Groundwater Remedial Action Report

PI #s 009949, 614465, and 625447

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Former Hoffmann-La Roche Inc. Facility
Nutley, New Jersey

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ACRONYM LIST

1,4-Dioxane	Dioxane
AOC	Area of Concern
ARRCS	Administrative Requirements for the Remediation of Contaminated Sites
ART	Accelerated Remedial Technologies
bgs	Below ground surface
CEA	Classification Exception Area
CAMS	Clifton-Allwood Municipal Sewer
cis-1,2-DCE	cis-1,2-Dichloroethene
COC	Contaminants of concern
CSM	Conceptual Site Model
DGW	Discharge to Groundwater
DNAPL	Dense non-aqueous phase liquid
EDD/EDS	Electronic Data Deliverables/Electronic Data Submittal
EISB	Enhanced *in-situ* bioremediation
ERH	Electrical resistance heating
FSPM	Field Sampling Procedures Manual
g	grams
GWQS	Ground Water Quality Standards
GWRAR	Groundwater Remedial Action Report
GWRAWP	Groundwater Remedial Action Work Plan
HGU	Hydrogeologic unit
IA	Investigative Area
IRM	Interim Remedial Measure
ISCO	*In-situ* chemical oxidation
ISTT	*In-situ* thermal treatment
IWAS	In-Well Air Stripping
kg	Kilograms
LNAPL	Light Non-Aqueous Phase Liquid
LSRP	Licensed Site Remediation Professional
LTM	Long-Term Monitoring
MeCl	Methylene Chloride
MNA	Monitored Natural Attenuation
MNATG	Monitored Natural Attenuation Technical Guidance
MSL	mean sea level
NAPLs	Non-aqueous phase liquids
ND	Not Detected
N.J.A.C	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
PBRs	Permit-By-Rule
PCBs	Polychlorinated biphenyls
PCE	Tetrachloroethene
PCE+	The sum of PCE, TCE, cis-1,2-DCE and VC
PDI	Pre-Design Investigation
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAO	Response Action Outcome
RAP	Remedial Action Permit

RAR	Remedial Action Report
RE	Receptor Evaluation
RI	Remedial Investigation
RIR	Remedial Investigation Report
Roche	Hoffmann-La Roche Inc.
Route 3	New Jersey State Highway Route 3
Site	120-acre former Roche facility
SVE	Soil Vapor Extraction
TCE	Trichloroethene
TI	Technical Impracticability
TRC	TRC Environmental Corporation
TRSR	Technical Requirements for Site Remediation
USTs	Underground Storage Tanks
VC	Vinyl chloride
VETs	Vapor extraction trenches
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Levels
VITG	Vapor Intrusion Technical Guidance
VOCs	Volatile Organic Compounds
WRA	Well Restriction Area
µg/L	Micrograms per liter

Executive Summary

On behalf of Hoffmann-La Roche Inc. (Roche), TRC Environmental Corporation (TRC) has prepared this *Groundwater Remedial Action Report* (GWRAR) 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. This GWRAR documents the remedial actions undertaken in accordance with the December 2019 *Groundwater Remedial Action Work Plan* (December 2019 GWRAWP) (TRC, 2019l), submitted to the NJDEP on December 16, 2019, and approved by the NJDEP in a letter dated August 20, 2020 (NJDEP, 2020).

Roche completed eight quarters of a post-Interim Remedial Measure (IRM) Monitored Natural Attenuation (MNA) groundwater monitoring program for the Site in accordance with the December 2019 GWRAWP (TRC, 2019l) to assess the groundwater quality related to the six Remedial Action Plumes, identified as the IA-2 Tank Farm Area Plume, IA-6 Chlorobenzene Plume, IA-9 Pipe Trench Area Plumes, IA-10 Building 104 Area Plume, IA-10 Building 70 Area Plume, and the On-Site Dioxane Plume. The results of the sampling and an evaluation of the analytical results with respect to MNA performance are provided in this Report.

Multiple *in-situ* and *ex-situ* IRMs have been implemented to address the six Remedial Action Plumes over the course of Roche's environmental Site remediation program. The remedial objective for all Remedial Action Plumes is to meet the NJDEP's Class II-A Groundwater Quality Standards (GWQS) New Jersey Administrative Code (N.J.A.C) [N.J.A.C. 7:26C] for the contaminants of concern (COCs) associated with each plume. These IRMs have reduced dissolved contaminant concentrations in each of the plume source areas by one or more orders of magnitude. The MNA monitoring program was implemented between March 2019 and December 2020, following the cessation of active groundwater IRMs, to assess the applicability of MNA for the Remedial Action Plumes.

The analytical results from the eight quarters of MNA monitoring demonstrate that the remnants of the six Remedial Action Plumes are stable or shrinking, and that the sources have been remediated to the extent that contaminant partitioning to groundwater does not exceed the natural attenuation capacity of the aquifer. Therefore, MNA in conjunction with institutional controls (*i.e.*, Classification Exception Area [CEA], Well Restriction Area [WRA], and Remedial Action Permit [RAP]) will meet the Site-specific remediation objectives and are protective of human health and the environment.

1.0 Introduction

On behalf of Hoffmann-La Roche Inc. (Roche), TRC Environmental Corporation (TRC) has prepared this *Groundwater Remedial Action Report* (GWRAR) 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).

This GWRAR documents the remedial actions undertaken in accordance with the December 2019 *Groundwater Remedial Action Work Plan* (December 2019I GWRAWP), submitted to the NJDEP on December 16, 2019, and approved by the NJDEP in a letter dated August 20, 2020 (NJDEP, 2020).

As documented in the December 2019 GWRAWP, Roche previously implemented Interim Remedial Measures (IRMs), described in Section 3.0, for six on-Site groundwater plumes, identified in that GWRAWP as the Investigative Area (IA)-2 Tank Farm Plume, IA-6 Chlorobenzene Plume, IA-9 Pipe Trench Area Plumes, IA-10 Building 104 Area Plume, IA-10 Building 70 Area Plume, and On-Site Dioxane Plume. The IAs at the Site are presented on Figure 2 and these six plumes are shown on Figure 3. Collectively, these six plumes constitute the "Remedial Action Plumes". Pursuant to the December 2019 GWRAWP, Roche conducted final remedial actions (RAs) for these six specific plumes at the Site associated with on-Site releases of contaminants[1].

Additional volatile organic compound (VOC) plumes are attributable to historical releases from breaches in the Clifton-Allwood Municipal Sewer (CAMS), which was never used by Roche. These historical CAMS releases occurred in at least four on-Site contaminant release areas, resulting in the generation of four VOC plumes:

- CAMS IA-12 Plume
- CAMS IA-3/IA-7 North Plume
- CAMS IA-7 South Plume
- CAMS IA-11 Plume

[1] At the request of the NJDEP and discussed in the December 2019 GWRAWP, Roche is planning the remediation of a seventh plume that originated from a release from an off-Site municipal sewer, identified as the Windsor Place Municipal Sewer Plume (herein referred to as the Windsor Sewer Plume). The Windsor Sewer Plume has been called in as a separate off-Site discharge and was assigned its own Case Number (21-04-30-1515-52). An on-Site release, the "MW-28 LNAPL Area of Concern (AOC)", was also recently called in as a newly discovered release (20-11-20-1335-00) and is currently under investigation. Both the Windsor Sewer Plume and the MW-28 LNAPL AOC (both in the IA-10 area) are not addressed in this GWRAR but will be documented in separate Remedial Action Reports (RARs) to be submitted to the NJDEP.

Although Roche did not discharge wastewater to the CAMS, it proactively implemented IRMs (Section 3.0) at all four CAMS source zones to facilitate redevelopment of the Site. The vast majority of contaminant mass from the CAMS releases was removed by Roche's IRM efforts. The results of these IRMs were reported to the NJDEP in IRM progress reports issued in December 2017 and April 2019 (TRC, 2019b; 2019c; 2019d; 2019f; and 2019j).

Several other plumes migrate onto, beneath, and downgradient of the Site. They, along with the four on-Site CAMS plumes, are referred to as the "Monitored Plumes"[2]. At the request of the NJDEP, Roche agreed to continue to monitor these plumes, and proposed a network of monitoring wells (*i.e.*, the Long-Term Monitoring [LTM] Program) in the December 2019 GWRAWP. The extent of the Monitored Plumes is shown on Figure 4.

Roche reported some of these plumes to the NJDEP as "verified unknown off-site sources" and the NJDEP assigned incident numbers 15-06-11-1108-08 (Eastern Plume) and 14-09-23-1206-41 (CAMS North Plume). An Unrestricted Use Response Action Outcome (RAO), with a "Contamination Remains On-Site due to Off-site Contamination" notice, was issued for the CAMS North Plume Area of Concern (AOC) in November 2016. Other Monitored Plumes emanate from other sites and already had established case numbers (*i.e.*, the former Deluxe site - E93460, 16-02-74; the Briad site – 14-03-31-1024-19; and the Sunoco site – 92-02-06-1315-26, 14-01-08-1157-33). Accordingly, the RAO will include the "Contamination Remains On-Site due to Off-site Contamination" notice.

A Classification Exception Area (CEA) map was initially established for the Site on January 5, 2021. As requested by the NJDEP, a revised CEA map was proposed for the combined extent of the Remedial Action Plumes and the Monitored Plumes and approved in a NJDEP letter dated August 30, 2021. The CEA Fact Sheet was approved and issued by the NJDEP on October 27, 2021. In the December 2019 GWRAWP, Roche proposed long-term monitoring utilizing selected wells in the existing monitoring well network, which is also presented in the Remedial Action Permit (RAP) Application (see Appendix A).

The Monitored Natural Attenuation (MNA) evaluation and demonstration included in this GWRAR addresses the following five Remedial Action Plumes associated with on-Site releases of contaminants:

- IA-2 Tank Farm Area Plume;
- IA-6 Chlorobenzene Plume;
- IA-9 Pipe Trench Area Plumes;
- IA-10 Building 104 Area Plume; and,
- On-Site Dioxane Plume.

[2] Six additional VOC plumes that migrate onto the Site and are beneath the Site have been identified in the December 2019 GWRAWP as follows: CAMS North Plume, Deluxe Plume, Briad/North Plume, Western Plume, Sunoco Plume, and the Eastern Plume.

For the IA-10 Building 70 Area Plume (a sixth Remedial Action Plume), no exceedances of the NJDEP's Ground Water Quality Standards (GWQS) were detected in the two most recent rounds of groundwater samples. Therefore, no remedy is required and an assessment of MNA for this plume was not warranted in accordance with the NJDEP's *Monitored Natural Attenuation Technical Guidance* (MNATG; NJDEP, 2012) and the approved December 2019 GWRAWP.

Executed copies of the NJDEP forms associated with this submission are included in Appendix B. This report will be submitted via the NJDEP *Remedial Action Report Online Service*.

1.1 Objective

Pursuant to the December 2019 GWRAWP, Roche has conducted post-IRM groundwater monitoring for the six Remedial Action Plumes associated with releases of contaminants at the Site from on-Site operations. The objectives for this GWRAR are 1) to present the results of the post-IRM monitoring; 2) demonstrate that additional remediation is not warranted for the IA-10 Building 70 Area Plume; and 3) demonstrate that MNA is an appropriate long-term remedy for the other five Remedial Action Plumes.

Based on the data and information presented herein, Roche has satisfied the requirements for remediation of the Remedial Action Plumes in accordance with N.J.A.C. 7:26E, has implemented a CEA, and is submitting a RAP application.

The CEA also includes the extents of the Monitored Plumes, and Roche has initiated a LTM Program utilizing the existing monitoring well network as proposed in the December 2019 GWRAWP. The LTM Program for these plumes is included with the RAP application.

Pursuant to N.J.A.C. 7:26E-5.8(b)2, the default Regulatory Timeframe to complete the RA was May 7, 2019, and pursuant to N.J.A.C. 7:26C-3.3(a)6, the default Mandatory Timeframe to complete the RA was May 7, 2021. However, on March 20, 2019, Roche submitted a request to extend the RA Regulatory Timeframe to the RA Mandatory Timeframe of March 20, 2021. On February 1, 2021, the NJDEP issued a Notice of Rule Waiver/Modification/ Suspension pursuant to Executive Order No. 103 that extended the default Mandatory Timeframe to complete the RA for this Site from May 6, 2021 to May 6, 2022. The objective of this GWRAR is to obtain applicable permits and issue an RAO for groundwater at the Site prior to the May 6, 2022 deadline.

1.2 Site Description

1.2.1 Setting

The Site occupies approximately 120 acres in northeastern New Jersey, straddling the municipal/county boundary of the Township of Nutley in Essex County and the City of Clifton in Passaic County (Figure 1). As shown on Figure 1, the Site is bounded to the north by New Jersey State Highway Route 3 (Route 3); to the south by Kingsland Street,

Nichols Park, residential properties, and St. Paul's Brook; to the east by residential properties; and to the west by residential, commercial, and industrial properties. Many of the surrounding former and current commercial/industrial areas have known soil and/or groundwater contamination due to historical operations; some of the industrial operations surrounding the Site persist to the present.

The Site is traversed from north to south by the CAMS (Figure 2), which conveys industrial and sanitary wastewater (historically and currently) from properties located north of Route 3 to a trunk line located south of the Site that leads to the Passaic Valley Sewerage Commission sewer system. The Township of Nutley abandoned a section of the CAMS on the southern portion of the Site in 1990 and replaced it with a new CAMS section located slightly to the west. This new section is still present and operational in the southern portion of the Site (Figure 2) and joins with the older section of the CAMS present in the northern portion of the Site. Roche never discharged process or sanitary wastewaters to the CAMS.

1.2.2 History

Roche acquired the Site from various entities and developed it in phases between 1929 and approximately 1970. Operations prior to Roche included agriculture, construction, milling, and manufacturing. During Roche's ownership, the eastern portion of the Site (east of the railroad tracks) was used for research, development, and manufacturing purposes, while the western portion of the Site (west of the railroad tracks) was used for materials storage, warehousing, garage, and office space.

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 existing at the time of sale have been demolished, and a new property owner has undertaken extensive redevelopment of the Site for mixed use, including a medical school that opened to students in 2018.

After the 2013 cessation of Site operations, Roche planned and implemented, with NJDEP and Licensed Site Remediation Professional (LSRP) oversight, an extensive environmental investigation and an accelerated and expansive soil and groundwater cleanup.

- As summarized in Section 2.0 of this GWRAR, Roche completed an accelerated investigation of soil conditions and implemented extensive Site-wide investigations of groundwater and surface water/sediment conditions.
- Roche removed more than 240,000 tons of impacted soil from the Site, leaving only small areas of impacted soil beneath building foundations (serving as "caps") and an engineered cap over a former industrial fill area in the northwestern corner of the Site. Roche's removal of HFM contaminants went beyond the NJDEP's presumptive "capping" remedy that allows such contaminants to remain in place. Soil RAOs have been issued with NJDEP approval for all portions of the Site. Further discussion can be found in Section 1.4.

- Roche has been similarly proactive in addressing groundwater impacts beneath the Site through the implementation of ten IRMs. Each IRM was preceded by a Pre-Design Investigation (PDI), which included source zone characterization to define the area requiring treatment and to select the optimal treatment approach. Implementation of these IRMs has greatly reduced contaminant mass at the Site.

Roche's efforts to date, undertaken on an accelerated timetable, have facilitated the redevelopment and re-use of the Site, which is already home to multiple educational and commercial uses, including the Hackensack Meridian Hall Medical School, the North American Headquarters of Ralph Lauren, corporate offices of Eisai Pharmaceuticals, and Modern Meadow, a facility that manufactures synthetic leather. Quest Laboratories has constructed and begun operations in a large medical laboratory facility. Two large parking decks are built and fully operating, and a third is in the final stages of construction. Plans call for additional commercial and residential development on the Site in the future.

1.2.3 Topography

The Site is located at the southern end of an approximately 500-acre valley between two ridges aligned along north-northeast to south-southwest axes (Figure 1). The areas to the east, west, and north of the Site are topographically higher than the Site. This valley begins north of Allwood Road and drains surface water to the south and then to the southeast, into St. Paul's Brook, then out to the Third River, and ultimately to the Passaic River (Figure 1). Ground surface ranges from 65 feet above mean sea level (msl) in the south up to 160 feet above msl in the north.

Originally, streams flowed through open channels from the north through the Site; at some point, these streams were routed into buried pipelines that presently convey surface water and storm water through the Site. The principal surface water/storm water conveyance pipeline that traverses the Site is referred to as the Valley Drain.

1.2.4 Geology and Hydrogeology

The geology and hydrogeology of the Site are discussed in detail in the *2014 Groundwater Remedial Investigation Report* (RIR) (Site-Wide Groundwater Remedial Investigation Report; TRC, 2014a) and the 2018 *Site-Wide Groundwater Conceptual Site Model Report* (CSM Report; TRC and B. Kueper, 2018a); elements of the Conceptual Site Model (CSM) relevant to this GWRAR are summarized below. In summary, the Site is underlain by up to 30 feet of overburden consisting of historic fill and glacial deposits. The overburden is underlain by bedrock of the Triassic Passaic Formation, which is a northwest-dipping, fractured and faulted, interbedded sequence of fluvial deposits consisting of conglomerate, sandstone, siltstone, and silty mudstone. The top of the bedrock is a highly fractured weathered zone that varies in thickness across the Site from less than 1 foot up to 25 feet thick.

Beneath the overburden/weathered bedrock zone, the fracture network in the competent bedrock consists of interconnected bedding-plane and high-angle fractures. The layered, fractured sedimentary bedrock beneath the Site and surrounding area was partitioned

into a system of five hydrogeologic units (HGUs). HGUs are defined as portions of the bedrock aquifer containing interconnected stratigraphic bedding-plane and high-angle fractures. HGUs are typically separated by thin zones of low vertical hydraulic conductivity, which inhibit vertical groundwater flow and create significant hydraulic head gradients across HGU boundaries. Beneath most of the Site, the frequency and interconnectedness of fractures diminishes with depth, with fewer fractures observed at depths greater than 100 to 150 feet below ground surface (bgs).

Groundwater elevation measurements have been collected from an extensive network of wells at the Site (well construction details for the MNA wells are included in Table 1). Eighteen synoptic events were conducted between 2013 and 2019. Groundwater flow in the overburden and weathered bedrock is to the south-southeast, generally mimicking topography with flow primarily toward local discharge boundaries (*i.e.*, the Valley Drain and St. Paul's Brook). Beneath the weathered bedrock, groundwater flows primarily through a network of transmissive bedding-plane fractures that are interconnected by numerous high-angle fractures, generally toward the south. The most recent groundwater contour data for shallow groundwater and by HGU are presented on Figure 5; previous groundwater contour maps are provided in Appendix C.

Due to the dip of the sedimentary rock bedding, HGUs that are present at significant depths in the northern and western portions of the Site become shallow and subcrop in the southern and eastern portions of the Site near St. Paul's Brook, which results in groundwater flowing toward St. Paul's Brook that acts as a local discharge boundary for the shallower portions of the flow system.

1.3 Investigative Area Summary

The Remediation Road Map (TRC, 2012a) divided the Site into 15 IAs that have been the focus of subsequent characterization efforts, remedial investigations (RIs), and IRMs. The process/sanitary sewer system, previously designated as IA-8, was investigated with other individual IA investigations, and therefore is no longer considered a separate IA. A map showing the IA boundaries is provided as Figure 2. Groundwater plumes and associated remedies have been named according to the IA in which the plume originates, as described in Section 3.0.

1.4 Previous Soil Remediation Activities

From 2012 to 2014, soil RIs were conducted for 14 separate IAs. Following the investigations, Roche implemented remedial actions and submitted Soil Remedial Action Reports to the NJDEP between 2014 to 2017 (TRC, 2014c, TRC, 2015b-i; TRC, 2016a-h; TRC, 2017b).

Since 2014, Roche removed more than 240,000 tons of impacted soil from the Site, principally soil containing historic fill material contaminants, VOCs, and, to a lesser extent, polychlorinated biphenyls (PCBs). Virtually all soils exceeding the New Jersey's most stringent soil remediation standards and screening levels (*i.e.*, Residential Direct Contact Soil Remediation Standards and Default Impact to Ground Water Soil Screening Levels)

then in effect were excavated and removed, leaving only small areas of impacted soil beneath building foundations (serving as “caps”), and an engineered cap over a former industrial fill area in the northwestern corner of the Site. Soil RAOs have been issued with NJDEP approval for all portions of the Site, as summarized below:

IA	Soil RAO Type	Date Issued
IA-1/5	Unrestricted Use	6/22/2016
IA-2	Unrestricted Use	6/22/2016
IA-3	Unrestricted Use	6/22/2016
IA-4	Restricted Use with Permit Requirements	3/28/2017
IA-6	Unrestricted Use	8/18/2016
IA-7	Restricted Use with Permit Requirements	3/28/2017
IA-9	Restricted Use with Permit Requirements	3/28/2017
IA-10 North	Restricted Use with Permit Requirements	3/14/2018
IA-10 South	Unrestricted Use	6/22/2016
IA-11	Unrestricted Use	9/15/2016
IA-12	Unrestricted Use	12/22/2014
IA-13	Restricted Use with Permit Requirements	3/19/2017
IA-14	Unrestricted Use	6/22/2016
IA-15 Upland Portion	Unrestricted Use	8/28/21
IA-14 and IA-15 Riparian Area	Restricted Use with Permit Requirements	3/27/2017

Deed notices were recorded with Essex and Passaic Counties. In December 2017, a Soil Remedial Action Permit Modification was submitted to the NJDEP to add the new Site owner, PB Nutclif Master LLC, as co-permittee. This permit modification became effective on March 16, 2018. The present owner of the Site has assumed responsibility for the engineering and institutional controls at the Site.

2.0 Remedial Investigation Summary

2.1 Remedial Investigation Objective

Extensive groundwater investigation has occurred at the Site as documented in the *April 2014 Site-Wide Groundwater RIR*, the IA-specific RIRs, several *Site-Wide Groundwater Progress Reports*, various PDIs, and the 2018 CSM Report (TRC, 2014a, 2015a, 2015j, 2016i, 2017a, 2017c, 2019a, 2020a, 2021; TRC and B. Kueper, 2018a).

The Site-Wide Groundwater RI was conducted under work plans approved by the NJDEP, and in accordance with the NJDEP's Technical Requirements for Site Remediation (TRSR) and applicable guidance documents. The objectives of the IA-specific and the Site-Wide Groundwater RIs were as follows:

- Identify contaminant sources;
- Characterize groundwater conditions;
- Delineate the extent of groundwater contamination; and,
- Identify potential receptors.

A summary of the RI findings for groundwater plumes addressed by this GWRAR is provided below, and additional details can be found in the above-referenced reports.

2.2 Identification of Groundwater Plumes

As presented in the *Site-Wide Groundwater Conceptual Site Model Report* (TRC and B. Kueper, 2018a) and in accordance with the NJDEP's *Commingled Plume Technical Guidance Document*, multiple lines of evidence were used to identify release areas, source zones, and plumes by considering some or all of the following factors:

- Release areas were identified through an evaluation of historical on-Site and off-Site operations, infrastructure conditions, and known or potential use of VOCs and 1,4-dioxane (dioxane). Release areas for some plumes of off-Site origin have not yet been identified.
- Source zones were identified by direct or indirect evidence of non-aqueous phase liquids (NAPLs) (*e.g.*, high groundwater or soil VOC concentrations indicative of NAPL), or the presence of relatively high VOC or dioxane concentrations in groundwater in the vicinity of a known or suspected release area.
- Each plume was defined primarily by mapping the horizontal and vertical distribution of similar chemical signatures (*i.e.*, relative fraction of each detected contaminant of concern [COC] to the total VOC concentration) in groundwater, in the context of known or potential sources or release areas.
- The presence or absence of tracer compounds further assisted with the definition of plumes. Tracer compounds are compounds detected at relatively low concentrations that are unique to a specific source and plume.
- Hydraulic gradients were used in conjunction with the strike and dip of HGUs and contaminant concentration gradients to define plume migration directions.

Based on the methodology described in the CSM, the six Remedial Action Plumes were identified as created by releases of VOCs and dioxane; they are shown on Figure 3:

- IA-2 Tank Farm Area Plume;
- IA-6 Chlorobenzene Plume;
- IA-9 Pipe Trench Area Plumes;
- IA-10 Building 104 Area Plume;
- IA-10 Building 70 Area Plume; and
- On-Site Dioxane Plume.

2.3 Receptor Evaluation

The February 11, 2011 initial Receptor Evaluation (RE), the April 30, 2014 RE Update, and the July 2, 2018 RE Update reports for the Site were previously submitted to the NJDEP (TRC, 2011; 2014b; and 2018b).

Roche has continued to update the RE throughout the investigation and remediation process. The initial RE and subsequent RE updates have been performed in accordance with the NJDEP regulations and guidance documents in effect at the time of evaluation and sampling, including the *Administrative Requirements for the Remediation of Contaminated Sites* (ARRCS) [N.J.A.C. 7:26C], the TRSR [N.J.A.C. 7:26E], the *Well Search E-Tools Instructions*, the *Vapor Intrusion Technical Guidance* (VITG), and the *Field Sampling Procedures Manual* (FSPM).

The April 2014 and July 2018 RE updates were approved by the NJDEP on March 17, 2015 and May 6, 2021, respectively.

An updated *Site-Wide Receptor Evaluation Report* detailing the evaluation of potential receptors will be submitted to the NJDEP under separate cover in conjunction with this GWRAR.

2.3.1 Land Use

Numerous residential properties, one park (Nichols Park), and one surface water body (St. Paul's Brook) are present within 200 feet of the Site boundary. No changes in land use that affect the outcome of the RE were identified since the July 2018 submission (TRC, 2018b).

2.3.2 Groundwater

An initial well search was completed in 2001. The well search was updated in 2009, 2014, 2018, and most recently on May 20, 2020. No new potentially potable wells were installed in either Nutley or Clifton and no additional well-sampling triggers were identified since the previous well search was submitted in July 2018 (TRC, 2018b). Results are provided in the REs (TRC, 2011; TRC, 2014b; and TRC, 2018b).

2.3.3 Vapor Intrusion

Roche has been evaluating and investigating the vapor intrusion (VI) pathway since 1998, prior to NJDEP requirements and guidance. All buildings and structures within the NJDEP-required VI investigation area have been identified, evaluated, and investigated in accordance with the applicable NJDEP VITG; completed VI pathways have not been identified. However, due to the presence of VOC concentrations in sub-slab soil gas that exceeded the NJDEP's VI Screening Levels (VISLs) in effect at the time of sampling (*i.e.*, March 2007 screening levels), VI mitigation measures were implemented at two off-Site buildings. Roche has elected to continue operating these systems even though the concentrations do not warrant VI mitigation pursuant to the VITG.

The findings of VI evaluation and the investigation results through April 3, 2017 are discussed in the April 30, 2014 *Site-Wide Receptor Evaluation Report* and the July 2, 2018 *Site-Wide Receptor Evaluation Progress Report;* these reports were approved by the NJDEP on March 17, 2015 and May 6, 2021, respectively. The findings of the VI evaluation completed for the period between April 4, 2017 and December 2020 are provided in the *Site-Wide Receptor Evaluation Report*, which is being submitted concurrently with this GWRAR.

2.3.4 Ecological

The findings of the ecological RE were provided to the NJDEP in the *April 2014 Ecological Evaluation and Surface Water Remedial Investigation Report* and approved by the NJDEP on July 11, 2014. The remedies proposed to the NJDEP in that document have been implemented by Roche and a RAO letter for the IA-14 and IA-15 Riparian Area was issued by the New Jersey LSRP on March 27, 2017.

3.0 Groundwater Interim Remedial Measures

3.1 Introduction

3.1.1 Goal

Roche proactively implemented IRMs to treat source areas for ten plumes beneath the Site (the six Remedial Action Plumes and the four on-Site CAMs plumes) for the purpose of expediting Site remediation. The IRMs resulted in significant decreases in contaminant concentrations and the areal extent of the plumes. Figures 6 through 8 depict the changes in plume concentrations and extent before and after the implementation of the IRMs.

3.1.2 Approach

After the completion of the groundwater RI at the Site in 2014, PDIs were implemented at each of the Remedial Action Plumes and CAMS plumes. Sampling results from the PDIs were used to refine the horizontal and vertical delineation of each plume, to evaluate alternative remedies, and as the basis for design for each IRM. For some plumes, multiple groundwater remediation technologies were used, as described below.

IRMs were implemented in accordance with their respective design plans and under NJDEP-issued Permits-By-Rule (PBRs), where required. Progress reports for each IRM have been submitted to the NJDEP. All IRMs have been completed and PBRs associated with each IRM have been closed. Each IRM is summarized below, and additional information about each IRM can be found in the report references provided herein. A matrix summarizing pertinent concentration data and remedial action information is provided below as Table 2.

Table 2: *Matrix of Plumes and Associated IRM Activities*

Plume Name	IRMs	Treatment Depth (feet bgs)	Maximum Historical Concentration (µg/L)	Maximum Current Concentrations (µg/L) see note 3	Dates of IRM Activity
IA-2 Tank Farm Area Plume	*In-situ* thermal treatment (ISTT) (source area) and In-Well Air Stripping (IWAS) (downgradient plume)	85 (ISTT) 60 (IWAS)	1,830,000 chloroform 113,000 benzene 339,000 methylene chloride (MeCl)	<1 chloroform 140 benzene <1 MeCl	June 2015–January 2016 (ISTT) July 2015–April 2018 (IWAS)
IA-6 Chlorobenzene Plume	IWAS/*in-situ* chemical oxidation (ISCO); enhanced *in-situ* bioremediation (EISB)	65	12,200 chlorobenzene 258 tetrachloroethene (PCE) 23.3 trichloroethene (TCE) 30.2 vinyl chloride (VC) 17.9 benzene	63 chlorobenzene Not detected (ND) PCE <1 TCE <1 VC 15 benzene	May 2016–December 2016 (IWAS/ozone) Restarted February - April 2018 (IWAS) May–June 2018 (EISB)

[3] With the exception of the CAMS IA-12, IA-3/IA-7 North, IA-7 South, and IA-11 Plumes, and for COCs chloroform, MeCl, and toluene, the current concentrations provided are from the 4Q 2020 MNA monitoring event; the current concentrations for the CAMS plumes are from groundwater monitoring events completed between 3Q 2017 and 4Q 2019; chloroform and MeCl concentrations are from 3Q 2017; and toluene concentrations are from 1Q 2017. Chloroform, MeCl, and toluene are not included in the RAWP and therefore older data were used.

Plume Name	IRMs	Treatment Depth (feet bgs)	Maximum Historical Concentration (µg/L)	Maximum Current Concentrations (µg/L) see note 3	Dates of IRM Activity
IA-9 Pipe Trench Area Plumes	Excavation with amended backfill (biodegradation amendment)	15	44,700 PCE 18,100 TCE 87,700 cis-1,2-diochloroethene (cis-1,2-DCE) 5,790 VC 19,900 toluene 842 benzene	120 PCE 7.1 TCE 21 cis-1,2-DCE 2.1 VC ND toluene 1.3 benzene	June 2015
IA-10 Building 70 Area Plume	ISCO/EISB	12	45 benzene	<1 benzene	February 2015
IA-10 Building 104 Area Plume	EISB	11	110 PCE 193 TCE 418 cis-1,2-DCE 31.3 VC	19 PCE 21 TCE 69 cis-1,2-DCE 18 VC	April 2015
On-Site Dioxane Plume	IWAS/ISCO (ozone and persulfate)	95	3,550 dioxane	200 dioxane	July 2016–November 2017 (IWAS/ozone) November 2017 (persulfate oxidation) Restarted February 2018 (IWAS/ozone) – January 2019
CAMS IA-12 Plume	ISTT (source area) and IWAS/ISCO (ozone and persulfate)	50	67,500 PCE 21,700 TCE	(October 2018) 340 PCE 460 TCE	March 2015–July 2015 (ISTT) July 2016–December 2017 (IWAS/ozone)

Plume Name	IRMs	Treatment Depth (feet bgs)	Maximum Historical Concentration (µg/L)	Maximum Current Concentrations (µg/L) see note 3	Dates of IRM Activity
CAMS IA-12 Plume (continued)			84,300 cis-1,2-DCE 24,500 VC	570 cis-1,2-DCE 20 VC	October/November 2017 (persulfate oxidation)
CAMS IA-3/IA-7 North Plume	IWAS/EISB with nitrogen sparge	40	275 PCE 68.3 TCE 515 cis-1,2-DCE 56.5 VC	(July 2018) ND PCE 1.3 TCE 16 cis-1,2-DCE 11 VC	March 2017–February 2018
CAMS IA-7 South Plume	IWAS/EISB pilot test	40	1,790 PCE 500 TCE 973 cis-1,2-DCE 106 VC	(December 2019) ND PCE 0.88 TCE 1 cis-1,2-DCE ND VC	March 2015–September 2015
CAMS IA-11 Plume	EISB Excavation with amended backfill	120 (EISB) 27 (Excavation)	11,900 PCE 2,860 TCE 15,300 cis-1,2-DCE 10,800 VC	(August 2017) 0.51 PCE ND TCE 0.41 cis-1,2-DCE ND VC	2006–2014 (EISB) 2016 and 2017 (excavations)

3.2 IA-2 Tank Farm Area Plume

The IA-2 Tank Farm Area Plume is attributable to historical releases of benzene, chloroform, and methylene chloride (MeCl) that occurred within a former tank farm (Figure 2). Between 1990 and 1998, the tank farm that housed the aboveground storage tanks and underground storage tanks (USTs) in IA-2 was demolished, and the tanks, impacted soil, and impacted bedrock were excavated and removed. A supplemental soil excavation was conducted to remove remaining soil impacts in 2015. In addition, the following IRM activities were completed for groundwater:

- *In-situ* thermal treatment (ISTT) using electrical resistance heating (ERH) in the source zone to treat bedrock.
- In-Well Air Stripping (IWAS) using an Accelerated Remedial Technologies (ART) recirculating well system technology in the shallow downgradient plume area (extending into northern IA-6).
- A soil vapor extraction (SVE) system using trenches to supplement the IWAS-ART treatment to recover VOCs from the vadose zone.

Based on a comparison of historical to current concentrations (Table 2 above), IRM activities and MNA have effectively treated this source area and have reduced dissolved concentrations in the plume by several orders of magnitude. Chloroform and MeCl are no longer detected in groundwater in IA-2. Benzene concentrations ranged from not detected to 140 micrograms per liter (µg/L), relative to the GWQS of 1 µg/L, during the most recent sampling event (4Q 2020). Additional information about this IRM, including performance monitoring data, is provided in the April 2019 *Interim Remedial Measure Progress Update* report (TRC, 2019j).

3.3 IA-6 Chlorobenzene Plume

The IA-6 Chlorobenzene Plume likely originated from local releases in the vicinity of former Buildings 15, 16, and 17 (Figure 2). Chlorobenzene and tetrachloroethene (PCE) and its degradation products (PCE+)[4] have been identified in groundwater in the source area. The following preliminary remedial efforts and IRM activities have been implemented for this plume:

- A groundwater pump-and-treat system was operated from 2004 to 2015 and was subsequently abandoned so that Building 86 could be demolished.
- A SVE system was operated from December 2007 until April 2014 to remove VOCs from soils above the water table.
- A combined IWAS and ozone injection using ART system technology and biosparging was operated from May to December 2016, and then again from

[4] PCE+ is defined as the sum of PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), and VC.

October through December 2017 with a single persulfate injection event conducted in December 2017.
- The IWAS system was restarted in February 2018 to treat localized rebound of chlorobenzene, with ozone injection restarting in April 2018.
- Enhanced in-situ bioremediation (EISB) injections were conducted from May to June 2018 to treat a small area with PCE exceedances.

Based on a comparison of historical maxima to current concentrations (Table 2 above), IRM activities and MNA have significantly reduced mass in this source area and have reduced dissolved concentrations in the plume by orders of magnitude. During the most recent sampling event, PCE+ concentrations were not detected or below the applicable GWQS. Chlorobenzene concentrations ranged from 6.5 to 63 µg/L, with only one sample exceeding the GWQS of 50 µg/L. Benzene concentrations ranged from not detected to 15 µg/L, relative to the GWQS of 1 µg/L. Additional information about the IRMs, including performance monitoring data, is provided in the March 2020 *Investigative Area (IA-6) IRM Progress Report Addendum: April/May & July 2019 Groundwater Sampling* (TRC, 2020b).

3.4 IA-9 Pipe Trench Area Plumes

The IA-9 Pipe Trench Area Plumes were almost entirely limited to the pipe trench backfill on the north and east sides of former Building 73. One of the two plumes originated from discharges associated with two Roche process sewer manholes on the north side of the building, and the other from a suspected sewer pipe leak on the east side of the building (Figure 2). The COCs were predominantly PCE+ on the north side, and toluene on the east side. IRM activities included the following:

- Removal of the two manholes, associated piping, and impacted soil from the northern trench adjacent to former Building 73 in June 2014.
- Excavation of the former Building 73 subsurface structure, including the entire pipe trench contents, in June and July 2015.
- Application of Daramend® (a combined anaerobic bioremediation and abiotic reduction reagent) amendment within the backfill placed in the northern trench area to treat any PCE+ that was remaining in the groundwater.
- Application of OBC™ (a combined aerobic bioremediation and chemical oxidation reagent) amendment to the eastern trench to treat any toluene that was remaining in the groundwater.

Based on a comparison of historical maxima to current concentrations (Table 2 above), IRM activities and MNA have successfully removed these source areas, and thereby have reduced dissolved concentrations in the plume by several orders of magnitude. During the most recent sampling event, benzene was ND in all wells except for MW-170R; the concentration in MW-170R did not exceed the GWQS of 1 µg/L. Toluene is no longer detected in the IA-9 Trench Plumes Area. The constituents that make up PCE+ have concentrations that are either below or within one order of magnitude of their respective

GWQS, except for PCE in MW-170BR (120 µg/L). Additional information about this IRM, including performance monitoring data, is provided in the *Investigative Area – 9 Interim Remedial Measure Progress Update* (TRC, 2019f).

3.5 IA-10 Building 70 Area Plume

The IA-10 Building 70 Area Plume is due to a release from former USTs and fuel dispensers located near the southeastern corner of former Building 70 (a vehicle maintenance building; Figure 2). The USTs and dispensers were removed in November 2014, and sodium persulfate and calcium peroxide solution were injected in February 2015 to promote short-term oxidation and long-term biological degradation of benzene.

Based on a comparison of historical maxima to current concentrations (Table 2 above), IRM activities successfully removed the source area and reduced dissolved concentrations in the plume by two orders of magnitude to below the GWQS. Additional information about the IRMs, including performance monitoring data, is provided in the April 2019 *Investigative Area - 10 Building 70 Interim Remedial Measure Progress Report* (TRC, 2019h).

3.6 IA-10 Building 104 Area Plume

The source of the IA-10 Building 104 Area Plume has not been identified, though it may be related to incidental spills near the former Building 104 loading dock (Figure 2). A groundwater IRM was implemented in April 2015 consisting of injections of ABCplus™ (EISB amendment) into shallow groundwater within the former building footprint to address the PCE+ concentrations in groundwater. The injection program and eight quarterly rounds of post-IRM monitoring were completed in April 2017, before the MNA sampling program and before the wells were decommissioned for construction of the new laboratory building.

Sampling data from April 2017 show that PCE+ concentrations were remediated to below or within one order of magnitude of their applicable GWQS, with the exception of PCE in 186RI-MW1 and 186RI-MW2, which was detected at 16 and 18 µg/L, respectively. Additional information about the IRMs, including performance monitoring data, is provided in the April 2019 *Investigative Area - 10 Former Building 104 Area Interim Remedial Measure Progress Report* (TRC, 2019i).

3.7 On-Site Dioxane Plume

The On-Site Dioxane Plume appears to originate from dioxane releases near the boundary of IA-1 and IA-4, in the vicinity of former Building 44 and former Building 56 (Figure 2). The resulting plume migrated to the south-southwest through IA-1 and IA-6 and south of the Site.

Roche implemented the following IA-1/4 IRM activities to remediate dioxane:

- IWAS with ozone sparging using ART system technology to address impacts in the bedrock, along with SVE for capturing VOCs in the vadose zone.
- One-time sodium persulfate ISCO injection to locally supplement the IWAS in November 2017 (11 well pairs).
- IWAS with ozone using ART system technology restarted in February 2018 and operated until January 2019, focusing on recalcitrant portions of the treatment zone that did not respond well to the initial ozone treatment.

The injection scheme for IA-1/4 included 44 ozone sparge well locations, 34 IWAS wells, and nine vapor extraction trenches (VETs). Each ozone sparge well included an upper and lower (*i.e.*, shallow and deeper) injection interval, for a total of up to 88 total sparge points in the treatment area. The treatment area contained a North System and a South System. The North System consisted of 16 shallow injection wells and 13 shallow ART IWAS wells, and five deep ozone injection wells and four deep ART IWAS wells. The South System consisted of 23 deep ozone injection wells and 17 deep ART IWAS wells.

Roche's implementation of the ISCO remedy reduced dioxane concentrations in the range of 1,000s of µg/L before treatment to an average of about 100 µg/L or less after treatment. Overall, the IRM activities and MNA have been successful in reducing dioxane concentrations by over one order of magnitude. Current concentrations range from not detected to a maximum of 200 µg/L.

This IRM appears to be one of the first full-scale *in-situ* remedies for dioxane in bedrock in New Jersey, and it has significantly reduced dioxane concentrations in groundwater (Table 2 above). Additional information about the IRMs, including performance monitoring data, is provided in the April 2019 *Investigative Area-1/4 Interim Remedial Measure Progress Report* (TRC, 2019b).

3.8 CAMS IA-12 Plume

The CAMS IA-12 Plume originated from breaches in the CAMS in the vicinity of the Route 3 guard shack along the northernmost portion of the Site (Figure 2). After an extensive PDI, Roche implemented the following IRM activities:

- ISTT via ERH in the core of the CAMS IA-12 Plume (at and immediately around the area of dense non-aqueous phase liquid (DNAPL) and elevated PCE+ concentrations), operated from March to July 2015.
- IWAS with ozone using ART system technology for the area surrounding the ISTT area, operated from July 2016 to December 2017.
- Spot treatment with sodium persulfate around monitoring well MW-80C in October and November 2017.

The CAMS IA-12 IRM has significantly reduced contaminant mass in the source area and has reduced plume concentrations by up to two orders of magnitude. The most recent sample data from this area show that PCE+ constituents range from not detected to up

to three orders of magnitude above the GWQS.

Roche investigated and remediated this plume even though the source is not associated with on-Site operations. Roche will continue to monitor this plume as part of the LTM Program. Additional information about the IRMs conducted for this plume, including performance monitoring data, are available in the April 2019 *Investigative Area – 12 Operable Unit-1 Interim Remedial Measure Update Report* (TRC, 2019g) and the *Investigative Area 12 Operable Unit-2 Interim Remedial Measure Progress Report* (TRC, 2019k).

3.9 CAMS IA-3/IA-7 North Plume

The CAMS IA-3/IA-7 North Plume likely originated from breaches in the CAMS at the boundary of IA-3 and IA-7 in the area southwest of former Building 115 and west of Building 123 (Figure 2). An IRM consisting of an IWAS system with EISB with nitrogen sparge operated from March 2017 to February 2018 to address groundwater impacts in the overburden and weathered bedrock. This IRM successfully reduced PCE+ concentrations by at least two orders of magnitude (with the exception of vinyl chloride [VC]) to ND or to concentrations that are below or within an order of magnitude of the applicable GWQS, as shown in Table 2 above. Roche investigated and remediated this plume even though the source is not associated with on-Site operations. Roche will continue to monitor this plume as part of the LTM Program. Additional information about the IRMs conducted for this plume, including performance monitoring data, are available in the April 2019 *Investigative Area -3/7-CAMS Interim Remedial Measure Progress Report* (TRC, 2019c).

3.10 CAMS IA-7 South Plume

The CAMS IA-7 South Plume originated from a manhole along the abandoned leg of the former CAMS in the center of IA-7, south of Building 123 in the area between former Building 85 and former Building 100 (Figure 2). An EISB pilot test was completed between March and September 2015 and effectively treated the groundwater and reduced the PCE+ concentrations in the overburden/shallow bedrock zone in this area to ND or below the applicable GWQS, as shown in Table 2 above. Roche investigated and remediated this plume even though the source is not associated with on-Site operations. Roche will continue to monitor this plume as part of the LTM Program. Additional information about the IRMs conducted for this plume, including performance monitoring data, are available in the April 2019 *Investigative Area – 7 South / CAMS Interim Remedial Measure Update* (TRC, 2019e).

3.11 CAMS IA-11 Plume

The CAMS IA-11 Plume originated from DNAPL releases from a manhole on the abandoned leg of the former CAMS (Figure 2). The releases created a source zone directly below the manhole that was concentrated in the overburden and weathered bedrock, but some DNAPL penetrated into the competent bedrock beneath the weathered bedrock. The following remedial activities were conducted to treat the CAMS IA-11 Plume:

- EISB injections to treat overburden groundwater from 2006 through 2014.
- Pilot-scale EISB injection in competent bedrock to evaluate treatment of the deeper portions of this source zone (attempts to inject amendments into the shallow weathered bedrock above the competent bedrock were unsuccessful due to the low permeability of this zone).
- Removal of former Manhole C-1 and excavation of impacted soil in 2016.
- Excavation of weathered bedrock to 27 feet bgs beneath Manhole C-1 in January 2017 and application of EHC® (an *in-situ* chemical reduction and bioremediation product composed of controlled-release carbon, zero valent iron particles, and nutrients) and Miracle Gro (additional water-soluble bionutrients) to the backfill to serve as a treatment mechanism for any remaining contaminant mass in the vicinity of the excavation.

IRM activities in IA-11 have successfully removed the PCE+ source, reducing dissolved concentrations in the plume by at least three orders of magnitude to ND or concentrations that are below the applicable GWQS. For a comparison of historical to current concentration data, see Table 2 above. Roche investigated and remediated this plume, even though the source is not associated with on-Site operations. Roche will continue to monitor this plume as part of the LTM Program. Additional information about the IRMs conducted for this plume, including performance monitoring data, are available in the December 2017 *Investigative Area IA-11 West Excavation Interim Remedial Measure (IRM) Discharge to Groundwater (DGW) Permit by-Rule (PBR) Report* (TRC, 2017d).

4.0 Site-Wide Groundwater Remedial Action

Roche has implemented IRMs for the groundwater plumes that originate on-Site, including plumes that originated from the CAMS. The IRMs have significantly improved groundwater quality by largely (or completely) eliminating sources, which has resulted in significant reductions in groundwater concentrations and plume extents. MNA was therefore proposed in the December 2019 GWRAWP (TRC, 2019l) as the final remedy for the Remedial Action Plumes. The NJDEP approved the December 2019 GWRAWP on August 20, 2020 (NJDEP, 2020).

In accordance with the NJDEP's Notification and Public Outreach requirements outlined in the ARRCS [N.J.A.C. 7:26C-1.7], and Roche's April 9, 2013 *Roche Nutley Enhanced Notification and Public Outreach Plan* (2013 Enhanced Notification Plan; TRC, 2013a), Roche placed a display advertisement in newspapers of general circulation (Herald News, Nutley Sun, and The Record) in the vicinity of the Site. The advertisement provided notification to the public that the December 2019 GWRAWP was approved by the NJDEP and that the public had a 30-day window to submit questions or concerns. No questions or concerns were received from the public regarding the proposed groundwater remedy.

The Monitored Plumes (*i.e.*, the four CAMS plumes and the plumes originating from off-Site sources) were not included in the MNA Monitoring Program discussed below. Instead, the Monitored Plumes will be monitored as part of the LTM Program.

4.1 Remedial Objectives

The remedial objective for the IA-2 Tank Farm Area, IA-6 Chlorobenzene, IA-9 Pipe Trench Area, IA-10 Building 70 Area, IA-10 B104 Plume, and On-Site Dioxane Plumes is to meet the NJDEP's Class II-A GWQS [N.J.A.C. 7:26C] for the COCs associated with each plume, as presented in Table 2 above.

Roche will maintain institutional controls (*i.e.*, CEA) and well restriction area (WRA) for the Remedial Action Plumes until the concentrations within these plumes no longer exceed the GWQS.

4.2 Remedial Action Plume MNA Groundwater Monitoring

As detailed in the GWRAWP, the results of statistical trend analyses completed prior to the GWRAWP had already identified MNA as an appropriate remedy for the IA-10 Building 70 Area and IA-10 Building 104 Area Plumes. Therefore, an annual sampling program was implemented between March 2019 and December 2020 for these two plumes pending initiation of the LTM Program. As proposed in the approved December 2019 GWRAWP, the evaluation of MNA for the IA-2 Tank Farm Area, IA-6 Chlorobenzene, IA-9 Pipe Trench Area, and On-Site Dioxane Plumes was completed using eight consecutive quarterly rounds of groundwater monitoring data collected in 2019 and 2020; the eight consecutive rounds of quarterly samples were collected from

wells located within the plume footprint areas of each plume. These data were evaluated for COC trends to support MNA remedy selection. Only two rounds of data were collected from wells that monitor the plume fringes and the sentinel wells; therefore, these data were not included in the MNA trend evaluation. The COCs for each of these plumes and number of wells evaluated for each plume is identified in Table 3 below.

Table 3: *Plume COCs and MNA Summary*

Plume Name	COC	MNA Well Count
IA-2 Tank Farm Area Plume	benzene	15
IA-6 Chlorobenzene Plume	chlorobenzene, PCE+, and benzene	16
IA-9 Pipe Trench Area Plumes	PCE+ and benzene	8
IA-10 Building 70 Area Plume	benzene	1
IA-10 Building 104 Area Plume	PCE+	10
On-Site Dioxane Plume	1,4-dioxane (dioxane)	44

Sample collection activities and laboratory analysis of groundwater samples obtained as part of the MNA Monitoring Program were performed in accordance with the TRSR, the NJDEP-approved groundwater RI Work Plans for shallow and deep bedrock investigations (TRC, 2012b; 2012c; 2013b; 2013c; 2013d; 2013f), the NJDEP-approved sampling plan in effect at the time of sample collection, and the revised Quality Assurance Project Plan (QAPP) (TRC, 2013e). Table 4 presents a list of groundwater samples collected for the MNA evaluation.

Sampling logs for the MNA monitoring events are provided in Appendix D. Groundwater analytical results for the MNA Monitoring Program are summarized in Tables 5-1 through 5-6 and in Appendix E (see Figures 1-1 through 6-1 of the MNA statistical analyses).

In addition, as proposed in the GWRAWP, a network of selected monitoring wells located at the Site that are unrelated to the Remedial Action Plumes were sampled on a semi-annual or annual basis. These data were presented in the previously submitted Site-Wide Groundwater Progress Reports (TRC, 2020a; TRC, 2021).

4.3 Data Reliability

The analytical methods used for the MNA monitoring events are provided in the QAPP (TRC, 2013e) and the laboratory analytical reports. The laboratory data reports and Electronic Data Deliverables/Electronic Data Submittal (EDD/EDS) for the recent data are included on a compact disc in Appendix F.

A quality assurance (QA) review was performed on the laboratory analytical reports for all samples collected as part of the MNA Monitoring Program. 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.

Based on a review of the laboratory reports, no data were rejected; therefore, the data discussed in this report can be used for the intended decision-making purposes.

4.4 Variances and Deviations

In accordance with N.J.A.C 7:26C-1.2(a) General Requirements, this section summarizes the rationale for the deviations from relevant NJDEP technical guidance. As proposed in the GWRAWP and approved by the NJDEP, the LTM Program proposed in Section 7.3 of this GWRAR includes a network of wells that include source area wells, plume fringe wells, and sentinel wells for each of the Remedial Action Plumes as per the NJDEP's MNATG (NJDEP, 2012), with the exception of the IA-10 Building 104 Area Plume. As discussed in Section 4.5.5, the monitoring network for the B104 Area Plume could only be re-established in the side- and down-gradient directions due to the construction of a building directly over the plume footprint.

In accordance with the NJDEP's *Off-Site Source Ground Water Investigation Technical Guidance*, Roche notified the NJDEP of some plumes that migrate onto the Site from off-Site sources (described in Section 1.0). However, the Deluxe Plume, the Off-Site Western Plume, and the Off-Site Briad/North Plume were not called in to the Hotline based on discussions with the NJDEP Case Team. These plumes are known to the NJDEP and are being addressed by others.

4.5 Remedial Action Plume MNA Assessment Methodology

Pursuant to the NJDEP's MNATG, and using the data collected in 2019 and 2020, multiple lines of evidence were evaluated for five of the Remedial Action Plumes to assess whether MNA and institutional controls are appropriate as the final remedy for groundwater. The assessment included a review of primary lines of evidence as defined by the MNATG (NJDEP, 2012) (described in Section 5.0).

The sixth Remedial Action Plume, the IA-10 Building 70 Area Plume, no longer exceeds the GWQS so assessment of MNA was not warranted.

A detailed discussion is provided below of the analytical data used to assess the primary lines of evidence that demonstrate that Site conditions meet the MNA Assessment Criteria for the Remedial Action Plumes.

4.5.1 IA-2 Tank Farm Area Plume

Pursuant to the December 2019 GWRAWP, the following wells were monitored to assess this plume between March 2019 and December 2020 (Figure 1-2 in Appendix E, Attachment 1):

- Source Area: ART-MW-6BR [quarterly]
- Plume Footprint Area: ART-MW-5BR, EW-4B, IW-190B, MW-186-2, MW-241B, MW-243B, MW-244B, MW-308B, and MW-341A [quarterly]
- Side-gradient: MW-252C and MW-314B [annually]
- Downgradient/Sentinel: MW-22A, MW-94, and MW-320C [annually]

The summary statistics from the eight quarterly MNA sampling rounds for benzene in IA-2 are provided below for the ten monitoring wells located within the source and plume footprint areas.

COC (µg/L)	GWQS	Site Data Summary				Frequency			
		n (site)	Min. Conc.	Max. Conc.	Mean Conc.	# Detected	% Detected	# > GWQS	% > GWQS
Benzene	1	80	0	410	40.64	44	55%	38	48%

Benzene was not detected above the GWQS in the side-gradient and downgradient wells during this period. Four of the ten plume footprint area wells did not exceed the GWQS for the last four rounds of sampling. The maximum benzene concentration, 410 µg/L, was detected in 1Q 2019 in source area well ART-MW-6BR. Benzene concentrations in the same well decreased to 140 µg/L in 4Q 2020.

4.5.2 IA-6 Chlorobenzene Plume

Pursuant to the December 2019 GWRAWP, the following wells were monitored to assess this plume between March 2019 and December 2020 (Figure 2-2 in Appendix E, Attachment 2):

- Plume Footprint Area: EW-6B, IW-195A, IW-196A, IW-197A, IW-198A, IW-199B, IW-200A, MW-504B, MW-508A, and MW-508B [quarterly]
- Upgradient: MW-505A, MW-506B, and MW-507C [annually]
- Downgradient/Sentinel: MW-22A, MW-94, and MW-320C [annually]

PCE+, benzene, and chlorobenzene were not detected above the GWQS in the upgradient, plume footprint (with the exception of MW-504B and IW-198A), and downgradient wells during this period. Results are shown on Figure 2-2 in Appendix E, Attachment 2.

The summary statistics from the eight quarterly MNA sampling rounds for the targeted COCs in IA-6 are shown below for the ten plume footprint monitoring wells.

COCs (µg/L)	GWQS	Site Data Summary				Frequency			
		n (site)	Min. Conc.	Max. Conc.	Mean Conc.	# Detected	% Detected	# > GWQS	% > GWQS
Chlorobenzene	50	80	0.67	460	74.01	80	100%	28	35%
Benzene	1	80	0	52	7.65	59	74%	34	43%
PCE	1	80	0	7.7	0.17	5	6%	2	3%
TCE	1	80	0	11	0.56	24	30%	6	8%
cis-1,2-DCE	70	80	0	460	8.3	62	78%	1	1%
VC	1	80	0	170	3.97	48	60%	14	18%

Of the ten plume footprint wells, nine wells did not exceed their respective GWQS for the last three rounds of sampling for PCE+ constituents. Contaminant levels for PCE+ did not exceed their respective GWQS by 4Q 2020 in the quarterly monitoring wells furthest downgradient within the plume footprint. Benzene and chlorobenzene were detected at maximum concentrations of 15 µg/L and 63 µg/L in 4Q 2020, respectively, in the plume footprint, which are significantly lower than the maximum concentrations detected during the MNA monitoring period.

4.5.3 IA-9 Pipe Trench Area Plumes

Pursuant to the December 2019 GWRAWP, the following wells were monitored to assess this plume between March 2019 and December 2020 (Figure 3-2 in Appendix E, Attachment 3):

- Plume Footprint Area: MW-170AR, MW-170BR, MW-170R, and MW-469A [quarterly]
- Upgradient: MW-152R and MW-467A [annually]
- Side-gradient: MW-468A [annually]
- Downgradient/Sentinel: MW-470A [annually]

The summary statistics from the eight quarterly MNA sampling rounds for the targeted COCs in IA-9 are shown below for the four monitoring wells located within the plume footprint area.

COCs (µg/l)	GWQS	Site Data Summary				Frequency			
		n (site)	Min. Conc.	Max. Conc.	Mean Conc.	# Detected	% Detected	# > GWQS	% > GWQS
Benzene	1	32	0	2.3	0.42	10	31%	5	16%
PCE	1	32	0	150	31.9	9	28%	8	25%
TCE	1	32	0	8.7	1.75	10	31%	8	25%
cis-1,2-DCE	70	32	0	26	6.68	30	94%	0	0%
VC	1	32	0	3.9	1.07	24	75%	10	31%

Of the four plume footprint wells, two wells did not exceed the GWQS for the last two rounds of sampling for all COCs.

4.5.4 IA-10 Building 70 Area Plume

Based on the groundwater sample analytical results from the annual sampling rounds in 2019 and 2020, benzene was not detected above the GWQS in any of these wells (see Figure 4-2 in Appendix E, Attachment 4). Therefore, no further action is required for this plume.

4.5.5 IA-10 Building 104 Area Plume

As noted in the GWRAWP, the following wells were sampled as part of a MNA quarterly monitoring program with 8 rounds completed from 2015 to 2017:

- Source Area: MW-259A, MW-284A, MW-285A [quarterly]
- Upgradient: MW-281A, MW-287A [quarterly]
- Side-gradient: 186RI-MW1, MW-283A, MW-286A, MW-32 [quarterly]
- Downgradient/sentinel: 138RI-MW1 [quarterly]

Due to new building construction (Quest Labs; see Figure 5-2 in Appendix E, Attachment 5), the following MNA wells within the footprint of the new building were decommissioned with NJDEP approval: MW-259A, MW-281A, MW-283A, MW-284A, and MW-285A. Therefore, continued annual sampling of the source area is no longer possible. As noted in the GWRAWP, Roche re-established the monitoring well network for the IA-10 Building 104 Area Plume. The re-established monitoring well network includes three existing wells, and the installation of three additional monitoring wells (*i.e.*, 138RI-MW1R, MW-259BR, and MW-287AR) to the south and east of the exterior walls of the new building (where Roche Building 104 was previously located). Monitoring wells MW-259BR and 138RI-

MW1R were installed into the bedrock of HGU 1 to monitor potential commingling with the Deluxe Plume as per the NJDEP's comments on the GWRAWP (NJDEP, 2019). The wells identified for annual monitoring for the IA-10 Building 104 Area Plume are outlined below:

- Downgradient/Sentinel: 138RI-MW1R (replaced 138RI-MW1), MW-31, MW-32, MW-259BR (replaced MW-259A), MW-286A, and MW-287AR.

Monitoring wells MW-31, MW-32, MW-286A, and MW-287AR were sampled annually in 2019 and 2020; wells MW-259BR and 138RI-MW1R were installed in 2020 and sampled only once in November 2020. PCE and trichloroethene (TCE) were detected at concentrations slightly above, but within one order of magnitude of, the applicable GWQS during the most-recent sampling event (2.8 µg/L and 1.6 µg/L, respectively) in HGU 1 well 138RI-MW1R.

4.5.6 On-Site Dioxane Plume

Pursuant to the December 2019 GWRAWP, the following wells were monitored to assess this plume between March 2019 and December 2020 (Figure 6-2 in Appendix E, Attachment 6):

- Plume Footprint Area: 187RI-MW2, MW-2, MW-2B, MW-22A, MW-103A, MW-104A, MW-104C, MW-126C, MW-136, MW-136B, MW-136C, MW-208C, MW-209C, MW-210, MW-244B, MW-275A, MW-275C, MW-320C, MW-347C, MW-348C, MW-357A, MW-357-S2, MW-357-S3, MW-391A, MW-391-S3, MW-394B, MW-394C, MW-505A, MW-506B, MW-507C, MW-508A [quarterly]
- Downgradient: MW-108A, MW-144A, MW-144B, MW-304B and MW-304C [annually]
- Upgradient: DW-15, DW-31A, DW-31B, DW-65-119-S3, DW-65-185-D1, DW-65-211-D1, DW-65-221-D1, and MW-237B [annually]

The summary statistics from the eight quarterly MNA sampling rounds for dioxane in the On-Site Dioxane Plume are shown below for the 31 monitoring wells located within the plume footprint area.

COC (µg/L)	Plume Edge Concentration[5]	Site Data Summary				Frequency			
		n (site)	Min. Conc.	Max. Conc.	Mean Conc.	# Detected	% Detected	# > Remediation Standard (0.4)	% > Remediation Standard
Dioxane	10	265	0	230	37.6	225	85%	162	61%

4.6 Technical Impracticability

Roche requested a Technical Impracticability (TI) Determination in the December 2019 GWRAWP for the Deep Dioxane Plume (*i.e.*, the portion of the dioxane plume that was deeper than 90 feet bgs) and the Eastern Plume. As requested by the NJDEP, Roche provided more detailed documentation in support of the TI Determination for the Deep Dioxane Plume TI on May 29, 2020. The NJDEP approved the TI Determination for the Deep Dioxane and Eastern Plumes as part of its approval of the December 2019 GWRAWP on August 20, 2020 (NJDEP, 2020).

Roche will continue to monitor the Deep Dioxane and Eastern Plumes; wells associated with these plumes are included in the LTM Program. As required by the NJDEP, Roche will reassess the TI Determination every 5 years to determine if advances in technology make remediation of these two plumes feasible.

[5] On-Site Dioxane Plume was defined in the December 2019 GWRAWP by the 10 µg/L contour to distinguish it from dioxane contributions from one or more of the Monitored Plumes that migrate onto the Site from off-Site sources.

5.0 Evaluation of Plume Characteristics and Remedial Effectiveness

Pursuant to the NJDEP's 2012 MNATG (NJDEP, 2012), the investigator must demonstrate the following criteria have been met prior to proposing MNA as a remedy for groundwater:

- That site characterization data demonstrate that natural attenuation is occurring (*i.e.*, stable or shrinking plume);
- That remaining sources have been remediated to the extent that contaminant migration to groundwater does not exceed the natural attenuation capacity of the aquifer (*i.e.*, stable or decreasing contaminant trends);
- That there are no conditions that generally preclude MNA as a remedy present at the site (*i.e.*, expanding groundwater plume, effective monitoring limitations, confirmed receptor impact, imminent threat to receptors, or free and/or residual product); and,
- That MNA in conjunction with institutional controls (*i.e.*, CEA and WRA) is protective of human health and the environment.

Multiple lines of evidence were evaluated for each of the Remedial Action Plumes to assess whether MNA and institutional controls can be proposed as the final remedy for groundwater (NJDEP, 2012). **Appendix E provides a detailed narrative describing the methods used to assess the lines of evidence and the outcomes of the assessments completed for the Remedial Action Plumes.** The conclusions derived from the assessment documented in Appendix E are summarized below.

5.1 MNA Assessment Outcome for Remedial Action Plumes

The monitoring well network effectively monitors the groundwater conditions within and surrounding the Remedial Action Plumes.

The plume-specific MNA evaluations for five of the Remedial Action Plumes provided in Appendix E discuss lines of evidence that demonstrate that Site conditions meet the following MNA Assessment Criteria:

- That the limits of the Remedial Action Plumes are stable or shrinking (*i.e.*, natural attenuation is occurring);
- That contaminant trends are stable or decreasing (*i.e.*, contaminant migration to groundwater does not exceed the natural attenuation capacity of the aquifer);
- That free and/or residual product are not present; and
- That MNA in conjunction with institutional controls is protective of human health and the environment. As documented in the April 2014 and July 2018 RE updates (TRC, 2014b; TRC, 2018b), no receptors are impacted and there is no imminent threat to receptors.

The findings detailed in Appendix E are summarized below.

5.1.1 IA-2 Tank Farm Area Plume

Based on a comparison of the areal footprints of the IA-2 Tank Farm Area Plume following the IRM cessation and at the end of the MNA monitoring period, the benzene plume is shrinking. The plume footprint decreased from approximately 13,400 square feet (feet^2) to approximately 4,800 feet^2. The contaminant mass in this plume decreased from an estimated 86 grams (g) in March 2019 to 50 g in December 2020. Benzene has not been detected in side-gradient and sentinel wells throughout the MNA monitoring period (with the exception of one detection, well below the GWQS), indicating that this plume is stable or decreasing.

There were five wells with benzene concentrations above the GWQS in December 2020. ART-MW-6BR, the source area well, shows a decreasing benzene concentration trend. The other four wells with concentrations above the GWQS (EW-4B, MW-186-2, MW-341A, and MW-244B) are located downgradient of the source area well within the plume footprint. A modest increase in benzene concentrations was observed in well EW-4B over the MNA monitoring period. However, benzene concentrations in plume monitoring wells MW-186-2, MW-341A, and MW-244B, downgradient of ART-MW-6BR and EW-4B, did not exhibit statistically significant trends (*i.e.*, concentrations were stable) over the MNA monitoring period, confirming that the observed modest increase in EW-4B is localized.

Light non-aqueous phase liquid (LNAPL) was not detected in the monitoring wells, nor were groundwater concentrations indicative of free or residual product.

As evidenced by the shrinking plume extent and mass, the decreasing trend in benzene concentrations, the absence of exceedances in the side-gradient and sentinel wells, and absence of detectable LNAPL in any monitoring wells, the final remedy for groundwater is effective in reducing remaining benzene concentrations for this Remedial Action Plume.

In accordance with the MNATG, MNA with institutional controls is an appropriate final remedy for groundwater for this Remedial Action Plume and is adequately protective of human health and the environment.

5.1.2 IA-6 Chlorobenzene Plume

Based on a comparison of the areal footprints of the IA-6 Chlorobenzene Plume following the IRM cessation (August 2018) and at the end of the MNA monitoring period (December 2020), the plume is shrinking and the concentrations in the plume show a continual decrease over time. The plume footprint decreased from approximately 25,900 feet^2 to approximately 410 feet^2. The chlorobenzene mass within the plume decreased from 115 g to 39 g, benzene mass within the plume decreased from 8.5 g to 2.6 g, and PCE+ mass within the plume decreased from 45 g to 1.3 g between March 2019 and December 2020. COCs have either not been detected or were detected at concentrations below their

respective GWQS in sentinel wells throughout the MNA monitoring period, indicating that this plume is stable or shrinking.

All wells showed decreasing contaminant concentration trends, no statistically significant concentration trend, or did not have exceedances for individual compounds by the end of the MNA monitoring period.

The contaminant concentrations in the MNA wells are at least one order of magnitude less than 1% solubility of the targeted compounds, which indicates an absence of separate-phase product in the subsurface.

As evidenced by the shrinking plume extent and mass, the decreasing or no statistically significant trends in contaminant concentrations, the absence of exceedances in the sentinel wells, and absence of separate-phase product, the final remedy for groundwater is effective in addressing remaining benzene, chlorobenzene, and PCE+ concentrations for this Remedial Action Plume.

In accordance with the MNATG, MNA with institutional controls is an appropriate final remedy for groundwater for this Remedial Action Plume and is adequately protective of human health and the environment.

5.1.3 IA-9 Pipe Trench Area Plumes

Based on a comparison of the areal footprints of the IA-9 Pipe Trench Area Plumes at the beginning and the end of the MNA monitoring period (1Q 2019 and 4Q 2020), the plumes are shrinking. When MNA sampling was initiated, concentrations of toluene were already below the GWQS. The footprint of the PCE+ plume decreased from approximately 940 feet^2 to approximately 400 feet^2. The total mass of the PCE+ plume decreased from 12.7 g to 11.9 g and benzene decreased from 0.15 g to 0.09 g between March 2019 and December 2020. COCs have not been detected or were below their respective GWQS in the side-gradient and sentinel well throughout the MNA monitoring period, indicating that this plume is stable or shrinking.

All wells within the plume footprint either showed decreasing contaminant concentration trends, no statistically significant concentration trend, or did not have exceedances for individual compounds by the end of the MNA monitoring period. Benzene concentrations did not exceed the GWQS in the last two rounds of sampling and showed a stable trend during the MNA monitoring period.

The contaminant concentrations in the MNA wells are at least two to three orders of magnitude less than 1% solubility of the targeted compounds, which indicates an absence of separate-phase product in the subsurface.

As evidenced by the shrinking plume extent and mass, the decreasing or no statistically significant trends in PCE+ concentrations, the absence of exceedances in the side-

gradient and sentinel well, and absence of separate-phase product, the final remedy for groundwater is effective in reducing remaining PCE+ concentrations for this Remedial Action Plume.

In accordance with the MNATG, MNA with institutional controls is an appropriate final remedy for groundwater for this Remedial Action Plume and is adequately protective of human health and the environment.

5.1.4 IA-10 Building 70 Area Plume

A decreasing benzene concentration trend in source area well 187RI-MW2 was observed from 2015 through 2018. In accordance with the GWRAWP, the MNA well network was sampled annually in 2019 and 2020. The benzene results for 187RI-MW2, 187RI-MW3, MW-210, and MW-477A were all below the GWQS of 1 μg/L, which confirms that the IA-10 Building 70 Area Plume remediation has been completed. Therefore, monitoring is no longer necessary for the IA-10 Building 70 Area Plume, and no further action is warranted.

5.1.5 IA-10 Building 104 Area Plume

Based on a review of data for the historical well network and for the sentinel well network of the IA-10 Building 104 Area Plume, the plume appears to be stable. The areal extent of the plume footprint cannot be evaluated as a primary line of evidence due to the construction of a building over the former source area. Based on the data from the wells within the plume footprint, the total mass of the PCE+ plume decreased from 16 g in July 2015 to 6 g in April 2017.

All wells within the plume footprint either showed decreasing contaminant concentration trends, no statistically significant concentration trend, or did not have exceedances for individual compounds by the end of the post-IRM sampling period. These wells are now decommissioned. Since decommissioning, a well network has been reestablished. PCE+ concentrations in the re-established sentinel wells were at or below the applicable GWQS in the 2020 sampling event. PCE+ concentrations in the wells closest to the decommissioned source area wells are below or at the GWQS, indicating the diminished source area is stable and not migrating. Additionally, low concentrations (marginally over the GWQS) in the deeper bedrock sentinel wells confirm plume stability and that the significant concentrations formerly observed in the overburden did not migrate into the deeper zones. The low-level PCE+ concentrations detected in the deeper bedrock sentinel wells during the first round of sampling are likely attributable to the Off-Site Deluxe Plume.

The latest available source area well data indicates that contaminant concentrations are at least four orders of magnitude less than 1% of the solubility of the targeted compounds, which indicates an absence of separate-phase product in the subsurface.

As evidenced by the shrinking plume mass, the decreasing or no statistically significant trends in PCE+ concentrations, and absence of separate-phase product, the final remedy for groundwater is effective in reducing remaining PCE+ concentrations for this Remedial Action Plume.

In accordance with the MNATG, MNA with institutional controls is an appropriate final remedy for groundwater for this Remedial Action Plume and is adequately protective of human health and the environment.

5.1.6 On-Site Dioxane Plume

The footprint of the On-Site Dioxane Plume decreased from 2,200,000 feet^2 in August 2018 to 1,600,000 feet^2 in the final quarter of the MNA monitoring program. The calculated contaminant mass in the On-Site Dioxane Plume decreased slightly from 38 kilograms (kg) in March 2019 to 36 kg in December 2020.

There are six wells that show a statistically significant increasing trend. However, these six wells are located within the middle of the plume, are delineated, and there are wells nearby or at the side- and downgradient edges of the plume that are below the GWQS, show a decreasing trend, or do not exhibit a statistically significant trend. Collectively, these data indicate that the plume is stable.

In accordance with the MNATG, MNA with institutional controls is an appropriate final remedy for groundwater for this Remedial Action Plume and is adequately protective of human health and the environment.

5.2 Remedial Action Conclusions

In accordance with the NJDEP's MNATG, Roche evaluated data to assess the contaminant trends and plume behavior in five Remedial Action Plumes (IA-2 Tank Farm Area Plume, IA-6 Chlorobenzene Plume, IA-9 Pipe Trench Area Plumes, IA-10 Building 104 Area Plume, and On-Site Dioxane Plume), which demonstrate that MNA with institutional controls is a suitable remedial action for these plumes. The LTM Program for these five plumes was included in the NJDEP-approved GWRAWP and is also provided in the GWRAR.

MNA is no longer necessary for the IA-10 Building 70 Area Plume, because it has already achieved GWQS, and no further action is warranted.

Based on multiple Primary Lines of Evidence presented in this report related to plume behavior (including plume size, mass calculation, and trend analysis), it can be concluded that the remaining five Remedial Action Plumes are stable or shrinking and that significant degradation and attenuation of groundwater COCs is occurring and that:

- There is no evidence of separate phase product in any of the Remedial Action

Plumes;

- All sentinel wells are below the GWQS or are at low concentrations slightly above the GWQS[6]; and show decreasing trends or are stable with respect to the targeted COCs;
- All potential receptors have been addressed by the groundwater CEA, VI mitigation, and ecological RA;
- Therefore, MNA with institutional controls is a suitable remedial action for these plumes. As previously discussed, Roche will continue to monitor the five Roche Plumes as proposed in the LTM Program included with the RAP.

[6] Dioxane concentrations in sentinel wells are less than 10 µg/L, which is used to distinguish the On-Site Dioxane Plume from dioxane contributions from one or more Monitored Plumes that flow onto the Site from off-Site sources. The GWQS for dioxane is 0.4 µg/L.

6.0 Contaminants of Emerging Concern

Roche evaluated operations at its former Nutley facility to determine whether PFAS should be considered a COC. That evaluation resulted in a recent focused groundwater sampling event for PFAS. Those samples revealed exceedances of New Jersey's groundwater quality standards for perfluorononanoic acid (PFNA), perfluorooctanesulfonic acid (PFOS), and perfluorooctanoic acid (PFOA). The NJDEP Hotline has been notified of these findings, and the NJDEP has assigned an Incident Number of 2021-10-14-1322-14 to the new case. Roche will conduct an RI of PFAS under that new number and, as part of that investigation, will evaluate whether perchlorate and 1,2,3-trichloropropane should also be considered COCs at Roche's former Nutley facility. Roche will perform the new RI and any remedial action required in accordance with the deadlines associated with the new case.

7.0 Long Term Monitoring

As presented above, MNA is an appropriate remedy to address the Remedial Action Plumes for the Site. This RAR is an attachment to the RAP application. A copy of this application is included in Appendix A. The LTM Program outlined in the RAP Application submitted with this GWRAR includes wells and sampling that monitor the remaining Monitored Plumes.

7.1 Classification Exception Area

On January 5, 2021, the CEA map for the Site was first established and uploaded to the NJDEP's GeoWeb database. As requested by the NJDEP, on June 4, 2021 Roche submitted a revised CEA map that encompasses the combined extent of the Remedial Action Plumes and the Monitored Plumes. The NJDEP issued an approval letter of the updated CEA map on August 30, 2021. The revised CEA Fact Sheet was approved and issued by the NJDEP on October 27, 2021.

7.2 Implementation Schedule

The following remedial action schedule is proposed, starting from the date of the NJDEP's issuance of a RAP for groundwater.

Tasks	Timeframe
Final Remediation Document	*An RAO will be issued by the LSRP following NJDEP issue of the RAP for groundwater – the RAO will be filed with the NJDEP within 30 days of issuance*
Remedial Action Implementation (performance monitoring)	*Long-Term Monitoring (LTM) began in late 2020, and will continue following NJDEP issuance of RAP – frequency specified in Section 7.3 of this GWRAR*
Remedial Action Reporting (Certification of Protectiveness)	*Remedial Action Protectiveness Certification to be submitted biennially following NJDEP issuance of RAP*

7.3 Long-Term Monitoring

After NJDEP issuance of the RAP for groundwater, selected wells will be monitored in accordance with the MNATG. The proposed post-remedial groundwater monitoring well network and sample analyses are specified in the RAP Application, a copy of which is included in Appendix A. The wells (shown on Figure 9) will be sampled on the following frequency and analyzed for TCL VOCs+15 and dioxane:

Situation	Performance Well Sampling Frequency	Reporting Schedule
Years 1-4 Following Issue of RAP	Sampled annually	With CEA Biennial Certification
Years 5-8 Following Issue of RAP	Sampled biennially	With CEA Biennial Certification
Years 9 through End of CEA	Sampled every 4 years	With next scheduled CEA Biennial Certification

The LTM well network includes approximately 200 wells that were proposed in the December 2019 GWRAWP, approved by the NJDEP on August 20, 2020 (NJDEP, 2020). For each of the Remedial Action Plumes, representative MNA wells were selected from the source area, along the axis of the plume, and at the plume's fringe for inclusion in the LTM. Some plumes are so small that only representative source and fringe wells were selected.

IA-2 Tank Farm Area Plume	ART-MW-6BR
	MW-243B
IA-6 Chlorobenzene Plume	IW-197A
	IW-199B
	MW-22A
IA-9 Pipe Trench Area Plume	MW-170AR
	MW-170BR
IA-10 Building 70 Area Plume	187RI-MW2
IA-10 Building 104 Area Plume	MW-286A
	MW-259BR
	138RI-MW1R
On-Site Dioxane Plume	MW-357A
	MW-394C
	MW-391C
	MW-136
	MW-136B
	MW-136C
	MW-126C
	MW-304B
	MW-304C

This combined network covers several hundred acres and monitors hydrogeologic zones extending from ground surface to about 500 feet bgs. The wells associated with the LTM network are shown on Figure 9 and summarized in Table 6. The data collected during the implementation of the LTM Program will be evaluated and modifications to the sampling frequency and monitoring network will be proposed, as warranted.

All samples will be collected and analyzed pursuant to the QAPP that has been in effect for investigations at the Site since 2013 (TRC, 2013e). Roche will prepare Biennial Certification Reports, which will include presentations of the monitoring data. Roche will continue to submit annual Progress Reports until the RAP is issued. A TI evaluation will be conducted every 5 years.

8.0 Total Remediation Costs

The total cost Roche has expended on the investigation and remediation of the groundwater at the Site is approximately $135 million.

9.0 References

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