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FIFTH FIVE-YEAR REVIEW REPORT FOR LOWRY LANDFILL SUPERFUND SITE ARAPAHOE COUNTY, COLORADO

Prepared by

U.S. Environmental Protection Agency
Region 8
Denver, Colorado

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LIST OF ABBREVIATIONS AND ACRONYMS

3DVA	3-dimensional data visualization
ARAR	Applicable or Relevant and Appropriate Requirement
BHC	Hexachlorocyclohexane
CAG	Community Advisory Group
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIC	Community Involvement Coordinator
COC	Contaminant of Concern
DADS	Denver Arapahoe Disposal Site
DBF	DADS Blower/Flare
DCA	Dichloroethane
DCE	Dichloroethylene
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
EMSI	Engineering Management Support, Inc.
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
ft bgs	Feet Below Ground Surface
FTPA	Former Tire Pile Area
FS	Feasibility Study
FS3	Flare Station 3
FYR	Five-Year Review
GAC	Granular Activated Carbon
gpm	Gallons per Minute
GTEP	Gas-to-Energy Plant
GWMP	Groundwater Monitoring Plan
HEM	Hexane Extractable Material
IC	Institutional Control
LCL	Lower Confidence Limit
LFG	Landfill Gas
LNAPL	Light Non-Aqueous Phase Liquid
MCL	Maximum Contaminant Level
Metro	Metro Water Recovery previously known as Metro Wastewater Reclamation District
µg/L	Microgram per Liter
$\mu g/m^3$	Micrograms per Cubic Meter
mg/kg	Milligram per Kilogram
mg/L	Milligram per Liter
MW	Monitoring Well
NAPL	Non-Aqueous Phase Liquid
NERA	North End Response Actions
NBBW	North Boundary Barrier Wall
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not Detected
NPL	National Priorities List
NTES	North Toe Extraction System
O&M	Operation and Maintenance
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene

pCi/L	Picocuries per Liter
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
POC	Point of Compliance
POTW	Publicly Owned Treatment Works
PQL	Practical Quantitation Limit
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	Regional Screening Level
SWMP	Stormwater Monitoring Plan
SWRA	Surface Water Removal Action
TAG	Technical Assistance Grant
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TT	Treatment Technique
UCL	Upper Confidence Limit
UU/UE	Unlimited Use and Unrestricted Exposure
VIAM	Vapor Intrusion Model
VOC	Volatile Organic Compound
WSD	Work Settling Defendant
WTP	Water Treatment Plant

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy 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 FYR 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 FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii)) and considering the EPA policy.

This is the fifth FYR for the Lowry Landfill Superfund Site (the Site). The triggering action for this statutory review is the completion date of the previous FYR. The FYR has been prepared because hazardous substances, pollutants or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site consists of six operable units (OUs). This FYR Report addresses all six OUs. Table 1 lists the OUs.

Table 1: Site OUs

OU #	Media
1	Shallow groundwater and subsurface liquids
2	Landfill solids
3	Landfill gas
4	Soils
5	Surface water and sediments
6	Deep groundwater

The EPA remedial project manager (RPM), Linda Kiefer, led the FYR. Participants included the EPA Community Involvement Coordinator (CIC), Lisa McClain-Vanderpool; Jeannine Natterman, Colleen Brisnehan and Dustin McNeil from the Colorado Department of Public Health and Environment (CDPHE); Lynn Robbio Wagner with the Tri-County Health Department (Tri-County); and Alison Cattani and Treat Suomi from the EPA support contractor Skeo. The Work Settling Defendants (WSDs) were notified of the start of this FYR. The review began on 4/1/2021.

The EPA has determined in this FYR that the response actions at the Lowry Landfill Superfund Site are protective of human health and the environment. The response actions and institutional controls in place at the Site prevent impacts to human health and the environment. The area around the Site consists of ongoing landfilling operations as well as residential areas. While response actions are ongoing, institutional controls, including deed restrictions, water rights, zoning, and ordinances, are ensuring nearby residential areas are not impacted by the Site contamination.

Site Background

Approximately 500 acres in size, the Site is in Arapahoe County, Colorado, near the eastern boundary of the City of Aurora (Figure C-1). From the mid-1960s to 1980, the City and County of Denver operated the landfill, which accepted liquid and solid municipal and industrial wastes, including sewage sludge disposed of in unlined waste pits or land applications. In 1980, Waste Management of Colorado (Waste Management) took over operation of the landfill. At that time, waste disposal on Site was restricted to municipal waste and later asbestos waste. Municipal solid waste disposal activities ceased in 1990 and a four-foot soil cover was installed over the landfill

unit. Asbestos disposal occurred northwest of the landfill and is ongoing northeast of the landfill (Figure 1).[1] Landfilling operations contaminated soil, groundwater, surface water and sediment with hazardous substances. Additionally, gases from buried wastes contaminated the air spaces in subsurface soil. The Site currently consists of remedy components as well as a Gas-to-Energy Plant (GTEP) which treats gas and provides electricity to the surrounding communities. The Denver Arapahoe Disposal Site (DADS), an operating municipal solid waste landfill, forms the north and east boundaries of the Site (Figure C-1). The City and County of Denver is the sole owner of the DADS parcels as well as parcels directly adjacent to the Site on all sides. Solid waste disposal operations are expected to continue at DADS for the next several decades. The areas west of the Site and north and west of DADS continue to see increased residential development (Figure C-1 in Appendix C).

The topography of the Site includes gently rolling hills, with a gentle slope on the north half of the Site and a topographic high on the south half of the Site caused by past landfilling activities. The Site is in the Murphy Creek drainage system. An unnamed tributary to Murphy Creek is on Site. This unnamed creek is typically dry, only containing water during significant precipitation or snow melt events. The unnamed creek extends from the toe of the landfill in the middle portion of the Site through the northern part of the Site. Murphy Creek is located immediately east of the Site (Figure 1). Groundwater beneath and near the Site exists in two major systems, each with two aquifer zones. The hydrostratigraphic units at the Site include (from shallowest to deepest) (Figure C-2 in Appendix C):

- Shallow groundwater:
    - Alluvium/weathered Dawson (0 to 60 feet below ground surface [ft bgs]).
    - Unweathered Dawson (30 to 120 ft bgs).
- Separation layer (confining unit, not an aquifer)
- Deep groundwater:
    - Upper Denver (120 to 210 ft bgs).
    - Lignite Layer (200 to 350 ft bgs).

The definition for OU1 (shallow groundwater and subsurface liquids) beneath the Site refers to the weathered Dawson Formation as the shallow groundwater unit; however, shallow groundwater north of the Site is in the Denver Formation because the Dawson Formation and the separation layer are absent in this area.[2] Groundwater flow within the shallow and deep groundwater systems is predominantly to the north, although the shallow groundwater system also shows components of flow to the east, west and south. Groundwater rights on Site and immediately off Site are owned by the City and County of Denver. Groundwater use on Site and immediately off Site is restricted to monitoring and remediation purposes. Two private residential wells (screened interval depths of 357 ft bgs to 545 ft bgs and 400 to 600 ft bgs respectfully) are located about a mile north of the Site, along East Jewell Avenue. Tri-County, in collaboration with the WSDs, has sampled these wells since 2006. No site-related contamination has been detected. The only additional downgradient wells identified in the 2017 5-mile survey are abandoned or used for monitoring purposes. Surveys are conducted every five years; the next is scheduled in 2022.[3] There are no other wells in the vicinity of the Site that could act as an exposure pathway. Appendix A lists the resources referenced during the development of this FYR Report. Appendix B provides the Site's chronology of events.

[1] Current asbestos landfilling is not part of the Superfund site.
[2] This information is based on the current understanding of hydrogeology beneath and north of the Site as included in the 2021 Conceptual Site Model. The Record of Decision (ROD) evaluated OUs 1 and 6 collectively beneath the Site. Because the change in formation at the surface north of the Site does not fundamentally alter the sitewide remedy, the EPA determined the OU definitions do not need to be changed.
[3] Additional details can be found on page 23 of this FYR Report.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Lowry Landfill		
EPA ID: COD980499248		
Region: 8	State: Colorado	**City/County:** Unincorporated Arapahoe County/Arapahoe
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the Site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA		
Author name: Linda Kiefer with contractor support provided by Skeo		
Author affiliation: EPA Region 8 and Skeo		
Review period: 4/1/2021 – 9/6/2021		
Date of site inspection: 5/10/2021		
Type of review: Statutory		
Review number: 5		
Triggering action date: 9/28/2017		
Due date *(five years after triggering action date)*: 9/28/2022		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

Various investigations took place from the mid-1970s to 1984. In 1984, the EPA listed the Site on the Superfund program's National Priorities List (NPL). From 1984 to 1993, investigations evaluated the nature and extent of contamination, assessed potential risks to human and ecological receptors, and evaluated remedial alternatives. In 1994, the EPA issued the Unilateral Administrative Order for Remedial Design/Remedial Action (RD/RA) to 34 potentially responsible parties (PRPs). The City and County of Denver, Waste Management and Chemical Waste Management, Inc. (Chemical Waste Management), agreed to perform the RD/RA on behalf of all the PRPs.

WSDs completed a series of remedial investigations and feasibility studies (RI/FSs) in 1993 to determine the nature and extent of contamination. The EPA identified the primary threats to human health and the environment as exposure to and contamination from landfill gas, waste-pit liquids, drums, groundwater and contaminated seepage in the unnamed creek drainage. Other threats included contaminated landfill solids, soils and sediments, and non-aqueous phase liquids (NAPLs). The baseline risk assessments were conducted as part of the RI/FSs for each media. The primary threats to human health were from ingestion of groundwater and soil, inhalation of gas

and dust, and dermal contact with all media under future residential, commercial/industrial and recreational use. An ecological assessment was also conducted as part of the RI/FSs and the results indicated potential exposure pathways for terrestrial wildlife including ingestion of vegetation, sediment, surface water and dermal contact with soil, sediment and surface water. The contaminants of concern (COCs) at the Site include volatile organic compounds (VOCs), semi-volatile organic compounds, metals, pesticides, polychlorinated biphenyls (PCBs), methane and other gases. Table 2 lists site COCs as identified in the 1994 Record of Decision (ROD) and the other decision documents, conceptual site models or monitoring plans, by media.

Table 2: Site COCs by Media

Landfill gas			
1,1,1-trichloroethane	2-methylnaphthalene	chloromethane	pentachlorophenol
1,1,2,2-tetrachloroethane	acetone	chromium	phenol
1,1,2-trichloroethane	acrylonitrile	cis-1,2-dichloroethene	selenium
1,1-dichloroethane	aniline	dieldrin	styrene
1,1-dichloroethene	arsenic	dioxins/furans	tetrachloroethylene (PCE)
1,2,4-trichlorobenzene	barium	ethylbenzene	toluene
1,2-dichlorobenzene	benzene	gamma bhc	trans-1,2-dichloroethene
1,2-dichloroethane (DCA)	beryllium	heptaclor	trichloroethylene (TCE)
1,2-dichloropropane	cadmium	lead	vanadium
1,4-dichlorobenzene	carbon disulfide	manganese	vinyl chloride
1-butanone	carbon tetrachloride	methylene chloride	xylenes
4,4- Dichloro-diphenyltrichloroethane	chlorobenzene	nickel	
	chloroethane	PCBs	
2-hexanone	chloroform		
Subsurface gas			
1,1,1-trichloroethane	chloroform		
1,1-DCA	ethylbenzene		
1,1-dichloroethene	methane		
1,2-DCA	methylene chloride		
2-butanone	toluene		
benzene	xylenes		
carbon disulfide	vinyl chloride		
Groundwater			
1,1,1-trichloroethane	benzene	iron	
1,1,2,2-tetrachloroethane	bromodichloromethane	methylene chloride	
1,1,2-trichloroethane	bromoform	naphthalene	
1,1-DCA	cadmium	nitrate	
1,1-dichloroethene	carbon tetrachloride	nitrite	
1,2-DCA	chlorobenzene	PCE	
1,2-dichloropropane	chloroform	toluene	
1,4-dioxane	cis-1,2-dichloroethene	trans-1,2 dichloroethene	
acetone	dibromochlormethane	TCE	
arsenic	ethylbenzene	vinyl chloride	
Surface soil and surface water			
2,3,7,8-tetrachlorodibenzodioxin	chloroform	mercury	
	chromium	nickel	
aluminum	cobalt	PCB-1260 (aroclor-1260)	
arsenic	copper	silver	
barium	cyanide	toluene	
beryllium	lead	vanadium	
cadmium	manganese	zinc	

Notes:
COCs are listed in the 1994 ROD and the other decision documents, conceptual site models and monitoring plans.

Response Actions

Prior to selecting a final remedy, several interim actions were conducted at the Site. In 1984, the City of Denver entered into an Administrative Order on Consent with the EPA for the design, construction and operation of a groundwater control and treatment system at the northern boundary of the Site (Table 4). Between 1989 and 1990, a drum removal action at the Site consisted of re-packaging and removing drums of highly contaminated liquids and solids. In 1990, all municipal solid waste landfill operations stopped, and Waste Management constructed a soil cover over the 200-acre main landfill (Figure 1). In 1991, the City and County of Denver and Waste Management/Chemical Waste Management entered into an Administrative Order on Consent with the EPA to construct and operate a surface water removal action (SWRA) that consisted of upgrading the existing water treatment plant (WTP) and constructing a collection system in the unnamed creek to segregate contaminated groundwater from uncontaminated surface water. The SWRA, completed in 1992, prevents contaminated groundwater from contacting surface water within the unnamed creek streambed. Permeable material was placed beneath the streambed and covered with a clay layer. The permeable material provides a pathway for groundwater to flow to the North Boundary Barrier Wall (NBBW) without contacting surface water (Figure 1).

The EPA selected the sitewide remedy in the Site's 1994 Record of Decision (ROD), with minor ROD modifications in 1995, 1996, 2001, 2002 and 2006, a ROD Amendment in 2005, and three Explanations of Significant Difference (ESDs) in 1995, 1997 and 2007. The EPA identified remedial action objectives (RAOs) for each medium in the 1994 ROD (Table 3).

Table 3: Site RAOs

RAOs - Groundwater (OUs 1 and 6)
o Prevention of exposure to humans and the environment (through ingestion, inhalation or dermal absorption) from liquids (either groundwater or waste-pit liquids) containing contaminants in excess of the performance standards. o Prevention of migration of contaminants beyond the compliance boundary in excess of the performance standards. o Prevention of horizontal migration of dissolved groundwater contaminants off Site and to surface waters. o Prevention of vertical migration of dissolved groundwater contaminants beyond the lignite layer. o Prevention of movement of NAPLs beyond the compliance boundary and minimization of movement of NAPLs. o Minimization of infiltration and leachate production in waste-pit source area.
RAOs - Landfill Solids (OU2)
o Protection of human health and the environment from direct contact or ingestion of landfill solids or soils intermingled with landfill solids containing contaminants. o Protection of humans from inhalation of volatilized contaminants from landfill solids or soils intermingled with landfill solids and from inhalation of contaminated airborne particulate matter from soils or landfill solids that exceed performance standards. o Minimization of the production and migration of leachate, from landfill solids or soils intermingled with landfill solids, to the saturated zone and groundwater. o Minimization of the migration of soils intermingled with solids, caused by erosion or entrainment by wind or water. o Prevention of off-site migration of landfill solids and soils intermingled with solids into other media. o Protection of human health and the environment from direct contact with or ingestion of leachate that exceeds the performance standards for shallow groundwater and subsurface liquids. o Prevention of off-site migration of leachate or infiltration into other media.
RAOs - Landfill Gas (OU3)
o Protection of human health from inhalation of landfill gases in excess of the performance standards. o Protection of human health and the environment from explosion hazards associated with landfill gases. o Prevention of off-site migration of landfill gas or migration to other media.
RAOs - Soils, Surface Water and Sediments (OUs 4 and 5)
o Protection of human health and the environment from direct contact or ingestion of soils, surface water and sediments containing contaminants that exceed the performance standards.

- Protection of human health from inhalation of volatilized contaminants from the soils, surface water or sediments and from inhalation of contaminated airborne particulate matter, from soils or sediments, that exceeds performance standards.
- Minimization of the production and migration of contaminated surface water to the saturated zone and groundwater.
- Minimization of the migration of soils and sediments by erosion or entrainment by wind or water.
- Minimization of migration of contaminated surface water off Site and into other media.

The 1994 ROD specified containment, collection, treatment and monitoring to address Site contamination. The groundwater remedy (OU1 and OU6) in the 1994 ROD includes a slurry wall, a groundwater extraction trench with treatment (called the North Toe Extraction System, or NTES) and a subsurface clay barrier (the NBBW), as well as contingency measures. The groundwater monitoring performance standards were updated in the 1995 ESD and the 2002 minor ROD modification. The 1997 ESD changed the WTP discharge to the publicly-owned treatment works (POTW).

The landfill solids remedy (OU2) includes a landfill cover and waste-pit excavation and treatment in the Former Tire Pile Area (FTPA). The FTPA remedy was changed from excavation and off-site disposal to on-site treatment in the 1997 ESD. The remedy was changed again in the 2005 ROD Amendment to in-situ treatment of the south waste pit. The 2006 minor ROD modification specified on-site disposal in a Corrective Action Management Unit. A description of the final remedy implemented at the FTPA is provided in Table 4.

The landfill gas remedy (OU3) includes a landfill gas extraction with conversion to usable energy. The air quality performance standards were amended in the 1995 ESD, and the air quality performance standard for 1,1-dichloroethylene (DCE) was revised in the 2001 minor ROD modification. The 1994 ROD selected "No action" for soils, surface water and sediments (OU4 and OU5) based on the interim removal actions completed at the Site. The 1994 ROD also required construction of wetlands to mitigate loss of wetlands areas from SWRA construction activities within unnamed creek. The wetland species were changed in the 1996 minor ROD modification. The 1994 Sitewide remedy also includes long-term groundwater monitoring and institutional controls. Table 4 provides a summary of the remedy components.

The EPA provided the Site-specific groundwater and gas performance standards in the 1994 ROD and updated them in the 1995 ESD and 2002 minor modification to the ROD. The subsurface gas performance standards were further revised in 2015 and 2018 and incorporated in the Landfill Gas Compliance Monitoring Plan revisions. These performance standards are listed in Appendix I, Table I-1 (groundwater) and Appendix J, Table J-1 (subsurface gas).

After the installation of the SWRA, contaminant transport to surface water was eliminated in the area of the SWRA. Therefore, surface water standards were selected to be applied in the event of a treatment system malfunction and subsequent discharge to surface water. The ROD indicated that periodic surface water runoff sampling was required but did not specify performance standards. Interim standards were provided in the 1996 Interim Compliance Monitoring Plan. In 2008, a Stormwater Monitoring Plan (SWMP) replaced the Interim Compliance Monitoring Plan, and the performance standards were replaced with stormwater water discharge monitoring requirements, which do not specify performance criteria. In 2020, the WSDs determined, and the EPA concurred, that Murphy Creek is not classified for water supply use, therefore eliminating the applicability of human health-based surface water quality standards.

Status of Implementation

Table 4 and Figure 1 provide a brief summary of the main remedial actions by OU. The EPA provided a full description of each remedial action in the 2012 FYR Report. The EPA certified construction completion of the Site's remedy in September 2006.

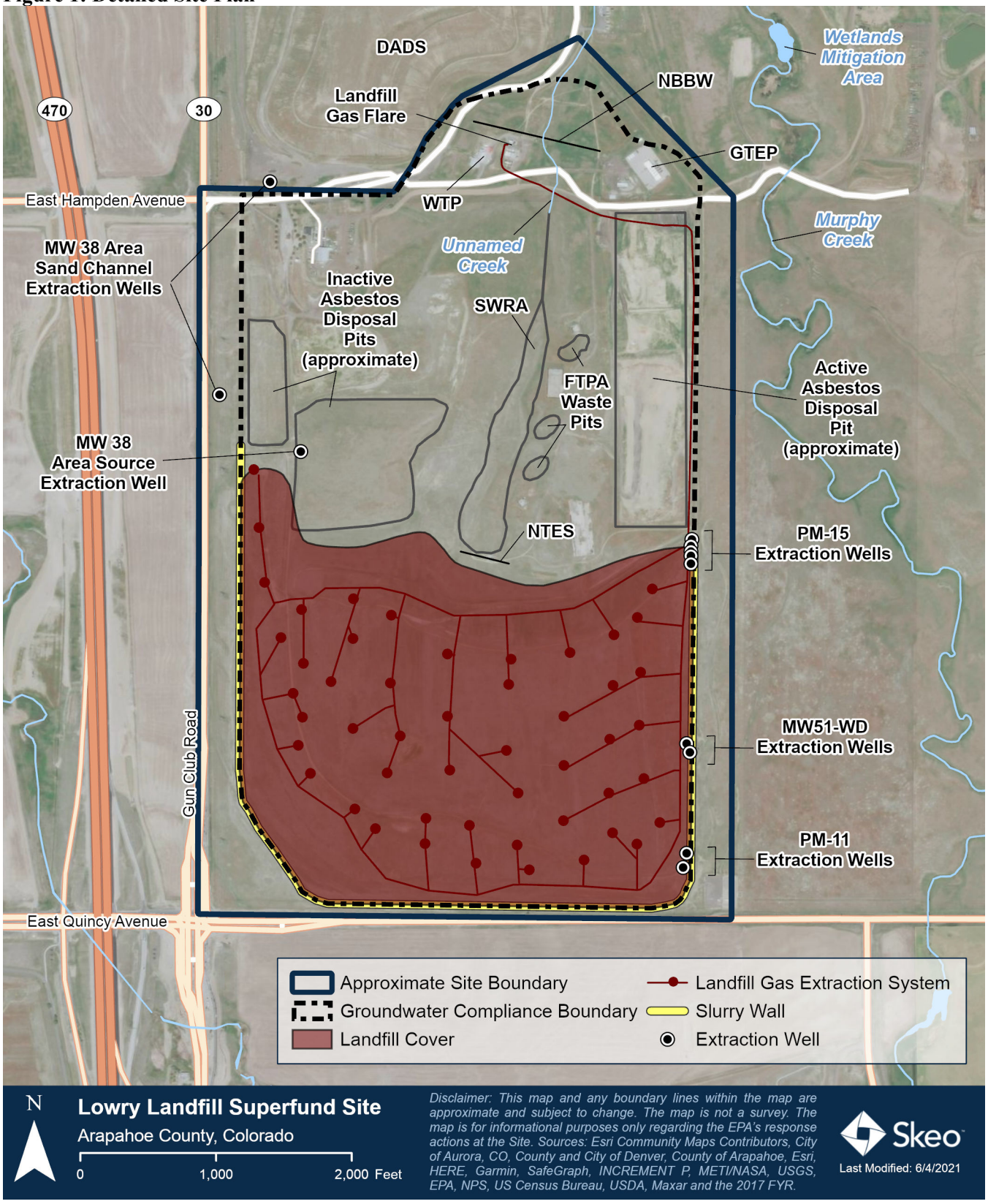
Table 4: Summary of the Main Remedy Components by OU

OU	Media	Year of Completion	Remedy Component
1 and 6	Shallow Groundwater, Subsurface Liquids and Deep Groundwater	1984	North Boundary Barrier Wall (NBBW): The original NBBW was completed in 1984 and was composed of a subsurface barrier clay wall, a collection drain and a sump located upgradient of the wall, a downgradient injection trench and wells, and the WTP and discharge line. Prior to 2000, water extracted from the NBBW sump was treated in the WTP and discharged to the injection trench. Since 2000, the extracted water has been treated and discharged to the sanitary sewer system subject to the provisions of an industrial pretreatment permit. The discharged water is further treated at a POTW. Water from the POTW is discharged to the South Platte River. Also beginning in 2000, potable water from the East Cherry Creek Valley Water and Sanitation District has been pumped into the injection trench. In 2018, potable water injections ceased. The cessation of potable water injections is described in Section III of this FYR Report.
		1998	Perimeter Slurry Wall: An 8,800-foot subsurface clay/soil wall encloses the west, south and east sides of the main landfill in the southern part of the Site. The slurry wall was designed to deflect or limit the flow of clean weathered Dawson aquifer groundwater into the Site from the south and to limit outward flow of potentially affected groundwater to the east and west of the waste-pit sources.
		1998	North Toe Extraction System (NTES): A 300-foot groundwater collection trench at the north toe of the main landfill that intercepts groundwater flow beneath the unnamed creek drainage at the toe of the landfill and transports it via an underground pipeline to the WTP on Site.
		2000	Water Treatment Plant (WTP): The original WTP was replaced in 2000. A biological treatment system was added in 2004-2005 to treat 1,4-dioxane. In 2018-2019, the WTP discharge was upgraded from a maximum discharge of 37 gallons per minute (gpm) to 75 gpm. See the Progress Since the Previous Review section of this FYR Report for more information (Section III).
		2002	MW38 Gradient Control Contingency Measure: Two extraction wells were installed to pump contaminated groundwater from the MW38 sand channel (see additional description below).
		Ongoing	Contingency Measures: The 1994 ROD included contingency measures if, during operation of the groundwater remedy, contaminant levels exceed performance standards at the point of compliance (POC) boundary. Contingency measures could include more engineering components, continued monitoring, re-evaluation of remedial technologies or additional institutional controls. The WSDs are conducting contingency measures at the Site to: • Control source associated with the MW38 sand channel. • Induce inward hydraulic gradients across the Perimeter Slurry Wall. • Remove VOCs from groundwater outside the Perimeter Slurry Wall. • Remove VOCs from groundwater north of the NBBW. More information is provided in the narrative below this table, under Contingency Measures.
2	Landfill Solids	1992	Landfill Cover: A minimum 4-foot and up to 10-foot compacted clay soil cover was placed over the landfill mass, minimizing

OU	Media	Year of Completion	Remedy Component
			infiltration of precipitation and reducing potential leachate and impacts to groundwater.
		1999	North Face Cover: An additional 2-foot compacted clay soil cover was installed on the 29-acre north face of the landfill mass.
		1999	Former Tire Pile Area (FTPA): Wastes from the middle pit were treated on Site to Toxicity Characteristic Leaching Procedure (TCLP)[4] non-hazardous levels, then buried in a clay-lined and capped disposal cell on top of the existing landfill. In-situ treatment of the south waste pit removed all the waste mass that could be reasonably removed (about 50% of the total). All the waste mass from the north waste pit that could be safely removed was also removed. The north and south pits were then covered.
3	Landfill Gas (LFG)	1996	Landfill Gas Collection and Treatment System: The landfill gas remedy consists of 64 extraction wells in the landfill area and 21 subsurface gas monitoring probes positioned outside of the landfill area. Treatment consists of a combination of an enclosed flare, a candlestick flare and a landfill GTEP. The GTEP began operation in 2008. Two flare candlesticks were installed: DADS Blower/Flare (DBF) in 2010 and Flare Station 3 (FS3) in 2015.
4 and 5	Soils, Surface Water and Sediment	2005	No Action: Consisted of maintenance on the cover areas, periodic monitoring of surface water runoff, operation and maintenance of the SWRA and NBBW, and construction of 0.87 acres of wetlands that were disturbed during the construction of the SWRA.

[4] TCLP is a chemical analysis procedure used to determine whether there are hazardous elements present in waste based on toxicity. The test involves a simulation of leaching through a landfill to determine the mobility of organic and inorganic chemicals in the waste.

Figure 1: Detailed Site Plan



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In the 1994 ROD, the EPA established POCs for the landfill gas remedy and the groundwater remedy at locations inside the Site boundaries (as shown on Figure 1). Contamination exists outside the POC boundary due to the following reasons:

- The EPA positioned the POC boundary in areas with known contamination. The Perimeter Slurry Wall is located to encompass source areas as well as to avoid existing utilities and roadways. Consequently, at some locations outside of the Perimeter Slurry Wall, shallow groundwater containing concentrations of certain chemicals above the established performance standards is present beyond the POC boundary.
- Contaminated groundwater flowed through the area of the NBBW before the barrier wall was put in place.
- Contaminated surface water, which could infiltrate into the underlying soil and groundwater, flowed through the NBBW both before and after the NBBW was constructed, up until the time the SWRA was constructed in 1992.
- The WTP initially was designed with a focus on removal of VOCs and, therefore, was not designed to remove 1,4-dioxane, nitrate or other constituents. Until 2000, the treated water that unknowingly contained 1,4-dioxane was injected into the recharge trench immediately downgradient of the NBBW, which resulted in the 1,4-dioxane contamination that is being addressed by the North End response actions (described below).

These circumstances resulted in residual contamination outside of the containment remedy that have complicated evaluations of remedy effectiveness. In accordance with the ROD, if performance standards are exceeded at the POC boundary, contingency measures must be implemented. More information on the implemented contingency measures and the North End response actions is provided below.

Contingency Measures

The 1994 ROD included provisions for contingency measures if contaminant levels exceed performance standards at compliance boundaries during operation of the groundwater remedy. Contingency measures implemented at the Site include extraction wells installed at the Perimeter Slurry Wall, the MW38 sand channel, and the NBBW. Extracted groundwater is sent to the WTP. The effectiveness of these contingency measures is monitored in accordance with the Groundwater Monitoring Plan (GWMP) and reported semiannually in the Site Status Reports. Table 5 and Figure 1 list and show the contingency measures operating at the Site, with the exception of the North End Response Action contingency measure (Figure C-5 in Appendix C).

Table 5: Contingency Groundwater Extraction Systems at the Site

System	Type	Description
MW38 Sand Channel		
MW38-WD	Gradient control	Groundwater extraction from three extraction wells (MW38-1028N-256E, MW38-170S-140W and MW38-825S-445E). Two wells, MW38-1028N-256E and MW38-170S-140W, are positioned in the sand channel to induce an inward (convergent) radial flow to the MW38 sand channel. The third well, MW38-825S-445E, is a voluntary well installed by the WSDs to minimize contaminant contribution to the sand channel.
Perimeter Slurry Wall		
PM-11	Gradient control	Groundwater extraction from two internal wells (PM-11I and BM-11I-100N).
MW51-WD	Gradient control	Groundwater extraction from three internal wells (MW51I-WD-15N, MW51I-WD and MW51I-WD-35S).
	VOC removal outside the wall	Air sparge at one well (MW70-WD).
PM-15	Gradient control	Groundwater extraction from five internal and one northern well.

	VOC removal outside the wall	Air sparge at one well (BM-15N5).
NBBW		
B-326-WD/GW-109	1,4-dioxane removal	Groundwater extraction from NBBW-IW-3, MW113-EW-1, B-321, and MW-113-UD.
MW-77	1,4-dioxane removal	Groundwater extraction from three extraction wells: MW-102-WD, MW-77-EW-1 and MW-98-WD.

MW38 Sand Channel

In 2002, two extraction wells were installed to pump contaminated groundwater from the MW38 sand channel, located north of the western portion of the slurry wall (Figure 1). In 2005, the MW38 area gradient control contingency measures were completed. The MW38 channel is a natural feature that, due to higher hydraulic conductivity of the channel sand deposits, results in convergent flow into the channel. The gradient control measure for the MW38 sand channel was implemented in response to groundwater contamination that was detected in the weathered Dawson monitoring well MW38-WD prior to the first FYR Report for the Site. The extraction wells are described in Table 5. The performance of the MW38 sand channel contingency measures was recently assessed and the system's effectiveness in achieving remedy component specific measures of effectiveness was documented in the 2021 Effectiveness Evaluation Report for MW38, NTES, and North End Response Actions (NERA) (see Data Review section of this FYR Report for additional details).

Perimeter Slurry Wall

The Perimeter Slurry Wall effectiveness monitoring well network is used to determine if contingency measures are needed at the Perimeter Slurry Wall (Figure 1). Contingency measures implemented at the slurry wall include extraction wells that were installed for gradient control or VOC removal outside of the wall. Air sparging systems have been installed in some of the wells to treat VOCs in groundwater. The air sparging systems operate intermittently to reduce concentrations of VOCs to below the performance standards. Three extraction systems have been installed around the slurry wall (Table 5). The performance of the slurry wall was assessed in 2021 and the results indicate the slurry wall is effective in achieving RAOs. See the Data Review section of this FYR report for additional information.

NBBW

Contingency measures augment groundwater extraction and containment at the NBBW. In 2020, WSDs developed, and the EPA approved, a Containment System Evaluation Plan to conduct a detailed characterization of groundwater flow in the NBBW area, and to evaluate the ability of the NBBW components to contain contaminated groundwater effectively and prevent contaminant migration beyond the compliance boundary. The resulting Containment System Evaluation, described further in the Data Review section of this FYR Report, determined that the NBBW is containing contaminated groundwater effectively, preventing migration of 1,4-dioxane.

North End Response Actions

Prior to 2000, groundwater extracted from the NBBW area was treated using air stripping and granular activated carbon (GAC). These technologies remove VOCs but not 1,4-dioxane. WTP effluent was injected north of the NBBW between 1984 and 2000 and contained 1,4-dioxane because no treatment process was in place to remove it. In 2005, the WSDs brought a new WTP online process that treats organic constituents, including 1,4-dioxane. Investigation of the lateral and vertical limits of 1,4-dioxane downgradient of the NBBW began in 2005 when the 1,4-dioxane performance standard decreased from 200 micrograms per liter (µg/L) to 6.1 µg/L. The current performance standard is 0.9 µg/L.

In 2007, a comprehensive sampling program was conducted downgradient of the NBBW, including off Site to the north in Sections 31, 30, 24 and 19. Results of those investigations showed that 1,4-dioxane occurred above its performance standard in both the NBBW area as well as in groundwater up to 2.4 miles downgradient.
As a result of these investigations, the WSDs implemented the North End response actions in accordance with the 2015 Groundwater Monitoring Plan and Response Action Work Plans, which include contingency procedures outlined in the ROD. The response actions consist of extraction wells and associated collection piping in five

extraction areas (Areas 1, 2, 3, 4 and 5) and the WTP. The operating objectives of the North End response actions are to:

- Reduce off-site migration of 1,4-dioxane.
- Reduce the mass of 1,4-dioxane north of the Site.
- Bring into compliance any monitoring well showing exceedance(s) of the performance standard.

Extracted groundwater from the off-site wells in Areas 1, 2 and 3 (Figure C-13 in Appendix C) is pumped to the WTP, blended with treated effluent from the WTP, and pumped to the POTW sanitary sewer. Extracted groundwater from the on-site wells in North End Areas 4 and 5 (Figure C-13 in Appendix C) is pumped to the WTP for treatment, blended with untreated off-site well groundwater, then pumped to the sanitary sewer. The WTP effluent and the North End off-site groundwater are monitored in accordance with the discharge permit (Industrial Discharge Permit No. 2360-5-1A [through December 2019] and Permit No. 2360-6 [January 2020 to present] issued by the Metro Wastewater Reclamation District now known as Metro Water Recovery (Metro)).

The WSDs completed a North End Response Area Investigation from 2018 to 2020. The North End Investigation is described in the Data Review Section of this FYR report. Monitoring of wells within the North End Response Area is ongoing. The performance of the North End Response Area was assessed and the system's effectiveness in achieving remedy component specific response action objectives was documented in the 2021 Effectiveness Evaluation Report for MW38, NTES, and NERA (see Data Review section of this FYR Report for additional details).

Institutional Control (IC) Review

The 1994 ROD required both on Site and off Site institutional controls. A summary of the required institutional controls in the 1994 ROD follows:

- On-site institutional controls shall include, but are not limited to, prohibitions on all groundwater well construction and use not necessary for remedy implementation and monitoring of the selected remedy, prohibitions on access, and prohibitions on activities and land use not connected with design, construction and implementation and monitoring of the selected Sitewide remedy.
- Off-site institutional controls shall include, but not be limited to, prohibition of all off-site activities in the vicinity of the Site that would interfere or be incompatible with, or that would in any way reduce or impair the effectiveness or protectiveness of, the selected Sitewide remedy.

In 2005, the WSDs finalized the Institutional Controls Plan, which summarizes the implementation, administration, and maintenance of institutional controls for the Site and surrounding property. Table 6 provides a full summary of the implemented institutional controls, and Figure 2 shows an overview of institutional controls in place on Site and off Site. The implemented institutional controls offer a multi-layered protection that eliminates exposure pathways both on Site and off Site. The institutional controls depicted on Figure 2 represent a summation of individual ICs that limit property use and groundwater use in the vicinity of Lowry Landfill. Also depicted on Figure 2 are areas that have been annexed into the City of Aurora (shown in green) where drinking water supply is delivered to households via piped-in city water and where new private drinking water wells cannot be installed.

In accordance with the 2005 Institutional Controls Plan, the WSDs perform a well survey every five years for wells within a half-mile of the Site. The most recent well survey took place in 2017. The 2017 well survey was extended 5 miles north of the Site, along the Murphy Creek drainage basin. Figure C-3 in Appendix C shows the locations of these wells, the search area north of the Site and the approximate boundaries of the 1,4-dioxane plume. Four wells are located within the footprint of the 1,4-dioxane plume. One well is immediately next to the plume. Two of these wells were identified as private domestic water supply wells in 2006 and thus were sampled and analyzed for 1,4-dioxane. 1,4-Dioxane was not detected in either well in 2017 or in any samples collected from the wells since sampling began in 2006. These wells are screened from 357 to 545 ft bgs and 400 to 600 ft bgs, respectively.

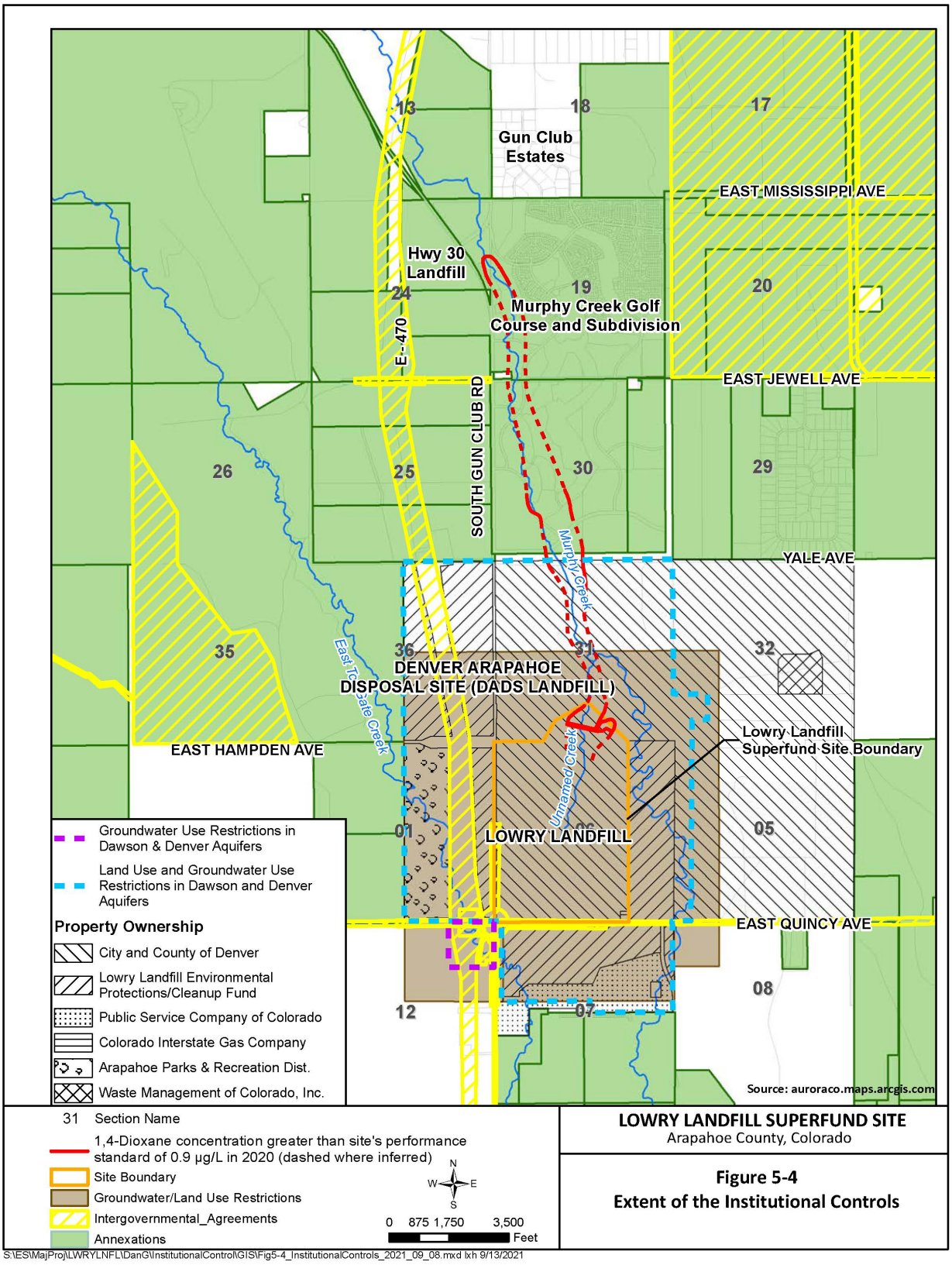
Table 6: Summary of Implemented Institutional Controls (ICs)

Media, Engineered Controls, and Areas That Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	IC Objective	Title of IC Instrument Implemented and Date (or planned)
On-Site – Land Use	Yes	Yes	Restricts land use to landfilling, monitoring or remediation activities; prohibit structures and excavation except as necessary for landfill purposes, monitoring or remediation; limit access.	Amended On-Site Restrictive Covenants (2002)
			Restricts land use and land development over closed landfills.	Zoning (City of Aurora and Arapahoe County), Certificate of Designation (Arapahoe County)
			Restricts residential use in areas affected by aircraft activity from Buckley Air National Guard.	Buckley Restriction (2001)
			Gives prospective purchaser of the property notice of the Superfund Site.	Federal Lien (1989)
			Restricts the use of land, surface water and groundwater on the Denver-owned Lowry Landfill property.	Denver Executive Order No. 97 (1991)
On-Site – Groundwater Use	Yes	Yes	Prohibits new wells for any use except monitoring or remediation purposes.	Amended On-Site Restrictive Covenants (2002)
			Construction and maintenance of wells that penetrate more than one aquifer must be constructed to prevent potential cross-contamination.	Denver Water Rights, District Court, Water Division I, Colorado Case numbers are 98CW377, 98CW378, 98CW379 and 98CW380 (1998)

Media, Engineered Controls, and Areas That Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	IC Objective	Title of IC Instrument Implemented and Date (or planned)
			Ensures that no water provider may include the landfill in its service area and obtain the right to use the groundwater underlying the landfill.	Notice of Non-consent for the Withdrawal of Water (1991) – Administrative orders filed with the Arapahoe County Clerk and the Denver City Clerk
			Restricts the use of land, surface water and groundwater on the Denver-owned Lowry Landfill property.	Denver Executive Order No. 97 (1991)
Off-Site – Land use	No	No	Restricts land use to landfilling, monitoring or remediation activities and industrial, commercial, utility, agricultural, open space and recreation uses.	Zoning and Declaratory Statement of Environmental Covenants (2001)
			Requires sellers of real property within a quarter-mile of the south or west exterior boundary to give notice to purchasers that the property is located near a Superfund Site.	Aurora Development Restriction (Ordinance No. 93-98, 1993)
			Restricts land use to open lands, park, recreational uses, farming, grazing, construction and operation of water supply wells, and certain defined transportation improvements, including but not limited to rail, light rail and public highway.	Deed Restrictions (1994 and 1995)
Off-Site Groundwater Use	Yes	Yes	Restricts use of groundwater.	Denver Water Rights, District Court, Water Division I, Colorado Case numbers are 98CW377, 98CW378, 98CW379 and 98CW380 (1998)

Media, Engineered Controls, and Areas That Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	IC Objective	Title of IC Instrument Implemented and Date (or planned)
			Restricts groundwater use from the Dawson and Denver aquifers.	Zoning and Declaratory Statement of Environmental Covenants (2001)
			Restricts drilling or use of wells and development or construction in the Dawson aquifer.	Aurora Development Restriction (Ordinance No. 93-98, 1993)
			Prohibits development or use of independent water system for any purpose, except as approved in writing by the director of water, including domestic and irrigation uses, within the city limits.	Aurora Code Section 138-154

Figure 2: Institutional Control Map



Source: 2021 Final Conceptual Site Model.

Systems Operations/Operation and Maintenance (O&M)

Operation and maintenance (O&M) activities are performed at the NTES, the WTP, groundwater monitoring and extraction wells, the landfill gas collection and treatment system, the NBBW system, and landfill covers. These activities are being performed in accordance with the Site O&M plans listed below and in Appendix A:

- Addendum 6, Operation and Maintenance Manual, Water Treatment Plant (EMSI/Parsons, 2019).
- Addendum 7, Operation and Maintenance Manual, Water Treatment Plant (EMSI/Parsons, 2021)
- Revision 3, Operations and Maintenance Manual, Groundwater Extraction (EMSI/Parsons, 2018).
- Revision 3, Operations and Maintenance Manual, Landfill Gas Remedy (EMSI, 2021).
- Final Operations and Maintenance Manual, Covers and Stormwater (EMSI, 2007).
- Stormwater Monitoring Plan (EMSI, 2008).
- Updated Waste Management Plan (EMSI/Parsons, 2020).

WTP

Operations of the WTP during this FYR period included treatment of Site waters originating from the NBBW, the NTES sump, boundary extraction wells (PM-11, PM-15 and MW-51 areas), MW38 area extraction wells, on- and off-site North End response action wells, the decontamination pad at the GTEP complex, landfill gas condensate, and miscellaneous sources such as well sampling purge waters and potable water used for plant washdown. Following treatment, all these waters were discharged to POTW pipeline. In 2019, the effluent pipe from the water treatment plant was upgraded from a 2-inch line to a 4-inch line, which increased the capacity of the plant to treat more water per day.

The treatment protocols, process monitoring, and effluent quality monitoring were performed in accordance with Industrial Discharge Permit No. 2360-6, effective January 5, 2020 (and previous permit iterations). Table 7 shows the various water sources, average flow rates and total volumes, as summarized in the most recent Remedial Action and Operations and Maintenance Status Report (July-December 2020).

Table 7: WTP Sources and Flow Rates, July through December 2020

Water Source	Average Flow Rates (gpm)	Total Volume (gallons)
NBBW water (total of volume sent directly to WTP plus volume temporarily routed to raw water storage tanks)	7.0	1,864,543
MW38 area (includes automatic pumping from the sand channel wells and the source-control well)	2.4 (calendar)	631,826
MW113-EW-1	NA[a]	80,526
NTES water	0.52 (calendar)	136,837
Landfill gas condensate from Tank 530 (treated in WTP from July 1 through December 31, 2020)	0.03 (calendar)	7,529
PM-11 area	NA[a]	61,928
MW51 area	NA[a]	65,295
PM-15 area	NA[a]	8,566
Decontamination water and precipitation	NA[a]	2,108
North End on-Site water	14.1 (calendar)	3,725,760
North End off-Site water	8.3 (calendar)	2,192,712
Potable water	NA[a]	21,226
Total influent	33.2 (calendar)	8,798,856
Discharge to POTW[b]	33.3 (calendar)	8,829,840

Notes:
Source: Remedial Action and Operations and Maintenance Status Report (July-December 2020), pdf page 19.
Calendar = timeframe used to derive average flow rate. For example, total volume during the reporting period (gallons) divided by number of calendar-minutes during the reporting period equals average flow rate in gpm.

a. NA = Not applicable – batch transfer to raw water storage tanks, Feed Surge Tank, or clear well, then treatment in WTP.
b. The difference between the total influent volume and the volume discharged to the POTW is accounted for in total tank storage capacity associated with the WTP (including temporary storage in external tanks) and in measurement error of the totalizers. Totalizer error is as much as +/-0.5% on each totalizer (10 totalizers are used to generate the volumes above). For example, the effluent totalizer range of error is +/- 43,994 gallons over the reporting period.

Groundwater Monitoring Wells

The WSDs conduct well inspections as a routine part of the GWMP. Routine maintenance was conducted during this FYR period. The general condition of each well and any necessary repairs are recorded in a comment field on the water level measurement form and electronically transferred to a separate data table stored in the Site's database and maintained by the WSDs. All necessary maintenance has been conducted during this FYR period. During this FYR period, the WSDs installed eight monitoring wells: MW141-UDEN, MW176-UDEN, MW177-DEN, MW177-UDEN, MW178-DEN, MW178-UDEN, MW179-UDEN, MW180-WD (Figure C-4 in Appendix C).

Landfill Gas Collection System

The WSDs conduct routine maintenance on the landfill gas collection system, including the flares and the GTEP. In March 2015, the Lowry/DADS treatment system was updated with the installation of large capacity candlestick flare, referred to as Flare Station 3 (FS3).

On June 4, 2019, the Colorado Department of Public Health and Environment approved a Title V Permit modification request to allow operation of the GTEP, DBF and FS3 at full capacity, full time. The combined capacity of the three treatment units is about 3,800 standard cubic feet per minute. The modification was necessary to accommodate increasing gas volume generated from the DADS Section 32 landfill. This operational change is a departure from the previous routine of operating the DBF on an as-needed basis only. During the most recent reporting period (July through December 2020), the combined average landfill gas flow from the Site and

DADS landfills was about 2,750 standard cubic feet per minute with 165 standard cubic feet per minute from the Site.

Landfill Covers and Stormwater Runoff Monitoring
The WSDs conduct a Sitewide inspection annually and after snow/rain events. Inspections identify and repair problems arising from settlement, cover or ditch erosion, sedimentation, and damage to security fences and gates. Weed control, mowing and prairie dog mitigation were done as needed during this FYR period. Shallow soil-filling in other low areas occurs as needed based on observations during routine inspections.

In 2020, two grass fires occurred within the Site boundary. The October 2020 fire occurred in a Site area just south of the WTP and a quarter-mile north of the landfill mass. The only damage was to the grass covering this area. The cause of the fire was determined to be several birds landing on a power pole equipped with high-voltage lightning arrestor equipment. The fire was quickly extinguished by on-site water trucks from the DADS, with assistance from local fire departments. As a preventive measure, a layer of recycled asphalt was placed around any power pole with fuses and lightning arrestors to prevent vegetation growth directly beneath the high voltage equipment.

A second grass fire in December 2020 burned across the southeast corner of the landfill cap. The fire caused only superficial damage to the vegetative cover and to one landfill gas well before it was quickly extinguished by local fire departments. Gas extraction from the Lowry wellfield was terminated when the fire was first reported by isolating the landfill's gas wells from the equipment used to remove landfill gas, as required by the 2018 Lowry Landfill Updated Contingency Plan (EMSI/Parsons, 2018). The cause of the fire was not determined, but it was believed to be from a flare or firework launched from a car on East Quincy Avenue. Inspections to the landfill cover burn area have been conducted since, with no issues or concerns observed requiring immediate attention.

Stormwater runoff is monitored annually during a precipitation event in accordance with the 2008 SWMP (EMSI, 2008), and results are reported in the semi-annual status reports. The runoff is monitored at one location for four parameters: oil and grease, pH, chemical oxygen demand, and total suspended solids (Figure C-17 in Appendix C). There are no performance criteria for these parameters. The Data Review Section of this FYR Report discusses the results.

III. PROGRESS SINCE the PREVIOUS REVIEW

This section includes the protectiveness determinations and statements as well as recommendations and status of those recommendations from the 2017 FYR Report and the 2021 FYR Addendum.

Table 8: Protectiveness Determinations/Statements from the 2017 FYR Report

OU #	Protectiveness Determination	Protectiveness Statement
1	Protectiveness Deferred	A protectiveness determination of the OU1 remedy cannot be made at this time until further information is obtained. Further information will be obtained by sampling and analyzing the wells located within the footprint of the plume for 1,4-dioxane. Based on the results, appropriate measures will be taken to prevent exposure to contaminated groundwater. It is expected these actions will take approximately 1 year to complete, at which time a protectiveness determination will be made.
2	Protective	The remedy at OU2 is protective of human health and the environment because there are no completed exposure pathways to landfill solids.

OU #	Protectiveness Determination	Protectiveness Statement
3	Short-term Protective	The remedy at OU3 currently protects human health and the environment because there is no exposure to hazardous waste due to a functioning landfill gas treatment system that prevents the release of landfill gases into ambient air. The LFG subsurface performance standards were provided in the 2002 minor modification to the ROD and then updated in 2007 and 2012 using the EPA's vapor intrusion model (VIAM). This model is undergoing updates to reflect the EPA's June 2015 final vapor intrusion guidance. In order for the remedy to be protective in the long-term, the LFG performance standards should be revised utilizing the EPA's updated toxicity values and Site-specific input data.
4	Protective	The remedy at OU4 is protective of human health and the environment because the ongoing maintenance of the cover areas prevents direct contact, ingestion and inhalation of soil contaminants as well as minimizes the migration of soil by wind or water erosion.
5	Protective	The remedy at OU5 is protective of human health and the environment because the operation and maintenance of the SWRA effectively prevents contamination from migrating to on-site surface water and sediments.
6	Protectiveness Deferred	A protectiveness determination of the OU6 remedy cannot be made at this time until further information is obtained. Further information will be obtained by installing additional vertical migration wells north of the Site within the 1,4-dioxane plume to assess if this contaminant, as well as any others, are confined to the shallow units. It is expected these actions will take approximately 1 year to complete; at which time a protectiveness determination will be made.
Sitewide	Protectiveness Deferred	Because a protectiveness determination cannot be made for the OU1 and OU6 remedies at this time until further information is obtained, a protectiveness determination cannot be made for the Site. Further information for OU1 will be obtained by sampling and analyzing the wells located within the footprint of the plume for 1,4-dioxane. Based on the results, appropriate measures will be taken to prevent exposure to contaminated groundwater. For OU6, further information will be obtained by installing additional vertical migration wells north of the Site within the 1,4-dioxane plume. It is expected these actions will take approximately 1 year to complete; at which time a protectiveness determination will be made.

Table 9: Protectiveness Determinations/Statements from the 2021 FYR Addendum

OU #	Protectiveness Determination	Protectiveness Statement
1	Short-term Protective	The remedy at OU1 is short-term protective of human health and the environment because there are no completed exposure pathways for 1,4-dioxane in shallow groundwater. In order to be determined protective in the long term, the Conceptual Site Model and the containment system evaluation for the North Boundary Barrier Wall will need to be completed.
3	Protective	The remedy at OU3 currently protects human health and the environment because there is no exposure to hazardous waste due to a functioning landfill gas treatment system that prevents the release of landfill gases at unacceptable levels into ambient air.

OU #	Protectiveness Determination	Protectiveness Statement
6	Protective	The remedy at OU6 is protective of human health and the environment because there are no completed exposure pathways, and the 1,4-dioxane plume is confined to the shallow units.
Sitewide	Short-term Protective	The remedy is short-term protective of human health and the environment because there are no completed exposure pathways for 1,4-dioxane in shallow groundwater and the deep groundwater plume is delineated. In order to be determined protective in the long term, the Conceptual Site Model and the containment system evaluation for the North Boundary Barrier Wall, will need to be completed.

Table 10: Status of Recommendations from the 2017 FYR Report

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
1	The potable water injections are not part of the remedy for the NBBW and the effectiveness or potential impact to the water balance and contaminant transport north of the NBBW has not been evaluated by the EPA.	Recommendation # 1: Discontinue potable water injections and conduct an optimization study of the groundwater containment remedy to assess changes in water levels, capture zones and water chemistry.	Completed	See description of Recommendation #1 status below Table 10.	9/21/2021
1	The capacity of the WTP was limited during times of high precipitation in 2015 and early 2016.	Recommendation # 2: Evaluate and upgrade the WTP's capacity.	Completed	The effluent pipe from the water treatment plant was upgraded from a 2-inch line to a 4-inch line, which increased the capacity of the plant to treat more water per day, as described in the Memorandum RE: Work Plan to Increase Capacity of Water Treatment Plant, June 27, 2018; Letter EMSI RE: Notification of Additional Action to Extract Groundwater from NBBW-IW-3 in B-326/MW113 Area, May 8, 2020.	2/1/2019
1	Numerous compliance wells continue to exceed the performance standards for 1,4-dioxane, chloroform, iron and nitrate in the northern, eastern, western and southern portions of the Site.	Recommendation # 3: Conduct a Capture Zone Analysis in accordance with EPA's 2008 guidance. Based on the results of the analysis, optimize the remedial extraction systems and off-Site to ensure the remedy is meeting RAOs.	Completed	See description of Recommendation #3 status below Table 10.	9/21/2021

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
1	Private or municipal wells are located within the Murphy Drainage downgradient of the Site. Four of these wells are located in the footprint of the 1,4-dioxane plume and one well is located immediately next to the plume.	Recommendation # 4: Sample these wells and analyze for 1,4-dioxane. Based on the results, implement appropriate remedial actions.	Completed	See description of Recommendation #4 status below Table 10.	6/30/2020
1	The containment effectiveness monitoring at the perimeter slurry wall does not monitor for 1,4-dioxane.	Recommendation # 5: Add 1,4-dioxane to the monitoring plan for the perimeter wells.	Completed	1,4-Dioxane was added as an indicator chemical for demonstration of the effectiveness of the Perimeter Slurry Wall in the Groundwater Monitoring Plan, Revision 2, August 16, 2018 (listed on EPA's Lowry Landfill website under September 6, 2018 [EPA approval date]).	8/16/2018
1	The performance standard for iron is based on background concentrations in the weathered Dawson aquifer. Several wells that are screened in the unweathered Dawson aquifer are out of compliance for iron.	Recommendation # 6: Reevaluate the performance standard for iron.	Completed	Based on the reevaluation of the performance standard, iron was removed as an indicator chemical in the Groundwater Monitoring Plan, Revision 2, August 16, 2018 (listed on EPA's website under September 6, 2018 [EPA approval date]).	8/16/2018
1	The 1,4-dioxane plume extends off-Site to the north. No institutional controls are in place in this area and there are private wells within the footprint and the vicinity of the plume. In addition, there are domestic drinking water wells about 1,000 ft east of the leading edge of the plume, just outside the Murphy Creek Drainage in the Gun Club Estates.	Recommendation # 7: Develop an updated plume map and Conceptual Site Model to ensure there is no potential for future exposure in this area. Based on the results, evaluate the need for a monitoring plan for wells in the vicinity of the plume edge. Also, assess the need for more institutional controls for the 1,4-dioxane plume area.	Completed	The North End Monitoring Plan Update 2 was completed on October 16, 2020, and the North End Monitoring Plan Update 3 was completed on August 23, 2021. The September 2, 2020, North End Investigation Report includes an updated plume map, a focused conceptual model and a risk assessment for the North End. Based on this assessment, there is no need for more institutional controls. Aurora Code Section 138-154 was not listed in the 2017 FYR Report but is considered an institutional control. A Site-wide Draft Updated Conceptual Site Model was finalized in October 2021. The results are discussed in the Data Review Section of this FYR Report.	10/12/2021

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
3	Several LFG performance standards may not be stringent enough based on current toxicity values.	Recommendation # 8: Reevaluate the LFG performance standards using updated toxicity values and Site-specific input data (as opposed to default values) in the Johnson-Ettinger model.	Completed	In 2018, performance standards for subsurface gas compounds were updated using the most recent version of the EPA's VIAM, Site-specific input variables and current toxicity values from the November 2017 EPA regional screening levels (RSLs), in Revision 3, Updated Compliance Monitoring Plan, Landfill Gas Remedy, Remedial Action/Operations & Maintenance, July 27, 2018.	7/27/2018
6	There are no vertical migration wells north of the Site within the 1,4-dioxane plume area to assess if 1,4-dioxane contamination is confined to shallow aquifer units.	Recommendation # 9: Review the vertical migration compliance well network and evaluate the need for an additional migration compliance well in the 1,4-dioxane plume area.	Completed	More wells were installed and sampled to assess the vertical extent of the 1,4-dioxane plume north of the Site, in accordance with the Work Plan to Further Assess the North End 1,4-Dioxane Plume, dated November 8, 2018 (SEMS #100005847). No 1,4-dioxane has been detected in any deep, unweathered bedrock well in the Study Area, nor within Section 31 north of the Site boundary. Based on these results, the deep plume is sufficiently characterized and monitored. The North End Monitoring Plan was updated accordingly.	10/16/2020

Recommendation # 1

The WSDs terminated the potable water injections in October 2018. The data collected during the subsequent synoptic sampling was reported in the May 2020 Cessation Summary Report. A numerical model was developed to study the water levels and capture zones upgradient and immediately downgradient of the NBBW. To study the water quality, a three-dimensional data visualization and analysis (3DVA) was completed in June 2020. These reports and models were created to support the final analysis of water balance and contaminant transport at the NBBW. The NBBW Containment System Evaluation Plan was finalized in October 2020. The NBBW Containment System Evaluation was completed in September 2021. The Data Review section of this FYR Report discusses the results of the evaluation.

Recommendation # 3

A numerical model to evaluate the effectiveness of the NBBW was developed, which is documented in the December 2019 Revised Calibration/Methodology Report (CDM Smith, 2019). In addition, 3DVA of the hydrogeology and groundwater plumes was completed in June 2020. These reports and models support the analysis of the effectiveness of the remedial extraction systems in meeting RAOs. The effectiveness evaluation for the Perimeter Slurry Wall and the effectiveness evaluation for the North End extraction features, NTES, and MW38 area extraction systems were completed in January 2021. The NBBW Containment System Evaluation was completed in September 2021. The Data Review section of this FYR Report discusses the results of these evaluations.

Recommendation # 4

The WSDs conducted a well survey in 2017 that extended five miles downgradient of the Site, along the Murphy Creek Drainage. Several private or municipal wells were identified in the drainage. Four of these wells are located within the footprint of the 1,4-dioxane plume. One well is located immediately next to the plume. In addition to

the wells in the drainage, domestic wells are located about 1,000 feet east of the leading edge of the plume, just outside the Murphy Creek Drainage and within the Gun Club Estates.

The WSDs and Tri-County investigated the four subject wells, among others, and concluded that two private wells were the only active private or municipal supply wells within or immediately next to the footprint of the off-site 1,4-dioxane plume. All other private or municipal wells within or next to the plume have been abandoned and cannot be sampled. The two active private wells are north of the Site and in unincorporated Arapahoe County. These two wells have been sampled annually since 2006. These wells are screened from 357 to 545 ft bgs and 400 to 600 ft bgs, respectively, and 1,4-dioxane has never been detected in either well.

The WSDs and Tri-County will continue to sample annually and monitor the two private wells identified, conduct surveys every five years to identify any newly placed wells that might have been installed, evaluate potential contamination, determine if an unacceptable risk is present in and immediately next to the off-site plume, and assure residents that their water supply is not affected by the North End 1,4-dioxane plume.

Two documents provide a more detailed summary of the well survey and sampling results:

- Technical Memorandum Identification and Sampling of Water Supply Wells Within and Immediately Adjacent to Off-Site 1,4-Dioxane Plume, June 3, 2020; SEMS #100008216.
- Evaluation of Private Wells Identified as an Issue in the 2017 Five Year Review, rev June 1, 2020, SEMS #100008217.

Institutional controls for the Site are outlined in the 2005 Institutional Controls Plan (Parsons, 2005).

IV. FIVE-YEAR REVIEW PROCESS

Community Involvement, Community Notification and Site Interviews

Community Involvement

Community involvement is an important component in the Superfund program. At Sites in the Operation and Maintenance phase such as the Lowry Landfill, the community plays a particularly important role in the FYR. The FYR interview process seeks insight and information from Community members that may not otherwise come to light because of their unique position living near the Site.

The EPA maintains the Lowry Landfill Superfund Site Community Involvement Plan which was updated in June 2020 and can be found at https://semspub.epa.gov/src/document/08/100008215.pdf. The EPA webpage has this and other publicly viewable Site documents at https://www.epa.gov/superfund/lowry-landfill.

The Lowry Landfill Community Advisory Group was formed in 2017. A Technical Assistance Grant (TAG) was awarded in 2018 to help the community better understand and comment on the reports and investigations that came out of the 2017 Five Year Review. The CAG was awarded an initial $50,000 and subsequent $25,000. These funds come from the Lowry Trust (funded by the WSDs.) The CAG hired Dr. Dietrick McGinnis of McGinnis and Associates to carry out the technical assistance they needed. This grant expired July 1, 2021.

A professional facilitator was hired from 2017 to 2019 to support the monthly CAG meetings, and then a new one was hired in January 2021. Attendees of the CAG meetings include the EPA Lowry Landfill Site team, the State's Site team, Tri-County Health Department's team, Arapahoe County representatives and one elected official, City of Aurora representative, the Work Settling Defendants and contractors, and 10 CAG members (representing eight households located within a radius of five miles of the Site).

Since 2017, the EPA has participated in multiple forms of community involvement, including:

- Participated in over forty Community Advisory Group (CAG) meetings (through July 2021, most were facilitated by a third party);
- Held five technical sessions (both over the phone and in person) with the CAG's Technical Advisors;
- Participated in three tours of Lowry Landfill for CAG members;
- Produced two fact sheets with CDPHE, the City of Aurora, Arapahoe County, and Congressional officials;
- Held public review periods on four Site documents;
- Conducted community interviews for the FYR and the Community Involvement Plan update;
- Responded to at least twenty-five letters, emails and requests to answer numerous community questions sent to the EPA upper management as well as Site team members. The State has also responded to many inquiries.
- Hosted five relationship-building meetings with the CAG members that were attended by the EPA's Acting Administrator, the Regional Administrator, the Regional Director of Public Affairs, the Regional Superfund Branch Chief, the EPA's Division Director and CDPHE's Waste Management Division Director.
- At the request of the City of Aurora's Planning and Economic Development Committee, the EPA presented information about the North End Risk Summary.

Resulting from a community concern, the sampling of private wells in Gun Club Estates was referred to the EPA's Site Assessment group. (The data collected and reviewed to date has provided no evidence that the Gun Club Estates private wells have been affected by the Lowry Landfill.)

A listing of community involvement activities can be found in the Appendix D Table D-1.

Community Notification

A public notice was made available in the Aurora Sentinel on May 20, 2021 (Appendix E). It stated that the FYR was underway and invited the public to submit any comments to the EPA. The results of the review and the report will be made available online at http://www.epa.gov/superfund/lowry-landfill and at the Site's information repository, Aurora Central Library, located at 14949 East Alameda Parkway in Aurora, Colorado (when COVID protocols allow).

Site Interviews

City of Aurora

City of Aurora representatives Karen Hancock (Principal Planner) and Sean Lieske (Environmental Services Manager) submitted written responses to the interview form for local government. City staff receive Site-related information that is prepared by the WSDs and their consultants. City staff often reaches out to CDPHE staff for assistance in understanding the EPA's position on site-related information to assure that issues can be adequately resolved. However, the City indicates that there is a deteriorating tone of communications between the CAG and the EPA and recommends that more resources be made available to address these communications issues. The City also recommends that both the EPA and CDPHE provide clear, written responses to questions from the CAG such as the status of emerging contaminants and the CAG's requests to attend technical meetings. The City also notes that downgradient investigations may be relevant to the WSDs' work products.

Arapahoe County

Arapahoe County representatives Jan Yeckes (Planning Division Manager) and Lisa Knerr (Environmental Manager) submitted written responses to the interview form for local government. They express concern about communication between the EPA, WSDs and the CAG, stating that it is difficult to determine correct information about the Site due to disagreements between the parties. They recommend that the EPA should hold meetings to address each question from the list recently submitted by the CAG and document the questions and answers in a

spreadsheet. They also recommend that the EPA provide stakeholders with access to all documents, potentially in an online archive. (Note: Site documents can be found at www.epa.gov/superfund/lowry-landfill.)

Arapahoe County District 3 Commissioner Jeff Baker participated in a phone interview during the FYR process. Commissioner Baker does not have any concerns with the Site's remedy and is not aware of any changes in land use or in regulations at the state or local level that would affect the remedy's protectiveness. Commissioner Baker said that he attends the CAG meetings and thinks that the EPA is doing a good job of communicating Site information through the website.

Tri-County Health Department
Tri-County participated in a group phone interview using the interview form for local government. Tri-County staff have been involved over the life of the Site. Tri-County reviews reports, technical information and provides updates to Arapahoe County and the City of Aurora. Tri-County believes that the EPA, CDPHE, WSDs and Tri-County have improved communications over the last five years to resolve outstanding issues. In addition, Tri-county states that the EPA is doing a good job moving Site progress forward. They emphasized that the EPA should continue to focus on communication and public outreach about the Superfund process and provide ongoing clarification that the Site is expected to remain a landfill. They suggest that potential outreach could incorporate technology such as videos, a document highlighting Site achievements, educational materials at recreational facilities near the Site and curriculum materials to nearby science and technology schools and environmental groups.

Tri-County also mentioned the changes in potential land use surrounding the Site, particularly trends in increasing residential use as large tracts of land nearby become available for development. They indicate that all stakeholders look proactively at this development and work to produce clear, consistent messaging about the Site.

Colorado Department of Public Health and Environment
Three CDPHE representatives – Dustin McNeil (State Project Manager), Jeannine Natterman (State Community Involvement Coordinator) and Colleen Brisnehan (Superfund and Site Assessment Unit Leader) – submitted a written response to the interview form for the state agency. CDPHE notes the community's concern about the Site-specific performance standard of 0.9 µg/L for 1,4-dioxane (which is based on the current laboratory practical quantitation limit) compared to the Colorado state groundwater standard of 0.35 µg/L. CDPHE recommends using the method 8270 selective ion monitoring to achieve a practical quantitation limit closer to the state standard. CDPHE summarizes community concerns about contaminant migration at the northern groundwater plume, requests to sample private wells, surface water and runoff, elevated molybdenum and emerging contaminants. CDPHE also emphasizes the need for a holistic understanding of the Site area to better evaluate the plume extent and contaminant transport.

Work Settling Defendants
Steve Richtel representing Waste Management and Dave Wilmoth representing the City and County of Denver submitted a written response to the interview form for the WSDs. The WSDs emphasize that the Site remedy is functioning as designed. They highlight the ongoing collaboration between Waste Management, the EPA, CDPHE and Tri-County. The interview response documents the measures the WSDs have taken since the 2017 FYR to further characterize the Site and evaluate the effectiveness of the remedy. The WSDs emphasize that the remedy is improving groundwater quality both outside the compliance zone and off Site at the North End. The WSDs state that they have responded proactively and efficiently to new concerns such as the finding of abnormal concentrations of molybdenum at the Site.

The WSDs repeatedly highlight their awareness of community needs pertaining to the Site. They state that the Site remedy allows for economic development of the surrounding area; that the Site is used for beneficial purposes such as environmental studies and generating electricity; and that the WSDs produce educational materials for the community. The WSDs suggest that the EPA should create informational videos in addition to those produced by the WSDs since the format is successful for communicating complex topics in an accessible format.

O&M Contractors
Parsons representatives Lyn Brill, Chris Carlson and Dan Griffiths submitted a written response to the interview for the O&M Contractors. The response emphasizes that the Site remedy is functioning as designed. The O&M Contractors describe the five O&M areas: the WTP; groundwater extraction systems; groundwater sampling for compliance, performance and effectiveness; landfill gas collection systems; and institutional controls and inspections. The interview response documents seven modifications to the O&M program in the last five years. The O&M Contractors acknowledge the discovery of molybdenum at the WTP and the problem of birds disrupting electrical equipment and describe mitigation strategies for both. They emphasize that the Site remedial system changes are documented every six months and that the remedy is optimized for performance and not cost savings.

Community Advisory Group and Local Residents
Ten residents representing eight households involved with the Site's CAG were interviewed during the FYR process using the interview form for residents, local businesses and community groups. In addition, nine of these CAG members also submitted written interview responses.

A major concern among CAG members is groundwater contamination extending to residential developments north of the Site, specifically the Murphy Creek Subdivision and Gun Club Estates. CAG members think that the EPA should conduct testing of private wells at Gun Club Estates. They also believe that the EPA should better define the extent of the plume so there are not any inferred areas and so the plume is also delineated by the minimum detectable level of 1,4-dioxane as well as the practical quantitation limit (PQL) of 0.9 µg/L. CAG members state that the EPA should expand the Site boundary to include the groundwater plume. They believe that infrastructure at the development, such as water and sewer lines, has been impacted by the groundwater plume and allows the contamination to spread throughout residential developments north of the Site. CAG members say that concerns about groundwater contamination have caused them emotional distress. CAG members are also concerned about potential volatilization of 1,4-dioxane and believe that the EPA should conduct vapor intrusion testing at homes in the Murphy Creek Subdivision. CAG members state that the EPA should ultimately seek to remove rather than contain the contamination.

CAG members also expressed concerns about their interactions with the EPA. They feel that the EPA has not done enough to communicate information about remedial activities in a proactive and timely manner and that this limits their ability to weigh in on Site issues. CAG members state that the EPA answers their questions in a manner that is too technical and avoids answering some questions. CAG members indicated they believe the EPA is glossing over issues at the Site to influence public opinion and that the website is insufficient for communicating to the public. CAG members believe that the EPA has fostered an adversarial relationship with the CAG and that there is a lack of mutual trust between the parties.

The EPA has overseen completion of all the projects resulting from the fourth FYR signed in 2017. There is no evidence of risk. The EPA has had many discussions with the community regarding risk, Superfund process, geology, hydrology, nature and extent of contamination. The community does not accept the information and results of investigations, risk assessments and data evaluations.

Data Review

During this FYR period, the WSDs conducted groundwater, landfill gas and stormwater monitoring in accordance with the 2018 GWMP, the 2018 Landfill Gas Compliance Monitoring Plan and the 2008 Stormwater Monitoring Plan, respectively. The monitoring results are summarized in semi-annual status reports. The results of these ongoing monitoring events are summarized in Appendix H. During this FYR period, the WSDs have conducted two effectiveness evaluations (on the Perimeter Slurry Wall, and on the North Toe Extraction System (NTES), MW38 area, and North End Response Actions), and a Containment System Evaluation of the NBBW. The EPA and the WSDs, in conjunction with CDPHE and Tri-County Health created a Numerical Three-Dimensional Finite-Element Groundwater Simulation Model, a Three-Dimensional Data Visualization and Analysis and updated the Sitewide Conceptual Site Model. Additionally, a Cessation Report and the North End Investigation

and Risk Summary/Assessment were completed. The North End Monitoring Plan, the Groundwater Monitoring Plan and the Landfill Gas Compliance Monitoring Plan were updated. A well survey and inspection of private wells were completed. The WSDs did an investigation and report on the molybdenum plume near the NBBW. It is in an isolated area and is not migrating. There is no potential exposure because it is in an isolated controlled area. The EPA wrote two responses to the CAG/TAG's Surface Water White Paper. This Data Review summary section provides an update on the current understanding of the data associated with each OU where ongoing data collection is occurring: OU1 (shallow groundwater and subsurface liquids), OU3 (landfill gas), OU5 (surface water and sediments) and OU6 (deep groundwater). These high-level summaries provide the conclusions of the various technical evaluations conducted during this FYR period as well as the current data collected as part of ongoing monitoring activities.

OU1 – Shallow Groundwater and Subsurface Liquids
The WSDs monitor shallow groundwater contamination at the Site boundary, the Perimeter Slurry Wall, the POC boundary, the NTES and MW38 areas, the NBBW area and the North End area (Figure C-4 and C-5 in Appendix C). During this FYR period, the WSDs evaluated the effectiveness of the remedy components associated with shallow groundwater at the Site. Monitoring also occurs at the influent and effluent of the WTP.

Within the Site Boundary
Within the Site boundary, the maximum concentrations of 1,4-dioxane and VOCs are detected immediately upgradient of the NTES and within the bed of the unnamed creek from the NTES to the NBBW. Except for 1,4-dioxane, the horizontal extent of contamination is contained within the Site boundaries by the Perimeter Slurry Wall and the NTES, NBBW and MW38 extraction systems. The vertical extent of contamination in this area extends partially into the unweathered Dawson aquifer.

Perimeter Slurry Wall
The effectiveness of the slurry wall is determined by evaluating the presence of an inward hydraulic gradient, using 15 paired monitoring wells inside and outside of the Perimeter Slurry Wall and by evaluating water quality data for five indicator compounds (1,1,1-trichloroethane, 1,1-dichloroethane, trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,4-dioxane) obtained from wells outside of the slurry wall (Figure C-6 in Appendix C). The presence of an inward hydraulic gradient and no trend or a decreasing trend in water quality data indicates the slurry wall is effective at containing Site contaminants. Conversely, the presence of an outward hydraulic gradient or increasing water quality trend indicates the need for investigation to determine if there is an issue with containment. As reported in the status reports for the Site, inward gradients have been demonstrated in at least 11 of the 15 PM-series monitoring well pairs across the slurry wall since 2006. Groundwater quality outside the slurry wall in the four areas where sufficient inward gradients have not been demonstrated has historically complied with groundwater performance standards, and historical data have shown no increasing trends.

The status reports and the 2021 Effectiveness Evaluation for Perimeter Barrier Wall concluded that the slurry wall is effective at containing groundwater within the eastern, southern, and western limits of the landfill footprint. The five indicator compounds were not detected above the performance standards in the monitoring wells used for the effectiveness monitoring.

The overall objective of the Perimeter Slurry Wall is to prevent migration of contaminants in groundwater beyond the groundwater POC boundary, which is coincident with the slurry wall, at levels that exceed groundwater performance standards. When installed, the slurry wall did not fully encompass the known extent of groundwater contamination, so residual groundwater contamination, in particular 1,4-dioxane and VOCs, is present at concentrations above the performance standards outside the Perimeter Slurry Wall. Residual contamination is being addressed through contingency measures, including extraction wells and air sparging systems. The measures consist of air sparging groundwater outside the wall in the PM-15 and MW-51 areas (voluntary measures) and sampling of groundwater from wells BM-11X-100N and BM-11X-100S, both of which are located outside the wall near well PM-11 in areas where hydraulic gradients across the wall are inward. PCE has statistically exceeded its performance standard in well BM-11X-100N. Sampling is being performed to monitor

for natural attenuation over time. Historical results indicate no groundwater performance standard exceedances at the property boundary.

POC Boundary

The WSDs regularly sample groundwater at the POC boundary and outside of the Site boundary as part of the groundwater monitoring and compliance program. Groundwater samples are collected from wells near the POC boundary, and detected concentrations are compared to the performance standards. Wells containing concentrations of the 29 indicator chemicals at concentrations exceeding the performance standards are further evaluated using the evaluation decision tree and criteria detailed in the GWMP and summarized in Appendix H. The most recent compliance evaluation was conducted for groundwater data collected during the second half of 2020 (June through December). Based on the statistical tests, water quality for one or more compliance monitoring parameters at six of the 60 compliance monitoring locations exceeded performance standards and are out of compliance. Based on empirical evidence, two other well locations were determined to potentially be out of compliance.[5] Figure C-8 in Appendix C shows these locations, and additional details are provided in Table H-1 in Appendix H.

The majority of the monitoring locations that are out of compliance are located along the northern boundary of the Site. The primary COC that exceeds performance standards in this area is 1,4-dioxane. Five NBBW-area compliance monitoring wells (B-313, B-326-UD, B-326-WD, MW62-WDR and MW77-WD) are out of compliance for 1,4-dioxane. Other COCs and areas that are out of compliance or potentially out of compliance include PCE at BM-11X-100N (described above), nitrate at BM-15N6, chloroform and 1,4-dioxane at MW-38-830N-230E, and nitrate at MW62-WDR (Figure C-8 in Appendix C). Appendix H provides the compliance evaluation for each of these locations.

The WSDs are implementing response actions, as required in the Response Action Work Plans for the five NBBW-area wells that are out of compliance, as well as the MW38 area. The WSDs will continue to implement response actions in these areas until compliance is attained. In accordance with the Consent Decree and associated work plans, the WSDs will continue monitoring other locations that are out of compliance and will continue to evaluate compliance using the decision tree and criteria detailed in the GWMP. Response actions are not currently warranted at these wells based on the compliance evaluation described in Appendix H and the 2018 GWMP.

NTES and MW38 Area

The WSDs evaluated the effectiveness of the NTES and MW38 area in the 2021 Effectiveness Evaluations for MW38 Area, North Toe Extraction System, and North End Response Actions.

For the MW38 area, the EPA-approved measure of effectiveness is hydraulic gradient control that induces inward (convergent) radial flow to the MW38 sand channel. The MW38 extraction system has been in place, operating and achieving inward flow within the MW38 sand channel since July 2002. Potentiometric data collected since at least 2006 indicate the effectiveness metric is being continuously achieved. See Figure C-9 in Appendix C for the most recent potentiometric surface map. Chloroform and 1,4-dioxane concentrations in monitoring well MW38-830N-230E exceed their groundwater performance standards. No temporal trends in the concentrations of these chemicals were identified in this well. This well is located along the POC boundary at the north end of the MW38 channel. The hydraulic gradient within the channel at this location is to the north, toward extraction well MW38-1028N-256E, so migration of these chemicals crosses the POC boundary by about 200 feet before reaching the extraction well for subsequent removal. As part of the groundwater containment remedy for the Site, groundwater extraction is conducted from the MW38 sand channel at two locations, including a location about 200 feet north of well MW38-830N-230E, which is downgradient from and beyond the POC boundary relative to the

[5] Evaluation of compliance at a well is performed by comparing the 90% upper confidence limit (UCL) and, if necessary, the 90% lower confidence limit (LCL) of the chemical concentration in groundwater to its performance standard. A well is statistically in compliance if the 90% UCL is less than its performance standard and a well is out of compliance if the 90% LCL is greater than its performance standard. If the performance standard lies within the confidence interval (i.e., between the UCL and LCL), it is unknown whether the well is in or out of compliance. In some cases, a determination may be made as to potentially in or out of compliance based on empirical evidence such as concentrations and trends.

compliance monitoring well. Therefore, although these chemicals may migrate across the POC boundary, impacted groundwater is hydraulically contained within, and removed from, the sand channel in the area immediately north of well MW38-830N-230E.

For the NTES, the EPA-approved measures of effectiveness are maintenance of a continuous decline in trench groundwater levels or maintenance of a trench groundwater level below the base of alluvium. Potentiometric data collected since 2005 indicate one or the other measure has been continuously achieved. Historical potentiometric surface maps are also available in O&M status reports for the Site. Figure C-10 in Appendix C provides the most recent potentiometric surface map. Extraction from NTES trench wells and associated monitoring programs will continue.

NBBW

The WSDs completed the Containment System Evaluation in accordance with the 2020 Containment System Evaluation Plan. The results indicated that the NBBW is achieving hydraulic containment, based on the following lines of evidence:

- Applications of a three-dimensional numerical groundwater model.
- Particle track and groundwater flow evaluations.
- Evaluation of the nature, extent and temporal trends of VOCs and 1,4-dioxane occurrences north (downgradient) of the NBBW.
- Chemical mass flux evaluations.

The Containment System Evaluation provided the following additional conclusions:

- 1,4-Dioxane is the only COC found at concentrations above the groundwater performance standard beyond the POC boundary in the NBBW.
- Multiple lines of evidence were evaluated as part of this effort, which provide sufficient data to conclude that hydraulic containment has been and continues to be achieved by the NBBW components.
- No additional data are needed to evaluate hydraulic containment.
- The RAOs are being met based on the current level of hydraulic containment.
- No more actions are needed to enhance hydraulic containment.

The Containment System Evaluation indicated current monitoring included in the EPA-approved plans is sufficient to provide data for continuing to evaluate groundwater containment at the NBBW and understanding of temporal trends in water quality. The CSE identified certain monitoring points (e.g., MW113-EW-1, MW113-UD, PTP-12, and PTP-14) for which quarterly monitoring was scheduled to stop at the end of 2020. The WSDs recommended that these wells continue to be monitored on a quarterly basis until the degree of saturated alluvium/weathered bedrock in the vicinity of these wells no longer supports collection of groundwater samples or until the currently identified increasing trends in 1,4-dioxane stabilize. The North End Groundwater Monitoring Plan was updated in 2020 to include quarterly monitoring of MW113-EW-1, MW113-UD and MW117-WD and semiannual monitoring of MW176-DEN and MW179-UDEN; however, monitoring wells PTP-12 and PTP-14 were not included. The North End Groundwater Monitoring Plan was updated again in 2021 to include quarterly monitoring of PTP-12 and PTP-14 (Parsons, 2021).

North End Response Actions/North End Investigation

The groundwater north of the Site boundary has been regularly monitored as part of the GWMP and investigated as part of the 2019 North End Investigation. Groundwater samples collected from shallow and deep groundwater monitoring wells were analyzed for 1,4-dioxane, VOCs, nitrate, metals, total dissolved solids and major anions and cations. The only COC that exceeded a groundwater performance standard north of the Site was 1,4-dioxane. The extent of 1,4-dioxane in the North End area exceeding the performance standard is shown on Figure C-12 in Appendix C. Sands in the shallow weathered groundwater unit (about 50 feet deep) serve as preferential groundwater pathways that generally align with the westernmost branch of Murphy Creek. The 1,4-dioxane plume delineated on Figure C-12 occurs within these preferential pathways. 1,4-Dioxane concentrations were detected in shallow groundwater north of Section 31 at a maximum concentration of 7.4 µg/L at monitoring well MW129-WD. Concentrations were highest in Section 31 and generally decreased to non-detect at the northern

end of the plume south of East Mississippi Avenue and east of Gun Club Road. See Question B in the Technical Assessment and Appendix J for a discussion on potential risk of 1,4-dioxane present north of the Site. 1,4-Dioxane has not been detected in groundwater north of the Site below a depth of about 50 feet. North End response actions were voluntarily implemented as a contingency measure of the GWMP on Site and north of the Site boundary in response to the discovery of 1,4-dioxane in this area. Beginning in 2007, groundwater extraction wells were installed in five areas (Areas 1 through 5) to reduce off-site migration of 1,4-dioxane, to reduce the mass of 1,4-dioxane north of the Site, and to bring compliance wells into compliance with the performance standard.

The WSDs evaluated the effectiveness of the North End response actions in an effectiveness evaluation (EMSI/Parsons, 2021) and updated the conceptual model for this area along with updating the 1,4-dioxane plume map in the North End Conceptual Model Technical Memorandum (EMSI/CDM Smith, 2020). The overall finding of these reports indicates that the North End response actions, including groundwater extraction from wells in Areas 1 through 5 (Figures C-13 and C-14 in Appendix C), have reduced 1,4-dioxane contaminant mass by about 8,088 grams since 2006. 1,4-Dioxane removal rates increased 102% between 2009 and 2020 due to addition and enlargement of extraction wells and increased extraction rates. For most of the wells in these areas, concentrations are declining or asymptotic at or near the practical quantitation limit (PQL) of 0.9 µg/L. The progress from the North End response actions is shown on Figure C-15 in Appendix C. Monitoring and extraction will continue.

WTP

The WSDs operate the WTP in accordance with the 2021 O&M Manual. Treatment protocols, process and effluent monitoring are performed in accordance with the discharge permit. The WTP monitoring consists of effluent monitoring as well as early warning influent monitoring. The specific monitoring schedule is included in the discharge permit. During this FYR period, in November 2019, all validated results from the WTP effluent sample location (MP-001) were below industrial wastewater discharge permit limits, with the exception of molybdenum, which is not a COC at the Site (due to the fact that molybdenum was not detected in significant concentrations during the RI). In November 2019, total molybdenum was detected in WTP effluent above its permitted limit, which led to a temporary shut-down of the WTP. After sampling all waters entering the WTP, WSDs determined the source was extraction well MW113-EW-1, located at the northern edge of the Site. The WSDs investigated; their molybdenum report notes that the source is likely from naturally occurring minerals. To address this issue, the WSDs are continuing to pump from the area to meet the 1,4-dioxane performance objectives and minimize the mobilization of molybdenum. In July 2020, WSDs began pumping MW113-EW-1 water into temporary tanks while a dedicated double-contained pipeline was constructed to the WTP. Design and construction of an ion exchange system inside WTP Building 1 to remove molybdenum from MW113 area water was completed during the second half of 2020. The WTP O&M Manual was updated in 2021 to reflect this change. See additional details on molybdenum in Appendix H.

OU3 – Landfill Gas

The primary sources of landfill gas contamination are subsurface liquids, saturated and unsaturated landfill solids, and leachate. As with other municipal solid waste landfills, methane gas and other gases are generated at the Site from the degradation of solids and chemical constituents present in the landfill mass. The WSDs continue to monitor landfill gas generation and potential migration, as described in the 2018 Landfill Gas Compliance Monitoring Plan. The current landfill gas extraction, collection and treatment system consists of the following components: 64 vertical gas extraction wells, header and lateral piping, three automatic and nine manual condensate traps, two flares, and the GTEP. The landfill gas extraction and collection system is monitored monthly as part of system O&M. POC probe locations are shown on Figure C-16 in Appendix C. A biennial sampling event for VOCs took place in June 2019. All results, with appropriate qualifiers, are presented in Appendix D-5 of the First Half 2019 Site Status Report. No POC subsurface gas performance standards were exceeded.

The POC probes were sampled quarterly for methane in the second half of 2020. All concentrations were below the methane performance standard of 5% by volume.

OU5 – Surface Water and Sediments
The only media sampled under OU5 includes stormwater sampling. Annual stormwater sampling is conducted in accordance with the 2008 Stormwater Monitoring Plan. Sampling only occurs when sufficient flow is available to activate the stormwater samplers. Stormwater sampling occurred in July 2018 and June 2019. Samples were analyzed for oil and grease, pH, chemical oxygen demand and total suspended solids. The results were consistent with historic results. The results are shown in Table H-2 in Appendix H. The stormwater sampling location is shown on Figure C-17 in Appendix C.

OU6 – Deep Groundwater
The deep groundwater system at the Site includes the water-bearing zones beneath the Dawson aquifer, which includes the Upper Denver aquifer and the Lignite Layer (Figure C-18 in Appendix C). The current compliance monitoring network includes six Upper Denver monitoring wells and 12 Lignite monitoring wells. These vertical compliance wells are monitored every five years. Although they are not compliance wells (because they are not located on the POC boundary), vertical migration wells B-504A, C-702P3 and GW-113 (Upper Denver) and B-506, PZ-101A, PZ-103 and GW-121 (Lignite) are also sampled every five years as part of the GWMP to compare concentrations in deeper groundwater to the groundwater performance standards. Unweathered Dawson well B-712-LD is monitored every two years. The Upper Denver and Lignite monitoring wells were sampled in 2018. The most recent results and statistical analyses were reported in the Second Half 2018 Site Status Report. The maximum concentrations of all compounds detected in all Upper Denver and Lignite groundwater monitoring wells in 2018 were less than the groundwater performance standards. For well B-712-LD, the historical maximum concentrations of all compounds were also less than their respective performance standards except for one detect of 1,4-dioxane (0.95 µg/L) in 2007. The seven subsequent samples obtained from this well were all reported as not detected for 1,4-dioxane, down to a method detection limit of 0.15 µg/L.

While the OU6 compliance wells are discussed in general as part of the compliance evaluation, the results are not discussed specifically in the status reports as associated with OU6. The detections for all sampled wells are provided in Table 4.5 of semiannual Site Status Reports.

Site Inspection
The Site inspection took place on 5/10/2021. Participants included Linda Kiefer (EPA RPM), Dustin McNeil, Tom Simmons and Andrea Kingcade (CDPHE), Daniel Griffiths and Chris Carlson (WSD support contract, Parsons), Lynn Robbio Wagner, Brian Hlavacek and Tom Butts (Tri-County), Steve Richtel (Waste Management), Dave Wilmoth (City of Denver, Department of Environmental Health) and Treat Suomi (Skeo, EPA FYR contractor). The purpose of the inspection was to assess the protectiveness of the remedy. Site visit participants met at the WTP, participated in a Site health and safety briefing and then toured the Site's remedial components. The group drove the Site and stopped and observed the following areas and remedy components:

- Landfill gas collection and treatment system (GTEP and flares).
- NTES.
- Perimeter Slurry Wall and perimeter contingency extraction wells.
- Landfill cover.
- MW38 area.
- Unnamed creek, SWRA and FTPA.
- NBBW and North End response action wells.
- Wetlands mitigation area.

Site visit participants then returned to the WTP to observe it and associated remedy components. All remedy components appeared well maintained and operational. The wells were all secure and above-ground pipes were in good condition. The landfill cover was well vegetated and in good condition. The flare was operational. The group also observed the new recycled asphalt around the electrical posts to mitigate possible future fires. The grass in the areas of the 2020 fires has been revegetated and appeared in good condition. For additional details see the Site inspection checklist and Site photographs in Appendices F and G, respectively.

V. TECHNICAL ASSESSMENT

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

OU1/OU6 – Shallow Groundwater and Subsurface Liquids/Deep Groundwater
The groundwater remedy and the implemented contingency measures are functioning as intended by the decision documents. While contamination exists beyond the compliance boundary, the WSDs conducted extensive investigations during this FYR period and confirmed the existing remedy components in place to address contaminated groundwater are performing as intended by the decision documents.

The groundwater remedy components (the NBBW, the NTES and extraction wells) extract groundwater for treatment and mitigate the off-site migration of contaminants. The upgradient Perimeter Slurry Wall also inhibits off-site groundwater from flowing into the Site's subsurface environment. The WSDs conduct performance and compliance groundwater monitoring at the Site in accordance with the GWMP. To assess whether the RAOs for groundwater are being met, the data collected as part of the groundwater monitoring program are used to evaluate (1) compliance with performance standards along the POC barrier/boundary; (2) the effectiveness of the four engineered components of the groundwater containment remedy (Perimeter Slurry Wall, NTES, NBBW and MW38 extraction systems); (3) the protectiveness of the remedy; and (4) changes in water quality, if any, in deeper bedrock units beneath the Site. Monitoring is ongoing and the results indicate that the implemented remedies are effective and operating as intended. Containment and treatment of groundwater will continue to reduce the contaminant concentrations in on-site groundwater.

The WTP operated effectively during this FYR period. During this FYR period, all validated results from the WTP effluent sample location (MP-001) were below industrial wastewater discharge permit limits, with the exception of molybdenum, which is not a COC at the Site. In November 2019, total molybdenum was detected in WTP effluent above its permitted limit, which led to a temporary shut-down of the WTP. WSDs determined the source was extraction well MW113-EW-1, located at the northern edge of the Site. The WSDs indicated that the source is likely from naturally occurring minerals. Design and construction of an ion exchange system inside WTP Building 1 to remove molybdenum from MW113 area water was completed during the second half of 2020. The WSDs updated the WTP O&M Manual to reflect this change in 2021.

The selected remedy for OU1 and OU6 specifies that appropriate measures shall be taken to prevent and remediate contaminant migration off Site if contaminant levels exceed performance standards at compliance boundaries during implementation or operation of the groundwater remedy. Contingency measures implemented at the Site include the Perimeter Slurry Wall extraction wells, the MW38 extraction wells, the NBBW extraction wells, and the North End response actions. Several wells contain contaminants at concentrations above the performance standards and were identified as out of compliance during this FYR period. Out-of-compliance conditions are evaluated and addressed by the agencies and the WSDs, in accordance with the GWMP.

The NBBW was evaluated in the Containment System Evaluation and the results indicated that the NBBW is achieving hydraulic containment. The WSDs recommended as part of the Containment System Evaluation that certain monitoring points (e.g., MW113-EW-1, MW113-UD, PTP-12, and PTP-14) for which quarterly monitoring is scheduled to stop at the end of 2020 continue to be monitored on a quarterly basis. The North End Groundwater Monitoring Plan was updated in 2020 to include quarterly monitoring of MW113-EW-1, MW113-UD, and MW117-WD and semiannual monitoring of MW176-DEN and MW179-UDEN, however monitoring wells PTP-12 and PTP-14 were not included. The North End Groundwater Monitoring Plan was updated again in 2021 to include quarterly monitoring of PTP-12 and PTP-14.

A 1,4-dioxane groundwater plume extends north from the Site. The risk assessment determined the concentrations of 1,4-dioxane equate to a risk well within the acceptable NCP risk range; therefore, the Site and OU boundaries did not change. This area north of the Site is monitored as part of the North End Monitoring Plan and was investigated in 2018 - 2020 as part of the North End investigation. Groundwater north of the NBBW is extracted

by wells within the North End response action areas (Areas 1 through 5). The extent of 1,4-dioxane in groundwater in the North End Response Area has been delineated. 1,4-Dioxane has been detected only in the shallow groundwater. It has not been detected in the deep unweathered groundwater monitoring wells north of the Site (below about 50 ft bgs). There are no complete exposure pathways from 1,4-dioxane in shallow groundwater. Monitoring results indicate concentrations are decreasing or stable in most off-site wells. Monitoring and extraction will continue to reduce 1,4-dioxane concentrations and prevent migration of the plume to the north.

Vertical migration and deep groundwater monitoring conducted in 2018 confirmed that groundwater concentrations in the Upper Denver and Lignite monitoring wells are below groundwater performance standards. A well survey in 2017 identified four private wells within the footprint of the 1,4-dioxane plume and one well immediately next to the plume (Figure C-3 in Appendix C). Two of the private wells have been sampled annually since 2006 and 1,4-dioxane has not been detected in these wells; the other three wells were abandoned. The annual sampling of these private wells will continue as part of the maintenance and monitoring of the Site. Residential areas north and east of the 1,4-dioxane plume contain private groundwater wells as shown on Figure C-3 in Appendix C. The use of these wells is unknown. Based on the results of the North End investigation, groundwater contamination from the Site is not affecting these residential areas.

OU2 – Landfill Solids
The remedy is functioning as intended by the decision documents. A cover was placed over the landfill mass. Surface and subsurface drums and contaminated soils in the middle FTPA pit were excavated. The other pits were covered and monitoring and NAPL recovery are ongoing. The landfill and FTPA areas are well vegetated and regular maintenance is conducted to ensure the cover remains intact. During this FYR period, maintenance was conducted in accordance with the 2007 Final Operations and Maintenance Manual to ensure protectiveness. NAPL is collected as needed from the waste-pit areas, although these liquids were not observed during this FYR period. Institutional controls are in place and adequate to prevent disturbance of landfill solids on Site.

OU3 – Landfill Gas
The remedy is functioning as intended by the decision documents. The landfill gas collection and treatment system consists of 64 vertical extraction wells in the landfill area. Treatment consists of a combination of an enclosed flare, a candlestick flare and landfill GTEP. The treatment system is operating appropriately, and performance standards are being met.

OU4 – Soils
The remedy is functioning as intended by the decision documents. The No Further Action remedy consists of continued maintenance on the cover areas. Regular maintenance ensures the covers remain intact.

OU5 – Surface Water and Sediment
The remedy is functioning as intended by the decision documents. The No Further Action remedy consists of periodic surface water runoff monitoring and continued O&M of the SWRA and the NBBW. In 2005, 0.87 acres of wetlands were constructed to mitigate the loss of wetlands during the construction of the SWRA. Stormwater monitoring, which replaced surface water monitoring, is conducted annually during precipitation events, and O&M activities are conducted regularly at both the SWRA and the NBBW.

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

OU1/OU6 – Shallow Groundwater and Subsurface Liquids/Deep Groundwater
The exposure assumptions and RAOs used at the time of the remedy selection are still valid. 1,4-Dioxane was added as a COC after the remedy was implemented and the WTP was amended to address it. The groundwater performance standards from the ROD and the GWMP (which include 1,4-dioxane) were compared to the current maximum contaminant levels (MCLs) and current CDPHE groundwater standards. The results are provided in Appendix I, Table I-1. While there have been changes in toxicity and groundwater standards, these changes do not affect the protectiveness of the current groundwater performance standards. There are several standards for which

the MCL or CDPHE standard is less than the PQL or reporting limit for that COC. The reporting limits and PQLs are reevaluated annually and updated accordingly. This is especially crucial for 1,4-dioxane. There is no MCL for 1,4-dioxane and the current PQL (0.9 µg/L) is greater than the standard set by CDPHE (0.35 µg/L). The PQL was reevaluated in 2020. It will continue to be reevaluated annually. The EPA further assessed potential risk of 1,4-dioxane in the 2020 memorandum to the file, *1,4-Dioxane Risk Summary.* This evaluation is described in Appendix J. The results indicated that risk from potential exposure to 1,4-dioxane are within the EPA's acceptable risk range for cancer and hazard quotient less than 1 for noncancer risk.

The RAOs for groundwater are still valid and include prevention of human and environmental exposure, migration beyond the compliance boundary and off Site, and prevention of vertical migration. In instances where the performance standards are not being met at the compliance boundary, contingency measures are being implemented to maintain hydraulic gradient and meet performance standards.

As reported in the updated Conceptual Site Model for the Site, vapor intrusion of 1,4-dioxane into indoor air is considered an incomplete exposure pathway based on the properties of 1,4-dioxane. In general, vapor intrusion of 1,4-dioxane is not considered a major route of exposure because of the relatively low potential of 1,4-dioxane to move from the groundwater phase to the vapor phase. Vapor intrusion and volatilization from groundwater or surface water are not considered significant sources of exposure to the general population because the Henry's Law constant and the high water solubility of 1,4-dioxane indicate that 1,4-dioxane will primarily remain in the aqueous phase and that volatilization to air will be limited. Based on these factors, the vapor intrusion pathway is considered incomplete.

Per- and polyfluoroalkyl substances (PFAS) is a large group of highly fluorinated synthetic chemicals which include perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). The EPA has classified PFOA and PFAS as emerging contaminants. Historic landfills are likely sources of PFOA/PFAS contamination. The EPA does not have evidence of PFOA/PFAS contamination at the Site. If there was PFOA/PFAS, it would likely exist in landfill leachate. The Lowry Landfill WTP uses Granulated Activated Carbon (GAC) filtration as part of the water treatment process. GAC filtration is the recommended method to remove PFAS from water. The leachate is treated and filtered at the WTP and the treated water goes to Metro for further treatment prior to use as drinking water.[6]

The EPA does not consider PFOA/PFAS to pose a risk at the Site because even if it is present at the Site, there are no expected potential or existing completed exposure pathways

As a matter of note for any Colorado private well owner who is concerned about PFAS, the State of Colorado has a new state-wide PFAS Grant Program which offers an opportunity for owners to have their wells tested for PFAS, free-of-charge, if they are using those wells for drinking or their home garden.

OU2 – Landfill Solids

The exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection are still valid. There have been no changes in exposure assumptions, toxicity data or RAOs. There are no cleanup levels for landfill solids as the wastes were contained. The RAOs are being met because landfill solids are covered, and the covers remain intact.

[6] Leachate from Lowry Landfill is processed by the on-site WTP. The WTP is divided into two treatment trains (Main Plant and Biological Treatment System). The Main Plant consists of inorganics removal plus organics removal using ultraviolet oxidation followed by liquid-phase Granulated Activated Carbon (GAC) treatment. Site waters originating from NBBW, perimeter extraction wells, MW38 extraction wells, and on-site and off-site North End extraction wells enter the Main Plant for treatment. The BTS consists of a fixed film, moving bed bio-reactor system targeting the removal of 1,4-dioxane and high concentrations of VOCs. Site liquid originating from the NTES and landfill gas condensate enter the BTS for initial organics removal. All NBBW, perimeter extraction well and MW38 extraction well waters can be directed to the BTS for organic removal following softening as an alternative to ultraviolet oxidation treatment. BTS effluent is then pumped to the Main Plant for final organics removal (polishing) via GAC. Additional information regarding the WTP system and operation thereof can be found in the 2021 Water Treatment Plant Operation and Maintenance Manual. WTP effluent is then sent to the Metro WTP for additional treatment before release as drinking water.

OU3 – Landfill Gas

The exposure assumptions and RAOs used at the time of the remedy selection are still valid. The 2002 standards were derived based on the EPA's vapor intrusion model and Site-specific assumptions (depth below grade to vadose zone sample, groundwater temperature of 15 degrees Celsius, slab on grade, sandy clay soil type) based on a risk level of 1 x 10^{-6} (cancer risk) or a hazard quotient of 1 (noncancer risk). These standards have been revised three times, in 2007, 2012 and 2018, using the EPA's Johnson and Ettinger Vapor Intrusion Model (VIAM). To determine if the updated 2018 landfill gas performance standards remain valid, they were evaluated using the EPA's Version 6 of the VIAM calculator. The VIAM calculator calculates indoor air cancer risk and noncancer hazards based on Site-specific information presented in the 2018 Landfill Gas Compliance Monitoring Plan, Revision 3 under a future commercial worker exposure scenario. Table J-1 in Appendix J shows that the landfill gas performance standards remain valid as the standards are equivalent to cancer risks of 1 x 10^{-6} or less while the noncancer hazard quotients are equal to or less than the target threshold of 1.

OU4 – Soils

The exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection are still valid. There have been no changes in exposure assumptions, toxicity data or RAOs.

OU5 – Surface Water and Sediment

The exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection are still valid. There have been no changes in exposure assumptions, toxicity data or RAOs.

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 FYR:
OU1, OU2, OU3, OU4, OU5 and OU6

OTHER FINDINGS

An additional recommendation was identified during the FYR. This recommendation does not affect current and/or future protectiveness.

- In order to provide clarity on the results of the OU6 groundwater monitoring, the WSDs should consider discussing the OU6 groundwater monitoring results under a separate header in the status reports and provide additional details to support the statement that vertical migration is not occurring and OU6 compliance wells are in compliance.
- Consider sampling the influent and effluent of the WTP for PFAS and PFOA.

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: 1	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU1 is protective of human health and the environment.	

Protectiveness Statement(s)	
Operable Unit: 2	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU2 is protective of human health and the environment.	

Protectiveness Statement(s)	
Operable Unit: 3	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU3 is protective of human health and the environment.	

Protectiveness Statement(s)	
Operable Unit: 4	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU4 is protective of human health and the environment.	

Protectiveness Statement(s)	
Operable Unit: 5	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU5 is protective of human health and the environment.	

Protectiveness Statement(s)	
Operable Unit: 6	*Protectiveness Determination:* Protective
Protectiveness Statement: The remedy at OU6 is protective of human health and the environment.	

Sitewide Protectiveness Statement
Protectiveness Determination: Protective
Protectiveness Statement: The Sitewide remedy is protective of human health and the environment.

VIII. NEXT REVIEW

The next FYR Report for the Lowry Landfill Superfund Site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

Addendum 5 to Final Operation and Maintenance Manual Water Treatment Plant, Lowry Landfill Superfund Site, Operations and Maintenance. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. August 2015.

Addendum 6 to Final Operation and Maintenance Manual, Water Treatment Plant, Lowry Landfill Superfund Site. Prepared by EMSI and Parsons. Prepared for City and County of Denver, CWM, and WMC. March 31, 2019.

Addendum 7 to Final Operation and Maintenance Manual, Water Treatment Plant, Lowry Landfill Superfund Site. Prepared by EMSI and Parsons. Prepared for City and County of Denver, CWM, and WMC. March 26, 2021.

Amendment to the Record of Decision, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. August 2005.

Area at the Lowry Landfill Superfund Site with Elevated Concentrations of Molybdenum in Shallow Groundwater. EPA Region 8. April 2020.

Explanation of Significant Differences, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. August 1995.

City of Aurora Code Section 138-154 – Prohibition to Drill Wells – Code 1979, section 39-70; Ordinance Number 2005-74, section 1, 10-10-2005; Ordinance Number 2018-57, Section 2, 10-29-2018 (accessed at: https://library.municode.com/co/aurora/codes/code_of_ordinances?nodeId=CICOVOII_CH138UT_ARTVWASE_DIV1GE_S138-154USINWASYCRCOUSDAAQ).

Community Involvement Plan, Updated, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. June 2020.

Development of Calibrated Numerical Three-Dimensional, Finite-Element Groundwater Simulation Model, Lowry Landfill Superfund Site. Final Report. Prepared by CDM Smith. December 2019.

Effectiveness Evaluation for the Perimeter Barrier Wall, 2017 Five-Year Review Issue #3, Lowry Landfill Superfund Site. Prepared by EMSI and Parsons. January 20, 2021.

Effectiveness Evaluations for MW38 Area, North Toe Extraction System, and North End Response Actions, 2017 Five-Year Review Issue #3, Lowry Landfill Superfund Site. Prepared by EMSI and Parsons. January 22, 2021.

Evaluation of Private Wells Identified as an Issue in the 2017 Five Year Review. Memorandum from Tim Shangraw (EMSI) and Lynn Robbio-Wagner (TCHD) to Leslie Sims (EPA). Prepared by EMSI and TCHD. March 5, 2018, Revised June 1, 2020.

Final Institutional Controls Plan, Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared by Parsons. September 2002 amended February 2005.

Final North Boundary Barrier Wall Containment System Evaluation Plan, Lowry Landfill Superfund Site. Prepared for the Lowry Landfill Superfund Sites Work Settling Defendants. Prepared by EMSI with assistance from Parsons and CDM Smith. October 2020.

Final North Boundary Barrier Wall Containment System Evaluation, Lowry Landfill Superfund Site. Prepared for the Lowry Landfill Superfund Sites Work Settling Defendants. Prepared by EMSI with assistance from Parsons and CDM Smith. September 2021.

Final Operations and Maintenance Manual, Covers and Stormwater, Lowry Landfill Superfund Site. EMSI 2007.

Final Updated Conceptual Site Model, Lowry Landfill Superfund Site, Arapahoe County, Colorado. October 2021.

Five-Year Review Addendum for the Lowry Landfill Superfund Site, Arapahoe County, Colorado, EPA Region 8. February 2021.

Five-Year Review Report, Fourth Review for Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. September 2017.

Groundwater Monitoring Plan, Revision 2, Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. September 2018.

Interim Compliance Monitoring Plan for Surface Water, Lowry Landfill Superfund Site, Parsons. December 1996.

Memorandum, 1,4-Dioxane Practical Quantitation Limit Update. Lowry Landfill Superfund Site. Prepared by EMSI and Parsons. Prepared for the Work Settling Defendants. December 3, 2020.

Memorandum, Work Plan to Increase Capacity of Water Treatment Plant. Lowry Landfill Superfund Site. Prepared by EMSI. Prepared for the Work Settling Defendants. June 27, 2018.

Minor Modification of the March 10, 1994 Record of Decision, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. August 1995.

Minor Modification of the March 10, 1994 Record of Decision, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. March 1996.

Minor Modification of the March 10, 1994 Record of Decision, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. May 2001.

Minor Modification of the March 10, 1994 Record of Decision, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. September 2002.

Minor Modification of the Selected Remedy, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. July 2006.

North Boundary Barrier Wall Containment System Evaluation Plan, Lowry Landfill Superfund Site. Prepared for the Lowry Landfill Superfund Sites Work Settling Defendants. Prepared by EMSI with assistance from Parsons and CDM Smith. Revised Draft October 25, 2019 and October 1, 2020.

North End Monitoring Plan, Update 2. Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared by EMSI. October 16, 2020.

North End Monitoring Plan, Update 3. Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared by Parsons. August 23, 2021.

Notification of Additional Action to Extract Groundwater from NBBW-IW-3 in B-326/MW113 Area. Lowry Landfill Superfund Site. Prepared by EMSI. May 8, 2020.

Pilot Test for Cessation of Potable Water Injection, Final Report, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. December 17, 2019.

Pilot Test for Cessation of Potable Water Injection. Revised Final Report. Prepared by EMSI and CDM Smith. May 15, 2020.

Responses to the Lowry Landfill Community Advisory Letter Dated March 31, 2021. EPA Region 8. June 11, 2021.

Risk Assessment, 1, 4-Dioxane Risk Summary, North End Sampling, Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared by the EPA in conjunction with CDPHE. September 2, 2020.

Record of Decision, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. March 1994.

Remedial Action and Operations and Maintenance Status Report, January through June 2017, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. September 2017.

Remedial Action and Operations and Maintenance Status Report, July through December 2018, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. March 2017.

Remedial Action and Operations and Maintenance Status Report, January through June 2017, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. September 2017.

Remedial Action and Operations and Maintenance Status Report, July through December 2018, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. March 2018.

Remedial Action and Operations and Maintenance Status Report, January through June 2018, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. September 2018.

Remedial Action and Operations and Maintenance Status Report, July through December 2018, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. March 2019.

Remedial Action and Operations and Maintenance Status Report, January through June 2019, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. September 2019.

Remedial Action and Operations and Maintenance Status Report, July through December 2019, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. March 2020.

Remedial Action and Operations and Maintenance Status Report, January through June 2020, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. September 2020.

Remedial Action and Operations and Maintenance Status Report, July through December 2020, Lowry Landfill Superfund Site. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. Reviewed and approved by the EPA. March 2021.

Response Action Work Plan, B-326-UD and B-313 Areas, Lowry Landfill Superfund Site, Operations and Maintenance. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. April 2013.

Response Action Work Plan to Extract Additional Groundwater from Upgradient of MW77-WD, Lowry Landfill Superfund Site, Remedial Action/Operations and Maintenance. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. November 2011.

Revised North End Initial Response Action (IRA) Work Plan Addendum, and North End Monitoring Data, Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared for EPA Region 8. Prepared by EMSI. February 2008.

Revision 2 Operations and Maintenance Manual Groundwater Extraction, Lowry Landfill Superfund Site, Operations and Maintenance. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. April 2015.

Revision 3 Operations and Maintenance Manual Groundwater Extraction, Lowry Landfill Superfund Site, Operations and Maintenance. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by Parsons. August 2021.

Revision 3, Updated Compliance Monitoring Plan, Landfill Gas Remedy, Lowry Superfund Site, Remedial Action/Operations and Maintenance. Prepared for City and County of Denver, Chemical Waste Management, Inc. and Waste Management of Colorado, Inc. Prepared by EMSI. July 2018.

Second Explanation of Significant Differences, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. October 1997.

Stormwater Monitoring Plan, Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared for EPA Region 8. Prepared by EMSI. April 2008.

Technical Memorandum, Evaluation of Potential Sources of Elevated Molybdenum in Wells MW113-WD and MW113-EW-1, Lowry Landfill Superfund Site. Prepared by EMSI and CDM Smith. November 6, 2020.

Technical Memorandum, Identification and Sampling of Water Supply Wells Within and Immediately Adjacent to Off-Site 1,4-Dioxane Plume. Final. Prepared by EMSI. June 3, 2020.

Technical Memorandum, Documentation of Three-Dimensional Data Visualization and Analysis (3DVA). Lowry Landfill Superfund Site, Arapahoe County, Colorado. Revision 3. Prepared by Pacific Western Technologies and Tetra Tech. June 2020.

Technical Memorandum, Review of Geologic Faulting and Groundwater Contaminant Migration, Revision 1. Lowry Landfill Superfund Site, Arapahoe County, Colorado. Prepared by Pacific Western Technologies and Tetra Tech. April 2018.

Technical Memorandum, Updated 1,4-Dioxane Plume Map and North End Conceptual Model (North End Investigation Report) 2017 Five-Year Review Issues #7 and #9, Lowry Landfill Superfund Site. Prepared by EMSI and CDM Smith. September 2, 2020.

Third Explanation of Significant Differences, Lowry Landfill Superfund Site, Arapahoe County, Colorado. EPA Region 8. May 2007.

Updated Contingency Plan, Lowry Landfill Superfund Site. Prepared by EMSI and Parsons. September 21, 2018.

Updated Waste Management Plan, Lowry Landfill Superfund Site. Prepared by EMSI and Parsons. October 14, 2020.

Work Plan to Assess Northern Extent of 1,4-Dioxane in Shallow Groundwater (North of Well MW144-WD). Prepared for the EPA. Prepared by EMSI. November 2014.

Work Plan to Further Assess the North End 1,4-Dioxane Plume, Prepared for the EPA. Prepared by EMSI. November 8, 2018.

APPENDIX B – SITE CHRONOLOGY

Table B-1: Site Chronology

Event	Date
The City and County of Denver purchased 60,000 acres southeast of Denver and deeded the land to the federal government	1939
The City and County of Denver operated Lowry Landfill as a municipal and industrial landfill	1965-1980
Citizens issued complaints about the Lowry Landfill to regulatory authorities. EPA, the CDPHE and Denver engaged in an ongoing process to identify contamination problems and modify operational practices.	1971-1979
Various investigations were conducted by the EPA, the United States Geological Survey and CDPHE and were performed by the City and County of Denver and Waste Management	Mid-1970s-1984
Waste Management took over the operation of the landfill under a contract with the City and County of Denver	1980
The EPA conducted a Preliminary Assessment for the Site	June 1, 1980
The EPA conducted a Site Inspection	August 1, 1982
The EPA listed the Site on the NPL	September 21, 1984
The City and County of Denver implemented an interim remedial measure consisting of a subsurface groundwater drain backed by a compacted clay barrier wall (the NBBW) and a WTP. The EPA issued a Community Relations Plan for the Site	1984
The EPA conducted the Phase I RI	1985-1986
The Agency for Toxic Substances and Disease Registry completed a public health assessment of the Site	1987
The EPA conducted the Phase II RI and designated Site OUs	1987-1989
the EPA completed an Engineering Evaluation/Cost Analysis of alternatives for the SWRA	1988
The EPA conducted the Drum Removal Action	1989-1990
Municipal solid waste disposal activities at Section 6 were discontinued	1990
The City and County of Denver and Waste Management implemented a tire-shredding operation to shred about 8 million tires stockpiled in Section 6	1989-1992
PRPs performed the RI for OU1 and OU6	1991-1992
The City and County of Denver, Waste Management, Chemical Waste Management performed the RI for OU2 and OU3. Metro and the City and County of Denver performed the RI for OU4 and OU5	1992-1993
The Lowry Coalition performed the FS for OU1 and OU6 The City and County of Denver, Waste Management and Chemical Waste Management performed the FS for OU2 and OU3 Metro and the City and County of Denver performed the FS for OU4 and OU5	1992-1993
Construction of SWRA completed	1992
Scrap Tire Removal Project completed	1993
The EPA issued the Proposed Plans for OUs 1 and 6, 2 and 3, and 4 and 5	1992-1993
The EPA issued the ROD	March 10, 1994
The EPA issued the Unilateral Administrative Order for RD/RA to 34 PRPs	November 18, 1994
The EPA issued a minor modification to the ROD, which clarified institutional controls and allowed ongoing waste disposal activities	1995
The EPA issued the first ESD for the ROD, which clarified performance standard criteria	1995
The EPA issued a minor modification to the ROD to clarify the wetland construction methodology	1996
Respondents constructed the landfill gas collection and treatment system	1996
The EPA issued the second ESD, which allowed on-site disposal of contaminated materials from the FTPA, and piping pretreated groundwater to Metro and the City of Aurora's Sand Creek Wastewater Reclamation facility	1997
Respondents completed the NTES and the east/south/west Perimeter Slurry Wall	1998

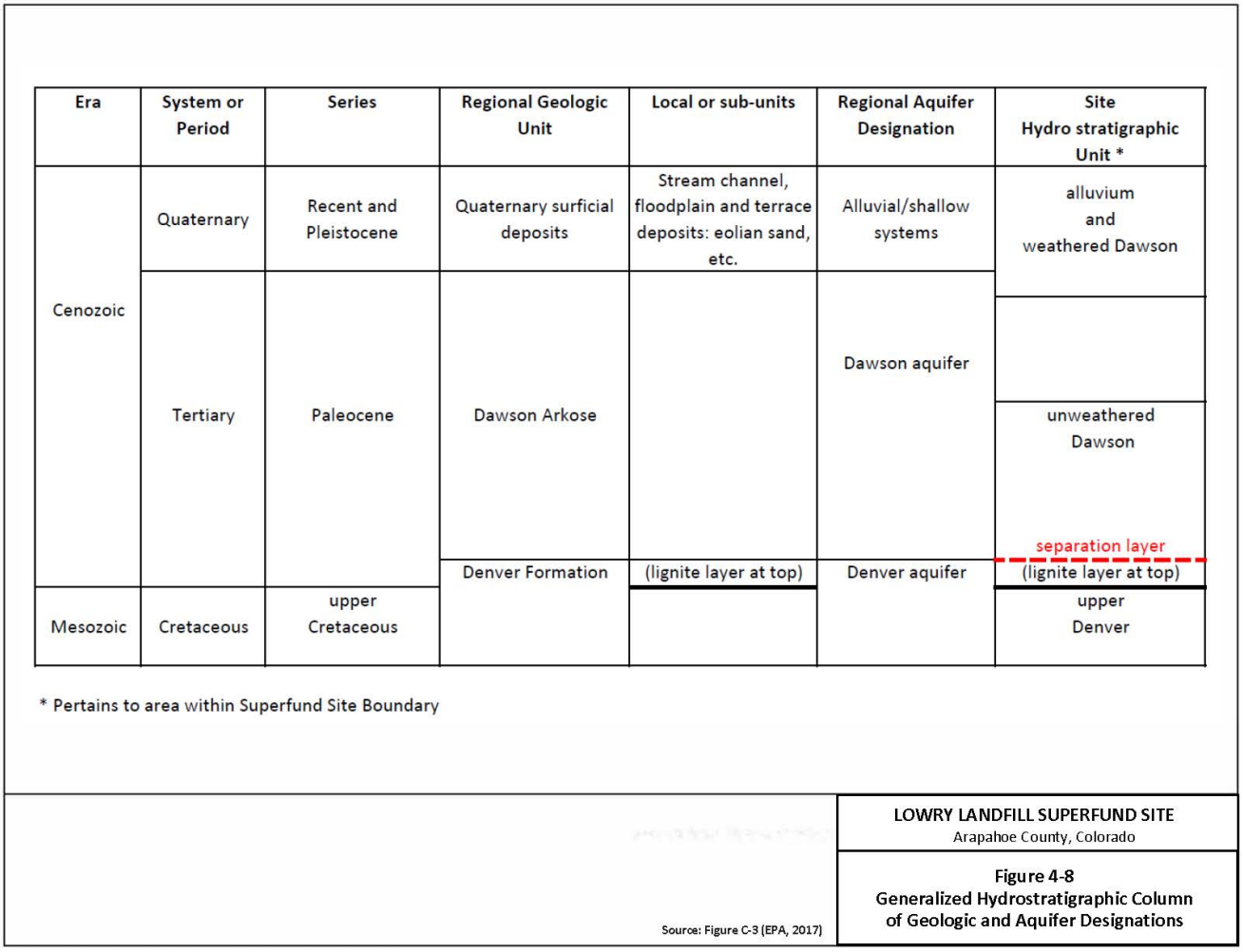
Event	Date
Respondents completed the FTPA Middle Waste Pit excavation	1999
Respondents completed the FTPA Middle Waste Pit treatment cell	1999
Respondents completed North Face Landfill Cover	1999
Respondents completed the new WTP	2000
The EPA issued a minor modification to the ROD, changing the 1,1-dichloroethene air quality performance standard	2001
Potable water injection started at the NBBW	2001
The EPA conducted the Site's first FYR Report	2001
The EPA issued a minor modification to the ROD to modify the performance standards based on new toxicity criteria and adding 1,4-dioxane as a COC	2002
The EPA issued the first Addendum to the first FYR Report	2002
1,4-Dioxane was detected in shallow groundwater north of the Site. Investigations and monitoring began, and monitoring wells were installed.	2003-Present
Respondents constructed the Biological Treatment System at the WTP	2004-2005
Groundwater extracted from the NTES treated in the upgraded WTP	2005-Present
The EPA approved the Sitewide GWMP	2005
The EPA updated the Institutional Controls Plan	2005
Respondents implemented the MW-38 Area Gradient Control Contingency Measure	2005
The EPA issued the ROD Amendment for the FTPA remedy	2005
The EPA certified the completion of construction of the groundwater monitoring network	2005
The EPA certified completion of Remedial Action for the SWRA, MW38 Area Gradient Control Contingency Measure and New WTP	2005
The EPA certified completion of work for the wetlands mitigation	2005
The EPA approved the Final Interim Closeout Report, Middle Waste Pit Remediation and Construction of the Treatment Cell, FTPA Waste Pit Remedy	2005
United States entered into a Consent Decree with the City and County of Denver, Waste Management, and Chemical Waste Management (the WSDs), and five other PRPs for recovery of the United States' costs and performance of remaining work at the Site	2005
The EPA established a new groundwater performance standard for 1,4 dioxane	2006
The EPA issued a minor modification to the ROD to designate a Corrective Action Management Unit for the disposal of treated FTPA soils	2006
The EPA certified construction completion for the sitewide remedy	2006
The EPA conducted the Site's second FYR Report	2007
The EPA issued the third ESD, modifying the treatment component of the landfill gas remedy by adding a new on-site landfill gas-to-energy facility	2007
The EPA certified completion of Interim Remedial Action for the Groundwater Monitoring Program	2007
WSDs installed wells to remove and treat 1,4-dioxane in groundwater north of the Site	2007-Present
The EPA approved the Final Remedial Action Completion Report for the South Waste Pit portion of the FTPA	2010
The EPA approved Addendum 1 to the Final Construction Closeout Report for the GTEP	2011
The EPA completed the Site's third FYR Report	September 27, 2012
The EPA approved Addendum 4 to the Final O&M Manual for the WTP	2012
The EPA approved completion of the Final Remedial Action Report for the North Waste Pit and FTPA	2013
EPA approved Revision 2, Updated Compliance Monitoring Plan, LFG Remedy with updated subsurface gas performance standards	2015
The EPA completed the Site's fourth FYR Report	September 28, 2017
The WSDs completed survey of private wells within 5 miles of the Site	2017
The WSDs provide a progress report on the Assessment of Northern Extent of 1,4 – dioxane in groundwater north of well MW 144-WD	2017
The WSDs updated the Site Management Plan	2018

Event	Date
The EPA approved Revision 3, Updated Compliance Monitoring Plan, LFG Remedy with updated subsurface gas performance standards	2018
The EPA approved Revision 2, GWMP	2018
The WSDs updated the Contingency Plan	2018
The WSDs completed the groundwater synoptic sampling event	2018-2019
The WSDs expanded WTP capacity and installed a larger discharge pipe; O&M manual was updated to reflect the upgrades	2018-2019
Potable water injection ceased	October 2, 2018
The WSDs conduct pilot-test to cease potable water injection north of the NBBW and prepared periodic monitoring reports to study the effect of the cessation on the NBBW. The EPA approved Final Cessation and Pilot-Test Report finalized.	2018-2020
The WSDs completed the annual evaluation and update to the PQLs, as required by the Consent Decree	2019
The WSDs updated the O&M Manual for the WTP, Addendum 6	2019
The EPA certified for use the Calibrated Numerical Three-Dimensional, Finite-Element Groundwater Simulation Model	2019
The EPA updated the Community Involvement Plan	June 1, 2020
The EPA approved Technical Memorandum, Identification and Sampling of Water Supply Wells Within and Immediately Adjacent to Off-Site 1,4-Dioxane Plume	June 3, 2020
The WSDs completed the North End investigation to assess the nature and extent of 1,4-dioxane in groundwater north of the NBBW to just north of East Mississippi Avenue	2019-2020 September 2, 2020
The EPA and CDPHE completed a risk assessment called the 1,4-Dioxane Risk Summary – North End Sampling	September 2, 2020
The WSDs updated the Waste Management Plan, Remedial Action and Operations Manual	October 14, 2020
The EPA completed 3-dimensional Data Visualization and Analysis of geology, hydrogeology, and chemistry.	2020
The WSDs complete the North End Groundwater Monitoring Plan - Update 2	October 16, 2020
The EPA approves the North Boundary Barrier Wall (NBBW) Containment System Evaluation Plan	October 16, 2020
The WSDs complete a report on Molybdenum	November 6, 2020
The WSDs began extraction of groundwater from NBBW-IW-3 in the B-326/MW-113 area north of the NBBW	2020
The WSDs completed the most recent annual evaluation and update to the PQLs, as required by the Consent Decree	December 2020
The WSDs finalize and EPA accepts the Technical Memorandum: Effectiveness Evaluations for MW38 Area, North Toe Extraction System, and North End Response Actions	January 28, 2021
The WSDs finalize and EPA accepts the Technical Memorandum: Effectiveness Evaluation for Perimeter Barrier Wall	January 28, 2021
The WSDs provide Technical Memorandum: Statistical Analysis of Acetone Detections in Groundwater Samples 2016 through 2020	February 5, 2021
The EPA approved the WSDs Revision 4, Updated LFG Compliance Monitoring Plan, LFG Remedy	February 10, 2021
The EPA signed the FYR Addendum	February 11, 2021
The WSDs complete the North End Groundwater Monitoring Plan, Update 3	August 23, 2021
The WSDs conducted a Containment System Evaluation for the NBBW	September 21, 2021
The EPA, in collaboration with the WSDs, in conjunction with CDPHE and Tri-County Health, developed the Site's Conceptual Site Model	October 12, 2021

APPENDIX C – SITE MAPS

Figure C-1: Site Vicinity Map

Figure C-2: Geologic Units and Aquifer Designations[7]



Era	System or Period	Series	Regional Geologic Unit	Local or sub-units	Regional Aquifer Designation	Site Hydro stratigraphic Unit *
Cenozoic	Quaternary	Recent and Pleistocene	Quaternary surficial deposits	Stream channel, floodplain and terrace deposits: eolian sand, etc.	Alluvial/shallow systems	alluvium and weathered Dawson
	Tertiary	Paleocene	Dawson Arkose		Dawson aquifer	unweathered Dawson
			Denver Formation	(lignite layer at top)	Denver aquifer	separation layer (lignite layer at top)
Mesozoic	Cretaceous	upper Cretaceous				upper Denver

* Pertains to area within Superfund Site Boundary

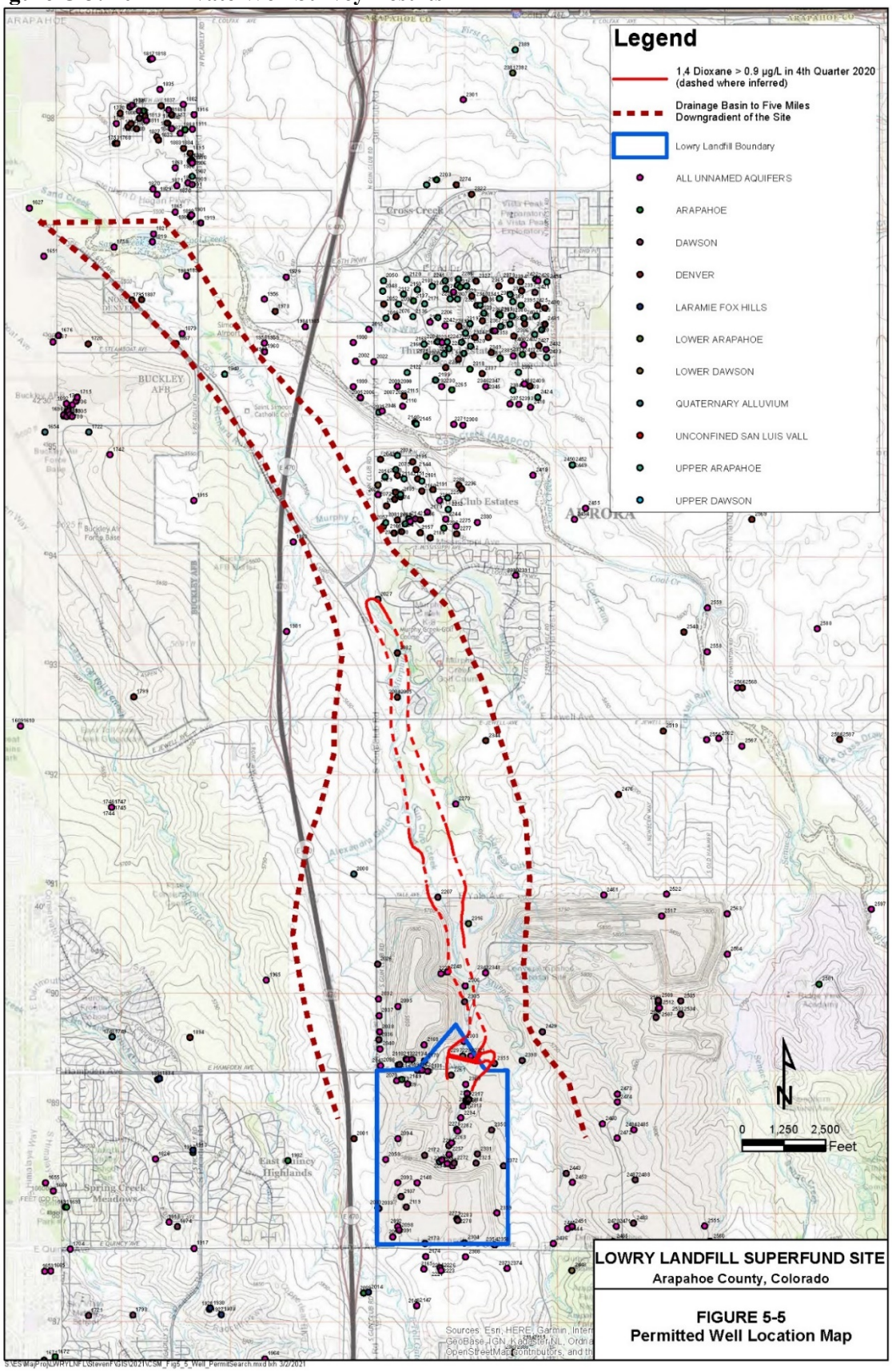
Source: Figure C-3 (EPA, 2017)

LOWRY LANDFILL SUPERFUND SITE
Arapahoe County, Colorado

Figure 4-8
Generalized Hydrostratigraphic Column
of Geologic and Aquifer Designations

[7] Source: 2018 GWMP, Revision 2

Figure C-3: 2017 Private Well Survey Results[8]

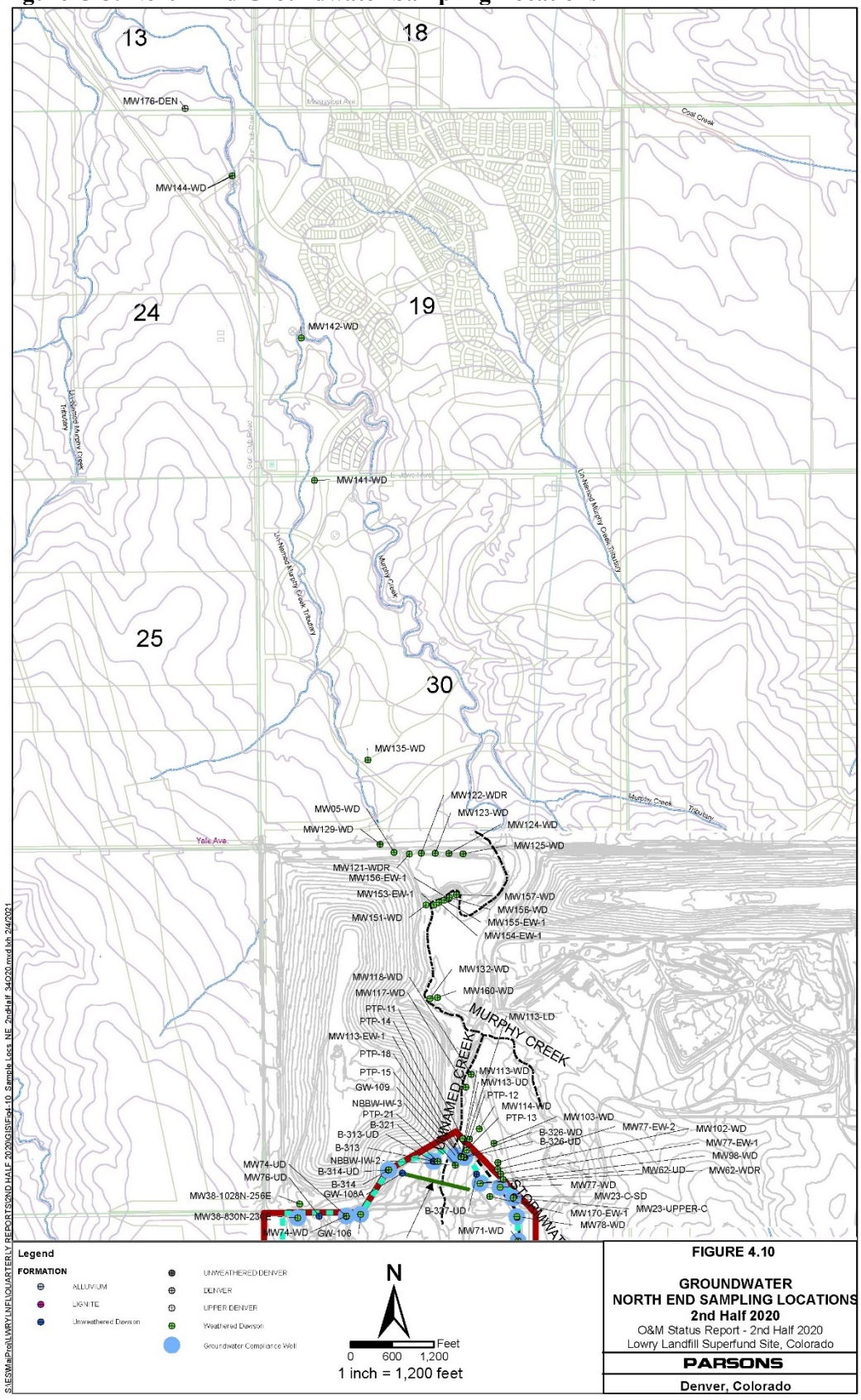


[8] 2021 Final Updated CSM

Figure C-4: Groundwater Sampling Locations[9]

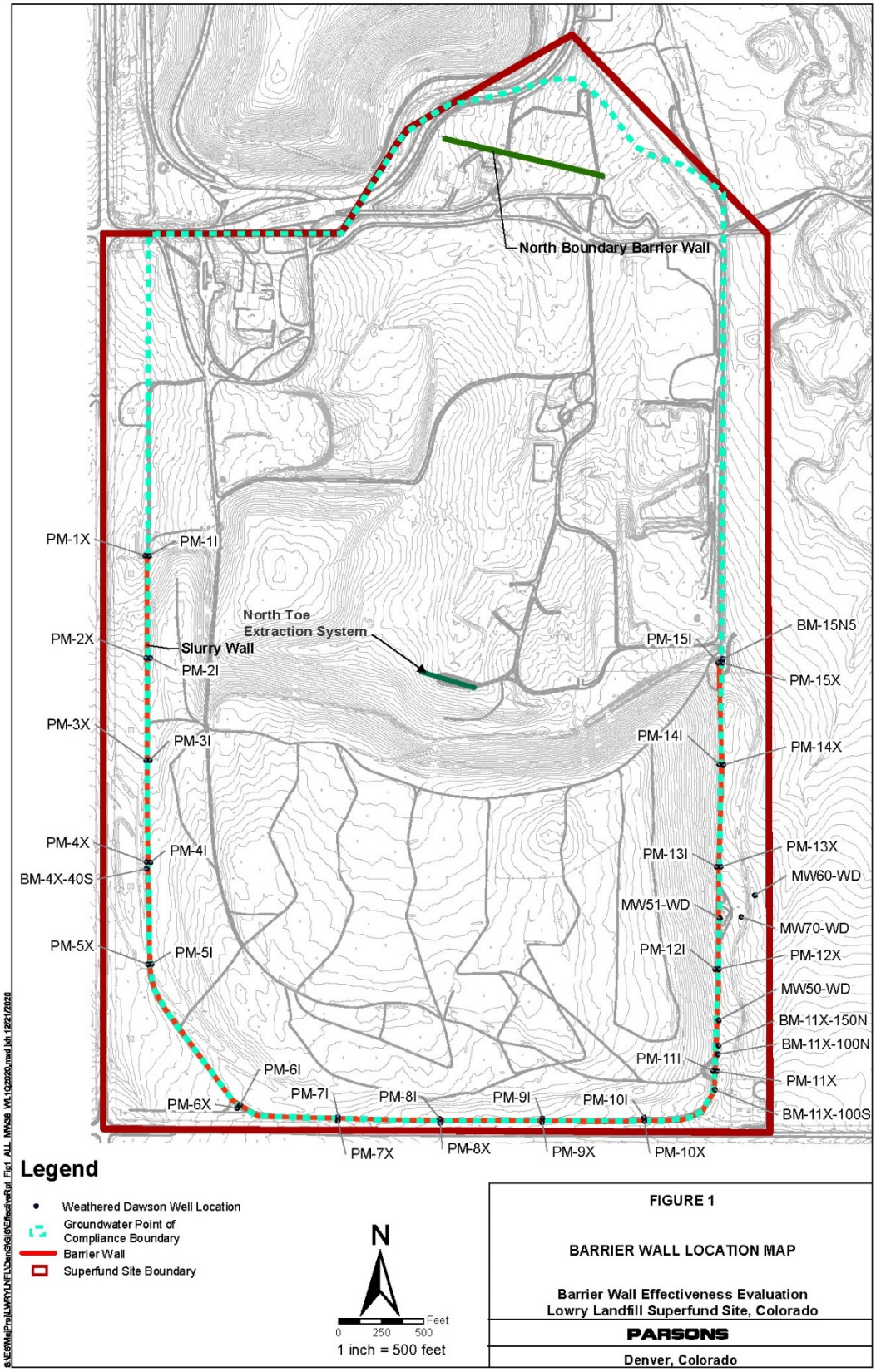
[9] Source: O&M Status Report – 2nd Half 2020

Figure C-5: North End Groundwater Sampling Locations[10]



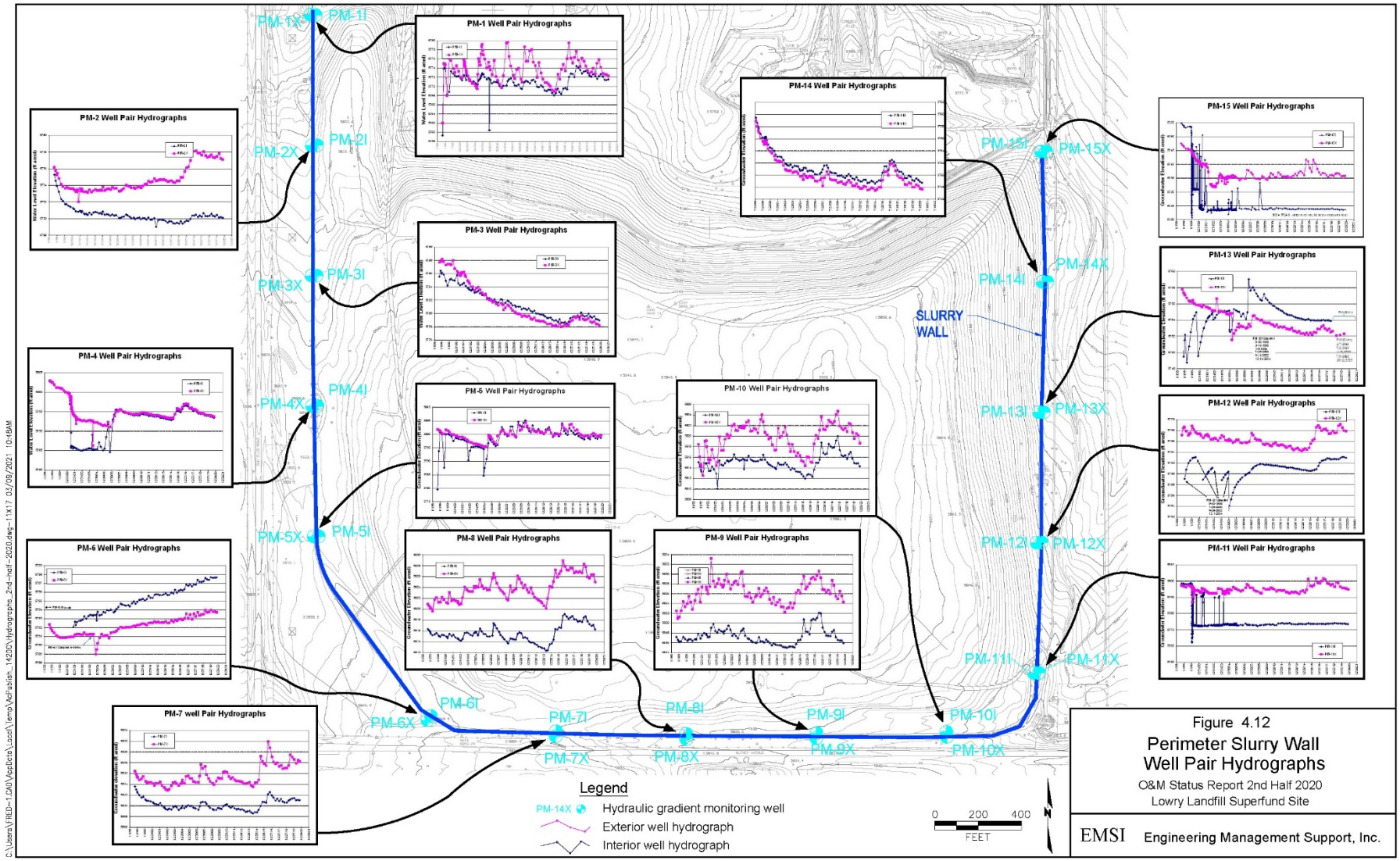
[10] Source: O&M Status Report – 2nd Half 2020

Figure C-6: Perimeter Slurry Wall Effectiveness Monitoring Locations[11]



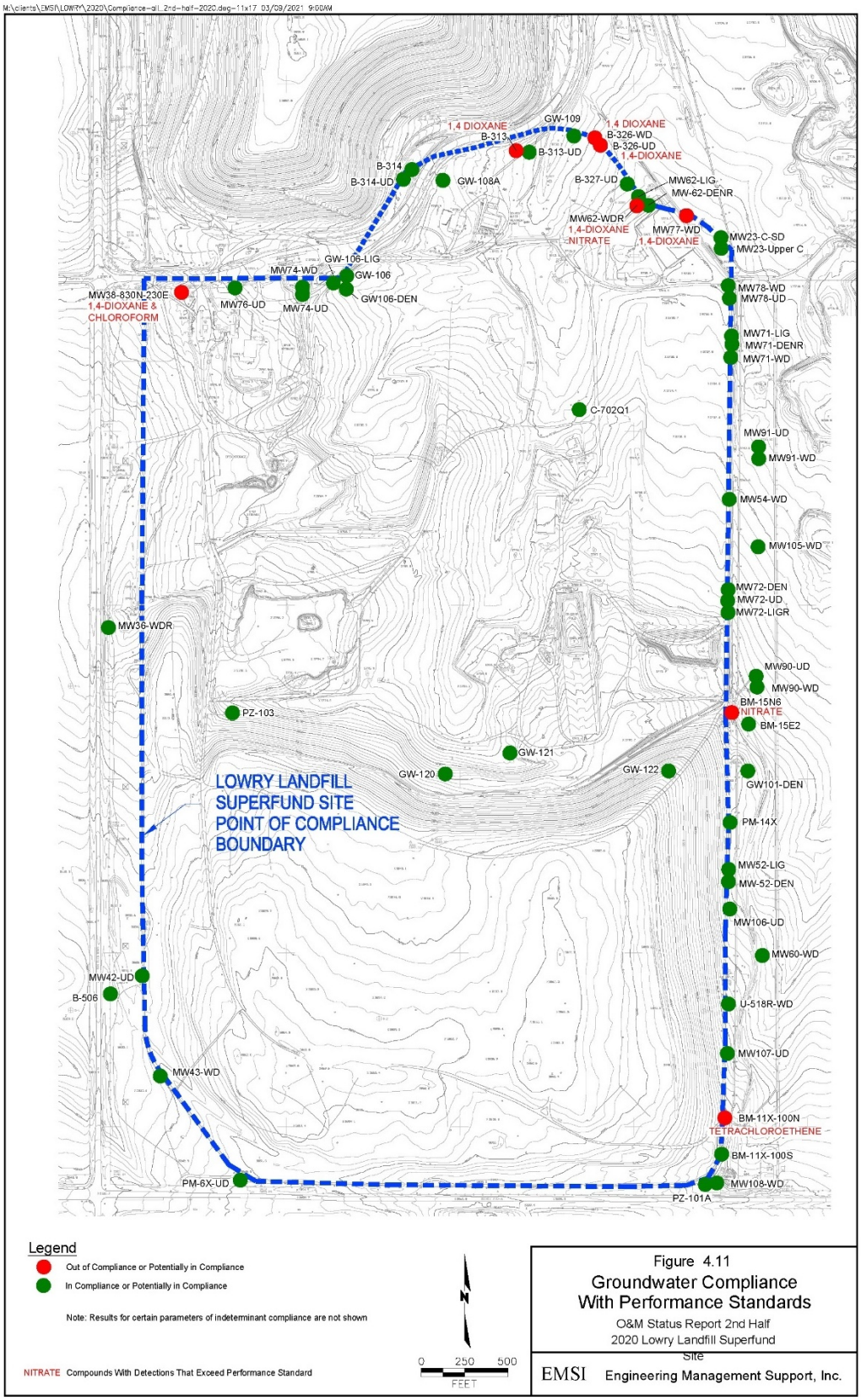
[11] Source: O&M Status Report – 2nd Half 2020

Figure C-7: Perimeter Slurry Wall Well Pair Hydrographs[12]



[12] Source: O&M Status Report – 2nd Half 2020

Figure C-8: Groundwater Compliance, Second Half of 2020[13]



[13] Source: O&M Status Report – 2nd Half 2020

Figure C-9: MW38 Area Potentiometric Surface Alluvium/Weathered Dawson, October 2020[14]

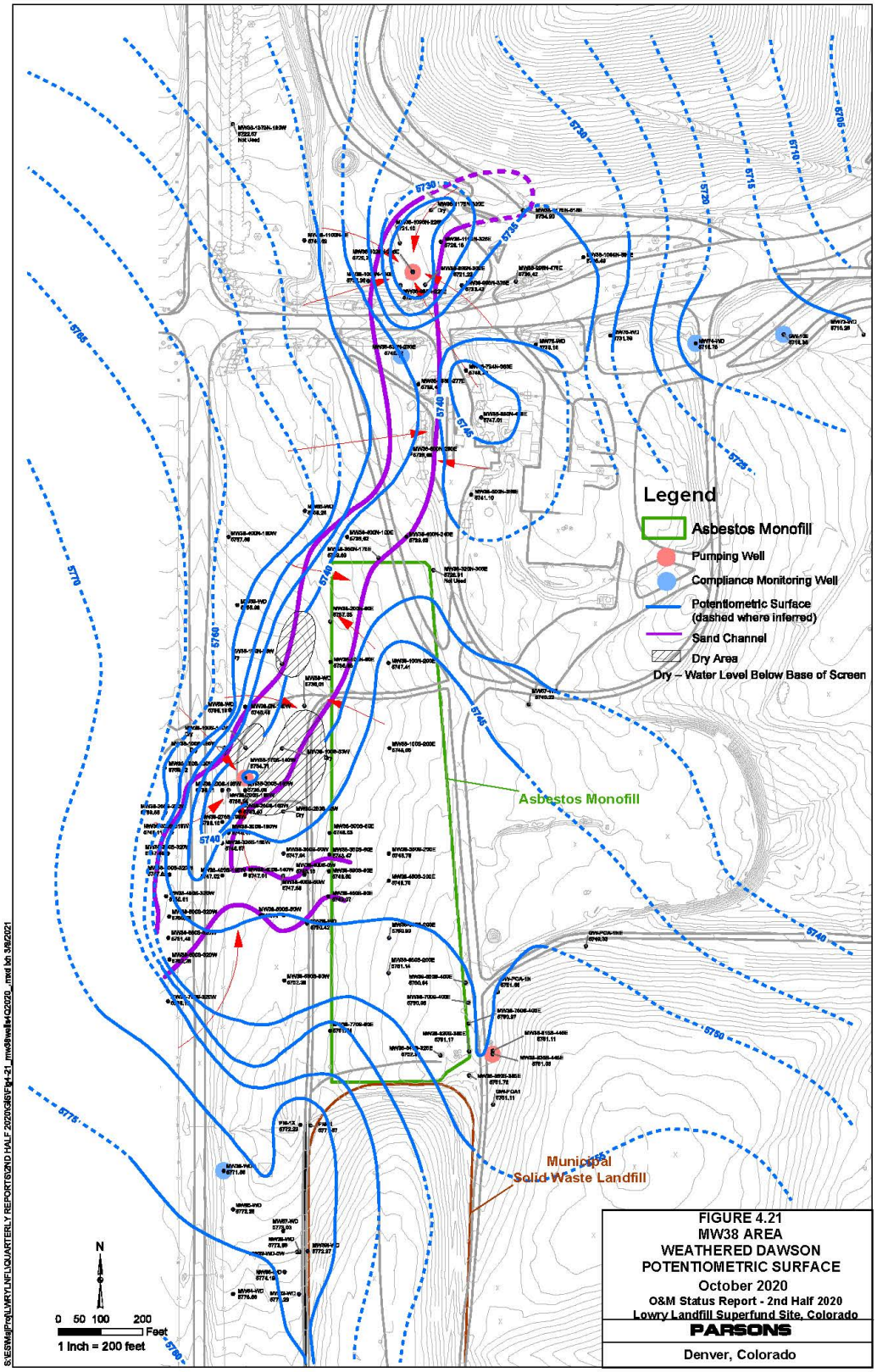
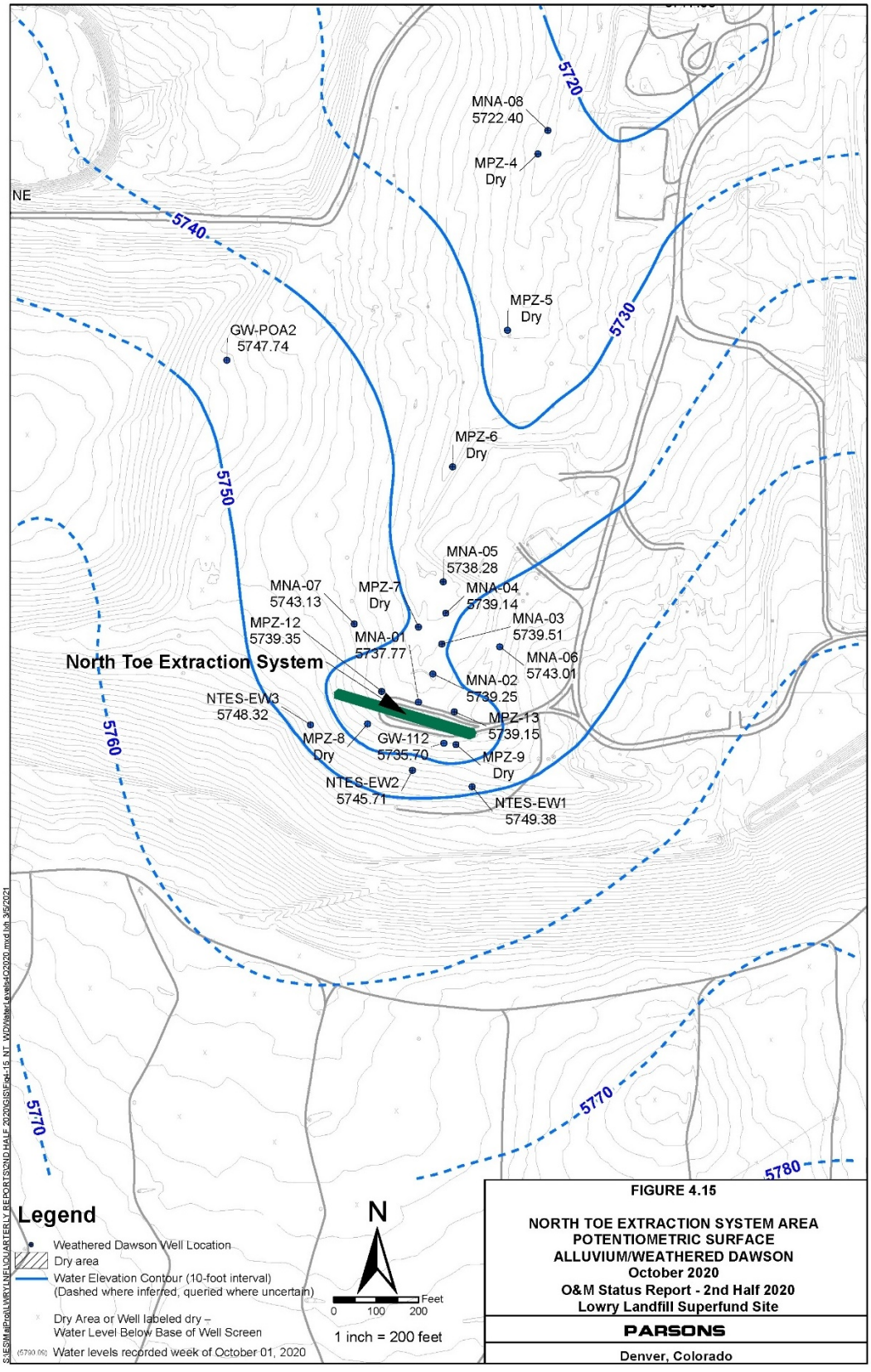
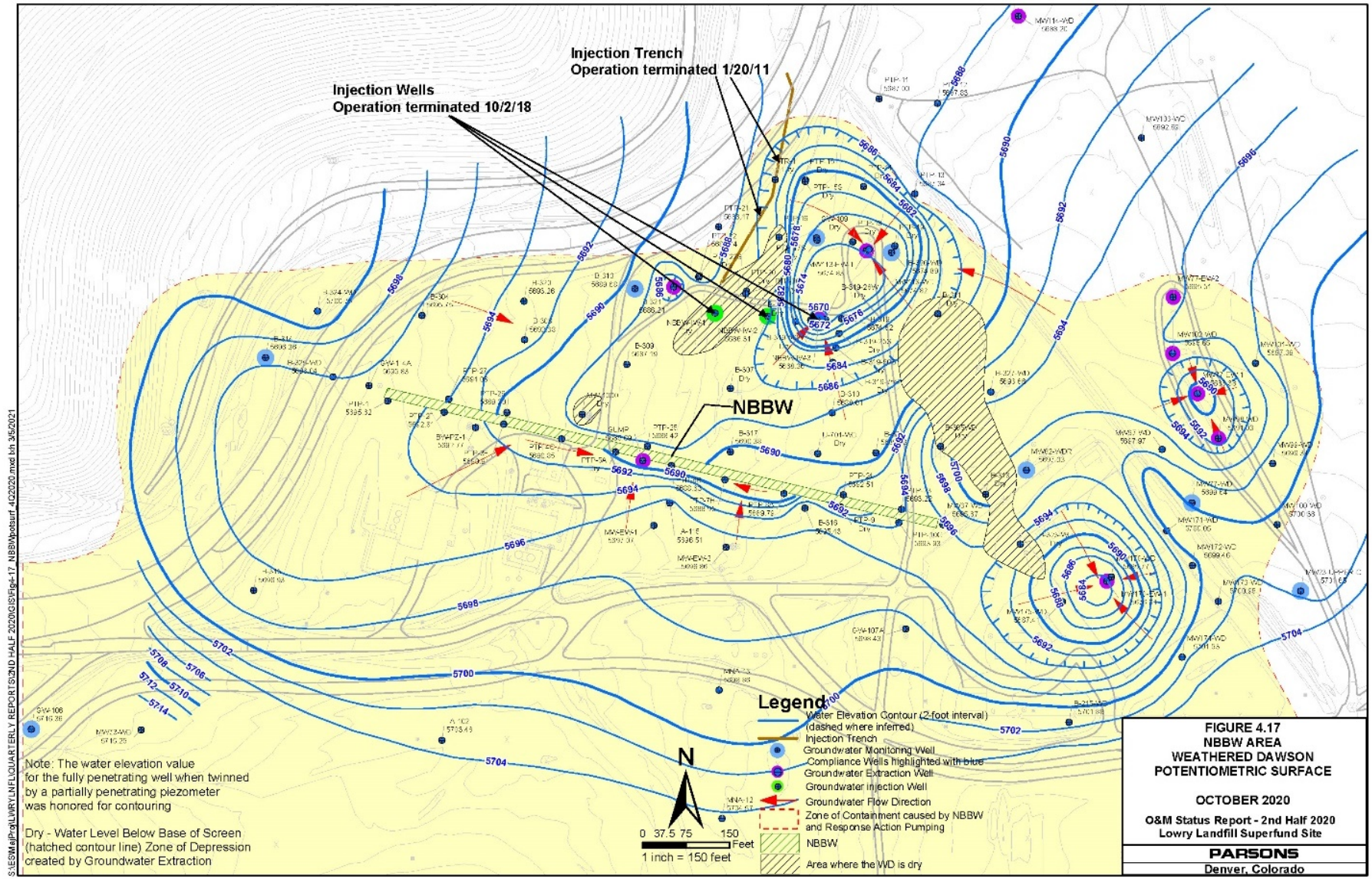


Figure C-10: NTES Potentiometric Surface Alluvium/Weathered Dawson, October 2020[15]



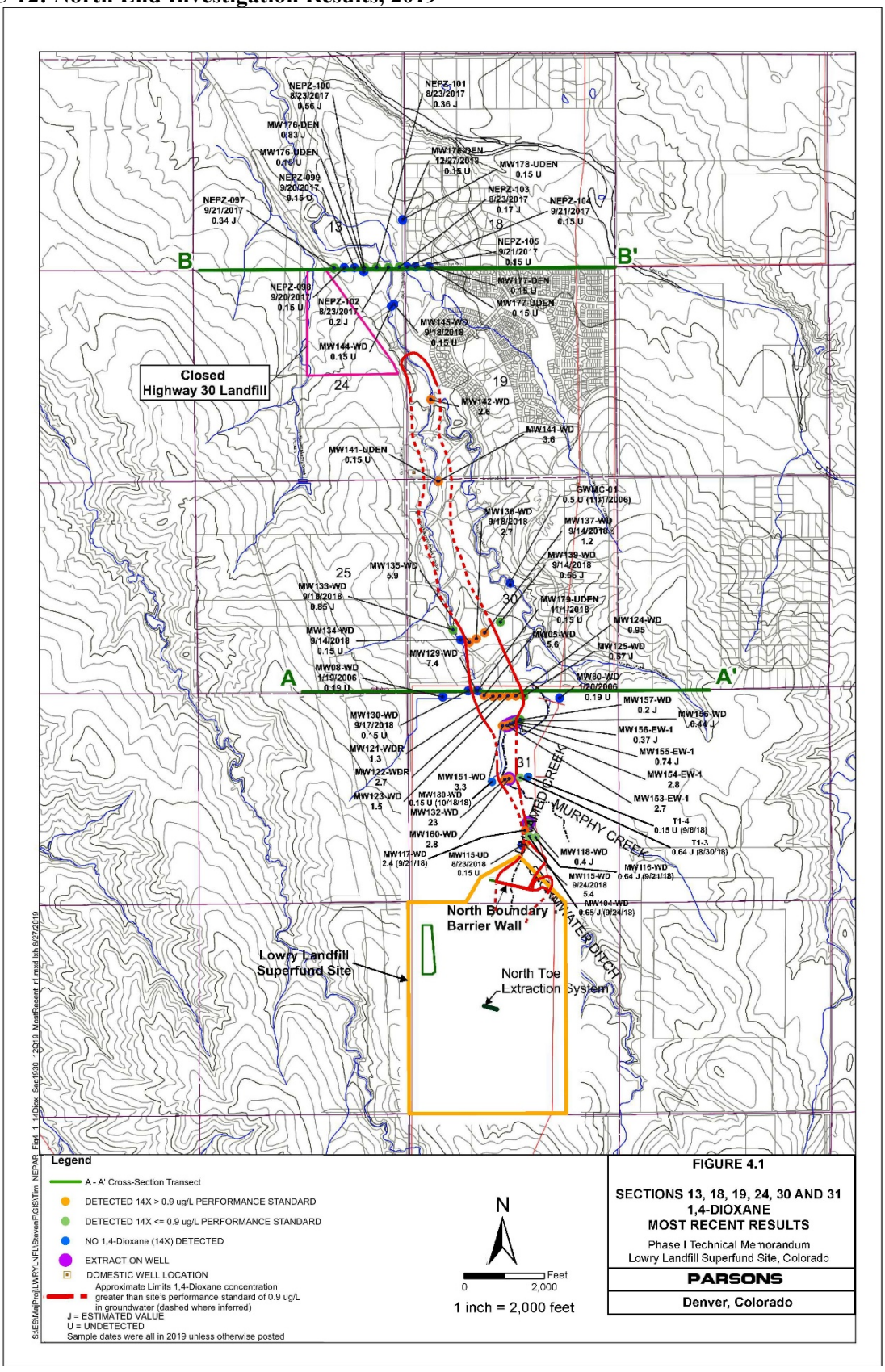
[14] Source: O&M Status Report – 2nd Half 2020
[15] Source: O&M Status Report – 2nd Half 2020

Figure C-11: NBBW Area Weathered Dawson Potentiometric Surface Map[16]



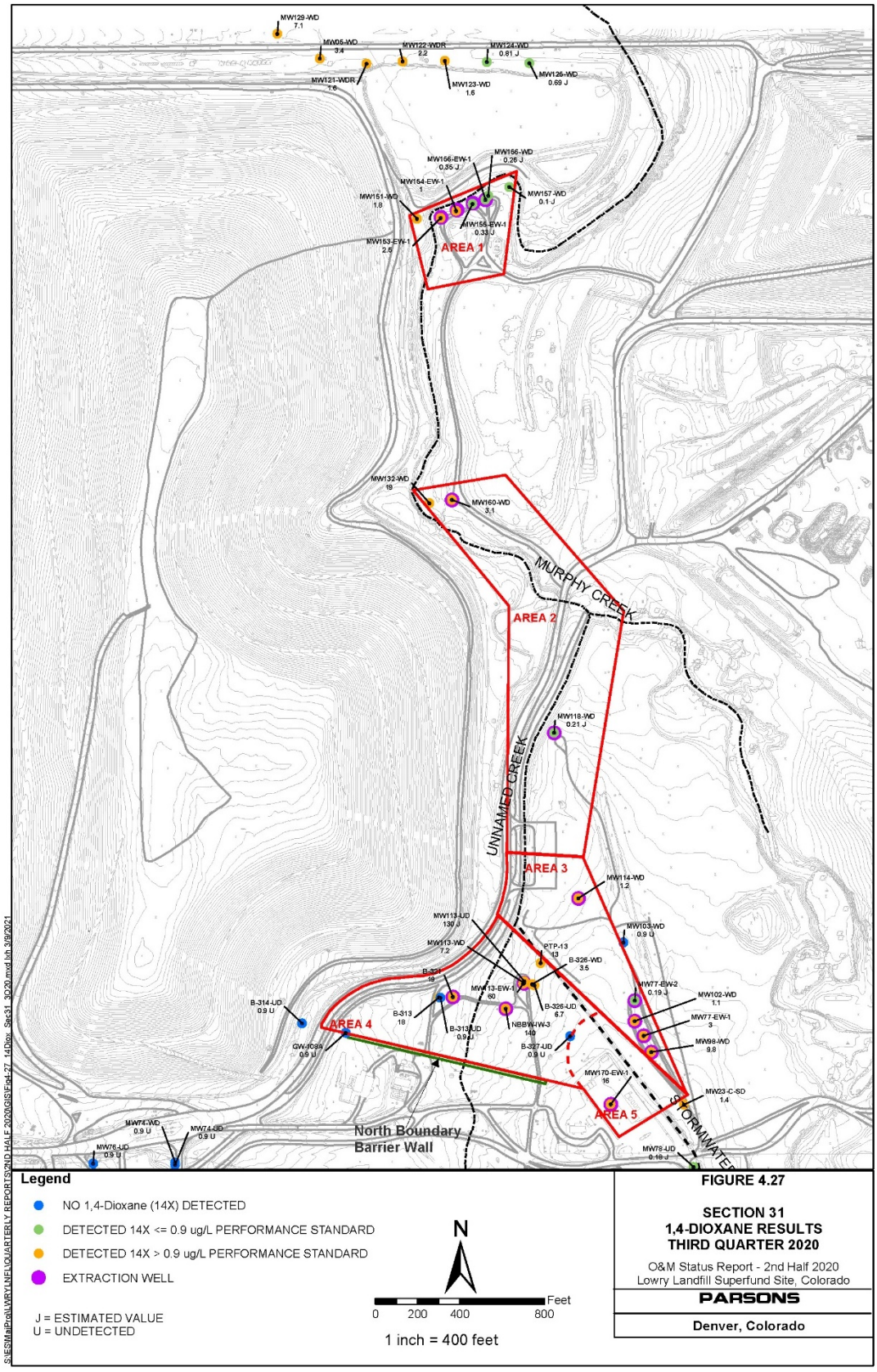
[16] Source: O&M Status Report – 2nd Half 2020

Figure C-12: North End Investigation Results, 2019[17]



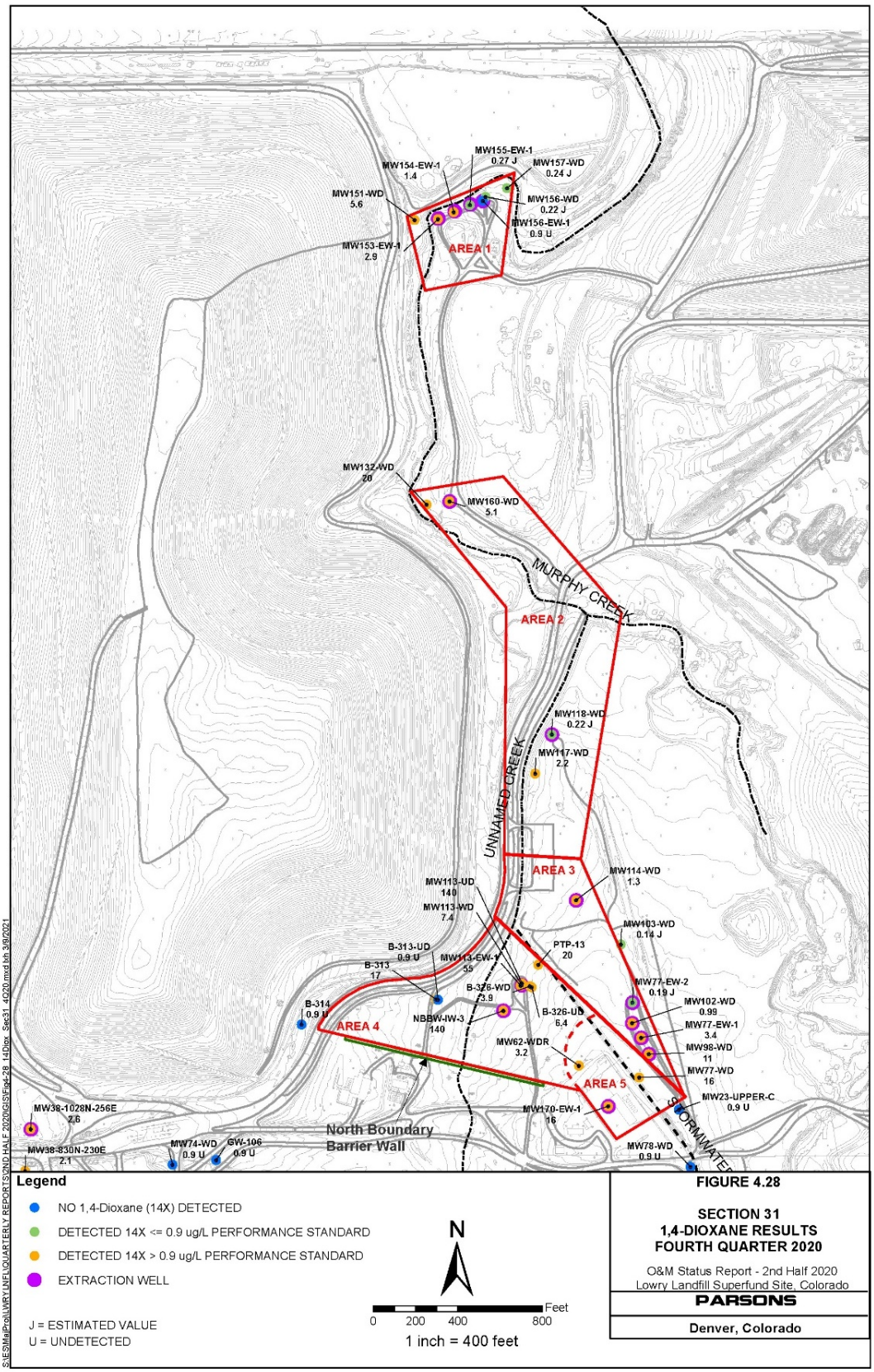
[17] 2021 Final Updated CSM

Figure C-13: Section 31 1,4-Dioxane Results, Third Quarter of 2020[18]



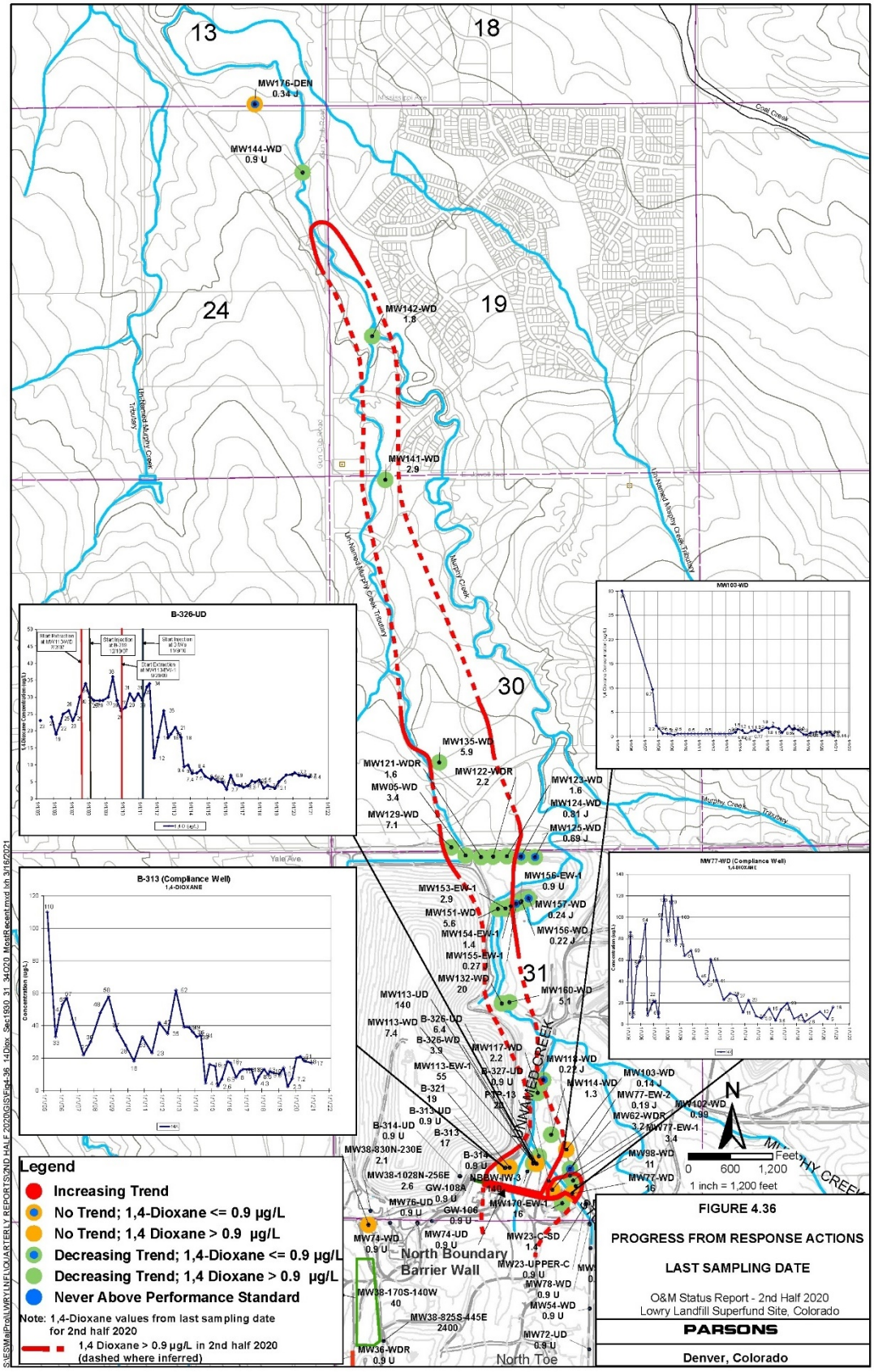
[18] Source: O&M Status Report – 2nd Half 2020

Figure C-14: Section 31 1,4-Dioxane Results, Fourth Quarter of 2020[19]



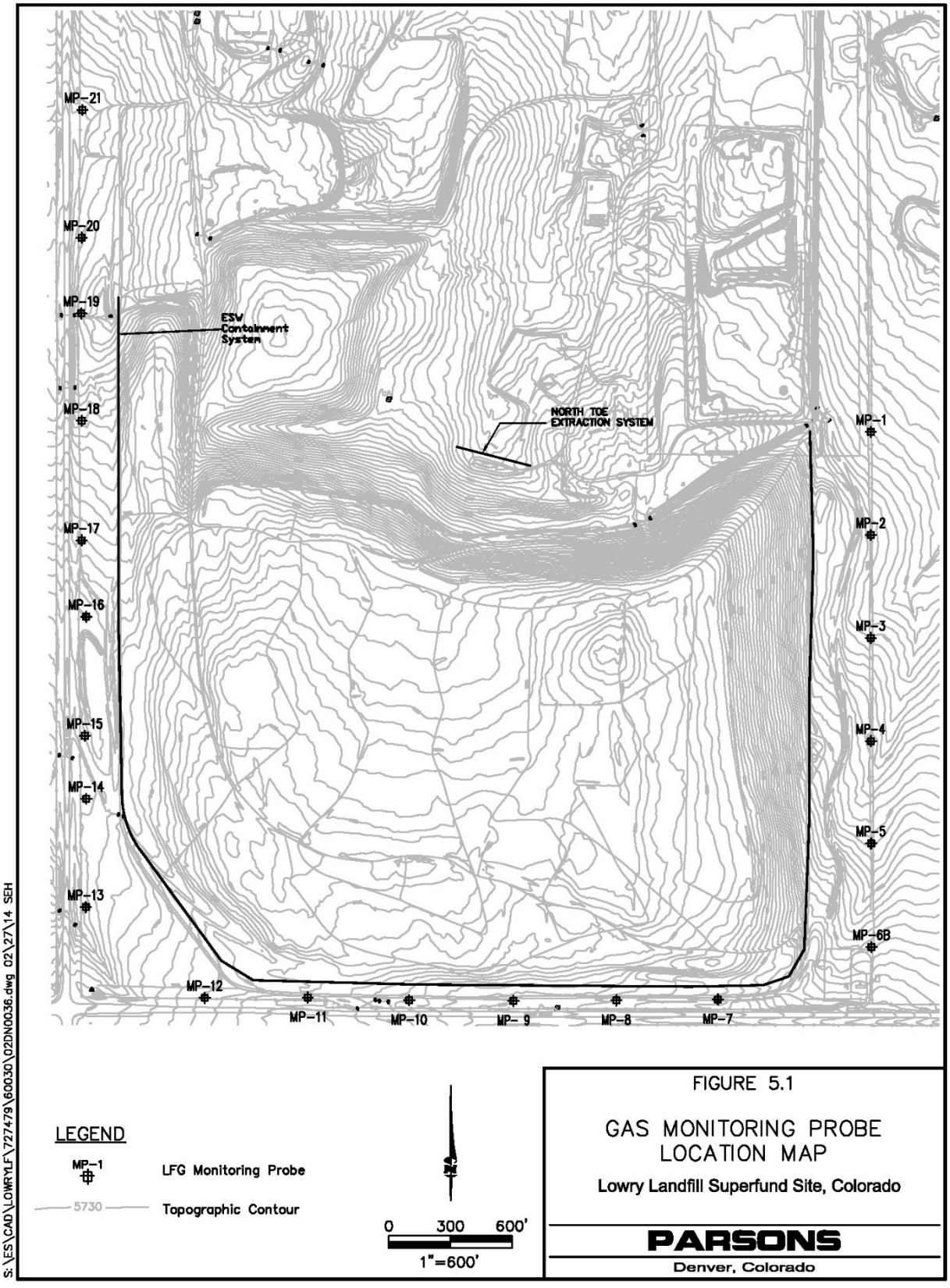
[19] Source: O&M Status Report – 2nd Half 2020

Figure C-15: 2020 Progress from Response Actions[20]



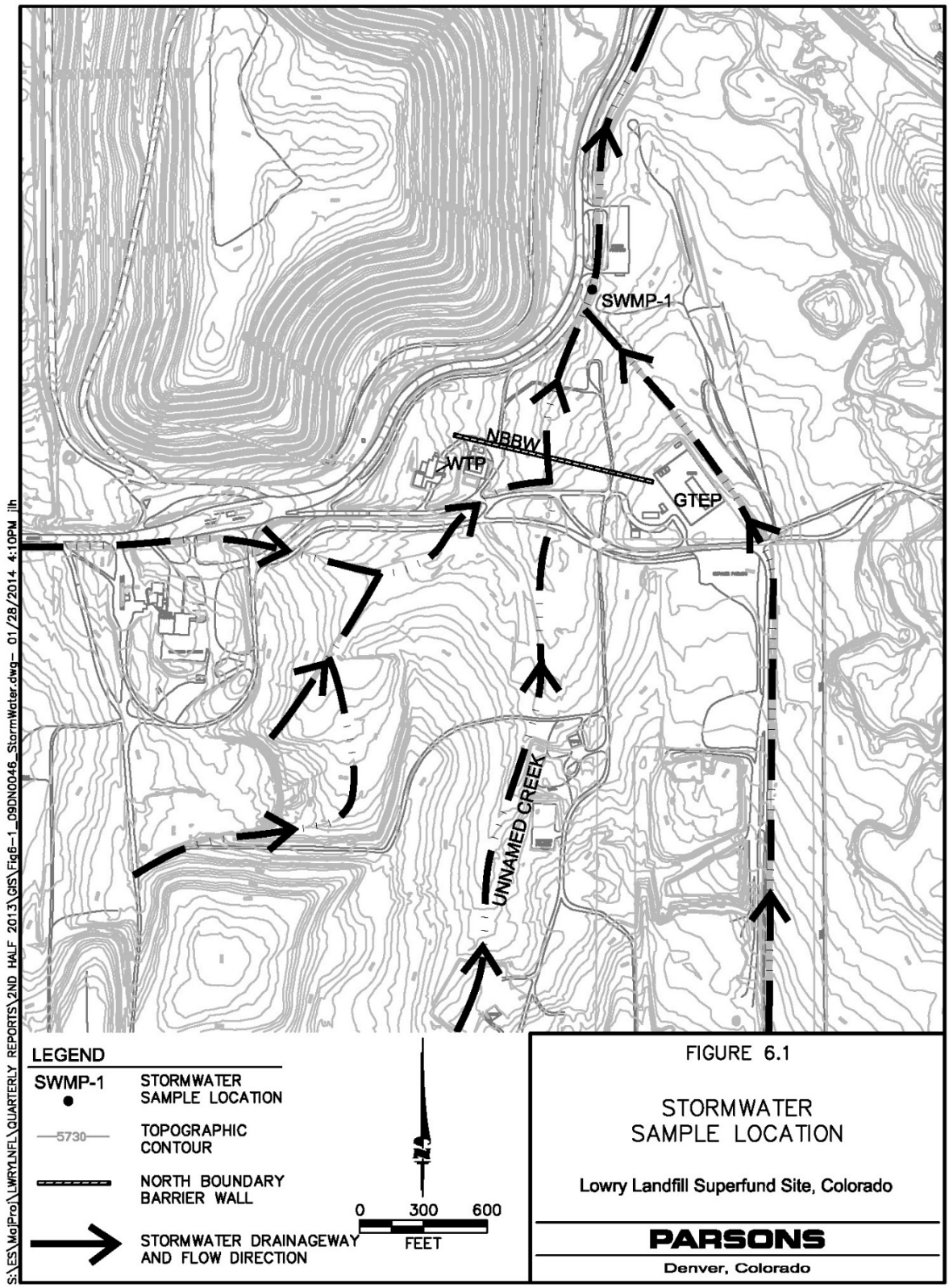
[20] Source: O&M Status Report – 2nd Half 2020

Figure C-16: Gas Monitoring Probe Locations[21]



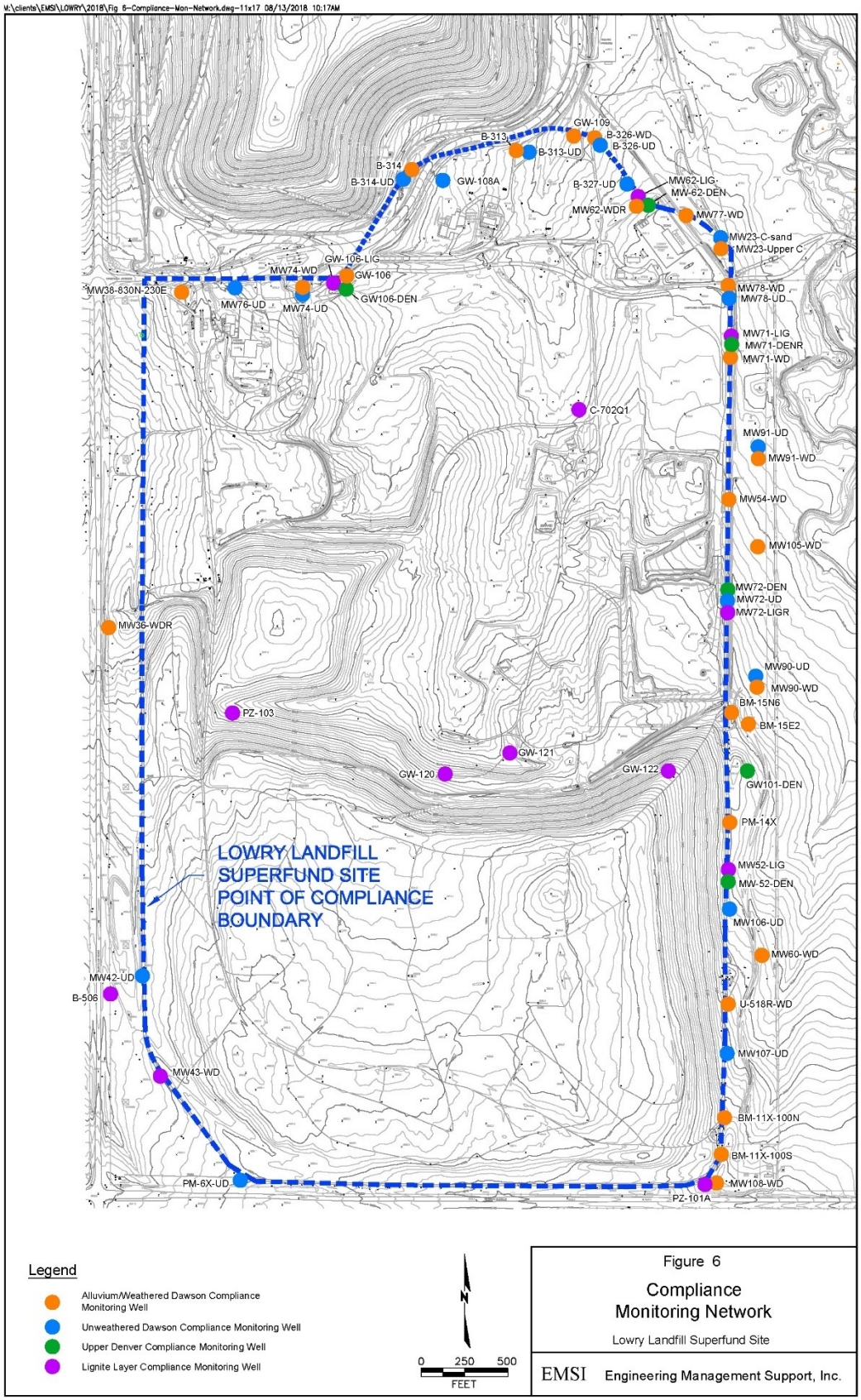
[21] Source: O&M Status Report – 2nd Half 2020

Figure C-17: Stormwater Sampling Location[22]



[22] Source: O&M Status Report – 2nd Half 2020

Figure C-18: Compliance Network[23]



[23] Source: 2018 GWMP

» COFFMAN, from 5

our neighbors experiencing homelessness, setting us up to waste more city resources on inevitable lawsuits to defend a policy that does not work."

The approach to reducing homelessness has become increasingly controversial among Aurora city lawmakers. Early this year Coffman took to the streets as "Homeless Mike" to investigate the problem himself, sharing his journey exclusively with CBS4.

"These encampments are not product of the economy or COVID. They're not a product of rental rates or housing. They are part of a drug culture," he told TV reporter Shaun Boyd. "It is a lifestyle choice and it is a very dangerous lifestyle choice."

Earlier this month, Coffman said in a tweet he is worried the majority of city council members and staff "are moving in the direction of adopting solutions that will ultimately increase the problem of homelessness rather than decrease it."

Johnston wrote a guest column in the Sentinel condemning Coffman's comments.

Coffman said Monday his urban camping ban proposal will follow the regular process and go before a committee, then to an informal study session meeting and the floor for a vote.

"Every member here, including myself as mayor, has the ability to put policy questions forward, and you have the ability to vote them down, although you probably will not be here when the issue comes up. You'll be a resident of Colorado Springs," Coffman told Johnston, who recently announced her resignation and plans to move to bring her family closer together.

"No, I'll stick around for a while," she said. "But I feel like that's intentional, the timing of this."

Obituary

EPA

The U.S. Environmental Protection Agency, Region 8 Announces the Fifth Five-Year Review for the Lowry Landfill Superfund Site in Arapahoe County, Colorado

The U.S. Environmental Protection Agency (EPA), in cooperation with the Colorado Department of Public Health and the Environment, is conducting the fifth five-year review of the Lowry Landfill Superfund site in Arapahoe County, Colorado. Five-year reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. The fifth five-year review will be completed in 2021.

Approximately 500 acres in size near the intersection of South Gun Club Road and East Quincy Avenue, Lowry Landfill accepted waste from the mid-1960s to 1980. Landfilling operations contaminated soil, groundwater, surface water, and sediment with hazardous substances. The site became a Superfund site when it was added to the National Priorities List in 1984. The site's long-term remedy, selected in 1994, includes containment, collection, treatment, and monitoring. Remedy construction began in 1996 and was completed in 2006. Operation and maintenance activities and monitoring are ongoing.

We want to hear from you! Community members are encouraged to share information that may be helpful in the five-year review process. Community members who have questions or who would like to participate in a community interview, are asked to contact Lisa below by June 11, 2021:

Lisa McClain-Vanderpool
EPA Community Involvement Coordinator
Phone: 303-312-6077
Email: mcclain-vanderpool.lisa@epa.gov

Due to Covid-19 the most current site information is only available online at:
http://www.epa.gov/superfund/lowry-landfill

APPENDIX D – INTERVIEW FORMS AND COMMUNITY INVOLVEMENT

Table D-1: Community Involvement Activities Completed

Event	Date
EPA Response to CLLEAN communications, January 27, 2017, and February 15, 2017	March 7, 2017
EPA Letter to CLLEAN supporting a Community Advisory Group (CAG)	May 25, 2017
Community Interviews for Fourth FYR	June 28, 2017
CAG Meeting - Purpose and Role of CAG, Introductions	July 19, 2017
CAG Meeting	August 17, 2017
CAG Meeting with Presentation on Site Overview	September 21, 2017
CAG Meeting with Presentation on the North Extent of the 1,4-Dioxane Plume	October 19, 2017
CAG Meeting with Presentations on the Water Treatment Plant, and TASC v. TAG	November 30, 2017
CAG Meeting with Presentations by Aurora Water and Metro Wastewater	January 18, 2018
Ad/Notice in Aurora Sentinel for 2/15/2018 CAG meeting	February 8, 2018
CAG Meeting re 2012 and 2017 FYR, and Remediation Work and Groundwater Monitoring with 1,4-Dioxane Plume	February 15, 2018
Ad/Notice in Aurora Sentinel for 3/15/2018 CAG meeting	March 8, 2018
CAG Meeting re Accessing Site Documents and Murphy Creek Irrigation and Reuse of Water	March 15, 2018
Lowry Landfill CAG Meeting Notice (for April CAG)	April 12, 2018
CAG Meeting with Presentation on History/Status of 1,4-Dioxane plume	April 19, 2018
CAG Meeting with Tour of the Site and Presentations on Analysis of 1,4-Dioxane - Detection Limits, PQL; and Defining the North End 1,4-Dioxane Plume	May 17, 2018
Ad/Notice in Aurora Sentinel for 6/21/2018 CAG meeting	June 7, 2018
CAG Meeting with Handouts on Org Structure and CDPHE records database instructions	June 21, 2018
CAG Meeting with Presentation on Tri-County Health	July 19, 2018
Fourth FYR Fact Sheet	August 1, 2018
CAG Meeting with Site Updates and Discussion on the Revised CSM and Potable Water Cessation	September 20, 2018
CAG Meeting - Potable Water Cessation, and Installation of Additional Wells in North End	October 18, 2018
CAG co-Chairs met with EPA and CDPHE	December 18, 2018
Government Shutdown	January 2019
EPA Meeting with City of Aurora Planning	February 20, 2019
CAG Meeting - Site Updates, Water Court Application, and Additional Wells for North End	February 21, 2019
Community Interviews for the Community Involvement Plan	April 2019
CAG Meeting - Increase Capacity of WTP, Presentation - Characterization and Monitoring of Groundwater Plume	March 21, 2019
TAG Advisors' Meeting with the EPA	March 28, 2019
CAG Meeting with Presentation - Site Update, Cessation Progress, 1,4-Dioxane Properties, PQL, Private Well Testing	April 25, 2019
CAG Meeting Council Member Johnston Tour, Oil and Gas, New Development, PQL with Presentation on 3DVA	May 16, 2019
Ad/Notice in Aurora Sentinel for 6/20/2019 CAG meeting	June 6, 2019
CAG Meeting	June 20, 2019
The EPA met with CAG members and facilitator for relationship building	July 11, 2019

Event	Date
EPA letter to Resident re: to her questions about development and the 1,4-dioxane plume and Site protectiveness	July 11, 2019
CAG Meeting with Presentation by Colorado Oil and Gas Commission, CDPHE's Energy Liaison, and Arapahoe's Oil and Gas Specialist	July 18, 2019
Ad/Notice in Aurora Sentinel for 8/15/2019 CAG meeting	August 1, 2019
Lowry Landfill Tour with Congressman Crow and Aides from Congressman Buck's office	August 2, 2019
CAG Meeting - Risk Communication, Congressional Tour of Site, Technical meetings with TAG Advisors	August 15, 2019
EPA technical staff phone conversations with the CAG's TAG Advisors	various days in August & September 2019
Ad/Notice in Aurora Sentinel for 9/19/2019 CAG meeting	September 12, 2019
CAG Meeting with Site Updates, Community Involvement Plan, TAG Advisor Technical Meetings, Congressional Tour	September 19, 2019
CAG Meeting with Site Updates and TAG Advisor Presentation	October 17, 2019
Lowry Landfill Tour with City of Aurora and Arapahoe County officials	October 22, 2019
Public Review period for the North End Investigation Report	November 2019 to January 2020
EPA letter to Potential Home Buyer in the Murphy Creek Area	November 5, 2019
EPA Regional Administrator Doug Benevento and Upper Managers met with CAG members	November 25, 2019
Technical meeting with TAG Advisors at EPA with EPA Contractors and CDPHE	December 10, 2019
The EPA responded to CAG comments on the North End Investigation	December 30, 2019
EPA Regional Administrator Letter to CAG	January 15, 2020
CAG Meeting with EPA's Regional Administrator	January 16, 2020
EPA Response to Congressman Crow's office	January 31, 2020
Public Review period for the Community Involvement Plan Update	February 2020 to April 2020
CAG Meeting with the EPA and CDPHE's Division Directors on the North End Investigation Report, and the development of the CSM and CSEs	February 20, 2020
EPA Response to TAG's comments on the North End Investigation	February 25, 2020
CAG Meeting on Site Updates, Monitoring Wells around DADS, COVID and Molybdenum in Monitoring Well MW-113-EW-1	March 19, 2020
March 2020 CAG meeting handouts	March 19, 2020
CDPHE response to CAG member re Molybdenum	March 26, 2020
CAG Meeting with Site Updates, Cessation at the NBBW, DADS wells, and Molybdenum	April 16, 2020
Technical Meeting with TAG Advisors, CDPHE and co-Chairs of CAG	May 12, 2020
CAG Meeting with Presentation on the North End Investigation Report	May 21, 2020
CDPHE email response to CAG member's questions about Molybdenum	May 26, 2020
Community Involvement Plan - final, Lowry Landfill Superfund Site	June 1, 2020
Technical Meeting with TAG Advisors, CDPHE and co-Chairs of CAG	June 9, 2020
EPA Response to Questions about Molybdenum, 1,4-dioxane monitoring wells and other topics	June 16, 2020
CAG Meeting an update on the Molybdenum with a Presentation on the Development of the Conceptual Site Model	June 18, 2020
CAG Meeting with Site and Molybdenum Updates, TAG Summary of Surface Water Topics of Concern, the Risk Assessment	July 23, 2020

Event	Date
The EPA responds to input on the Community Involvement Plan	July 27, 2020
The EPA responded to the TAGs Surface Water presentation	August 19, 2020
CAG Meeting with Site Updates and a Presentation on the Risk Assessment	August 20, 2020
The EPA presents Risk Summary/Assessment for the City Aurora Planning and Economic Development Committee	September 9, 2020
CAG Meeting with Site Updates and a Presentation on Stormwater Management at the Site	September 24, 2020
EPA letter to City of Aurora Planning and Economic Development Committee re: Aurora Proposed Ordinance - Lowry Landfill	October 1, 2020
EPA Response Letters RE: three Gun Club Estate Property Owner Well Sampling Requests	October 7, 2020
EPA Response to TAGs Surface Water White Paper dated 8/16/2020	October 9, 2020
EPA Response to CAG Questions Re Determining Protectiveness, Synoptic Sampling, North End	October 13, 2020
CAG Meeting with Site Updates, a Discussion about DADS, and Responses to CAGs written questions	October 15, 2020
EPA letter to CAG re: EPA's response to Surface Water White Paper dated 8/16/2020	November 13, 2020
Letter from EPA Regional Administrator to CAG re: Documents Distributed by WSDs for Lowry Landfill Site	November 17, 2020
EPA email response to CAG's Storm Water questions	November 17, 2020
CAG Meeting with Site Updates, Continuation of DADS Discussion, and Responses to CAGs written questions	November 19, 2020
CDPHE letter to CAG re: 11/28/2020 letter re: Aurora Study Session	December 3, 2020
The EPA responded to Six CAG questions	December 7, 2020
CAG Meeting with Presentations on the Conceptual Site Model and Laboratory Contaminants	December 10, 2020
EPA email to CAG re: EPA Responses to Two Questions from 12/10/2020 CAG Meeting	December 16, 2020
CAG Meeting with Site Updates, TAG and ARARS discussion	January 21, 2021
Technical Memorandum re: Acetone in response to CAGs concern	February 5, 2021
EPA Fact Sheet re FYR Addendum	February 17, 2021
CAG Meeting Site Updates with Presentations on the Effectiveness Evaluations for the Perimeter and Extraction Areas	February 18, 2021
Response to CAG re Matrix Diffusion email	March 5, 2021
CAG Meeting with Site Updates and Information on the FYR Addendum	March 18, 2021
CAG Meeting with Site Updates, CAG Position Paper, and the Public View Periods for the CSM and NBBW CSE	April 22, 2021
Public Review period for the NBBW Containment System Evaluation	May 6, 2021 to July 6, 2021
Public Review period for the Conceptual Site Model	May 6, 2021 to July 6, 2021
Ad/Notice in Aurora Sentinel for Public Review Period for CSM and NBBW CSE	May 13, 2021
Ad/Notice in Aurora Sentinel inviting public to provide input for FYR	May 20, 2021
CAG Meeting with Presentations on the CSM and NBBW CSE	May 20, 2021
Community Interviews for FYR	June 2021
EPA letter from Division Director responding to CAG letter re facilitation dated 4/11/2021	June 2, 2021
CDPHE email response re Colorado Basic Standards, ARARs, 1,4-Dioxane and Molybdenum	June 7, 2021
EPA letter from Division Director responding to CAG 3/31/2021 letter	June 11, 2021

Event	Date
CAG Meeting with Presentation on Particle Tracking and Seasonal Variations in Groundwater and Surface Water	June 17, 2021
The EPA received comments from the CAG on the Public Review documents – the NBBW Containment System Evaluation and the Updated Conceptual Site Model	July 6, 2021
CAG Meeting discussing the NBBW Containment System Evaluation and Vertical Migration	August 19, 2021
The EPA submits responses to the CAG's comments on the NBBW Containment System Evaluation, the Updated Conceptual Site Model, and two CAG Position Papers	September 21, 2021
The EPA, CAG, TA Advisor and WSDs present at the Arapahoe County Board of County Commissioners' Work Session	September 27, 2021
CAG Meeting with discussion on CAG concerns	October 19, 2021
CAG Meeting discussing CAG questions regarding compliance, MW113 and other items	December 9, 2021

Completed Interview Forms

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Karen Hancock & Sean Lieske	**Subject affiliation:** City of Aurora, Colorado
Subject contact information: khancock@auroragov.org, (303) 739-7107; slieske@auroragov.org, (720) 859-4411	
Interview date: Form Date 06/22/2021	**Interview time:**
Interview location:	
Interview format (circle one): In Person Phone Mail (Email) Other:	
Interview category: Local Government	

1. Are you aware of the former environmental issues at the Site and the remedial activities that have taken place to date?

   City staff participates as ex officio members of the Community Advisory Group (CAG) and attend meetings to keep up-to-date with issues and activities.

2. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might the EPA convey site-related information in the future?

   Site-related information is prepared by the Work Settling Defendants (WSDs) and their consultants. City staff often reaches out to CDPHE staff for assistance in understanding the EPA's position on Site-related information to assure that issues can be adequately resolved.

3. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   City staff became aware of a small brush fire on Site in October 2020 and a second larger brush fire that occurred on Site in December 2020.

4. Are you aware of any changes to state laws or local regulations that might affect the protectiveness of the Site's remedy?

   The City is not aware of any changes that affect the Site. More information about how Superfund will address emerging contaminants that are not currently included in the LLSS ROD or subsequent ROD Modification or ESDs would be helpful to CAG members.

5. Are you aware of any changes in projected land use(s) at the Site?

   In August 2020, a City Council policy committee vetted a proposal to add a buffer from residential development north of DADS landfill, however, the proposal did not move forward.

   City Council has full land use authority for property inside the incorporated city limits. Landowners and their agents have indicated readiness to develop entitled areas within the Murphy Creek neighborhood and

areas to the east that are adjacent to DADS landfill. New residents and business owners may request information about Site conditions and activities.

6. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   Based on feedback expressed during CAG meetings, the surrounding neighbors have continued to lodge concerns about being provided timely Site-related information.

   Neighbors continually express interest in attending technical meetings, even if not permitted to participate. The City recommends that the EPA and CDPHE provide a clear, definitive written answer to these multiple requests.

7. Do you have any comments, suggestions or recommendations regarding the project?

   The tone of the CAG meetings and correspondence between members has deteriorated over the past few years, causing escalating levels of tension. The City recommends that additional resources be allocated to address this issue.

   There is additional information from downgradient investigations that may be relevant to work products prepared by the WSDs and their consultants.

8. Do you consent to have your name included along with your responses to this questionnaire in the FYR report?

   Yes

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Jan Yeckes and Lisa Knerr	**Subject affiliation:** Arapahoe County
Subject contact information: 720-874-6500	
Interview date: June 9, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other:	
Interview category: Local Government	

1. Are you aware of the former environmental issues at the Site and the remedial activities that have taken place to date?

   Yes.

2. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might the EPA convey Site-related information in the future?

   Partially. The U.S. Environmental protection Agency (USEPA) and the Work Settling Defendants (WSDs) and the Lowry Landfill Citizen Advisory Group (CAG) disagree on several topics and it is difficult to determine which information is correct.

3. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   No

4. Are you aware of any changes to state laws or local regulations that might affect the protectiveness of the Site's remedy?

   Recent state law on perfluorinated compounds (https://cdphe.colorado.gov/pfcs)

   Update to Regulation 38 (https://cdphe.colorado.gov/water-quality-control-commission-regulations)

5. Are you aware of any changes in projected land use(s) at the Site?

   There have been proposals in proximity to the Site. One, for a recycling plant for construction materials on the DADS site that would have allowed sales of materials, did not move forward; the direct end use of the materials would not have been for public projects (i.e., materials would have been sold), and the City and County of Denver did not want to serve as the applicant for the proposal (the current land use approval is for a public facility). Another project that has been of concern to nearby residents is an application still pending for a commercial injection disposal well for water from oil and gas facilities (i.e., not a non-commercial injection disposal well for water produced from oil and gas activity on the same site). Members of the CAG have expressed concern about potential for seismic activity resulting from the injection of water at a site they feel is in proximity to the Superfund site and impacts to the efforts to contain contaminants at the Superfund site. The proposed injection well is located approximately 6.4 miles east of the eastern boundary of the Lowry

Environment Cleanup Trust Fund property. Waste Management recently proposed a Materials Recovery Facility and offices/truck maintenance shop on property owned by the Lowry Environment Cleanup Trust Fund on the north side of E Quincy Avenue. That application is still in the pre-submittal stage and we have not received a formal submittal.

6. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   Partially. The EPA emails the CAG and other stakeholders some documents. It would be helpful to be emailed all documents or a link to where one could access all documents on the EPA's website.

   CDPHE sends an email of all new documents related to the Site each month. That email is very helpful for staying up-to-date on new activities.

7. Do you have any comments, suggestions or recommendations regarding the project?

   USEPA should address each of the issues outlined in the CAG's recent letter to USEPA. Each monthly meeting should be dedicated to each issue to get it resolved or agree to disagree and document those actions to resolve, or decisions to disagree, in writing. A running spreadsheet should be provided to the EPA or from the EPA to summarize the issues and the responses. A spreadsheet would be an easy and efficient way to track responses/comments/actions.

   USEPA should continue to have a facilitator at the monthly meetings. The meetings seem more organized, and it is helpful to keep everyone on the topic at hand.

8. Do you consent to have your name included along with your responses to this questionnaire in the FYR report?

   Yes.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Lisa McClain-Vanderpool	**Interviewer affiliation:** EPA
Subject name: Jeff Baker	**Subject affiliation:** District 3 Commissioner
Subject contact information: Email: jbaker@arapahoegov.com; Phone: (303) 795-4630	
Interview date: May 26, 2021	**Interview time:** 1:30-2:00pm MT
Interview location: Zoom Meeting	
Interview format (circle one): In Person Phone Mail Email Other: Zoom	
Interview category: Local Government	

1. Are you aware of the former environmental issues at the Site and the remedial activities that have taken place to date?

   Yes, I am.

2. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might the EPA convey Site-related information in the future?

   I feel very well-educated. I don't remember everything I've learned, because it's complex – a lot went on in the past. There are a lot of claims being thrown around and a lot to remember. I am aware of the EPA website. I get most of the information I need to get from CAG meetings and the website.

3. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   I think we had a couple of kids that escaped from Ridgeview out there and were being chased around by sheriff's deputies a couple years ago. No unusual or unexplained activity. There was a lightning strike and a transformer that fried a bird on the easement.

4. Are you aware of any changes to state laws or local regulations that might affect the protectiveness of the Site's remedy?

   No changes locally. State – I cannot think of anything at this time.

5. Are you aware of any changes in projected land use(s) at the Site?

   No. We've got the state land board (the former Lowry bombing range) there to the east. I'm always hearing about things that may come up, but nothing has come to fruition.

6. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   Yes. I think everybody knows about the website – you can't do a better job. The EPA has bent over backwards to communicate information through the website. People that are the most concerned and most involved are on the CAG. Everybody has had an opportunity to become part of the CAG. They've done a good job of advertising when the meetings are and inviting them to come. I see some new folks every meeting, and most come back. The EPA is doing a great job.

7. Do you have any comments, suggestions or recommendations regarding the project?

   No concerns. Nothing else to add.

8. Do you consent to have your name included along with your responses to this questionnaire in the FYR report?

   Yes.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Lisa McClain-Vanderpool	**Interviewer affiliation:** EPA
Subject name: Lynn Robbio Wagner/Brian Hlavacek/Keith Homersham	**Subject affiliation:** Tri-County Health Department (TCHD)
Subject contact information: lwagner@tchd.org/bhlavacek@tchd.org/khomersham@tchd.org	
Interview date: 06/03/2021	**Interview time:** 1:00 pm MST
Interview location: Via Teams/conference calls	
Interview format (circle one): In Person Phone Mail Email Other (Teams)	
Interview category: Local Government	

1. Are you aware of the former environmental issues at the Site and the remedial activities that have taken place to date?

   Yes, TCHD, as the local health department is very aware and knowledgeable about the Lowry Landfill Superfund Site activities. TCHD Staff have historically been involved in complaint response pre NPL and has continued to stay involved with current remediation activities over the lifetime of the Site. TCHD reviews reports, technical information, and provides updates to the local jurisdictions which are Arapahoe County and the City of Aurora. TCHD samples off-site private wells and observes additional annual off-site sampling efforts in association with the Site.

2. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might the EPA convey Site-related information in the future?

   TCHD believes the current the EPA project manager, Linda Kiefer, is doing a very good job organizing the WSD's, CDPHE, and TCHD to review and actively participate in reviewing Site-related documents and moving Site progress forward. The EPA, WSD's, TCHD and most recently CDPHE have really improved communication to resolve outstanding issues since the last (Fourth) Five Year Review. This includes providing guidance and resolution with long-time barriers communicating the site protectiveness over time. This is a big milestone for the Site. Agencies and responsible parties also work diligently to inform the community advisory group of activities on the Site.

3. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   TCHD is a partner with the local emergency management system and CDPHE spills tracking system. TCHD is usually notified of unusual conditions, and to date we were notified of two small, unplanned fires that occurred at the Site since the last Five-Year Review. One was an electrical fire by a utility pole and the second was a grass fire that originated from Quincy Avenue and traveled onto the Site.

4. Are you aware of any changes to state laws or local regulations that might affect the protectiveness of the Site's remedy?

   We are not currently aware of any changes to state or local regulation that might affect the protectiveness of the remedy. Currently, the City of Aurora has approved development to the north of the Site boundary of the DADs facility, which has sparked an increase interest from the local communities and neighborhoods. This zoning could change pending the City of Aurora approval or denial.

5. Are you aware of any changes in projected land use(s) at the Site?

   There are no projected changes to the land use for the Site. The Site has a certificate of designation (CD) from Arapahoe County for a landfill. It will always be a landfill according to the current county use. The area surrounding the Lowry Landfill is experiencing an increase in development pressures, such as Gun Club and Quincy Ave road improvements and E470 tollway access. The land area directly to the east of the Lowry Superfund Site and the DADs landfill is 100 square miles owned by the State Land Board and is the Former Lowry Bombing and Gunnery Range. (FLBGR). The FLBGR will soon meet FUD's requirements, which will increase the development pressure and population in the surrounding area. However, changes to land use by the State Land Board is a process that will include public involvement. Currently, there is not a large population around the Site, but that will likely change in the upcoming years. It is important to be proactive and have information available that contains clear Site messaging all of the entities support.

6. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   TCHD believes outreach from the EPA and CDPHE community involvement could work closer with the locals and the WSD's public relations representative to provide better clarity and accurate information to the public. For instance, utilizing technology such as videos/YouTube to highlight the Site accomplishments over time. Maybe writing a collaboration document that highlights the Site successes over the last 30 years such as the Gas to Energy Plant and the innovative technologies that have been created to treat ground water. Maybe all of the agencies and the WSD's can work with the Arapahoe County Fairgrounds and the City of Aurora to sponsor Lowry Landfill Superfund Site educational materials to be installed along the bike paths to the fairgrounds. The Site could be highlighted for the STEM schools and local environmental or scout groups for open houses and tours by all of the entities that are involved.

7. Do you have any comments, suggestions or recommendations regarding the project?

   TCHD believes there needs to be continued focus on explaining to the public the Superfund process and the containment remedy elements. The land use is not going to change for the Site, at this time, the landfill mass is permanent and is not being excavated, plus the EPA Five Year Review process is designed to continue to assess and assure protectiveness throughout time.

8. Do you consent to have your name included along with your responses to this questionnaire in the FYR report?

   Yes

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Dustin McNeil, Jeannine Natterman, and Colleen Brisnehan	**Subject affiliation:** Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division
Subject contact information: dustin.mcneil@state.co.us, jeannine.natterman@state.co.us, colleen.brisnehan@state.co.us	
Interview date: June 21, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other:	
Interview category: State Agency	

1. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   The project is complex, with a complicated Site history, requiring a holistic approach to ongoing Site management and evaluations of remedy protectiveness. Current remedial activities, maintenance and reuse activities appear to be appropriate based on the information known to date.

2. What is your assessment of the current performance of the remedy in place at the Site?

   Based on the information provided and reviewed as part of the containment system evaluations, the groundwater remedies appear to be performing as designed. Based on information provided in the O&M reports, all other remedies also appear to be performing as designed. Evaluation of the effects of cessation of potable water injection, which occurred in late 2018, is ongoing.

3. Are you aware of any complaints or inquiries regarding Site-related environmental issues orremedial activities from residents in the past five years?

   The community has expressed concerns about exposure to contaminants present off Site, north of the compliance boundary. These concerns are tied to another issue expressed by the community that the off-site plume, present beyond the point of compliance, has been deemed not part of the Site by the EPA and the WSDs, and is not specifically addressed by the ROD or the subsequent ROD amendment, modifications, or ESDs.

   The community has expressed concern that additional contamination, that has not been identified, may be present in areas beyond the points of compliance and that the community might be exposed to this unidentified contamination. The groundwater monitoring well network density dissipates significantly from the compliance boundary to the plume terminus, off Site to the north, adding to this community concern. Additionally, community unease regarding potential for vertical migration of contaminants has been expressed. This concern is related to differing horizontal/vertical dispersion ratios for groundwater that have been documented at the Site and in areas north of the compliance boundary.

   The community has also expressed a concern about risk based on the difference between the Lowry Landfill performance standard of 0.9 ug/L for 1,4-dioxane and the Colorado groundwater standard of

0.35 ug/L. To address this concern, the current laboratory practical quantitation limit (PQL)-based performance standard should continue to be reviewed annually to determine if a lower PQL and performance standard can be achieved. The Interstate Technology Regulatory Council (ITRC) 1,4-dioxane team recently indicated that method 8270 selective ion monitoring (SIM) is the "gold standard" for 1,4-dioxane analysis, as it is not as prone to interference as method 8260SIM. Therefore, the Lowry Landfill team should evaluate whether a lower PQL can be achieved using method 8270SIM on Lowry Landfill groundwater, aligning more closely with the Colorado groundwater standard.

Additional community concerns, some of which have been addressed, include:

- Information exchange – sharing and integration of regional groundwater chemistry, potentiometric surface, lithologic, and other subsurface data from known sites in the area of Lowry Landfill would be beneficial to holistic understanding of plume dimensions and contaminant transport
- Private wells – repeated requests to sample private wells located in Gun Club Estates
- Surface water – risk of exposure to 1,4-dioxane from contact with surface water
- Stormwater controls/sampling – inquiries into what types of controls are in place and how often routine and non-routine sampling is conducted
- Molybdenum – community members have asked about recent elevated molybdenum detections in on-Site groundwater and whether it is associated with a source present at the Lowry Landfill Site.
- Emerging contaminants – is sampling being conducted for emerging contaminants at the Site?
- Surface geophysical – requests for further use of this technology to aid with identification of potential additional preferential flow sand channels and potential geological fractures that may allow contaminants from the Lowry Landfill Site to migrate into deeper aquifers.

4. Has your office conducted any Site-related activities or communications in the past five years? If so, please describe the purpose and results of these activities.

   Our agency has participated in Site-related meetings with the EPA, the WSDs, Tri-County Health and the CAG. We have reviewed and commented on-Site-related documents and community involvement materials. We have also answered questions directed to our agency by thecommunity, media and the City of Aurora.

5. Are you aware of any changes to state laws that might affect the protectiveness of the Site's remedy?

   We are not aware of any changes in state laws that would affect the protectiveness of the remedy.

6. Are you comfortable with the status of the institutional controls at the Site? If not, what are the associated outstanding issues?

   The institutional controls at the Site are appropriate and comply with state statute. The current off-site institutional controls appear to be sufficient to prevent unacceptable exposure.

7. Are you aware of any changes in projected land use(s) at the Site?

   Not at the Site, as defined. There are off-site areas near surface and groundwater impacts that are planned for redevelopment.

8. Do you have any comments, suggestions or recommendations regarding the management or operation of

the Site's remedy?

See the discussion under #3 regarding evaluation of method 8270SIM for 1,4-dioxane.

9. Do you consent to have your name included along with your responses to this questionnairein the FYR report?

   Yes

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Lisa McClain-Vanderpool, Jeannine Natterman	**Interviewer affiliation:** EPA Region 8, CDPHE
Subject name: CAG Members	**Subject affiliation:** CAG Members
Subject contact information:	
Interview date: May 26, 2021	**Interview time:** 11:00am – 1:30pm MT
Interview location: Zoom Meeting	
Interview format (circle one): In Person Phone Mail Email Other: Zoom	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund Sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

Ten CAG members participated in a group interview. Multiple people answered each of the questions; answers were compiled and are not attributed to individuals.

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review?

   Yes, I am aware of everything. I don't agree with the word "former" to describe the issues, since it implies that the issues have been resolved, when they are current and ongoing. I have three points: The Site is not in compliance at the point of compliance where ROD says it is; the Site is not meeting RAOs based on the mass balance data; and the Site is not meeting ARARs. The WSDs are working to convince the EPA that we can remove some requirements. As a community member with a private domestic well, I don't think we can afford to lose any of the ARARs.

   I agree about "former." The only thing different is injection of water has stopped, but that doesn't mean anything has been cleaned up, or not to the extent to feel confident. It's the same issues we've had all along.

   Yes, I agree. The issues are ongoing.

   Further on in the question, it mentions remedial activities. We don't see the process, how the problem is solved. There isn't much transparency on how they solve the problem. And our consultant then tells us the red flags. They won't answer how they got there. The conclusions are opaque. We don't see enough of the remedial activities to be able to be aware of the activities. The WSDs and the EPA say they have solved the problem but won't show the community the process and tells the community to trust them. Not much transparency. We just see the issues, they say it's solved, but the community sees that it's not solved and wants to know how and why.

I agree with all the previous statements. The community becomes aware of issues after a considerable time lag. Once reports are released, the community asks questions, but they seem to be dismissed or are not answered. We are peripherally aware, with a great time lag, after activities are carried out.

A lot of issues surrounding remedial activities are based on assumptions, not good science. Others have agreed and written about the same thing. We don't think the EPA is doing a good job according to the guidance. We have concerns about assumptions on volume of plume.

I am also concerned with the glossing over of some issues. During the ongoing monitoring, when something new comes up, it needs to be addressed in the FYR even though it wasn't previously included. Molybdenum is an example – I understand that it's not going to be in the new FYR. Until we brought it up nothing was going to be said or done about it. They did an evaluation but didn't do a workplan. And what they decided was that they would deal with it as much as they can in the water treatment plant. But since they couldn't treat the volume they had – they plugged the well with the molybdenum and they did not find the primary pathway and chose a monitoring with lower volume, and they chose an extraction well that wasn't in the path of the molybdenum. Then their next answer was it is naturally occurring. Why has it now become soluble after all these years? I don't understand how molybdenum became soluble in place, were there changing conditions to make it become soluble? When community asks, there isn't an effort to try and make an answer. and when we ask that there is not an answer and not effort to make an answer. And they say this won't be in the FYR.

The answer is in the 300-page report.

In the synopsis of this interview, it should be written down that things aren't right. Make sure it comes across loud and clear in the FYR.

In terms of awareness, the CAG co-chairs should make a list of issues the CAG has become aware of where we haven't received completed or appropriate responses from the EPA. Our awareness and understanding of the issues is very compromised by nature of the response the CAG has been getting. In some cases our concerns are validated by CDPHE and our technical advisor.

I agree with everything said previously. I appreciate the statement about finding molybdenum.

I only learned about Superfund Site last August because I moved to the area recently. When I was talking to others in the neighborhood, I was caught off guard by how people are aware of action taken at Site. Neighbors say all the money has been spent, they have no confidence in the EPA or the government. One neighbor's water smells and is colored, and he had to install an infiltration system. Many of us out here just hope things are okay. There's an attitude of "that's what we have to work with." All the new homes out here and nobody cares about us 300 older existing homes. Nobody looks at what's happening to 300-400 families. I was also caught off guard by the public not being allowed to attend the EPA and WSD meetings. The EPA hires marketing firms and creates distrust in the process. PR firms are designed to sway public opinion. So the issues aren't being resolved; they're just spinning it. This is a top 150 Superfund Site in the nation, and I believe all discussion around the Site should be held in the public eye. We need the opportunity to listen at these types of meetings and hold those in charge accountable. That hasn't been afforded to the CAG, let alone larger community. I am disgruntled when officials from the EPA said there were legal reasons why public couldn't attend internal meetings. There is no proper, open, two-way communication. It's always the CAG coming up with questions for the EPA. It's a very adversarial relationship, never the EPA reaching out first. It seems like the EPA dreads getting involved with the CAG.

Going back to idea of core mission of the EPA – the mission to protect human health and environment – and *guarantee* the safety of chemicals in the marketplace. The EPA and WSDs are overlooking that mission because they don't want to deal with it.

The EPA and the state of Colorado have been leveraged by WSDs by the consent decree. The role the EPA was meant to play is now the opposite of what was intended. The EPA stands behind the decree and lets the WSDs decide what work will be done and how it will be communicated. The EPA uses the consent decree to keep the entities quiet, and I don't think they are interpreting that document correctly.

I cannot find where the WSDs have anything to say anything about what and how it is done. I think this is a real ruse. Citizens' participation is limited. The consent decree does not give the WSDs power to do anything except quit and let the EPA take over. I am discouraged that the EPA is bending over to let the WSDs do what they want to do.

The EPA is letting the WSDs do whatever they want. I don't know what the reason is – money, fear of a lawsuit, political reasons? It is dissatisfying to see the EPA can't exercise their mandate.

Our awareness about the issue is limited by the WSDs. They seem to be limited access to what the EPA is releasing to the public. The central issue is that the process is not transparent because the public can't have access to meetings between the WSDs and the EPA. Our understanding and participation are extremely limited.

[Read aloud 40 CFR § 25.3 (c)(6): "To foster a spirit of openness and mutual trust among the EPA, States, substate agencies, and the public" and (c)(7): "To use all feasible means to create opportunities for public participation, and to stimulate and support participation."] The EPA doesn't fulfill that. They're not fostering any spirit of mutual trust.

All entities involved aren't going to be personally impacted like the CAG is. We're paying the price, dealing with the issues. The end result comes down on our head. Maybe there would be a greater call to action if they were in our community. We're getting the brunt of the impact. There's not much compassion for our situation other than political answers.

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

I have seven points. OU1 and OU2 have failed to achieve performance standards. The EPA is confused about the locations of OU1 and OU6 and the definition of the Denver Aquifer. You can't be doing good studies if you don't have that information. The CERCLA National Contingency Plan requires, if there is no MCL drinking standard, state standards can't be ignored (in the case of 1,4-dioxane). Is the EPA not following CERCLA, or do they not have to? The EPA and the WSDs continue to deny that the Denver Aquifer has been impacted. The Dietrich study does not confirm compliance at the point of compliance, but the EPA and the WSDs are saying this study is the final word. Legally, it should not be – there should be a ROD amendment or ESD to explain why they are using this study as opposed to the on-Site point of compliance. MW-38 was not included in this FYR, which makes it incomplete. The EPA and the WSDs refuse to follow the 2008 capture zone analysis, so remedial action is moot.

I agree. I want to emphasize that the CAG all agrees about concerns whether they speak or not. We speak with one voice no matter how many people are speaking.

Yes, although we speak individually, we have met and are all in agreement on our statements.

In regard to the first part of the question – the Site is politically charged. After observing the EPA and CAG meetings on a monthly basis, I have seen that the EPA looks very bored. It's not a good interaction and not a good educational partnership. [CAG Member] goes out of their way to ask great questions and gives technical information. They never get a direct answer from the EPA. I think some questions we present could be yes or no – I don't understand why the EPA won't give clear answers to our technical advisors. We are trying to be educated, but not getting information back. The EPA is using older data and documents, which doesn't give the sense that things are being accomplished. It feels covered up. The wells seem like they're drilled down to

a clean area, and the names are reused 400 feet away from the contaminated well. They haven't gone back to the old well to test to see if things are taken care of and okay. When you have a technical advisor the caliber of Dietrich, we see how the EPA seems dismissive of him. Why wouldn't they openly embrace his comments to make sure their ducks are in a row. He is free to them. They don't act like any of us have enough brains to help with anything. We have been doing this for 40 years – what a waste of money.

We know who does have their ducks in a row. It isn't the EPA.

I want to underscore on this question that it should be well noted in public comments that both CAG meetings and extensive correspondence with the EPA have documented limitations on awareness and obstructions in our ability to understand issues. Many questions have not been answered directly or at all. It shows that our awareness and impressions are extremely limited since information flow is curtailed.

I get the sense that the EPA wants to chalk this project up as done – and it is not. The EPA is willing to let the WSDs run the show when the EPA is the ultimate responsible entity with regard to this Site. Site documents are extremely old with few adjustments or amendments, but things have changed over time. In regard to what [CAG Member] said about molybdenum – nowhere do we see that this mass of toxicity that the comingling of those chemicals cannot change the geology. Nobody has given reassurance that that these chemicals wouldn't affect substances that they're flowing through. It could be very corrosive; it could eat away a penny. We have no reassurance that this is not long-term, or not static. I don't like the explanations about vertical flow of contaminants. It's not a satisfactory explanation. I want it documented and proved regardless of whether it's a direct threat to the community.

I want to clarify about MW-38 that [CAG member] mentioned. About OU1 and OU6 – OU1 is defined as top of the Dawson through Denver down to the separation layer. Below that is the upper Denver, down to lignite layer – that is OU6. When you go off Site, there is no Dawson, only Denver – that's a problem. Now the EPA is renaming various levels within the Site but doesn't clarify the definitions. This has created confusion. A councilman in Aurora thought there was only one aquifer that was contaminated, when both the Dawson and Denver aquifers have been contaminated. This creates confusion whenever we talk about OUs. The WSDs have used this to cloud the issues and create an idea that everything is okay. The definitions are really important, but the WSDs refuse to define them. Outside of the Site, the EPA gave the CAG a plume map for 1,4-dioxane that is an estimate of 0.9 PQL [practical quantitation limit]. The EPA determined that that measurement is Site-specific, but off Site, the state of Colorado's standards should apply. State standard says the practical load is supposed to be 0.35 unless it can't be measured to that level – that's why we have a Site standard. But off Site those chemicals aren't present so they should be able to measure down to state standards. The state isn't holding them accountable for that, and the state should do that. One example is Buckley Air Force base – they can measure down to 0.35. But because of the confusion at the Site, other groups are now thinking that Site-specific level is the real one. That puts state regulations at risk since they are supposed to be applied universally. The enforcement no longer becomes valid. The EPA is only showing 1,4-dioxane plume limits of 0.9 micrograms per liter on maps. They need to be showing it to state standards where they can measure to that. They also need to be showing a plume down to the minimum detection limit. The public needs to have an idea of how wide the contaminants go in regard to these measurements. Get the PQL measurement of the plume. It's important because that plume brushes the edge of townhouses at Murphy Creek. The people living there need to know that isn't a dashed line it is something that has been established – at that low level; it is not toxic but extends into their residential area. The most recent maps came out with a new Conceptual Site Model that does show PQL of 0.9 touching some of the townhomes. The EPA and WSDs have responsibility of testing all pathways – sewer lines, electrical lines, water lines – that have been dug and buried. Those are primary pathways that could be taking that PQL of 0.9 and distributing it further into the Murphy Creek townhome and residential area.

The 0.9 issue is really confusing. For some reason the state water quality division is accepting that. I don't know how they can do that. The minimum detection limits – the lab that the WSDs are using can test down to 0.15. They ran the test for permitting at Piccadilly at Coal Creek down to 0.22, so the labs are there. There are

6 labs available that can do that. The determination of 10 times the PQL doesn't seem very scientific – why is acceptance of that allowed? 1,4-dioxane and other chemicals of concern are in the plume at these concentrations. This affects Aurora water and people living in Murphy Creek and dynamically could affect wells further north in Thunderbird and Gun Barrel estates. The WSDs say it's not going that far – but it's "downhill" with the flow of groundwater. The WSDs claim it doesn't make a difference, but it does.

I want to underscore what [CAG Member] said, in in terms of the non-responsiveness of the EPA to the CAG's questions on some issues such as the PQL. We have experienced disingenuous responses from the EPA that don't appear to be supported by scientific or lab capabilities. That process of obfuscation is now impacting other regions and public health and safety issues at other sites – Lowry is used as a precedent. There are further negative off-site responses that are damaging to public health and safety.

3. What have been the effects of this Site on the surrounding community, if any?

It's hard to synopsize. The management of the Site by the EPA and the WSDs has caused confusion and mistrust in the community. Remedial activities and ongoing technical disagreements regarding OU1 and OU6 and the identification of the Dawson vs. Denver are causing confusion of Aurora and Arapahoe County developers, and owners are taking advantage of misinformation to move forward with building communities with no regard to future public safety. The EPA's refusal to test private wells systems has falsely validated the WSDs to pronounce that no one is drinking that water. The public now believes unproven and possibly harmful information.

I am a resident of one of the impacted communities. Any time I notice a strange odor, if I don't feel well, when my hair is thinning badly, I'm thinking – is this coming from the Superfund Site? Am I getting sick, am I going to have cancer? Nobody has been able to make me feel more comfortable anytime one of those unusual circumstances appears in my home.

I live a few feet from what's going on. There is an emotional component and a financial component to all this. [CAG Members] addressed this – that the city council is only willing to listen to what they deem is scientific information, but the CAG has pointed out that information should be brought into question. When development is poised to take place, the EPA doesn't make any statement about the land that is to be developed. That land should be tested in a rigorous manner, knowing that it abuts the Site. You can't expect that it is going to stop at Yale Avenue. The city council is relying on what they hear from the EPA, and making decisions to allow developers to populate land, when I believe that land is dangerous. People who are potential homeowners should be given this information. The EPA should have accurate, up-to-date information on the website, that references where potential homeowners can make an in-depth investigation into the homes they buy. Developers should be held liable if something happens to homeowners. They should have to meet rigorous level of protection. My home is already exposed. I'm not sure what I can do about what already exists. The developers have covered their asses. The EPA has a responsibility to make sure that stringent rules are put in place with regard to testing of property brought to the city council for development.

Before Murphy Creek was developed, the City of Aurora and developers had an environmental site assessment (ESI) done. Phase I stated that they felt that the Site could impact the new development. They went back and did a Phase II assessment. The final report found no contamination at that time, but it predicted that the Site would impact the area. Now the off-site plume does impact the area, so the assessment was true. It's hard to understand why the EPA can't do more when this assessment predicted that impact. No one went through further measures – now we have a whole neighborhood impacted.

The area of the plume is not being protected appropriately. Neither the EPA nor the Aurora city council has power over where somebody builds a home. But the reason the city council makes the decisions they do is that the EPA does not include the plume within the Superfund Site. I think that the EPA needs to expand the Site to include the 1,4-dioxane plume. Then the building of homes can be handled by the EPA.

If I could hear the WSDs or the EPA say, "We did X, Y, and Z and that's why we believe Site is safe" – instead we hear, "We drilled here, there and there and did not find anything, so we think it is safe." We get provided technical explanations, which doesn't satisfy the CAG.

Question #3 is central to the CAG. I was alarmed a few years ago when one of the WSDs stated in a meeting that there were no public health impacts on water. This was before the toxicology study was done. As Resident 7 pointed out, primary pathway exposure hasn't occurred yet, so the EPA doesn't have any assurance that there is no public health impact because it hasn't been assessed. A health assessment wasn't done. The EPA hasn't done its due diligence in collecting data, so they shouldn't be saying that there is no public health impact. This is a major issue of contention. The party in charge claims that things are "proven" when claims are made in the absence of scientific data. We don't get answers when the CAG continues to ask. The effects are myriad in terms of perceptions and fears of the community, and what could transpire in the future. None of these issues have been answered in a straightforward way.

I agree. It seems like everyone involved is chasing the problem rather than trying to prevent it by doing analysis and preventative measures. The EPA shouldn't have allowed the plume to exist. The contamination hasn't been contained. There has been procrastination in testing private wells. This reflects an attitude of not wanting to take on expense, and not caring about how it impacts the community now and in the future.

Piggybacking on what [CAG Member] said, it sounds like there is a territorial dispute in testing wells. All COCs should be tested for. Wells should be tested on a regular basis. People are drinking the water. Tri-County Health shouldn't have to be the one to test. The EPA has the authority to say who should be doing testing. They reassure residents that there is nothing in the wells. If something is found, something should be done about it. Putting this off for 40 years is ridiculous.

Those concerns are very valid and have been bothering the community for a long time. The EPA does have that authority. The 2005 consent decree does prevent the EPA and the WSDs from the EPA being able to test private wells without the WSDs wanting to. Waste Management tells the CAG if they test the wells and even one bit of dioxane comes up, it will ruin them, and they will be responsible. That is why we believe the EPA refuses to test, and why the public is so distrusting. The WSDs don't want to come anywhere near testing the Gun Club estate area because they are afraid that those wells might have been impacted. The EPA is refusing to insist they do tests, and now they have turned it over to the state, so WSDs won't be held responsible for the findings.

As a resident of Murphy Creek, when they were doing injection, I felt strongly affected because my sump pump ran almost continually. I was worried it would go out. Now that injections have ceased, it is acting more normally. In March, my basement flooded. I am walking around in the water in my bare feet, wondering "am I in contaminated water?" I was worried about what contaminants might be in the water, and whether I was exposed.

1,4-dioxane is the only thing the EPA is focusing on, but the CAG knows that in the City of Aurora's recent study on the Highway 30 landfill, they did find that dioxane evaporates into the air. They did find a sample of 1,4-dioxane under a convenience store and in the City of Aurora water. There is air intrusion. If dioxane does volatilize, or other contaminants do, every home in Murphy Creek that has a sump pump could be pulling in water that could volatilize. Air testing in Murphy Creek should be done – I have asked. It probably worries anyone in Murphy Creek. We have asked the EPA to verify that there are no vaporized contaminants in the homes but the EPA and the WSDs say that cannot be a possibility. The WSDs and the EPA says that dioxane is not volatilized even though the City of Aurora did find air intrusion in their study on the Highway 30 landfill. The EPA has not built trust in the neighborhood, so the public feels rebuffed.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

Two things – there was a fire when a bird exploded on an electrical line and started a grass fire. There was also a fire from lightning 2-3 weeks later that was quickly handled. Finding molybdenum was also unexpected. I have not heard of vandalism or trespassing, only the emergency response for the fires. But I also consider the molybdenum being an unexpected activity at the Site. The only way that we knew about the molybdenum was the water treatment plant report when they got the exceedance, and a letter from the WSDs about the molybdenum in the treatment plant. The WSDs reported they drilled a well and tried to find where it was from coming from. When they found levels of molybdenum they didn't want to see, they moved a few feet and drilled a new well that wasn't as impacted. There should be a search to determine where the molybdenum is actually coming from. They say on Site, but USGS reports don't indicate it should be naturally occurring on the Site. I am wondering why it is now dissolving and moving easier. This is a surprise, and I am not pleased with the fact that molybdenum is not going to be included in FYR. It should be considered a COC.

They are only drilling down 100 feet maximum – not very deep. If they wanted to find out what was down there, should have drilled with a core driller. Dissect the core to see what it actually is, not what they think it is. It wouldn't cost much – but they won't do it. I think they're afraid.

In terms of unusual or unexpected activities – when there are new adverse findings that surface, there is a wholly inappropriate response from the EPA, such as regarding molybdenum and the like. Open question raised by the CAG – it is unclear how new findings should be followed up appropriately by the EPA when they do occur. It seems that rules are not being followed by the EPA.

The molybdenum levels for the state is 210 micrograms per liter. They found molybdenum levels of 42,000 micrograms per liter. Two hundred times the state standard. Even if molybdenum was deposited there naturally, they are probably the people that caused it to become soluble. The state is not holding them accountable. The EPA does have to do something about it. Are they going to enforce their standards of 210 micrograms per liter within groundwater, or let 42,000 go unaddressed?

The EPA doesn't directly have to do with this, but they are in charge of the treatment plant. The EPA had WSDs do retrofitting on the treatment plant because it was being overwhelmed by the molybdenum. So, the EPA does have authority over the situation.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   The EPA has not willingly kept the public informed. There was so much opposition to the CAG starting. Now we are moving along well, and thanks to CDPHE running the YouTube site we are now getting meetings available to the public. I wish there was more public response, but it is a tough subject. Our neighbors at Thunderbird Estates are concerned but they hate going to meetings and hearing that their comments are wrong or incomplete. They don't have energy to sit and fight to get them to listen to us. People worked so hard for 40 years and have spent hard-earned personal time to get the EPA to do a good study of the Site, trying to find a way to get it taken care of and stop contamination from moving towards their water. When Governor Richard Lamm had a Lowry monitoring committee, they all came to the table, and pushed for burial because it was the cheapest option at the time. I told them will never be able to contain 138 million gallons of chemical waste. We are still fighting that battle of how to get chemicals out of our environment. If the aquifers become polluted, we will have 4 aquifers polluted – from Pueblo into Cheyenne in addition to Dawson and Denver. We can't sit and wait for the worst to happen. The EPA finally is supporting the CAG, but they are still trying to penalize us for things said and questions asked. The CAG is the guide for the community. We would prefer to work with the EPA and the WSDs towards solutions. The EPA can provide info that has supporting data instead of removing our interest and work towards a solution instead of trying to remove interest from Superfund Site. This last report was done on the north end. That is not the biggest threat, but we are experiencing concern from the point of compliance being breached.

In terms of being informed, the CAG gets informed on activities long after plans have been formulated and activities have occurred. When asking questions, the long lag time renders them moot. "Why did you put wells in these locations instead of these other areas?" – those questions don't get addressed. So, our message is that we are not being appropriately informed in meetings or in writing. Our central questions and issues do not get addressed.

[Read from CERCLA law about public interaction requirements.] Conferring with the public after an agency decision does not meet the requirements. The EPA is in violation of this standard. There is contamination of the Denver (per Harding Lawson Associates, 1992). Tests on B-504 found dioxane and other contaminants (including benzene, aluminum, cyanide, cobalt, nickel, etc.) after just a couple tests. There should be some way to get them to re-drill that through the lignite to see if anything is above or below there.

The EPA's public involvement and opportunity to make comments is like lip service – they're checking a box. They can't just throw data at the CAG. It doesn't meet the responsibility of community involvement. Keep track of the questions posed, how they are addressing questions, how solutions are being developed. People outside of the CAG aren't going to the EPA website to check for updates. They have the responsibility to simplify in a synoptic way what's happening. People should be able to find out what questions are being posed and what the answers are. You have to wade through a 300-page Conceptual Site Model (CSM) that the public can't begin to read or try to understand. The EPA has a responsibility to do more, not just the bare minimum.

I don't feel that the EPA has done a good job of involving or informing our surrounding neighbors. I was at breakfast with a couple who had lived in the community for four years, and they had no idea what Lowry Landfill was. There needs to be a better way of informing people.

I was at the same breakfast. There was core drilling in the area, but they had no idea whether it had something to do with Lowry or just a developer drilling. I moved to Murphy Creek in 2005. In 2006 or 2007, there was a single meeting held at the community center, and the EPA and the City of Aurora were there. It was designed to give a warm, fuzzy feeling about the Lowry Site. I spoke with then-president of HOA board who was also a developer attorney – they said the chemicals were contained and there were no problems. They lied to my face. The plume was already in existence at that time. When the CAG first got off the ground, there were a handful of very concerned residents from Murphy Creek with young children. They didn't get any answers, and every one of them has since moved out of the community. It's sad that the EPA and other agencies won't do anything. Other agencies are being strongarmed into silence to keep their jobs – and I can't blame them, they need to work. Now I am president of the HOA board. I asked for information about the Superfund Site to show up in our monthly newsletter, but I was initially denied because it was too political. Now I'm concerned about including it because I don't want to start a huge panic and make people leave. If the EPA would do what they're supposed to and contain the problem, there wouldn't be a mass exodus.

[CAG Member] was writing well-done articles. The EPA shouldn't make the Site sound like what people want to believe it is. Just give information and resources to ask questions and discuss. The EPA and the community are on two different routes. The EPA appears to be helping WSDs not get involved in future lawsuits. The community is saying, "Let's find a solution to 138 million gallons of chemical waste, let's get together and decide what to do about it." Now there is a lot more technology and engineering knowledge. Nobody is investigating what can be done. The EPA is constantly confusing the public and the City so there isn't a lawsuit. Residents have led the way. We have a wonderful technical advisor if the EPA would go along with them. Stop kicking the can down the road and come to a solution that removes the threat from the neighborhood. But that might bring the responsible parties back into the picture when the EPA promised to protect them from future lawsuits. No one is investigating what might be able to be done – it's just a merry go round of confusion so we don't have a lawsuit.

It's clear why communities are not hearing from the EPA. Had I not listened to CAG members, instead just relied on the EPA website, I wouldn't have known that this was an issue that affects three communities. When

[CAG Member] read about the EPA's obligations to the public – why isn't the EPA reaching out and conducting surveys? They are leaving it up to the CAG group to disseminate information – are we being jeopardized legally? I have nowhere to send the public for information that can be trusted. If I go out there and make statements or raise concerns, I might be able to be sued – or my property values might go down. I wouldn't want to be in murphy creek right now. It's hard to spot the Superfund signs on the fence. Communication has to be presented more aggressively, with more urgency. We need to get out and talk to people, and push the EPA to come to HOA meetings. The community doesn't want to just be told that everything is fine – they want to know the actual issues.

If only there were a section of the website dedicated to the opinion of the CAG, to say where the EPA was wrong. What is out there right now is the EPA propaganda. Let people go out and speak for themselves. If people think concerns are overblown, that is fine. The funding is a hammer over the CAG's heads.

We can't get even get our facilitator to keep track of questions the CAG is asking, so I'm not sure how those solutions would work. The city government is part of the community and doesn't know what's going on with the Superfund Site. The CAG presented at a study session and there were dropped jaws. But then they decided to listen only to scientists. The city government needs to be continually updated.

In regard to the second part of the question – the EPA should be providing information in a more timely, forthright manner. They should be answering questions, not evading them or casting aspersions on those questioning scientists. There needs to be greater transparency and public involvement for the project to continue. There have been a number of ideas thrown out – the EPA present at HOAs, regular yearly discussions with Arapahoe County or the City of Aurora at a public forum so they can hear from all parties. It should be assumed by the EPA that those are things they should be doing, but we don't see signs of it. It's concerning that the EPA would ask these questions but doesn't follow through with any of those underlying assumptions regarding their role.

On April 20th, 2021, the CAG put out a paper with 15 different points on actions to ensure compliance. The EPA said they would post this paper where the public could access it. To date, nothing has been done. In the FYR, OU1 (shallow groundwater) compliance wells continue to exceed compliance standards for 1,4-dioxane, chloroform, iron, etc. The EPA has taken nitrate off the COC list because nitrate is there because of sludge placed around and outside the Superfund Site. The recommendation was to conduct a capture zone analysis with 2008 guidelines – a systemic approach to evaluation of capture zones and pump and treat systems. The EPA refused to do basic requirements for this paper: establish a target zone and establish where chemicals are at minimum detection limits. The EPA hasn't done either of those. The EPA said the capture zone is the same as the cone of depression in an extraction well – it is not the same, since it is not necessarily where the chemicals are. When we pointed this out, the EPA says this is a Conceptual Site Model – but a CSM doesn't take those things into account.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   Three families on this call are on private domestic wells in the area. All use water for drinking, bathing – everything to do in our daily lives.

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   The EPA needs to correct inconsistent and contradictory statements in the reporting documents. Until this is done, I don't believe the next FYR should be called a 2022 review – we haven't finished the 2017 FYR.

   The basic issue is trust. The EPA is not building trust, so this will stay this way until transparency comes. The CAG isn't in control – we can't build trust. Until they decide to become transparent, there can't be trust.

The Site has such complex issues, it's mindboggling. Scientific opinions can differ, which is a point where the truth can be stretched. Take this simple issue – the facilitator of our meetings acted in inappropriate manner. They contacted CAG members personally, got upset, and tried to get the CAG to change their opinions. We put that complaint in writing, asking that to stop. There is still no response, and that same facilitator is still there. That's a straightforward example of how communication is skewed and not forthcoming from the EPA.

The CAG is very fortunate to have competent technical advisors. They stand at equal status with the EPA's "scientists," but their commentary is taken as adversarial. It should not be – it should be taken as complementary.

The entire CAG can agree that we are appreciative of McGuinness and Associates, our technical advisors. It is very well done – every report goes to the EPA, but the EPA gives comments that are misleading information. It is inappropriate that everything the CAG submits is treated like this. CDPHE did a white paper that was extensively reviewed by peer review. The Army Corps of Engineers and other big organizations were supportive of this white paper. When it came to the EPA, they told CDPHE that study was misinformation. That is a disservice of the EPA to the public.

Stop the bleed. Without complete removal of contamination, the EPA and the WSDs will never be able to 100% protect the public. Remove any financial benefits skewing interests. Clean up the Site – not containment. The plume alone proves containment has not been successful.

The CAG submitted a position paper to the EPA outlining concerns about the Site.

POSITION PAPER
FUTURE ACTION ITEMS NEEDED TO ASSURE
COMPLIANCE AND PROTECTIVENESS
AT the LOWRY LANDFILL SUPERFUND SITE
Written by [CAG Member], MD, LLSF Site TAG/CAG Board Member
Prepared on behalf of and with input from
The Lowry Landfill Superfund Site TAG/CAG Board of Directors
April 20, 2021

The proposed goal of this Position Paper is that we address these issues with respect, politely and in scientific terms without attributing ulterior motives to anyone. Only then can we address the issues which are needed to make the Site protective of the environment and human health.

It is our opinion that the following areas are not being addressed adequately, and as such are putting the containment of contaminants and the protectiveness of the environment and human health in jeopardy.

1. The relatively narrow preferential flow pathways of groundwater in the North needs to be better defined. A preferential pathway less than 40ft. wide has been demonstrated at Well MW113-EW1. The northern and southern extent of that pathway has not been defined. A high resolution surface seismic reflection geophysics survey should be done to evaluate all groundwater flow pathways in the North Boundary Barrier Wall area. The USGS, as an independent third party should be asked to make this survey because of their expertise and past involvement with the Site. This would use the latest technology to provide additional data points for making decisions about the Site. For example it would allow better placement of the extraction and monitoring wells for the MW113 molybdenum plume. It would optimize the extraction of 1,4 dioxane before it gets to the molybdenum. That would allow for the optimal extraction of molybdenum at MW113-EW. It would also optimize the monitoring of the 1,4-dioxane and molybdenum downstream of the extraction.
2. Particle tracking needs to be done as planned for in the numerical groundwater model. However, practical tracking must be based on a three dimensional plume map in order to be accurate.
3. All 29 analytes of concern need to be tested to see if they have reached the POC. Right now only 4 analytes, (indicator parameters) are tested at the POC. There are multiple disposal pits at the Site. We are not aware of a study that has been done to show that all those disposal pits contain at least one of the 4 indicator parameters. If chemicals from a pit not containing one of the 4 indicator perimeters reaches the POC, traveling by an independent pathway, those chemicals would escape without being recognized.
4. When determining the protectiveness of human health and environment the decision needs to be based on the cumulative effects of all contaminants present. To do this all contaminants should be tested for and reported at their method detection limit (MDL) as well as their PQL. Think that these tests are being done and reported in the O&M reports attachment G, but I am not sure of that. Those present at or above the MDL are still toxic and need to be considered when determining risk. The risk determination was made for carcinogens present above their PQL. We are not certain how the risk of carcinogens present above their MDL, but below their PQL can be factored in. The risk also needs to be determined for toxic non-carcinogens using their hazard index. It is not clear that this information was provided for and used when Dr. Berry when he made his evaluation of protectiveness.
5. We would prefer that the EPA not be using a Site specific PQL and MDL off Site. For the LLSS the Site specific PQL of 1,4-dioxane is 0.9ug/l. Off-Site the State PQL is 0.35ug/L. The State sanctioned a "Site specific PQL based on a Site specific MDL". According to the State the Site specific "MDL, established through this process, is matrix specific and may not be applied to other matrices." Furthermore "That MDL is applicable inside the Superfund Site based on the worst case situation for the chemicals in the water matrix." (Appendix A "Development of a Discharge/Site Specific PQL" from CDPHE PQL

Guidance Document, 2014.) I contend that the off-site matrices have no other chemicals ("matrices") which compete with testing to the State PQL of 0.35ug/L. Therefore, the site specific PQL does not apply off Site. By allowing a higher PQL to be used off-site the boundaries of the 1,4 dioxane plume become artificially small. This allows the plume map to look as if 1,4-dioxane is not located under any inhabited structures. It also means that any Target Capture Zone would be too small.

6. In Nov. 2018 molybdenum became soluble at the very high level of 42,000 ug/L at the POC. To date the conditions that caused the solid metal to become soluble have not been determined. Since the conditions that caused the molybdenum to dissolve are within the Superfund Site boundary the WSDs/RPs should be held responsible until proven otherwise. As such, the State Standard for molybdenum of210 ug/L needs to be enforced by CDPHE, and the molybdenum required to be contained by the EPA. Furthermore the LLSS needs to be using the 2008 guidance to create a Target Capture Zone for the molybdenum. The EPA Claims that since the molybdenum is naturally occurring they are not responsible for containing it. The Climax and Henderson molybdenum mines would be happy if they were not held accountable for releasing naturally occurring molybdenum into state groundwater. At the mine they are milling and dissolving the molybdenum and are therefore responsible. At the LLSS the Site chemicals, and conditions are most likely dissolving the molybdenum so the WSD/RPs should be held responsible until they can prove otherwise. (Occam's Razor.)

7. The 2017 five year review called for compliance with the EPA's 2008 Guidance, "A systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems." (page 35 of the 2017 Five-Year Review). The following guidance recommendations have not been followed. A) A capture zone in three dimensions has not been identified. B) A target capture zone in 3 dimensions has not been identified. C) Potentiometric water levels appear to be used as the sole indicator of groundwater flow. D.) Multiple physical and chemical data sources need to be used to make decisions. E) The cone of depression caused by extraction wells should not be confused with the capture zone associated with that extraction. The capture zone is the region that contributes the groundwater extracted by the extraction wells. The capture zone is a function of the drawdown and background (i.e.without remedial pumping) hydraulic gradient. (pages 11-12 EPA 2008 guidelines). F) The "capture zone analysis is the process of evaluating field observations of hydraulic heads and groundwater chemistry to interpret the actual capture zone." G) When multiple contaminants in a plume are identified within a plume the capture zone for each contaminant needs to be defined. H) Once all of this has been done this information needs to be used to decide where the monitoring, extraction and sentinel wells need to be placed. I) Target capture zones define the area in which chemicals are contained and captured. Therefore, without a Target Capture Zone the EPA should not be claiming capture or containment. J) An optimization study done by the EPA showed that 14 of 20 sites evaluated did not have a defined Target Capture Zone, and 16 of the 20 sites were given recommendations to improve their capture zone analysis. (page 2) Why does the EPA feel that they do not need to comply with its own guidelines at the LLSS? Especially when compliance with the guidelines was a recommendation of the 2017 five year review.

8. Is the EPA practicing due diligence by testing for emerging contaminants (EC) of concern within the LLSS? An emerging contaminant is a chemical that is on the cusp of being recognized as one that needs to be controlled by the EPA. 1,4-dioxane was an EC that had to be controlled after the LLSS was established. For example, 1,2,3-Trichloropropane is an EC. We know that 1,2,3-Trichloropropane (TCP) is a very toxic chemical that was found in pesticides and fumigants in the 1950s through the 1970s. The LLSS accepted 138 million gallons of waste from 1966 to 1980 during that same time period. Therefore it is likely that TCP is an unrecognized contaminant in the Site. It causes cancer in mice. The EPA considers it a likely human carcinogen. It is considered so toxic that it has a CDPHE 5 CCR 1002-41 groundwater standard of 0.00037 ug/L. (Table A). It is not readily biodegradable, it is a Dense Non-aqueous Phase Liquid (DNAPL). It has the potential to form a chemical plume. It is considered much more toxic than 1,4-dioxane. Has 1,2,3-Trichloropropane or have other emerging contaminants been tested for at the Site? One possible way to do that is to target any unexpected Spectrometry spikes in the water screened at the Water Treatment Plant. Then analyze those spikes to

find the responsible chemical. It would be best to prevent another contaminant plume like the one that occurred when 1,4 dioxane was an emergent continent of concern.

9. In 2015 the EPA and CDPHE developed a horizontal/vertical dispersion ratio for ground water in order to predict groundwater flow horizontally and vertically at the LLSS. That ratio is 2.67/1. The horizontal flow rate based on data collected over 15 years from 1972 to 2013 is 2.67ft./day. (Table 3: Summary of Groundwater velocity Calculations EMSI, March, 2006.) That means for every 2.67 feet that water travels horizontally it travels 1 foot vertically. A second dispersion ratio is implied in the EPA's claim that 1,4-dioxane has traveled for 3 miles (15,840ft.) to the north of the injection site while only descending vertically to 92 feet below the surface (well MW176-UDEN). That would mean the dispersion ratio is 172/1. A third dispersion ratio comes from the Numerical Model based on 6 months of testing during a major drought (Jan. Through July 2017). It estimates horizontal flow to be 0.26 feet/day. That gives a horizontal/vertical dispersion ratio of 0.26/1. This very large discrepancy of three dispersion ratios (2.67/1, 172/1, 0.26/1) needs to be explained and resolved. In addition, since the CSM is a living document, all this data needs to be incorporated into the CSM. Then it needs to be applied when determining the horizontal flow of groundwater and the horizontal distribution of chemicals of concern.

10. The distribution, placement and number of monitoring wells existing from the bottom of the weathered Dawson to the lignite Point Of Compliance layer needs to be reexamined. At a 2.67/1 dispersion ratio any highly soluble chemical would have traveled the 300ft. To the lignite POC by the time it had traveled horizontally for 800 feet. Yet few if any chemicals have been found in the unweathered Dawson none in the upper Denver above the lignite layer. The LLSS is an area of 0.75 square mile. There are only12 lignite level monitoring wells. That means there is an average of 1 well per every 40 acres. Is it possible that the monitoring well network at the lignite POC is inadequate both in placement and quantity? Is it also inadequate in the un-weathered Dawson and upper Denver areas? There are not enough wells in identified preferential pathways to detect the COCs that are predicted to be present.

11. The slurry wall, NBBW, and extraction/treatment are deployed to provide containment down to about 80 feet. From that point down to just above the lignite layer I see no monitoring to assure containment. From 80 feet to about 300 feet below the ground surface DNAPLS and other COC's have the potential for unrecognized escape beyond the POC. What is being done to prevent containment breach at this depth?

12. It would be wise for the EPA to test to see if the COCs have contaminated the two lowest sources of our drinking water, the Arapahoe and Laramie/Fox Hills aquifers. The two upper drinking water aquifers, the Dawson, and Denver are already contaminated. The bedrock of the lowest aquifer is only 2300 feet below the surface. At a 2.67/1 dispersion ratio chemicals would only have to travel 1.13 miles horizontally to contaminate the Arapahoe and Laramie/Fox hills. Chemicals have already traveled 4 miles north, much further than 1.4 miles, so they have had time to contaminate the Arapahoe and Laramie/Fox hills aquifers. We once thought of the lignite POC as a chemical barrier. We were misinformed. The charcoal that comprises the lignite is not activated so it will not filter any chemicals. It is also only 20 feet wide with a 1/1 dispersion ratio so chemicals have to travel only 20 feet horizontally to get through the lignite.

13. High Resolution Site Characterization (HRSC) should be investigated, and consideration given to how it would benefit the Site. HRSC would give more accurate plume data and result in a more accurate CSM. It would also help to define the narrow preferential groundwater flow pathways. By allowing for more accurate placement of monitoring and extraction wells it would reduce drilling and monitoring costs. IT would be especially useful in the defining of the Molybdenum plume.

14. The Numerical Model divides the LLSS into nine hydraulic zones with #1 being the deepest. #1 is just about the Lignite layer. In every zone the associated geologic zone is identified, with the exception of #1-4. Zones 1-4 are labeled "Unweathered Zone". They do not identify the geologic formations represented in each zone. The 4 zones are made up of 3 geologic formations; the Unweathered Dawson, the Separation Layer, and the Unweathered Denver. Each of the 4 model layers needs to identify the

geologic formation that constitutes that layer. This labeling is important because in the event that any layer became contaminated its associated contaminated aquifer needs to be known.

15. What stage are we in the Project Life Cycle of the LLSS? What does this stage entail and what do future stages entail? What are your projected dates for each stage?

If any of the ideas above were to be evaluated according to the recommendations of the 2017 Five-Year Review, we request that the above comments be addressed in the finalized 5-Year Review response. If any of the ideas presented above are considered valid, but not addressed within the Five-Year Review evaluation, we request that they be investigated in the 2022 5-Year Review.

The CAG also submitted comments on the 2017 FYR and the current FYR.

The CAG's comments on the Five-year Review from July 6, 2021

THE FOLLOWING ADDRESSES THE NINE RECOMMENDATIONS MADE IN THE FOURTH (2017) FIVE YEAR REVIEW (FYR):

These issues are critical for providing accurate data to the CSM. For fairness and completes all the issues are discussed.
Below, each issue will be stated or summarized and the CAG's assessment of the implementation of the issue will follow.

ISSUE #1: Discontinue potable water injections and conduct an optimization study of the groundwater continent remedy to assess changes in water levels, capture zones and water chemistry. This was to be done to evaluate the effectiveness or potential impact to the water balance and contaminant transport north the NBBW.
IMPLEMENTATION: Potable water injection has ceased. However the target capture zone has not been established. see Issue # 3

ISSUE # 2: Evaluate and upgrade the Water Treatment Plant capacity.
IMPLEMENTATION: The WTP has been evaluated and updated both for capacity and for the treatment of a newly emerged contaminant, Molybdenum. We have been informed that the problem of high levels of soluble Molybdenum in the MW-113 area will be addressed in the 2022 fifth Five-Year Review. We are also concerned that Betsy Smidinger's report stated that there are no new issues and recommendations since the 2017 FYR

ISSUE #3: Numerous compliance wells continue to exceed the performance standards for 1,4-dioxane, chloroform, iron and nitrate in the northern, eastern, western, and southern portions of the Site. Conduct a Capture Zone Analysis in accordance with EP{A's 2008

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guidelines. Based on the results of the Capture Zone Analysis, optimize the remedial extraction systems on-Site and off-Site to ensure the remedy is meeding remedial action objectives.

IMPLEMENTATION: The 2008 EPA Guidelines "A Systematic Approach fo Evaluation of Capture Zones at Pump and Treat Systems" was not used to establish a Target Capture Zone. In addition the site is incorrectly conflating the DRAWDOWN of the water level due to pumping, and the CONE OF DEPRESSION in a region due to pumping, with the CAPTURE ZONE. They do not recognize that a CAPTURE ZONE is a function of the "cone of depression" and the "background, without remedial pumping, hydraulic gradient". In addition there has been no attempt to establish the zone where chemical are present Below Cleanup Levels and/or where the chemicals are addresses by other technologies. This Uncaptured zone is also recommended in the 2008 EPA guidelines.

ISSUE # 4: Private or municipal wells are located within the Murphy Creek drainage downgrading of the Site. The recommendation was to sample these wells and analyze for 1,4- dioxane. Based on these results implement appropriate remedial actions.

IMPLEMENTATION: These wells were sampled. However the site specific PQL of 0.9 ug/L was used rather than the Colorado State PQL of 0.35 ug/L. Off-site the Colorado State PQL should be followed. This higher PQL use resulted in a plume that is narrowed in width and depth, and shortened in length. A lower PQL would show that the plume extends into adjacent housing. Therefore we feel that any remedial actions were not appropriate. Furthermore, due diligence should include the testing of existing Arapahoe aquifer wells in contaminated areas. The Dawson and Denver aquifers have already been contaminated and the next aquifer down is the Arapahoe. Testing of the Arapahoe aquifer would help to assure the public that it is not being contaminated. Those wells that are easily accessible and exist in the Arapahoe aquifer are # 2316 in Section 31, and #2113, #2234 on site.

ISSUE #5: The containment effectiveness monitoring at the perimeter slurry wall should include 1,4-dioxane testing

IMPLEMENTATION: 1,4-dioxane was added to the monitoring plan for the perimeter wells.

ISSUE #6: Reevaluate the performance standard for iron based on weathered Dawson wells needs to be reevaluated because several unweathered Dawson wells are out of compliance for iron.

IMPLEMENTATION: This was done.

ISSUE #7: The 1,4-dioxane plume extends off-Site to the North. No institutions controls are in place in this area, and there are private wells located within the footprint and the vicinity of the plume. In addition, there are domestic drinking water wells located approximately 1,000 feet east of the leading edge of the plume, just outside the Murphy Creek drainage, in the Gun Club Estates.
The recommendation was to develop an updated plume map and conceptual site model to ensure that there is no potential for future exposure in this area. Based on the results, evaluate the need for a monitoring plan for wells within the vicinity of the plume edge. Also assess the need for additional institutional controls for the 1,4-dioxane plume.

IMPLEMENTATION: The updated plume map and conceptual site model of the plume used the site specific PQL of 0.9 ug/L to evaluate the off site plume.

The site specific PQL was only awarded because on site contaminants interfered with an analytical lab's ability to achieve the Colorado State groundwater PQL of 0.35 ug/L for 1,4 dioxane. However, the off-site plume does not contain those onsite contaminants. Therefore, the off site plume map and the CSM need to use the Colorado State groundwater (Reg. 41) PQL standard of 0.35 ug/L for 1,4-dioxane. That is an ARAR.

There are three off site areas with that have been able to use the PQL fo 0.35 ug/L. The Aurora Landfill, which is located immediately adjacent to the plume. The Buckley Air-force, Space-force base, within the same Denver Aquifer, is able to use the State Standard PQL while abiding to the same CIRCLA lab standards as does the EPA. The Chemical Sales Superfund site is able to use the State standard PQL, while using the same CERCLA and EPA lab standards. They are able to use the ARAR of Regulation 41 State groundwater standard by finding an analytical lab able to achieve a reporting limit for 1,4-dioxane that is less than or equal to the groundwater standard of 0.35 ug/L. Then EPA at the LLSS have not even tried to use updated technology and Labs that achieve the same standards for the plume groundwater off site. The result is that the LLSS 1,4-dioxane plume is artificially smaller. When state ARAR standards are used the plume is larger, extends under the homes of Murphy Creek Estates, and extends closer to the Gun Club estates drinking water wells.

An additional problem with the implementation is the triangle of three wells that was drilled between the plume and Gun Club Estates in order to asses if contaminants were going into Gun Club Estates. "The detection probability a three well system reaches at the most 26.4% even under the most favorable conditions for all other parameters" (Reliability assessment of groundwater monitoring networks at landfill sites, N. Buket Yenigün et al. Journal of Hydrogeology, 308, 2005, p1-17). A detection probability of 26.4% is a totally inadequate.

A third problem is that the plan is to test wells within the Gun Club Estates, has not been done. This testing was put on hold due to the COVID pandemic.
FOR THESE THREE REASONS WE FEEL THAT THIS ISSUE HEAS NOT BEEN RESOLVED

ISSUE# 8: Several Landfill Gas performance standards may not be stringent enough based on current toxicity values. Reevaluation using updated toxicity values and Site-specific input data in the Johnson-Ettinger model was recommended.
IMPLEMENTATION: In the document "REVISION 3, UPDATED COMPLIANCE MONITORING PLAN LANDFILL GAS REMEDY LOWRY LANDFILL SUPERFUND SITE REMEDIAL ACTION/ OPERATIONS AND MAINTENANCE", dated July 27, 2018, it is stated that the Updated LFG PSs were calculated using EPA's (2018) VIAM. This model is based on the Johnson and Ettinger (1991) Model.
We ask that the CDPHE comment on whether site specific input data (as opposed to default values) were appropriately incorporated into the Johnson-Ettinger model.

ISSUE# 9: There are no vertical migratory wells located north the Site within the 1,4-dioxane plume area to assess if 1,4-dioxane contamination is confined to the shallow aquifer units.
RECOMMENDATION: Review the vertical migration compliance well network and evaluate the need for an additional vertical migration compliance well in the 1,4-dioxane plume area.
IMPLEMENTATION: Additional vertical migration wells were added. Please see our comments below related to vertical Migratory wells.

To see how the EPA has addressed the issues/recommendations in the 2017 FYR we refer you to Betsy Smidinger's report of 02/11/2021 setting forth the additional information received since the protectiveness statement for the 2017 FYR. document #100009527. Ms. Smidinger is the director of the Superfund and Emergency Management Division.

The FYR then asks for New Issues/Recommendations to be addressed in the 2021 FYR. The EPA does not list any issues.

We believe that the CSM needs the data generated by the resolution of the following issues in order to be accurate and complete.

Below we discuss the issues that we feel need to be examined more completely in the 2022 FYR.

Finding the preferential flow pathways on and off-site should be a priority. The extent of those pathways should be defined. Then groundwater compliance wells and vertical migratory wells should be placed within these pathways.

Using well transects to find the primary flow pathways has its place, but can miss narrow pathways. The primary example of a narrow preferential pathway is found at well MW113-EW1 where the preferential pathway is only 10-40 feet wide. The well transect at Mississippi has 300ft. centers. The wells at the Yale transit a similar distances apart. That is too far apart. Therefore, the existing Well transects need to be augmented by the use of up to date technology, as was recommended by the USGS. Contemporary 3D acoustic visualization would identify the areas where the primary flow pathway his most likely to be found. Then High resolution Site characterization can be used to give a 3D visualization of the primary flow pathway. It utilizes standard and low level Membrane Interface Probes, a Hydraulic profiling tool, Soil electrical conductivity, an optical image profiler, natural Gamma Ray logging tool, high resolution soil and groundwater sampling, continuous soil core collecting, and discreet ground water sampling all coupled to a real time analyzer. They can monitor to a depth of 150 feet. This technology gives a 3D map of petroleum NAPL, and chlorinated solvent concentration, horizontal and vertical extent of migration, formation permeability, hydrostatic pressure under zero flow conditions, and estimate K, all in real time on sight measurements. In addition, since the Separation layer has gamma radiation, the gamma ray logging tool can be used to accurately define its location and thickness by simply lowering the probe into any existing monitoring well.

The present groundwater compliance monitoring well network is inadequate to monitor compliance below the Dawson formation. There are only 6 wells in the Upper Denver formation and 8 wells at the lignite layer. The preferential flow pathway needs to be defined to see if the wells are correctly placed.

The vertical monitoring network is also inadequate in well placement, numbers and testing frequency to measure vertical migration. The preferential flow pathway needs to be defined to see if the wells are correctly placed. The vertical migration network consists of 4 wells within the Site boundaries. B-712-LD and GW113 are adjacent to each other a little SE of the North Toe extraction system. B-504A and C-702P3 are east of the primary flow pathway for the North Toe extraction system. Three of these wells are tested every 3 years and B-504A is tested every 5 years. The last test was done in 2018. In order to collect enough data to do a statistical analysis of the trend it taken 12 years to collect the 10 required samples.

The preferential flow pathways on-site and off-site need to be identified using state of the art technology. Then monitoring wells and extraction wells need to be placed within those pathways.

The EPA has not detected contaminants deeper than 80 feet. They state that "Based on vertical monitor samples there is no evidence of vertical migration of contaminants beneath and north of the landfill." What the EPA does not adequately explain is how the contaminants can have only migrated vertically only 80 feet in 55 years while traveling 4 miles horizontally. They say that the lack of conductivity in deeper layers has inhibited vertical flow. However, the established Horizontal/Vertical groundwater flow ratio of 3/1 was determined in 2006**. That ratio means that as the ground water flowed 4 miles north over 55 years the horizontal flow would be 1.3 miles down, 4mi./1.3mi, ie 3/1, not just 80 feet down.

This following is the history of the site that backs up this groundwater flow ratio of 3/1. The contaminated ground water began flowing in 1966. For the next 14 years approximately 138

million gallons of waste was deposited in the unlined waste pits within the Lowery site. From 60 to 75% of the waste pits were dug into the water table so that the vertical migration into groundwater began right away.

There are plenty fo contaminants contained in enough water to migrate. In 1994, at the time of the Remedial Investigation, the volume of contaminated shallow ground water was estimated to be 900 million to 2 billion gallons. The volume of the deep groundwater was 93 million gallons. Over 150 contaminants/analytes were identified at the Site.

Those contaminants had enough time, 26 years, to migrate out of the Superfund site both horizontally and vertically, before final containment mechanisms could be fully implemented in 1993 (Revision 2 GWMP page 7). The Site water flow goes mainly to the North and down. The majority of waste pits are in the southern half of the Site. Contaminants only had to travel 1 mile north, or 340 feet down to escape the superfund site Point of Compliance (POC). At a 3/1 flow ratio contaminants traveling that 1 mile (5280ft) would have traveled 1,760 feet vertically. That is well below the deep POC. They also would have traveled below the 80 foot barrier that the North Boundary Barrier Wall (NBBW) provides.

Contaminants could have already penetrated the Lignite layer. The lignite Layer POC is not impermeable, It is 10 to 20 feet thick. It is made of coal so it cannot filter contaminants as activated charcoal would.

We know that the Dawson and Denver aquifers have been contaminated. The bedrock of the deeper potable water aquifers is only abut ½ mile deep. The surface plume north of the site has extended for over 3 miles. A 3 mile plume would have descended 1 mile deep. Therefore the deeper Arapahoe and Laramie/Fox hills aquifers have the potential of being contaminated.

The disparity of were contaminants are found and where flow ratios indicate they should be is too great not to be resolved. Placing monitoring wells and extraction wells within preferential flow pathways will give more accurate date. Where appropriate, state of the art technology can be used to check conductivity. An optical imaging profiler would accomplish that. Not to resolve these issues would greatly endanger the protectiveness of human health and the environment.

Molybdenum that was found at levels 200 times the State groundwater standard in the area of MW113-EW1 was evaluated and it was determined that the source was natural. Therefore the EPA concluded that the LLSS was not responsible for controlling the contamination. There are several problems with that reasoning.

First, The source was postulated to be volcanic deposits originating at Castlewood Canyon. In order to prove that hypothesis an isotope analysis of the molybdenum would need to be done at the source as well as at the LLSS and the relative concentration of isotopes would need to match.

Second, A measurement of the total volume of molybdenum found at the LLSS was measured and determined to be large enough to account for the volume of soluble molybdenum found. The surface volume of the molybdenum is the only layer that is able to be dissolved by ground water. Molybdenum not on the surface is not accessible to being dissolved. Therefore, an analysis of the surface volume of molybdenum that is accessible by water would need to be determined. Then the surface volume would need to be compared to the dissolved volume of molybdenum to see if there is enough surface molybdenum deposited to account for the mass of the dissolved molybdenum.

Third, It would then need to be determined, not hypothesized, what change had caused the Molybdenum to become soluble after millennium of being insoluble. The fact that the molybdenum only became soluble immediately after the cessation of groundwater injection can't be discounted or ignored. There are 4 main conditions that can account for molybdenum becoming soluble. Redox condition, Cation exchange capacity, iron presence, Sulfur presence, Those conditions have not been adequately studied.

Forth, The Molybdenum was found in a deep and narrow preferential flow pathway that is only 10 to 40 feet wide. The well was then plugged and the extraction of groundwater reduced. These actions resulted in both molybdenum and 1,4-dioxane being able to flow beyond the POC within the preferential flow pathway. An extraction well and monitoring well were then designated. Since the position of the preferential pathway upstream and downstream of MW113-EW1 was not determined the wells were randomly place. They were also placed at a depth above where the main source molybdenum was detected. This action allows 1,4-dioxane to escape beyond the POC and is contrary to the ROD. The preferential flow pathway needs to be determined and the extraction well and monitoring wells repositioned within that pathway.

Fifth, The State of Colorado is inconsistently applying its groundwater standards for molybdenum and as such is putting the groundwater standards in jeopardy.

Sixth, The vertical migration of contaminants needs to be addressed. The EPA and WSD contend that the vertical migration of contaminants has extended 4 miles while never going deeper that 80 feet. Yet they proved in the Remedial investigation that for every three feet that ground water travels horizontally it descends one foot vertically. That means if it went 4 miles horizontally it would have descended 1.3 miles down. If contaminants have already extended even a half a mile down they are contaminating not just two aquifers, but all four aquifers. That dichotomy needs to be resolved. Go to Volume II of the 1992 remedial investigation. On pages 4-62 to 4-65 it explains how the horizontal groundwater flow is related to the vertical flow at the site.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not Applicable	**Interviewer affiliation:** Not Applicable
Subject name: Resident 1	**Subject affiliation:** Resident
Subject contact information: Not applicable	
Interview date: May 31, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other: Zoom	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   The questions posed in this interview have been changed from the questions posed in the November 18, 2016 interview. Question #1 in 2018 asks - "What is your overall impression of the project – to this interview – are you aware of the *former* environmental issues, the remedial activities that have taken place to date and activities since the last 5-year Review?

   "Former" issues continue to be "*current*" issues:
   Not in compliance at the Point of Compliance,
   Not meeting Remedial Action Objectives, WSDs claim they are but the mass balance data says they are not,
   Not meeting ARARs,

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   OU1 and OU2 have failed to achieve the performance standards. The EPA appears to be confused about the location of OU1 & OU6, If following CERCLA, National Contingency Plan requires, if you don't have an MCL, State Standards cannot be ignored, the EPA & WSDs continue to deny that the Denver Aquifer has been impacted, North End Study does not confirm compliance at the ROD Point of Compliance, MW 38 was not included in this 5-Year Review – makes it incomplete, the EPA & WSDs refuse to follow 2008 Capture Zone Analysis which renders "remedial action" moot.

3. What have been the effects of this Site on the surrounding community, if any?

The management of the LLSF Site by both the EPA and the WSDs has caused confusion and mistrust in the community. The remedial activities at the Site and the ongoing technical disagreements regarding the OU1 and OU6 remedy effectiveness are causing confusion for the City of Aurora and Arapahoe County Commissioners. Developers and land owners are taking advantage of incomplete and manipulated information on Site conditions and off-site contaminants impact to move forward with building communities with no regard for future public safety. the EPA's refusal to test more than two private domestic well systems north of the POC have falsely validated Tri-County and WSDs public pronouncement that "no-one is drinking the water". This has caused the public to believe unproven, and possibly harmful information.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   Yes, new finding of Molybdenum with no serious effort to find the source and correct the movement. Two on-site (Section 6) fires that were managed by City of Aurora Fire Department.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   Attempts to access Site Records which, by directive of the LLSF Record of Decision are to be kept for public review at EPA Region 8 Library or City of Aurora Library, have revealed a concerted effort by the EPA to remove any in-depth, historical documents from the record as regards the LLSF Site. Currently, all information that the public receives from EPA Region 8 is believed to be vetted, and written, by the Work Settling Defendants (WSDs), therefore the public believes the information is biased in favor of the polluters, not protection of public health and the environment. When the public has complained about this situation or questioned the final decision, the EPA responds by attempting to silence the public by threatening to take away their TAG Grant funding.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   Yes, we utilize a water well that is located in the Denver Aquifer. We use the water for any aspect of daily life that may be necessary: drinking, bathing, irrigating property plants, water for animals.

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   The 2017 5-Year Review has resulted in so much investigation past the ROD Point of Compliance that a certain positive response to "is the Site in compliance" cannot be determined. In order to make a clear decision on compliance, the EPA should require the following:

   - Clarify the original Site boundary within the ROD defined Site boundaries,
   - Perform a Supplemental Site Review to clarify the off Site past the Point of Compliance boundaries,
   - In the ROD, containment is the remedy, verify containment has been achieved at the Point of Compliance,
   - Conduct a Supplemental Remedial Investigation to determine actual extent of past the Point of Compliance contamination, establish the correctly identified area impacted by off-site movement as the actual boundaries of the Superfund Site. Because of poorly done investigations on behalf of Superfund in the past, include Section 31/DADs, the North End and DACWPF sites in the resultant remedial work.

   There is a need to correct inconsistent and contradictory statements in all of the current LLSF Site documents and work plans which have led to insufficient, misleading and possibly harmful to the public technical information. Once the corrected data is used to present an accurate interpretation of Site conditions, then it would be appropriate to develop a Conceptual Site Model for use in the 2022 5-Year Review.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Resident 2	**Subject affiliation:** LLSF CAG Board Member
Subject contact information:	
Interview date: June 22, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other:	
Interview category: Resident/Local Business/Local Community Group	

Interview Introduction

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As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

PLEASE INCLUDE MY COMMENTS IN THEIR ENTIRETY IN YOUR FINAL REPORT

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   Yes. As a member of the Lowry Landfill Superfund Site CAG, I am very well aware of the FORMER, CURRENT and ONGOING environmental issues at the Site. Because I know the issues are still ONGOING, I take issue with the phrasing of this question. I believe the use of the word "former" is intended to make the general public believe that the issues no longer exist. In my opinion, this is not a transparent or ethical way to communicate with the public.

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   I do not claim to have deep, technical knowledge about the Site, but my overall impression of the project is that it is being severely mishandled. One doesn't have to have a great deal of technical knowledge to know that if a site is supposed to CONTAIN the chemicals, then it is a severe problem when the chemicals are no longer contained and have actually migrated about 3 miles north of the Site. And to allow this migration to continue for decades without any attempts, or perhaps failed attempts, to pull back the contamination is an abomination.

3. What have been the effects of this Site on the surrounding community, if any?

I live in Murphy Creek, the neighborhood closest to the contamination. When the CAG first began, several homeowners were very interested and willing to get involved, as they wanted the best for their families. However, they soon realized the EPA wasn't going to take community concerns seriously and wasn't going to do anything to remove the contamination. Those families, particularly the ones with very young children, moved out of the neighborhood quickly. For myself, every time there is a strange odor in my home, particularly if it is near a water source, I wonder if it is coming from the chemical plume. I wonder if I am being impacted daily by gases I cannot see or smell. It doesn't matter that the EPA keeps saying there is no completion pathway for vapors, as others have already proven there is a pathway. In my opinion, the EPA, through its contractors, has provided no concrete evidence that my neighborhood is not being impacted. Instead, they are: playing shell games with monitoring wells; using outdated data for reports and analyses; not answering direct questions directly; using estimates and assumptions, instead of scientific proof; and continually restricting the CAG's participation in anything meaningful.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   I believe there have been a couple of fires: one the CAG found out about on its own, and another the CAG was notified about. Because of my deep distrust about how this Site is managed, I would say that CAG members would most likely be the last ones to find out about any problems at the site. Whenever possible, I believe we are intentionally kept in the dark.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   The EPA communication is abysmal – because they really don't want anybody to know anything or to ask any questions. That much is very clear. Before the 2017 5 Year Review Interviews, CAG members received copies of the interview questions in advance and were encouraged to get the word out to their communities. That did not happen this year. And, based on the fact that only 4 HOAs were contacted for interviews this year, it's clear the EPA doesn't want the surrounding neighbors to know anything.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   No

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   Yes, please stop spending so much time, energy, and money on: ways to justify actions that don't follow the EPA's own guidelines; ways to develop and spin questionable conclusions; ways to intentionally convey misleading information to the CAG and to the public; writing lengthy letters and emails that circumvent the questions, instead of answering them; and redirect those resources toward actually resolving the problems.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Resident 3	**Subject affiliation:** CAG Member
Subject contact information:	
Interview date: May 31, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other: Zoom	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   I am aware of the issues at the LLSF SITE but I take issue with the way the question is posed. These are not former issues, they are on going issues many of which we as CAG members haverepeatedly brought to the EPA and other entities involved and they remain un- addressed or unsatisfactorily addressed. It is not uncommon for the EPA to send a written response to a question and take the position that the issue is resolved because they said so in writing.

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   Containment is the remedy set forth on the Record of Decision (ROD) but the chemicalsare not contained – evidence the progress of the contaminants nearly 3 miles outside of the identified "SITE."

   I believe the EPA wants to declare the Site protective and safe and chalk it up as "done" despite thepersistent questions the public poses as threats to their health and the environment.

   I believe the EPA is allowing the Work Settling Defendants (WSDs) to run the show and approve whatever means the WSDs want to use including methodology and data interpretation – to avoid usingtheir (the EPA's) authority over the Site.

   I believe we are nowhere near the end of the escape of 138 million gallons of toxins coming from thepits into our surface water, ground water and aquifers.

Also, in my opinion, there has not been an adequate demonstration through documents, comments or quoted data by the EPA as to the vertical migration of the COCs. What they claim does not coincide with my understanding of how water flows and the influence of gravity, despite their claims that the flow is essentially horizontal.

I believe the co-mingling of chemicals creates issues no one foresaw or included in the original documents and remedies put in place many years ago. These documents can be amended as the newerissues arise and that includes putting in to use the most up-to-date approaches, technology, evaluationsof threats and adjustments used by the WSDs to contain the Chemicals of Concern (COCs). There seems to be a great resistance on the part of the EPA to amend the ROD. Case in point – the use of .9 pql instead of the State standard of .35 for I,4 dioxane. Does this mean that because the State has approved .9 at LLSF Site, even though the State Regs require .35, that we (the CAG) may be at risk ofWSDs using this to wave the ARARs at LLSF Site – thereby removing one of the protections allowedthe public? This regulating at .9 is causing much concern due to the fact that many site managers (for example, Dewatering Permits) are being allowed to use the .9 to report to the State.

Another issue is the sudden appearance of Molybdenum. Isn't it possible that the co-mingling of chemicals flowing through this Site has caused the geology to change in such a way that Moly becomessoluble? There is no convincing evidence that Moly is naturally present in the geology at this site that itwould appear at such high levels. When the "discovery" of the Moly was revealed, WSDs put forth no work plan as to how this would be dealt with.

I believe the geology of any place on earth changes over time let alone how chemicals can acceleratethe change when subjected to such an influence.

I believe the COCs are flowing out past what is the sampling site on Mississippi into other bodies ofwater further away from the Site as it is defined by the EPA.

3. What have been the effects of this Site on the surrounding community, if any?

Effects on the community include stress this Site has on those who live nearby. This stress includes the effect on property values as the City of Aurora fails to support efforts from the public to do in-depth environmental testing on the property that comes up for development.

I believe that information about the Site should be such that any future homeowner would know what they are buying into and that, with accurate information, the city can **demand** that the developer MUSTbe responsible for remediation of any contamination – liquid or airborne- and be obliged to take the strongest protective measures for any property they develop.

In our experience, the City Council of the City of Aurora has no idea of the threat and is not informed – except for the protestations by the concerned public – of what is actually happening there. City Council members have said to us they will believe the "scientists" of the EPA when it comes to making decisions about developments to the adjacent properties. The EPA has not, to my knowledge, given any presentation to the City as to the status of the Site. If the EPA is charged with the protection health and the environment, it would be in the best interest of the citizens for them to know what is happening straight from the mouth of the "scientists" which the EA has never done.

In my opinion, there should be a resource continually up-dated which council members and citizens canaccess to include **not only** what the EPA says about the containment efforts, but the **questions** and **unresolved issues** the public (by way of the CAG) has for this Super-fund Site. This way, the public cansee that it is not safe.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   Not that I am aware of.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   I believe the EPA does not treat questions about the Site as serious.

   As stated above in relation to question 3, I think the EPA should keep all the questions openly availableto the public and reveal the status of these questions and challenges raised by the public so anyone can follow the "conversation" and discussions and not hide the process. This is part of the continual mistrust the CAG and others have with the EPA – lack of transparency.

   The EPA and other entities involved in the operation of this Site hire PR firms to edit what they put outto the public which largely tells us the "everything is just fine and you have nothing to worry about." We who are directly affected by this Site know differently and what proof that "everything is just fine"not a letter stating that it is.

   I believe information about the Site should be included on the City website with links to resourceswhere the public – especially potential homeowners – can get the best, most accurate information.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   I do not have a private well but homes nearby – within feet of the flow of contaminants-do have wells which are for home use, including drinking water.

   I believe as part of the reassurance the community needs is the continual testing of water wells near theSite without the red tape that currently exists and the "territorial" disputes as to which entity is to do thetesting. There should be no expense to the homeowner. In addition, the wells must be tested for all COC's, not SOME of the COCs.

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   I believe the CAG has provided scrutiny of the EPA, and other entities, that would haveotherwise gone unaddressed. Except for the history and vigilance of that group, no current or future resident could ever live with any confidence that the threat will be dealt with and that they will be safesometime in the future. The CAG has to keep pulling back the onion skin to get to the truth and not be intimidated by the EPA or the other entities. Up till now, however, we have not been included in the conversation even though the ROD includes the public as part of the process.

   I also believe that the CAG is fortunate to have learned, competent Technical Advisors who are immanently qualified to comment and question what is put forth by the EPA and other entities. These scientists stand with equal status to any put forth by the EPA. Their opinions and analysis should never be treated as irritating and confrontational.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Resident 4	**Subject affiliation:** CAG Member
Subject contact information:	
Interview date: May 31, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other: Zoom	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   Yes, I have served on the CAG since 2017. I am familiar with the ROD and the 2005 Consent Decree. I understand that the ROD, in 1994, was to contain the 138 million gallons of toxic waste that was dumped into open pits. The ROD to date has not been followed and the Site is currently out of compliance with the ROD. Chemicals have moved far beyond the point of compliance. As far as activities, it is my opinion that outside of the installation of the slurry wall the activities have mostly been to cover up, dilute the chemicals with water injection and to deceive the communities near by saying things like, the chemicals have no exposure pathway to humans. Seems the EPA / WSD's have forgotten that chemicals migrate downward as well as out and at times only need a narrow pathway to escape. Once loose it is far more destructive and far more costly to clean up.

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   The ROD said the agreement was containment at the point of compliance. That has absolutely been ignored. The EPA and the WSD's collaborate and work together in secret, and then come to our meetings present their "science" as fully vetted fact and list other agencies that are allegedly in agreement. We however as the CAG, including our TA are only allowed to express our opinion within the perimeters that have been put on the CAG by the EPA. Those opinions sometimes make the public record and sometimes make the public record as misinformation and sometimes never make the public record. Technical information and decision making about the data is done in secret, no meeting minutes, no recording, no transparency, just here is our conclusion and the science, let's move on. When this is the process, any rational person would be at minimum be suspect of that science. If the EPA and WSD's had a pure motive to contain the toxic waste as agreed to in the ROD, there would be no reason to hide behind closed doors. Sadly money and politics

overrule public health and safety and those of us at risk on the CAG, who live under the shadow of the toxic waste will be the ones found to be the victims. Those that are supposed to be stewards over the LLSF site and serve with the EPA and WSD's will retire and go on with life no matter the outcome to those exposed.

3. What have been the effects of this Site on the surrounding community, if any?

   Those that are aware, fear. Those that are not aware, victims. For those of us that are aware, because the sight is so complex, we dare not speak to the community of the risk or lack of transparency from the EPA. In today's environment there is little trust of our government. Sharing the issues of unanswered questions and lack of transparency would propagate fear. Sharing issues with the surrounding communities, especially with the complexity, would ignite fear and migration out of our communities. Please understand, when these chemicals and toxic waste come into our communities and the community looks at us and says why did you not tell us? Where will the EPA / WSD's be, behind the government / corporate veil or on to something else?

   Meanwhile the WSD's hire agencies to market to the community that all is well and safe using old data, deception and leaving out certain data, they accuse us of misinformation and say the professionals declare it safe with no pathway to human contact.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   Not to my knowledge, however I suspect if there were issues it would be concealed like much of what goes on with the Site currently.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   Be transparent, open and honest with the CAG and the public. It is really not that difficult to solve the community concern. Go to a CAG meeting with the Lowry AFB contamination concerns and watch and learn. Honest presentations about the issues / concerns, honesty about the work to being done and what needs to be done. Honest collaborative dialog without condescending decent and technical bullying. Because we cannot see what goes on behind closed door, it is hard to believe that the WSD's are not bullying / threatening the agencies involved into silence.

   It has always been concerning to me that the only ones asking questions about the LLSF is the CAG. There seems to be no curiosity among the WSD's or other entities involved. Their only concern is to respond to the CAG and they are not forthcoming and honest in their response. Nor is there any problem-solving dialog that goes on. No questions from the EPA or WSD's to the CAG for clarification of our concern, just we will get back with you and the question is never really directly answered.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   No.

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   It is not productive to have the defensive adversarial relationship between the WSD's / the EPA and the CAG. That defense posture is not only demonstrated to the members of the CAG but it extends to our TA as well. Trust has been broken, deception has been accepted as truth and the only way that can be fixed is humility and transparency. It is the truth that sets us free. If all that is hidden was to come to light and real accountability put in place with honest collaboration the amount of time, money and effort would greatly diminish.

We just want to be ensured we are safe and that those that come behind us will also be safe. It has been said that a generation that plants trees that will never be able to benefit from their shade, that generation has left a legacy. What legacy are we leaving?

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Resident 5	**Subject affiliation:** CAG Member
Subject contact information:	
Interview date: May 31, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other:	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   To the degree that the EPA has allowed the public to be aware, via reports that the public is given access to months (often many months) after they are produced. Since the CAG is inappropriately denied access to hear meetings of the EPA with Work Settling Defendants where planning and prioritizing of Site activities and their outcomes are discussed, we are only able to raise issues regarding apparent troubling or insufficient data / data collection methods once projects have been completed, at CAG meetings with the EPA and other agencies. Most of our concerns are dismissed as invalid, even when they are clearly elucidated in full scientific and technical terms by our eminently qualified Technical Advisor (whose expert opinions have not only dismissed by the EPA, but also inappropriately characterized as "misinformation, in direct violation of the EPA's own policies regarding scientific integrity and the scientific process, by "*Welcom(ing) differing views and opinions on scientific and technical matters as a legitimate and necessary part of the scientific process",* per CFR 40, 25.4(d)). Our recurring issues of central concern are not answered forthrightly nor substantively nor in the context of relevant decision-making.

   It is important to note that the environmental issues at the Site are not only "former", but also **active and current**, given the leachate plume of 1-4 Dioxane (of indeterminant dimensions) and molybdenum (of indeterminant source), both of which are of significant health concern to the CAG. The EPA's oral and written responses regarding investigation and containment of these emerging active and current issues is the primary source of contended issues between the CAG and the EPA, where we perceive the EPA communications as not being fully responsive nor fully protective of public health.

2. What is your overall impression of the project, including (as appropriate)?

The remedial activities, maintenance and reuse activities of this complex, multi decade project appears to the public to have been compromised by what appears to us to be inadequate response to new findings of lack of containment (e.g. The extensive but not yet fully delineated dioxane leachate plume , the molybdenum of indeterminate origin, as well as lack of comprehensive follow up regarding other chemicals of concern) and the inadequate investigation of their implications for public health (which have so far not included testing of private well water and other means of actually assessing impact to the public).

3. What have been the effects of this Site on the surrounding community, if any?

   Mistrust of the EPA, due to communication issues discussed in #1. Unknown health impacts, since not adequately investigated or surveyed.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   Two fires, readily controlled, are all that I am aware of.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   No: See #1 re communication issues with the CAG, public, and elected officials, which need to be resolved. the EPA should make a concerted effort to contact nearby HOAs and residents, to invite them to CAG meetings and also do a yearly overview for the community. Many nearby residents are entirely unaware of the LL Super Fund Site.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   No.

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   I am in agreement with statements submitted by other CAG members and as given orally at the group interview.

   Suggestions:

   1. It is critical for the EPA to become more forthwith in its communications with the CAG, especially in response to questions regarding our concerns.

   2. It is also critical for the EPA to provide appropriate public transparency and meaningful participation in decision making, by allowing the CAG (or its Co Chairs as representatives of the CAG) to attend meetings of the EPA with Work Settling Defendants. Allowing meeting participation would dispel the appearance of WSD's inappropriate controlling of the Site priorities and solutions and information flow to the public, and would allow the CAG to have more meaningful and appropriate input to Site decision-making which impacts their community in the present and future.

   Failure to honor the CAG's repeated requests for suggestions #1 and 2 appear to be in violation of the EPA policy. As [CAG Member]noted, regulations governing the EPA require transparency, meaningful public participation in decision making, and demonstration that public viewpoints and preferences have been considered:
   " ***CFR 40, 25.4(d);*** *Public participation includes providing access to the decision-making process, seeking input from and conducting dialogue with the public, assimilating public viewpoints and preferences, and demonstrating that those viewpoints and preferences have been considered by the decision-making official. "*

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Resident 6	**Subject affiliation:** CAG Member
Subject contact information:	
Interview date: May 30 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other: Zoom	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   YES, CAG board members and I agree that the EPA-8 does not follow the guidance of the Scientific Integrity Policy to ensure scientific integrity throughout the EPA-8 and promote scientific and ethical standards, including quality standards; communications with the public; the use of peer review and advisory committees; and professional development.

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   NO, the EPA-8 and their Contractor WSD's, do not follow the EPA Guidance and the Scientific Integrity Policy, The ROD and the containment of Toxic Chemicals. at the LLSF Site.

3. What have been the effects of this Site on the surrounding community, if any?

   The EPA-8 and responsible parties (WSD's) do not use "Best Management practices" The Community is very concerned regarding the Lowry Landfill Site contamination breach causing a larger pollution PLUME into their neighborhood. They are very concerned that the 140-million gallons at the Site of will continue to breach the point of compliance.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

YES, a couple of Fires at DADS [Denver Arapahoe Disposal Site].

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   SDs and, if required by Sections 113(k)(2) or 117 of CERCLA, 42 U.S.C. § 9613(k)(2) or 9617, the public, will be provided with an opportunity to comment on any further response actions proposed by the EPA as a result of the review conducted pursuant to Section 121(c) of CERCLA and to submit written comments for the record during the comment period.

   CFR 40, 25.4(d) the EPA, State [State means any of the several States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands], interstate, and substate agencies shall provide for early and continuing public consultation in any significant action covered by this part. Merely conferring with the public after an agency decision does not meet this requirement.
   CFR 40, 25.4(d); Public participation includes providing access to the decision-making process, seeking input from and conducting dialogue with the public, assimilating public viewpoints and preferences, and demonstrating that those viewpoints and preferences have been considered by the decision-making official.

   the EPA-8, promoting a culture of scientific integrity is closely linked to transparency. The Agency must be committed to transparency in its interactions with all members of the public (CAG).

   Scientific Integrity Policy
   - Appropriately characterize, convey, and acknowledge the intellectual contributions of others.
   - Welcome differing views and opinions on scientific and technical matters as a legitimate and necessary part of the scientific process.
   - the EPA's longstanding commitment to the timely and unfiltered dissemination of its scientific information – uncompromised by political or other interference.
   - To ensure that scientific information for the general public and media is clearly, comprehensively, consistently, and accurately presented and explained.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   YES, we use the well water from the Denver Aquifer, for Drinking and Home water usage.

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   EPA-8 must closely follow all Federal guidelines in CFR 40, 25.4(d) CERCLA and the ROD
   Comments, Suggestions and Recommendations
   EPA-8 and CDPHE must: **CFR 40, 25.4(d)**
   - A Deputy Scientific Integrity Official be appointed to oversee the EPA-8 LLSF. Program Office Foster to make sure the EPA-8 sets forth a spirit of openness and mutual trust among the EPA-8, CDPHE, substate agencies and the PUBLIC.
   - Must follow the Site ROD, CERCLA, NCP. The EPA-8, must use all feasible means to create opportunities for public participation, and to stimulate and support participation.
   - Must assure that the government does not make any significant decision on any activity covered by this part without consulting interested and affected [will or may have an effect on] segments of the CAG (public);

- Must keep the public informed about significant issues and proposed project or program changes as they arise;
- Must provide to the CAG (public) copies of any and all communications and draft Work Plans for comment before the EPA-8 accepts the Work Plans.
- Appropriately characterize, convey, and acknowledge the intellectual contributions of others.
- Welcome differing views and opinions on scientific and technical matters as a legitimate and necessary part of the scientific process.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Resident 7	**Subject affiliation:** CAG Member
Subject contact information:	
Interview date: June 10, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other: Zoom	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   Yes

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   The remedy chosen by the ROD is to contain the contaminants of concern within the point of compliance. Contaminants of concern pass beyond the point of compliance in the North, East, and West. They are extracted and brought back into the Site for treatment. However, at the North boundary Barrier Wall Area the Primary flow pathway has been determined to be as narrow as 10 to 40 feet wide. This pathway is not well defined to the North and South of Well MW113-EW-1 (which is on the point of compliance) where the primary flow pathway was found to be so narrow. 1,4-Dioxane was being extracted from that well. The deepest portion of that well where the concentration of contaminants were the highest was blocked off by the placement of a pack because Molybdenum at concentrations 200 times above State groundwater standards was found in the area. The EPA appropriately started treating and extracting the molybdenum by updating the water treatment plant. However, the quantity of molybdenum that was in the effluent from the plant was still greater than they were allowed to discharge into the water system. The EPA's response was to pack well MW113-EW-1. They also reduced extraction from that Well by at least two thirds. They then arbitrarily chose a monitoring well and Extraction well that were shallower than the original MW113-EW-1 to take its place. Since the EPA has not defined the primary flow pathway, they could not place the monitoring and extraction wells in the correct location. This sets up the possibility for COC's migrating beyond the POC in the future. When recommendations were made by the CAG to define the primary flow pathway with such things as a high-resolution surface seismic reflection geophysics survey or using High Resolution Site characterization with subsurface imaging tools there was no response from the

EPA. When it was suggested by the CAG that defining the primary flow pathway would allow for more appropriate placement of monitoring and extraction wells the EPA indicated that the ones that were chosen were fine. It is this kind of response that has led to the impression that the "Project activities" are inadequate.

3. What have been the effects of this Site on the surrounding community, if any?
   The ROD has defined Shallow groundwater OU1 and Deep groundwater OU6 within the Site boundaries. With the new numerical Conceptual Site Model, they are now defining the subsurface by dividing it into 9 hydrologic zones. This is appropriate for the new Conceptual Site Model, but no attempt is being made to say which zones make up each operating unit that was defined in the ROD. Furthermore, on Site the surface comprises the Weathered and Unweathered Dawson aquifer. However off Site, where there is a three-mile plume of 1,4-dioxane, the Dawson aquifer no longer exists, and the top surface consists of the Denver aquifer. The EPA continues to use the Terms OU1 for shallow groundwater off Site, and OU6 for deep groundwater off Site. This has led to confusion within the Aurora City Council. Both the Dawson aquifer on Site and the Denver aquifer off Site have been contaminated with 1,4-dioxane. Yet the city council felt that only one aquifer had been contaminated. This lack of consistency in, and clarification of terminology, has led to confusion within the community and a lack of trust.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   Nothing major that I can think of now.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   The EPA has allowed the Tri-County Health Department to make statements, in public online documents, that no one is drinking any contaminated water based on the testing of two drinking water wells in or adjacent to the off-site plume of 1,4-dioxane. Where the plume is close to drinking water wells within Gun Club Estates no wells to date have been tested to make sure that there is no completed pathway to drinking water wells. A more accurate statement should have been demanded. The following statement would have been more accurate. It is unlikely that there is a completed pathway to any drinking water wells based on the EPA's present studies, but once COVID restrictions are lifted The State of County or the EPA will test adjacent wells to make sure no drinking water has been contaminated. The EPA should have demanded a clarification.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   I have a drinking water domestic well just a little north of Gun Club Estates

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   I have 15 comments, suggestions, and recommendations, and wrote them up as "future action items needed to assure compliance and protectiveness at the Lowry Landfill Superfund Site". They were compiled into a Position paper put out by the CAG. That is enclosed below.

LOWRY LANDFILL SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Lowry Landfill	
the EPA ID: COD980499248	
Interviewer name: Not applicable	**Interviewer affiliation:** Not applicable
Subject name: Residents 8 & 9	**Subject affiliation:** CAG Members
Subject contact information:	
Interview date: May 27, 2021	**Interview time:** Not applicable
Interview location: Not applicable	
Interview format (circle one): In Person Phone Mail (Email) Other: Zoom	
Interview category: Resident/Local Community Group	

Interview Introduction

The EPA conducts regular checkups, called Five-Year Reviews, on Superfund sites. The Five-Year Review is a way to evaluate the progress of remedial activities and make sure they are protecting people and the environment.

As part of the Five-Year Review for the Lowry Landfill Superfund Site, the EPA is speaking with community members to hear their concerns and gather additional information about Site conditions. We are interested in your opinions and would like you to be as candid as possible. Your responses will not be attributed to you.

We expect the interview to take approximately half an hour. Do you have any questions for us before we get started?

1. Are you aware of the former environmental issues at the Site, the remedial activities that have taken place to date and the activities since the last Five-Year Review.

   Superficially yes.

   The [Residents 8 & 9] have been residents in Thunderbird Estates since 1990. The real estate agent, the community HOA, the EPA/or other agency, nor the media, has ever brought the LLSF Site to our attention. It was by coincidence, in August of 2020, that we became aware of this critical situation through a Community Advisory Group member/neighbor. Since learning of this situation, we have personally spoken to others that rely on domestic well water and have asked them to share their experiences and opinions of the Site. One neighbor believes that the "entire" trust fund was depleted years ago, and it "does no good" to worry about it or to get involved. He and his wife have "no confidence that the EPA, City Gov't, or the WSD's, will ever get the situation corrected". His water "smells and is colored" and only the horses are provided this water to drink. This family has installed an infiltration system they "hope works".

   We have diligently attended all CAG meetings, researched websites and educated ourselves about this Superfund Site. What we have ascertained is that it is *wrought* with a political agenda, the EPA is *adversarial* with the CAG membership and seemingly, *lacks complete transparency* with the public.

   The public is not allowed to attend the EPA/WSD meetings – even if the "no public comment" is in place. The WSD's (& the EPA?) hire Public Relations firms to develop palatable marketing campaigns for the public. P.R. firms are hired to take negative situations and spin the perception into a positive position to sway public opinion. The idea of having to put a "spin on the data" creates distrust in the entire process.

   It is my belief that a contaminated SUPER FUND SITE, that directly impacts the public, should have *all* negotiations, discussions and policy development be held openly in public. It is critically important that the

public is aware of the issues, how these issues will be addressed, and how the governmental oversight organization, such as the EPA, is *negotiating and regulating on the public's behalf.*

The opportunity for the public to listen, and hold accountable, all decisions about this Site between the EPA and the WSD's has not been afforded to the CAG or general community. T*he EPA verbally expressed that there were "legal" reasons that did not allow for this accommodation.*

2. What is your overall impression of the project, including remedial activities, maintenance and reuse activities (as appropriate)?

   LLSF is a politically charged Site. Observing the EPA/CAG public monthly meetings, it became obvious that the EPA dreads these meetings. It is painful to watch the moderators faces and body language during the meeting. The information provided is preplanned and there are *never* direct answers to any of the CAG members technical questions. The graphics and educational materials used in presentations are older documents, and designation of water well names/locations are re-used in a manner that leads the citizens to a conclusion that "all is okay". I do not understand why, if a well test reflects heavy contamination, that a new well is drilled 40 - 100 feet away, tested to reflect no contamination, and then this "re-drilled well" is issued the same number/name of the contaminated well? The original contaminated well site is never retested. This indicates manipulation of data to arrive at a conclusion favorable to the WSD's & the EPA. Clear examples of this strategy can be found with the OU1 & OU6 wells. Bait & Switch?

   The CAG's technical advisor, Dr. Deitrick McGinnis, is nationally recognized in this field and has worked on numerous Superfund Sites. Yet, any documents or analysis he has provided the CAG has been disregarded by the EPA. Not only will the EPA not address the issues raised, but his White Papers are labeled, in writing, as "misinformation" not worthy of answering. At public meetings the EPA staff have been condescending of this prestigious advisor's opinions.

3. What have been the effects of this Site on the surrounding community, if any?

   The Site has not been "contained" to the point of origin as regulated by the R.O.D. A plume has been allowed, *and deemed acceptable by the EPA*, to travel northwards by about 3 miles from the Site of compliance. This progression comes extremely close to the Murphy Creek community. But, since municipal water has been supplied to Murphy Creek, the powers-to-be, feel that there is not a great sense of urgency to address the migration of the contamination. Just north of Murphy Creek, are 3 communities that rely totally on a water supply through wells drilled directly into the impacted Aquifers.

   These communities, through the CAG, have repeatedly asked to have their wells tested. It has been a gruel-some process to even get a commitment to test a *few* wells of potentially impacted residents. These tests were put off due to "Covid". Hopefully, these tests will occur sooner than later since mandated quarantines have been lifted.

   As a member of the public, this procrastination of testing private wells reflects the attitude of not wanting to bear the expense of "protecting" the public's health and no genuine desire to ascertain the degree of contamination impact.

   The EPA should have never allowed this plume to exist. Clearly, the contamination has not been contained at the LLSF Site as per the ROD. The plume that exists should be brought under LLSF's/WSD/the EPA's responsibility. WSD representatives have stated that their decision to "contain" the chemicals by back flushing water possibly created the 1.4 dioxane issue. Therefore, the EPA should expand the Site to include the contaminated plume.

On a side note, the *100's of millions of gallons* of fresh domestic water used in this back flush technique, was pulled from our *non-replenishing* aquifers! The percentage they put back seems to be what they *believe* contaminated the water.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   Since the [Residents] have only recently become aware of this contaminated Site, no media coverage, or community activism surrounding the LLSF Site is covered, we are not aware of any situation. Apparently, there were two fires that were contained. However, it seems the public would need to post an individual at the Site 24/7 to get any clear information from the management of the Site.

5. Has the EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can the EPA best provide Site-related information in the future?

   The EPA has not developed a proactive outreach to the various communities that are currently being built or that have historically bordered the LLSF Site. This area's population is increasing at an exponential rate. It is disappointing educational brochures, or surveys, have not been distributed to each household, sharing the contamination issues/resolutions at the LLSF Site, and *actively seeking involvement* from the community. If things were going "well" at the LLSF Site and candid answers to tough questions were immediately available, it seems that proactively providing community communication would be embraced. If the EPA is solely relying on a CAG group to communicate to the entire surrounding community, then the EPA is leaving the marketing and distribution of critical information to a volunteer type basis. I believe this would also put a CAG, and its members, into a jeopardized position. Therefore, the community is *not* being informed. The EPA LLSF website only portrays the favorable position on the LLSF Site and does not address the publics concerns or comments. A suggestion would be to create a section on the website for public comment with answers from the EPA.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?

   Our property's well is the *sole* method of providing all domestic water to the residence. It is drilled over 600 feet into the Denver Aquifer.

   No city, county agency, or private company will install the necessary infrastructure to provide municipal water to our communities. They will however, lay the pipes to the over 9,000 newly developed homes at the *edge* of my 4-acre property. It is the David/Goliath syndrome. The three impacted communities are made up of approximately 400+ families. I have been told it is "too expensive" to lay the infrastructure to provide water, every family would have to participate, the ROI would be too slow, and the tax base from these few people would not support the cost to provide water to them from the city's perspective. Cherry Creek Water laid pipe along the entire stretch of Gun Club Road in 2020. They would be happy to sell water to us but … the community would have to bear the cost of bringing the water lines to their individual homes. That leaves only water wells for domestic use and the possibility of contamination issues that have been kicked down the road for 40-years!

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?

   Forty years of battling the LLSF's Site's contamination *must stop*. The salary costs, the commitment of time from city officials, the EPA staff, legal battles and the precious volunteer time has been too great. The cost to originally remove this contaminated waste would have been far less than this constant battle of trying to reign the issue under control for 40-years. Without complete removal of the contamination, the EPA and the WSD's will NEVER be able to 100% protect the public.

Eliminate the political bias. Remove any possible government benefits from the WSD's trust funds being held in interest bearing financial institutions. The plume alone shows that the containment approach has not been successful. Perpetuating this exercise in futility will cost even more. REMOVE the 138 MILLION GALLONS OF CONTAMINATED WASTE *and be done*.
Clean up the Site, not contain it.

Previous EPA Responses to Community Member Concerns

Recent EPA communications in response to community concerns are listed below with links. Additional documentation can be found on the Site's profile page (https://www.epa.gov/superfund/lowry-landfill).

- EPA letter to the Arapahoe County Commissioners, October 20, 2021 https://semspub.epa.gov/src/document/08/100010504

- EPA presentation to the Arapahoe County Commissioners, September 27, 2021 https://semspub.epa.gov/src/document/08/100010894

- EPA response to the comments received during the Public Review periods for the draft North Boundary Barrier Wall Containment System Evaluation and the draft Updated Conceptual Site Model, September 21, 2021 https://semspub.epa.gov/src/document/08/100010914

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region8

June 11, 2021

Ref: SEMD-RBA

Mrs. Bonnie Rader
Lowry Landfill Superfund Site Citizens Advisory Group
71 Algonquian Street
Aurora, Colorado 80018-1517

Re: Responses to the Lowry Landfill Community Advisory letter dated March 31, 2021

Dear Mrs. Rader:

Thank you for your March 31, 2021, letter regarding your concerns with how the Lowry Landfill Site 2017 Five Year Review (FYR) has been managed. The EPA welcomes Community Advisory Group (CAG) members expressing concerns or asking questions.

On February 22, 2021, the Environmental Protection Agency (EPA) shared the 2021 Addendum to the 2017 FYR by emailing it to the community members, along with links to the supporting documents. During the March CAG meeting, the EPA Region 8 FYR Coordinator, Fran Costanzi, attended to discuss FYRs and the 2021 FYR Addendum along with announcing the start of the Fifth FYR for the Lowry Landfill Superfund Site. The EPA's Site Project Manager, Linda Kiefer, also went through the 2021 FYR Addendum at the meeting, which included opportunities for questions.

The EPA stands behind the accuracy of the data and documentation of the 2021 FYR Addendum and has provided the attached responses to your questions and comments. In summary, none of the three concerns raised in your letter warrant an Explanation of Significant Differences.

To the extent possible, the EPA takes into consideration CAG concerns and addresses them accordingly. One example is how the CAG raised the absence of the Murphy Creek Townhomes on a map in one of the Lowry Landfill Superfund Site's Remedial Action Operations and Maintenance Reports, and the EPA then ensured the maps were corrected and would be in subsequent reports.

Additionally, issues raised concerning your Technical Assistance Grant were addressed in separate response to your April 19, 2021 letter.

Please contact Lisa McClain-Vanderpool at mcclain-vanderpool.lisa@epa.gov and (303) 312-6077 or Linda Kiefer at kiefer.linda@epa.gov and (303) 312-6689 with any questions.

Sincerely,

BETSY SMIDINGER Digitally signed by BETSY SMIDINGER Date: 2021.06.11 16:59:42 -06'00'

Betsy Smidinger
Director
Superfund and Emergency Management Division

Enclosure

The EPA received the Lowry Landfill Community Advisory Group's letter dated March 31, 2021. The EPA team's responses are below.

CAG Request to EPA: EPA is not currently building on the 1992 RI CSM or the 2001 Revised CSM provided as an attachment in 2001. If EPA intends to proceed with the use of an entirely new CSM at LLSF Site, EPA Region 8 is legally required to develop and document the change consistent with the ROD process (NCP 300.435©(2)(ii)(A) through (H) that highlights the proposed changes.

A Conceptual Site Model (CSM) is a tool which provides an illustrative summary of the key aspects of a site to help visualize and understand available site information including the current understanding of geology, hydrogeology, remedy components, contaminant sources, and transport pathways. A CSM is dynamic and can be refined throughout the life of the project. While the CSM can provide understanding of the site, changes to the CSM do not require the Record of Decision (ROD) to be modified. However, changes to a site remedy, if determined to be necessary, would have to follow the required ROD modification process. The 2021 Conceptual Site Model updates information obtained since the last revision of the CSM through the incorporation of a better understanding of the site conditions and the interpretation of both new and existing datasets, but none of the refinements to the CSM trigger a change to the remedy. This effort incorporates all information collected for the site to date.

The EPA's policies and procedures evolve over time; updating a CSM is a common practice. Here is a link to the recent guidance on CSMs https://www.epa.gov/sites/production/files/2015-04/documents/csm-life-cycle-fact-sheet-final.pdf.

As part of the upcoming public review process, the community has the opportunity to review and comment by July 6, 2021 on the *2021 Conceptual Site Model*.

CAG Request to EPA: The current discussion and data presented in the 2017 5-Year Review Addendum indicates the presence of vertical gradients and directly contradicts data and conclusions from the original 1992 RI and ROD. The information in the 2017 Addendum is consistent with the 1992 RI, which talks about strongly downward gradients and the flow rates are strongly downward (Figure 4.54). If EPA and the WSDs continue to make major changes to the ROD definitions of OU1 and OU6, the CAG requests that the EPA prepare an ESD to explain when and why these major differences to the ROD were established.

The Conceptual Site Model update was not yet out for public review at the time that the letter was submitted. The following information from the CSM addresses your request:

In Section 5.12 Contingency Measures,

> The 1994 ROD included provisions for contingency measures if contaminant levels exceed performance standards at compliance boundaries during operation of the groundwater remedy. The effectiveness of these contingency measures is monitored in accordance with the Groundwater Monitoring Plan and reported semiannually in the Site Status Reports (SSR).

As described in Section 5.13 in the Conceptual Site Model,

> North End response actions were implemented as a contingency measure on site and north of the site boundary in response to the discovery of 1,4-dioxane in this area. Groundwater extraction wells were installed in five areas (Areas 1 through 5) to reduce off-site migration of 1,4-dioxane, reduce the mass of 1,4-dioxane north of the site, and to bring compliance wells into compliance with the performance standard (Figure 5-13). Charts of 1,4-dioxane concentrations over time are included in Attachment E of the first half 2020 SSR (EMSI and Parsons 2020). The charts indicate declining concentrations of 1,4-dioxane in the North End monitoring wells.

As stated in Section 4.1:

> The geology at the land surface north of the LLSS compliance boundary transitions from the Dawson Formation to the Denver Formation. The definition for OU1 (shallow groundwater and subsurface liquids) beneath Section 6 refers to the weathered Dawson formation as the shallow water bearing unit; however, shallow groundwater north of the site is in the Denver Formation because the Dawson Formation and the separation layer are absent in this area. The ROD evaluated OUs 1 and 6 collectively beneath LLSS, including the identification and evaluation of risk, applicable or relevant and appropriate requirements, RAOs, and remedial alternatives. Because the change in the formations at the surface north of LLSS does not fundamentally alter the sitewide remedy presented in the 1994 ROD (or subsequent amendments), or the evaluation of site risks or remedial alternatives, *EPA determined the OU definitions do not need to be changed to reflect conditions north of the site.*

The definitions of OU1 and OU6 only apply to the site and have not changed; groundwater north of the site is evaluated in terms of its depth and the degree of bedrock weathering rather than as part of an OU.

According to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), a remedy can be formally modified if the selected remedy changes with respect to scope, performance or cost. The scope, performance, or cost of the remedy has not changed. Therefore, an Explanation of Differences is not warranted.

<u>North End Plume Information</u>

The data collected to date on the North End 1,4-dioxane groundwater plume indicate that the contamination is limited to the shallow sediments along sections of Murphy Creek. The lateral and vertical extent of the 1,4-dioxane groundwater plume is depicted in the 2020 *North End Investigation Report* (prepared in consultation with the State of Colorado and put out for public review in 2019/2020). There is no indication that the contamination has reached the deeper unweathered zone in which domestic wells have been completed.

Characterization of the 1,4-dioxane groundwater plume north of Lowry Landfill shows that the 1,4-dioxane groundwater plume exists in weathered bedrock material of the shallow-most geologic formation. While the groundwater plume's maximum depth in this area is

approximately fifty feet deep (in the Denver aquifer) there are hundreds of feet of competent bedrock between the groundwater plume and the Gun Club Estates private drinking wells.

Due to the geologic setting, the shallowest formation shifts from the Dawson formation to the Denver formation north of the site. This does not mean that the contamination is closer to the depths that water supply wells pull from, or that those wells are any more at risk based on the name of the shallow-most formation. Groundwater is flowing primarily through sand channels within the weathered portion of these formations. The 1,4-dioxane contaminated water in the north end is not migrating to water supply wells.

As noted in site documents and on websites, the statement that there is "…no completed exposure pathway" is accurate. It is not the shift from the Dawson formation to the Denver formation (conceptually, at what is referred to as the "separation layer") that affects the exposure pathway, but instead the difference between weathered and unweathered bedrock.

Monitoring of the 1,4-dioxane groundwater plume began over thirteen years ago. More information about the groundwater monitoring in the North End can be found in the recently updated 2020 *North End Groundwater Monitoring Plan.* In addition, the two offsite private wells along Jewell have been tested annually since 2006, for 1,4-dioxane and volatile organic compounds; these wells have never shown these contaminants. In 2019, additional monitoring wells were installed along the southern and western borders of Gun Club Estates, between the groundwater plume and the domestic wells in the deeper zones to monitor specifically for the presence of contamination. The data from those deeper wells are non-detect for 1,4-dioxane. Contamination is not migrating downward. This is described in the *North End Investigation Report*. There is no evidence that people are drinking water from the 1,4-dioxane plume, or that chemicals from the Lowry Landfill Superfund are impacting private drinking wells in the area.

All of the regulatory agencies – the EPA, the Colorado Department of Public Health and Environment (CDPHE) and Tri-County Health – are dedicated to the highest level of scrutiny of the operation and maintenance of the Lowry Landfill Superfund Site remedy to ensure the remedy is functioning as designed. Nothing will interfere with our effort to protect public health.

CAG Request to EPA: The Risk Assessment is irrelevant and incomplete. EPA does not acknowledge that off-site dioxane at .9 presents a risk, in spite of lack of data and no testing of Gun Club Estates wells. The community would feel better if there was compliance at the Point of Compliance, which there never has been, when EPA tells us that we are "Not Receptors."

The Work Settling Defendants (WSDs) conduct ongoing groundwater monitoring to demonstrate that the remedy achieves the remedial action objectives. The compliance monitoring network consists of sixty monitoring wells, most of which are located along the point of compliance surrounding the site except for five interior wells. These compliance monitoring wells are sampled for twenty-nine contaminants of concern. In addition, four wells are sampled to assess the potential for vertical migration.

The effectiveness monitoring program consists of another 400+ wells. These wells are used to assess the direction of groundwater movement beneath the site and the effectiveness of the

remedy components, including the perimeter slurry wall, North Toe Extraction System, the North Boundary Barrier Wall, and the MW38 sand channel extraction systems. The effectiveness of the groundwater remedial components is also evaluated by examining how chemicals are moving or not moving in the vicinity of remedial components and by studying the contaminant concentration trends over time. If a well is out of compliance for a particular chemical, follow-up is required.

The 1994 ROD included provisions for contingency measures if contaminant levels exceed performance standards at compliance boundaries during operation of the groundwater remedy. As mentioned above, the 1,4-dioxane plume is being managed with a contingency measure as discussed in Section 5.13 of the CSM. The effectiveness of these contingency measures is monitored in accordance with the Groundwater Monitoring Plan and is under constant review by EPA, CDPHE, and Tri-County Health personnel.

Chemical source and migration and exposure potential are considered when determining remedy effectiveness and protectiveness. As noted in the September 2020 *Risk Assessment*: "Exposure to 1,4-dioxane in groundwater is not occurring and is not expected to occur in the future." Moreover, there are no completed exposure pathways for the1,4-dioxane plume in groundwater.

There appears to be continued confusion regarding the meaning of a completed exposure pathway for risk assessment purposes. An exposure pathway is the route a substance takes from its source (where it began) to its end point (where it ends), and how people can encounter (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway. Therefore, an example of an incomplete exposure pathway would occur when contamination exists in shallow groundwater and residents are not using the shallow groundwater as a drinking water source. Current residents are using municipal water or water from private wells from deep groundwater sources that are not contaminated by site-related contaminants. (Click here for a more in-depth explanation of completed exposure pathways.) However, to be responsive to the community's concern about private wells, CDPHE with EPA oversight will be sampling private wells under the Site Assessment program in the coming months (after COVID-19-related delays).

Risks are calculated based on the concentrations of chemicals present, not on a prescribed risk range. The EPA compares these calculations using standard risk assessment methodology for all sites to provide a consistent, scientifically based process to evaluate potential threats to public health and the environment. Under NCP, 40 CFR §300, an acceptable risk range is defined as one additional cancer case associated with the exposure to contamination in a population of one million (typically expressed as 1 in 1,000,000 or 1 x 10^{-6}) to one in ten thousand (1 in 10,000, 1 x 10^{-4}). The NCP outlines CERCLA's implementing regulations. EPA's toxicologist calculated the corresponding concentrations of 1,4-dioxane: for 10^{-4}, the concentration is 46 parts per billion (ppb); and for 10^{-6}, the concentration is 0.46 ppb. The concentrations of 1,4 dioxane in the plume

are at trace levels (an average of around 2 ppb). An adult would have to drink two liters of water that contained 2 ppb of 1,4 dioxane, every day for seventy years to have a chance of a four in one million (10^{-6}) carcinogenic risk.

The performance standard for 1,4-dioxane is 0.9 ppb based on the practical quantitation limit (PQL). A PQL is a measure of laboratory performance and can vary based on site-specific and laboratory-specific factors. *This value is not used to compute risks at the site.* The PQL is the lowest concentration that can be reliably detected in groundwater from the site by the laboratory. The PQL is re-evaluated every year to check to see if a lower concentration can be reliably detected.

At the 1,4- dioxane performance standard concentration of 0.9 ppb, the risk is 2×10^{-6}. At the low end of the risk range, a concentration of 0.46 ppb corresponds to a risk of 1×10^{-6}; and the Colorado groundwater standard concentration of 0.35 ppb corresponds to a risk of 8×10^{-7} cancer risk [sum of ingestion + inhalation + dermal].

The difference between the performance standard for 1,4-dioxane (0.9 ppb) and the Colorado groundwater standard (0.35 ppb) does not change the risk of exposure to contamination from Lowry Landfill.

The table below from the September 2020 North End 1,4-Dioxane Risk Summary, depicts the calculated risks from several potential exposure pathways. There is a vapor intrusion section in the Risk Summary also.

Table 1. Risk Assessment Summary for Hypothetical Future Residents

Ingestion	Inhalation	Dermal Contact	Total Hypothetical Cancer Risk
4×10^{-6} (4 in 1,000,000)	2×10^{-6} (2 in 1,000,000)	1×10^{-8} (1 in 100,000,000)	**6×10^{-6} (6 in 1,000,000)**

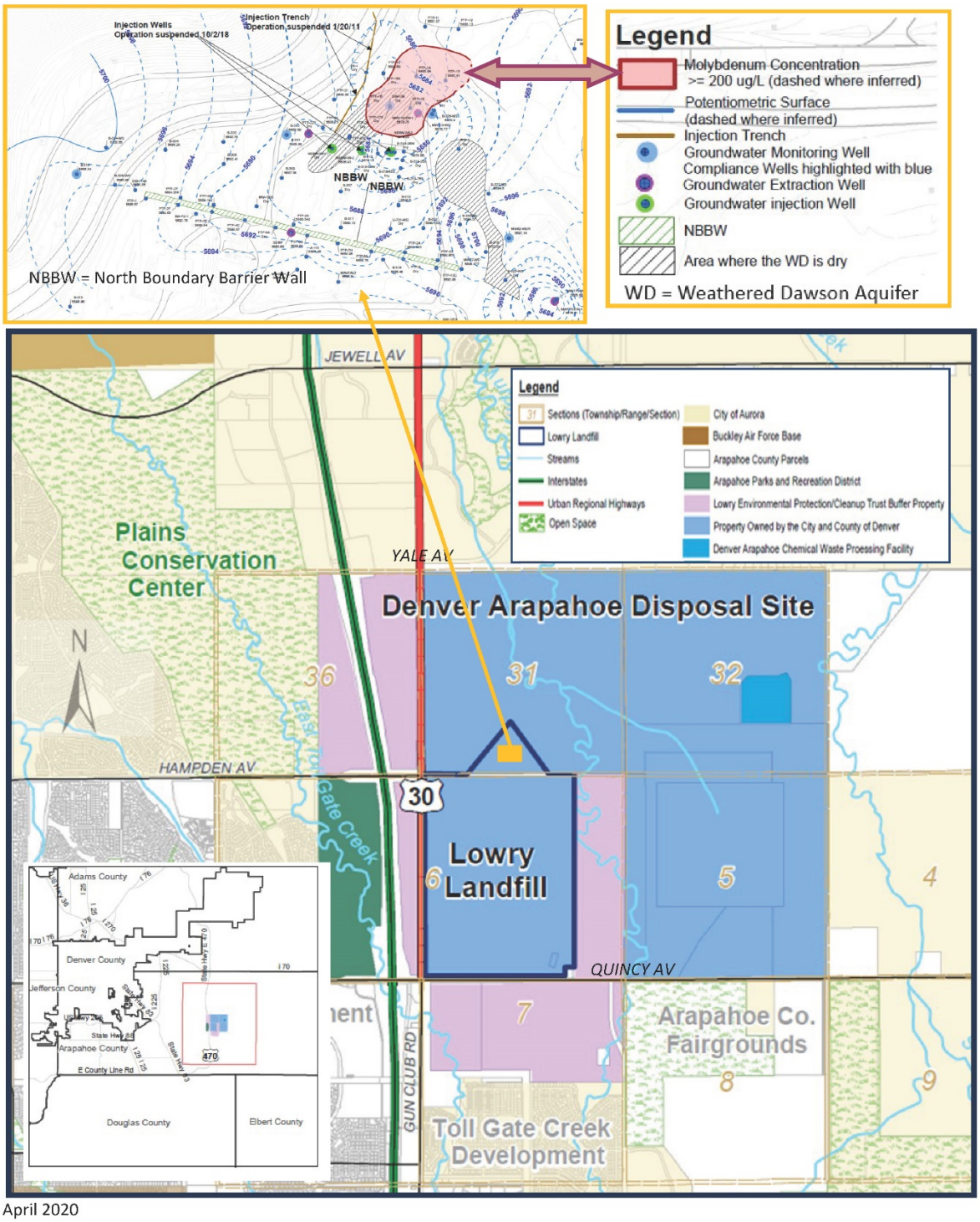
The EPA, in conjunction with CDPHE and Tri-County Health, will continue to monitor, evaluate, and verify the nature and extent of constituents of concern and will remain committed to protecting the surrounding community. Ongoing monitoring of water quality trends north of the site will continue to provide the agencies ongoing information about the groundwater plume.

Despite the lack of evidence indicating that Gun Club Estates drinking water wells are being impacted by the Lowry Landfill, and in an effort to be responsive to community concern, the EPA referred the testing of wells in the Gun Club Estates area to the EPA and State site assessment programs which is a wholly separate process that will begin later this year once the State lifts COVID-19 restrictions.

100007652

Area at the Lowry Landfill Superfund Site

with Elevated Concentrations of Molybdenum in Shallow Groundwater



April 2020

APPENDIX E – PUBLIC NOTICE

EPA United States Environmental Protection Agency

The U.S. Environmental Protection Agency, Region 8 Announces the Fifth Five-Year Review for the Lowry Landfill Superfund Site in Arapahoe County, Colorado

The U.S. Environmental Protection Agency (EPA), in cooperation with the State of Colorado, is conducting the fifth five-year review of the Lowry Landfill Superfund site in Arapahoe County, Colorado. Five-year reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. The fifth five-year review will be completed in 2021.

Approximately 500 acres in size near the intersection of South Gun Club Road and East Quincy Avenue, Lowry Landfill accepted waste from the mid-1960s to 1980. Landfilling operations contaminated soil, groundwater, surface water, and sediment with hazardous substances. The site became a Superfund site when it was added to the National Priorities List in 1984. The site's long-term remedy, selected in 1994, includes containment, collection, treatment, and monitoring. Remedy construction began in 1996 and was completed in 2006. Operation and maintenance activities and monitoring are ongoing.

We want to hear from you! Community members are encouraged to share information that may be helpful in the five-year review process. Community members who have questions or who would like to participate in a community interview, are asked to contact Lisa below by June 11, 2021:

Lisa McClain-Vanderpool
EPA Community Involvement Coordinator
Phone: 303-312-6077
Email: mcclain-vanderpool.lisa@epa.gov

Due to Covid-19 the most current site information is only available online at: http://www.epa.gov/superfund/lowry-landfill

APPENDIX F – SITE INSPECTION CHECKLIST

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

I. SITE INFORMATION

Site Name: Lowry Landfill	**Date of Inspection:** May 10, 2021
Location and Region: Aurora, Arapahoe County, Colorado 8	**the EPA ID: COD980499248**
Agency, Office or Company Leading the Five-Year Review: EPA Region 8	**Weather/Temperature:** Overcast, occasional rain, 50 degrees fahrenheit

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other: Gas to Energy Plant
- ☐ 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** Parsons Corporation _____ _____
   Name Title Date
   Interviewed ☐ at site ☒ at office ☐ by phone Phone: _____
   Problems, suggestions ☒ Report attached: Appendix D

2. **O&M Staff** _____ _____ _____
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone: _____
   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). Fill in all that apply.

   Agency City of Aurora
   Contact Karen Hancock and Sean Lieske _____ _____ _____
   Name Title Date Phone No.
   Problems/suggestions ☒ Report attached: Appendix D

   Agency Arapahoe COunty
   Contact Jan Yeckes, Lisa Knerr and Jeff BakerName _____ _____ _____
   Title Date Phone No.
   Problems/suggestions ☒ Report attached: Appendix D

   Agency Tri-County Health Department
   Contact Lynn Robbio Wagner, Brian Hlavacek and Kieth Homersham _____ _____ _____
   Name Title Date Phone No.
   Problems/suggestions ☒ Report attached: Appendix D

   Agency CDPHE
   Contact Dustin McNeil, Jeannine Natterman and Colleen _____ _____ _____
   Title Date Phone No.

	Brisnehan Name Problems/suggestions ☒ Report attached: Appendix D
4.	**Other Interviews** (optional) ☒ Report attached: Appedix D includes WSDs (Dae Wilmoth and Steve Richtel), CAG and residential interviews

III. ON-SITE DOCUMENTS AND RECORDS VERIFIED (check all that apply)

1.	**O&M Documents**				
	☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A	
	☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A	
	☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
2.	**Site-Specific Health and Safety Plan**	☒ Readily available	☒ Up to date	☐ N/A	
	☒ Contingency plan/emergency response plan	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
3.	**O&M and OSHA Training Records**	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
4.	**Permits and Service Agreements**				
	☒ Air discharge permit	☒ Readily available	☒ Up to date	☐ N/A	
	☒ Effluent discharge	☒ Readily available	☒ Up to date	☐ N/A	
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A	
	☐ Other permits: _____	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
5.	**Gas Generation Records**	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
7.	**Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A	
	Remarks: _____				
9.	**Discharge Compliance Records**				
	☒ Air	☒ Readily available	☒ Up to date	☐ N/A	
	☒ Water (effluent)	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				
10.	**Daily Access/Security Logs**	☒ Readily available	☒ Up to date	☐ N/A	
	Remarks: _____				

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for state

☐ PRP in-house ☒ Contractor for PRP

☐ Federal facility in-house ☐ Contractor for Federal facility

☐ _____

2. **O&M Cost Records**

☐ Readily available ☐ Up to date

☐ Funding mechanism/agreement in place ☒ Unavailable

Original O&M cost estimate: _____ ☐ Breakdown attached

Total annual cost by year for review period if available

From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached
From: _____ Date	To: _____ Date	_____ Total cost	☐ Breakdown attached

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: Fencing was in excellent condition and is repaired as needed. Two areas of repaired fence were observed to be in excellent condition, where car accidents had occurred on surrounding roads.

B. Other Access Restrictions

1. **Signs and Other Security Measures** ☐ Location shown on Site map ☐ N/A

Remarks: Signage around the site boundary was frequent and in excellent condition.

C. Institutional Controls (ICs)

1. **Implementation and Enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive by): Daily on-site presence.

Frequency: _____

Responsible party/agency: WSDs

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up to date ☐ Yes ☐ No ☒ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A

Violations have been reported ☐ Yes ☒ No ☐ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks: _____

D. General

1. **Vandalism/Trespassing** ☐ Location shown on Site map ☒ No vandalism evident

Remarks: _____

2. **Land Use Changes On Site** ☒ N/A

Remarks: _____

3. **Land Use Changes Off Site** ☐ N/A

Remarks: Road expansion was occurring south of the site. This road expansion is not negatively affecting the Site or any remedial components. Residential expansion and growth continue to occur in the areas surrounding the Site.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads Damaged** ☐ Location shown on Site map ☒ Roads adequate ☐ N/A

Remarks: _____

B. Other Site Conditions

Remarks: _____

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (low spots) ☐ Location shown on Site map ☒ Settlement not evident

Area extent: _____ Depth: _____

Remarks: _____

2. **Cracks** ☐ Location shown on Site map ☒ Cracking not evident

Lengths: _____ Widths: _____ Depths: _____

Remarks: _____

3. **Erosion** ☐ Location shown on Site map ☒ Erosion not evident

Area extent: _____ Depth: _____

Remarks: _____

4. **Holes** ☐ Location shown on Site map ☒ Holes not evident

Area extent: _____ Depth: _____

Remarks: _____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established

☐ No signs of stress ☐ Trees/shrubs (indicate size and locations on a diagram)

Remarks: Across the waste pit covers and landfill covers the vegetation is well established. Specifically the ares of the two 2020 fires appeared in good condition with new grass growth.

6. **Alternative Cover** (e.g., armored rock, concrete) ☒ N/A

Remarks: _____

7. **Bulges** ☐ Location shown on Site map ☒ Bulges not evident

Area extent: _____ Height: _____

Remarks: _____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on Site map Area extent: _____

☐ Ponding ☐ Location shown on Site map Area extent: _____

☐ Seeps ☐ Location shown on Site map Area extent: _____

☐ Soft subgrade ☐ Location shown on Site map Area extent: _____

Remarks: Although there had been a fair amount of rain in recent days, there were no areas that appeared to have water damage or surface flow that was causing inappropriate water collection.

9. **Slope Instability** ☐ Slides ☐ Location shown on Site map

☒ No evidence of slope instability

Area extent: _____

Remarks: _____

B. Benches ☐ Applicable ☒ 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.)

C. Letdown Channels ☐ Applicable ☒ 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.)

D. Cover Penetrations ☒ Applicable ☐ N/A

1. **Gas Vents** ☒ Active ☐ Passive

☐ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

2. **Gas Monitoring Probes**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A

Remarks: _____

3. **Monitoring Wells** (within surface area of landfill)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A

Remarks: _____

4. **Extraction Wells Leachate**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A

Remarks: _____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A

Remarks: _____

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

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

H. Retaining Walls ☐ Applicable ☒ N/A

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

1. **Siltation** ☐ Location shown on Site map ☒ Siltation not evident

Area extent: _____ Depth: _____

Remarks: _____

2. **Vegetative Growth** ☐ Location shown on Site map ☐ N/A

☒ Vegetation does not impede flow

Area extent: _____ Type: _____

Remarks: _____

3. **Erosion** ☐ Location shown on Site map ☒ Erosion not evident

Area extent: _____ Depth: _____

Remarks: _____

4. **Discharge Structure** ☐ Functioning ☒ N/A

Remarks: _____

VIII. VERTICAL BARRIER WALLS ☒ Applicable ☐ N/A

1. **Settlement** ☐ Location shown on Site map ☒ Settlement not evident

Area extent: _____ Depth: _____

Remarks: _____

2. **Performance Monitoring** Type of monitoring: Head differential

☐ Performance not monitored

Frequency: Quarterly ☐ Evidence of breaching

Head differential: _____

Remarks: Applies to NBBW, NTES, Barrier/Slurry Wall, Voluntary Extraction Systems

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

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

C. Treatment System ☒ Applicable ☐ 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: UV/Oxidation, Ion exchange

☒ 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

E. 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 and 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.

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 designed to accomplish (e.g., to contain contaminant plume, minimize infiltration and gas emissions). The final selected remedy utilized containment, collection, treatment and monitoring to address contamination at the Site. Contamination is mostly contained on Site with the exception of the North End 1,4-dioxane plume, which extends off Site to the north. Contingency measures are in place in areas that are out of compliance. These measures are being implemented in accordance with the decision documents and GWMP.
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. O&M procedures are adequate.
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. There are no early indicators of potential remedy problems.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. _____

Site visit participants:
Linda Kiefer (the EPA RPM), Dustin McNeil, Tom Simmons and Andrea Kingcade (CDPHE), Daniel Griffiths and Chris Carlson (WSD support contract, Parsons), Lynn Robbio Wagner, Brian Hlavacek and Tom Butts (Tri-County), Steve Richtel (Waste Management), Dave Wilmoth (City of Denver, Department of Environmental Health) and Treat Suomi (Skeo, the EPA FYR contractor)

APPENDIX G – SITE INSPECTION PHOTOS

Warning sign placed along perimeter fence

Landfill gas extraction system, typical well

Road above eastern slurry wall and PM-15 extraction wells

South end landfill cover

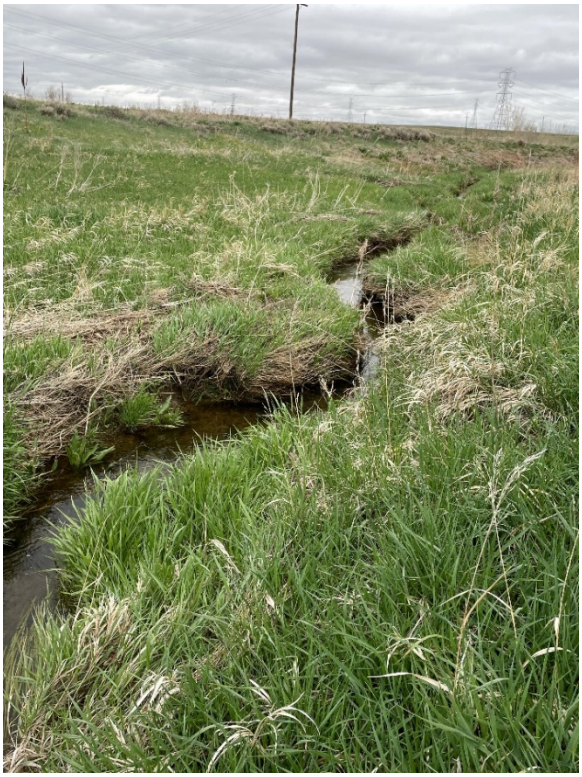
NTES

WTP Building Number 2

GTEP

Wetlands mitigation area

NBBW Area



Murphy Creek north of the Site

MW-155-WD

APPENDIX H – DETAILED DATA ANALYSIS

This Data Review Appendix provides an overview of the ongoing monitoring activities at the Site as reported in the semi-annual Remedial Action and O&M Status Reports (2017-2020), with a focus on the most recent data collected at the Site (July through December 2020).

This Data Review Appendix is organized by media, response action and/or area, as listed below. During this FYR period, the WSDs have conducted the following monitoring activities:

- OU1/OU6 (Groundwater)
    - WTP monitoring
    - Groundwater monitoring
        - Sitewide groundwater elevations
        - Compliance evaluation (POC boundary)
        - Effectiveness evaluation (Perimeter Slurry Wall, NTES, NBBW, MW38 area, vertical migration)
        - Voluntary actions (MW38 and perimeter systems)
    - NAPL skimming (NTES)
    - North End response actions and investigations
    - GTEP area
- OU3 (Landfill gas)
    - Extraction, collection and treatment system monitoring
- OU5 (Surface water and sediments)
    - Stormwater Monitoring

OU1/OU6 (Groundwater)

WTP Monitoring

The WSDs operate the WTP in accordance with the 2021 O&M Manual. Treatment protocols, process and effluent monitoring are performed in accordance with the discharge permit. The WTP monitoring consists of effluent monitoring as well as early warning influent monitoring. The specific monitoring schedule is included in the discharge permit. During this FYR period, all validated results from the WTP effluent sample location (MP-001) were below industrial wastewater discharge permit limits, with the exception of molybdenum in November 2019.[24]

In November 2019, total molybdenum was detected in WTP effluent above its permitted limit, which led to a temporary shut-down of the WTP. After sampling all waters entering the WTP, WSDs determined the source was extraction well MW113-EW-1, located at the northern edge of the Site (Figure C-5 in Appendix C). Flow from the well was decreased to 1 gpm and the WTP was returned to service. In June 2020, flow was further reduced to 0.5 gpm at MW113-EW-1. Since the initial detection, the WSDs have been investigating the extent of elevated molybdenum in groundwater both on Site and north of (downgradient from) the Site, and possible sources of the elevated molybdenum. The results of the evaluation were summarized in a Technical Memorandum in 2020. Molybdenum is not a current COC in groundwater at the Site, nor has it been previously identified as a COC at the Site. Based on the information presented in the Technical Memorandum, the area exceeding the Colorado Basic Standard for Groundwater (210 µg/L) is limited to a relatively small area around MW-113 and B-326 well clusters that is coincident with a localized groundwater table depression created by a combination of groundwater extraction in this area and cessation of potable water injection upgradient from this area. The WSDs indicated that the source is likely from naturally occurring minerals. To address this issue, the WSDs are continuing to pump from the area to meet the 1,4-dioxane performance objectives and minimize the mobilization of molybdenum. In May 2020, WSDs began extraction of groundwater in this area from former injection well NBBW-IW-3 (EMSI,

[24] Prior to 2019, North End groundwater was sampled at MP-004 under the 2017 permit. In 2019, North End off-site water was processed through the WTP, so compliance only involved sampling from MP-001, per the amended discharge permit.

2020). In July 2020, WSDs began pumping MW113-EW-1 water into temporary tanks while a dedicated double-contained pipeline was constructed to WTP Building 1 to connect to a new ion exchange system. On November 4, 2020, pumping from MW113-EW-1 ceased and stored water from the tanks began being pumped to the WTP at 0.5 gpm. Tank pumping continued at this rate until the tanks were emptied, which occurred on December 29, 2020. Molybdenum and 1,4-dioxane concentrations in the temporary tanks were determined before the water was introduced to the WTP. Design and construction of an ion exchange system inside WTP Building 1 to remove molybdenum from MW113 area water was completed during the second half of 2020. The WTP O&M Manual was updated in the first quarter of 2021 to reflect this change.

Early warning monitoring is conducted yearly and monthly at select WTP influent points. During the annual sampling event, if a COC in the influent exceeds the discharge limit, the location is sampled monthly. In 2020, the only COC in the influent that exceeded the discharge limit was 1,4-dioxane. Consequently, 1,4-dioxane was monitored monthly. Molybdenum was also monitored monthly due to the issue presented above. There were no statistically significant increasing trends for either contaminant and both are currently treated in the WTP.

Groundwater Monitoring

The WSDs conduct the performance and compliance groundwater monitoring at the Site in accordance with the 2018 GWMP. In order to assess whether the RAOs for groundwater are being met, the data collected in the groundwater monitoring program are used to demonstrate compliance with performance standards along the POC boundary, demonstrate the effectiveness of the four engineered components of the groundwater containment remedy (Perimeter Slurry Wall, NTES, NBBW and MW38 area) and detect changes in water quality, if any, in deeper bedrock units beneath the Site.

Groundwater monitoring data and evaluations of compliance, effectiveness and vertical migration are presented semi-annually in RA/O&M Status Reports prepared by the WSDs. The semi-annual reports are submitted to the EPA and CDPHE in September and March. Reports received from September 2017 through March 2020 were reviewed for this FYR. This Data Review section also provides a summary of the NTES, North End response and Perimeter Slurry Wall effectiveness evaluations conducted by the WSDs in response to recommendations from the previous FYR. Data from the most recent status report (July through December 2020) are summarized below.

Sitewide Groundwater Elevations

The WSDs measure groundwater elevations quarterly. In general, groundwater in the weathered Dawson moves from south to north, with some variations near drainages and ridgelines and as influenced from extraction systems. In general, the groundwater gradient associated with the unweathered Dawson trends from south-southwest to north-northeast beneath the Site. In the Denver and Lignite formations, the horizontal gradients are relatively flat. Groundwater flow directions and hydraulic gradients remained consistent throughout this FYR period.

Compliance Evaluation

There are 60 monitoring wells included in the compliance monitoring network (Figures C-4 and C-5 in Appendix C). Compliance is assessed at each compliance well for each chemical identified in the 2018 GWMP as an "indicator chemical." Evaluation of compliance at a well is performed by comparing the 90% upper confidence limit (UCL) and, if necessary, the 90% lower confidence limit (LCL) of the chemical concentration in groundwater to its performance standard. A well is statistically in compliance if the 90% UCL is less than its performance standard and a well is out of compliance if the 90% LCL is greater than its performance standard. If the performance standard lies within the confidence interval (i.e., between the UCL and LCL), it is unknown whether the well is in or out of compliance. In some cases, a determination may be made as to potentially in or out of compliance based on empirical evidence such as concentrations and trends.

Based on the statistical tests, water quality for one or more compliance monitoring parameters at six of the 60 compliance monitoring locations exceeded performance standards and are out of compliance. Based on empirical evidence, two other well locations were determined to be potentially out of compliance. The locations, parameters and response action status for locations found to be out of compliance or potentially out of compliance in the most recent status report are shown in Table H-1 below and on Figure C-8 in Appendix C.

Table H-1: Compliance Evaluation, Second Half of 2020

Well	Compound	Compliance Decision	Trend	Response Action Status
B-313	1,4-Dioxane	Out of compliance	No trend	Response action implemented
B-326-UD	1,4-Dioxane	Out of compliance	No trend	Response action implemented
B-326-WD	1,4-Dioxane	Out of compliance	Increasing	Response action implemented
BM-11X-100N	PCE	Potentially out of compliance	Increasing	Continued monitoring
BM-15N6	Nitrate	Out of compliance	No trend	Continued monitoring
MW38-830N-230E	1,4-Dioxane	Potentially out of compliance	Decreasing	Continued monitoring
MW38-830N-230E	Chloroform	Out of compliance	No trend	Continued monitoring
MW62-WDR	1,4-Dioxane	Potentially out of compliance	Decreasing	Response action implemented
MW62-WDR	Nitrate	Potentially out of compliance	Increasing	Response action implemented
MW77-WD	1,4-Dioxane	Out of compliance	No trend	Response action implemented

Notes:
Source: Remedial Action and Operations and Maintenance Status Report, July through December 2020, pdf page 38.

The WSDs are implementing response actions, as required in the Response Action Work Plans. In 2020, increasing concentrations were noted in three wells. At B-326-WD, the first eight of the 10 most recent 1,4-dioxane concentrations display an increasing trend up through the first half of 2020, peaking at levels of 10 µg/L and 11 µg/L in February and May 2020, respectively. In the second half of 2020, concentrations of 1,4-dioxane dropped significantly to 3.5 µg/L (August 26, 2020) and 3.9 µg/L (November 23, 2020). The changing concentrations of 1,4-dioxane in B-326-WD most likely reflect changes due to cessation and extraction at nearby wells affecting concentration trends. The WSDs will continue to implement response actions in this area.

PCE concentrations in BM-11X-100N are potentially out of compliance, with an increasing trend. The 10 most recent PCE concentrations in this well range from a low of 4.6 µg/L in October 2017 to a high of 7.2 µg/L in the most recent (October 2020) sample. The well is located outside of the Perimeter Slurry Wall in an area where the hydraulic gradient across the slurry wall is inward due to groundwater extraction along the interior of the slurry wall, but with increasing distance away from the slurry wall becomes outward to the northeast toward the Site boundary. Well MW50-WD, a weathered Dawson well positioned about 150 feet north of well BM-11X-150N (200 feet north of well BM-11X-100N) and outside the slurry wall, has never detected PCE. The WSDs will continue to monitor this well.

The third well with increasing concentrations, MW62-WDR, has increasing concentrations of nitrate. This well is located along the northern boundary of the Site, in an area where sewage sludge was historically land farmed. Based on the results of other wells in this area, the extent of nitrate exceedances is limited to the eastern part of the NBBW and is not a concern for migration of nitrate. Response actions are being implemented in this area for 1,4-dioxane, which will also address nitrate.

Effectiveness Evaluation

Four components of the groundwater containment remedy (the Perimeter Slurry Wall, the NTES, the NBBW and the MW38 area) are intended to provide hydraulic control and contaminant containment in the shallow (weathered Dawson) groundwater at the Site. The effectiveness of these features is demonstrated either by hydraulic (water level) monitoring or water quality monitoring.

Perimeter Slurry Wall

The overall objective of the Perimeter Slurry Wall is to prevent migration of contaminants in groundwater beyond the groundwater POC boundary, which is coincident with the Perimeter Slurry Wall, at concentrations that exceed groundwater performance standards. Measures of effectiveness consist of: 1) demonstration of inward hydraulic gradients across the slurry wall; and 2) where outward gradients exist, groundwater quality sampling outside the wall to demonstrate the wall prevents chemical migration through or beneath the wall at concentrations in excess of performance standards. As reported in status reports for the Site, inward gradients have been demonstrated in at least 11 of the 15 PM-series monitoring well pairs across the slurry wall since 2006 (Figure C-7 in Appendix C). Groundwater quality outside the slurry wall in the four areas where sufficient inward gradients have not been

demonstrated has historically complied with groundwater performance standards and data show no increasing trends. Residual VOCs present in groundwater outside the slurry wall are being addressed. The measures consist of air sparging groundwater outside the wall in the PM-15 and MW-51 areas (voluntary measures) and sampling of groundwater from wells BM-11X-100N and BM-11X-100S, both of which are located outside the wall near well PM-11 in areas where hydraulic gradients across the wall are inward. PCE has statistically exceeded its performance standard in well BM-11X-100N. Sampling is being performed to monitor for natural attenuation over time. Historical results indicate no exceedances at the property boundary.

NTES

Effectiveness of the NTES is demonstrated based on hydraulic monitoring alone if either of the following conditions occurs:

1. Pumping from the NTES results in continuous decline of trench water levels as demonstrated by the well hydrographs for MPZ-10R, NTES-180W, and MPZ-11.
2. Trench water levels (as measured in MPZ-10R, NTES-180W and MPZ-11) remain below the base of alluvium (elevation of 5,740 feet above mean sea level).

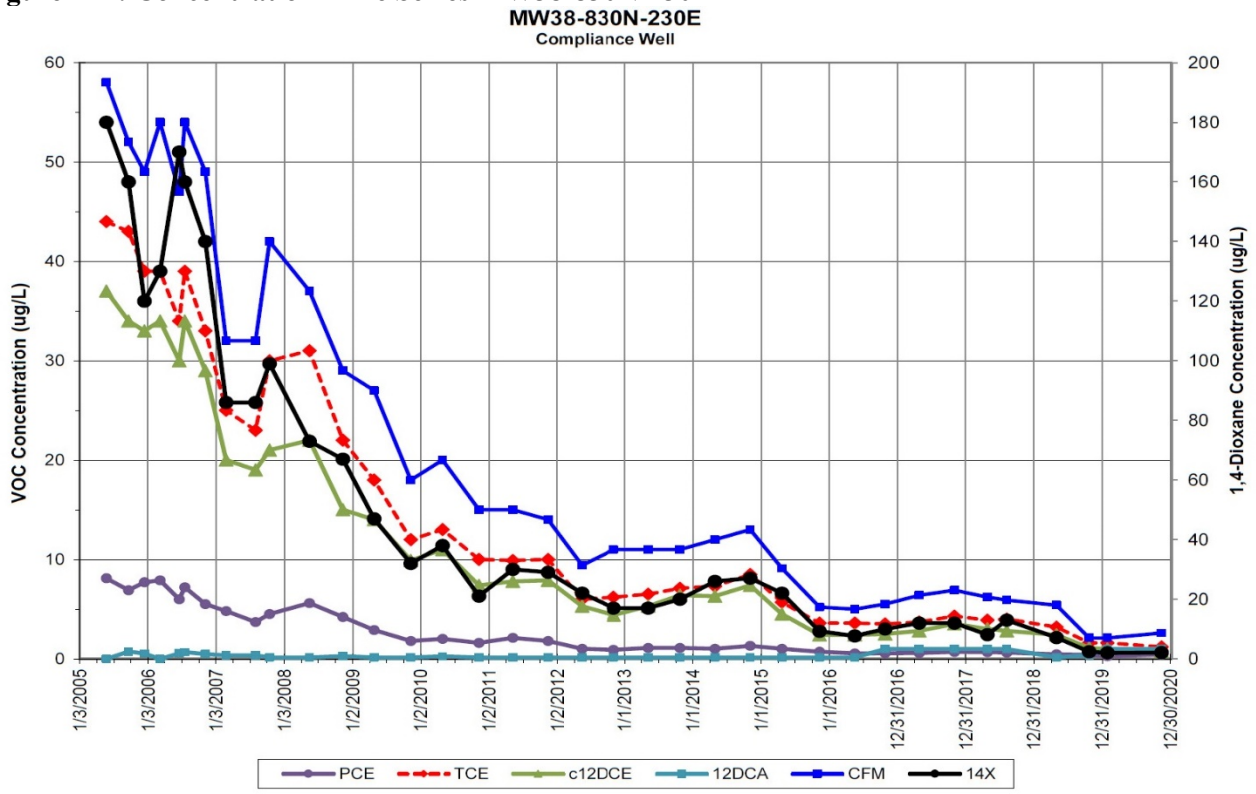
During this FYR period, water level data from NTES-180W, MPZ-10R, MPZ-11 and the extraction sump indicate that trench water levels remained below the base of alluvium throughout the reporting period. Therefore, NTES is effective at capturing contaminated groundwater emanating from the toe of the landfill. The WSDs evaluated the effectiveness of the NTES in the 2021 Technical Memorandum (Effectiveness Evaluations for MW38 Area, North Toe Extraction System, and North End Response Actions, 2017 Five-Year Review Issue #3, Lowry Landfill Superfund Site). The memorandum concluded that, since 2005, one or the other measure listed above has been achieved continuously. Extraction from the NTES trench wells and associated monitoring program will continue. The 2020 NTES potentiometric surface map is shown on Figure C-10 in Appendix C.

MW38 Area

Hydraulic (water level) monitoring is used to demonstrate the effectiveness of the MW38 extraction system at containing groundwater in the MW38 area. The WSDs use these data to prepare potentiometric maps of the MW38 area (Figure C-9 in Appendix C). Review of this map indicates the presence of convergent groundwater flow along the entire length of the MW38 sand channel, as indicated by the flow direction arrows on this figure. The presence of convergent flow into the MW38 sand channel indicates that the channel effectively prevents shallow contaminated groundwater within the channel from migrating to the west, east, north, or south of the sand channel. The northern extraction well (MW38-1028N-256E) is positioned 100 feet north of the Site boundary to take advantage of the thicker and deeper extent of porous channel sand at this location. Groundwater quality from the compliance well (MW38-830N-230E), which is positioned within the sand channel near the Site boundary, is representative of groundwater that will not migrate beyond the sand channel.

The concentration time-series graph below shows that hydraulic gradient control pumping at channel wells MW38-170S-140W and MW38-1028N-256E and source control pumping at MW38-825N-445E (when pumping) have been successful at reducing contaminant concentrations in MW38-830N-230E, where the 1,4-dioxane concentration has been reduced by 98.8% (Figure H-1).

Figure H-1: Concentration Time Series MW38-830N-230E[25]



PCE = Tetrachloroethene TCE = Trichloroethene c12DCE = cis-1,2-Dichloroethene
12DCA = 1,2-Dichloroethane CFM –=Chloroform 14X = 1,4-Dioxane

On December 11, 2019, a leak from the DADS buried potable water supply pipe was identified near MW38-500N-396E. Potable water is believed to have preferentially flowed along the pipeline bedding and was observed in the pipeline trench 50 feet east of MW38-680N-419E. From this area, the pipeline heads eastward, aligning parallel to the DADS main access road. The pipeline is located about 40 feet south of MW76-WD and MW75-WD. Potable water was observed daylighting between MW75-WD and MW74-WD. Denver repaired the leak in January 2020. By April 2020, the higher groundwater elevation at MW38-680N-419E observed in January 2020 had decreased to within a couple feet of historical water elevations.

Since 2002, the MW38 extraction system has been in place, operating and achieving an inward flow. Potentiometric data collected since at least 2006 indicate the effectiveness metric is being continuously achieved.

NBBW

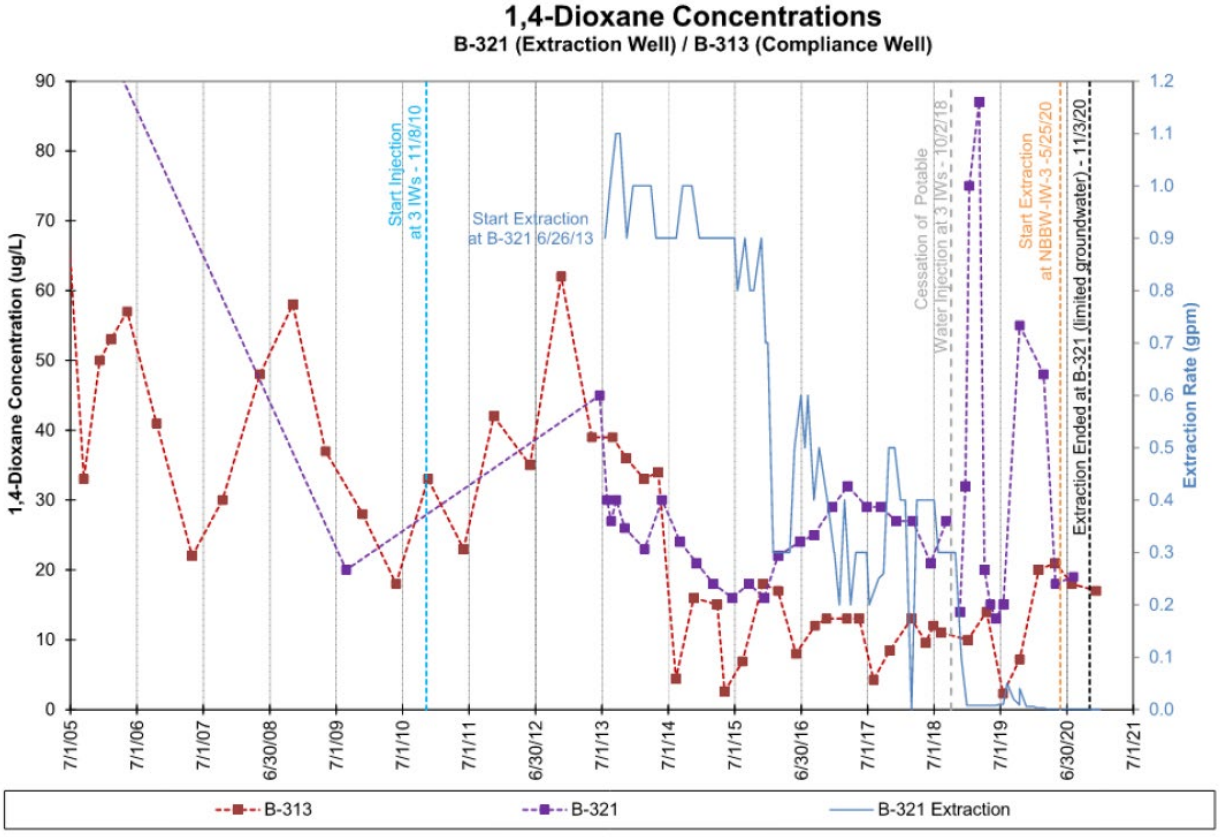
The presence, location and extent of the containment area created by the NBBW systems are defined by the weathered Dawson potentiometric surface in the NBBW. The NBBW zone of containment is highlighted in yellow on Figure C-11 in Appendix C. After potable water injection ceased on October 2, 2018, the water table between the NBBW and the MW113 area has been flattening and a clear groundwater divide cannot be definitely demonstrated. Instead, a larger containment area north of the NBBW caused by cessation of potable water injection in conjunction with response action extraction has developed and has encompassed compliance wells B-313 and B-326-WD, plus monitoring wells GW-109, PTP-17, PTP-16, PTP-21, TR-1, PTP-15 and PTP-14. Directions of groundwater flow into cones of depression within the enhanced containment zone is shown on Figure C-11 in Appendix C.

[25] Source: O&M Status Report – 2nd Half 2020

Since potable water injection stopped north of the NBBW, capture of contaminated groundwater migrating from the Site does not appear to have been compromised and the NBBW continues to function as intended. Flattening of the water table north (downgradient) of the wall is expected to continue. VOC and 1,4-dioxane concentrations provide an additional line of evidence that the NBBW is effectively performing as intended and containing contamination within the alluvium/weathered Dawson that might otherwise migrate across the POC boundary along the northern boundary of the Site. Extraction of groundwater north of the NBBW continued during cessation.

The time-series graph below shows an overall declining 1,4-dioxane trend for compliance well B-313 prior to and following the start of cessation (Figure H-2). It also shows the duration and rates of groundwater extraction from nearby extraction well B-321, and concentrations of 1,4-dioxane in the extraction well over time. As shown, between 2010 and the start of cessation, 1,4-dioxane concentrations in the extraction well varied between 16 µg/L and 45 µg/L, with no apparent trend. Since the start of cessation, 1,4-dioxane concentrations became more variable, ranging between 13 µg/L and 87 µg/L, also with no apparent trend. The WSDs attribute the increased variability to changes in the direction and rate of groundwater movement caused by cessation of potable water injection, changes in groundwater pumping rates and changes in groundwater levels. The extraction rate from well B-321 is formation limited and dictated by groundwater availability, so the observed 1,4-dioxane concentration variability is anticipated to continue. The Revised Final Cessation Report provides additional information.

Figure H-2: 1,4-Dioxane Concentrations, B-321 and B-313[26]



North End Response Actions

Measures of effectiveness can be summarized with the following metrics:

1. Mass reduction of 1,4-dioxane in the groundwater plume immediately north of the NBBW.

[26] Source: O&M Status Report – 2nd Half 2020

2. Acceleration of mass removal of 1,4-dioxane from the groundwater plume in Section 31.
3. Addressing contaminant concentrations at compliance wells that exceed Site applicable or relevant and appropriate requirements (ARARs).
4. Monitoring off-site contamination and groundwater use to ensure there are no completed groundwater exposure pathways to shallow or deep groundwater.
5. Monitoring off-site contaminant concentrations in shallow groundwater to demonstrate they are not increasing over time.

For the first objective, groundwater extraction from wells in Areas 1 through 5 (Figure C-13 in Appendix C) has reduced contaminant mass from these areas by 8,654 grams, or about 19.1 pounds since 2006. Time-concentration curves for most of the wells are also showing declining curves to asymptotic conditions, many near the Lowry Landfill groundwater performance standard of 0.9 µg/L, which is based on the Site PQL.

For the second objective, between 2009 and 2020, 1,4-dioxane removal rates from the North End response action areas increased by about 102% due to addition and/or enlargement of extraction wells and increased extraction rates.

For the third and fifth objective, long-term monitoring has confirmed that 1,4-dioxane is not present in deep groundwater beneath the shallow 1,4-dioxane plume, and concentrations of 1,4-dioxane in most North End shallow wells are declining over time. The progress from the North End response actions are shown on Figure C-15 in Appendix C.

To achieve the fourth and fifth objectives, North End groundwater wells in Sections 31, 30, 19 and 24 will continue to be monitored and sampled in accordance with Update No. 3 to the North End Groundwater Monitoring Plan (Parsons, 2021). Private water supply wells beneath and immediately next to the 1,4-dioxane plume will continued to be sampled for 1,4-dioxane in accordance with the 2018 Tri-County Health Updated Work Plan for Identifying and Sampling Future-At-Risk Water Supply Wells Within and Immediately Adjacent to Off-Site 1,4-Dioxane Plume. Off-site water well records will be searched every five years in accordance with the 2005 Final Institutional Controls Plan (Parsons, 2005). This process was most recently completed in 2020 with the publication of the Final Technical Memorandum Identification and Sampling of Water Supply Wells Within and Immediately Adjacent to Off-Site 1,4-Dioxane Plume (EMSI, 2020). Collectively, these efforts will continue to ensure that there are no completed groundwater exposure pathways, and that concentrations of 1,4-dioxane are not increasing over time.

Vertical Migration

Although not compliance wells, vertical migration wells (B-504A, B-712-LD, C-702P3 and GW-113) are subject to the same statistical tests used in Section 4.4.1 of semiannual status reports for comparison of UCLs and LCLs to performance standards. Upper Denver aquifer wells B-504A, C-702P3 and GW-113 are sampled every five years and unweathered Dawson Formation well B-712-LD is sampled every two years. Only B-712-LD was sampled during the reporting period. The results and statistical analyses for all wells are summarized below:

- For wells B-504A, C-702P3 and GW-113, the maximum concentrations for all compounds for each well were less than their respective performance standards.
- For well B-712-LD, the historical maximum concentrations of all compounds were also less than their respective performance standards, except for one detection of 1,4-dioxane (0.95 µg/L) in 2007.

No significant increasing trends were identified for any of the indicator chemicals of compliance in any of these wells. Based on evaluation of the results obtained during this FYR period, there is no evidence of vertical migration of contamination beneath and north of the landfill.

NAPL Skimming (NTES)

During the FYR period, no light non-aqueous phase liquid (LNAPL) extraction was necessary from the sump riser, MPZ-10R or MPZ-11, based on monitoring of the thickness of the LNAPL layer. A measured product

thickness of greater than 6 inches is used to trigger NAPL extraction. The most recent LNAPL extraction from the NTES took place on September 13, 2011.

North End Response Actions and Investigations

During this FYR period, the WSDs monitored groundwater levels and groundwater quality in accordance with the 2007 and 2020 North End Groundwater Monitoring Plan. Depths to groundwater are measured quarterly from all North End investigation wells installed in Section 31. Water levels in North End wells in Sections 30, 19 and 24 are measured semiannually during the first and third quarters.

Section 31 1,4-dioxane concentrations are shown on Figures C-13 and C-14 for the third and fourth quarters of 2020, respectively. Section 31 wells are sampled quarterly. Figure C-15 shows the spatial distribution of 1,4-dioxane in shallow groundwater in the Sections 19 and 30 in the third of quarter 2020, where the wells are sampled semi-annually. No data are available in Section 19 and 30 for the fourth quarter of 2020.

Two private domestic wells along East Jewell Avenue have been sampled annually each spring (second quarter) since 2006 for 1,4-dioxane and were last sampled on June 25, 2020. The wells are perforated from depths of 357 to 545 ft bgs and 400 to 600 ft bgs, respectively. Sampling of these wells is intended to provide assurances to the well owners that are proximal to the shallow groundwater plume that their drinking water does not contain 1,4-dioxane at concentrations above acceptable levels. Sampling of these wells is not for compliance monitoring purposes. 1,4-Dioxane has never been detected in either of these wells above method detection limits of 0.5 µg/L (from March 28, 2006 to July 16, 2015), 0.15 µg/L (July 16, 2015 to May 23, 2019), or 0.09 µg/L (June 25, 2020).

Groundwater is extracted from four areas (Figure C-13) in the North End area. An update on extraction at each area is provided below.

- *Area 1:* extraction occurred from three wells (MW153-EW-1, MW154-EW-1 and MW155-EW-1) at a combined rate of between 7.2 gpm and 8.7 gpm during the most recent reporting period.
- *Area 2:* pumping from one well (MW160-WD) occurred. Groundwater extraction from this well is limited by the formation and ranged from 0.4 gpm to 0.5 gpm. The most recent (November 2020) 1,4-dioxane concentrations in this well and adjacent well MW132-WD are 5.1 µg/L and 20 µg/L, respectively.
- *Area 3:* three wells (MW102-WD, MW77-EW-1 and MW98-WD) were pumped at a combined rate of 0.97 gpm to 1.1 gpm during the most recent reporting period.
- *Area 4 (NBBW):* discussed above relative to compliance with groundwater standards and regarding effectiveness at reducing 1,4-dioxane and nitrate concentrations. WSDs will continue to optimize pumping from the weathered and unweathered Dawson Formation wells in accordance with the Remedial Action Work Plan protocols to meet the RAOs.
- *Area 5 (GTEP):* discussed below.

There are currently 12 active North End response action wells. During the most recent reporting period, about 6.3 million gallons of groundwater were pumped in total from the 12 active wells, which correlates to about 523.3 grams (1.15 pounds) of 1,4-dioxane. Since the response actions began, about 142 million gallons have been pumped, with a cumulative mass removal of 8,654 grams of 1,4-dioxane. The WSDs provide trend analyses for 37 of the 38 wells being monitored in the North End area. All trend results are summarized in the table below. Of the 37 wells where trend analysis was performed, 30 wells (81%) are showing declining trends and seven wells (19%) are showing no trends. No wells are showing an increasing trend for 1,4-dioxane. The decreasing trends in all four areas are evidence that the ongoing response actions are effective at removing mass from within Section 31. Extraction well B-321 is showing an increasing trend in nitrate. This increase may be caused by variations in groundwater levels and/or flow directions in the vicinity of this extraction well resulting from cessation of potable water injection.

GTEP

Pumping from the GTEP extraction well (MW170-EW-1, Figure C-13, Area 5) was started on January 9, 2012, and continued throughout this FYR period. During the most recent reporting period, the pumping rate ranged between 11.0 gpm and 13.3 gpm, with about 3.2 million gallons pumped during the period. A cone of depression exists beneath the GTEP and has remained consistent throughout the FYR period, preventing contaminants from migrating toward MW77-WD and MW62-WDR. About 57.6 million gallons have been extracted since the start of pumping. The 1,4-dioxane concentration at compliance well MW77-WD has steadily decreased from 41 µg/L just prior to GTEP pumping to 16.0 µg/L on October 28, 2020.

Statistical trend analyses of VOCs, 1,4-dioxane and nitrate in well MW170-EW-1 are provided in the status summary reports. 1,1-Dichloroethane (DCA), 1,1-dichloroethylene (DCE), 1,4-dioxane, PCE, nitrate and trichloroethylene (TCE) showed statistically significant decreasing trends while cis-1,2-DCE is showing an increasing trend; all other analytes were not trending.

OU3 (Landfill Gas)

The current landfill gas extraction, collection and treatment system consists of the following components: 64 vertical gas extraction wells, header and lateral piping, three automatic and nine manual condensate traps, two flares, and the GTEP (Figure C-16 in Appendix C). Landfill gas quality measurements (including methane, carbon dioxide, oxygen and balance gas [mostly nitrogen]) were collected monthly from the 64 extraction wells. The overall gas quality remained stable within the well field and at the GTEP, DBF and FS3 stations. POC probes are sampled biennially for COCs in soil gas and quarterly for methane. A biennial sampling event for VOCs was performed in June 2019. The data were validated and all results, with appropriate qualifiers, are presented in Appendix D-5 of the first half 2019 status report. No POC boundary subsurface gas performance standards were exceeded.

OU5 (Surface Water and Sediments)

Stormwater

Annual stormwater sampling is conducted in accordance with the 2008 Stormwater Monitoring Plan. Sampling only occurs when sufficient flow is available to activate the stormwater samplers. Stormwater sampling occurred in July 2018 and June 2019. Samples were analyzed for oil and grease, pH, chemical oxygen demand and total suspended solids. Sample locations are shown on Figure C-17 in Appendix C. The results are shown below in Table H-2.

Table H-2: Stormwater Sample Results

Parameter Name	June 2019	July 2018	Units
HEM (oil and grease)	2.3 J	1.6 J	mg/L
pH	6.81	6.73	standard units
chemical oxygen demand	120	57 J	mg/L
total suspended solids	4,500	2,000	mg/L

Notes:
Source: Remedial action and O&M status reports.
J = estimated value
mg/L = milligrams per liter
HEM = hexane extractable material

APPENDIX I – DETAILED PERFORMANCE STANDARD REVIEW TABLES

Table I-1: Groundwater Performance Standard Review

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	
1,1,1-Trichloroethane	200	200	14,000 or 200	200	MCL	µg/L
1,1,2,2-Tetrachloroethane	0.055	--	0.18	1	Reporting limit	µg/L
1,1,2-Trichloroethane	3	5	2.8 to 5	5	MCL	µg/L
1,1-Dichloroethane	990	--	--	990	Noncarcinogenic risk-based	µg/L
1,1-Dichloroethene	7	7	7	7	MCL	µg/L
1,2,4,5-Tetrachlorobenzene	2	--	2.1	10	Reporting limit	µg/L
1,2,4-Trichlorobenzene	70	70	70	70	MCL	µg/L
1,2-Dibromo-3-chloropropane	0.2	0.2	0.2	5	Reporting limit	µg/L
1,2-Dibromoethane	0.05	--	0.018	1	Reporting limit	µg/L
1,2-Dichlorobenzene	600	600	600	600	MCL	µg/L
1,2-Dichloroethane	0.4	5	0.38 to 5	5	MCL	µg/L
1,2-Dichloropropane	0.56	5	0.52 to 5	5	MCL	µg/L
1,2-Diphenylhydrazine	0.05	--	0.044	10	Reporting limit	µg/L
1,3-Dichlorobenzene	620	--	94	94	Colorado groundwater standard	µg/L
1,4-Dichlorobenzene	75	75	75	75	MCL	µg/L
1,4-Dioxane	8	--	0.35	0.9	PQL	µg/L
2,3,7,8-Tetrachlorodibenzodioxin	0.00000022	0.00003	2.2×10^{-7} to 3×10^{-5}	0.00003	MCL	µg/L
2,4,5 Trichlorophenoxyproprionic acid	50	50	50	50	MCL	µg/L
2,4,6-Trichlorophenol	2	--	3.2	10	Reporting limit	µg/L
2,4-Dichlorophenoxyacetic acid	70	70	70	70	MCL	µg/L
2,4-Dichlorophenol	21	--	21	21	Colorado groundwater standard	µg/L

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	
2,4-Dinitrophenol	14	--	14	30	Reporting limit	µg/L
2-Butanone	1,904	--	--	1,904	Noncarcinogenic risk-based	µg/L
2-Chlorophenol	0.1	--	35	35	Colorado groundwater standard	µg/L
2-Methylnaphthalene	0.0031	--	--	10	Reporting limit	µg/L
4,4'-DDE	0.1	--	0.1	0.1	Colorado groundwater standard	µg/L
4,4'-DDT	0.1	--	0.1	0.1	Colorado groundwater standard	µg/L
4-Methyl-2-pentanone	158	--	--	158	Noncarcinogenic risk based	µg/L
Acetone	1,600	--	6,300	1,600	--	µg/L
Alachlor	2	2	2	2	MCL	µg/L
Aldicarb	3	--	7	7	Colorado groundwater standard	µg/L
Aldicarb Sulfone	2	--	7	7	Colorado groundwater standard	µg/L
Aldicarb Sulfoxide	4	--	7	7	Colorado groundwater standard	µg/L
Aldrin	0.002	--	0.0021	0.05	Reporting limit	µg/L
Alpha-BHC	0.006	--	0.0056	0.05	Reporting limit	µg/L
Alpha, Gross	15	15	15	55.4	Background	pCi/L
Aluminum	5,000	--	5,000	5,000	Colorado agricultural Standard	µg/L

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	
Americium-241	0.46	--	0.15	0.15	Colorado groundwater standard	pCi/L
Antimony	6	6	6	770	Background	µg/L
Aroclor 1260	0.005	0.5	0.0175 to 0.5	1	Reporting limit	µg/L
Arsenic	50	10	10	52.18	Background	µg/L
Asbestos.	30,000	7,000,000	7,000,000	7,000,000	MCL	fibers/L
Atrazine	3	3	3	3	MCL	µg/L
Barium	1,000	2,000	2,000	2,000	MCL	µg/L
Benzene	5	5	5	5	MCL	µg/L
Benzidine	0.0002	--	0.00015	100	Reporting limit	µg/L
Benzo(a)anthracene	0.1	--	0.16	4	Reporting limit	µg/L
Benzo(a)pyrene	0.01	0.2	0.016	4	Reporting limit	µg/L
Beryllium	4	4	4	4	MCL	µg/L
Beta, Gross	80	80	80	80	MCL	pCi/L
Bis(2-Chloroethyl)Ether	0.03	--	0.032	10	Reporting limit	µg/L
Bis(2-Ethylhexyl)adipate	400	400	400	400	MCL	µg/L
Bis(2-Ethylhexyl)phthalate	4.8	6	2.5 to 6	10	Reporting limit	µg/L
Boron	750	--	750	750	Colorado agricultural standard	µg/L
Bromodichloromethane	0.3	--	0.56	1	Reporting limit	µg/L
Bromoform	4	--	4	4	Colorado groundwater standard	µg/L
Cadmium	5	5	5	5.48	Background	µg/L
Carbofuran	36	40	35 to 40	40	MCL	µg/L
Carbon Tetrachloride	0.3	5	0.5 to 5	5	MCL	µg/L
Cesium-134	80	--	80	80	Colorado groundwater standard	pCi/L
Chlordane	0.03	2	0.1 to 2	2	MCL	µg/L
Chloride	250,000	--	250,000	1,000,000	Background	µg/L
Chlorobenzene	100	100	100	100	MCL	µg/L

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	
Chloroform	6	--	3.5	3.5	Colorado groundwater standard	µg/L
Chromium	50	100	100	100	MCL	µg/L
Chromium (hexavalent)	50	--	--	83.47	Background	µg/L
cis-1,2-Dichloroethene	70	70	14 to 70	70	MCL	µg/L
Cobalt	50	--	50	50	Colorado agricultural standard	µg/L
Coliform (total)/100 milliliters	1	5	2.2 (30 day average) to 23 (max)	5	MCL	%
Color, color units	15	--	15	15	Colorado groundwater standard	color units
Copper	200	1,300	1,000	200	Colorado agriculture standard	µg/L
Corrosivity	non-corrosive	--	non-corrosive	non-corrosive	Colorado groundwater standard	µg/L
Cyanide	200	200	200	200	MCL	µg/L
Dalapon	200	200	200	200	MCL	µg/L
Dibromochloromethane	0.42	--	14	14	Colorado groundwater standard	µg/L
Dieldrin	0.002	--	0.002	0.05	Reporting Limit	µg/L
Dinoseb	7	7	7	7	MCL	µg/L
Diquat	20	20	15 to 20	20	MCL	µg/L
Endothall	100	100	100	100	MCL	µg/L
Endrin	0.2	2	2	2	MCL	µg/L
Endrin Aldehyde	0.2	--	2.1	2.1	Colorado groundwater standard	µg/L
Ethylbenzene	680	700	700	700	MCL	µg/L

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	
Fluoranthene	188	--	280	280	Colorado groundwater standard	µg/L
Fluoride	2,000	4,000	4,000	50,000	Background	µg/L
Foaming Agents	500	--	500	500	Colorado drinking water standard	µg/L
Gamma-BHC	0.2	0.2	0.2	0.2	MCL	µg/L
Glyphosate	700	700	700	700	MCL	µg/L
Heptachlor	0.008	0.4	0.008 to 0.4	0.4	MCL	µg/L
Heptachlor Epoxide	0.004	0.2	0.004 to 0.2	0.2	MCL	µg/L
Hexachlorobenzene	1	1	0.022 to 1.0	10	Reporting limit	µg/L
Hexachlorobutadiene	1	--	0.45	1	Reporting limit	µg/L
Hexachlorocyclopentadiene	50	50	42 to 50	50	MCL	µg/L
Iron	300	--	300	2060.4	Background	µg/L
Isophorone	40	--	140	140	Colorado groundwater standard	µg/L
Lead	15	15	50	50	Colorado groundwater standard	µg/L
Lead-210	0.037	--	--	0.037	Carcinogenic risk	pCi/L
Malathion	2,500	--	140	140	Colorado groundwater standard	µg/L
Manganese	50	--	50	1,620	Background	µg/L
Mercury	2	2	2	2	MCL	µg/L
Methoxychlor	40	40	35 to 40	40	MCL	µg/L
Methylene chloride	5	5	5.6 or 5	5	MCL	µg/L
Naphthalene	6.2	--	140	140	Colorado groundwater standard	µg/L
Nickel	2	--	100	100	Colorado groundwater standard	µg/L

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	
Nitrobenzene	3.5	--	14	14	Colorado groundwater standard	µg/L
Nitrogen, Nitrate	10,000	10,000	10,000	28,000	Background	µg/L
Nitrogen, Nitrate plus Nitrite	10,000	--	10,000	34,000	Background	µg/L
Nitrogen, Nitrite	1,000	1,000	1,000	1,000	MCL	µg/L
Oxamyl	200	200	175 to 200	200	MCL	µg/L
Pentachlorobenzene	6	--	5.6	10	Reporting limit	µg/L
Pentachlorophenol	1	1	0.088 to 1.0	50	Reporting limit	µg/L
pH	6.5 to 8.5	--	6.5 to 8.5	6.5 to 8.5	Colorado drinking water standard	µg/L
Phenanthrene	0.0031	--	--	4	Reporting limit	µg/L
Phenol	300	--	2,100	2,100	Colorado groundwater standard	µg/L
Picloram	500	500	490	500	MCL	µg/L
Plutonium-238	0.15	--	--	0.15	Colorado groundwater standard	pCi/L
Plutonium-239	0.15	--	--	0.15	Colorado groundwater standard	pCi/L
Plutonium-239/240	0.15	--	0.15	0.15	Colorado groundwater standard	pCi/L
Plutonium-240	0.15	--	--	0.15	Colorado groundwater standard	pCi/L
Potassium-40	1.9	--	--	1.9	Carcinogenic risk	pCi/L
Radium-226	5	--	--	5	--	pCi/L
Radium-226/228	5	5	5	5	MCL	pCi/L
Radium-228	5	--	--	5	--	pCi/L
Selenium	10	--	50	371.98	Background	µg/L

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	
Silver	50	--	50	50	Colorado groundwater standard	µg/L
Simazine	4	4	4	4	MCL	µg/L
Strontium-90	8	--	8	8	Colorado groundwater standard	pCi/L
Styrene	100	100	100	100	MCL	µg/L
Sulfate	250,000	--	250,000	2,400,000	Background	µg/L
Tetrachloroethylene	5	5	17 or 5	5	MCL	µg/L
Thallium	2	2	2	15	Reporting limit	µg/L
Thorium-228	0.16	--	--	0.16	Carcinogenic risk	pCi/L
Thorium-230 + 232	60	--	60	60	Colorado groundwater standard	pCi/L
Toluene	1,000	1,000	560 to 1,000	1,000	MCL	µg/L
Toxaphene	0.03	3	0.032 to 3	3	MCL	µg/L
trans-1,2-Dichloroethene	100	100	140 or 100	100	MCL	µg/L
trans-1,3-Dichloropropene	87	--	--	87		µg/L
Trichloroethene	5	5	5	5	MCL	µg/L
Tritium	20,000	--	20,000	20,000	Colorado groundwater standard	pCi/L
Uranium-234	30	30	--	30	MCL	pCi/L
Uranium-235	30	30	--	30	MCL	pCi/L
Uranium-238	30	30	--	30	MCL	pCi/L
Vanadium	100	--	100	100	Colorado agricultural standard	µg/L
Vinyl chloride	2	2	0.023 to 2	2	MCL	µg/L
Xylenes, Total	10,000	10,000	1,400 to 10,000	10,000	MCL	µg/L
Zinc	2,000	--	2,000	2,000	Colorado agricultural standard	µg/L

Analyte	Performance Standard based on Minor Modification (dated 9/30/02) to ROD (dated 3/10/94)	Current MCLs[a]	Current Colorado Basic Standard for Groundwater[b]	Current Performance Standard[c]		Units
				Value	Basis	

Notes:

a. The EPA National Primary Drinking Water Regulations MCL: https://www.EPA.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations (accessed 4/26/21).

b. CDPHE Water Quality Control Commission, Regulation 41 – Basic Standards for Groundwater, Table A: https://www.sos.state.co.us/CCR/GenerateRulePdf.do?ruleVersionId=8819&fileName=5%20CCR%201002-41 (accessed 4/26/21).

c. Table 1, 2018 GWMP.

d. Per CDPHE Water Quality Control Commission, Basic Standards for Groundwater: whenever a range of standards is listed and referenced to this footnote, the first number in the range is a strictly health-based value, based on the Commission's established methodology for human health-based standards. The second number in the range is an MCL, established under the federal Safe Drinking Water Act that has been determined to be an acceptable level of this chemical in public water supplies, taking treatability and laboratory detection limits into account. The Commission intends that control requirements for this chemical be implemented to attain a level of ambient water quality that is at least equal to the first number in the range, except as follows:

   i. Where groundwater quality exceeds the first number in the range due to a release of contaminants that occurred prior to September 15, 2012, (regardless of the date of discovery or subsequent migration of such contaminants), cleanup levels for the entire contaminant plume shall be no more restrictive than the second number in the range or the groundwater quality resulting from such release, whichever is more protective.

   ii. Wherever the Commission has adopted alternative, Site-specific standards for the chemical, the Site-specific standards shall apply instead of these statewide standards.

e. No more than 5.0% samples total coliform-positive in a month. For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive per month.

pCi/L = picocuries per liter

TT = treatment technique

-- = No standard or basis not identified

APPENDIX J – SCREENING LEVEL RISK REVIEW

OU1/OU6 (Groundwater)
The EPA uses standard risk assessment methodology for all sites to provide a consistent, scientifically based process to evaluate potential threats to public health and the environment. A risk assessment provides the basis for: 1) determining the need for action; 2) identification of contaminant levels that are protective of public health; 3) comparison of remedial alternatives; and 4) evaluation and documentation of public health threats. Under the NCP, 40 CFR §300, an acceptable risk range is defined as one additional cancer case associated with the exposure to contamination in a population of one million (typically expressed as 1 in 1,000,000 or 1 x 10^{-6}) to one-in-ten-thousand (1 in 10,000, 1 x 10^{-4}). Risks greater than one-in-ten thousand (1 in 10,000, 1 x 10^{-4}) generally require some form of action to mitigate those risks. Estimated cancer risks of 1 x 10^{-6} to 1 x 10^{-4} are within the risk management range and, depending on the circumstances, do not require action.

Site evaluations indicate that the community or environmental receptors are not exposed to significant concentrations of 1,4-dioxane in groundwater north of the Site. However, using data from 2019, the EPA assessed the potential risks to human health and the environment to provide context for the levels detected. Intermittent exposure to surface water occurs in Murphy Creek and the ponds in and around Murphy Creek Golf Course. For this evaluation, the EPA used highly conservative exposure scenarios to illustrate the potential risks associated with the observed 1,4-dioxane concentrations in surface water and groundwater. The risk evaluation focused on cancer risk because this is the predominant health hazard from exposure to 1,4-dioxane; however, the noncancer hazard quotient was also calculated to evaluate other effects of exposure, such as damage to the liver, kidneys, or nervous system. The EPA considers a hazard quotient less than 1 acceptable. The risk evaluation focused on human health risk from groundwater, surface water and vapor intrusion. The results were summarized in a memorandum to the file, *1,4-Dioxane Risk Summary.* The results indicated that risk from potential exposure to 1,4-dioxane are within the EPA's acceptable risk range for cancer and hazard quotient less than 1 for noncancer risk.

OU3 (Landfill Gas)
The 1994 ROD established landfill gas performance standards to be achieved at the POC boundary (Figure H-11). The landfill gas performance standards were based on ambient air quality standards but later revised in the 2002 minor modification to the ROD to reflect standards based on subsurface soil vapor. The 2002 standards were derived based on the EPA's vapor intrusion model and Site-specific assumptions (depth below grade to vadose zone sample, groundwater temperature of 15º Celsius, slab on grade, sandy clay soil type) based on a risk level of 1 x 10^{-6} (cancer risk) or a hazard quotient of 1 (noncancer risk). These standards have been revised three times, in 2007, 2012 and 2018, using the EPA's Johnson and Ettinger VIAM calculator. To determine if the landfill gas performance standards remain valid since the previous FYR, the 2018 landfill gas performance standards were evaluated using the EPA's Version 6 of the VIAM calculator. The VIAM calculator calculates indoor air cancer risk and noncancer hazards based on site-specific information presented in the 2018 Landfill Gas Compliance Monitoring Plan Revision 3 under a future commercial worker exposure scenario. Table J-1 shows that the landfill gas performance standards remain valid as the standards are equivalent to cancer risks of 1 x 10^{-6} or less while the noncancer hazard quotients are equal to or less than the target threshold of 1.

Table J-1: Vapor Intrusion – Landfill Gas Subsurface Performance Standard Screening Level Risk Review

COC	2018 Subsurface Gas Performance Standard (µg/m^3)[a]	Future Commercial Worker Vapor Intrusion	
		Carcinogenic Risk[b]	Hazard Quotient[b]
Acetone	1,341	-	0.000001
Benzene	636	3 x 10^{-8}	0.0004
Bromodichloromethane	47	7 x 10^{-9}	-
Bromoform	38	1 x 10^{-10}	-
Bromomethane	238,617	-	1
Carbon disulfide	31,610,952	-	1

COC	2018 Subsurface Gas Performance Standard (µg/m³)[a]	Future Commercial Worker Vapor Intrusion	
		Carcinogenic Risk[b]	Hazard Quotient[b]
Carbon tetrachloride	3,226	8×10^{-8}	0.0004
Chlorobenzene	6,260	-	0.002
Chloroform	307	4×10^{-8}	0.00005
Chloromethane	3,507,842	-	1
Dibromo-3-chloropropane, 1,2-	4.8	2×10^{-7}	0.0002
Dibromochloromethane	284	-	-
Dibromoethane, 1,2-	13	3×10^{-8}	0.00001
Dichlorobenzene, 1,2-	20,072	-	0.001
Dichlorodifluoromethane	6,265,815	-	1
Dichloroethane, 1,1-	99,797	1×10^{-6}	-
Dichloroethane, 1,2-	131	2×10^{-8}	0.0003
Dichloroethylene, 1,1-	4,780	-	0.0004
Dichloroethylene, 1,2-cis-	6,782	-	-
Dichloroethylene, 1,2-trans-	160,950	-	-
Dichloropropane, 1,2-	311	6×10^{-9}	0.001
Dioxane, 1,4-	2.88	2×10^{-10}	0.000004
Ethyl chloride (Chloroethane)	462,841,323	-	1
Ethylbenzene	77,680	1×10^{-6}	0.001
Hexanone, 2-	1,885,425	-	1
Methane	5% by volume	-	-
Methyl Ethyl Ketone (2-Butanone)	2,426	-	0.00001
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	437	-	0.000002
Methylene chloride	405	9×10^{-11}	0.00001
Styrene	5,269	-	0.00008
Tetrachloroethane, 1,1,2,2-	7.0	2×10^{-9}	-
Tetrachloroethylene	1,816	2×10^{-9}	0.0005
Toluene	140,528	-	0.0005
Trichloro-1,2,2-trifluoroethane, 1,1,2-	626,594,409	-	1
Trichloroethane, 1,1,1-	80,285	-	0.0002
Trichloroethane, 1,1,2-	84	7×10^{-9}	0.006
Trichloroethylene	1,092	9×10^{-8}	0.008
Trichlorofluoromethane	-	-	-
Vinyl chloride	1,620	6×10^{-8}	0.0004
Xylenes	1,290,338	-	0.2

Notes:
a. Appendix C, Table 3, Updated Landfill Gas Compliance Monitoring Plan Revision 3, July 2018.
b. Calculated based on commercial use using the EPA's Johnson and Ettinger VIAM calculator, version 6 (https://semspub.EPA.gov/src/document/HQ/100000499, accessed 4/26/21) and using the Site-specific assumptions listed in Table 2 of the Updated Compliance Monitoring Plan Landfill Gas Remedy, Revision 3, dated July 2018.
µg/m³ = micrograms per cubic meter