SIXTH FIVE-YEAR REVIEW REPORT FOR
GREENWOOD CHEMICAL SUPERFUND SITE
ALBEMARLE COUNTY, VIRGINIA

Prepared by

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Region III
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08/31/2023

Date

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LIST OF ABBREVIATIONS & ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FYR	Five-Year Review
HI	Hazard Index
ICs	Institutional Controls
MCL	Maximum Contaminant Level
MG	Million Gallons
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
RA	Remedial Action
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
TBC	To be considereds
USACE	United States Army Corps of Engineers
VPDES	Virginia Pollution Discharge Elimination System
VOC	Volatile Organic Compound

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the sixth FYR for the Greenwood Chemical Superfund Site. The triggering action for this statutory review is the date of the fifth five-year review: September 6, 2018. The five-year review has been prepared due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site has been addressed in four operable units (OUs) and all four OUs will be addressed in this FYR:

- OU1 – Lagoons and disposal areas were excavated and transported to a permitted thermal destruction facility for treatment;
- OU2 – Ground water recovery wells were installed for "hot-spot" removal to prevent groundwater from migrating toward drinking water sources and treat recovered water in the on-Site treatment plant;
- OU3 – Former manufacturing buildings removed; and,
- OU4 – Ground water recovery wells used to contain contaminated groundwater within the waste management area (below OU1 excavations) to restore ground water quality within the area of attainment and treat recovered water in the on-Site treatment plant.

The Greenwood Chemical Superfund Site Five-Year Review was led by Eric Newman, EPA Remedial Project Manager (RPM), with EPA technical support staff Ayowale Ayodele (Hydrogeologist), Martin Gehlhaus (Toxicologist), Kimberly Hudson (Biologist) and John Brakeall (Community Involvement Coordinator). Aaron Siegel, VDEQ Remediation Project Manager, assisted in the review as the project lead directing remedy implementation at the Greenwood Chemical Site. EPA received technical assistance from Retaw Engineering and Apex Companies, the contractor team implementing the operation and maintenance for VDEQ. The review began on September 19, 2022.

Site Background

The Greenwood Chemical Site is located at 634 Newtown Road in the village of Newtown, Albemarle County, Virginia (Site). See Figure 1. The Site is owned by the now-defunct Greenwood Chemical Company (GCC) and encompasses 33.59 acres, of which approximately 18 acres were used for chemical manufacturing and waste disposal activities.

The historic land use of the Site was agricultural until 1946. Starting in 1947 a chemical manufacturing plant specializing in pharmaceutical intermediates began operations. From 1947 until 1985, chemicals including pharmaceutical, dye and paint intermediates, plant growth regulators and photographic chemicals were manufactured on-Site. The two main areas of the property utilized by GCC for business operations are known as the "manufacturing area" and the "drum disposal area." A more detailed Site location map with features associated with historic land use is presented in Figure 2. Historic features within the manufacturing area included chemical processing buildings, offices and laboratory space, storage trailers and sheds, a pump house, a concrete bunker, five treatment lagoons and several abandoned structures.

EPA dismantled and removed the former chemical production buildings and other facility features. The Site is currently inactive except for the operation of an on-Site water treatment plant, operated as a long-term response action. The entire Site is enclosed by a chain-link fence. The gate is opened during weekday business hours to accept deliveries at the treatment plant. The gate is locked in the evenings and on weekends.

The setting is rural and land use surrounding the Site is generally undeveloped woodlands or agricultural. There is a residential area along Summers Rest Road east of the northern property boundary. The Mt. Zion Baptist Church is located adjacent to the northwest corner of the Site. The Mt. Zion Baptist Church owns the undeveloped woodland along the western property boundary. The properties east and south of the Site are agricultural, currently used for cattle pastures. The farms in the area are generally 100+ acres and include a residence. The projected land use for the former Greenwood Chemical Site is light industrial, recreational or conservancy/open space; however, local zoning restrictions on the property have reverted to agricultural use only.

Groundwater beneath the Site is not currently being used, however, surrounding properties do utilize groundwater for potable and agricultural purposes. Surface water features on the Site are limited to a small pond, referred to as "South Pond," and several intermittent streams which serve as tributaries to a perennial stream designated as "West Stream" located south of the Site. The groundwater treatment plant discharges clean water to one of the intermittent streams flowing to West Stream. West Stream meanders through cattle pastures and ultimately enters Stockton Creek several miles south of the Site.

The bedrock aquifer underlying the Site is used as a drinking water source in surrounding residential areas. The area surrounding the Site is not presently serviced with public water. The closest residential well is located approximately 400 feet west of the Site, while the closest downgradient well is approximately 2,500 feet from the Site. The dominant groundwater flow direction is to the east-southeast in the direction of Stockton Creek and its tributaries.

The topography of the Site slopes predominantly to the southeast and levels off at the southern end. Total relief across the Site is approximately 196 feet with an average grade of 10 percent. The majority of the Site is covered with overburden ranging in thickness from 0 - 15 feet. Groundwater at the Site is present in both the overburden and underlying fractured bedrock. Aquifer testing indicates that overburden and bedrock units exhibit a high degree of hydraulic interconnection sufficient to consider the two units to be part of a single aquifer system. Significant movement within the bedrock is limited to its uppermost 50 feet. The water table at the Site is encountered at depths ranging from 5 feet to 35 feet below ground surface.

The water table generally follows surface topography. Groundwater in the overburden layer flows in a southeasterly direction toward West Stream, a tributary of Stockton Creek into which it discharges. The bedrock groundwater flow system is controlled by the nature and extent of bedrock fracturing. The direction of groundwater flow in the bedrock is also in a southeasterly direction. Groundwater located in the sloped areas of the Site generally has a downward vertical gradient (water moves downward from the overburden to the shallow bedrock). Topography at the southern end of the Site levels off and the vertical gradient of the groundwater is upward. The water table is generally located at or above the top of the bedrock.

In the southern portion of the Site, the groundwater elevations are at, or slightly above, ground surface elevations. Since the groundwater is found close to the surface in the southern portion of the Site, this indicates that the area serves as a groundwater discharge area. The West Stream and associated features at the southern periphery of the Site are probably groundwater discharge features.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Greenwood Chemical Superfund Site		
EPA ID: VAD003125374		
Region: 3	**State:** VA	**City/County:** Newtown/Albemarle
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: State ***[If "Other Federal Agency", enter Agency name]*:**		
Author name (Federal or State Project Manager): Eric Newman		
Author affiliation: U.S. EPA Region 3		
Review period: 9/19/2022 - 8/30/2023		
Date of site inspection: 5/11/2023		
Type of review: Statutory		
Review number: 6		
Triggering action date: 9/6/2018		
Due date *(five years after triggering action date)*: 9/6/2023		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

During operations liquid wastes were discharged through floor drains in the process buildings to a series of unlined lagoons adjacent to the plant. The unlined lagoons were interconnected by unlined drainage ditches or above-ground piping. Liquid hazardous substances were routinely spilled onto process building floors and drained into the ground beneath and adjacent to the process buildings. In addition, drums were systematically buried on plant property. Trenches were used for the disposal of large quantities of 55-gallon drums containing hazardous substances. This activity resulted in the contamination of soil, groundwater, surface water and lagoon sludge. Contamination in groundwater consists primarily of volatile organic compounds (VOCs) including 1,2-dichloroethane, carbon tetrachloride and vinyl chloride, semi-volatile organic compounds including naphthalene and other organic compounds such as bis (2-chloroethyl) ether.

In October 1988 EPA initiated a site-wide Remedial Investigation. EPA conducted a baseline risk assessment using all available data collected during previous removal work and identified data gaps. Several data gaps were

identified in the baseline risk assessment; however, it became clear that some initial steps could be taken to address obvious environmental problems at the Site. In order to simplify the management of the Site, EPA has divided the Site into components or Operable Units (OUs).

A Remedial Investigation and Feasibility Study (RI/FS) for the entire Greenwood Chemical Site was completed in August 1990. The report characterized the nature and extent of soil, surface water, sediment and groundwater contamination. The 1990 RI/FS process, including several preliminary reports, provided the basis for Records of Decision for OU1, Interim OU2, the 1991 Explanation of Significant Differences (ESD) which defined OU3, and the 1994 ESD.

The baseline risk assessment determined that risk pathways driving the risk at the Site under current and future use scenarios were dermal contact and ingestion of contaminated soil and ingestion of contaminated groundwater. The baseline risk assessment completed for the OU1 (1989) and Interim OU2 (1990) RODs assumed a future residential land use scenario. The baseline risk assessment completed for the final OU2/4 ROD (2005) assumed industrial and recreational future land use based on recommendations from state and local officials. The baseline risk assessment was completed prior to the development of the current ecological risk assessment guidance; however, a comparison of pre-remediation concentrations of contaminants in soil at the Site to ecological soil screening levels indicates that exposure to ecological receptors would have presented an unacceptable risk. Similarly, pre-remediation concentrations of contaminants in lagoon water were well above surface water quality standards currently known to be protective of aquatic life and ecological receptors.

Soil

The 1989 OU1 ROD listed the COCs for Site soil, which were refined in the 1994 ESD. See Table 1. The carcinogenic risks were highest for exposures to surface soil due to elevated concentrations of arsenic. Arsenic was the primary contributor to both the total excess cancer risk and the non-carcinogenic risk for exposure to soil[1]. The soil cleanup levels selected for organic compounds were based on the potential for migration to groundwater because the soil to groundwater performance standards were more conservative (i.e., lower) than cleanup concentrations developed for direct contact with soil assuming residential use. See Table 1 for soil cleanup standards for organics used during OU1 soil excavation[2]. The arsenic cleanup level in soil (27 mg/kg) was based on the direct exposure route because it was lower than the soil to groundwater target.

Groundwater

The 1990 interim OU2 ROD established that groundwater beneath the Site was grossly contaminated, primarily in the center of the Site (beneath the manufacturing area and the drum disposal area). The eleven contaminants identified as driving the risk assuming ground water consumption were:

Groundwater	
Arsenic	Non-carcinogenic polycyclic aromatic hydrocarbons (PAHs)
Benzene	Semi-volatile Tentatively Identified Compounds (TICs)
Methylene Chloride	Toluene
Trichloroethene	Volatile TICs
Chlorobenzene	Cyanide
Tetrachloroethene	

The interim ROD deferred establishment of groundwater cleanup levels to a subsequent ROD. See Operable Unit 2 (Final) and Operable Unit 4 Remedy Selection on Page 11 for final groundwater cleanup level discussion.

[1] The primary ecological risk driver was also arsenic in surface soil.
[2] In areas where arsenic was the only contaminant of concern present, excavation was deferred to the removal response taken in 2004/2005.

Lagoons 4 and 5

The response action for lagoon water was based on cyanide concentrations which exceeded the Virginia Surface Water Quality Standards for cyanide (5.2 ug/l). The cyanide levels presented an unacceptable risk to aquatic life. Once the lagoon was drained, the sludge/sediment was determined to exceed the soil cleanup level for arsenic.

A complete chronology of milestones for this project can be reviewed in Appendix A

Response Actions – Remedy Selection and Implementation Status OU1 and OU3

Between 1987 and 1990, EPA conducted two removal actions which included the removal of drums and smaller containers of chemicals (both buried and surface), the removal and treatment of lagoon water and sludges. In 1987, approximately 400 buried drums and 32 pressurized gas cylinders were excavated and removed from the Site. Waste water from lagoons 1, 2 and 3 was pumped into lagoon 4, treated with activated carbon, and released to lagoon 5. In addition, contaminated lagoon sludges were excavated and removed from the Site for disposal. In November 1989, EPA determined that further removal action was necessary after heavy rains in the region damaged the temporary soil/synthetic membrane cap covering the former drum disposal area. EPA repaired the temporary cover and several drainage swales were constructed around the waste lagoons to prevent further erosion. EPA has issued three Records of Decision (RODs) and issued one Action Memorandum for the Site after placing it on the National Priorities List (NPL) in July 1987 (see 55 Fed Reg. 27263). The first ROD addressed the OU1 source control remedy. The second ROD addressed the OU2 interim groundwater and lagoon water remedy. The third ROD reaffirmed the groundwater pump and treat remedy selected as an interim action and established performance standards for groundwater (OU2). The third ROD also addressed remaining deep soil contamination (OU4) located beneath areas excavated as part of OU1. EPA has also issued three Explanations of Significant Differences (ESD) in 1991, 1994, and 2013 that have subsequently modified the remedies and are further discussed below.

OU1 Remedy Selection:

On December 29, 1989, EPA issued the OU1 ROD selecting a remedy to address contaminated soils remaining in the lagoons and other disposal areas after emergency removal actions had been completed to address the sludges from those areas. The Remedial Action Objectives (RAOs) were to prevent direct exposure to contaminated soils and to eliminate the continued migration of contaminants to the underlying groundwater.

The OU1 ROD and subsequent 1994 ESD developed cleanup standards for each compound considering: 1) the direct contact exposure route; and, 2) its potential to migrate from soil to groundwater. The cleanup standards developed for the protection of groundwater in the 1994 ESD were more stringent than the standards developed for direct contact in each case except arsenic. See Table 1 for site-specific soil clean-up standards utilized for OU1. The major components of the selected remedy include:

- Excavation of soil exceeding risk-based cleanup levels (soil associated with Lagoons 1, 2, 3 and Backfill North were estimated at 4,500 cubic yards[3]);
- Off-Site treatment of contaminated soil in a Resource Conservation and Recovery Act (RCRA)-permitted thermal destruction facility (i.e., incinerator);
- Characterization and stabilization of treated soils in compliance with RCRA land ban restrictions, as appropriate, prior to its disposal in a RCRA-permitted Subtitle C landfill;
- Backfill excavations with clean fill and re-vegetate; and,
- Abandoned chemicals located in on-Site buildings were to be treated via thermal destruction and disposed of off-Site.

[3] These soils were considered to be a principal threat to human health and the environment and are shown in Table 1

OU3 Remedy Selection:

An Explanation of Significant Differences (ESD-1) augmenting the remedy selected in the OU1 ROD was issued on July 17, 1991. The OU1 ROD had been issued based on preliminary nature and extent of contamination data available at the time. The final RI Report completed in September 1990 identified additional contaminated soils exceeding risk-based soil cleanup levels (identified in the OU1 ROD) extending beneath on-Site Process Buildings A, B and C. ESD-1 required the removal of the process buildings to allow delineation of soils exceeding cleanup levels. The primary changes described in ESD-1 were:

- The Process Buildings A, B, and C were to be dismantled, decontaminated to the extent possible and appropriately disposed of in an off-Site landfill. Contaminated demolition debris was to be disposed of in a RCRA Subtitle C landfill; nonhazardous debris was to be disposed of in a RCRA Subtitle D landfill.

ESD-2 (Modification to OU1 Remedy Selection)

A second ESD (ESD-2) modifying the remedy selected in the OU1 ROD was issued on March 24, 1994. ESD-2 refined the extent of contamination estimates based on soil sampling completed during pre-design activities in the footprint of the demolished process buildings and other disposal areas. ESD-2 asserted that contaminated soils in the source areas to be addressed by OU1 extended beyond 15 feet, which it established as the practical limit of cost-effective excavation. ESD-2 also stated that EPA would evaluate appropriate response actions for the deeper contaminated soils as Operable Unit 4. Further, ESD-2 modified the cleanup levels presented in the OU1 ROD based on an extensive fate and transport modeling program completed as part of pre-design activities. See Table 1.

ESD-2 determined that the remedy for OU1 would address contaminated soil in the following additional areas of the Site:

- The Backfill North area extending to and beneath former Process Building A;
- An area including the location of former process Buildings B and C; and
- The former Drum Disposal Area, the Waste Dump area, the Northeast Drum Area, and other areas if subsequent sampling revealed contaminant concentrations above risk-based levels.

The area of contaminated soil requiring remediation increased from the 1.5 acres estimated in the original OU1 ROD to approximately 7 acres. The estimated volume of soil to be transported off-Site for treatment and/or disposal increased from 4,500 cubic yards to approximately 11,000 cubic yards. ESD-2 also noted the following clarification to the original remedy:

- Certain areas on the Site were only contaminated with elevated levels of arsenic. These arsenic-contaminated soils do not pose an unacceptable risk through the groundwater pathway but only through direct contact. Noting that the incineration technology selected for OU1 is inappropriate for arsenic, EPA deferred the remediation of these arsenic-contaminated soils to a subsequent decision document.

OU1 and OU3 Remedy Implementation

The work associated with OU3 was the first remedial action to be performed at the Site. In accordance with an interagency agreement (IA) with the US Army Corps of Engineers (USACE), construction of the OU3 remedial action began in December 1991 and extended through March 1993. Major components of the remedial action included:

- Installation of a security fence;
- Removal of abandoned chemical containers in and around the buildings;

- Demolition, decontamination and off-Site disposal of 4 concrete block buildings (process buildings A, B and C and a laboratory/office building);
- Removal of a metal shed (storage shed/garage); and,
- Decontamination and proper disposal of six aboveground chemical storage tanks, one underground chemical storage tank and associated piping.

In March 1993 EPA, USACE and VDEQ conducted the final inspection and concluded that construction had been completed in accordance with the project work plans.

Construction to implement OU1 remedial action began in February 1996 and completed in August 1997. Major components of the remedial action included:

- Excavation of approximately 11,000 yd^3 of contaminated soil from the source areas addressed under OU1 and OU3;
- Shipment by rail of contaminated soils to a thermal destruction facility (incinerator) in Utah for treatment;
- Disposal of residue (ash) in an adjacent RCRA Subtitle C landfill;
- Implementation of stormwater drainage controls around excavation areas; and,
- Backfilling, regrading and revegetation of excavation areas.

On August 8, 1997 EPA, USACE and VDEQ conducted the final inspection and concluded that construction had been completed in accordance with the remedial design plans and specifications.

Response Actions – Remedy Selection and Implementation Status OU2/4

OU2 Remedy Selection (Interim):

On December 31, 1990, EPA issued an Interim ROD for OU2. The ROD was considered "interim" because the selection of groundwater cleanup goals was deferred to a subsequent ROD. The RAOs were to minimize migration of contaminants toward residential wells, eliminate unacceptable ecological risks in Lagoons 4 and 5, and to obtain additional information regarding aquifer characteristics to assist in designing a final groundwater remedy. The major components of the interim OU2 remedial action include:

- Installation and operation of groundwater recovery wells to minimize migration of contaminated groundwater from the Site;
- Construction and operation of a water treatment plant to treat the recovered groundwater and surface water collected from Lagoons 4 and 5, and discharge to surface water in compliance with Virginia Pollution Discharge Elimination System (VPDES) criteria; and,
- Monitoring the effectiveness of the groundwater extraction network and systematic optimization to meet RAOs over time.

OU2 Remedy Implementation (Interim)

Construction of the OU2 interim remedial action began in September 1998 and completed in May 2000. Major components of the remedial action included:

- Installing and operating of five bedrock groundwater recovery wells (BR-2, BR-7, MW-23, BR-8 and BR-6);
- Installing a floating pump assembly to pump surface water from Lagoons 4 and 5 to the on-Site water treatment plant;
- Constructing a water treatment plant utilizing the following treatment train: precipitation/filtration, ultraviolet/chemical oxidation and carbon adsorption;

- Install plumbing necessary to convey recovered groundwater and lagoon surface water to the treatment plant;
- Operating the water treatment plant so that discharge achieves VPDES criteria; and
- Installing an expanded monitoring well network.

On May 9, 2000 EPA, USACE and VDEQ conducted the final inspection and concluded that construction had been completed in accordance with the remedial design plans and specifications. The water treatment system began continuous operations in May 2000 and on May 15, 2001, EPA and VDEQ determined the water treatment system to be operational and functional.

2004/2005 Removal Action Selection and Implementation – Surface Soil, Lagoons 4 and 5 (No Operable Unit Number)

On June 22, 2004 EPA issued an Action Memorandum . The RAOs of the removal action were to:

- Prevent exposure to laboratory chemicals abandoned by GCC
- Prevent direct contact with arsenic contaminated surface soils (exceeding 27 mg/kg) which had been excluded from incineration under OU1 remedial action, and
- Prevent exposure of ecological receptors to contaminated surface water and sediments in Lagoons 4 and 5.

Construction of the 2004/2005 removal response action began in June 2004 and was completed in June 2005. Major components of the response action included:

- Off-Site disposal of abandoned laboratory chemicals.
- Excavation and off-Site disposal of contaminated lagoon sludge (Lagoons 4 and 5) and surface soil with an arsenic concentration greater than 27 mg/kg.
- Backfilling lagoons and excavations.

The soil sampling program determined that no excavated soils were RCRA-characteristic waste. Approximately 19,500 tons of arsenic-contaminated soil and sludge was excavated, sampled and appropriately disposed in a solid waste landfill. EPA implemented an extensive confirmation sampling program to document that all soils with elevated arsenic concentrations were removed. The excavations were backfilled with a minimum 2-feet clean soil and seeded for erosion control.

OU2 (Final) and OU4 Remedy Selection

On September 22, 2005, EPA issued a final ROD for groundwater (OU2) and deep soil contamination (OU4). The 2005 ROD (OU2/4 ROD) established groundwater performance standards for the OU2 interim action pump and treat system. In addition, the OU2/4 ROD defined the area including the deep soil contamination as a "waste management area." The OU2/4 ROD selected hydraulic containment of the waste management area utilizing an enhanced version of the pump and treat system selected for interim OU2. The RAO was to contain the contaminant plume within the waste management area and to restore groundwater quality in the area of attainment. A 2005 Groundwater Investigation and Focused Feasibility Study included a groundwater capture zone analyses that recommended additional wells be added to the existing five-well groundwater extraction network.

The risk-based remedial goals that were selected as groundwater cleanup standards for the area of attainment are specified in Table 2. The OU2/4 selected remedy includes the following elements:

- Continued operation of the groundwater pump and treat system enhanced to prevent migration of contaminated groundwater to the area of attainment;

- Continued treatment of recovered groundwater to achieve VPDES limits prior to discharge to on-Site stream;
- Soil cover over the former drum disposal and manufacturing areas;
- Long-term groundwater monitoring; and,
- Institutional controls to be implemented and maintained by the property owner to ensure that prospective users of the Site are aware that deep soil contamination is present, and to prevent: the extraction of groundwater from the aquifer beneath the Site for use as a potable water source; any interference with the groundwater extractions wells, treatment system, and related equipment; and any removal of the soil cover without the written permission of VDEQ, and EPA as appropriate.

2013 ESD (Modification to Institutional Controls Selected in OU2/4 ROD)

An ESD modifying the institutional controls that were selected in the OU2/4 ROD was issued on July 24, 2013. The ESD determined that there is potential for vapor intrusion into future buildings constructed near groundwater contaminated by VOCs. The ESD added a land use restriction requiring that any new habitable building constructed over or within 100 feet of the groundwater contaminated by VOCs above MCLs should include, at a minimum, a foundation vapor barrier and the subsurface piping for a sub-slab depressurization system.

Additionally, the ESD expanded the types of institutional controls that may be used. The Greenwood Chemical Company had abandoned the Site property, stopped paying property taxes and dissolved as a company. There is currently no party authorized to enter into an Environmental Covenant and Easement implementing the Institutional Controls for the Site property. The ESD expanded the types of institutional controls that may be used to implement the restrictions to include other forms of notice including listing on State or local Registries of Contaminated Sites and advisories.

Final OU2 and OU4 Remedy Implementation

Construction to implement OU2/4 remedial action began in August 2005 and completed in May 2006. Major elements of the enhanced pump and treat remedial action included:

- Six additional recovery wells installed using the 1) drilling, 2) geophysical survey, 3) hydro-fracturing, 4) targeted zone screening sequence;
- Locking vaults were installed over each recovery well;
- Piping and wiring necessary to connect the new wells to the treatment plant were installed;
- Pumps were installed and the Programmable Logic Controller was modified; and
- Long term groundwater monitoring was refined to measure effectiveness of the recovery well network.

On May 16, 2006 EPA and VDEQ conducted the final inspection and concluded that construction had been completed in accordance with the remedial design plans and specifications. On March 15, 2012, EPA transferred responsibility for ongoing operations of the system to VDEQ.

The groundwater treatment plant effluent has consistently met its respective VPDES discharge limits. A groundwater monitoring program is in effect to evaluate the effectiveness of establishing the hydraulic containment necessary to achieve groundwater performance standards at the area of attainment. See Long Term Monitoring/Operation and Maintenance below.

The soil cover that was selected as a final remedy over the former drum disposal and manufacturing areas was acknowledged in the OU2/4 ROD to have been already completed during Removal Response actions conducted by EPA in 2004 and 2005.

Implementation of Institutional Controls

On September 18, 2013, EPA filed a Notice of Contamination with the Albemarle Recorder of Deeds Office (Book 4413, pages 601-618) to provide information concerning subsurface contamination affecting the property and to provide a list of activities and uses that may result in an increased threat of harm to public health or the environment. The Notice of Contamination has been placed on the Albemarle County Land Record Management System, the Albemarle County GIS-web and the EPA website for the Greenwood Chemical Site (https://semspub.epa.gov/src/document/03/2251195).

In recognition that the Site had been abandoned, pursuant to Virginia Code § 10.1-1406.1, the Circuit Court of Albemarle County granted access to VDEQ under Court Order (Case No.: CL12000268-00) for the purpose of performing remediation at the Site. VDEQ representatives are on the Site operating the water treatment plant on a daily basis. No activities have been observed that would violate the institutional controls. The subject property is fenced and the gate is locked each night and weekend.

IC Summary Table 3

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Site soil, groundwater	Yes	Yes	Parcel # 05400-00-00-01300	No residential use; No potable use of groundwater; Future buildings constructed above contaminated groundwater must use vapor barrier	Notice of Contamination with the Albemarle Recorder of Deeds Office (Book 4413, pages 601-618) September 18, 2013

Systems Operations/Operation & Maintenance

Response actions associated with OU1, OU3 and the 2004/2005 Removal Action did not require any operation and maintenance activities.

The long-term operations, maintenance and monitoring requirements for the OU2/4 remedies are set forth in the final OU2/4 ROD. EPA managed the long-term response action (LTRA) at the Greenwood Chemical Site until March 2012, when responsibility for ongoing operations were transferred to the Commonwealth of Virginia. VDEQ contracted RETAW Engineering, LLC., to perform work during the review period. The work is being conducted in accordance with the Operation and Maintenance Manual, as amended March 10, 2017.

The primary activities associated with O&M include the following:

- Operation of the groundwater recovery well network and water treatment facility.
- Inspection and maintenance of each component of the treatment system.
- Monitoring treatment plant effluent quality and submission of monthly discharge monitoring reports to demonstrate compliance with the Virginia State Water Control Law, Code of Virginia §§ 62.1-44.2 et. seq., and the site-specific discharge limits established in accordance with VPDES Regulations (VR 680-14-01).
- Environmental monitoring appropriate to evaluate the effectiveness of the groundwater recovery well network in establishing and maintaining hydraulic containment of the waste management area.

Monitoring includes generation of potentiometric maps and water quality sampling to measure progress toward meeting performance standards in the area of attainment.

- Inspection and maintenance of access to water treatment facility and all environmental monitoring points.
- Adjusting and upgrading the recovery well network as appropriate to maintain hydraulic containment and optimize water treatment system.
- Annual sampling of residential wells participating in a voluntary program.
- Preparation of Semi-Annual and Annual Operation, Maintenance and Monitoring Reports. Annual O&M Reports describe activities completed, present environmental data and include an engineering evaluation of system effectiveness and optimization analyses.

Since the Fifth Five-Year Review was issued in September 2018 there have been no significant changes to the treatment system.

The treatment system increased treatment flow rates from approximately 6 million gallons/year to 16-20 million gallons/year in 2006 after the additional 6 extraction wells went online. Routine effluent monitoring has documented that the water quality discharged from the treatment facility meets numeric limits established by VDEQ.

The water treatment plant has one full-time operator and one part time operator on staff. Operational uptime at the treatment plant was reported to be 98% or greater during each year 2018 through 2022. The short downtimes that did occur were primarily due to power outages and system maintenance (e.g., carbon replacement) and included optimization related drawdown and recovery testing.

During the review period, EPA's Office of Land and Emergency Management funded an Optimization Review, an independent review that focuses on opportunities for optimization as related to protectiveness, cost-effectiveness, site closure, technical improvements and efficient use of resources. The Optimization Review, dated October 26, 2020 includes recommendations for the consideration of EPA, VDEQ and other stakeholders but does not include additional funding to implement recommendations. The VDEQ management team has incorporated several of the recommendations into their medium-range planning forecast such as replacing worn carbon vessels and updating the Programable Logic Controller (PLC) hardware and Supervisory Control and Data Acquisition (SCADA) software. The Optimization Report recommendations offer potential refinements to the ongoing response action.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the **last** five-year review as well as the recommendations from the **last** five-year review and the current status of those recommendations.

Table 4: Protectiveness Determinations/Statements from the 2018 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Protective	The remedy at OU1 is protective of human health and the environment. Contaminated soil and waste material was excavated and transported off-Site for treatment and/or disposal to minimize migration to groundwater and direct exposure. The excavated areas were backfilled with clean soil. The remedial action objectives have been met.
2/4	Protective	The remedy at OU2/4 is protective of human health and the environment. Hydraulic containment has been achieved, there is no current exposure to contaminated groundwater and institutional controls are in place.

3	Protective	The remedy at OU3 is protective of human health and the environment. The former manufacturing buildings and chemical wastes stored within those buildings were dismantled and properly disposed off-Site. The remedial action objectives have been met.
Sitewide	Protective	The site-wide remedy is protective of human health and the environment.

There were no Issues or Recommendations listed in the 2018 FYR.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

A public notice was made available by newspaper posting in the Charlottesville, Virginia *Daily Progress* on 3/7/2023, stating that there was a FYR underway and inviting the public to submit any comments to the EPA. No comments were received. The results of the review and the report will be made available at the Site information repository located at Jefferson-Madison Regional Library at 5791 Three Notched Road, Crozet, VA 22932, and online at http://www.epa.gov/superfund/greenwood.

During the FYR process, interviews were conducted with with VDEQ personnel and support contractors operating the treatment plant, local residents and local officials to inform them the EPA was completing the Five-Year Review process to confirm that the constructed remedy remains protective and document any perceived problems or successes with the remedy that has been implemented to date**.** During each interview Mr. Newman outlined the review process, including a detailed review of environmental monitoring and maintenance reports, a field inspection of the constructed remedy, and a literature review to confirm that the performance standards remain protective when considering the most up-to-date regulatory standards and toxicity data of site-related compounds. Mr. Newman conveyed the importance of communicating with local citizens and public officials to learn of any concerns related to the Site. The results of these interviews are summarized below.

On August 7, 2023 Shawn Maddox, Assistant Fire Marshall, Albemarle County Fire and Rescue, provided written responses to EPA's FYR questionnaire noting that his office performs annual fire code inspections and the hazardous materials team has done training with the facility. Mr. Maddox shared that they have received no complaints or inquiries regarding the facility and that his interactions with staff and facility make him feel confident that the clean up and maintenance are effective and have the community's best interests in mind. Assistant Fire Marshall Maddox also participated in follow-up calls and shared information with EPA regarding historic fire response actions at the Site.

On July 27, 2023, the Director of Zoning for Albemarle County, Bart Svoboda, provided written responses to EPA's FYR questionnaire. Bart Svoboda consulted with other Ambemarle County officials when preparing his responses. There were no concerns or issues from the county on the status of the site. The county stated that they are informed of the site's activities and progress but expressed interest in periodic updates on the Site. The representatives are up to date with the Site team's contact information, and we will continue to work together as the cleanup progresses.

On August 4, 2023 Jack McClelland, Virginia Department of Health – Thomas Jeffereson Health District informed Eric Newman, EPA that there have been no inquiries regarding Greenwood Chemical and tht the last time the topic came up at the office was when EPA inquired 5 years ago as part of the previous FYR.

On May 11, 2023 as part of the Site Inspection process, Eric Newman, EPA interviewed the treatment system and environmental monitoring team comprised of Ignatius Mutoti and Phillip Bwanya, Retaw Engineering and Gavin Kitchens, Apex. There have been no complaints or concerns received by the facility operational staff.

None of the citizens interviewed expressed any specific concerns related to the Site. The local citizens were aware of the cleanup work that EPA has completed and that responsibility for continuing operations at the Site had transitioned to VDEQ. Based on the interviews, the local citizens and officials continue to be comfortable with the work completed. The citizens expressed general satisfaction that EPA does maintain an interest in the Site and reviews the remedy for continued protectiveness after cleanups have occurred.

Data Review

Documents reviewed in the process of conducting this five-year review included the last five-year review, the 1989 ROD, the 1990 Interim ROD, the 1991 and 1994 ESDs, the June 2004 Action Memorandum, the 2005 On-Scene Coordinator Report, the 2005 final OU2/4 ROD, the 2013 ESD, 2013 Deed Notice, 2014 Technical Memorandum on Dioxin Sampling, and the Semi-Annual and Annual O&M Reports from 2018 through March 2023, including treatment plant operational data, treatment plant discharge and groundwater monitoring. A complete list of documents reviewed can be found in Appendix B.

Groundwater Monitoring

There are currently 59 groundwater/overburden monitoring wells and 11 extraction wells located across the Site and hydraulically down gradient of the Site. The groundwater monitoring plan includes approximately 20 wells for semi-annual monitoring (including extraction wells) and 41 wells for annual water quality monitoring. Water level measurements are collected from all 59 groundwater monitoring wells to generate potentiometric maps quarterly. The Annual Long-Term Monitoring reports completed by VDEQ between 2018 and 2022 present a general evaluation of the pump and treat system capture zone using a simple flow net analysis and augments that with a trend analysis to support the evaluation using converging lines of evidence. Conducting a capture zone analysis is difficult in fractured bedrock or fractured rock aquifers due to the limited understanding of fracture characteristics such as aperture, orientation, density and connectivity. The actual capture zone is more complicated than predicted by the simple flow net analysis but it is considered as one line of evidence in assessing the effectiveness of the recovery well network along with evaluating groundwater elevation data (potentiometric maps), groundwater contaminant concentration trends and concentrations in perimeter wells. The groundwater contour maps generated using bedrock well elevation data (see Figure 4) suggest that the recovery wells are creating an inward gradient. The contours are more pronounced along the southern portion of the extraction well field where the topography begins to level off. Comparing TCE concentration contours from 2012 to 2022, the 1 µg/L and 5 µg/L contour line has indicated a measurable contraction in the southern and eastern portions of the Site (see Figure 5). In addition, there is a reduction in size of the plume concentration contour >50 µg/L, currently centered between MW-23, BR08, CW03, and CW04. This evidence indicates that the 11 recovery wells are preventing migration of contaminated groundwater

In addition, residential well sampling has been conducted on an annual basis, generally in February. The last sampling event reviewed was conducted in February 2022. Over the last five years 8 residential wells within an approximate one-half mile radius of the Site have participated in the voluntary sampling program. A review of the residential well data confirmed that no site-related contaminants have been detected above MCLs or above any other risk-based action level in a residential well.

Long term groundwater monitoring samples are analyzed for Target Compound List (TCL) volatile and semi-volatile organic compounds and Target Analyte List (TAL) metals. This five-year review focused on the Annual O&M Reports, including environmental analytical data and treatment plant operational data presented from 2018

through December 2022[4].

Flow rates and water quality data from extraction wells were reviewed along with potentiometric maps to evaluate the effectiveness of the recovery well network in establishing hydraulic containment of the waste management area. The most concentrated portion of the "plume" within the waste management area appears to be located at the center of the Site between recovery wells MW-23, CW-5 and CW-2, north and east of the treatment plant (See Figure 5.). This is consistent with previous years, as MW-23 was originally placed in the center of the former manufacturing area as a hot-spot recovery well. The water level measurements and associated contour maps indicate that the recovery wells arrayed across the Site are containing groundwater moving down-slope toward the southern boundary. In July 2008 EPA installed additional monitoring wells (PMW-6 and PMW-7) downgradient of monitoring well PMW-5 to better understand groundwater flow along the eastern property boundary. The additional data points confirm that the recovery wells CW-4, CW-5 and CW-6 are cutting off the groundwater moving to the east in the vicinity of monitoring well PMW-5. Hydraulic containment of the waste management area has been achieved with the current extraction well alignment; however, further adjustments to the recovery well system (i.e., adding wells or changing extraction well alignment) may be useful to optimize the system.

The expanded 11-well extraction system has been in operation for seventeen years. A review of monitoring data collected over the last 5 years confirmed that the risk-based remediation goals have been met in perimeter monitoring wells (PMW) but several other monitoring wells within the area of attainment closer to the WMA remain above remediation goals. See Table 5 for contaminant concentration trends applying the Mann-Kendall trend analysis using ProUCL statistical software. Data trends are presented in the Annual O&M Reports and will need to continue to be graphed over the next several years to confirm that the project is on track to meet risk-based remediation goals within a reasonable timeframe. The data trends in all wells located outside of the waste management area demonstrated either a decreasing Mann-Kendall trend or a no statistically valid trend for all contaminants of concern.

The review team looked at the water quality along the property boundary to determine if contaminants are migrating off the Site property. The four perimeter monitoring well locations (PMW-1, PMW-2, PMW-3 and PMW-4) that were placed along the southern property boundary all meet MCLs and additionally meet the more conservative site-specific risk-based groundwater performance standards[5], based upon the 2018-2023 sampling results. The two off-Site wells west of the property boundary near the former drum disposal area (MW-19 and BR-04) meet both MCLs and site-specific performance standards. The well placed along the eastern boundary of the property (PMW-5) is below the trichloroethene MCL (5 µg/L) but has not consistently met the site-specific performance standards for trichloroethene (1.0 µg/L). The trichloroethene concetration at PMW-5 in 2012 was more than a magnitude greater than the MCL. Three additional extraction wells (CW-4, CW-5 and CW-6) were placed upgradient of PMW-5 in 2005. CW-4 and CW-5 are recovering relatively high concentrations of trichloroethene and a reduction in trichloroethene concentration at PMW-5 is evident. The off-Site well concentrations east of PMW-5 (PMW-6 and PMW-7) do not exceed site-specific performance standards, indicating that the contaminant plume has been confined to the Greenwood Site.

Groundwater Pump and Treat System

The total volume of groundwater treated in 2022 was 16.1 million gallons (MG) and the cumulative quantity of groundwater treated from 2001 through 2022 is approximately 338 MG. Table 6 presents the annual groundwater and lagoon water recovery and treatment rates from 2001 to 2022. Lagoons 4 and 5 were closed in November 2004; the six new recovery wells came on-line in December 2005.

[4] Analytical data from Spring 2023 were evaluated specifically for PMW-2S, PMW-3S and PMW-3D which had obstructions removed, which had prevented sampling during recent annual monitoring reports.

[5] The site-specific performance standards are lower than MCLs to account for the potential cumulative risk of multiple contaminants.

Table 7 shows the average influent concentrations to the treatment plant from 2002 through 2022. The average influent concentrations have been fairly constant since the extraction system was expanded. Based on the plant flow rate and influent contaminant concentrations, the mass of organic contaminants removed from the groundwater has increased from 25.2 pounds in 2003 (the first full year of operational data) to a maximum of 88.4 pounds in 2019. The 2022 organic contaminant mass removed was 35.6 pounds (last full year of operational data).

Monitoring of the groundwater treatment system effluent for VPDES discharge requirements is conducted on a monthly basis and Discharge Monitoring Reports are submitted to VDEQ. VPDES discharge parameters include flow, pH, total cyanide. In addition, plant effluent is tested for chronic whole effluent toxicity on a quarterly basis and acute whole effluent toxicity annually. Review of the monthly effluent sampling results submitted from 2018 through 2022 confirmed effluent discharge was within the VPDES required limits except for the following exceedance:

- Chronic toxicity to *C. dubia* reproduction August 2022

The August 2022 *C. dubia* chronic toxicity testing completed as part of the quarterly sampling cycle failed the reproduction outcomes. The test concentration which produced no observable effect (NOEC) was <51.8% test concentration and the lowest test concentration to produce a negative observable effect (LOEC) was the 51/8% test concentration. This data corresponds to a Toxicity Unit-chronic (TUc) for reproduction to >1.93, indicating the effluent was noticeably toxic weith regards to reproduction of *C. dubia*. The VDEQ permit equivalent limits are established at 1.4 TUc. An item of interest that occurred in the reproduction portion of the test was that the reproduction of the test organisms in 100.0% effluent was not significantly different from the reproduction of the test organisms in the Control. This is fairly rare, but does occur, and is referred to as "an Interrupted Dose Response". This occurs when the test organisms in the weaker test concentrations are more negatively affected than organisms in the stronger, more concentrated, test concentrations. Prior and subsequent quarterly chronic toxicity testing conducted during the 5 year period passed the reproduction outcomes.

In addition to monitoring for the parameters required by the VPDES permit-equivalent, the groundwater treatment system effluent was sampled for other known site contaminants to monitor the effectiveness of the treatment plant. Effluent data was screened against EPA's "informal performance goals" (See Table 8). All informal performance goals were met in plant effluent, meaning that effluent is meeting the Virginia Surface Water Quality Standards. Historically, carbon tetrachloride has been the first compound to break through the first of two 5,000 lb carbon filters in the treatment facility, indicating that replacing the carbon media in the lead filter tank needs to be scheduled.

Site Inspection

The inspection of the Site was conducted on 5/11/2023. In attendance were Eric Newman, EPA RPM, Aaron Siegel, VDEQ Project Manager and project lead responsible for ongoing operations, maintenance and monitoring at the Site. The Site inspection focused on evaluating the condition of engineered features and the protectiveness of the constructed remedy including the integrity of the soil cover and the operation of the wastewater treatment plant as part of the five-year review process. Also attending the Site inspection were Ignatius Mutoti and Phillip Bgwanya, Retaw Engineering, the prime contractor performing operations, maintenance and monitoring services for VDEQ, and Gavin Kitchens, Apex Companies, LLC a subcontractor to Retaw providing support by maintaining the grounds and conducting the environmental monitoring. Virginia DEQ representatives maintain a routine presence on the Site to operate the government-financed water treatment plant. Weather at the time of inspection was sunny and in the low 80's F.

The water treatment plant was physically inspected with a walk through. The water treatment plant was in good condition with the exception of the carbon vessels which have been corroded over time. VDEQ operations team

has made initial preparations required to replace the carbon vessels and upgrade the PLC computer hardware and SCADA software system. VDEQ operations team recently replaced the media in gravity sand filters.

Each recovery well was inspected and determined to be in operable condition. Physical access to recovery wells and monitoring wells has been maintained. The inspection team discussed the fact that multiple monitoring wells have been become obstructed which has prevented sampling from those points. The VDEQ operations team was able to remove obstructions that included dedicated tubes and unfunctional pumps from many locations but blockages persist at MW-12S, MW-18D2, MW-18S, MW-20S and PMW-08. The existing monitoring well network is robust and is sufficient to characterize the groundwater containment system. Nevertheless, the VDEQ operations team has developed a comprehensive well inventory and phased well rehabilitation program to be implemented on a rolling basis.

The soil cover constructed over the former drum disposal and former manufacturing areas were inspected and found to be well vegetated. A dense stand of bamboo covers the former drum disposal area. Surface water conveyance details such as ditches and culverts, and treatment plant discharge points were observed to be free of debris. All components of the remedial action were confirmed as functioning as designed. No significant issues have been identified regarding the physical condition of the Site, the monitoring points or the operation of the water treatment plant.

During the Site inspection no activities were observed or reported that would violate the land use restrictions called for in the OU 2/4 ROD as augmented by the 2013 ESD. The subject property was fenced (not required by the ICs), the soil cover and surrounding areas were undisturbed, and no new uses of groundwater were observed. The gate to the facility is only opened during standard business hours.

V. TECHNICAL ASSESSMENT

QUESTION A: Is the remedy functioning as intended by the decision documents?

Yes. The remedy is functioning as intended by the decision documents but not all remedial action objectives have been met. Former drum disposal area and manufacturing areas, including the former lagoons 4 and 5, were excavated and backfilled with clean soil. The recovery well network is capturing groundwater and treating the groundwater successfully before discharge. Hydraulic containment has been demonstrated along the eastern, southern, and western edges of the waste management area (north is upgradient). Nevertheless, assessment and realignment of the recovery well network may be warranted to optimize the performance of the system. The extent of the plume has been reduced and the area of the plume exceeding MCLs is limited to the Site property (See Figure 5).

Concentrations of contaminants in groundwater beyond the waste management area (i.e., area of attainment) remain above MCLs. Natural attenuation processes expected to further reduce concentrations in groundwater within the area of attainment are very slow. Data trends will need to be graphed over the next several years to statistically confirm that the project is on track to meet performance standards within a reasonable timeframe. Stable concentrations of contaminants, particularly trichloroethylene, in the area of MW-21S suggest that improved capture in the area of containment well BR-06 may be warranted.

The groundwater treatment facility is functioning as designed. Effluent meets appropriate VPDES discharge standards for all organic and inorganic parameters and the effluent passes toxicity tests. No impact has been detected in any residential drinking water wells or agricultural wells around the Site.

Institutional controls are in place with the Albemarle Recorder of Deeds Office (see Table 3). The land use restrictions can be readily accessed online on the Albemarle County GIS-Web.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Changes in Standards and TBCs

The groundwater Risk-Based Remedial Goals established in the 2005 ROD (see Table 2) remain protective, as demonstrated by the acceptable risk at the cleanup levels in Table 10. In addition, the MCLs have not been updated for the COCs included in the 2005 ROD.

The designated use of surface water on the Site is secondary use recreation/protection of aquatic life (ecological receptors). The discharge standards for the water treatment plant (see Table 8) have been established to meet ambient surface water standards for the protection of aquatic life assuming no dilution. The discharge standards being utilized were re-evaluated and determined to be consistent with current ARARs and protective of ecological receptors.

The ARARs identified in the RODs and reassessed in this 6th FYR are listed in Appendix C.

Changes in Toxicity and Other Contaminant Characteristics

ROD contaminant toxicity profile changes made since the 2005 ROD was issued are listed in Table 9. There were no new toxicity profile changes since the 2018 5th FYR. Table 10 provides the residential cancer and noncancer risk for the cleanup level for each contaminant of concern. As shown in the table, any changes to toxicity values since the last five-year review do not affect the protectiveness of the remedy as the cleanup goals result in acceptable risks.

Table 10. Estimated residential cancer and noncancer risk for the groundwater cleanup levels from the 2005 ROD

Contaminants of Concern	Cleanup Level (ug/L)	Residential Risk at Cleanup Level	
		cancer	noncancer
1,2-dichloroethane	5	3E-05	4E-01
bis(2-chloroethyl)ether	0.5	4E-05	- -
carbon tetrachloride	4	9E-06	8E-02
tetrachloroethene	0.8	7E-08	2E-02
trichloroethene	1	2E-06	4E-01
vinyl chloride	0.5	3E-05	1E-02
	total	1E-04	5E-01

The 27 mg/kg soil cleanup standard for arsenic contaminated surface soil was established in the 2004/2005 Removal Action. The exposure assumptions and toxicity factors for arsenic have not changed and this cleanup concentration remains protective.

Soil cleanup standards for organic compounds were developed in the OU1 ROD and modified by ESD-2. See Table 1. The soil cleanup levels selected for organic compounds were based on the potential for migration to groundwater because the soil to groundwater performance standards were more conservative (i.e., lower) than cleanup concentrations developed for direct contact and residential use. The soil cleanup standards set forth in ESD-2 were compared to the November 2022 Region III RBC Table for industrial land use[6]. The analysis determined that the OU1 cleanup levels for carcinogens represent a cancer risk within or less than EPA's acceptable risk range of 10^{-4} to10^{-6} for all compounds.

[6] EPA's 2005 Record of Decision established that the reasonably anticipated future land use at the Site is recreational or industrial.

The OU1 soil cleanup levels for site-related non-carcinogenic compounds represent a Hazard Index of approximately 1.0 for the industrial worker if they all affected the same target organ, with the exceptions of chlorobenzene and tetrahydrofuran. The OU1 cleanup level for chlorobenzene would represent an HI of 5.5 if chlorobenzene remained in surface soil at 7,708 mg/kg. This would be above EPA's target of less than 1.0 HI. The OU1 cleanup level for tetrahydrofuran would represent an HI of 1.0 if tetrahydrofuran remained in surface soil at 97,269 mg/kg (i.e., 9.72% tetrahydrofuran). This is at EPA's target of 1.0 HI. It is very unlikely that chlorobenzene or tetrahydrofuran remains in surface soil at even a fraction of these high levels for the reasons stated below.

- Table 6 of the OU1 ROD reports that the pre-remediation maximum concentration of chlorobenzene measured at the site was 150 mg/kg. The presence of chlorobenzene was a potential contaminant of concern, but chlorobenzene was not driving the cleanup at the Site. The 150 mg/kg chlorobenzene measured before the cleanup began would only present 0.1 HI to an industrial worker. Again, it is possible that chlorobenzene was present at higher concentrations in areas of actual waste material, but it is unlikely that it was present at elevated concentrations in soil after the disposal areas were excavated.
- Table 6 of the OU1 ROD reports that the maximum concentration of tetrahydrofuran measured at the site was 2.5 mg/kg. Again, it is possible that tetrahydrofuran was present at higher concentrations in areas of actual waste material (e.g., in a drum), but it is unlikely that it was present in soil after the disposal areas were excavated. The lagoons and disposal areas remediated during OU1 remedial action were contaminated with multiple contaminants. Excavation proceeded until the lateral extent of the excavation was confirmed clean or the depth reached approximately 15 feet. Chlorobenzene and tetrahydrofuran were typically collocated with other contaminants and therefore would have been excavated to concentrations on average much lower than 7,708 mg/kg/97,269 mg/kg, respectively, due to the proximity of other contaminants with much lower cleanup targets. For example, cleanup levels for benzene, chloroform and 1,2-dichloroethane are more than 4 orders of magnitude lower that the chlorobenzene cleanup level.
- The excavation areas and former manufacturing area was covered with a minimum of 2 feet of clean soil and vegetated.

Based on these considerations, EPA has a high degree of confidence that the OU1 cleanup levels remain protective of human health for the future industrial land use scenario.

Changes in Risk Assessment Methods

There have not been significant changes in EPA's risk assessment guidance since the final 2005 ROD. As demonstrated in Table 10, the cleanup levels from the 2005 ROD result in acceptable risks when applying updated risk assessment methodologies.

There have been significant changes in EPA's human health risk assessment guidance since the original risk assessment was performed. These include changes in dermal guidance, inhalation methodologies and exposure factors. The original risk assessment assumed a conservative residential future land use and the ROD chose even lower performance standards for soil because the soil to groundwater migration model generated lower concentrations than those for direct contact. Accordingly, these changes are not expected to affect the protectiveness of the remedy.

The remedial investigation and Record of Decision were completed prior to the development of the current ecological risk assessment guidance. The decision documents did not specifically establish ecologically protective remedial action objectives or cleanup values. While these ecologically protective objectives and values have not been specified, the available data indicates that the remedial action is protective of ecological receptors. Contaminated soil was excavated and treated / disposed of offsite and the remediated areas were covered with clean soil and vegetated. Groundwater is being captured and treated; the area of capture prevents

contaminated groundwater from discharging to area surface water bodies. Monitoring data does not indicate the potential for unacceptable ecological risk when compared to Virginia surface water quality regulations or ecologically protective freshwater screening benchmarks.

Changes in Exposure Pathways

Local zoning for the Site remains agricultural use only. Local land use remains mixed residential, woodlands and agricultural. There are no newly identified exposure routes or receptors. There are no newly identified contaminant sources at the Site.

Due to the presence of multiple chlorinated solvents, and more specifically trichloroethane, as stated in the 1990 Remedial Investigation Report, sampling groundwater to determine the presence of 1,4-dioxane is recommended. 1,4-Dioxane has been used in the past as a stabilizer for chlorinated solvents and the 1,4-dioxane toxicity values, including a reference dose, reference concentration, oral slope factor, and inhalation unit risk, were finalized by the U.S. EPA Integrated Risk Information System in 2013.

Considering history of manufacturing novel chemical compounds at the Site, perfluoroalkyl and polyfluoroalkyl substances (PFAS) may have been produced or used and sampling the groundwater to determine the presence of PFAS is recommended.

Expected Progress Towards Meeting RAOs

The remedy has met all remedial action objectives established by the EPA decision documents with the exception of meeting groundwater performance standards throughout the area of attainment. Hydraulic containment of the waste management area has generally been achieved with the current extraction well alignment.

Several wells located along the western edge of the Site within the area of attainment demonstrated contaminant concentrations at or below the target groundwater performance standards, based upon sampling conducted in 2022; however, there are wells located in the eastern and central portions of the area of attainment which do not currently meet the groundwater performance standards. Continued monitoring and data/trend analysis of the wells within the area of attainment will be necessary to ensure that remedial action objectives will be achieved within a reasonable timeframe.

The extent of the plume has been reduced and the area of the plume exceeding MCLs is limited to the Site property. Nevertheless, continued assessment and realignment of the recovery well network may be warranted to optimize the performance of the system.

QUESTION C: Has any **other** information come to light that could call into question the protectiveness of the remedy?

No other information has come to light that would call into question the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU1, OU3

OU(s): 2, 4	**Issue Category:** Other			
	Issue: The presence of 1,4-dioxane in groundwater is unknown			
	Recommendation: Sample 1,4-dioxane at monitoring wells that will be sampled for VOCs using a method with reporting limits and method detection limits at or below the 0.46 µg/L RSL.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA/State	12/31/2025

OU(s): 2, 4	**Issue Category:** Other			
	Issue: The presence of perfluoroalkyl and polyfluoroalkyl substances (PFAS) is unknown.			
	Recommendation: Sample PFAS at monitoring wells using a method with reporting limits and method detection limits at or below the most up-to-date RSLs.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA/State	12/31/2025

OTHER FINDINGS

Assessment and realignment of the recovery well network may be warranted to optimize the performance of the system. The extent of the plume has been reduced and the area of the plume exceeding MCLs or the lower site-specific performance standards is limited to the Site property (See Figure 5). However, concentrations of contaminants in groundwater beyond the waste management area (i.e., area of attainment) remain above MCLs. Natural attenuation processes expected to further reduce concentrations in groundwater within the area of attainment are very slow. Data trends will need to be graphed over the next several years to statistically confirm that the project is on track to meet performance standards within a reasonable timeframe. Stable concentrations of contaminants in the area of MW-21S suggest that improved capture in the area of containment well BR-06 may be warranted.

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: 1	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:* Click here to enter a date
Protectiveness Statement: The remedy at OU1 is protective of human health and the environment. Contaminated soil and waste material was excavated and transported off-Site for treatment and/or disposal to minimize migration to groundwater and direct exposure. The excavated areas were backfilled with clean soil. The remedial action objectives have been met.		

Protectiveness Statement(s)		
Operable Unit: 2/4	*Protectiveness Determination:* Short-term Protective	*Planned Addendum Completion Date:* Click here to enter a date
Protectiveness Statement: The remedy at OU2/4 is currently protective of human health and the environment, but for future protectiveness PFAS and 1,4 Dioxane sampling will be completed and the results will be assessed. Hydraulic containment has been achieved, there is no current exposure to contaminated groundwater and institutional controls are in place.		

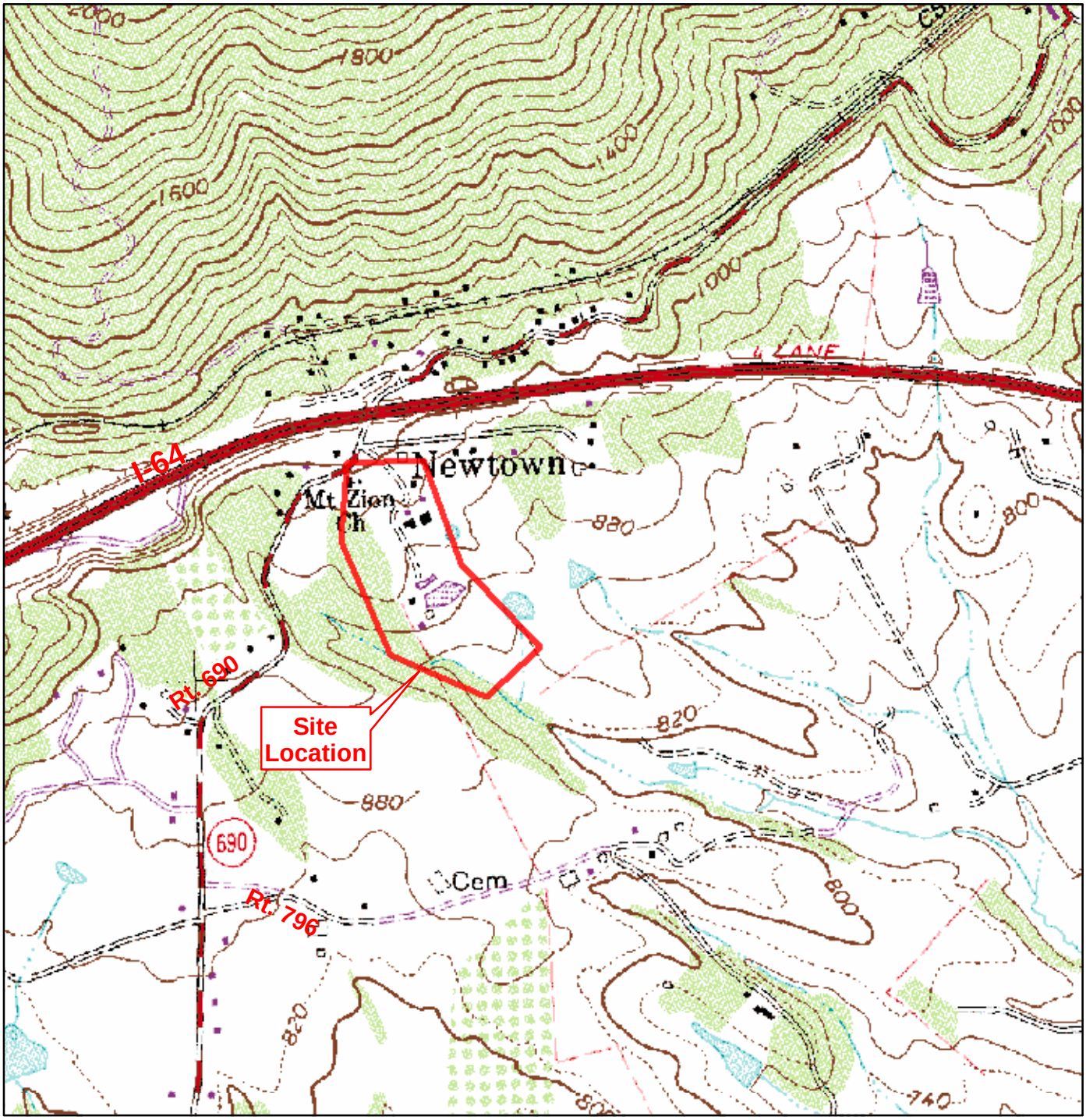
Protectiveness Statement(s)		
Operable Unit: 3	*Protectiveness Determination:* Protective	*Planned Addendum Completion Date:* Click here to enter a date
Protectiveness Statement: The remedy at OU3 is protective of human health and the environment. The former manufacturing buildings and chemical wastes stored within those buildings were dismantled and properly disposed off-Site. The remedial action objectives have been met.		

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Planned Addendum Completion Date:* Click here to enter a date
Protectiveness Statement: The Site-wide remedy is currently protective of human health and the environment, but for future protectiveness PFAS and 1,4 Dioxane sampling will be completed and the results will be assessed. Hydraulic containment has been achieved, there is no current exposure to contaminated groundwater and institutional controls are in place.	

VIII. NEXT REVIEW

The next five-year review report for the Greenwood Chemical Superfund Site is required five years from the completion date of this review.

FIGURES



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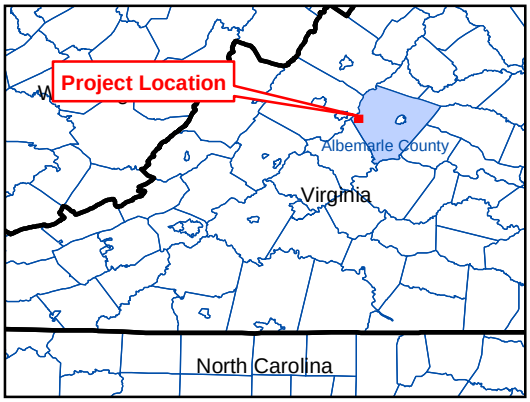


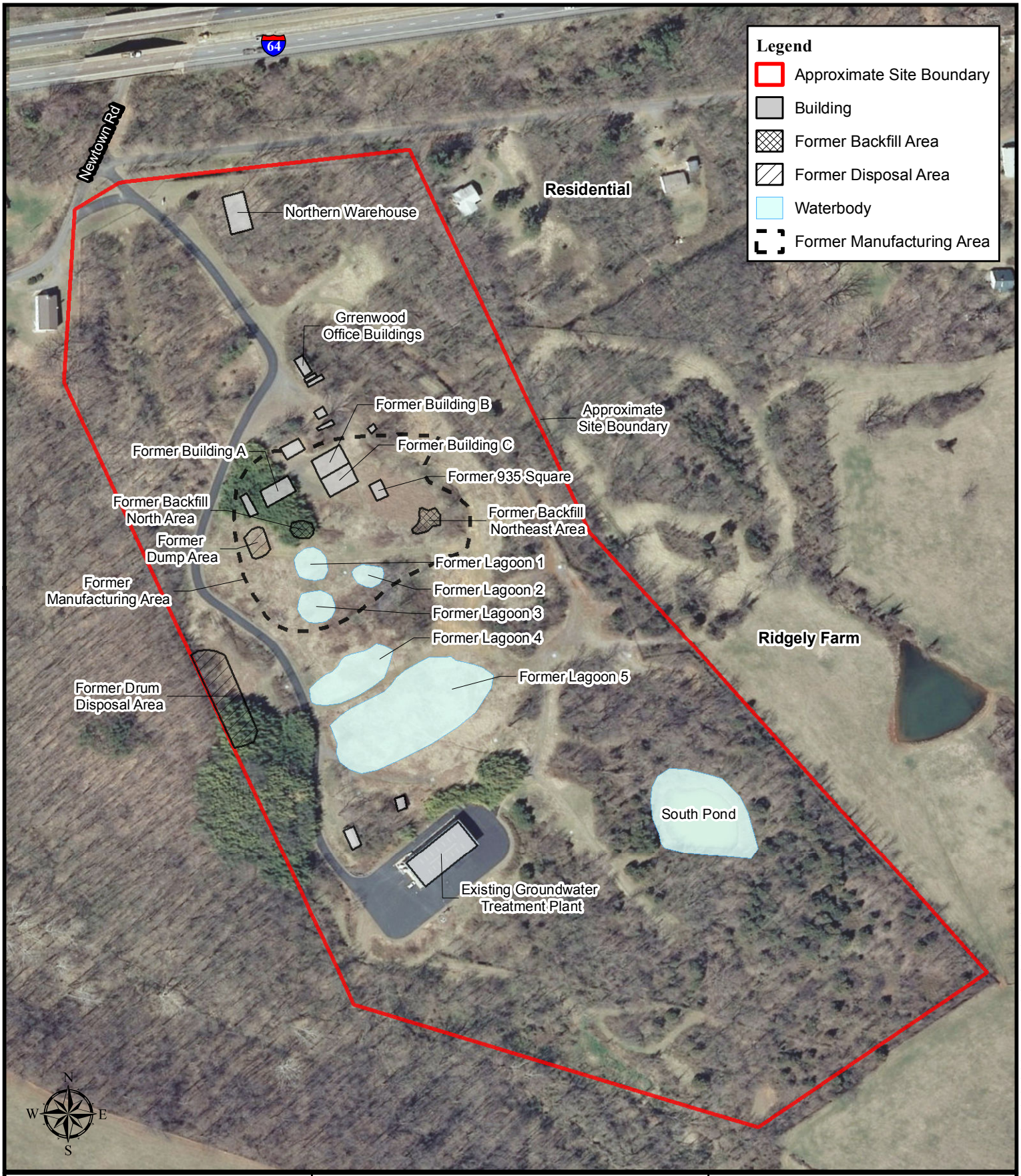
U.S. Environmental Protection Agency

GREENWOOD CHEMICAL SUPERFUND SITE

Albermarle County
Greenwood, Virginia

Figure 1
Site Location Map

EGA N:\Projects\T00000\T40000\T47124 Greenwd Chem-GW\Documents\ROD\Figures\Fig-1Site Location Map



Greenwood Chemical Site

Albemarle County
Greenwood, VA

0 150 300 Feet

Projection: NAD 83 State Plane Virginia South Feet
Aerial Image: USDA National Agriculture Imagery Program, 2003

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

FIGURE 2

HISTORIC SITE FEATURES

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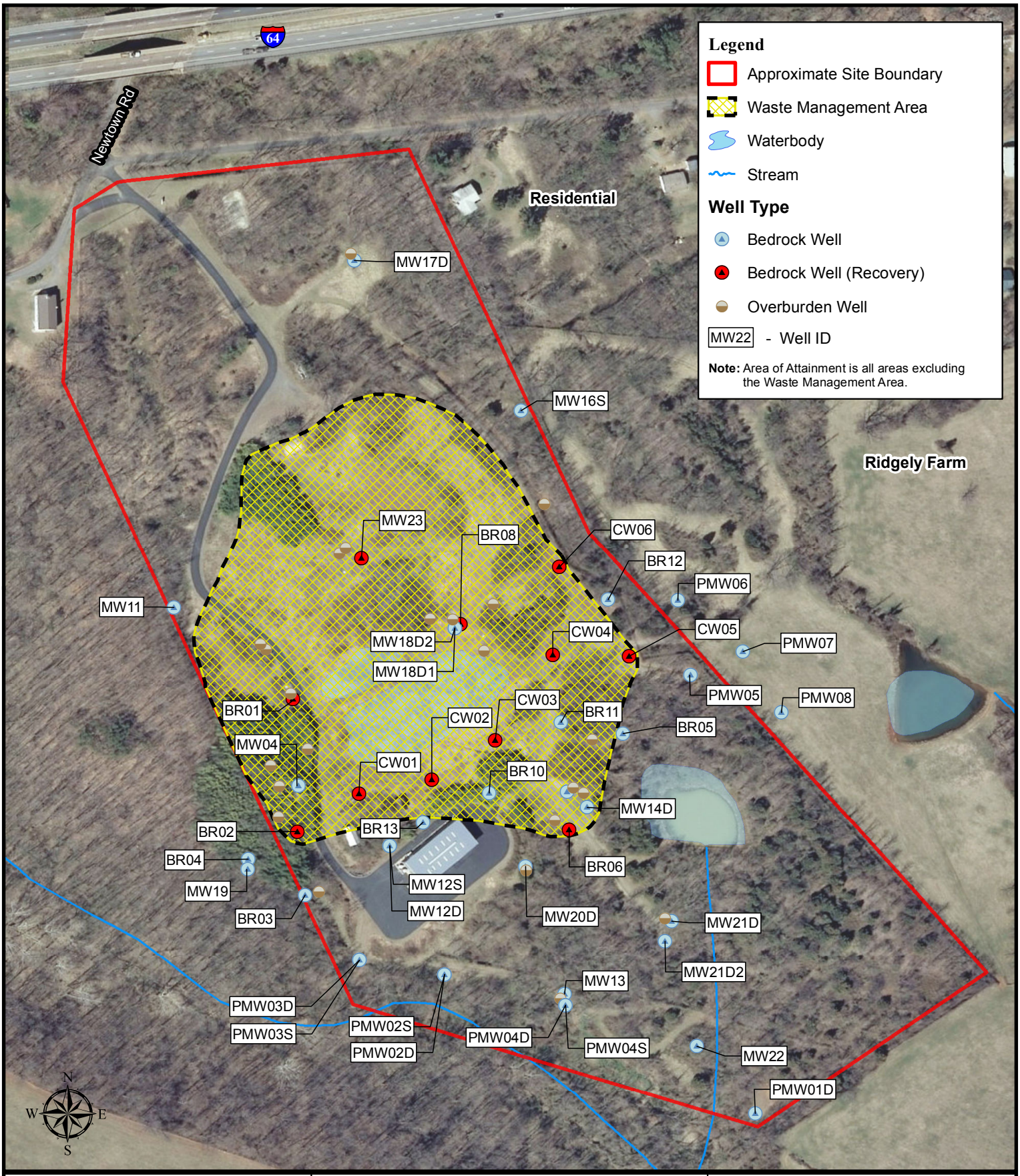

Greenwood Chemical Site

Albemarle County
Greenwood, VA

0 150 300 Feet

Projection: NAD 83 State Plane Virginia South Feet
Aerial Image: USDA National Agriculture Imagery Program, 2003

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

FIGURE 3

WASTE MANAGEMENT AREA

\\lovetonfederal\GISData\Northeast\Virginia\GreenwoodChem\GIS\MXD\2023_5yrReview\Figure 3 Area of Attainment.mxd cohara

Summer Rest Lane

MW-17D 940.17
MW-16S 875.13
MW-16D 875.05
MW-23 839.82
CW-06 814.97
BR-12 855.53
PMW-06 861.59
MW-11
BR-08 817.27
MW-18D2
CW-04 849.95
CW-05 814.96
PMW-07 847.37
BR-07 832.38
PMW-05S 846.27
PMW-08 848.55
BR-11 841.59
CW-03 837.16
BR-05 841.58
MW-14S 862.72
CW-02 839.34
CW-01 795.41
BR-10 835.3
BR-01 854.24
BR-02 837.56
MW-14D 847.99
BR-04 853.45
BR-13 845.79
MW-20D 847.09
BR-06 832.02
MW-19 854.39
MW-12S
MW-12D 847.02
BR-03 852.6
MW-21D 839.11
MW-21D2 848.31
PMW-03S 851.81
PMW-03D
MW-13 847.26
PMW-02D 846.24
PMW-04S 833.97
MW-22 826.69
PMW-01D 824.23
PMW-02S 839.27
PMW-04D 836.43

Legend

- Bedrock Well
- Extraction Well
- Groundwater Flow Direction
- Bedrock Groundwater Contour (2ft)
- Greenwood Fence
- Road
- Dirt Road
- Approximate Site Boundary
- Building
- Groundwater Treatment Plant
- Old Building Site
- Slab Inside Metal Building
- Truck Decontamination Slab

MW-3 - Well Label
111.11 - Groundwater Elevation (ft bgs)

N

0 50 100 200
Feet

Retaw Engineering
A GLOBAL WATER PRACTICE
3400 Lady Marian Court
Midlothian, Virginia 23113
Phone: (804) 744-1792
Website: http://www.retaweng.com

CHECK BY: TL
DRAWN BY: MD
DATE: 8/14/2023
SCALE: 1:1,600
CRD SYS: VA STATE PLANE
PRJ NO: 1575101

Groundwater Elevation Contours for Bedrock Wells
During Fourth Quarter 2022

GREENWOOD CHEMICAL SUPERFUND SITE
GREENWOOD, VIRGINIA 22943

APEX
EA

FIGURE
4

Acronyms:
ROD GPS = Record of Decision Groundwater Performance Standard
µg/L = micrograms per liter
Notes:
All results are reported in µg/L
ROD GPS = 1.0 µg/L
Plume developed in C-Tech EVS Software
Coordinate Projection:
NAD83 StatePlane Virginia South (Feet)

Legend

02/2012 Trichloroethylene Concentrations (µg/L)

- 1
- 5
- 50

08/2022 Trichloroethylene Concentrations (µg/L)

- 1 - 5
- 5 - 50
- >50

103,735 sq ft (2 Plumes)
161,583 sq ft (2 Plumes)
100,205 sq ft

MW-17S
MW-17D ND
MW-16S ND
MW-16D ND
MW-09
CW-06 1.49
MW-10D
MW-10S
MW-23 126
OB-05
OB-04
MW-11
MW-02S
MW-02D ND
MW-18S
MW-18D1
MW-18D2
OB-06
CW-04 168
CW-05 41.6
BR-12 ND
PMW-06 ND
PMW-07 ND
PMW-05S 3.73
PMW-08
BR-11 1.85
BR-08 207
CW-03 37.6
MW-03
BR-07 0.99
BR-05 ND
OB-07
MW-04
OB-01
OB-02
BR-01
OB-03
BR-02 ND
CW-01 3.48
CW-02 4.12
MW-14S
MW-07S ND
MW-07D ND
OB-08
BR-10 5.24
BR-13 ND
MW-14D
BR-06 22.9
BR-04 ND
MW-19
MW-12D
MW-12S
MW-20D ND
MW-20S
MW-21S 48.0
MW-21D ND
MW-21D2 ND
BR-03 ND
MW-05
MW-13 ND
PMW-03D
PMW-03S
PMW-02D ND
PMW-02S
MW-06
PMW-04S ND
PMW-04D ND
MW-22 ND
PMW-01D ND

Legend

- Bedrock Well
- Containment Well
- Overburden Well
- Waste Management Area
- Approximate Site Boundary

MW-3 - Well Label
111.11 - Concentration (µg/L)

Notes: Concentration area calculations given in square feet (sqft). Labels appear on plumes.
Area of Attainment is all areas excluding the Waste Management Area.

0 50 100 200
Feet

11400250 11400500 11400750 11401000 11401250 11401500

Sample depth spheres correspond with concentration levels

950 ft
900 ft
850 ft
800 ft
750 ft
700 ft
650 ft

MW-17D MW-23 MW-02D BR-07 BR-04 BR-02 BR-03 CW-01 BR-13 CW-02 BR-08 BR-10 CW-03 MW-16D/S CW-04 CW-06 BR-12 CW-05 PMW-06 PMW-07 BR-11 MW-20D BR-06 BR-05 MW-21S PMW-05S PMW-02D PMW-04D MW-21D2 MW-22 PMW-01D

Concentration at Sample Depth

- >50 µg/L
- 5 - 50 µg/L
- 1 - 5 µg/L
- < 1 µg/L or ND

Plume
Overburden

11,400,250 11,400,500 11,400,750 11,401,000 11,401,250 11,401,500

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A GLOBAL WATER PRACTICE
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CHECK BY: TL
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SCALE: 1:1,600
CRD SYS: VA STATE PLANE
PRJ NO: 1575101

Trichloroethyene Results
August 2022

GREENWOOD CHEMICAL SUPERFUND SITE
GREENWOOD, VIRGINIA 22943

APEX
EA

FIGURE
5

TABLES

Tables 3, 4 and 10 Embedded in Text

Table 1

SOIL CLEANUP LEVELS FOR CONTAMINANTS AT GREENWOOD CHEMICAL SUPERFUND SITE

	SOURCE AREA ACTION LIMITS (GROUNDWATER PROTECTION)	DRUM DISPOSAL ACTION LIMITS (GROUNDWATER PROTECTION)
CLEANUP LEVELS		
Volatile Organics	mg/kg	mg/kg
Benzene	0.225	0.0224
Chlorobenzene	7,708.7	*
Methylene Chloride	2,665.1	10.83
Tetrachloroethylene	*	0.2364
Trichloroethylene	*	0.0974
Toluene	40,917.6	101.4
1,2-Dichloroethane	0.124	*
Acetone	1,462.1	*
Tetrahydrofuran	97,269	*
Chloroform	0.219	0.3262
Semi-Volatile Organics		
Semi-Volatile TICs	*	158.6
4-Chloroanaline	565.7	*

Notes:

* Soil excavation for the referenced hazardous substances is not required because their cleanup levels have not been exceeded in the referenced area. See "Final Fate & Transport Modeling For Determination of Soil Cleanup Goals Protective of Ground water (February, 1993), Table ES-1, p. ES-3.

1. EPA has determined that acetone present in the Northern Warehouse Area may also require remediation, and through the risk-based modeling has determined that the cleanup level for acetone in this area is 10.1 mg/kg. However, the acetone cleanup level is not presented in this table because, to date, EPA has documented only one exceedance of this cleanup level in this area. Whether remediation of this area is necessary will depend upon additional soil sampling.

Table 2
Groundwater Performance Standards
(Excerpt from 2005 OU2/4 ROD)

In accordance with the NCP, cleanup options that include leaving the deep soils contamination in place require establishment of an area of attainment beyond the waste management area. Accordingly, EPA has developed chemical-specific cleanup goals for ground water which would not only meet the relevant and appropriate standards for drinking water but would also be sufficient to address the cumulative risk presented by multiple contaminants within the "area of attainment."

Table 2
Risk-Based Remedial Goals ("RBRG") for Ground Water - Area of Attainment

Chemical of Potential Concern	PQL (ug/l)*	MCL (ug/l)	Final RBRG (ug/l)
1,2-Dichloroethane	0.5	5.0	5.0
Bis(2-Chloroethyl)Ether	0.01	no MCL	0.5
Carbon Tetrachloride	0.5	5.0	4.0
Tetrachloroethene	0.5	5.0	0.8
Trichloroethene	0.5	5.0	1.0
Vinyl Chloride	0.5	2.0	0.5

* The RBRG of 0.5 ug/L selected for vinyl chloride is the **practical quantitation limit ("PQL")** and represents an approximate risk level of 4×10^{-5}. The final RBRG for each of the other five contaminants was set at a level equivalent to a 1×10^{-5} risk.

The ground water risk-based remediation goals ("RBRGs") set forth in Table 2 fall within the acceptable risk range of a cancer risk of 1×10^{-4} to 1×10^{-6} and a HI of 1, and assume that all six contaminants are present in a single well. In fact, the contamination at the Site varies by location, and no more than two contaminants above RBRGs were found in any one monitoring well. In summary, the contaminant-specific ground water cleanup goals were established at levels which: 1) comply with ARARs; 2) are detectable in a laboratory; and, 3) would achieve a cumulative risk within EPA's target risk range.

Table 5

Summary of Mann-Kendall Staistics and Trend Results

Well Identification	Analyte	Units	Number of Results	Results Summary				Mann-Kendall Test		
				Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Mann-Kendall S	Two-Tailed P-Value	Mann-Kendall Trend
Wells Located Outside of the Capture Zone										
PMW-01	1,2-dichloroethane	µg/L	6	0.2	2.3	1.55	0.93	-6	0.371	NSVT
	Bis(2-chloroethyl) ether	µg/L	12	NA	NA	NA	NA	-22	0.15	NSVT
	Carbon tetrachloride	µg/L	6	N/A	N/A	N/A	N/A	0	0.85	NSVT
	Tetrachloroethene	µg/L	6	N/A	N/A	N/A	N/A	0	0.85	NSVT
	Trichloroethene	µg/L	6	N/A	N/A	N/A	N/A	-13	0.0166	Decreasing
	Vinyl chloride	µg/L	6	N/A	N/A	N/A	N/A	0	0.85	NSVT
BR-03	1,2-dichloroethane	µg/L	32	N/A	N/A	N/A	N/A	0	0.98800	NSVT
	Bis(2-chloroethyl) ether	µg/L	39	0.027	0.25	0.07	0.09	-88	0.29500	NSVT
	Carbon tetrachloride	µg/L	32	0.11	0.21	0.20	0.06	-16	0.81000	NSVT
	Tetrachloroethene	µg/L	32	0.1	0.43	0.23	0.14	-92	0.14000	NSVT
	Trichloroethene	µg/L	32	0.1	6.4	0.31	2.50	-68	0.28000	NSVT
	Vinyl chloride	µg/L	32	N/A	N/A	N/A	N/A	0	0.98800	NSVT
BR-04	1,2-dichloroethane	µg/L	35	N/A	N/A	N/A	N/A	0	0.98933	NSVT
	Bis(2-chloroethyl) ether	µg/L	42	0.016	0.31	0.05	0.10	-148	0.01955	Decreasing
	Carbon tetrachloride	µg/L	35	0.1	2.1	0.33	0.54	-167	0.01800	Decreasing
	Tetrachloroethene	µg/L	35	0.12	0.12	0.12	0.00	-54	0.45500	NSVT
	Trichloroethene	µg/L	35	0.19	0.19	0.19	0.00	-10	0.89900	NSVT
	Vinyl chloride	µg/L	35	N/A	N/A	N/A	N/A	0	0.98933	NSVT
PMW-01D	1,2-dichloroethane	µg/L	43	0.19	3.2	0.87	0.67	-155	0.09725	NSVT
	Bis(2-chloroethyl) ether	µg/L	51	0.02	28	0.38	4.90	-267	0.02750	Decreasing
	Carbon tetrachloride	µg/L	44	0.27	0.27	0.27	0.00	-9	0.75276	NSVT
	Tetrachloroethene	µg/L	44	N/A	N/A	N/A	N/A	0	1.00000	NSVT
	Trichloroethene	µg/L	44	0.1	2.5	0.82	0.87	-437	0.00001	Decreasing
	Vinyl chloride	µg/L	44	N/A	N/A	N/A	N/A	0	1.00000	NSVT
PMW-02D	1,2-dichloroethane	µg/L	47	0.65	0.65	0.65	N/A	-42	0.13072	NSVT
	Bis(2-chloroethyl) ether	µg/L	61	0.04	0.12	0.08	0.03	-325	0.00056	Decreasing
	Carbon tetrachloride	µg/L	47	0.8	20	10.40	13.58	-37	0.34295	NSVT
	Tetrachloroethene	µg/L	47	0.11	0.88	0.48	0.29	-126	0.03147	Decreasing
	Trichloroethene	µg/L	47	0.2	0.7	0.43	0.19	-130	0.02642	Decreasing
	Vinyl chloride	µg/L	47	0.12	0.12	0.12	N/A	-42	0.13072	NSVT
PMW-02S	1,2-dichloroethane	µg/L	34	N/A	N/A	N/A	N/A	0	9.89E-01	NSVT
	Bis(2-chloroethyl) ether	µg/L	48	0.0039	0.33	0.09	0.11	-176	0.016144778	Decreasing
	Carbon tetrachloride	µg/L	34	N/A	N/A	N/A	N/A	0	9.89E-01	NSVT
	Tetrachloroethene	µg/L	34	0.1	0.41	0.22	0.15	-46	5.08E-01	NSVT
	Trichloroethene	µg/L	34	0.1	0.36	0.21	0.08	-79	2.50E-01	NSVT
	Vinyl chloride	µg/L	34	N/A	N/A	N/A	N/A	0	9.89E-01	NSVT
PMW-03D	1,2-dichloroethane	µg/L	40	N/A	N/A	N/A	N/A	-343	0.00000	Decreasing
	Bis(2-chloroethyl) ether	µg/L	53	0.021	0.37	0.10	0.11	177	0.15064	NSVT
	Carbon tetrachloride	µg/L	40	0.18	0.18	0.18	N/A	-320	0.00001	Decreasing
	Tetrachloroethene	µg/L	40	0.3	0.3	0.30	N/A	-340	0.00000	Decreasing
	Trichloroethene	µg/L	40	0.081	1.2	0.71	0.57	-299	0.00008	Decreasing
	Vinyl chloride	µg/L	40	N/A	N/A	N/A	N/A	-343	0.00000	Decreasing
PMW-03S	1,2-dichloroethane	µg/L	41	N/A	N/A	N/A	N/A	0	1.00000	NSVT
	Bis(2-chloroethyl) ether	µg/L	55	0.01	0.43	0.12	0.15	-232	0.00606	Decreasing
	Carbon tetrachloride	µg/L	41	0.11	4.51	1.59	2.53	-15	0.72631	NSVT
	Tetrachloroethene	µg/L	41	0.26	0.37	0.32	0.08	-53	0.11575	NSVT
	Trichloroethene	µg/L	41	0.18	0.29	0.24	0.05	-130	0.00468	Decreasing
	Vinyl chloride	µg/L	41	N/A	N/A	N/A	N/A	0	1.00000	NSVT
PMW-04D	1,2-dichloroethane	µg/L	51	0.1	0.42	0.28	0.09	-270	0.01844	Decreasing
	Bis(2-chloroethyl) ether	µg/L	63	0.011	0.64	0.10	0.12	-577	0.00015	Decreasing
	Carbon tetrachloride	µg/L	51	0.21	0.21	0.21	0.00	42	0.16371	NSVT
	Tetrachloroethene	µg/L	51	0.1	1.5	0.56	0.47	-503	0.00000	Decreasing
	Trichloroethene	µg/L	50	0.1	2.2	0.67	0.47	-903	0.00000	Decreasing
	Vinyl chloride	µg/L	51	0.2	0.27	0.23	0.03	-98	0.08970	NSVT
PMW-04S	1,2-dichloroethane	µg/L	52	0.2	0.51	0.40	0.13	-188	0.02466	Decreasing
	Bis(2-chloroethyl) ether	µg/L	63	0.012	0.47	0.17	0.16	-801	0.00000	Decreasing
	Carbon tetrachloride	µg/L	52	N/A	N/A	N/A	N/A	41	0.18267	NSVT
	Tetrachloroethene	µg/L	51	0.1	6.2	1.35	1.38	-664	0.00000	Decreasing
	Trichloroethene	µg/L	51	0.1	3.1	0.77	0.72	-568	0.00000	Decreasing
	Vinyl chloride	µg/L	52	0.18	0.76	0.39	0.26	-188	0.00134	Decreasing
PMW-05S	1,2-dichloroethane	µg/L	22	0.26	17	2.03	7.09	-92	0.00900	Decreasing
	Bis(2-chloroethyl) ether	µg/L	22	0.041	2.3	0.14	1.12	8	0.84600	NSVT
	Carbon tetrachloride	µg/L	22	0.32	1.9	0.60	0.67	-90	0.01100	Decreasing
	Tetrachloroethene	µg/L	21	0.76	6.4	2.10	1.38	-143	0.00000	Decreasing
	Trichloroethene	µg/L	21	0.4	210	31.00	55.10	-158	0.00000	Decreasing
	Vinyl chloride	µg/L	22	0.33	0.33	0.33	0.00	-21	0.57800	NSVT
PMW-06	1,2-dichloroethane	µg/L	26	N/A	N/A	N/A	N/A	0	0.98267	NSVT
	Bis(2-chloroethyl) ether	µg/L	33	0.023	3.2	0.59	1.28	-125	0.05400	NSVT
	Carbon tetrachloride	µg/L	26	N/A	N/A	N/A	N/A	0	0.98267	NSVT
	Tetrachloroethene	µg/L	26	0.31	0.31	0.31	N/A	-17	0.72600	NSVT
	Trichloroethene	µg/L	26	0.3	2.3	0.81	0.46	-195	0.00000	Decreasing
	Vinyl chloride	µg/L	26	N/A	N/A	N/A	N/A	0	0.98267	NSVT
PMW-07	1,2-dichloroethane	µg/L	35	0.2	1.7	0.60	0.42	-87	0.22400	NSVT
	Bis(2-chloroethyl) ether	µg/L	46	0.043	0.18	0.09	0.05	-197	0.00145	Decreasing
	Carbon tetrachloride	µg/L	35	N/A	N/A	N/A	N/A	0	0.98933	NSVT
	Tetrachloroethene	µg/L	35	0.23	0.3	0.27	0.05	-57	0.43000	NSVT
	Trichloroethene	µg/L	35	0.3	9.6	2.93	2.52	-435	0.00000	Decreasing
	Vinyl chloride	µg/L	35	N/A	N/A	N/A	N/A	0	0.98933	NSVT
MW-02D*	1,2-dichloroethane	µg/L	35	N/A	N/A	N/A	N/A	0	0.98933	NSVT
	Bis(2-chloroethyl) ether	µg/L	48	0.031	0.55	0.09	0.19	-160	0.02081	Decreasing
	Carbon tetrachloride	µg/L	35	0.31	19	2.10	4.07	190	0.00600	Increasing
	Tetrachloroethene	µg/L	35	0.2	0.77	0.34	0.14	-41	0.57200	NSVT
	Trichloroethene	µg/L	35	N/A	N/A	N/A	N/A	0	0.98933	NSVT
	Vinyl chloride	µg/L	35	N/A	N/A	N/A	N/A	0	0.98933	NSVT
MW-21S	1,2-dichloroethane	µg/L	40	1.2	21	5.71	5.95	-129	0.13700	NSVT
	Bis(2-chloroethyl) ether	µg/L	49	0.025	19	5.58	3.52	-258	0.02664	Decreasing
	Carbon tetrachloride	µg/L	41	0.1	0.67	0.33	0.17	-282	0.00067	Decreasing
	Tetrachloroethene	µg/L	40	9	35	18.80	6.96	-255	0.00200	Decreasing
	Trichloroethene	µg/L	40	4.6	48.8	13.70	10.40	-58	0.51000	NSVT
	Vinyl chloride	µg/L	40	0.3	4.8	1.61	1.06	-195	0.02300	Decreasing

Table 5 - Summary of Mann-Kendall Staistics and Trend Results

Well Identification	Analyte	Units	Number of Results	Results Summary				Mann-Kendall Test		
				Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Mann-Kendall S	Two-Tailed P-Value	Mann-Kendall Trend
MW-21D	1,2-dichloroethane	µg/L	41	0.1	23	0.72	6.46	-472	0.00000	Decreasing
	Bis(2-chloroethyl) ether	µg/L	51	0.04	30	0.37	5.52	-454	0.00014	Decreasing
	Carbon tetrachloride	µg/L	41	0.2	1.1	0.46	0.39	-100	0.27000	Decreasing
	Tetrachloroethene	µg/L	40	0.2	11	0.75	2.67	-511	0.00000	Decreasing
	Trichloroethene	µg/L	40	0.24	88	2.16	20.90	-475	0.00000	Decreasing
	Vinyl chloride	µg/L	41	0.1	1	0.45	0.49	-99	0.27000	Decreasing
MW-21D2	1,2-dichloroethane	µg/L	33	N/A	N/A	N/A	N/A	0	9.88E-01	NSVT
	Bis(2-chloroethyl) ether	µg/L	44	0.023	0.71	0.18	0.23	-146	0.036670358	Decreasing
	Carbon tetrachloride	µg/L	33	5.69	5.69	5.69	0.00	28	6.78E-01	NSVT
	Tetrachloroethene	µg/L	33	1.12	1.12	1.12	0.00	28	6.78E-01	NSVT
	Trichloroethene	µg/L	33	0.4	5.04	2.72	3.28	11	8.78E-01	NSVT
	Vinyl chloride	µg/L	33	N/A	N/A	N/A	N/A	0	9.88E-01	NSVT
MW-22	1,2-dichloroethane	µg/L	37	0.1	3.5	0.98	0.71	-259	0	Decreasing
	Bis(2-chloroethyl) ether	µg/L	46	0.01	1.7	0.45	0.43	-295	0.004226297	Decreasing
	Carbon tetrachloride	µg/L	37	N/A	N/A	N/A	N/A	0	9.90E-01	NSVT
	Tetrachloroethene	µg/L	36	0.2	2.4	0.93	0.46	-366	0.00E+00	Decreasing
	Trichloroethene	µg/L	36	0.1	7.2	2.10	1.62	-334	0.00E+00	Decreasing
	Vinyl chloride	µg/L	37	0.26	0.53	0.40	0.19	-67	3.91E-01	NSVT
Containment Wells										
BR-02	1,2-dichloroethane	µg/L	49	2.8	6.1	4.45	2.33	-27	5.11E-01	NSVT
	Bis(2-chloroethyl) ether	µg/L	61	0.0069	16	0.11	4.35	-461	9.73357E-05	Decreasing
	Carbon tetrachloride	µg/L	48	0.2	130	0.56	24.20	-569	1.76431E-07	Decreasing
	Tetrachloroethene	µg/L	49	0.1	2.7	0.27	0.81	-228	0.027452204	Decreasing
	Trichloroethene	µg/L	49	0.1	50	0.70	12.80	-50	0.611251002	NSVT
	Vinyl chloride	µg/L	49	0.74	0.74	0.74	0.00	-32	2.73E-01	NSVT
BR-06	1,2-dichloroethane	µg/L	49	1.36	85	16.00	19.70	-808	3.38E-12	Decreasing
	Bis(2-chloroethyl) ether	µg/L	62	0.03	29	2.40	6.98	-1441	0.00E+00	Decreasing
	Carbon tetrachloride	µg/L	49	0.22	245	16.00	61.80	-398	6.20E-04	Decreasing
	Tetrachloroethene	µg/L	49	1.17	22.1	5.50	5.10	-610	1.51E-07	Decreasing
	Trichloroethene	µg/L	49	2.1	310	64.50	53.80	-745	1.40E-10	Decreasing
	Vinyl chloride	µg/L	50	0.34	4.9	1.10	1.79	-333	3.16E-05	Decreasing
BR-07	1,2-dichloroethane	µg/L	48	0.4	71	0.25	13.00	-74	1.92E-01	NSVT
	Bis(2-chloroethyl) ether	µg/L	60	0.0054	5.9	0.03	0.86	-260	0.087214869	NSVT
	Carbon tetrachloride	µg/L	48	8.8	810	220.00	174.00	160	0.183365962	NSVT
	Tetrachloroethene	µg/L	48	0.2	23	0.40	5.50	650	2.84925E-08	Increasing
	Trichloroethene	µg/L	48	0.1	390	0.25	56.60	334	2.35E-03	Increasing
	Vinyl chloride	µg/L	48	3.9	5.3	0.25	4.50	-83	4.24E-02	Decreasing
BR-08	1,2-dichloroethane	µg/L	42	0.3	410	120.00	89.00	-174	0.060401939	NSVT
	Bis(2-chloroethyl) ether	µg/L	56	0.09	26	1.10	8.27	-490	0.000190246	Decreasing
	Carbon tetrachloride	µg/L	43	0.2	747	5.70	193.00	-110	0.243050633	NSVT
	Tetrachloroethene	µg/L	42	0.3	100	3.38	32.00	-245	0.008127968	Decreasing
	Trichloroethene	µg/L	42	0.56	1500	231.00	400.00	-12	0.905091325	NSVT
	Vinyl chloride	µg/L	42	1	80	24.50	20.60	312	0.000683148	Increasing
CW-01	1,2-dichloroethane	µg/L	48	0.3	15	2.80	7.52	-56	2.42E-01	NSVT
	Bis(2-chloroethyl) ether	µg/L	59	0.005	8.8	0.07	1.92	-466	0.000370208	Decreasing
	Carbon tetrachloride	µg/L	47	0.4	54	6.44	13.00	293	0.007366584	Increasing
	Tetrachloroethene	µg/L	47	0.3	7.8	1.22	1.81	236	3.09E-02	Increasing
	Trichloroethene	µg/L	47	0.6	110	2.34	19.80	43	0.699943455	NSVT
	Vinyl chloride	µg/L	48	0.1	0.13	0.11	0.02	-17	6.80E-01	NSVT
CW-02	1,2-dichloroethane	µg/L	48	0.1	11	0.67	2.66	-139	1.50E-01	NSVT
	Bis(2-chloroethyl) ether	µg/L	59	0.0068	57	0.24	10.20	-85	0.568904919	NSVT
	Carbon tetrachloride	µg/L	47	0.2	291	35.60	84.50	420	0.000121587	Increasing
	Tetrachloroethene	µg/L	47	0.7	55.7	8.87	12.20	592	5.88E-08	Increasing
	Trichloroethene	µg/L	47	0.2	12	2.65	2.31	174	0.112482367	NSVT
	Vinyl chloride	µg/L	48	0.1	1.2	0.36	0.31	149	8.25E-02	NSVT
CW-03	1,2-dichloroethane	µg/L	46	6.7	160	21.00	28.40	-4	0.977307347	NSVT
	Bis(2-chloroethyl) ether	µg/L	57	0.31	55	8.92	13.70	-770	1.13557E-07	Decreasing
	Carbon tetrachloride	µg/L	46	25	1100	353.00	199.00	182	8.64E-02	NSVT
	Tetrachloroethene	µg/L	46	2.5	27	7.53	4.30	286	0.00694243	Increasing
	Trichloroethene	µg/L	46	16	200	51.70	38.60	-44	0.683818265	NSVT
	Vinyl chloride	µg/L	47	0.13	7.25	1.31	1.55	542	1.90365E-07	Increasing
CW-04	1,2-dichloroethane	µg/L	47	2.62	170	50.30	35.90	-697	1.71E-10	Decreasing
	Bis(2-chloroethyl) ether	µg/L	58	0.07	107	2.68	16.70	-1034	3.62E-12	Decreasing
	Carbon tetrachloride	µg/L	47	3.67	1100	330.00	219.00	-491	6.95175E-06	Decreasing
	Tetrachloroethene	µg/L	47	5.03	53	24.80	10.10	-364	8.62E-04	Decreasing
	Trichloroethene	µg/L	47	36.2	490	175.00	87.10	-336	0.002065702	Decreasing
	Vinyl chloride	µg/L	48	0.46	5.4	1.45	1.25	288	0.008678563	Increasing
CW-05	1,2-dichloroethane	µg/L	47	2.96	44	8.04	8.46	-506	3.62E-06	Decreasing
	Bis(2-chloroethyl) ether	µg/L	59	0.02	1	0.17	0.28	-531	0.000305393	Decreasing
	Carbon tetrachloride	µg/L	47	0.1	75.6	5.34	18.60	-474	1.24E-05	Decreasing
	Tetrachloroethene	µg/L	47	1.19	32	6.14	6.50	-751	5.99E-12	Decreasing
	Trichloroethene	µg/L	47	33.2	1800	129.00	316.00	-783	7.30E-13	Decreasing
	Vinyl chloride	µg/L	48	0.16	2.11	0.64	0.43	608	7.39323E-09	Increasing
CW-06	1,2-dichloroethane	µg/L	47	0.1	92	1.05	15.80	95	3.83E-01	NSVT
	Bis(2-chloroethyl) ether	µg/L	59	0.0051	22	0.16	5.65	-382	0.001416373	Decreasing
	Carbon tetrachloride	µg/L	47	0.1	500	1.64	141.00	-15	8.83E-01	NSVT
	Tetrachloroethene	µg/L	47	0.1	34	0.79	5.29	-131	2.33E-01	NSVT
	Trichloroethene	µg/L	46	1.49	290	27.10	49.10	-506	1.73E-06	Decreasing
	Vinyl chloride	µg/L	47	0.14	1.09	0.40	0.42	6	0.924186247	NSVT

Table 5 -Summary of Mann-Kendall Staistics and Trend Results

Well Identification	Analyte	Units	Number of Results	Results Summary				Mann-Kendall Test		
				Minimum Detected Concentration	Maximum Detected Concentration	Mean	Standard Deviation	Mann-Kendall S	Two-Tailed P-Value	Mann-Kendall Trend
MW-23	1,2-dichloroethane	µg/L	49	3.1	38	12.30	8.62	406	0.000314707	Increasing
	Bis(2-chloroethyl) ether	µg/L	61	0.11	43	9.84	10.00	-66	0.685360319	NSVT
	Carbon tetrachloride	µg/L	48	46	9700	3720.00	2630.00	21	0.858883248	NSVT
	Tetrachloroethene	µg/L	48	13	111	36.80	23.00	377	0.000819595	Increasing
	Trichloroethene	µg/L	48	9.7	126	38.60	24.00	570	4.14091E-07	Increasing
	Vinyl chloride	µg/L	49	0.97	3.6	1.74	1.39	-37	0.453222026	NSVT
Overburden/Bedrock Wells										
OB-02	1,2-dichloroethane	µg/L	4	0.3	3	1.03	1.32	1	0.5	NSVT
	Bis(2-chloroethyl) ether	µg/L	4	0.0046	3	1.56	1.67	-1	0.5	NSVT
	Carbon tetrachloride	µg/L	4	N/A	N/A	N/A	N/A	0	NA	NSVT
	Tetrachloroethene	µg/L	4	7.2	8.6	7.95	0.58	-4	0.154	NSVT
	Trichloroethene	µg/L	4	0.3	11	6.10	4.40	4	0.154	NSVT
	Vinyl chloride	µg/L	4	0.3	3	1.03	1.32	1	0.5	NSVT
OB-05	1,2-dichloroethane	µg/L	3	430	470	443.30	23.09	2	0.27	NSVT
	Bis(2-chloroethyl) ether	µg/L	4	0.005	3	1.71	1.53	1	0.5	NSVT
	Carbon tetrachloride	µg/L	3	N/A	N/A	N/A	N/A	0	NA	NSVT
	Tetrachloroethene	µg/L	3	38	42	39.33	2.31	-2	0.27	NSVT
	Trichloroethene	µg/L	3	N/A	N/A	N/A	N/A	0	NA	NSVT
	Vinyl chloride	µg/L	3	57	89	76.33	17.01	-1	0.5	NSVT
OB-07	1,2-dichloroethane	µg/L	4	11	110	69.25	41.73	2	0.367	NSVT
	Bis(2-chloroethyl) ether	µg/L	5	0.96	26	15.19	9.11	-4	0.231	NSVT
	Carbon tetrachloride	µg/L	4	4.7	72	44.18	28.86	4	0.154	NSVT
	Tetrachloroethene	µg/L	4	1.4	21	14.10	8.83	4	0.154	NSVT
	Trichloroethene	µg/L	4	26	400	236.50	165.30	2	0.367	NSVT
	Vinyl chloride	µg/L	4	0.5	3.8	2.03	1.77	3	0.235	NSVT
BR-05	1,2-dichloroethane	µg/L	19	1.2	1.3	1.25	0.07	-33	0.266	NSVT
	Bis(2-chloroethyl) ether	µg/L	26	0.0057	0.078	0.03	0.04	-40	0.394	NSVT
	Carbon tetrachloride	µg/L	19	0.1	9	4.55	6.29	-17	0.58	NSVT
	Tetrachloroethene	µg/L	19	0.3	0.62	0.46	0.23	-15	0.628	NSVT
	Trichloroethene	µg/L	19	0.1	2.3	1.75	0.95	-52	0.074	NSVT
	Vinyl chloride	µg/L	19	N/A	N/A	N/A	N/A	0	0.972	NSVT
BR-10	1,2-dichloroethane	µg/L	18	0.3	120	19.90	40.30	-66	0.012	Decreasing
	Bis(2-chloroethyl) ether	µg/L	24	0.065	71	6.31	19.40	-117	0.003	Decreasing
	Carbon tetrachloride	µg/L	18	0.1	140	19.90	38.50	-64	0.016	Decreasing
	Tetrachloroethene	µg/L	18	0.1	11	2.75	3.54	-45	0.096	NSVT
	Trichloroethene	µg/L	18	0.1	84.3	21.30	31.10	-42	0.122	NSVT
	Vinyl chloride	µg/L	18	1.9	2.4	2.15	0.35	-33	0.23	NSVT
BR-11	1,2-dichloroethane	µg/L	17	0.1	7.3	0.40	2.88	-56	0.022	Decreasing
	Bis(2-chloroethyl) ether	µg/L	22	0.052	0.11	0.08	0.04	-35	0.342	NSVT
	Carbon tetrachloride	µg/L	17	0.3	140	10.90	34.90	-97	0.00E+00	Decreasing
	Tetrachloroethene	µg/L	17	0.1	5.4	0.74	1.35	-76	2.00E-03	Decreasing
	Trichloroethene	µg/L	17	0.4	24	2.92	5.92	-93	0.00E+00	Decreasing
	Vinyl chloride	µg/L	17	N/A	N/A	N/A	N/A	0	0.968	NSVT
BR-12	1,2-dichloroethane	µg/L	17	1.4	3.9	2.34	1.77	-31	0.22	NSVT
	Bis(2-chloroethyl) ether	µg/L	23	0.082	0.53	0.21	0.32	-31	0.432	NSVT
	Carbon tetrachloride	µg/L	17	0.25	0.25	0.25	0.00	-14	0.598	NSVT
	Tetrachloroethene	µg/L	17	0.56	0.56	0.56	0.00	-14	0.598	NSVT
	Trichloroethene	µg/L	17	0.2	93	3.83	43.80	-50	0.042	Decreasing
	Vinyl chloride	µg/L	17	N/A	N/A	N/A	N/A	0	0.968	NSVT

NOTES:

NSVT = No statistically valid trend.

µg/L = Microgram(s) per liter.

Appendix H, 2022 Annual O&M Plan [database 2004 through August 2022]

* MW-02D is in the Waste Management Area between the former Drum Disposal Area and the former manufacturing area

Table 6 Treatment Plan Flow Rates 2001-2022			
Year	**Lagoon Water (gallons/year)**	**Groundwater (gallons/year)[1]**	**Total (gallons/year)**
2001	0 (Zero)	5,928,652	5,928,652
2002	258,539	4,775,987	5,034,526
2003	430,847	5,961,277	6,392,124
2004	2,212,850	6,549,862	8,762,712
2005	0 (Zero)	6,878,236	6,878,236
2006	0 (Zero)	17,638,447	17,638,447
2007	0 (Zero)	19,409,215	19,409,215
2008	0 (Zero)	18,954,023	18,954,023
2009	0 (Zero)	18,510,558	18,510,558
2010	0 (Zero)	19,050,941	19,050,941
2011	0 (Zero)	19,148,420	19,148,420
2012	0 (Zero)	17,344,503	17,344,503
2013	0 (Zero)	17,367,779	17,367,779
2014	0 (Zero)	17,617,525	17,617,525
2015	0 (Zero)	16,707,320	16,707,320
2016	0 (Zero)	18,337,119	18,337,119
2017	0 (Zero)	16,990,729	16,990,729
2018	0 (Zero)	16,587,315	16,587,315
2019	0 (Zero)	20,866,227	20,866,227
2020	0 (Zero)	19,449,691	19,449,691
2021	0 (Zero)	15,359,358	15,359,358
2022	0 (Zero)	16,190,591	16,190,591

NOTES:

1. Six additional extraction wells were installed and began operating in December 2005.

Table 7 Treatment Plant Influent Concentrations and Pounds of Contaminants Removed Annually 2002-2022

Time Period	CCl_4 (µg/L)	BCEE (µg/L)	Others (µg/L)	Total Organics (µg/L)	Influent Flow (gallons)	Mass Removed (pounds) [1]	Annual Total Mass (pounds)
Mar-02	207.0	23.5	106.1	336.6	327,184	0.9	18.5
Apr-02	197.0	29.0	116.0	342.0	322,741	0.9	
May-02	210.0	27.0	176.0	413.0	327,458	1.1	
Jun-02	270.0	27.0	240.0	537.0	397,374	1.8	
Jul-02	400.0	46.0	222.0	668.0	541,603	3.0	
Aug-02	190.0	35.0	221.0	446.0	563,167	2.1	
Sep-02	250.0	47.0	276.0	573.0	453,346	2.2	
Oct-02	410.0	48.0	423.0	881.0	434,044	3.2	
Nov-02	250.0	46.0	246.0	542.0	490,304	2.2	
Dec-02	130.0	22.0	85.4	237.4	530,810	1.1	
Jan-03	72.0	45.0	126.7	243.7	519,089	1.1	25.2
Feb-03	470.0	21.0	303.7	794.7	459,077	3.0	
Mar-03	0.0	20.0	138.0	158.0	504,799	0.7	
Apr-03	83.0	12.0	53.5	148.5	412,636	0.5	
May-03	190.0	13.0	90.4	293.4	509,022	1.2	
Jun-03	210.0	22.0	240.0	472.0	541,938	2.1	
Jul-03	320.0	24.0	197.2	541.2	538,729	2.4	
Aug-03	330.0	24.0	173.8	527.8	614,305	2.7	
Sep-03	400.0	25.0	287.0	712.0	501,655	3.0	
Oct-03	220.0	13.0	114.2	347.2	635,084	1.8	
Nov-03	510.0	24.0	314.6	848.6	688,806	4.9	
Dec-03	250.0	22.0	164.4	436.4	466,984	1.7	
Jan-04	360.0	24.0	219.1	603.1	911,079	4.6	39.7
Feb-04	100.0	27.0	101.9	228.9	775,940	1.5	
Mar-04	250.0	15.0	572.8	837.8	734,302	5.1	
Apr-04	440.0	17.0	218.1	675.1	672,508	3.8	
May-04	140.0	17.0	154.7	311.7	661,850	1.7	
Jun-04	460.0	22.0	266.4	748.4	624,352	3.9	
Jul-04	220.0	21.0	189.9	430.9	534,085	1.9	
Aug-04	350.0	16.0	239.0	605.0	538,252	2.7	
Sep-04	180.0	11.0	115.3	306.3	606,336	1.5	
Oct-04	210.0	7.4	159.7	377.1	807,601	2.5	
Nov-04	490.0	23.0	225.9	738.9	1,406,220	8.7	
Dec-04	260.0	15.0	154.6	429.6	490,187	1.8	
Jan-05	140.0	18.0	93.2	254.4	463,888	1.0	27.9
Feb-05	310.0	18.0	219.0	554.2	480,857	2.2	
Mar-05	460.0	20.0	213.9	703.0	627,217	3.7	
Apr-05	460.0	15.0	269.2	744.2	417,367	2.6	
May-05	410.0	6.8 J	257.5	667.5	556,098	3.1	
Jun-05	260.0	23.0	186.2	469.2	475,376	1.9	

Table 7 Treatment Plant Influent Concentrations and Pounds of Contaminants Removed Annually 2002-2022

Time Period	CCl_4 (µg/L)	BCEE (µg/L)	Others (µg/L)	Total Organics (µg/L)	Influent Flow (gallons)	Mass Removed (pounds) [1]	Annual Total Mass (pounds)
Jul-05	280.0	15.5	126.7	422.2	503,597	1.8	27.9
Aug-05	245.0	21.3	107.8	374.1	506,351	1.6	
Sep-05	190.2	9.2	113.9	313.3	452,948	1.2	
Oct-05	98.0	17.0	127.9	242.9	489,829	1.0	
Nov-05	740.0	19.0	489.6	1248.6	192,608	2.0	
Dec-05	130.0	11.0	309.2	450.2	1,583,054	5.9	
Jan-06	140.0	11.0	216.0	367.0	1,407,803	4.3	75.8
Feb-06	130.0	8.3	259.6	397.9	1,350,960	4.5	
Mar-06	140.0	15.0	271.8	426.8	1,433,760	5.1	
Apr-06	280.0	12.0	380.1	672.1	1,225,250	6.9	
May-06	240.0	12.0	284.2	536.2	1,187,577	5.3	
Jun-06	210.0	14.0	264.0	488.0	1,352,785	5.5	
Jul-06	300.0	13.0	325.6	638.6	1,639,485	8.7	
Aug-06	280.0	11.0	373.1	664.1	1,612,527	8.9	
Sep-06	290.0	13.0	382.9	685.9	1,384,525	7.9	
Oct-06	200.0	7.7	267.5	475.2	1,411,204	5.6	
Nov-06	210.0	13.0	281.9	504.9	1,491,593	6.3	
Dec-06	200.0	3.2	261.9	465.1	1,747,054	6.8	
Jan-07	120.0	7.4	168.2	295.6	1,734,053	4.3	56.0
Feb-07	110.0	12.0	177.1	299.1	1,497,348	3.7	
Mar-07	130.0	5.8	187.8	323.6	1,357,745	3.7	
Apr-07	220.0	5.0	191.4	416.4	1,558,601	5.4	
May-07	230.0	9.6	201.9	441.5	1,601,221	5.9	
Jun-07	320.0	11.0	248.0	579.0	1,265,251	6.1	
Jul-07	160.0	10.0	150.8	320.8	1,636,007	4.4	
Aug-07	190.0	5.4	117.7	313.1	1,597,163	4.2	
Sep-07	380.0	7.5	217.4	604.9	1,791,013	9.0	
Oct-07	120.0	8.5	217.5	346.0	1,485,646	4.3	
Nov-07	20.0	1.8	38.9	60.7	1,660,671	0.8	
Dec-07	130.0	9.2	188.4	327.6	1,545,735	4.2	
Jan-08	240.0	5.9	286.1	532.0	2,010,607	8.9	74.3
Feb-08	245.0	5.8	197.9	448.7	1,839,200	6.9	
Mar-08	250.0	5.7	109.7	365.4	1,562,871	4.8	
Apr-08	130.0	8.0	156.2	294.2	1,640,741	4.0	
May-08	190.0	8.7	243.7	442.4	1,686,810	6.2	
Jun-08	280.0	6.1	157.8	443.9	1,393,427	5.2	
Jul-08	300.0	9.7	194.7	504.4	1,648,660	6.9	
Aug-08	290.0	10.0	209.3	509.3	1,518,133	6.4	
Sep-08	340.0	6.7	212.8	559.5	1,258,913	5.9	

Table 7 Treatment Plant Influent Concentrations and Pounds of Contaminants Removed Annually 2002-2022

Time Period	CCl_4 (µg/L)	BCEE (µg/L)	Others (µg/L)	Total Organics (µg/L)	Influent Flow (gallons)	Mass Removed (pounds) [1]	Annual Total Mass (pounds)
Oct-08	360.0	5.4	231.3	596.7	1,677,727	8.3	
Nov-08	280.0	5.7	207.2	492.9	1,224,931	5.0	
Dec-08	230.0	6.0	168.2	404.2	1,683,776	5.7	
Jan-09	260.0	7.6	203.5	471.1	1,612,580	6.3	65.8
Feb-09	99.0	9.1	157.4	265.5	1,438,436	3.2	
Mar-09	180.0	ns	218.8	398.8	1,671,821	5.6	
Apr-09	160.0	6.4	273.7	440.1	1,672,789	6.1	
May-09	370.0	ns	245.7	615.7	1,490,294	7.7	
Jun-09	240.0	ns	154.5	394.5	1,459,671	4.8	
Jul-09	240.0	5.1	158.3	403.4	1,713,926	5.8	
Aug-09	350.0	ns	210.5	560.5	1,668,457	7.8	
Sep-09	270.0	ns	134.5	404.5	1,532,196	5.2	
Oct-09	330.0	6.3	274.9	611.2	1,580,667	8.1	
Nov-09	79.0	7.7	72.5	159.2	1,726,326	2.3	
Dec-09	130.0	ns	132.4	262.4	1,407,162	3.1	
Jan-10	260.0	ns	145.1	405.1	1,565,549	5.3	72.4
Feb-10	210.0	2.5 J	132.9	345.4	1,598,412	4.6	
Mar-10	140.0	ns	90.0	230.0	1,737,301	3.3	
Apr-10	180.0	ns	129.4	309.4	1,569,676	4.1	
May-10	270.0 E	6.3 E	160.9	437.2	1,574,334	5.7	
Jun-10	390.0	ns	194.5	584.5	1,443,807	7.0	
Jul-10 [2]	0.2 J	ns	UL [2]	0.2	1,659,556	0.0	
Aug-10	410.0	7.4 E	234.6	652.0	1,780,193	9.7	
Sep-10	220.0	ns	145.9	365.9	1,582,260	4.8	
Oct-10	380.0	ns	937.7	1317.7	1,536,527	16.9	
Nov-10	220.0	nd	177.7	397.7	1,639,390	5.4	
Dec-10	250.0	ns	146.9	396.9	1,652,934	5.5	
Jan-11	180.0 +	ns	168.9	348.9	1,428,788	4.2	55.6
Feb-11	300.0 +	7.5	188.4	495.9	1,300,455	5.4	
Mar-11	88.0 +	ns	99.5	187.5	1,753,447	2.7	
Apr-11	150.0 +	3.6 J	133.2	286.8	1,780,020	4.3	
May-11	190.0 +	ns	186.3	376.3	1,920,276	6.0	
Jun-11	180.0 L	ns	167.9	347.9	1,395,817	4.1	
Jul-11	130.0 +	nd	117.8	247.8	1,852,948	3.8	
Aug-11	220.0 +	ns	187.5	407.5	1,835,454	6.2	
Sep-11	330.0 +	ns	207.0	537.0	1,507,956	6.8	
Oct-11	210.0 +	5.9	128.2	344.1	975,035	2.8	
Nov-11	100.0 +L	ns	62.2	162.2	1,535,090	2.1	
Dec-11	290.0 +J	ns	153.3	443.3	1,959,229	7.2	

Table 7 Treatment Plant Influent Concentrations and Pounds of Contaminants Removed Annually 2002-2022

Time Period	CCl_4 (µg/L)	BCEE (µg/L)	Others (µg/L)	Total Organics (µg/L)	Influent Flow (gallons)	Mass Removed (pounds) [1]	Annual Total Mass (pounds)
1Q 2012	220.0	3.0	170.0	445.2	4,335,125	16.1	69.8
2Q 2012	195.0	2.1	175.0	583.0	4,365,123	21.2	
3Q 2012	191.0	2.2	165.0	543.0	4,315,435	19.6	
4Q 2012	192.0 +J	2.1	153.3	355.0	4,345,327	12.9	
	(kg)	(kg)	(kg)	(kg)[3]	(gallons)	(pounds)	
Jan-Jun 2013	10.7	0.2	6.1	17.0	9,257,468	37.5	61.9
Jul-Dec 2013	6.3	0.2	4.6	11.1	8,110,311	24.4	
Jan-Jun 2014	12.1	0.1	5.9	18.1	8,575,285	39.8	72.9
Jul-Dec 2014	8.7	0.0	6.2	15.0	9,042,240	33.1	
Jan-Jun 2015	7.5	0.1	5.5	13.0	8,795,564	28.7	56.8
Jul-Dec 2015	7.6	0.1	5.0	12.7	7,911,756	28.1	
Jan-Jun 2016	8.5	0.1	5.0	13.6	8,961,985	29.9	62.5
Jul-Dec 2016	8.9	0.1	5.8	14.8	9,375,134	32.7	
Jan-Jun 2017	7.2	0.1	5.1	12.4	8,673,325	27.2	58.9
Jul-Aug 2017	9.4	0.1	4.9	14.4	8,317,404	31.7	
Jan-Jun 2018	7.0	0.0	5.4	12.5	7,857,885	27.4	56.4
Jul-Dec 2018	8.1	0.0	5.0	13.2	8,729,430	29.0	
Jan-Jun 2019	13.0	0.0	4.9	18.0	10,510,285	39.6	88.4
Jul-Dec 2019	13.9	0.0	8.2	22.2	10,355,942	48.9	
Jan-Jun 2020	7.3	0.1	5.4	12.7	9,859,938	28.0	45.5
Jul-Dec 2020	5.0	0.0	2.9	7.9	9,589,753	17.5	
Jan-Jun 2021	6.9	0.0	4.3	11.2	8,338,338	24.6	45.6
Jul-Dec 2021	5.2	0.0	4.3	9.5	7,021,020	21.0	
Jan-Jun 2022	2.9	0.0	2.9	5.8	6,657,961	12.7	35.6
Jul-Dec 2022	5.4	0.0	5.0	10.4	9,532,630	22.9	
Total mass removed since 2002 (pounds)							**1165.7**

Notes:

1 Mass removed is based on calculations using monthly concentrations from the SL-1 sampling port (equalizatio

2 The samples arrived at the lab > 4°F and many data were UL qualified.

3 Mass (in kilograms) provided in the 2013-2017 (first half) Annual O&M Reports; mass removed calculated by

Acronyms:

µg/L - micrograms per liter

BCEE-Bis(2-chloroethyl) Ether

CCl_4 - carbon tetrachloride

kg - kilograms

nd - not detected above quantitation limit

Data Qualifiers:

E - Estimated

J - Analyte present. Value may not be accurate or precise.

L-Analyte present.Actual value is expected to be higher.

UL - Not detected. Quantitation limit is probably higher.

+ - sample was diluted

Table 8 Effluent Discharge Limits Pre-2009 compared to current (2023).

PARAMETER	Pre-2009 DMR QUALITY or CONCENTRATION			EPA Calculated Limit	Calculated Limited Based Upon Aquatic Protection	Calculated Limited Based Upon Human Health	2009 VADEQ Revised Limit	2009 Informal Performance Goal	EPA Monitoring Frequency
	Minimum	Maximum Continuous	Units						
Inorganics									
pH	6	9	SU	6.0 to 9.0	Y		6 to 9	6 to 9	M
ALUMINUM, TOTAL RECOVERABLE	NA	87	µg/L	87 [1]			NR	NA	NR [2]
CADMIUM, DISSOLVED	NA	1	µg/L	1.1	Y		NR	NA	NR [2]
CHROMIUM, DISSOLVED TRIVALENT	NA	171.6	µg/L	69	Y		NR	NA	NR [2]
CHROMIUM, DISSOLVED HEXAVALENT	NA	16	µg/L	11	Y		NR	NA	NR [2]
COPPER. DISSOLVED	NA	9.2	µg/L	8.3	Y		NR	NA	NR [2]
CYANIDE	NA	7.6	µg/L	5.2	Y		7.2 [5]	7.2	M
LEAD	NA	1.9	µg/L	12	Y	Y	NR	NA	NR [2]
MERCURY, DISSOLVED	NA	0.018	µg/L	0.0051		Y	NR	NA	NR [2]
NICKEL, DISSOLVED	NA	128.3	µg/L	19	Y		NR	19	M
ZINC, DISSOLVED	NA	65	µg/L	110	Y		NR	NA	NR [2]
Toxicity									
ACUTE WHOLE EFFL TOXICITY (NOAEC%)	100	NA	NOAEC	100	Y		1 Tua	1 Tua	Q [6]
CHRONIC WHOLE EFFL TOXICITY (TUc)	NA	1	Tuc	1	Y		1.4 TUc	1.4 TUc	Q
Organics									
BENZENE	NA	77.5	µg/L	71		Y	NR	71	M
BIS-2-CHLOROETHYL ETHER	NA	1.4	µg/L	1.4		Y	NR	1.4	Q
BIS-2-ETHYLHEXL PHTHALATE	NA	R	µg/L	59		Y	NR	NA	NR [3]
CARBON TETRACHLORIDE	NA	90.8	µg/L	44		Y	NR	44	M
CHLOROBENZENE	NA	21000	µg/L	21000		Y	NR	NA	NR [4]
CHLOROFORM	NA	R	µg/L	2900		Y	NR	NA	NR [4]
1,2-DICHLOROBENZENE	NA	R	µg/L	1700		Y	NR	NA	NR [3]
1,2-DICHLOROETHANE	NA	R	µg/L	990		Y	NR	990	Q
METHYLENE CHLORIDE	NA	1600	µg/L	1600		Y	NR	NA	NR [4]
NAPHTHALENE	NA	90.7	µg/L	90.7		Y	NR	NA	NR [3]
TETRACHLORO-ETHYLENE	NA	R	µg/L	89		Y	NR	89	M
TRICHLOROETHENE	NA	R	µg/L	810		Y	NR	810	M
TOLUENE	NA	256	µg/L	256		Y	NR	NA	NR [4]
VINYL CHLORIDE	NA	NA	µg/L	5300		Y	NR	5300	M

ABBREVIATIONS:
µg/L = Micrograms per liter
M = Monthly
NOAEC% = No observed adverse effect concentration
NA = Not applicable
NR = Not required
Q = Quarterly
R = Report only, no limit established
SU = Standard units
Tua = Toxicity Units, Acute
Tuc = Toxicity Units, Chronic
Y = Yes

NOTES:
1. Analyte not listed on the 2008 Piedmont Region Water Quality spreadsheet.
EA proposed retaining the previous value for continuity purposes
2. Sampling not required for DMR/Informal Performance Goals; however, this analyte is included in monthly TAL metals sampling used to evaluate Site treatment plant performance
3. Sampling not required for DMR/Informal Performance Goals; however, this analyte is included in quarterly SVOC sampling used to evaluate Site groundwater quality
4. Sampling not required for DMR/Informal Performance Goals; however, this analyte is included in monthly VOC sampling used to evaluate Site treatment plant performance
5. In 2013, the Cyanide value was changed to 7.9 µg/L.
6. In 2013, the Acute Whole Effl Toxicity monitoring frequency was changed to annually.

TABLE 9
COMPARISON OF TOXICITY VALUES
GREENWOOD CHEMICAL SITE

Chemical of Concern	2005 ROD[1]				2023 FYR[2]			
	Carcinogenic Toxicity Value		Non-Carcinogenic Toxicity Value		Carcinogenic Toxicity Value		Non-Carcinogenic Toxicity Value	
	Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Reference Dose (mg/kg-day)	Reference Concentration (mg/m^3)	Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Reference Dose (mg/kg-day)	Reference Concentration (mg/m^3)
Bis(2-Chloroethyl)Ether	1.1E+00	3.3E-04	--	--	1.1E+00	3.3E-04	--	--
Carbon Tetrachloride	1.3E-01	1.5E-05	7.0E-04	2.0E-03	7.0E-02	6.0E-06	4.0E-03	1.0E-01
1,2-Dichloroethane	9.1E-02	2.6E-05	2.0E-02	4.9E-03	9.1E-02	2.6E-05	6.0E-03	7.0E-03
Tetrachloroethene	5.4E-01	--[3]	1.0E-02	4.9E-01	2.1E-03	2.6E-07	6.0E-03	4.0E-02
Trichloroethene	4.0E-01	--[3]	3.0E-04	4.0E-02	4.6E-02	4.1E-06	5.0E-04	2.0E-03
Vinyl Chloride	7.2E-01	4.4E-06	3.0E-03	1.0E-01	7.2E-01	4.4E-06	3.0E-03	1.0E-01

-- = No toxicity values available

1) 2005 toxicity values taken from TetraTech/Black & Veatch, 2005, *Final Ground-Water Investigation and Focused Feasibility Study Report, Green Chemical Site, Greenwood, Albemarle County, Virginia*. June 2005

2) 2022 toxicity values taken from USEPA Regional Screening Level Summary Table, November 2022, for resident adult and child exposure to tap water, available at: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm.

3) Inhalation unit risks were extrapolated based upon the oral slope factor.

APPENDIX A - Site Chronology

Event	Date
Chemical Manufacturing Operations	1947-1985
Finalized on National Priorities List (NPL)	July 22, 1987
EPA begins Emergency Removal Actions	October 15, 1987
Operable Unit 1 (OU1) Record of Decision (ROD) issued requiring excavation, treatment and disposal of surface soil and sludge and off-Site disposal of abandoned chemicals.	December 29, 1989
Operable Unit 2 (OU2) Interim ROD issued requiring groundwater pump and treat to be implemented as a preliminary action.	December 31, 1990
Explanation of Significant Differences (ESD) No. 1 clarified that former manufacturing buildings needed to be demolished to access contaminated soil. Referred to as OU3.	July 17, 1991
OU1 State Superfund Contract (SSC) signed	October 17, 1991
EPA accepted the OU3 Remedial Action Report documenting demolition and disposal of buildings	October 15, 1993
ESD-2 clarified that excavation required by OU1 ROD would extend to practical limits of excavation; deeper contamination would be addressed by an OU4 Record of Decision.	March 24, 1994
EPA completed Remedial Design for OU1; excavation, treatment, off-Site disposal of contaminated soil and sludge	June 30, 1994
EPA accepted the OU1 Remedial Action Report documenting completion	September 3,1996
EPA completed Remedial Design for Interim Remedy OU2, including water treatment plant	September 29, 1997
First Five-Year Review issued	January 23, 1998
Final inspection and acceptance of constructed water treatment plant (Interim OU2)	May 9, 2000
Interim OU2 remedy determined to Operational and Functional	May 15, 2002
EPA accepted the Interim OU2 Remedial Action Report documenting completion	September 19, 2003
Second Five-Year Review issued	September 29, 2003
Issue Action Memo, Remove Lagoons 4&5 and arsenic-contaminated surface soil	June 22, 2004 – May 2005
OU2 (final) and OU4 ROD issued requiring containment of deep soils and achieving groundwater performance standards with upgraded pump and treat system	September 22, 2005
Preliminary Closeout Report issued	September 30, 2005
EPA accepts Interim OU2 Remedial Action Report	July 10, 2006
Third Five-Year Review issued	September 29, 2008
Operations transferred from EPA to VDEQ	March 15, 2012
ESD for OU 2/4 ROD issued requiring new buildings on Site to be constructed in a manner that protects occupants from vapor intrusion from underlying contaminated ground water.	July 24, 2013
Fourth Five-Year Review Issued	September 9, 2013
Institutional Controls placed by filing of Notice of Contamination with Albemarle Recorder of Deeds Office	September 18, 2013
Site-Wide Ready for Anticipated Use determination signed	January 16, 2014
Fifth Five Year Review Issued	September 6, 2018
Optimization Report	October 26, 2020

APPENDIX B – Reference List

Record of Decision [OU1], Greenwood Chemical, Albemarle County, Newtown, VA, dated December 29, 1989

Record of Decision [Interim OU2], Greenwood Chemical, Albemarle County, Newtown, VA, dated December 31, 1990

Explanation of Significant Differences, Greenwood Chemical, Albemarle County, Newtown, VA, dated July 17, 1991

Explanation of Significant Differences, Greenwood Chemical, Albemarle County, Newtown, VA, dated March 24, 1994

Record of Decision [final OU2 and OU4], Greenwood Chemical, Albemarle County, Newtown, VA, dated September 22, 2005

Explanation of Significant Differences, Record of Decision [final OU2 and OU4], Greenwood Chemical, Albemarle County, Newtown, VA, dated July 24, 2013

Deed Notice – Notice of Contamination filed with Albemarle County Recorder of Deeds September 17, 2013 (Doc ID 032729990018)

Fifth Five-Year Review Report, Greenwood Chemical, Newtown, VA, September 2018

Technical Memorandum, VDEQ/EA Discharge Limits Comparison Discussion, Greenwood Chemical Site, Operable Unit (OU) -2 and OU-4, Greenwood, Albemarle County, Virginia, December 2008

Semi-Annual Operation, Maintenance and Monitoring Report, September 2017-June 2018, dated August 31, 2018

Annual Operations & Maintenance (O&M) and Monitoring Report [September 2017 to December 2018], dated April 12, 2019

Semi-Annual Operation, Maintenance and Monitoring Report, Jan-Jun 2019, dated September 19, 2019

Annual Operations & Maintenance (O&M) and Monitoring Report for 2019, dated January 28, 2020

Semi-Annual Operation, Maintenance and Monitoring Report, Jan-Jun 2020, dated September 29, 2020

Annual Operations & Maintenance (O&M) and Monitoring Report for 2020, dated February 14, 2021

Semi-Annual Operation, Maintenance and Monitoring Report, Jan-Jun 2021, dated October 25, 2021

Annual Operations & Maintenance (O&M) and Monitoring Report for 2021, dated January 31, 2022

Semi-Annual Operation, Maintenance and Monitoring Report, Jan-June 2022, dated August 1, 2022

Annual Operations & Maintenance (O&M) and Monitoring Report for 2022, dated March 10, 2023

Memorandum of 2023 Semi-Annual Monitoring – Preliminary results of samples collected from February to March 2023

EPA Risk Based Screening Tables, November 2022

Sampling and Analysis Plan, Greenwood Chemical Superfund Site, revision date October 2019

Optimization Review Technical Memorandum, Greenwood Chemical, October 26, 2020

APPENDIX C – Assessment of ROD ARARs

An assessment of the Applicable or Relevant and Appropriate Requirements (ARARs) was conducted during the document review. The assessment determined that the ARARs are being met and/or are still appropriate for the remedies in place at the Site. The major ARARs include:

- MCLs and non-zero MCLGs are still promulgated under the Safe Drinking Water Act, 40 CFR § 141.11-16; 40 CFR §§ 141.50-51 and are still relevant and appropriate to the groundwater cleanup remedy in the area of attainment.

- MCLs and non-zero MCLGs are still promulgated under the Virginia Waterworks Regulation, 12 VAC 5-590-440, and are still relevant and appropriate to the groundwater cleanup remedy in the area of attainment.

- Discharge limitations into surface waters of the Commonwealth are still promulgated under the Virginia Pollutant Discharge Elimination System, 9 VAC 25-31-10 to 940 and are still applicable to the effluent discharge from the on-Site water treatment facility. A permit is not required for on-Site discharge; however, the substantive standards must be attained.

In January 2009 EPA and VDEQ completed a reassessment of the water treatment effluent quality. As part of the process the VDEQ VPDES program conducted a statistical analysis of the Greenwood Chemical Treatment Plant discharge reports between 2001 and 2008 and provided EPA with recommended Discharge Monitoring Report (DMR) modifications in October 2008 which were slightly revised again in 2013. VDEQ recommended that metals (aluminum, calcium, chromium (III), chromium (VI), copper, lead, mercury, and zinc) be removed from the monthly discharge monitoring requirements. VDEQ also recommended that the previously requested organics (benzene, bis-2-chloroethyl ether, bis-2-ethylhexyl phthalate, carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,2-dichloroethane, methylene chloride, naphthalene, tetrachloroethene, trichloroethene, toluene, and vinyl chloride) be removed from discharge monitoring requirements based on 8 years of effluent data demonstrating consistent abatement of organic contaminants by the treatment plant. EPA confirmed that VDEQ reports only the limited parameters required by the VDEQ water program in its Quarterly and Annual VPDES Discharge Monitoring Reports but maintains a more robust data set in the Semi-Annual and Annual O&M Reports. The VPDES Discharge Monitoring Reports cannot be used alone to determine whether the water treatment plant is meeting its ARARs (Virginia Surface Water Quality Standards) because the DMRs do not report on all the known contaminants of concern.

In January 2009 EPA utilized the VDEQ Piedmont Region Water Quality Spreadsheet (Piedmont Spreadsheet) to generate water quality parameters for known Site contaminants that data collected from water treatment plant effluent can be compared against to confirm ARAR compliance for the receiving stream. See Table 9, column referred to as “informal performance goals.” Table 9 includes effluent limits for nickel, benzene, bis-2-chloroethyl ether, carbon tetrachloride, 1,2-dichloroethane, tetrachloroethene, trichloroethene, and vinyl chloride. As part of this five-year review, EPA confirmed that the surface water quality standards used to generate the informal performance goals remain current. The informal performance goals allow EPA to monitor the effectiveness of the treatment system and confirm ARAR compliance.