United States Army Corps of Engineers
New England District

Final
Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 4.e, Validate the Updated Groundwater Flow Model with Sufficient Field-Measured Hydraulic Data to Confirm Conclusions

Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts

Contract No. W912WJ-19-D-0014

Contract Delivery Order No. W912WJ-20-F-0022

October 13, 2021

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Acronyms and Abbreviations

3PE	three-point estimation
Army	United States Department of the Army
ATP	Arsenic Treatment Plant
Geosyntec	Geosyntec Consultants, Inc.
NOAA	National Oceanic and Atmospheric Administration
S-A JV	SERES-Arcadis 8(a) Joint Venture 2, LLC
SHL	Shepley's Hill Landfill
site	Area of Contamination 5 – Shepley's Hill Landfill, located at the former Fort Devens Army Installation in Devens, Massachusetts
SOW	scope of work
Technical Memo 1	Phase I USEPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data
Technical Memo 2	Phase I USEPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 2.d Delineate Lateral and Vertical Extent Upgradient
Technical Memo 4	Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 4.e, Validate the Updated Groundwater Flow Model with Sufficient Field-Measured Hydraulic Data to Confirm Conclusions
USEPA	United States Environmental Protection Agency

1 Introduction

SERES-Arcadis 8(a) Joint Venture 2, LLC (S-A JV) prepared this Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 4.e, Validate the Updated Groundwater Flow Model with Sufficient Field-Measured Hydraulic Data to Confirm Conclusions (Technical Memo 4) in accordance with a scope of work (SOW; United States Environmental Protection Agency [USEPA] 2016) developed and agreed to between the United States Department of the Army (Army) and the USEPA, Region 1, for the Area of Contamination 5 Shepley's Hill Landfill (SHL), located at the former Fort Devens Army Installation in Devens, Massachusetts (site; Figure 1). Technical Memo 4, listed as Phase I Subtask 4.e in the SOW, is the fourth of five memoranda required by the USEPA in accordance with the SOW (USEPA 2016). The S-A JV prepared this Technical Memo 4 on behalf of the United States Army Corps of Engineers, New England District, under contract number W912WJ-19-D-0014.The EPA SOW is based on a Conceptual Site Model (CSM) that assumes the SHL is the primary source of arsenic in the groundwater and that, by intercepting the "plume" emanating from that source, a groundwater extraction and treatment remedy would result in the restoration of groundwater downgradient of the remedial system. This EPA CSM also includes the assumption that advective transport is the primary mechanism of contaminant migration. As presented to the EPA in numerous meetings and correspondence, the Army disagrees with this CSM, as there is substantial evidence that advective transport is not the only mechanism of contaminant migration, and that the naturally-occurring geochemical conditions associated with wetland and natural organic matter deposits, combined with geogenic arsenic sources, contribute to arsenic in groundwater in and downgradient from the area of current groundwater extraction. Further, the Army believes failure to account for these documented geochemical conditions and arsenic inputs provides misleading conclusions concerning the efficacy of a groundwater extraction and treatment remedy for restoration of downgradient groundwater.

1.1 Goals of Technical Memorandum

Building on the foundation outlined in Phase I USEPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data (Technical Memo 1; S-A JV 2021a) and Phase I USEPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 2.d Delineate Lateral and Vertical Extent Upgradient (Technical Memo 2; S-A JV 2021b), the primary objective of this Technical Memo 4 is to present the results of a comparison of modeled data to field data undertaken to determine if the model is appropriate to be used for capture zone analysis. The conclusion presented in the SHL Groundwater Flow Model Revision Report (Geosyntec Consultants, Inc. [Geosyntec] 2020) was that the zone of capture for the Arsenic Treatment Plant (ATP) extraction wells extends beyond the full width of the landfill. The groundwater flow model was developed for the area encompassing SHL using the United States Geological Survey MODFLOW numerical flow model to evaluate the potential migration of arsenic at SHL (Geosyntec 2020). The model also included an evaluation of the hydraulic capture zone created by the two ATP extraction wells using MODPATH. To further evaluate the capture zone of the two extraction wells, the USEPA requested that the Army perform additional analysis of groundwater flow within the glacial overburden aquifer from 2016 to 2020 using multiple data evaluation methods. Specific goals of this Technical Memo 4 include:

- Provide field data to support groundwater flow model results
- Compare flow model vectors to flow vectors calculated in Technical Memo 1.

1.2 Background – Development of Scope of Work for Technical Memorandum

The original USEPA SOW for this Technical Memo 4 was developed for groundwater monitoring events that occurred between 2016 and 2019; however, additional groundwater elevation measurements obtained in 2020 were incorporated in the analysis (Table 1). These groundwater elevations were used to develop potentiometric maps for each groundwater monitoring event from 2016 to 2020, with sufficient data to complete a potentiometric map in the Nearfield Area of SHL, at the toe of the capped landfill area where the ATP extraction wells are located. To evaluate the potential influence of precipitation, snow melt, and other seasonal variations, the analyses described in this Technical Memo 4 were performed for events that occurred in spring and fall each year where data were sufficient to provide detail and consistency throughout the entire period.

The groundwater flow model developed for the area encompassing SHL (Geosyntec 2020; referred to hereafter as the 2020 SHL Model) was used to develop the model-simulated groundwater elevations (potentiometric heads) for each corresponding time period identified in Technical Memo 1 (S-A JV 2021a). The groundwater model previously developed for SHL included 17 transient stress periods through the end of 2016 (an 18th stress period was modeled as steady state from the beginning of 2017 through the end of 2025). To simulate conditions for periods since the 2020 SHL Model development, 16 additional stress periods were added (33 stress periods in total) to predict groundwater elevations on a transient basis through the end of 2020. These additional stress periods represent quarterly time intervals from the beginning of 2017 through the end of 2020. To simulate seasonal variations in site conditions, boundary conditions were modeled using site-specific data to calculate average quarterly values for each stress period from 2017 to 2020. Groundwater recharge was based on daily precipitation records from the Fitchburg Municipal Airport in Fitchburg, Massachusetts (Global Historical Climatology Network Designation: GHCND: USW00004780; National Oceanic and Atmospheric Administration [NOAA] 2021). The distribution of recharge for this modeling analysis is the same as with the 2020 SHL Model (Geosyntec 2020). Recharge multipliers used in the 2020 SHL Model for each quarter from 2012 through 2016 were averaged together to obtain representative multipliers for each quarter for 2017 through 2020. For example, all first quarter recharge multipliers from 2012 through 2016 were averaged together (values of 2.0, 2.0, 1.4, and 2.0) to obtain representative a first quarter multiplier of 1.9 for each first quarter for 2017 through 2020. The groundwater recharge rates for each stress period are presented in Table 2. Pumping from the ATP extraction wells, EW-01 and EW-04, was based on daily pumping records (using both uptime and downtime rates) and then averaged for a quarterly rate. The daily pumping records for EW-01 and EW-04 for 2017 through 2020 are included in Attachment 1. Surface water boundary conditions and pumping from municipal supply wells was kept at the steady-state values used in the 18th stress period in the 2020 SHL Model (beginning of 2017 through the end of 2025; Geosyntec 2020). The ATP extraction well pumping rates used for each stress period are presented in Table 3.

2 Comparison of Hydraulic Head Data

This section summarizes and compares the field data measurements of groundwater elevation and the groundwater model generated groundwater elevations from 2016 to 2020.

2.1 Field Data Measurements

Water level data from 2016 to 2020 were collected by the USEPA Office of Research and Development, and the Army. Table 1 presents water level data used to generate the 10 potentiometric maps presented in Technical Memo 1 (S-A JV 2021a).

2.2 Model Potentiometric Heads

Table 4 presents the model-simulated potentiometric heads for the 10 semiannual periods presented in Technical Memo 1 (S-A JV 2021a). A comparison of the model-simulated potentiometric heads to field-measured potentiometric water levels (model residuals) for the 10 semiannual periods spanning August 16, 2016 to November 4, 2020 are presented in Table 5. The heads computed using MODFLOW were imported into Groundwater Vistas where the monitoring wells were simulated as targets (locations specified in x, y, and z directions where z is the mid-point of the screen elevation). Groundwater Vistas then applies an interpolation scheme to assign a modeled head value to each monitoring well. Groundwater Vistas uses bilinear interpolation in space and linear interpolation in time. Negative residuals indicate the model is overpredicting groundwater elevations (i.e., the field measured groundwater elevations are less than the model simulated groundwater elevations). Conversely, positive residuals indicate the model is underpredicting groundwater elevations (i.e., the field measured groundwater elevations are greater than the model simulated groundwater elevations). In general, the model closely simulates field-measured groundwater elevations, with 81% of the model-simulated potentiometric water levels within one foot of the field-measured potentiometric water levels. Model residuals presented as part of this exercise are comparable with those presented in the SHL Groundwater Flow Model Revision Report (Geosyntec 2020); overburden residuals ranged from -3.62 ft to 3.62 ft in the 2020 SHL Model and ranged from -1.96 ft to 2.15 ft in this exercise. While additional stress periods were added to the model to include the additional data, the model was not recalibrated or updated using data from monitoring wells and vertical profile borings collected after the Groundwater Flow Model Revision Report (Geosyntec 2020). These data are described in Technical Memo 2 (S-A JV 2021b).

3 Flow Vectors

This section compares vectors from Technical Memo 1 to vectors from the groundwater flow model and compares vectors to particle tracking results.

3.1 Comparison of Vectors from Technical Memo 1 to Vectors from Groundwater Flow Model

The groundwater gradient vectors obtained from the three-point estimation (3PE) gradient analysis in Technical Memo 1 (S-A JV 2021a) were compared to groundwater vectors obtained from the groundwater flow modeling exercise described in Section 2.2. Figures 2 through 11 show the 3PE vectors from Technical Memo 1 (S-A JV 2021a), the model-simulated groundwater elevation contours, and the groundwater gradient vectors obtained from the groundwater flow model for each of the 10 semiannual periods from 2016 through 2020. The groundwater gradient vectors were obtained from the groundwater flow model by saving the modeled groundwater elevation data as a Surfer grid and plotting as vectors in Surfer and scaled such that the longest vector arrows are locations with the steepest groundwater gradient. In general, the direction of the groundwater gradient vectors from both 3PE and the groundwater flow model are similar. For time periods where the groundwater gradient directions are slightly different, the groundwater flow model gradient vectors indicate more influence from the extraction wells than the 3PE analyses.

While the 3PE analysis provides a direct mathematical formula from which water level data can be used to calculate hydraulic gradients and groundwater flow directions within triangular areas, it is a simplistic method that does not account for the complexities of groundwater flow under pumping conditions. Accordingly, the SHL groundwater flow model is better suited to evaluate hydraulic capture of a recovery well since the 3PE analysis treats each triangular area as an independent steady-state analysis, whereas the groundwater model simulates all aspects of the groundwater flow regime (including vertical components of flow, and the transient effects of variable pumping, recharge, and boundary conditions) and honors a water mass balance across the area. Furthermore, the size of the 3PE triangles provide a much coarser assessment of flow direction and magnitude than the SHL groundwater flow model because the model is much more discretized within each 3PE triangle area. For example, within the triangle located closest to the extraction wells (bounded by wells SHP-2016-1B, SHP-05-45B, and EPA-PZ-202-4B), there are approximately 30 model cells, thus providing a higher resolution than a single 3PE triangle. 3PE also represents the gradient and direction for a single time whereas the groundwater flow model results are for an average of three months. A 3PE analysis could vary significantly over a three-month period. For these reasons, Army believes that the groundwater model is the preferred tool for estimating capture extent because it reasonably represents groundwater levels and flow.

3.2 Comparison of Vector to Particle Tracking Results

Reverse particle tracking was used to evaluate the model-predicted capture of the ATP extraction wells EW-01 and EW-04. To predict the extent of the capture zone for each of the 10 semiannual periods, particles were tracked in reverse starting at the end of the stress period of interest (e.g., if the capture zone for stress period 16 was of interest, particles would start at the end of stress period 16). The particles were released in a 4x4 array for every 2 feet of well screen around each recovery well (224 particles per well). The particles were run for a simulated period of 5 years. These were the same starting locations as presented in the 2020 SHL Model (Geosyntec 2020). Figures 12 through 21 show the model-generated capture zones for each semiannual time period from 2016 through 2020. The model-predicted capture zones for each of the time periods of interest show the zone of capture extends the full width of the landfill[1]. Attachment 2 shows the reverse particle pathlines for the entire SHL boundary.

Figures 12 through 21 also depict the capture zones delineated in Technical Memos 1 and 2 (S-A JV 2021a, 2021b). Technical Memos 1 and 2 (S-A JV 2021a, 2021b) delineated capture zones for average spring 2017 through 2020 events and fall/summer 2016 through 2020 conditions. Therefore, for fall events (Figures 13, 15, 17, 19, and 21) the average fall capture zone delineated in Technical Memos 1 and 2 (S-A JV 2021a, 2021b) are shown along with the model-predicted capture zones for each time period. In general, the model-predicted capture zones extend farther to the north, east, and west than the capture zones estimated from the 3PE analysis in Technical Memos 1 and 2 (S-A JV 2021a, 2021b). The limited extent of the capture zone demonstrated by the 3PE analysis included in Technical Memo 1 is partially limited in the eastern portion of the site, as the eastern most triangles are spatially limited by the existing well network. The model accounts for flow potential in the eastern portion of the site (east of the monitoring well SHM-10-06A) that the 3PE analysis cannot fully represent due to the lack of additional triangles in the eastern portion of the site. Both the model-predicted capture zones and the capture zones estimated from the 3PE analysis fully encompass the SHL landfill boundary.

To assess whether the ATP extraction wells were a strong sink, forward particle tracking was performed. Particles were tracked forward starting at the beginning of stress period 14 (which corresponds to the beginning of 2016). The particles were released at the mid-point of model layers 1, 2, 3, and 4 throughout the SHL boundary north of the barrier wall. Figure 22 shows the forward particle tracking results. The results of the forward particle tracking show that the particles in each layer were fully captured by the extraction wells and match the eastern and western extent of the 3PE estimated capture zones. The northern extent of the 3PE estimated capture zone is farther to the north than the forward particles migrate from 2016 through 2020. The source of that water is likely outside of the landfill boundary or from bedrock discharge (model layers 5 & 6).

[1] The key design criterion for the ATP extraction wells, as specified in the 100% Design (CH2MHill 2005) were to "provide containment of the groundwater plume in the vicinity of the base boundary," seek to reduce the design rate of 50 gpm as appropriate, and to focus groundwater extraction in the deeper part of the glacial aquifer". It should be noted the modeling results presented in the final design of the ATP extraction system did not include full capture east of the landfill boundary (between wells SHM-10-06 and SHM-21; Figures A-8 and A-9 of CH2MHill 2005).

4 Summary and Conclusions

Hydraulic gradient vectors, field data, and capture zones presented and discussed in Technical Memos 1 and 2 were used to help validate the groundwater flow model with sufficient field-measured hydraulic data to confirm the conclusions presented in the groundwater model report (Geosyntec 2020). The groundwater flow model (Geosyntec 2020), which presented 17 transient stress periods through the end of 2016, was further expanded through the end of 2020 such that the water levels, hydraulic gradient vectors, and capture zones estimated based on the 3PE analyses presented in Technical Memos 1 and 2 (S-A JV 2021a, 2021b) could be compared to model results. In general, the water levels and hydraulic gradient vector directions generated by the model matched closely with the analyses presented in Technical Memo 1 (S-A JV 2021a). While additional stress periods were added to the model, the model was not recalibrated with the 2017 through 2020 data and was not updated based on data collected at recently installed monitoring wells or vertical profile borings (described in Technical Memo 2 [S-A JV 2021b]). The reverse pathline analyses showing the groundwater capture zones of the ATP extraction wells extended farther to the north, east, and west than the capture zones delineated in Technical Memos 1 and 2 (S-A JV 2021a, 2021b).

5 References

CH2MHill. 2005. Remedial Design and Remedial Action Workplan. Final 100% Submittal. Groundwater Extraction, Treatment, and Discharge Contingency Remedy. Shepley's Hill Landfill, Fort Devens, Massachusetts. May.

Geosyntec. 2020. SHL Groundwater Flow Model Revision Report. Shepley's Hill Landfill, Fort Devens, Massachusetts. December.

NOAA. 2021. Fitchburg Municipal Airport in Fitchburg, Massachusetts (Global Historical Climatology Network Designation: GHCND: USW00004780. https://www.ncdc.noaa.gov/cdo-web/results

S-A JV. 2021a. Draft Phase I EPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

S-A JV. 2021b. Draft Phase I EPA SOW – Demonstrate Plume Capture Technical Memorandum Phase I Subtask 2.d Delineate Lateral and Vertical Extent Upgradient. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. May 17.

USEPA. 2016. Letter from Lynn A. Jennings (USEPA) to William O'Donnell (Army) re: Former Fort Devens Installation – Dispute Resolution, 2015 Devens Five Year Review (FYR) Report. February 24.

Tables

Table 1
Field-Measured Groundwater Elevations 2016 through 2020
Technical Memo 4
Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts

SERES
Engineering & Services, LLC
ARCADIS
a joint venture

Well ID	Reference Elevation (feet)	8/16/2016		10/20/2016		3/2/2017		11/2/2017		5/22/2018		11/1/2018		5/13/2019		10/22/2019		5/18/2020		11/4/2020	
		DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)	DTW (feet)	Elevation (feet)
EPA-PZ-2012-1B	223.53	12.51	211.02	12.63	210.90	10.35	213.18	10.35	213.18	10.72	212.81	10.43	213.10	9.82	213.71	11.80	211.73	10.09	213.44	11.93	211.60
EPA-PZ-2012-2B	223.37	12.12	211.25	12.22	211.15	10.13	213.24	10.11	213.26	10.53	212.84	10.29	213.08	9.77	213.60	11.44	211.93	9.98	213.39	11.51	211.86
EPA-PZ-2012-3B	222.57	12.27	210.30	12.37	210.20	9.97	212.60	10.11	212.46	10.36	212.21	10.20	212.37	9.43	213.14	11.60	210.97	9.68	212.89	11.70	210.87
EPA-PZ-2012-4B	226.39	16.49	209.90	16.57	209.82	14.07	212.32	14.31	212.08	14.56	211.83	14.18	212.21	13.46	212.93	15.76	210.63	13.85	212.54	15.90	210.49
EPA-PZ-2012-5B	219.38	8.82	210.56	8.93	210.45	6.68	212.70	6.70	212.68	7.10	212.28	6.83	212.55	6.26	213.12	8.24	211.14	6.72	212.66	8.32	211.06
EPA-PZ-2012-6B	234.08	24.14	209.94	24.25	209.83	21.75	212.33	21.92	212.16	22.17	211.92	21.87	212.21	21.12	212.96	23.55	210.53	21.39	212.69	23.63	210.45
SHP-2016-1B	227.24	18.04	209.20	18.46	208.78	16.08	211.16	16.01	211.23	16.59	210.65	16.65	210.59	15.41	211.83	17.75	209.49	16.19	211.05	18.00	209.24
SHP-2016-2B	225.95	-	-	15.96	209.99	13.59	212.36	13.69	212.26	13.97	211.98	13.22	212.73	13.00	212.95	16.29	209.66	13.35	212.60	15.30	210.65
SHP-2016-3B	223.18	13.07	210.11	13.13	210.05	10.78	212.40	10.86	212.32	11.15	212.03	10.95	212.23	10.21	212.97	12.37	210.81	10.55	212.63	12.47	210.71
SHP-2016-4B	229.75	19.75	210.00	19.78	209.97	17.39	212.37	17.52	212.23	17.74	212.01	17.56	212.19	16.74	213.01	19.10	210.65	17.13	212.62	19.17	210.58
SHP-2016-5B	226.95	16.95	210.00	17.01	209.94	14.60	212.36	14.70	212.25	14.93	212.02	14.79	212.16	13.93	213.02	16.28	210.67	14.29	212.66	16.38	210.57
SHM-05-42B	216.80	6.59	210.21	6.68	210.12	4.44	212.36	4.52	212.28	4.84	211.96	4.68	212.12	3.99	212.81	7.50	209.30	-	-	6.00	210.80
SHM-96-5B	218.92	8.17	210.75	8.26	210.66	5.99	212.93	6.08	212.84	6.38	212.54	6.10	212.82	5.50	213.42	7.49	211.43	5.79	213.13	7.63	211.29
SHP-05-45B	229.11	18.84	210.27	19.04	210.07	16.71	212.40	16.87	212.24	16.94	212.17	16.89	212.22	15.87	213.24	18.42	210.69	-	-	18.31	210.80
SHP-05-46B	227.60	16.86	210.74	17.09	210.51	14.67	212.93	14.74	212.86	14.88	212.72	14.74	212.86	13.83	213.77	16.30	211.30	-	-	16.38	211.22
SHM-10-06A	248.54	36.03	212.51	36.19	212.35	34.04	214.50	34.02	214.52	34.24	214.30	33.98	214.56	33.41	215.13	35.30	213.24	-	-	36.11	212.43
SHM-10-06	232.91	20.70	212.21	20.87	212.04	18.62	214.29	18.60	214.31	18.78	214.13	18.55	214.36	17.87	215.04	20.00	212.91	-	-	20.31	212.60
SHM-10-16	219.23	9.22	210.01	9.32	209.91	7.01	212.22	7.13	212.10	7.40	211.83	7.20	212.03	6.48	212.75	8.62	210.61	-	-	8.63	210.60
SHM-05-41C	222.57	-	-	-	-	-	-	10.53	212.04	10.68	211.89	10.60	211.97	-	-	12.15	210.42	10.31	212.26	12.12	210.45
EPA-PZ-2012-7B	234.03	24.01	210.02	24.12	209.91	21.68	212.35	21.87	212.16	22.01	212.02	22.05	211.98	20.96	213.07	23.39	210.64	21.37	212.66	23.45	210.58

Notes:

1. Data sources:
   - · 11/2/2017: Table 5-4 of the Draft Final 2018 Annual Operations, Maintenance, and Monitoring Report (KOMAN Government Solutions, LLC 2019).
   - · 8/16/2016, 11/1/2018, 10/22/2019, 5/18/2020, and 11/4/2020: Long Term Monitoring datasets, downloaded from the database at ftdevens.org.
   - · 10/20/2016, 3/2/2017, 5/22/2018, and 5/13/2019: SHL ORD Manual Water Levels_2016-2019.xlsx Microsoft Excel file, transmitted via electronic mail on 9/18/2020 by Carol Keating (United States Environmental Protection Agency) to Robert Simeone (United States Department of the Army).

2. Grey highlighted cells indicate that DTW data do not match the rounded value shown in the Shepley's Hill Landfill (SHL) Office of Research and Development (ORD) Manual Water Levels_2016-2019.xlsx file (ORD data file). The data for this monitoring well on this date in the ORD data file includes three decimal places. In instances where this occurs, the groundwater elevation shown in the ORD data file was used, and the DTW was calculated based on the groundwater elevation and the reference elevation.

3. Data for EPA-PZ-2012-5B shown for 5/18/2020 were recorded on 5/22/2020. Data for SHP-2016-1B shown for 11/4/2020 were recorded on 11/5/2020. DTW data collected during the synoptic gauging event at these locations were not consistent with historical data, so the DTW measurements collected prior to subsequently sampling these locations is shown above and were used in calculations.

4. Elevations shown are in North American Vertical Datum of 1988.

Acronyms and Abbreviations:
- = No water level collected
DTW = depth to water
Technical Memo 4 = Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 4.e, Validate the Updated Groundwater Flow Model with Sufficient Field-Measured Hydraulic Data to Confirm Conclusions

Reference:

KOMAN Government Solutions, LLC. 2019. Draft Final 2018 Annual Operations, Maintenance, and Monitoring Report, Shepley's Hill Landfill, Former Fort Devens Army Installation. December.

Table 2
Groundwater Recharge Rate by Stress Period
Technical Memo 4
Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts

SERES Engineering & Services, LLC
ARCADIS
a joint venture

Stress Period	Start Date	End Date	Precipitation (feet/day)	Recharge Multiplier	Recharge Rate (feet/day)				
					6% Precipitation	32% Precipitation	42% Precipitation	42% Precipitation	75% Precipitation
					Zone 2	Zone 3	Zone 4	Zone 7	Zone 9
1	9/30/2012	12/31/2012	0.009	1.1	0.0006	0.0033	0.0044	0.0044	0.0078
2	12/31/2012	3/31/2013	0.007	2.0	0.0008	0.0041	0.0055	0.0055	0.0098
3	4/1/2013	6/30/2013	0.014	1.2	0.0010	0.0053	0.0070	0.0070	0.0125
4	7/1/2013	9/30/2013	0.007	0.5	0.0002	0.0010	0.0014	0.0014	0.0025
5	10/1/2013	12/31/2013	0.007	0.5	0.0002	0.0011	0.0014	0.0014	0.0025
6	12/31/2013	3/31/2014	0.009	1.4	0.0007	0.0038	0.0051	0.0051	0.0091
7	4/1/2014	6/30/2014	0.008	1.9	0.0009	0.0049	0.0066	0.0066	0.0118
8	7/1/2014	9/30/2014	0.008	0.5	0.0002	0.0013	0.0017	0.0017	0.0030
9	10/1/2014	12/31/2014	0.012	0.7	0.0005	0.0027	0.0036	0.0036	0.0063
10	12/31/2014	3/31/2015	0.006	2.0	0.0008	0.0040	0.0053	0.0053	0.0094
11	4/1/2015	6/30/2015	0.009	1.5	0.0008	0.0042	0.0056	0.0056	0.0099
12	7/1/2015	9/30/2015	0.008	0.5	0.0002	0.0013	0.0017	0.0017	0.0031
13	9/30/2015	12/31/2015	0.008	1.0	0.0005	0.0027	0.0036	0.0036	0.0064
14	12/31/2015	3/31/2016	0.007	2.0	0.0009	0.0046	0.0061	0.0061	0.0109
15	4/1/2016	6/30/2016	0.005	2.0	0.0005	0.0029	0.0038	0.0038	0.0068
16	7/1/2016	9/30/2016	0.006	0.5	0.0002	0.0009	0.0012	0.0012	0.0021
17	9/30/2016	12/31/2016	0.009	1.1	0.0006	0.0031	0.0041	0.0041	0.0073
18	1/1/2017	3/31/3017	0.011	1.9	0.0012	0.0065	0.0085	0.0085	0.0152
19	4/1/2017	6/30/2017	0.017	1.7	0.0017	0.0093	0.0122	0.0122	0.0219
20	7/1/2017	9/30/2017	0.010	0.5	0.0003	0.0016	0.0022	0.0022	0.0038
21	10/1/2017	12/31/2017	0.015	0.9	0.0008	0.0043	0.0056	0.0056	0.0100
22	1/1/2018	3/31/2018	0.010	1.9	0.0012	0.0063	0.0082	0.0082	0.0147
23	4/1/2018	6/30/2018	0.012	1.7	0.0013	0.0067	0.0088	0.0088	0.0158
24	7/1/2018	9/30/2018	0.025	0.5	0.0007	0.0040	0.0052	0.0052	0.0093
25	10/1/2018	12/31/2018	0.016	0.9	0.0009	0.0047	0.0061	0.0061	0.0110
26	1/1/2019	3/31/3019	0.009	1.9	0.0011	0.0056	0.0074	0.0074	0.0132
27	4/1/2019	6/30/2019	0.016	1.7	0.0016	0.0087	0.0114	0.0114	0.0204
28	7/1/2019	9/30/2019	0.009	0.5	0.0003	0.0014	0.0018	0.0018	0.0033
29	10/1/2019	12/31/2019	0.007	0.9	0.0004	0.0021	0.0028	0.0028	0.0050
30	1/1/2020	3/30/2020	0.009	1.9	0.0011	0.0056	0.0074	0.0074	0.0131
31	4/1/2020	6/30/2020	0.010	1.7	0.0010	0.0053	0.0069	0.0069	0.0123
32	7/1/2020	9/30/2020	0.006	0.5	0.0002	0.0009	0.0012	0.0012	0.0021
33	10/1/2020	12/31/2020	0.015	0.9	0.0008	0.0043	0.0057	0.0057	0.0101

Notes:

1. The recharge rate applied to a zone for a given stress period (SP) = Precipitation * Percent Precipitation * Recharge Multiplier.
2. Precipitation rates represent a daily average of the total recorded rainfall for a given stress period. Precipitation data are primarily from the Fitchburg, Massachusetts Municipal Airport (GHCND:USW00004780). Supplementary data from a meteorological station in Ayer, Massachusetts (GHCND:US1MAMD0025) were used to address gaps in the recorded data from the Fitchburg Municipal Airport (September 8 to 30, 2016 and October 21, 2016).
3. Recharge multiplier was an adjusted parameter during the calibration process.
4. Recharge multiplier for SP18 through 33 is the average recharge multiplier by quarter for SP 1 through SP 17.
5. A map of recharge zones is shown on Figure 6.2 of the SHL Groundwater Flow Model Revision Report (Geosyntec Consultants, Inc. 2020).

Acronyms and Abbreviations:

% = percent

Technical Memo 4 = Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 4.e, Validate the Updated Groundwater Flow Model with Sufficient Field-Measured Hydraulic Data to Confirm Conclusions

Reference:

Geosyntec Consultants, Inc. 2020. SHL Groundwater Flow Model Revision Report. Shepley's Hill Landfill, Fort Devens, Massachusetts. December.

Table 3
Arsenic Treatment Plan Extraction Well Rates by Stress Period
2021 Technical Memo
Shepley's Hill Landfill, Former Fort Devens Army Installation, Massachusetts

Stress Period	Start Date	End Date	EW-01 Average Effective Flow Rate (gpm)	EW-04 Average Effective Flow Rate (gpm)
1	9/30/2012	12/31/2012	21.2	21.2
2	12/31/2012	3/31/2013	19.2	19.2
3	4/1/2013	6/30/2013	21.4	21.4
4	7/1/2013	9/30/2013	22.2	22.2
5	10/1/2013	12/31/2013	21.2	21.2
6	12/31/2013	3/31/2014	22.3	22.3
7	4/1/2014	6/30/2014	22.0	22.0
8	7/1/2014	9/30/2014	22.9	22.9
9	10/1/2014	12/31/2014	21.1	21.1
10	12/31/2014	3/31/2015	21.9	19.7
11	4/1/2015	6/30/2015	26.8	21.9
12	7/1/2015	9/30/2015	29.7	23.3
13	9/30/2015	12/31/2015	34.0	22.7
14	12/31/2015	3/31/2016	32.7	21.8
15	4/1/2016	6/30/2016	31.5	21.0
16	7/1/2016	9/30/2016	31.8	21.1
17	9/30/2016	12/31/2016	33.0	19.4
18	1/1/2017	3/31/3017	33.6	18.1
19	4/1/2017	6/30/2017	33.3	17.9
20	7/1/2017	9/30/2017	33.9	18.3
21	10/1/2017	12/31/2017	31.1	16.7
22	1/1/2018	3/31/2018	33.9	18.2
23	4/1/2018	6/30/2018	33.4	18.0
24	7/1/2018	9/30/2018	33.5	18.0
25	10/1/2018	12/31/2018	22.4	12.1
26	1/1/2019	3/31/3019	31.8	17.1
27	4/1/2019	6/30/2019	24.7	13.3
28	7/1/2019	9/30/2019	33.6	18.1
29	10/1/2019	12/31/2019	33.7	18.2
30	1/1/2020	3/30/2020	34.0	18.3
31	4/1/2020	6/30/2020	33.8	18.2
32	7/1/2020	9/30/2020	33.6	18.1
33	10/1/2020	12/31/2020	33.2	17.9

Notes & Abbreviations:

1. Arsenic treatment plant (ATP) effective flow rate data for Stress Periods 1 through 17 was compiled from the Groundwater Model Report (Geosyntec, 2020)
2. ATP effective flow rate data was compiled from Sovereign Consultants data (ATP Well Data 2012-2020.xlsx)
3. The average quarterly effective flow rates for the ATP system were estimated by averaging the effective flow rates for the three months in each quarter.
4. gpm = gallons per minute

Table 4
Model-Simulated Groundwater Elevations 2016 through 2020
Technical Memo 4
Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts

SERES Engineering & Services, LLC
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Well ID	Groundwater Elevation (feet)									
	8/16/2016 (Stress Period 16)	10/20/2016 (Stress Period 17)	3/2/2017 (Stress Period 18)	11/2/2017 (Stress Period 21)	5/22/2018 (Stress Period 23)	11/1/2018 (Stress Period 25)	5/13/2019 (Stress Period 27)	10/22/2019 (Stress Period 29)	5/18/2020 (Stress Period 31)	11/4/2020 (Stress Period 33)
EPA-PZ-2012-1B	211.72	211.87	212.36	212.56	212.87	212.93	213.41	212.81	213.03	212.40
EPA-PZ-2012-2B	212.04	212.20	212.66	212.77	213.04	213.08	213.50	213.00	213.24	212.64
EPA-PZ-2012-3B	210.86	211.03	211.56	211.80	212.16	212.24	212.77	212.06	212.26	211.62
EPA-PZ-2012-4B	210.22	210.38	210.94	211.25	211.62	211.77	212.37	211.51	211.70	211.04
EPA-PZ-2012-5B	211.23	211.43	211.94	212.07	212.39	212.42	212.88	212.30	212.53	211.91
EPA-PZ-2012-6B	209.95	210.14	210.73	211.07	211.47	211.61	212.23	211.32	211.52	210.84
SHP-2016-1B	208.39	208.52	209.10	209.54	209.90	210.29	210.99	209.79	209.94	209.29
SHP-2016-2B	NA	210.69	211.25	211.48	211.86	211.91	212.44	211.71	211.93	211.28
SHP-2016-3B	210.68	210.87	211.42	211.63	211.99	212.04	212.56	211.86	212.08	211.44
SHP-2016-4B	210.33	210.53	211.10	211.37	211.77	211.84	212.41	211.61	211.83	211.16
SHP-2016-5B	210.37	210.56	211.12	211.39	211.77	211.87	212.44	211.64	211.85	211.19
SHM-05-42B	210.66	210.90	211.42	211.55	211.89	211.88	212.33	211.75	NA	211.38
SHM-96-5B	211.39	211.56	212.06	212.24	212.56	212.61	213.09	212.48	212.71	212.08
SHP-05-45B	209.95	210.06	210.60	211.00	211.37	211.62	212.25	211.30	NA	210.79
SHP-05-46B	210.83	210.93	211.45	211.83	212.19	212.37	212.96	212.14	NA	211.64
SHM-10-06A	213.04	213.10	213.54	213.79	214.07	214.12	214.59	214.07	NA	213.66
SHM-10-06	212.67	212.73	213.19	213.51	213.81	213.89	214.39	213.83	NA	213.37
SHM-10-16	210.31	210.54	211.11	211.30	211.69	211.67	212.17	211.49	NA	211.10
SHM-05-41C	NA	NA	NA	211.35	211.77	211.75	NA	211.55	211.80	211.13
EPA-PZ-2012-7B	210.22	210.42	211.03	211.35	211.80	211.86	212.49	211.60	211.82	211.12

Note:
1. Elevations shown are in North American Vertical Datum of 1988.

Abbreviation:
Technical Memo 4 = Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 4.e, Validate the Updated Groundwater Flow Model with Sufficient Field-Measured Hydraulic Data to Confirm Conclusions

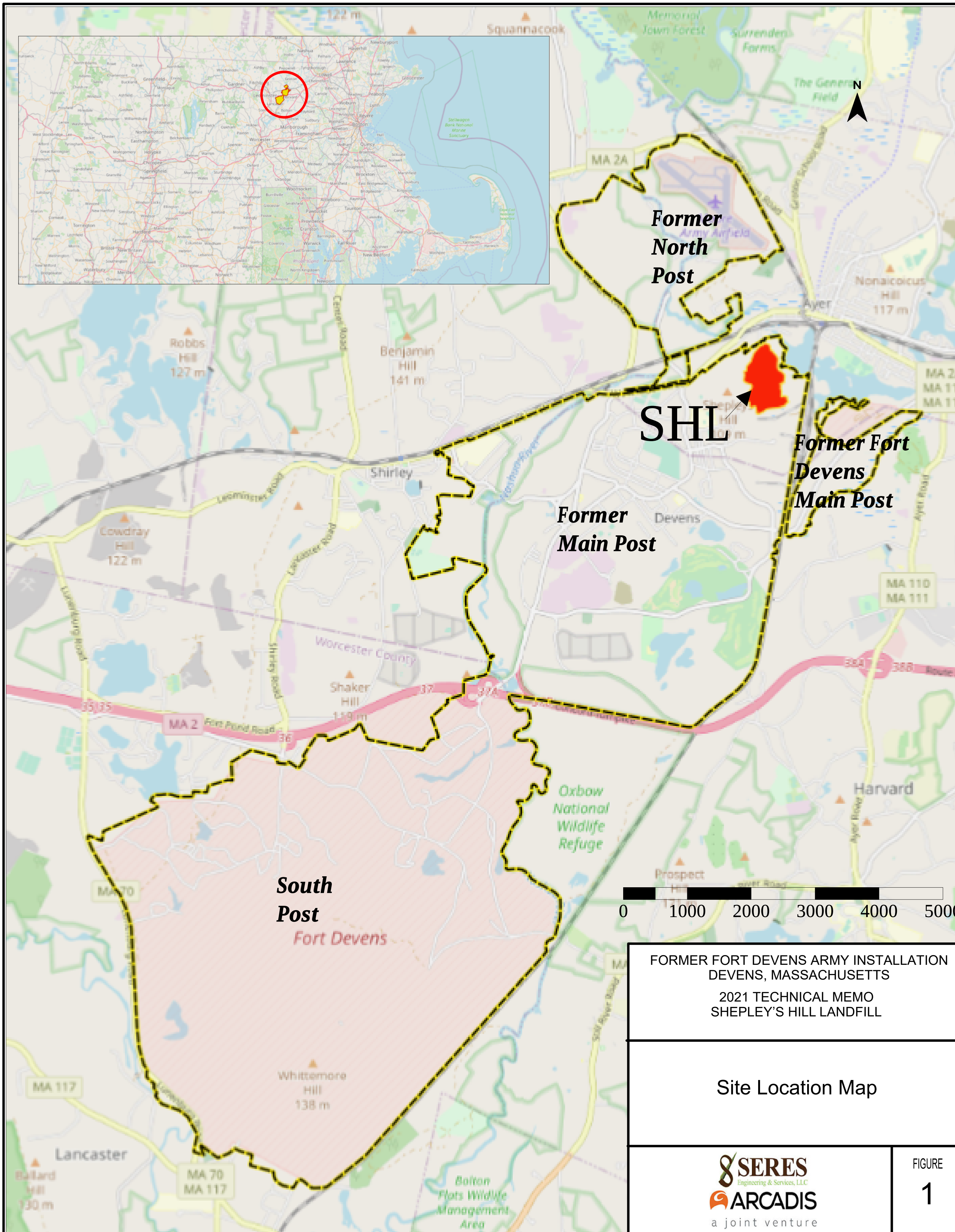
Table 5
Comparison of Model-Calculated and Observed Groundwater Elevations 2016 through 2020
Technical Memo 4
Shepley's Hill Landfill
Former Fort Devens Army Installation
Devens, Massachusetts

Well ID	Field Groundwater Elevation – Model Simulated Groundwater Elevation (feet)									
	8/16/2016 (Stress Period 16)	10/20/2016 (Stress Period 17)	3/2/2017 (Stress Period 18)	11/2/2017 (Stress Period 21)	5/22/2018 (Stress Period 23)	11/1/2018 (Stress Period 25)	5/13/2019 (Stress Period 27)	10/22/2019 (Stress Period 29)	5/18/2020 (Stress Period 31)	11/4/2020 (Stress Period 33)
EPA-PZ-2012-1B	-0.24	-0.53	1.00	0.77	-0.06	0.22	0.26	-0.48	0.83	-0.67
EPA-PZ-2012-2B	-0.24	-0.54	0.81	0.68	-0.16	0.16	0.15	-0.46	0.62	-0.61
EPA-PZ-2012-3B	-0.15	-0.45	1.15	0.74	0.03	0.06	0.24	-0.50	0.99	-0.67
EPA-PZ-2012-4B	0.14	-0.13	1.48	0.88	0.16	0.21	0.33	-0.28	1.18	-0.48
EPA-PZ-2012-5B	-0.22	-0.56	0.90	0.72	-0.12	0.21	0.22	-0.60	0.51	-0.78
EPA-PZ-2012-6B	0.47	0.14	1.67	1.13	0.39	0.34	0.46	-0.19	1.49	-0.34
SHP-2016-1B	1.66	1.09	2.15	1.64	0.68	-0.38	0.35	0.32	1.44	0.02
SHP-2016-2B	NA	-0.34	1.17	0.84	0.07	0.77	0.36	-1.49	0.99	-0.59
SHP-2016-3B	-0.16	-0.45	1.07	0.77	0.01	0.15	0.30	-0.49	0.89	-0.68
SHP-2016-4B	0.06	-0.19	1.33	0.91	0.19	0.23	0.41	-0.39	1.11	-0.54
SHP-2016-5B	0.03	-0.24	1.32	0.92	0.20	0.15	0.40	-0.39	1.15	-0.56
SHM-05-42B	-0.07	-0.43	1.00	0.80	0.04	0.30	0.44	-1.96	NA	-0.57
SHM-96-5B	-0.19	-0.48	1.02	0.72	-0.03	0.25	0.28	-0.47	0.82	-0.69
SHP-05-45B	0.87	0.54	1.91	1.27	0.75	0.21	0.66	0.01	NA	0.11
SHP-05-46B	0.34	-0.01	1.61	1.11	0.48	0.27	0.57	-0.23	NA	-0.31
SHM-10-06A	-0.02	-0.28	1.22	0.95	0.26	0.53	0.52	-0.21	NA	-1.02
SHM-10-06	-0.03	-0.29	1.32	0.99	0.31	0.49	0.57	-0.30	NA	-0.58
SHM-10-16	0.04	-0.32	1.13	0.85	0.08	0.38	0.46	-0.38	NA	-0.50
SHM-05-41C	NA	NA	NA	0.75	0.07	0.20	NA	-0.59	0.75	-0.67
EPA-PZ-2012-7B	0.21	-0.12	1.36	0.86	0.16	-0.05	0.34	-0.37	1.14	-0.50

Note:
1. Elevations shown are in North American Vertical Datum of 1988.

Acronyms and Abbreviations:
NA = not applicable; field water levels were not collected
Technical Memo 4 = Phase I USEPA SOW – Demonstrate Plume Capture, Technical Memorandum Phase I Subtask 4.e, Validate the Updated Groundwater Flow Model with Sufficient Field-Measured Hydraulic Data to Confirm Conclusions

Figures



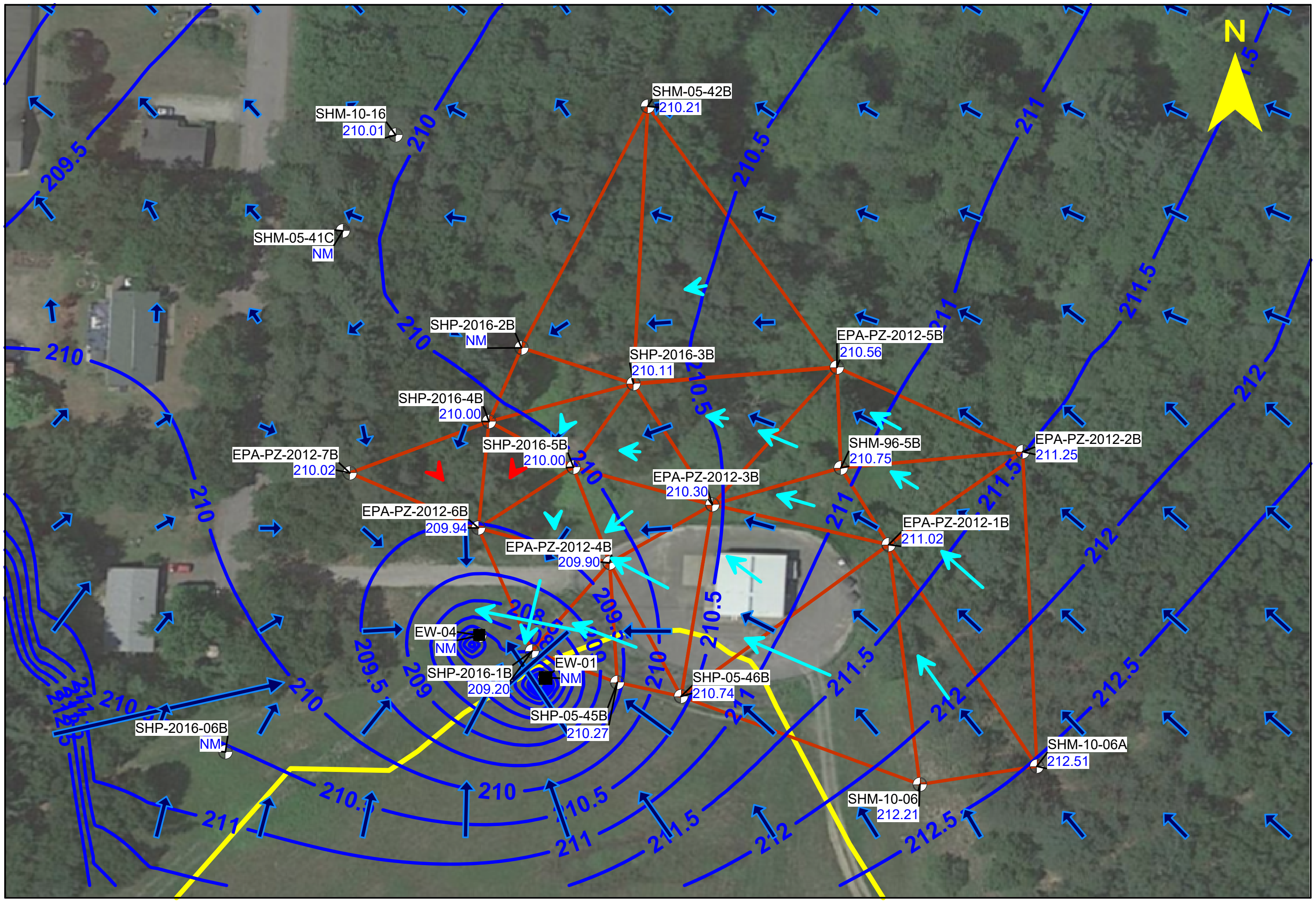
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS

2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

Site Location Map

SERES Engineering & Services, LLC
ARCADIS
a joint venture

FIGURE
1



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)

Scale in feet

0 120 240

Notes:

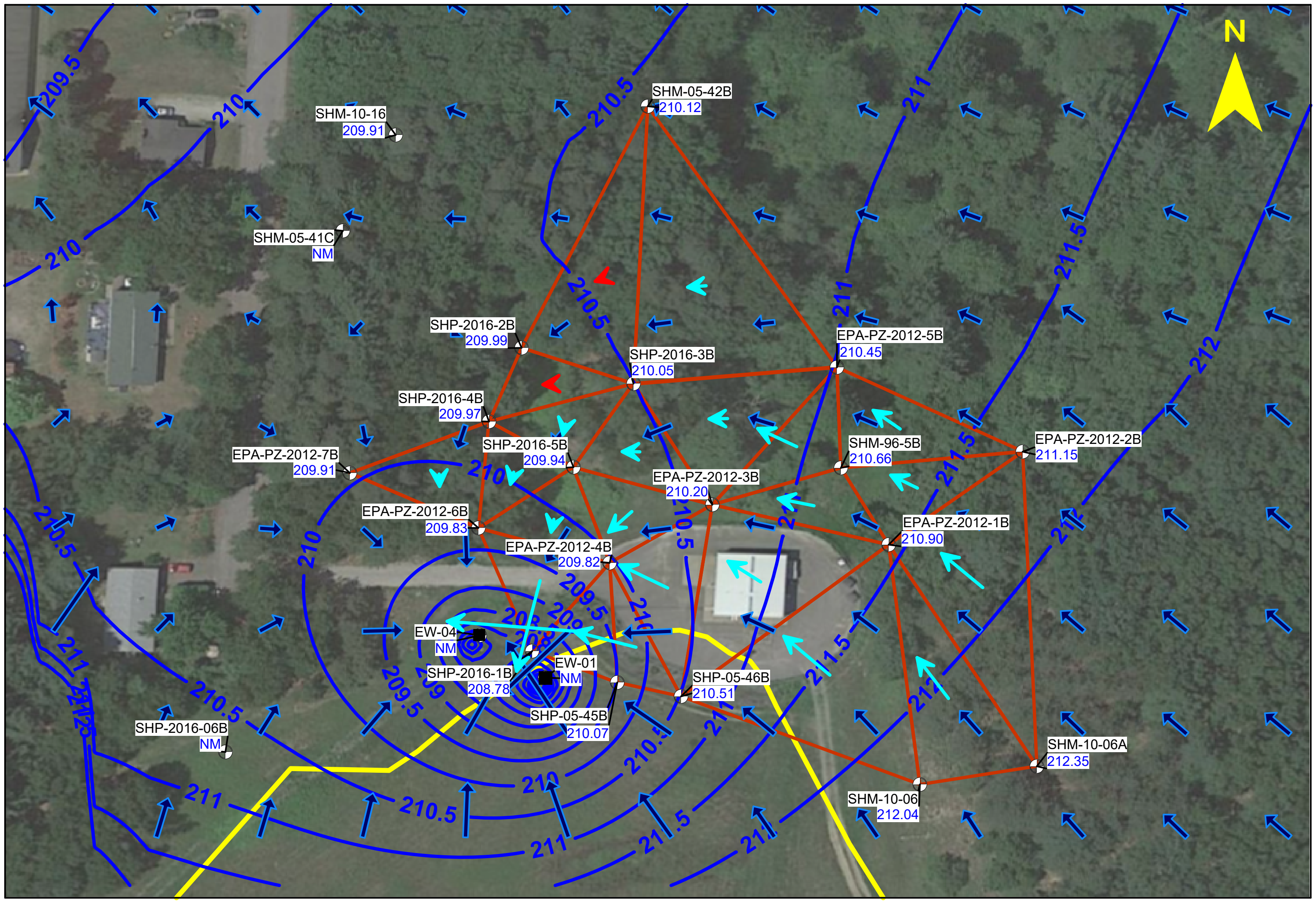
1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

August 16, 2016 (Stress Period 16)
3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours

SERES ARCADIS a joint venture

FIGURE 2



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021)
  (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)

Scale in feet
0 120 240

Notes:
1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

October 20, 2016 (Stress Period 17)
3PE and Model-Generated Hydraulic Vectors
and Groundwater Elevation Contours

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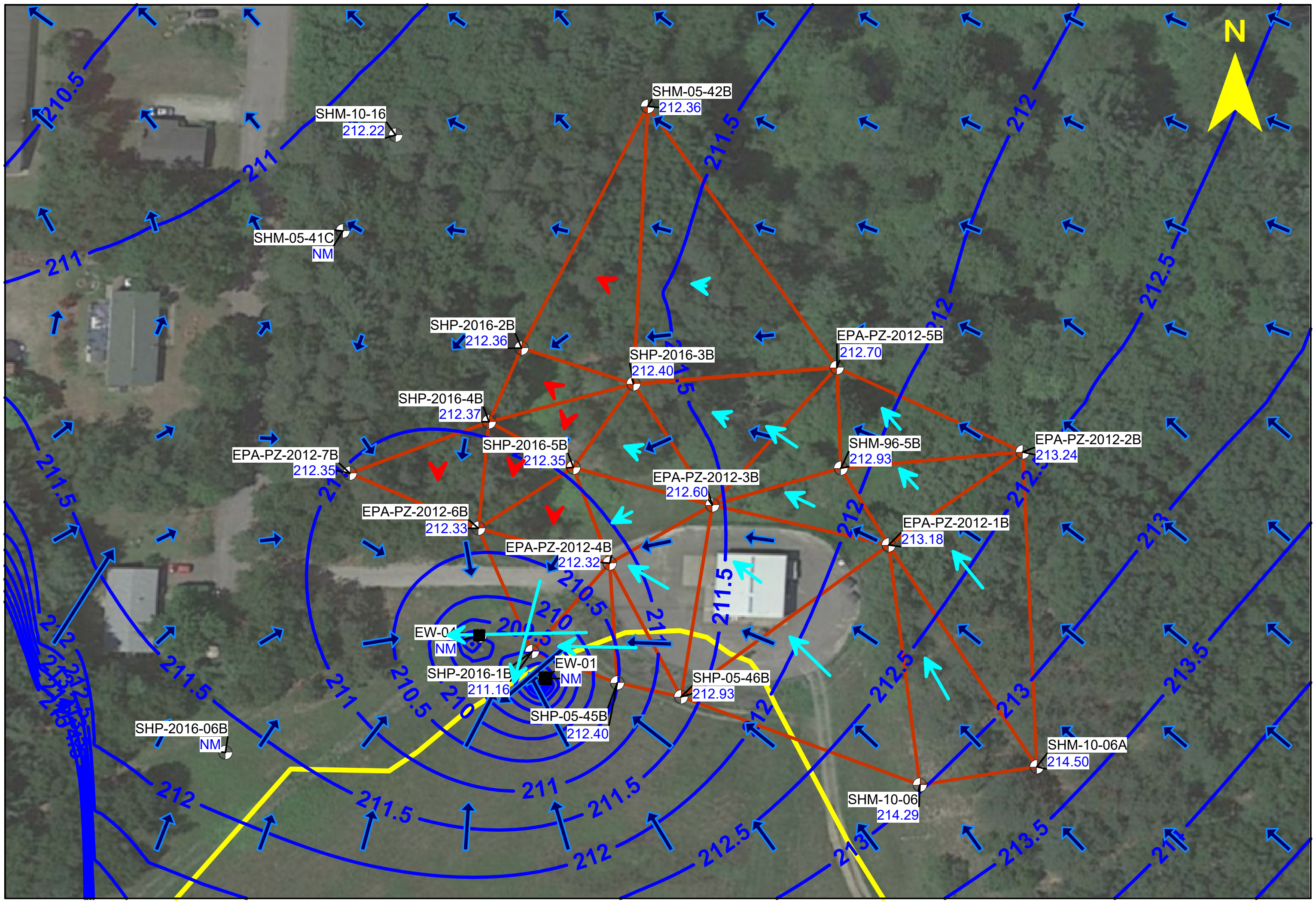
FIGURE
3



Legend

■ Extraction Wells

Shepley's Hill Landfill Boundary

Monitoring Wells

Triangle for Vector Analysis

Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021)
(Scale Factor = 5,000)

Hydraulic Gradient Arrow from Groundwater Model

Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)

Scale in feet

0 120 240

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

March 2, 2017 (Stress Period 18)
3PE and Model-Generated Hydraulic Vectors
and Groundwater Elevation Contours

SERES ARCADIS
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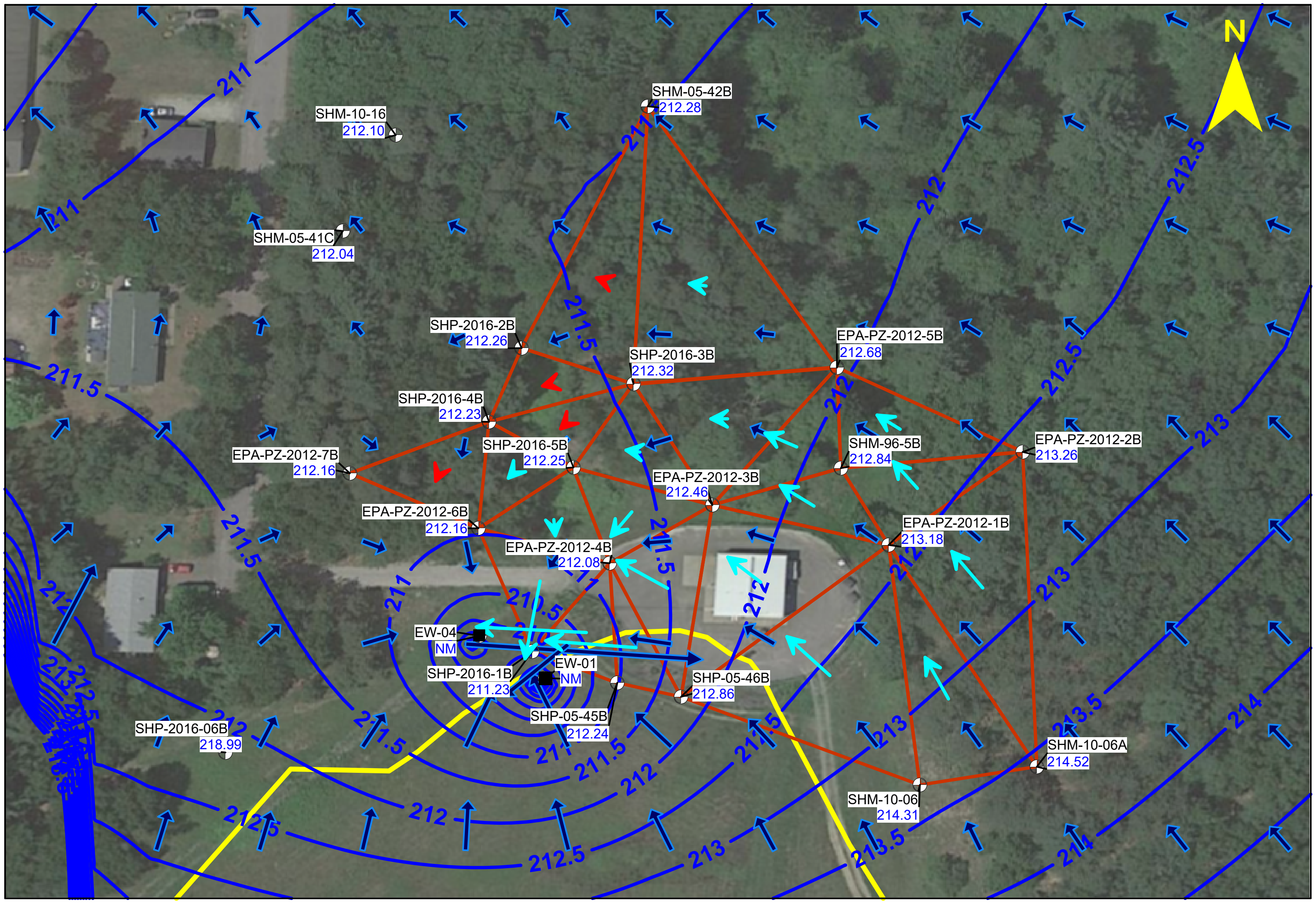
FIGURE
4



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)
- Shepley's Hill Landfill Boundary

Scale in feet

0 120 240

Notes:

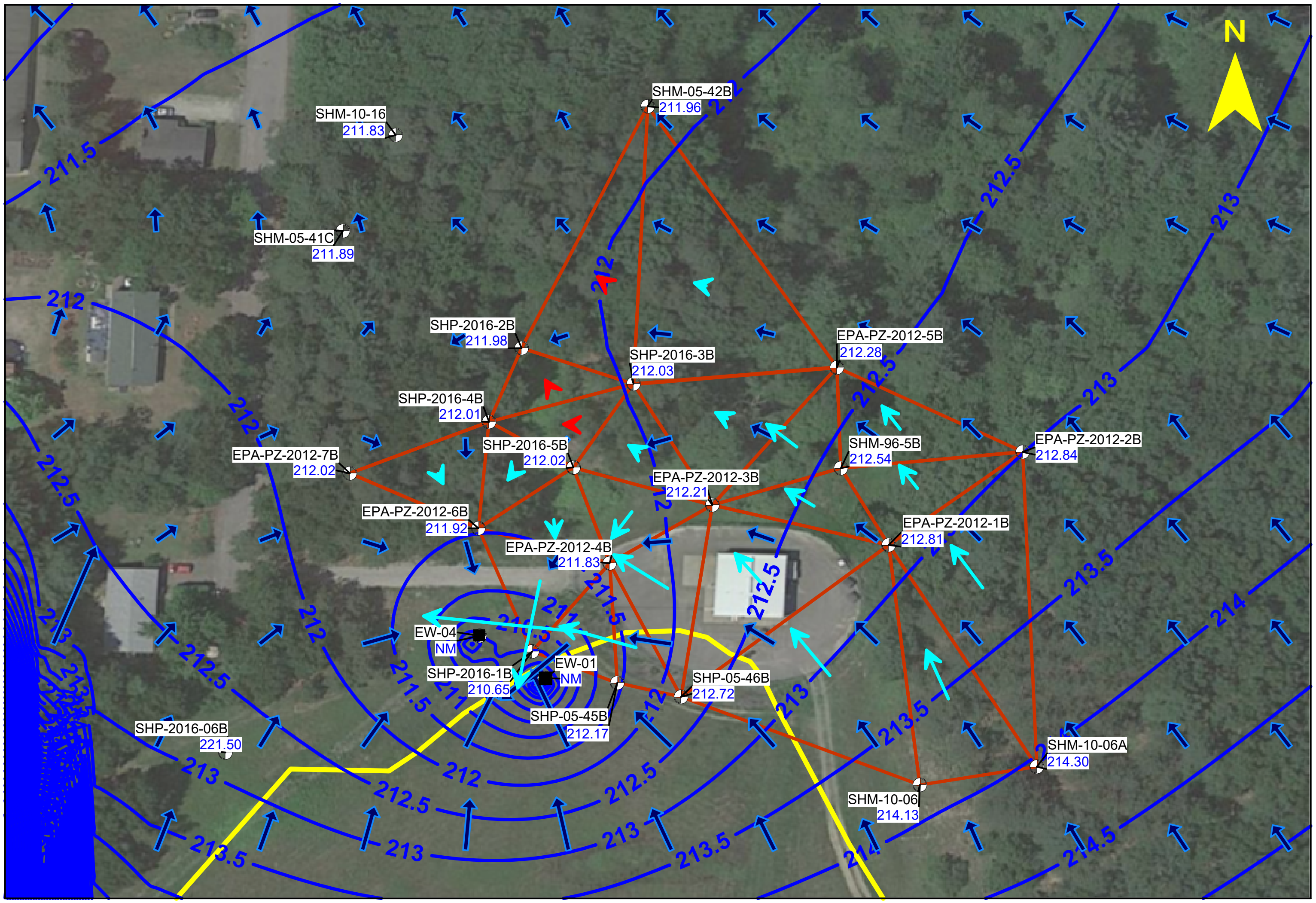
1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 2, 2017 (Stress Period 21)
3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours

SERES ARCADIS a joint venture

FIGURE 5



Legend

Extraction Wells

Monitoring Wells

Triangle for Vector Analysis

Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021)
(Scale Factor = 5,000)

Hydraulic Gradient Arrow from Groundwater Model

Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)

Shepley's Hill Landfill Boundary

Scale in feet

0 120 240

Notes:

1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 22, 2018 (Stress Period 23)
3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours

SERES ARCADIS
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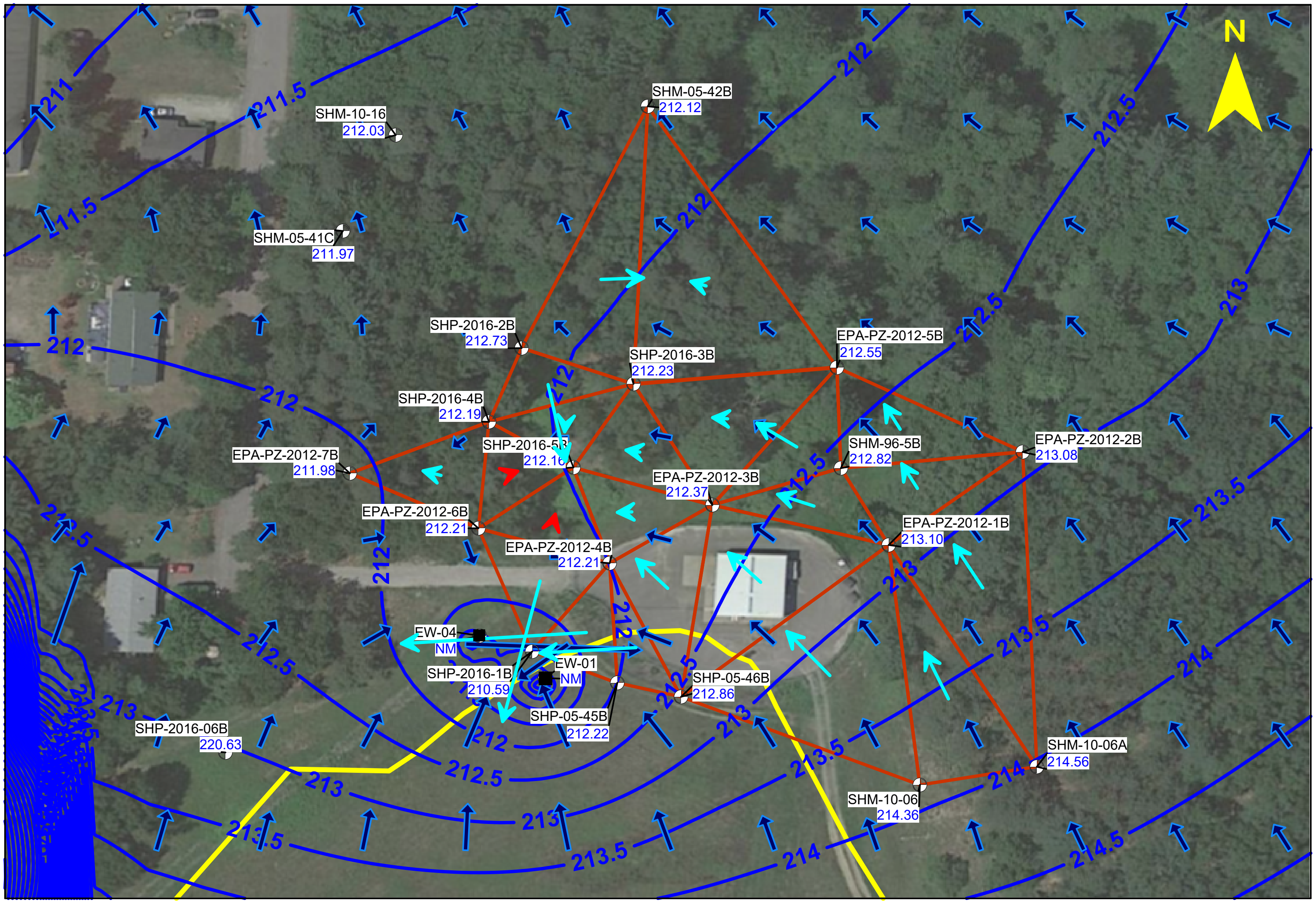
FIGURE

6



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)

Scale in feet

0 120 240

Notes:

1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 1, 2018 (Stress Period 25)
3PE and Model-Generated Hydraulic Vectors
and Groundwater Elevation Contours

SERES Engineering & Services, LLC
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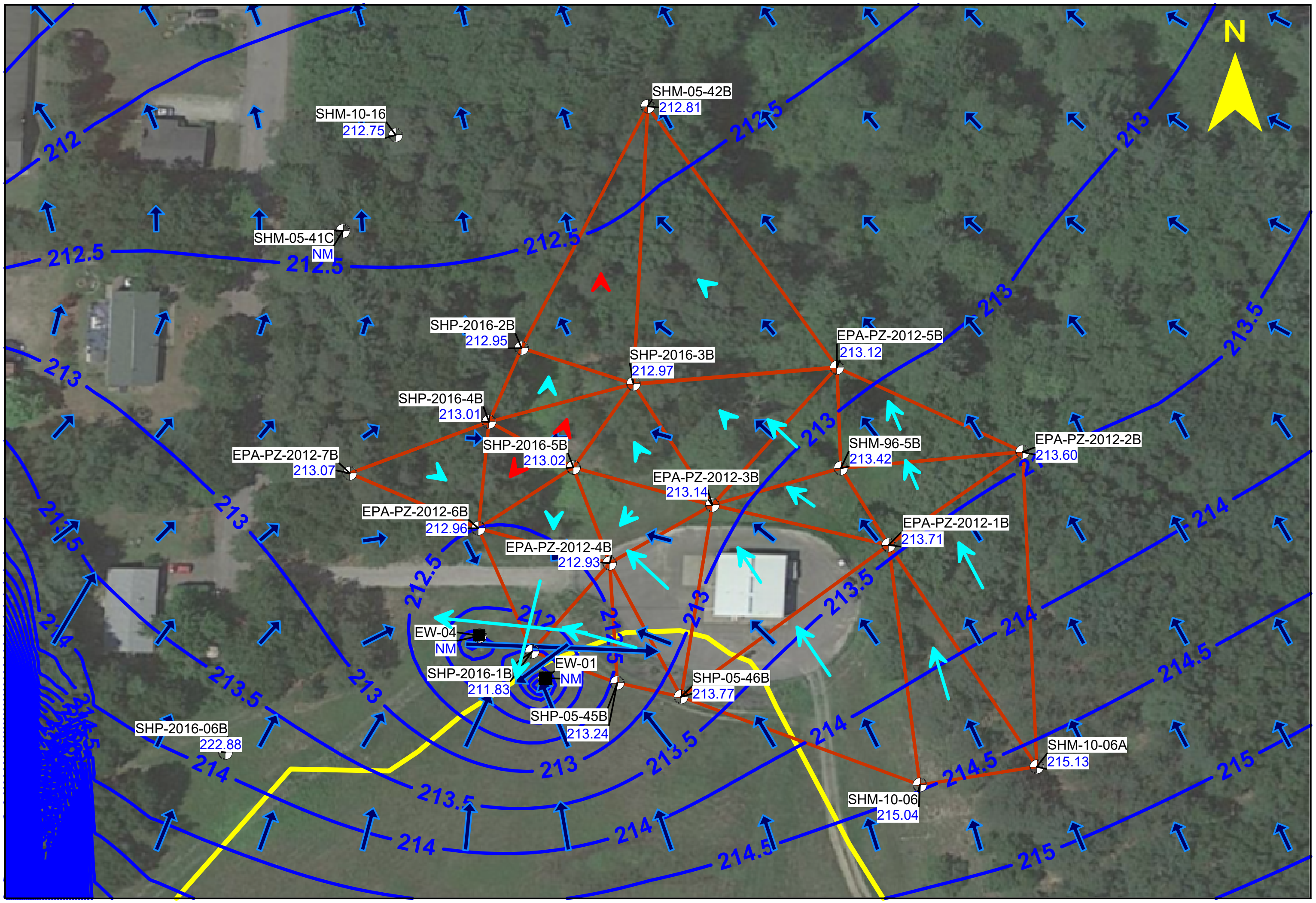
FIGURE
7



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)
- Shepley's Hill Landfill Boundary

Scale in feet

0 120 240

Notes:

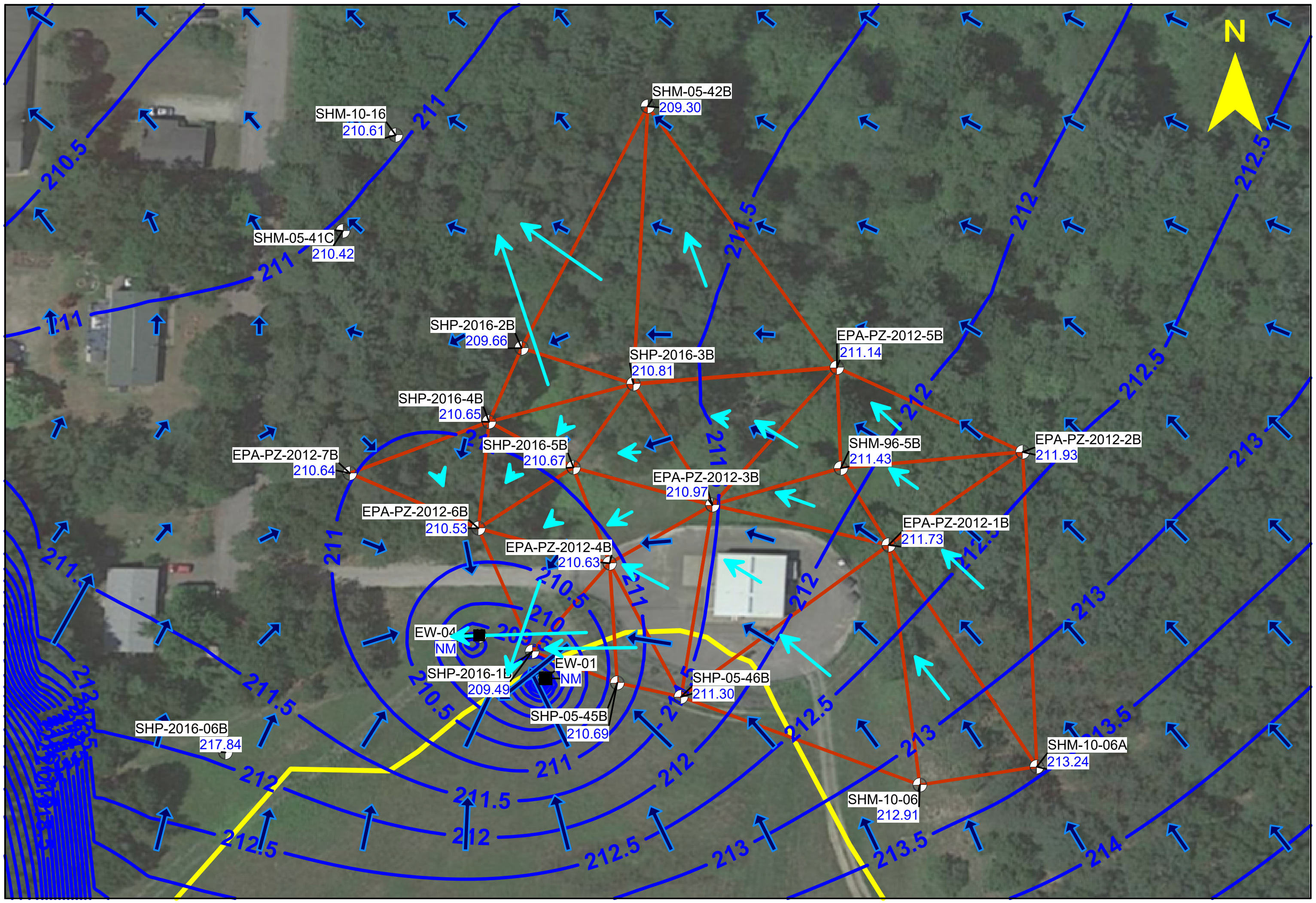
1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 13, 2019 (Stress Period 27)
3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours

SERES ARCADIS a joint venture

FIGURE
8



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)
- Shepley's Hill Landfill Boundary

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

October 22, 2019 (Stress Period 29)
3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours

SERES Engineering & Services, LLC
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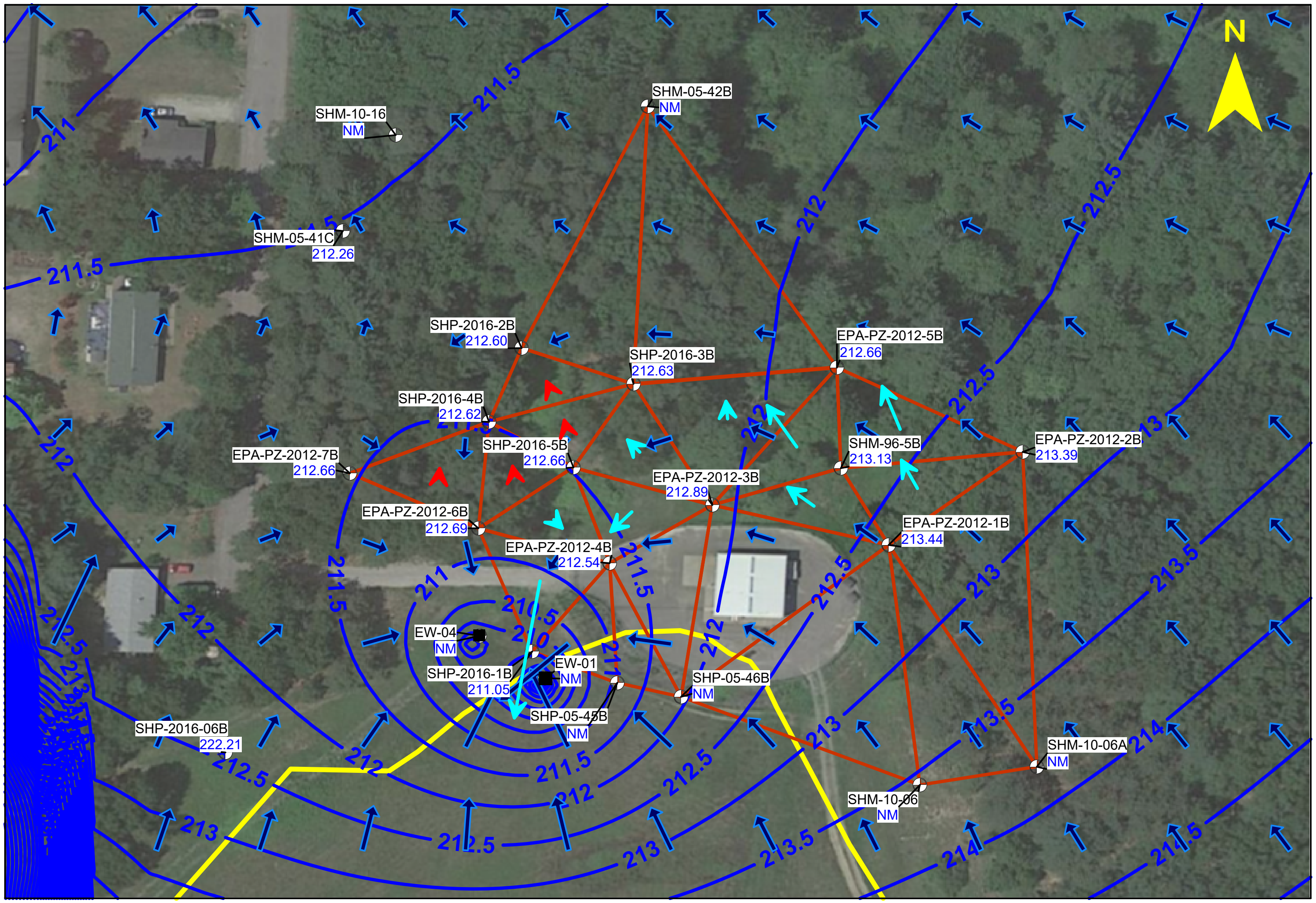
FIGURE
9



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)

Scale in feet
0 120 240

Notes:
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2. Red arrows indicate gradients less than 0.001 foot per foot.
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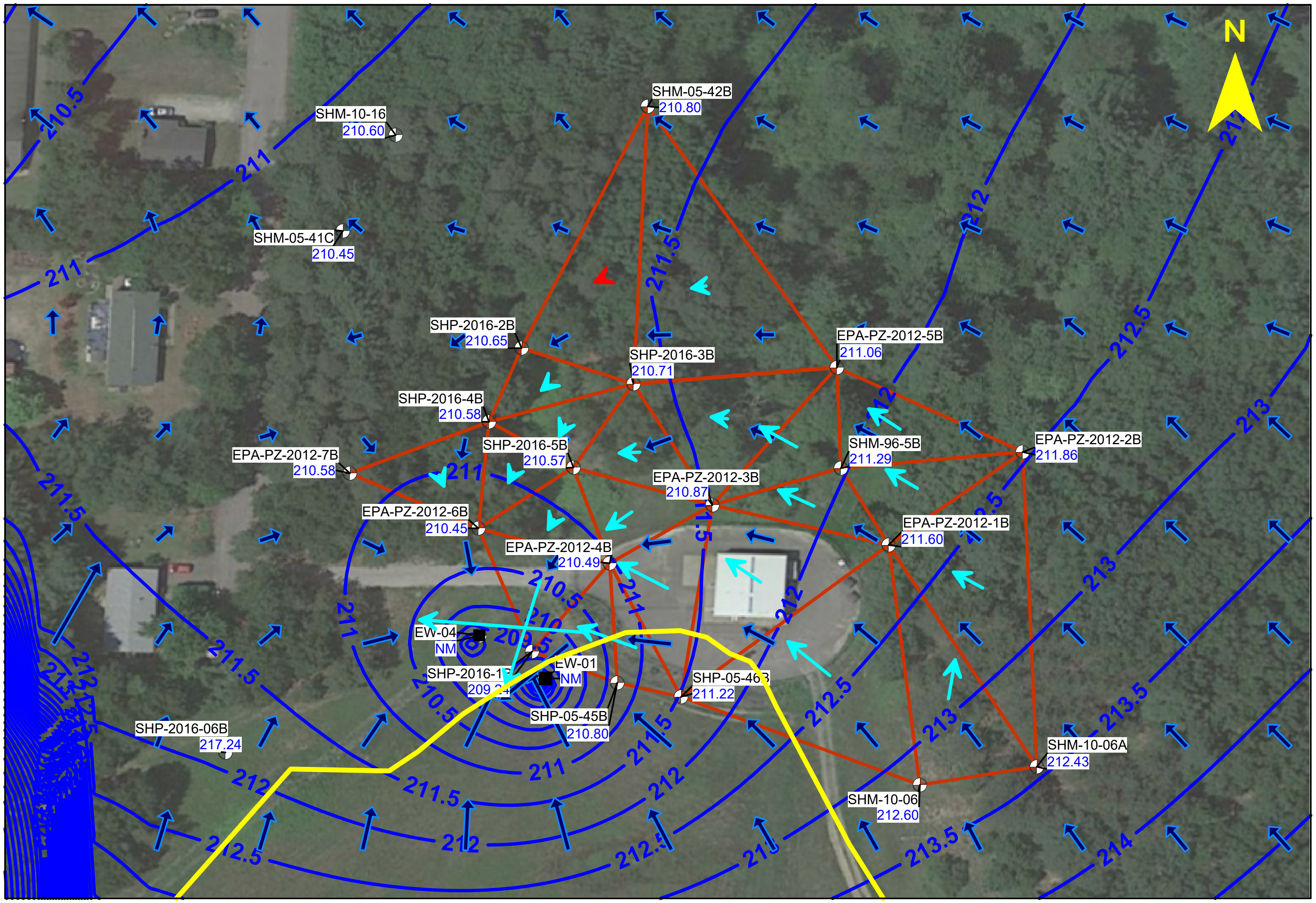
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 18, 2020 (Stress Period 31)
3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours

SERES ARCADIS a joint venture

FIGURE 10



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Hydraulic Gradient Arrow from Groundwater Model
- Groundwater Elevation Contour from Groundwater Model (0.5 foot interval)
- Shepley's Hill Landfill Boundary

Scale in feet: 0 120 240

Notes:

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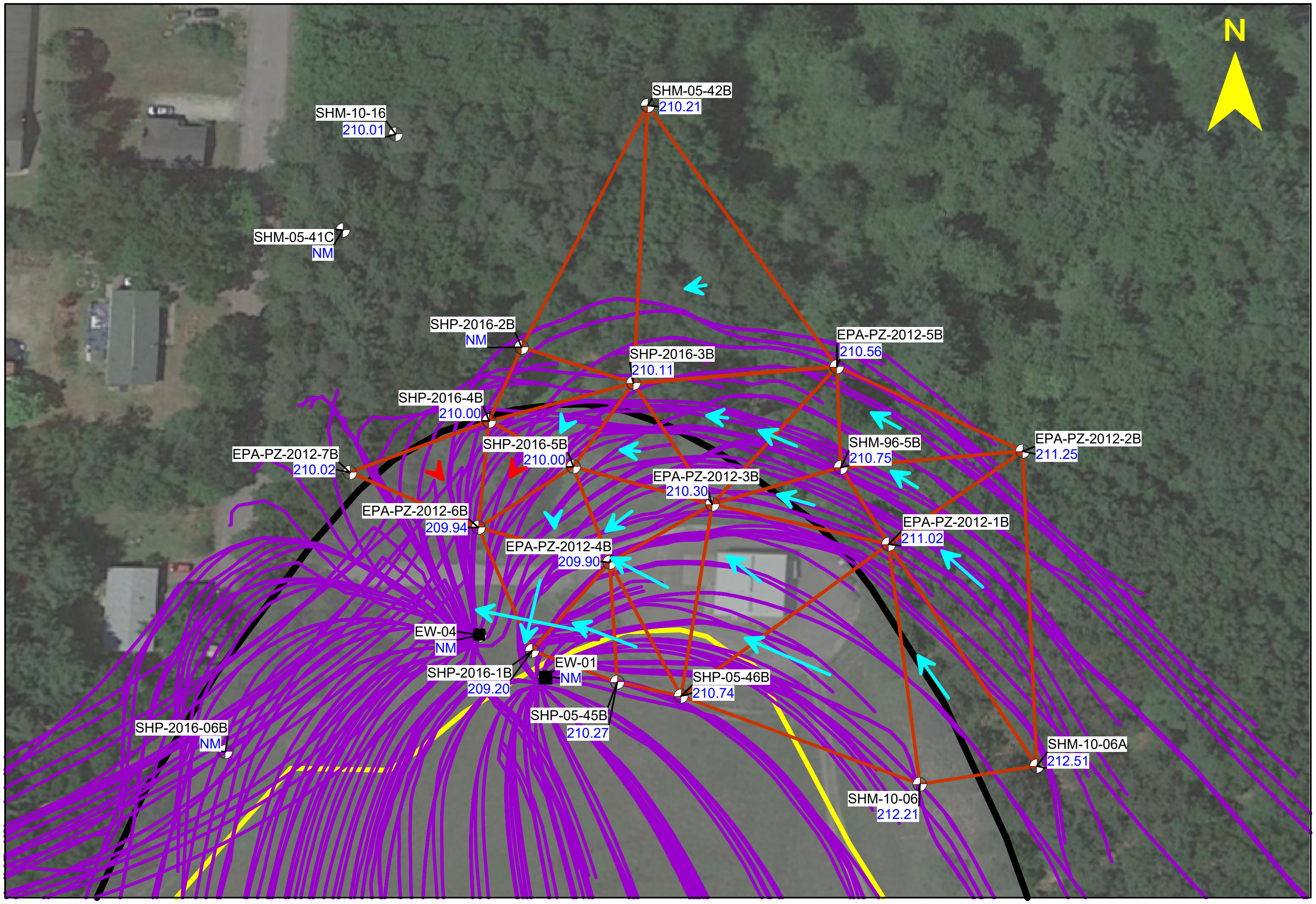
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

**November 4, 2020 (Stress Period 33)
3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours**

SERES ARCADIS a joint venture

FIGURE 11



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 120 240

Notes:

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2. Red arrows indicate gradients less than 0.001 foot per foot.
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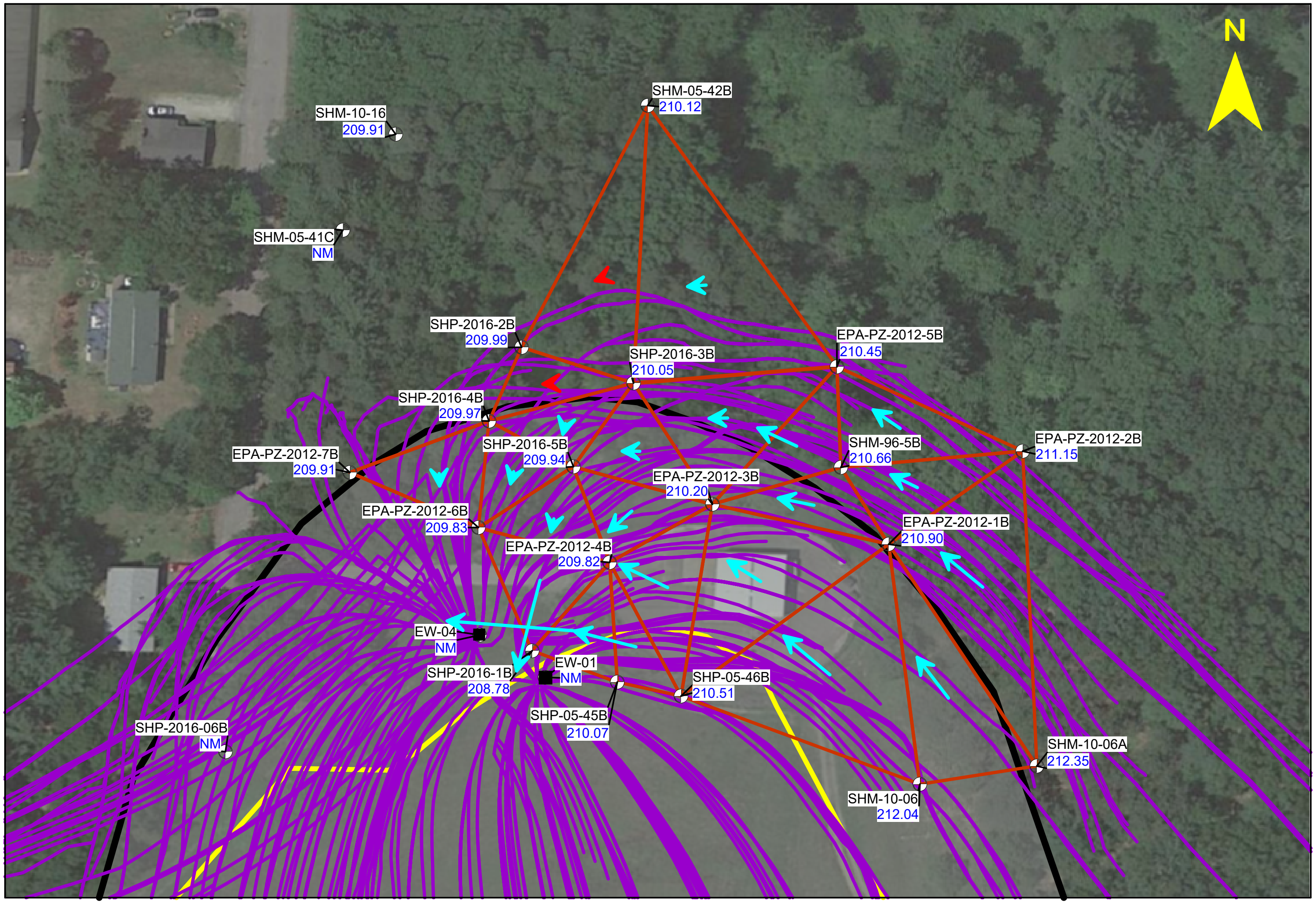
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

August 16, 2016 (Stress Period 16)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

SERES ARCADIS a joint venture

FIGURE 12



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 120 240

Notes:

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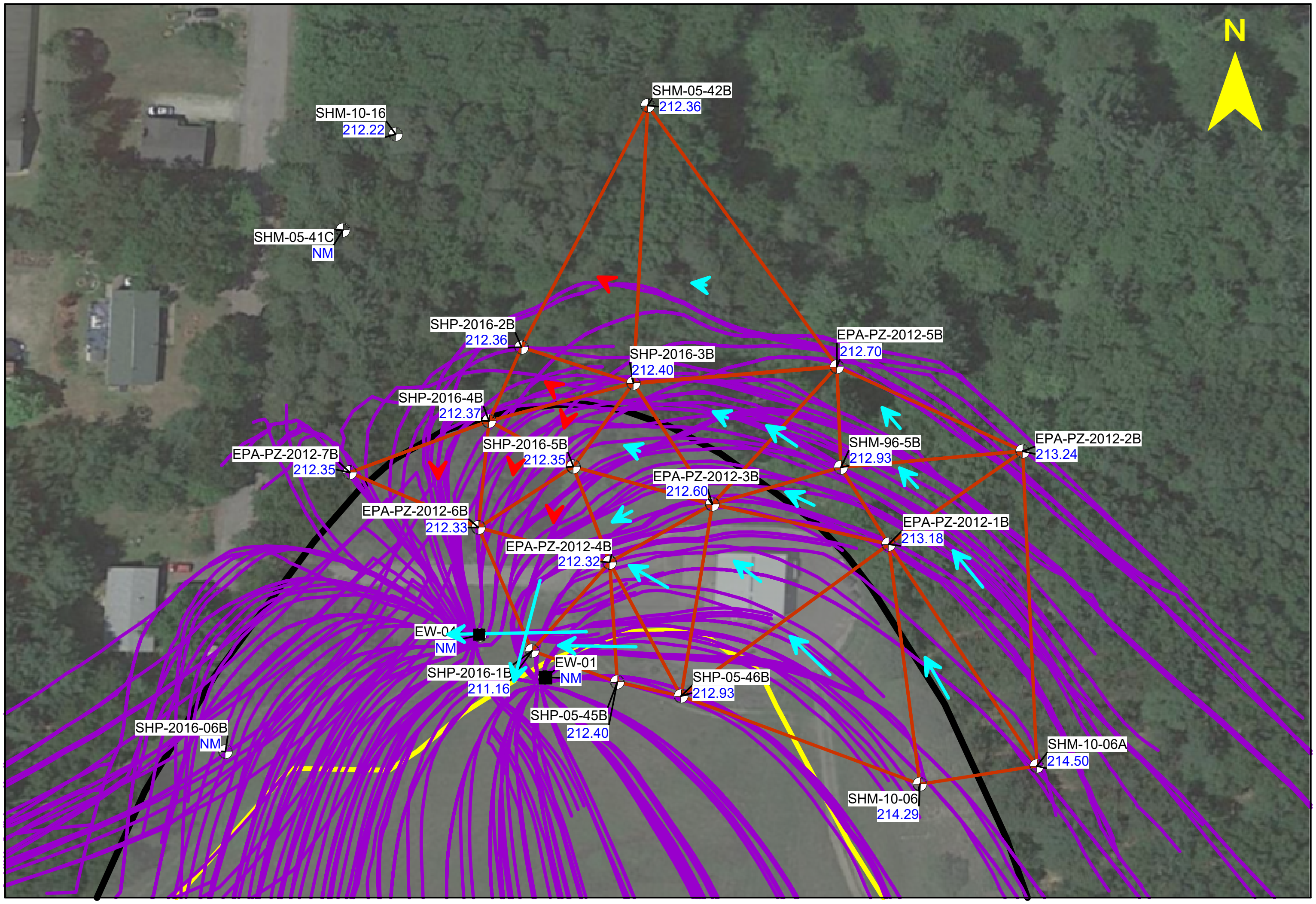
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

October 20, 2016 (Stress Period 17)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

SERES ARCADIS a joint venture

FIGURE 13



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 120 240

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

March 2, 2017 (Stress Period 18)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

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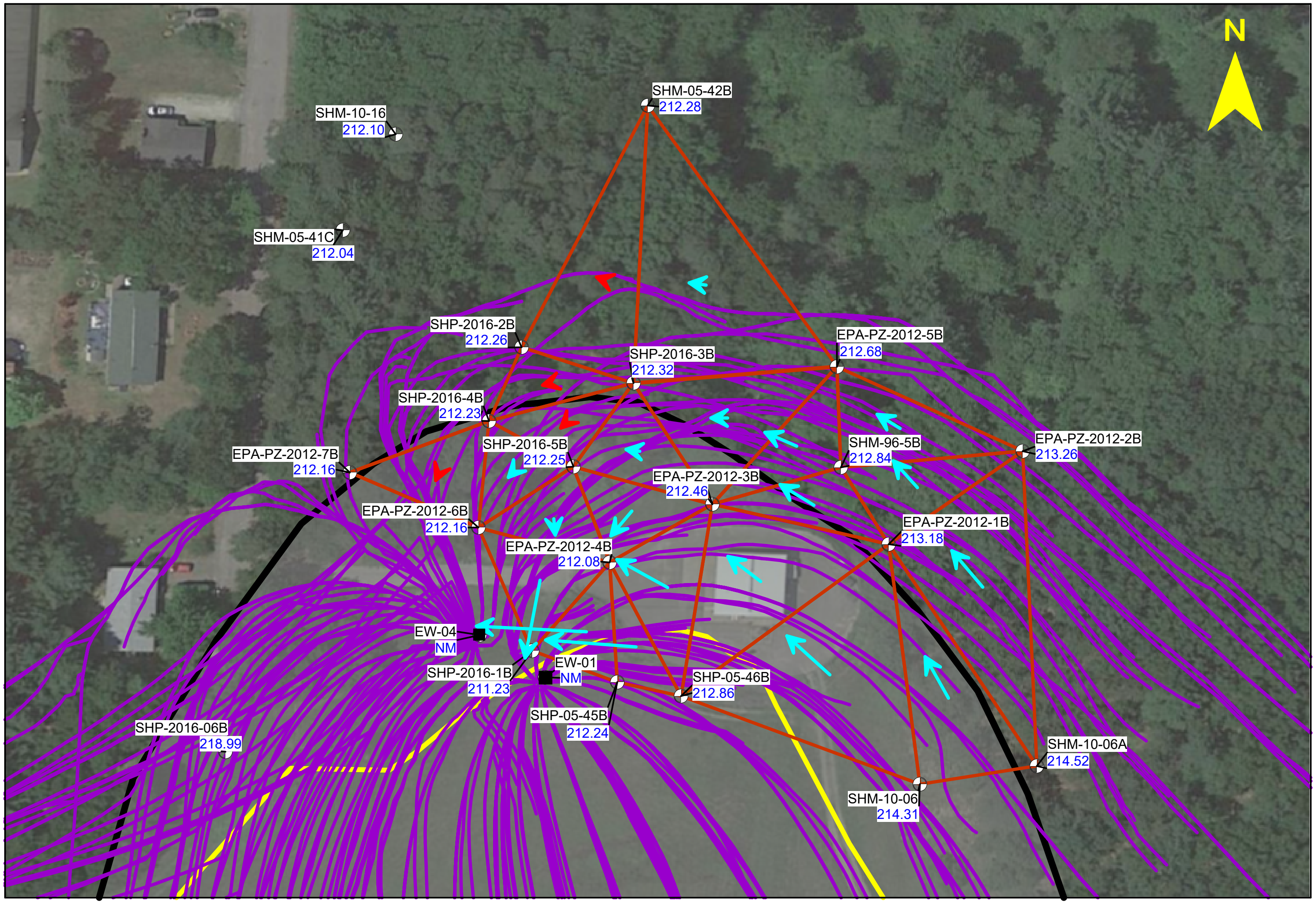
FIGURE
14



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 120 240

Notes:

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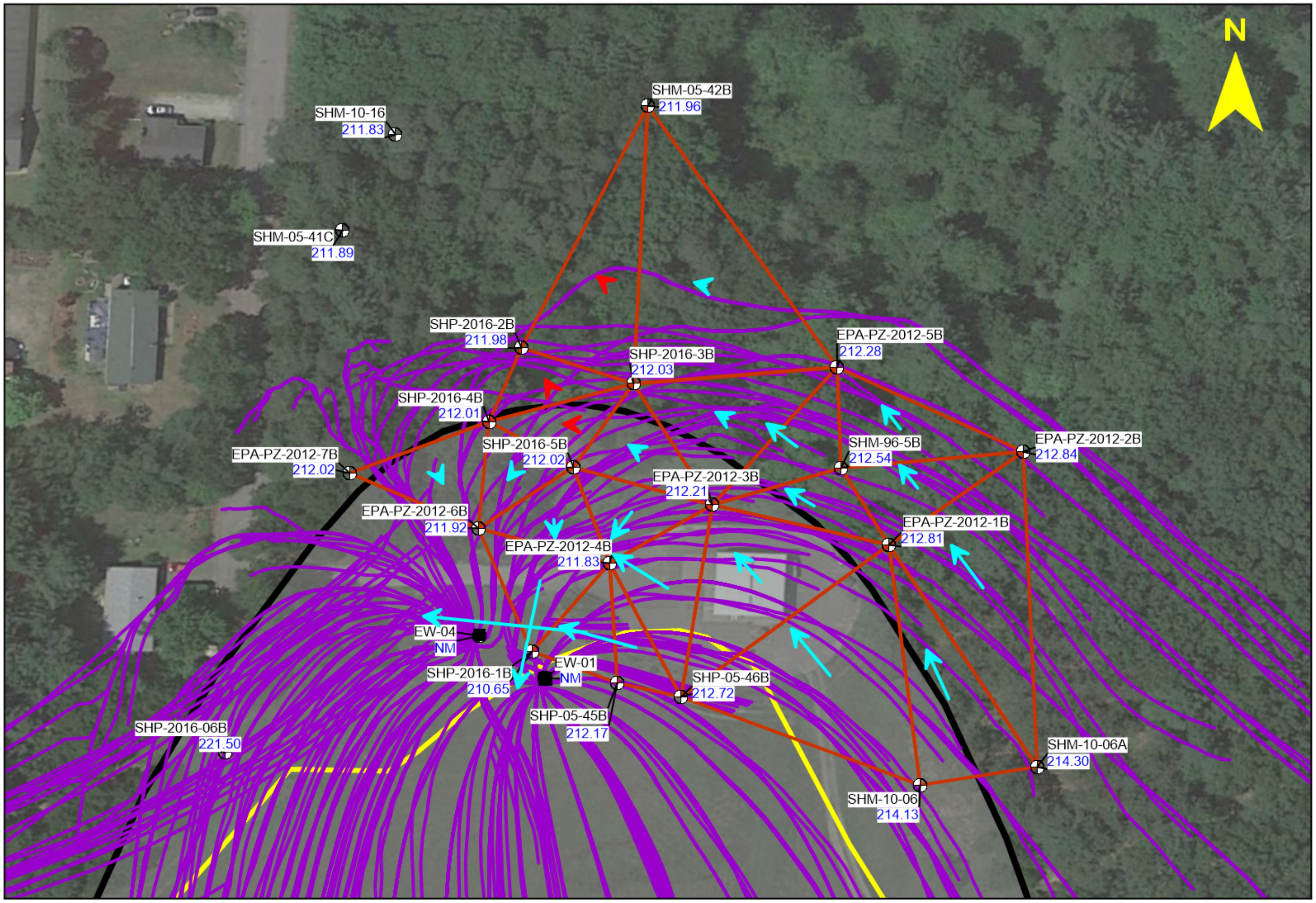
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 2, 2017 (Stress Period 21)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

SERES ARCADIS a joint venture

FIGURE 15



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 120 240

Notes:

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4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 22, 2018 (Stress Period 23)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

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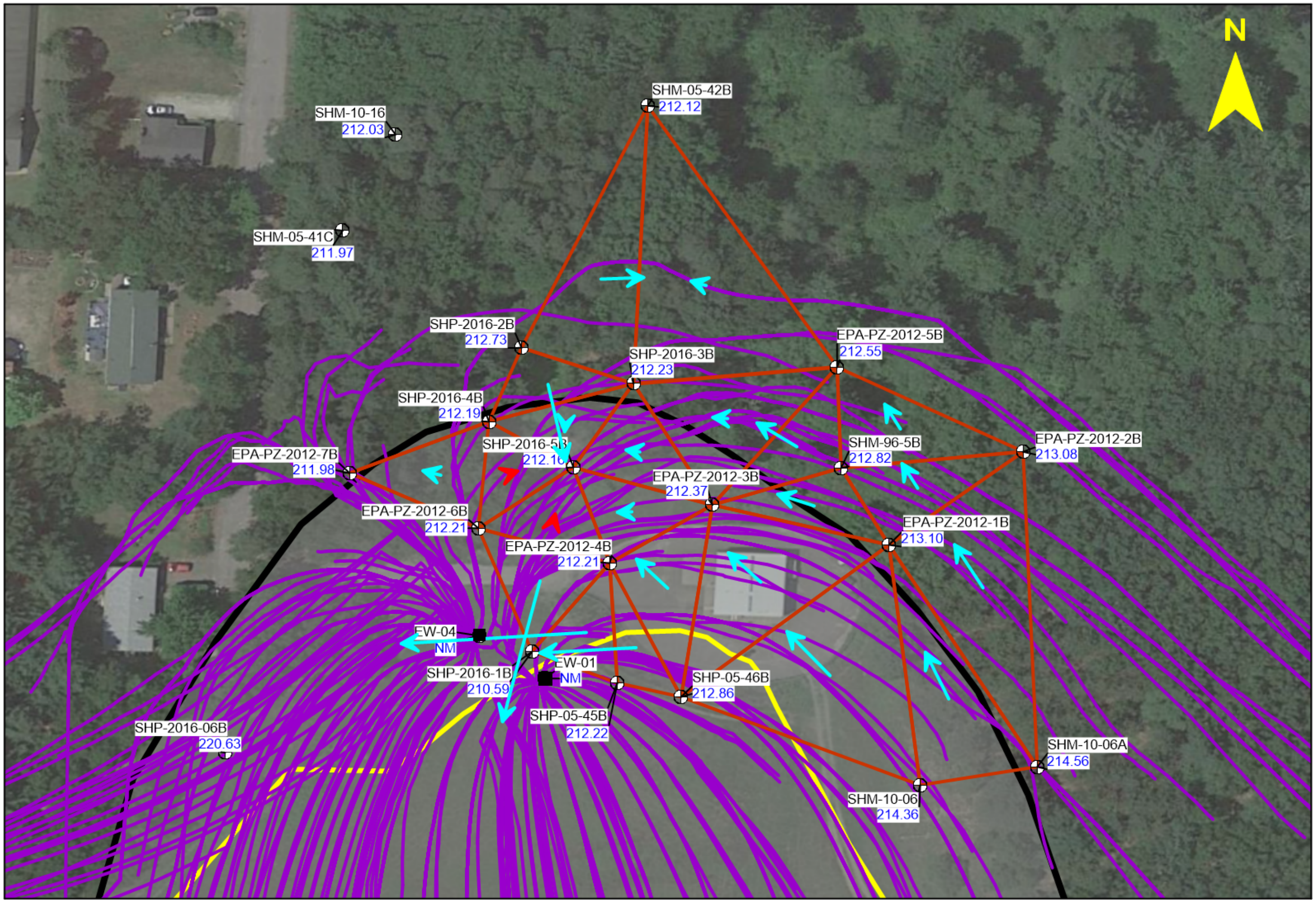
FIGURE 16



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 120 240

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 1, 2018 (Stress Period 25)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

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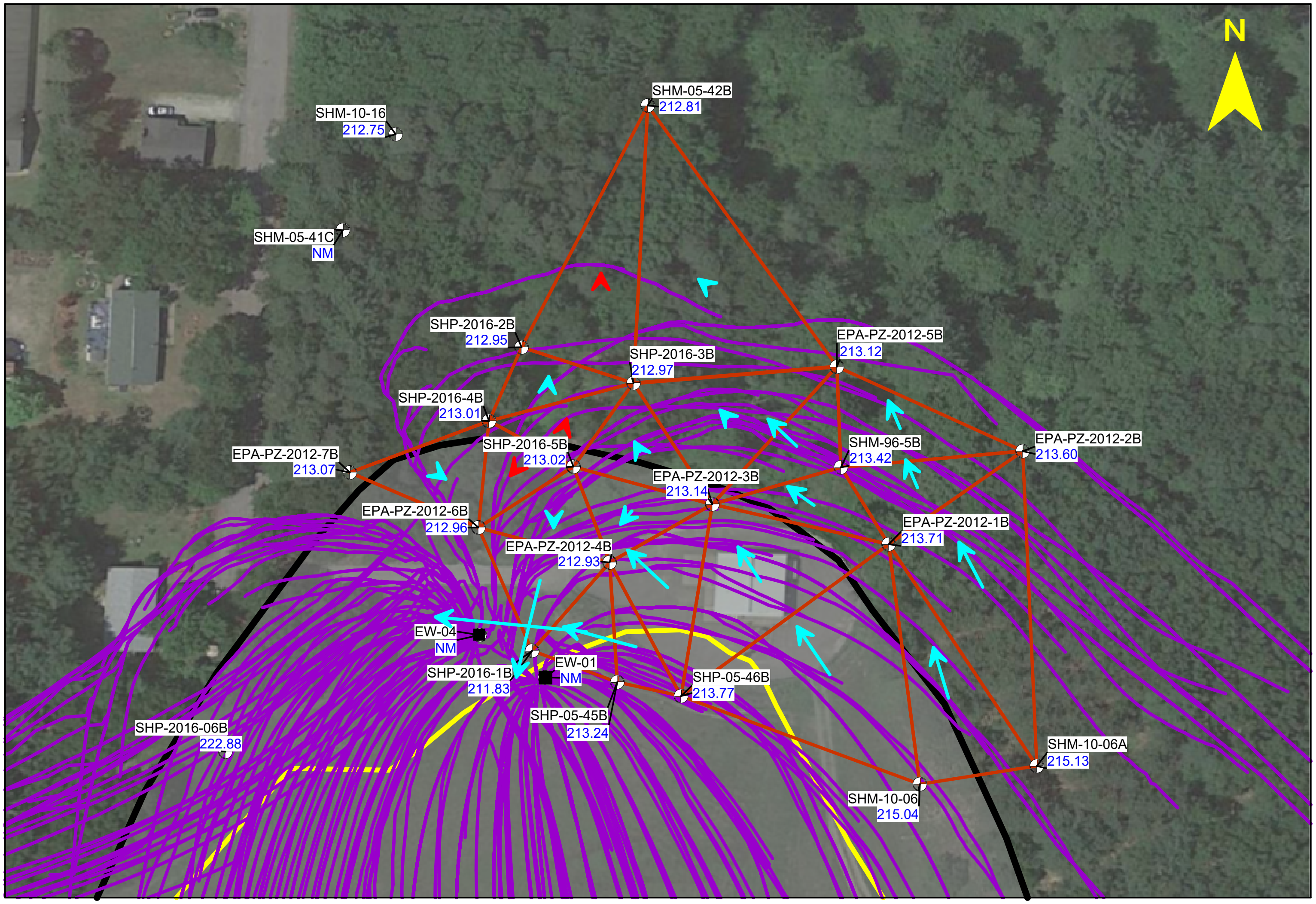
FIGURE 17



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 120 240

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 13, 2019 (Stress Period 27)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

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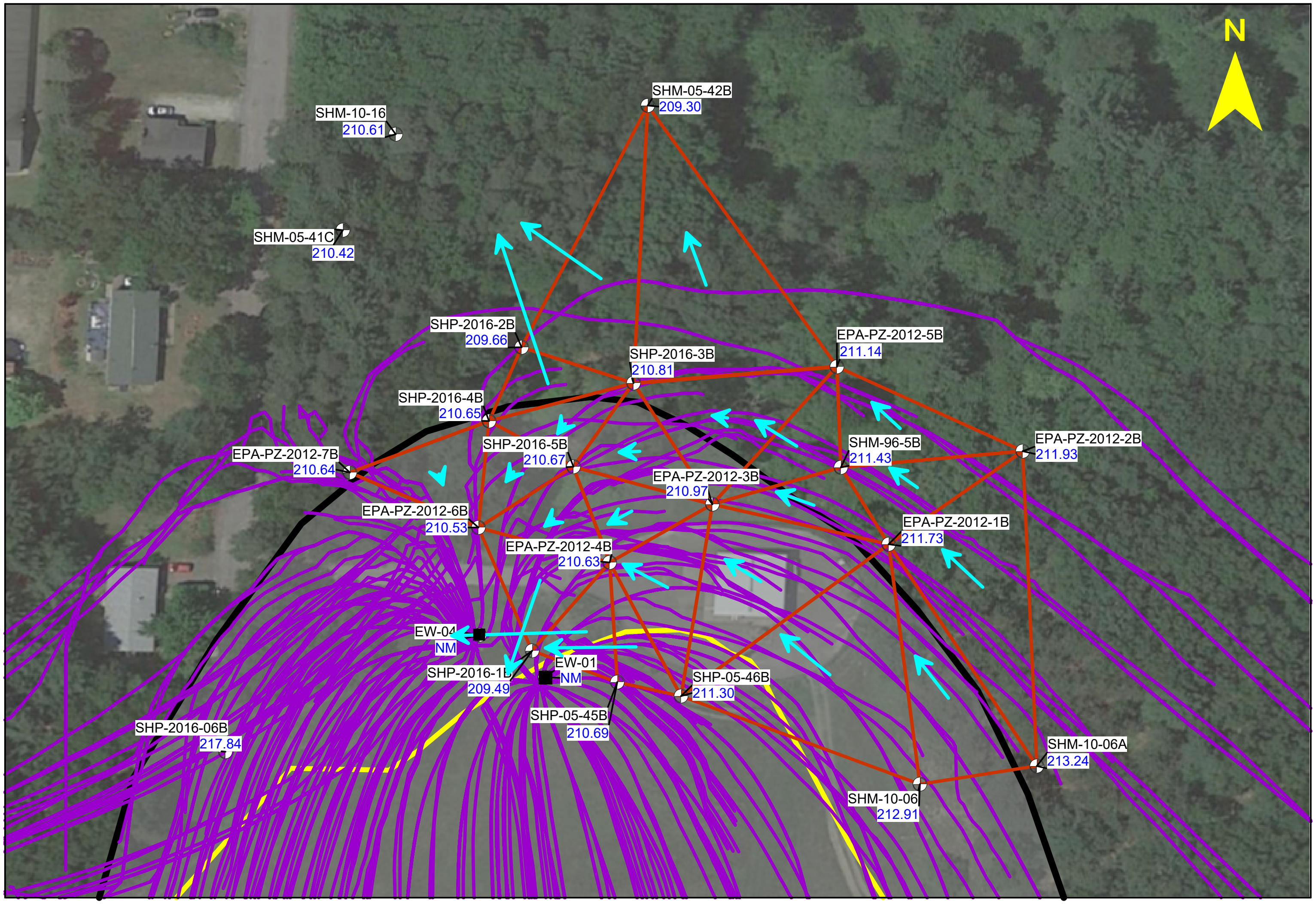
FIGURE 18



Scale in feet

0 120 240

Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

October 22, 2019 (Stress Period 29)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

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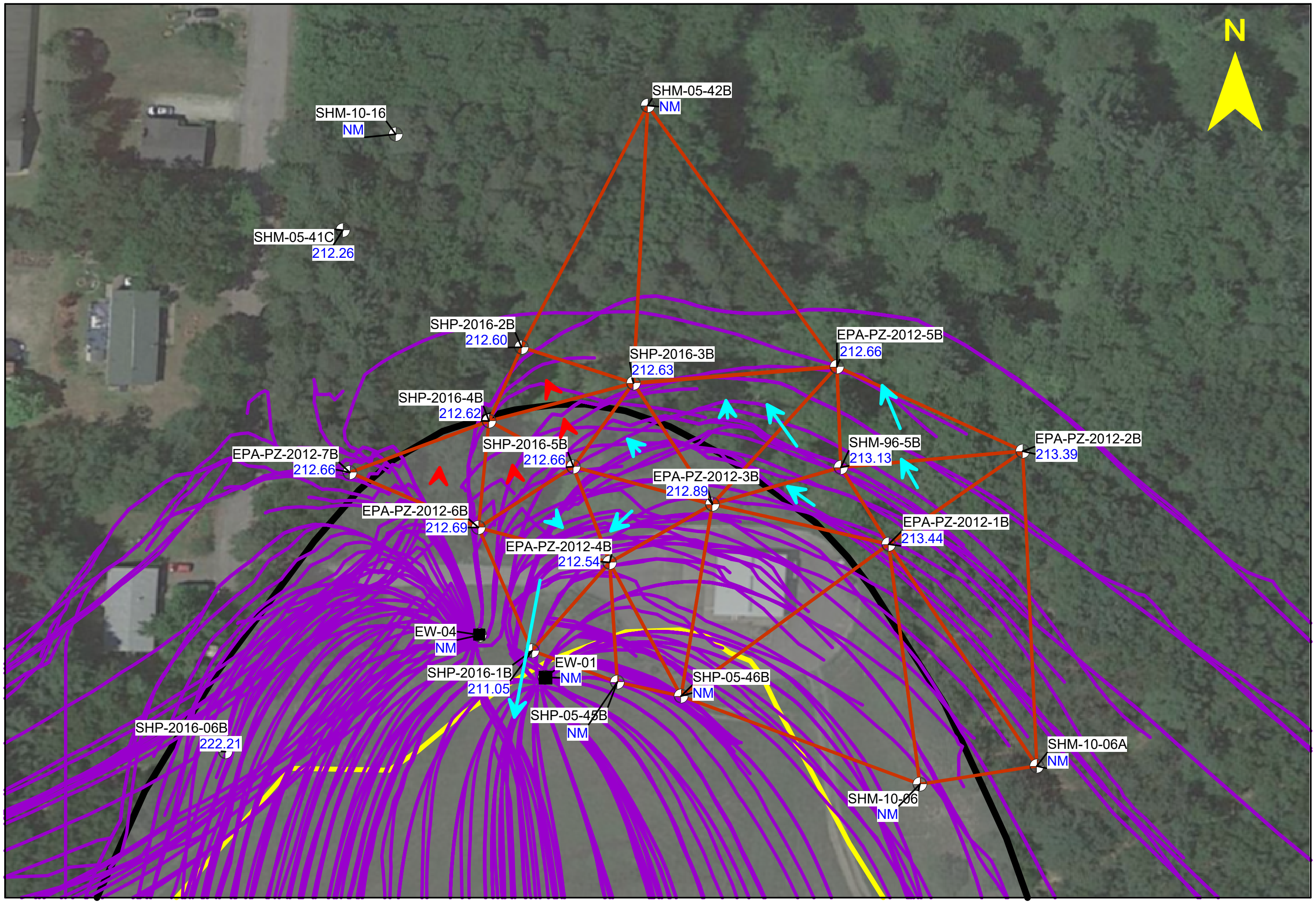
FIGURE

19



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 120 240

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 18, 2020 (Stress Period 31)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

SERES Engineering & Services, LLC
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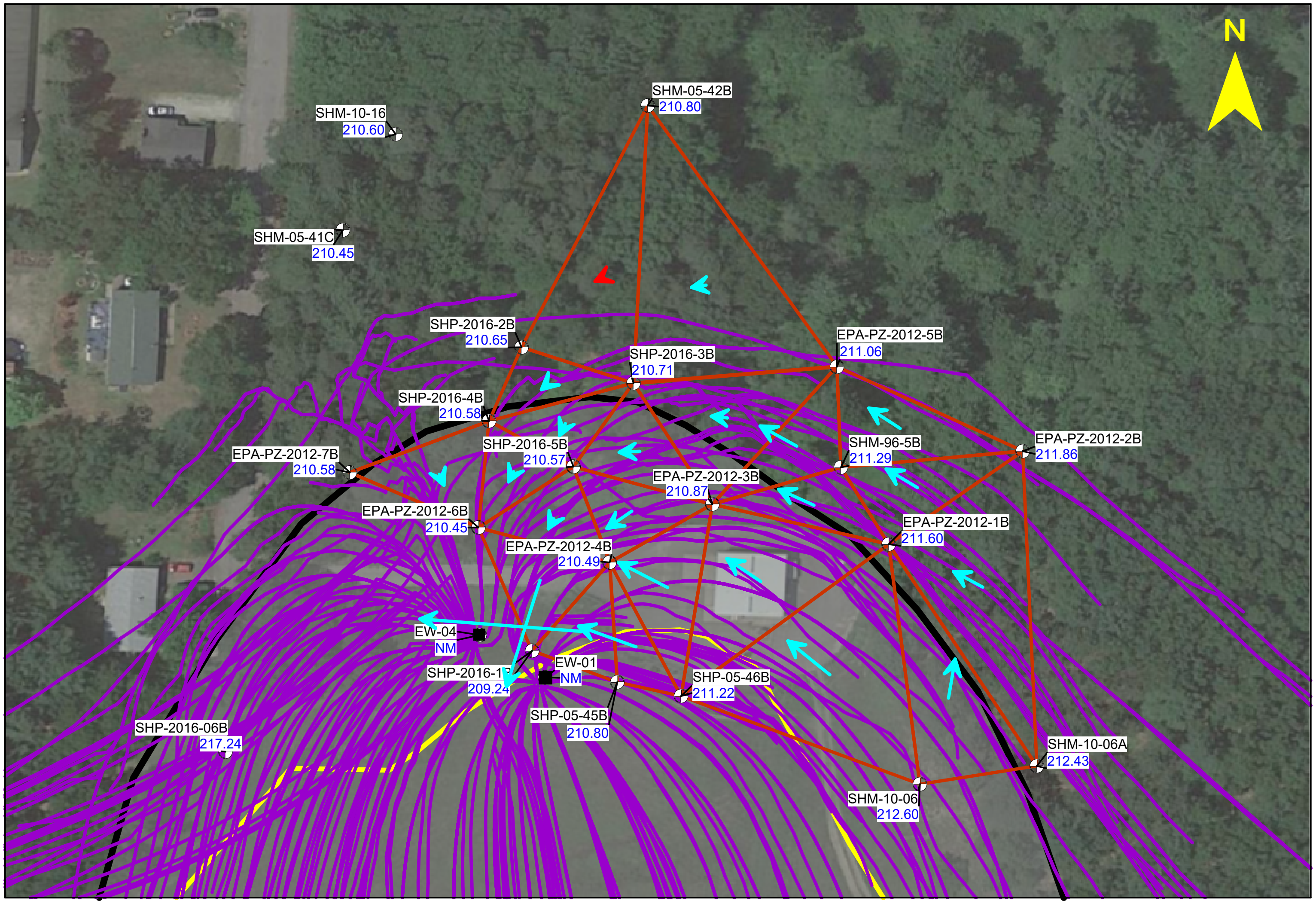
FIGURE
20



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 120 240

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 4, 2020 (Stress Period 33)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Particle Tracks

SERES
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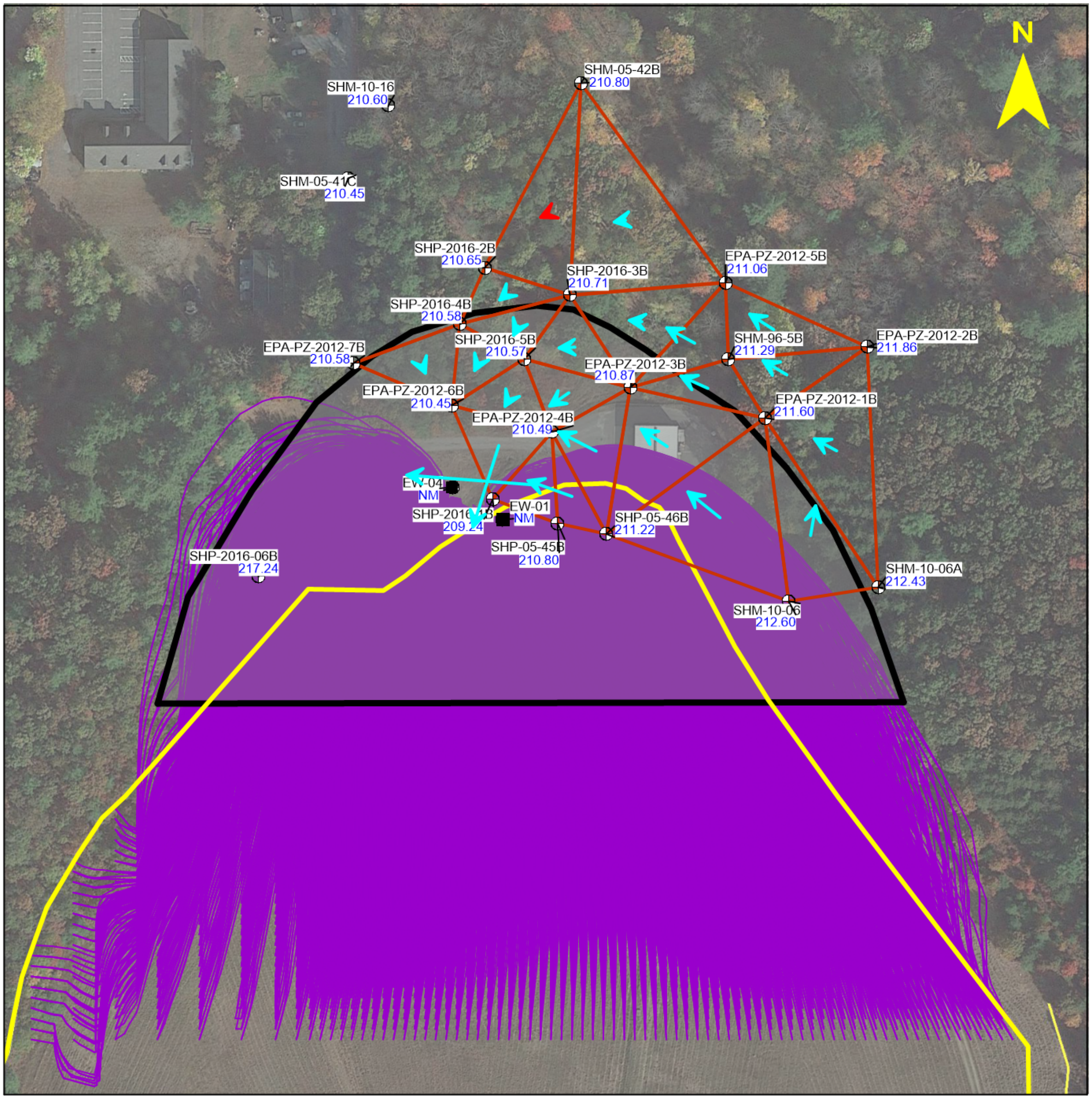
FIGURE

21



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Forward Groundwater Pathlines
- Shepley's Hill Landfill Boundary

Scale in feet
0 150 300

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 4, 2020 (Stress Period 33)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Forward Particle Tracks

SERES Engineering & Services, LLC
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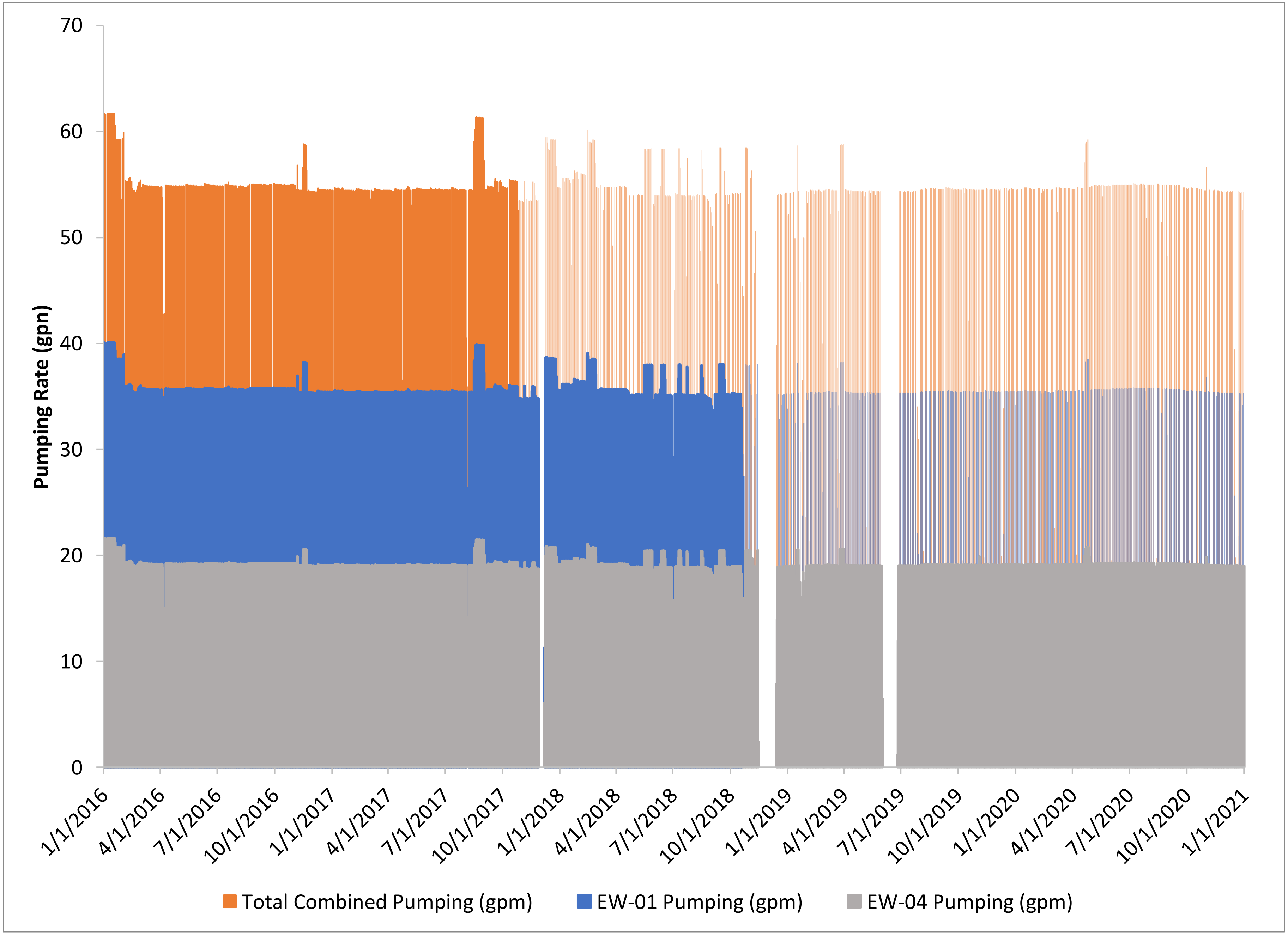
FIGURE
22

Attachment 1

Daily Pumping Rates for EW-01 and EW-04



Pumping Rate (gpn)
70
60
50
40
30
20
10
0
1/1/2016
4/1/2016
7/1/2016
10/1/2016
1/1/2017
4/1/2017
7/1/2017
10/1/2017
1/1/2018
4/1/2018
7/1/2018
10/1/2018
1/1/2019
4/1/2019
7/1/2019
10/1/2019
1/1/2020
4/1/2020
7/1/2020
10/1/2020
1/1/2021
Total Combined Pumping (gpm)
EW-01 Pumping (gpm)
EW-04 Pumping (gpm)

Total Combined Influent Flow Rate (GPM)

Day	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
1	61.60	59.17	54.72	54.72	54.86	54.79	54.86	54.65	55.00	55.00	54.51	54.38	54.44	54.44	54.44	54.44	54.51	54.51	54.44	54.51	57.29	54.72	53.40	0.00
2	61.67	59.93	20.83	54.79	54.31	54.79	54.86	47.15	54.93	55.00	54.93	54.31	54.44	54.38	54.38	54.38	54.79	54.44	54.51	54.44	54.51	54.79	53.40	0.00
3	61.60	18.89	20.07	54.72	54.79	54.65	54.79	54.58	54.93	54.93	8.54	54.31	18.19	54.38	53.61	54.44	54.65	54.51	54.51	54.44	54.51	54.72	53.33	0.00
4	61.60	24.72	55.00	53.75	54.86	54.79	54.86	54.79	55.00	55.00	16.32	54.31	21.46	54.44	50.00	54.38	54.72	54.44	54.44	40.49	54.44	54.72	53.26	0.00
5	21.46	55.35	54.93	18.19	54.79	54.86	54.44	51.39	54.93	55.00	54.51	54.24	54.72	54.38	54.44	54.44	51.53	54.51	54.51	0.00	54.51	43.89	55.35	0.00
6	22.71	55.28	54.86	21.25	54.79	54.72	54.86	54.79	55.00	54.93	56.81	54.31	54.58	18.40	54.38	54.38	54.44	18.19	54.44	0.00	38.75	54.65	20.14	0.00
7	61.67	55.28	54.93	42.78	54.79	54.79	54.79	54.86	54.93	48.89	54.51	19.24	54.58	21.60	54.38	54.38	54.44	21.88	54.44	35.90	54.86	54.58	21.81	17.36
8	61.67	55.28	54.86	36.32	54.86	54.79	54.79	54.79	55.00	55.00	54.51	20.90	54.58	54.44	19.10	54.38	53.06	54.65	54.51	54.44	54.79	54.58	53.61	56.81
9	61.67	55.00	54.86	54.93	54.79	18.33	54.86	54.72	54.93	54.93	47.92	54.65	54.58	54.58	24.79	54.38	39.17	54.58	54.44	54.51	54.79	54.65	53.61	59.44
10	61.67	55.56	54.86	54.93	17.92	21.04	54.79	54.79	55.00	54.93	54.44	54.58	54.65	54.58	54.58	15.00	54.51	54.51	18.54	54.44	54.72	20.76	33.06	59.51
11	61.67	54.65	54.86	54.86	22.99	55.07	54.79	54.72	54.93	55.00	54.44	54.51	54.51	54.51	54.58	22.15	54.51	47.50	21.04	54.51	51.18	22.01	33.13	59.44
12	61.67	55.63	54.79	54.86	55.00	55.00	19.58	54.79	54.93	54.65	54.38	54.51	54.58	54.51	52.22	54.58	54.17	54.51	54.72	54.51	54.79	55.49	53.47	58.96
13	61.67	55.28	52.57	54.93	55.00	55.00	24.03	54.72	55.00	54.93	54.44	54.51	41.46	54.58	53.82	54.58	54.51	54.51	54.58	54.44	53.68	55.35	53.40	58.33
14	61.67	54.72	54.86	54.86	55.00	55.00	55.00	54.65	54.93	54.93	54.31	54.51	54.51	54.44	54.51	54.51	54.51	48.47	54.65	18.06	54.79	55.35	53.54	58.13
15	61.67	55.28	54.79	54.86	54.93	55.00	55.00	54.72	55.00	54.93	56.60	54.51	54.51	54.51	54.51	54.44	19.10	54.51	54.58	23.61	54.72	55.35	53.54	58.26
16	61.67	54.58	54.79	54.86	54.93	47.99	55.00	54.72	54.86	55.00	58.82	54.44	54.58	54.51	54.44	54.44	23.75	54.58	54.51	59.03	54.72	55.35	53.47	59.31
17	61.67	54.31	54.86	54.86	54.93	55.00	54.93	54.72	54.93	54.93	58.75	54.51	54.65	54.44	53.68	54.51	54.65	54.51	54.58	59.03	54.72	55.35	54.65	59.24
18	61.67	53.96	54.79	54.86	54.93	54.93	54.93	54.79	54.93	54.93	58.75	54.44	54.58	54.44	54.51	54.44	54.58	54.51	54.58	60.14	55.28	55.28	55.28	59.31
19	60.56	54.44	54.79	54.86	54.93	54.93	55.21	54.86	54.93	54.93	58.61	54.51	54.44	54.44	54.44	54.44	54.58	54.51	54.51	61.32	55.56	55.35	55.28	59.31
20	59.38	54.24	54.79	54.79	54.93	54.93	54.93	54.86	54.93	54.86	58.68	54.44	54.03	49.79	54.44	54.44	54.58	54.44	54.51	61.39	55.28	55.28	53.33	59.24
21	59.24	54.03	54.79	54.79	54.86	54.86	54.93	54.86	54.86	54.93	56.32	54.51	54.44	54.44	54.38	54.44	54.58	54.58	49.38	61.25	55.28	55.28	55.14	59.31
22	59.24	54.24	54.79	54.86	54.86	54.93	54.86	55.00	54.93	54.93	54.38	54.44	54.44	54.44	54.44	54.51	54.51	54.44	39.31	61.25	55.28	55.35	53.96	59.03
23	59.17	54.44	54.79	54.79	54.86	54.93	54.86	18.33	55.00	54.93	54.38	54.44	54.44	54.44	51.11	24.51	54.58	54.51	54.44	61.32	55.28	55.28	53.54	59.17
24	59.24	54.24	54.79	54.72	54.93	54.86	54.86	18.96	54.93	54.93	54.44	54.51	54.44	54.44	54.44	36.53	54.51	54.51	54.51	61.32	50.28	55.28	53.54	59.24
25	59.17	54.86	54.79	54.86	54.79	54.93	54.93	55.00	55.00	20.35	54.38	54.44	54.44	38.47	54.44	54.44	54.51	54.51	54.51	61.32	54.24	52.57	53.54	59.24
26	59.24	55.14	54.72	54.86	54.86	54.86	54.79	55.00	54.93	23.40	54.31	54.44	54.44	54.38	54.44	53.68	39.44	54.51	45.76	61.25	55.21	53.47	53.47	56.74
27	59.17	54.93	54.79	54.79	54.79	54.86	54.86	55.00	19.17	55.00	54.38	54.44	54.44	54.44	54.44	54.44	54.51	54.51	54.51	61.25	55.35	53.47	53.54	54.72
28	59.24	55.21	54.72	54.79	54.86	54.86	54.86	55.00	23.47	55.00	54.38	54.51	54.38	54.38	54.44	54.44	54.51	53.61	54.51	61.18	55.21	53.54	24.17	54.79
29	53.61	55.42	54.79	54.79	54.86	54.86	54.79	55.00	55.07	55.00	54.31	54.44	54.44		54.44	54.44	54.51	54.44	54.44	61.32	55.07	53.54	0.00	54.72
30	42.92		54.72	54.79	54.79	54.79	54.86	55.00	55.07	55.00	54.31	54.44	54.38		54.38	54.58	54.51	54.51	54.51	61.18	54.79	53.47	0.00	54.72
31	59.31		54.72		54.79		54.86	54.93		55.00		54.44	54.44		54.44		54.44		54.51	61.25		53.47		54.72
Minimum	21.46	18.89	20.07	18.19	17.92	18.33	19.58	18.33	19.17	20.35	8.54	19.24	18.19	18.40	19.10	15.00	19.10	18.19	18.54	0.00	38.75	20.76	0.00	0.00
Maximum	61.67	59.93	55.00	54.93	55.00	55.07	55.21	55.00	55.07	55.00	58.82	54.65	54.72	54.58	54.58	54.58	54.79	54.65	54.72	61.39	57.29	55.49	55.35	59.51
Average	57.42	52.90	52.52	51.44	52.63	52.31	52.74	52.13	52.72	52.62	52.34	52.23	51.83	51.26	51.96	50.44	51.27	51.75	51.34	51.07	54.13	52.16	45.70	45.45

<u>Notes</u>

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

Total Combined Influent Flow Rate (GPM)

Day	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19
1	54.65	0.00	54.65	54.79	18.96	52.99	0.00	53.89	51.81	19.72	58.40	0.00	49.79	53.26	54.44	19.10	54.31	18.33	54.38	54.51
2	17.92	20.63	54.72	19.38	54.03	54.03	21.67	53.96	51.11	17.85	55.63	0.00	52.22	54.38	54.51	23.96	54.38	0.00	54.31	54.51
3	20.42	56.04	54.65	23.40	54.10	54.03	45.00	53.96	51.81	54.24	54.03	0.00	54.17	54.31	54.58	54.58	53.89	0.00	54.38	54.58
4	55.56	56.04	54.72	54.86	54.03	54.03	54.10	53.89	18.82	54.17	56.32	0.00	54.31	21.32	20.76	54.58	54.38	0.00	54.31	54.51
5	55.63	55.90	22.01	54.86	54.03	53.68	54.17	53.89	21.94	54.24	19.03	0.00	54.17	20.07	17.50	54.51	54.31	0.00	54.31	18.19
6	55.63	55.97	18.19	54.86	54.10	53.96	54.03	17.71	54.17	54.10	18.06	0.00	54.24	54.51	54.65	54.44	19.31	0.00	54.38	20.42
7	55.63	56.04	54.93	54.86	54.03	54.03	54.10	21.53	54.10	54.24	54.31	0.00	20.56	54.51	54.58	54.44	22.64	0.00	54.31	54.79
8	55.28	55.97	54.86	54.86	54.03	54.03	54.10	54.03	54.10	53.61	46.67	0.00	19.03	54.44	54.58	54.44	54.51	0.00	54.31	54.72
9	55.63	55.97	54.93	54.79	53.96	53.96	56.39	54.10	54.17	54.17	34.31	0.00	54.38	54.51	54.58	54.51	54.51	0.00	54.38	54.65
10	55.63	55.90	54.86	54.86	54.03	54.03	58.40	54.03	45.63	54.17	50.63	0.00	54.31	54.38	52.22	54.10	54.38	0.00	54.31	54.72
11	55.63	11.67	52.57	54.86	54.03	54.86	58.40	54.03	31.67	54.17	54.17	0.00	51.53	54.44	54.44	54.44	54.44	0.00	54.38	54.58
12	55.63	35.14	54.72	54.79	54.03	58.33	58.40	54.03	44.03	54.17	55.90	0.00	49.93	54.10	54.51	54.38	54.44	0.00	54.31	54.65
13	55.63	59.86	54.79	53.13	54.03	58.33	56.60	54.03	58.47	54.17	58.47	22.36	49.93	54.44	54.51	54.44	54.17	0.00	54.38	54.03
14	55.63	60.14	54.79	54.86	40.07	58.33	54.03	48.75	58.47	54.10	6.81	39.86	49.86	54.44	54.44	54.38	54.44	0.00	54.31	54.65
15	55.63	59.72	54.79	54.79	28.06	58.40	54.10	58.26	58.47	54.17	0.00	54.03	55.35	54.38	54.44	54.44	54.44	0.00	54.38	54.58
16	55.42	59.03	54.79	54.79	58.33	58.33	53.96	58.26	58.47	54.10	0.00	54.10	58.68	54.38	54.44	54.38	54.38	0.00	54.31	54.58
17	55.49	59.03	54.79	54.72	58.33	58.33	54.03	56.46	58.40	54.17	0.00	54.10	58.68	54.38	54.44	54.38	54.44	0.00	54.38	54.65
18	55.14	59.03	54.79	54.72	58.33	56.32	53.96	53.96	58.47	52.15	0.00	50.56	54.38	54.38	54.44	54.38	54.38	0.00	54.31	54.58
19	47.36	59.10	54.79	54.65	58.19	53.96	54.03	54.03	58.47	42.15	0.00	54.03	49.86	54.51	54.38	54.38	54.38	0.00	54.31	54.65
20	55.56	58.96	54.72	54.44	58.40	53.96	53.96	53.96	58.40	45.42	0.00	54.10	49.93	54.51	54.44	54.38	54.38	0.00	54.38	54.58
21	55.49	59.17	54.79	54.31	58.33	53.89	53.89	53.89	56.25	45.35	0.00	52.57	45.83	54.51	29.10	54.38	54.03	0.00	54.38	54.58
22	55.56	59.24	54.79	53.96	58.33	53.96	46.32	53.89	54.10	44.44	0.00	54.03	12.64	54.38	37.71	54.38	54.38	0.00	51.94	54.65
23	56.39	59.24	54.72	53.89	58.33	53.96	58.13	53.75	54.03	42.29	0.00	54.03	0.00	54.31	52.50	54.38	54.38	0.00	54.31	54.58
24	56.32	59.17	54.79	53.61	58.40	53.89	57.50	53.68	54.10	48.96	0.00	54.10	36.53	54.31	27.71	54.38	54.38	0.00	54.38	54.65
25	56.25	59.17	54.72	53.96	58.33	53.96	53.96	53.61	48.68	58.47	0.00	54.17	52.57	40.00	58.82	53.26	54.31	3.26	54.31	54.65
26	56.11	59.17	49.24	54.03	58.33	54.03	53.96	53.47	54.03	58.33	0.00	54.10	50.00	52.64	58.75	54.38	54.38	34.10	50.21	54.58
27	56.18	57.01	54.79	53.89	58.40	53.89	53.96	53.47	54.10	58.47	0.00	54.17	49.93	54.44	58.82	54.38	54.38	54.38	34.03	54.65
28	56.18	54.79	54.79	53.96	58.33	53.89	53.96	53.47	53.19	58.40	0.00	54.24	50.00	53.33	58.82	54.38	54.31	54.38	0.00	54.58
29	56.25		54.79	53.96	18.89	18.26	53.96	53.47	54.03	58.26	0.00	54.24	23.61		58.75	54.31	54.38	54.31	30.97	54.65
30	55.56		54.79	18.54	20.49	0.00	53.96	52.85	54.03	58.47	0.00	54.24	21.32		58.75	54.38	54.31	54.38	54.44	54.58
31	25.28		54.79		53.19		53.54	52.36		58.40		52.08	54.38		58.82		54.31		54.51	48.06
Minimum	17.92	0.00	18.19	18.54	18.89	0.00	0.00	17.71	18.82	17.85	0.00	0.00	0.00	20.07	17.50	19.10	19.31	0.00	0.00	18.19
Maximum	56.39	60.14	54.93	54.86	58.40	58.40	58.40	58.26	58.47	58.47	58.47	54.24	58.68	54.51	58.82	54.58	54.51	54.38	54.51	54.79
Average	52.08	52.04	52.29	51.05	51.18	51.92	51.50	51.76	51.25	50.94	20.76	31.45	44.91	51.34	50.82	52.17	52.19	9.10	50.97	52.11

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

Total Combined Influent Flow Rate (GPM)

Day	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
1	54.58	54.58	54.51	54.51	54.65	54.58	54.51	54.58	54.86	19.44	55.00	55.00	33.26	54.58	56.67	54.31
2	54.58	54.51	54.51	54.51	54.51	54.65	22.78	54.58	54.79	19.51	55.00	55.00	54.93	54.58	17.36	54.31
3	54.58	54.51	56.81	54.10	54.58	18.61	22.57	54.58	54.86	55.00	55.00	55.07	54.93	54.65	25.35	54.31
4	54.58	54.51	54.51	54.58	54.58	24.31	54.72	54.58	19.03	55.00	55.00	55.00	54.93	54.58	54.65	43.75
5	54.58	54.58	54.51	54.44	54.58	54.72	54.72	54.58	25.63	55.00	55.00	55.00	54.93	19.51	54.58	54.38
6	54.58	54.51	54.51	54.44	54.58	54.65	54.72	20.63	54.93	55.00	19.24	55.00	54.93	23.47	54.51	54.38
7	54.58	22.36	54.51	54.44	54.51	54.65	54.65	20.07	54.93	54.93	20.42	55.00	54.93	54.72	54.51	54.31
8	54.58	19.51	54.51	54.58	54.58	54.65	52.43	54.79	54.93	55.00	55.14	55.00	52.29	54.72	54.44	54.31
9	19.24	54.65	54.51	19.93	54.51	54.65	54.72	54.79	54.93	54.93	55.07	55.00	54.86	54.72	54.51	54.31
10	17.50	54.65	54.51	16.32	54.58	54.58	53.13	54.72	55.00	55.00	55.07	19.10	54.93	54.65	54.44	54.38
11	54.79	54.17	20.00	54.79	54.58	54.24	54.72	54.72	54.86	54.93	55.07	22.85	54.93	54.65	54.44	54.31
12	54.79	54.65	19.79	33.89	54.51	54.58	54.65	10.35	54.93	55.00	55.00	54.10	54.93	54.65	54.44	54.31
13	54.65	54.65	54.72	54.72	18.89	54.58	54.65	28.26	54.86	54.93	55.07	19.72	54.86	54.65	54.44	54.38
14	54.65	54.58	51.67	54.65	22.64	54.38	54.65	54.65	54.93	54.93	55.00	30.35	54.93	54.65	54.51	16.46
15	54.72	54.58	54.65	54.65	54.72	54.58	54.72	54.65	54.86	55.00	55.07	55.07	54.86	54.65	54.44	25.97
16	54.58	54.51	54.65	54.72	54.72	54.58	54.65	54.65	54.86	53.61	55.07	55.07	55.00	54.65	54.44	39.44
17	54.65	42.15	54.58	54.65	54.65	54.58	54.65	54.65	54.93	54.93	55.00	54.86	54.93	54.58	53.96	54.58
18	54.65	54.58	54.58	54.65	54.72	54.58	49.93	54.65	54.86	55.00	55.07	55.00	54.93	54.65	54.38	19.79
19	54.65	54.58	53.47	54.58	54.65	54.58	54.65	54.65	53.89	54.93	55.00	55.07	54.93	54.58	54.44	33.40
20	54.58	54.51	54.51	54.44	54.65	54.51	54.65	57.08	54.86	55.00	55.07	55.00	54.86	54.24	54.44	54.51
21	54.65	54.58	54.58	54.58	54.65	54.58	54.65	58.89	54.93	54.93	55.00	51.46	18.40	54.58	54.44	42.99
22	54.58	54.58	54.58	54.58	54.58	54.51	54.65	59.24	54.86	54.93	55.00	55.00	25.83	54.58	54.38	33.61
23	54.51	54.51	54.58	54.58	54.65	54.51	53.06	59.03	54.86	55.00	55.07	54.93	54.86	54.51	54.38	54.38
24	54.31	54.51	54.58	54.58	54.58	54.58	52.01	59.24	54.93	54.93	55.00	54.93	54.79	54.58	54.38	54.31
25	54.58	54.58	54.58	54.65	54.65	54.31	54.65	59.24	54.86	55.00	55.00	55.00	54.72	54.51	54.38	54.31
26	54.58	54.51	54.58	54.58	54.58	54.51	54.58	59.24	54.93	55.00	55.07	55.00	54.79	54.58	54.38	54.24
27	54.58	54.51	54.44	54.58	54.58	54.51	54.65	56.81	54.86	55.00	54.65	54.93	54.72	54.44	54.31	54.31
28	54.51	54.58	54.58	54.58	53.96	54.51	54.58	54.79	54.86	54.93	51.81	53.06	54.72	53.82	54.38	54.31
29	54.58	54.44	54.51	54.58	54.58	54.58	54.58	54.86	54.93	55.00	55.07	55.00	54.65	54.44	54.38	52.57
30	54.58	54.51	54.51	54.58	54.58		54.58	54.79	54.86	48.54	55.00	54.93	54.65	54.44	54.38	54.31
31		54.51		52.64	54.58		54.65		54.86		55.00	48.26		54.44		54.31
Minimum	17.50	19.51	19.79	16.32	18.89	18.61	22.57	10.35	19.03	19.44	19.24	19.10	18.40	19.51	17.36	16.46
Maximum	54.79	54.65	56.81	54.79	54.72	54.72	54.72	59.24	55.00	55.00	55.14	55.07	55.00	54.72	56.67	54.58
Average	52.19	51.98	52.19	51.49	52.40	52.27	52.18	51.08	52.76	52.34	52.65	50.44	51.88	52.42	52.29	48.50

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

EW-1 Monthly Flow Rate (GPM)

Day		Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
	1	40.04	38.46	35.57	35.57	35.66	35.61	35.66	35.52	35.75	35.75	35.43	35.34	35.39	35.39	35.39	35.39	35.43	35.43	35.39	35.43	37.24	35.57	34.71	0.00
	2	40.08	38.95	13.54	35.61	35.30	35.61	35.66	30.65	35.70	35.75	35.70	35.30	35.39	35.34	35.34	35.34	35.61	35.39	35.43	35.39	35.43	35.61	34.71	0.00
	3	40.04	12.28	13.05	35.57	35.61	35.52	35.61	35.48	35.70	35.70	5.55	35.30	11.83	35.34	34.85	35.39	35.52	35.43	35.43	35.39	35.43	35.57	34.67	0.00
	4	40.04	16.07	35.75	34.94	35.66	35.61	35.66	35.61	35.75	35.75	10.61	35.30	13.95	35.39	32.50	35.34	35.57	35.39	35.39	26.32	35.39	35.57	34.62	0.00
	5	13.95	35.98	35.70	11.83	35.61	35.66	35.39	33.40	35.70	35.75	35.43	35.25	35.57	35.34	35.39	35.39	33.49	35.43	35.43	0.00	35.43	28.53	35.98	0.00
	6	14.76	35.93	35.66	13.81	35.61	35.57	35.66	35.61	35.75	35.70	36.92	35.30	35.48	11.96	35.34	35.34	35.39	11.83	35.39	0.00	25.19	35.52	13.09	0.00
	7	40.08	35.93	35.70	27.81	35.61	35.61	35.61	35.66	35.70	31.78	35.43	12.50	35.48	14.04	35.34	35.34	35.39	14.22	35.39	23.34	35.66	35.48	14.17	11.28
	8	40.08	35.93	35.66	23.61	35.66	35.61	35.61	35.61	35.75	35.75	35.43	13.59	35.48	35.39	12.41	35.34	34.49	35.52	35.43	35.39	35.61	35.48	34.85	36.92
	9	40.08	35.75	35.66	35.70	35.61	11.92	35.66	35.57	35.70	35.70	31.15	35.52	35.48	35.48	16.11	35.34	25.46	35.48	35.39	35.43	35.61	35.52	34.85	38.64
	10	40.08	36.11	35.66	35.70	11.65	13.68	35.61	35.61	35.75	35.70	35.39	35.48	35.52	35.48	35.48	9.75	35.43	35.43	12.05	35.39	35.57	13.50	21.49	38.68
	11	40.08	35.52	35.66	35.66	14.94	35.80	35.61	35.57	35.70	35.75	35.39	35.43	35.43	35.43	35.48	14.40	35.43	30.88	13.68	35.43	33.27	14.31	21.53	38.64
	12	40.08	36.16	35.61	35.66	35.75	35.75	12.73	35.61	35.70	35.52	35.34	35.43	35.48	35.43	33.94	35.48	35.21	35.43	35.57	35.43	35.61	36.07	34.76	38.32
	13	40.08	35.93	34.17	35.70	35.75	35.75	15.62	35.57	35.75	35.70	35.39	35.43	26.95	35.48	34.98	35.48	35.43	35.43	35.48	35.39	34.89	35.98	34.71	37.92
	14	40.08	35.57	35.66	35.66	35.75	35.75	35.75	35.52	35.70	35.70	35.30	35.43	35.43	35.39	35.43	35.43	35.43	31.51	35.52	11.74	35.61	35.98	34.80	37.78
	15	40.08	35.93	35.61	35.66	35.70	35.75	35.75	35.57	35.75	35.70	36.79	35.43	35.43	35.43	35.43	35.39	12.41	35.43	35.48	15.35	35.57	35.98	34.80	37.87
	16	40.08	35.48	35.61	35.66	35.70	31.19	35.75	35.57	35.66	35.75	38.23	35.39	35.48	35.43	35.39	35.39	15.44	35.48	35.43	38.37	35.57	35.98	34.76	38.55
	17	40.08	35.30	35.66	35.66	35.70	35.75	35.70	35.57	35.70	35.70	38.19	35.43	35.52	35.39	34.89	35.43	35.52	35.43	35.48	38.37	35.57	35.98	35.52	38.50
	18	40.08	35.07	35.61	35.66	35.70	35.70	35.70	35.61	35.70	35.70	38.19	35.39	35.48	35.39	35.43	35.39	35.48	35.43	35.48	39.09	35.93	35.93	35.93	38.55
	19	39.36	35.39	35.61	35.66	35.70	35.70	35.89	35.66	35.70	35.70	38.10	35.43	35.39	35.39	35.39	35.39	35.48	35.43	35.43	39.86	36.11	35.98	35.93	38.55
	20	38.59	35.25	35.61	35.61	35.70	35.70	35.70	35.66	35.70	35.66	38.14	35.39	35.12	32.36	35.39	35.39	35.48	35.39	35.43	39.90	35.93	35.93	34.67	38.50
	21	38.50	35.12	35.61	35.61	35.66	35.66	35.70	35.66	35.66	35.70	36.61	35.43	35.39	35.39	35.34	35.39	35.48	35.48	32.09	39.81	35.93	35.93	35.84	38.55
	22	38.50	35.25	35.61	35.66	35.66	35.70	35.66	35.75	35.70	35.70	35.34	35.39	35.39	35.39	35.39	35.43	35.43	35.39	25.55	39.81	35.93	35.98	35.07	38.37
	23	38.46	35.39	35.61	35.61	35.66	35.70	35.66	11.92	35.75	35.70	35.34	35.39	35.39	35.39	33.22	15.93	35.48	35.43	35.39	39.86	35.93	35.93	34.80	38.46
	24	38.50	35.25	35.61	35.57	35.70	35.66	35.66	12.32	35.70	35.70	35.39	35.43	35.39	35.39	35.39	23.74	35.43	35.43	35.43	39.86	32.68	35.93	34.80	38.50
	25	38.46	35.66	35.61	35.66	35.61	35.70	35.70	35.75	35.75	13.23	35.34	35.39	35.39	25.01	35.39	35.39	35.43	35.43	35.43	39.86	35.25	34.17	34.80	38.50
	26	38.50	35.84	35.57	35.66	35.66	35.66	35.61	35.75	35.70	15.21	35.30	35.39	35.39	35.34	35.39	34.89	25.64	35.43	29.75	39.81	35.89	34.76	34.76	36.88
	27	38.46	35.70	35.61	35.61	35.61	35.66	35.66	35.75	12.46	35.75	35.34	35.39	35.39	35.39	35.39	35.39	35.43	35.43	35.43	39.81	35.98	34.76	34.80	35.57
	28	38.50	35.89	35.57	35.61	35.66	35.66	35.66	35.75	15.26	35.75	35.34	35.43	35.34	35.34	35.39	35.39	35.43	34.85	35.43	39.77	35.89	34.80	15.71	35.61
	29	34.85	36.02	35.61	35.61	35.66	35.66	35.61	35.75	35.80	35.75	35.30	35.39	35.39		35.39	35.39	35.43	35.39	35.39	39.86	35.80	34.80	0.00	35.57
	30	27.90		35.57	35.61	35.61	35.61	35.66	35.75	35.80	35.75	35.30	35.39	35.34		35.34	35.48	35.43	35.43	35.43	39.77	35.61	34.76	0.00	35.57
	31	38.55		35.57		35.61		35.66	35.70		35.75		35.39	35.39		35.39		35.39		35.43	39.81		34.76		35.57
Minimum		13.95	12.28	13.05	11.83	11.65	11.92	12.73	11.92	12.46	13.23	5.55	12.50	11.83	11.96	12.41	9.75	12.41	11.83	12.05	0.00	25.19	13.50	0.00	0.00
Maximum		40.08	38.95	35.75	35.70	35.75	35.80	35.89	35.75	35.80	35.75	38.23	35.52	35.57	35.48	35.48	35.48	35.61	35.52	35.57	39.90	37.24	36.07	35.98	38.68
Average		37.32	34.38	34.14	33.43	34.21	34.00	34.28	33.89	34.26	34.20	34.02	33.95	33.69	33.32	33.77	32.79	33.33	33.64	33.37	33.19	35.18	33.90	29.70	29.54
Quarterly Average				35.30			33.88			34.14			34.06			33.60			33.25			33.90			31.07

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

EW-1 Monthly Flow Rate (GPM)

Day	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19
1	35.52	0.00	35.52	35.61	12.32	34.44	0.00	35.03	33.67	12.82	37.96	0.00	32.36	34.62	35.39	12.41	35.30	11.92	35.34	35.43
2	11.65	13.41	35.57	12.59	35.12	35.12	14.08	35.07	33.22	11.60	36.16	0.00	33.94	35.34	35.43	15.57	35.34	0.00	35.30	35.43
3	13.27	36.43	35.52	15.21	35.16	35.12	29.25	35.07	33.67	35.25	35.12	0.00	35.21	35.30	35.48	35.48	35.03	0.00	35.34	35.48
4	36.11	36.43	35.57	35.66	35.12	35.12	35.16	35.03	12.23	35.21	36.61	0.00	35.30	13.86	13.50	35.48	35.34	0.00	35.30	35.43
5	36.16	36.34	14.31	35.66	35.12	34.89	35.21	35.03	14.26	35.25	12.37	0.00	35.21	13.05	11.38	35.43	35.30	0.00	35.30	11.83
6	36.16	36.38	11.83	35.66	35.16	35.07	35.12	11.51	35.21	35.16	11.74	0.00	35.25	35.43	35.52	35.39	12.55	0.00	35.34	13.27
7	36.16	36.43	35.70	35.66	35.12	35.12	35.16	13.99	35.16	35.25	35.30	0.00	13.36	35.43	35.48	35.39	14.72	0.00	35.30	35.61
8	35.93	36.38	35.66	35.66	35.12	35.12	35.16	35.12	35.16	34.85	30.33	0.00	12.37	35.39	35.48	35.39	35.43	0.00	35.30	35.57
9	36.16	36.38	35.70	35.61	35.07	35.07	36.65	35.16	35.21	35.21	22.30	0.00	35.34	35.43	35.48	35.43	35.43	0.00	35.34	35.52
10	36.16	36.34	35.66	35.66	35.12	35.12	37.96	35.12	29.66	35.21	32.91	0.00	35.30	35.43	33.94	35.16	35.34	0.00	35.30	35.57
11	36.16	7.58	34.17	35.66	35.12	35.66	37.96	35.12	20.58	35.21	35.21	0.00	33.49	35.39	35.39	35.39	35.39	0.00	35.34	35.48
12	36.16	22.84	35.57	35.61	35.12	37.92	37.96	35.12	28.62	35.21	36.34	0.00	32.45	35.16	35.43	35.34	35.39	0.00	35.30	35.52
13	36.16	38.91	35.61	34.53	35.12	37.92	36.79	35.12	38.01	35.21	38.01	14.53	32.45	35.39	35.43	35.39	35.21	0.00	35.34	35.12
14	36.16	39.09	35.61	35.66	26.05	37.92	35.12	31.69	38.01	35.16	4.42	25.91	32.41	35.39	35.39	35.34	35.39	0.00	35.30	35.52
15	36.16	38.82	35.61	35.61	18.24	37.96	35.16	37.87	38.01	35.21	0.00	35.12	35.98	35.34	35.39	35.39	35.39	0.00	35.34	35.48
16	36.02	38.37	35.61	35.61	37.92	37.92	35.07	37.87	38.01	35.16	0.00	35.16	38.14	35.34	35.39	35.34	35.34	0.00	35.30	35.48
17	36.07	38.37	35.61	35.57	37.92	37.92	35.12	36.70	37.96	35.21	0.00	35.16	38.14	35.34	35.39	35.34	35.39	0.00	35.34	35.52
18	35.84	38.37	35.61	35.57	37.92	36.61	35.07	35.07	38.01	33.90	0.00	32.86	35.34	35.34	35.39	35.34	35.34	0.00	35.30	35.48
19	30.78	38.41	35.61	35.52	37.83	35.07	35.12	35.12	38.01	27.40	0.00	35.12	32.41	35.43	35.34	35.34	35.34	0.00	35.30	35.52
20	36.11	38.32	35.57	35.39	37.96	35.07	35.07	35.07	37.96	29.52	0.00	35.16	32.45	35.43	35.39	35.34	35.34	0.00	35.34	35.48
21	36.07	38.46	35.61	35.30	37.92	35.03	35.03	35.03	36.56	29.48	0.00	34.17	29.79	35.43	18.91	35.34	35.12	0.00	35.34	35.48
22	36.11	38.50	35.61	35.07	37.92	35.07	30.11	35.03	35.16	28.89	0.00	35.12	8.22	35.34	24.51	35.34	35.34	0.00	33.76	35.52
23	36.65	38.50	35.57	35.03	37.92	35.07	37.78	34.94	35.12	27.49	0.00	35.12	0.00	35.30	34.13	35.34	35.34	0.00	35.30	35.48
24	36.61	38.46	35.61	34.85	37.96	35.03	37.38	34.89	35.16	31.82	0.00	35.16	23.74	35.30	18.01	35.34	35.34	0.00	35.34	35.52
25	36.56	38.46	35.57	35.07	37.92	35.07	35.07	34.85	31.64	38.01	0.00	35.21	34.17	26.00	38.23	34.62	35.30	2.12	35.30	35.52
26	36.47	38.46	32.00	35.12	37.92	35.12	35.07	34.76	35.12	37.92	0.00	35.16	32.50	34.22	38.19	35.34	35.34	22.16	32.64	35.48
27	36.52	37.06	35.61	35.03	37.96	35.03	35.07	34.76	35.16	38.01	0.00	35.21	32.45	35.39	38.23	35.34	35.34	35.34	22.12	35.52
28	36.52	35.61	35.61	35.07	37.92	35.03	35.07	34.76	34.58	37.96	0.00	35.25	32.50	34.67	38.23	35.34	35.30	35.34	0.00	35.48
29	36.56		35.61	35.07	12.28	11.87	35.07	34.76	35.12	37.87	0.00	35.25	15.35		38.19	35.30	35.34	35.30	20.13	35.52
30	36.11		35.61	12.05	13.32	0.00	35.07	34.35	35.12	38.01	0.00	35.25	13.86		38.19	35.34	35.30	35.34	35.39	35.48
31	16.43		35.61		34.58		34.80	34.03		37.96	0.00	33.85	35.34		38.23		35.30		35.43	31.24
Minimum	11.65	0.00	11.83	12.05	12.28	0.00	0.00	11.51	12.23	11.60	0.00	0.00	0.00	13.05	11.38	12.41	12.55	0.00	0.00	11.83
Maximum	36.65	39.09	35.70	35.66	37.96	37.96	37.96	37.87	38.01	38.01	38.01	35.25	38.14	35.43	38.23	35.48	35.43	35.34	35.43	35.61
Average	33.85	33.83	33.99	33.18	33.26	33.75	33.48	33.65	33.31	33.11	13.06	20.45	29.19	33.37	33.03	33.91	33.93	5.92	33.13	33.87
Quarterly Average			33.89			33.40			33.48			22.20			31.81			24.69		

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

EW-1 Monthly Flow Rate (GPM)

	Day	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
	1	35.48	35.48	35.43	35.43	35.52	35.48	35.43	35.48	35.66	12.64	35.75	35.75	21.62	35.48	36.83	35.30
	2	35.48	35.43	35.43	35.43	35.43	35.52	14.81	35.48	35.61	12.68	35.75	35.75	35.70	35.48	11.28	35.30
	3	35.48	35.43	36.92	35.16	35.48	12.10	14.67	35.48	35.66	35.75	35.75	35.80	35.70	35.52	16.48	35.30
	4	35.48	35.43	35.43	35.48	35.48	15.80	35.57	35.48	12.37	35.75	35.75	35.75	35.70	35.48	35.52	28.44
	5	35.48	35.48	35.43	35.39	35.48	35.57	35.57	35.48	16.66	35.75	35.75	35.75	35.70	12.68	35.48	35.34
	6	35.48	35.43	35.43	35.39	35.48	35.52	35.57	13.41	35.70	35.75	12.50	35.75	35.70	15.26	35.43	35.34
	7	35.48	14.53	35.43	35.39	35.43	35.52	35.52	13.05	35.70	35.70	13.27	35.75	35.70	35.57	35.43	35.30
	8	35.48	12.68	35.43	35.48	35.48	35.52	34.08	35.61	35.70	35.75	35.84	35.75	33.99	35.57	35.39	35.30
	9	12.50	35.52	35.43	12.95	35.43	35.52	35.57	35.61	35.70	35.70	35.80	35.75	35.66	35.57	35.43	35.30
	10	11.38	35.52	35.43	10.61	35.48	35.48	34.53	35.57	35.75	35.75	35.80	12.41	35.70	35.52	35.39	35.34
	11	35.61	35.21	13.00	35.61	35.48	35.25	35.57	35.57	35.66	35.70	35.80	14.85	35.70	35.52	35.39	35.30
	12	35.61	35.52	12.86	22.03	35.43	35.48	35.52	6.73	35.70	35.75	35.75	35.16	35.70	35.52	35.39	35.30
	13	35.52	35.52	35.57	35.57	12.28	35.48	35.52	18.37	35.66	35.70	35.80	12.82	35.66	35.52	35.39	35.34
	14	35.52	35.48	33.58	35.52	14.72	35.34	35.52	35.52	35.70	35.70	35.75	19.73	35.70	35.52	35.43	10.70
	15	35.57	35.48	35.52	35.52	35.57	35.48	35.57	35.52	35.66	35.75	35.80	35.80	35.66	35.52	35.39	16.88
	16	35.48	35.43	35.52	35.57	35.57	35.48	35.52	35.52	35.66	34.85	35.80	35.80	35.75	35.52	35.39	25.64
	17	35.52	27.40	35.48	35.52	35.52	35.48	35.52	35.52	35.70	35.70	35.75	35.66	35.70	35.48	35.07	35.48
	18	35.52	35.48	35.48	35.52	35.57	35.48	32.45	35.52	35.66	35.75	35.80	35.75	35.70	35.52	35.34	12.86
	19	35.52	35.48	34.76	35.48	35.52	35.48	35.52	35.52	35.03	35.70	35.75	35.80	35.70	35.48	35.39	21.71
	20	35.48	35.43	35.43	35.39	35.52	35.43	35.52	37.10	35.66	35.75	35.80	35.75	35.66	35.25	35.39	35.43
	21	35.52	35.48	35.48	35.48	35.52	35.48	35.52	38.28	35.70	35.70	35.75	33.45	11.96	35.48	35.39	27.94
	22	35.48	35.48	35.48	35.48	35.48	35.43	35.52	38.50	35.66	35.70	35.75	35.75	16.79	35.48	35.34	21.85
	23	35.43	35.43	35.48	35.48	35.52	35.43	34.49	38.37	35.66	35.75	35.80	35.70	35.66	35.43	35.34	35.34
	24	35.30	35.43	35.48	35.48	35.48	35.48	33.81	38.50	35.70	35.70	35.75	35.70	35.61	35.48	35.34	35.30
	25	35.48	35.48	35.48	35.52	35.52	35.30	35.52	38.50	35.66	35.75	35.75	35.75	35.57	35.43	35.34	35.30
	26	35.48	35.43	35.48	35.48	35.48	35.43	35.48	38.50	35.70	35.75	35.80	35.75	35.61	35.48	35.34	35.25
	27	35.48	35.43	35.39	35.48	35.48	35.43	35.52	36.92	35.66	35.75	35.52	35.70	35.57	35.39	35.30	35.30
	28	35.43	35.48	35.48	35.48	35.07	35.43	35.48	35.61	35.66	35.70	33.67	34.49	35.57	34.98	35.34	35.30
	29	35.48	35.39	35.43	35.48	35.48	35.48	35.48	35.66	35.70	35.75	35.80	35.75	35.52	35.39	35.34	34.17
	30	35.48	35.43	35.43	35.48	35.48		35.48	35.61	35.66	31.55	35.75	35.70	35.52	35.39	35.34	35.30
	31		35.43		34.22	35.48		35.52		35.66		35.75	31.37		35.39		35.30
	Minimum	11.38	12.68	12.86	10.61	12.28	12.10	14.67	6.73	12.37	12.64	12.50	12.41	11.96	12.68	11.28	10.70
	Maximum	35.61	35.52	36.92	35.61	35.57	35.57	35.57	38.50	35.75	35.75	35.84	35.80	35.75	35.57	36.83	35.48
	Average	33.92	33.78	33.92	33.47	34.06	33.98	33.92	33.20	34.29	34.02	34.22	32.79	33.72	34.08	33.99	31.52
	Quarterly Average	33.64			33.72			33.99			33.84			33.57			33.19

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

EW-4 Monthly Flow Rate (GPM)

Day	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
1	21.56	20.71	19.15	19.15	19.20	19.18	19.20	19.13	19.25	19.25	19.08	19.03	19.06	19.06	19.06	19.06	19.08	19.08	19.06	19.08	20.05	19.15	18.69	0.00
2	21.58	20.98	7.29	19.18	19.01	19.18	19.20	16.50	19.23	19.25	19.23	19.01	19.06	19.03	19.03	19.03	19.18	19.06	19.08	19.06	19.08	19.18	18.69	0.00
3	21.56	6.61	7.02	19.15	19.18	19.13	19.18	19.10	19.23	19.23	2.99	19.01	6.37	19.03	18.76	19.06	19.13	19.08	19.08	19.06	19.08	19.15	18.67	0.00
4	21.56	8.65	19.25	18.81	19.20	19.18	19.20	19.18	19.25	19.25	5.71	19.01	7.51	19.06	17.50	19.03	19.15	19.06	19.06	14.17	19.06	19.15	18.64	0.00
5	7.51	19.37	19.23	6.37	19.18	19.20	19.06	17.99	19.23	19.25	19.08	18.98	19.15	19.03	19.06	19.06	18.03	19.08	19.08	0.00	19.08	15.36	19.37	0.00
6	7.95	19.35	19.20	7.44	19.18	19.15	19.20	19.18	19.25	19.23	19.88	19.01	19.10	6.44	19.03	19.03	19.06	6.37	19.06	0.00	13.56	19.13	7.05	0.00
7	21.58	19.35	19.23	14.97	19.18	19.18	19.18	19.20	19.23	17.11	19.08	6.73	19.10	7.56	19.03	19.03	19.06	7.66	19.06	12.57	19.20	19.10	7.63	6.08
8	21.58	19.35	19.20	12.71	19.20	19.18	19.18	19.18	19.25	19.25	19.08	7.32	19.10	19.06	6.68	19.03	18.57	19.13	19.08	19.06	19.18	19.10	18.76	19.88
9	21.58	19.25	19.20	19.23	19.18	6.42	19.20	19.15	19.23	19.23	16.77	19.13	19.10	19.10	8.68	19.03	13.71	19.10	19.06	19.08	19.18	19.13	18.76	20.81
10	21.58	19.44	19.20	19.23	6.27	7.36	19.18	19.18	19.25	19.23	19.06	19.10	19.13	19.10	19.10	5.25	19.08	19.08	6.49	19.06	19.15	7.27	11.57	20.83
11	21.58	19.13	19.20	19.20	8.05	19.27	19.18	19.15	19.23	19.25	19.06	19.08	19.08	19.08	19.10	7.75	19.08	16.63	7.36	19.08	17.91	7.70	11.59	20.81
12	21.58	19.47	19.18	19.20	19.25	19.25	6.85	19.18	19.23	19.13	19.03	19.08	19.10	19.08	18.28	19.10	18.96	19.08	19.15	19.08	19.18	19.42	18.72	20.64
13	21.58	19.35	18.40	19.23	19.25	19.25	8.41	19.15	19.25	19.23	19.06	19.08	14.51	19.10	18.84	19.10	19.08	19.08	19.10	19.06	18.79	19.37	18.69	20.42
14	21.58	19.15	19.20	19.20	19.25	19.25	19.25	19.13	19.23	19.23	19.01	19.08	19.08	19.06	19.08	19.08	19.08	16.97	19.13	6.32	19.18	19.37	18.74	20.34
15	21.58	19.35	19.18	19.20	19.23	19.25	19.25	19.15	19.25	19.23	19.81	19.08	19.08	19.08	19.08	19.06	6.68	19.08	19.10	8.26	19.15	19.37	18.74	20.39
16	21.58	19.10	19.18	19.20	19.23	16.80	19.25	19.15	19.20	19.25	20.59	19.06	19.10	19.08	19.06	19.06	8.31	19.10	19.08	20.66	19.15	19.37	18.72	20.76
17	21.58	19.01	19.20	19.20	19.23	19.25	19.23	19.15	19.23	19.23	20.56	19.08	19.13	19.06	18.79	19.08	19.13	19.08	19.10	20.66	19.15	19.37	19.13	20.73
18	21.58	18.89	19.18	19.20	19.23	19.23	19.23	19.18	19.23	19.23	20.56	19.06	19.10	19.06	19.08	19.06	19.10	19.08	19.10	21.05	19.35	19.35	19.35	20.76
19	21.19	19.06	19.18	19.20	19.23	19.23	19.32	19.20	19.23	19.23	20.51	19.08	19.06	19.06	19.06	19.06	19.10	19.08	19.08	21.46	19.44	19.37	19.35	20.76
20	20.78	18.98	19.18	19.18	19.23	19.23	19.23	19.20	19.23	19.20	20.54	19.06	18.91	17.43	19.06	19.06	19.10	19.06	19.08	21.49	19.35	19.35	18.67	20.73
21	20.73	18.91	19.18	19.18	19.20	19.20	19.23	19.20	19.20	19.23	19.71	19.08	19.06	19.06	19.03	19.06	19.10	19.10	17.28	21.44	19.35	19.35	19.30	20.76
22	20.73	18.98	19.18	19.20	19.20	19.23	19.20	19.25	19.23	19.23	19.03	19.06	19.06	19.06	19.06	19.08	19.08	19.06	13.76	21.44	19.35	19.37	18.89	20.66
23	20.71	19.06	19.18	19.18	19.20	19.23	19.20	6.42	19.25	19.23	19.03	19.06	19.06	19.06	17.89	8.58	19.10	19.08	19.06	21.46	19.35	19.35	18.74	20.71
24	20.73	18.98	19.18	19.15	19.23	19.20	19.20	6.64	19.23	19.23	19.06	19.08	19.06	19.06	19.06	12.78	19.08	19.08	19.08	21.46	17.60	19.35	18.74	20.73
25	20.71	19.20	19.18	19.20	19.18	19.23	19.23	19.25	19.25	7.12	19.03	19.06	19.06	13.47	19.06	19.06	19.08	19.08	19.08	21.46	18.98	18.40	18.74	20.73
26	20.73	19.30	19.15	19.20	19.20	19.20	19.18	19.25	19.23	8.19	19.01	19.06	19.06	19.03	19.06	18.79	13.81	19.08	16.02	21.44	19.32	18.72	18.72	19.86
27	20.71	19.23	19.18	19.18	19.18	19.20	19.20	19.25	6.71	19.25	19.03	19.06	19.06	19.06	19.06	19.06	19.08	19.08	19.08	21.44	19.37	18.72	18.74	19.15
28	20.73	19.32	19.15	19.18	19.20	19.20	19.20	19.25	8.22	19.25	19.03	19.08	19.03	19.03	19.06	19.06	19.08	18.76	19.08	21.41	19.32	18.74	8.46	19.18
29	18.76	19.40	19.18	19.18	19.20	19.20	19.18	19.25	19.27	19.25	19.01	19.06	19.06		19.06	19.06	19.08	19.06	19.06	21.46	19.27	18.74	0.00	19.15
30	15.02		19.15	19.18	19.18	19.18	19.20	19.25	19.27	19.25	19.01	19.06	19.03		19.03	19.10	19.08	19.08	19.08	21.41	19.18	18.72	0.00	19.15
31	20.76		19.15		19.18		19.20	19.23		19.25		19.06	19.06		19.06		19.06		19.08	21.44		18.72		19.15
Minimum	7.51	6.61	7.02	6.37	6.27	6.42	6.85	6.42	6.71	7.12	2.99	6.73	6.37	6.44	6.68	5.25	6.68	6.37	6.49	0.00	13.56	7.27	0.00	0.00
Maximum	21.58	20.98	19.25	19.23	19.25	19.27	19.32	19.25	19.27	19.25	20.59	19.13	19.15	19.10	19.10	19.10	19.18	19.13	19.15	21.49	20.05	19.42	19.37	20.83
Average	20.10	18.51	18.38	18.00	18.42	18.31	18.46	18.25	18.45	18.42	18.32	18.28	18.14	17.94	18.19	17.65	17.95	18.11	17.97	17.87	18.95	18.26	15.99	15.91
Quarterly Average			19.01			18.25			18.38			18.34			18.09			17.90			18.26			16.73

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

EW-4 Monthly Flow Rate (GPM)

	Day	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19
	1	19.13	0.00	19.13	19.18	6.64	18.55	0.00	18.86	18.13	6.90	20.44	0.00	17.43	18.64	19.06	6.68	19.01	6.42	19.03	19.08
	2	6.27	7.22	19.15	6.78	18.91	18.91	7.58	18.89	17.89	6.25	19.47	0.00	18.28	19.03	19.08	8.39	19.03	0.00	19.01	19.08
	3	7.15	19.61	19.13	8.19	18.93	18.91	15.75	18.89	18.13	18.98	18.91	0.00	18.96	19.01	19.10	19.10	18.86	0.00	19.03	19.10
	4	19.44	19.61	19.15	19.20	18.91	18.91	18.93	18.86	6.59	18.96	19.71	0.00	19.01	7.46	7.27	19.10	19.03	0.00	19.01	19.08
	5	19.47	19.57	7.70	19.20	18.91	18.79	18.96	18.86	7.68	18.98	6.66	0.00	18.96	7.02	6.13	19.08	19.01	0.00	19.01	6.37
	6	19.47	19.59	6.37	19.20	18.93	18.89	18.91	6.20	18.96	18.93	6.32	0.00	18.98	19.08	19.13	19.06	6.76	0.00	19.03	7.15
	7	19.47	19.61	19.23	19.20	18.91	18.91	18.93	7.53	18.93	18.98	19.01	0.00	7.19	19.08	19.10	19.06	7.92	0.00	19.01	19.18
	8	19.35	19.59	19.20	19.20	18.91	18.91	18.93	18.91	18.93	18.76	16.33	0.00	6.66	19.06	19.10	19.06	19.08	0.00	19.01	19.15
	9	19.47	19.59	19.23	19.18	18.89	18.89	19.74	18.93	18.96	18.96	12.01	0.00	19.03	19.08	19.10	19.08	19.08	0.00	19.03	19.13
	10	19.47	19.57	19.20	19.20	18.91	18.91	20.44	18.91	15.97	18.96	17.72	0.00	19.01	19.03	18.28	18.93	19.03	0.00	19.01	19.15
	11	19.47	4.08	18.40	19.20	18.91	19.20	20.44	18.91	11.08	18.96	18.96	0.00	18.03	19.06	19.06	19.06	19.06	0.00	19.03	19.10
	12	19.47	12.30	19.15	19.18	18.91	20.42	20.44	18.91	15.41	18.96	19.57	0.00	17.48	18.93	19.08	19.03	19.06	0.00	19.01	19.13
	13	19.47	20.95	19.18	18.59	18.91	20.42	19.81	18.91	20.47	18.96	20.47	7.83	17.48	19.06	19.08	19.06	18.96	0.00	19.03	18.91
	14	19.47	21.05	19.18	19.20	14.02	20.42	18.91	17.06	20.47	18.93	2.38	13.95	17.45	19.06	19.06	19.03	19.06	0.00	19.01	19.13
	15	19.47	20.90	19.18	19.18	9.82	20.44	18.93	20.39	20.47	18.96	0.00	18.91	19.37	19.03	19.06	19.06	19.06	0.00	19.03	19.10
	16	19.40	20.66	19.18	19.18	20.42	20.42	18.89	20.39	20.47	18.93	0.00	18.93	20.54	19.03	19.06	19.03	19.03	0.00	19.01	19.10
	17	19.42	20.66	19.18	19.15	20.42	20.42	18.91	19.76	20.44	18.96	0.00	18.93	20.54	19.03	19.06	19.03	19.06	0.00	19.03	19.13
	18	19.30	20.66	19.18	19.15	20.42	19.71	18.89	18.89	20.47	18.25	0.00	17.69	19.03	19.03	19.06	19.03	19.03	0.00	19.01	19.10
	19	16.58	20.68	19.18	19.13	20.37	18.89	18.91	18.91	20.47	14.75	0.00	18.91	17.45	19.08	19.03	19.03	19.03	0.00	19.01	19.13
	20	19.44	20.64	19.15	19.06	20.44	18.89	18.89	18.89	20.44	15.90	0.00	18.93	17.48	19.08	19.06	19.03	19.03	0.00	19.03	19.10
	21	19.42	20.71	19.18	19.01	20.42	18.86	18.86	18.86	19.69	15.87	0.00	18.40	16.04	19.08	10.18	19.03	18.91	0.00	19.03	19.10
	22	19.44	20.73	19.18	18.89	20.42	18.89	16.21	18.86	18.93	15.56	0.00	18.91	4.42	19.03	13.20	19.03	19.03	0.00	18.18	19.13
	23	19.74	20.73	19.15	18.86	20.42	18.89	20.34	18.81	18.91	14.80	0.00	18.91	0.00	19.01	18.38	19.03	19.03	0.00	19.01	19.10
	24	19.71	20.71	19.18	18.76	20.44	18.86	20.13	18.79	18.93	17.14	0.00	18.93	12.78	19.01	9.70	19.03	19.03	0.00	19.03	19.13
	25	19.69	20.71	19.15	18.89	20.42	18.89	18.89	18.76	17.04	20.47	0.00	18.96	18.40	14.00	20.59	18.64	19.01	1.14	19.01	19.13
	26	19.64	20.71	17.23	18.91	20.42	18.91	18.89	18.72	18.91	20.42	0.00	18.93	17.50	18.42	20.56	19.03	19.03	11.93	17.57	19.10
	27	19.66	19.95	19.18	18.86	20.44	18.86	18.89	18.72	18.93	20.47	0.00	18.96	17.48	19.06	20.59	19.03	19.03	19.03	11.91	19.13
	28	19.66	19.18	19.18	18.89	20.42	18.86	18.89	18.72	18.62	20.44	0.00	18.98	17.50	18.67	20.59	19.03	19.01	19.03	0.00	19.10
	29	19.69		19.18	18.89	6.61	6.39	18.89	18.72	18.91	20.39	0.00	18.98	8.26		20.56	19.01	19.03	19.01	10.84	19.13
	30	19.44		19.18	6.49	7.17	0.00	18.89	18.50	18.91	20.47	0.00	18.98	7.46		20.56	19.03	19.01	19.03	19.06	19.10
	31	8.85		19.18		18.62		18.74	18.33		20.44		18.23	19.03		20.59		19.01		19.08	16.82
	Minimum	6.27	0.00	6.37	6.49	6.61	0.00	0.00	6.20	6.59	6.25	0.00	0.00	0.00	7.02	6.13	6.68	6.76	0.00	0.00	6.37
	Maximum	19.74	21.05	19.23	19.20	20.44	20.44	20.44	20.39	20.47	20.47	20.47	18.98	20.54	19.08	20.59	19.10	19.08	19.03	19.08	19.18
	Average	18.23	18.21	18.30	17.87	17.91	18.17	18.03	18.12	17.94	17.83	7.26	11.01	15.72	17.97	17.79	18.26	18.27	3.19	17.84	18.24
	Quarterly Average			18.25			17.98			18.03			12.09			17.13			13.29		

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

EW-4 Monthly Flow Rate (GPM)

Day		Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
	1	19.10	19.10	19.08	19.08	19.13	19.10	19.08	19.10	19.20	6.81	19.25	19.25	11.64	19.10	19.83	19.01
	2	19.10	19.08	19.08	19.08	19.08	19.13	7.97	19.10	19.18	6.83	19.25	19.25	19.23	19.10	6.08	19.01
	3	19.10	19.08	19.88	18.93	19.10	6.51	7.90	19.10	19.20	19.25	19.25	19.27	19.23	19.13	8.87	19.01
	4	19.10	19.08	19.08	19.10	19.10	8.51	19.15	19.10	6.66	19.25	19.25	19.25	19.23	19.10	19.13	15.31
	5	19.10	19.10	19.08	19.06	19.10	19.15	19.15	19.10	8.97	19.25	19.25	19.25	19.23	6.83	19.10	19.03
	6	19.10	19.08	19.08	19.06	19.10	19.13	19.15	7.22	19.23	19.25	6.73	19.25	19.23	8.22	19.08	19.03
	7	19.10	7.83	19.08	19.06	19.08	19.13	19.13	7.02	19.23	19.23	7.15	19.25	19.23	19.15	19.08	19.01
	8	19.10	6.83	19.08	19.10	19.10	19.13	18.35	19.18	19.23	19.25	19.30	19.25	18.30	19.15	19.06	19.01
	9	6.73	19.13	19.08	6.98	19.08	19.13	19.15	19.18	19.23	19.23	19.27	19.25	19.20	19.15	19.08	19.01
	10	6.13	19.13	19.08	5.71	19.10	19.10	18.59	19.15	19.25	19.25	19.27	6.68	19.23	19.13	19.06	19.03
	11	19.18	18.96	7.00	19.18	19.10	18.98	19.15	19.15	19.20	19.23	19.27	8.00	19.23	19.13	19.06	19.01
	12	19.18	19.13	6.93	11.86	19.08	19.10	19.13	3.62	19.23	19.25	19.25	18.93	19.23	19.13	19.06	19.01
	13	19.13	19.13	19.15	19.15	6.61	19.10	19.13	9.89	19.20	19.23	19.27	6.90	19.20	19.13	19.06	19.03
	14	19.13	19.10	18.08	19.13	7.92	19.03	19.13	19.13	19.23	19.23	19.25	10.62	19.23	19.13	19.08	5.76
	15	19.15	19.10	19.13	19.13	19.15	19.10	19.15	19.13	19.20	19.25	19.27	19.27	19.20	19.13	19.06	9.09
	16	19.10	19.08	19.13	19.15	19.15	19.10	19.13	19.13	19.20	18.76	19.27	19.27	19.25	19.13	19.06	13.81
	17	19.13	14.75	19.10	19.13	19.13	19.10	19.13	19.13	19.23	19.23	19.25	19.20	19.23	19.10	18.89	19.10
	18	19.13	19.10	19.10	19.13	19.15	19.10	17.48	19.13	19.20	19.25	19.27	19.25	19.23	19.13	19.03	6.93
	19	19.13	19.10	18.72	19.10	19.13	19.10	19.13	19.13	18.86	19.23	19.25	19.27	19.23	19.10	19.06	11.69
	20	19.10	19.08	19.08	19.06	19.13	19.08	19.13	19.98	19.20	19.25	19.27	19.25	19.20	18.98	19.06	19.08
	21	19.13	19.10	19.10	19.10	19.13	19.10	19.13	20.61	19.23	19.23	19.25	18.01	6.44	19.10	19.06	15.05
	22	19.10	19.10	19.10	19.10	19.10	19.08	19.13	20.73	19.20	19.23	19.25	19.25	9.04	19.10	19.03	11.76
	23	19.08	19.08	19.10	19.10	19.13	19.08	18.57	20.66	19.20	19.25	19.27	19.23	19.20	19.08	19.03	19.03
	24	19.01	19.08	19.10	19.10	19.10	19.10	18.20	20.73	19.23	19.23	19.25	19.23	19.18	19.10	19.03	19.01
	25	19.10	19.10	19.10	19.13	19.13	19.01	19.13	20.73	19.20	19.25	19.25	19.25	19.15	19.08	19.03	19.01
	26	19.10	19.08	19.10	19.10	19.10	19.08	19.10	20.73	19.23	19.25	19.27	19.25	19.18	19.10	19.03	18.98
	27	19.10	19.08	19.06	19.10	19.10	19.08	19.13	19.88	19.20	19.25	19.13	19.23	19.15	19.06	19.01	19.01
	28	19.08	19.10	19.10	19.10	18.89	19.08	19.10	19.18	19.20	19.23	18.13	18.57	19.15	18.84	19.03	19.01
	29	19.10	19.06	19.08	19.10	19.10	19.10	19.10	19.20	19.23	19.25	19.27	19.25	19.13	19.06	19.03	18.40
	30	19.10	19.08	19.08	19.10	19.10		19.10	19.18	19.20	16.99	19.25	19.23	19.13	19.06	19.03	19.01
	31		19.08		18.42	19.10		19.13		19.20		19.25	16.89		19.06		19.01
Minimum		6.13	6.83	6.93	5.71	6.61	6.51	7.90	3.62	6.66	6.81	6.73	6.68	6.44	6.83	6.08	5.76
Maximum		19.18	19.13	19.88	19.18	19.15	19.15	19.15	20.73	19.25	19.25	19.30	19.27	19.25	19.15	19.83	19.10
Average		18.27	18.19	18.27	18.02	18.34	18.30	18.26	17.88	18.47	18.32	18.43	17.66	18.16	18.35	18.30	16.97
Quarterly Average		18.11			18.16			18.30			18.22			18.08			17.87

Notes

1 - Both extraction wells operate simultaneously. When the system is running, both wells are pumping.

2 - EW-1 is set to 65% of total flow, and EW-4 is set to 35% of total flow.

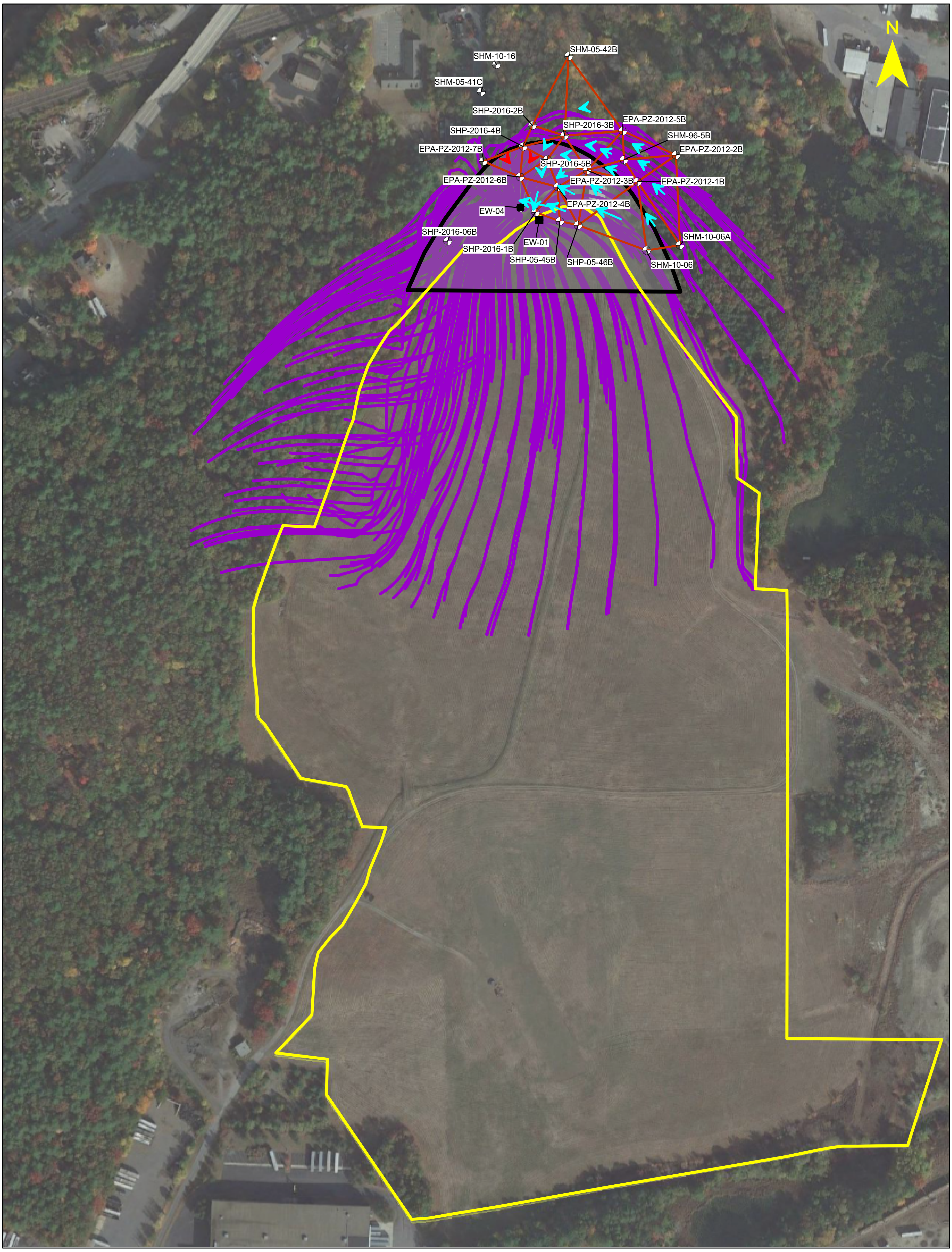
3 - The system was offline between 29 November 2017 and 7 December 2017 due to the failure of the main PLC.

4 - The system was offline between 14 November 2018 and 13 December 2018 due to the failure of the main electrical breaker.

5 - The system was offline between 01 June 2019 and 27 June 2019 due to the failure of the chlorine dioxide PLC.

Attachment 2

Full Shepley's Hill Landfill Area Reverse Particle Tracking



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 250 500

Notes:

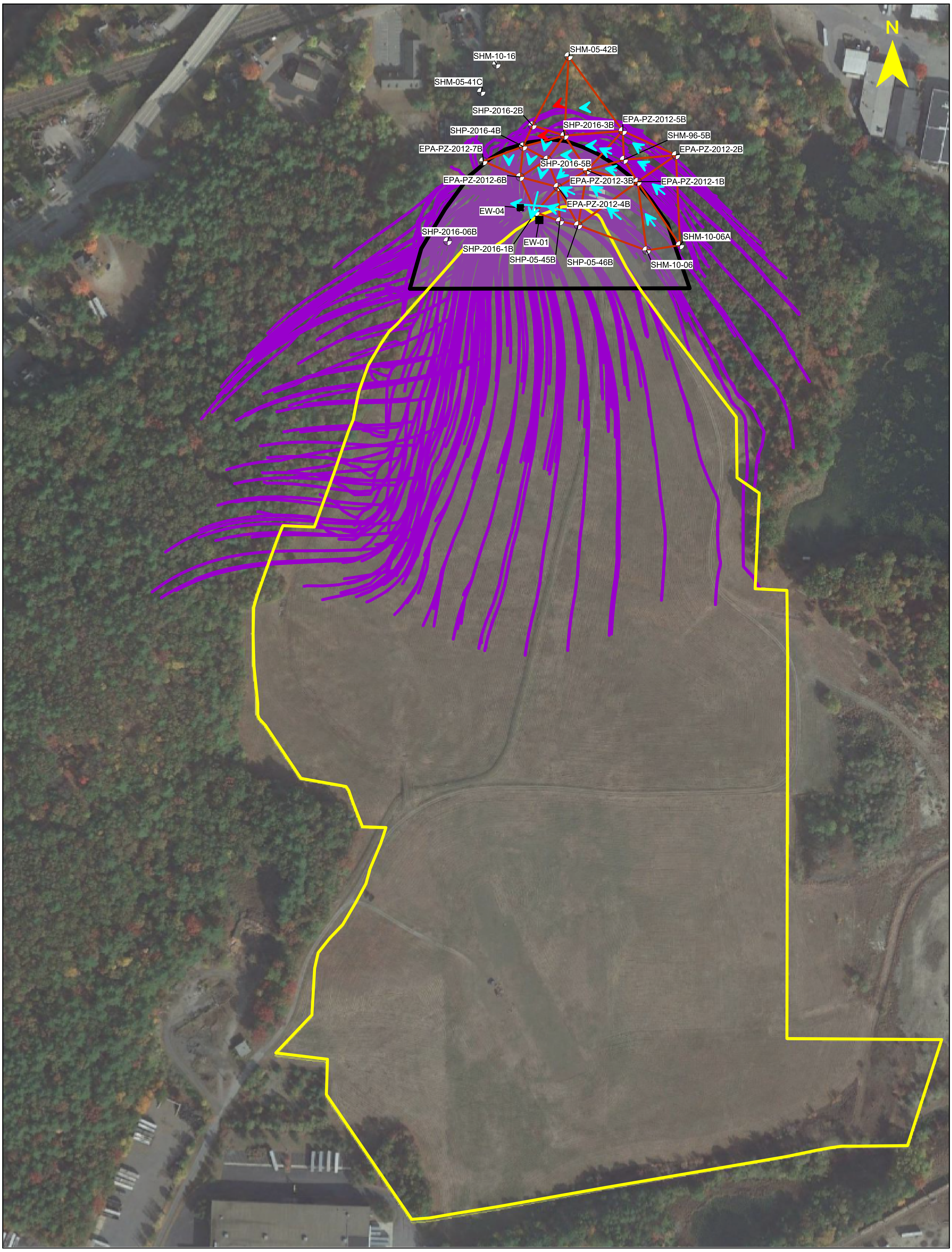
1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

August 16, 2016 (Stress Period 16)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES ARCADIS a joint venture

FIGURE 2-1



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 250 500

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

October 20, 2016 (Stress Period 17)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES
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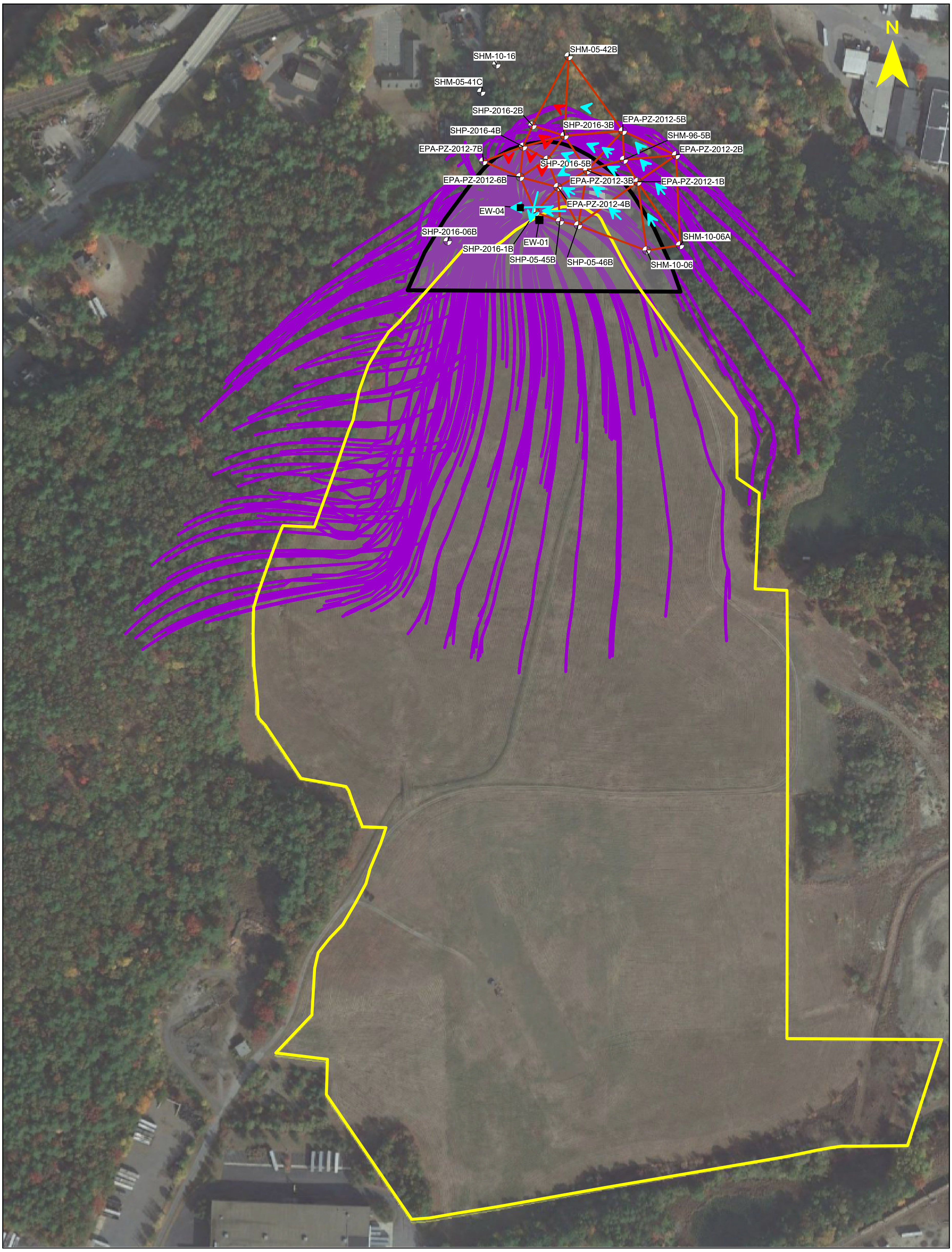
FIGURE
2-2



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 250 500

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

March 2, 2017 (Stress Period 18)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES Engineering & Services, LLC
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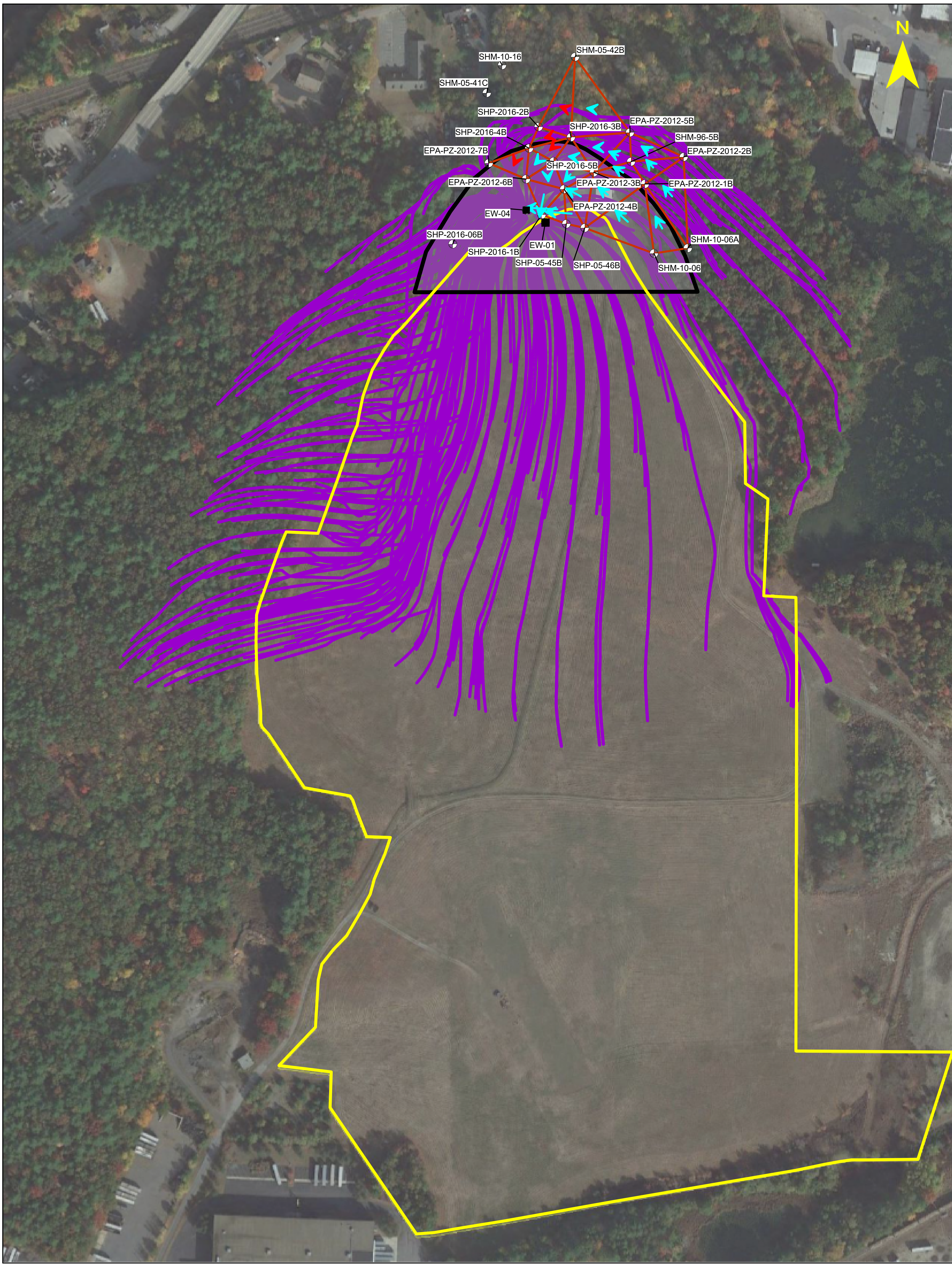
FIGURE
2-3



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 250 500

Notes:

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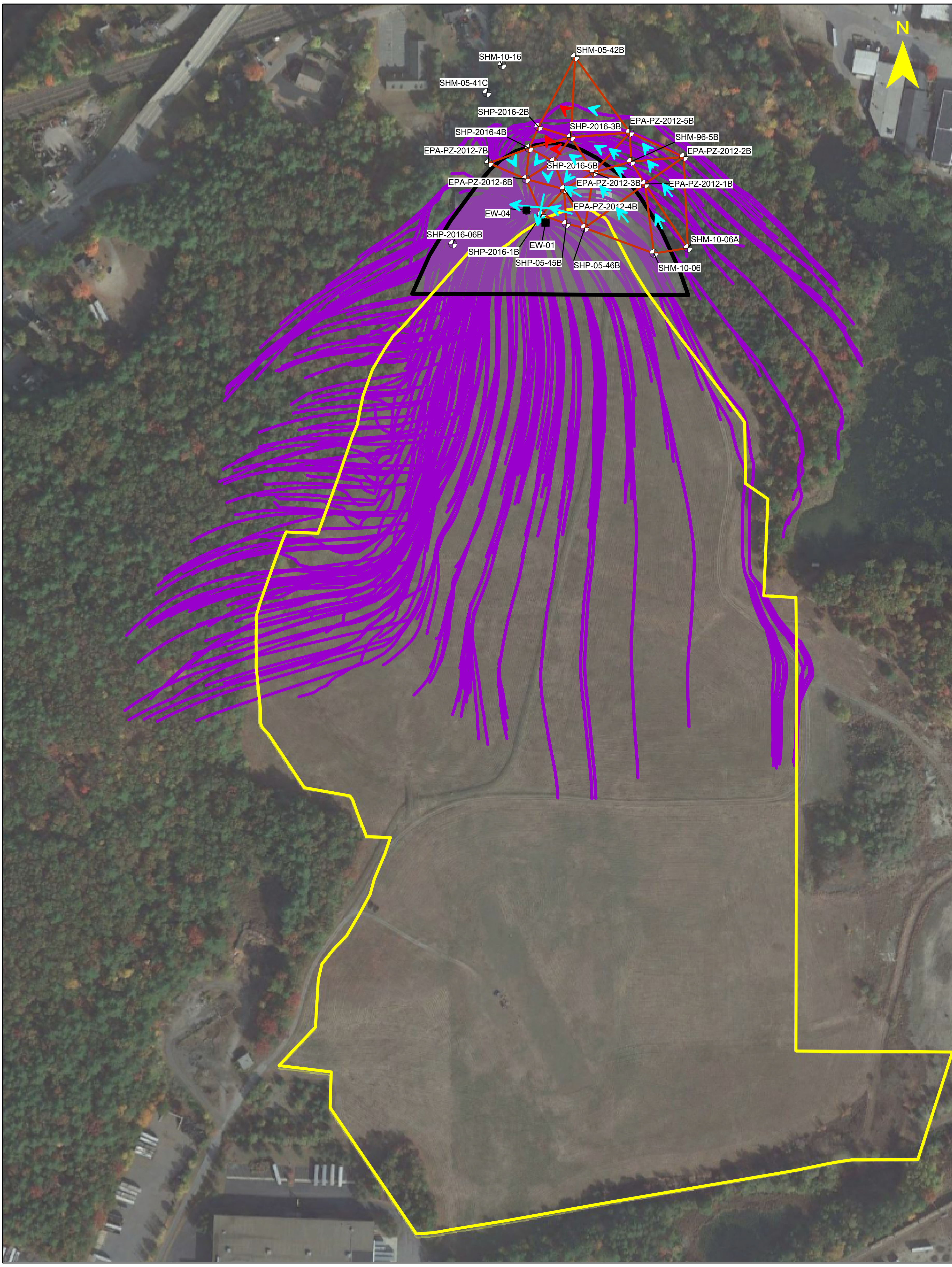
4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 2, 2017 (Stress Period 21)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES ARCADIS a joint venture

FIGURE
2-4



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet
0 250 500

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 22, 2018 (Stress Period 23)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES Engineering & Services, LLC
ARCADIS
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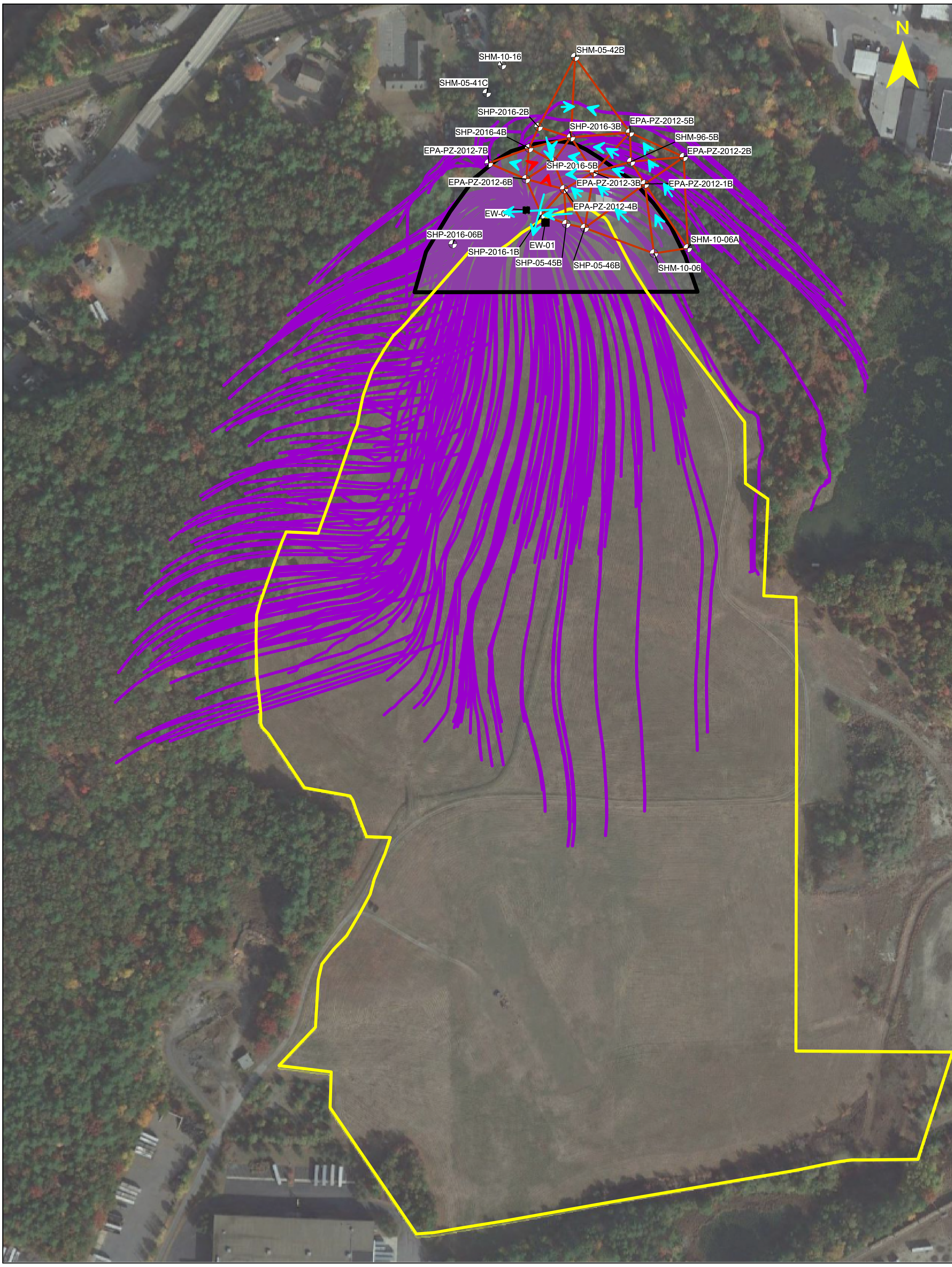
FIGURE
2-5



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 250 500

Notes:

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4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 1, 2018 (Stress Period 25)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES
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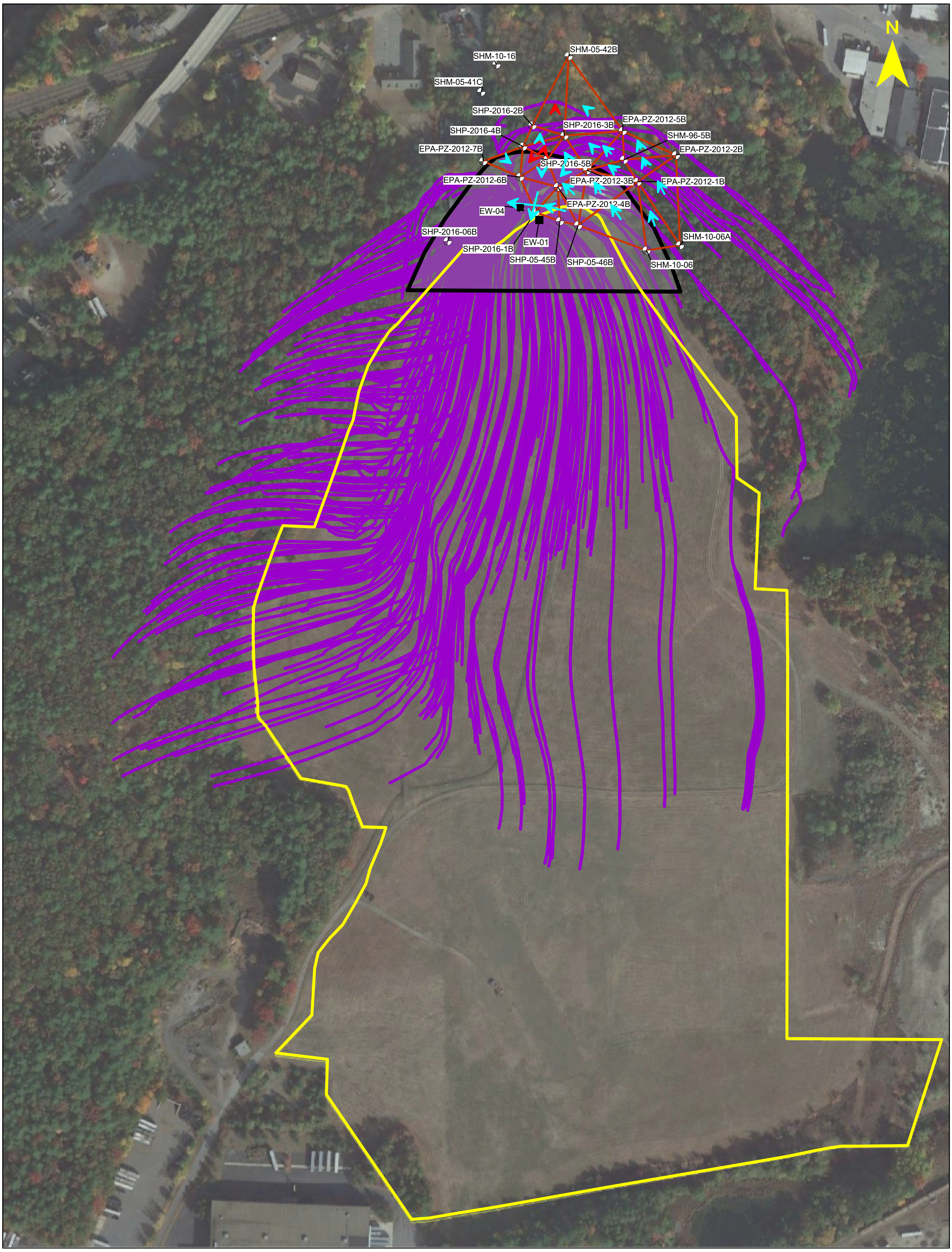
FIGURE
2-6



Legend

- Extraction Wells
- Shepley's Hill Landfill Boundary
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells

Scale in feet

0 250 500

Notes:

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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 13, 2019 (Stress Period 27)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES Engineering & Services, LLC
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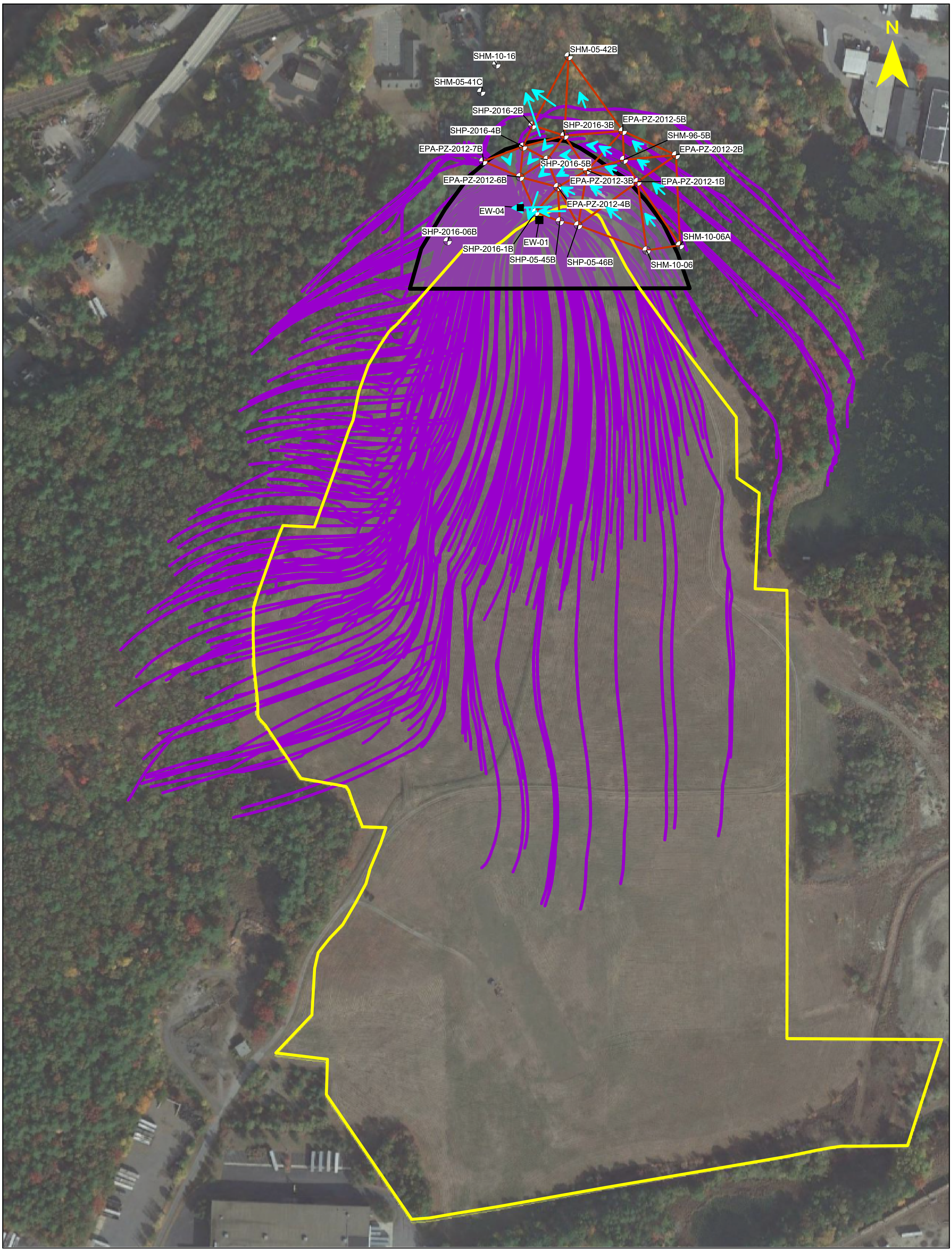
FIGURE
2-7



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet
0 250 500

Notes:
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FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

October 22, 2019 (Stress Period 29)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES Engineering & Services, LLC
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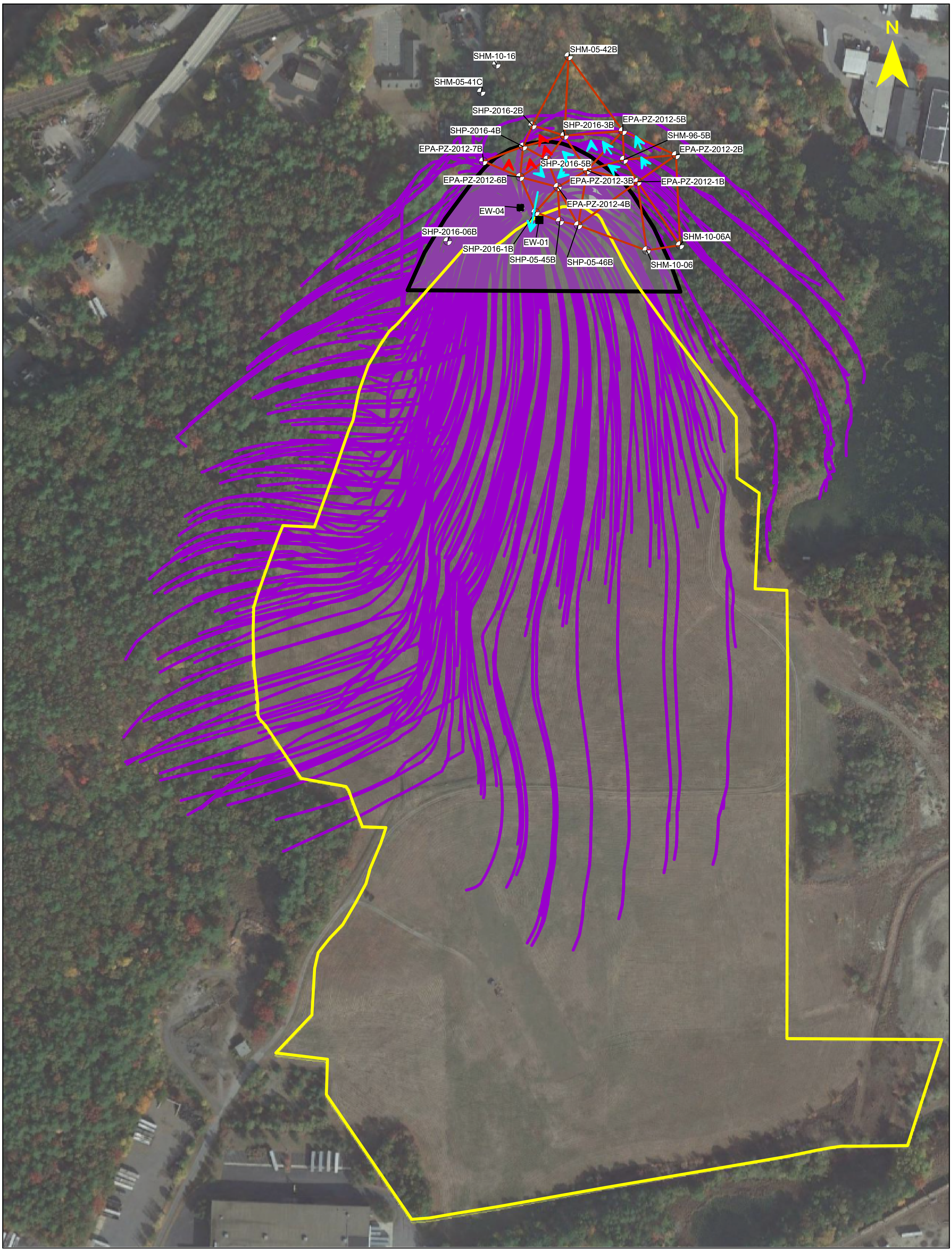
a joint venture

FIGURE
2-8



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 250 500

Notes:

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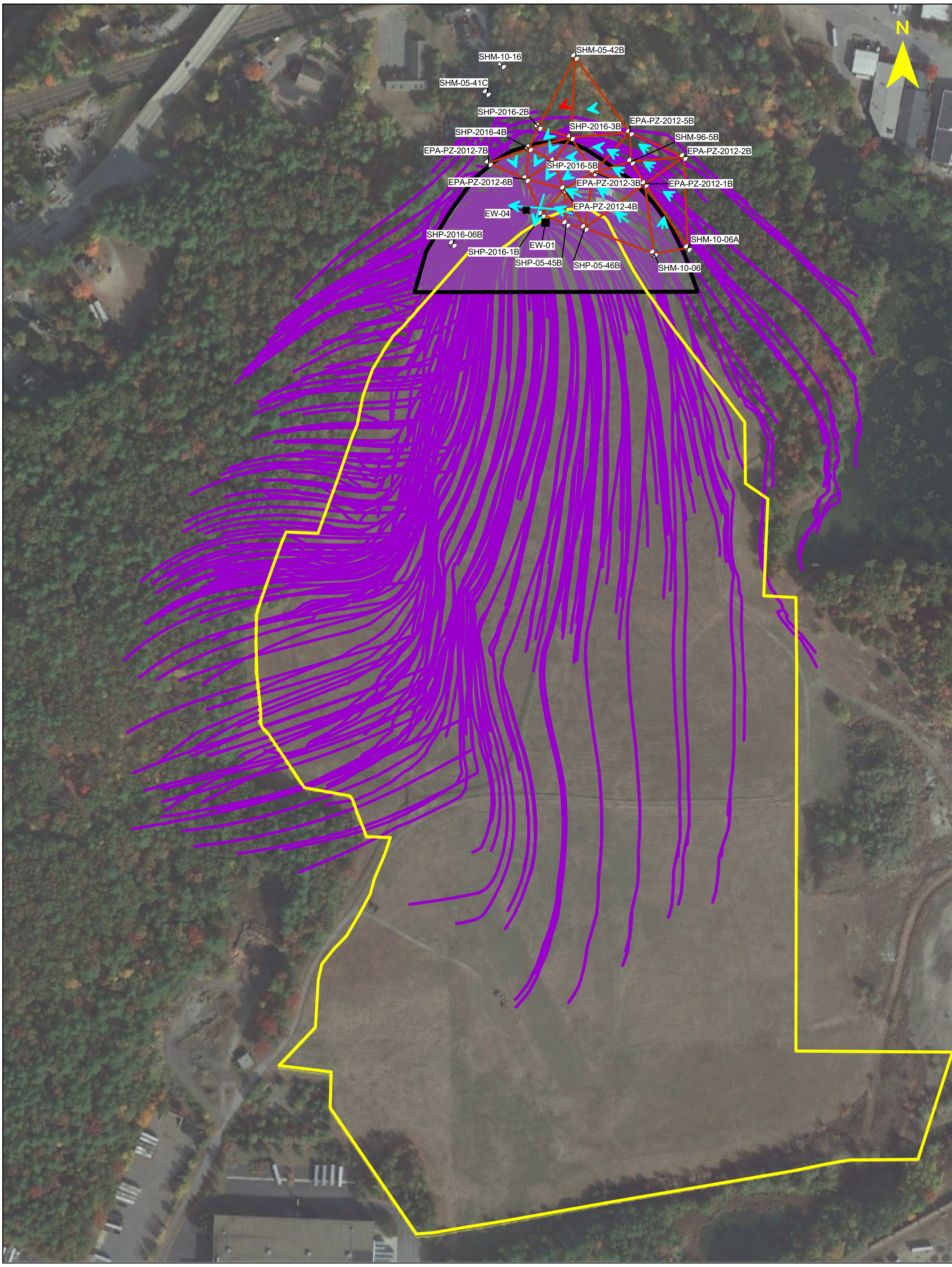
FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

May 18, 2020 (Stress Period 31)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

SERES ARCADIS a joint venture

FIGURE
2-9



Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 5,000)
- Groundwater Capture Zone from Technical Memo 1 (S-A JV, 2021)
- Reverse Groundwater Pathlines from Extraction Wells
- Shepley's Hill Landfill Boundary

Scale in feet

0 250 500

Notes:

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4. S-A JV. 2021. Draft Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. March 28.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

November 4, 2020 (Stress Period 33)
Technical Memo 1 Groundwater Capture Zone and Model-Generated Reverse Particle Tracks

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FIGURE
2-10

Attachment 3

Response to Comments

Comment No.	Reviewer	Section & Page Number	Comment	Response
1	EPA	General	As you are aware, on February 24, 2016, EPA issued a Scope of Work (SOW) for the Additional Work necessary to address deficiencies in the 2015 Devens Five-Year Review (FYR) Report and more specifically, to determine whether the selected remedy for the Shepley's Hill Landfill (SHL) is protective of human health and the environment over the long-term. The SOW was divided into three phases with task and subtasks to be completed within each phase. The Phase 1 Additional Work identified five specific tasks that Army must complete to demonstrate to EPA's satisfaction that the existing extraction and treatment system as designed, constructed, and operated provides sufficient containment/capture of the contamination migrating from SHL. Despite numerous milestone extensions and efforts to complete the 2016 SHL SOW Additional Work prior to the next (2020) Devens FYR, four of the five Phase 1 tasks (i.e. Tasks 1, 2, 4 and 5) and both Phase 2 tasks remained incomplete as of September 2020. As a result, these tasks were incorporated into EPA's September 29, 2020 Additional Work letter to resolve issues in the 2020 Devens FYR Report. Although Army has yet to submit an updated SOW with enforceable milestones for completion of the required 2020 FYR Additional Work, it recently issued the Final Phase 1 Task 1 and draft Phase 2 Task 2 Technical Memoranda. On June 14, 2021, EPA received the draft SHL SOW Phase 1 Task 4 Technical Memorandum. In accordance with the Additional Work requirements set forth in the 2016 SHL SOW Phase 1 Task 4, upon submission of an updated groundwater flow model, Army was required to collect sufficient site-specific, field-measured hydraulic head and water level data to support and validate the projections of groundwater flow predicted by the model. The first task in the model validation process required Army to calculate hydraulic gradient vectors using groundwater elevation data obtained (post-2015 ATP upgrade) from the well network presented in Figure 2 of EPA ORDs February 4, 2014, "Revised Hydraulic Gradient Analysis of Pump and Treat System Performance" and compare those to the vectors predicted by the updated groundwater flow model. Using the same methodology and technical guidance provided in EPA's 2014 "3PE: A Tool for Estimating Groundwater Flow Vectors", the next task required Army to perform an analysis of hydraulic gradient vectors using the wells/piezometers in the same EPA ORD network screened near the water table and compare those vectors with vectors predicted by the updated groundwater flow model. The third task required Army to evaluate upgradient flow lines through plume cross-section based on an assessment of upgradient flow lines captured by the extraction system using forward particle-track projections from specified monitoring locations and the release of particles from each modeled layer across the modeled overburden cross-section. The final task required that Army submit the results of these tasks (and data used to perform the tasks) in Technical Memorandum for EPA review and approval.	The EPA comment seems to indicate that no progress has been made on the Phase I and Phase II memoranda and that numerous extensions were requested without subsequent submissions. This is not the case. The Army has put forth a tremendous amount of time, effort, and funding towards completing the EPA SOW and would like to document the steps undertaken to complete the Phase I Work. As indicated in EPA's November 3, 2016 to the Army, the Army was required to complete the EPA SOW work in phases identified as Phase I, II and III. The following text is extracted from the letter. *"The required Work is separated into three distinct phases to ensure that specific "precursor" (i.e., Phase 1) tasks/subtasks are completed prior to commencement of succeeding (i.e., Phases 2 and 3) activities that rely on results of initial tasks/subtasks for successful design and implementation. Specifically, as described in the "Introduction and Purpose" portion of the SOW, the initiation of Phase 2 activities to evaluate remedy performance is predicated on EPA's determination (based on successful completion of Phase 1 tasks/subtasks) that the existing extraction and treatment system is providing sufficient containment/capture of the contamination migrating from SHL. EPA has not made that determination."* At the April 6, 2017 informal dispute meeting, it was agreed that the Army and EPA would work together to complete the groundwater model, which was to be used to complete the Phase I memoranda. In its letter to EPA on December 7, 2017, the Army requested an extension request *"due to the ongoing efforts between the Army and EPA on the Updated Groundwater Flow Model that have required additional changes to the model inputs prior to model calibration and validation. In addition, the technical memoranda associated with Tasks 1.g., 2.d., 4.e. and 5.e. are all dependent on completion of the Updated GW Flow Model and will be submitted 30-45 days from approval of the final GW model."* The model could not proceed until the calibration parameters were agreed to. *Once the calibration parameters were agreed to in 2018, the model report was submitted to EPA for review. It took over two years to achieve approval of the modeling report. The Army received written approval of the groundwater model from EPA on December 3, 2020. Thirteen days after the approval, the Army submitted outlines for the Phase I memorandum for agency review. All four of the Phase I Memoranda have been submitted; two of the four Phase I Memoranda are final.* A chronology of the groundwater modeling work and the Phase I Memoranda is presented below. Groundwater Model • 3/4/16 interim modeling report • 10/7/16 draft model report • 10/13/16 EPA letter requesting revisions • 11/9/16 meeting • 12/9/16 EPA extension letter • Mar-June 2017 – re-surveyed all SHL wells per EPA request. Included multiple EPA/ORD comments on survey results. • Dec 2016 – Apr 2018 groundwater model (GWM) revisions with Office of Research and Development (ORD) input. o Several technical meetings with ORD. Continual EPA/ORD comments during this process. Provided interim model runs/analyses as needed to support tech meetings an reach agreement on model parameters • 8/17/17 GWM input, calibration approach, & validation approach submitted to EPA o 9/12/17 teleconference. Some consensus & some additional comments. o 9/21/17 tech meeting. Some consensus & some additional comments. • 5/14/18 Interim Submittal to EPA o Comments due 6/13/18. EPA extension request to 7/30 but EPA did not provide comments until 9/13/18. o 9/26/18 tech meeting.

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				o 10/12/18 EPA notice to proceed with GWM (approval of interim submittal) • 1/11/19 submitted draft GWM to EPA o Comments due 2/10/19. EPA comments received 8/4/19. • 11/8/19 submitted draft final GWM to EPA o Comments due 11/29/19. EPA comments received 4/14/20. • 5/20/20 RTCs to EPA • June 2020 - EPA verbal approval of GWM. • 7/13/20 submitted final GWM • Aug 2020 –EPA indicated focusing on FYR before issuing final approval letter for GWM. • 12/3/20 EPA written approval of final GWM Phase I Technical Memoranda The chronology for the Phase I Technical Memoranda is listed below. Once the Phase I Memoranda are complete, the Army will proceed to the next phase. • 12/16/20– Army submits outlines for memorandum for agency review • 01/05/21- EPA indicates that they will provide written comments by 1/30/21 • 01/26/21 – EPA provides comments on Tech Memo Phase I Subtask 1.g; comments on the other memoranda were not received. • Outlines for the other memorandum were received on 3/3/21, 4/6/21 and 5/13/21 • 03/29/21 – Draft Technical Memorandum Phase 1 Subtask 1.g • 05/17/2021 – Draft Technical Memorandum Phase I Subtask 2.d • 06/11/21 – Final Technical Memorandum Phase I Subtask 1.g • 06/14/21 – Draft Technical Memorandum Phase I Subtask 4.e • 08/20/21 – Final Tech Memorandum Phase I Subtask 2.d • 09/10/21 – Draft Technical Memorandum Phase I Subtask 5.e
2	EPA	General	As discussed above, the Additional Work in SHL SOW Phase 1 Task 4, required that Army collect sufficient site-specific, field-measured ***hydraulic head and water level data*** to support and validate the 2020 model revision report. Unfortunately, the draft Technical Memorandum appears to have been based on water level data only. This is unacceptable and inconsistent with Army's prior commitment to perform the Additional Work as specified in the SHL SOW. The issue has elevated to EPA management for discussion/resolution with Army management.	Hydraulic head and water level data are synonymous when referring to an unconfined aquifer, which is the case at SHL. Additional water level data has been collected, as presented in Technical Memos 1 and 2.

Comment No.	Reviewer	Section & Page Number	Comment	Response
3	EPA	General	The field-measured data evaluated in the draft Technical Memorandum do not support and/or validate the projections of groundwater flow predicted by the July 2020, "FINAL SHEPLEY'S HILL LANDFILL GROUNDWATER FLOW MODEL REVISION REPORT, FORMER FORT DEVENS ARMY INSTALLATION DEVENS, MASSACHUSETTS" (Geosyntec Consultants, Inc., 2020).	The groundwater model and field data are generally in agreement when estimating the capture zone areas presented in this memorandum. As noted in the Technical Memo 4 text, the groundwater model inferred capture zone is slightly larger than that inferred from the 3PE analyses presented in Technical Memos 1 and 2. While the 3PE analysis provides a direct mathematical formula from which water level data can be used to calculate hydraulic gradients and groundwater flow directions within triangular areas, it is a simplistic method that does not take into account the complexities of groundwater flow under pumping conditions. The 3PE analysis treats each triangular area as an independent analysis. Accordingly, the SHL groundwater flow model is better suited to evaluate hydraulic capture of a recovery well, as it simulates all aspects of the groundwater flow regime (including vertical components of flow) and honors a water mass balance across the area. Furthermore, the size of the 3PE triangles provide a much coarser assessment of flow direction and magnitude than the SHL groundwater flow model because the model is discretized within each 3PE triangle area. 3PE also represents the gradient and direction for a single point in time, whereas the groundwater flow model results are for an average of three months. Results of a 3PE analysis could vary more significantly over a three month period. For these reasons, Army believes that the groundwater model is the preferred tool for estimating capture extent because it reasonably represents both groundwater hydraulic head and flow and a sloping water table surface in proximity to the extraction wells.
4	EPA	General	The model simulations are not recalibrated but rather just compared against observed water levels. Automated calibration is useful for this purpose (Welter and others, 2015). Also, the model was not updated per data collected in conjunction with the Phase 1 Task 1 Technical Memo.	The groundwater model was not recalibrated, but compared against observed water levels after boundary conditions (i.e. recharge and pumping) were updated. No other changes to the model were made. The intent of this scope of work was not to recalibrate the model, but rather to use the approved model as a predictive tool and demonstrate if field data support and validate the conclusions of the approved flow model.
5	EPA	General	The model significantly overestimates the influence of the extraction system on the groundwater flow field and the spatial extent of the capture zone and is not a reliable tool for estimating the dimensions of the capture zone produced by the extraction wells. Observed, site-specific field data will be a more reliable line of evidence.	Observed, site-specific data were used as a basis of comparison for the model. The 3PE analyses conducted as part of Technical Memo 1 and 2 used observed site-specific data to estimate the capture zone for the ATP extraction wells. As noted in the text of Technical Memo 4: "In general, the model-predicted capture zones extend farther to the north, east, and west than the capture zones estimated from the 3PE analysis in Technical Memos 1 and 2."
6	EPA	General	A description of how the modeled heads are extrapolated from model is important. The model solves for head at the center of the grid for a standard finite-difference model (Harbaugh, 2005) To get a more precise model head value at the well location, a post processing interpolation scheme is needed to extract the model-computed head for the well location (in the z direction also). A rough approximation to calculate the head in the pumping well .vs. the head at the cell node can be provided by the Thiem equation. A description of the post processing is needed.	The heads computed using MODFLOW were imported into Groundwater Vistas where the monitoring wells were defined as targets (locations specified in x, y, and z directions where z is the mid-point of the screen elevation). Groundwater Vistas then applies an interpolation scheme to assign a modeled head value to each monitoring well. Groundwater Vistas uses bilinear interpolation in space and linear interpolation in time. A description of how the modeled heads were extrapolated from the model has been added to Section 2.2.

Comment No.	Reviewer	Section & Page Number	Comment	Response
7	EPA	General	The boundary conditions from the Ponds (stage levels) were not adjusted to approximate 2016-2020 conditions. This is problematic because the Ponds exert a major control on flow along the east side of the arsenic plume. Pond stage should be adjusted per stress period.	As stated on page 2 of the Technical Memo, "Surface water boundary conditions and pumping from municipal supply wells was kept at the steady-state values used in the 18th stress period in the 2020 SHL Model (beginning of 2017 through the end of 2025; Geosyntec 2020)." The 18th stress period in the 2020 SHL Model was intended to represent the five year average stages (average of 2012 through 2016 stages).
8	EPA	Page 1, § 1.1 - Goals of Technical Memorandum	The first sentence states, "the primary objective of this Technical Memo 4 is to validate the updated groundwater flow model with sufficient field-measured hydraulic data to confirm the conclusion presented in the SHL Groundwater Flow Model Revision Report (Geosyntec Consultants, Inc. [Geosyntec] 2020) that the zone of capture for the Arsenic Treatment Plant (ATP) extraction wells extends beyond the full width of the landfill." Please note that while the first sentence in Section 12 - Conclusions of the July 2020 "FINAL SHEPLEY'S HILL LANDFILL GROUNDWATER FLOW MODEL REVISION REPORT, FORMER FORT DEVENS ARMY INSTALLATION DEVENS, MASSACHUSETTS" does state that "the results of flow path analysis using the calibrated model indicate that at the current pumping rates, the zone of capture extends beyond the full width of the landfill," the next sentence reveals that "The model analysis using 3PE gradient analysis indicated a westerly bias in the model-calculated flow directions east of the ATP compared to the distribution of observed flow directions, suggesting that the model may overestimate groundwater capture by the ATP in this area." In addition, while Army-defined "primary objective" of the Technical Memo may be to confirm that the zone of capture for the ATP extraction wells extends beyond the full width of the landfill," this is inconsistent with the stated objective of the Phase 1 Task 4 Additional Work requirements outlined on page 5 of the February 2016 SHL Phase 1 Task 4 Additional Work which required that Army, upon submittal of an updated groundwater flow model, collect (and submit) sufficient field measured hydraulic head data and water level measurements to support and validate the projections of groundwater flow predicted by the updated model. (See Comment 1.)	As stated in the responses to Comments 1 and 2, sufficient field measured hydraulic head data was collected after the SHL groundwater model was complete. This data was presented in Technical Memo 1. 3PE analyses were performed using this data (as presented in Technical Memo 1) and were compared to the model output, as specified in the SOW.

Comment No.	Reviewer	Section & Page Number	Comment	Response
9	EPA	Page 3, § 2.2	The text states that "A comparison of the model-simulated potentiometric heads to field-measured potentiometric water levels (model residuals) for the 10 semiannual periods spanning August 16, 2016 to November 4, 2020 are presented in Table 5." The spatial patterns of the model residuals listed in Table 5 of the memorandum were plotted for various time periods and examined for evidence of bias in the model with respect to the simulation of capture. Figure 1 below depicts a contour map of the residuals (i.e., field measured groundwater elevation minus model predicted groundwater elevation) for the average of the residuals calculated for all of the monitoring events included in Table 5, except for the field measurements performed on October 22, 2019. As discussed in comments provided by the EPA regarding the draft Phase 1 Task 1 Subtask 1.g Technical Memorandum (S-A JV, 2021), this dataset included several poor quality measurements as evidenced by the inconsistent groundwater flow vectors calculated using these data and further evidenced by the excessively large residuals presented in Table 5 of this draft memorandum. For purposes of this review, the dataset obtained by EPA/ORD on October 24, 2019, was used instead of the October 22, 2019, data. In a well calibrated model, it is expected that a plot of the model residuals would appear relatively random and not display distinct spatial patterns indicative of bias in the model. However, in Figure 1 below, it is clear that the model significantly underestimates groundwater elevations with increasing proximity to the extraction wells. This bias results in the over prediction of the influence of the extraction wells on groundwater flow and plume capture. The overestimation of the influence of the capture system is even more pronounced in the plot of the average spring model residuals from Table 5 (Figure 2 of this review) and in the plot of the model residuals from the monitoring event conducted on March 2, 2017 (Figure 3 of this review). The majority of the datasets provided in the memorandum indicate over estimation of the capture zone by the model to varying degrees. It is noted that Section 3.2 of the memorandum also concludes that the model-predicted capture zones generally extend farther north, east, and west than the capture zones estimated using the observed hydraulic data. In order to illustrate the effects of the 2020 model bias on groundwater flow, field-measured groundwater elevations from March 2, 2017, and model predicted elevations for stress period 18 were used to produce a plot (Figure 4 of this review) of the observed versus modeled hydraulic gradient vectors calculated using the 3PE spreadsheet (Beljin and others, 2014). As depicted in this figure, the flow vectors predicted using the model projections (green arrows) show a much stronger influence and broader capture zone than indicated by the observed data (blue arrows). In summary, this analysis indicates that the model significantly overestimates the capture zone associated with the extraction wells, particularly during the spring season, and should not be relied upon to assess the extent of capture. It appears that field measurements will provide a more reliable assessment of plume capture.	The groundwater model and field data are generally in agreement for the capture zones presented in this memorandum. As noted in the Technical Memo 4 text and noted in the comment, the groundwater model inferred capture zone is slightly larger than that inferred from the 3PE analyses presented in Technical Memos 1 and 2. While the 3PE analysis provides a direct mathematical formula from which water level data can be used to calculate hydraulic gradients and groundwater flow directions within triangular areas, it is a simplistic method that does not take into account the complexities of groundwater flow under pumping conditions. Accordingly, the SHL groundwater flow model is better suited to evaluate hydraulic capture of a recovery well since the 3PE analysis treats each triangular area as an independent analysis, whereas the groundwater model simulates all aspects of the groundwater flow regime (including vertical components of flow) and honors a water mass balance across the area. Furthermore, the size of the 3PE triangles provide a much coarser assessment of flow direction and magnitude than the SHL groundwater flow model because the model is much more discretized within each 3PE triangle area. 3PE also represents the gradient and direction for a single time whereas the groundwater flow model results are for an average of three months. A 3PE analysis could vary more significantly over a three month period. For these reasons, Army believes that the groundwater model is the preferred tool for estimating capture extent because it reasonably represents groundwater levels and flow.
10	EPA	Page 3, § 2.2	The memorandum states that the model closely simulates field-measured groundwater elevations, with 81% of the model-simulated potentiometric water levels within one foot of the field-measured potentiometric water levels. This is not a meaningful statistic with respect to the modeling objective of estimating the extent of the hydraulic capture zone. One-foot differences in hydraulic head can result in large differences in hydraulic gradients and in the estimated dimensions of the capture zone.	As stated in the response to Comment 4, the intent of this scope of work was not to recalibrate the model, but to use it to compare field and model generated results. The 1 foot comparison noted in the text does not compare the resultant hydraulic gradients. This comparison is made elsewhere. Model residuals presented as part of this exercise are comparable with those presented in the SHL Groundwater Flow Model Revision Report (Geosyntec 2020); overburden residuals ranged from -3.62 ft to 3.62 ft in the 2020 SHL Model and ranged from -1.96 ft to 2.15 ft in this exercise.

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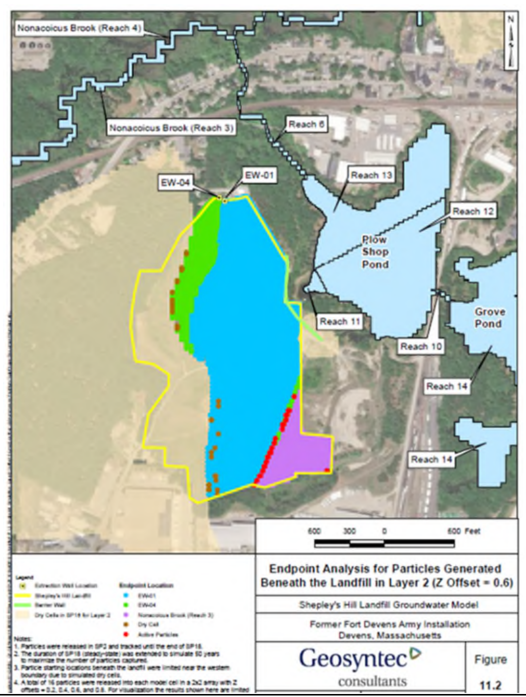
11	EPA	Page 4, § 3.1	This section discusses the use of groundwater elevations from piezometer SHP-2016-06B in the creation of the potentiometric surfaces in this memorandum. This well is screened in a different hydrostratigraphic unit (i.e., bedrock) from the other wells/piezometers, which are screened in the alluvial aquifer, and should not be used in these analyses. This is evidenced by the huge model residuals for this piezometer presented in Table 5 of the memorandum.	The memo has been revised to only include water levels and residuals for wells that are screened in the overburden.
12	EPA	Page 4, § 3.2	The discussion states that "reverse particle tracking was used to evaluate the model-predicted capture of the ATP extraction wells EW-01 and EW-04." This is not a SOW-specified task and must be revised to reflect the Additional Work specified in Phase 1 Task 4 .d (*which requires that Army evaluate upgradient flow lines captured by the extraction system using forward particle-track projections*). Forward tracking is required with sufficient density to allow for particles to fully identify flow and assess whether the ATP extraction wells are strong sinks. Further, model particle tracking is not rigorous enough to evaluate capture of the ATP and statements made in the memo are not supported by forward tracking methods. Please refer to Figure 11.2 in the 2020 model revision report (shown below) which demonstrates a forward tracking endpoint analysis from the entire footprint of the landfill and clearly shows incomplete capture of the entire landfill. The area shaded purple is not captured by the ATP. A similar analysis should be included in the Task 4 Technical Memorandum.  	Forward particle tracking from locations upgradient of the extraction wells are included in the revised Technical Memorandum. The forward particle tracks were initialized starting in 2017 with release points in the middle of model layers 1, 2, 3, and 4. A figure with the forward particle tracking results has been added (Figure 22).

Comment No.	Reviewer	Section & Page Number	Comment	Response
13	EPA	Page 6, § 4.0	For reasons stated above, the draft Task 4 Technical Memorandum does not comply with the requirements set forth in the 2016 SHL SOW Phase 1 Task 4. As currently constituted, Army's submittal does not provide information that can be used to demonstrate plume capture or validate the 2020 model revision report. Validation implies residuals are comparable in performance both spatially and temporarily with no particular bias. There is insufficient information to evaluate validation in this respect.	As stated in the responses to Comments 4 and 10, the intent of this scope of work was not to recalibrate the model, but to use it to compare field and model generated results.
14	EPA	Figures 2 through 11	The memorandum subjectively compares flow vectors calculated using field-measured data and the 3PE spreadsheet with vectors inferred from the potentiometric surfaces obtained from the flow model using a series of maps. Based on the vector scaling that was used, this visual comparison is not useful for the objective of evaluating the potential differences in the dimensions of the hydraulic capture zones indicated by these two types of data. A more valid approach would be to present a table comparing the flow vector azimuth calculated using 3PE with predicted groundwater elevation data from the model and with field-measured groundwater elevations. Further, it is also recommended that any comparison of flow vectors calculate all vectors using the same scaling factor as in Figure 4 of this review.	Hydraulic gradient vectors are not directly compared between the model results and the 3PE results because they are on a different scale. For example, within the triangle located closest to the extraction wells (bounded by wells SHP-2016-1B, SHP-05-45B, and EPA-PZ-202-4B), there are approximately 30 model cells, thus providing much higher resolution than the 3PE triangles and allowing for higher resolution results. The Army feels that the changes made to pumping rate, recharge and river stage for plow shop pond present a flow field and capture zone comparable to the 3PE analysis
15	EPA	Figures 2 through 11 and 12 through 21	The enlargements shown next to the ATP wells are only useful if they are included on a larger-scale version of the landfill footprint area. Also, the focus on a small areal extent of the toe of the landfill is too small to analyze particle tracking results. EPA requests that a revised set of figures be included in the next version of the Technical Memorandum that show the entire, full footprint of the landfill.	This set of figures is now provided in an appendix. However, only the model-generated pathlines are shown, as the 3PE inferred capture zones only encompass the toe of the landfill (the area in which the 3PE analyses were performed).
16	D. Chaffin / DEP	Section 1.1	The statement indicating that the primary objective of the memorandum is to "validate" the updated groundwater model and "confirm" the conclusion presented in the groundwater model report regarding the extent of capture zones during 2016-2020 is confusing and misleading because it appears to entail the assumption that the model is valid and the assumption that the conclusion in the groundwater model report will be confirmed. Text should be clarified to indicate the memo presents the results of a comparison of model data to field data undertaken to determine if the model is accurate enough to be used for capture zone analysis.	The text has been revised to indicate the memo presents the results of a comparison of model data to field data, undertaken to determine if the model is accurate enough to be used for capture zone analysis.

Comment No.	Reviewer	Section & Page Number	Comment	Response
17	D. Chaffin / DEP	Section 2.2	The statement: "In general, the model closely simulates field-measured groundwater elevations, with 81% of the model-simulated potentiometric water levels within one foot of the field-measured potentiometric water levels" is misleading. While in the case of a regional groundwater flow model the cited statistics might indicate a good match between measured and simulated water levels, the purpose of this memo is to compare the extent of model-predicted capture zones to the actual extent of the capture zones determined using field data, and the cited statistics do not provide a meaningful measure of this comparison.	The comparisons between the model-simulated potentiometric water levels and the field measured potentiometric water levels are comparable to those presented in the EPA-approved SHL Groundwater Model Report (2020).
18	D. Chaffin / DEP	Section 3.1	Section 3.1: The conclusion that flow vectors based on 3PE analyses and model predictions are generally similar, with exceptions when modeled vectors exhibit more influence from the extraction wells, is misleading because in the context of this memo, which concerns capture zones, it suggests that the model-generated capture zones are accurate simulations of the actual capture zones indicated by field-data-based 3PE flow vectors. The comparisons presented in the memo show the actual capture zones indicated by 3PE vectors are significantly smaller than the model-predicted capture zones: a. As acknowledged in Section 3.2: "In general, the model-predicted capture zones extend farther to the north, east, and west than the capture zones estimated by 3PE analysis…" b. Conflicts between model-predicted flow vectors and 3PE flow vectors derived from field data (Figures 2 through 11) consistently indicate the actual capture zones that existed during 2016-2020 are smaller than the model-predicted capture zones. c. Conflicts between model-predicted particle tracks and 3PE flow vectors derived from field data (Figures 12 through 21) consistently indicate the actual capture zones that existed during 2016-2020 are smaller than the model-predicted capture zones. These results indicate that the model should not be used for capture zone analysis without correction to improve accuracy.	As noted in previous comments, the 3PE inferred capture zones rely on the size of the 3PE triangles, which provide a much coarser assessment of flow direction and magnitude than the SHL groundwater flow model, because the model is much more discretized within each 3PE triangle area. For example, within the triangle located closest to the extraction wells (bounded by wells SHP-2016-1B, SHP-05-45B, and EPA-PZ-2012-4B), there are approximately 30 model cells, thus providing much higher resolution than the 3PE triangles and allowing for higher resolution results (see Figure 1-1 of this Attachment). The Army believes that the groundwater model is the preferred tool for estimating capture extent because it reasonably represents groundwater levels and flow and is less sensitive to individual observed water levels at monitoring wells than the 3PE analysis. For example, at the triangle bounded by EPA-PZ-2012-4B, EPA-PZ-2012-3B, and SHP-05-46B the direction of the 3PE arrow (which is from the analysis done in Technical Memo 1) is being driven by the water level at EPA-PZ-2012-4B, which is 0.28 ft lower than the water level at EPA-PZ-2012-3B and 0.61 ft lower than the water level at SHP-05-46B. The groundwater model uses water levels in every cell to generate groundwater vector directions, so it is less sensitive to water levels at individual monitoring wells.
19	D. Chaffin / DEP	Section 3.2	The conclusion that the modeled capture zones and capture zones inferred from 3PE analyses "fully encompass the SHL Landfill boundary" is confusing and misleading because the purpose of the memo is to compare the modeled capture zones to the capture zones determined using field data, rather than comparing the modeled capture zones to the landfill boundary. Further, the conclusion that the model predicts capture zones that fully encompass the SHL Landfill boundary indicates that the model requires correction; as acknowledged in Tech Memo 2 and explained in MassDEP Comments on Tech Memos 1 and 2 and MassDEP comments on the groundwater model, a significant portion of the arsenic-contaminated groundwater exiting the landfill in the vicinity of well SHM-10-06 by-passes the extraction wells, showing that actual capture zones at the site during 2016-2020 did not fully encompass the SHL boundary. This critical conflict between the model results and field data indicates that the model should not be used for capture zone analysis without correction.	The key design criterion for the ATP extraction wells, as specified in the 100% Design (CH2MHill 2005) were to "provide containment of the groundwater plume in the vicinity of the base boundary," seek to reduce the design rate of 50 gpm as appropriate, and to focus groundwater extraction in the deeper part of the glacial aquifer". It should be noted the modeling results presented in the final design of the ATP extraction system did not include full capture east of the landfill boundary (between wells SHM-10-06 and SHM-21; Figures A-8 and A-9 of CH2MHill 2005).

Comment No.	Reviewer	Section & Page Number	Comment	Response
20	D. Chaffin / DEP	Section 4	MassDEP disagrees with conclusions presented here. The comparison of model results to field data did not "validate" the model or "confirm" the conclusions presented in the groundwater model report (refer to preceding comments). Also, the model-generated water levels did not "closely match" the actual water levels for the purposes of capture zone analysis (refer to Comment 2); as acknowledged in the final sentence of this section, the model-predicted capture zones extend well beyond the limits indicated by field data. Information presented in the memo suggests several potential sources of error that might contribute to the mismatch between modeled and field data-based capture zones: a. Modeled contours shown in Figures 2 through 11 suggest that water levels measured in the extraction wells were used in the model to represent water levels at the locations of the wells. These water levels overestimate the actual drawdown in the nearby aquifer (e.g., measured at SHP-2016-1B), likely resulting in predicted capture zones that are larger than actual capture zones. b. The large errors (< 9.77 feet, Table 5) in the modeled water levels at well SHP-2016-06B indicate the model does not provide an accurate simulation of groundwater flow within bedrock and between bedrock and overburden in the vicinity of the extraction wells. c. Extraction rates determined when pumps were operating were used to simulate withdrawals from the extraction wells. Actual extraction rates are smaller due to downtime, potentially contributing to overestimates of capture zone extent.	a. Water levels measured in the extraction wells were not used in the model. b. As specified in Comment #11, water levels in bedrock wells will not be used as part of the analysis. c. Extraction well rates were determined using both uptime and downtime rates, which represent the overall extraction rate for each stress period. As discussed in previous comments, intent of the model is to determine flow direction and hydraulic gradients and compare that to the measured values.
21	D. Chaffin / DEP	Table 1	Please confirm/correct the data listed for well SHM-05-42B on October 22, 2019 (the water level is anomalously low).	As discussed in the Technical Memo 1 responses to comments, to maintain consistency with the other water levels collected, groundwater elevations used in the 3PE analysis at SHM-05-42B were from October 22, 2019.
22	D. Chaffin / DEP	Table 5	Model-field data differences listed for May 22, 2018 match differences listed for November 1, 2018 exactly, an unlikely occurrence; please confirm/correct listings as appropriate.	The model-field data differences were corrected in Table 5.
23	D. Chaffin / DEP	Figures 16 and 17	Modeled particle tracks for May 22, 2018 are identical to those shown for November 1, 2018, an unlikely occurrence; please confirm/correct the figures as appropriate.	The modeled particle tracks were corrected in the figures.

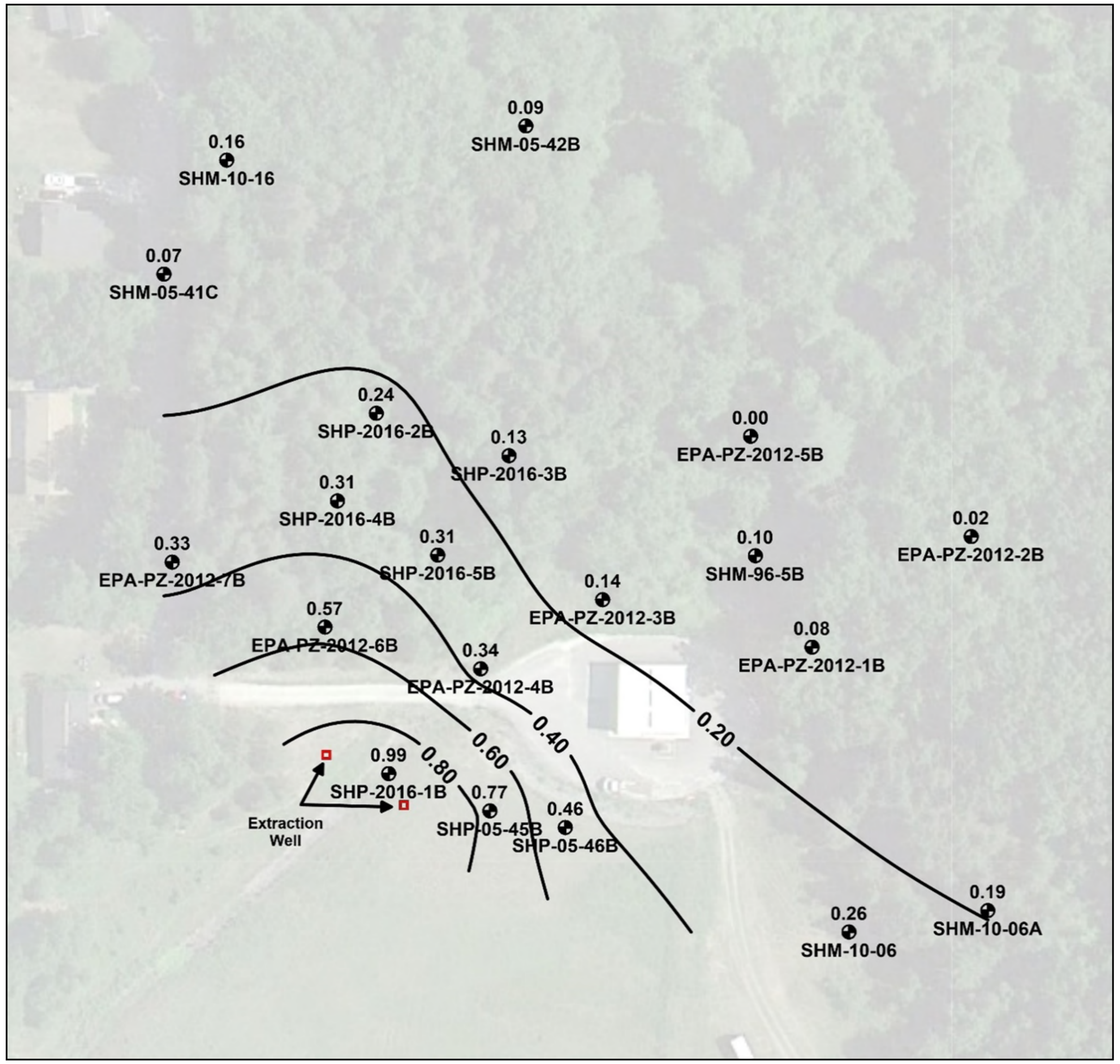


Figure 1. Contour map of the mean of the field measured minus model predicted groundwater elevations (model residuals) for the monitoring events on August 16, 2016; October 20, 2016; March 2, 2017; November 2, 2017; May 22, 2018; November 1, 2018; May 13, 2019; October 24, 2019; May 18, 2020; and November 4, 2020. The contour interval is 0.2 ft.

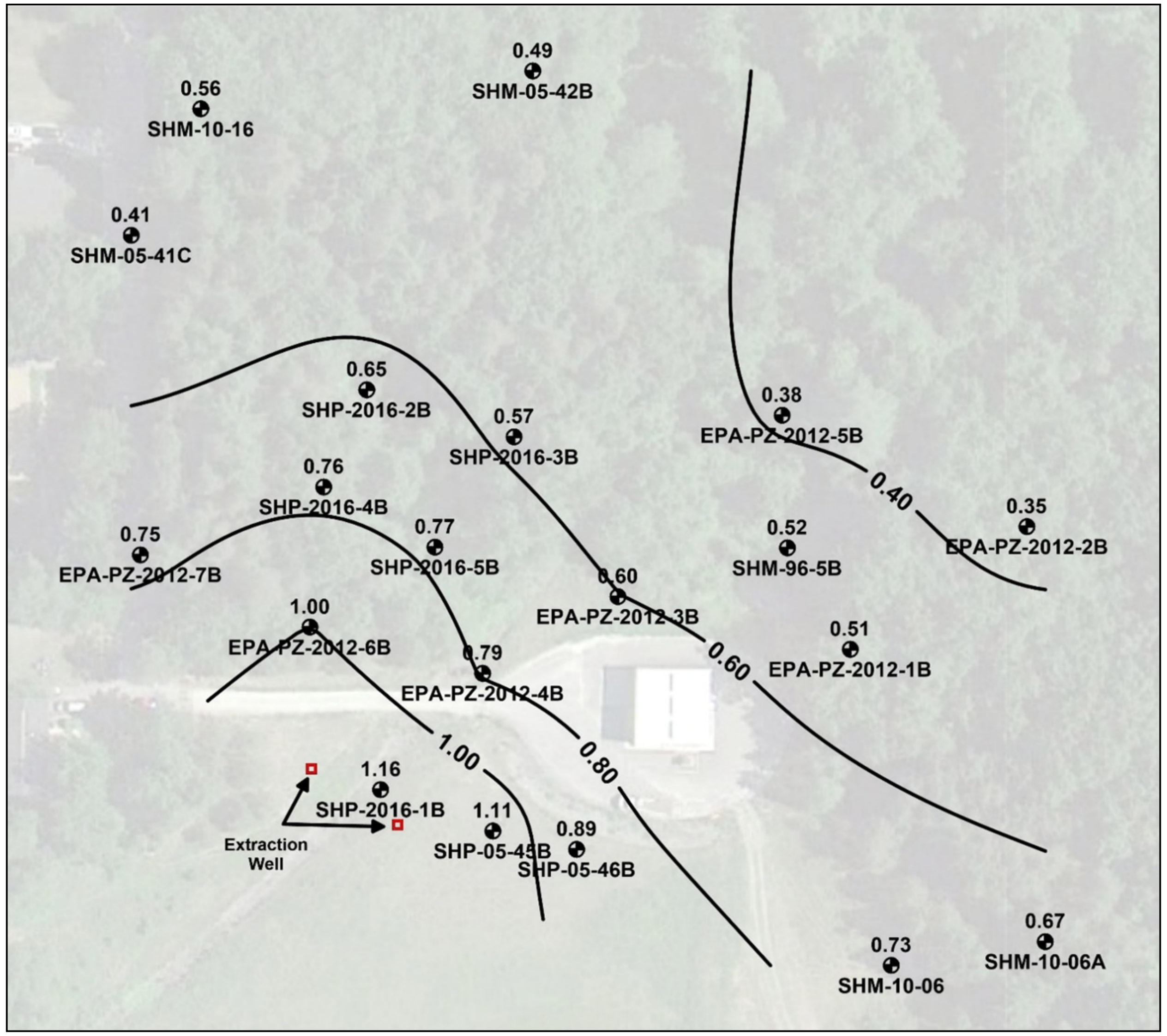


Figure 2. Contour map of the mean of the field measured minus model predicted groundwater elevations (model residuals) for the spring monitoring events on March 2, 2017; May 22, 2018; May 13, 2019; and May 18, 2020. The contour interval is 0.2 ft.

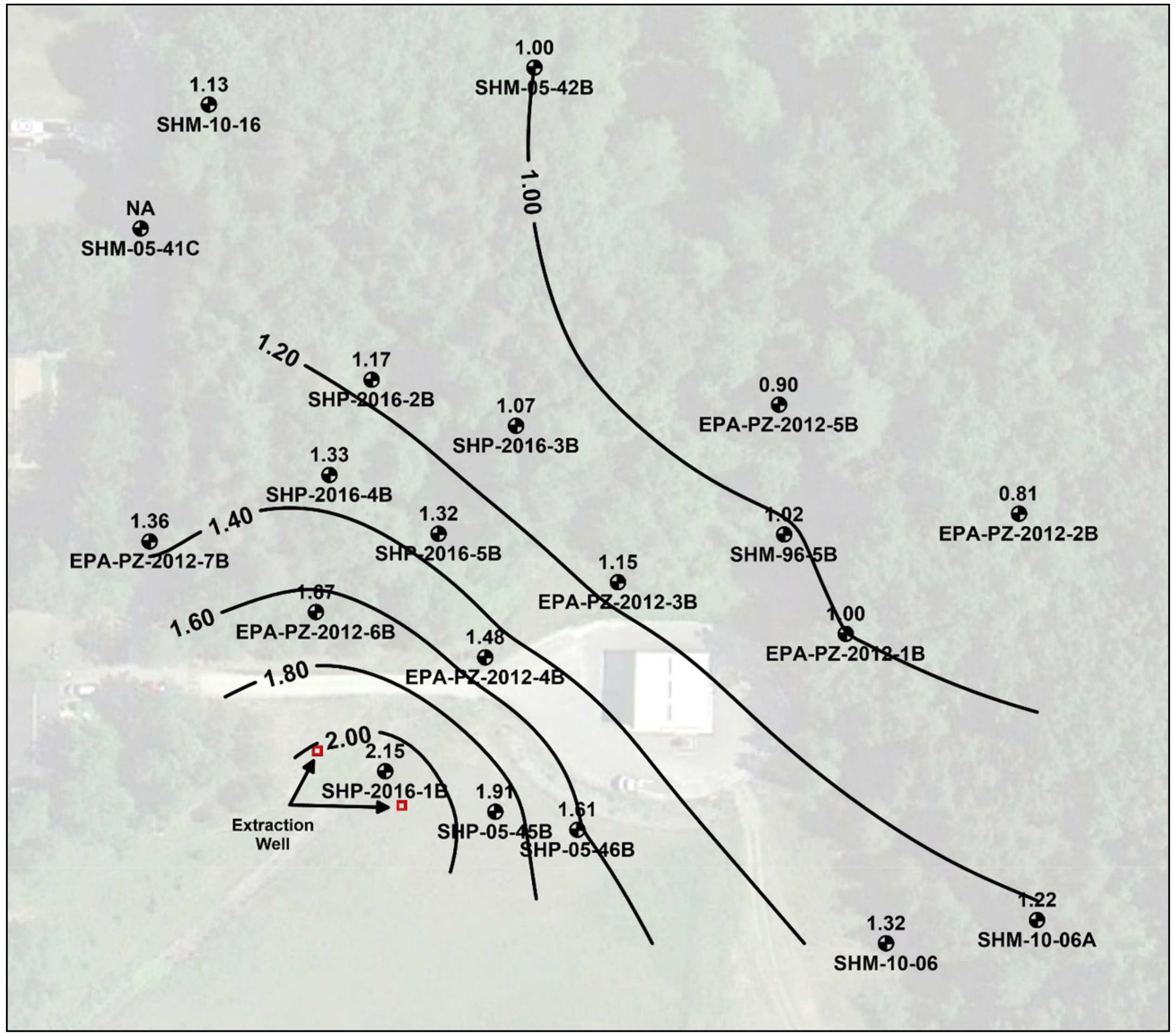


Figure 3. Contour map of the field measured minus model predicted groundwater elevations (model residuals) for the monitoring event performed on March 2, 2017. The contour interval is 0.2 ft.

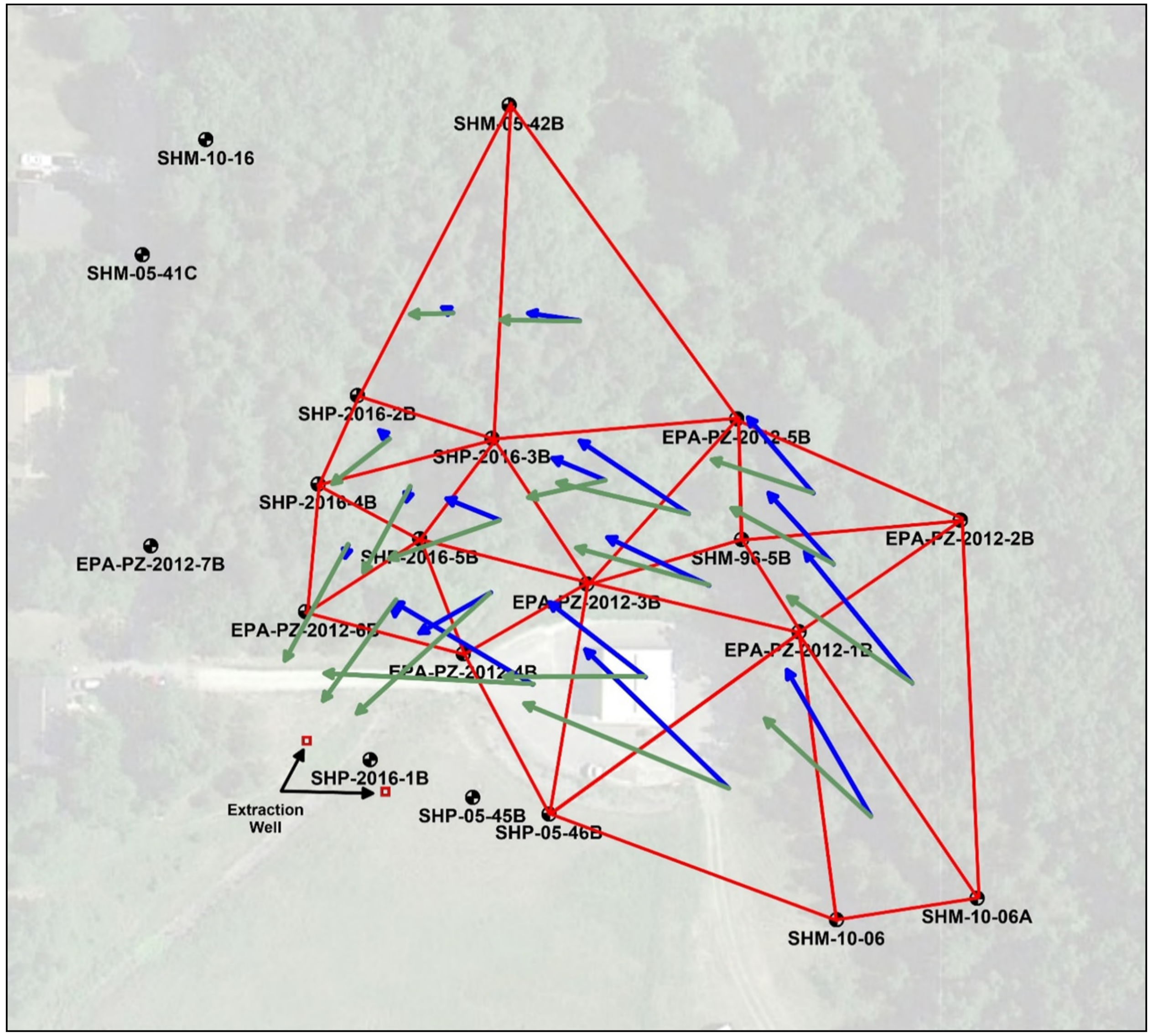
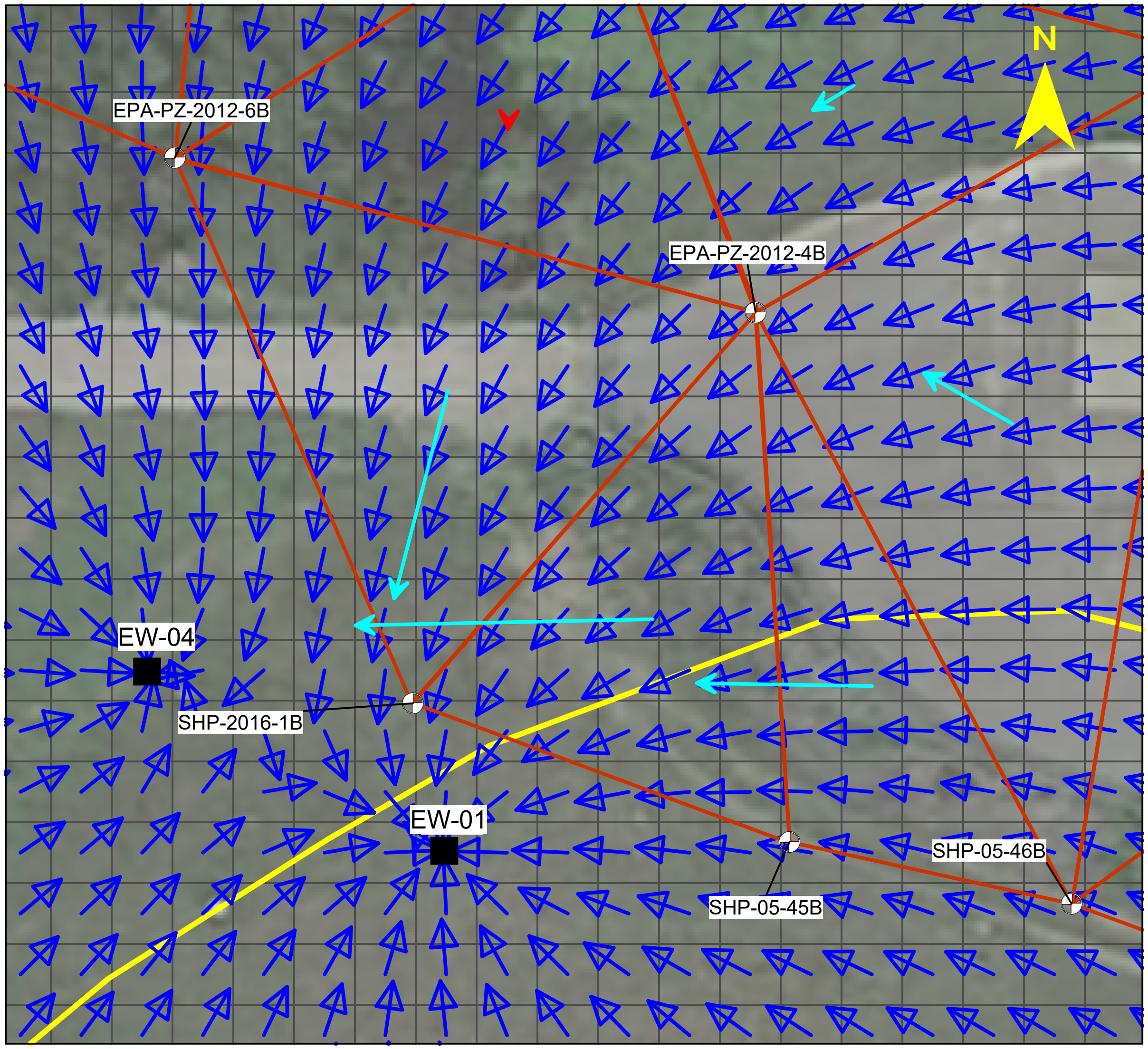


Figure 4. Comparison of groundwater flow vectors calculated by the 3PE spreadsheet (Beljin and others, 2014) using field-measured groundwater elevations (blue arrows) and model predicted groundwater elevations for stress period 18 (green arrows). The length of each arrow is scaled using the calculated magnitude of the hydraulic gradient and a scaling factor. The same scaling factor was used for all arrows. This allows for a direct visual comparison of the hydraulic gradient magnitudes.



Scale in feet
0 30 60

Legend

- Extraction Wells
- Monitoring Wells
- Triangle for Vector Analysis
- Hydraulic Gradient Arrow from Technical Memo 1 (S-A JV, 2021) (Scale Factor = 2,500)
- Hydraulic Gradient Arrow from Groundwater Model (One gradient per model cell; all gradients are downward in this figure)
- Shepley's Hill Landfill Boundary
- Groundwater Model Cell

Notes:

1. NM = not measured
2. Red arrows indicate gradients less than 0.001 foot per foot.
3. S-A JV = SERES-Arcadis 8(a) Joint Venture 2, LLC
4. S-A JV. 2021. Final Phase I EPA SOW Demonstrate Plume Capture Technical Memorandum Phase I Subtask 1.g Delineate Capture Zone based on Hydraulic and Geochemical Data. Shepley's Hill Landfill, Former Fort Devens Army Installation, Devens, Massachusetts. Prepared for U.S. Army Corps of Engineers New England District. June 11.

FORMER FORT DEVENS ARMY INSTALLATION
DEVENS, MASSACHUSETTS
2021 TECHNICAL MEMO
SHEPLEY'S HILL LANDFILL

Subset of March 2, 2017 (Stress Period 18) 3PE and Model-Generated Hydraulic Vectors and Groundwater Elevation Contours

SERES ARCADIS a joint venture

FIGURE 1-1