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

OCT 30 2018

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Hazardous Waste
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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: Work Plan for Tracer Testing in Support of the Phase 2 Amendments Test for Chromium Plume Center Characterization

Enclosed please find two hard copies with electronic files of the "Work Plan for Tracer Testing in Support of the Phase 2 Amendments Test for Chromium Plume Center Characterization." This work plan was referred to in the U.S. Department of Energy Environmental Management Los Alamos Field Office September 20, 2018, letter to the New Mexico Environment Department (NMED), "Request for Extension of Phase 2 Pilot Amendments Testing Work Plan Milestone." The tracer study described in the work plan is an important technical precursor to the development of the "Phase 2 Pilot Amendments Testing Work Plan," which will be submitted to NMED by June 28, 2019.

If you have any questions, please contact Danny Katzman at (505) 309-1371 (danny.katzman@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. Work Plan for Tracer Testing in Support of the Phase 2 Amendments Test for Chromium Plume Center Characterization (EM2018-0060)

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

cc (letter with electronic enclosure[s]):
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cc (letter emailed without enclosure[s]):
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October 2018
EM2018-0060

Work Plan for Tracer Testing in Support of the Phase 2 Amendments Test for Chromium Plume Center Characterization

N3B Los Alamos

EM2018-0060

Work Plan for Tracer Testing in Support of the Phase 2 Amendments Test for Chromium Plume Center Characterization

October 2018

Responsible program director:

Printed Name	Signature	Title	Organization	Date
Bruce Robinson	for Bruce Robinson	Program Director	Water Program	9-27-18

Responsible N3B representative:

Printed Name	Signature	Title	Organization	Date
Joseph A. Legare		Program Manager	N3B Environmental Remediation Program	9-27-18

Responsible DOE-EM-LA representative:

Printed Name	Signature	Title	Organization	Date
Arturo Q. Duran		Designated Agency Manager	Office of Quality and Regulatory Compliance	10/29/18

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1.0 INTRODUCTION

This work plan presents a tracer study that will be conducted in support of upcoming Phase 2 pilot-scale amendments testing that will subsequently be implemented as part of ongoing characterization of potential remedial alternatives for chromium contamination beneath Mortandad Canyon at Los Alamos National Laboratory. The Phase 2 amendments test will build on the work conducted under the New Mexico Environment Department–Hazardous Waste Bureau's (NMED-HWB's) approved "Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon" (Phase 1 Work Plan) (LANL 2017, 602505; NMED 2017, 602546). This tracer-test work plan focuses specifically on the objectives and approach for cross-hole tracer testing, which is a necessary first step of the Phase 2 amendments work. The Phase 1 amendments testing at regional aquifer wells R-42 and R-28 is still underway as of the date of this work plan, and study data from those tests and from the tracer test presented in this work plan will be used to guide the specific technical approach for the Phase 2 amendments test. A Phase 2 amendments testing work plan will be submitted to NMED-HWB when the tracer test data collected under this work plan and sufficient data from the Phase 1 amendments test are available to design the Phase 2 amendment study. Figure 1.0-1 shows the area of the chromium plume and the location of proposed tracer-test location.

2.0 OBJECTIVES

The following two subsections describe the objectives of the Phase 2 amendments testing and the cross-hole tracer testing described in this work plan. The objectives of the Phase 2 amendments test are presented first to provide context for the tracer test objectives discussion that follows.

2.1 Phase 2 Amendments Test

The overarching objective of the Phase 2 amendments test is to build on the Phase 1 test by scaling up the area of the aquifer where geochemical conditions are favorably altered to induce conversion of hexavalent chromium [Cr(VI)] to trivalent chromium [Cr(III)] through introduction of an amendment. Cross-hole amendment deployments that involve a downgradient pumping well have the potential to treat a greater volume of aquifer using the same amount of amendment as in single-well tests and also offer the potential for better spatial control and distribution of amendments than single-well deployments. These factors will likely lead to improved estimates and less uncertainty of Cr(VI) reduction capacity per unit mass of amendment deployed in a cross-hole test. Additionally, cross-hole amendments tests can provide interpretive advantages because of capture of the treated groundwater by downgradient pumping wells, providing better data on the conditions within the treatment zone.

The Phase 2 amendments test will likely propose CrPZ-1 for amendment deployment and CrEX-2 as the cross-hole pumping location. This cross-hole setting provides several ideal advantages over other potential locations because (1) historically elevated chromium concentrations present in CrPZ-1 and CrEX-2 (approximately 350 and 320 µg/L, respectively, based on extended-purge data collected in 2017) offer the opportunity to evaluate Cr(VI) reduction capacity more quickly than at locations with lower concentrations, (2) the distance between the wells (approximately 120 ft) is far enough apart to allow interrogation of a representative area of the aquifer but is close enough to provide a high likelihood of hydraulic capture, and therefore may shorten the overall duration required by the test, and (3) the location is well within the Los Alamos National Laboratory boundary and sufficiently far from water-supply wells, providing some inherent protection if unanticipated adverse effects occur in association with geochemical reactions resulting from amendment deployment. More recent data from CrPZ-1 and CrEX-2 showing decreasing chromium concentrations and increasing perchlorate concentrations suggest that CrPZ-1 is in the CrEX-2 capture zone.

2.2 Cross-Hole Tracer Test

An important first step that will inform the Phase 2 amendments test study design is to characterize cross-hole hydrology between CrPZ-1 and CrEX-2. The regional aquifer stratigraphy and the position of screened intervals for CrPZ-1 (originally drilled as a core hole, CrCH-1, and completed as a piezometer) and CrEX-2 are shown in Figure 2.2-1. The screen and filter pack in CrPZ-1 is entirely within the Puye Formation and the screen in CrEX-2 straddles the contact between the Puye Formation and the Puye pumiceous subunit (see Attachment 3 in LANL 2018, 602964, "Compendium of Technical Reports Conducted Under the Work Plan for Chromium Plume Center Characterization"). Characterization of the hydrology between these two wells via the cross-hole tracer test includes confirming cross-hole communication; evaluating travel times, which will support study design for the deployment, sampling frequency, and interpretation of data during the amendments deployment; and providing important insights into the portion of CrEX-2 water coming through the treatment zone around CrPZ-1. Hydraulic pressure data from CrPZ-1 provide initial indications of favorable hydraulic response at CrPZ-1 associated with pumping activities at CrEX-2 (Figure 2.2-2). The stratigraphic relation of these two screened intervals and the strong correlation between pumping at CrEX-2 and pressure responses at CrPZ-1 suggest a high probability that this is an ideal location for a successful cross-hole study. Because of the strong correlation in the pressure response in CrPZ-1 to CrEX-2 pumping, no additional dilution tracer testing will be conducted in CrPZ-1.

The basic concept is that pumping at CrEX-2 will create a capture zone that includes the CrPZ-1 area. The area of the aquifer that would be treated by application of an amendment is anticipated to be within the CrEX-2 capture zone. However, the CrEX-2 capture zone is likely to also include areas north (and possibly south) of the area around CrPZ-1, where reducing conditions would be established with amendment deployment. Cross-hole tracer samples collected from CrEX-2 during continuous pumping for the interim measure will provide data on initial breakthrough (travel time) and the amount of tracer recovery and allow for a more optimal design and interpretation of a cross-hole amendment test. A tracer would also be deployed in conjunction with subsequent amendment deployment. The amendment tracer will provide comparative data between the two tracer studies and, therefore, facilitate interpretation of data during the cross-hole amendments test. The amendment tracer will also provide well-capture information that will be contemporaneous with the amendment application.

3.0 TRACER TEST APPROACH

The initial tracer-study design is to deploy a conservative tracer mixed into approximately 3000 gal. of water into CrPZ-1 followed by a similar volume of chase water to push the tracer into the aquifer and away from the piezometer. The deployment of these volumes will provide insights into the hydraulics of CrPZ-1 and the surrounding aquifer that will be very useful in the design and methodology for the deployment of the amendment under the Phase 2 Work Plan. CrEX-2 is expected to be operating at a nominal pumping rate of approximately 60 gallons per minute (gpm) during the tracer study. It is optimal for CrEX-2 to operate continuously during the duration of the tracer study, but short-duration shutdowns that may occur for various operational purposes should not adversely affect meeting the objectives of the tracer study.

The tracer planned for this test is sodium iodide (NaI). The tracer deployment requires regulatory acceptance from NMED’s Groundwater Quality Bureau (GWQB). The iodide will move conservatively with groundwater, can be readily analyzed and measured at low concentrations in the field and at an analytical laboratory, is stable in the aquifer, and is distinct from other naturally occurring constituents in the groundwater. Final details of the tracer injection will be provided in a notice of intent to discharge (NOI) submitted to NMED-GWQB following approval of this work plan. A separate tracer will then be used to deploy with the amendment in the phase 2 test at CrPZ-1.

Sampling will take place at the CrEX-2 well head to obtain data to characterize tracer breakthrough. Sampling will take place at CrEX-2 before deployment of the tracer into CrPZ-1 to establish baseline conditions before tracer arrival. The combination of pumping at CrEX-2 and approximately 6000 gal. of tracer-injection water and chase water is likely to result in rapid breakthrough at CrEX-2. The sample-collection frequency will be daily during the early period following deployment to ensure characterization of initial arrival at CrEX-2. Depending on the rate of change in tracer concentration, the sampling frequency may be lowered while still fully characterizing the complete tracer breakthrough curve, including the recessional portion of the curve. If the ideal tracer can be readily measured using ion-specific field probes, the field data will help inform the sampling and analysis frequency.

4.0 STATUS OF PHASE 1 PILOT-SCALE AMENDMENTS TESTING

The initial, and ongoing, pilot-scale tests being conducted under Phase 1 involve use of sodium dithionite at R-42, and molasses at R-28 to create reducing conditions in the regional aquifer (LANL 2017, 602505). Those tests began with deployment of amendments in August and September of 2017, with the goal of evaluating reduction capacity induced with each amendment, volume of the aquifer that can be treated from single deployment locations, and potential adverse physical or geochemical conditions that may occur in association with amendment deployment and subsequent geochemical changes. To date, the dithionite amendment test at R-42 still requires more time to determine Cr(VI) reduction capacity imparted to aquifer sediments because chromium concentrations have not yet begun to break through in R-42. The molasses amendment test at R-28 will also require more time to determine reduction capacity.

The results of the ongoing Phase 1 study are presented in quarterly reports submitted to NMED. Three quarterly reports were submitted in January, April, and July of 2018 (LANL 2018, 602862; LANL 2018, 603031; LANL 2018, 700032). Future Phase 1 quarterly reports will document the progress of the ongoing study and be used to determine when sufficient data are available to guide the second step of Phase 2, which will involve amendment deployment.

5.0 SCHEDULE

The goal is to deploy the tracer for the cross-hole tracer study during the final quarter of calendar 2018, following NMED-HWB's review and approval of this work plan and NMED-GWQB's acceptance of the NOI that will be submitted following approval of this work plan. The overall duration of the cross-hole test is expected to require several months and roughly coincide with the period that it will likely require to obtain sufficient additional data from the Phase 1 tests at R-42 and R-28. Data from the cross-hole tracer study and the Phase 1 amendment tests will be used to develop and submit a supplement to this work plan that provides specific details of the selection and deployment approach for the amendment step of this Phase 2 test.

The amendment deployment design and monitoring plan will be submitted to NMED after data from the cross-hole tracer test and results of the Phase 1 amendments testing are sufficient to inform the Phase 2 study design. The deployment design will include the type and concentration of amendment, the quantity of amendment to be deployed, and deployment approach, including introduction rate and quantity of chase water, and the accompanying tracer.

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 Newport News Nuclear BWXT – Los Alamos, LLC (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), July 2017. "Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon," Los Alamos National Laboratory document LA-UR-17-25406, Los Alamos, New Mexico. (LANL 2017, 602505)

LANL (Los Alamos National Laboratory), January 2018. "Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater beneath Mortandad Canyon," Los Alamos National Laboratory document LA-UR-18-20467, Los Alamos, New Mexico. (LANL 2018, 602862)

LANL (Los Alamos National Laboratory), March 2018. "Compendium of Technical Reports Conducted Under the Work Plan for Chromium Plume Center Characterization," Los Alamos National Laboratory document LA-UR-18-21450, Los Alamos, New Mexico. (LANL 2018, 602964)

LANL (Los Alamos National Laboratory), April 2018. "Second Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon," Los Alamos National Laboratory document LA-UR-18-23418, Los Alamos, New Mexico. (LANL 2018, 603031)

LANL (Los Alamos National Laboratory), July 2018. "Third Quarterly Report on Pilot-Scale Amendments Testing for Chromium in Groundwater Beneath Mortandad Canyon," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2018, 700032)

NMED (New Mexico Environment Department), July 31, 2017. "Approval, Pilot-Scale Amendments Testing Work Plan for Chromium in Groundwater beneath Mortandad Canyon," New Mexico Environment Department letter to D. Hintze (DOE-EM) and B. Robinson (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2017, 602546)

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.

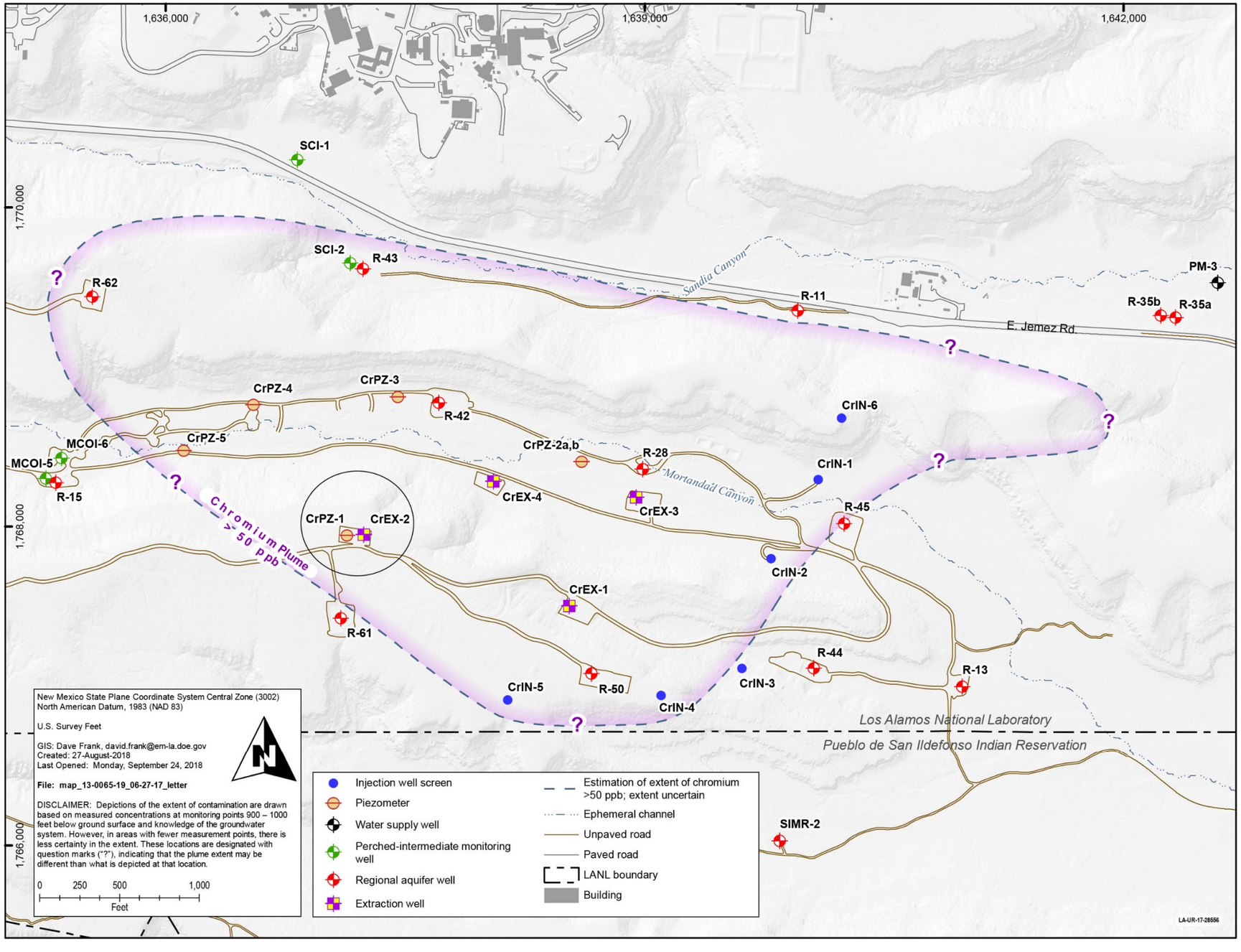

Figure 1.0-1 Chromium plume area and proposed tracer test location shown in circled area

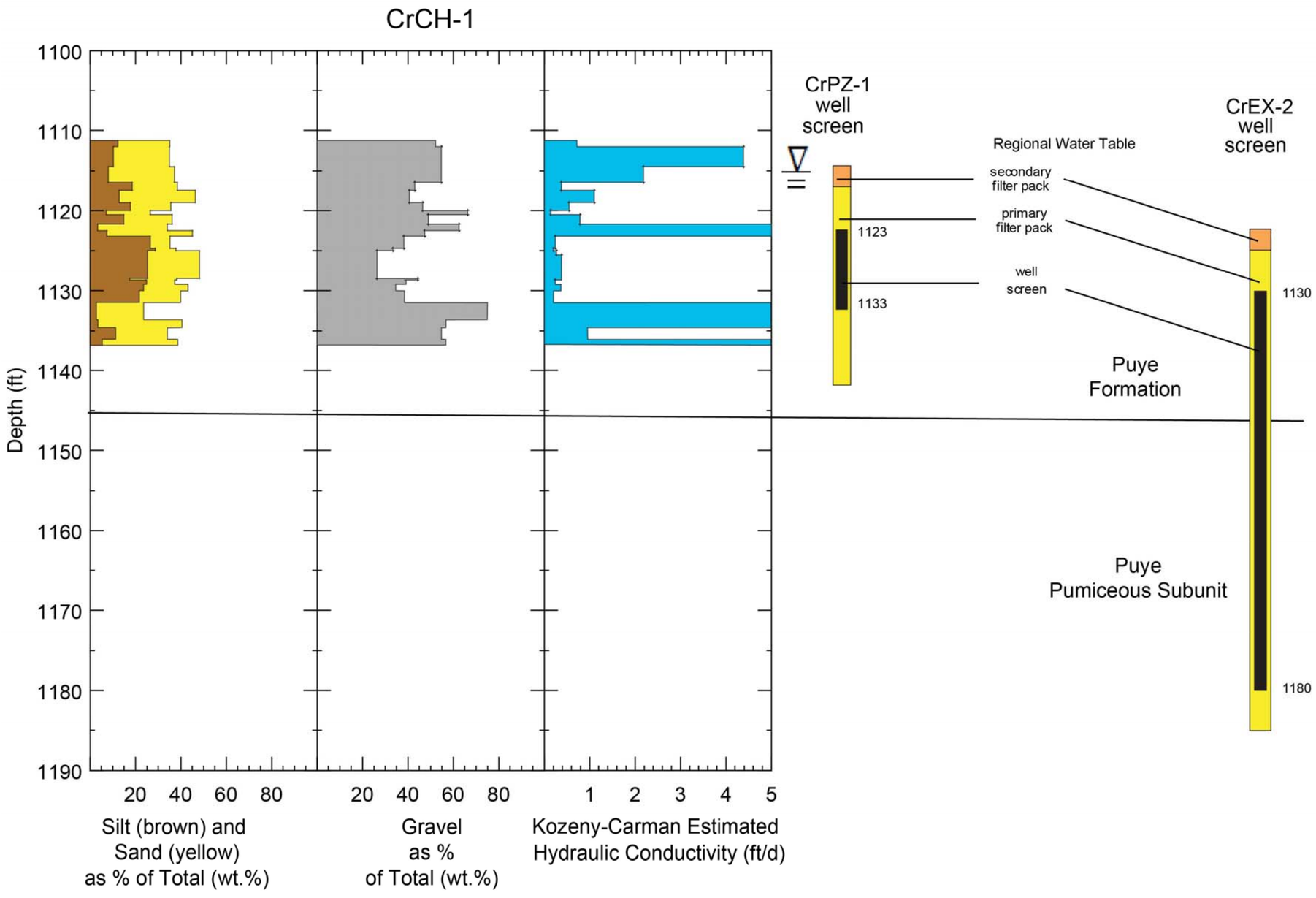

Figure 2.2-1 **Grain-size variations for strata in the upper part of the regional aquifer. The CrPZ-1 (completed in the CrCH-1 borehole) and CrEX-2 well screens are shown for reference. The contact between the Puye Formation and the Puye pumiceous subunit is based on well CrEX-2, which is located on the same drill pad as CrPZ-1.**

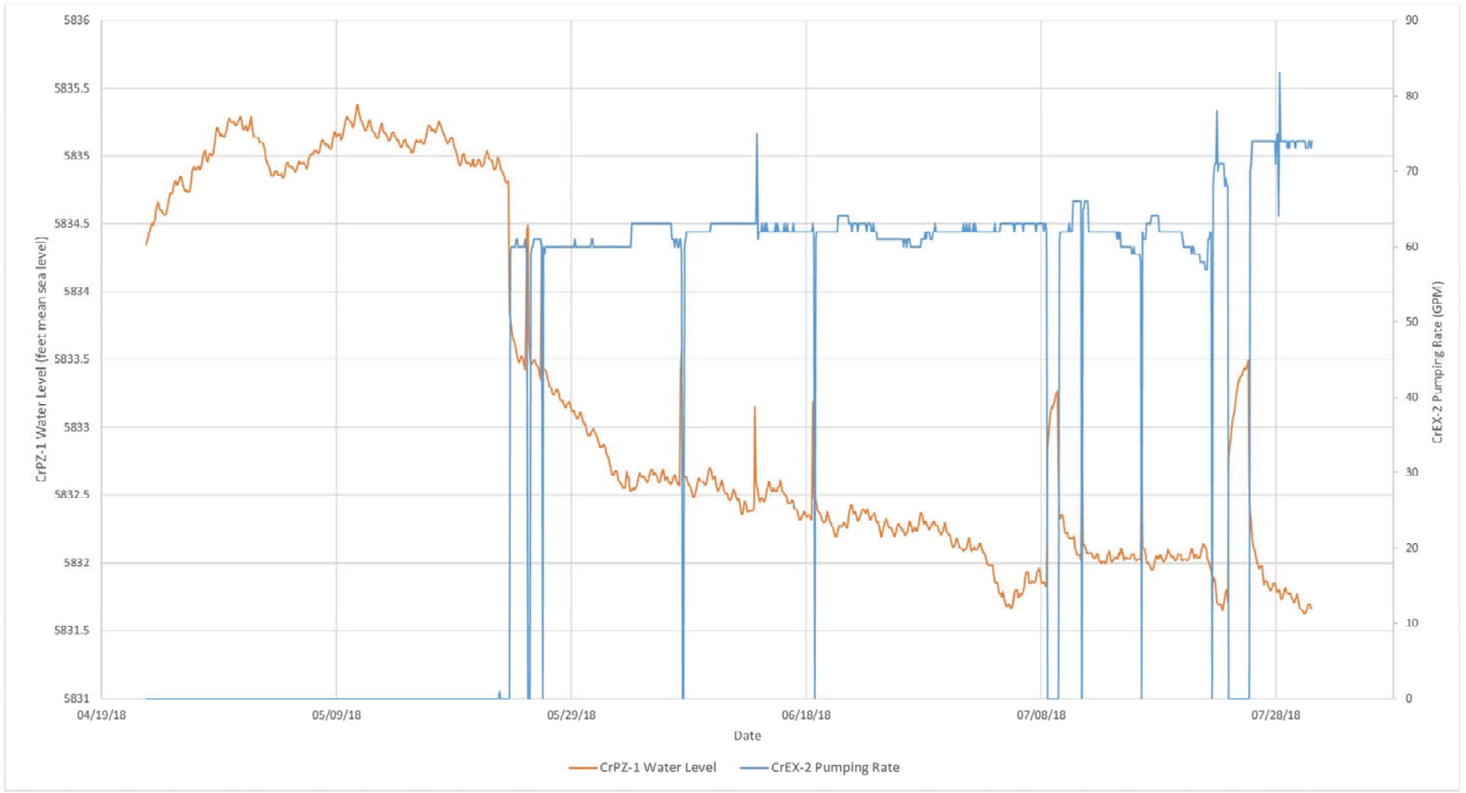

Figure 2.2-2 CrEX-2 pumping record/rates and CrPZ-1 hydrograph