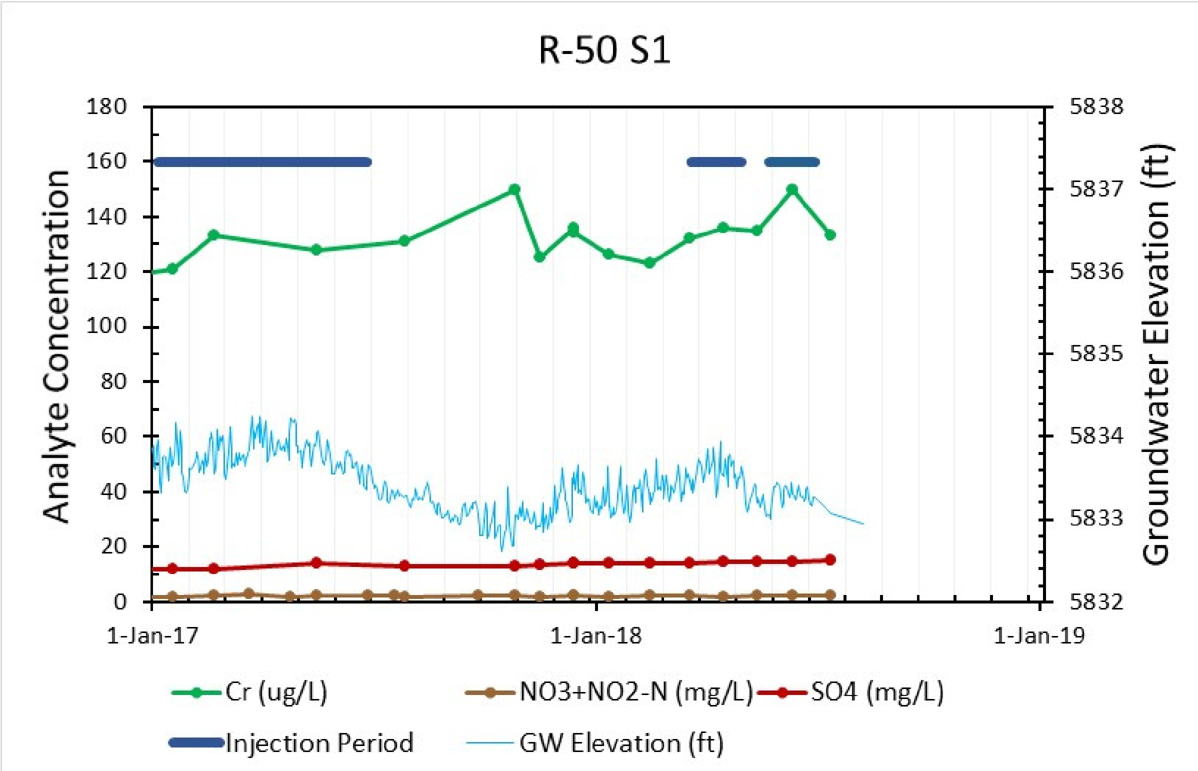
Figure 3.2-19 Time-series plots for CrPZ-4





Note: Data represented by triangles and dashed lines are from screening level analyses.

Figure 3.2-20 Time-series plots for CrPZ-5



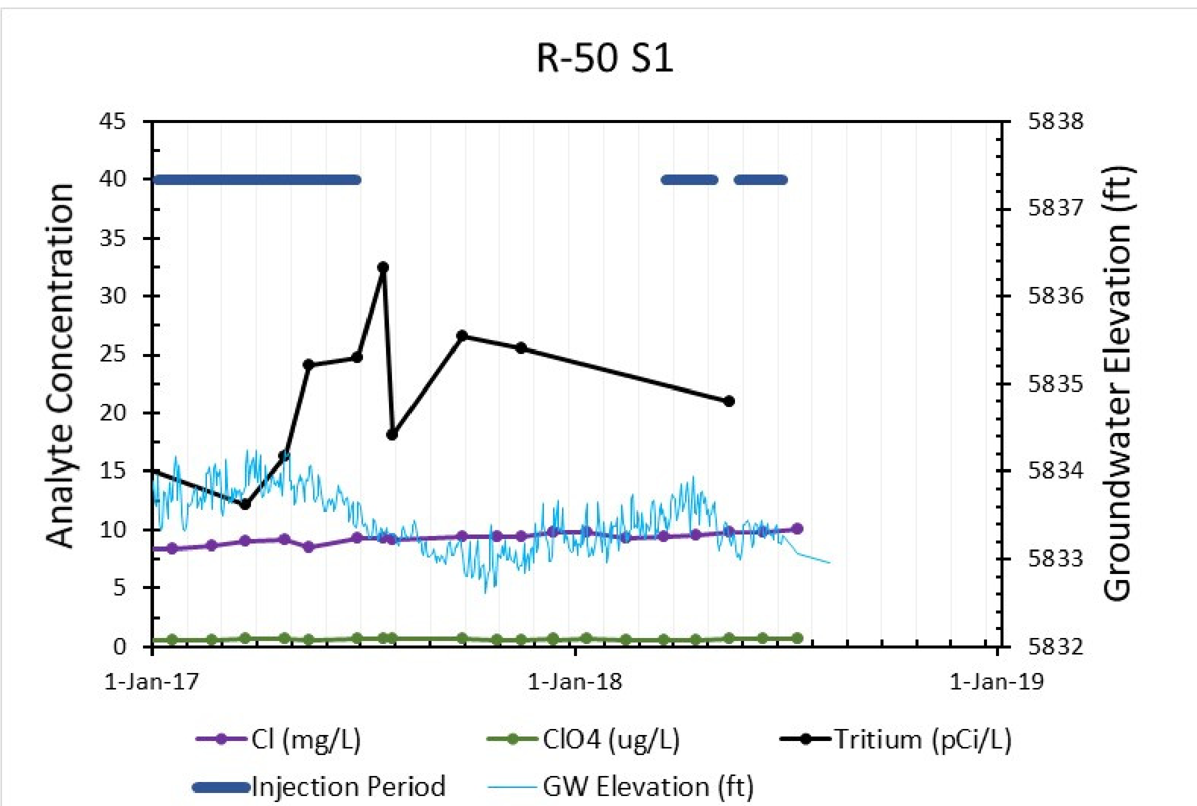
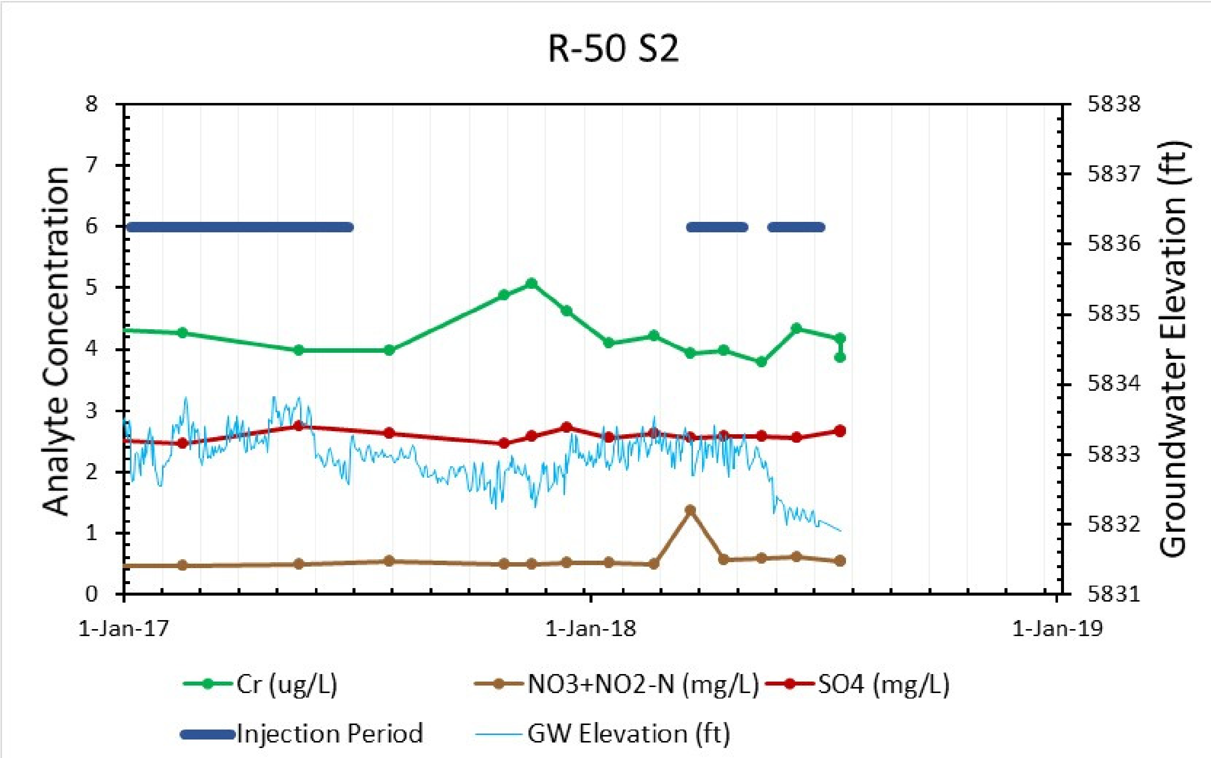


Figure 3.2-21 Detailed time-series plots that focus on the 2017 to 2018 time period for R-50 S1



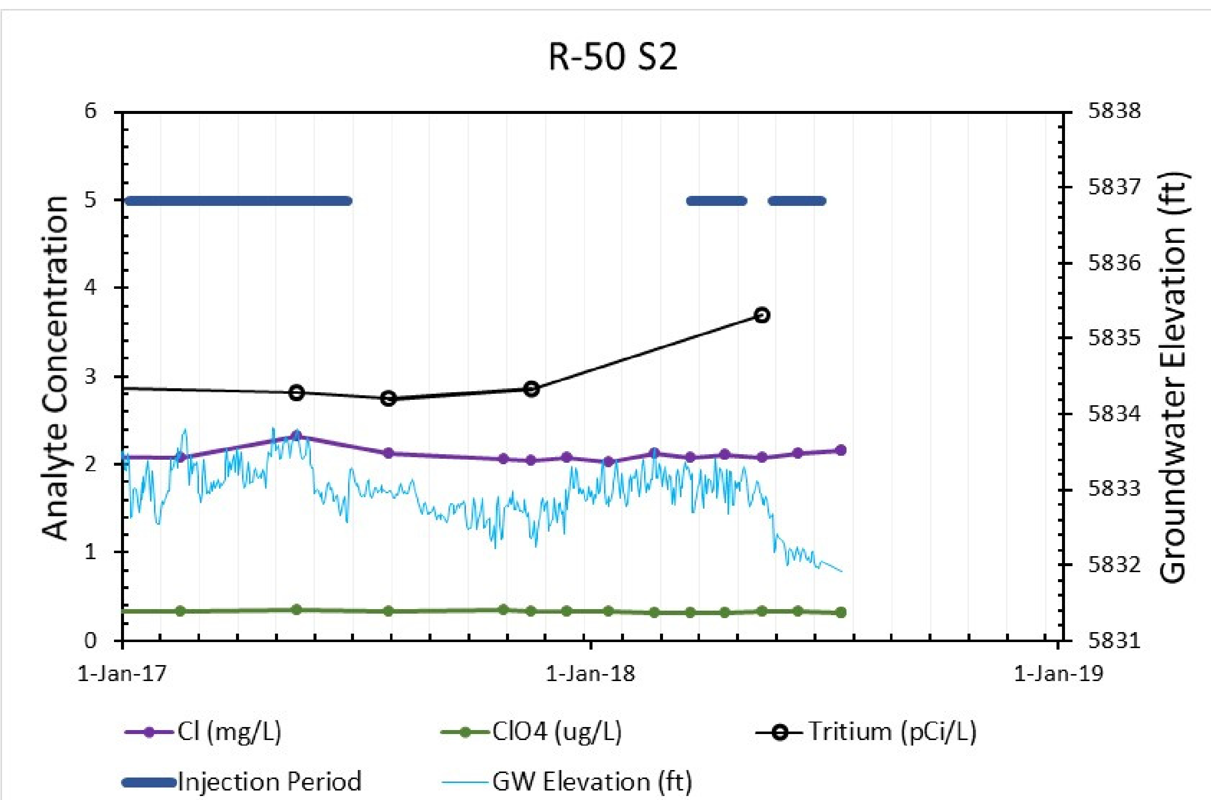


Figure 3.2-22 Detailed time-series plots that focus on the 2017 to 2018 time period for R-50 S2

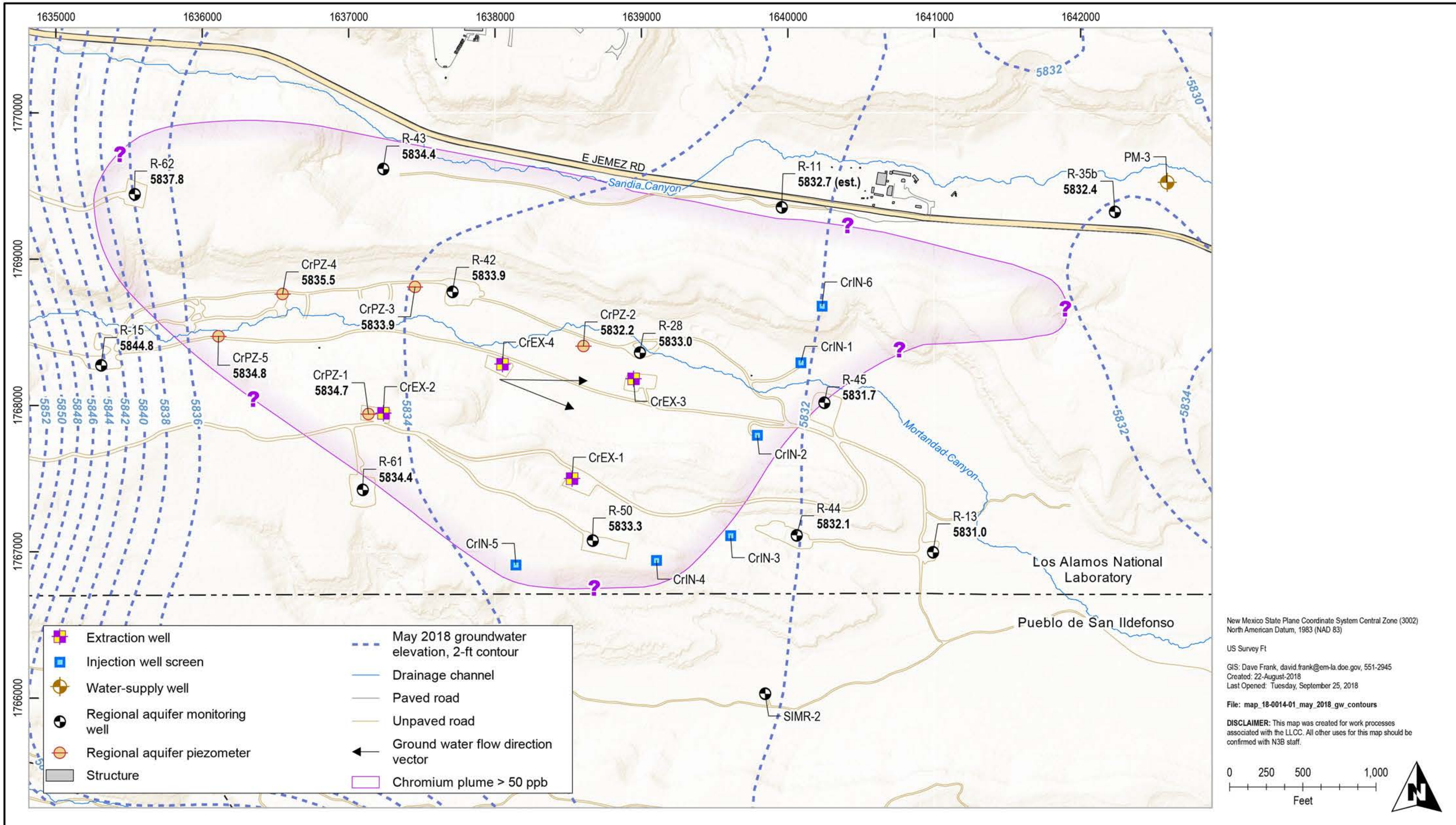


Figure 3.3-1 Water-table map

Table 2.1-1
IM Operations and Maintenance Activities

Maintenance Time Period	Elements Impacted	Maintenance Description
1/5/17 through 2/7/17	CrEX-1, CTUA[a], CrIN-4, and CrIN-5	Injection of treated groundwater resumed at CrIN-4 and CrIN-5 after Laboratory closure.
1/31/17	CTUA[b]	For treatment train C, replaced primary IX vessel with the secondary IX vessel and installed a new secondary IX vessel.
2/7/17 through 2/21/17	CrEX-1, CTUA, CrIN-4, and CrIN-5	Injection of treated groundwater did not occur because of electrical system and panel upgrades.
3/16/17	CTUA[b]	For treatment train A, replaced primary IX vessel with the secondary IX vessel and installed a new secondary IX vessel.
4/11/17	CTUA[b]	For treatment train C, replaced primary IX vessel with the secondary IX vessel and installed a new secondary IX vessel.
4/27/17 through 5/30/17	CrEX-1, CTUA, CrIN-4, and CrIN-5	Injection of treated groundwater did not occur because 1. CrEX-2 aquifer testing was being completed. 2. Pipeline construction activities limited site access to the CrEX-1, CTUA, CrIN-4, and CrIN-5 locations.
5/10/17	CTUA[b]	For treatment train A, replaced primary IX vessel with the secondary IX vessel and installed a new secondary IX vessel.
6/26/17 through 7/12/17	CrEX-1, CTUA[b], CrIN-4, and CrIN-5	Injection of treated groundwater did not occur to allow relocation of the CTUA treatment skid to centralized location and CrEX-2 aquifer testing.
7/12/17 through 10/2/17	CrEX-1, CrEX-2, CrEX-3, CTUA, CrIN-1, CrIN-2, CrIN-3, CrIN-4, and CrIN-5	Injection of treated groundwater did not occur because of 1. Installation of treatment train B IX units in CTUA. 2. System buildout and testing activities related to bringing CrEX-2, CrEX-3, CrIN-1, CrIN-2, and CrIN-3 online.
11/21/17	CTUA	For treatment train A, replaced primary IX vessel with the secondary IX vessel and installed a new secondary IX vessel.
12/15/17 through 2/14/18	CrEX-1, CrEX-2, CrEX-3, CTUA, CrIN-1, CrIN-2, CrIN-3, CrIN-4, CrIN-5, and CrIN-6	Injection of treated groundwater did not occur as a precautionary measure with the Laboratory closure between 12/22 and 1/2 since operations are scheduled to resume with a new configuration of extraction from CrEX-1, CrEX-2, and CrEX-3 with injection into CrIN-3, CrIN-4, and CrIN-5.
2/14/18 through 2/16/18	CrEX-1, CrEX-2, CrEX-4, CTUA[b], CrIN-1, CrIN-2, CrIN-3, CrIN-4, and CrIN-5	Extraction, treatment, and injection of treated groundwater occur related to the CrEX-4 acceptance test.
2/20/18, 2/21/18, 2/28/18, 3/1/18, 3/5/18 through 3/9/18, 3/15/18, and 3/16/18	CrEX-1, CrEX-2, CrEX-3, CrEX-4, CTUA[b], CrIN-1, CrIN-2, CrIN-3, CrIN-4, and CrIN-5	Extraction, treatment, and injection of treated groundwater occur related to the system acceptance test.
3/14/18	CTUA[b]	IX vessels exchanges were completed for treatment trains B and C as follows: • Treatment train B - replaced primary IX vessel with the secondary IX vessel and installed a new secondary IX vessel. • Treatment train C - replaced primary IX vessel with the secondary IX vessel and installed a new secondary IX vessel.

Table 2.1-1 (continued)

Maintenance Time Period	Elements Impacted	Maintenance Description
3/19/18 through 4/23/18	CrEX-1, CrEX-2, CrEX-3, CrEX-4, CTUA, CrIN-1, CrIN-2, CrIN-3, CrIN-4, CrIN-5	Extraction, treatment, and injection of treated groundwater occur related to the system functional test.
4/1/18 through 4/23/18	CrEX-1, CrEX-2, CrEX-3, CTUA, CrIN-3, CrIN-4, CrIN-5	Extraction, treatment, and injection of treated groundwater occurred related to the system functional test.
4/4/18 through 4/5/18	CrIN-5	Maintenance back flushing of injection well with approximately 15,000 gal. of water produced. Back-flush water was transferred to land application system for treatment.
4/9/18 through 4/10/18	CrIN-4	Maintenance back flushing of injection well with approximately 12,000 gal. of water produced. Back-flush water was transferred to land application system for treatment.
4/11/18	CrIN-3	Maintenance back flushing of injection well with approximately 13,700 gal. of water produced. Back-flush water was transferred to land application system for treatment.
4/12/18	CrEX-4	Extraction well pump variable frequency drive was reset and tested.
4/18/18	CrIN-4	Additional maintenance back flushing of injection well with approximately 4000 gal. of water produced. Back-flush water was transferred to land application system for treatment.
4/19/18	CrIN-5	Additional maintenance back flushing of injection well with approximately 3000 gal. of water produced. Back-flush water was transferred to land application system for treatment.
4/23/18	CrEX-1, CrEX-2, CrEX-3, CTUA, CrIN-3, CrIN-4, CrIN-5	System was shut down and secured in preparation LANS to N3B contract transition.
4/25/18	CTUA[b]	IX vessel exchanges were completed for CTUA as follows: Treatment train B – replaced primary IX vessel with the secondary IX vessel; installed new secondary IX vessel. Treatment train C – replaced primary IX vessel with the secondary IX vessel; installed new secondary IX vessel.
5/23/18 through 7/1/18	CrEX-1, CrEX-2, CrEX-3, CTUA, CrIN-3, CrIN-4, CrIN-5	Restart of extraction, treatment, and injection of treated groundwater occurred related to the system functional test following transition to N3B contract.
5/23/18	CrIN-2	Injection well briefly tested during system restart.
6/14/18	CTUA[b]	IX vessel exchanges were completed for CTUA as follows: Treatment train A – replaced primary IX vessel with the secondary IX vessel; installed new secondary IX vessel.
6/19/18	CTUA[b]	IX vessel exchanges were completed for CTUA as follows: Treatment train B – replaced primary IX vessel with the secondary IX vessel; installed new secondary IX vessel. Treatment train C – replaced primary IX vessel with the secondary IX vessel; installed new secondary IX vessel.

[a] CTUA = Chromium treatment unit A.

[b] CTUA contains three treatment trains: train A, train B, and train C.

Table 2.2-1
Interim Measure Chromium Mass Removal Estimates

Quarter	Average HACH CrVI (ppb)	Extracted and Treated Volume (gal.)	Chromium Removed (kg)
1st Qtr 2017	181	6,226,097	4.3
2nd Qtr 2017	184	4,952,226	3.4
3rd Qtr 2017	284	95,471	0.1
4th Qtr 2017	237	5,599,138	5.0
1st Qtr 2018	237	3,045,820	2.7
2nd Qtr 2018	227	13,360,000	11.5
TOTAL		33,944,019	27.5

Table 3.1-1
Performance Monitoring Locations and Analyte Suite, Including Tracers That Have Been or Will Be Deployed in Monitoring Wells, Piezometers, and Injection Wells in the Project Area

Location	Metals	Low-Level Tritium	General Inorganics[a]	Naphthalene Sulfonate Tracers	Sodium Bromide Tracer	Sodium Perrhenate Tracer	Deuterated Water Tracer
R-11	M[b]	Q[c]	M	M	M	M	M
R-35a	M	Q	M	M	—[d]	M	M
R-35b	M	Q	M	M	—	M	M
R-44 S1	M	Q	M	M	—	M	—
R-44 S2	M	Q	M	M	—	M	—
R-45 S1	M	Q	M	M	M	M	M
R-45 S2	M	Q	M	M	M	M	M
R-50 S1	M	Q	M	M	—	—	—
R-50 S2	M	Q	M	M	—	—	—
R-61 S1	M	Q	M	M	—	—	—
SIMR-2	M	Q	M	M	—	—	—
CrPZ-1	Q	Q	Q	—	—	—	—
CrPZ-2a	Q	Q	Q	—	—	—	—
CrPZ-2b	Q	Q	Q	—	—	—	—
CrPZ-3	Q	Q	Q	—	—	—	—
CrPZ-4	Q	Q	Q	—	—	—	—
CrPZ-5	Q	Q	Q	—	—	—	—

[a] Includes nitrate, sulfate, and perchlorate.

[b] M = Monthly.

[c] Q = Quarterly.

[d] — = Not analyzed at the noted location.

Appendix A

Interim Facility-Wide
Groundwater Monitoring Plan Analytical Data
(on CD included with this document)