FOURTH FIVE-YEAR REVIEW REPORT FOR ORDNANCE WORKS DISPOSAL AREAS SUPERFUND SITE MONONGAHELA COUNTY, WEST VIRGINIA

SEPTEMBER 2021

Prepared by

U.S. Environmental Protection Agency
Region III
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Linda Dietz, Acting Division Director

September 3, 2021

Date

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LIST OF ABBREVIATIONS & ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
BaP	Benzo(a)pyrene
bgs	Below Ground Surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
FYR	Five-Year Review
ICs	Institutional Controls
MCL	Maximum Contaminant Level
MSL	Mean Sea Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SVOCs	Semivolatile organic compounds
TAL	Target Analyte List
UU/UE	Unlimited Use and Unrestricted Exposure
WVDEP	West Virginia Department of Environmental Protection

I. INTRODUCTION

The U.S. Environmental Protection Agency (EPA), with assistance from the West Virginia Department of Environmental Protection (WVDEP), conducted a five year review (FYR) of Operable Unit One (OU1) at the Ordnance Works Disposal Areas Superfund Site (OWDA or Site) pursuant to Section 121(c) of the Comprehensive Environmental Response Compensation, and Liability Act, as amended (CERCLA), 42 U.S.C. § 9621(c), consistent with section 300.425(f)(4)(ii) of the National Oil and Hazardous Substances Contingency Plan (NCP), 40 C.F.R. § 300.425(f)(4)(ii), and EPA policy.

The purpose of a FYR is to evaluate the implementation and performance of a Superfund remedy to determine if the remedy is and will continue to be protective of human health and the environment. In addition, FYR Reports identify issues, if any, found during the review and document recommendations to address them. The methods, findings, and conclusions of these reviews are documented in FYR Reports such as this one.

This is the fourth FYR for OU1. The review began on October 1, 2020. The triggering action for this statutory review was the completion date of the previous FYR in September 2016. FYRs continue to be performed because hazardous substances and/or pollutants or contaminants remain at OU1 above levels that allow for unlimited use and unrestricted exposure (UU/UE).

This FYR Report documents EPA's assessment of the OU1 remedy selected after OU1 was placed on the CERCLA National Priorities List (NPL) and studied. This FYR does not address

Operable Unit 2 (OU2) of the Site, a non-NPL listed area of approximately 800 acres, which was cleaned up under EPA's CERCLA removal program.[1]

EPA Remedial Project Managers (RPMs) Christopher Hinkle and Debra Rossi led the FYR. Additional participants from EPA included human health risk assessor Nancy Rios-Jafolla, ecological risk assessor Kimberly Hudson, and hydrogeologist Ayowale Ayodele. WVDEP Project Manager Emily Bumgarner also provided input. The Project Coordinator for the potentially responsible party (PRP) group, Adam Carringer, was notified of the FYR.

Site Background

OWDA is located in Monongalia County, West Virginia, on the west bank of the Monongahela River approximately one mile southwest of the city of Morgantown. The Site lies within the Appalachian Plateau Physiographic Province of northern West Virginia. The topography surrounding the Site is rugged and dominated by the Chestnut Ridge – a long anticlinal mountain in the Allegheny Mountain Range located seven miles east of Morgantown. Elevation ranges from 975 feet above mean sea level (MSL) to 1010 feet above MSL at the Site. The Monongahela River is adjacent to the Site at 825 feet above MSL, with a cliff separating the river from the Site. Surface runoff on the Site drains to the river. The land surface of the Site has been altered by activities such as waste pond excavation, backfilling, removal of soil, and grading. Drainage swales that discharge both storm and surface water from the Site extend beyond the fenced perimeter and ultimately discharge to the Monongahela River. The regional groundwater flow direction is also eastward towards the Monongahela River. The City of Morgantown (population 31,000) operates a drinking water intake one mile downstream of the Site.

OU1 occupies approximately 6 acres and contains an abandoned landfill, a former lagoon area, and an area known as the "scraped area." These locations were used for the disposal of wastes containing hazardous substances that were generated by several manufacturing facilities that operated, beginning in the early 1940s, on an approximately 800-acre tract (OU2) to the north of the Site. Wastes in the OU1 lagoon included chrome-plating waste and various tars, oils, and catalyst pellets. Waste materials identified in the former landfill included construction debris, slag, ash, and catalyst pellets. Several residences, one known private drinking water well (upgradient from the Site), natural wetlands, livestock grazing areas, a junk yard, and an active railroad are located within one mile of OU1.

Appendix A lists documents reviewed during this FYR. Appendix B provides a chronology of historic site events. **Figure 1** shows a map of OU1 of the Site.

[1] The Ordnance Works Disposal Areas Site consists of numerous tracts of land containing over 800 acres purchased by E.I. DuPont de Nemours & Company ("DuPont") between 1940-1943 pursuant to agreements between DuPont and the United States. These agreements additionally provided for the construction and operation of manufacturing facilities. A small portion of this land—OU1—was used as a disposal ground. The remaining portion of the Site containing, among other things, the manufacturing facilities, is OU2.

Figure 1. *Detailed map of OU1, located 39.5970, -79.9710. Existing wells available for future sampling are shallow monitoring well MW-6 and deep groundwater well DGW-6. All other wells have been decommissioned, with the exception of DGW-1, which was inadvertently buried by gravel and is located outside OU1. The white dashed line represents the approximate path of the perimeter fence. Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at OU1.*

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Ordnance Works Disposal Areas		
EPA ID: WVD000850404		
Region: 3	**State:** WV	**City/County:** Monongahela

SITE STATUS	
NPL Status: Deleted	
Multiple OUs? No	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA
Author name (Federal or State Project Manager): Christopher Hinkle and Debra Rossi
Author affiliation: EPA Region 3
Review period: 10/1/2020 - 9/12/2021
Date of site inspection: 6/22/2021
Type of review: Statutory
Review number: 4
Triggering action date: 9/12/2016
Due date *(five years after triggering action date)*: 9/12/2021

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

As part of site investigation and feasibility studies completed by EPA in 1989, human health risk assessments were performed to evaluate potential threats to human health as a result of direct and indirect exposure to contaminated media under existing and potential future OU1 Site use conditions. The existing use scenario described in the 1989 focused feasibility study (FFS) considered potential exposure to sediment in leachate seeps and surface water runoff, and consumption of fish potentially impacted by runoff from the OU1 Site. The future use scenario described in the 1989 FFS considered potential exposure to contaminated soil and dust during construction of an industrial facility on the OU1 property.

The risk assessments indicated that soil and sediment at OU1 of the Site contained carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and metals (arsenic, cadmium, copper, and lead) at levels that would present an unacceptable risk to potential future industrial workers at the Site. In addition, arsenic, cadmium, chromium, copper, lead, mercury, and zinc concentrations in sediment at OU1 were found to be potentially harmful to ecological receptors.

Groundwater at and downgradient of the Site is not used as a drinking water source and potential exposure to groundwater at the Site was not evaluated in the human health risk assessments. There were no Maximum Contaminant Level (MCL) exceedances among the groundwater samples collected during the Remedial Investigation or additional groundwater samples collected in 1998 at the request of WVDEP.

Response Actions

In 1981, under the supervision of the West Virginia Department of Natural Resources (currently WVDEP), Rockwell International Corporation excavated the contents of two lagoons at OU1 used from 1970 to 1976 for the disposal of metal plating wastes and disposed of the material at an offsite landfill. The Site was first inspected by the EPA Region III Field Investigative Team (FIT) in 1983. Several drums in the area of the landfill and former lagoons which contained oils contaminated with polychlorinated biphenyls (PCBs), and PCB-contaminated soil in a drum staging area, were removed by Morgantown Industrial Park, Inc., and disposed of at a permitted offsite facility in 1984. The area now known as OU1 of the Site was proposed for inclusion on the NPL on October 15, 1984, and finalized on the NPL on June 10, 1986.

Three Records of Decision (RODs) have been issued for OU1 of the Site. The first, issued in 1988, called for onsite incineration of soil and sediment contaminated with cPAHs and metals; however, that ROD was not implemented due to a request for additional comments from the PRPs. In 1989, following completion of the FFS, EPA issued a second ROD which selected a new preferred remedial action and a contingency remedial action. The preferred and contingency remedial actions included different combinations of excavation and onsite treatment of contaminated soil and sediment using solidification, bioremediation and/or soil washing, and capping. In June 1990, EPA issued an administrative order directing several PRPs to implement the 1989 ROD. Based on the results of treatability studies completed by the PRPs in 1998, EPA

determined that the treatment technologies selected in the 1989 ROD would not achieve the cleanup level for cPAHs within a reasonable time frame or were otherwise deficient. Consequently, the remedy selected in the 1989 ROD was not implemented. Instead, the PRPs performed a second FFS from 1997 to 1998 to identify an effective remedy for OU1. EPA approved the FFS in 1998 and issued the third and final ROD in September 1999. In December 1999, EPA issued an amendment to the 1990 administrative order to require implementation of the remedy selected in the 1999 ROD. The remedy selected in the 1999 ROD is the focus of this FYR.

As stated in the 1999 ROD, no unacceptable risks were identified for the current use exposure scenario evaluated in the human health risk assessments performed for OU1. The remedial action objectives (RAOs) in the 1999 ROD, and the soil and sediment cleanup standards for protection of human health, were established to address potential future use of the OU1 Site. In particular, the RAOs and cleanup levels are based on potential exposure of an "industrial worker" to soil and sediment while working at an industrial facility on the OU1 Site following completion of remediation.

An ecological risk assessment was not performed for the Site. However, EPA's Biological Technical Assistance Group (BTAG) concluded in 1998, following a review of 1988 Remedial Investigation (RI) data, that organic and inorganic contaminants found in surface water and sediment in the streams/drainage swales traversing the OU1 Site were potentially harmful to ecological receptors.

The following RAOs were included in the 1999 ROD to address risks to human health and ecological receptors:

- Eliminate the potential for direct contact with contaminants in surface and subsurface soils and sediment at concentrations that exceed the risk-based cleanup standards in Table 1[2];
- Reduce concentrations of inorganic contaminants in wetland and stream/drainage swale sediments to the cleanup levels in Table 2[3];
- Reduce the potential for organic and inorganic contaminants in surface and subsurface soils and sediments to migrate into groundwater or offsite;
- Reduce or eliminate the threat of direct contact with contaminants in the landfill; and
- Reduce or eliminate the threat of migration of contaminants from the landfill.

The OU1 Site-specific risk-based cleanup standards for protection of human health are listed in **Table 1**, and the standards for protection of ecological receptors are listed in **Table 2**.

[2] The cleanup standard for cPAHs developed for the protection of human health was determined by EPA's BTAG to also be protective of ecological receptors.
[3] Sediment cleanup levels for protection of ecological receptors are background concentrations.

Table 1: Soil/Sediment Cleanup Standards for Protection of Human Health

Contaminant	Cleanup Level (mg/kg)
Total cPAHs	78 (18.2 benzo(a)pyrene [BaP]-equivalent toxicity)[4]
Arsenic	88.8
Cadmium	642
Copper	41,100
Lead	500

Table 2: Sediment Cleanup Standards for Protection of Ecological Receptors

Contaminant	Cleanup Level (mg/kg)
Arsenic	9.62
Cadmium	0.35
Chromium	30.2
Copper	22.7
Lead	31.6
Mercury	ND
Zinc	86.8

The remedy selected in the 1999 ROD includes the following components:

- Excavation and offsite thermal treatment of all soil and/or sediment contaminated with visibly stained tar-like material in the former lagoon area, the scraped area, and onsite streams/drainage swales and wetlands;
- Excavation and consolidation, into the existing landfill, of all soil and/or sediment in the former lagoon area, scraped area, and onsite streams/drainage swales and wetlands with contaminant concentrations exceeding the cleanup standards in Tables 1 and 2;
- Backfilling, regrading, revegetating, and restoration of the excavated areas;
- Construction of a multi-layer RCRA Subtitle C cap atop the landfill;
- Long-term monitoring;
- Maintenance of the existing perimeter fence; and
- Institutional controls to protect the cap and prohibit residential development, recreational use, schools, and child care facilities.

Status of Implementation

The selected remedy was implemented by the PRPs between 2001 and 2003 under EPA's administrative order. Remedy implementation activities are discussed below.

Excavation

Excavation of tar and soil in the former lagoon area, swales, and scraped area began in September 2001 and was completed in August 2002. Tar and tar-like materials were excavated and stockpiled separately from impacted soil.[5] The impacted soil was transported to the onsite landfill for disposal, while the tar and tar-like materials were stockpiled for processing into a fuel

[4] Attainment of the cleanup standard for cPAHs requires that concentrations of total cPAHs not exceed 78 mg/kg and that BaP-equivalent toxicity not exceed 18.2 mg/kg.

[5] Impacted soil did not contain visible tar material but was suspected of having cPAH and metals concentrations above the ROD cleanup levels.

material which was subsequently shipped to a local fluidized bed coal power generation facility, the Grant Town Power Plant (GTPP). The excavation area was divided into cells, and confirmation samples were taken from each wall and floor of the open cells. If confirmation samples showed that the Site-specific cleanup standards had been met, the cells were declared "clean" and approved for backfill. Cells that did not meet the cleanup standard were excavated further. The re-excavated area was then resampled using the process for confirmation sampling. In some cells, excavation continued to a depth of nearly 30 feet below ground surface (bgs) due to the discovery of free-phase oil. In the scraped area, excavation volumes were more than twice the original estimate due to the presence of construction debris encountered during excavation activities. This material did not include any tar or tar-like material and was placed into the landfill.

Free-phase oil was encountered at approximately 12 feet bgs in the former lagoon area in the cracks of the overburden clay and underlying shale. Approximately 10,000 cubic yards (CY) of soil, clay, and shale were excavated to a maximum depth of approximately 30 feet bgs. The oil was tested and found to contain constituents similar to those in creosote or coal tar.

Two mounded areas were discovered near the scraped area and investigated during remedy implementation. Approximately 800 CY of material, primarily soil, was excavated from one of the mounds to recover approximately 50 CY of tar which was processed into fuel. The remaining soil was relocated to the onsite landfill. Test pits in the second mound revealed no tar material and excavation of the mound was determined to be unnecessary.

During excavation of the three drainage swales, tar was found only in Swale 1. Excavation down to six feet bgs was required to remove the tar. Swales 2 and 3 were excavated to a depth of two feet bgs. Also, the existing wetland at the intersection of Swale 3 and the railroad track was excavated. This wetland had received leachate from the former landfill. Excavation of the swales and wetland was discontinued when wall and floor confirmation samples yielded results below the cleanup levels required by the 1999 ROD.

Approximately 45,000 CY of soil and waste material was excavated during the remedial action. An estimated 40,000 CY of impacted soil and debris was placed into the onsite landfill. Approximately 5,000 CY of tar, tar-like material, and coke breeze was mixed with additives and shipped to GTPP. Of the 40,000 total CY placed into the onsite landfill, approximately 27,000 CY of material was excavated from the scraped area and former lagoon area, about 10,000 CY of sediment was removed from the swales, and 3,000 CY of impacted soil was excavated as part of the final work area excavation.

Processing of Tar and Tar-Like Material

Tar and tar-like material was stockpiled and combined with additives, including sawdust, carbon black, and/or coal, to achieve the required 7,580 British Thermal Unit (BTU) value prior to shipment to GTPP for use as a fuel. A total of 14,623 tons of fuel product was shipped between October 2001 and August 2002.

Landfill Cap

During the summer and fall of 2002, the existing landfill material and excavated material and sediment were graded and compacted to meet the final design contour. The final cover system was installed in the spring and summer of 2003 and consists of the following components in descending order: a 24-inch thick vegetated soil cover; a lateral drainage layer; a composite hydraulic barrier comprised of a 40-mil textured high density polyethylene geomembrane and a geosynthetic clay liner; and a passive gas venting system consisting of a stone trench and perforated pipe installed along the ridge (high point) of the cap. A drainage ditch was created around the perimeter of the cap to convey surface water runoff away from the landfill and associated leachate treatment wetlands into Swale 3.

Leachate Collection and Treatment Wetlands

A leachate collection system, consisting of a french-drain collection pipe within a gravel bed, was installed at the toe of the landfill prior to cap construction and buried beneath the finished grade of the landfill subgrade material. The leachate collection pipe discharges to a treatment wetland system consisting of three constructed ponds known as Ponds 1, 2, and 3.

Pond 1 is primarily a settling basin for heavier particulates. It has a limestone bed to maintain an alkaline pH and is covered with organic compost. Leachate containing dissolved metals flows through the limestone, resulting in the formation of insoluble iron hydroxides which settle out. Pond 1 was planted with cattails to maintain aerobic conditions and deter entry by wildlife.

Pond 2 was constructed with a two-foot limestone bed overlaid with two feet of leaf compost mixed with crushed limestone. Water enters at the surface and flows downward to a collection pipe beneath the limestone layer. This pond was designed to support growth of sulfate-reducing bacteria to facilitate the removal of dissolved zinc and copper from the leachate through the formation of insoluble zinc, copper sulfides, and carbonates. Treatment in Pond 2 requires anaerobic conditions and ongoing maintenance is required to ensure that this pond remains free of vegetation.

Pond 3 provides a polishing step by removing any remaining metals and biochemical oxygen demand from the leachate. This shallow pond was planted with cattails to deter use by wildlife. Discharge from Pond 3 is from an elevated pipe directly to Swale 3 and through a culvert running under an operating railroad track. Water exiting the culvert continues to drain down an embankment toward the river floodplains and eventually to the Monongahela River.

Performance criteria for the treatment wetlands are included in the May 2002 Design Report.

Mitigation Wetland

Seven-tenths of an acre of existing wetlands in the vicinity of Swale 3 was lost during remedy implementation. To mitigate this loss, a 1.05-acre mitigation wetland (also referred to as the "replacement" wetland in some EPA documents) was constructed along the Monongahela River

in 2002. The mitigation wetland was inspected twice a year and then annually between 2003 and 2007, consistent with plans approved by EPA.

Post Closure Groundwater Monitoring Network

As part of the remedial action, three bedrock monitoring wells installed during the RI (DGW-02, DGW-03, and DGW-4) were abandoned in accordance with State regulations. In 2003, a new bedrock well (DGW-03R) was installed and six shallow monitoring wells (MW-1, MW-2, MW-3, MW-4, MW-5, and MW-6) were installed in the unconsolidated unit overlying the bedrock. The seven new wells and three additional bedrock wells installed during the RI (DGW-01, DGW-05 and DGW-06) were included in the post closure groundwater monitoring program for the OU1 Site.

Institutional Control (IC) Review

The selected remedy included institutional controls to protect the landfill cap and prohibit residential development, recreational uses, schools, and child care facilities at OU1 of the Site. Institutional controls are summarized below in **Table 3** and Appendix C. These institutional controls were implemented on September 12, 2006 with the recording of an environmental covenant in the office of the Clerk of the County Commission of Monongalia County. Except as approved by EPA and WVDEP, and consistent with the 1999 ROD, the environmental covenant:

- Prohibits digging, trenching, excavation, or any type of intrusive work within the fenced area of OU1, which includes the capped area and the leachate treatment ponds;
- Prohibits construction on the capped area within OU1;
- Prohibits vehicular traffic, with the exception of mowing equipment, on the capped area;
- Prohibits vehicular traffic on, and excavation or intrusive work in proximity to, OU1 drainage swales;
- Prohibits digging, trenching, excavation, footings, or any type of intrusive work extending more than two (2) feet bgs beyond the fenced area of OU1; and
- Restricts use of OU1 to industrial/commercial activities.

In addition, the environmental covenant prohibits installation of potable and non-potable water supply wells on OU1 of the Site property.

Table 3: Summary of Implemented ICs for OU1

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
Soil and Landfill Cap	Yes	Yes	Parcels 7-14B-9 and 7-14B-8	Protect landfill cap and other remedy components, prevent exposure to contaminated materials in the landfill and restrict future Site uses to commercial/ industrial uses	2006 Environmental Covenant

Property Transfer

The parcels upon which OU1 is located were sold by Morgantown Industrial Park Associates to KBG Partners LLC in 2011. As required by the 2006 environmental covenant, the deed conveying title to the property includes provisions requiring the current owner to comply with the land use restrictions specified in the 1999 ROD.

Systems Operation and Maintenance (O&M)

O&M is conducted by the PRPs. The O&M requirements, per the 2012 Revised Operations and Maintenance/Post Closure Plan (O&M Plan), include the following:

- Annual inspection of the landfill cap system, including gas vents and perimeter fencing, treatment wetlands, and associated drainage systems;
- Annual inspection of the former lagoon excavation area;
- Collection of groundwater samples from bedrock monitoring wells DGW-01 and DGW-06 and shallow monitoring wells MW-1 through MW-6 during the spring of 2012 and analylsis of the samples for semivolatile organic compounds (SVOCs) and target analyte list (TAL) metals;[6]
- Collection of groundwater samples from bedrock monitoring wells DGW-01 and DGW-06 in 2014 (year three of the five-year review period) and analysis of the samples for SVOCs and TAL metals;[7] and
- Sampling and analysis of treatment wetland influent and effluent, if present, during the third and fifth year of each five-year review period.

[6] The 2012 Revised Operations and Maintenance/Post Closure Plan states that no further sampling of shallow monitoring wells will be performed following the spring 2012 sampling event.
[7] The 2012 Revised Operations and Maintenance/Post Closure Plan requires no further sampling of bedrock monitoring wells provided the 2014 sample results are consistent with past sample results, which was the case.

Shallow groundwater at OU1 was last monitored in 2012 and bedrock groundwater was last monitored in 2014, consistent with the 2012 Revised Operations and Maintenance/Post Closure Plan. A discussion of post-closure groundwater monitoring at OU1 and EPA's determination that the OWDA landfill is not a significant source of groundwater contamination is included in the Final Close Out Report (EPA, September 2017).

Current and ongoing O&M activities include annual inspection of the landfill cap, fencing, gas vents, signage, monitoring wells, and treatment wetlands; sampling and analysis of treatment wetlands influent and effluent, if present; and cap maintenance once every five years to remove invasive species and woody vegetation. The annual OU1 Site visit was not conducted in 2020, as a COVID-19 precaution, but will be completed by fall of 2021. There have been no major issues with O&M since the 2016 FYR.

III. PROGRESS SINCE THE LAST REVIEW

Issues and Recommendations from Previous Five Year Review

No issues affecting the protectiveness of the remedy were identified during the previous (2016) FYR. **Table 4** includes the protectiveness determination and statement from the 2016 FYR.

Table 4: Protectiveness Determination from the 2016 FYR

OU 1	Protectiveness Determination	Protectiveness Statement
All of OU1	Long-Term Protective	This FYR concludes that the remedy is protective of human health and the environment. The PRPs have implemented the remedy at Operable Unit One in accordance with the remedial action objectives of the 1999 ROD, and it is currently functioning as intended. The landfill has not been found to be a significant source of contamination to the groundwater in the area. The multi-layer RCRA landfill cap was determined to be effective in containing hazardous waste materials, the treatment wetland ponds appeared to be functioning as intended, and OU1 Site access restrictions were found to be functional. Institutional controls are in place to prohibit disturbing the landfill cap, use of groundwater, or non-commercial use of any kind within OU1. O&M including annual inspections, leachate monitoring and treatment wetland monitoring are performed pursuant to the 2012 O&M Plan. Results of this FYR report indicate that the remedial action objectives for the Selected Remedy have been achieved.

Wells Decommissioning

Because the landfill was determined not to be a significant source of contamination to the groundwater in the area and groundwater monitoring was no longer required, five shallow monitoring wells (MW-1 through MW-5) and two bedrock monitoring wells (DGW-03R and DGW-05) were decommissioned in 2017 in accordance with WVDEP regulations, with EPA approval. Shallow monitoring well MW-6 and bedrock monitoring well DGW-06 remain in

place at the Site for future sampling, if determined to be necessary. Upgradient bedrock monitoring well DGW-01 was inadvertently buried when a gas pipeline staging area was installed on property west of the OU1 Site in or around 2016. If upgradient groundwater quality in the bedrock unit needs to be reassessed in the future, it would be necessary to drill another groundwater monitoring well to replace DGW-1.

Evaluation of PFAS

Perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and other per- and polyfluoroalkyl substances (PFAS) are emerging contaminants often associated with metal plating wastes, fire-fighting foams, teflon, and other industrial sources. Soil, sediment, surface water, and groundwater samples at the Site have not been analyzed for PFAS contaminants. However, because metal plating wastes existed at OU1 before they were removed in 1981, EPA reviewed available PFAS test results for surface water in the Monongahela River and the downriver Morgantown public drinking water supply as part of this FYR.

The nearest public drinking water intake on the Monongahela River is at the Morgantown Water Treatment Plant about a mile downstream from the Site. EPA reviewed PFAS test results for four surface water samples collected at the intake between November 2019 and September 2020. The combined PFOA and PFOS concentrations in surface water samples collected during this period ranged from none detected to 3.3 nanograms per liter (ng/L), well below EPA's health advisory of 70 ng/L for PFOA and PFOS. In 2013 and 2014, Morgantown Utility Board sampled treated water for PFAS under EPA's Unregulated Contaminant Monitoring Rule 3 (UCMR3) and PFAS were not detected in the treated water. While groundwater and surface water at OU1 has not been sampled directly, the low concentrations at the Morgantown water intake indicate that PFAS is not an immediate concern.

Final Closeout Report

EPA issued a Final Closeout Report (FCOR) in September 2017, to document that the OU1 Site was eligible for site completion status. As reported in the FCOR, all response actions at the OU1 Site were completed in accordance with the 1999 ROD and institutional controls are in place to ensure long-term protectiveness of the remedy.

Site Deletion

In 2018, EPA and the State of West Virginia, through the WVDEP, determined that all appropriate response actions under CERCLA, other than operation and maintenance, monitoring, and five-year reviews had been completed at OU1 of the Site. OU1 was deleted from the NPL on August 21, 2018.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement and Site Interviews

A public notice was published in the Morgantown Dominion Post on 3/31/2021, notifying the public that a Five Year Review was being conducted and inviting the public to submit any comments to EPA. A copy of the public notice is included in Appendix D of this report. No comments were received. The results of the review and the report will be made available at the Site information repository located at the Morgantown Public Library located at 373 Spruce Street in Morgantown, West Virginia, and online at: https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.scs&id=0302884&doc=Y&colid=30812&region=03&type=SC. Due to a lack of public interest in the Site, and a lack of responses to the aforementioned public notice, no community interviews were conducted as part of this FYR.

Data Review

Per the 2012 O&M Plan, no groundwater samples were collected. Although the O&M plan calls for collection of samples from the influent and effluent of the treatment wetland twice during the FYR period, the volume of leachate entering and leaving the treatment wetlands has been insufficient for sample collection since 2009. Therefore, no data were generated during this five-year review period.

Site Inspection

The inspection of OU1 was conducted on 6/22/2021. The inspection checklist is included as Appendix E. Photos of the inspection are included in Appendix F. In attendance were Remedial Project Managers Christopher Hinkle and Debra Rossi representing EPA, Kimberly Hudson representing EPA as the ecological risk assessor, and Emily Bumgarner representing WVDEP. The purpose of the inspection was to assess the protectiveness of the remedy.

Site inspection participants observed the landfill cap, surrounding fenced-in area, and the leachate treatment ponds at the toe of the landfill cap. All areas are surrounded by locked fences. Some of the fences were overgrown by shrubs and vines, and in one location fallen vegetation has damaged the barbed wire (see photos in Appendix F); however, this damage was minor and should be easily repaired during the next site maintenance by the PRPs, which will be completed in fall 2021. “No trespassing” signage was present, but did not identify the property as a Superfund site; Site contacts were listed on a sign on the entrance gate, but the contacts were out of date and should be updated as a part of this fall’s maintneance by the PRPs.

The landfill cap was generally in good condition and covered in topsoil. Participants noticed one location halfway down the northeast flank of the landfill cap where landscaping fabric was exposed, and the soil was slightly eroded. Some invasive species were observed, including Autumn Olive (*Elaeagnus umbellata*) and Multiflora Rose (*Rosa multiflora*), but the landfill cap was generally well vegetated with mostly native vegetation including flowers and small shrubs.

Some larger woody vegetation was observed around the edges of the landfill cap. This should be addressed through routine maintenance by the PRPs.

Participants found both of the remaining operational monitoring wells – bedrock well DGW-6 and shallow monitoring well MW-6. Both wells appeared to be in good condition. The treatment ponds at the toe of the landfill cap were inspected. Pond 1 was halfway full with water, perhaps owing to recent precipitation. Participants could not determine if leachate was draining into the treatment ponds; the leachate pipe draining into Pond 1 could not be located. However, PRPs located the leachate pipe two weeks earlier, and noted that there was no leachate. It has been suggested that the PRPs more visibly mark the location of the leachate pipe.

Ponds 2 and 3 were dry. All three ponds were vegetated with primarily native vegetation, including willows, grasses, and sedges. Although the O&M plan for the site states that Pond 2 should remain free of vegetation, that is no longer necessary, as Pond 2 is always dry, as documented in the 2016 FYR.

Overall conditions of the cap, treatment ponds, and surrounding Site were protective, but PRPs should take care to follow the maintenance guidelines, including keeping the landfill cap free of woody vegetation, maintaining the perimeter fence, mowing, and addressing other noted observations made during this FYR. Minor maintenance lapses, such as the damage to the permimeter fence, have not yet been addressed because maitnenace fell behind schedule during the Covid-19 pandemic. EPA approved a missed annual inspection by the PRPs in 2020, and has communicated with the PRPs an expectation that maintenance will be completed by fall of 2021.

FYR inspection participants also visited the offsite 1.05-acre mitigation wetland. The mitigation wetland was in good condition, with no noted deficiencies.

V. TECHNICAL ASSESSMENT

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

Remedial Action Performance

Yes. The remedy is functioning as intended by the decision documents. All construction associated with the ROD is complete. The landfill cap prevents direct contact with buried wastes and reduces precipitation infiltration which, in turn, reduces leachate generation and prevents groundwater contamination. The perimeter fence is intact and restricts access, although care should be taken to ensure the perimeter fence is properly maintained when vegetation damages the barbed wire. One deep bedrock well and one shallow monitoring well remain intact at OU1 for potential future sampling if necessary. Since the landfill cap was installed in 2003, the volume of leachate generated by the landfill has declined substantially such that the amount of leachate entering and leaving the treatment wetlands has been insufficient for sample collection since 2009.

The results of this FYR indicate that the remedy is functioning in accordance with design documents. The excavation and capping of contaminated soil and sediments has achieved the RAOs identified in the 1999 ROD and discussed in Section II, above.

System Operations/O&M

Current O&M consists of an annual OU1 Site inspection (security check of property, fence damage, etc.), monitoring the treatment wetlands influent and effluent in the 3rd and 5th year of the five year review periods (if there is flow), and cap maintenance once every five years to remove invasive species and woody vegetation. Regular maintenance such as mowing when needed, removal of silt from drainage areas, and re-vegetation of barren areas should also performed and should continue for as long as necessary. This includes monitoring of the treatment wetlands influent and effluent seepage for possible reemergence of seepage.

Implementation of Institutional Controls

Institutional controls were implemented via an environmental covenant meeting the requirements of the West Virginia Uniform Environmental Covenants Act, WV Code Chapter 22, Article 22B. This environmental covenant, filed in the land records in 2006, limits the OU1 property to commercial and industrial uses, prohibits the use of groundwater, prohibits excavation in the capped area or disturbance of other remedy components, and provides for access by regulatory agencies and the PRPs. These restrictions are effectively preventing exposure to hazardous substances. Fencing and signage are in good condition and there is no evidence of significant trespassing or vandalism at OU1.

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?

Although there have been changes in toxicity criteria, the exposure assumptions, cleanup levels, and RAOs used at the time of remedy selection remain valid. Any changes in toxicity criteria do not affect the protectiveness of the remedy. As part of this FYR, EPA reviewed the soil and sediment cleanup levels specified in the 1999 ROD to determine if they remain protective of future industrial workers potentially exposed to contaminants in soil and sediment via ingestion, dermal contact, and dust inhalation.

EPA's online Regional Screening Level (RSL) calculator was used to calculate risk at the cleanup levels in the 1999 ROD. The calculated excess lifetime cancer risk for an industrial worker was within EPA's acceptable risk management range of 1E-06 to 1E-04 and the noncancer hazard index (HI) based on target organ was less than 1 (see Appendix G). The soil cleanup levels are also protective for an OU1 Site trespasser.

The lead soil cleanup level of 500 ppm continues to be protective for an industrial worker and is below the current commercial/industrial worker soil screening level for lead of 800 ppm.

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 could call into question the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
None.

OTHER FINDINGS

The following are suggestions that were identified during the FYR. These suggestions do not affect current and/or future protectiveness. Although maintenance fell behind schedule during the Covid-19 pandemic, EPA expects that these suggestions will be addressed during the Site inspection/mowing/maintenance to be completed by the PRPs in fall 2021:

- Bedrock monitoring well DGW-01, which was installed during the RI, was inadvertently destroyed in or around 2016. The well should be located and properly decommissioned by the PRPs.
- During the site inspection, it was noted that some of the fences were overgrown by shrubs and vines, and in one location fallen vegetation has damaged the barbed wire. The vegetation should be removed, and the barbed wire should be repaired.
- Site contacts should be updated on the sign at the site entrance gate.
- One location of minor soil erosion along with some invasive species and some larger woody vegation was observed at the landfill cap. Cap maintenance to address these issues should be performed during the planned maintenance by the PRPs in fall 2021. Maintenance fell behind schedule due to Covid-19.
- Consider updating the O&M Plan so that it reflects the current status of Site maintenance activities.
- Consider modifying the O&M Plan so that treatment wetlands influent/effluent sampling is scheduled for springtime when there may be a greater opportunity to obtain samples.
- Consider marking the location of the leachate effluent pipe to be more easily located.

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: OU1	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at the Site is protective of human health and the environment. Exposure pathways that could result in unacceptable risks are being controlled through a landfill cap, a perimeter fence, and signage. Institutional controls are in place to protect the landfill cap and prevent unacceptable uses of the OU1 portion of the Site.	

VIII. NEXT REVIEW

The next five-year review report for OU1 of the Ordnance Works Disposal Areas Superfund Site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

Environmental Protection Agency, Final Close Out Report for Morgantown Ordnance Works Disposal Areas Site, Morgantown, West Virginia, September 2017

Environmental Strategies Corporation, Design Report (Final Submittal), Morgantown Ordnance Works Site Operable Unit No.1, April 3, 2002.

Environmental Protection Agency, Third Five-Year Review Report for Ordnance Works Disposal Areas Superfund Side, Monongalia County, West Virginia, September 12, 2016.

Environmental Strategies Consulting LLC, Remedial Action Report (Final Submittal), Morgantown Ordnance Works Operable Unit No. 1, December 31, 2003.

Olin Corporation, Operation and Maintenance/Post Closure Plan, Morgantown Ordnance Works Operable Unit No. 1, Morgantown, WV, April 13, 2012

Steptoe and Johnson Attorneys at Law, Environmental Covenant, Ordnance Works Disposal Areas Site, Operable Unit No. 1, Morgantown, West Virginia, June 22, 2005

U.S. Army Corps of Engineers, Final Design Report, Morgantown Ordnance Works Operable Unit No. 1, May 23, 2002.

APPENDIX B – SITE CHRONOLOGY.

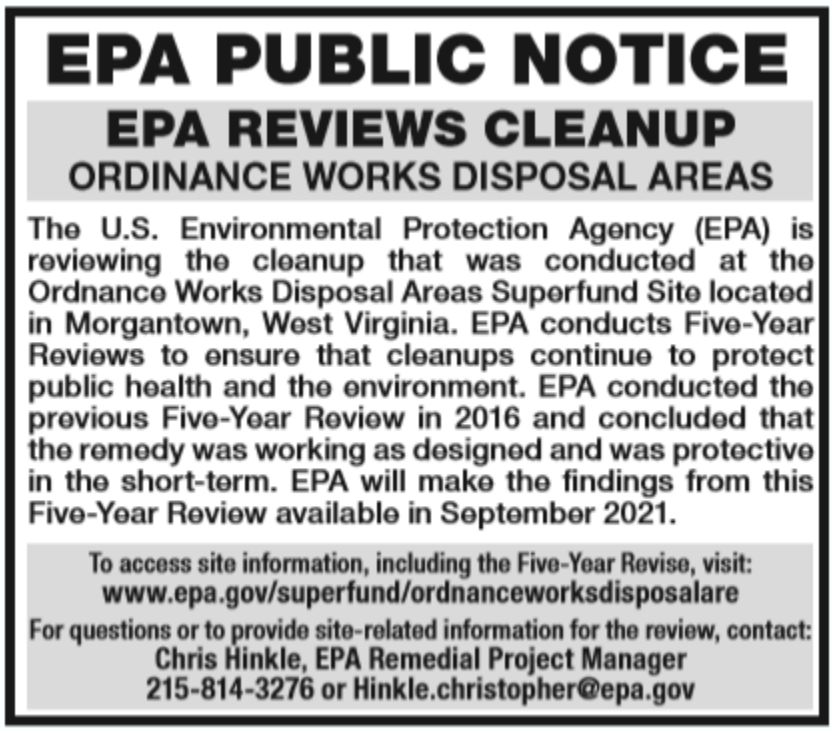
SITE CHRONOLOGY	
1981 PCB Site Discovery. Two lagoons used for chrome plating waste disposal were excavated and disposed of by Rockwell Int'l	**1998** Sept: Focused FS approved by EPA
1982 October: State Site Investigations Sept: Preliminary Assessment	**1999** June: EPA issued Proposed Remedial Action Plan identifying a new remedy for OU1 Sept: Third (final) ROD for OU1 December: EPA issued modified Administrative Order directing the PRPs to implement the remedy selected in the 1999 ROD.
1983 April: EPA Region III Field Investigation Team (FIT) site inspection and sampling of aqueous and soil sediment and air samples	**2001** September: Implementation of the Remedial Action for the 1999 ROD. Feb: Final Design approved
1984 May through June: offsite disposal of PCB-containing drums July: EPA Region III FIT Team Site inspection	**2003** July: Construction effectively completed September: Final Inspection
1986 June: OU1 Site added to National Priorities List	**2006** First Five-Year Review
1988 RI/FS completed. March: First ROD issued	**2011** Second Five-Year Review
1989 Sept: Second ROD issued	**2016** Third Five-Year Review
1990 June: Administrative Order directing the PRPs to implement the 1989 ROD	**2018** OU1 Site Delisted from NPL
1996 Sept: EPA executed Consent Order for a Removal Action with the PRPs for OU2	**2021** Fourth Five-Year Review
1997 March: Treatability Studies for BioremediationFocused FS June: Removal Action complete for OU2	**2026** Projected Fifth Five-Year Review

APPENDIX C – MAP OF INSTITUTIONAL CONTROLS

Map of approximate parcels.

Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the Site.

APPENDIX D – AD NOTICE



EPA PUBLIC NOTICE

EPA REVIEWS CLEANUP
ORDINANCE WORKS DISPOSAL AREAS

The U.S. Environmental Protection Agency (EPA) is reviewing the cleanup that was conducted at the Ordnance Works Disposal Areas Superfund Site located in Morgantown, West Virginia. EPA conducts Five-Year Reviews to ensure that cleanups continue to protect public health and the environment. EPA conducted the previous Five-Year Review in 2016 and concluded that the remedy was working as designed and was protective in the short-term. EPA will make the findings from this Five-Year Review available in September 2021.

To access site information, including the Five-Year Revise, visit:
www.epa.gov/superfund/ordnanceworksdisposalare

For questions or to provide site-related information for the review, contact:
Chris Hinkle, EPA Remedial Project Manager
215-814-3276 or Hinkle.christopher@epa.gov

Ad notice published in print in the Morgantown, WV Dominion Post on Wednesday, March 31st, 2021.

APPENDIX E – SITE INSPECTION CHECKLIST

I. SITE INFORMATION	
Site name: Ordnance Works Disposal Areas	**Date of inspection:** 6/22/2021, 2:00-5:00pm
Location and Region: Morgantown, West Virginia, EPA Region III	**EPA ID:** WVD 980713036
Agency, office, or company leading the five-year review: EPA	**Weather/temperature:** 65-70º F, cloudy, recent rain

Remedy Includes: (Check all that apply)

- X Landfill cover/containment
- X Access controls
- X Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- X Other___Leachate treatment ponds___
- ☐ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls

_____

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____Adam Carringer_____ ___PRP Site Lead___ _____6/15/2021__
   Name Title Date
   Interviewed ☐ at site ☐ at office X by videoconference
   Problems, suggestions; ☐ Report attached

Provided videoconference update on Site status. No concerns. Okayed inviting state counterparts to regular maintenance and inspections if the state requests to be present. Unused wells were decommissioned in 2017, except DGW-1 which could not be located, and was presumably buried by gravel on adjacent property. Performed inspection and maintenance in early June 2021, but was interrupted prematurely; will complete routine maintenance in the fall. Checked leachate drainage pipe into Pond 1 and no leachate was found. Treatment ponds 1, 2, and 3 were empty during his inspection. Annual inspections will continue. Invasive species and deep-rooted trees will be cleared on a 5 year basis. Next check of treatment ponds influent/effluent scheduled for 2024 (the third year of the Five-Year Review cycle, as outlined in the O&M guide). Amenable to changing date of inspections and maintenance, if EPA and/or the state request so.

2. **O&M staff** _____N/A_____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached _____
   _____

3.	**Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply. Agency _____N/A_____ Contact _____ _____ _____ _____ Name Title Date Phone no. Problems; suggestions; □ Report attached _____ _____
4.	**Other interviews** (optional) □ Report attached. N/A

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

☐ O&M manual	☐ Readily available	☐ Up to date	X N/A
☐ As-built drawings	☐ Readily available	☐ Up to date	X N/A
☐ Maintenance logs	☐ Readily available	☐ Up to date	X N/A

Remarks_____

_____

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☐ Up to date X N/A

☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date X N/A

Remarks_____

_____

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date X N/A

Remarks_____

_____

4. **Permits and Service Agreements**

☐ Air discharge permit	☐ Readily available	☐ Up to date	X N/A
☐ Effluent discharge	☐ Readily available	☐ Up to date	X N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	X N/A
☐ Other permits_____	☐ Readily available	☐ Up to date	X N/A

Remarks_____

_____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date X N/A

Remarks_____

_____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date X N/A

Remarks_____

_____

7. **Groundwater Monitoring Records** ☐ Readily available ☐ Up to date X N/A

Remarks_____

_____

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date X N/A

Remarks_____

_____

9. **Discharge Compliance Records**

☐ Air	☐ Readily available	☐ Up to date	X N/A
☐ Water (effluent)	☐ Readily available	☐ Up to date	X N/A

Remarks_____

_____

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date X N/A

Remarks_____

_____

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
X PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☐ Other_____
_____

2. **O&M Cost Records**

☐ Readily available ☐ Up to date
☐ Funding mechanism/agreement in place
Original O&M cost estimate_____ ☐ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost
From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____
_____
_____
_____
_____
_____

V. ACCESS AND INSTITUTIONAL CONTROLS ☐ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks____Gates are secured and signed. Fencing was grown over in vines and shrubs in places. Barbed wire topping the fence just right of the entrance gate (at the top of the landfill cap) was damaged by fallen woody vegetation._____
_____

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A

Remarks__Contact info on the sign on the main entrance gate was out of date and should be updated. No trespassing signs were present but not robust. Signage did not identify the site as a superfund site. ___

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes X No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes X No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) _____Annual inspections_____
Frequency _____Annual_____
Responsible party/agency _____PRPs_____
Contact ___Adam Carringer__ __Site Lead___ __ ABCarringer@olin.com ___
Name Title Contact info

Reporting is up-to-date X Yes ☐ No ☐ N/A
Reports are verified by the lead agency X Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met X Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☐ No X N/A
Other problems or suggestions: ☐ Report attached
_____

2. **Adequacy** X ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks_____ICs are adequate, but care should be taken to make sure the upkeep is complaint with the O&M plan, given that a few minor discrepancies were noted.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map X No vandalism evident
Remarks_____
_____

2. **Land use changes on site** ☐ N/A
Remarks_____
_____

3. **Land use changes off site** ☐ N/A
Remarks_____New paved road was build bordering the edge of the Site on the north edge of the site._____
_____

VI. GENERAL SITE CONDITIONS

A. Roads ☐ Applicable X N/A

1. **Roads damaged** ☐ Location shown on site map X Roads adequate ☐ N/A
Remarks_____
_____

B. Other Site Conditions

Remarks _____

Site inspection participants observed the landfill cap, surrounding fenced-in area, and the leachate treatment ponds at the toe of the landfill cap. All areas are surrounded by locked fences. Some of the fences were overgrown by shrubs and vines, and in one location fallen vegetation has damaged the barbed wire; however, this damage was minor and would be easily repaired. "No trespassing" signage was present but did not identify the property as a Superfund site; Site contacts were listed on a sign on the entrance gate, but the contacts were out of date and should be updated.

The landfill cap was generally in good condition and covered in topsoil. Participants noticed one location halfway down the northeast flank of the landfill cap where landscaping fabric was exposed, and the soil was slightly eroded. Some invasive species were observed, including Autumn Olive (Elaeagnus umbellata) and Multiflora Rose (Rosa multiflora), but the landfill cap was generally well vegetated with mostly native vegetation including flowers and small shrubs. Some larger woody vegetation was observed around the edges of the landfill cap.

Participants found both of the remaining operational monitoring wells – bedrock well DGW-6 and shallow monitoring well MW-6. Both wells appeared to be in good condition. The leachate treatment ponds at the toe of the landfill cap were inspected. Pond 1 was halfway full with water, perhaps owing to recent precipitation. Participants could not determine if leachate was draining into the treatment ponds; the leachate pipe draining into Pond 1 could not be located. Ponds 2 and 3 were dry. All three ponds were vegetated with primarily native vegetation, including willows, grasses, and sedges. Ponds 1 and 3 are supposed to be vegetated. The O&M plan for the site states that Pond 2 should remain free of vegetation to maintain anaerobic conditions, but because Pond 2 is now always dry, mowing Pond 2 is no longer necessary, as documented in the 2016 Five Year Review.

Overall conditions of the cap, treatment ponds, and surrounding Site were protective, but PRPs should take care to follow the guideline of keeping deep-rooted trees and invasive plants off the landfill cap to ensure that the remedy remains protective.

Participants also visited the offsite 1.05-acre mitigation wetland. The mitigation wetland was in good condition.
_____

VII. LANDFILL COVERS X Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map X Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

2. **Cracks** ☐ Location shown on site map X Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____
   _____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
   Areal extent___About 20 sq feet_____ Depth___6 inches___
   Remarks_____Minor erosion and exposed landscaping fabric noted halfway down the landfill cap toward the treatment ponds. Could be covered with topsoil and re-seeded._____
   _____

4. **Holes** ☐ Location shown on site map X Holes not evident
Areal extent_____ Depth_____
Remarks_____
_____

5. **Vegetative Cover** ☐ Grass X Cover properly established X No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks_____Small area of bare ground as noted above under erosion section. Otherwise well-vegetated, but care should be taken to remove invasives and woody vegetation_____
_____

6. **Alternative Cover (armored rock, concrete, etc.)** X N/A
Remarks_____

7. **Bulges** ☐ Location shown on site map X Bulges not evident
Areal extent_____ Height_____
Remarks_____
_____

8. **Wet Areas/Water Damage** X Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent_____
☐ Ponding ☐ Location shown on site map Areal extent_____
☐ Seeps ☐ Location shown on site map Areal extent_____
☐ Soft subgrade ☐ Location shown on site map Areal extent_____
Remarks____A wet area of apparent runoff was found just inside the entrance gate to the Site, but was not on the landfill cover. This runoff was apparently coming from the entrance road, and could be diverted with a ditch to ensure the water does not affect the Site._____
_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map X No evidence of slope instability
Areal extent_____
Remarks_____
_____

B. Benches ☐ Applicable X N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☐ N/A or okay
Remarks_____
_____

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay
Remarks_____
_____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay
Remarks_____
_____

C. Letdown Channels ☐ Applicable X N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1.	**Settlement** ☐ Location shown on site map ☐ No evidence of settlement Areal extent_____ Depth_____ Remarks_____ _____	
2.	**Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation Material type_____ Areal extent_____ Remarks_____ _____	
3.	**Erosion** ☐ Location shown on site map ☐ No evidence of erosion Areal extent_____ Depth_____ Remarks_____ _____	

4. **Undercutting** ☐ Location shown on site map X No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____
_____

5. **Obstructions** Type_____ X No obstructions
☐ Location shown on site map Areal extent_____
Size_____
Remarks_____
_____

6. **Excessive Vegetative Growth** Type_____
X No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent_____
Remarks_____
_____

D. Cover Penetrations ☐ Applicable ☐ N/A

1. **Gas Vents** ☐ Active X Passive
X Properly secured/locked XFunctioning ☐ Routinely sampled X Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance
☐ N/A
Remarks____No evidence of damage. No monitoring is required, pursuant to O&M plan._____
_____

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance X N/A
Remarks_____
_____

3. **Monitoring Wells** (within surface area of landfill)
X Properly secured/locked X Functioning ☐ Routinely sampled X Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____No longer sampled, pursuant to O&M plan, but available for future sampling if necessary._____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance X N/A
Remarks_____
_____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed X N/A
Remarks_____
_____

E. Gas Collection and Treatment ☐ Applicable X N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition☐ Needs Maintenance
   Remarks_____
   _____

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition☐ Needs Maintenance
   Remarks_____
   _____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐ Good condition☐ Needs Maintenance ☐ N/A
   Remarks_____
   _____

F. Cover Drainage Layer X Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
   Remarks_____Inspection participants could not find outlet pipe, but the outlet ("leachate") pipe was inspected two weeks prior to the Five Year Review inspection, and no leachate was found. This is consistent with the past few years, when no leachate has been found._____
   _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
   Remarks_____
   _____

G. Leachate Treatment Ponds X Applicable ☐ N/A Comments: only Pond 1 (out of 3) had water.

1. **Siltation** Areal extent_____ Depth_____ X N/A
   ☐ Siltation not evident
   Remarks_____
   _____

2. **Erosion** Areal extent_____ Depth_____ X Erosion not evident
   Remarks_____
   _____

3. **Outlet Works** X Functioning ☐ N/A
   Remarks_____
   _____

4. **Dam** X Functioning ☐ N/A
   Remarks_____
   _____

H. Retaining Walls ☐ Applicable X N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks_____
   _____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks_____
   _____

I. Perimeter Ditches/Off-Site Discharge X Applicable ☐ N/A

1. **Siltation** ☐ Location shown on site map X Siltation not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
   X Vegetation does not impede flow
   Areal extent_____ Type_____
   Remarks_____Ditch at the toe of the landfill is overgrown with grasses, but does not impede flow._____
   _____

3. **Erosion** ☐ Location shown on site map X Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

4. **Discharge Structure** X Functioning ☐ N/A
   Remarks_____
   _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable X N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____
   _____

2. **Performance Monitoring** Type of monitoring_____
   ☐ Performance not monitored
   Frequency_____☐ Evidence of breaching
   Head differential_____
   Remarks_____
   _____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☐ Applicable X N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable X N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks_____
_____
_____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition☐ Needs Maintenance
Remarks_____
_____

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition☐ Requires upgrade ☐ Needs to be provided
Remarks_____
_____

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable X N/A

1. **Collection Structures, Pumps, and Electrical**
☐ Good condition☐ Needs Maintenance
Remarks_____
_____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition☐ Needs Maintenance
Remarks_____
_____

3. **Spare Parts and Equipment**
☐ Readily available ☐ Good condition☐ Requires upgrade ☐ Needs to be provided
Remarks_____
_____

C. Treatment System ☐ Applicable X N/A

1. **Treatment Train** (Check components that apply)
   ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☐ Air stripping ☐ Carbon adsorbers
   ☐ Filters_____
   ☐ Additive (*e.g.*, chelation agent, flocculent)_____
   ☐ Others_____
   ☐ Good condition ☐ Needs Maintenance
   ☐ Sampling ports properly marked and functional
   ☐ Sampling/maintenance log displayed and up to date
   ☐ Equipment properly identified
   ☐ Quantity of groundwater treated annually_____
   ☐ Quantity of surface water treated annually_____
   Remarks_____
   _____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ☐ N/A ☐ Good condition☐ Needs Maintenance
   Remarks_____
   _____

3. **Tanks, Vaults, Storage Vessels**
   ☐ N/A ☐ Good condition☐ Proper secondary containment ☐ Needs Maintenance
   Remarks_____
   _____

4. **Discharge Structure and Appurtenances**
   ☐ N/A ☐ Good condition☐ Needs Maintenance
   Remarks_____
   _____

5. **Treatment Building(s)**
   ☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair
   ☐ Chemicals and equipment properly stored
   Remarks_____
   _____

6. **Monitoring Wells** (pump and treatment remedy)
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ All required wells located ☐ Needs Maintenance ☐ N/A
   Remarks_____
   _____

D. Monitoring Data

1. Monitoring Data
   ☐ Is routinely submitted on time ☐ Is of acceptable quality

2. Monitoring data suggests:
   ☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks_____
_____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

Not applicable.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

_____

See comments in the main text of the Five Year Review.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

_____

See comments in the main text of the Five Year Review.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

_____

No indicators of potential remedy problems.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

_____

See comments in main text of Five Year Review.

APPENDIX F – SITE INSPECTION PHOTOS

Minor erosion and exposed landscaping fabric

No trespassing signage

Condition of vegetation of landfill cap

Damage to perimeter fence from fallen woody vegetation

Site-specific
Composite Worker Soil Inputs

Variable	Composite Worker Soil Default Value	Form-input Value
A (PEF Dispersion Constant)	16.2302	16.2302
A (VF Dispersion Constant)	11.911	11.911
A (VF Dispersion Constant - mass limit)	11.911	11.911
B (PEF Dispersion Constant)	18.7762	18.7762
B (VF Dispersion Constant)	18.4385	18.4385
B (VF Dispersion Constant - mass limit)	18.4385	18.4385
City (PEF Climate Zone) Selection	Default	Default
City (VF Climate Zone) Selection	Default	Default
C (PEF Dispersion Constant)	216.108	216.108
C (VF Dispersion Constant)	209.7845	209.7845
C (VF Dispersion Constant - mass limit)	209.7845	209.7845
foc (fraction organic carbon in soil) g/g	0.006	0.006
F(x) (function dependent on U_m/U_t) unitless	0.194	0.194
n (total soil porosity) L_{pore}/L_{soil}	0.43396	0.43396
ρ_b (dry soil bulk density) g/cm ^{3}	1.5	1.5
ρ_b (dry soil bulk density - mass limit) g/cm ^{3}	1.5	1.5
PEF (particulate emission factor) m ^{3}/kg	1359344438	1359344438
ρ_s (soil particle density) g/cm ^{3}	2.65	2.65
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	93.77
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18	68.18
Q/C_{vol} (g/m^2-s per kg/m^3 - mass limit)	68.18	68.18
A_s (PEF acres)	0.5	0.5
A_s (VF acres)	0.5	0.5
A_s (VF mass-limit acres)	0.5	0.5
AF_w (skin adherence factor - composite worker) mg/cm ^{2}	0.12	0.12
AT_w (averaging time - composite worker)	365	365
BW_w (body weight - composite worker)	80	80
ED_w (exposure duration - composite worker) yr	25	25
EF_w (exposure frequency - composite worker) day/yr	250	250
ET_w (exposure time - composite worker) hr	8	8
THQ (target hazard quotient) unitless	0.1	0.1

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Site-specific
Composite Worker Soil Inputs

Variable	Composite Worker Soil Default Value	Form-input Value
IRS_w (soil ingestion rate - composite worker) mg/day	100	100
LT (lifetime) yr	70	70
SA_w (surface area - composite worker) cm^2/day	3527	3527
TR (target risk) unitless	1.0E-06	1.0E-06
T_w (groundwater temperature) Celsius	25	25
$Theta_a$ (air-filled soil porosity) L_{air}/L_{soil}	0.28396	0.28396
$Theta_w$ (water-filled soil porosity) L_{water}/L_{soil}	0.15	0.15
T (exposure interval) s	819936000	819936000
T (exposure interval) yr	26	26
U_m (mean annual wind speed) m/s	4.69	4.69
U_t (equivalent threshold value)	11.32	11.32
V (fraction of vegetative cover) unitless	0.5	0.5

Site-specific

Composite Worker Regional Screening Levels (RSL) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o $(mg/kg\text{-}day)^{-1}$	SF_o Ref	IUR $(ug/m^3)^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1	0.03	0.6
Benzo[a]pyrene	50-32-8	Yes	No	Organics	1.00E+00	I	6.00E-04	I	3.00E-04	I	2.00E-06	I	1	0.13	1
Cadmium (Diet)	7440-43-9	No	No	Inorganics	-		1.80E-03	I	1.00E-03	I	1.00E-05	A	0.025	0.001	1
Copper	7440-50-8	No	No	Inorganics	-		-		4.00E-02	H	-		1	-	1

Site-specific

Composite Worker Regional Screening Levels (RSL) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)	K_d \ (cm^3/g)	HLC (atm-m^3/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia} \ (cm^2/s)
-	-	-	2.90E+01	-	-		888.15	PHYSPROP	1673	CRC89	INORGANIC	-
-	1.62E-03	5.87E+05	-	4.57E-07	1.87E-05	PHYSPROP	768.15	PHYSPROP	969.27	EPA 2001 Fact Sheet	PAH	2.55E-02
-	-	-	7.50E+01	-	-		1038.15	PHYSPROP	2291	YAWS	INORGANIC	-
-	-	-	3.50E+01	-	-		2868.15	PHYSPROP	5123	YAWS	INORGANIC	-

Site-specific

Composite Worker Regional Screening Levels (RSL) for Soil

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = DWSHA; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

D_{iw} \ (cm^2/s)	D_A \ (cm^2/s)	Particulate Emission Factor (m^3/kg)	Volatilization Factor (m^3/kg)	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL THQ=0.1 (mg/kg)	Dermal SL THQ=0.1 (mg/kg)	Inhalation SL THQ=0.1 (mg/kg)	Noncarcinogenic SL THI=0.1 (mg/kg)	Screening Level (mg/kg)
-	-	1.36E+09	-	3.63E+00	1.72E+01	3.88E+03	3.00E+00	5.84E+01	2.76E+02	8.93E+03	4.79E+01	3.00E+00 ca*
6.58E-06	-	1.36E+09	-	3.27E+00	5.94E+00	2.78E+04	2.11E+00	3.50E+01	6.37E+01	1.19E+03	2.22E+01	2.11E+00 ca*
-	-	1.36E+09	-	-	-	9.26E+03	9.26E+03	1.17E+02	6.90E+02	5.95E+03	9.82E+01	9.82E+01 nc
-	-	1.36E+09	-	-	-	-	-	4.67E+03	-	-	4.67E+03	4.67E+03 nc

Site-specific
Composite Worker Risk for Soil

Chemical	SF_o (mg/kg-day) $^{-1}$	SF_o Ref	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	ABS	RBA	Soil Saturation Concentration (mg/kg)	S (mg/L)	K_{oc} \ (cm^3/g)	K_d \ (cm^3/g)
Arsenic, Inorganic	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1	0.03	0.6	-	-	-	2.90E+01
Benzo[a]pyrene	1.00E+00	I	6.00E-04	I	3.00E-04	I	2.00E-06	I	1	0.13	1	-	1.62E-03	5.87E+05	-
Cadmium (Diet)	-		1.80E-03	I	1.00E-03	I	1.00E-05	A	0.025	0.001	1	-	-	-	7.50E+01
Copper	-		-		4.00E-02	H	-		1	-	1	-	-	-	3.50E+01
*Total Risk/HI	-		-		-		-		-	-	-	-	-	-	-

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Site-specific
Composite Worker Risk for Soil

Chemical	HLC (atm-m³/mole)	Henry's Law Constant Used in Calcs (unitless)	H` and HLC Ref	Normal Boiling Point BP (K)	BP Ref	Critical Temperature TC (K)	TC Ref	Chemical Type	D_{ia}\ (cm^2/s)	D_{iw}\ (cm^2/s)	D_A\ (cm^2/s)	Particulate Emission Factor (m^3/kg)
Arsenic, Inorganic	-	-		888.15	PHYSPROP	1673	CRC89	INORGANIC	-	-	-	1.36E+09
Benzo[a]pyrene	4.57E-07	1.87E-05	PHYSPROP	768.15	PHYSPROP	969.27	EPA 2001 Fact Sheet	PAH	2.55E-02	6.58E-06	-	1.36E+09
Cadmium (Diet)	-	-		1038.15	PHYSPROP	2291	YAWS	INORGANIC	-	-	-	1.36E+09
Copper	-	-		2868.15	PHYSPROP	5123	YAWS	INORGANIC	-	-	-	1.36E+09
**Total Risk/HI*	-	-		-		-			-	-	-	-

Site-specific
Composite Worker Risk for Soil

Chemical	Volatilization Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk	Dermal Risk	Inhalation Risk	Carcinogenic Risk	Ingestion HQ	Dermal HQ	Inhalation HQ	Noncarcinogenic HI
Arsenic, Inorganic	-	8.88E+01	2.44E-05	5.17E-06	2.29E-08	2.96E-05	1.52E-01	3.22E-02	9.94E-04	1.85E-01
Benzo[a]pyrene	-	1.82E+01	5.57E-06	3.06E-06	6.55E-10	8.63E-06	5.19E-02	2.86E-02	1.53E-03	8.20E-02
Cadmium (Diet)	-	6.42E+02	-	-	6.93E-08	6.93E-08	5.50E-01	9.31E-02	1.08E-02	6.53E-01
Copper	-	4.11E+04	-	-	-	-	8.80E-01	-	-	8.80E-01
**Total Risk/HI*	-	-	*3.00E-05*	*8.23E-06*	*9.29E-08*	*3.83E-05*	*1.63E+00*	*1.54E-01*	*1.33E-02*	*1.80E+00*

Inhalation Unit Risk Toxicity Metadata

Chemical	CASNUM	Chemical Type	Inhalation Unit Risk (µg/m ^{3})$^{-1}$	Toxicity Source	EPA Cancer Classification	Inhalation Unit Risk Tumor Type	Inhalation Unit Risk Target Organ	Inhalation Unit Risk Species
Arsenic, Inorganic	7440-38-2	Inorganics	0.0043	IRIS	A	Cancer	Lung	Human
Benzo[a]pyrene	50-32-8	Organics	0.0006	IRIS	Carcinogenic to humans	Squamous cell neoplasia in the larynx, pharynx, trachea, nasal cavity, esophagus, and forestomach.	Gastrointestinal, Respiratory	Hamster
Cadmium (Diet)	7440-43-9	Inorganics	0.0018	IRIS	B1	Lung, trachea, bronchus cancer deaths	Lung	Human
Copper	7440-50-8	Inorganics	-					

Inhalation Unit Risk Method	Inhalation Unit Risk Route	Inhalation Unit Risk Treatment Duration	Inhalation Unit Risk Study Reference	Inhalation Unit Risk Notes
Absolute-risk linear model	NA	NA	Brown and Chu 1983a,b,c, Lee-Feldstein 1983, Higgins 1982, Enterline and Marsh 1982	NA
Time-to-tumor dose-response model with linear extrapolation from the POD (BMCL10HED) associated with 10% extra cancer risk.	NA	NA	Thyssen et al. 1981	NA
Two stage; only first affected by exposure; extra risk	NA	NA	Thun et al. 1985	NA

Oral Slope Factor Toxicity Metadata

Chemical	CASNUM	Chemical Type	Oral Slope Factor (mg/kg-day) $^{-1}$	Toxicity Source	EPA Cancer Classification	Oral Slope Factor Tumor Type	Oral Slope Factor Target Organ	Oral Slope Factor Species	Oral Slope Factor Method	Oral Slope Factor Route
Arsenic, Inorganic	7440-38-2	Inorganics	1.5	IRIS	A	Skin cancer	Skin	Human	Time- and dose-related formulation of the multistage model	NA
Benzo[a]pyrene	50-32-8	Organics	1	IRIS	Carcinogenic to humans	forestomach, esophagus, tongue, and larynx tumors	Gastrointestinal	Mouse	Time-to-tumor dose-response model with linear extrapolation from the POD (BMDL10HED) associated with 10% extra cancer risk.	NA
Cadmium (Diet)	7440-43-9	Inorganics	-							
Copper	7440-50-8	Inorganics	-							

Oral Slope Factor Treatment Duration	Oral Slope Factor Study Reference	Oral Slope Factor Notes
NA	Tseng, 1977, Tseng et al., 1968	NA
NA	Kroese et al. 2001 and Beland and Culp 1998	NA

Oral Chronic Toxicity Metadata

Chemical	CASNUM	Chemical Type	Chronic Oral Reference Dose (mg/kg-day)	Toxicity Source	Oral Chronic Reference Dose Basis	Oral Chronic Reference Dose Confidence Level	Oral Chronic Reference Dose Critical Effect	Oral Chronic Reference Dose Target Organ	Oral Chronic Reference Dose Modifying Factor	Oral Chronic Reference Dose Uncertainty Factor	Oral Chronic Reference Dose Species
Arsenic, Inorganic	7440-38-2	Inorganics	0.0003	IRIS	NOAEL: 0.0008 mg/kg-day	Medium	Hyperpigmentation, keratosis and possible vascular complications	Skin and blood	1	3	Human
Benzo[a]pyrene	50-32-8	Organics	0.0003	IRIS	BMDL 1SD (HED): 0.092	Medium	Neurobehavioral changes	Developmental	1	300	Rat
Cadmium (Diet)	7440-43-9	Inorganics	0.001	IRIS	NOAEL: 0.01 mg/kg-day	High	Significant proteinuria	Urinary	1	10	Human
Copper	7440-50-8	Inorganics	0.04	HEAST	LOAEL: 5.3 mg	NA	Irritation	Gastrointestinal system	NA	NA	Human

Oral Chronic Reference Dose Route	Oral Chronic Reference Dose Study Duration	Oral Chronic Reference Dose Study Reference	Oral Chronic Reference Dose Notes
NA	NA	Tseng, 1977, Tseng et al., 1968	NA
NA	NA	Chen et al. 2012	NA
NA	NA	US EPA 1985	NA
Oral	Single dose	U.S. EPA. 1987. Drinking water criteria document for Copper. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Drinking Water, Washington, DC	Current drinking water standard of 1.3 mg/L. DWCD (1987) concluded toxicity data were inadequate for calculation of an RfD for copper.

Inhalation Chronic Toxicity Metadata

Chemical	CASNUM	Chemical Type	Chronic Inhalation Reference Concentration (mg/m³)	Toxicity Source	Inhalation Chronic Reference Concentration Basis	Inhalation Chronic Reference Concentration Confidence Level	Inhalation Chronic Reference Concentration Critical Effect	Inhalation Chronic Reference Concentration Target Organ	Inhalation Chronic Reference Concentration Modifying Factor	Inhalation Chronic Reference Concentration Uncertainty Factor
Arsenic, Inorganic	7440-38-2	Inorganics	0.000015	CALEPA	NA	NA	NA	NA	NA	NA
Benzo[a]pyrene	50-32-8	Organics	2E-6	IRIS	LOAEL: 0.0046	Low/medium	Decreased embryo/fetal survival	Developmental	1	3000
Cadmium (Diet)	7440-43-9	Inorganics	1E-5	ATSDR	NOAEL: 0.0001 mg/m3	NA	No effects	Renal	NA	3
Copper	7440-50-8	Inorganics	-							

Inhalation Chronic Reference Concentration Species	Inhalation Chronic Reference Concentration Route	Inhalation Chronic Reference Concentration Study Duration	Inhalation Chronic Reference Concentration Study Reference	Inhalation Chronic Reference Concentration Notes
NA	NA	NA	NA	NA
Rat	NA	NA	Archibong et al. 2002	NA
Human	Renal	NA	Buchet et al. 1990; Jarup et al. 2000; Suwazono et al. 2006	calculated from the 95% lower confidence limit of the urinary cadmium level associated with a 10% increased risk of low molecular weight proteinuria (0.5 ug/g creatinine) estimated from a meta-analysis of select environmental exposure studies.