Site-Wide Groundwater Progress Report

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Nutley Site Remediation
NJDEP PI ID Nos. 009949, 614465, and 625447

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ACRONYM LIST

μg/l	Micrograms Per Liter
1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethene
1,4-Dioxane	Dioxane
1,1,1-TCA	1,1,1-Trichloroethane
CAMS	Clifton-Allwood Municipal Sewer
CEA	Classification Exception Area
cis-1,2-DCE	cis-1,2-dichloroethene
COC	Contaminants of Concern
DNAPL	Dense Non-Aqueous Phase Liquid
EDD	Electronic Data Deliverables
EDS	Electronic Data Submission
GES	Groundwater & Environmental Services, Inc.
GWPR	Groundwater Progress Report
GWRIR	Groundwater Remedial Investigation Report
GWQS	Ground Water Quality Standards
HFM	Historic Fill Material
HGU	Hydrogeologic Unit
IRM	Interim Remedial Measures
ISGWQC	Interim Specific Ground Water Quality Criterion
IA	Investigative Area
LNAPL	Light Non-Aqueous Phase Liquids
MDL	Method Detection Limit
MEK	Methyl Ethyl Ketone
MNA	Monitored Natural Attenuation
MTBE	Methyl Tert-Butyl Ether
NJDEP	New Jersey Department of Environmental Protection
PCE+	Tetrachloroethene, Trichloroethene, cis-1,2-Dichloroethene, and Vinyl Chloride
PCE	Tetrachloroethylene
PDB	Passive Diffusion Bag
PID	Photo Ionization Detector
RI	Remedial investigation
Roche	Hoffmann-La Roche Inc.
RPPS	Rigid Porous Polyethylene Samplers

QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SVOC	Semi-Volatile Organic Compound
TICs	Tentatively Identified Compounds
TCA+	1,1-Dichloroethane, 1,1-Dichloroethene, and 1,1,1-Trichloroethane
TCE	Trichloroethylene
TRC	TRC Companies
TRSR	Technical Requirements for Site Remediation
VC	Vinyl Chloride
VOC	Volatile Organic Compound

1.0 INTRODUCTION

On behalf of Hoffmann-La Roche Inc. (Roche), TRC Companies (TRC) has prepared this Site-Wide Annual Groundwater Progress Report (GWPR) for submission to the New Jersey Department of Environmental Protection (NJDEP) for the 120-acre former Roche facility (Site) located at 340 Kingsland Street, in Nutley, New Jersey (Figure 1).

1.1 Overview

The groundwater data presented in this report covers the period of May 2018 through June 2019 and includes results from two Site-wide semi-annual groundwater sampling events, three Interim Remedial Measure (IRM) performance monitoring programs completed in selected areas, and one round of monitored natural attenuation (MNA) sampling[1].

In accordance with the NJDEP-approved Modification to the Site-Wide Groundwater Sampling Plan – IRM Implementation Period Rev. 1 (July 2015) dated November 2016 (TRC, 2016b) (Approved Sampling Plan), monitoring wells located along the plume fringes and in the vicinity of active IRM systems were sampled between August 2018 and June 2019 to monitor plume behavior during the IRM implementation or post-completion phase.[2] As the IRMs have been completed over time, this supplemental sampling has been reduced. The sampling of monitoring and remedial wells during this reporting period helped to further refine the understanding of contaminant distribution within the aquifer system and document beneficial changes resulting from IRM activities.

This is the sixth GWPR submitted to the NJDEP, following completion of the Remedial Investigation (RI) and submission of the Site-wide Groundwater Remedial Investigation Report (GWRIR) dated April 2, 2014 (TRC, 2014). The previous GWPRs were submitted in January 2015, December 2015, August 2016 (a supplement to the December 2015 GWPR), January 2017, November 2017, and February 2019 (TRC, 2015a; 2015d; 2016a; 2017a; 2017b; 2019b).

In December 2019, Roche submitted a Groundwater Remedial Action Work Plan (December 2019 RAWP) (TRC, 2019n), which summarized the effectiveness of the IRMs in treating source areas and proposed an active remedy for one plume and MNA for the remaining plume extents. The MNA sampling was initiated in 1Q 2019.

1.2 Document Organization

This document is organized into the following sections:

- Section 2.0 provides references to deliverables that summarize the most recent Site background information;

[1] With the exception of well MW-31 (sampled in the 2Q 2019), the remaining wells were sampled in 1Q 2019.

[2] The most recent IRM performance monitoring data (for IA-1/IA-4, IA-6, and IA-12) are included with this report to fill in data gaps and provide the most comprehensive depiction of current groundwater conditions. Discussion of the IRM activities and evaluation of the IRM performance monitoring results were submitted to the NJDEP in separate IRM progress reports in early 2019.

- Section 3.0 provides a brief overview of the Site's groundwater IRM programs;

- Section 4.0 provides a list of groundwater Contaminants of Concern (COCs) identified at the Site to date;

- Section 5.0 provides a technical overview (scope/methods) of the completed supplemental groundwater programs;

- Section 6.0 provides supplemental investigation findings for Investigative Area (IA)--specific investigations and Site-wide groundwater monitoring programs, and provides an evaluation of groundwater elevations and groundwater quality; and

- Section 7.0 provides a list of references.

Previous Site-Wide GWPRs provided an evaluation of contaminant trends over time, particularly for monitoring wells located at the downgradient edges of plumes. These previous evaluations determined that the plume margins are stable in concentration and extent, and are not expanding. The data presented herein continue to support this conclusion.

2.0 SITE BACKGROUND AND GENERAL INFORMATION

2.1 Site Background and History

A comprehensive Site background (including Site description and history, physical setting, and historical regulatory compliance and deliverables) was provided in the April 2014 Site-Wide GWRIR and subsequent GWPRs. To manage the investigation of the large Site, Roche divided the Site into 15 IAs, as shown on Figure 2.

During the course of the RI and subsequent work, Roche installed monitoring wells at various depths. Monitoring wells have been assigned vertically to distinct Hydrogeologic Units (HGUs). The HGU concept, and the rationale for selecting depth intervals for the HGUs, are explained in a previous GWPR (TRC, 2019a). A summary illustration is provided on Figure 3.

2.2 Current Ownership and Site Redevelopment

Roche officially ceased all business operations at the Site in December 2013 and sold the property to a developer in September 2016. Most of the on-Site buildings have been demolished, and a new property owner is redeveloping the Site for mixed use, including a medical school.

The Site redevelopment activities prompted the sampling of select wells and required the decommissioning of others during this reporting period. Refer to Sections 5.1 and 5.2 for monitoring well sampling and well decommissioning information. Figure 2 provides the location of all former and existing buildings, but is not updated to reflect recent Site redevelopment.

3.0 GROUNDWATER INTERIM REMEDIAL MEASURE (IRM) PROGRAMS

Several remediation programs (*i.e.*, soil and shallow bedrock excavations, and groundwater IRMs) implemented by Roche have significantly improved groundwater quality at the Site. The groundwater IRM programs were initiated in 2015 and 2016 to reduce contaminant mass in the source areas of groundwater contaminant plumes.

This report (and previous GWPRs) uses the term "plume" to refer to areas where groundwater contaminants exceed the current NJDEP's Ground Water Remediation Standards (GWQS), and to depict the overall extent of contaminant distribution at on- and off-Site locations for a specific group of chemicals. For instance, the PCE+ (tetrachloroethene [PCE] and its associated degradation products: trichloroethene [TCE], cis-1,2-dichloroethene [cis-1,2-DCE], and vinyl chloride [VC]) plumes shown on figures discussed in Section 6.0 identify areas where PCE and its breakdown products have been detected at concentrations above groundwater remediation standards on a Site-wide basis, without distinguishing or depicting the separate and distinct plumes that have different chemicals in different proportions and that emanate from different potential sources.

The groundwater IRMs targeted treatment of elevated PCE+ constituents in plumes emanating from the Clifton-Allwood Municipal Sewer (CAMS IA-12 Plume, CAMS IA-3/IA-7 North Plume, CAMS IA-7 South Plume, and CAMS IA-11 Plume), as well as volatile organic compound (VOC) constituents in the following on-Site plumes: the IA-9 Pipe Trench Area Plumes (PCE+ and toluene), the IA-2 Tank Farm Area Plume (benzene, chloroform, and methylene chloride), the IA-6 Chlorobenzene Plume (chlorobenzene and PCE+), the IA-10 Building 104 Area Plume (PCE+), the IA-10 Building 70 Area Plume (benzene), and the IA-1/4 Dioxane Plume (1,4-dioxane [dioxane], benzene, and toluene). These plumes are shown on figures provided in Appendix A.

IRM implementation activities and associated performance monitoring data were documented in several groundwater IRM Progress Reports submitted to the NJDEP, dated April 2019 (TRC, 2019b through 2019 l) and September 2019 (TRC 2019m). As documented in these reports, all IRM programs have been completed in IA-1 B55 Area, IA-1/4, IA-2, CAMS IA-3/IA-7 North, CAMS IA-7 South, IA-9, IA-10 Building 104, IA-10 Building 70, IA-11 (TRC, 2017c), and CAMS IA-12. A final IRM Progress Report will be submitted for IA-6 in the near future. Contamination exceeding GWQS after IRM completion is addressed in the December 2019 RAWP.

4.0 GROUNDWATER CONTAMINANTS OF CONCERN

During the 2013 RI and supplemental investigations (2014-2017), a total of 59 confirmed Site-specific COCs[3] were identified in groundwater samples collected from monitoring wells installed at the Site. The list of Site-specific contaminants included numerous VOCs (primarily chlorinated VOCs), semi-volatile organic compounds (SVOCs), pesticides, and metals. The SVOC, pesticide, and metal exceedances were attributed to impacted historic fill material (HFM) placed throughout most of the Site and/or from naturally occurring conditions.

As described in the NJDEP-approved April 2018 Semi-Volatile Organic Compound Groundwater Sampling Report (TRC, 2018a), hexachlorobenzene, 2-methylnaphthalene, 2-methylphenol, 3&4-methylphenol, and pentachlorophenol are no longer present in Site groundwater at concentrations above the GWQS.

The table below summarizes the current list of Site-specific groundwater COCs, which has been revised to exclude the remediated contaminants as well as those that have been included in the HFM Classification Exception Area (CEA) established by the NJDEP in March 2017 (NJDEP, 2017).

[3] Any chemical compound detected in groundwater with a concentration that exceeds the NJDEP GWQS for Class IIA Aquifers (N.J.A.C. 7:9C) is defined as a groundwater COC, or contaminant. In November 2015, the NJDEP revised the Interim Specific Ground Water Quality Criterion (ISGWQC) for 1,4-dioxane (dioxane), reducing the ISGWQC from 10 micrograms per liter (µg/L) to 0.4 µg/L. Laboratory analyses associated with the recent monitoring events achieved the lower contaminant detection limits for dioxane, which allowed for the detection of this compound at or below the established 0.4 µg/L ISGWQC. Effective January 16, 2018, the NJDEP adopted amendments to the GWQS rules (N.J.A.C. 7:9C). As part of this change, the dioxane 0.4 µg/L ISGWQC became a specific GWQS and is now listed in N.J.A.C. 7:9C Appendix Table 1.

VOCs†	SVOCs‡	Pesticides‡	Metals‡
1,1,1-Trichloroethane (1,1,1-TCA)	Tentatively Identified Compounds (TICs)		
1,2,4-Trichlorobenzene			
1,1-Dichloroethane (1,1-DCA)			
1,1-Dichloroethene (1,1-DCE)			
1,2-Dichloroethane			
2-Butanone (MEK)			
Acetone			
Benzene			
Bromodichloromethane			
Carbon disulfide			
Carbon tetrachloride			
Chlorobenzene			
Chloroethane			
Chloroform			
cis-1,2-DCE			
Cyclohexane			
Ethylbenzene			
Methyl Tert Butyl Ether (MTBE)			
Methylcyclohexane			
Methylene chloride			
PCE			
Toluene			
trans-1,2-Dichloroethene			
TCE			
VC			
Xylenes (total)			
Dioxane			
TICs			

† The following VOC constituents have only been detected above their respective GWQS once in a limited number of monitoring wells since the 2013 monitoring period: 1,1,2,2-tetrachloroethane, 1,2-dibromoethane, 1,2-dichloropropane, 1,3-dichloropropene (total), bromomethane, chloromethane, and dibromochloromethane. These compounds are, therefore, not considered Site-specific COCs and have been removed from the above table.

‡ The groundwater contaminants captured under the HFM CEA have been removed from this table. Specifically the following polycyclic aromatic hydrocarbons (PAHs) were removed from the SVOC column: benzo(a)anthracene , benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene; as well as all identified metal exceedances including aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, nickel, sodium , thallium, and zinc; and exceeding pesticides dieldrin, lindane, and chlordane. Likewise, SVOCs no longer present after remediation of Site groundwater were also excluded from this table, namely hexachlorobenzene, 2-methylnaphthalene, 2-methylphenol, 3&4-methylphenol, and pentachlorophenol.

5.0 TECHNICAL OVERVIEW

This section provides a technical overview of the groundwater sampling and related groundwater activities completed at the Site between May 2018 and June 2019. Tables 1-1 through 1-3 provide a sample collection summary (including the quality assurance [QA] and quality control [QC] samples) for this investigation period. Detected concentrations were compared with NJDEP GWQS for Class IIA Aquifers (N.J.A.C. 7:9C).

5.1 Groundwater Sampling Programs

The subsections below describe the sampling programs completed between May 2018 and June 2019:

- Site-wide semi-annual sampling was conducted to monitor plume conditions at the Site perimeter and selected locations in the Site interior;
- IRM monitoring was conducted for the IA-1/4, IA-6, and IA-12 IRMs;
- MNA sampling was conducted for the IA-9 Pipe Trench Plumes, IA-2 Tank Farm Plume, IA-10 B70 Area Plume, IA-10 B104 Area Plume, and IA-1/4 Dioxane Plume; and
- A monitoring event was conducted in 3Q 2018 including wells in IA-6 and IA-10 to document groundwater quality conditions in those areas prior to well decommissioning.

All sampling activities for both semi-annual sampling events were completed in accordance with the Roche Quality Assurance Project Plan (QAPP; TRC, 2013d), The NJDEP's Technical Requirements for Site Remediation (TRSR) (N.J.A.C. 7:26E) (NJDEP, 2012), the NJDEP Field Sampling Procedures Manual (NJDEP, 2005), appropriate groundwater sampling standard operating procedures, and the Approved Sampling Plan (defined in Section 5.1.1).

The field sampling forms, Electronic Data Deliverables/Electronic Data Submission (EDD/EDS), and laboratory reports associated with the sampling programs described below are included in Appendices C and D.

5.1.1 Site-Wide Groundwater Monitoring Program

On December 21, 2016, the NJDEP approved Roche's request for the modification of the Site-Wide Groundwater Sampling Plan – Interim Remedial Measures (IRM) Implementation Period Rev. 1 – July 13, 2015, submitted in November 2016 (TRC, 2016b). The revised groundwater sampling plan (Approved Sampling Plan) modified the sampling frequency from a quarterly to a semi-annual basis and reduced the list of sampled wells from all wells on-Site to approximately 168 wells.

A description of the implemented groundwater sampling methodologies and field activities is provided below. Tables 2-1 through 2-3 provide a summary of well construction details. Table 3 lists the established HGUs and the total number of on- and off-Site monitoring wells associated with each of them. Monitoring well construction and other documentation is included in Appendix B. Refer to Figure 2 for the location of on- and off-Site monitoring wells.

5.1.1.1 Water-Level Measurements

On September 5, 2018 (3Q 2018) and March 11, 2019 (1Q 2019), synoptic water-level measurements were collected from accessible on-Site and off-Site wells (nearly 700 Rocheowned wells). The groundwater elevation measurements for these events are provided in Tables 4-1 and 4-2.

Prior to initial water-level measurements, the integrity of each well was inspected, and a photoionization detector (PID) was used to screen the well opening for the presence of volatile gases. A Solinst® oil-water interface probe was used to record depth-to-water measurements from established surveyed points and to assess for the potential presence of light/dense non-aqueous phase liquids (LNAPL/DNAPL) in each well. All pertinent observations and data were recorded on field sampling forms and in a field logbook.

Groundwater gauging also included measurements collected at the four Westbay multiport wells (DW-65, DW-69, DW-70, and DW-72) using Westbay's proprietary pressure transducer system. The pressure transducer is lowered to the sample port, where it engages and seals the sampling port. The sampling port is then opened, allowing the hydrostatic pressure at the sampling port to be directly measured and recorded. Following collection of the pressure measurement, the sample port is closed again. The measured hydrostatic pressure is subsequently converted to equivalent depth to water, correcting for atmospheric pressure at the time of the hydrostatic pressure measurement, and groundwater elevation values are then calculated. The calculated groundwater elevation measurements are included in Tables 4-1 and 4-2. The individual depth to water measurements collected at each port and the formulae used to calculate the potentiometric heads (from the measured hydrostatic pressures) within the monitored HGUs are presented in Tables 4-3 and 4-4.

Groundwater elevation contour maps for shallow groundwater and HGUs 1 through 5 are provided on Figure 4 (3Q 2018) and Figure 5 (1Q 2019). Shallow groundwater is considered as the saturated zone in the overburden or in wells with an approximate screen interval greater than 80 feet above mean sea level; therefore, the shallow groundwater elevation contour maps (the upper-left panel of Figures 4 and 5) represent elevations of the water table, which may be intercepted within the screened intervals of select wells.

The water levels used for the HGU groundwater elevation contour maps were generally selected from monitoring wells screening the mid-section of the HGU. For HGU 5 (E and W), water levels were used from a consistent interval closer to the top of the unit owing to the undefined thickness of the unit. A discussion of the Site's groundwater flow regime is provided in Section 6.1.

5.1.1.2 Semi-Annual Groundwater Sampling

Groundwater samples were collected using Passive Diffusion Bags (PDBs) for analysis of VOCs (SW-846 Method 8260) and Rigid Porous Polyethylene Samplers (RPPSs) for analysis of dioxane (SW-846 Method 8270 with selective ion monitoring [SIM]). The PDBs and RPPSs were filled with laboratory-grade deionized water and deployed at the 5-foot depth interval displaying the highest VOC or dioxane concentrations during vertical screening the first time a well was sampled. The PDBs and RPPSs were kept in the well to equilibrate for at least 14 days prior to removal and sample collection.

The 3Q 2018 and 1Q 2019 semi-annual sampling events included sampling of the four Westbay multiport wells (DW-65, DW-69, DW-70, and DW-72). Groundwater samples were collected using Westbay's proprietary sampling system, consisting of an evacuated (i.e., under vacuum) sealed stainless steel canister. This evacuated canister is lowered to the sample port, where it engages and seals the sampling port. The canister and sampling port are then both opened, allowing groundwater to flow through the sample port and into the canister under negative (vacuum) pressure. Following sample collection, the canister and sample port are closed, the canister is retrieved from the multiport well, and the collected groundwater is transferred to laboratory glassware for analysis.

All groundwater samples were submitted to Eurofins TestAmerica of Edison, New Jersey for analysis. Summary lists of groundwater samples collected during the semi-annual sampling events are provided in Table 1-1[4]. Analytical data from the 3Q 2018 and 1Q 2019 sampling events are presented in Tables 5-1 through 5-6D. Field sampling forms are provided in Appendix C. The groundwater sampling results for the semi-annual sampling events are discussed in Section 6.2.

3Q 2018 Sampling Event

On September 6, 2018, TRC initiated sampling activities at the on- and off-Site Westbay multiport wells, collecting groundwater samples from a total of 84 sampling ports. On September 10, 2018, Groundwater & Environmental Services, Inc. (GES) initiated the deployment of PDBs and RPPSs in on- and off-Site monitoring wells. Between September 24 and 28, 2018, groundwater samples (including duplicates) were collected from 226 wells located along the perimeter of the Site and select wells located in close proximity to and/or downgradient of IRM treatment areas.

The following deviations from the monitoring program are noted:

- MW-204C (central portion of IA-7) was inaccessible due to a blockage and could not be sampled during this sampling event. This well was repaired and PDB and RPPS samplers were deployed on October 19, 2018 and sampled on November 2, 2018.
- PDB and RPPS samplers became lodged within the well casing and could not be retrieved from DW-38A. The samplers were later dislodged and this well was sampled in the subsequent sampling event (1Q 2019).
- Monitoring wells 179RI-MW1, 186RI-MW1, DW-35B, MW-56, and MW-70C were abandoned and were not sampled. Well decommissioning is discussed in Section 5.2.

1Q 2019 Sampling Event

On March 11, 2019, TRC installed PDBs and RPPSs in on- and off-Site monitoring wells. On March 5, 2019, TRC initiated sampling activities at the on- and off-Site Westbay multiport wells, collecting groundwater samples from a total of 84 sampling ports. Between March 26 and May 10, 2019, groundwater samples (including duplicates) were collected from 229 wells located along the perimeter of the Site and in close proximity to and/or downgradient of IRM treatment areas. The following deviation from the monitoring program is noted:

- The target sample intervals could not be reached for DW-43A and MW-15B due to apparent obstructions within the wells and these wells were not sampled during this

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[4] Except for the multiport well samples, each groundwater sample collected in 3Q 2018 and 1Q 2019 is listed as two separate entries in Table 1-1 to individually track and more easily differentiate between samples collected via PDB and RPPS methods. This approach was taken as a quality control measure to reduce potential errors in the field (e.g., collecting samples, completing the chain-of-custody) and in the laboratory (e.g., running the sample for the correct analytical method).

event. The obstructions will be cleared if these wells are included in future sampling events.

5.1.2 Groundwater IRM Performance Monitoring Programs

In accordance with NJDEP-approved Permit-by-Rule applications, groundwater sampling within IRM treatment zones has been conducted prior to, during, and after completion of IRM implementation to monitor remedial system operations and to assess the effectiveness of each program. With one exception, all post-IRM sampling has been completed in accordance with the PBR sampling plans and have been reported in the IRM Progress Reports submitted in April 2019 (TRC, 2019b through 2019l) and September 2019 (TRC, 2019m) and the last GWPR submitted in February 2019 (TRC, 2019a). Performance monitoring data from the most recent phase of the IA-6 IRM will be reported in a final IRM Progress Report that will be submitted to the NJDEP in the near future. A limited number of groundwater IRM analytical data were collected 1 or 2 months before or after the 3Q 2018 semi-annual Site-wide groundwater sampling event and are incorporated into the figures in this report to provide the most comprehensive depiction of groundwater quality conditions at the Site for that time frame.

Groundwater analytical data from 102 IRM wells were incorporated into the 3Q 2018 and 1Q 2019 groundwater quality maps - Figures 6 through 53. The IRM performance monitoring samples were collected from IA-1/4, IA-6, and IA-12 using the low-flow sampling method and analyzed for VOCs (SW-846 Method 8260) and/or dioxane (SW-846 Method 8260 or SW-846 Method 8270 with SIM). A list of the IRM samples incorporated into this report is presented in Table 1-2. Dioxane data collected during IRM performance monitoring events displaying laboratory method detection limits (MDLs) above the 0.4 µg/L GWQS for dioxane were not used to supplement the data sets for 3Q 2018 and 1Q 2019 (Figures 42 through 47 and Figure 50). Refer to Table 1-2A for a list of dioxane samples rejected due to elevated MDLs.

5.1.3 MNA Sampling

MNA sampling for some plumes that were addressed by IRMs was initiated in 1Q 2019. In some instances, the Site-wide semi-annual network overlapped with wells in the MNA network. A list of the MNA samples collected is presented in Table 1-2. The purpose of including some of the MNA data in this GWPR is to supplement the semi-annual data to create a more spatially extensive dataset; therefore, only the MNA samples collected within a quarter of each semi-annual sampling event are included in this report. All MNA data will be included in a Remedial Action Report.

5.2 Monitoring Well Decommissioning

The current property owner notified Roche of their intention to re-grade and pave portions of the Site for development that included construction of roadways, parking lots, a parking structure, and buildings. To accommodate this development, monitoring and remedial wells that are no longer needed for IRM or Site-wide monitoring were decommissioned by New Jersey-licensed drillers under TRC supervision and with NJDEP approval (TRC, 2018b-d). The NJDEP decommissioning reports are included in Appendix B. The decommissioning activities are summarized in the following table.

IA	Decommissioned Monitoring and Remedial Wells	Vertical Investigation Zone	HGU	Date Decommissioned
IA-02	ART-MW-4AR, MW-243A	S1	3W	7/31/2018
	MW-13AR, MW-309A, MW-310A, MW-342A, MW-343A	S1	OVB	7/31/2018
	EW-2B, EW-3B, EW-5B, IW-191B, IW-192B, IW-193B	S2	--	7/31/2018
	MW-246B, MW-307B, MW-316B	S2	3W	7/31/2018
	ART-99, ART-100	S3	--	7/31/2018
	MW-186B	S3	4W	7/31/2018
IA-03	IW-187A1, IW-187A2, IW-188A1, IW-188A2	S1	--	6/11/2018
	IW-187B, IW-188B	S2	--	6/11/2018
IA-06	CGVP-3, CGVP-4, CGVP-5, CGVP-6, CGVP-7, CGVP-8, CGVP-11, CGVP-13, CGVP-14, CGVP-15, CGVP-16, EGVP-7, EGVP-10, EGVP-11, EGVP-12, EGVP-13, EGVP-14, EGVP-15, EGVP-16, EGVP-17, EGVP-18, EGVP-19, EGVP-21, EGVP-23, EGVP-24, EGVP-25, EGVP-26, EGVP-27, EGVP-28, EGVP-29, EGVP-30, IA2-VP-01, IA2-VP-02, IA6-VP1, IA6-VP2, IA6-VP3, IA6-VP4, IA6-VP5, IA6-VP6, IA6-VP7, IA6-VP8, IA6-VP9, IA6-VP10, IA6-VP11, SVE-WSG-1, SVE-WSG-6, SVE-WSG-7	S1	--	7/31/2018
	EGSVE-3, EGVP-1, EGVP-2, EGVP-3, EGVP-4, EGVP-5, EGVP-6, EGVP-8, EGVP-9, EGVP-31	S1	--	8/1/2018
	ART-75, ART-76, ART-78, ART-89, IW-104A, IW-105A, IW-106A, IW-107A, IW-108A, IW-109A, IW-110A, IW-111A, IW-112A, IW-113A, MW-5, MW-52, MW-161, MW-162, MW-163, MW-350A, MW-395A, MW-396A, MW-397A, MW-447A	S1	2W	7/31/2018
	MW-318A	S1	2W	9/18/2018
	MW-6A, MW-160, MW-398A	S1	3W	7/31/2018
	MW-155R, MW-156R, MW-158, MW-159, MW-322A, MW-317A, MW-346A, MW-423A	S1	OVB	7/31/2018
	IW-194B	S2	--	9/18/2018
	ART-77, ART-79, ART-80, ART-82, ART-84, ART-87, BIOS-7B, BIOS-2B, BIOS-4B, BIOS-5B, BIOS-8B, BIOS-9B, BIOS-10B, BIOS-11B, BIOS-12B, BIOS-13B, BIOS-14B, BIOS-15B, MW-157B	S2	2W	7/31/2018

IA	Decommissioned Monitoring and Remedial Wells	Vertical Investigation Zone	HGU	Date Decommissioned
	BIOS-1B	S2	2W	9/18/2018
	ART-7, ART-13, ART-8, ART-14, ART-9, ART-15, ART-10, ART-81, ART-11, ART-83, ART-12, ART-85, BIOS-3B, BIOS-6B, MW-50, MW-53, MW-158B, MW-251B, MW-264B, MW-317B, MW-321B, MW-346B, MW-350B, MW-418B, MW-419B, MW-420B, MW-421B, MW-422B, MW-447B	S2	3W	7/31/2018
	MW-318B	S2	3W	9/18/2018
	MW-423B, MW-424B	S2	4W	7/31/2018
	ART-86, ART-88	S3	2W	7/31/2018
	MW-54, MW-56, MW-251C, MW-317C, MW-321C, MW-346C, MW-350C	S3	3W	7/31/2018
	MW-264C, MW-420C, MW-421C, MW-422C, MW-424C	S3	4W	7/31/2018
	DW-26	D1	5W	7/31/2018
	DW-44B	D2	5W	7/31/2018
	DW-44C	D3	5W	7/31/2018
IA-07	IA7-VP1, IA7-VP2, IW-116A1, IW-116A2, IW-117A2	S1	--	6/11/2018
	IW-117A1	S1	2E	6/11/2018
	ART-90, ART-103, IW-116B, IW-117B	S2	--	6/11/2018
IA-09	MW-14A, MW-17, MW-165, MW-166, MW-323A	S1	OVB	7/31/2018
	MW-323B	S2	4W	7/31/2018
	MW-323C	S3	4W	7/31/2018
IA-10	138RI-MW1, MW-45	S1	1W	9/12-13/2018
	190RI-MW1, 190RI-MW2	S1	2W	9/12/2018
	179RI-MW1, 186RI-MW1, MW-205, 186RI-MW2, PZ-02, 23RI-MW2, 53RI-MW2, 53RI-MW3, 66RI-MW2, 66RI-MW3, 66RI-MW8, MW-259A, MW-280A, MW-281A, MW-283A, MW-284A, MW-285A, PZ-03	S1	OVB	9/12-13/2018
	MW-223B, MW-259B, MW-268B, MW-280B	S2	1W	9/12-13/2018
	MW-230B	S2	1W	2/7/2019
	MW-70-1, MW-70-2, MW-70-3	S2	2W	9/12/2018
	MW-319B	S2	3W	9/13/2018
	MW-223C	S3	1W	9/13/2018
	MW-268C	S3	1W	9/25/2018
	MW-280C	S3	1W	2/7/2019

IA	Decommissioned Monitoring and Remedial Wells	Vertical Investigation Zone	HGU	Date Decommissioned
	MW-259C	S3	2W	9/12/2018
	MW-70C, MW-319C	S3	3W	9/12-13/2018
	DW-35A	D1	2W	9/12/2018
	DW-35B	D2	5W	9/13/2018
	DW-15C	D3	5W	9/13/2018

5.3 Data Reliability

The analytical methods used for the semi-annual Site-wide groundwater sampling events are provided in the QAPP and the laboratory analytical reports. The laboratory data reports and EDD/EDS for the recent data are included on compact disc in Appendix D. Tables 1-1, 1-2 and 1-3 present a summary of groundwater samples collected between May 2018 (the last reporting period) and June 2019.

Sample collection activities and laboratory analysis of groundwater samples obtained as part of the low-flow, PDB, and RPPS sampling program were performed in accordance with the TRSR, the NJDEP-approved groundwater RI Workplans for shallow and deep bedrock investigations (TRC 2012a; 2012b; 2013a; 2013b; 2013c; 2013e), the Approved Sampling Plan (TRC, 2016b), and the revised QAPP (TRC, 2013d).

A QA review was performed on the laboratory analytical reports for all VOC samples collected as part of the Site-wide semi-annual monitoring program and supplemental investigations. The method-specific calibrations and quality control performance criteria were met for the data generated during this investigation, except as indicated in the conformance/non-conformance summaries provided in the laboratory reports. Laboratory sample analysis for dioxane was generally not requested via SW-846 Method 8270 with SIM during select IRM performance monitoring events. As a result, the non-detect concentrations that are reported in SW-846 Method 8260 analysis at MDLs exceeding the 0.4 µg/L GWQS for dioxane were rejected from the data set (Table 1-2A).

Based on a review of the laboratory reports, the overwhelming majority of the data were not qualified and are deemed useful for decision-making purposes.

5.4 Factors Influencing Data

The synoptic rounds of groundwater elevation measurements were completed in one day for each semi-annual sampling period (September 5, 2018 and March 11, 2019). No significant events or seasonal variations are known to have influenced the sampling procedures or the results of the sampling programs presented in this GWPR. As discussed in Section 3.0, groundwater IRMs have been implemented at selected IAs. As documented herein and detailed in the IRM Progress Reports (TRC, 2019b through 2019m), the IRMs have resulted in significant improvement in groundwater quality in targeted areas.

5.5 Deviation from the Technical Requirements and Guidance

All field activities were conducted in compliance with the approved RI workplans (TRC 2012a; 2012b; 2013a; 2013b; 2013c; 2013e), the Approved Sampling Plan (TRC, 2016b), the QAPP (TRC, 2013d), the TRSR (NJDEP, 2012), and applicable NJDEP guidance documents.

Due to the large number of monitoring wells sampled via PDBs, NJDEP's PDB Data Checklist forms (documenting field activities associated with the deployment of PDBs at each well) were not completed. Instead, relevant data (e.g., monitoring well ID, time/installation depth/depth to water during deployment and retrieval, etc.) for the groundwater samples collected using PDBs and RPPSs are presented in a table format, which is included in Appendix C.

6.0 FINDINGS FROM RECENT GROUNDWATER MONITORING

This section presents results from semi-annual, IRM, and MNA groundwater monitoring events conducted between May 2018 and June 2019, which characterize current groundwater conditions.

6.1 Groundwater Flow Regime

The semi-annual groundwater sampling program monitors groundwater elevations at the Site over time to assess temporal variability in the data (e.g., seasonal fluctuations) and to continue monitoring for any potential off-Site influences on the groundwater flow system. In addition, groundwater elevation data were evaluated to assess whether the operation of ongoing IRM systems (the only IRM system operating during this reporting period was in IA-1/IA-4) have resulted in changes to the Site's groundwater flow regime.

Approximately 0.12 foot of LNAPL[5] was measured in MW-237A during the September 2018 gauging event, followed by 0.2 foot of LNAPL measured during the March 2019 sampling event. LNAPL was not detected in any other on- or off-Site well, nor has DNAPL been detected in any monitoring well installed on- or off-Site, during the time period covered by this GWPR.

Figures 4 and 5 are six-panel maps that provide the potentiometric surfaces of the shallow groundwater (i.e., top of the water table) and HGUs 1 through 5. Data collected during the September 2018 and March 2019 gauging events (including depth to water, groundwater elevation measurements, presence/absence of product [LNAPL/DNAPL], PID readings, etc.) are summarized in Tables 4-1 and 4-2 for September 2018 and March 2019, respectively.

Figures 4 and 5 show that groundwater has a southerly flow component toward St. Paul's Brook. Shallow groundwater flow is convergent in the vicinity of the Valley Drain and St. Paul's Brook, which are local shallow groundwater discharge zones. Consistent with the regional topography, groundwater then flows to the southeast (parallel with St. Paul's Brook), toward the Third River, and ultimately toward the Passaic River (Figure 1).

Overall, there is minimal seasonal variability in the horizontal groundwater gradient and hydraulic heads measured in 3Q 2018 (September 5, 2018) and 1Q 2019 (March 11, 2019), as shown in Tables 4-1 and 4-2, and on Figures 4 and 5. From the consistency in flow patterns, it can also be concluded that groundwater flow across the Site is not significantly affected by any of the ongoing IRM activities or any off-Site pumping influences.

6.2 Site-Wide Groundwater Quality Assessment

In compliance with the Approved Sampling Plan, approximately 226 accessible on-Site and off-Site wells were sampled for VOCs and dioxane in 3Q 2018 and 1Q 2019. The dataset for this

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[5] The presence of LNAPL (determined to be weathered gasoline) and associated groundwater impacts detected in monitoring well MW-237A (IA-12) have been attributed to an off-Site source, located north of Route 3 (a Sunoco service station). LNAPL was first detected at this location in IA-12 during the installation of a temporary well (TW-158A) and during gauging of a permanent monitoring well, in March 2014 (0.08 foot of LNAPL), June 2014 (0.12 foot of LNAPL), September 2016 (0.13 foot of LNAPL), February 2017 (0.11 foot of LNAPL), September 2017 (0.2 foot of LNAPL).

monitoring period also incorporates analytical results from 84 sampling ports in four multiport wells, 102 wells sampled for performance monitoring of IRMs, and 40 wells sampled for MNA monitoring in 1Q. To further supplement the contouring of plumes in areas not recently sampled, the most recent sampling results were used for select wells last sampled between 1Q 2015 and 3Q 2018. However, data collected in IRM treatment areas (primarily in the overburden, HGU 2, and HGU 3) prior to the start of the particular groundwater IRM programs were not used to depict current conditions.

Groundwater quality data from off-Site properties were used for plume depiction in areas upgradient, side-gradient, and downgradient of the Site. Data shown at the Briad property (north of Route 3) were collected in April 2018, as reported in the June 2018 Ransom Environmental Remedial Action Report Addendum (Ransom Environmental, 2018) and in February 2016, as reported in the April 2017 Ransom Environmental Remedial Investigation Report (Ransom Environmental, 2017). Deluxe wells located on Site (in IA-10) and off Site (at Deluxe property) were last sampled by Roche between July 2015 and June 2016. Nova wells were last sampled by Roche in June 2015. These data are shown on Figures 6 through 53.

Figures 6 through 17 depict the total PCE+ concentrations (above the reported laboratory MDL) for the 3Q 2018 and 1Q 2019 events. Similarly, Figures 18 through 29 depict the TCA+ (1,1,1-TCA and its associated degradation products: 1,1-DCE and 1,1-DCA), and detections for the semi-annual events. Figures 30 through 41 show the benzene and chlorobenzene concentrations; other VOC exceedances (i.e., excluding the PCE+, TCA+, and dioxane compounds) are identified on the tables at the bottom of each map. The dioxane concentrations that exceeded the 0.4 µg/L GWQS are depicted on Figures 42 through 53. The discussions presented in sections below are based on these maps.

6.2.1 PCE+ Groundwater Results – 3Q 2018 and 1Q 2019

The extent of PCE+ concentrations in excess of the GWQS are generally similar to what was detected in previous sampling events (TRC, 2019a).

Separate PCE+ plumes can be discerned on the shallow maps. Some of the plumes have a highly degraded signature (with abundant cis-1,2-DCE in addition to the parent PCE), while at least one plume, the Eastern Plume, has an almost pure PCE signature. The Nutley Windsor Sewer Plume has a pure TCE signature. The plume maps shown on Figures 6 through 17 do not distinguish between the different chemical signatures that define individual plumes, but rather simply contour the distribution of PCE+ concentrations, independent of its origin, chemical signature or consideration of groundwater flow directions.

6.2.1.1 3Q 2018

As shown on Figures 6 through 11, the extent of PCE+ in groundwater is more widespread at depth, in HGUs 4 and 5, than in overburden or shallower HGUs. The margins of PCE+ are generally similar in extent to what was reported in previous progress reports (TRC, 2015d; 2017a; 2017b; 2019a), and PCE+ concentrations at the outer edges of the plume are similar to those detected earlier, indicating the commingled PCE+ plume or plumes are stable and not expanding or increasing in concentration.

Roche’s groundwater IRM programs have significantly improved groundwater quality conditions in the shallow groundwater and HGUs 2 and 3 in the interior portions of the Site. The historical maximum PCE+ concentrations exceeded 100,000 µg/L in IA-9 well MW-170 (145,790 µg/L) and were detected as high as 93,006 µg/L in the CAMS IA-12 area (MW-60). As a result of IRM activities, the 3Q 2018 analytical data reflects a decline in PCE+ concentrations by four to five orders of magnitude in the area of the IA-9 Pipe Trench Plumes, and at least one to two orders of magnitude in the CAMS IA-12 Plume.

6.2.1.2 1Q 2019

Figures 12 through 17 present the PCE+ analytical results from the 1Q 2019 sampling event. Conditions are similar to those reported in 3Q 2018, indicating that the commingled PCE+ plume or plumes are stable and not expanding or increasing in concentration.

6.2.2 TCA+ Groundwater Results – 3Q 2018 and 1Q 2019

The extent of TCA+ concentrations in excess of the GWQS are generally similar to what was detected in previous sampling events (TRC, 2019a).

6.2.2.1 3Q 2018

As shown on Figures 18 through 23, the 3Q 2018 extent of TCA+ concentrations in groundwater is primarily limited to the western portion of the Site.

The extent of the TCA+ plume is larger in HGUs 2 and 3 than in overburden and HGU 1. In HGUs 2 and 3, TCA+ was detected in off-Site wells located on Allwood Road (as shown on Figures 20 and 21). Lower TCA+ concentrations are present in groundwater within HGUs 4 and 5. These impacts are found primarily in IA-10, but also in the western portion of IA-12, IA-1, IA-2, IA-6 and off-Site in Nichols Park.

6.2.2.2 1Q 2019

Figures 24 through 29 summarize analytical results from the 1Q 2019 sampling event for the overburden and HGUs 1 through 5. Overall, the distribution and concentrations of TCA+ in groundwater observed during the 1Q 2019 are similar to the previous semi-annual sampling event (3Q 2018), indicating that the TCA+ plume is stable and not growing or increasing in concentration.

6.2.3 Benzene, Chlorobenzene, and Other VOCs Groundwater Results – 3Q 2018 and 1Q 2019

Benzene and chlorobenzene concentrations in excess of the GWQS are limited in areal extent and do not extend beyond the downgradient boundaries of the Site.

Prior to implementation of groundwater IRM programs, benzene concentrations in the former IA-2 Tank Farm and immediately downgradient in the northern IA-6 area exceeded 113,000 µg/L. Most recent sampling showed that benzene concentrations in this area are now less than 5 µg/L. Prior to implementation of groundwater IRM programs, chlorobenzene concentrations in IA-6 exceeded 12,000 µg/L. Chlorobenzene concentrations are now less than 180 µg/L.

6.2.3.1 3Q 2018

Figures 30 through 35 summarize the 3Q 2018 groundwater analytical results in the shallow groundwater and HGUs 1 through 5 for benzene, chlorobenzene, and other VOCs present at concentrations exceeding their respective GWQSs; benzene and chlorobenzene exceedances are contoured, and other exceedances are noted in the table. As shown on these maps, benzene and/or chlorobenzene exceedances occur in HGUs 2, 3, 4, and 5 in very limited areas. There are no exceedances of the GWQS for either benzene or chlorobenzene in HGU 1. Benzene was detected at low concentrations in small localized areas in IA-6, IA-1, IA-4, IA-10, and IA-12. A large benzene plume emanates from the Sunoco site, an area upgradient of IA-12 (north of Route 3) in HGU 2.

Other VOCs (listed in the COC table of Section 4.0) were detected in groundwater at concentrations exceeding their respective GWQSs in one or more HGUs during the 3Q 2018 sampling event. These VOC exceedances are localized and limited to specific Site areas within a particular HGU.

6.2.3.2 1Q 2019

Figures 36 through 41 summarize analytical results from the 1Q 2019 sampling event for the shallow groundwater and HGUs 1 through 5. Overall, the distribution and concentrations of benzene and chlorobenzene in groundwater observed during the 1Q 2019 are similar to the previous semi-annual sampling event (3Q 2018). Results from the MNA sampling at the IA-2 Tank Farm Area, IA-6 Chlorobenzene Area, IA-9 Pipe Trench East Area, and IA-10 Building 70 Plumes all showed declining levels of benzene (<5 µg/L) and chlorobenzene (<70 µg/L) concentrations with the following exceptions:

- IA-2 Tank Farm Plume – Elevated benzene concentrations (410 µg/L to 25 µg/L) were detected in ART-MW-5BR, ART-MW-6BR, and EW-4B within the plume footprint.

- IA-6 Chlorobenzene Plume – Elevated chlorobenzene concentrations (370 µg/L to 99 µg/L) were detected in four wells (IW-197A, IW-198A, EW-6B, and MW-504B) and elevated benzene concentrations (44 µg/L and 19 µg/L) were detected in two wells (MW-504B and IW-197A) in the plume footprint area.

6.2.4 Dioxane Groundwater Results – 3Q 2018 and 1Q 2019

As described in the CSM Report (TRC and B. Kueper & Associates, Ltd., 2018), there is a dioxane plume of on-Site origin, emanating from a release area in IA-1 and IA-4; this is referred to as the IA-1/4 Dioxane Plume. This plume commingles with other dioxane-containing plumes that migrate onto and beneath the Site.

An on-Site source of dioxane was identified near the IA-1/IA-4 boundary, between former Buildings 56 and 44. An IRM for dioxane was initiated in July 2016 and operated until January 2019.This IRM has significantly reduced dioxane concentrations in HGUs 2 and 3 in the source area. As reported in the IRM Progress Report for IA-1/4, an optimization study was performed to reduce the persistent concentrations present in IA-1 until no further benefit was observed (TRC, 2019b).

6.2.4.1 3Q 2018

As shown on Figures 42 through 47, most of the dioxane exceedances occur in the western portion of the Site.

The 3Q 2018 analytical data indicate that elevated dioxane concentrations (> 100 µg/L and < 620 µg/L) persist in IA-1 in an area between former Buildings 69 and 45 in HGU 2 (Figure 44), HGU 3 (Figure 45), and HGU 4 (Figure 46).

The off-Site margins of the commingled dioxane plume are similar in extent to what was reported in previous GWPRs (TRC, 2017a, 2017b, 2019a), and dioxane concentrations at the outer edges of the plumes are similar to those detected earlier, indicating that the commingled dioxane plume is stable and not expanding or increasing in concentration.

6.2.4.2 1Q 2019

Figures 48 through 53 present the dioxane analytical results from the 1Q 2019 sampling event for the overburden and HGUs 1 through 5. As shown on these maps, the overall extent and distribution of dioxane contamination across the Site did not significantly change between the 3Q 2018 and the 1Q 2019 sampling events, with the plumes in each HGU remaining stable.

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