2019 Evaluation Report
S-Area Remedial Program

S-Area Landfill Site
Niagara Falls, New York

Glenn Springs Holdings, Inc.

GHD | 455 Phillip Street Waterloo Ontario N2L 3X2 Canada | 009957 | Report No 61| March 31, 2020 Revised June 30, 2020

Executive Summary

Glenn Springs Holdings, Inc. (GSH), in accordance with the "Stipulation on Requisite Remedial Technology (RRT) Program", dated September 1990 (RRT Stipulation), operates, maintains, and monitors the S-Area Landfill Site (Site) in Niagara Falls, New York. GSH has been assigned management responsibility for the S-Area Remedial Program by Occidental Chemical Corporation (OxyChem). Since October 1, 2008, GHD Services, Inc. (GHD), formerly Conestoga-Rovers & Associates (CRA) has performed operation, monitoring, and maintenance activities at the Site, under contract to and direct management of GSH, in addition to the reporting activities previously conducted. The purpose of this report is to summarize and evaluate the monthly, quarterly, semiannual, and annual monitoring data collected in 2019 and present appropriate conclusions as wells as to make recommendations for 2020.

Performance

The S-Area Drain Collection System (SDCS) and the on-Site purge/recovery wells were effective in containing Aqueous Phase Liquid (APL) and Non-Aqueous Phase Liquid (NAPL) within the Site Barrier Wall (SBW) during 2019. These systems were also effective in removing NAPL within the SBW and minimizing the migration of chemicals toward the new City of Niagara Falls Drinking Water Treatment Plant (DWTP). The V-Area Drain Collection System (VDCS) was effective in providing hydraulic containment of APL, which prevented migration of S-Area chemicals to the Niagara River. The off-Site purge/recovery wells were effective in containing APL and NAPL within the existing S-Area overburden NAPL plume and collecting NAPL inside the SBW.

The shallow bedrock APL purge wells created sufficient drawdown during 2019 to intercept any groundwater coming from the southeast and passing under the S-Area Landfill and through the shallow bedrock NAPL plume. The shallow bedrock NAPL recovery wells located along the southern edge of the shallow bedrock NAPL plume boundary were effective in removing NAPL from this area of the Site. The NAPL recovery wells located at the V-Area were effective in intercepting NAPL, thus preventing NAPL from continuing to migrate toward the east. The total organic concentrations in the Shallow Bedrock Chemical Monitoring Program (SBCP) wells included in the May and October/November 2019 sampling events continued to fluctuate compared to the concentrations reported in past events.

Total organic concentrations in middle ring well OW626 and outer ring wells OW411D and OW805 had increased by an order of magnitude in 2015 compared to 2014 concentrations; however, this was not attributable to migration from the S-Area shallow bedrock plume. Rather, this was attributable to impacted Niagara Plant groundwater being drawn toward the S-Area shallow bedrock purge well system due to the limited pumping of the Niagara Plant D-Zone bedrock groundwater extraction system in 2015. Full-scale pumping in the Niagara Plant D-Zone bedrock groundwater extraction system resumed on January 25, 2016. Since then, concentrations at these three wells have been decreasing. These wells will continue to be monitored in 2020.

The intermediate/deep bedrock purge wells were effective in intercepting groundwater passing through the intermediate/deep bedrock NAPL plumes, thus preventing the groundwater from migrating away from the Site as APL. The total organic concentrations in the Intermediate/Deep

Bedrock Chemical Monitoring Program (IDCP) wells included in the May and November 2019 sampling events continued to fluctuate compared to the concentrations reported in past events.

2020 Implementation Plan

The following actions will be implemented in 2020 for the S-Area Remedial Program:

1. No changes or adjustments to overburden pumping systems, intermediate/deep bedrock pumping systems, overburden monitoring programs, or intermediate/deep bedrock monitoring programs.
2. For shallow bedrock pumping systems the following actions will be implemented:
   i. Hydraulic testing will be performed at seven NAPL production wells along the southern border of the Site in the April 2020.
   ii. OW806 will be converted to a NAPL pumping well by the end of 2020.
   iii. A statistical analysis of shallow bedrock groundwater indicator chemical concentrations will be submitted concurrently with this report.

Recommendations

There are no recommendations at this time.

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1. Introduction

Glenn Springs Holdings, Inc. (GSH), in accordance with the "Stipulation on Requisite Remedial Technology (RRT) Program", dated September 1990 (RRT Stipulation), operates, maintains, and monitors the S-Area Landfill Site (Site) in Niagara Falls, New York. GSH has been assigned management responsibility for the S-Area Remedial Program by Occidental Chemical Corporation (OxyChem). Since October 1, 2008, GHD Services, Inc. (GHD), formerly Conestoga-Rovers & Associates (CRA) has performed operation, monitoring, and maintenance activities at the Site, under contract to and direct management of GSH, in addition to the reporting activities previously conducted.

The components of the S-Area Remedial System, shown on Figure 1.1, include the following:

i. A capped 7-acre landfill with a perimeter drain collection system (DCS).

ii. The neighboring former City of Niagara Falls Drinking Water Treatment Plant (DWTP) with a DCS along the southern property boundary (hereinafter, former DWTP referred to as V-Area).

iii. An overburden Site Barrier Wall (SBW).

iv. Overburden, shallow bedrock, and intermediate/deep bedrock groundwater Aqueous Phase Liquid (APL) purge wells.

v. Overburden and shallow bedrock Non-Aqueous Phase Liquid (NAPL) extraction wells.

vi. A treatment facility including APL/NAPL separation, NAPL storage and trailer loading, APL storage, and APL treatment by filtration and granular activated carbon. The treated APL is discharged to the Niagara River, via outfall 003R, in accordance with the OxyChem Niagara Plant State Pollutant Discharge Elimination System (SPDES) permit no. NY 0003336. NAPL is shipped off Site for incineration.

In 2001, GSH initiated Phase III of the S-Area Bedrock RRT Program, as outlined in the document entitled "Final Design Report, Phase III Bedrock RRT System", dated August 31, 2001 (Phase III Design Report). Although this document only addressed the design and monitoring of the bedrock components of the remedy, a proposed schedule for quarterly monitoring and annual evaluation reports was included that has been used by GSH for reporting of quarterly data for overburden and bedrock programs, as well as treatment plant operations.

The quarterly monitoring reports consist solely of data acquired from weekly and monthly data collection, and quarterly, semiannual, and annual monitoring events, with no data interpretation or specific data evaluation.

In addition to the quarterly data reports, annual evaluation reports are prepared to summarize the quarterly, semiannual, and annual monitoring data, evaluate the data, and present appropriate conclusions and recommendations. The annual evaluation reports include descriptions of the activities undertaken, a summary of any problems encountered, and any operational or system modifications implemented during the past year.

This report evaluates the data collected during 2019, as compiled in the "Quarterly Monitoring Report – Fourth Quarter 2019", dated January 31, 2020 (2019 Fourth Quarter Report). The pertinent data tables from the 2019 Fourth Quarter Report are repeated in this annual report to assist in the evaluation.

2. Overburden Remedial Systems

The RRT Stipulation divides the Overburden Remedial Systems into the following three distinct areas:

1. The Site Containment System, which addresses the area beneath and immediately around S-Area Landfill Site
2. The Overburden RRT System, which addresses any areas outside the Site Containment System (primarily south of S-Area)
3. The City DWTP Remedial Program, which addresses the adjacent property to the east of S-Area (V-Area) (DWTP Remedial Program)

The remedial objectives of the Site Containment System are as follows:

- To contain APL and NAPL
- To maximize the collection of NAPL within the SBW at the S-Area Landfill
- To minimize potential migration of chemicals toward the DWTP (RRT Stipulation, page I-3)

The Site Containment System consists of the SBW, the S-Area Drain Collection System (SDCS), seven overburden purge wells (OPWs) installed in areas of thinning clay/till beneath the Site, and the final S-Area Landfill cap. The portions of the SBW pertinent to the Site Containment System include only the west, north, and east legs (i.e., those portions north of the Industrial Intake Pipe Trench [IIPT]).

The remedial objectives of the Overburden RRT System are as follows:

- To contain APL and NAPL within the existing S-Area overburden NAPL plume
- To collect NAPL outside the SBW to the maximum extent practicable (RRT Stipulation, page I-10)

The Overburden RRT System consists of the portions of the SBW south of the IIPT and the Robert Moses Parkway (RMP)[1], 16 OPWs installed along the IIPT and south of the RMP adjacent to the Niagara River, and the perimeter cap installed between the S-Area Landfill and the RMP.

The remedial objectives of the DWTP Remedial Program are "to prevent chemicals which have migrated from the Landfill Site from entering the DWTP water supply structures and service lines in order to protect users of the City of Niagara Falls drinking water from endangerment and to minimize structural impacts on DWTP pipelines, utilities, buildings, and other DWTP structures due to remedial activities" (RRT Stipulation, page I-2). As part of the remedial design implementation, the City of Niagara Falls constructed a new drinking water treatment facility further to the east.

1 The Robert Moses Parkway was renamed to the Niagara Scenic Parkway in 2016.

Therefore, the objectives have been simplified to the prevention of chemicals from migrating to the western boundary of the new DWTP.

The DWTP Remedial Program consists of the V-Area Drain Collection System (VDCS) along the southern property boundary of the V-Area.

The RRT Stipulation divides the required overburden remedy into three distinct areas (as described above); however, the operation of the pumping systems installed within these three areas does not adhere to these invisible boundaries. The discussion of the installed pumping systems will not be referred to by the RRT-stipulated programs in this annual evaluation report, but simply by their location (shown on Figure 2.1), as follows:

- S-Area Drain Collection System (SDCS – Site Containment System)
- V-Area Drain Collection System (VDCS – DWTP Remedial Program)
- On-Site Purge/Recovery Wells (OPWs 516-522 – Site Containment System)
- Off-Site Purge/Recovery Wells (OPWs 500-515 – Overburden RRT System)

To assist in evaluating the effectiveness of the above pumping systems, various monitoring programs associated with each of these systems have been implemented. The following subsections describe the current status of each of the four pumping systems and summarize and evaluate the monitoring data presented in previous quarterly reports.

2.1 S-Area Drain Collection System

The SDCS was installed around the limits of the original Landfill Site to provide complete hydraulic containment of overburden groundwater (APL) and NAPL within the SBW. The SBW was constructed of soil-bentonite backfill, engineered to a permeability less than 10^{-7} centimeters per second (cm/sec), creating a barrier to horizontal flow of groundwater away from the Site. To complement the SBW, there is a naturally occurring clay/till confining layer (i.e., an aquitard) beneath the Site that restricts vertical groundwater movement, effectively creating a “bathtub” within the Site for the containment of APL and NAPL. It is within this “bathtub” that the SDCS was constructed for the removal of accumulated liquids (APL and NAPL).

The SDCS consists of a perforated high-density polyethylene (HDPE) pipe installed down to the surface of the native clay/till confining layer, sloping toward Wet Well A (WWA) in the southwest corner of the original landfill. The SDCS also includes two northern legs; one from MH-2 to MH-3 and the other from MH-4 to MH-9. WWA is a 6-foot-square concrete chamber, installed to a depth of 537.5 feet (ft) above mean sea level (AMSL) or 4 ft below the lowest inlet pipe elevation (541.5 ft). Within this 4-ft sump, a submersible pump is continuously operated to keep the water level within WWA below the inlet pipe elevation.

A variable speed drive on the pump in WWA ensures the water level in this chamber is maintained within the 4-ft sump. By keeping the water level within the 4-ft sump below the inlet pipe elevation, the collection pipe around the perimeter of the landfill remains dry. The hydraulic condition of the SDCS is monitored at the seven manholes (MH-1 through MH-6, and MH-9), as well as 12 piezometers installed within the SDCS trench backfill between manhole locations.

2.1.1 Inward Gradient Hydraulic Monitoring

Table 2.1 presents the calculated inward hydraulic gradients for the overburden gradient well pairs for 2019. An inward gradient is demonstrated by a lower water elevation inside the SBW as compared to water elevations outside SBW, or, along the southern portion of the Site, a lower water elevation in monitoring wells than the elevation of the Niagara River. As shown in Table 2.1, there was an inward hydraulic gradient present throughout 2019 at all overburden well pairs around the SBW, except for OW552/OW551 and River/OW551 in all quarters, and River/OW536 and River/OW532 in the second and fourth quarters. OW551 is prone to abnormally high levels in the spring and during heavy precipitation events.

2.1.2 Upward Gradient Hydraulic Monitoring

Upward hydraulic gradient is determined by comparing the groundwater elevations within the overburden and shallow bedrock regimes. An upward hydraulic gradient is demonstrated by a higher water elevation in the bedrock regime than in the overburden regime. To facilitate this comparison, water levels are collected quarterly from all available shallow bedrock wells concurrently with water levels at all overburden wells within the SBW.

The four quarterly letter reports prepared in 2019 present the comparative isopach gradient contours (overburden vs. shallow bedrock) for each quarter. These negative isopach contour maps represent upward hydraulic gradients and indicate that the area of upward hydraulic gradient covered a significant portion of the southern half of the Site and the area south of the Site to the Niagara River during all four quarters in 2019. The area of net upward hydraulic gradient also covered the majority of the area within the confining layer discontinuity (defined by the RRT as the area beneath the Site where less than 3 ft of clay/till is present).

In a letter from the United States Environmental Protection Agency and New York State Department of Environmental Conservation (USEPA/NYSDEC) dated May 4, 2017, a concern was raised that a downward hydraulic gradient over the confining layer discontinuity was present in the vicinity of OPW513 and OPW514. GSH addressed this concern by reactivating OPW512, OPW513, and OPW514 on June 23, 2017. These wells had been shut down on a trial basis in 2016 as approved by USEPA/NYSDEC by letter dated May 9, 2016 in accordance with recommendations in the report "Hydraulic Response Testing Program – Off-Site Overburden Purge Wells (2002 Retesting)". In a letter dated July 4, 2017, GSH indicated that reactivation of OPW512, OPW513, and OPW514 had restored the upward gradient in this area. The isopach contours presented in the fourth quarter report for 2019 corroborated this. The northern portion of the Site has a considerably thicker underlying clay layer that rises to a much higher elevation, thus causing the dewatered groundwater table to now exist within this clay layer. As the groundwater in the overburden has been removed to the top of the clay layer or below, it is not possible to demonstrate the presence of an upward hydraulic gradient in this area. However, the thickness of the clay layer across the northern portion of the Site would naturally preclude downward groundwater flow and any potential S-Area chemicals contained therein.

2.1.3 NAPL Presence Monitoring

The objective of the Overburden NAPL Monitoring Program (ONP) is to manually check for NAPL presence in wells located outside (but adjacent to) the SBW to evaluate the effectiveness of the

SDCS and OPWs at containing NAPL and the effectiveness of the SBW at preventing further NAPL migration. The ONP consists of NAPL presence checks conducted at all overburden monitoring wells located immediately outside the SBW alignment, including the outside well of each inward gradient well pair. The 2019 Third Quarter Report presented the annual NAPL presence data at the overburden wells located outside the SBW, showing that no NAPL was present in any of the monitored wells.

2.2 V-Area Drain Collection System

The VDCS was installed along the southern boundary of the former DWTP property to provide hydraulic containment of APL that had historically migrated through the overburden materials east of the Site prior to installation of the SBW. (The western half of the former DWTP property is now owned by OxyChem and has been designated as the V-Area). The natural overburden groundwater flow direction across the V-Area is from north to south, toward the Niagara River, picking up S-Area chemicals as it moves southward through the area of contamination. The VDCS was installed across this groundwater flow path in order to intercept overburden groundwater (APL) and prevent potential migration of S-Area chemicals to the Niagara River.

The VDCS consists of a perforated HDPE pipe installed down to the surface of the native clay/till confining layer. The pipes slope both west and east toward Wet Well B (WWB) located near the middle of the southern V-Area boundary. WWB is a 6-foot-square concrete chamber installed to a depth of 537.5 ft AMSL or 1 ft below the lowest inlet pipe elevation (538.5 ft). A 30-gallon per minute (GPM) submersible pump was installed within WWB, and it is continuously operated to keep the water level within the VDCS trench approximately 2 to 3 ft below the static groundwater table, as measured at the Niagara River. In this manner, all groundwater moving north to south is captured by the depressed water table along the VDCS alignment and directed toward WWB.

The operation of WWB involves continuous pumping. The amount of drawdown is controlled by valving back the pump to maintain an appropriate amount of drawdown below river elevation (average 3.09 ft within WWB in 2019) without pumping excessive quantities of APL (currently maintained at approximately 8 GPM) that would require treatment. By keeping the level within the VDCS trench below the groundwater table to the north and south, this effectively keeps APL from the V-Area from migrating across the property boundary and toward the Niagara River.

2.2.1 Hydraulic Gradient Monitoring

The hydraulic gradient produced by the VDCS is monitored by measuring water levels at the two manholes at each end of the VDCS (MH-7 and MH-8), as well as the four piezometers installed within the VDCS trench between WWB and the two manhole locations. In general, there is typically between 0.2 and 1 ft of drawdown as compared to the Niagara River water elevation at the manholes and piezometers, with the water level within the VDCS trench sloping toward WWB.

As shown in Table 2.2, there was an inward hydraulic gradient (indicated by a positive value) between WWB and all of the manholes and piezometers throughout 2019. Drawdown was present towards WWB (indicated by a positive value) from both directions along the gravel trench throughout 2019. An inward hydraulic gradient was also maintained throughout 2019 between the Niagara River and all of the manholes and piezometers, except for PZ B-1 in the second, third, and fourth quarters, MH-8 and PZ B-3 in the second and fourth quarters, and at PZ B-4 and MH-7 in the fourth quarter.

The four quarterly letter reports prepared in 2019 present an overburden groundwater contour map for the V-Area. This groundwater contour map illustrates that the VDCS is drawing groundwater through the V-Area and intercepting it to the south, preventing APL migration to the Niagara River and the new DWTP to the east.

2.2.2 Chemical Monitoring

The report entitled “Former DWTP Overburden Groundwater Study”, dated April 2001, recommended that chemical sampling of the overburden monitoring wells at the V-Area (outside the SBW) be conducted annually for 3 years. The three events were conducted in June/July 2002, June 2003, and May 2004, respectively. Total organic concentrations observed during these three sampling events are presented in Table 2.3.

The primary issue resulting from the three sampling events was the elevated volatile organic compound (VOC) concentrations at OW595. The concentration of total VOCs at this well in 2004 was 5,851 micrograms per liter (μg/L) (increased from 5,208 μg/L in 2003). The source of these chemicals is unknown but did not appear to be connected to the chemistry found on the former DWTP property, as the two adjacent wells along the property boundary (OBG-3 and OW597) have traditionally shown non-detect or estimated “J” concentrations below the detection limits (5 μg/L). It should be noted that the City of Niagara Falls found shallow soil contamination on the new DWTP property not far from well OW595 during construction activities in June 2004. This contamination has been addressed by the City of Niagara Falls.

GSH decided to voluntarily continue the V-Area Chemical Monitoring Program in 2005 on an annual basis. The results from the 2005 through 2019 sampling events are also presented in Table 2.3.

In the 2008 Evaluation Report, GSH recommended that the number of monitoring wells included in the sampling program should be reduced to just six monitoring wells (OW595, OW596, OW597R, OBG-3R, OBG-4R, and OBG-5R). USEPA/NYSDEC stated in an email dated November 10, 2009 that the sampling program should include the six above-mentioned monitoring wells plus an additional seven wells (CW-13A, OW260, OW262, OW278, OW282, OW549, and OW599). Therefore, commencing in 2009, only the 13 monitoring wells were sampled.

The 2019 sampling event was conducted between December 10, 2019 and December 12, 2019 and included sample collection from 12 V-Area monitoring wells. A sample was not obtained from OBG-3R because it was dry. The concentrations of total VOCs in all wells were generally consistent with previous events. Previous elevated VOC concentrations at well OW595 are no longer present. It should be noted that the total VOC concentration in OW597R increased from 1.4 μg/L in 2011 to 171 μg/L in 2012, remained essentially unchanged through the 2013 and 2014 sampling events, decreased to 130 μg/L in 2015, and continued to decrease since 2016, with a total VOC concentration of 0.11 μg/L in 2019. This well is 300 ft east of OBG-4R (5,010/5,125 μg/L in 2017, duplicate samples; 4263/4476 μg/L in 2018, duplicate samples; 4071/4181 μg/L in 2019, duplicate samples) and cross-gradient with respect to groundwater flow (see Figure 4 in the Quarterly Reports).

2.3 Overburden Purge/Recovery Well Operations

In addition to the SDCS, there are also 23 individual OPWs within the SBW that assist with hydraulic containment and NAPL removal in specific areas both on Site and off Site. These OPWs are 6-inch diameter stainless steel wells, each equipped with an air-operated Protec RP2 reciprocating pump capable of 1 GPM (except for OPW503, which has an airlift pump). The pumping mechanism for these pumps involves air lifting of the collected liquids as the internal pump cylinder becomes full. The pumped liquids from each of the OPWs are collected by two forcemain systems, separated for measurement of on-Site and off-Site flows, prior to combined discharge to the overburden Decanter No. 1 at the S-Area Treatment Plant.

The 23 OPWs have been operated since 1996. However, the measurement of flow rates at the individual well locations has been difficult due to the inability of the air regulating equipment to consistently activate the pump with every fill cycle. Therefore, the pumps have been set to manually stroke, regardless of whether the pump cylinders are full, and thus the stroke counters are not accurate.

To provide discrete flow measurement of the two (on-Site and off-Site) OPW systems, flow meters have been installed as the two separate forcemains exit the ground and enter the treatment facility. This provides a measurement of the total flow for the two OPW systems. The on-Site OPW flow includes the SDCS (after the variable speed drive and flow meter were installed in WWA) and the VDCS (after it was reconnected to the on-Site overburden forcemain).

2.3.1 On-Site Purge/Recovery Well Operations

There are seven OPWs installed as part of the on-Site overburden pumping system to complement the SDCS. Three OPWs (OPW520-522) were installed at the south end of the former lagoons, near the southwest corner of the original landfill site. These wells were installed to contain and remove known pockets of NAPL in the overburden soils in this immediate area. Four other OPWs (OPW516-519) were installed in the southwest corner of the expanded landfill (property formerly owned by Niagara Mohawk Power Corporation), adjacent to the N-Area. These wells were installed within a low point in the clay/till surface due to the concern that the hydraulic influence of the SDCS would not adequately address this area. NAPL was also present in this area.

Table 2.4 shows that the combined flow of the seven on-Site OPWs (OPW516-522) plus WWA and WWB (collectively represented by Flow Meter #1) averaged 43 GPM during 2019, which is slightly below the target flow range for 2019 (50 to 60 GPM). WWA and WWB had average flows of 29 GPM and 8 GPM, respectively, during 2019. Table 2.4 shows that the sum of the flow rates from WWA and WWB was typically similar to Flow Meter #1 over the same time period. Therefore, very little flow is produced from the seven on-Site OPWs, although it is likely that there are some minor calibration differences between the three flow meters (WWA, WWB, and Flow Meter #1). It should also be noted that the drawdown achieved at WWA, as well as in the entire SDCS, likely means there is less overall water available to the OPWs.

Wells OPW516-519 appear to be hydraulically connected (i.e., pumping at any one well causes significant drawdown at the other three wells), as previously discussed in the document entitled "Hydraulic Evaluation of Overburden Purge Well Operations", dated June 24, 1997 (OPW Hydraulic

Evaluation Report). The drawdown in all four wells is creating gradient control in this area of reduced clay/till thickness.

Wells OPW520-OPW522 do not appear to be hydraulically connected and have historically pumped very little water. The recovery test results presented in the OPW Hydraulic Evaluation Report showed that each of these three wells could produce approximately 0.5 GPM; however, the long-term continuous operation of the SDCS appears to have greatly reduced the groundwater available to these wells. Complete drawdown in these three wells is not required, only that the amount of drawdown is sufficient for NAPL recovery.

During 2019, none of the seven on-Site overburden purge wells (OPW519 and OPW522) recorded NAPL presence during the annual monitoring event; however, OPW516 through OPW522 have each historically contained NAPL.

2.3.2 Off-Site Purge/Recovery Well Operations

There are 16 OPWs installed as part of the off-Site overburden pumping system to address the overburden groundwater regime not affected by the SDCS. Six OPWs (OPW510-515) were installed along the southern edge of the IIPT, immediately south of the Site, with one additional well (OPW509) further to the east. The IIPT consists of seven water intake pipes and was constructed into the native clay/till, thus providing hydraulic separation between the Site and the area to the south. The IIPT also provides a physical separation for NAPL movement/recovery, caused by the excavation of the trench into the clay/till where NAPL can collect but cannot be removed by the SDCS. Thus, the six OPWs along the IIPT were installed to deeper depths than the SDCS.

Nine other OPWs (OPW500-508) were installed south of the RMP, where it was expected to be difficult to construct a collection trench due to the presence of shot-rock. These wells are also located in the only uncapped area within the SBW. These two groups of wells make up the off-Site groundwater removal system and are also intended for NAPL removal, if present.

Table 2.4 shows that the combined flow of the 16 off-Site OPWs (OPW500-515) plus shallow bedrock purge well (BPW) 604 (collectively represented by Flow Meter #2) averaged 4.3 GPM during 2019, which is slightly below the target flow range for 2019 (5.5 to 6.5 GPM). This is likely due to the fact that some OPWs were shut down as approved by NYSDEC and USEPA in a letter dated May 9, 2016 in accordance with the recommendations in the report entitled "Hydraulic Response Testing Program - Off-Site Overburden Purge Wells (2002 Retesting)" dated March 2003. OPW500, OPW502, OPW504, OPW507, OPW509, OPW511, OPW512, OPW513, and OPW514 were shut down on May 10, 2016.

In the May 9, 2016 letter, USEPA and NYSDEC requested that an evaluation of the modified system be submitted to USEPA/NYSDEC for review after four consecutive quarters of modified operation. The fourth quarterly monitoring event since the implementation of the above modifications occurred in March 2017. The requested evaluation was submitted on July 4, 2017. As indicated in Section 2.1.2 and in the July 4, 2017 letter, OPW512, OPW513, and OPW514 were reactivated on June 23, 2017 to address the downward hydraulic gradient that appeared to be present in the vicinity of OPW513 and OPW514 following shut down of these wells. The isopach contours presented in the fourth quarter report for 2019 corroborated this.

3. Bedrock RRT System

The RRT Stipulation divides the Bedrock RRT System into three distinct areas:

1. The Shallow Bedrock APL/NAPL Containment System addressing the northwesterly movement of groundwater from the shallow bedrock NAPL plume beneath and around the S-Area Landfill Site
2. The Shallow Bedrock NAPL Recovery System addressing any areas where NAPL is migrating from the shallow bedrock NAPL plume along the dipping bedrock fractures (i.e., not in the primary direction of groundwater movement)
3. The Intermediate/Deep Bedrock APL/NAPL Containment System addressing both groundwater movement and NAPL recovery from the bedrock intervals beneath the shallow bedrock zone (top 30 ft of bedrock)

The remedial objectives of the Bedrock RRT System are as follows:

- To contain APL and NAPL within the existing S-Area Bedrock NAPL plume
- To prevent further NAPL migration in the Bedrock under the Niagara River
- To collect NAPL within this plume to the maximum extent practicable (RRT Stipulation, page I-24)

The Bedrock RRT System consists of four remedial pumping systems comprised of groups of BPWs, as shown on Figures 3.1 and 3.2 and as listed below:

- Shallow Bedrock APL Purge Well System (seven BPWs)
- Shallow Bedrock NAPL Recovery Well System along the Niagara River (seven BPWs)
- Shallow Bedrock NAPL Recovery Well System on the V-Area property (five BPWs)
- Intermediate/Deep Bedrock Purge Well System (five BPWs)

To assist in evaluating the effectiveness of the bedrock pumping systems, various monitoring programs associated with each of these systems have been implemented. The following subsections discuss the operation of the various purge/recovery well networks during 2019 and summarize and evaluate the monitoring data presented in the quarterly reports.

3.1 Shallow Bedrock APL Purge Wells

There are seven APL BPWs (BPW600-603R and BPW605-607) located along the downgradient edge of the shallow bedrock NAPL plume boundary. These wells range from BPW600, located to the northeast of the S-Area, to BPW607, located to the southwest of the S-Area. The APL BPWs operate at individually set pumping rates in order to create sufficient drawdown to produce an adequate cone of influence back toward the line of purge wells. In this manner, any groundwater coming from the southeast and passing under the S-Area and through the shallow bedrock NAPL plume is intercepted by the APL BPWs and prevented from continuing to migrate northwesterly as APL.

During 2019, the seven APL BPWs were fully operational with the exception of downtime for minor maintenance, cleaning, component replacements, and vacuuming of accumulated surface water in chambers. There were also pump replacements at BPW602 and BPW605.

As part of routine operational checks performed by S-Area personnel, weekly flow totalizer readings are recorded for the seven APL BPWs, along with monthly water levels in each BPW.

Table 3.1 shows that the combined flow of the seven APL BPWs averaged 87 GPM during 2019, which is within the target flow range for 2019 (85 to 110 GPM). The monthly flow rates ranged from 57 GPM (January 2019) to 95 GPM (August 2019). Although flow rates are helpful at the Site in roughly assessing the effective pumping of these wells, the actual drawdown elevation is the key factor in maintaining gradient.

The 2019 Fourth Quarter Report presented the monthly groundwater elevation data collected from the shallow bedrock purge and monitoring wells during 2019. The average drawdown elevation for wells BPW600 through BPW603R and BPW605 ranged from 535.88 to 544.77 ft AMSL during 2019. The goal is to maintain the groundwater elevation in these five APL BPWs between 545 and 550 ft AMSL, as this has historically resulted in the required inward gradient at the adjacent monitoring well pairs. The average drawdown elevation at the other two APL BPWs (BPW606 and BPW607) was 531.52 and 536.31 ft AMSL, respectively. The further reduced drawdown elevations are required at these two APL BPWs due to their closer proximity to the Niagara River.

3.2 Shallow Bedrock NAPL Recovery Wells

3.2.1 Recovery Wells along Niagara River

There are seven NAPL recovery wells located along the southern edge of the shallow bedrock NAPL plume boundary (BPW237, BPW238R, BPW239, BPW609, BPW610R, BPW611, and BPW671). The RRT Stipulation requires that the NAPL recovery wells be operated “at the maximum rate achievable (to a maximum of 5 gallons/minute)” in order to affect slow rate APL pumping to remove all available NAPL. In this manner, any NAPL coming from the north (migrating from the S-Area via the dipping bedrock fractures) is intercepted by the NAPL recovery wells and prevented from migrating to the Niagara River.

The NAPL recovery wells are operated at the pump capacity (typically 10 GPM or less) to effect NAPL recovery through pumping of combined APL/NAPL; however, lower flow rates are achieved. (Initial operations showed that greater pumping rates were required to keep some pumps from plugging.) Drawdown elevations within the individual NAPL recovery wells are not as imperative as they are within the APL BPWs.

During 2019, all seven NAPL recovery wells along the Niagara River were fully operational except for downtime due to minor maintenance, cleaning, component replacements, and vacuuming of accumulated surface water in chambers. There was also a pump replacements at BPW239.

As part of routine operational checks performed by S-Area personnel, weekly flow totalizer readings are recorded for the NAPL recovery wells, along with quarterly water levels in each NAPL recovery well.

Table 3.2 presents average monthly, quarterly, and 2019 yearly flow rates for the seven NAPL recovery wells located along the Niagara River. Target flow rates are also presented. The combined average flow of the seven NAPL recovery wells along the Niagara River was 20 GPM during 2019, which is within the target flow range for 2019 (15 to 20 GPM). The monthly total flow rates ranged from 18 GPM (August, September, October, and December) to 23 GPM (April).

Although drawdown is not as important for the NAPL recovery wells, a review of the collected water level data can assist in understanding the recovery well operations. The 2019 Fourth Quarter Report presented the quarterly groundwater elevation data from the shallow bedrock purge and monitoring wells during 2019. The average drawdown elevation in the seven Niagara River NAPL recovery wells ranged from 548.73 to 560.82 ft AMSL. This is consistent with 2018 except for BPW238R which had fluctuating levels between quarters in the past several years. The observed average drawdown is approximately 1-9 ft below the average Niagara River elevation (562.25 ft AMSL), thus there was sufficient hydraulic containment, as well as NAPL recovery.

3.2.2 Recovery Wells in V-Area

There are four NAPL recovery wells (BPW613, BPW615, BPW682, and BPW683) located along the eastern boundary of the shallow bedrock NAPL plume. BPW613 and BPW615 are oriented south to north on the western side of V-Area, with BPW682 and BPW683 located further to the east in V-Area. The NAPL recovery wells are operated at low APL pumping rates to remove available NAPL. For this system, any NAPL coming from the west (migrating from the S-Area) is intercepted by the NAPL recovery wells and prevented from continuing to migrate toward the new DWTP.

All NAPL recovery wells in V-Area were fully operational during 2019. There was downtime in the NAPL recovery wells in the V-Area for vacuuming of accumulated surface water from well chambers. As part of routine operational checks performed by S-Area personnel, weekly flow totalizer readings are recorded for the five V-Area NAPL recovery wells, along with quarterly water levels in each NAPL recovery well.

Table 3.3 presents average monthly, quarterly, and 2019 yearly flow rates for the four V-Area NAPL recovery wells. Target flow rates are also presented. The combined flow of the four V-Area NAPL recovery wells was 19 GPM during 2019, which is within the target flow range for 2019 (18 to 25 GPM). The monthly total flow rates ranged from 18 GPM (February and August 2019) to 20 GPM (September 2019).

Although drawdown is not as important for the NAPL recovery wells, a review of the collected water level data can assist in understanding the recovery well operations. The 2019 Fourth Quarter Report presented the monthly groundwater elevation data from the shallow bedrock purge and monitoring wells during 2019. The average drawdown elevations in the four V-Area NAPL wells ranged from 541.93 to 555.93 ft AMSL. The observed average drawdown is approximately 6 to 19 ft below the average Niagara River elevation (562.02 ft AMSL), thus there was hydraulic containment as well as NAPL recovery.

3.3 Intermediate/Deep Bedrock Purge Wells

There are four BPWs located within the intermediate bedrock NAPL plume (BPW631I, BPW632I, BPW689I, and BPW698I) and one BPW located within the deep bedrock NAPL plume (BPW688D).

The intermediate/deep BPWs are operated at individually set pumping rates, either to cause enough drawdown to create an adequate cone of influence back toward the purge wells, or to the maximum drawdown to remove NAPL accumulation at the bottom of the wells. In this manner, any groundwater passing through the intermediate or deep bedrock NAPL plumes is intercepted by the BPWs and prevented from continuing to migrate away from the Site as APL.

Intermediate/deep BPWs were all fully operational during 2019, except for minor maintenance, and repairs at BPW689I between March and July. As part of routine operational checks performed by S-Area plant personnel, weekly flow totalizer readings are recorded for the five Intermediate/Deep BPWs, along with quarterly water levels in each BPW.

Table 3.4 presents average monthly, quarterly, and 2019 yearly flow rates for the four intermediate BPWs and the one deep BPW. Target flow rates are also presented. The combined flow of the four intermediate BPWs averaged 0.3 GPM during 2019, which is within the target flow range for 2019 (0.1 to 1 GPM). The average monthly flow rate for the four intermediate BPWs ranged from 0.2 GPM (March, May, June, and August) to 0.3 GPM (January, February, April, July, September, and October through December 2019). The water elevations in these wells were generally consistent with those measured the previous year. When the pumps were fully operational, there was a drawdown of approximately 4 to 72 ft below static (non-pumping) conditions.

The flow from BPW688D averaged 6.4 GPM during 2019, which is within the target flow range for 2019 (6 to 7 GPM). The monthly flow rates from BPW688D ranged from 2.3 GPM (July 2019) to 7.2 GPM (February and May 2019). Pumping at these rates produced a drawdown between approximately 132 ft and 137 ft below static (non-pumping) conditions.

3.4 NAPL Presence Monitoring

3.4.1 Shallow Bedrock Zone

The objective of the SBNP is to manually check for NAPL in wells located outside the known limit of NAPL presence to evaluate the effectiveness of the Bedrock RRT System at containing NAPL within the existing NAPL plume boundaries in the shallow bedrock zone. The SBNP consists of quarterly NAPL presence checks conducted at all shallow bedrock monitoring wells within 200 ft of the historic NAPL plume boundaries. NAPL presence checks are also performed at the outer piezometers used for the hydraulic monitoring program and the shallow bedrock monitoring wells installed along the eastern property boundary adjacent to the V-Area.

Table 14 of the 2019 Fourth Quarter Report presented all four quarters of NAPL presence data for 2019 at the shallow bedrock wells located both inside and outside the historic NAPL plume boundary. There were 11 wells located inside the NAPL plume at which NAPL was observed during 2019, with all of these wells showing NAPL in all four quarters. S-Area NAPL has also been observed at one well (OW674) located outside the NAPL plume during 2019, consistent with previous years.

Since 2007, GSH has been recovering NAPL from wells OW234, OW235, OW245, OW625, OW670, and OW806, as necessary, on a quarterly basis due to the significant amounts of NAPL historically found in these wells. Two additional wells were added to this program in 2009 due to NAPL presence: OW617 and OW674. OW412D was added to the program in 2014 and OW226 was added to the program in 2016.

For NAPL recovery in 2019, the following wells continued to be checked on a more frequent basis:

- OW670 – approximately weekly
- OW806 – approximately monthly
- OW412D – approximately quarterly.

In total, the following amounts of recoverable NAPL were collected in 2019: OW225 - 0 gallons; OW234 - 0 gallons (NAPL not pumped due to presence of phosphorus); OW235 - 0 gallons; OW245 - 0 gallons; OW617 - 0 gallons; OW625 – 0.5 gallons; OW670 – 508.08 gallons; OW806 – 17.75 gallons; OW674 – 1.75 gallons: OW412D - 0 gallons; and OW226 – 0.35 gallons. NAPL checks and recovery will continue at OW225, OW226, OW234, OW235, OW245, OW412D, OW617, OW625, and OW674 on a quarterly basis. NAPL checks/recovery will be carried out approximately weekly for OW670 and monthly for OW806 in 2020. This frequency of NAPL checks at OW670 and OW806 may be reevaluated and changed during 2020 based on NAPL recovery.

In the fourth quarter of 2015, elemental phosphorus was found in the NAPL of OW234 which is located within the historic NAPL plume boundary. For safety reasons, NAPL pumping temporarily ceased when this was discovered. As discussed at a meeting with NYSDEC on June 9, 2016 and summarized in an email from GSH dated July 22, 2016, GSH will no longer remove NAPL from this well due to the hazards and disposal issues associated with elemental phosphorus. NAPL removal from this well was not required under the Stipulation or the Phase III Design report and GSH was doing voluntarily. The well is located within the historic NAPL plume and is only required to be monitored.

In addition, there were six wells besides OW674 (OW229, OW243, OW618, OW619, OW620, and OW621) located outside the historic NAPL plume boundary at which NAPL was observed. However, based on color, odor, and thickness of the NAPL, it was determined that the NAPL observed in these six wells was representative of Niagara Plant N-Area NAPL. In accordance with the letter to NYSDEC dated February 26, 2009, GSH incorporated quarterly NAPL monitoring and collection of N-Area NAPL at shallow bedrock wells OW229, OW243, OW618, and OW621 as part of the Niagara Plant Corrective Action Program. Shallow bedrock wells OW619 and OW620 were also added to this program in 2009.

In total, the following amounts of recoverable N-Area NAPL were collected in 2019: OW229 – 0.5 gallons; OW243 – 2.2 gallons; OW618 – 0.35 gallons; OW619 - 0 gallons; OW620 - 0 gallons; and OW621 – 0.6 gallons. These six wells will continue to be monitored for NAPL recovery as part of the Niagara Plant Corrective Action Program.

3.4.2 Intermediate/Deep Bedrock Zone

The objective of the Intermediate/Deep Bedrock NAPL Monitoring Program (IDNP) is similar to that of the SBNP. The IDNP consists of annual NAPL presence checks conducted at all intermediate/deep bedrock monitoring wells within 400 ft of their respective NAPL plume boundaries, plus the intermediate bedrock monitoring wells installed along the eastern property boundary adjacent to the new V-Area.

Table 4 of the 2019 Third Quarter Report presented the 2019 annual NAPL presence data at the intermediate/deep wells, both inside and outside the individual intermediate and deep bedrock historic NAPL plumes. In 2019, NAPL was observed in three intermediate bedrock wells (OW636, OW637, OW641) and no deep bedrock wells located inside the historic NAPL plume boundaries. Since 2007, GSH has been monitoring NAPL recovery in intermediate bedrock well OW637 and recovering NAPL as necessary on a quarterly basis due to the amount of NAPL historically found in this well. In total, 3.25 gallons of recoverable NAPL were collected from OW637 in 2019. NAPL was not present in sufficient amounts for recovery from OW636 and OW641.

NAPL was also observed in two intermediate bedrock wells (OW634 and OW638) and two deep bedrock wells (OW635 and OW643) located outside of the NAPL plume boundaries during the 2019 annual NAPL presence checks consistent with previous years. Based on color, odor, and viscosity, the NAPL observed in wells OW634, OW638, OW635, and OW643 appears to be N-Area NAPL. NAPL was found in OW642 in 2013 in trace amounts (the first year that NAPL had been observed in that well) but has not been observed since. In accordance with the letter to NYSDEC dated February 26, 2009, GSH incorporated quarterly NAPL monitoring and collection of N-Area NAPL at intermediate bedrock well OW638 and deep bedrock well OW643 as part of the Niagara Plant Corrective Action Program. Intermediate bedrock well OW634 was added to this program in 2009 and deep bedrock well OW635 was added in 2012 due to the observed presence of N-Area NAPL.

In total, the following amounts of recoverable N-Area NAPL were collected in 2019: OW634 – 0 gallons; OW635 – 0 gallons; OW638 – 1.45 gallons; and OW643 – 7.45 gallons. These four wells will continue to be monitored for NAPL recovery as part of the Niagara Plant Corrective Action Program.

3.5 Hydraulic Gradient Monitoring

3.5.1 Shallow Bedrock Zone

The objective of the Shallow Bedrock Hydraulic Monitoring Program (SBHP) is to evaluate the effectiveness of the Bedrock RRT System in maintaining an inward hydraulic gradient across the shallow bedrock NAPL plume boundary, thus eliminating the potential for groundwater to migrate from the NAPL plume as APL. The SBHP consists of 12 pairs of monitoring wells, designated as performance piezometer pairs, the inner location being within or directly adjacent to the NAPL plume boundary and the outer location being within approximately 400 ft outside the NAPL plume boundary. Water levels were taken quarterly by measuring the depth to water from the top of the well casing using an electronic water sensor. In addition to the 12 performance piezometer pairs, hydraulic monitoring is performed at all available S-Area shallow bedrock wells to evaluate the overall groundwater flow regime.

Table 3.5 presents the calculated quarterly inward hydraulic gradients for the 12 well pairs straddling the shallow bedrock NAPL plume during 2019. An inward hydraulic gradient, indicated by a positive value, was present at 11 of the 12 well pairs in all four quarters of 2019, except for OW691/OW627R, at which an outward gradient was present in all quarters.

Each quarterly report presents a groundwater contour map for the shallow bedrock zone across the entire OxyChem Niagara Plant. This map is produced each quarter to delineate the boundary between the two shallow bedrock pumping systems (Niagara Plant and S-Area) in order to visually demonstrate overall hydraulic containment beyond the 12 piezometer pairs. The maps produced in 2019 show that there is a distinct hydraulic divide northwest of the S-Area, such that the S-Area RRT shallow bedrock pumping system collects all groundwater flow southeast of this divide.

The quarterly reports for the first, second, and fourth quarters also present drawdown maps for the shallow bedrock zone. The drawdown maps are created using the quarterly 2019 groundwater contours (pumping conditions) and the June 19, 2003 groundwater contours (static conditions). The drawdown maps show that drawdown is produced in essentially all areas of the shallow bedrock NAPL plume.

3.5.2 Intermediate/Deep Bedrock Zone

The objective of the Intermediate/Deep Bedrock Hydraulic Monitoring Program (IDHP) is to evaluate the effectiveness of the Bedrock RRT System in maintaining an inward hydraulic gradient within the intermediate and deep bedrock zones, thus eliminating the potential for groundwater to migrate from these two NAPL plumes as APL. The RRT Stipulation does not specify the use of performance piezometer pairs in the intermediate and deep bedrock zones; however, GSH has selected six well pairs within each of the intermediate and deep bedrock zones. Water levels were collected by measuring the depth to water from the top of the well casing using an electronic water sensor. In addition to the selected piezometer pairs, hydraulic monitoring is performed at all available S-Area intermediate/deep bedrock wells to evaluate the overall groundwater flow regime.

Table 3.6 presents the quarterly calculated inward hydraulic gradients for the 12 well pairs surrounding the intermediate and deep bedrock NAPL plumes during 2019. An inward hydraulic gradient, indicated by a positive value, was present throughout 2019 at three of the six intermediate bedrock well pairs and four of the six deep bedrock well pairs.

An outward hydraulic gradient was present during all four quarters of 2019 at intermediate bedrock well pair OW638/OW634. An outward hydraulic gradient was present during the second, third, and fourth quarters of 2019 at OW412C/OW694. However, there is significant drawdown from both of these wells to the BPWs and contours indicated containment in the area of the historic NAPL plume. In addition, the outward hydraulic gradient present in the second quarter was minor (0.05 ft). An outward hydraulic gradient was present during the second, third, and fourth quarters of 2019 at OW686/OW640. However, contours indicated containment in the area of the historic NAPL plume. It should be noted that OW640 is located at the edge of the historic NAPL plume and there is significant drawdown from this well to the BPWs. In 2019, the water levels in BPW689I and BPW698I were drawn down by between 4 and 72 ft and in BPW631I and BPW632I were drawn down by between 7 and 43 ft when compared to static groundwater elevations.

An outward hydraulic gradient was present for all four quarters of 2019 at deep bedrock well pairs OW210/OW697 and OW643/OW645. However, across the NAPL plume, there was still an inward gradient between wells OW697 (edge of plume) and OW699 (middle of plume), and the groundwater contours indicated overall containment. It should be noted that, in 2019, the water level in BPW688D was drawn down by between 132 and 137 ft when compared to static groundwater elevation.

Groundwater contour maps were prepared for the intermediate and deep bedrock zones. These maps are used to assist in evaluating the hydraulic gradient around the intermediate and deep bedrock NAPL plume boundaries. The 2019 quarterly reports present the intermediate bedrock groundwater contours. In addition, drawdown maps for the intermediate bedrock zone were created using the 2019 quarterly groundwater contours (pumping conditions) and the June 18, 2003 groundwater contours (static conditions) for the first, second, and fourth quarters. These maps show that drawdown is produced in essentially all areas of the intermediate NAPL plume, and containment is achieved even though outward gradients were observed during 2019.

The 2019 quarterly reports present the deep bedrock groundwater contours. In addition, drawdown maps for the deep bedrock zone were created using the 2019 quarterly groundwater contours (pumping conditions) and the June 18, 2003 contours (static conditions) for the first, second, and fourth quarters. These maps show that drawdown is produced in all areas of the deep bedrock NAPL plume and that there is overall containment around the deep bedrock NAPL plume during 2019.

3.6 Chemical Monitoring

3.6.1 Shallow Bedrock Zone

The objective of the Shallow Bedrock Chemical Monitoring Program (SBCP) is to evaluate the effectiveness of the Bedrock RRT System, in conjunction with the other monitoring programs, by monitoring the chemical concentrations in the APL both inside and outside the NAPL plume. The SBCP consists of three concentric rings of monitoring wells around the shallow bedrock NAPL plume boundary, each ring consisting of monitoring wells with similar chemical concentrations. The RRT Stipulation requires that groundwater samples are collected from 6 inner ring wells, 16 middle ring wells, and 6 outer ring wells, but also acknowledges that the inner ring wells may be removed from the sampling program due to the consistency in chemical concentration data collected from these wells within the NAPL plume boundary.

The Phase III Design Report presented the list of SBCP wells, consisting of 10 of the previous Baseline Chemical Monitoring Program (BCMP) wells used for Phase II sampling plus another 17 existing wells and one new shallow bedrock monitoring well. The RRT Stipulation requires that the SBCP wells be sampled on a semiannual basis; however, GSH increased this frequency during the initial stages of this program (previously unused wells only) in order to acquire more data to prepare the required statistical evaluation. SBCP sampling was performed quarterly for the first six events, which commenced in August 2001, and semiannually thereafter. The 39^{th} SBCP sampling event was conducted in May 2019. Groundwater samples were collected from 16 middle ring wells and 6 outer ring wells. The data from this event were presented in the 2019 Second Quarter Report. The 40^{th} sampling event was performed in October/November 2019. Groundwater samples were collected from 16 middle ring wells and 6 outer ring wells, as well as the 6 inner ring wells that are only sampled annually. The data from this event were presented in the 2019 Third Quarter Report. The data submitted in these reports includes individual chemical concentrations for each well sampled.

The total organic concentrations observed in the shallow bedrock monitoring wells during the 2019 semiannual events are compared to the concentrations observed during the historic events and the previous quarterly and semiannual events in Table 3.7. The total organic concentrations consist of the sum of the parameters listed in Table 3.8. Comparison of individual wells in Table 3.7 shows that the total organic concentrations in the shallow bedrock monitoring wells included in the 2019 sampling events continued to fluctuate compared to the concentrations reported in past events. The total organic concentrations in the shallow bedrock monitoring wells ranged between 2.0 μg/L (OW220) and 10,702 μg/L (OW670) in May 2019, and between 0.5 μg/L (OW236) and 17,686 μg/L (OW670) in October/November 2019.

It should be noted that total organic concentrations in middle ring well OW626 and outer ring wells OW411D and OW805 increased by an order of magnitude in 2015 compared to 2014 concentrations. These wells are located north of the shallow bedrock APL purge system. Groundwater contours and gradient well pair data all indicate containment and inward gradients in the area of these wells. Therefore, the increase in concentration observed in 2015 is not migration from the S-Area shallow bedrock plume. As noted previously, only limited pumping from the shallow bedrock zone (D-Zone) at the OxyChem Niagara Plant occurred in 2015 due to a treatment system upgrade project. The increased concentrations in these wells could be attributable to impacted Niagara Plant groundwater being drawn toward the S-Area shallow bedrock purge well system due to the limited pumping of the Niagara Plant D-Zone bedrock groundwater extraction system. Full-scale pumping in the Niagara Plant D-Zone bedrock groundwater extraction system resumed on January 25, 2016. Since then, concentrations at these three wells have been decreasing. These wells will continue to be monitored in 2020.

USEPA/NYSDEC approved the statistical method proposed in the Phase III Design Report for analysis of SBCP data in their May 9, 2016 letter. A preliminary analysis of the data was completed; however, there were several factors that complicated interpretation of the results. Some of the middle ring wells are located within the historic NAPL plume and residual NAPL has an impact on concentrations over time as it is dissolved into groundwater. In addition, the outer ring wells are located within OxyChem's Niagara Plant. These wells are impacted with Niagara Plant constituents and/or are hydraulically influenced by the Niagara Plant remedial system. As noted above, concentrations in some of these outer ring wells and an inner ring well increased in 2015 due to limited pumping from the shallow bedrock zone (D-Zone). Now that concentrations in these have begun to decrease over the past three years, the results of this statistical analysis have been revaluated and will be submitted in a separate report. Any recommendations to address the complicating factors indicated above will also be included. After submission of this report, statistical analysis, along with tables summarizing individual chemical concentrations, will be included in future annual reports.

3.6.2 Intermediate/Deep Bedrock Zone

The objective of the Intermediate/Deep Bedrock Chemical Monitoring Program (IDCP) is to evaluate the effectiveness of the Bedrock RRT System by monitoring the chemical concentrations in the APL outside the NAPL plume in the intermediate and deep bedrock zones. The RRT Stipulation requires six wells around each of the intermediate and deep bedrock plumes.

The Phase III Design Report refers to three distinct intervals (upper, middle, and lower) within the intermediate bedrock zone. The 1988/1989 Bedrock Survey found that the upper intermediate bedrock interval was generally non-waterbearing, while the combined middle/lower intermediate bedrock interval was more typically waterbearing. Therefore, it was decided to create separate monitoring programs for these two portions of the intermediate bedrock zone. The Phase III Design

Report identified the IDCP monitoring well network, consisting of four wells within each of the upper intermediate, middle/lower intermediate, and deep bedrock zones.

Phase III chemical sampling in the intermediate/deep bedrock zone is conducted semiannually and commenced in April 2002. The 2019 semiannual events were performed in April/May and October. The groundwater samples were collected from four upper intermediate bedrock wells, four middle/lower intermediate bedrock wells, and four deep bedrock wells, all of which are located around their respective NAPL plume boundaries. A sample was also collected from well OW808, which is installed into the ungrouted portion of the bedrock intake tunnel and is located on Buckhorn Island. The data from the April/May event were presented in the 2019 Second Quarter Report, and the data from the October event was presented in the 2019 Fourth Quarter Report. The data submitted in these reports includes individual chemical concentrations for each well sampled.

The total organic concentrations observed in the intermediate/deep bedrock monitoring wells during the 2019 semiannual events are compared to the organic concentrations observed during the 2002 through 2019 semiannual events in Table 3.9. The total organic concentrations consist of the sum of the baseline parameters listed in Table 3.10. Comparison of individual wells in Table 3.9 shows that the total organic concentrations in the intermediate/deep bedrock monitoring wells included in the April/May and October 2019 sampling events continued to fluctuate compared to the concentrations reported in 2002 through 2018. The total organic concentrations in the intermediate/deep monitoring wells ranged between non-detect (OW679, OW693, OW800, OW807, and OW412C) and 8,530 μg/L (OW643) in April/May 2019, and between non-detect (OW679, OW693, OW800, OW807, and OW412C) and 5,991 μg/L (OW643) in October 2019.

3.6.3 Environmental Monitoring Program

In a letter dated May 9, 2016, USEPA/NYSDEC approved termination of the EMP and continuation of EMP monitoring at an annual frequency as part of the Niagara Plant Corrective Action Program.

The EMP wells continue to be sampled; however, will only be reported through the Niagara Plant Corrective Action Program Annual Report.

3.7 DWTP Closure Activities

GSH implemented a work plan for the injection of potassium permanganate ($KMnO_4$) to address the chemicals present in the water that became trapped in the former DWTP intake tunnel during grouting. This work plan was submitted to USEPA/NYSDEC on September 10, 2003, and was resubmitted (after verbal comments) on December 2, 2003. Verbal approval of the work plan was received on December 11, 2003, and a final version was sent to USEPA/NYSDEC on December 17, 2003. The first round of $KMnO_4$ injections into well OW808 was conducted from January 6, 2004 to January 13, 2004. Verification sampling was conducted on February 13, 2004. A second round of $KMnO_4$ injections was conducted from March 30, 2004 to April 2, 2004. Verification sampling was conducted on June 29, 2004. The results were presented in the 2004 Third Quarter Report.

A third round of $KMnO_4$ injections into well OW808 was conducted from January 11, 2007 to January 19, 2007. Verification sampling was conducted on May 24, 2007, the results of which were presented in the 2007 Second Quarter Report. OW808 is currently sampled on a semiannual basis as part of the IDCP, and the most recent sampling event was conducted on October 22, 2019. The results from this sampling are presented in Table 3.9.

The total organic chemical concentrations detected in OW808 from the April/May and October 2019 sampling events were 6.7 μg/L and 7.7 μg/L, respectively. These results are approaching the 2006 concentrations measured before the 2007 $KMnO_4$ injection, but have been stable since 2010 (in the range of 5.7 to 10.1 μg/L in this period). If the concentrations increase in 2020, an additional $KMnO_4$ injection may be considered.

4. Tracer Monitoring

4.1 APL Tracer Monitoring Program

Phase II APL Tracer Monitoring Program (ATP) was deemed complete in November 2001, following three consecutive non-detect analyses. No further APL tracer testing is planned. The "APL Tracer Monitoring Program Final Evaluation Report" was submitted to USEPA/NYSDEC on March 6, 2003, with a recommendation that "no further ATP monitoring be performed". This report was approved by USEPA/NYSDEC in a letter dated May 21, 2018.

4.2 NAPL Tracer Monitoring Program

The objective of the NAPL Tracer Monitoring Program (NTP) was to collect information and evaluate the effectiveness of the Bedrock RRT System in containing southward migration of NAPL. The particular focus of the NTP is on the mobility of NAPL in the bedrock as it dips southerly toward and beneath the Niagara River.

In a letter dated May 9, 2016, USEPA/NYSDEC indicated that the tracer monitoring programs can be discontinued as they no longer provide useful data. However, the USEPA/NYSDEC still found the results of tracer monitoring to be inconclusive, and did not provided definitive evidence that the RRT System is preventing further migration of NAPL under the Niagara River. GSH and NYSDEC met on June 9, 2016 to discuss additional steps to address the above concern. GSH and NYSDEC agreed at the meeting that implementing a revised tracer program would be difficult and not yield more conclusive results than the original program. Therefore, GSH proposed the following in a July 22, 2016 email:

- Convert OW806 into a NAPL Recovery well. Conversion of this well will fill the "gap" between existing recovery wells BPW610R and BPW237.
- Evaluate additional methods available in literature to demonstrate containment of NAPL. The results of this evaluation will be used as another "line of evidence" that the NAPL recovery system is working to prevent further NAPL migration toward the Niagara River.
- Submit a revised "Shallow Bedrock RRT Compliance Assessment" report reflecting the above.

Conversion of OW806 will be completed in 2020. The second two bullet items were addressed by submittal of the report "Effectiveness Evaluation, Shallow Bedrock NAPL Recovery System", dated May 30, 2017. USEPA/NYSDEC provided a response regarding this report in a letter dated June 10, 2019. GSH responded to those comments in a letter dated July 31, 2019 and submitted a work plan for hydraulic testing associated with these wells on August 28, 2019. USEPA/NYSDEC provided a draft response to GSH's July 31, 2019 letter on November 21, 2019. GSH and USEPA/NYSDEC discussed these comments on November 21, 2019. A follow-up discussion between GSH/USEPA occurred on January 17, 2020. During that call, GSH/USEPA agreed to conduct the hydraulic testing proposed in the work plan before responding to the draft November 21, 2019 USEPA/NYSDEC comments. The hydraulic testing will be conducted in April 2020.

5. Conclusions

Based on the monitoring data collected and the evaluations performed in 2019, the following conclusions have been made.

5.1 Overburden Pumping Systems

1. The combined flow of the seven on-Site OPWs (OPW516-522), plus WWA and WWB (Flow Meter #1) averaged 43 GPM during 2019, which is slightly below the target flow range for 2018 (50 to 60 GPM).
2. The average flow rates of WWA and WWB were 29 GPM and 8 GPM, respectively. The flow rate of the seven on-Site OPWs was minimal during 2019.
3. The combined flow of the 16 off-Site OPWs (OPW500-515) plus BPW604 (Flow Meter #2) averaged 4.3 GPM during 2019, which is slightly below the target flow range for 2019 (5.5 to 6.5 GPM).

5.2 Shallow Bedrock Pumping Systems

1. The combined flow of the seven APL BPWs (BPW600-603R and BPW605-607) averaged 87 GPM during 2019, which is within the target flow range for 2019 (85 to 110 GPM).
2. The combined flow of the seven NAPL recovery wells along Niagara River (BPW237, BPW238R, BPW239, BPW609, BPW610R, BPW611, and BPW671) was 20 GPM during 2019, which is within the target flow range for 2019 (15 to 20 GPM).
3. The combined flow of the four V-Area NAPL recovery wells (BPW613, 615, BPW682, and BPW683) was 19 GPM during 2019, which is within the target flow range for 2019 (18 to 25 GPM).

5.3 Intermediate/Deep Bedrock Pumping Systems

1. The combined flow of the four intermediate BPWs (BPW631I, BPW632I, BPW689I, and BPW698I) averaged 0.3 GPM during 2019, which is within the target flow range for 2019 (0.1 to 1 GPM). The flow from BPW688D averaged 6.4 GPM during 2019, which is within the target flow rate for 2019 (6 to 7 GPM).

5.4 Overburden Monitoring Programs

1. There was an inward hydraulic gradient present throughout 2019 at all overburden well pairs around the SBW, except for OW552/OW551 and River/OW551 in the first and fourth quarters,

and River/OW536 and River/OW532 in the fourth quarter. OW551 is prone to abnormally high levels in the spring and during heavy precipitation events, and the gradient was inward toward OW551 for all other quarters.

2. The area of upward hydraulic gradient covered a significant portion of the southern half of the Site and much of the area south of the Site to the Niagara River during all four quarters in 2018. In a letter from the USEPA/NYSDEC dated May 4, 2017, a concern was raised that a downward hydraulic gradient over the confining layer discontinuity was present in the vicinity of OPW513 and OPW514. GSH addressed this concern by reactivating OPW512, OPW513, and OPW514 on June 23, 2017. These wells had been shut down on a trial basis in 2016 as approved by USEPA/NYSDEC by letter dated May 9, 2016 in accordance with recommendations in the report “Hydraulic Response Testing Program – Off-Site Overburden Purge Wells (2002 Retesting)”. In a letter dated July 4, 2017, GSH indicated that reactivation of OPW512, OPW513, and OPW514 had restored the upward gradient in this area which is confirmed by the 2019 monitoring data.

3. No NAPL was present in any of the overburden monitoring wells located outside the SBW during the annual NAPL presence checks.

4. Drawdown was present towards WWB from both directions along the VDCS and there was an inward hydraulic gradient present between WWB and all of the manholes and piezometers throughout 2019. An inward hydraulic gradient was also maintained throughout 2019 between the Niagara River and all of the manholes and piezometers, except for PZ B-1 in the second, third, and fourth quarters, MH-8 and PZ B-3 in the second and fourth quarters, and at PZ B-4 and MH-7 in the fourth quarter.

5. Annual chemical sampling of the overburden monitoring wells in V-Area (outside the SBW) has identified elevated VOC concentrations at well OBG-4R consistent with the 2005 through 2019 events. Previous elevated VOC concentrations at well OW595 are no longer present. The concentrations of total VOCs in all wells were generally consistent with the previous events.

5.5 Shallow Bedrock Monitoring Programs

1. There were 11 wells located inside the NAPL plume at which NAPL was observed during 2019, with eight of these wells showing NAPL in all four quarters. S-Area NAPL has also been observed at one well (OW674) located outside the NAPL plume during 2019, consistent with previous years.

2. There were six wells located outside the historic NAPL plume boundary at which NAPL was observed that is representative of N-Area.

3. An inward hydraulic gradient, indicated by a positive value, was present at 11 of 12 well pairs throughout 2019. OW-691/OW627R had outward gradients in all four quarters. However, groundwater contours indicated overall containment.

4. The total organic concentrations in the shallow bedrock monitoring wells included in the May and October/November 2019 sampling events continued to fluctuate compared to the concentrations reported in past events. Total organic concentrations in middle ring well OW626 and outer ring wells OW411D and OW805 had increased by an order of magnitude in

2015 compared to 2014 concentrations; however, this was not attributable to migration from the S-Area shallow bedrock plume. Rather, this was attributable to impacted Niagara Plant groundwater being drawn toward the S-Area shallow bedrock purge well system due to the limited pumping of the Niagara Plant D-Zone bedrock groundwater extraction system in 2015. Full-scale pumping in the Niagara Plant D-Zone bedrock groundwater extraction system resumed on January 25, 2016. Since then, concentrations at these three wells have been decreasing. These wells will continue to be monitored in 2020.

5.6 Intermediate/Deep Bedrock Monitoring Programs

1. NAPL was observed in three intermediate bedrock wells located inside the NAPL plume boundary during 2019.
2. NAPL was observed in two intermediate bedrock wells located outside the NAPL plume boundary during 2019. However, the NAPL observed was re presentative of N-Area NAPL.
3. NAPL was not observed in any deep bedrock wells located inside the deep bedrock NAPL plume boundary during 2019.
4. NAPL was observed in two deep bedrock wells located outside the deep bedrock NAPL plume boundary during 2019. However, the NAPL observed in the wells was representative of N-Area NAPL.
5. An inward hydraulic gradient was present at three of the six intermediate bedrock well pairs throughout 2019. Inward gradients were achieved at four of the six deep monitoring wells throughout 2019. Groundwater contour maps show that drawdown is produced in essentially all areas of the intermediate and deep NAPL plumes, and containment is achieved even though some outward gradients were observed during 2019.
6. The total organic concentrations in the intermediate/deep bedrock monitoring wells included in the April/May and October 2019 sampling events continued to fluctuate.
7. The total organic chemical concentrations detected in OW808 from the April/May and October 2019 sampling events were 6.7 μg/L and 7.7 μg/L, respectively. These results are approaching the 2006 concentrations measured before the 2007 KMnO4 injection, but have been stable since 2010 (in the range of 5.7 to 10.1 μg/L in this period).

6. 2020 Implementation Plan

The following actions will be implemented in 2019 for the S-Area Remedial Program.

6.1 Overburden Pumping Systems

No changes or adjustments are recommended.

6.2 Shallow Bedrock Pumping Systems

OW806 will be converted to a NAPL pumping well by the end of 2020. Hydraulic testing will be performed at the existing seven NAPL pumping wells along the south border of the Site in the April 2020.

A statistical analysis of shallow bedrock groundwater indicator chemical concentrations will be submitted by concurrently with this report.

6.3 Intermediate/Deep Bedrock Pumping Systems

No changes or adjustments are recommended.

6.4 Overburden Monitoring Programs

No changes or adjustments are recommended.

6.5 Shallow Bedrock Monitoring Programs

No changes or adjustments are recommended.

6.6 Intermediate/Deep Bedrock Monitoring Programs

No changes or adjustments are recommended.

7. Recommendations

7.1 Overburden Pumping Systems

There are no recommendations at this time.

7.2 Shallow Bedrock Pumping Systems

There are no recommendations at this time.

7.3 Intermediate/Deep Bedrock Pumping Systems

There are no recommendations at this time.

7.4 Overburden Monitoring Programs

There are no recommendations at this time.

7.5 Shallow Bedrock Monitoring Programs

There are no recommendations at this time.

7.6 Intermediate/Deep Bedrock Monitoring Programs

There are no recommendations at this time.

7.7 Tracer Monitoring

There are no recommendations at this time.

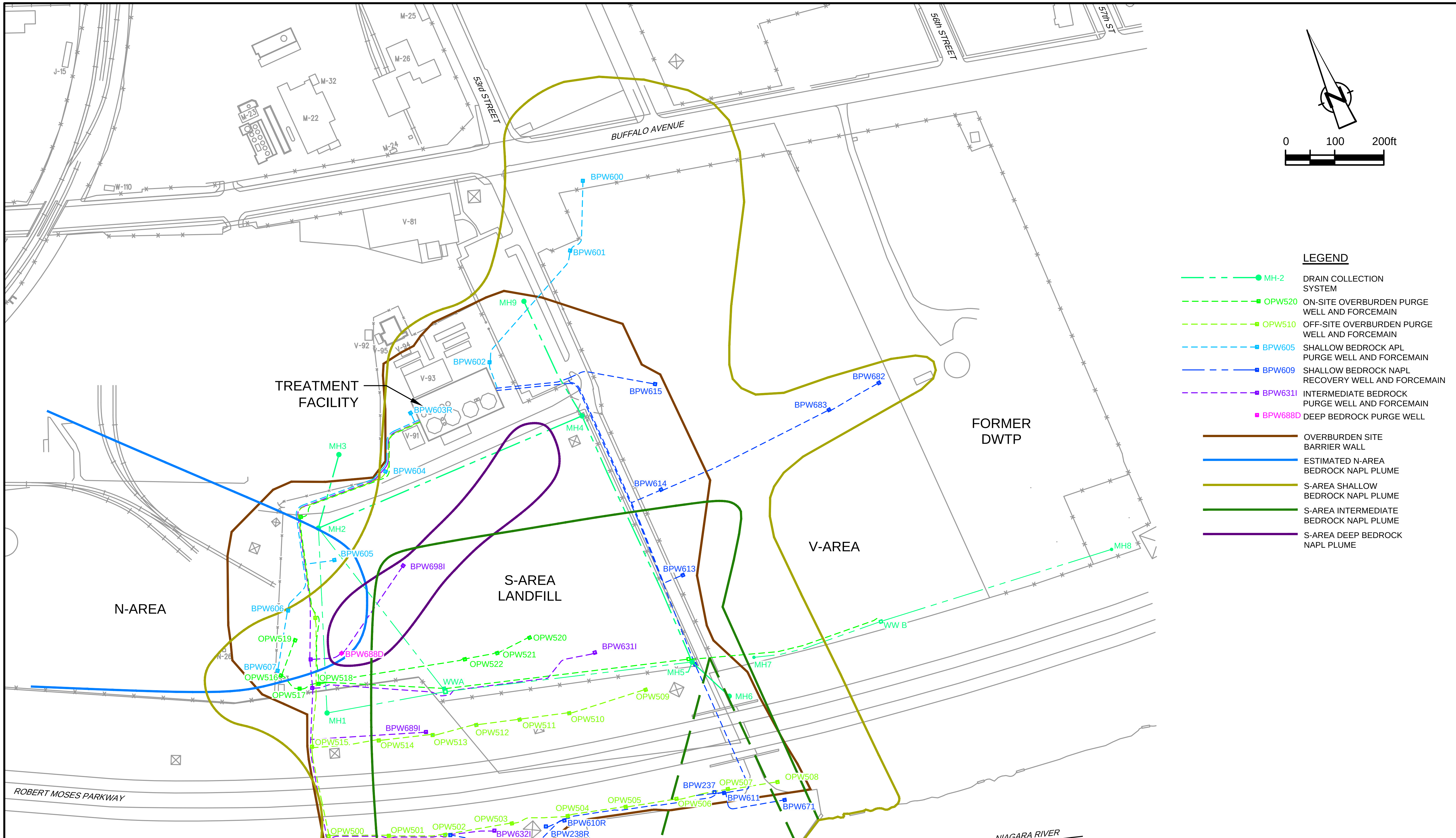

figure 1.1

OVERALL RRT PLAN
S-AREA LANDFILL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

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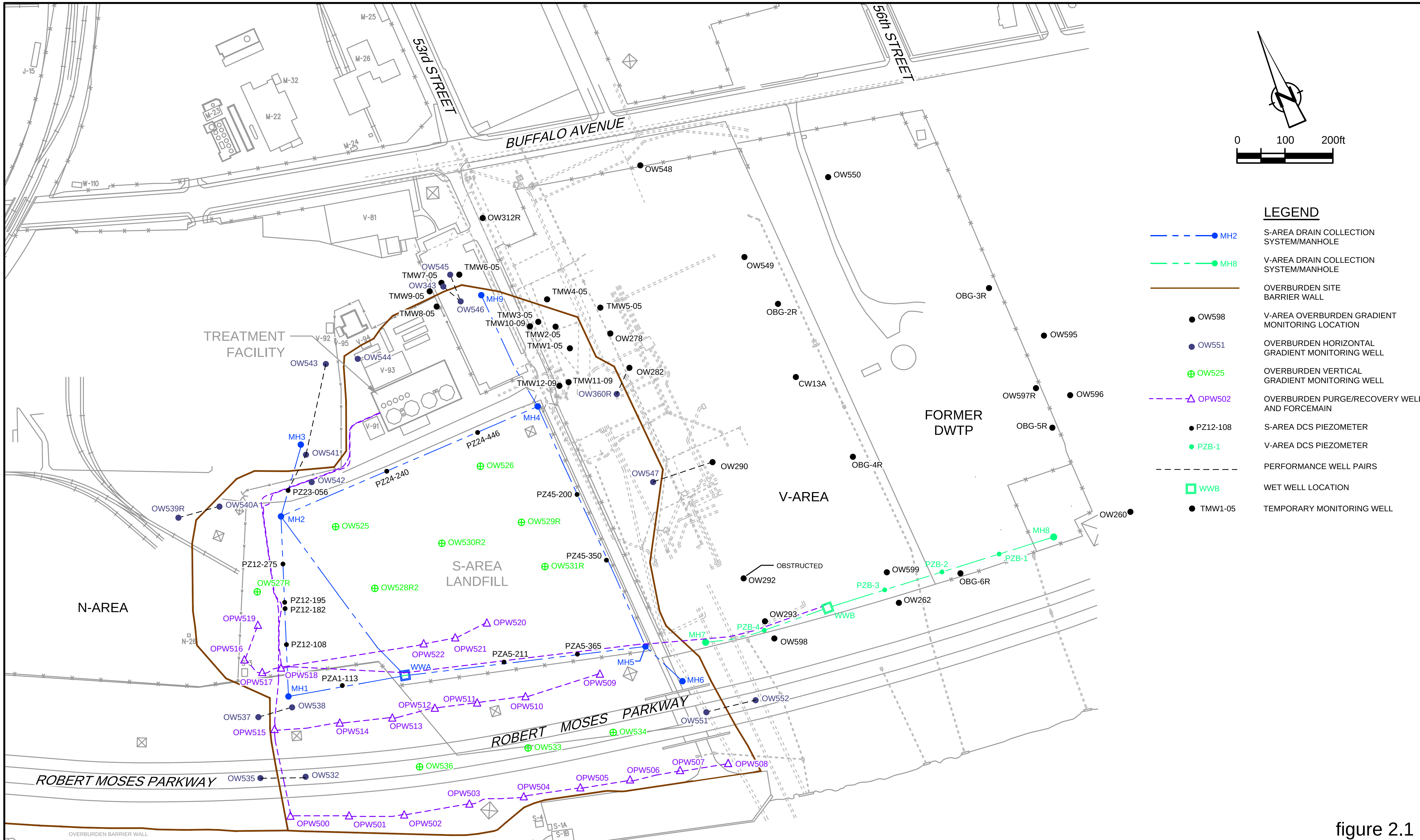

figure 2.1

OVERBURDEN REMEDIAL SYSTEMS
S-AREA LANDFILL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

GHD

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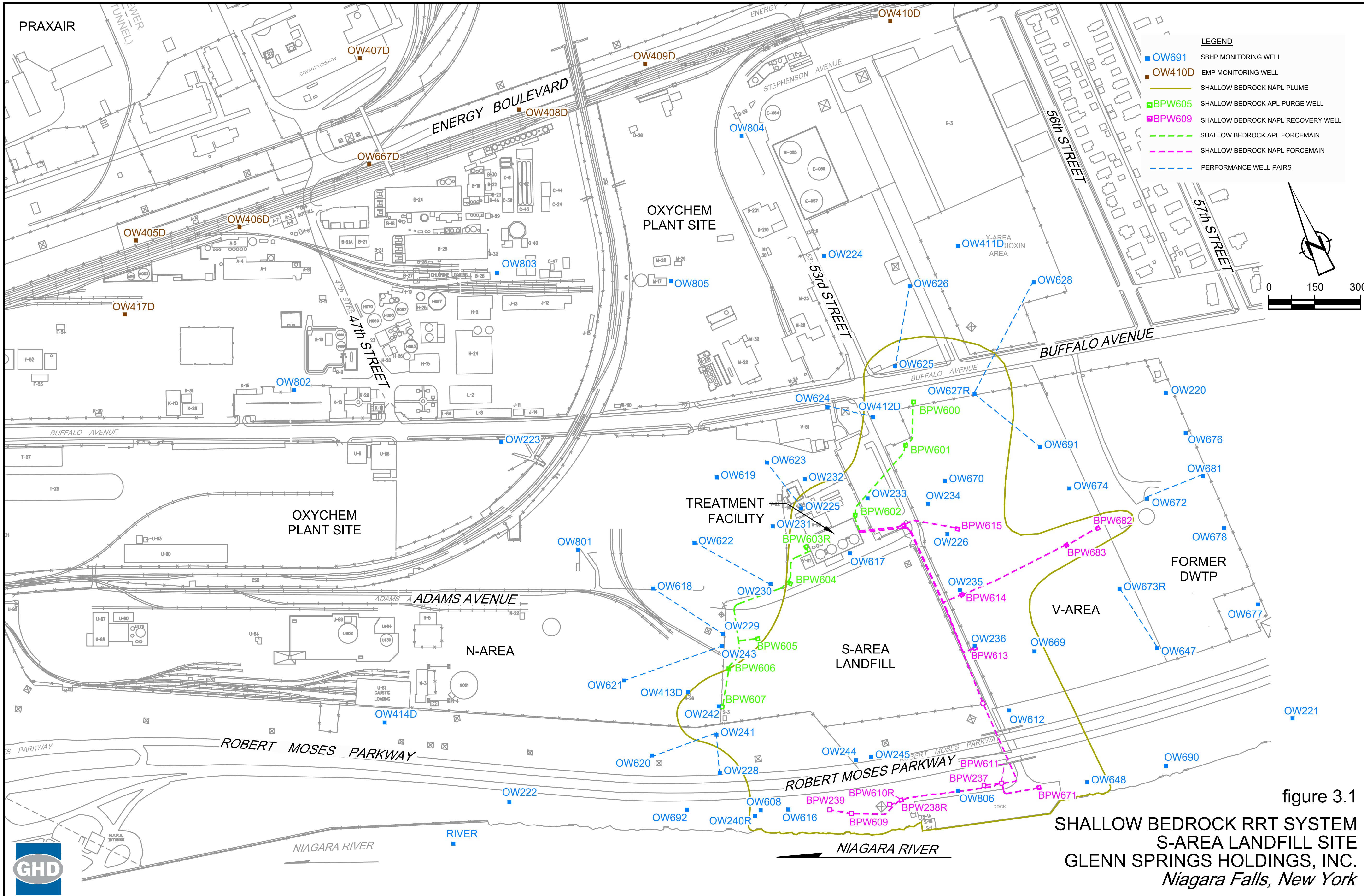

figure 3.1

SHALLOW BEDROCK RRT SYSTEM
S-AREA LANDFILL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

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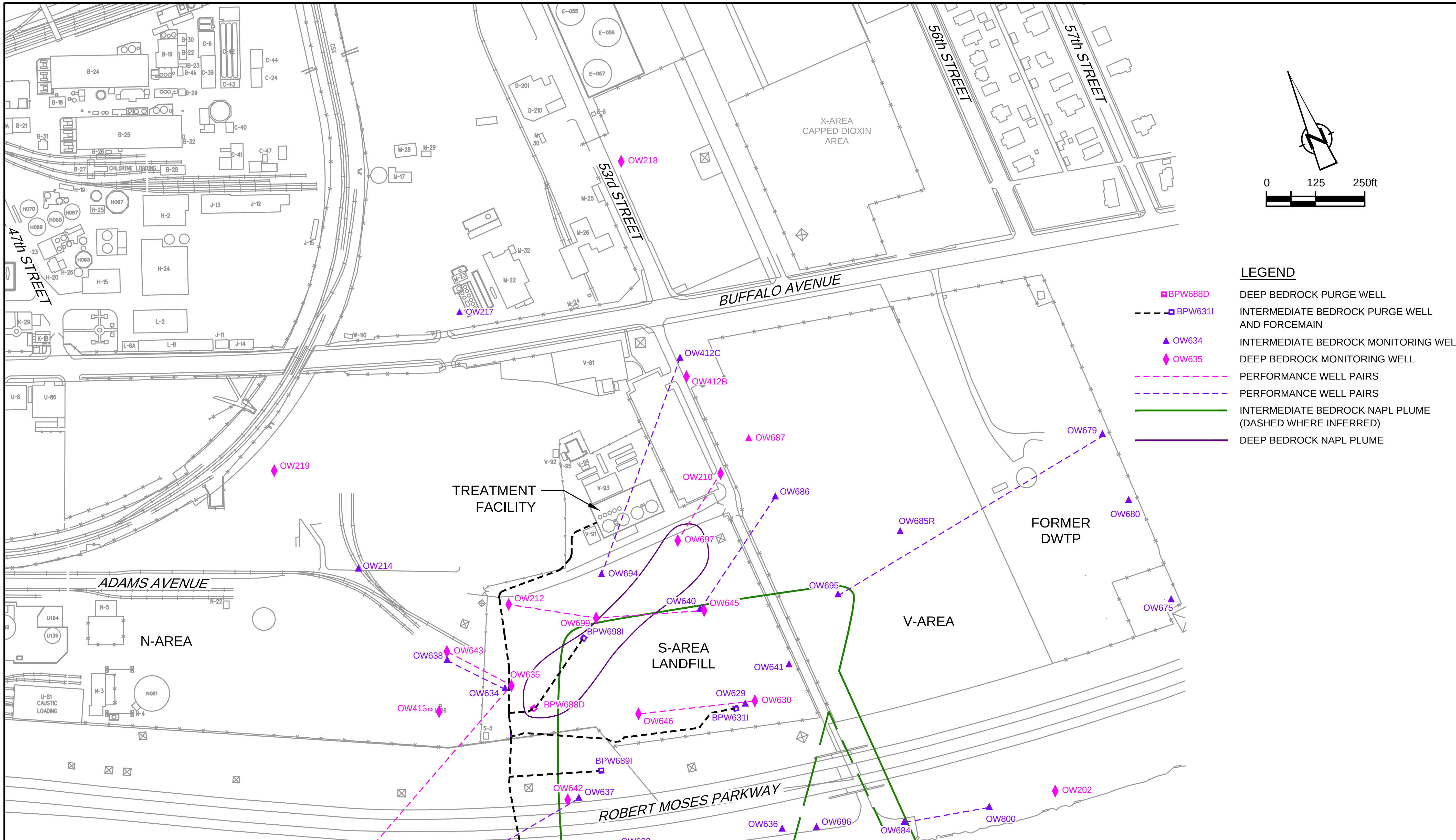

figure 3.2

INTERMEDIATE/DEEP BEDROCK RRT SYSTEM
S-AREA LANDFILL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

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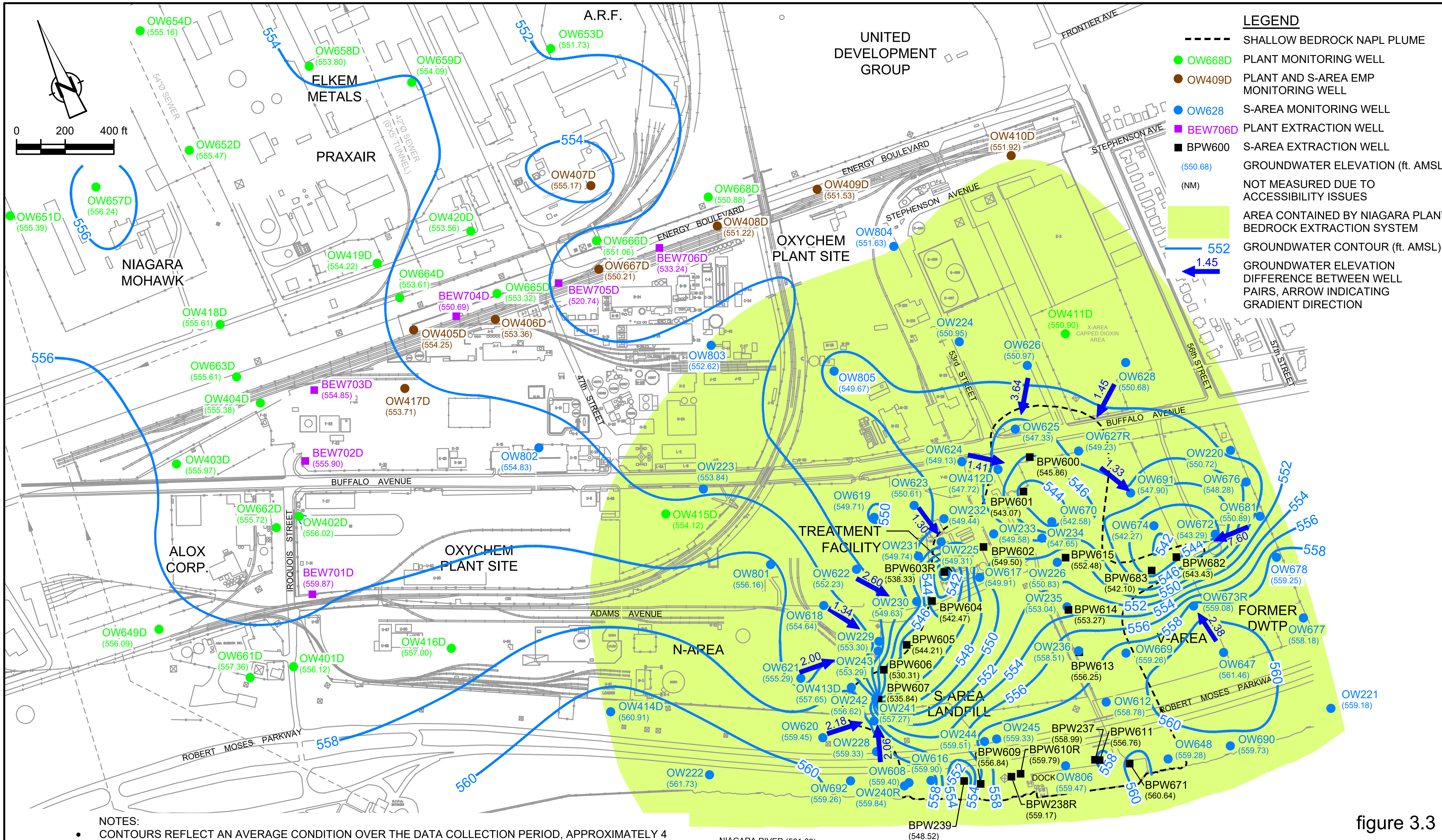

NOTES:

- CONTOURS REFLECT AN AVERAGE CONDITION OVER THE DATA COLLECTION PERIOD, APPROXIMATELY 4 HOURS. UNLESS OTHERWISE NOTED, CONTOURS RESPECT ALL WATER LEVEL MEASUREMENTS TO THE LEVEL OF UNCERTAINTY ASSOCIATED WITH COLLECTING LEVELS OVER A PERIOD OF SEVERAL HOURS. THAT UNCERTAINTY IS APPROXIMATELY +/-0.5 FEET FOR NYPA WINTER OPERATING CONDITIONS.
- MEASURED ELEVATIONS FOR S-AREA PLANT EXTRACTION WELLS BEW701D-BEW706D WERE NOT USED FOR CONTOURING.
- A CONTOUR ELEVATION OF 548 ft AMSL WAS USED FOR EXTRACTION WELL BPW606. A CONTOUR ELEVATION OF 545 ft AMSL WAS USED FOR EXTRACTION WELL BPW607.

GHD

figure 3.3

SHALLOW BEDROCK GROUNDWATER CONTOURS
NOVEMBER 25, 2019
S-AREA LANDFILL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

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Table 2.1

Calculated Inward Hydraulic Gradients
Overburden Gradient Well Pairs
S-Area Remedial Program

Well Pair: **Date**	**OW535/OW532** **Outer - Inner**	**OW537/OW538** **Outer - Inner**	**OW539R/OW540A** **Outer - Inner**	**OW541/PZ23-056** **Outer - Inner**	**OW543/OW541** **Outer - Inner**	**OW545R/OW546R** **Outer - Inner**	**OW282/OW360R** **Outer - Inner**
3/7/2019	11.51	7.79	2.80	7.03	1.48	0.84	6.67
6/5/2019	2.69	6.67	2.77	5.70	0.80	1.07	6.34
9/5/2019	1.90	5.54	2.86	4.77	1.42	1.00	4.13
11/25/19	3.39	5.20	3.03	4.54	1.53	1.18	4.23
Average	**4.87**	**6.30**	**2.86**	**5.51**	**1.31**	**1.02**	**5.34**

Well Pair: **Date**	**OW290/OW547** **Outer - Inner**	**OW552/OW551** **Outer - Inner**	**River/OW551** **Outer - Inner**	**River/OW534** **Outer - Inner**	**River/OW533** **Outer - Inner**	**River/OW536** **Outer - Inner**	**River/OW532** **Outer - Inner**
3/7/2019	14.70(1)(2)	-22.68(2)	-22.59(2)	2.92	0.76	0.03	0.17
6/5/2019	16.71(1)	-4.34	-4.78	1.67	0.14	-0.88	-0.21
9/5/2019	10.72(1)	-0.83	-0.84	1.20	0.50	0.22	0.82
11/25/19	14.95(1)	-5.85	-6.16	0.31	0.24	-4.31	-0.04
Average	**14.10**	**-8.43**	**-8.59**	**1.52**	**0.41**	**-1.24**	**0.18**

Notes:

Positive value indicates inward gradient demonstrated by a lower water elevation inside the SBW as compared to water elevations outside SBW or along the southern portion of the Site, a lower water elevation in monitoring wells than the elevation of the Niagara River.
As per NYSDEC approval November 15, 2011, hydraulic monitoring frequency has been changed from monthly to quarterly in 2012.
(1) OW547 was dry and the bottom elevation was used for calculation
(2) OW290 and OW551 are prone to abnormally high levels in the spring.

Table 2.2

Calculated Inward Hydraulic Gradients
V-Area Drain Collection System Manholes/Piezometers
S-Area Remedial Program

Date	Niagara River (ft. AMSL)	MH 8 Gradient	PZ B-1 Gradient	PZ B-2 Gradient	PZ B-3 Gradient	Wet Well B Gradient	PZ B-4 Gradient	MH 7 Gradient
3/7/2019	561.94	0.09	0.17	1.14	0.51	3.53	1.15	1.24
6/5/2019	562.10	-0.37	-0.47	0.11	-0.37	2.50	0.13	0.21
9/5/2019	562.43	0.00	-0.04	0.58	0.12	3.09	0.76	0.89
11/25/19	561.62	-0.33	-0.45	0.30	-0.31	2.26	-0.07	-0.02
Average	**-**	**-0.74**	**0.19**	**0.48**	**0.31**	**3.17**	**0.82**	**0.88**

Date	Wet Well B Elevation (ft. AMSL)	MH 8 Gradient	PZ B-1 Gradient	PZ B-2 Gradient	PZ B-3 Gradient		PZ B-4 Gradient	MH 7 Gradient
3/7/2019	558.41	3.44	3.36	2.39	3.02		2.38	2.29
6/5/2019	559.6	2.87	2.97	2.39	2.87		2.37	2.29
9/5/2019	559.34	3.09	3.13	2.51	2.97		2.33	2.20
11/25/2019	559.36	2.59	2.71	1.96	2.57		2.33	2.28
Average	**-**	**4.04**	**2.98**	**2.68**	**2.86**		**2.34**	**2.29**

Notes:

ft AMSL - Feet Feet Above Mean Sea Level.
Positive value indicates inward gradient as demonstrated by a lower water elevation in MH or piezometers than the elevation of the Niagara River or WWB.
As per NYSDEC approval November 15, 2011, hydraulic monitoring frequency has been changed from monthly to quarterly in 2012.

Table 2.3

Total Organic Chemical Concentrations
V-Area Chemical Monitoring Program
S-Area Remedial Program

Well	Total Organic Concentration (µg/L)																	
	June/July 2002	**June 2003**	**May 2004**	**December 2005**	**September 2006**	**April/May 2007**	**April 2008**	**December 2009**	**December 2010**	**December 2011**	**January 2013**	**December 2013**	**December 2014**	**December 2015**	**December 2016**	**December 2017**	**December 2018**	**December 2019**
CW13A	0.41	11	8.0	NS	NS	1.67	191	416	167	284	366	399	406	365	211	511	412	416 [5]
OBG-2 [1]	ND	ND	NS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OBG-3 [2]	ND	ND	NS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OBG-4 [2]	144/146	94	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OBG-5 [2]	2.0	13	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OBG-6 [2]	868	504	590/582	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OBG-2R [3]	-	-	-	ND/ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
OBG-3R [4]	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	0.5	NS	NS	NS	NS	NS	NS
OBG-4R [4]	-	-	-	7,577/7,710	4,145	6,434	5,105	7,039	5,551	5,350	5,010	4791/4801	4177/3856	4520/3842	3849/3751	5010/5125	4263/4476	4071/4181 [5]
OBG-5R [4]	-	-	-	ND	1.4	ND	ND	0.52	0.46/ND	1.45/1.32	1.51/1.9	1.9	4.3	4.4	2.1	2.7	3.3	3.7 [5]
OBG-6R [4]	-	-	-	0.29	0.10	ND/ND	ND	-	-	-	-	-	-	-	-	-	-	-
OW260	ND	ND	ND/ND	ND	ND	ND/ND	0.77/0.81	ND	0.21	ND	ND	1.3	ND/ND	0.21	0.02	0.91	ND	ND
OW262	1.5	0.71	0.64	1.6	6.7	7.3	10	26.97/26.61	51	39	39	22	14	13	13	17	12	15
OW278	-	-	22	47	34	12	30	17	49	22	24	21	17	16	15	11	10	7 [5]
OW282	1.2	1.94/ND	2.7	1.2	0.7	0.5	8.4	1.8	21	5.7	9.0	5.2	2.0	2.3	1.2	2.4	1.4	1.2
OW290	6.9	9.2	NS	NS	NS	0.6	0.5	-	-	-	-	-	-	-	-	-	-	-
OW292	ND	0.51	ND	0.18	0.32	0.10	0.43	-	-	-	-	-	-	-	-	-	-	-
OW293	ND	0.77/ND	ND	ND	ND	0.42	0.98	-	-	-	-	-	-	-	-	-	-	-
OW312R	NS	NS	NS	NS	NS	0.11	ND	-	-	-	-	-	-	-	-	-	-	-
OW548	1.0	ND	NS	ND	ND	ND	ND	-	-	-	-	-	-	-	-	-	-	-
OW549	ND	ND	NS	2.2	1.3	0.59	0.27	ND	ND	ND	ND	ND	ND	ND	0.20	ND	ND	ND
OW550	ND	NS	ND	NS	NS	NS	NS	-	-	-	-	-	-	-	-	-	-	-
OW595	NS	5,208	5,851	35	233	9.0	22	72	27	42	55	65	47	86	16	67	27	62
OW596	NS	0.29	ND	0.19	0.53	0.16	2.1	ND	0.18	0.22	ND	ND	0.30	ND	ND	ND	0.02	ND [5]
OW597 [2]	ND	1.8	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OW597R [4]	-	-	-	NS	NS	1.9	2.1	1.5	1.6	1.4	171	186	164	130	0.12	0.07	0.01	0.11 [5]
OW598	ND	ND	4.09	ND	1.3	24	1.1	-	-	-	-	-	-	-	-	-	-	-
OW599	ND/ND	ND	ND	2.9	1.2	1.2	1.70/1.59	0.89	0.84	1.5	1.3	1.9	2.0	2.2	2.5	1.8	2.3	2.1

Notes:

(1)	Well buried by berm construction during the first quarter of 2005.
(2)	Well abandoned due to freeze/thaw sludge bed construction in May 2004.
(3)	Well installed to replace OBG-2 on May 20, 2005.
(4)	Well installed in October 2004.
(5)	Pesticide results not included as data was rejected upon validation.
ND	Not detected (NDs were assumed to be zero).
NS	Not sampled (insufficient water sample or well was dry).
-	Not part of program.
µg/L	Micrograms per liter.

Table 2.4

Overburden Extraction System Flow Rates
Wet Wells and Overburden Purge Wells
S-Area Remedial Program

	Wet Well A Average Flow Rate (GPM)	Wet Well B Average Flow Rate (GPM)	Flow Meter #1 (WWA/WWB and On-Site OPWs) Average Flow Rate (GPM)	Flow Meter #2 (Off-Site OPWs and BPW604) Average Flow Rate (GPM)
January 2019	36	17	52	3.7
February 2019	7(1)	7(1)	50	3.9
March 2019	8(1)	16	49	3.6
First Quarter Average	**17**	**7**	**51**	**3.7**
April 2019	38	13	51	4.4
May 2019	36	13	46	4.8
June 2019	34	12	41	5.4
Second Quarter Average	**36**	**13**	**46**	**4.9**
July 2019	34	11	40	4.8
August 2019	31	10	38	4.5
September 2019	30	11	38	4.5
Third Quarter Average	**32**	**2**	**39**	**4.6**
October 2019	29	11	36	4.4
November 2019	32	9	36	3.9
December 2019	33	8	34	3.5
Fourth Quarter Average	**31**	**9**	**36**	**3.9**
Year-to-Date Average	**29**	**8**	**43**	**4.3**
Target Flow Rate for 2019	37-41	10-18	50-60	5.5-6.5
Target Flow Rate for 2020	37-41	10-18	50-60	5.5-6.5

Note:

GPM Gallons per minute.
(1) Flow meter malfunctions occurred at WWA and WWB in the first quarter of 2019. Actual flow rate was higher than shown

Table 3.1

Bedrock Extraction System Flow Rates
Shallow Bedrock APL Purge Wells
S-Area Remedial Program

	BPW600 Average Flow Rate (GPM)	BPW601 Average Flow Rate (GPM)	BPW602 Average Flow Rate (GPM)	BPW603R Average Flow Rate (GPM)	BPW605 Average Flow Rate (GPM)	BPW606 Average Flow Rate (GPM)	BPW607 Average Flow Rate (GPM)	Total APL Purge Well Network Average Flow Rate (GPM)
January 2019	14.8	13.1	7.4	2.9	(1)	12.1	6.7	57
February 2019	15.3	14.2	7.1	15.7	(1)	12.9	12.5	78
March 2019	15.2	13.5	6.6	20.4	10.6	11.9	10.4	88
First Quarter Average	**15.1**	**13.6**	**7.1**	**13.0**	**3.5**	**12.3**	**9.9**	**74**
April 2019	15.2	13.4	5.9	20.1	15.6	11.5	8.8	90
May 2019	15.7	14.3	3.6	19.8	15.6	11.6	10.1	91
June 2019	15.2	12.3	5.7	19.4	15.7	11.1	15.1	94
Second Quarter Average	**15.4**	**13.3**	**5.1**	**19.8**	**15.6**	**11.4**	**11.4**	**92**
July 2019	15.2	12.8	0.9	19.6	15.5	11.3	15.7	91
August 2019	14.2	13.6	4.9	18.7	15.3	11.6	16.4	95
September 2019	13.2	13.9	4.1	18.5	15.7	11.6	17.3	94
Third Quarter Average	**14.2**	**13.4**	**3.3**	**18.9**	**15.5**	**11.5**	**16.4**	**93**
October 2019	12.4	14.8	(2)	18.2	15.8	11.5	17.8	91
November 2019	10.8	15.1	0.5	18.0	15.9	11.4	16.4	88
December 2019	8.8	12.9	3.6	17.6	15.4	10.7	12.6	82
Fourth Quarter Average	**10.7**	**14.2**	**1.4**	**18.0**	**15.7**	**11.2**	**15.6**	**87**
Year-to-Date Average	**13.8**	**13.6**	**4.2**	**17.4**	**12.6**	**11.6**	**13.3**	**87**
Target Flow Rate for 2019	10-20	4-6	9-16	29-32	13-16	15-17	11-15	85-110
Target Flow Rate for 2020	10-20	4-6	9-16	29-32	13-16	15-17	11-15	85-110

Note:

GPM Gallons per minute.
(1) - BPW605 was down for repairs in January and February of 2019
(2) - BPW602 was down for repairs in October 2019

Table 3.2

Bedrock Extraction System Flow Rates
Shallow Bedrock NAPL Recovery Wells (River)
S-Area Remedial Program

	BPW237 Average Flow Rate (GPM)	BPW238R Average Flow Rate (GPM)	BPW239 Average Flow Rate (GPM)	BPW609 Average Flow Rate (GPM)	BPW610R Average Flow Rate (GPM)	BPW611 Average Flow Rate (GPM)	BPW671 Average Flow Rate (GPM)	Total NAPL Recovery Well Network Average Flow Rate (GPM)
January 2019	3.9	0.6	3.9	3.4	4.7	4.9	0.2	22
February 2019	3.8	0.7	3.6	3.2	4.5	4.7	0.02[1]	21
March 2019	4.0	0.8	3.9	3.4	4.8	4.9	0.001[1]	22
First Quarter Average	**3.9**	**0.7**	**3.8**	**3.3**	**4.7**	**4.8**	**0.1**	**21**
April 2019	3.9	2.0	3.9	3.4	4.8	4.4	0.2	23
May 2019	3.8	1.0	3.7	3.4	4.7	2.2	0.24	19
June 2019	3.3	0.6	3.5	3.2	4.2	4.0	0.2	19
Second Quarter Average	**3.7**	**1.2**	**3.7**	**3.3**	**4.6**	**3.5**	**0.2**	**20**
July 2019	3.0	0.5	3.3	2.9	3.9	5.2	0.2	19
August 2019	3.1	0.2	3.2	2.2	3.6	5.6	0.3	18
September 2019	3.3	0.0	2.9	2.2	3.1	6.0	0.1	18
Third Quarter Average	**3.1**	**0.2**	**3.1**	**2.4**	**3.5**	**5.6**	**0.2**	**18**
October 2019	3.2	0.7	1.1	2.9	5.0	4.8	0.2	18
November 2019	3.4	0.7	3.6	3.0	4.5	5.4	0.2	21
December 2019	3.6	[2]	0.4[3]	3.1	5.2	5.4	0.2	18
Fourth Quarter Average	**3.4**	**0.5**	**1.7**	**3.0**	**4.9**	**5.2**	**0.2**	**19**
Year-to-Date Average	**3.5**	**0.6**	**3.1**	**3.0**	**4.4**	**4.8**	**0.2**	**20**
Target Flow Rate for 2019	1-3	1-3	1-3	1-5	2-4	3-10	1-3	15-20
Target Flow Rate for 2020	1-3	1-3	1-3	1-5	2-4	3-10	1-3	15-20

Note:

GPM Gallons per minute.
(1) - Flow meter malfunction occurred at BPW671 in February and March.
(2) - BPW238R was down for repairs in November and December
(3) - BPW239 was down for repairs in December

Table 3.3

Bedrock Extraction System Flow Rates
Shallow Bedrock NAPL Recovery Wells (V-Area)
S-Area Remedial Program

	BPW613 Average Flow Rate (GPM)	BPW615 Average Flow Rate (GPM)	BPW682 Average Flow Rate (GPM)	BPW683 Average Flow Rate (GPM)	Total NAPL Recovery Well Network Average Flow Rate (GPM)
January 2019	3.2	0.1	5.9	9.6	19
February 2019	2.7	0.1	5.7	9.9	18
March 2019	3.3	0.1	5.8	9.7	19
First Quarter Average	**3.1**	**0.1**	**5.8**	**9.7**	**19**
April 2019	3.4	0.1	6.0	9.7	19
May 2019	3.4	0.03	6.4	9.5	19
June 2019	3.2	0.03	6.9	9.1	19
Second Quarter Average	**3.3**	**0.04**	**6.4**	**9.4**	**19**
July 2019	3.0	0.03	7.2	8.6	19
August 2019	3.2	0.03	7.9	6.9	18
September 2019	3.1	0.04	7.5	9.1	20
Third Quarter Average	**3.1**	**0.03**	**7.5**	**8.2**	**19**
October 2019	3.2	0.04	7.5	8.6	19
November 2019	3.2	0.03	7.6	8.4	19
December 2019	2.9	0.03	7.3	8.6	19
Fourth Quarter Average	**3.1**	**0.03**	**7.4**	**8.5**	**19**
Year-to-Date Average	**3.2**	**0.1**	**6.8**	**9.0**	**19**
Target Flow Rate for 2019	3-6	2-4	1-4	4-7	18-25
Target Flow Rate for 2020	3-6	2-4	1-4	4-7	18-25

Notes:

GPM Gallons per minute.

Table 3.4

Bedrock Extraction System Flow Rates
Intermediate/Deep Bedrock Purge Wells
S-Area Remedial Program

	BPW631I Average Flow Rate (GPM)	BPW632I Average Flow Rate (GPM)	BPW689I Average Flow Rate (GPM)	BPW698I Average Flow Rate (GPM)	Intermediate Bedrock Purge Well Network Average Flow Rate (GPM)	Deep Bedrock BPW688D Average Flow Rate (GPM)
January 2019	0.03	0.005	0.03	0.2	0.3	6.0
February 2019	0.04	0.001	0.01	0.2	0.3	7.2
March 2019	0.03	0.001	(1)	0.2	0.2	7.1
First Quarter Average	**0.03**	**0.002**	**0.02**	**0.2**	**0.3**	**6.7**
April 2019	0.04	0.001	(1)	0.2	0.3	7.1
May 2019	0.03	0.001	(1)	0.2	0.2	7.2
June 2019	0.04	0.001	(1)	0.2	0.2	5.6
Second Quarter Average	**0.04**	**0.001**	**(1)**	**0.2**	**0.2**	**6.6**
July 2019	0.04	0.001	(1)	0.2	0.3	2.3
August 2019	0.03	0.001	0.03	0.2	0.2	6.8
September 2019	0.03	0.001	0.04	0.2	0.3	6.9
Third Quarter Average	**0.03**	**0.001**	**0.02**	**0.2**	**0.3**	**5.4**
October 2019	0.04	0.001	0.04	0.2	0.3	6.9
November 2019	0.03	0.001	0.04	0.2	0.3	7.1
December 2019	0.03	0.001	0.04	0.2	0.3	6.8
Fourth Quarter Average	**0.04**	**0.001**	**0.04**	**0.2**	**0.3**	**6.9**
Year-to-Date-Average	**0.03**	**0.002**	**0.03**	**0.2**	**0.3**	**6.4**
Target Flow Rate for 2019	0.12-0.20	0.001-0.005	0.02-0.05	0.1-1	0.1-1	6-7
Target Flow Rate for 2020	0.12-0.20	0.001-0.005	0.02-0.05	0.1-1	0.1-1	6-7

Note:

GPM Gallons per minute.
(1) - BPW689I was down for repairs from March to July 2019.

Table 3.5

Calculated Inward Hydraulic Gradients
Shallow Bedrock Performance Piezometer Pairs
S-Area Remedial Program

Well Pair:	**OW-228/OW-241 Outer - Inner**	**OW-620/OW-241 Outer - Inner**	**OW-621/OW-243 Outer - Inner**	**OW-618/OW-229 Outer - Inner**	**OW-622/OW-230 Outer - Inner**	**OW-623/OW-225 Outer - Inner**
Date						
03/07/19	2.13	2.28	2.33	1.86	3.26	2.01
06/05/19	2.38	2.75	2.30	1.28	3.00	1.87
09/05/19	2.62	2.79	2.43	1.83	2.77	1.95
11/25/19	2.06	2.18	2.00	1.34	2.60	1.30
Average	**2.30**	**2.50**	**2.26**	**1.58**	**2.91**	**1.78**

Well Pair:	**OW-624/OW-412D Outer - Inner**	**OW-626/OW-625 Outer - Inner**	**OW-628/OW-627R Outer - Inner**	**OW-691/OW-627R Outer - Inner**	**OW-647/OW-673R Outer - Inner**	**OW-681/OW-672 Outer - Inner**
Date						
03/07/19	1.74	5.80	1.16	-1.53	2.38	6.76
06/05/19	1.88	5.42	1.89	-0.69	2.43	7.31
09/05/19	1.54	5.18	1.86	-0.71	2.50	7.50
11/25/19	1.41	3.64	1.45	-1.33	2.38	7.60
Average	**1.64**	**5.01**	**1.59**	**-1.06**	**2.42**	**7.29**

Notes:

Positive value indicates inward gradient as demonstrated by a lower water elevation in the inner well than the outer well of the pair.

Table 3.6

Calculated Inward Hydraulic Gradients
Intermediate/Deep Bedrock Well Pairs
S-Area Remedial Program

Well Pair:	**OW-693/OW-637**	**OW-638/OW-634**	**OW-412C/OW-694**	**OW-686/OW-640**	**OW-679/OW-695**	**OW-800/OW-684**
	Outer - Inner	**Outer - Inner**	**Outer - Inner**	**Outer - Inner**	**Outer - Inner**	**Outer - Inner**
Date						
03/07/19	1.53	-0.81	0.97	0.18	0.84	4.10
06/05/19	1.75	-0.14	-0.05	-0.20	2.57	4.53
09/05/19	2.16	-1.06	-0.24	-0.09	1.97	4.02
11/25/19	0.88	-0.15	-0.13	-0.12	1.79	3.50
Average	**1.58**	**-0.54**	**0.14**	**-0.06**	**1.79**	**4.04**

Well Pair:	**OW-206/OW-635**	**OW-643/OW-635**	**OW-212/OW-699**	**OW-210/OW-697**	**OW-645/OW-699**	**OW-630/OW-646**
	Outer - Inner	**Outer - Inner**	**Outer - Inner**	**Outer - Inner**	**Outer - Inner**	**Outer - Inner**
Date						
03/07/19	2.41	-8.04	8.00	-3.26	1.99	1.97
06/05/19	1.76	-8.88	7.09	-3.08	1.61	2.01
09/05/19	2.11	-9.31	7.28	-3.23	1.53	1.88
11/25/19	1.94	-10.21	6.99	-3.23	1.53	2.61
Average	**2.06**	**-9.11**	**7.34**	**-3.20**	**1.66**	**2.12**

Notes:

Positive value indicates inward gradient as demonstrated by a lower water elevation in the inner well than the outer well of the pair.

Table 3.7

Total Organic Chemical Concentrations
Shallow Bedrock Chemical Monitoring Program (SBCP)
S-Area Remedial Program

Total Organic Concentration (µg/L)

Well	Historic [1]	2001 Aug	2001 Dec	2002 Feb/Mar	2002 Apr	2002 July	2002 Oct	2003 Jan	2003 July	2004 Feb/Mar	2004 July/Aug	2005 Apr	2005 Aug	2006 Apr	2006 Oct/Nov	2007 Apr	2007 Sept	2008 Apr	2008 Oct	2009 Apr	2009 Oct
Inner Ring																					
OW226	13,267	--	--	--	--	263	--	--	318	--	405	--	192	--	228	--	266	--	153	--	888
OW242	6,432	--	--	--	--	1,324	--	--	2,027	--	1,728	--	991	--	1,159	--	1,566	--	989	--	1,797
OW225	--	--	--	--	--	143	--	--	623	--	265	--	44	--	64	--	155	--	263	--	112
OW236	--	--	--	--	--	17	--	--	56	--	701	--	16	--	3	--	2	--	1/1	--	31
OW616	--	--	--	--	--	72	--	--	224	--	95	--	324	--	379	--	866	--	381	--	639
OW806	--	--	--	--	--	1,746	--	--	857	--	7,222	--	18,684	--	5,581	--	11,827	--	9,808	--	30,155
Middle Ring																					
OW618	724	339	--	553	--	313	--	330	187	297	160	69	342	141	108	395	127	102/422	236	649/611	824
OW619	832	397	--	476	--	372	--	379	272	475	322	71	307	255	213	211	206	340	305	543	749
OW231	1,029	844	--	101	--	183	--	187	991	290	188	152	264	298	184	367	255	528	530	795	758
OW243	1,352	914	--	1,495	--	191	--	62	196	39	1,498	1,159	536	1,783	1,955	1,667	108	27,100	926	991	1,622
OW412D	783	1,058	--	467	--	1,707	--	ND	865	545	758	1,076	1,003	1,455	655	732	891	719	621	1,008	862
OW230	--	142	455	297	957	85	116	166	476	181	153	325	410	478	782	627	498	787	599	536	652
OW240R	--	16	85	46	87	24	15	74	29	73	152	76	116	19	88	135	161	156	115	52	211/184
OW241	--	1,186	1,494	47	456	659	72	75	63	126	25	23	12	168	129	85/495	34/39	79	29	229	141
OW620	--	337	398	342	952	991	304	1,127	198	693	647	96	52	415	358	405	241	406	154	1,023	349
OW621	--	565	1,183	550	2,181	321	3,729	5,854	737	2,630	1,161	--	1,756	16,418	4,358	3,430	1,732	3,653	1,333	4,465	2,159
OW624	--	519	513	323	1,530	223	1,606	1,284	821	2,575	868	2,526	1,808	244	1,774	2,360	2,246	1,148	1,080	1,810	1,401
OW626	--	60	37	7.6	155	66	76	60	107	75	85	206	175	120	203	207	199	175	174	387	210
OW648	--	16	12	95	175	136	24	31	51	140	136	56	11	10	31	36/28	38	46	13/12	58	26
OW670	--	101	95	82	134	8,350	7,405	44,273	--	16,066	17,618	11,370	9,476	2,799	2,364	9,657	34,564	7,300	31,767	36,678	28,554
OW672	--	23	23	27	18	16	23	11	13	29	56	20	12	15	16	18	18	21	20	19	8.9
OW674	--	2,777	3,972	3,041	4,886	3,686	4,378	3,592	2,655	8,322	2,727	3,558	3,999	2,851	3,140	2,236	2,817	2,179	1,146	1,752	3,415
Outer Ring																					
OW224	2,287	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OW220	74	ND	--	6.1	--	6.0	--	4.1	1.3	6.1	11	2.0	4.0	5.8	3.7	4.1	4.7	5.8	5.9	5.7	6.1
OW223	110	452	--	504	--	253	--	1,138	687	100	6.3	93	1,967	3,124	4,002	3,695	211	824	131	42	300
OW414D	87	11	--	16	--	ND	--	40	66	16	24	23	4.7	30	9	95	ND	ND	ND	39/31	41/41
OW411D	--	ND	ND	1.0	28	ND	4.7	ND	0.5	5.3	65	ND	23	37	17	30	32/29	77	44	30	55
OW677	--	ND	ND	3.6	3.4	3.7	3.1	5.9	2.8	--	5.8	5.1	5.3	4.7	7.2	6.4	5.7	9.8	5.0	5.0	2.2
OW805	--	617	688	115	94	234	170	154	18	90	36	156	175	1,888	167	202	169	229/229	135	3,999	254

Well	2010 Apr	2010 Oct	2011 Apr/May	2011 Oct	2012 Apr/May	2012 Oct/Nov	2013 Apr	2013 Oct	2014 Apr/May	2014 Sep/Oct	2015 Apr	2015 Oct	2016 Apr	2016 Nov	2017 Apr	2017 Sep/Oct	2018 Apr/May	2018 Sep/Oct	2019 May	2019 Oct/Nov
Inner Ring																				
OW226	--	244/266	--	168	--	210	--	261	--	331	--	269	--	446	--	366	--	579	--	2,434
OW242	--	1,298	--	584	--	1,126	--	938	--	952	--	784	--	638	--	753	--	1,128	--	959
OW225	--	240	--	129	--	811	--	285	--	464	--	317	--	574	--	633	--	248	--	181
OW236	--	1	--	2	--	ND	--	1.0	--	ND	--	ND	--	0.76	--	ND	--	1.2	--	0.5
OW616	--	489/574	--	1	--	1,331/1,402	--	844	--	825	--	666	--	680	--	582	--	455/445	--	408/253
OW806	--	32,740	--	6,345	--	9,840	--	3,827	--	8,919	--	2,557	--	4,774	--	2,954	--	3,434	--	2,840
Middle Ring																				
OW618	717	303	1,356	665	636	572	660	593	494	510	525	573	501	393	372	265	380	436	489	830
OW619	491	266	2,477	196	382	260	397	303	349	352	411	391	372	448	342	302	342	311	274	349
OW231	574	566	598	339	656	478	619	778	1,076/1,148	983	984/960	609	361/346	192	176/172	196	165/160	145	459/395	227
OW243	121	2.7	145	499	666	408	307	520	414	301	272	303	279	286	184	247	248	224	229	212
OW412D	719	567	346	598	616	825	680	1,298/1,313	6,857	4,138	2,687	3,228	4,747	2,385	1,749	5,468	1,634	2,163	1,471	1,479
OW230	535	477	504	283	904/885	357	511/508	422/435	819	691	593	434	287	366	396	533	562	398	556	411
OW240R	84	121	91	89	112	247	95	185	105	114	94	94	66	84	131	97	82	108	104	99
OW241	154	23	35	16	274/281	182	170	44	358/345	110	221/224	112	207/201	80	148/150	109	514/525	83.59	140	44.02
OW620	352/373	202	365	239	457	211	411	243	446	346/308	358	221/226	281	241/248	331	218/221	420	235/226	270	221
OW621	2,964	1,420	2,191	1,592	3,071	2,303	3,060	363	30	120	64	90	59	138	50	44	42	32	64	33
OW624	2,099	2,266	709/699	997	1,534	1,805	854	4,516	1,653	2,881	1,219	1,185	1,279	1,390	4,806	1,163	602	884	795	443
OW626	147	128	138	129	165	141	142	139	140	125	10,394	12,904	14,168	7,675	6,164	3,811	2,571	2,251	1,759	1,206
OW648	16	20	19/14	19	32	31	23	24	43	13	44	17	31	30	70	72	102	62	36	41
OW670	6,264	46	4,300	1,513	10,950	8,127	7,751	2,726	8,664	10,197	8,715	7,361	19,138	11,939	7,330	5,673	7,956	11,535	10,702	17,686
OW672	12	13	5.6	16	23	33	26	28	23	22	20	21	22	17	23	25	28	24	26/30	31
OW674	2,505	2,474	2,284	26,270	4,679	24,148	4,371	1,679	14,255	3,787	3,252	10,521	1,836	3,748	1,172	1,394	1,306	1,054	1,806	1,524
Outer Ring																				
OW224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OW220	4.0	2.7	3.1	2.4	3.4	4.0	3.3	2.3	2.2	2.3	1.5	4.3	5.5	2.3	3.0	2.7	2.0	2.7	2.0	3.8
OW223	260	278	119	99	136	4,302	6,992	8,000	7,639	6,321	7,769	6,233	4,544	9,418	1,844	2,310	2,054	662	1,546	444
OW414D	105/92	127	119	0.9	22	232/141	166	137	144	180	354	232	257	146	132	267/277	218	249	236	389
OW411D	40	30	32	39	36	46	30	28	22	42/43	846	1,922/2,007	2,069	1,039/1,066	348	584	299	383	217	230
OW677	6.7	5.6	5.0	3.8	5.6	4.0	5.7	4.2	4.3	4.5	5.5	4.3	3.9	3.0	3.5	3.3	3.5	3.0	3.8	3.3/3.0
OW805	146	118	181	94	226	135	344	298	432	828	3,934	5,554	1,414	626	697	542	102	178	68	69

Notes:

(1) The historic total organic concentration is the sum of the mean concentrations for each parameter from the Baseline Chemical Monitoring Program (excluding total organic halides).
ND Not detected (NDs were assumed to be zero).
-- Not sampled.
µg/L Micrograms per liter.

Table 3.8

Analytical Parameters
Shallow Bedrock Chemical Monitoring Program (SBCP)
S-Area Remedial Program

Parameters	Reporting Limit (µg/L)
Volatile Organic Compounds	
1,2,3-Trichlorobenzene	1
1,2,4-Trichlorobenzene	1
1,2-Dichlorobenzene	1
1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	1
Benzene	1
Chlorobenzene	1
cis-1,2-Dichloroethene	1
Tetrachloroethene	1
trans-1,2-Dichloroethene	1
Trichloroethene	1
Vinyl chloride	1
Semi-Volatile Organic Compounds	
1,2,3,4-Tetrachlorobenzene	4.7
1,2,4,5-Tetrachlorobenzene	4.7
Hexachlorobenzene	4.7
Hexachlorobutadiene	4.7
Hexachlorocyclopentadiene	4.7
Octachlorocyclopentene	4.7

Note:

µg/L Micrograms per liter.

Table 3.9

Total Organic Chemical Concentrations
Intermediate/Deep Bedrock Chemical Monitoring Program (IDCP)
S-Area Remedial Program

	Total Organic Concentration (µg/L)																																			
	2002		**2003**		**2004**		**2005**		**2006**		**2007**		**2008**		**2009**		**2010**		**2011**		**2012**		**2013**		**2014**		**2015**		**2016**		**2017**		**2018**		**2019**	
Well	**Apr/May**	**Oct**	**Apr**	**Nov**	**June**	**Nov/Dec**	**Apr/May**	**Dec/Jan**	**May**	**Nov/Dec**	**May**	**Oct**	**Apr/May**	**Oct**	**Apr**	**Oct**	**Apr**	**Oct**	**Apr/May**	**Oct**	**Apr/May**	**Oct/Nov**	**Apr**	**Oct**	**May**	**Oct**	**Apr/May**	**Oct/Nov**	**Apr/May**	**Nov**	**Apr/May**	**Oct**	**May**	**Nov**	**Apr/May**	**Oct**
Upper Intermediate Bedrock Zone																																				
OW679	7.83	ND	2.6	ND	--	ND	2.8	ND	0.44	0.27	ND	ND	0.57	ND	ND	ND	0.55	ND	ND	0.65	ND/ND	ND	ND/ND	ND/ND	ND	ND	ND	0.44	0.82	ND	ND	ND	ND	ND	ND	ND
OW693	ND	ND	ND	ND	3.59	ND	0.19	0.26	0.28	0.59	7.49	0.50	0.55	ND	ND	ND	ND/ND	ND	ND	ND	ND	ND	ND	ND	ND	ND/ND	0.34	ND/ND	30	ND/ND	ND/ND	ND/ND	ND	ND	ND	ND
OW800	ND	ND	ND	ND	6.95	0.48	ND	0.24	ND	1.48	0.32	0.41	0.19	ND/ND	ND	ND/ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.22	ND	ND	ND	ND	ND	ND
OW807	NS	0.48	ND	126	6.96	ND	66.3	0.42	ND	ND	0.33	0.3/0.2	0.67	0.40	ND	ND	ND	ND/ND	ND	0.26/0.27	0.31	0.32/0.32	0.29	ND	0.25	0.26	ND	0.25	0.26	0.31	ND	ND	ND	ND	ND	ND
Middle/Lower Intermediate Bedrock Zone																																				
OW412C	ND	ND	3	ND	ND	4	1	ND	ND	ND	ND	ND	ND	ND	0.89/0.74	ND	ND	0.22	ND/ND	ND	ND	ND	ND	ND	ND	ND	0.39	ND	ND	ND	ND	ND	ND	ND/ND	ND	ND/ND
OW634	568	1,827	16	28	174	1,814	2,449	1,673	12,731	1,640	4,000	5,765	2,564/3,286	5	847	769	437	275	396	467	634	990	797	593	777	613	994	768	649	775	652	170	695	596	632	598
OW685R	632	555	126	524	490	93	279	420	408	229	187	414	117	238	198	118	155	78	56	102	114	116	130	156	83/88	185	121/117	140	165/169	116	108	153	158	144	164	172
OW694	7	108	5	117	73	106	ND	128	133	98	151	118	181	127	111	122	129	101	113	100	152	116	124	112	89	111	96	84	140	113	123	148	160	140	154/155	148
Deep Bedrock Zone																																				
OW630	207	184	5,023	6,488	6,073	6,250	2,650	8,941	7,623	8,703	9,445	8,230	10,730	8,000	12,348	13,759	8,100	10,000	11,500	12,864	15,128	10,974	13,429	15,206	8,862	8,466	7,215	11,944	9,664	9,522	8,622	8,696	7,994/7,124	5,238	7,298	4,604
OW642	ND	ND	ND	ND	1	2	3	1	2	3	3	3	5	12	14	20	8	12	5	19	9	3	21	14	25	22	28	27	ND	23	28	21	28	19	27	16
OW643	1,144	617	1,412	778	554	1,528	1,529	1,837	1,714	1,846	5,226	4,072	4,384	5,604	4,297	6,404	4,720	8,217	9,643	7,344	10,537	6,404	3,382	10,368	10,697	7,592	11,316	7,639	10,128	10,798	7,877	6,123	7,953	7,837	8,530	5,991
OW687	10	255	277	86	54	204	121	156	108	147	135/127	125	173	124	117	145	107	92	98	104	108	94	96	88	80	92	74	84	86	85	76	85	84	69	76	68
Intake Tunnel																																				
OW808	--	128	121	65	ND	ND	12	12	10	15	0.8	0.8	2.8	8.8	5.1	6.8	8.4	8.0	7.5	7.9	9.1	10.1	8.7	9.8	8.9	5.7	6.0	8.9	7.9	9.6	8.7	7.0	5.9	6.1	6.7	7.7

Notes:

ND Not detected (NDs were assumed to be zero).
-- Not sampled.
µg/L Micrograms per liter.

Table 3.10

Analytical Parameters
Intermediate/Deep Bedrock Chemical Monitoring Program (IDCP)
S-Area Remedial Program

Baseline Parameters	Reporting Limit (µg/L)
Volatile Organic Compounds	
1,2,3-Trichlorobenzene	1
1,2,4-Trichlorobenzene	1
1,2-Dichlorobenzene	1
1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	1
Benzene	1
Chlorobenzene	1
cis-1,2-Dichloroethene	1
Tetrachloroethene	1
trans-1,2-Dichloroethene	1
Trichloroethene	1
Vinyl chloride	1
Semi-Volatile Organic Compounds	
1,2,3,4-Tetrachlorobenzene	4.7
1,2,4,5-Tetrachlorobenzene	4.7
Hexachlorobutadiene	4.7
Octachlorocyclopentene	4.7
Long-Term Parameters (commencing 2018)	
Volatile Organic Compounds	
cis-1,2-Dichloroethene	1
Benzene	1
Chlorobenzene	1
Tetrachloroethene	1
Trichloroethene	1
Vinyl Chloride	1
Semi-Volatile Organic Compounds	
1,2,3,4-Tetrachlorobenzene	4.7
1,2,4,5-Tetrachlorobenzene	4.7

Note:

µg/L Micrograms per liter.

Table 3.11

Total Organic Chemical Concentrations
Wells from Former Environmental Monitoring Program (EMP)
S-Area Remedial Program

Total Organic Concentration (µg/L)

	2004				2005				2006				2007			
Well	**Feb**	**May**	**Aug**	**Oct/Nov**	**Mar/Apr**	**May**	**Sep**	**Nov**	**Mar**	**May**	**Sep**	**Nov**	**Mar**	**May**	**Sep**	**Nov**
OW405D	2,038	136	4,305	514	3,539	1,771	10,093	1,200	1,960	12,590	13,930	12,590/9,505	12,736	9,973	7,403	16,040/6,545
OW406D	1,635	2,710/2,900	4,598	3,531	7,350	4,603	1,569	1,315	4,954	4,392	620	1,963	1,524/1,569	1,070	884	533
OW407D	360	233	384	567/542	1,065	214	251	317	402/450	275	409	327	407	343/338	292	242
OW408D	2,228	2,983	3,915	2,527	1,910	3,882	3,158	4,347	4,202	3,788	3,566	3,318	1,867	1,942	3,244	3,278
OW409D	27.4/30.1	39.8	134	28.0	66.2	31.7/31.6	84.5	25.6	27.9	107.1	38.3	27.6	34.9	26.7	28.6	36.2
OW410D	1.01	ND	0.722	1.61	2.67	0.670	0.370	ND/0.340	2.17	0.930	0.630	5.63	0.49	3.51	0.41	0.51
OW417D	48,027	54,171	15,892	14,222	15,473/9,240	7,227	45,390/31,010	53,536	78,560	56,380	56,160/54,763	55,660	53,980	53,340	53,600/42,449	49,810
OW667D	3,338	12,688	7,351/7,121	5,714	4,227	2,822	1,508	8,403	6,008	3,023/3,699	6,929	6,382	9,709	5,408	6,096	8,342

Total Organic Concentration (µg/L)

	2008				2009				2010				2011			
Well	**Mar**	**Jun**	**Sep**	**Dec**	**Mar**	**Jun**	**Sep**	**Dec**	**Mar**	**Jun**	**Sep**	**Dec**	**Mar**	**Jun/Jul**	**Oct**	**Dec**
OW405D	4,037/4,140	3,647	2,530	9,398	27,588	9,883	8,030	9,387	7,809	7,498	5,078	5,800	5,157	4,305	4,108	9,715/9,243
OW406D	653	562	353	381/552	510	440	714	792	493	606	587	125	393	399	664	652
OW407D	257	291	262	200	371	261	384	361	254	247	233	178	263	173	311/296	155
OW408D	2,241	3,848	2,692	2,394	3,300	3,170/2,909	2,288	3,666	2,259	2,751	992	2,309	3,015	1,956	2,508	1,721
OW409D	49.7	53.5	80.7	21.6	80.2	22.5	235.6	31.4/30.5	507.7	24/20.4	29.2	22.9	18.8	21.0	22	19
OW410D	3.44	0.49	3.07	0.38	ND	3.14	17.10	4.10	2.15/2.3	1.86	1.66	1.19/1.23	1.27	0.54	0.93	0.53
OW417D	42,626	39,926	37,020/29,538	63,574	93,248/88,279	71,577	90,241	70,269	87,870	74,830	63,596/63,318	73,646	81,229/76,914	77,249/82,402	68,827	86,263
OW667D	8,276	4,436/4,216	3,006	6,096	4,361	2,367	1,872/2,075	3,031	3,278	3,058	3,699	5,118	6,128	3,519	5,511	4,833

Total Organic Concentration (µg/L)

	2012				2013				2014				2015			
Well	**Mar/Apr**	**Jun**	**Sep**	**Dec**	**Mar**	**Jun**	**Sep**	**Dec**	**Mar**	**Jun/Jul**	**Sep**	**Dec**	**Mar**	**Jun**	**Sep**	**Dec**
OW405D	5,526	3,803	3,081	3,598	5,334	4,079	2,504	3,523	2,713	2,643	7,557	8,581	14,455	27,821	26,221	34,831
OW406D	5,524	747	1,524	918	673	1,744	743	2,604	2,137	2,918	2,355	2,468	2,698	1,721	2,027	2,405
OW407D	314	347	345/362	280	304	274	319	290	289	274	292	247	289	308	344	258
OW408D	1,526	2,242	2,500	3,207	3,241	3,217	3,337	3,168	1,958	2,201	2,977	9,676	11,987	8,961	12,393	6,707
OW409D	24.5	36.6	37.8	25.8	35	30	31	22	25	20	58	310/301	1,207/1,239	1,929/1,867	2,929/3,250	2,962/3,185
OW410D	0.39	1.2	0.50	1.2	0.5	0.6	2.1	0.5	0.4	2.7	0.7	7.1	12	6	5,928	2,356
OW417D	131,354	104,507/115,373	98,428	101,344/97,901	121,662/79,632	133,726/136,706	114,142/113,893	117,079/112,888	161,097/151,850	126,262/133,835	163,564/166,853	193,544	180,785	185,928	251,892	197,190
OW667D	3995/4,469	4,096	3,352	3,810	2,429	2,298	1,788	5,458	2,927	7,490	4,213	6,256	7,372	6,610	5,087	7,668

Total Organic Concentration (µg/L)

	2016		2017	2018	2019
Well	**Mar/Apr**	**May**	**Mar**	**Feb-Mar**	**Mar-Apr**
OW405D	8,079	(1)	6,690	7,124	3,949
OW406D	906	(1)	827	2,043	615
OW407D	182	(1)	209	205	150
OW408D	7,116	(1)	3,543	5,608	2,991
OW409D	1,062	(1)	247	157	94
OW410D	243	(1)	26	75	4.0
OW417D	129,196/143,329	(1)	295,314/257,001	338,573/463,414	199,822/313,750
OW667D	7,114	(1)	6,085	4,040	5,644

Notes:

1.54/1.98 Duplicate sample results.
ND Non-detect.
µg/L Micrograms per liter.
(1) In accordance with approval from USEPA and NYSDEC in a letter dated May 9, 2016, quarterly EMP sampling was terminated.
The eight EMP wells are sampled annually (starting March 2017) as part of the Niagara Plant Corrective Action Program for combined Niagara Plant and EMP parameters.

Table 3.12

Toxic Equivalency Quotients
Wells from Former Environmental Monitoring Program (EMP)
S-Area Remedial Program

Well	Toxic Equivalency Quotients (TEQs) (pg/L)															
	2007								2008							
	Mar		May		Sep		Nov		Mar		Jun		Sep		Dec	
	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5
OW405D	5.4	16	0.002	48	2.2	23	0.77/0.67	41/42	10	19	0.05	50	0.03	48	63	104
OW406D	60	62	4.4	28	0.84	41	6.3	14	12	21	2.4	38	1.0	43	5.6	31
OW407D	0.02	48	0.04	48	0.07	46	0.09	45	25	39	0.004	48	1.1	39	0.01	48
OW408D	1.9	45	3.9	13	1.4	37	1.3	41	3.3	29	8.7	17	0.91	41	1.85	42
OW409D	0.00	48	0.02	50	2.8	43	0.19	46	21	42	6.4	28	0.15	45	0.04	48
OW410D	16.5	45	11	15	1.0	41	11	14	0.23	45	0.05	50	0.25	45	2,064	2,088
OW417D	1,827	1,917	5,569	5,569	39,814	40,064	1,073	1,123	579	579	8,789	8,789	23,079	23,129	212,118	212,142
OW667D	ND	48	3.7	47	0.02	48	0.02	48	6.5	30	0.27	43	0.002	48	0.01	48

Well	Toxic Equivalency Quotients (TEQs) (pg/L)															
	2009								2010							
	Mar		Jun		Sep		Dec		Mar		Jun		Sep		Dec	
	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5	U=0	U=0.5
OW405D	20.4	20.4	2.86	25.9	1.91	198	2.00	54.2	0.34	52.12	48.1	55.2	134	139	0.90	50.0
OW406D	68.5	68.5	13.2	47.8	2.45	193	20.0	60.9	9.87	43.42	27.4	40.6	2.49	46.7	611	613
OW407D	0.045	60.2	5.14	48.6	2.26	227	17.6	58.3	10.33	32.60	60.8	73.5	45.2	72.5	0.60	52.6
OW408D	10.4	48.0	0.08	58.1	0.25	331	4.09	32.4	3.60	28.99	5.40	28.4	0.78	50.3	24.8	37.5
OW409D	0.17	60.3	0.00	60.7	0.01	384	7.51	59.4	20.04	47.82	110	123	39.9	67.2	88.9	101
OW410D	193.5	193.5	3.61	19.9	8.51	93.5	9.43	35.1	27.74	27.14	9.06	18.6	6.03	52.6	108	121
OW417D	160,066	161,841	136.9	411.9	231	3,531	1,189	1,514	3,532	3,557	31,061	32,711	55,328	55,328	90,923	90,968
OW667D	1.12	52.5	1.03	55.8	0.00	466	0.003	60.7	21.18	42.00	321	321	30.1	66.7	38.8	43.9

Table 3.12

Toxic Equivalency Quotients
Wells from Former Environmental Monitoring Program (EMP)
S-Area Remedial Program

Well	2011 Mar U=0	2011 Mar U=0.5	2011 Jun U=0	2011 Jun U=0.5	2011 Sep U=0	2011 Sep U=0.5	2011 Dec U=0	2011 Dec U=0.5	2012 Mar U=0	2012 Mar U=0.5	2012 Jun U=0	2012 Jun U=0.5	2012 Sep U=0	2012 Sep U=0.5	2012 Dec U=0	2012 Dec U=0.5
	Toxic Equivalency Quotients (TEQs) (pg/L)															
OW405D	0.59	50.0	21.1	28.5	2.60	28.0	1.30	43.5	5.50	6.82	2.63	22.5	18.4	22.7	4.89	20.7
OW406D	21.3	31.9	3.28	50.0	33.6	40.8	5.52	42.7	5.80	12.3	1.18	22.6	2.07	27.1	3.18	21.4
OW407D	12.3	32.4	0.09	54.5	6.00	21.3	3.54	39.5	3.84	5.52	0.67	24.6	1.09	27.4	0.12	27.2
OW408D	16.8	35.3	47.0	58.9	3.30	16.0	12.6	19.8	4.73	5.93	20.9	22.6	0.71	26.8	3.57	19.4
OW409D	46.6	59.0	7.38	37.8	6.70	31.7	0.34	52.2	2.03	9.84	1.48	23.0	1.55	24.9	0.91	22.9
OW410D	107	120	9.00	16.4	6.80	16.6	4.32	19.4	10.5	12.2	32.4	34.1	25.8	27.8	21.61	22.8
OW417D	29,600	30,400	1,698	1,773	1,912	1,937	1,111	1,116	5,296	5,296	1,409	1,415	1,927	1,927	2,107	2,111
OW667D	0.52	52.3	15.5	38.3	24.7	37.8	5.58	37.2	28.8	30.0	5.01	24.7	3.75	26.9	0.635	26.6

Well	2013 Mar U=0	2013 Mar U=0.5	2013 Jun U=0	2013 Jun U=0.5	2013 Sep U=0	2013 Sep U=0.5	2013 Dec U=0	2013 Dec U=0.5	2014 Mar U=0	2014 Mar U=0.5	2014 Jun-Jul U=0	2014 Jun-Jul U=0.5	2014 Sep U=0	2014 Sep U=0.5	2014 Dec U=0	2014 Dec U=0.5
	Toxic Equivalency Quotients (TEQs) (pg/L)															
OW405D	10.3	14.2	21.4	22.8	97.3	97.3	12.1	16.8	17.7	23.8	132.3	133.7	549.2	549.3	7.8	23.6
OW406D	2.7	20.9	8.1	11.7	46.7	47.0	0.6	22.0	1.9	21.8	21.3	21.3	9.9	25.0	3.6	23.5
OW407D	0.9	26.7	3.2	21.0	16.3	18.8	1.6	22.4	0.7	23.3	1.5	23.8	0.7	24.0	6.9	9.5
OW408D	2.0	24.0	1.0	23.1	9.4	12.5	0.6	23.9	0.0	27.8	0.8	25.7	5.0	23.3	4.4	12.6
OW409D	0.9	25.4	4.8	11.2	0.3	26.2	3.6	9.9	0.3	28.1	0.2	27.2	1.1	22.2	1.2	18.8
OW410D	14.7	18.9	26.3	27.5	19.2	20.4	12.6	12.6	18.9	25.3	47.3	47.3	22.1	22.8	37.0	37.0
OW417D	1,705	1,709	21,678	21,680	9,302	9,307	5,983	5,986	10,690	10,702	33,773	33,773	27,708	27,708	7,140	7,142
OW667D	5.6	27.5	6.3	26.2	2.8	25.0	2.1	20.5	1.2	28.2	70.2	95.0	23.1	44.0	6.5	26.4

Table 3.12

Toxic Equivalency Quotients
Wells from Former Environmental Monitoring Program (EMP)
S-Area Remedial Program

Toxic Equivalency Quotients (TEQs) (pg/L)

Well	2015 Mar U=0	2015 Mar U=0.5	2015 Jun U=0	2015 Jun U=0.5	2015 Sep U=0	2015 Sep U=0.5	2015 Dec U=0	2015 Dec U=0.5	2016 Mar/Apr U=0	2016 Mar/Apr U=0.5	2016 May U=0	2016 May U=0.5	2017 Mar U=0	2017 Mar U=0.5	2018 Feb/Mar U=0	2018 Feb/Mar U=0.5
OW405D	186	200	5.7	47.0	1,201	1,224	6,634	6,652	12.2	36.6	(1)	(1)	387	388.0	15.20	17.84
OW406D	7.0	23.0	0.1	54.0	26.0	33.0	6.1	28.5	0.0	26.9	(1)	(1)	2.8	10.6	2.55	18.44
OW407D	19.0	20.0	0.1	54.0	6.5	30.0	2.9	25.3	0.6	27.2	(1)	(1)	5.4	10.9	1.43	18.94
OW408D	16.0	20.0	2.5	22.0	1.1	27.0	3.4	25.4	0.5	27.1	(1)	(1)	3.8	10.3	6.60	22.36
OW409D	0.0	25.0	0.9	45.0	5.9	32.0	42.8	61.9	0.2	27.6	(1)	(1)	5.0	11.4	1.44	21.28
OW410D	25.0	26.0	19.0	22.0	42.0	44.0	37.3	58.1	8.8	31.8	(1)	(1)	5.2	21.2	33.74	33.74
OW417D	30,718	30,718	10,987	11,412	13,803	13,803	28,414	28,427	9,143	9,143	(1)	(1)	24,679	24,679	1189.96	1192.36
OW667D	6.0	26.0	1.9	32.0	83.0	98.0	1,690	1,715	7.3	31.6	(1)	(1)	39.5	39.8	3.66	19.62

Toxic Equivalency Quotients (TEQs) (pg/L)

Well	2019 Apr U=0	2019 Apr U=0.5
OW405D	6.8	9.4
OW406D	1.5	27.2
OW407D	1.4	23.4
OW408D	0.5	21.7
OW409D	0.7	24.2
OW410D	26.8	30.4
OW417D	3,570	3,570
OW667D	23.2	36.5

Notes:

1.54/1.98 Duplicate sample results.
ND Non-detect.
pg/L Picograms per liter.
(1) In accordance with approval from USEPA and NYSDEC in a letter dated May 9, 2016, the EMP was terminated.
The eight EMP wells are sampled annually (starting March 2017) as part of the Niagara Plant Corrective Action Program for combined Niagara Plant and EMP parameters.

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