2014 Sitewide Groundwater Sampling Technical Memorandum, Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

PREPARED FOR: U.S. Environmental Protection Agency, Region II
U.S. Army Corps of Engineers, Kansas City District

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Introduction

CH2M HILL conducted groundwater monitoring activities at the Garfield Groundwater Contamination Superfund Site in the city of Garfield, Bergen County, New Jersey (site) during a 3-week period in December 2014. This sitewide groundwater sampling event was conducted to supplement the *Remedial Investigation Report* (RIR) that was prepared for the U.S. Environmental Protection Agency (USEPA), Region II and the U.S. Army Corps of Engineers (USACE), Kansas City District (CH2M HILL 2014a). These groundwater monitoring activities consisted of the following:

- Groundwater elevation level synoptic monitoring at 50 monitoring wells and one Passaic River "stream gauge" (one monitoring well was excluded from the synoptic measurements because of a parked car blocking access).
- Groundwater sampling at 51 monitoring wells including flexible liner underground technology (FLUTe) multiport monitoring wells for hexavalent chromium (Cr(VI)) and field analysis of ferrous (+II) iron. Select monitoring wells also were analyzed for groundwater redox parameters including total chromium, dissolved iron, dissolved manganese, sulfate, nitrate/nitrite, and total organic carbon (TOC). The groundwater sample tracking table is included as Table 1.

The data other than Cr(VI) were collected during this 2014 sitewide sampling event to support the in-situ reduction pilot study (pilot study) that was conducted in phases during 2014. This technical memorandum incudes a discussion about the process of collecting the data while the results of the pilot study are discussed in the *Results of the In Situ Reduction Pilot Study Test* memorandum (CH2M HILL 2015).

Groundwater sampling activities were conducted in accordance with the procedures outlined in the primary site-specific Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP; CH2M HILL 2012) and the addendum to the primary site-specific UFP-QAPP (CH2M HILL 2014b) at each of the monitoring wells sampled. Figure 1 depicts the locations of the site monitoring wells. Details of the synoptic water level event, groundwater sampling activities, and groundwater analytical results are described below.

Monitoring Well Water Level Synoptic Event

Before sampling groundwater, one round of synoptic depth-to-water measurements was collected on December 3, 2014, from 50 of 51 onsite monitoring wells (including select Kalama Chemical and T.A. Farrell monitoring wells). Monitoring well EPA-09-OB could not be measured on December 3, 2014, nor when attempted again on December 4, 2014, because a car was parked on top of the well. Monitoring well EPA-19-BR was not able to be measured on December 3, 2014, because a car was parked on the well, but was measured on the following day. Flowing artesian groundwater conditions were observed at EPA-24R-BR, EPA-28-BR, and each of the ports within EPA-20-BR except port EPA-20-BR-125. As a result, no groundwater elevations were calculated at these locations. The water level measurements were used to calculate the groundwater elevation at each well. Groundwater elevation contour maps were prepared for the overburden and bedrock aquifers from these measurements and calculations to provide information on the

inferred groundwater flow direction (Figures 2 and 3). Table 2 presents a summary of the depth-to-water measurements and corresponding groundwater elevations.

Before obtaining water levels at each monitoring well, well headspace and breathing zone readings were collected using a calibrated photoionization detector (PID) with a 10.6-electron volt lamp. At conventional monitoring wells, depth-to-water measurements were collected using an electronic water level indicator following an equilibration period to allow the water column to stabilize to atmospheric pressure after removing the well cap. Depth–to-water measurements at the FLUTe wells were collected from within the sample tubing of each FLUTe port following the manufacture's specified procedures using a narrow-diameter electronic water level indicator. Following the manufacturer's recommendations, the sample tubing at each FLUTe port was purged before each synoptic event to minimize the potential for inaccurate water level measurements caused by a check-valve integrated in the FLUTe construction and changes in water levels and barometric pressure over time. Each water level indicator/probe and probe measuring tape was decontaminated with a rinse of Alconox and deionized water after each location to minimize the potential for cross-contamination between monitoring wells.

The inferred groundwater flow directions (flow perpendicular to the groundwater elevation contours) were similar to those from previous synoptic measurement events. Groundwater is inferred to flow generally east to west toward the Passaic River for both the overburden and bedrock aquifers.

Groundwater Sampling

Groundwater Sampling Procedure

One round of groundwater samples was collected from the 51 monitoring wells in general accordance with the procedures outlined in the site-specific UFP-QAPPs (CH2M HILL 2012, 2014b). Groundwater samples from conventional monitoring wells were collected following the USEPA standard operating procedures (SOPs) for low-stress (low-flow)/minimal drawdown groundwater sample collection and procedures using decontaminated Grundfos RediFlo-2 submersible pumps with polyethylene purge/sample tubing. Significantly more costly Teflon-lined discharge tubing was not required because volatile organic compounds were not analyzed. Groundwater samples from FLUTe wells were collected using inert nitrogen gas to expel water from the sample port following procedures described in the UFP-QAPPs (CH2M HILL 2012, 2014b).

Groundwater samples were shipped to Australian Laboratory Services Group (ALS) of Rochester, New York for Cr (VI) analysis using USEPA Method 218.6. Samples also were analyzed by the USEPA's Contract Laboratory Program and Division of Environmental Science and Assessment laboratory systems for the following analyses:

- Total chromium
- Dissolved iron and manganese (Method ISM01.3)
- TOC (Method SM 5310B)
- Nitrate + nitrite (USEPA Method 353.2)
- Sulfate (Method SW9056)

Disposable, single-use 0.45-micron filters were used to filter groundwater in the field for dissolved metals and Cr(VI).

Ferrous (+II) iron was analyzed for in the field with a field Hach colorimeter following the stabilization of groundwater parameters. Water quality parameters, including hydrogen ion potential (pH), temperature, specific conductivity, oxidation-reduction potential (ORP), dissolved oxygen (DO), and salinity, were collected using a Horiba U-52 during the purging of each well and recorded on field data sheets. An airtight Horiba flow-through cell was used to ensure accurate water quality parameters data, specifically DO and ORP, which can be influenced by atmospheric oxygen. Turbidity was measured using a Hach 2100Q turbidity meter. Groundwater purge and sample field data sheets are included in Attachment 1.

Field sample collection, decontamination, and quality control (QC)/quality assurance (QA) procedures were followed in accordance with the project-specific UFP-QAPPs (CH2M HILL 2012, 2014b). Field duplicates (FD) and matrix spike (MS)/matrix spike duplicates (MSD) volumes were collected at a rate of 1 per 20 field samples for all analysis, with the exception of redox potential parameters, which did not require QA/QC procedures. Equipment blanks were collected at a rate of one sample per day by running Type II reagent grade deionized water through a decontaminated pump into the required sample bottles.

Data Quality Evaluation

CH2M HILL performed a data quality evaluation (DQE) for Cr(VI) groundwater sample analytical data collected as part of the 2014 sitewide sampling event. The DQE reports contain an assessment of the quality and usability of the Cr(VI) analytical data. The DQE is included at Attachment 2.

The DQE found that the data generated from groundwater sample analyses were of sufficient quality and quantity necessary for accomplishing the project objectives. However, the DQE did describe equipment blank contamination issues likely attributable to buffer solution used by the laboratory. The blank contamination resulted in “B” or “UB” data qualifier flags for 81 analytical results associated with equipment blanks that had concentrations of Cr(VI) over the reporting limit. The DQE includes recommendations to avoid potential blank contamination during future sampling events.

Deviations during Groundwater Sampling

The sample from EPA-21-BR-183 was collected on January 7, 2015, because of a blockage of unknown origin and composition in the discharge line during the initial December 9, 2014 sample attempt. CH2M HILL attempted to reconcile the blockage/sample issue by consulting with FLUTe personnel; however, the discharge line remains blocked. The groundwater sample was ultimately collected on the second attempt through the air line following an alternative sample procedure SOP provided by FLUTe.

The ALS laboratory mistakenly failed to analyze Cr(VI) groundwater samples collected from EPA-11-OB, EPA-19-OB, EPA-21-BR sampling Port 1 (85 feet below ground surface [bgs]), EPA-21-BR sampling Port 2 (127 feet bgs), and EPA-21-BR sampling Port 3 (159 feet bgs) within the required hold time. As a result, these wells were resampled on February 4 and 5, 2015 for Cr(VI) analysis.

EPA-21-BR-225 was sampled twice during the 2014 sampling event because the initial Cr(VI) result from December 17, 2014 (2,940 micrograms per liter [µg/L]) was significantly higher than the August and September 2012 results (31 µg/L and 7 µg/L, respectively). The Cr(VI) result from February 5, 2015 was 2,820 µg/L, which was similar to the December 17, 2014 result.

The results for EPA-21-BR-127 also exhibited varying concentrations of Cr(VI). The concentration of Cr(VI) for the sample collected from this port in December, 2014 was 33 µg/L, which is significantly lower than the concentrations observed in August and September, 2012 (3,370 µg/L and 3,520 µg/L, respectfully).

It was determined in September 2015, the reason for these varying concentrations of Cr(VI) at EPA-21-BR was that the sampling ports for EPA-21-BR-127 and EPA-21-BR-225 were not installed in sequence when the FLUTe monitor well was re-installed in December 2013, therefore the results for EPA-21-BR-127 are the actual results for EPA-21-BR-225 and the sample results for EPA-21-BR-225 are the actual results for EPA-21-BR-127. .

Groundwater Sampling Results

The analytical results of the groundwater samples are presented in Table 3 along with a summary of groundwater field parameters. Groundwater redox parameters were collected and analyzed as part of this 2014 sitewide sampling event; the results of these parameters are evaluated in the *Results of the In Situ Reduction Pilot Study Test* memorandum (CH2M HILL 2015). Figure 4 shows Cr(VI) isoconcentration contours in the overburden aquifer wells, and Figure 5 shows Cr(VI) isoconcentration contours in the bedrock aquifer

wells. Isoconcentration contours for the overburden aquifer and bedrock aquifer were created using Cr(VI) analytical results from the 2014 groundwater sampling event.

The extent of the overburden groundwater Cr(VI) plume based on the December 2014 analytical data is similar to that describe in the RIR (CH2M HILL 2014a). The overburden plume expands westward from the E.C. Electroplating (ECE) property and appears to dissipate at the Passaic River. Although the general size and geometry of the 2D overburden Cr(VI) plume was similar in 2014 to 2012, new wells on the ECE property from the pilot study were available in 2014. The wells in the center of the property (EPA-29-OB, EPA-31-OB, and EPA-32-OB) had significantly higher Cr(VI) concentrations (between 213,000 µg/L and 269,000 µg/L) than EPA-13-OB did during the remedial investigation (RI) (from 44,300 to 56,500 µg/L). EPA-13-OB was the only overburden well in the ECE property area that was installed and sampled during the RI. It should be noted that EPA-13-OB and EPA-30-OB were influenced by the pilot test and had significant reduced Cr(VI) concentrations in December 2014 compared to before the pilot testing injections.

The approximate overburden boundaries of the Cr(VI) plume, defined as concentrations exceeding the New Jersey Department of Environmental Protection (NJDEP) groundwater quality standard (GWQS) of 70 µg/L, encompass a north-south width of approximately 1,700 feet (from the area near Van Winkle Avenue to Commerce Street) and a length of approximately 3,200 feet from the east (ECE site) to the west (Passaic River). This plume boundary is similar to that which was observed during the RI.

The extent of Cr(VI) contamination in bedrock extends west from the ECE site in Garfield, beneath the Passaic River, and into the city of Passaic at EPA-19-BR. Cr(VI) has been detected in bedrock at concentrations exceeding the NJDEP GWQS to depths of 330 feet bgs (EPA-16-BR) and at concentrations near the source area at more than 1,000 times the NJDEP GWQS.

Results from the 2014 sampling event were entered into the 3D visualization software program Mining Visualization System (MVS) developed by C-Tech Development Corporation. The software was used to create a 3D image of the extent of Cr(VI) contamination in the overburden and bedrock aquifers based on the laboratory analytical data from the 2014 sitewide groundwater sampling event. The 3D images are presented in this memorandum to help visually convey the spatial distribution and relative concentrations of the Cr(VI) plume in groundwater. Figures 6, 7, and 8 present images of the 3D Cr(VI) plume in the overburden and bedrock aquifers from three different perspectives.

The MVS software also was used to estimate the volume of the Cr(VI) plume in groundwater beneath the site. The boundaries of the plume for the volumetric estimate/calculation were defined as the 3D extent of groundwater with Cr(VI) concentrations equal to or greater than the NJDEP GWQS of 70 µg/L. The porosity values that are required to estimate the plume volume using MVS were averaged from analytical soil porosity values obtained during the 2012 RI from borehole locations EPA-18-OB through EPA-20-OB for overburden material. The matrix porosity used for overburden soils and weathered bedrock (together comprising the overburden aquifer) was 0.35 (35 percent). The matrix porosity value for bedrock aquifer was obtained from the results of the matrix diffusion study (University of Guelph 2013). The average porosity value determined by the matrix diffusion study performed at EPA-21-BR is 0.10 (10 percent).

The estimated volume of groundwater with concentrations above the NJDEP GWQS beneath the site, as calculated from the 2014 sampling event, is approximately 815 million gallons. Approximately 46 percent (378 million gallons) of the contaminated groundwater is located within the overburden aquifer, and 54 percent (436 million gallons) of the volume is within the bedrock (Brunswick) aquifer. This is similar to the volumetric size estimate that was calculated by MVS for the RIR (CH2M HILL 2014a): 785 million gallons, which was approximately 50 percent each overburden and bedrock plume volume. The relative location and extent of the sample points in the 2012 data set relative to the 2014 data set (e.g., the packer testing results from the former ECE production well were included in the 2012 data set but not in the 2014 data set, the four overburden pilot study wells at the ECE property were included in the 2014 data set but were not part of the 2012 data set, etc.) in addition to the variation in Cr(VI) analytical results resulted in the different volumetric size estimate between the two data sets.

The 3D MVS depictions on Figures 6, 7, and 8, show the plume at the highest concentration (bright red color) at the ECE property. As previously observed during the RI, the shape of the plume extends north toward monitoring well EPA-20-BR although at concentrations lower than the NJDEP GWQS of 70 µg/L. It extends, south just beyond EPA-22R-BR, and west just beyond EPA-19-BR. The plume is unbound to the east/southeast of the ECE property because no sample points are in that area. The Cr(VI) plume is interpolated by MVS to extend to a relatively uniform maximum depth of approximately 230 feet below mean sea level below the central portion of the plume. The maximum plume depth is interpolated to be slightly shallower at approximately 180 feet below mean sea level at the western and northeastern edges of the plume.

Investigation-derived Waste Management

Investigation-derived waste (IDW) created throughout the sampling event was stored within the ECE property and stored in 55-gallon drums.

Two IDW samples were collected and analyzed by a subcontracted laboratory (ALS) for the following:

- Hexavalent chromium, target compound list volatile organics, semivolatile organics, pesticides, polychlorinated biphenyls, target analyte list metals (including mercury and cyanide), total petroleum hydrocarbons – gasoline and diesel ranges, corrosivity, and ignitability

Portions of wastewater from the sampling event were classified as hazardous and non-hazardous based on analytical results of the IDW samples collected.

Two 55-gallons drums of hazardous wastewater were disposed of by Capital Environmental at the EQ Pennsylvania (Envirite of PA) facility in York, Pennsylvania. Seven 55-gallon drums of non-hazardous wastewater was transported to Environmental Recovery of Lancaster, Pennsylvania by Capitol Environmental.

Pilot Study Groundwater Data Results and Conclusions

The pilot study-specific groundwater data results are discussed in detail in the *Results of the In Situ Reduction Pilot Study Test* memorandum (CH2M HILL 2015) but chromium-related results are summarized below.

- The Pilot Study found that the injection of organic substrates such as EVO can stimulate the anaerobic reduction of Cr(VI), however only where the pH of groundwater was neutral. For example, after *in situ* EVO injections the resultant reduction in Cr(VI) concentrations in EPA-13-OB (just downgradient of the ECE source area where pH is neutral) was 97 percent. Where pH was acidic (approximately 3 to 6) at the ECE source area, microbial activity and biological reduction of Cr(VI) was inhibited. The lack of Cr(VI) reduction at the source area also could be associated with toxic effects of high Cr(VI) concentrations (above approximately 200,000 µg/L) on microbial growth.

- Where the greatest Cr(VI) reductions were observed at downgradient wells EPA-13-OB and EPA-30-OB, geochemical parameters indicated that EVO injections created reducing conditions, as indicated by low ORP (less than -200 mV), reduced nitrate concentrations (less than 1 mg/L), reduced iron and manganese concentrations, and the generation of methane. Similarly, where Cr(VI) reduction was not observed in areas of low pH, geochemical parameters showed that groundwater conditions remained oxidizing (approximately 100 to 500 mV), with limited reduction of terminal electron acceptor concentrations.

- Dissolved total chromium was analyzed to evaluate the potential for organic acids resulting from the breakdown of EVO to form soluble complexes with Cr(III). The complexation of Cr(III) by organic acids occurs after Cr(VI) is reduced either biologically or abiotically, so the presence of organic acids

does not have a bearing on biotic or abiotic Cr(VI) reduction. The complexes, while stable and not likely to re-oxidize to Cr(VI), would allow Cr(III) to remain in solution at higher pH levels where Cr(III) is expected to precipitate. In most of the monitoring wells, Cr(VI) composed a majority of the dissolved chromium. In downgradient monitoring well EPA-13-OB, Cr(III) made up approximately 70 to 80 percent of the dissolved chromium, an indication that Cr(III) had complexed with organic acids. However, the concentration of dissolved chromium in this well was still below the NJDEP Groundwater Quality Standard (GWQS) of 70 µg/L. Compared to the greater than two-orders-of magnitude reduction of total chromium and Cr(VI) concentrations in this well, the magnitude of Cr(III) complexation is not significant.

Summary and Conclusions

The following are the conclusions of the 2014 sitewide groundwater sampling event:

- The inferred groundwater flow direction in the overburden and bedrock aquifers is west to east toward the Passaic River. The groundwater elevation contours and flow direction were similar between the 2012 and 2014 data.
- The Cr(VI) concentrations from the 2014 sitewide groundwater sampling event were generally similar to those from the 2012 sampling events with the exception of EPA-21-BR-225, which displayed concentrations in 2014 that were approximately two orders of magnitude higher than observed in 2012.
- The estimated volume of groundwater with concentrations above the NJDEP GWQS beneath the site, as calculated from the 2014 sampling event is approximately 815 million gallons. Approximately 46 percent (378 million gallons) of the contaminated groundwater is located within the overburden aquifer, and 54 percent (436 million gallons) of the volume is within the bedrock (Brunswick) aquifer.

References

CH2M HILL. 2012. *Remedial Investigation Uniform Federal Policy for Quality Assurance Project Plan, Garfield Groundwater Contamination Superfund Site, Garfield, Bergen County, New Jersey.*

CH2M HILL. 2014a. *Remedial Investigation Report, Garfield Groundwater Contamination Superfund Site, Garfield, Bergen County, New Jersey.*

CH2M HILL. 2014b. *Addendum to the Remedial Investigation Uniform Federal Policy for Quality Assurance Project Plan, Garfield Groundwater Contamination Superfund Site, Garfield, Bergen County, New Jersey.*

CH2M. 2015. *Results of the In Situ Reduction Pilot Study Test, Garfield Groundwater Contamination Superfund Site, Garfield, Bergen County, New Jersey.*

University of Guelph, School of Engineering (Guelph). 2013. Data Report on Rock Core Subsampling and Hexavalent Chromium Analysis at the Garfield Chromium Contamination Superfund Site, Garfield, NJ.

Enclosures

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2 Synoptic Groundwater Measurements - December 3, 2014
3 Concentrations in Groundwater (NJDEP GWQS)
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TABLE 1

Groundwater Sample Tracking Table

Groundwater Technical Memorandum

Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

Station ID	Sample ID	CLP ID	Sample Date and Time	MS/MSD	Duplicate (Duplicate CLP ID)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Collection Depth (ft bgs)	Hexavalent Chromium	Total Chromium	Redox* Parameters	Pilot** Study Parameters	IDW*** Parameters
Overburden Monitoring Wells													
EPA-01-OB	GCGC-EPA-01-OB-05	N/A	12/12/2014 10:05	N/A	N/A	19.0	29.0	24.0	X				
EPA-02-OB	GCGC-EPA-02-OB-05	N/A	12/12/2014 12:26	N/A	N/A	19.5	29.5	24.5	X				
EPA-03-OB	GCGC-EPA-03-OB-05	N/A	12/12/2014 10:15	MS/MSD	N/A	57.0	67.0	62.0	X				
EPA-04-OB	GCGC-EPA-04-OB-05	MBBEG2	12/15/2014 13:28	N/A	N/A	40.0	50.0	45.0	X		X		
EPA-05-OB	GCGC-EPA-05-OB-05	MBBEG3	12/16/2014 9:40	N/A	N/A	17.0	32.0	24.5	X		X		
EPA-06-OB	GCGC-EPA-06-OB-05	N/A	12/17/2014 11:06	MS/MSD	N/A	70.0	90.0	80.0	X				
EPA-07-OB	GCGC-EPA-07-OB-05	N/A	12/16/2014 13:50	N/A	D-12162014-01	26.5	36.5	31.5	X				
EPA-08-OB	GCGC-EPA-08-OB-05	N/A	12/16/2014 11:34	N/A	N/A	35.0	45.0	40.0	X				
EPA-09-OB	GCGC-EPA-09-OB-05	N/A	12/11/2014 9:13	N/A	N/A	24.0	34.0	29.0	X				
EPA-10-OB	GCGC-EPA-10-OB-05	N/A	12/11/2014 11:03	N/A	N/A	82.0	97.0	89.5	X				
EPA-11-OB	GCGC-EPA-11-OB-05	N/A	12/9/2014 15:12	N/A	N/A	22.0	32.0	27.0	X				
EPA-11-OB	GCGC-EPA-11-OB-05b	N/A	2/5/2015 12:45	N/A	N/A	22.0	32.0	27.0	X				
EPA-12-OB	GCGC-EPA-12-OB-05	N/A	12/10/2014 9:45	MS/MSD	N/A	20.0	30.0	25.0	X				
EPA-13-OB	GCGC-EPA-13-OB-05	MBBEK0	12/18/2014 11:55	N/A	D-12182014-01 (Cr6 and TCr Only) (MBBEK4)	22.0	32.0	27.0	X	X	X	X	
EPA-14-OB	GCGC-EPA-14-OB-05	MBBEG1	12/4/2014 10:50	N/A	N/A	10.0	20.0	15.0	X		X		
EPA-15-OB	GCGC-EPA-15-OB-05	MBBEG4	12/15/2014 12:50	MS/MSD (Cr6 and TCr Only)	N/A	20.0	30.0	25.0	X	X	X		
EPA-16-OB	GCGC-EPA-16-OB-05	MBBEG5	12/15/2014 10:05	N/A	N/A	14.5	24.5	19.5	X	X	X		
EPA-18-OB	GCGC-EPA-18-OB-05	N/A	12/12/2014 12:55	N/A	N/A	35.0	40.0	37.5	X				
EPA-19-OB	GCGC-EPA-19-OB-05	N/A	12/9/2014 10:51	N/A	N/A	55.0	60.0	57.5	X				
EPA-19-OB	GCGC-EPA-19-OB-05b	N/A	2/4/2015 15:50	N/A	N/A	55.0	60.0	57.5	X				
EPA-20-OB	GCGC-EPA-20-OB-05	N/A	12/10/2014 14:20	MS/MSD	N/A	27.0	32.0	29.5	X				
EPA-29-OB	GCGC-EPA-29-OB-05	MBBEJ7	12/17/2014 10:35	N/A	N/A	15.0	20.0	17.5	X	X		X	
EPA-30-OB	GCGC-EPA-30-OB-05	MBBEK2	12/17/2014 10:15	N/A	N/A	17.0	22.0	19.5	X	X		X	
EPA-31-OB	GCGC-EPA-31-OB-05	MBBEK3	12/17/2014 10:10	N/A	N/A	15.0	25.0	20.0	X	X		X	
EPA-32-OB	GCGC-EPA-32-OB-05	MBBEJ8	12/17/2014 12:35	N/A	N/A	10.0	20.0	15.0	X	X		X	
Bedrock Monitoring Wells													
EPA-02-BR	GCGC-EPA-02-BR-05	N/A	12/17/2014 13:16	N/A	N/A	103.0	113.0	108.0	X				
EPA-04-BR	GCGC-EPA-04-BR-05	N/A	12/15/2014 10:48	N/A	N/A	125.0	135.0	130.0	X				
EPA-08-BR	GCGC-EPA-08-BR-05	N/A	12/16/2014 9:44	N/A	N/A	110.0	120.0	115.0	X				
EPA-10-BR	GCGC-EPA-10-BR-05	N/A	12/10/2014 11:56	N/A	N/A	234.0	244.0	239.0	X				
EPA-12-BR	GCGC-EPA-12-BR-05	N/A	12/10/2014 11:40	N/A	N/A	75.0	85.0	80.0	X				
EPA-13-BR	GCGC-EPA-13-BR-05	MBBEK1	12/17/2015 9:53	N/A	N/A	50.0	70.0	60.0	X		X		
EPA-14-BR	GCGC-EPA-14-BR-05	N/A	12/4/2014 11:05	N/A	N/A	90.0	100.0	95.0	X				
EPA-16-BR-63	GCGC-EPA-16-BR-63-05	MBBEH4	12/16/2014 9:40	N/A	N/A	58.0	68.0	63.0	X	X	X		
EPA-16-BR-95	GCGC-EPA-16-BR-95-05	MBBEH5	12/16/2014 9:50	N/A	N/A	90.0	100.0	95.0	X		X		
EPA-16-BR-128	GCGC-EPA-16-BR-128-05	MBBEH6	12/16/2014 10:00	N/A	N/A	123.0	133.0	128.0	X		X		
EPA-16-BR-207	GCGC-EPA-16-BR-207-05	MBBEH7	12/16/2014 12:00	N/A	N/A	202.0	212.0	207.0	X		X		
EPA-16-BR-295	GCGC-EPA-16-BR-295-05	MBBEH8	12/16/2014 12:10	N/A	N/A	290.0	300.0	295.0	X		X		
EPA-16-BR-322	GCGC-EPA-16-BR-322-05	MBBEH9	12/16/2014 12:10	N/A	N/A	317.0	327.0	322.0	X		X		
EPA-17-BR	GCGC-EPA-17-BR-05	N/A	12/12/2014 10:20	N/A	N/A	115.0	125.0	120.0	X				

TABLE 1

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Station ID	Sample ID	CLP ID	Sample Date and Time	MS/MSD	Duplicate (Duplicate CLP ID)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Collection Depth (ft bgs)	Hexavalent Chromium	Total Chromium	Redox* Parameters	Pilot** Study Parameters	IDW*** Parameters
EPA-18-BR-74	GCGC-EPA-18-BR-74-05	MBBEG6	12/15/2014 10:25	N/A	D-12152014-01 (Cr6 only)	69.0	79.0	74.0	X		X		
EPA-18-BR-115	GCGC-EPA-18-BR-115-05	MBBEG7	12/15/2014 10:35	N/A	N/A	110.0	120.0	115.0	X		X		
EPA-18-BR-135	GCGC-EPA-18-BR-135-05	MBBEG8	12/15/2014 10:45	N/A	N/A	130.0	140.0	135.0	X		X		
EPA-18-BR-185	GCGC-EPA-18-BR-185-05	MBBEG9	12/15/2014 10:55	N/A	N/A	180.0	190.0	185.0	X		X		
Bedrock Monitoring Wells													
EPA-18-BR-262	GCGC-EPA-18-BR-262-05	MBBEH0	12/15/2014 11:50	N/A	N/A	257.0	267.0	262.0	X		X		
EPA-18-BR-305	GCGC-EPA-18-BR-305-05	MBBEH1	12/15/2014 12:00	N/A	N/A	300.0	310.0	305.0	X		X		
EPA-18-BR-323	GCGC-EPA-18-BR-323-05	MBBEH2	12/15/2014 12:10	N/A	N/A	318.0	328.0	323.0	X		X		
EPA-19-BR-87	GCGC-EPA-19-BR-87-05	N/A	12/10/2014 9:33	N/A	N/A	82.0	92.0	87.0	X				
EPA-19-BR-123	GCGC-EPA-19-BR-123-05	N/A	12/10/2014 9:38	N/A	D-12102014-01	118.0	128.0	123.0	X				
EPA-19-BR-167	GCGC-EPA-19-BR-167-05	N/A	12/10/2014 9:43	N/A	N/A	162.0	172.0	167.0	X				
EPA-19-BR-195	GCGC-EPA-19-BR-195-05	N/A	12/10/2014 10:40	N/A	N/A	190.0	200.0	195.0	X				
EPA-19-BR-299	GCGC-EPA-19-BR-299-05	N/A	12/10/2014 10:45	N/A	N/A	294.0	304.0	299.0	X				
EPA-19-BR-335	GCGC-EPA-19-BR-335-05	N/A	12/10/2014 10:50	N/A	N/A	330.0	340.0	335.0	X				
EPA-20-BR-93	GCGC-EPA-20-BR-93-05	N/A	12/11/2014 9:55	N/A	N/A	88.0	98.0	93.0	X				
EPA-20-BR-125	GCGC-EPA-20-BR-125-05	N/A	12/11/2014 10:00	N/A	N/A	120.0	130.0	125.0	X				
EPA-20-BR-183	GCGC-EPA-20-BR-183-05	N/A	12/11/2014 10:05	N/A	N/A	178.0	188.0	183.0	X				
EPA-20-BR-235	GCGC-EPA-20-BR-235-05	N/A	12/11/2014 10:10	N/A	N/A	230.0	240.0	235.0	X				
EPA-20-BR-289	GCGC-EPA-20-BR-289-05	N/A	12/11/2014 11:10	N/A	N/A	284.0	294.0	289.0	X				
EPA-20-BR-318	GCGC-EPA-20-BR-318-05	N/A	12/11/2014 11:15	N/A	N/A	313.0	323.0	318.0	X				
EPA-20-BR-335	GCGC-EPA-20-BR-335-05	N/A	12/11/2014 11:15	N/A	N/A	330.0	340.0	335.0	X				
EPA-21-BR-85	GCGC-EPA-21-BR-85-05	N/A	12/9/2014 10:50	N/A	N/A	80.0	90.0	85.0	X				
EPA-21-BR-85	GCGC-EPA-21-BR-85-05a	MBBEJ0	12/17/2014 10:05	N/A	N/A	80.0	90.0	85.0			X		
EPA-21-BR-85	GCGC-EPA-21-BR-85-05b	N/A	2/4/2015 14:30	N/A	N/A	80.0	90.0	85.0	X				
EPA-21-BR-127	GCGC-EPA-21-BR-127-05	N/A	12/9/2014 10:55	N/A	N/A	122.0	132.0	127.0	X				
EPA-21-BR-127	GCGC-EPA-21-BR-127-05a	MBBEJ1	12/17/2014 10:15	N/A	N/A	122.0	132.0	127.0			X		
EPA-21-BR-127	GCGC-EPA-21-BR-127-05b	N/A	2/4/2015 14:35	N/A	N/A	122.0	132.0	127.0	X				
EPA-21-BR-159	GCGC-EPA-21-BR-159-05	N/A	12/9/2014 11:00	N/A	N/A	154.0	164.0	159.0	X				
EPA-21-BR-159	GCGC-EPA-21-BR-159-05a	MBBEJ2	12/17/2014 10:25	N/A	N/A	154.0	164.0	159.0			X		
EPA-21-BR-159	GCGC-EPA-21-BR-159-05b	N/A	2/4/2015 14:40	N/A	N/A	154.0	164.0	159.0	X		X		
EPA-21-BR-183	GCGC-EPA-21-BR-183-05^	N/A	1/7/2015 12:50	N/A	N/A	178.0	188.0	183.0	X		X		
EPA-21-BR-225	GCGC-EPA-21-BR-225-05a	MBBEJ4	12/17/2014 11:40	N/A	N/A	220.0	230.0	225.0	X		X		
EPA-21-BR-225	GCGC-EPA-21-BR-225-05b	N/A	2/4/2015 14:45	N/A	N/A	220.0	230.0	225.0	X		X		
EPA-21-BR-282	GCGC-EPA-21-BR-282-05a	MBBEJ5	12/17/2014 11:50	N/A	N/A	277.0	287.0	282.0	X		X		
EPA-21-BR-345	GCGC-EPA-21-BR-345-05a	MBBEJ6	12/17/2014 12:00	N/A	N/A	340.0	350.0	345.0	X		X		
EPA-22R-BR-151	GCGC-EPA-22R-BR-151-05	N/A	12/8/2014 10:45	N/A	N/A	146.0	156.0	151.0	X		X		
EPA-22R-BR-208	GCGC-EPA-22R-BR-208-05	N/A	12/8/2014 10:50	N/A	N/A	203.0	213.0	208.0	X				
EPA-22R-BR-289	GCGC-EPA-22R-BR-289-05	N/A	12/8/2014 10:55	N/A	N/A	284.0	294.0	289.0	X				
EPA-22R-BR-325	GCGC-EPA-22R-BR-325-05	N/A	12/8/2014 11:00	N/A	N/A	318.0	333.0	325.5	X				
EPA-23-BR	GCGC-EPA-23-BR-05	N/A	12/4/2014 15:00	N/A	N/A	148.0	158.0	153.0	X				
EPA-24R-BR	GCGC-EPA-24R-BR-05	N/A	12/11/2014 14:15	N/A	N/A	135.0	145.0	140.0	X				
EPA-25-BR	GCGC-EPA-25-BR-05	N/A	12/8/2014 13:10	N/A	N/A	322.0	347.0	334.5	X				
EPA-26-BR	GCGC-EPA-26-BR-05	N/A	12/8/2014 10:25	N/A	D-12082014-01	135.0	145.0	140.0	X				

TABLE 1

Groundwater Sample Tracking Table

Groundwater Technical Memorandum

Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

Station ID	Sample ID	CLP ID	Sample Date and Time	MS/MSD	Duplicate (Duplicate CLP ID)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Collection Depth (ft bgs)	Hexavalent Chromium	Total Chromium	Redox* Parameters	Pilot** Study Parameters	IDW*** Parameters
EPA-27-BR	GCGC-EPA-27-BR-05	N/A	12/8/2014 15:05	N/A	N/A	260.0	275.0	267.5	X				
EPA-28-BR	GCGC-EPA-28-BR-05	N/A	12/11/2014 10:15	N/A	N/A	269.0	284.0	276.5	X				

TABLE 1

Groundwater Sample Tracking Table

Groundwater Technical Memorandum

Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

Station ID	Sample ID	CLP ID	Sample Date and Time	MS/MSD	Duplicate (Duplicate CLP ID)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Collection Depth (ft bgs)	Hexavalent Chromium	Total Chromium	Redox* Parameters	Pilot** Study Parameters	IDW*** Parameters
Kalama Site Monitoring Wells													
KAL-MW 16D (overburden well)	GCGC-KAL-MW-16D-05	N/A	12/5/2014 13:43	N/A	N/A	43.0	53.0	48.0	X				
KAL-MW 20D2	GCGC-KAL-MW-20D2-05	N/A	12/5/2014 12:48	N/A	N/A	62.0	72.0	67.0	X				
KAL-MW-35 (overburden well)	GCGC-KAL-MW-35-05	N/A	12/5/2014 12:00	N/A	N/A	16.5	26.5	21.5	X				
KAL-MW-35D	GCGC-KAL-MW-35D-05	N/A	12/5/2014 10:15	N/A	N/A	41.5	51.5	46.5	X				
KAL-MW-35D2	GCGC-KAL-MW-35D2-05	N/A	12/5/2014 10:30	N/A	N/A	85.0	95.0	90.0	X				
T.A. Farrell Site Monitoring Wells													
TAF-04C-BR	GCGC-TAF-04C-05	N/A	12/11/2014 16:13	N/A	N/A	80.0	90.0	85.0	X				
TAF-08B-BR	GCGC-TAF-08B-05	N/A	12/11/2015 15:50	N/A	N/A	56.0	66.0	61.0	X				
TAF-09B-BR	GCGC-TAF-09B-05	N/A	12/11/2014 16:55	N/A	N/A	56.0	66.0	61.0	X				
Equipment Blanks													
Equipment Blank	EB-120414	N/A	12/4/2014 15:15	N/A	N/A	N/A	N/A	N/A	X				
Equipment Blank	EB-120514	N/A	12/5/2014 14:00	N/A	N/A	N/A	N/A	N/A	X				
Equipment Blank	EB-120914	N/A	12/9/2014 15:00	N/A	N/A	N/A	N/A	N/A	X				
Equipment Blank	EB-121014	N/A	12/10/2014 15:00	N/A	N/A	N/A	N/A	N/A	X				
Equipment Blank	EB-121114	N/A	12/11/2014 15:00	N/A	N/A	N/A	N/A	N/A	X				
Equipment Blank	EB-121214	N/A	12/12/2014 12:00	N/A	N/A	N/A	N/A	N/A	X				
Equipment Blank	EB-121514	MBBEH3	12/15/2014 16:00	N/A	N/A	N/A	N/A	N/A	X	X			
Equipment Blank	EB-121614	N/A	12/16/2014 13:50	N/A	N/A	N/A	N/A	N/A	X				
Equipment Blank	EB-121714	MBBEJ9	12/17/2014 16:00	N/A	N/A	N/A	N/A	N/A	X	X			
Equipment Blank	EB-020415-01	N/A	2/4/2015 15:30	N/A	N/A	N/A	N/A	N/A	X				
Field Blanks													
Field Blanks	FB-020415-01	N/A	2/4/2015 15:35	N/A	N/A	N/A	N/A	N/A	X				
IDW Samples													
IDW-Wastewater	IDW-WW-12192014-01	N/A	12/17/2014 9:00	N/A	N/A	N/A	N/A	N/A					X
IDW-Wastewater	IDW-WW-12192014-02	N/A	12/17/2014 9:30	N/A	N/A	N/A	N/A	N/A					X

Notes:
BR - Bedrock
ft - feet
ft bgs - feet below ground surface
ID - Identification
N/A - Not Applicable
KAL - Kalama Chemical Site
OB- Overburden
TAF - T.A. Ferrell Site
IDW - Investigation Derived Waste

* **Redox Parameters** include the following analyses: total organic carbon, sulfate, nitrate, dissolved iron, and dissolved manganese

** **Pilot Study Parameters** include the following analyses: dissolved chromium, dissolved iron, total iron, sulfide, sulfate, chloride, total organic carbon

*** **IDW Parameters** includes volatile organic compounds, semivolatile organic compounds, pesticides, PCBs, metals including mercury and cyanide hexavalent chromium, pH, flashpoint, diesel range organics, and gasoline range organics

^ The sample from EPA-21-BR-183 was collected January 7th due to a blockage in the sample line during the first sample attempt in December.

TABLE 2

Synoptic Groundwater Measurements - December 3, 2014

2014 Sitewide Groundwater Sampling Event

Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

Monitoring Well	Date	Time	Top of Inner Casing Elevation NAVD88	Well Head PID Reading (ppm)	Depth to Water (Feet BTIC)	Depth to Bottom of Well (Feet BTIC)	Elevation of Water NAVD88
Passaic River							
Monroe St. Bridge Staff Gauge	12/3/2014	16:00	23.37	0.0	22.20	N/A	1.17
Conventional Wells							
EC Electroplating Wells							
EPA-29-OB	12/3/2014	8:32	58.23	0.0	11.55	19.64	46.68
EPA-30-OB	12/3/2014	9:02	55.50	0.0	13.64	21.32	41.86
EPA-31-OB	12/3/2014	8:47	56.31	0.0	13.90	24.77	42.41
EPA-32-OB	12/3/2014	8:45	58.29	0.0	14.10	19.87	44.19
EPA Wells - Overburden and Bedrock							
EPA-1-OB	12/3/2014	9:30	19.13	0.0	13.09	28.68	6.04
EPA-2-OB	12/3/2014	10:40	25.60	0.0	11.80	28.86	13.80
EPA-2-BR	12/3/2014	11:00	24.92	0.0	10.66	114.80	14.26
EPA-3-OB	12/3/2014	11:25	24.20	0.0	2.40	67.30	21.80
EPA-4-OB	12/3/2014	13:30	12.35	0.0	8.20	49.35	4.15
EPA-4-BR	12/3/2014	13:15	12.15	0.0	6.90	135.15	5.25
EPA-5-OB	12/3/2014	13:35	23.08	0.0	10.40	31.10	12.68
EPA-6-OB	12/3/2014	14:00	28.77	0.1	10.24	90.00	18.53
EPA-7-OB	12/3/2014	14:10	15.33	0.3	7.40	35.60	7.93
EPA-8-OB	12/3/2014	14:15	22.68	0.0	11.75	44.20	10.93
EPA-8-BR	12/3/2014	14:00	32.65	0.0	17.30	120.10	15.35
EPA-9-OB*	12/3/2014	NM	32.65	NM	NM	NM	NM
EPA-10-OB	12/3/2014	11:30	24.94	0.0	15.00	97.30	9.94
EPA-10-BR	12/3/2014	10:50	23.61	0.0	18.70	245.50	4.91
EPA-11-OB	12/3/2014	11:52	37.31	0.0	14.83	31.20	22.48
EPA-12-OB	12/3/2014	12:00	45.58	0.0	4.35	29.30	41.23
EPA-12-BR	12/3/2014	12:20	46.14	0.0	4.35	85.00	41.79
EPA-13-OB	12/3/2014	9:00	55.54	6.7	13.51	32.04	42.03
EPA-13-BR	12/3/2014	9:10	54.52	0.0	10.85	69.31	43.67
EPA-14-OB	12/3/2014	12:30	58.23	0.2	7.05	18.72	51.18
EPA-14-BR	12/3/2014	12:15	58.12	0.0	13.62	102.00	44.50
EPA-15-OB	12/3/2014	13:10	44.22	0.0	13.25	29.20	30.97
EPA-16-OB	12/3/2014	15:20	30.59	0.0	6.80	22.95	23.79
EPA-17-BR	12/3/2014	10:34	14.79	0.0	9.25	125.00	5.54
EPA-18-OB	12/3/2014	15:35	37.92	0.0	10.50	39.90	27.42
EPA-19-OB	12/3/2014	NR	17.65	0.0	13.27	59.60	4.38
EPA-20-OB	12/3/2014	11:50	27.00	0.0	3.82	32.00	23.18
EPA-23-BR	12/3/2014	11:05	24.69	0.0	17.70	158.30	6.99
EPA-24R-BR	12/3/2014	NR	29.58	0.0		artesian	
EPA-25-BR	12/3/2014	NR	77.90	0.0	67.00	350.00	10.90
EPA-26-BR	12/3/2014	NR	25.77	0.0	15.40	145.00	10.37
EPA-27-BR	12/3/2014	NR	24.01	0.0	18.47	275.00	5.54
EPA-28-BR	12/3/2014	NR	31.07	0.0		artesian	

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2014 Sitewide Groundwater Sampling Event

Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

Monitoring Well	Date	Time	Top of Inner Casing Elevation NAVD88	Well Head PID Reading (ppm)	Depth to Water (Feet BTIC)	Depth to Bottom of Well (Feet BTIC)	Elevation of Water NAVD88
Multiport FLUTe Well							
EPA-16-BR-63	12/3/2014	14:00	30.23	0.0	6.02	N/A	24.21
EPA-16-BR-95	12/3/2014	14:02	30.27	0.0	5.98	N/A	24.29
EPA-16-BR-128	12/3/2014	14:03	30.26	0.0	4.22	N/A	26.04
EPA-16-BR-207	12/3/2014	14:04	30.28	0.0	2.75	N/A	27.53
EPA-16-BR-295	12/3/2014	14:05	30.22	0.0	5.19	N/A	25.03
EPA-16-BR-322	12/3/2014	14:07	30.22	0.0	5.00	N/A	25.22
EPA-18-BR-74	12/3/2014	14:42	37.62	0.0	8.01	N/A	29.61
EPA-18-BR-115	12/3/2014	14:44	37.59	0.0	11.19	N/A	26.40
EPA-18-BR-135	12/3/2014	14:45	37.58	0.0	11.48	N/A	26.10
EPA-18-BR-185	12/3/2014	14:46	37.58	0.0	9.60	N/A	27.98
EPA-18-BR-262	12/3/2014	14:48	37.59	0.0	11.98	N/A	25.61
EPA-18-BR-305	12/3/2014	14:49	37.58	0.0	21.22	N/A	16.36
EPA-18-BR-323	12/3/2014	14:51	37.56	0.0	12.18	N/A	25.38
EPA-19-BR-87 **	12/4/2014	NR	18.76	0.0	13.70	N/A	5.06
EPA-19-BR-123 **	12/4/2014	NR	18.71	0.0	12.90	N/A	5.81
EPA-19-BR-167 **	12/4/2014	NR	18.65	0.0	12.65	N/A	6.00
EPA-19-BR-195 **	12/4/2014	NR	18.65	0.0	12.65	N/A	6.00
EPA-19-BR-299 **	12/4/2014	NR	18.69	0.0	11.90	N/A	6.79
EPA-19-BR-335 **	12/4/2014	NR	18.70	0.0	11.30	N/A	7.40
EPA-20-BR-93	12/3/2014	13:40	26.91	0.0	0.22	N/A	26.69
EPA-20-BR-125	12/3/2014	13:41	26.91	0.0	0.92	N/A	25.99
Multiport FLUTe Well							
EPA-20-BR-183	12/3/2014	13:42	26.92	0.0		artesian	
EPA-20-BR-235	12/3/2014	13:43	26.94	0.0		artesian	
EPA-20-BR-289	12/3/2014	13:44	26.94	0.0		artesian	
EPA-20-BR-318	12/3/2014	13:46	26.94	0.0		artesian	
EPA-20-BR-335	12/3/2014	13:47	26.96	0.0		artesian	
EPA-21-BR-95	12/3/2014	14:17	15.71	0.0	3.22	N/A	12.49
EPA-21-BR-127	12/3/2014	14:23	15.76	0.0	1.07	N/A	14.69
EPA-21-BR-159	12/3/2014	14:19	15.85	0.0	1.42	N/A	14.43
EPA-21-BR-183	12/3/2014	14:21	15.86	0.0	0.51	N/A	15.35
EPA-21-BR-225	12/3/2014	14:18	15.79	0.0	0.62	N/A	15.17
EPA-21-BR-282	12/3/2014	14:24	15.71	0.0	0.22	N/A	15.49
EPA-21-BR-345	12/3/2014	14:26	15.78	0.0		artesian	
EPA-22-BR-151	12/3/2014	15:07	34.09	0.0	19.85	N/A	14.24
EPA-22-BR-208	12/3/2014	15:10	34.06	0.0	29.23	N/A	4.83
EPA-22-BR-289	12/3/2014	15:12	34.04	0.0	14.78	N/A	19.26
EPA-22-BR-323	12/3/2014	15:13	34.07	0.0	14.99	N/A	19.08

TABLE 2

Synoptic Groundwater Measurements - December 3, 2014

2014 Sitewide Groundwater Sampling Event

Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

Monitoring Well	Date	Time	Top of Inner Casing Elevation NAVD88	Well Head PID Reading (ppm)	Depth to Water (Feet BTIC)	Depth to Bottom of Well (Feet BTIC)	Elevation of Water NAVD88
Kalama Site Wells							
KAL-16D	12/3/2014	15:45	27.11	0.0	15.65	50.80	11.46
KAL-20D2	12/3/2014	9:40	30.34	0.0	15.30	72.50	15.04
KAL-35	12/3/2014	15:00	31.55	0.0	19.15	26.10	12.40
KAL-35D	12/3/2014	14:45	31.48	0.0	40.40	50.20	-8.92
KAL-35D2	12/3/2014	9:30	31.40	0.0	16.95	95.50	14.45
T.A. Farrell SiteWells							
TAF-04C	12/3/2014	NR	39.18	0.0	10.70	34.90	28.48
TAF-08B	12/3/2014	NR	37.92	0.0	9.45	65.25	28.47
TAF-09B	12/3/2014	NR	39.13	0.0	10.30	67.50	28.83

Notes:

BR - bedrock

OB - overburden

NAVD88 - Vertical Datum North American Vertical Datum of 1988 in US Survey Feet

PPM - parts per million

BTIC - below top of inner casing

NM - not measured

NR - Not Recorded

* Car parked over well on 12/3 and when revisited on 12/4

** Car parked over well and was revisited on 12/4

TABLE 3
Concentrations in Groundwater (NJDEP GWQS)
2014 Site Wide Groundwater Sampling Technical Memorandum
Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

	Location	*EPA-21-BR-225*	*EPA-21-BR-127*	*EPA-21-BR-127*	EPA-21-BR-159	EPA-21-BR-183	*EPA-21-BR-225*	EPA-21-BR-282	EPA-21-BR-345	EPA-22R-BR-151	EPA-22R-BR-208
	Sample ID	*GCGC-EPA-21-BR-127-05B*	*GCGC-EPA-21-BR-225-05A*	*GCGC-EPA-21-BR-225-05B*	GCGC-EPA-21-BR-159-05B	GCGC-EPA-21-BR-183-05	*GCGC-EPA-21-BR-127-05B*	GCGC-EPA-21-BR-282-05A	GCGC-EPA-21-BR-345-05A	GCGC-EPA-22R-BR-151-05	GCGC-EPA-22R-BR-208-05
	Sample Depth (ft)	225	127	127	159	183	225	282	345	151	208
	Sample Date	2/4/2015	12/17/2014	2/4/2015	2/4/2015	1/7/2015	2/4/2015	12/17/2014	12/17/2014	12/8/2014	12/8/2014
	(A) NJDEP Groundwater Screening Levels										
Metals (µg/L)											
Chromium (hexavalent), dissolved	70	**33**	**2940**	**2820**	**279**	**190**	**33**	**0.8 J**	**0.082**	**176**	**43**
Chromium (trivalent), dissolved (calculated)	70	--	--	--	--	--	--	--	--	--	--
Chromium, total	70	--	--	--	--	--	--	--	--	--	--
Groundwater Redox Parameters (mg/L)											
Iron, dissolved	- -	**0.321**	**0.16 J**	--	**0.0908 J**	0.05 U	**0.321**	**0.263**	**0.208**	--	--
Manganese, dissolved	- -	**0.0583 NE**	**0.0112 NE**	--	**0.0114 NE**	0.005 U	**0.0583 NE**	**0.0215 NE**	**0.0277 NE**	--	--
Nitrate/Nitrite (As N)	- -	**0.5**	**4.3**	--	**4**	**2.2**	**0.5**	0.05 U	0.05 U	--	--
Sulfate	- -	**160**	**30**	--	**18**	**44**	**160**	**180**	**200**	--	--
Total Organic Carbon	- -	1 U	1 U	--	1 U	1 U	1 U	1 U	1 U	--	--
Field Parameters											
Conductivity (mS/cm)	- -	0.523	0.551	--	0.335	--	0.523	0.584	0.533	0.683	0.53
Dissolved Oxygen (mg/l)	- -	1.08	0.38	--	2.81	--	1.08	0.3	6.8	3.44	1.93
ORP (mV)	- -	105	-106	--	109	--	105	-78	-67	-66	-84
pH (standard units)	- -	9.28	8.51	--	8.52	--	9.28	8.43	8.3	10.41	10.27
Salinity (ppt)	- -	0.2	0.3	--	0.2	--	0.2	0.3	0.3	0.3	0.3
Temperature (degree Celsius)	- -	12.67	13.89	--	12.47	--	12.67	13.68	12.72	11.79	12.2
Turbidity (NTU)	- -	0	0	--	0	--	0	0	0	0	0
Ferrous Iron (mg/L)	- -		0.00					0.00	0.01	0.01	0.00

Notes:
Italic - It was determined in September 2015 that the sampling ports for EPA-21-BR-127 and EPA-21-BR-225 were not installed in sequence when the FLUTe monitor well was re-installed in December 2013

(A) - New Jersey Department of Environmental Protection
(NJDEP) Groundwater Quality Standards Class IIA Constituent Values (July 2010)
[1] Total hardness value calculated based on assumed hardness of 100 mg/kg as $CaC0_3$.

* Note that the hexavalent concentration was higher than the total chromium concentration, so both should be considered to be estimated
-- = Not analyzed
- - = No screening criteria established
Bold indicates the analyte was detected
Shading indicates exceedance of the screening criteria

S = Screening level data quality only. Chromium (trivalent) result, dissolved. Calculated by subtracting hexavalent chromium from chromium, dissolved.
ft = Feet
J = Analyte detected at an estimated concentration
U = Non-detect or not detected at significantly greater than that in an associated blank
UJ = Non-detect, estimated concentration
µg/L = Micrograms per liter
mS/cm = millisiemen per centimeter
mg/L = milligram per liter
mV = millivolts
ppt = parts per thousand
NTU = nephelometric turbidity units
N = nitrogen

TABLE 3
Concentrations in Groundwater (NJDEP GWQS)
2014 Site Wide Groundwater Sampling Technical Memorandum
Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

	Location	EPA-22R-BR-289	EPA-22R-BR-325	EPA-23-BR	EPA-24R-BR	EPA-25-BR	EPA-26-BR	EPA-26-BR	EPA-27-BR	EPA-28-BR	EPA-29-OB	EPA-30-OB	EPA-31-OB
	Sample ID	GCGC-EPA-22R-BR-289-05	GCGC-EPA-22R-BR-325-05	GCGC-EPA-23-BR-05	GCGC-EPA-24R-BR-05	GCGC-EPA-25-BR-05	D-12082014-01	GCGC-EPA-26-BR-05	GCGC-EPA-27-BR-05	GCGC-EPA-28-BR-05	GCGC-EPA-29-OB-05	GCGC-EPA-30-OB-05	GCGC-EPA-31-OB-05
	Sample Depth (ft)	289	325.5	153	140	334.5	140	140	267.5	276.5	17.5	19.5	21
	Sample Date	12/8/2014	12/8/2014	12/4/2014	12/11/2014	12/8/2014	12/8/2014	12/8/2014	12/8/2014	12/11/2014	12/17/2014	12/18/2014	12/18/2014
	(A) NJDEP Groundwater Screening Levels												
Metals (µg/L)													
Chromium (hexavalent), dissolved	70	**8**	0.331 U	0.086 U	**0.17 J**	**0.911 J**	0.466 UB	0.469 U	**0.804 J**	0.033 U	**213000**	**9880**	**241000**
Chromium (trivalent), dissolved (calculated)	70	--	--	--	--	--	--	--	--	--	**54000 S**	0* S	**29000 S**
Chromium, total	70	--	--	--	--	--	--	--	--	--	**267000**	**9150**	**270000**
Groundwater Redox Parameters (mg/L)													
Iron, dissolved	- -	--	--	--	--	--	--	--	--	--	0.2 U	**0.447**	**1.21**
Manganese, dissolved	- -	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate/Nitrite (As N)	- -	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	- -	--	--	--	--	--	--	--	--	--	**92**	**68**	**130**
Total Organic Carbon	- -	--	--	--	--	--	--	--	--	--	**6.3 J**	**3.7**	**8.6**
Field Parameters													
Conductivity (mS/cm)	- -	0.351	0.312	0.501	0.533	0.362	--	0.855	0.889	0.404	1.4	1.19	1.74
Dissolved Oxygen (mg/l)	- -	2.11	1.97	0.45	0	3.25	--	2.31	1.48	0	0	2.17	0
ORP (mV)	- -	-60	-65	-6	-4	91	--	147	125	4	459	-3	331
pH (standard units)	- -	11.65	10.15	10.75	9.07	8.92	--	8.82	10.34	11.95	3.28	7.04	5.81
Salinity (ppt)	- -	0.2	0.2	0.2	0.3	0.2	--	0.4	0.4	0.2	0.7	0.6	0.9
Temperature (degree Celsius)	- -	12.71	12.59	15.04	12.2	14.07	--	14.45	11.66	11.1	17.43	18.72	16.97
Turbidity (NTU)	- -	0	0.3	30.9	20.9	1.64	--	8.04	18.6	20.4	7.09	7.03	36.9
Ferrous Iron (mg/L)	- -	0.06	0.00	0.14	0.14	0.34	--	0.29	0.00	0.00	0.00	0.15	Error limit

Notes:
Italic - It was determined in September 2015 that the sampling ports for EPA-21-BR-127 and EPA-21-BR-225 were not installed in sequence when the FLUTe monitor well was re-installed in December 2013

(A) - New Jersey Department of Environmental Protection
(NJDEP) Groundwater Quality Standards Class IIA Constituent Values (July 2010)
[1] Total hardness value calculated based on assumed hardness of 100 mg/kg as $CaC0_3$.

* Note that the hexavalent concentration was higher than the total chromium concentration, so both should be considered to be estimated
-- = Not analyzed
- - = No screening criteria established
Bold indicates the analyte was detected
Shading indicates exceedance of the screening criteria

S = Screening level data quality only. Chromium (trivalent) result, dissolved. Calculated by subtracting hexavalent chromium from chromium, dissolved.
ft = Feet
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µg/L = Micrograms per liter
mS/cm = millisiemen per centimeter
mg/L = milligram per liter
mV = millivolts
ppt = parts per thousand
NTU = nephelometric turbidity units
N = nitrogen

TABLE 3
Concentrations in Groundwater (NJDEP GWQS)
2014 Site Wide Groundwater Sampling Technical Memorandum
Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

	Location	EPA-32-OB	KAL-16D	KAL-20D2	KAL-35	KAL-35D	KAL-35D2	TAF-04C-BR	TAF-08B-BR	TAF-09B-BR
	Sample ID	GCGC-EPA-32-OB-05	GCGC-KAL-MW-16D-05	GCGC-KAL-MW-20D2-05	GCGC-KAL-MW-35-05	GCGC-KAL-MW-35D-05	GCGC-KAL-MW-35D2-05	GCGC-TAF-04C-05	GCGC-TAF-08B-05	GCGC-TAF-09B-05
	Sample Depth (ft)	15.5	48	67	21.5	46.5	90	85	61	61
	Sample Date	12/17/2014	12/5/2014	12/5/2014	12/5/2014	12/5/2014	12/5/2014	12/11/2014	12/11/2014	12/11/2014
	(A) NJDEP Groundwater Screening Levels									
Metals (µg/L)										
Chromium (hexavalent), dissolved	70	**269000**	**15**	**4**	**5**	0.056 U	0.183 U	0.075 U	**221**	**2**
Chromium (trivalent), dissolved (calculated)	70	**43000 S**	--	--	--	--	--	--	--	--
Chromium, total	70	**312000**	--	--	--	--	--	--	--	--
Groundwater Redox Parameters (mg/L)										
Iron, dissolved	- -	**0.731 D**	--	--	--	--	--	--	--	--
Manganese, dissolved	- -	--	--	--	--	--	--	--	--	--
Nitrate/Nitrite (As N)	- -	--	--	--	--	--	--	--	--	--
Sulfate	- -	**150**	--	--	--	--	--	--	--	--
Total Organic Carbon	- -	**5.2**	--	--	--	--	--	--	--	--
Field Parameters										
Conductivity (mS/cm)	- -	1.68	1.04	8.28	0.701	0.625	3.5	1.05	0.85	6.56
Dissolved Oxygen (mg/l)	- -	0.14	0	2.18	6.95	0.22	0.26	0.43	3.37	0
ORP (mV)	- -	488	20	-72	185	136	-171	-138	100	-341
pH (standard units)	- -	3.25	8.57	13.75	7.43	8.42	9.86	7.44	7.36	6.83
Salinity (ppt)	- -	0.8	0.5	4.6	0.3	0.3	2	0.5	0.4	3.6
Temperature (degree Celsius)	- -	17.87	14.96	15.44	16.97	15.29	13.4	9.83	13.96	14.91
Turbidity (NTU)	- -	4.39	2.96	1.23	0.99	4.34	20.2	1.94	1.9	98.6
Ferrous Iron (mg/L)	- -	0.27	0.15	2.87	0.00	0.06	0.07	0.72	0.00	0.63

Notes:
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(NJDEP) Groundwater Quality Standards Class IIA Constituent Values (July 2010)
[1] Total hardness value calculated based on assumed hardness of 100 mg/kg as $CaC0_3$.

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NTU = nephelometric turbidity units
N = nitrogen

TABLE 3
Concentrations in Groundwater (NJDEP GWQS)
2014 Site Wide Groundwater Sampling Technical Memorandum
Garfield Groundwater Contamination Superfund Site, Garfield, New Jersey

	Location	*EPA-21-BR-225*	*EPA-21-BR-127*	*EPA-21-BR-127*	EPA-21-BR-159	EPA-21-BR-183	*EPA-21-BR-225*	EPA-21-BR-282	EPA-21-BR-345	EPA-22R-BR-151	EPA-22R-BR-208
	Sample ID	*GCGC-EPA-21-BR-127-05B*	*GCGC-EPA-21-BR-225-05A*	*GCGC-EPA-21-BR-225-05B*	GCGC-EPA-21-BR-159-05B	GCGC-EPA-21-BR-183-05	*GCGC-EPA-21-BR-127-05B*	GCGC-EPA-21-BR-282-05A	GCGC-EPA-21-BR-345-05A	GCGC-EPA-22R-BR-151-05	GCGC-EPA-22R-BR-208-05
	Sample Depth (ft)	225	127	127	159	183	225	282	345	151	208
	Sample Date	2/4/2015	12/17/2014	2/4/2015	2/4/2015	1/7/2015	2/4/2015	12/17/2014	12/17/2014	12/8/2014	12/8/2014
	(A) NJDEP Groundwater Screening Levels										
Metals (µg/L)											
Chromium (hexavalent), dissolved	70	**33**	**2940**	**2820**	**279**	**190**	**33**	**0.8 J**	**0.082**	**176**	**43**
Chromium (trivalent), dissolved (calculated)	70	--	--	--	--	--	--	--	--	--	--
Chromium, total	70	--	--	--	--	--	--	--	--	--	--
Groundwater Redox Parameters (mg/L)											
Iron, dissolved	- -	**0.321**	**0.16 J**	--	**0.0908 J**	0.05 U	**0.321**	**0.263**	**0.208**	--	--
Manganese, dissolved	- -	**0.0583 NE**	**0.0112 NE**	--	**0.0114 NE**	0.005 U	**0.0583 NE**	**0.0215 NE**	**0.0277 NE**	--	--
Nitrate/Nitrite (As N)	- -	**0.5**	**4.3**	--	**4**	**2.2**	**0.5**	0.05 U	0.05 U	--	--
Sulfate	- -	**160**	**30**	--	**18**	**44**	**160**	**180**	**200**	--	--
Total Organic Carbon	- -	1 U	1 U	--	1 U	1 U	1 U	1 U	1 U	--	--
Field Parameters											
Conductivity (mS/cm)	- -	0.523	0.551	--	0.335	--	0.523	0.584	0.533	0.683	0.53
Dissolved Oxygen (mg/l)	- -	1.08	0.38	--	2.81	--	1.08	0.3	6.8	3.44	1.93
ORP (mV)	- -	105	-106	--	109	--	105	-78	-67	-66	-84
pH (standard units)	- -	9.28	8.51	--	8.52	--	9.28	8.43	8.3	10.41	10.27
Salinity (ppt)	- -	0.2	0.3	--	0.2	--	0.2	0.3	0.3	0.3	0.3
Temperature (degree Celsius)	- -	12.67	13.89	--	12.47	--	12.67	13.68	12.72	11.79	12.2
Turbidity (NTU)	- -	0	0	--	0	--	0	0	0	0	0
Ferrous Iron (mg/L)	- -		0.00					0.00	0.01	0.01	0.00

Notes:
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TABLE 3
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	Location	EPA-22R-BR-289	EPA-22R-BR-325	EPA-23-BR	EPA-24R-BR	EPA-25-BR	EPA-26-BR	EPA-26-BR	EPA-27-BR	EPA-28-BR	EPA-29-OB	EPA-30-OB	EPA-31-OB
	Sample ID	GCGC-EPA-22R-BR-289-05	GCGC-EPA-22R-BR-325-05	GCGC-EPA-23-BR-05	GCGC-EPA-24R-BR-05	GCGC-EPA-25-BR-05	D-12082014-01	GCGC-EPA-26-BR-05	GCGC-EPA-27-BR-05	GCGC-EPA-28-BR-05	GCGC-EPA-29-OB-05	GCGC-EPA-30-OB-05	GCGC-EPA-31-OB-05
	Sample Depth (ft)	289	325.5	153	140	334.5	140	140	267.5	276.5	17.5	19.5	21
	Sample Date	12/8/2014	12/8/2014	12/4/2014	12/11/2014	12/8/2014	12/8/2014	12/8/2014	12/8/2014	12/11/2014	12/17/2014	12/18/2014	12/18/2014
	(A) NJDEP Groundwater Screening Levels												
Metals (µg/L)													
Chromium (hexavalent), dissolved	70	**8**	0.331 U	0.086 U	**0.17 J**	**0.911 J**	0.466 UB	0.469 U	**0.804 J**	0.033 U	**213000**	**9880**	**241000**
Chromium (trivalent), dissolved (calculated)	70	--	--	--	--	--	--	--	--	--	**54000 S**	0* S	**29000 S**
Chromium, total	70	--	--	--	--	--	--	--	--	--	**267000**	**9150**	**270000**
Groundwater Redox Parameters (mg/L)													
Iron, dissolved	- -	--	--	--	--	--	--	--	--	--	0.2 U	**0.447**	**1.21**
Manganese, dissolved	- -	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate/Nitrite (As N)	- -	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	- -	--	--	--	--	--	--	--	--	--	**92**	**68**	**130**
Total Organic Carbon	- -	--	--	--	--	--	--	--	--	--	**6.3 J**	**3.7**	**8.6**
Field Parameters													
Conductivity (mS/cm)	- -	0.351	0.312	0.501	0.533	0.362	--	0.855	0.889	0.404	1.4	1.19	1.74
Dissolved Oxygen (mg/l)	- -	2.11	1.97	0.45	0	3.25	--	2.31	1.48	0	0	2.17	0
ORP (mV)	- -	-60	-65	-6	-4	91	--	147	125	4	459	-3	331
pH (standard units)	- -	11.65	10.15	10.75	9.07	8.92	--	8.82	10.34	11.95	3.28	7.04	5.81
Salinity (ppt)	- -	0.2	0.2	0.2	0.3	0.2	--	0.4	0.4	0.2	0.7	0.6	0.9
Temperature (degree Celsius)	- -	12.71	12.59	15.04	12.2	14.07	--	14.45	11.66	11.1	17.43	18.72	16.97
Turbidity (NTU)	- -	0	0.3	30.9	20.9	1.64	--	8.04	18.6	20.4	7.09	7.03	36.9
Ferrous Iron (mg/L)	- -	0.06	0.00	0.14	0.14	0.34	--	0.29	0.00	0.00	0.00	0.15	Error limit

Notes:
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[1] Total hardness value calculated based on assumed hardness of 100 mg/kg as $CaC0_3$.

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	Sample ID	GCGC-EPA-32-OB-05	GCGC-KAL-MW-16D-05	GCGC-KAL-MW-20D2-05	GCGC-KAL-MW-35-05	GCGC-KAL-MW-35D-05	GCGC-KAL-MW-35D2-05	GCGC-TAF-04C-05	GCGC-TAF-08B-05	GCGC-TAF-09B-05
	Sample Depth (ft)	15.5	48	67	21.5	46.5	90	85	61	61
	Sample Date	12/17/2014	12/5/2014	12/5/2014	12/5/2014	12/5/2014	12/5/2014	12/11/2014	12/11/2014	12/11/2014
	(A) NJDEP Groundwater Screening Levels									
Metals (µg/L)										
Chromium (hexavalent), dissolved	70	**269000**	**15**	**4**	**5**	0.056 U	0.183 U	0.075 U	**221**	**2**
Chromium (trivalent), dissolved (calculated)	70	**43000 S**	--	--	--	--	--	--	--	--
Chromium, total	70	**312000**	--	--	--	--	--	--	--	--
Groundwater Redox Parameters (mg/L)										
Iron, dissolved	- -	**0.731 D**	--	--	--	--	--	--	--	--
Manganese, dissolved	- -	--	--	--	--	--	--	--	--	--
Nitrate/Nitrite (As N)	- -	--	--	--	--	--	--	--	--	--
Sulfate	- -	**150**	--	--	--	--	--	--	--	--
Total Organic Carbon	- -	**5.2**	--	--	--	--	--	--	--	--
Field Parameters										
Conductivity (mS/cm)	- -	1.68	1.04	8.28	0.701	0.625	3.5	1.05	0.85	6.56
Dissolved Oxygen (mg/l)	- -	0.14	0	2.18	6.95	0.22	0.26	0.43	3.37	0
ORP (mV)	- -	488	20	-72	185	136	-171	-138	100	-341
pH (standard units)	- -	3.25	8.57	13.75	7.43	8.42	9.86	7.44	7.36	6.83
Salinity (ppt)	- -	0.8	0.5	4.6	0.3	0.3	2	0.5	0.4	3.6
Temperature (degree Celsius)	- -	17.87	14.96	15.44	16.97	15.29	13.4	9.83	13.96	14.91
Turbidity (NTU)	- -	4.39	2.96	1.23	0.99	4.34	20.2	1.94	1.9	98.6
Ferrous Iron (mg/L)	- -	0.27	0.15	2.87	0.00	0.06	0.07	0.72	0.00	0.63

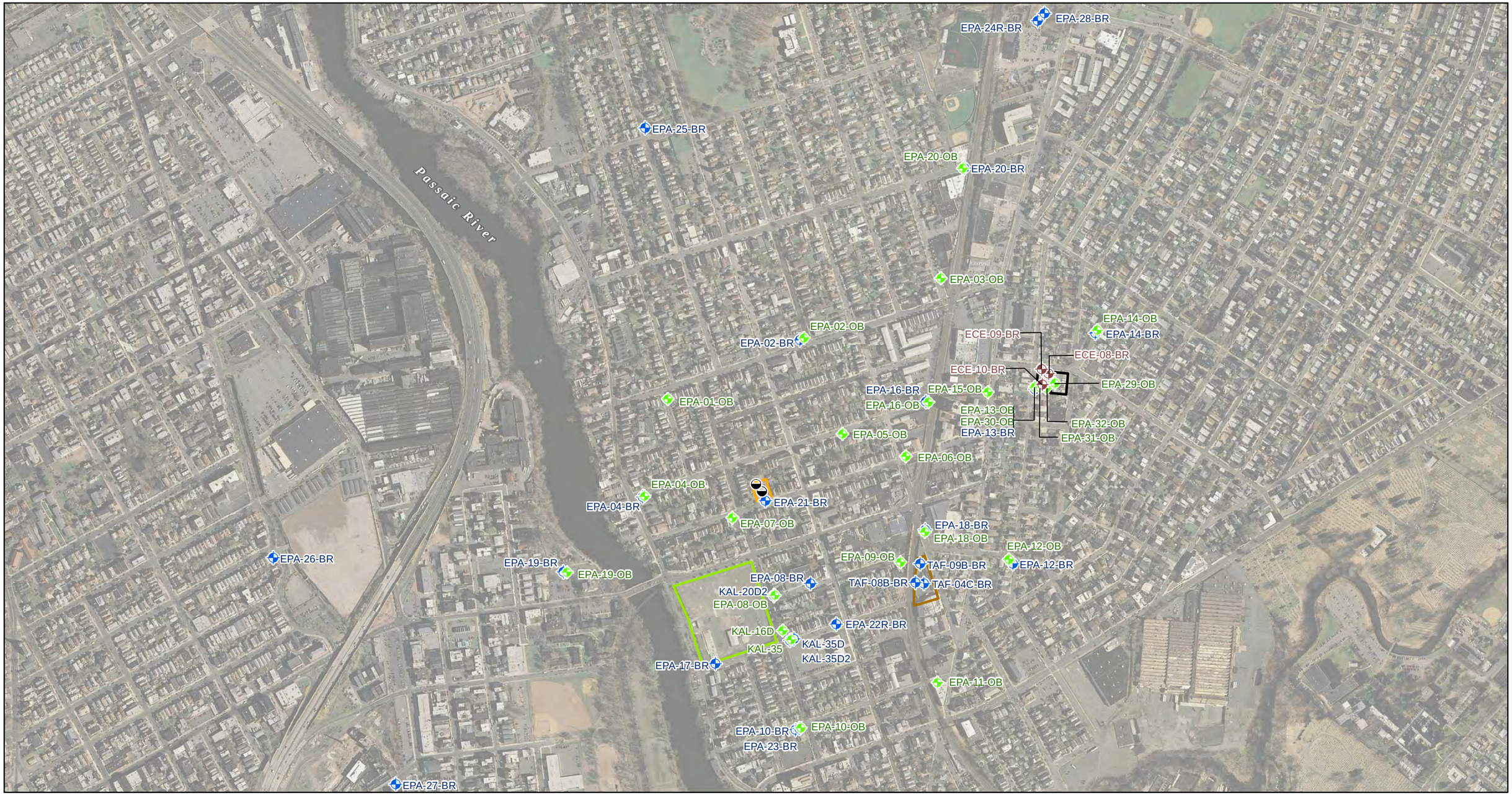
Notes:
Italic - It was determined in September 2015 that the sampling ports for EPA-21-BR-127 and EPA-21-BR-225 were not installed in sequence when the FLUTe monitor well was re-installed in December 2013

(A) - New Jersey Department of Environmental Protection
(NJDEP) Groundwater Quality Standards Class IIA Constituent Values (July 2010)
[1] Total hardness value calculated based on assumed hardness of 100 mg/kg as $CaC0_3$.

* Note that the hexavalent concentration was higher than the total chromium concentration, so both should be considered to be estimated
-- = Not analyzed
- - = No screening criteria established
Bold indicates the analyte was detected
Shading indicates exceedance of the screening criteria

S = Screening level data quality only. Chromium (trivalent) result, dissolved. Calculated by subtracting hexavalent chromium from chromium, dissolved.
ft = Feet
J = Analyte detected at an estimated concentration
U = Non-detect or not detected at significantly greater than that in an associated blank
UJ = Non-detect, estimated concentration
µg/L = Micrograms per liter
mS/cm = millisiemen per centimeter
mg/L = milligram per liter
mV = millivolts
ppt = parts per thousand
NTU = nephelometric turbidity units
N = nitrogen

Figures



- Overburden Monitoring Well
- Groundwater Montoring Well
- Abandoned Monitoring Well
- Former Garfield Municipal Well
- Grand Street Lot
- Kalama Chemical Site
- T.A. Farrell Site
- E.C. Electoplating Site (125 Clark St., Garfield, NJ)

N

0 250 500 750 1,000 Feet

NOTES:
New Jersey State Plane Coordinate System Horizontal Datum NAVD83, Imagery Source: National Aerial Imagery Program, 2010.

Figure 1

Sitewide Groundwater Sampling Event Sample Locations
2014 Sitewide Groundwater Sampling Event Technical Memorandum
Garfield Groundwater Contamination Superfund Site
Garfield, NJ 07026

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- Conventional Monitoring Well
- Former Garfield Municipal Well
- Grand Street Lot
- Kalama Chemical Site
- T.A. Farrell Site
- E.C. Electoplating Site (125 Clark St., Garfield, NJ)
- Overburden Groundwater Contour (ft bgs) (Dashed Where Inferred)
- Inferred Groundwater Flow Direction
- EPA-08-OB (35-45 ft bgs): 10.93 — Monitoring Well ID; Groundwater Elevation (Feet NAVD88); Screen Interval (Feet Below Ground Surface)

N

NOTES:
New Jersey State Plane Coordinate System
Horizontal Datum NAD83, Vertical Datum NAVD88
US Survey Feet
MSL - Mean Sea Level
NM - Not Measured
Imagery Source: National Aerial Imagery Program, 2010
Overburden elevation ranges from 0 to -72.1 ft NAVD88

0 250 500 750 1,000 Feet

Figure 2
Garfield December 2014 Overbuden Groundwater Contour
2014 Sitewide Groundwater Sampling Event Technical Memorandum
Garfield Groundwater Contamination Superfund Site
Garfield, NJ 07026

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EPA-25-BR
(322-347): 10.90

EPA-20-BR
(88:98 ft bgs) : Artesian
(120:130 ft bgs) : Artesian
(178:188 ft bgs) : Artesian
(230:240 ft bgs) : Artesian
(284:294 ft bgs) : Artesian
(313:323 ft bgs) : Artesian
(330:340 ft bgs) : Artesian

Passaic River

EPA-13-BR
(50-70 ft bgs): 43.67

EPA-02-BR
(103-113 ft bgs): 14.26

EPA-14-BR
(90-100 ft bgs): 44.50

EPA-16-BR
(58:68 ft bgs) : 24.21
(90:100 ft bgs) : 24.29
(123:133 ft bgs) : 26.04
(202:212 ft bgs) : 27.53
(290:300 ft bgs) : 25.03
(317:327 ft bgs) : 25.22

EPA-21-BR
(122:132 ft bgs) : 14.69
(154:164 ft bgs) : 14.43
(178:188 ft bgs) : 15.35
(220:230 ft bgs) : 15.17
(277:287 ft bgs) : 15.49
(340:350 ft bgs) : Artesian

EPA-18-BR
(69:79 ft bgs) : 29.61
(110:120 ft bgs) : 26.40
(130:140 ft bgs) : 26.10
(180:190 ft bgs) : 27.98
(257:267 ft bgs) : 25.61
(300:310 ft bgs) : 16.36
(318:328 ft bgs) : 25.38

EPA-04-BR
(125-135 ft bgs): 5.25

TAF-09B-BR
(56-66 ft bgs): 28.83

EPA-19-BR
(82:92 ft bgs) : 5.06
(118:128 ft bgs) : 5.81
(162:172 ft bgs) : 6.00
(190:200 ft bgs) : 6.00
(294:304 ft bgs) : 6.79
(330:340 ft bgs) : 7.40

EPA-08-BR
(110-120 ft bgs): 15.35

EPA-12-BR
(75-85 ft bgs): 41.79

EPA-26-BR
(135-145 ft bgs): 10.37

KAL-20D2
(62-72 ft bgs): 15.04

TAF-04C-BR
(80-90 ft bgs): 28.48

KAL-35D2
(85-95 ft bgs): 14.45

TAF-08B-BR
(56-66 ft bgs): 28.47

EPA-17-BR
(115-125 ft bgs): 5.54

EPA-22R-BR
(146:156 ft bgs) : 14.24
(203:213 ft bgs) : 4.83
(284:294 ft bgs) : 19.26
(318:333 ft bgs) : 19.08

KAL-35D*
(41.5-51.5 ft bgs): -8.92

EPA-23-BR
(148-158 ft bgs): 6.99

EPA-10-BR
(234-244 ft bgs): 4.91

EPA-27-BR
(260-275 ft bgs): 5.54

- Conventional Monitoring Well
- Former Garfield Municipal Well
- Grand Street Lot
- Kalama Chemical Site
- T.A. Farrell Site
- E.C. Electoplating Site (125 Clark St., Garfield, NJ)
- Bedrock Groundwater Contour (ft bgs) (Dashed Where Inferred)
- Inferred Groundwater Flow Direction

EPA-04-BR
(125-135 ft bgs): 5.25
- Monitoring Well ID
- Groundwater Elevation (Feet NAVD88)
- Screen Interval (Feet Below Ground Surface)

N

NOTES:
*The groundwater elevation at KAL-35D was not used for contouring because the elevation was anomolous.
Groundwater elevations collected on December 3, 2014.
Multiport FLUTe well sample intervals shown.
The bold water elevation was used for contouring.
New Jersey State Plane Coordinate System Horizontal Datum NAVD83, Vertical Datum NAVD88 US Survey Feet.
Imagery Source: National Aerial Imagery Program, 2010.

0 250 500 750 1,000 Feet

Figure 3
Garfield December 2014 Bedrock Groundwater Contours
2014 Sitewide Groundwater Sampling Event Technical Memorandum
Garfield Groundwater Contamination Superfund Site
Garfield, NJ 07026

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Notes:
Results in µg/L (ppb)

J - analyte is detected, estimated concentration
ND - No Detection
Red font indicates exceedances of NJDEP Groundwater Quality Standards

NJDEP GW QUALITY Standards
Chromium(hexavalent), dissolved = 70 µg/L

EPA-02-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(19.5 : 29.5 ft bgs)	[5.42 : -4.58 ft NAVD88]	3

EPA-01-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(19 : 29 ft bgs)	[0.13 : -9.87 ft NAVD88]	5

EPA-05-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(17 : 32 ft bgs)	[6.08 : -8.92 ft NAVD88]	9570

EPA-04-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(40 : 50 ft bgs)	[-27.65 : -37.65 ft NAVD88]	1690

EPA-07-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(26.5 : 36.5 ft bgs)	[-11.17 : -21.17 ft NAVD88]	5770

EPA-19-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(55 : 60 ft bgs)	[-37.35 : -42.35 ft NAVD88]	ND

EPA-08-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(35 : 45 ft bgs)	[-12.32 : -22.32 ft NAVD88]	1

KAL-16D		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(43 : 53 ft bgs)	[-15.89 : -25.89 ft NAVD88]	15

KAL-35		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(16.5 : 26.5 ft bgs)	[15.05 : 5.05 ft NAVD88]	5

EPA-16-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(14.5 : 24.5 ft bgs)	[16.09 : 6.09 ft NAVD88]	7860

EPA-06-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(70 : 90 ft bgs)	[-41.23 : -61.23 ft NAVD88]	14900

EPA-20-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(27 : 32 ft bgs)	[0 : -5 ft NAVD88]	ND

EPA-03-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(57 : 67 ft bgs)	[-32.8 : -42.8 ft NAVD88]	38

EPA-15-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(20 : 30 ft bgs)	[24.22 : 14.22 ft NAVD88]	12400

EPA-14-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(10 : 20 ft bgs)	[48.23 : 38.23 ft NAVD88]	0.233

EPA-29-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(15 : 20 ft bgs)	[43.23 : -58.23 ft NAVD88]	213000

EPA-32-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(10.5 : 20.5 ft bgs)	[47.79 : -58.29 ft NAVD88]	269000

EPA-31-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(16 : 26 ft bgs)	[40.31 : -56.31 ft NAVD88]	241000

EPA-13-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(22 : 32 ft bgs)	[33.54 : 23.54 ft NAVD88]	9

EPA-30-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(17 : 22 ft bgs)	[38.5 : -55.5 ft NAVD88]	9880

EPA-12-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(20 : 30 ft bgs)	[25.58 : 15.58 ft NAVD88]	0.711

EPA-18-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(35 : 40 ft bgs)	[2.92 : -2.08 ft NAVD88]	112

EPA-09-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(24 : 34 ft bgs)	[11.29 : 1.29 ft NAVD88]	ND

EPA-11-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(22 : 32 ft bgs)	[15.31 : 5.31 ft NAVD88]	0.366

EPA-10-OB		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(82 : 97 ft bgs)	[-57.06 : -72.06 ft NAVD88]	40

Passaic River

- Conventional Monitoring Well
- Former Garfield Municipal Well
- Grand Street Lot
- Kalama Chemical Site
- T.A. Farrell Site
- E.C. Electoplating Site (125 Clark St., Garfield, NJ)

Approximate Hexavalent Chromium Isoconcentration Contour Lines

- 70 µg/L (dashed where inferred)
- 700 µg/L (dashed where inferred)
- 7000 µg/L (dashed where inferred)
- 70,000 µg/L (dashed where inferred)

0 250 500 750 1,000 Feet

N

NOTES:
New Jersey State Plane Coordinate System Horizontal Datum NAD83, Vertical Datum NAVD88 US Survey Feet.
MSL - Mean Sea Level
ND - Not Detected
Imagery Source: National Aerial Imagery Program, 2010
The hexavalent chromium analytical result from EPA-13-OB was not honored by the isoconcentration contour lines because it was anomalously low likely due to the effects of the 2014 Pilot Study.
Screen Interval 1 (Feet Below Ground Surface)
Screen Interval 2 (Feet NAVD88)
Overburden elevation ranges from 0 to -72.1 ft NAVD88

Figure 4
Garfield December 2014 Overburden Hexavalent Chromium Isoconcentration Contours
2014 Sitewide Groundwater Sampling Event Technical Memorandum
Garfield Groundwater Contamination Superfund Site
Garfield, NJ 07026

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Notes:
Results in µg/L (ppb)

J - analyte is detected, estimated concentration
ND - No Detection
Red font indicates exceedances of NJDEP Groundwater Quality Standards

NJDEP GW QUALITY Standards
Chromium(hexavalent), dissolved = 70 µg/L

Passaic River

EPA-25-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(322 : 347 ft bgs)	[-244.1 : -269.1 ft NAVD88]	0.911

EPA-28-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(269 : 284 ft bgs)	[-237.93 : -252.93 ft NAVD88]	ND

EPA-24R-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(135 : 145 ft bgs)	[-105.42 : -115.42 ft NAVD88]	0.17

EPA-20-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(88 : 98 ft bgs)	[-61.09 : -71.09 ft NAVD88]	12
(120 : 130 ft bgs)	[-93.09 : -103.09 ft NAVD88]	18
(178 : 188 ft bgs)	[-151.08 : -161.08 ft NAVD88]	18
(230 : 240 ft bgs)	[-203.06 : -213.06 ft NAVD88]	18
(284 : 294 ft bgs)	[-257.06 : -267.06 ft NAVD88]	0.96
(313 : 323 ft bgs)	[-286.06 : -296.06 ft NAVD88]	ND
(330 : 340 ft bgs)	[-303.04 : -313.04 ft NAVD88]	ND

EPA-16-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(58 : 68 ft bgs)	[-28.4 : -38.4 ft NAVD88]	26800
(90 : 100 ft bgs)	[-60.4 : -70.4 ft NAVD88]	4090
(123 : 133 ft bgs)	[-93.4 : -103.4 ft NAVD88]	5950
(202 : 212 ft bgs)	[-172.4 : -182.4 ft NAVD88]	219
(290 : 300 ft bgs)	[-260.4 : -270.4 ft NAVD88]	6
(317 : 327 ft bgs)	[-287.4 : -297.4 ft NAVD88]	0.6

EPA-13-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(50 : 70 ft bgs)	[4.52 : -15.48 ft NAVD88]	1370

EPA-14-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(90 : 100 ft bgs)	[-31.88 : -41.88 ft NAVD88]	0.375

EPA-02-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(103 : 113 ft bgs)	[-77.4 : -87.4 ft NAVD88]	0.6

EPA-21-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(80:90 ft bgs)	[-64.79:-74.79 ft NAVD88]	731
(122:132 ft bgs)	[-106.21:-116.21 ft NAVD88]	2820
(154:164 ft bgs)	[-138.15:-148.15 ft NAVD88]	279
(178:188 ft bgs)	[-159.14:-169.14 ft NAVD88]	190
(220:230 ft bgs)	[-204.24:-214.24 ft NAVD88]	33
(277:287 ft bgs)	[-261.29:-271.29 ft NAVD88]	0.8
(340:350 ft bgs)	[-324.22:-334.22 ft NAVD88]	0.082

EPA-04-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(125 : 135 ft bgs)	[-112.85 : -122.85 ft NAVD88]	164

KAL-20D2		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(62 : 72 ft bgs)	[-31.66 : -41.66 ft NAVD88]	4

EPA-19-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(82 : 92 ft bgs)	[-63.24 : -73.24 ft NAVD88]	102
(118 : 128 ft bgs)	[-99.29 : -109.29 ft NAVD88]	269
(162 : 172 ft bgs)	[-143.35 : -153.35 ft NAVD88]	14
(190 : 200 ft bgs)	[-171.35 : -181.35 ft NAVD88]	22
(294 : 304 ft bgs)	[-275.31 : -285.31 ft NAVD88]	ND
(330 : 340 ft bgs)	[-311.3 : -321.3 ft NAVD88]	ND

EPA-08-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(110 : 120 ft bgs)	[-77.35 : -87.35 ft NAVD88]	14000

TAF-09B-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(56 : 66 ft bgs)	[-16.87 : -26.87 ft NAVD88]	2

EPA-18-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(69 : 79 ft bgs)	[-31.38 : -41.38 ft NAVD88]	2160
(110 : 120 ft bgs)	[-72.41 : -82.41 ft NAVD88]	425
(130 : 140 ft bgs)	[-92.42 : -102.42 ft NAVD88]	1130
(180 : 190 ft bgs)	[-142.42 : -152.42 ft NAVD88]	8
(257 : 267 ft bgs)	[-219.41 : -229.41 ft NAVD88]	61
(300 : 310 ft bgs)	[-262.42 : -272.42 ft NAVD88]	1
(318 : 328 ft bgs)	[-280.44 : -290.44 ft NAVD88]	ND

EPA-12-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(75 : 85 ft bgs)	[-28.86 : -38.86 ft NAVD88]	4

EPA-26-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(135 : 145 ft bgs)	[-109.23 : -119.23 ft NAVD88]	ND

TAF-04C-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(80 : 90 ft bgs)	[-40.82 : -50.82 ft NAVD88]	ND

KAL-35D		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(41.5 : 51.5 ft bgs)	[-10.02 : -20.02 ft NAVD88]	ND

EPA-17-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(115 : 125 ft bgs)	[-100.21 : -110.21 ft NAVD88]	1

TAF-08B-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(56 : 66 ft bgs)	[-18.08 : -28.08 ft NAVD88]	221

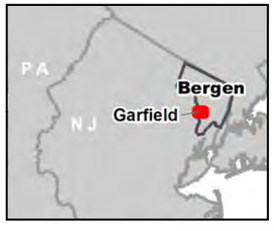
TAF-22R-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(146 : 156 ft bgs)	[-111.91 : -121.91 ft NAVD88]	176
(203 : 213 ft bgs)	[-168.94 : -178.94 ft NAVD88]	43
(284 : 294 ft bgs)	[-249.6 : -259.6 ft NAVD88]	8
(318 : 333 ft bgs)	[-283.93 : -298.93 ft NAVD88]	ND

EPA-10-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(234 : 244 ft bgs)	[-210.39 : -220.39 ft NAVD88]	0.419

EPA-27-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(260 : 275 ft bgs)	[-235.99 : -250.99 ft NAVD88]	0.804

KAL-35D2		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(85 : 95 ft bgs)	[-53.6 : -63.6 ft NAVD88]	ND

EPA-23-BR		
Screen Interval (ft bgs)	Screen Interval (ft MSL)	Cr, VI
(148 : 158 ft bgs)	[-123.31 : -133.31 ft NAVD88]	ND



- Conventional Monitoring Well
- Former Garfield Municipal Well
- Grand Street Lot
- Kalama Chemical Site
- T.A. Farrell Site
- E.C. Electoplating Site (125 Clark St., Garfield, NJ)

Approximate Hexavalent Chromium Isoconcentration Contour Lines

- 70 µg/L (dashed where inferred)
- 700 µg/L (dashed where inferred)
- 7000 µg/L (dashed where inferred)

NOTE: Bedrock groundwater sample elevations range from -10.02 to -334.22 feet NAVD88, and the contours show the greatest Cr(VI) concentrations throughout the bedrock water column.

N

NOTES:
New Jersey State Plane Coordinate System
Horizontal Datum NAD83, Vertical Datum NAVD88
US Survey Feet
MSL - Mean Sea Level
ND - Not Detected
Imagery Source: National Aerial Imagery Program
Imagery Date: 2010

0 250 500 750 1,000 Feet

Figure 5
Garfield December 2014 Bedrock Hexavalent Chromium Isoconcentration Contours
2014 Sitewide Groundwater Sampling Event Technical Memorandum
Garfield Groundwater Contamination Superfund Site
Garfield, NJ 07026

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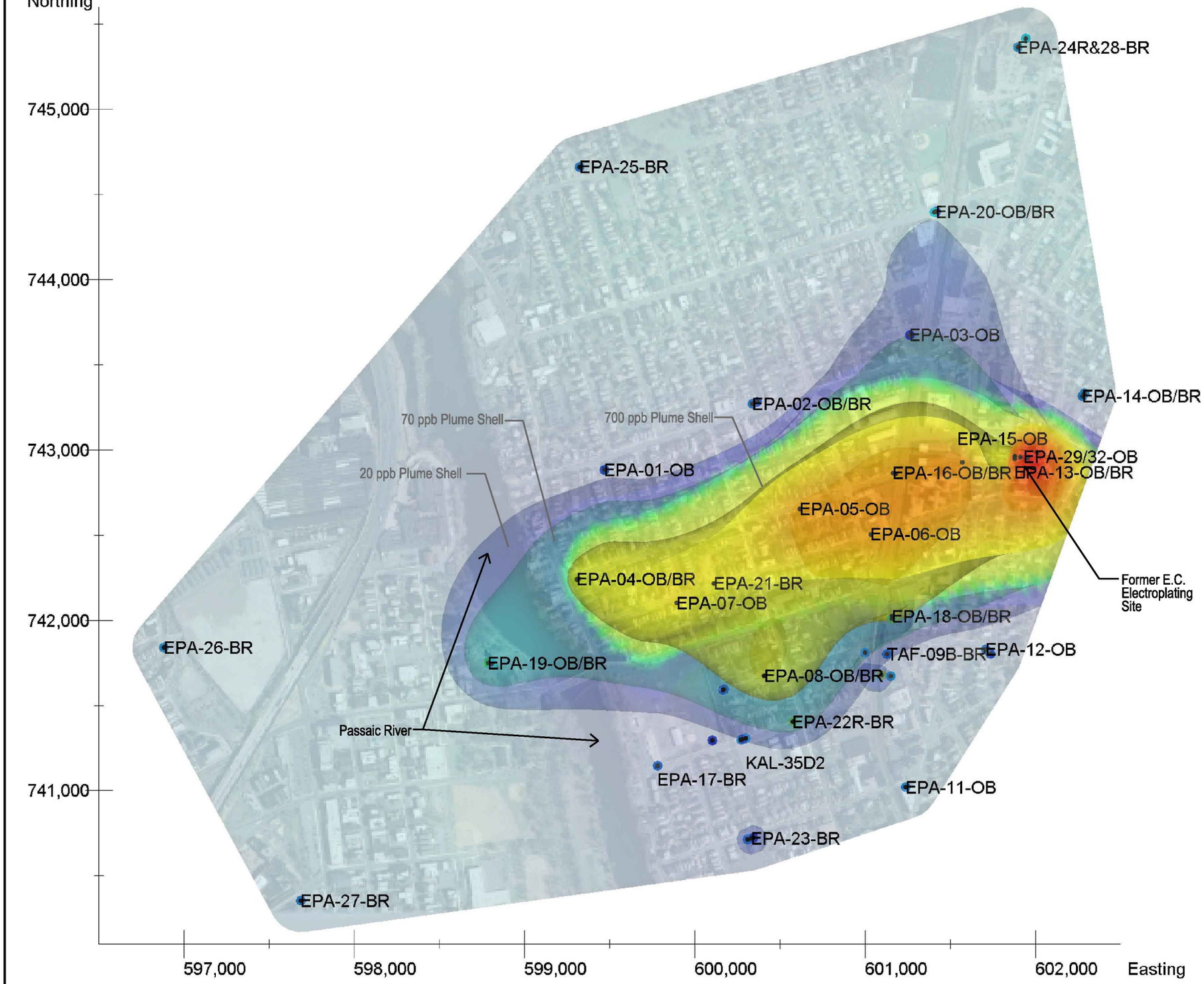


NOTES:

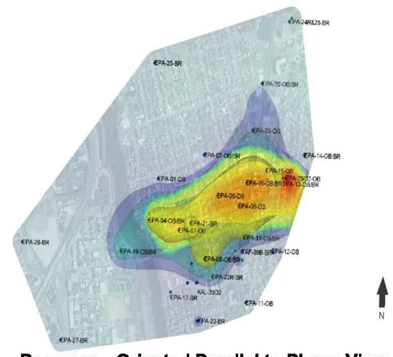
1) New Jersey State Plane Coordinate System Horizontal Datum NAD83, Vertical Datum NAVD88 US Survey Feet

2) Imagery Source: National Aerial Imagery Program Imagery Date: 2010

3) Aerial image overlain on water table surface, vadose zone not depicted

4) The saturated zone depiction is based on groundwater elevation data collected during the December 2014 synoptic water level measurement round. The groundwater elevation data used to depict the saturated zone at each FLUTe well was obtained from averaging the groundwater elevation of each FLUTe port.

5) The color break between green and blue shading occurs at 70 µg/L.



Basemap - Oriented Parallel to Plume View

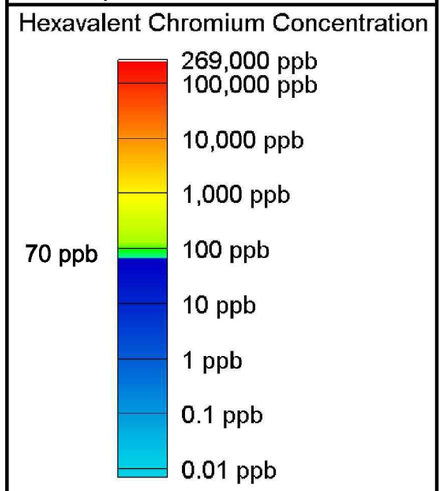


Figure 6
View of Hexavalent Chromium Plume in Groundwater – Aerial View
2014 Sitewide Groundwater Sampling Event Technical Memorandum
Garfield Groundwater Contamination Superfund Site
Garfield, NJ 07026

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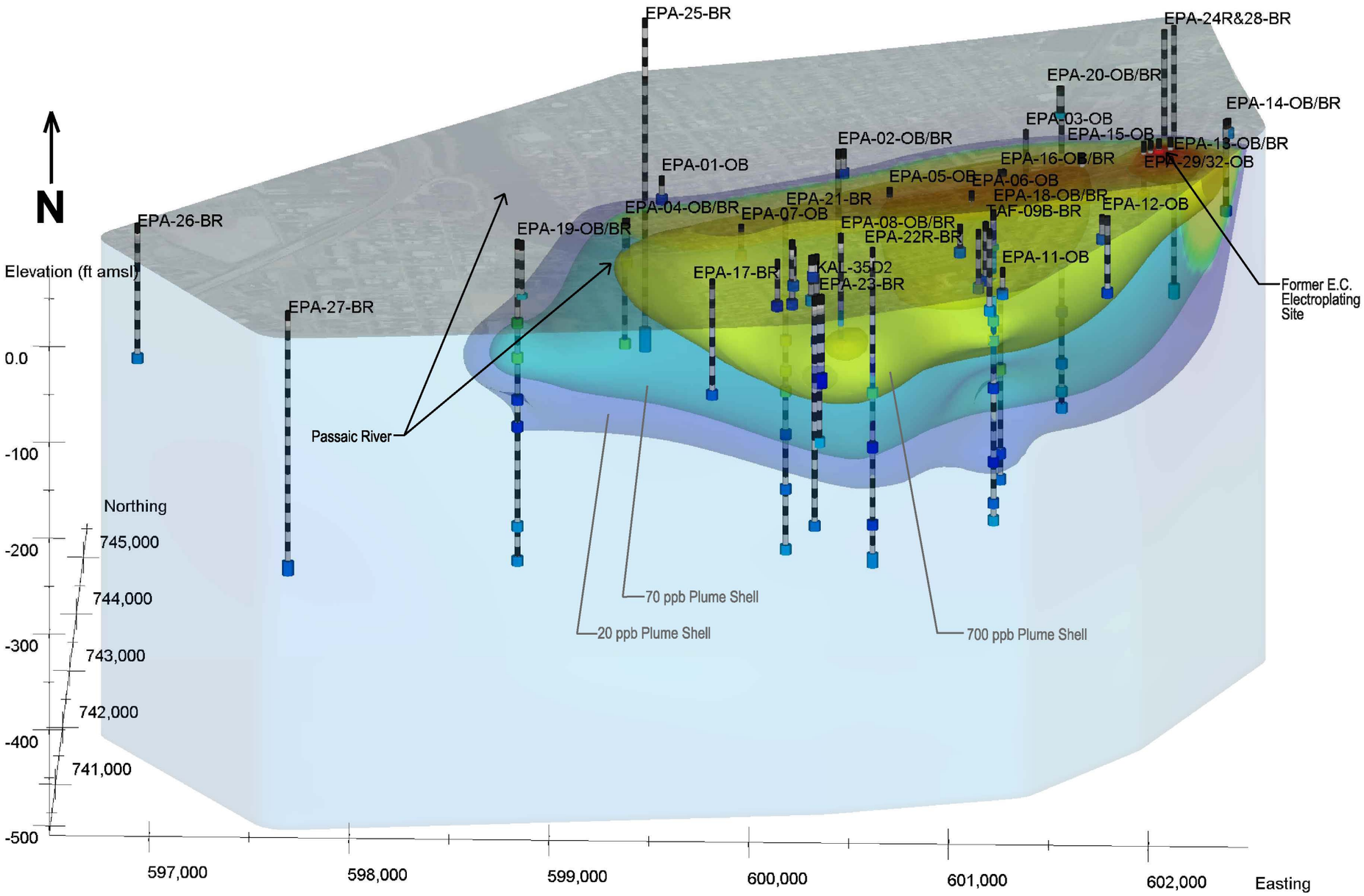
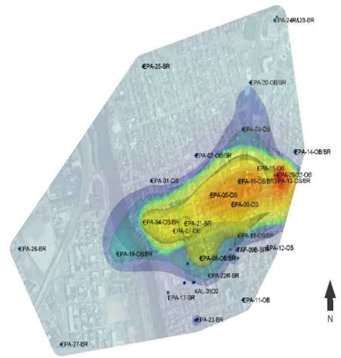


NOTES:

1) New Jersey State Plane Coordinate System Horizontal Datum NAD83, Vertical Datum NAVD88 US Survey Feet
2) Imagery Source: National Aerial Imagery Program Imagery Date: 2010
3) Aerial image overlain on water table surface, vadose zone not depicted
4) The saturated zone depiction is based on groundwater elevation data collected during the December 2014 synoptic water level measurement round. The groundwater elevation data used to depict the saturated zone at each FLUTe well was obtained from averaging the groundwater elevation of each FLUTe port.
5) The color break between green and blue shading occurs at 70 µg/L.



Basemap - Oriented Parallel to Plume View

Hexavalent Chromium Concentration

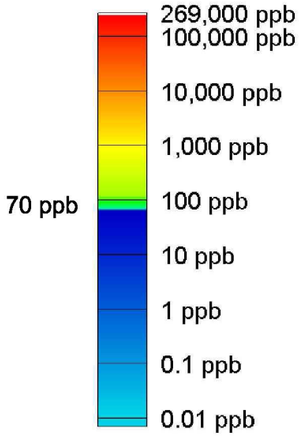


Figure 7
3D View of Hexavalent Chromium Plume in Groundwater – South to North, View Looking Down Slightly from Above Horizontal Plane
2014 Sitewide Groundwater Sampling Event Technical Memorandum
Garfield Groundwater Contamination Superfund Site
Garfield, NJ 07026

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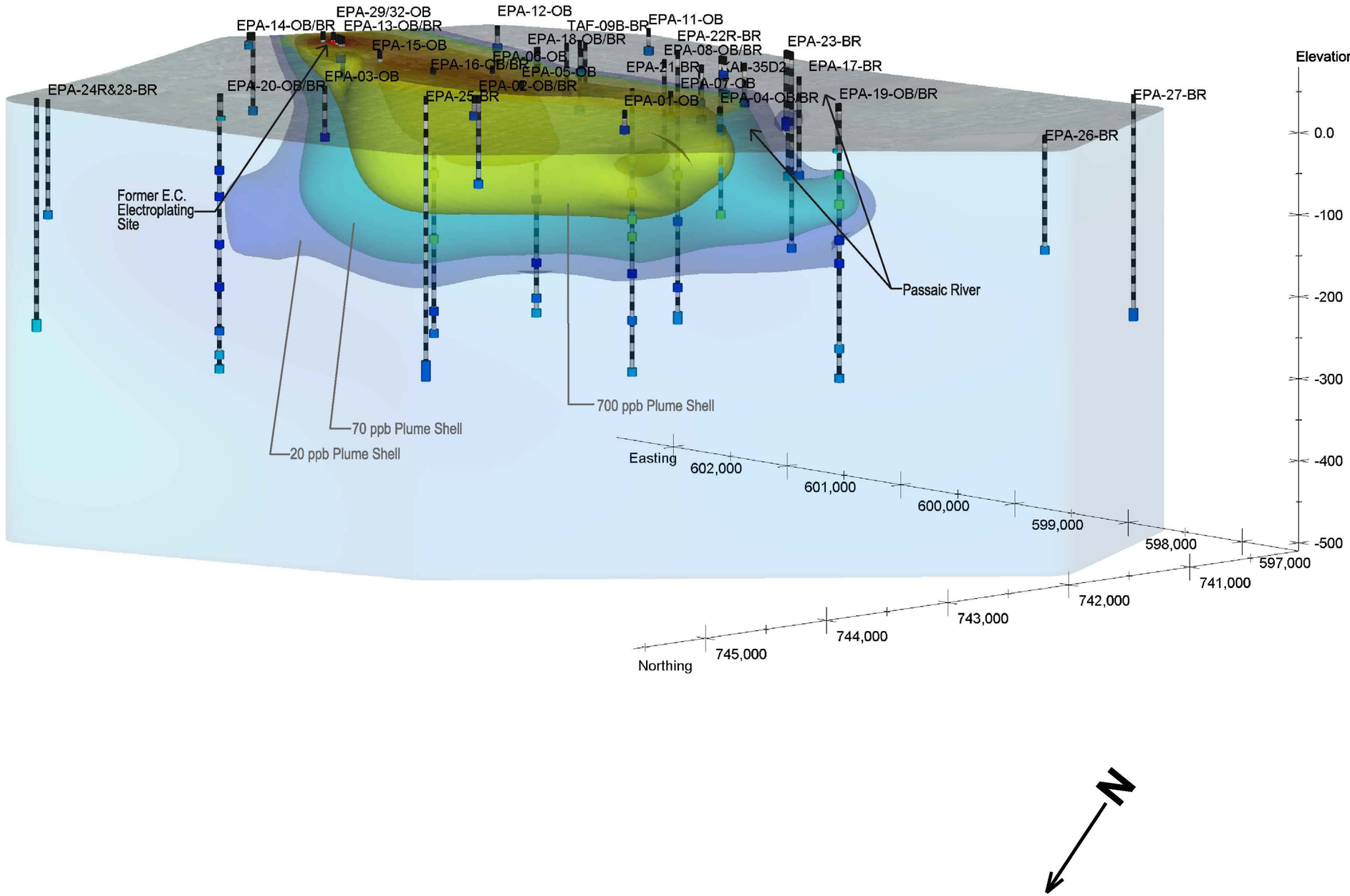
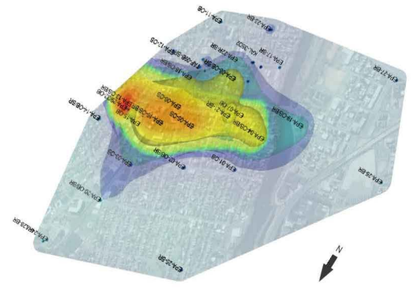


NOTES:

1) New Jersey State Plane Coordinate System Horizontal Datum NAD83, Vertical Datum NAVD88 US Survey Feet
2) Imagery Source: National Aerial Imagery Program Imagery Date: 2010
3) Aerial image overlain on water table surface, vadose zone not depicted
4) The saturated zone depiction is based on groundwater elevation data collected during the December 2014 synoptic water level measurement round. The groundwater elevation data used to depict the saturated zone at each FLUTe well was obtained from averaging the groundwater elevation of each FLUTe port.
5) The color break between green and blue shading occurs at 70 µg/L.



Basemap - Oriented Parallel to Plume View

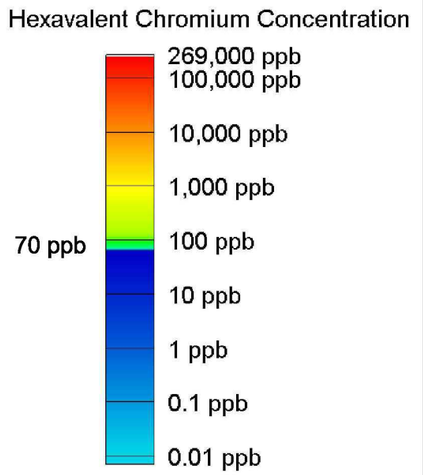


Figure 8
3D View of Hexavalent Chromium Plume in Groundwater – Northwest to Southeast, View Looking Down Slightly from Above Horizontal Plane
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Attachment 1
Field Data Sheets

Attachment 2
Data Quality Evaluation