HydroGeoLogic, Inc
Exceeding Expectations

January 18, 2023

Mr. Chris Sklaney 3SD21
Remedial Project Manager
U.S. Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Submittal of Track 1 Work Plan to Address Issues 1 and 2 from the Fifth Five-Year Review
Keystone Sanitation Landfill, Union Township, Adams County, Pennsylvania

Dear Mr. Sklaney:

HydroGeoLogic, Inc. (HGL) is pleased to submit this work plan on behalf of Waste Management Disposal Services of Pennsylvania, Inc. (WMDSPI) for your review. This work plan details the approach to address the following recommendations identified in the Fifth Five-Year Review (FYR) Report for the Keystone Sanitation Landfill Superfund Site (Site), signed on September 14, 2020:

- Evaluate alternatives for source treatment of 1,4-dioxane, including possible development of leachate performance standards, and record in an appropriate decision document, as necessary.
- Optimize the source control remedy or evaluate new alternatives to reduce concentrations of manganese in groundwater at the Landfill perimeter and record in an appropriate decision document, as necessary.

This work plan also includes discussion of the current Enhanced Land Fill Gas Extraction (ELGE) system volatile organic compound removal performance standard and proposes a new standard based on a May 2018 submittal by WMDSPI.

This work plan is consistent the response letter submitted to EPA by HGL on April 14, 2021 and references the conceptual site model accepted by EPA on November 25, 2022. Should you have any questions or comments, please contact me via email at [redacted] or via phone at [redacted]

Sincerely,
[redacted]

Enc.
cc: [redacted] WMDSPI
Larry Smith, PADEP

DRAFT
TRACK 1 WORK PLAN TO ADDRESS ISSUES 1 AND 2 FROM THE FIFTH FIVE-YEAR REVIEW
KEYSTONE SANITATION LANDFILL SUPERFUND SITE
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

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January 2023

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TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1-1
- 1.1 PURPOSE AND OBJECTIVES 1-1
- 1.2 FIVE-YEAR REVIEW ISSUES 1-1
- 1.3 WORK PLAN ORGANIZATION 1-1

2.0 UPDATED CONCEPTUAL SITE MODEL 2-1

3.0 FOCUSED FEASIBILITY STUDY TO EVALUATE SOURCE CONTROL ALTERNATIVES FOR 1,4-DIOXANE 3-1
- 3.1 CONFIRM REMEDIAL ACTION OBJECTIVES 3-1
- 3.2 CONFIRM APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS 3-2
- 3.3 PERFORMANCE STANDARD MODIFICTIONS 3-4
  - 3.3.1 Development of 1,4-Dioxane Leachate Performance Standard 3-4
  - 3.3.2 Proposed Revision of the ELGE VOC Removal Performance Standard 3-5
- 3.4 SCREEN TECHNOLOGIES FOR ADDRESSING 1,4-DIOXANE 3-5
- 3.5 DEVELOP ALTERNATIVES BASED ON THE TECHNOLOGY SCREENING 3-5
- 3.6 CONDUCT COMPARATIVE ANALYSIS OF THE ALTERNATIVES AGAINST CERCLA EVALUATION CRITERIA 3-6
- 3.7 PREPARE DRAFT AND FINAL FOCUSED FEASIBILITY STUDY REPORT 3-6

4.0 MANGANESE OPTIMIZATION EVALUATION 4-1
- 4.1 REFERENCE TO THE UPDATED CSM 4-1
- 4.2 CONFIRM REMEDIAL ACTION OBJECTIVES FOR MANGANESE 4-2
- 4.3 IDENTIFY POTENTIAL CHANGES TO THE ELGE TO REDUCE MANGANESE MOBILIZATION 4-2
- 4.4 EVALUATE OTHER ALTERNATIVES TO REDUCE MANGANESE MOBILIZATION 4-3
- 4.5 RECOMMEND APPROACH TO ADDRESSING MANGANESE IN GROUNDWATER 4-3
- 4.6 PREPARE DRAFT AND FINAL OPTIMIZATION MEMORANDUM 4-4

5.0 ADDITIONAL TESTING 5-1

6.0 WORK PLAN SCHEDULE 6-1

7.0 REFERENCES 7-1

LIST OF APPENDICES

APPENDIX A	Final Updated Conceptual Site Model, Keystone Sanitation Landfill Superfund Site, Accepted by EPA on November 25, 2022
APPENDIX B	Safety Data Sheets

LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable or relevant and appropriate requirements
BAT	best available technology
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	contaminant of concern
CSM	conceptual site model
EDTA-Fe	ferric ethylenediaminetetraacetic acid
ELGE	Enhanced Landfill Gas Extraction
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FFS	Focused Feasibility Study
FYR	Five-Year Review
GETS	groundwater extraction and treatment system
HGL	HydroGeoLogic, Inc
LFG	landfill gas
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
OSWER	Office of Solid Waste and Emergency Response
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SIM	selective ion monitoring
TBC	to be considered
USGS	United States Geological Survey
VOC	volatile organic compound
WMDSPI	Waste Management Disposal Services of Pennsylvania, Inc

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UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

1.0 INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

On February 24, 2021 EPA issued a letter to Waste Management Disposal Services of Pennsylvania, Inc. (WMDPSI) requesting that WMDSPI submit for EPA's review and approval a Work Plan outline and schedule to address three issues identified in the Fifth Five-Year Review (FYR). On behalf of WMDSPI, HydroGeoLogic, Inc. (HGL), prepared a response letter dated April 14, 2021 with the requested Work Plan outline and schedule.

1.2 FIVE-YEAR REVIEW ISSUES

The HGL response letter identified two tracks to address the Five-Year Review issues. Track 1 began with preparing an update conceptual site model (CSM) followed by the development of a Work Plan to prepare two submittals: a Focused Feasibility Study (FFS) and an optimization memorandum. Track 2, which involves cap maintenance and repair, has been addressed in a separate work plan. The FYR issues, divided into the two tracks by the HGL response letter are as follows:

Track 1

- The Respondents shall initiate a FFS to evaluate source control treatment alternatives, including possible development of leachate performance standards, for 1,4-dioxane, which is a Site-related Contaminant of Concern [COC] not addressed by the Enhanced Landfill Gas Extraction (ELGE) remedy.
- Conduct optimization of the ELGE remedy and/or evaluate new alternatives to address high concentrations of manganese in groundwater at the landfill perimeter.

Track 2

- Provide a plan and schedule to remove woody vegetation and repair any subsidence and the cover generally to meet Soil Cover Performance Standards.

1.3 WORK PLAN ORGANIZATION

This Work Plan provides the updated CSM as Appendix A, and Section 2.0 of this report simply references Appendix A. Section 3.0 discusses the planned development of the FFS to address source control for 1,4-dioxane and recommends that the FFS propose a revised ELGE volatile

organic compound (VOC) performance standard that is more consistent overall and in line with the current CSM. Section 4.0 discusses the development of the manganese optimization memorandum.

2.0 UPDATED CONCEPTUAL SITE MODEL

An updated conceptual site model (CSM), accepted by EPA on November 25, 2022, is included as Appendix A. The CSM has been updated to correct Table 3.2 based on comments provided to WMDSPI.

3.0 FOCUSED FEASIBILITY STUDY TO EVALUATE SOURCE CONTROL ALTERNATIVES FOR 1,4-DIOXANE

3.1 CONFIRM REMEDIAL ACTION OBJECTIVES

The Remedial Action Objectives (RAOs) from the 1990 Record of Decision (ROD) are to "prevent current and future exposure to the contaminated soils, to reduce contaminant migration into the groundwater and to prevent migration of contaminated groundwater to uncontaminated areas." (EPA 1990, page 29)

The 1990 ROD further states, "It has also been determined that due to the volume of the waste which is considered the source (1.7 million cubic yards) and the nonhomogeneity of the waste that it is impracticable to treat the source. Therefore, the remedial action response is to contain the waste (source) and treat the groundwater." (EPA 1990, page 43) With regard to the source control remedy selected in the 1990 ROD, the ROD states, "Leachate collection would not be considered necessary as the contaminated groundwater would be intercepted as it moves laterally from the Site." (EPA 1990, page 47)

The 2000 ROD Amendment further updated the RAOs with respect to the source control remedy. It states the following:

> The selected remedy shall actively remove VOCs from the landfill. The main goals of this remedy are to: 1) prevent migration of site-related contaminants from the landfill that could result in groundwater concentrations in excess of performance standards; 2) prevent future releases of contamination into surface water and sediments; 3) prevent direct contact with contaminated soil and waste; and 4) control methane build-up and migration in the landfill. In combination with the planned remedial actions selected in the 1990 ROD (that are not being changed by this Amendment), this remedy will satisfy the remedial objectives for this Site and be effective in capturing, containing, and cleaning up the contaminants in the landfill and the groundwater to the performance standards, while protecting human health and the environment. (EPA 2000, page 11)

With regard to performance standards (referenced in the first item in the above paragraph), leachate and groundwater performance standards were established in Table 1 of the 2000 ROD Amendment. In presenting the performance standards, the 2000 ROD Amendment states, "The goal was to determine the leachate concentrations that would not result in exceedances of the groundwater performance standards at the points of compliance." (EPA 2000, page 12) The points of compliance are the groundwater monitoring wells at the boundary of the waste.

With the addition of 1,4-dioxane as a COC with a groundwater cleanup standard of 6.4 µg/L in the 2015 Explanation of Significant Differences (ESD), the first RAO from the 2000 ROD Amendment will include the prevention of migration of 1,4-dioxane from the landfill that could result in groundwater concentrations in excess of the groundwater performance standards (6.4 µg/L) at the boundary of the waste. As discussed in Section 3.3, the FFS will include the development of a leachate performance standard for 1,4-dioxane to apply to leachate collected within the waste.

The ELGE remedy also includes other performance standards, including one for VOC removal. The VOC removal performance standard states that an ELGE well can be shut down when the ELGE well achieves a 90 percent reduction in select target VOC concentrations (not less than the practical quantitation limits) in associated ELGE gas monitoring probes compared to baseline sampling of monitoring points prior to system startup. Once the 90 percent reduction of select target VOC concentrations is initially achieved in an ELGE well(s) and associated monitoring probes for two semi-annual ELGE monitoring events, the 2000 ROD Amendment requires eight consecutive quarters of meeting the performance standard based on sampling conducted at least 48 hours after the extraction system has been shut down to allow for concentration rebound. As discussed in Section 3.3, the FFS will include propose an alternative ELGE VOC removal performance standard that is more consistent across the landfill and is in line with the CSM.

3.2 CONFIRM APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law, which are collectively referred to as "ARARs", unless such ARARs are waived under CERCLA§ 121(d)(4).

"Applicable" requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. "Relevant and appropriate" requirements are those requirements that, while not legally "applicable", address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site. Only those State standards that are promulgated, are identified by the State in a timely manner, and are more stringent than federal requirements may be applicable or relevant and appropriate. ARARs may relate to the substances addressed by the remedial action (chemical-specific), to the location of the site (location-specific), or the manner in which the remedial action is implemented (action-specific).

In addition to applicable or relevant and appropriate requirements, the EPA may, appropriate, identify other advisories, criteria, or guidance to be considered. The "to be considered" (TBC) category consists of advisories, criteria, or guidance that were developed by EPA, other federal agencies or states that may be useful in developing CERCLA remedies.

The ARARs identified in the 1990 ROD and the September 2000 ROD Amendment are provided below. Many of these ARARs have been superseded by subsequent regulations or decisions documents. For example, Pennsylvania has eliminated the "background quality" regulation and the 1999 ROD Amendment removed this ARAR. The FFS will provide an updated list of ARARs and TBCs using the existing ARARs and TBCs below as a starting point.

ARARs from the 1990 ROD are as follows:

- Safe Drinking Water Act (42 U.S.C.300f et. Seq.) (MCLGs) Maximum Contaminant Levels (MCLs) (40 CFR 141.11-141.16)

- Pennsylvania "Background Quality" for remediation of groundwater as specified in 25 PA Code §§ 264.97(i), (j) and 264.100(a)(9)

- Pennsylvania Water Quality Standards in 25 PA Code §§ 93.1 et seq. which establishes water quality criteria and designated water use protection for each stream.

- Pennsylvania NPDES Regulations in 25 PA Code §§ 92.1 et. seq.

- Federal Water Quality Standards, 51 CFR 43665

- Offsite Disposal requirements in 40 CFR 268.1-268.50 (Land Ban)

- Pennsylvania Air Quality Standard, 25 PA Code §§ 123.1(c) establishes requirements for fugitive dusts

- 25 PA Code §§ 127.12 (a)(5) requiring emissions be reduced to minimum obtainable levels through the use of best available technology (BAT).

- OSWER Directive 9355.0-28 for emission from air stripper in ozone nonattainment areas.

- National Emissions Standards for Hazardous Air Pollutants (NESHAPS) which contains emission standards for vinyl chloride plants. (61 CFR §§ 61.60 – 61.71)

- Clean Air Act (Part D) (42 USC Section 7402-7642)

- Pennsylvania Municipal Landfill Requirements, 25 PA Code § 75.1 et. seq. in particular 25 PA Code §§273.234, which sets forth municipal landfill cap requirements.

- 25 PA Code §§ 102.1 et. seq. sets forth requirements for control of soil erosion and sedimentation resulting from earth moving activities.

- 25 U.S.C. Parts 1910 and 1926 and 29 CFR Part 1910 Occupational Health and Safety Act states requirements for response actions at Superfund Sites.

ARARs from the September 2000 ROD Amendment area as follows:

- Air Resources, Pennsylvania Code, Title 25, Sections 121.1, 121.7, 121.9, 123.1, 123.2, 123.21, 123.31, 123.41-123.43, and 127.1 which are applicable to fugitive dust control, use of BAT, emissions of specific air pollutants. These regulations were applicable to the air

pollution control measures to be employed during work associated with the upgrading of the soil cover as part of the Alternate Source Control Remedy or the Contingent Remedies, as well as emissions from the ELGE system or the Contingent Remedy treatment system.

- Pennsylvania Municipal Waste Landfill Regulations, Pennsylvania Code Title 25, Sections 273.234(a)(3), (c), (e), 273.235, 273.236, 273.241-244 which were applicable to the work associated with the upgrading of the soil cover as part of the Alternate Source Control Remedy or the Contingent Remedies.

- Pennsylvania Municipal Waste Landfill Regulations, Pennsylvania Code Title 25, Section 273.292. This regulation is applicable to the operation of the Alternate Source Control Remedy as a methane control system and to the methane control system that is part of the Contingent Remedies.

- Erosion and Sedimentation Controls, Pennsylvania Code Title 25, Sections 102.1, 102.2, 102.4, 102.1 1, 102.22 which were applicable to work associated with the upgrading of the soil cover and other earth moving activities conducted during installation of the Alternate Source Control Remedy or the Contingent Remedies.

The TBC from the September 2000 ROD Amendment is as follows:

- Pennsylvania 's Erosion and Sediment Control Manual, dated January 1996 [Updated March 2012], sets standards for erosion and sediment control associated with the upgrading of the soil cover and other earth moving activities conducted during installation of the Alternate Source Control Remedy or the Contingent Remedies.

3.3 PERFORMANCE STANDARD MODIFICTIONS

3.3.1 Development of 1,4-Dioxane Leachate Performance Standard

The updated CSM (Appendix A) identifies that 1,4-dioxane concentrations in leachate are approximately 10 times the 1,4-dioxane concentrations in groundwater, suggesting substantial dilution between leachate and groundwater. For other COCs, leachate performance standards are approximately 2 times (cis-1,2-dichloroethene), 3 times (tetrachloroethene), 4 times (trichloroethene), and 20 times (vinyl chloride) the groundwater performance standards. However, the CSM also notes that the above COCs are generally not detectable in leachate and that COC contamination is present in bedrock below the waste. As such, it is difficult to determine if the leachate performance standards for these other COCs are overly conservative.

The development of the 1,4-dioxane leachate performance standard will consider the factor of 10 dilution noted in the CSM and the approximate magnitudes of the other leachate performance standards to develop an appropriately conservative 1,4-dioxane leachate performance standard.

3.3.2 Proposed Revision of the ELGE VOC Removal Performance Standard

The intent of the ELGE system is to remove COC mass from the unsaturated waste to prevent that COC mass from creating leachate that would result in groundwater contamination exceeding performance standards at the boundary of the waste. The existing VOC removal performance standard, however, has the following limitations given this intent:

- First, the resulting target vapor concentrations from applying the uniform 90 percent removal performance standard are not consistent from location to location, potentially resulting in under protective targets at some locations and overly restrictive targets in other locations.
- Second, an arbitrary 90 percent reduction performance standard does not have a physical or chemical basis tying the ELGE mass removal to the objective of meeting the leachate performance standards for VOCs.

The *Leachate Monitoring Results and Recommended Changes to the ELGE Remedy* (Golder and HGL, 2018) proposed basing the VOC removal performance standard on Henry's Law to provide consistent target vapor concentrations across all ELGE wells and to establish a physical and chemical basis for the VOC removal performance standard to result in achieving the VOC leachate performance standards. Therefore, in addition to developing a leachate performance standard for 1,4-dioxane, the FFS will also propose and develop modified VOC removal performance standards based on Henry's Law.

3.4 SCREEN TECHNOLOGIES FOR ADDRESSING 1,4-DIOXANE

As discussed in Section 3.1, the 1990 ROD states that the source material will be contained rather than treated due to the volume and nonhomogeneity of the waste within the landfill. The alternatives to be considered will be forms of containment, which may involve various technologies for sufficient containment and/or treatment of leachate to allow the 1,4-dioxane groundwater cleanup goal to be met at the boundary of the waste. A screening of containment and treatment technologies consistent with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988) will be conducted for 1,4-dioxane prior to developing alternatives.

3.5 DEVELOP ALTERNATIVES BASED ON THE TECHNOLOGY SCREENING

A range of remedial alternatives for meeting the RAOs with respect to 1,4-dioxane will be developed. These alternatives will include, but not necessarily be limited to, the following:

- No Action – Under this alternative 1,4-dioxane would be addressed through the groundwater extraction and treatment system (GETS) that currently extracts and treats groundwater to meet cleanup goals at the boundary of the waste.
- Containment of 1,4-dioxane contamination with the GETS with enhancements to specifically treat 1,4-dioxane in accordance with a potential future discharge limit.

- Partial containment of the leachate by installing an impermeable cap over the waste.
- Partial containment of leachate achieved by extracting available leachate from the bottom of the waste with appropriate treatment or disposal of the extracted leachate.
- In situ treatment of leachate using technologies identified by the technology screening.

3.6 CONDUCT COMPARATIVE ANALYSIS OF THE ALTERNATIVES AGAINST CERCLA EVALUATION CRITERIA

The development and screening of the remedial alternatives shall consider the following three criteria: effectiveness, implementability, and cost. After screening alternatives based on these criteria, a detailed analysis of alternatives shall be conducted using the following nine criteria, as set forth in the 1994 National Contingency Plan (NCP) and the Remedial Investigation and Feasibility Study (RI/FS) Guidance referenced above:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reductions in of toxicity, mobility or volume through treatment
- Short-term effectiveness
- Implementability
- State acceptance
- Community acceptance
- Cost

3.7 PREPARE DRAFT AND FINAL FOCUSED FEASIBILITY STUDY REPORT

A draft FFS report will be prepared for EPA review, and a final FFS report will be prepared to address EPA's comments on the draft FFS report. These reports will be submitted in accordance with the schedule provided in Section 6.0 of this work plan.

4.0 MANGANESE OPTIMIZATION EVALUATION

4.1 REFERENCE TO THE UPDATED CSM

An updated CSM accepted by EPA on November 25, 2022 is included as Appendix A. The CSM identifies several key findings regarding manganese present in groundwater, including the following:

- Beneath the saprolite is fractured bedrock of the Precambrian Marburg Schist that range that ranges in color from silvery green to blue and gray…. Albite, ottrelite, and pyrite mineral zones are common in these rocks and many of the minerals may leach inorganic elements including iron, chloride, barium, potassium, magnesium, calcium, and manganese into the groundwater. (Appendix A, page 3-2 to 3-3)
- A United States Geological Survey (USGS) Report on the Geohydrology of Southeastern Pennsylvania (USGS, 2002) also reports that elevated concentrations of manganese are among the most common water-quality problems. (Appendix A, page 4-5)
- Elevated manganese concentrations in groundwater are commonly found at contaminated sites where organic compounds are present, such as service stations where hydrocarbons have been released to the subsurface, in situ bioremediation remedies for CVOCs where carbon substrates have been added to the subsurface, or landfill waste. Manganese is present because microbial activity consumes the organic compounds, depletes dissolved oxygen in groundwater, and creates reducing conditions and low pH that mobilizes manganese from the native soil, rock, and waste. (Appendix A, page 4-5)
- … manganese is mobilized by reducing conditions and will persist as long as the reducing conditions persist, and the manganese bearing materials exposed to those reducing conditions have leachable manganese. (Appendix A, page 4-6)
- Manganese is prevalent at elevated concentrations in extracted water from each of the extraction wells because each of the extraction wells is extracting water emanating from the reducing environment below the landfill through rock that contains leachable manganese.
- Manganese concentrations have also increased over time in several of the extraction wells as expected (Figure 4.8). The landfill closed in 1990, and the cover was not substantially improved until 2003 and 2004. With landfill closure and an improved cover comes reduced aeration and reduced infiltration of oxygenated rainwater. As oxygen sources are depleted, cellulose and hemicellulose (common organic content in landfills) and other organic matter degrade under anaerobic conditions supporting fermentation reactions by hydrolytic and fermentative bacteria, acetogenic bacteria, and methanogens (Kjeldsen, et al., 2002). Carbon dioxide and methane are generated, and the formation of carboxylic acids lowers the pH (Kjeldsen, et al., 2002). The reducing conditions and lower pH caused by the microbial activity reduces manganese to a more soluble

oxidation state (Mn^{2+}) as depicted in the following Eh-pH diagram with "a" referring to aqueous. (Appendix A, page 4-6)

- Additionally, although landfill gas (LFG) systems extract vapors to control methane, they purposely limit vapor extraction so that oxygen is not entrained into the landfill waste because the presence of oxygen can lead to intensified microbial activity, increased temperatures, and a landfill fire. Based on the manganese concentration trends observed in the extraction wells, a concentration between 10,000 and 20,000 µg/L is expected to continue in the extracted groundwater. (Appendix A, page 4-7)

4.2 CONFIRM REMEDIAL ACTION OBJECTIVES FOR MANGANESE

As a COC identified in the 1990 ROD, the RAOs for manganese is to "prevent current and future exposure to the contaminated soils, to reduce contaminant [manganese] migration into the groundwater and to prevent migration of [manganese] contaminated groundwater to uncontaminated areas." (EPA 1990, page 29) The 2000 ROD Amendment states, "The metals [including manganese] that are present in the landfill will not volatilize, but will be treated by the groundwater extraction system." (EPA 2000, Responsiveness Summary page 4) As such, the current remedy has been successfully meeting the RAOs by capturing and treating manganese at the boundary of the waste to prevent further migration of manganese.

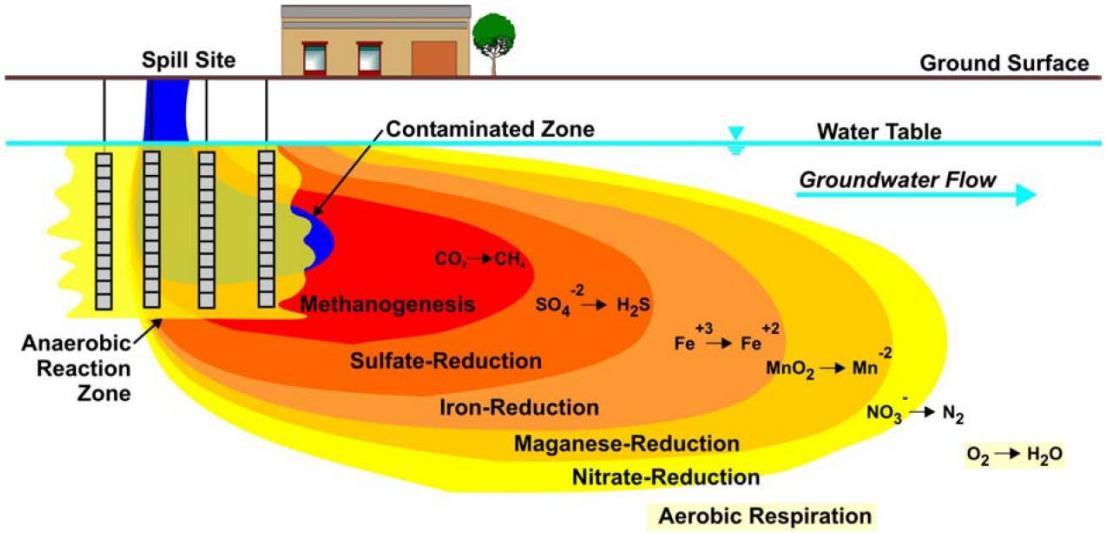
4.3 IDENTIFY POTENTIAL CHANGES TO THE ELGE TO REDUCE MANGANESE MOBILIZATION

The ELGE remedy was designed to address VOC contamination along with landfill gas. However, as stated in the updated CSM (Appendix A), "although LFG systems extract vapors to control methane, they purposely limit vapor extraction so that oxygen is not entrained into the landfill waste because the presence of oxygen can lead to intensified microbial activity, increased temperatures, and a landfill fire." The potential for a landfill fire at Keystone is illustrated in the following photographs of what used to be LMP-3 on December 7, 2022 where oxygen likely entered the waste near LMP-3 and provided the conditions for combustion.

Given historical experiences with subsurface landfill fires at other landfills and this occurrence at Keystone Sanitation Landfill, HGL and Waste Management would be concerned about increasing ELGE extraction rates to increase oxygen within the landfill.

4.4 EVALUATE OTHER ALTERNATIVES TO REDUCE MANGANESE MOBILIZATION

The following diagram from the *Principles and Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents* (ESTCP, 2004) illustrates the order in which common electron acceptors are depleted in the subsurface due to biodegradation of an organic substrate. The diagram and the text from the document convey that "After DO [dissolved oxygen] is consumed anaerobic microorganisms typically use native electron acceptors (as available) in the following order of preference: nitrate, manganese, and ferric iron oxyhydroxides, sulfate, and finally carbon dioxide." (ESTCP, 2004) The organic waste within the Keystone Landfill has progressed through all of these electron acceptors with oxygen, nitrate, and sulfate depleted. Iron, manganese, and carbon dioxide are all undergoing reduction resulting in elevated dissolve iron, dissolve manganese, and methane. The manganese optimization memorandum will evaluate the injection of potential electron acceptors that can compete with manganese reduction in an effort to mitigate dissolved manganese concentrations. Manganese also precipitates typically at a pH > 10. The memorandum will also consider in situ approaches to enhancing manganese precipitation. Similar to FFS, the evaluations will consider implementability, effectiveness, and cost of the technologies considered.



4.5 RECOMMEND APPROACH TO ADDRESSING MANGANESE IN GROUNDWATER

Based on the evaluation described in Section 4.5, an approach to addressing manganese in groundwater will be developed and presented in an optimization memorandum.

4.6 PREPARE DRAFT AND FINAL OPTIMIZATION MEMORANDUM

A draft optimization memorandum will be prepared for EPA review, and a optimization memorandum report will be prepared to address EPA's comments on the draft memorandum. These draft and final memoranda will be submitted in accordance with the schedule provided in Section 6.0 of this work plan.

5.0 ADDITIONAL TESTING

Based on the potential for the 1,4-dioxane FFS to consider the in situ treatment of 1,4-dioxane, this Work Plan includes limited bench-scale testing with activated persulfate. Activated persulfate is known to degrade 1,4-dioxane in situ, but the competing oxidant demand and therefore the dose of activated persulfate and the activation amendments is unknown. To provide an estimate of the dose that would be required for effective treatment without substantially affecting the FFS schedule, the following limited testing is proposed. The testing is primarily limited to aqueous phase testing because leachate with elevated 1,4-dioxane concentrations is readily available from LMP-5. The results would be applicable to treating leachate that is extracted, amended, and reinjected. Direct injections of activated persulfate would need to consider the oxidant demand of the waste in contact with the leachate, which is likely substantially higher and heterogenous depending on the local content of the waste. A second batch of tests will be conducted on leachate that is extracted from LMP-5 after surging the well in an attempt to introduce solids into the samples prior chemical testing.

Batch A: Testing Leachate Extracted from LMP-5

Test A.1: Persulfate activated by addition of EDTA

Group	**Dose of sodium persulfate (mg/L)**	**Dose of EDTA-Fe* (mg/L)**
Control	0	0
Experimental Sample 1	10	3,000
Experimental Sample 2	100	3,000
Experimental Sample 3	1,000	3,000
Experimental Sample 4	10,000	3,000

** 3,000 mg/L of ferric ethylenediaminetetraacetic acid (EDTA-Fe) corresponds to approximately 375 mg/L of iron.*

Test A.2: Persulfate activated by increased pH

Group	**Dose of sodium persulfate (mg/L)**	**pH adjusted by addition of Sodium Hydroxide***
Control	Use Control from Test A.1	
Experimental Sample 1	10	11 to 12
Experimental Sample 2	100	11 to 12
Experimental Sample 3	1,000	11 to 12
Experimental Sample 4	10,000	11 to 12

** 25 percent sodium hydroxide will be added until a pH of 11 to 12 is reached.*

Batch B: Testing Leachate Extracted from LMP-5 after Surging Well to Introduce Solids into the Well Bottom or Aquifer Solids into the Sample

Test B.1: Persulfate activated by addition of EDTA

Group	Dose of sodium persulfate (mg/L)	Dose of EDTA-Fe (mg/L)*
Control	Use control from Test A.1	
Experimental Sample 1	100	3,000
Experimental Sample 2	1,000	3,000
Experimental Sample 3	10,000	3,000
Experimental Sample 4	100,000	3,000

** 3,000 mg/L of ferric ethylenediaminetetraacetic acid (EDTA-Fe) corresponds to approximately 375 mg/L of iron.*

Test B.2: Persulfate activated by pH 12

Group	Dose of sodium persulfate (mg/L)	pH adjusted by addition of Sodium Hydroxide*
Control	Use Control from Test A.1	
Experimental Sample 1	100	11 to 12
Experimental Sample 2	1,000	11 to 12
Experimental Sample 3	10,000	11 to 12
Experimental Sample 4	100,000	11 to 12

** 25 percent sodium hydroxide will be added until a pH of 11 to 12 is reached.*

The Safety Data Sheets for sodium persulfate, EDTA-Fe, and sodium hydroxide are provided in Appendix B.

Each sample (a total of 17 plus two duplicates and matrix spike and a matrix spike duplicate) will be analyzed for 1,4-dioxane using method 8270D with selective ion monitoring (SIM), which should provide a reporting limit below the 1,4-dioxane cleanup goal of 6.4 µg/L.

HGL notes that the results of this testing could also potentially inform the preparation of the manganese optimization memorandum because the addition of persulfate leads to oxidation and pH adjustment could affect manganese precipitation. As such, all of the above samples will be monitored for oxidation reduction potential, and manganese Hach field test kits will be used to analyze the manganese concentration of the water from the samples subject to pH adjustment with sodium hydroxide.

6.0 WORK PLAN SCHEDULE

The following table provides the Work Plan schedule.

Item	Completion Date
EPA approval of the Work Plan	February 17, 2023
FFS and optimization kickoff virtual meeting	Within 1 week of work plan approval
Bench-scale testing and reporting	Within 60 days of work plan approval
Draft FFS report	Within 120 days of work plan approval
EPA review of draft FFS report	Within 30 days of submittal
Final FFS report	Within 30 days of receiving EPA comments on the draft FFS report
Draft optimization memo	Within 120 days of work plan approval
EPA review of draft optimization memo	Within 30 days of submittal
Final optimization memo	Within 30 days of receiving EPA comments on draft optimization memo

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APPENDIX A

UPDATED CONCEPTUAL SITE MODEL
KEYSTONE SANITATION LANDFILL SUPEFUND SITE

ACCEPTED BY EPA NOVEMBER 25, 2022

FINAL
UPDATED CONCEPTUAL SITE MODEL
KEYSTONE SANITATION LANDFILL SUPERFUND SITE
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

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February 2022
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TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1-1
- 1.1 PURPOSE AND OBJECTIVES 1-1
- 1.2 REPORT ORGANIZATION 1-1

2.0 SITE DESCRIPTION AND HISTORY 2-1
- 2.1 SITE BACKGROUND 2-1
- 2.2 SITE HISTORY 2-1
- 2.3 REGULATORY HISTORY AND HISTORICAL INVESTIGATIONS 2-2
- 2.4 REMEDIAL ACTIONS 2-7
  - 2.4.1 Alternate Source Control Remedy (OU1 and OU3) 2-7
  - 2.4.2 Groundwater Remedy (OU2 and OU4) 2-8

3.0 ENVIRONMENTAL SETTING 3-1
- 3.1 METEOROLOGY 3-1
- 3.2 LAND USE AND SURFACE WATER FEATURES 3-1
- 3.3 TOPOGRAPHY 3-2
- 3.4 GEOLOGY AND HYDROGEOLOGY 3-2
- 3.5 PRECIPITATION AND INFILTRATION 3-3

4.0 CONTAMINANT FATE AND TRANSPORT 4-1
- 4.1 CHLORINATED VOLATILE ORGANIC COMPOUNDS 4-1
  - 4.1.1 Vapor 4-1
  - 4.1.2 Leachate 4-2
  - 4.1.3 Groundwater 4-2
- 4.2 1,4-DIOXANE 4-4
  - 4.2.1 Vapor 4-4
  - 4.2.2 Leachate 4-4
  - 4.2.3 Groundwater 4-5
- 4.3 MANGANESE 4-5
  - 4.3.1 Vapor 4-6
  - 4.3.2 Leachate 4-6
  - 4.3.3 Groundwater 4-6

5.0 ELGE AND LANDFILL COVER REMEDY PERFORMANCE 5-1
- 5.1 LEACHATE CONCENTRATIONS 5-1
- 5.2 METHANE CONCENTRATIONS 5-2
- 5.3 VAPOR CONCENTRATIONS 5-3
- 5.4 LANDFILL COVER PERFORMANCE 5-3

6.0 GROUNDWATER EXTRACTION TREATMENT SYSTEM PERFORMANCE 6-1
- 6.1 GETS PERFORMANCE 6-1
- 6.2 NORTHEASTERN PLUME AREA 6-1

6.3 NORTHERN PLUME AREA 6-2
6.4 WESTERN PLUME AREA 6-3
6.5 SOUTHERN PLUME AREA 6-3
6.6 GETS PERFORMANCE SUMMARY 6-4

7.0 CONCLUSIONS AND CRITICAL DATA GAPS 7-5
7.1 CONCLUSIONS 7-5
7.2 CRITICAL DATA GAPS 7-7

8.0 REFERENCES 8-1

LIST OF FIGURES

Figure 2.1 Site Layout
Figure 2.2 ELGE System Wells
Figure 3.1 Land Use and Surface Water Features
Figure 4.1 Plot of Estimated Mass Removal of Select Target VOCs
Figure 4.2a PCE Vapor Concentration Distribution 2011
Figure 4.2b PCE Vapor Concentration Distribution 2019
Figure 4.3 PCE Mass Removal
Figure 4.4 CVOC Conceptual Cross-Section Prior to Landfill Closure
Figure 4.5 CVOC Conceptual Cross-Section After ASCR Implementation
Figure 4.6 CVOC Conceptual Cross-Section Current Conditions
Figure 4.7 CVOC Signatures at EW-7, K-3, EW-6, and FE-3 in 2020
Figure 4.8 Manganese Concentrations at Extraction Wells
Figure 6.1 December 2020 Groundwater Elevation Contour Map

LIST OF TABLES

Table 2.1 Maximum Concentrations of VOC and inorganics in 1982
Table 2.2 Leachate Performance Standards
Table 2.3 Groundwater Performance Standards
Table 3.1 Climate Summary, Gettysburg, PA
Table 3.2 2018-2020 Groundwater Levels in the LMPs
Table 3.3 GETS Extraction Volumes
Table 3.4 Landfill Monitoring Points and Piezometers Analytical Results (2018-2020)
Table 5.1 Summary of Landfill Gas Sample Results (Five-Year Review 2020)

LIST OF APPENDICES

APPENDIX A HELP Model Results
APPENDIX B ELGE Vapor Concentration Trends
APPENDIX C October 2020 Landfill Cover Repair Summary

LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
1,1-DCE	1,1-Dichloroethene
1,1,2-TCA	1,1,2-Trichloroethane
1,1-DCA	1,1 Dichloroethane
1,1,1-TCA	1,1,1-Trichloroethane
1,2-DCA	1,2-Dichloroethane
1,1,2,2 PCA	1,1,2,2 Tetrachloroethane
amsl	above mean sea level
ASCR	Alternative Source Control Remedy
bgs	below ground surface
CA	Chloroethane
cis-1,2-DCE	cis-1,2 Dichloroethene
cm/sec	centimeters per second
COC	contaminant of concern
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
ELGE	Enhanced Landfill Gas Extraction
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
ESI	Environmental Standards, Inc.
ft	feet
FS	Feasibility Study
FYR	Five-Year Review
GETS	Groundwater extraction and treatment system
HELP	Hydrologic Evaluation of Landfill Performance
HGL	HydroGeoLogic, Inc
ICs	Institutional Controls
LFG	landfill gas
LMPs	leachate monitoring points
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal

NPL	National Priorities List
OGDs	Original Generator Defendants
OUs	Operable Unites
PADEP	Pennsylvania Department of Environmental Protection
PADER	Pennsylvania Department of Environmental Resources
RAOs	Remedial Action Objectives
RFU	residential filtration unit
RI	Remedial Investigation
ROD	Record of Decision
RODA	Record of Decision Amendment
TCE	Trichloroethene
PCE	Tetrachloroethene
USGS	U.S. Geological Survey
VC	vinyl chloride
VOCs	volatile organic compounds
WMDSPI	Waste Management Disposal Services of Pennsylvania, Inc
WP	work plan

FINAL
UPDATED CONCEPTUAL SITE MODEL
KEYSTONE SANITATION LANDFILL SUPERFUND SITE
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

1.0 INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

This document provides an updated conceptual site model (CSM) for the Keystone Sanitation Superfund Site (Site) that considers historical and recently collected data. HydroGeoLogic, Inc. (HGL) submitted a letter on behalf of Waste Management Disposal Services of Pennsylvania, Inc. (WMDSPI) suggesting the development of this updated CSM as an important step in addressing two issues identified in the Fifth Five-Year Review (FYR) Report for the Site (U.S. Environmental Protection Agency (EPA), 2020):

1) The Respondents shall initiate a Focused Feasibility Study to evaluate source control treatment alternatives, including possible development of leachate performance standards, for 1,4-dioxane, which is a Site-related Contaminant of Concern (COC) not addressed by the Enhanced Landfill Gas Extraction (ELGE) remedy.
2) Conduct optimization of the ELGE remedy and/or evaluate new alternatives to address high concentrations of manganese in groundwater at the landfill perimeter.

EPA approved the letter on May 12, 2021, and a virtual CSM kickoff meeting was held on June 9, 2021 to discuss the components of the CSM. Therefore, the main objective of this CSM is to provide the narrative of the current understanding of the Site covering the following components:

- Site history
- Environmental setting
- Contaminant fate and transport
- Remedy performance

The resulting analysis will provide a basis for identifying critical data gaps and provide a basis for future Site decision-making.

1.2 REPORT ORGANIZATION

This CSM is organized as follows:

- Site Description and History (Section 2): This section provides a Site background and setting, as well as current and historical Site hydrogeological characteristics.
- Environmental Setting (Section 3): Among other items, this section summarizes land use, geology and hydrogeology, and precipitation and infiltration.

- Contaminant Fate and Transport (Section 4): This section summarizes the fate and transport potential of Site-related contamination and the distribution of COCs in the various media.
- ELGE and Landfill Cover Remedy Performance (Section 5): This section presents an assessment of ELGE and cover performance relative to set objectives and performance standards.
- Groundwater Extraction Treatment System (GETS) Performance (Section 6): This section presents an assessment of GETS performance relative to set objectives and performance standards.
- Conclusions and Critical Data Gaps (Section 7): This section summarizes the major findings of this updated CSM and identifies critical data gaps related to the two FYR issues raised by EPA.
- References (Section 8): Lists the documents referenced in this report.

2.0 SITE DESCRIPTION AND HISTORY

2.1 SITE BACKGROUND

The Keystone Sanitation Landfill is located at 355 Clouser Road in Hanover (Union Township), Adams County, Pennsylvania and is an inactive privately-owned landfill covering approximately 50 acres. The Site is fenced on all sides and is bounded to the north by Clouser Road and to the south by Line Road (Figure 2.1). The Pennsylvania-Maryland border is located approximately 800 feet south of the southern boundary of the Site.

The owner of the property maintains a single-family residence. Additional structures within the fenced Site include three detached garages owned by the former operators of the landfill, a two-story building that contains components of the GETS, the ELGE flare system, and landfill gas extraction wells and monitoring wells. The regional area is residential and agricultural with scattered forested land. Residents in the area of the Site utilize domestic wells to obtain their water supply.

The Site is not located in or near an environmentally sensitive area. The topography of the area consists of gently rolling hills and valleys formed by the northeasterly tending elongated valleys and ridges. Most surface water flows northward to an unnamed perennial tributary of Conewago Creek located 100 feet north of the Site. A smaller quantity of runoff flows southward into an unnamed tributary to Piney Creek, located about 2,000 feet south of the Site, in the State of Maryland (EPA, 1990). Based on a Pennsylvania Natural Diversity Inventory search, conducted in February 2021, through the Pennsylvania Conservation Explorer, the Site is still not in close proximity with environmentally sensitive areas and no threatened or endangered species have been identified in the area of the Site.

2.2 SITE HISTORY

The Keystone Landfill operated as a sanitary landfill and received waste from 1966 until 1990. It is built in a horse-shoe shape and is situated on top of a ridge. No engineered liner or leachate collection system was installed by the owners or operators. The landfill was permitted in 1980 to receive household and municipal wastes and certain types of industrial and construction debris (EPA, 2010). The landfill contains an estimated 1.7 million cubic yards of waste. The exact types and amounts of waste received are not known (EPA, 2020). As the 1990 ROD states, characterization of the waste was not conducted because it could cause contamination by breaching isolated pockets. In 1974, five monitoring wells (K1 through K5) were installed at the landfill perimeter (eastern, southern, and western side) to monitor groundwater quality. Three additional wells (K6, K7, and K8) were installed at the perimeter of the landfill for the same purpose (Williams-Russel and Johnson, 1990).

In 1982, state-permitted monitoring identified volatile organic compounds (VOCs) at monitoring well K1, the onsite residential well and the nearby Mundorf spring (located more than 500 feet east of the Site). The maximum concentrations of VOCs and inorganics detected in 1982 are tabulated below:

Table 2.1: Maximum Concentrations of VOC and inorganics in 1982

Contaminant	Maximum Concentration (µg/L)
1,1-Dichloroethene (1,1-DCE)	600
Trichloroethene (TCE)	120
Tetrachloroethene (PCE)	250
Vinyl Chloride (VC)	107
cis-1,2 Dichloroethene (cis-1,2-DCE)	Not sampled
1,1,2-Trichloroethane (1,1,2-TCA)	3
Chloroethane (CA)	4.2
1,1 Dichloroethane (1,1-DCA)	120
1,1,1 Trichloroethane (1,1,1-TCA)	1,800
1,2 Dichloroethane	9
1,1,2,2 Tetrachloroethane (1,1,2,2 PCA)	4
Iron	80,000
Manganese	22,000

µg/L= micrograms per liter

Sample results collected in response to citizen complaints from the Pennsylvania Department of Environmental Resources (PADER, now PADEP) and EPA investigations in 1984 confirmed that some residential wells contained low levels of VOC contamination (Williams-Russel and Johnson, 1990). In August 1984, a spray irrigation system was installed by the landfill owners and operators near monitoring well K1 to prevent migration of contaminants and to remove VOCs from the groundwater. The spray-irrigation system covered about 2.5 acres and operated until 1992 (EPA, 2020).

In addition, a leachate collection system was installed on the southern side of the landfill along Line Road. The leachate collection system consisted of two approximately 10-foot lengths of 6-inch perforated pipe located at the base of the landfill. The pipe ran parallel to Line Road and discharged into a storage tank. The storage tank was pumped periodically, and the contents were disposed off Site (Williams-Russel and Johnson, 1990). This leachate collection system was not adopted as part of the remedy and is no longer operating.

In the spring of 1985, the State of Maryland installed monitoring wells at the state border to monitor potential contaminant migration into Maryland. Sampling indicated low levels of VOCs in one of these wells. EPA proposed the Site for listing on the Superfund program's National Priorities List (NPL) on April 10, 1985 and added it to the NPL on July 22, 1987 (EPA, 2020).

2.3 REGULATORY HISTORY AND HISTORICAL INVESTIGATIONS

Pre-ROD Investigation

EPA initiated a Fund-lead Remedial Investigation (RI) and Feasibility Study (FS) in the spring of 1989 and was completed in the winter of 1990. The RI/FS report documented contaminated soils only within the Site and mainly in the spray irrigation area. Surface water samples near Mundorf spring and along Clouser Road had low VOC concentrations ranging from 0.3 to 2 µg/L.

Groundwater samples from on- and off-Site wells indicated VOC contamination present down to 150 feet below ground surface (bgs), ranging from 3 to 20 µg/L, and extending as far as 500 feet northeast and southwest of the Site. No contamination was detected in any of the nearby residential wells. Based on a risk assessment conducted as part of the RI/FS, chromium, nickel, cadmium, beryllium, VC, 1,1-DCE, 1,1-DCA, benzene, and PCE were identified as the major contaminants (Williams-Russel and Johnson, 1990).

Parallel to the RI/FS investigation, a Groundwater Plan (Buchart-Horn, Inc, 1987) to capture, contain, and treat any contamination emerging from the landfill based on existing and supplemental information was submitted. In addition to installing three more monitoring wells (MW6 through MW8) at the perimeter of the Site, geophysical testing and aquifer tests were conducted. These tests showed that contaminated groundwater migrates mainly to the northeast and south. Aquifer testing indicated decreasing relative hydraulic conductivity with depth. With respect to contaminants at this Site, the renovating base material (weather bedrock ripped and compacted into the base of excavation prior to filling) appears to be a contributing factor to inorganic contaminants in groundwater. A Supplemental Groundwater Plan (Buchart-Horn, Inc, 1990), conducted to the property east of the landfill, included the same field activities (installation of monitoring wells and piezometers, extended geophysics investigation, and aquifer testing). These field activities indicated low levels of VOC contaminants migrating east away from the landfill.

1990 ROD

Based on the findings of the RI/FS and the two Groundwater Plans, EPA selected a remedy for the Site that was recorded in the 1990 ROD. The ROD established the following remedial action objectives (RAOs) for the Site:

- Prevent direct contact with contaminated soils and buried waste,
- Prevent the future releases of Site-related contaminants to groundwater,
- Prevent migration of contaminated groundwater to uncontaminated areas of groundwater, surface water bodies and sediment,
- Prevent current and future exposure to Site-related contaminants in groundwater that exceed cleanup standards, and
- Restore the aquifer to its beneficial use as a potable water source.

The 1990 ROD stated that "due to the volume of the waste which is considered the source (1.7 million cubic yards) and the non-homogeneity of the waste that it is impracticable to treat the source"; therefore, the selected remedy to address the principal threat at the Site included the following components:

1. Installation and maintenance of an impermeable cap (constructed of clay, synthetic materials, or a composition of the two) over the 50-acre landfill.
2. Installation and maintenance of a gas collection system with gas collection wells to depths of approximately 20 feet and a gas burner.

3. Excavation and burial of contaminated surface soils from the spray irrigation area beneath the cap.

As noted in the 1990 ROD, "leachate collection would not be considered necessary as the contaminated groundwater would be intercepted as it moves laterally from the Site". The remedial action response was to contain the waste (source) and treat the groundwater. To accomplish this, the 1990 ROD selected the installation and maintenance of groundwater extraction wells, placed along the perimeter of the landfill, and a treatment plant to capture, contain and treat a wide range of VOCs and naturally occurring inorganics and hazardous metals. The GETS would operate until Federal Maximum Contaminant Levels (MCLs) promulgated pursuant to Section 42 U.S.C. §§ 300f et seq. of the Safe Drinking Water Act and codified at 40 CFR Part 141; non-zero MCL goals (MCLGs), or concentrations of "background quality" as specified by Pennsylvania Code, whichever are lowest, are met. Monitoring of the groundwater in monitoring and residential wells as well as, monitoring of surface water and sediment was included in the selected remedy.

In addition to the groundwater treatment and cap, institutional and administrative controls were included in the selected remedy:

- Provision of a point-of-use groundwater treatment system to residents on the landfill property
- Installation and maintenance of a fence around the landfill
- Deed restrictions regarding present and future Site activities including limitations on construction and aquifer use

Based on the knowledge of the Site and COCs at the time the ROD was published, it was estimated that treatment time would be approximately 46 years. The selected remedy addressed the principal threat at the Site from groundwater contamination by preventing infiltration through the waste and provided control and treatment of the contaminant plume (EPA, 1990).

1997 Remedial Investigation

A second RI was conducted to further assess the off Site environmental and public health impacts of the landfill operations. EPA proposed to address any off-Site contamination with a modification to the 1990 ROD. Several rounds of media sampling (surface water, sediment, surface and subsurface soils, soil gas, and groundwater sampling (monitoring wells and residential wells)) were conducted. As part of the hydrogeologic investigation, 12 groundwater monitoring wells were installed south of the landfill (over 800 feet south of Line Road).

Compared to background samples, chlorinated VOCs (CVOCs), including 1,1,1-TCA, TCE, PCE, and associated degradation products, and five metals (iron, cobalt, manganese, mercury, and zinc) were either detected at levels statistically greater than background (metals) or are considered significant and Site-related due to the frequency of detection and potential risks posed by these compounds (CVOCs). These compounds show evidence of migration to off-site wells and discharge to nearby surface water bodies, ponds and springs (Brown & Root Environmental, 1997).

1999 ROD Amendment

Based on the results of the 1997 RI, EPA signed a ROD Amendment (RODA) to address migration of Site-related contaminants beyond the landfill boundaries via groundwater and the potential for the discharge of contaminated groundwater to surface water bodies and adjacent land areas. The remedial response actions discussed in the 1999 RODA supplement the selected groundwater remedy in the 1990 ROD; they do not replace it and do not pertain to the landfill cap and associated source control measures. The following components were included in the 1999 RODA:

- The installation and operation of off-Site extraction wells to capture, contain, and remediate contaminated groundwater emanating from the landfill to levels that comply with groundwater cleanup standards,
- Installation of filters for current and future residences located north of the tributary to Piney Creek and within a 0.75-mile radius from the center of the landfill (a filter will also be installed for one residence located within the 0.75-mile to one-mile radius because of a finding of unacceptable current risk in the risk assessment),
- Annual monitoring of current and future residential wells north of the tributary to Piney Creek and within 0.75 mile to one mile from the center of the landfill, with the provision of filters for residences within this radius if monitoring shows two consecutive exceedances of any cleanup standard,
- Evaluation for inclusion in the monitoring program for homes greater than one mile from the center of the landfill if Site-related contamination is detected nearby (i.e., within the one-mile border). Provision of filters to such residence if the residential well is adjacent to the one-mile border, within the same hydrogeologic flow path, and two consecutive samples exceed a cleanup standard for a Site-related COC,
- Preparation of a Hydrogeological Evaluation Report after five years of data collection, and
- Sampling of surface water and sediment from local tributaries.

In addition, the 1999 RODA modified the Site COCs and their respective cleanup standards for the onsite pump and treatment system based on a risk-based requirement due to the presence of multiple contaminants and exposure pathways (EPA, 1999).

2000 ROD Amendment

While under a Unilateral Administrative Order (Order) to conduct the remedial action of the landfill cap that was presented in the 1990 ROD, Waste Management of Pennsylvania (now known as WMDSPI) conducted a pilot study to evaluate the feasibility of utilizing an ELGE system to remove VOCs from the landfill mass and to control landfill gas migration, as part of the proposed Alternate Source Control Remedy (ASCR) for the Site (Golder, 1999).

Based on the findings of the pilot study, EPA issued a second RODA in September 2000 to install the ASCR rather than the impermeable cap, selected in the 1990 ROD, which would have decreased the mobility of VOCs in the landfill. The ASCR would more effectively reduce volume

and toxicity through treatment while allowing a limited, but controlled, increase in mobility (EPA, 2000). The primary components of the ASCR included in the 2000 RODA were:

1. Upgrades to the existing Landfill soil cover including addition of low permeability cover soil to maintain a minimum two feet of soil cover across the landfill, regrading of the landfill surface to repair minor erosion gullies, improve drainage, and ensure adequate slope stability, and removal of woody vegetation.
2. Installation and operation of an ELGE system to actively remove VOCs and methane from the landfill waste.
3. Monitoring to ensure proper functioning of the ELGE system and to evaluate VOC removal from the landfill.
4. Monitoring to determine the impact of the ELGE system on the quality of the leachate within the landfill.
5. Use of surface water management controls to minimize soil erosion and sedimentation.
6. Maintenance of the existing fence.
7. Specification that institutional controls (ICs) listed in the 1990 ROD were intended to apply to the landfill only.

According to the 2000 RODA, the overall RAOs of the ASCR remedy are consistent with those identified in the 1990 ROD. The ASCR combined with the groundwater remedy would be effective in capturing, containing, and remediating contamination from the waste fill and groundwater, and they will achieve the cleanup standards established by EPA and protect both human health and the environment. The overall time frame to restore the ground water is not expected to be significantly different from the 1990 ROD, which estimated a cleanup time frame of 46 years. Finally, performance standards for ELGE and methane extraction were established. The performance standards for the leachate COCs were also established in this RODA (EPA, 2000) and are tabulated in Table 2.2.

Table 2.2: Leachate Performance Standards

Contaminant	Maximum Concentration (µg/L)
TCE	20
PCE	15
VC	20
cis-1,2-DCE	50

2015 Explanation of Significant Changes

As additional Site-specific data became available, EPA determined it was necessary to revise the list of COCs and their respective cleanup standards. Routine groundwater monitoring detected the presence of 1,4-dioxane in several extraction wells. In addition, statewide standards for certain COCs without MCLs or risk based cleanup standards were revised and the list of groundwater cleanup standards was modified accordingly (Table 2.3). The 2015 Explanation of Significant Difference (ESD) further modified ICs requirements for the Site by limiting construction and aquifer use on the entire landfill property and establishing aquifer use restrictions for certain properties adjacent to the landfill property (EPA, 2015).

Table 2.3: Groundwater Performance Standards

Contaminant	Maximum Concentration (µg/L)
TCE	5
PCE	5
VC	1
cis-1,2-DCE	25
1,1-DCE	3
1,1,2-TCA	3
1,1,1-TCA	55
1,1-DCA	31
1,2-DCA	5
CA	22
1,1,2,2-TeCA	0.84
1,4-Dioxane	6.4
Iron	3,900
Manganese	200
Mercury	2

2.4 REMEDIAL ACTIONS

EPA separated the remedy into four Operable Units (OUs): 1) fence; 2) residential filters; 3) source control; and 4) groundwater pump and treat. The Owner/Operators group of Waste Management of Pennsylvania, Inc. and Waste Management of Maryland, Inc., the Keystone Sanitation Company, and the Landfill Property owner are responsible for implementing, operating, and maintaining OU1 and OU3. The Original Generator Defendants (OGDs) include Quebecor Printing Fairfield, Inc., C&J Clark America, Inc., The ESAB Group, The Genlyte Group, Inc., Hanover Bronze and Aluminum Foundry, Inc., Kemper Industries, Inc., R.H. Sheppard Company, Inc., and SKF USA, Inc. are responsible for OU2 and OU4 (EPA, 2020).

2.4.1 Alternate Source Control Remedy (OU1 and OU3)

After issuance of the 1990 ROD and the 2000 RODA, the Owner/Operators, pursuant to a Consent Decree that was entered in federal court in April 2001, installed a fence along the perimeter of the landfill. The fence is maintained by the Owner/Operators since its installation by identifying and repairing breaches. The ASCR included construction of the ELGE system as well as upgrades to the landfill cover and storm water management controls. Construction of the ELGE system took place between September 10, 2002, and June 27, 2003. The upgrades to the Landfill cover and storm water management system took place between October 14, 2003, and June 4, 2004. Remedial activities at the Site were consistent with the ROD, RODAs and remedial design documents. The Site achieved construction completion status with EPA's issuance of a Preliminary Close-Out Report on September 13, 2004. In 2017, additional leachate monitoring points (LMPs) and associated piezometers were installed to address the issue identified in the Fourth FYR regarding leachate collection and assessment (EPA, 2020). Figure 2.2 presents a layout of the landfill and identifies the locations of ELGE system and LMPs.

2.4.2 Groundwater Remedy (OU2 and OU4)

The OGDs implemented the groundwater remedy, consistent with the 1990 ROD and the 1999 RODA, pursuant to a Consent Decree between the United States and the OGDs, which was entered in federal court on September 10, 1999. Installation of residential filtration units (RFU) began in November 1999 and continued through the spring of 2000. Following installation, monitoring, maintenance, and decommissioning of the RFUs occurred as specified in the 1999 ROD Amendment and 1999 Remedial Design. Construction of the groundwater extraction and treatment system began on August 11, 1998. The treatment system has drawn water from eight extraction wells since 2017 and consists of numerous individual treatment components. Off-gas from the shallow-tray air-stripper is treated by a single-phase carbon unit for treatment then discharged to the atmosphere. Treated groundwater is discharged to an unnamed tributary of the South Branch of Conewago Creek located north of the Landfill. (EPA, 2020)

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3.0 ENVIRONMENTAL SETTING

3.1 METEOROLOGY

Adams County is in the humid temperate domain, which means that the region has a mild climate with long, warm summers, short, cool winters, and a frost-free period of about 175 days (EPA, 1990). Based on a National Climatic Data Center weather station, located in Gettysburg, Pennsylvania, temperature and precipitation ranges since 1961 are provided in Table 3.1.

Table 3.1: Climate Summary, Gettysburg, PA.

Period	Temperature (°Fahrenheit)			Precipitation (inches)		
	Monthly Average min (month)	Monthly Average max (month)	Annual Average (min-max)	Monthly Total min (month)	Monthly Total max (month)	Annual Total
1961-1990	19.5 (January)	85.3 (July)	42.2-62.4	2.98 (February)	4.10 (September)	40.75
1971-2000	19.4 (January)	85.1 (July)	42.1-62.5	2.96 (February)	4.47 (September)	44.03
1981-2010	16.9 (January)	86.1 (July)	42.3-62.1	1.93 (October)	4.20 (June)	34.99

3.2 LAND USE AND SURFACE WATER FEATURES

The Site is located in a rural agricultural area within south-central Pennsylvania. Pennsylvania is comprised of four physiographic regions: Appalachian Highlands, Middle Western Upland Plain, Piedmont, and Adirondack-New England Highlands. Adams County is within the Appalachian Highlands physiographic region and is characterized by rolling hills and river valleys with numerous spring-fed streams. Figure 3.1 depicts the area surrounding the Site.

The streams originate from surface drainage or from groundwater springs and are typically shallow, with depths ranging from 5 to 16 inches. The Site straddles a topographic ridge and is situated on a surface water drainage divide (northwest to southeast). Most surface water north of the landfill drains to Conewago Creek, and surface water south of the landfill drains to Piney Creek or Silver Run. The streams near the Site and the radial surface runoff paths are depicted on Figure 3.1.

Typical of many areas in south-central Pennsylvania, oak, locust, walnut, and maple are dominant upland trees in the vicinity of the Site. Woodlands are characterized primarily as mixed deciduous forests. Principal canopy species include white oak, red oak, black locust, black walnut, red maple, and tulip poplar. Agricultural fields and meadows are the dominant wildlife habitats of the area. The less extensive forested areas occur primarily along the drainageways, although a few scattered woodlots are present in other areas surrounding the Site. Wetlands are limited to areas surrounding surface seeps and along streams. Based on the US Fish and Wildlife Service National Wetlands Inventory, all wetlands in the vicinity of the Site are depicted on Figure 3.1.

3.3 TOPOGRAPHY

The topography of the area consists of gently rolling hills and valleys formed by elongated, northeast trending ridges and valleys. Elevations within a 1-mile radius of the Site range from approximately 600 to 800 feet above mean sea level (amsl). The Site itself is situated on top of a ridge. The maximum elevation at the Site, prior to the completion of the ASCR, was approximately 780 feet amsl, with a vertical relief of about 200 feet within a 2,000-foot radius of the Site and an average gradient of 5 percent (EPA, 1990).

After the completion of the ASCR, the elevation within the Site ranged from 730 feet amsl near the northeast corner up to 810 feet amsl near landfill gas (LFG) well LFG-15 at the center of the landfill. Based on the topographic survey conducted in 2001, and supplemented in 2004, 2010 and 2018, there are no locations within the landfill (over the limits of waste) where the slope exceeds 15 degrees. The main Site features and the 2004 elevation contours are presented on Figure 3.2 It should be noted that since 2004, ponded water areas have developed due to subsidence that locally alter the topography where ponded water is present.

3.4 GEOLOGY AND HYDROGEOLOGY

The regional bedrock geology in the Piedmont Upland section consists of folded and faulted pre-Cambrian phyllites (a shiny, fine-grained metamorphic rock) locally intruded by Triassic diabase dikes. These dikes are dense, fine-grained rocks of volcanic origin. More specifically, within the footprint of the landfill, surface and subsurface material is as follows:

- Cover material consisting of 18-inches of soils having an average permeability not greater than 2.2×10^{-6} centimeters per second (cm/sec) and a maximum permeability no greater than two this this value overlain by a minimum 6-inch erosion layer. (Golder, 2002) Field testing of the low permeability soil after placement and compacting resulted in an permeability arithmetic mean of 4.6×10^{-7} cm/sec. (Golder, 2002)
- Waste, described in boring logs as trash and debris with a total thickness ranging from 18 to 52 feet bgs. (Golder, 2004) A soil layer is encountered in some borings, typically about 15 to 18 feet bgs. In several LFG wells, the logs describe the layer as “dirt”. In the boring logs for LMP-3(P), LMP-4(P), and LMP-6(M) the soil is describe as “silt” or “silt and clay”. (Golder, 2018)
- A renovating base, constructed by ripping the native rock and compacting the resulting material prior to filling, is present at the interface of the waste and underlying natural subsurface (Williams-Russel and Johnson, 1990). It is unclear if this renovating base is distinguishable from the saprolite although “clay” or “clayey silt” is present at the base of the waste at LMP-3(M), LMP-3(P), LMP-5(M), LMP-5(P), and LMP-6(M). (Golder, 2018)
- Beneath the renovating base is a highly variable thickness of saprolitic, clayey regolith (saprolite) with an average thickness of 45 feet. (Williams-Russel and Johnson, 1990).
- Beneath the saprolite is fractured bedrock of the Precambrian Marburg Schist that ranges in color from silvery green to blue and gray. The main structural feature of the Marburg Schist is well developed parallel cleavages that are oriented in a northeast-southwest

direction (N 60° E) and dip at approximately 80 degrees southeast. Albite, ottrelite, and pyrite mineral zones are common in these rocks and many of the minerals may leach inorganic elements including iron, chloride, barium, potassium, magnesium, calcium, and manganese into the groundwater (Williams-Russel and Johnson, 1990).

Within the landfill, liquid is sporadically present in the LMPs at the waste/saprolite interface, and the water table is generally present within the saprolite. Table 3.2 presents the range of liquid and groundwater levels in the LMPs between 2018 and 2020 relative to the waste/saprolite interface. LMP-5(M) routinely has a mound of leachate, likely due to increased infiltration from ponding in a depression of the landfill cover in the vicinity of LMP-5(M). Elsewhere, leachate levels are very low, and often too low to collect a sample for VOCs.

As discussed in Section 4, the water table has changed under the influence of local infiltration and groundwater extraction. Therefore, the water table can be observed in certain LMPs (LMP-5), while other LMPs are not even in close proximity with the capillary fringe. The capillary fringe is mostly located in the saprolite, when saturated, and in the underlying shallow fractured bedrock. This means that liquid in waste can seep by gravity through the renovating base and the saprolite under normal conditions but liquid in waste can also be affected by capillary forces when saturated saprolite is present. The saturated saprolite and the underlying shallow fractured bedrock are well connected hydraulically.

Based on the geophysical results conducted as part of the RI and additional Site investigations, there are numerous open fractures within bedrock but only two sets are considered dominant. The first set is a set of fractures subparallel to the cleavages and is oriented in a northeast-southwest direction (mean dip of >75 degrees). The second set consists of thinner fractures and is oriented in a northwest-southeast direction. That means that the second set is almost perpendicular to the first set and the main structural feature. Both sets of fractures are highly permeable and their influence is reflected in the directions of some stream valleys (EPA, 1990 and Buchart-Horn, Inc, 1987).

Overall, groundwater flows to discharge areas such as stream valleys and springs matching the general and local topography. As such, the water level is highest furthest from the discharge areas, which corresponds to the area occupied by the landfill. Aquifer tests indicated that the main groundwater flow path has a northeast-southwest direction, following the first set of fractures (Buchart-Horn, Inc., 1987). Additional aquifer tests also identified radial flow in certain areas of the Site, indicating the second set of fractures also contributes to the groundwater flow patterns (Buchart-Horn, Inc., 1990). Groundwater flow patterns under the influence of the GETS are described further in Section 6.

3.5 PRECIPITATION AND INFILTRATION

A simple water budget, incorporating all hydrologic paths, can be expressed as:

$$P + Q_{in} = ET + I + R + Q_{out}$$

where

P = precipitation
Q_{in}= surface water flow into the Site
ET = evapotranspiration (sum of evaporation from soils and plants)

I = infiltration
R = runoff
Q_{out}= surface water flow out of the Site

Since the Site is situated on top of a ridge and there are no streams crossing through the Site, there are no long-term changes in the water storage and surface volumes entering or leaving the Site (Q_{in} and Q_{out}) can be set to zero. The resulting equation then reduces to precipitation, evapotranspiration, infiltration, and runoff. Based on Table 3.1, the average precipitation in Adams County is approximately 40 inches per year and is distributed evenly. This means, that over the course of the year, approximately 54 million gallons of rainwater falls over the 50 acres of the Site.

Based on the Summary Groundwater Resources of Adams County (Taylor and Royer, 1981), the average annual loss to evapotranspiration is about 24 inches, with normal conditions representing 61 percent of precipitation and dry years having as much as 75 percent of precipitation lost. Based on more recent data published in the Pennsylvania Stormwater Management Manual (PADEP, 2005), vegetation can remove over two thirds of the precipitation on an annual basis.

Some precipitation, particularly during heavy rain events would also be expected to runoff. This area of Adams County has approximately 8 inches runoff and 7 inches infiltration per year (Buchart-Horn, Inc, 1987). The landfill was backfilled and covered by the end of 2004 with low permeability soils that were field tested to have permeability of 4.6×10^{-7} cm/sec, satisfying the 2000 RODA requirements. Based on the Site-specific information, a hydrologic soil type "D" (i.e., relatively impermeable) is assumed for the landfill cover, which is less permeable than the other soils in Adams County. Therefore, 7 inches, or 9.5 million gallons, of infiltration per year is a conservative estimate.

Running the EPA Hydrologic Evaluation of Landfill Performance (HELP) model with Site-specific information over the five-year period from 2016 through 2020 (see Appendix A), suggests 27 percent results in runoff, 60 percent is lost to evapotranspiration, and 13 percent infiltrates. Comparing these infiltration results are generally similar to those reported for Adams County, with 13 percent of 40 inches of rain resulting in 5.2 inches of infiltration. An average of 5.2 inches of infiltration across a 50-acre landfill results in 7.1 million gallons of infiltration, with the majority of the infiltration occurring in depressions or ponded areas within the landfill cover. The HELP model estimates more runoff and less evapotranspiration than the other values for Adams County, but the values are generally comparable and evapotranspiration may be somewhat limited by precipitation that is lost to runoff.

The above information suggests that approximately 8.3 million gallons (average of 7.1 and 9.5) per year might infiltrate through the landfill cover. Infiltrated precipitation moves through the waste and has the potential to be retained by the waste, be removed through gas extraction, or generate leachate. Since the landfill was not constructed with a liner or a leachate collection system, six LMPs were installed to monitor whether the leachate performance standards are achieved and assess leachate concentrations seeping into the groundwater. The last four LMPs were installed in strategic locations where leachate levels were expected to be the highest based on the underlying waste/saprolite surface and waste thickness. As reflected in Table 3.2, leachate

levels in the LMPs have generally been very low and often of insufficient volume to collect VOC samples. One exception is the leachate level at LMP-5(M), where leachate levels have ranged from 7 to 24 feet, regardless of when the measurement was taken (i.e., winter or summer months). Groundwater mounding is also observed at the corresponding LMP piezometer (LMP-5(P)), and the LMP-5 cluster is located in an area where ponding has been observed.

Leachate eventually migrates vertically through the thick zone of saprolite (hydraulic conductivity of 0.6 feet per day, EPA 1990) where it reaches the water table and leachate-impacted groundwater migrates vertically into fractured bedrock. As discussed in Section 3.4, the flow directions are controlled by the two major fracture sets (hydraulic conductivity measured as low as 2.8×10^{-3} feet per day and as high as 28.3 feet per day, EPA 1990). The hydraulic conductivities from the 1990 RI are representative of the typical formations in the region. Aquifer tests conducted by Buchart-Horn, Inc. (1989 and 1990) estimated hydraulic conductivities of the aquifer from 0.2 to 12 ft/day and from 1×10^{-4} to 1.56 ft/day. These numbers are similar to the ones listed in the 1990 RI.

The groundwater flow pattern within the saprolite and outside the zone of influence of the extraction wells, depends on the water table elevation and heterogeneity within the saprolite. Overall, the groundwater flow pattern within the saprolite is anticipated to exhibit the same characteristics with the underlying bedrock, where most of the flow occurs in relic structure. The groundwater flow in the underlying bedrock and the saprolite is eventually captured by the extraction wells located at the perimeter of the Site. Table 3.3 shows that the GETS has consistently extracted over 8 million gallons of groundwater since 2015, demonstrating general agreement between the leachate volumes and extracted groundwater volumes. Given that the GETS effectively captures groundwater contamination migrating from under the footprint of the landfill (discussed further in Section 6.0 of this report), the GETS extraction rate and the water budget analysis using data from Adams County and simulations with the HELP model provide converging lines of evidence that the amount of leachate due to infiltration is comparable to but generally less than the extraction rate. If leachate generation was higher than the extraction rates, then the GETS would not be providing effective capture.

Table 3.3: GETS Extraction Volumes

Year	Volume (gallons)
2015	9,808,710
2016	16,188,379
2017	8,636,158
2018	12,034,868
2019	9,189,137
2020	8,331,636

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4.0 CONTAMINANT FATE AND TRANSPORT

The following contaminant and fate transport analysis is focused on the three main COCs that are still detected at the Site and are the subject of the two FYR issues: chlorinated VOCs (CVOCs), 1,4-dioxane, and manganese. The distribution of each COC is discussed in the following subsections with each medium addressed separately.

4.1 CHLORINATED VOLATILE ORGANIC COMPOUNDS

The currently or historically detected CVOCs in vapor, leachate, and groundwater are PCE, TCE, cis-1,2-DCE, VC, 1,1-DCA, and CA. Under sufficiently reducing conditions the CVOCs serve as terminal electron acceptors during microbial degradation of organic matter and undergo reductive dechlorination. Through this process a PCE molecule loses a chloride ion resulting in TCE, a TCE molecule loses a chloride ion resulting in cis-1,2-DCE, a cis-1,2-DCE molecule loses a chloride ion resulting in VC, and VC loses the final chloride ion to become ethene (a harmless end product). A similar reductive dechlorination sequence can also reduce a 1,1,1-TCA molecule to a harmless end product. The sequence generally involves degradation of 1,1,1-TCA to 1,1-DCA to CA to ethane. The cis-1,2-DCE and VC detected at the Site are likely degradation products of PCE and/or TCE, and the 1,1-DCA and CA detected at the Site are likely degradation products of 1,1,1-TCA. In addition to degrading in the reducing conditions in and beneath a landfill, these compounds are also volatile, allowing them to be removed through vapor extraction from LFG and ELGE wells.

4.1.1 Vapor

The vapor concentrations of select VOCs at 22 non-flare monitoring points (i.e., ELGE gas extraction wells and ELGE gas monitoring probes) since the installation of the ELGE system show a decreasing trend in most of the monitoring points and for all the select VOCs (Appendix B). The following is evident when reviewing these trends.

- For the locations where PCE concentrations were historically high and higher relative to other CVOCs, PCE concentrations have been dramatically reduced (e.g., LFG-1, LFG-6/6R, LFG-9, LFG-11, and LFG-12). The reductions appear to be correlated with ELGE system operation. The ELGE remedy has removed approximately 5,000 pounds of CVOCs since startup (see Figure 4.1).
- The highest vapor concentrations at all locations for the past 10 or more years are products of reductive dechlorination, demonstrating the important role that the reducing conditions play in destroying CVOC mass.
- Some trend charts have very low values for the vertical axis (i.e., GMP-17, GMP-20, and GMP-25). The low values on these axes should be considered when comparing these charts with the charts for other monitoring points because the vapor concentrations at these sampling locations are very low.

The fate of CVOCs is also evident in comparing the PCE concentrations in 2011 with the PCE concentrations in 2019 at the ELGE performance monitoring wells. As shown in Figures 4.2a and 4.2b , there is a stark difference in PCE vapor concentrations between these two time periods, and

removal of over 5,000 pounds of CVOCs since the ELGE system began operation suggests these declines are in large part due to ELGE system operation. The presence of degradation products in the extracted vapor suggest reductive dechlorination is also an important factor in mass removal. The highest remaining PCE vapor concentrations are at LFG-5, LFG-13, and LFG-14.

The progress made in reducing PCE concentrations in vapor is in stark contrast to the persistent PCE concentrations in EW-6. This is illustrated in Figure 4.3, which plots LFG PCE mass removal from the LFG wells upstream of EW-6 and the PCE concentration at EW-6. A substantial decrease in LFG mass removal occurred between 2008 and 2015 while PCE concentrations at EW-6 persisted and only declined after K-3 began operating in 2017. These results suggest that the persistent PCE concentrations at EW-6 (now influenced by operation at K-3) is disconnected from the PCE mass in the waste.

4.1.2 Leachate

The LMPs are distributed throughout the ELGE area, with the four most recent LMPs located in areas where the waste/saprolite interface is topographically deepest and mostly likely to collect leachate. Additionally, these LMPs are well distributed between various ELGE wells. For example, referring to Figure 4.2a or Figure 4.2b, the LMP-5 cluster is located near LFG-13 and LFG-14, which is an area with relatively higher PCE vapor concentrations compared with most other ELGE areas. Additionally, the LMP-6 cluster is located near LFG-9 and LFG-11, an area that historically had elevated PCE concentrations that have since decreased substantially.

With the exception of two detections of cis-1,2-DCE above the groundwater performance standards and one detection of PCE below groundwater performance standards at LMP-3(M) since 2018, all other LMP samples have had no detections of CVOCs (Table 3.4). This includes LMP-5(M), which is located between LFG-13 and LFG-14, which both have relatively higher PCE vapor concentrations compared to other ELGE wells. This also includes LMP-6(M), which is located between LFG-9 and LFG-11, which have had substantial reductions in PCE vapor concentrations over time. It should be noted that, on several occasions, insufficient leachate is available to sample for VOCs in some LMPs (Table 3.4). The absence of detectable CVOC concentrations in leachate is likely due to removal of CVOCs via the ELGE system and reductive dechlorination that is occurring as described in Section 4.1.1. CVOCs in the waste do not appear to be contributing meaningfully to groundwater contamination because CVOCs are generally not detected in leachate samples.

4.1.3 Groundwater

Samples collected from the four LMPs and associated piezometers installed in the underlying saprolite in January 2018 provide the unique opportunity of investigating the distribution of CVOCs in groundwater below the landfill (Table 3.4). The LMP-5(P) sample had no detections of CVOCs, but it is recognized that the detection limits were higher than the leachate performance standards. LMP-4(P) had a detection of cis-1,2-DCE of 1.2 µg/L, and LMP-6(P) had concentrations of PCE, TCE, cis-1,2-DCE, and VC in groundwater that were above their respective groundwater performance standards.

The LMP-6(P) results show that CVOCs (including PCE) are present in elevated concentrations in groundwater despite substantially lower or undetectable concentrations of CVOCs in subsequent leachate samples from LMP-6(M). It is also notable that the PCE vapor concentrations detected at nearby EGLE wells (LFG-9 and LFG-11) had substantially decreased and were below 1 part per million by volume as of 2019. The demonstrated removal of CVOC mass by nearby ELGE wells LFG-9 and LFG-11, the low residual CVOC vapor concentrations in these ELGE wells, the absence of CVOCs in leachate in adjacent LMP-6(M), and the presence of CVOCs in saprolite groundwater suggests that the landfill waste is not the ongoing source of the detected CVOCs in groundwater. Rather, it suggests that there is CVOC mass (including PCE) in the unsaturated and saturated saprolite that continues to feed the dissolved CVOC plume that is migrating to the southwest toward EW-6 as depicted in Figures 4.2a and 4.2b.

The concept of contamination present in saturated and unsaturated saprolite continuing to feed the dissolved saprolite and bedrock plume is consistent with a general understanding of contaminant migration and experience with other chlorinated solvent bedrock sites. As evidenced at other Region 3 CVOC bedrock sites (including Valmont TCE, Watson Johnson Landfill, North Penn Area 5) and other sites nationwide, CVOC mass released at or near the surface migrates vertically from the surface under influence gravity until it reaches the water table, and in releases with sufficient mass migrating below the water table. It therefore follows that at Keystone, CVOCs originally released at the historical surface at some point during landfilling migrated vertically under the influence of gravity (either directly or assisted by leachate through uncovered waste) through the waste, into the saprolite and/or bedrock, and into groundwater. As a result, shortly after releases, CVOC mass was present in the waste and in the saprolite above and below the water table. CVOCs would continue to migrate in groundwater through the saprolite into bedrock and migrate horizontally toward and beyond the perimeter of the landfill. CVOCs were documented at the perimeter of the landfill as early as 1982 (the landfill closed in 1990), supporting the concept of rapid migration from the release location to the water table. As landfilling progressed and the landfill was closed, the waste became depleted of oxygen, decomposition of waste proceeded under anaerobic conditions, and the associated reducing conditions allowed for reductive dechlorination of the CVOCs. Over time, the ELGE system began operating and removed substantial quantities of CVOCs from the waste, and a low permeability cover was installed as part of the ASCR that substantially reduced the quantity of leachate. After several years of degradation and ELGE operation, CVOC concentrations in leachate would decrease below leachate performance standards as is evident from the leachate sampling conducted from 2018 through 2020. However, contamination would persist in the saprolite and bedrock groundwater, continuing to feed the CVOC plume detected at the perimeter of the landfill. The above conceptual model is illustrated in Figures 4.4 through 4.6.

The CVOC signature in LMP-6(P), with elevated cis-1,2-DCE and VC, supports the concept that reductive dechlorination is occurring beneath the landfill due to reducing conditions. Detections of CVOCs at the landfill perimeter indicate varying degrees of degradation. VC is the only CVOC detected in the north/northeast side of the landfill at one location (EW-4) in 2020. With a concentration of 3.7 µg/L at EW-4, this location exceeds the groundwater performance standard of 1 µg/L. As discussed in Section 5.0, the detected VC is contained by the operation of the extraction wells.

The CVOC signatures at EW-7, K-3, EW-6, and FE-3 in 2020 (Figure 4.7) are instructive. 1,1-DCA and CA are the only CVOCs above their respective performance standards at EW-7, suggesting a predominance of 1,1,1-TCA contamination upgradient of this extraction well and high degree of reductive dechlorination. CA, cis-1,2-DCE, and VC are the only CVOCs detected in K-3, with VC concentrations substantially higher than cis-1,2-DCE concentrations. These results, suggest historical releases of both 1,1,1-TCA and PCE upgradient of K-3 and a high degree of reductive dechlorination. At EW-6, 1,1-DCA and CA are both present but at much lower concentrations than PCE, TCE, cis-1,2-DCE, and VC. Unlike at K-3, PCE is detected and is detected at higher concentrations than TCE and VC, suggesting the contamination upgradient of EW-6 is exposed to reducing conditions but not to the degree the contamination upgradient of EW-7 and K-3 are exposed. Finally, at FE-3, PCE concentrations are higher than the concentrations of TCE, cis-1,2-DCE, and VC. Given that reducing conditions are likely strongest in leachate before leachate is diluted by groundwater and the absence of PCE in leachate, the detected PCE concentrations at EW-6 and FE-3 suggest that the PCE has not been residing in leachate and likely originated from PCE that directly reached the saprolite or bedrock during the original release.

The stable, but elevated CVOC concentrations at EW-6 (despite substantial CVOC removal by the ELGE system), decreasing CVOC concentrations in the ELGE vapor, and no detections of PCE in leachate other than a single detection of 4.4 µg/L at LMP-3(M) during the initial sampling event, strongly supports the concept that CVOC mass in the saprolite and bedrock is feeding the plume extracted by EW-6.

4.2 1,4-DIOXANE

The 2015 ESD added 1,4-dioxane to the list of Site-related COCs and established a groundwater cleanup standard of 6.4 µg/L (Table 2.4). 1,4-Dioxane is an organic compound that was commonly used as stabilizer for 1,1,1-TCA (Mohr, 2010) and is often present at sites with 1,1,1-TCA releases. The chemical 1,4-dioxane is miscible in water and due to its low sorption potential (low organic carbon portioning coefficient) has the potential to migrate considerably farther in groundwater than co-occurring chlorinated solvents such as 1,1,1-TCA or TCA breakdown products. More importantly, 1,4-dioxane is relatively recalcitrant to degradation under ambient subsurface conditions and in most anaerobic environments commonly present in landfills (Adamson et al. 2015, Gedalanga et al. 2016). 1,4-Dioxane's low Henry's law constant indicates a low potential for volatilization from the aqueous phase compared to other solvents. As a result, the processes substantially reducing CVOC concentrations (biodegradation and removal by the ELGE system) do not meaningfully apply to 1,4-dioxane.

4.2.1 Vapor

Given the properties of 1,4-dioxane discussed above, 1,4-dioxane is not present at meaningful concentrations in the ELGE vapor.

4.2.2 Leachate

The seven leachate samples collected from LMP-5(M) since 2018 have a stable trend of 1,4-dioxane with concentrations ranging from 210 to 390 µg/L. 1,4-dioxane at LMP-6(M) has no statistically definable trend with concentrations ranging from 77 to 140 µg/L. Detections of 1,4-

dioxane at the other LMPs, whenever sufficient leachate was present, ranged from 54 to 270 µg/L, clearly indicating that 1,4-dioxane is present in the leachate at multiple locations. The primary fate of 1,4-dioxane in leachate is to eventually migrate vertically into groundwater; however, like CVOCs, substantial mass of 1,4-dioxane would also be present in the saprolite and bedrock below the waste.

4.2.3 Groundwater

Leachate contaminated with 1,4-dioxane eventually migrates vertically through the saprolite and/or bedrock until it reaches the water table. Once in the water table 1,4-dioxane will migrate laterally toward the perimeter of the landfill based on the hydraulic gradient and orientation of the bedrock fractures. As with CVOCs, 1,4-dioxane is also present in the saprolite and bedrock from the original release. As discussed in Section 6.0, 1,4-dioxane is successfully captured and contained by the GETS prior to migration to off-Site receptors.

1,4-dioxane at the south side of the landfill is routinely detected in all three extraction wells (EW-7, K-3, and EW-6) and is likely partially explained by the concentrations of elevated 1,4-dioxane concentrations in LMP-5(M), LMP-5(P), and other LMP clusters. 1,4-dioxane concentrations at LMP-5(M) of 210 to 390 µg/L are approximately 10 times higher than the 1,4-dioxane concentrations detected at EW-7, K-3, or EW-6 (12.6 µg/L to 32.3 µg/L), suggesting substantial dilution between leachate and groundwater at the nearby landfill perimeter. This is further instructive for evaluating CVOC migration because CVOCs would be expected to attenuate even more due to degradation, and CVOC detections in leachate are very limited.

The north/northeast side of the landfill also had three locations with 1,4-dioxane detections in 2020 (EW-1, MW-QE-2, and EW-4) but at lower detections than those on the south side of the landfill. The highest 1,4-detection in 2020 at the north/northeast side of the landfill was recorded at EW-4 with 11.3 µg/L. LMP-1(M), with a 1,4-dioxane concentration of 250 µg/L in December 2020, is located hydraulically upgradient of EW-4. Again, substantial dilution of 1,4-dioxane between leachate and groundwater at the perimeter of the landfill is evident. Consideration should also be given to the presence of 1,4-dioxane in unsaturated and saturated saprolite and bedrock that could continue to feed the 1,4-dioxane plumes detected at the above-noted locations.

4.3 MANGANESE

Unlike CVOCs and 1,4-dioxane, manganese is a naturally occurring metal found in soil, rock, and waste. As the 1990 RI states, common mineral zones of the Marburg Formation may leach inorganic elements, including manganese. A U.S. Geological Survey (USGS) Report on the Geohydrology of Southeastern Pennsylvania (USGS, 2002) also reports that elevated concentrations of manganese are among the most common water-quality problems. In addition, manganese was detected in 1982 with a maximum concentration of 22,000 µg/L (Table 2.1). Elevated manganese concentrations in groundwater are commonly found at contaminated sites where organic compounds are present, such as service stations where hydrocarbons have been released to the subsurface, in situ bioremediation remedies for CVOCs where carbon substrates have been added to the subsurface, or landfill waste. Manganese is present because microbial activity consumes the organic compounds, depletes dissolved oxygen in groundwater, and creates reducing conditions and low pH that mobilizes manganese from the native soil, rock, and waste.

Therefore, unlike CVOCs that are degraded by reducing conditions, manganese is mobilized by reducing conditions and will persist as long as the reducing conditions persist, and the manganese-bearing materials exposed to those reducing conditions have leachable manganese.

4.3.1 Vapor

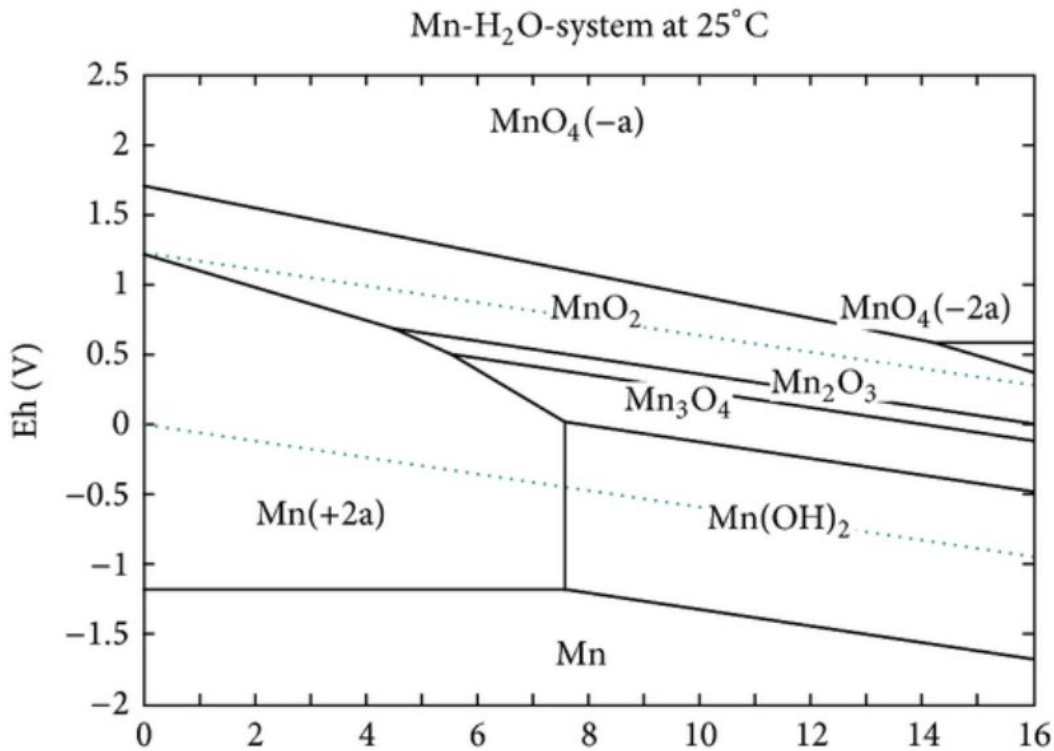
Manganese is an inorganic compound that is not volatile. It would therefore not be found in the extracted vapor.

4.3.2 Leachate

Leachate samples are not analyzed for manganese. The primary source of manganese to groundwater is expected to be mobilization from the natural rock and saprolite beneath the landfill due to the reducing conditions.

4.3.3 Groundwater

Manganese is prevalent at elevated concentrations in extracted water from each of the extraction wells because each of the extraction wells is extracting water emanating from the reducing environment below the landfill through rock that contains leachable manganese. Manganese concentrations have also increased over time in several of the extraction wells as expected (Figure 4.8). The landfill closed in 1990, and the cover was not substantially improved until 2003 and 2004. With landfill closure and an improved cover comes reduced aeration and reduced infiltration of oxygenated rainwater. As oxygen sources are depleted, cellulose and hemicellulose (common organic content in landfills) and other organic matter degrade under anaerobic conditions supporting fermentation reactions by hydrolytic and fermentative bacteria, acetogenic bacteria, and methanogens (Kjeldsen, et al., 2002). Carbon dioxide and methane are generated, and the formation of carboxylic acids lowers the pH (Kjeldsen, et al., 2002). The reducing conditions and lower pH caused by the microbial activity reduces manganese to a more soluble oxidation state (Mn^{2+}) as depicted in the following Eh-pH diagram with “a” referring to aqueous.



Eh-pH diagram showing the predominant manganese forms Mn-H20 systems. Temperature, 25°C ± 0.5.

Additionally, although LFG systems extract vapors to control methane, they purposely limit vapor extraction so that oxygen is not entrained into the landfill waste because the presence of oxygen can lead to intensified microbial activity, increased temperatures, and a landfill fire. Based on the manganese concentration trends observed in the extraction wells, a concentration between 10,000 and 20,000 µg/L is expected to continue in the extracted groundwater.

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5.0 ELGE AND LANDFILL COVER REMEDY PERFORMANCE

The 2000 RODA selected the ASCR, including enhancements to the landfill cover and implementation of the ELGE system, to remove and destroy VOCs and methane from the landfill rather than the impermeable cap, selected in the 1990 ROD, which would have decreased the mobility of VOCs in the landfill (EPA, 2000). In addition, the RODA requires that LMPs be installed in the landfill near ELGE wells in order to monitor the impact of the ELGE system on the quality of the leachate within the landfill. The RODA requires the ELGE system to reduce VOC contamination in the leachate within the landfill to the selected leachate performance standards for the COCs (see Table 2.3). In no event is the ELGE required to address source areas located below the water table (EPA, 2000). The combined remedies (ELGE and cover) have the following main goals:

1. Prevent migration of Site-related contaminants from the landfill that could result in groundwater concentrations in excess of performance standards;
2. Prevent future releases of contamination into surface water and sediments;
3. Prevent direct contact with contaminated soil and waste; and
4. Control methane build-up and migration within the landfill.

Performance standards are also established for the cessation of the ELGE and are based on 90% reduction of select CVOCs (PCE, TCE, cis-1,2-DCE, VC, 1,1-DCE, 1,1-DCA, and CA) in associated ELGE gas monitoring probes compared to baseline sampling of monitoring points prior to system startup. Recognizing that 90% reduction relative to a baseline result may not be protective or may be overly conservative depending on the baseline concentrations, WMDSPI recommended alternative performance standards in 2018 (Golder, 2018). The proposed ELGE performance standards are based on Henry's Law because it takes into account the dynamic equilibrium VOCs in aqueous and vapor phases. The dynamic equilibrium considers that contaminant molecules are transferring from the water to the vapor and from the vapor to the water but result in the equilibrium concentrations in both media. If the concentrations are not in equilibrium, there would be a net transfer of contamination from one medium to the other. As such, vapor concentrations that meet a vapor performance standard based on Henry's Law and the leachate performance standards should allow leachate to meet performance standards.

The performance of the ELGE on achieving the above goals is evaluated based on the leachate concentrations, methane concentrations, and vapor concentrations while the performance of the landfill cover is evaluated based on observation during routine Site visits and measurements of fluid levels in the LMPs.

5.1 LEACHATE CONCENTRATIONS

To address the issue identified in the Fourth FYR regarding the limited leachate observed in the two original LMPs, WMDPSI installed four additional LMPs and associated groundwater piezometers at the Site in 2018 to increase the potential for obtaining leachate samples in the future. The LMP locations were selected in consultation with EPA to identify locations where leachate levels were expected to be highest based on the underlying topography of the waste/saprolite-bedrock interface. As a result, even though the LMPs may not be adjacent to specific ELGE wells,

the leachate detected in the LMPs should be representative of a relatively broad area. There have been seven sampling events that included these four LMPs plus the original two LMPs. The analytical results are presented in Table 3.4. Not all LMPs are sampled in each sampling event due to limited leachate presence.

With the exception of sporadic detections of cis-1,2-DCE above the leachate performance standards at LMP-3(M), all other LMPs either have no detections of CVOCs or have not been sampled due to low levels of generated leachate (Table 3.4). On the other hand, 1,4-dioxane has been detected in every sample collected from any of the six LMPs. Leachate samples are not analyzed for manganese. The primary source of manganese to groundwater is expected to be mobilization from the natural saprolite and bedrock beneath the landfill due to reducing conditions.

The ASCR, and more specifically the ELGE, was tasked to remove VOCs and methane. The absence of VOC detections in 15 out of the 18 samples collected from the LMPs and the sporadic detection of a degradation compound (cis,1-2-DCE) below the leachate performance standard indicate that the ELGE and naturally reducing conditions within the landfill are highly effective at meeting remedy objectives. The ELGE was never expected to address 1,4-dioxane or manganese and given the properties of these COCs discussed in Section 4.0, the presence of 1,4-dioxane in the leachate and the likely presence of manganese in the leachate are not surprising. To this end, EPA stated in the first response of the responsiveness summary to 2000 RODA (EPA, 2000):

> *The volatile organic contaminants in the landfill will respond well to the proposed system. The metals that are present in the landfill will not volatilize, but will be treated by the groundwater extraction system.*

5.2 METHANE CONCENTRATIONS

For the methane extraction and control portion of the ELGE system, a demonstration of compliance with the following state standards is required:

- 25 percent of the LEL for methane is not exceeded within nearby structures (i.e. must be less than 1.25 percent methane by volume); and
- The LEL for methane is not exceeded at the landfill property boundaries (i.e. must be less than 5 percent methane be volume).

Based on the measurements of all the perimeter gas monitoring probes in 2020, there is no indication of off-site migration of methane, and all readings are below the ROD performance standard. Methane was only detected in GMP-4 and GMP-7. The latter probe is installed in waste at the southwest corner of the landfill and methane reading varied from 0.9 to 39.3 percent of methane in 2020. GMP-7A, which is installed adjacent to GMP-7 but outside the landfill, had no methane detected. GMP-4 is also installed just outside the estimated limit of waste, but methane detection exceeded the ROD performance standard in April 2020 (5.4% methane). Methane was not detected in any of the on-Site structures in 2020 and has never been detected at these locations since monitoring began. In addition, the performance of the sub-slab depressurization system in the basement of the residence was checked on October 20, 2020 and was found to be functioning properly. Methane concentrations have remained stable since 2018.

The methane results show that the ELGE system is capable of controlling methane build-up and migration within the landfill. Other non-ELGE wells also extract methane (and VOCs) but do not have probes and are not sampled as part of the approved sampling plan.

5.3 VAPOR CONCENTRATIONS

Table 5.1 tabulates the exceedances of the original 2000 RODA ELGE standards and the 2018 Proposed ELGE standards for every one of the ELGE monitoring points in 2019. Based on Table 5.1, there are seven monitoring points with no exceedances, 15 monitoring points with exceedances of the 2000 RODA standards, and four with exceedances of both the 2000 RODA standards and the 2018 proposed ELGE standards (LFG-5, LFG-13, LFG-14, and GMP-19). This represents significant progress relative to the post-startup period for the ELGE system when all 22 monitoring points exceeded the 2000 RODA standards and 19 of the monitoring points exceeded the 2018 proposed ELGE standards.

The decreasing trends in vapor concentrations (see Appendix B) and the substantial mass removal (approximately 5,000 pounds of CVOCs since start-up) further demonstrate remedial progress by the ELGE system. In the absence of the ELGE system, over 5,000 pounds of CVOCs would still be present in the landfill. Mass removal continues to be strong (Figure 4.1), suggesting that the ELGE system, as currently operated will continue to remove contaminant mass as intended by the 2000 RODA.

5.4 LANDFILL COVER PERFORMANCE

The enhanced landfill cover installed as part of the ASCR was constructed with at least 18 inches of soil designed to have an average permeability of 2.2×10^{-6} cm/s with a maximum permeability no greater than two times this value, overlain with a minimum 6-inch thick erosion layer. The permeability of 22 samples collected during the cover upgrades in 2003 and 2004 ranged from 2.2×10^{-6} cm/s to 3.5×10^{-9} with an arithmetic mean of 4.6×10^{-7} cm/s, confirming the laboratory testing results (2.9×10^{-7} cm./s). As part of the maintenance activities conducted by the WMDSPI, quarterly visual inspections of the conditions of the cover surface are conducted by traversing the area parallel to the topographic contours.

It is natural for an almost 20-year landfill cover to identify small areas with poor vegetation, presence of woody vegetation, presence of erosional features, and disturbance of the cover system by burrow animals. Five deficiency locations were identified after the Site visit in September 2020. Since these areas of ponding could increase infiltration through landfill, such as near LMP-5(M), WMDSPI repaired these areas in October 2020 (Appendix C); however, more substantial work is required to provide positive drainage and limit infiltration. To that end, WMDSPI submitted a Work Plan in July 2021 to investigate the areas in need of repairs. Landfill cover repairs are expected to be conducted in 2022.

With the exception of LMP-5 cluster, the LMP boring logs and leachate monitoring results confirm the cover is substantially limiting leachate as expected given the low permeability of the cover material. Leachate volumes are insufficient to fill VOC sample bottles during most leachate sampling events, and the LMP boring logs indicate substantial intervals of dry material as follows:

- LMP-3(M): over 30-feet of dry material from 20 to 53 feet bgs.
- LMP-3(P): over 50-feet of dry material from 1.3 to 53 feet bgs.
- LMP-4(P): over 20-feet of dry to moist material from 16 to 37.5 feet bgs followed by dry saprolite
- LMP-6(P): several dry intervals and some moist intervals followed by over 40 feet of dry to damp saprolite

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6.0 GROUNDWATER EXTRACTION TREATMENT SYSTEM PERFORMANCE

6.1 GETS PERFORMANCE

The GETS operation is directly related to the following two RAOs from the ROD and achieves these objectives by hydraulically containing contaminated groundwater emanating from beneath the landfill.

- Prevent migration of contaminated groundwater to uncontaminated areas of groundwater, surface water bodies and sediment.
- Restore the aquifer to its beneficial use as a potable water source

Therefore, evaluation of the GETS performance primarily involves evaluating the GETS capture zone because effective capture of groundwater contamination will allow aquifer restoration downgradient of the capture zone.

The extent and effectiveness of plume capture can be accomplished by evaluating the hydraulic capture zone with potentiometric surface maps, hydraulic capture through groundwater modeling, and trends in downgradient performance monitoring wells. For consistency with previous documentation, capture is evaluated for the following areas as described in the September 2018 Demonstration of Groundwater Control Southern Plume Area report prepared by Environmental Standards, Inc. (ESI), on behalf of the OGDs:

- northeastern (addressed by EW-2, EW-3, EW-4, and EW-8)
- northern (addressed by EW-1, EW-2, and EW-3)
- western (characterized by MW-QE-7)
- southern plume (addressed by EW-6, EW-7, and K3)

The December 2020 potentiometric surface map prepared by ESI on behalf of the OGDs is provided as Figure 6.1 to reference locations and a typical potentiometric surface map prepared by ESI.

6.2 NORTHEASTERN PLUME AREA

The potentiometric surface map as presented in Figure 6.1 is unreliable for evaluating plume capture because it was developed with large contour intervals and is heavily influenced by water levels in the operating extraction wells. For reference, the bias introduced by using the water levels from the operating extraction wells is evident when looking at EW-6 and PZ-1, PZ-2, and PZ-3 in the southern plume area. The water level in the operating extraction well is 19.31 to 32.24 ft lower than the adjacent piezometers. As a result, the water level in EW-6 is not reflective of the water level in the aquifer within a short distance from the well. A similar bias translates to EW-2, EW-3, EW-4, and EW-8. However, evaluation of water level measures from individual well pairs are instructive as follows:

- MW-QE-8 and MW-P: The water level is lower at MW-P, suggesting groundwater from the east migrates toward MW-P, which supports capture.
- MW-BO1 and MW-AO5, MW-BO5, and MW-BO6: The water levels are lower at MW-BO1 relative to the other wells, suggesting groundwater flow to the south, which supports capture.
- C-3 and C-7: The water level is lower at C-7, suggesting groundwater flows to the west, which supports capture.

Based on the above analysis, the capture between EW-3, EW-4, and EW-8 appears robust. No exceedances at MW-BO1 and a clear decreasing trend for chlorinated VOCs at MW-P, among other water quality results, support effective capture in this area. Insufficient water level information is available between EW-2 and EW-3 to evaluate capture using water levels; however, the water quality information from MW-QE-3 supports capture. There was a decrease in PCE concentrations from 2000 to 2010, a slight increase around 2013, and then a subsequent decrease from 2017 through 2020. A similar pattern for 1,4-dioxane was also observed after sampling for 1,4-dioxane began. The decreasing trends support capture, and the temporary increase in concentrations may have been the result of temporary changes in groundwater extraction rates from EW-2 and EW-3. As reflected in the 2020 Annual Monitoring Report, there are no exceedances of COCs in the northeastern plume area. Therefore, the GETS is meeting performance standards for the northeastern plume area.

6.3 NORTHERN PLUME AREA

The potentiometric surface map and available water level measurements in the northern plume area between EW-1 and EW-2 are limited as is the case between EW-2 and EW-3. An evaluation of capture must therefore rely on the water quality results from MW-QE-2. An increasing 1,4-dioxane concentration from 2011 through 2015 appears to have been temporarily addressed in 2016, 2017, and 2018; however, concentrations rebounded above the performance standard of 6.4 µg/L in 2019 and the first 2020 event. The 1,4-dioxane concentration decreased to 2 µg/L in the confirmation sampling event in 2020. Manganese is often present above performance standards at MW-QE-2. Manganese concentrations decreased from approximately 500 to 600 µg/L in 2000 to approximately 200 to 300 µg/L in 2020 with concentrations below the performance standard in 2016 and 2017. Based on these results, it appears that the concentrations of 1,4-dioxane and manganese may be influenced by variable extraction rates from EW-1 and EW-2. Extraction rates for individual extraction wells over time are not available in the annual monitoring reports and were therefore not evaluated to confirm this preliminary conclusion.

It is likely that capture is effective between EW-1 and EW-2 despite the presence of COC concentrations above standards at MW-QE-2 because the location of MW-QE-2 is located between and almost in line with EW-1 and EW-2. MW-QE-2 is very possibly located within the capture zone of EW-1 and EW-2, and the contaminated groundwater flowing through this monitoring well may be eventually captured by one of the extraction wells. Groundwater in this location that is not extracted by EW-1 and EW-2 would migrate toward the surface water feature and MW-GS, and the COC concentrations at MW-GS are routinely below performance standards. Therefore, the GETS is meeting performance standards for the northern plume area. In the future, COC exceedances at MW-QE-2, should not be construed as a gap in capture.

6.4 WESTERN PLUME AREA

Concentrations of 1,1-DCA routinely exceeded the performance standard and concentrations of PCE fluctuated between 3.8 and 6.6 µg/L between 2000 and 2007 but all sampled COCs have routinely met performance standards since 2008. 1,1-DCA and PCE concentrations noticeably decreased after 2007. No groundwater extraction occurs in this area and groundwater extraction in other parts of the landfill began in 2000. A likely explanation for the improved conditions is the upgrade to the landfill cover and storm water management system, which occurred between October 2003 and June 2004. The combined remedies meet performance standards for the western plume area.

6.5 SOUTHERN PLUME AREA

Groundwater extraction from K-3 was initiated in December 2017, and the December 2020 potentiometric surface map suggests robust capture for the southern plume area with K-3 operating. Similar to the northeastern plume area, the potentiometric surface map is biased due to the use of operating extraction wells in generating water level contours. A comparison of the water levels between MW-EI and FE-3 is instructive because the water level at MW-EI is higher than the water level at FE-3, suggesting that groundwater flows from MW-EI toward FE-3 if the fractures screened by the two wells are connected. However, MW-EI is screened from 647.47 to 667.47 ft amsl and FE-3 is screened from 704 to 714 ft amsl, and the two wells may not be hydraulically connected.

The water quality results at FE-3 are concerning because despite the recent groundwater extraction from K3, the PCE concentrations at FE-3 have been above the performance standard for 2019, July 2020, and December 2020. One potential explanation is the shallow nature of FE-3, which is immediately below the saprolite. Contamination in the saprolite may be migrating downward into FE-3. Another possibility is that there is still a gap in capture between K-3 and EW-6. The chemical signature at FE-3 is instructive because the PCE concentration (9.9 µg/L in July 2020) is noticeably higher than the TCE, cDCE, and VC concentrations (4.1 µg/L, 5.7 µg/L, and < 0.5 µg/L, respectively, in 2020). By contrast, the chemical signatures at K-3 and EW-6 have cis-1,2-DCE and VC concentrations that are higher than the PCE concentrations. As a result, it is reasonable to conclude that the VOC concentrations at FE-3 might be migrating from a different, less reductive pathway, than the contamination extracted by EW-6 and K-3.

The COC concentrations at MW-EI support capture since the onset of pumping from K-3. Concentrations of manganese and 1,4-dioxane have consistently decreased since pumping from K-3 began. The chemical signature at MW-EI more closely resembles the chemical signature at EW-7, suggesting that pumping from K-3 has improved the capture provided by E-7.

In summary, plume capture in the southern area appears to be sufficient with the exception of low-level PCE concentrations persisting above performance standards at FE-3.

6.6 GETS PERFORMANCE SUMMARY

Based on the above analysis, the GETS effectively captures COCs emanating from beneath the footprint of the landfill with the potential exception of PCE contamination migrating to monitoring well FE-3. Additional information would be required to identify the mechanism that is allowing contamination to continue to reach FE-3.

7.0 CONCLUSIONS AND CRITICAL DATA GAPS

7.1 CONCLUSIONS

The following conclusions result from the analysis in the preceding sections:

- CVOC mass from the original release was not contained solely within the landfill waste. Contaminated groundwater indicates that CVOCs can migrate through waste and saprolite into groundwater, and detections of CVOCs at the landfill perimeter as early as 1982 suggest that this migration happened early. CVOC mass from the original release migrated under the influence of gravity either directly or dissolved in leachate during and after landfill operations and migrated vertically to groundwater leaving residual mass in the waste, unsaturated saprolite, and saturated saprolite and bedrock.
- The low permeability landfill cover (with a field measured permeability of 4.6×10^{-7} cm/sec) has substantially reduced infiltration as demonstrated by HELP model calculations and a water balance that compares the amount of estimated infiltration with the amount of impacted groundwater captured by the GETS.
- Over time, the portions of the landfill cover have subsided, leaving depressions and ponded water. These depressions, such as that near LMP-5(M), have resulted in increased localized infiltration relative to other portions of the landfill. These depressions and ponded areas require repair. Further evidence of the general effectiveness of the landfill cover is the degree of leachate mounding that has occurred at LMP-5(M) as a result of the localized ponding. This mounding is not detected in any of the other five leachate monitoring points, suggesting that the conditions at LMP-5(M) might be more representative of what would occur in the absence of the low permeability cover.
- The ELGE system has been effective at removing CVOC mass from the waste. Approximately 5,000 pounds has been removed to date, resulting in decreasing CVOC vapor concentration trends in ELGE performance monitoring wells and substantially reduced residual vapor concentrations.
- CVOC mass within the landfill is also degraded by reducing conditions caused by the degradation of organic material in the landfill under anaerobic conditions.
- Due to a combination of CVOC removal from the ELGE system and through reductive dechlorination, CVOCs are not detectable in the leachate above leachate performance standards and are rarely detectable. No CVOC detections have exceeded the leachate performance standards, and only two cis-1,2-DCE concentrations at LMP-3(M) exceeded the groundwater performance standard. The LMPs were strategically located in consultation with EPA in areas where leachate was most likely to accumulate. In addition, the LMPs are placed through the ELGE performance area, including areas with residual CVOC concentrations in landfill vapors. Therefore, the absence of CVOCs in leachate strongly suggests that landfill leachate is not adversely affecting the CVOC concentrations in groundwater.

- The presence of PCE and other CVOCs in saprolite groundwater at LMP-6(P) and the absence of CVOCs in leachate strongly suggest that CVOC mass in the saturated and unsaturated saprolite and bedrock is feeding the dissolved CVOC plume.
- Persistent CVOC concentrations at EW-6 and other extraction wells despite substantial CVOC mass removal from the ELGE system and substantially reduced CVOC vapor concentrations in upgradient ELGE wells further supports the concept that the CVOCs extracted by EW-6 originate from contamination in the saprolite, not the overlying waste.
- ELGE operation and reductive dechlorination are expected to continue to substantially remove CVOC mass from the landfill; however, CVOC contamination may persist at the extraction wells due to the CVOC contamination below the waste and already present in groundwater.
- Unlike CVOCs, 1,4-dioxane is not affected by the ELGE system or by reductive dechlorination. Therefore, 1,4-dioxane concentrations persist in the leachate. Because 1,4-dioxane is not expected to be removed or degraded, the ultimate fate of the 1,4-dioxane in the leachate is to migrate into groundwater where it is extracted by the GETS at the perimeter of the landfill.
- Based on the concentrations of 1,4-dioxane in the leachate and extracted groundwater, the attenuation that occurs (by dilution and dispersion) is approximately a factor of 10. This factor of 10 attenuation for a contaminant that does not degrade is instructive when evaluating CVOC contamination. For example, if leachate were the source of 32.3 µg/L of PCE at an extraction well, the contamination of PCE in leachate would need to be approximately 323 ug/L if PCE was not susceptible to degradation by reductive dechlorination. However, because PCE is susceptible to degradation by reductive dechlorination, the PCE concentration in leachate would need to be substantially higher. In all of the leachate sampling to date, there has only been a single detection of PCE (4.4 µg/L at LMP-3(M)), which is orders of magnitude lower than what would be required to be the source of the contamination detected at the extraction well. This finding again supports the conceptual model that there is contaminant mass below the waste in the saturated and unsaturated saprolite and bedrock that is feeding the CVOC contamination detected at the extraction wells.
- Manganese is also not susceptible to vapor extraction or degradation. Rather, manganese is mobilized as a result of the reducing conditions that foster reductive dechlorination. As waste decomposes under anaerobic conditions within the landfill, the pH decreases and reducing conditions occur, and these changes alter the oxidation state of the naturally occurring manganese in the soil and rock to a form (Mn^{2+}) that is highly soluble in water. Manganese is therefore mobilized from the native rock and soil into groundwater. Manganese concentrations have risen over time as waste degradation advances through various stages, increasing the availability of fermentable organic material.

- The GETS has been effective at providing capture in the northeastern, northern, western, and southern plume areas with the potential exception of a small gap in capture at FE-3. The remedy is therefore protective despite the CVOCs that continue to feed the dissolved plume from the saprolite and bedrock, the migration of 1,4-dioxane from leachate to groundwater, and the mobilization of manganese from soil and rock into groundwater.

7.2 CRITICAL DATA GAPS

Given the relatively limited data generally available from Site characterizations and environmental cleanups, many data gaps are often identified during CSM development. However, it is only the critical data gaps affecting remedy decisions that merit further attention. The vapor, leachate, and groundwater data and associated analysis provided in this document provide a clear understanding of the CSM for contaminant fate and transport and for determining that the remedy is protective. The following critical data gaps remain:

- What is the volume of extractable leachate present at LMP-5(M) and what is the possible leachate recovery rate? Would it be beneficial to extract this leachate in the interim before the landfill cover is repaired?
- What is the cause of the persistent PCE concentrations at FE-3, and are they the result of a gap in capture in shallow bedrock? Because it is a shallow bedrock well, is the contamination migrating from the overlying saprolite? Can changes in the extraction rates at K-3 and EW-6 effectively address this issue?
- Can additional tuning of LFG-13, LFG-14, and LFG-5 further enhance CVOC removal at these locations?

These data gaps are easily addressed while a Focused Feasibility study and manganese optimization evaluation are conducted to address the FYR issues.

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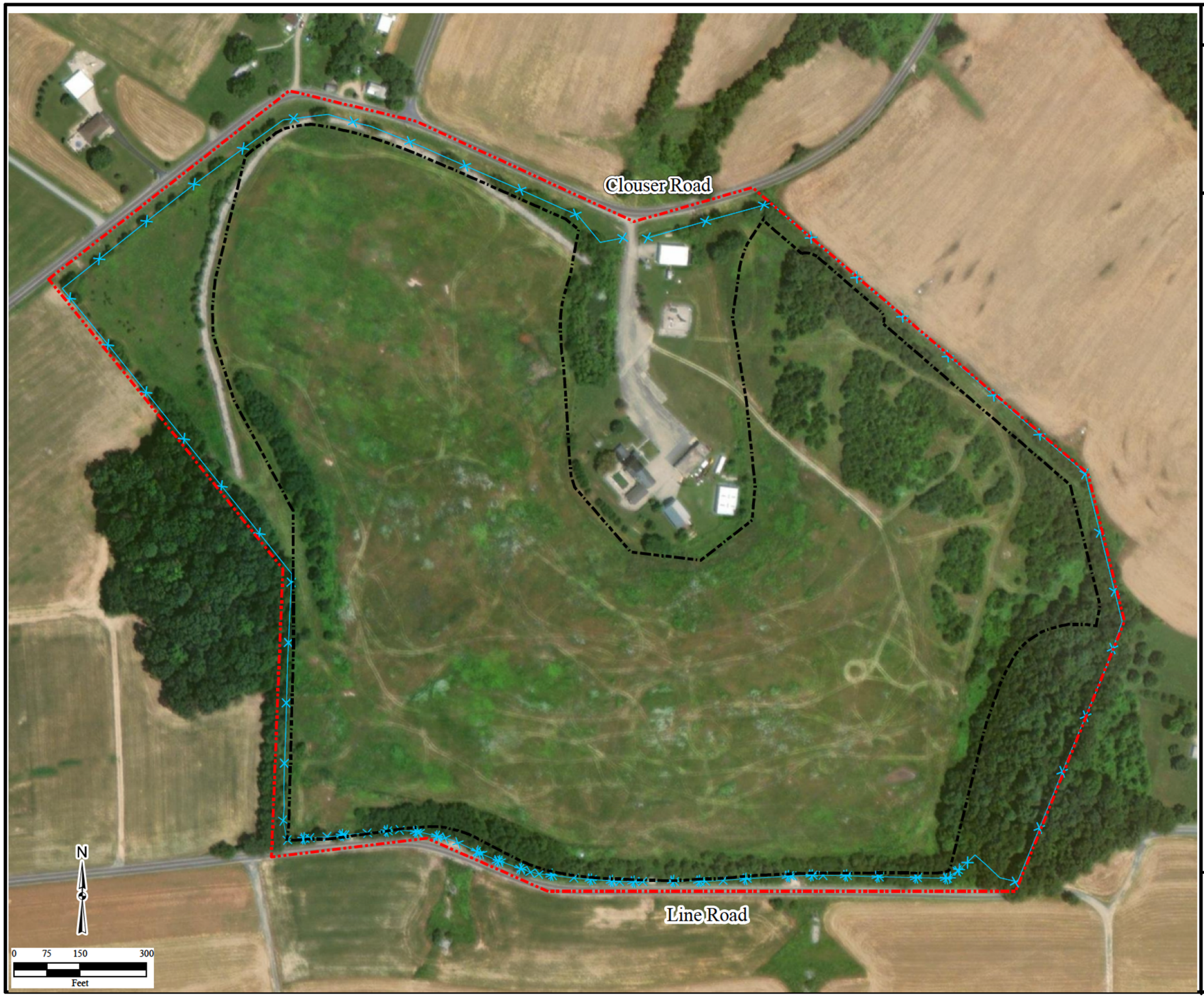
FIGURES



HGL— Updated CSM, Keystone Sanitation Landfill Superfund Site, Union Township, Adams County, Pennsylvania

Figure 2.1
Site Location Map

Legend

Existing Fence

Limit of Refuse (approximate)

Site Boundary

Notes:
CSM = Conceptual Site Model

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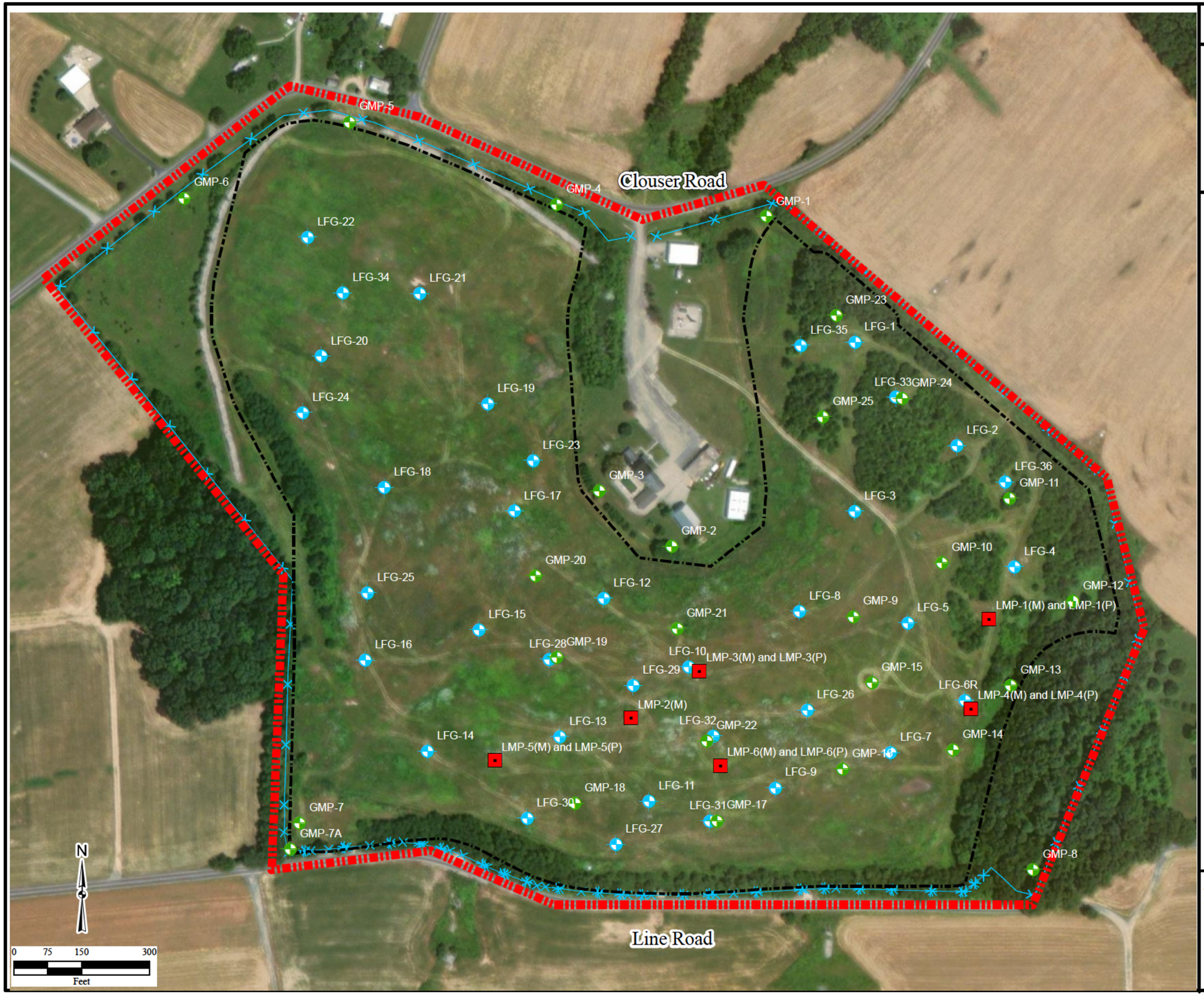
6/8/2021 RR
Source: HGL, Golder Associates 2016
ArcGIS Online Imagery

HGL HydroGeoLogic, Inc



HGL— Updated CSM, Keystone Sanitation Landfill Superfund Site, Union Township, Adams County, Penns ylvania

Figure 2.2
Enhanced Landfill Gas Extraction System Wells

Legend

- Landfill Gas Wells (LFG)
- Gas Monitoring Probes (GMP)
- Leachate Monitoring Points and Piezometers (LMP)
- Existing Fence
- Limit of Refuse (approximate)
- Site Boundary

Notes:
CSM = Conceptual Site Model

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8/6/2021 RR
Source HGL Golder Associates 2016
ArcGIS Online Imagery

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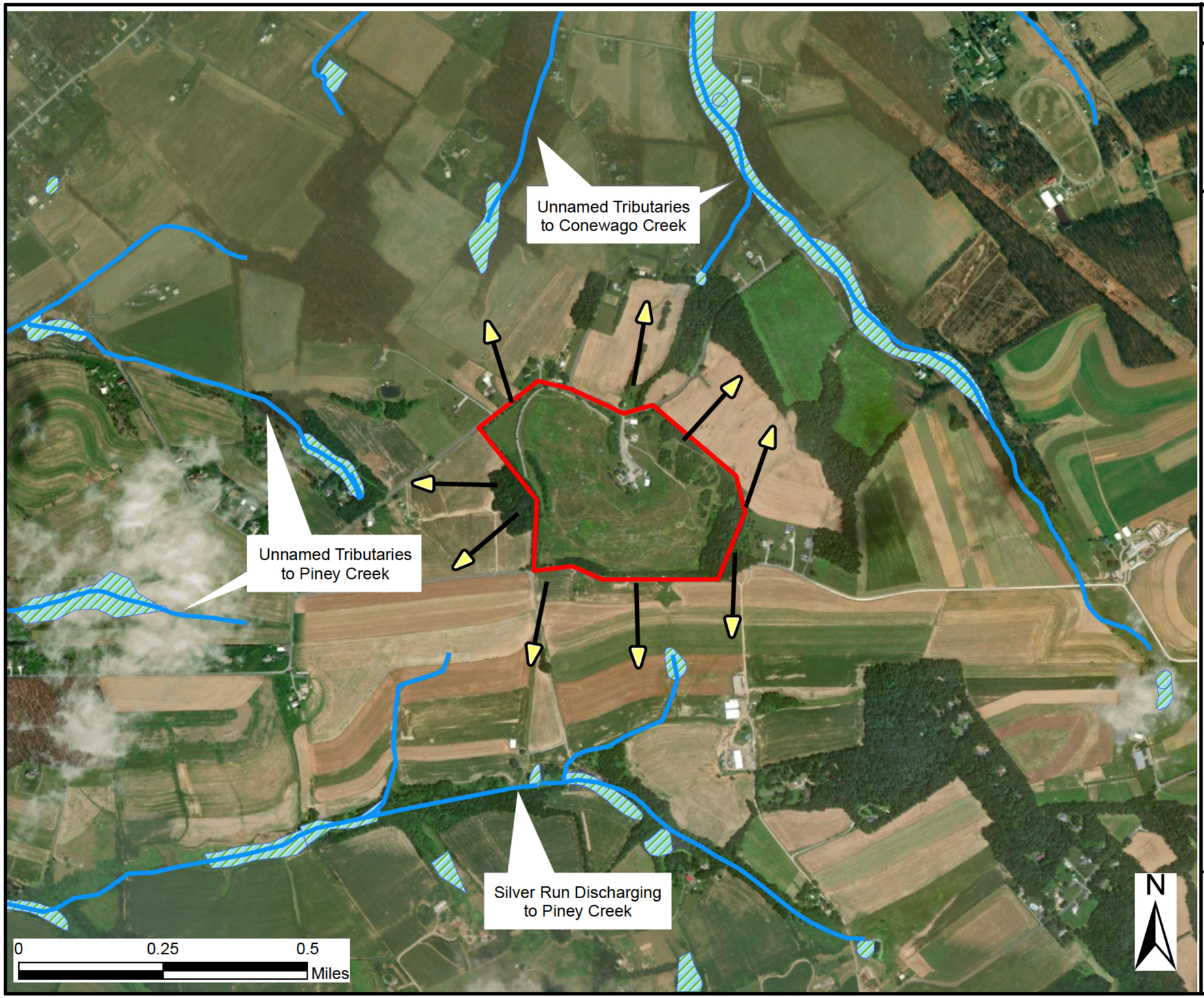

HGL— Updated CSM, Keystone Sanitation Landfill Superfund Site, Union Township, Adams County, Pennsylvania

Figure 3.1
Land Use and Surfce Water Features

Legend

- Site Boundary
- Wetlands (USFW NWI)
- Streams/Creeks/Tributaries
- Surface Water Drainage

Notes:
CSM = Conceptual Site Model
NWI = National Wetlands Inventory
USFW = U.S. Fish and Wildlife Service

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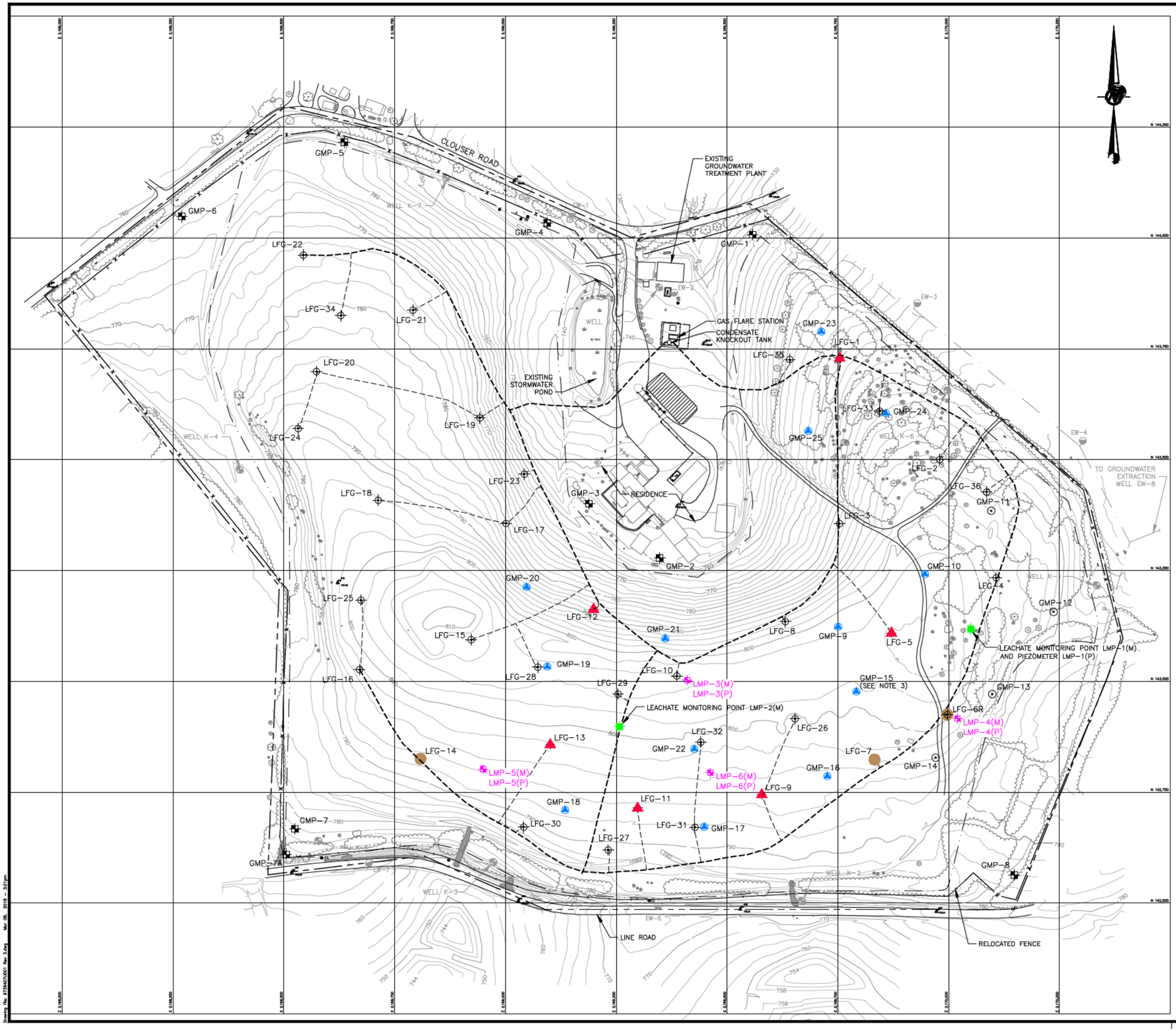


LEGEND

- PROPERTY LINE
- ESTIMATED LIMIT OF WASTE
- FENCELINE
- FENCELINE RELOCATED DURING STORMWATER UPGRADES
- TOPOGRAPHIC CONTOUR
- GAS HEADER PIPE
- GAS LATERAL PIPE

ELGE SYSTEM:
- LFG-12 — ELGE SYSTEM GAS EXTRACTION WELL (SEE NOTE 1)
- LFG-6 — GAS EXTRACTION WELL FOR MONITORING ONLY (SEE NOTE 2)
- LMP-1 — ELGE LEACHATE MONITORING POINT
- GMP-7 — ELGE GAS MONITORING PROBE (SEE NOTE 1)

- LFG-1 — NON-ELGE GAS EXTRACTION WELL
- GMP-1 — PERIMETER GAS MONITORING PROBE
- GMP-13 — GAS MONITORING PROBE NOT INCLUDED IN ELGE SYSTEM
- EW-4 — GROUNDWATER EXTRACTION WELL
- K-1 — GROUNDWATER MONITORING WELL
- LMP-3(M) — LEACHATE MONITORING POINT
- LMP-3(P) — GROUNDWATER PIEZOMETER

NOTES

1.) WELLS DESIGNATED AS ELGE WILL BE SUBJECT TO ELGE SYSTEM PERFORMANCE STANDARDS AT WELL AND ADJACENT ELGE MONITORING PROBES, PER 2000 ROD AMENDMENT.

2.) WELLS DESIGNATED FOR MONITORING ONLY ARE NOT SUBJECT TO ELGE SYSTEM PERFORMANCE STANDARDS, AND DO NOT REQUIRE INSTALLATION OF ADJACENT ELGE MONITORING PROBES.

3.) GMP-15 WAS PREVIOUSLY SHOWN AS GMP-7(L).

REFERENCES

1.) BASE MAP TAKEN FROM CADD FILES 011620 AND 011610, CREATED BY HARFORD AERIAL SURVEYS, INC., DATED MARCH 28, 2001, PROVIDED BY JOHNSON, MIRMIRAN & THOMPSON.

2.) GROUNDWATER EXTRACTION SYSTEM INFORMATION TAKEN FROM AS-BUILT DRAWINGS (NUMBERS C-1 AND C-2) DATED OCTOBER 22, 2000, PROVIDED BY QUEST ENVIRONMENTAL & ENGINEERING SERVICES, INC.

3.) LOCATIONS OF ELGE LEACHATE MONITORING POINTS LMP-1(M) AND LMP-2(M) GROUNDWATER PIEZOMETER LMP-1(P), LANDFILL GAS EXTRACTION WELLS LFG-1 THROUGH LFG-23, ELGE GAS MONITORING PROBES, PERIMETER GAS MONITORING PROBES, HEADER AND LATERAL PIPES, FLARE STATION, FENCE ALONG SOUTHERN PROPERTY BOUNDARY AND UPDATED TOPOGRAPHIC CONTOURS IN THE COVER THICKNESS UPGRADE AREAS TAKEN FROM DRAWING ENTITLED "AS-BUILT SURVEY AND DETAILS, KEYSTONE LANDFILL", PREPARED BY WORLEY SURVEYING, REVISION 6, DATED DECEMBER 13, 2004.

4.) LANDFILL GAS EXTRACTION WELLS LFG-6R AND LFG-24 THROUGH 36, HEADER AND LATERAL PIPES, AND UPDATED TOPOGRAPHIC CONTOURS IN WASTE RELOCATION AREA TAKEN FROM DIGITAL CAD FILE AS-BUILT PLAN.DWG, ENTITLED "AS-BUILT SURVEY AND DETAILS," PREPARED BY HANOVER LAND SERVICES, INC., DATED NOVEMBER 15, 2010.

5.) LMP-3(M)/LMP-3(P) TO LMP-6(M)/LMP-6(P) TAKEN FROM DIGITAL CAD FILE AS-BUILT PLAN.DWG, ENTITLED "AS-BUILT SURVEY AND DETAILS," PREPARED BY HANOVER LAND SERVICES, INC., DATED FEBRUARY 5, 2018.

100 0 100 200
SCALE FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
3	03/08/18	FTA	REVISED WITH AS-BUILT LEACHATE MONITORING POINTS AND PIEZOMETERS	GLS		
2	10/02/14	JLH	REMOVED CALLOUT TO NOTE 4 ON GMP-7	GLS	CBM	FTA
1	07/15/11	FTA	ADDED LFG-6R, LFG-24 THROUGH LFG-36	AM	CBM	FTA

PROJECT
KEYSTONE SANITATION LANDFILL
PERFORMANCE MONITORING REPORT
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

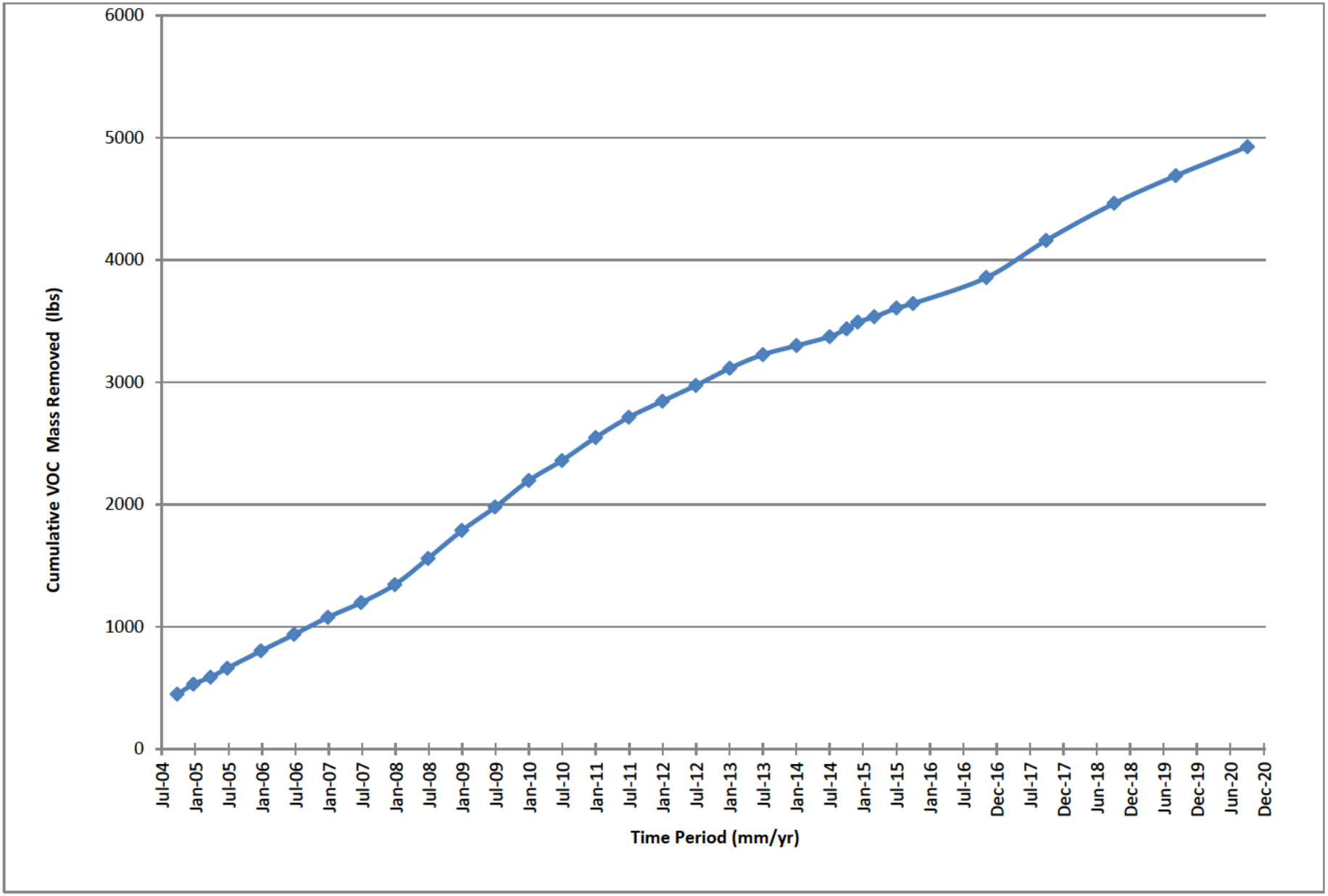
TITLE
GAS SYSTEM LAYOUT

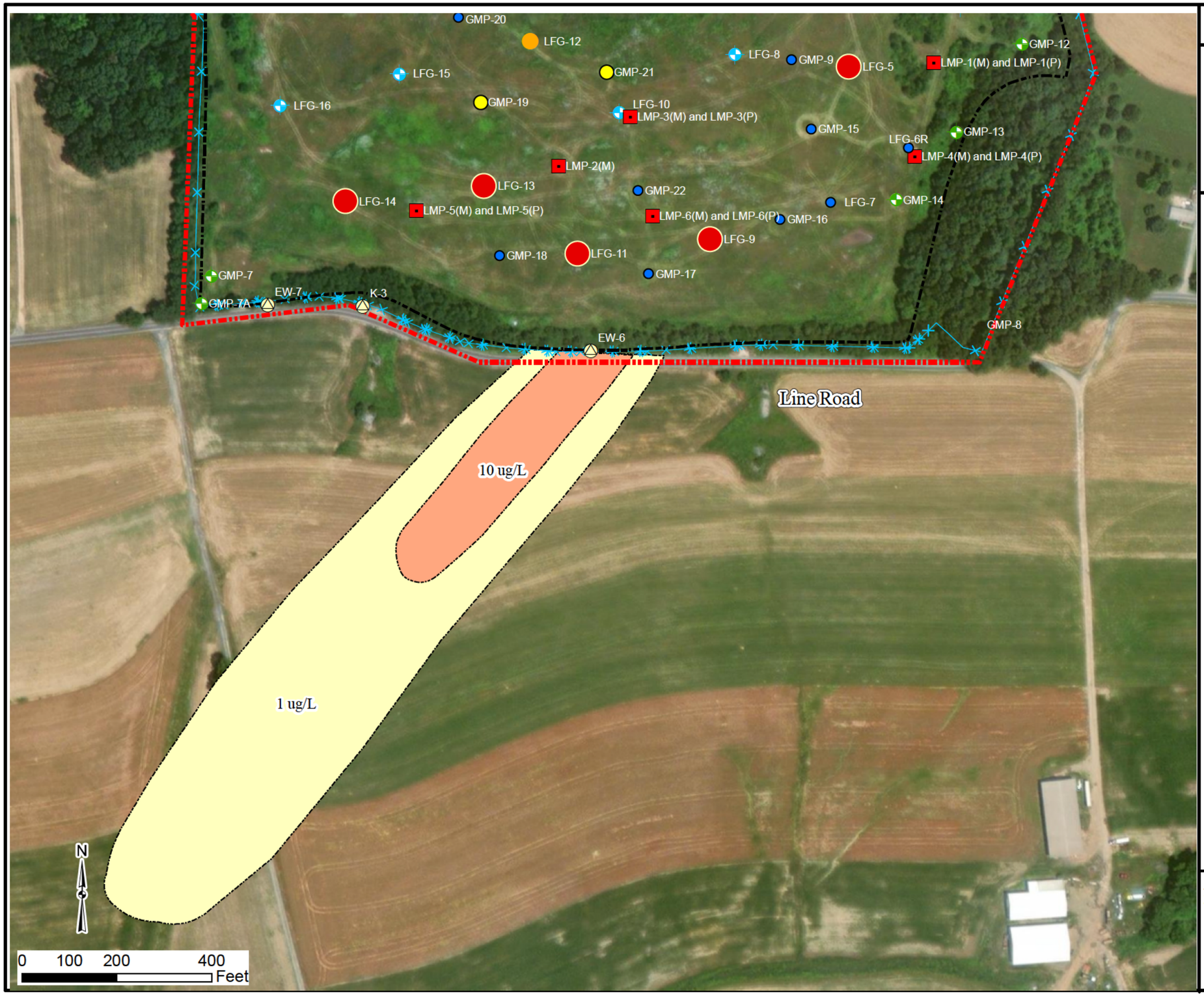
PROJECT No.		973-6407	FILE No.	9736407U001
DESIGN	FTA	02/17/05	SCALE AS SHOWN	REV. 3
CADD	AM	02/18/05		
CHECK	VEF	03/10/05		
REVIEW	FTA	03/10/05		

FIGURE 3.2

Drawing File: 9736407U001 Rev 3.dwg Mar 08, 2018 - 3:21pm

FIGURE 4.1
PLOT OF ESTIMATED MASS REMOVAL OF SELECT TARGET VOCS
KEYSTONE SANITATION LANDFILL
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA





HGL— Updated CSM, Keystone Sanitation Landfill Superfund Site, Union Township, Adams County, Penns ylvania

Figure 4.2a
2011 PCE Vapor Concentrations

Legend

- Landfill Gas Wells (LFG)
- Gas Monitoring Probes (GMP)
- Leachate Monitoring Points and Piezometers (LMP)
- Groundwater Extraction Well
- Existing Fence
- Limit of Refuse (approximate)
- Site Boundary

PCE Concentrations

- less than 1 ppmv
- between 1 and 2 ppmv
- between 2 and 4 ppmv
- greater than 4 ppmv

Notes:
CSM = Conceptual Site Model
PCE = Tetrachloroethene
ppmv = parts per million volume
ug/L = micrograms per liter

The 1 and 10 ug/L PCE groundwater contours are inferred by the PCE plume extent, presented in the Annual Monitoring Report - Year 13 Groundwater Pump and Treatment System (Frey Engineering, 2014)

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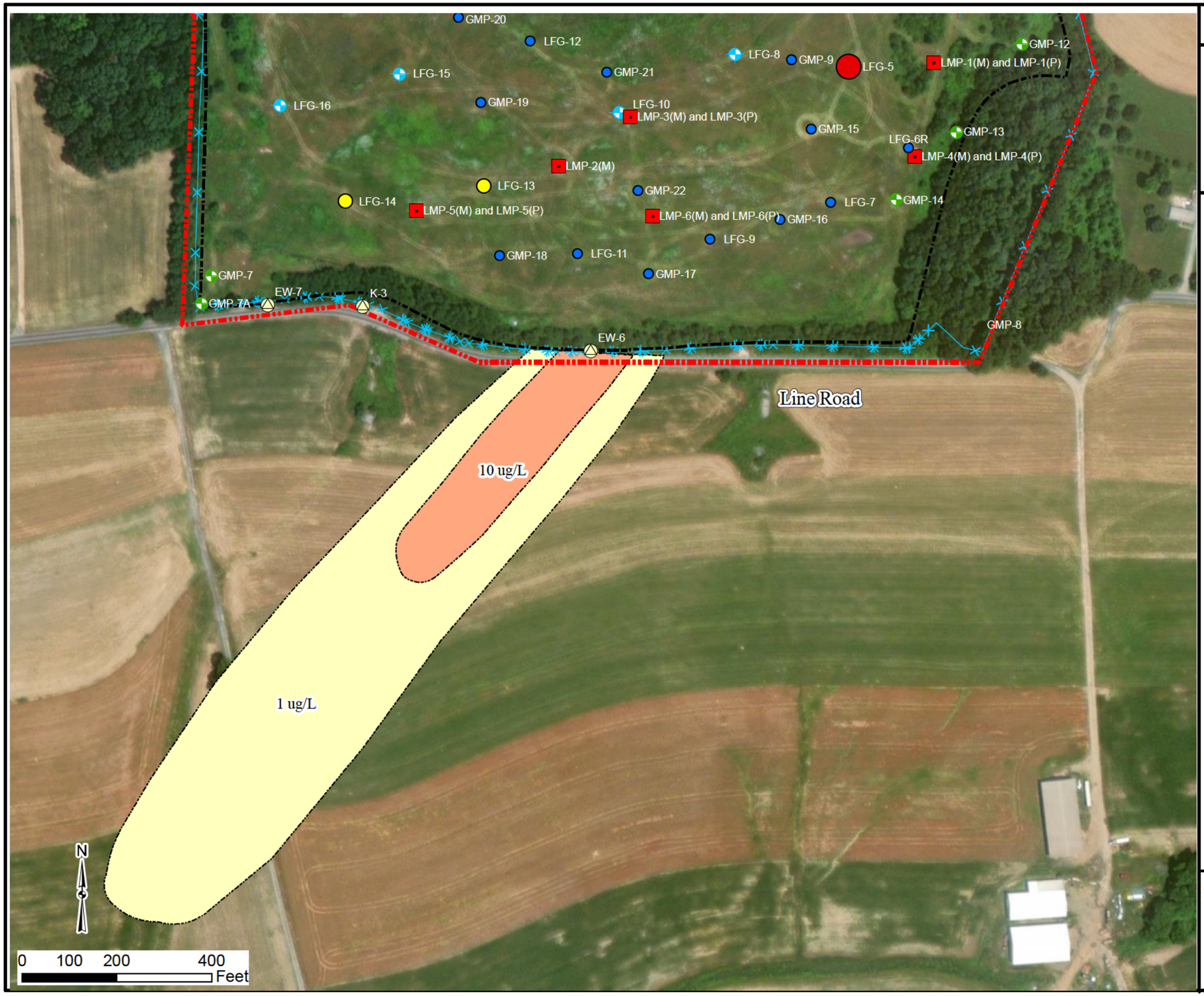
8/12/2021 RR
Source HGL Golder Associates 2016 ArcGIS Online Imagery

HGL HydroGeoLogic, Inc



HGL— Updated CSM, Keystone Sanitation Landfill Superfund Site, Union Township, Adams County, Penns ylvania

Figure 4.2b
2019 PCE Vapor Concentrations

Legend

- Landfill Gas Wells (LFG)
- Gas Monitoring Probes (GMP)
- Leachate Monitoring Points and Piezometers (LMP)
- Groundwater Extraction Well
- Existing Fence
- Limit of Refuse (approximate)
- Site Boundary

PCE Concentrations

- less than 1 ppmv
- between 1 and 2 ppmv
- between 2 and 4 ppmv
- greater than 4 ppmv

Notes:
CSM = Conceptual Site Model
PCE = Tetrachloroethene
ppmv = parts per million volume
ug/L = micrograms per liter

The 1 and 10 ug/L PCE groundwater contours are inferred by the PCE plume extent, presented in the Annual Monitoring Report - Year 13 Groundwater Pump and Treatment System (Frey Engineering, 2014)

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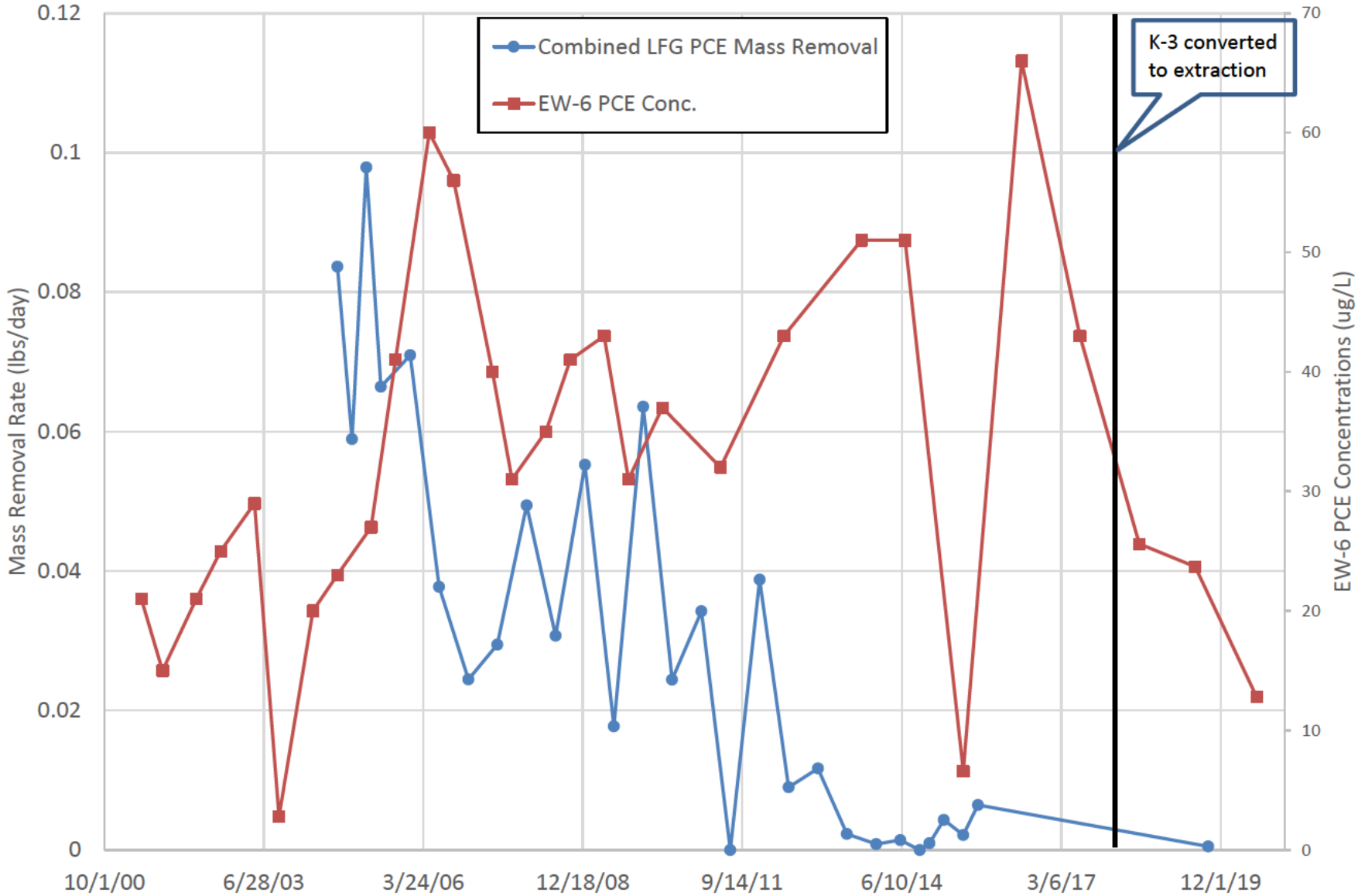
8/12/2021 RR
Source HGL Golder Associates 2016 ArcGIS Online Imagery

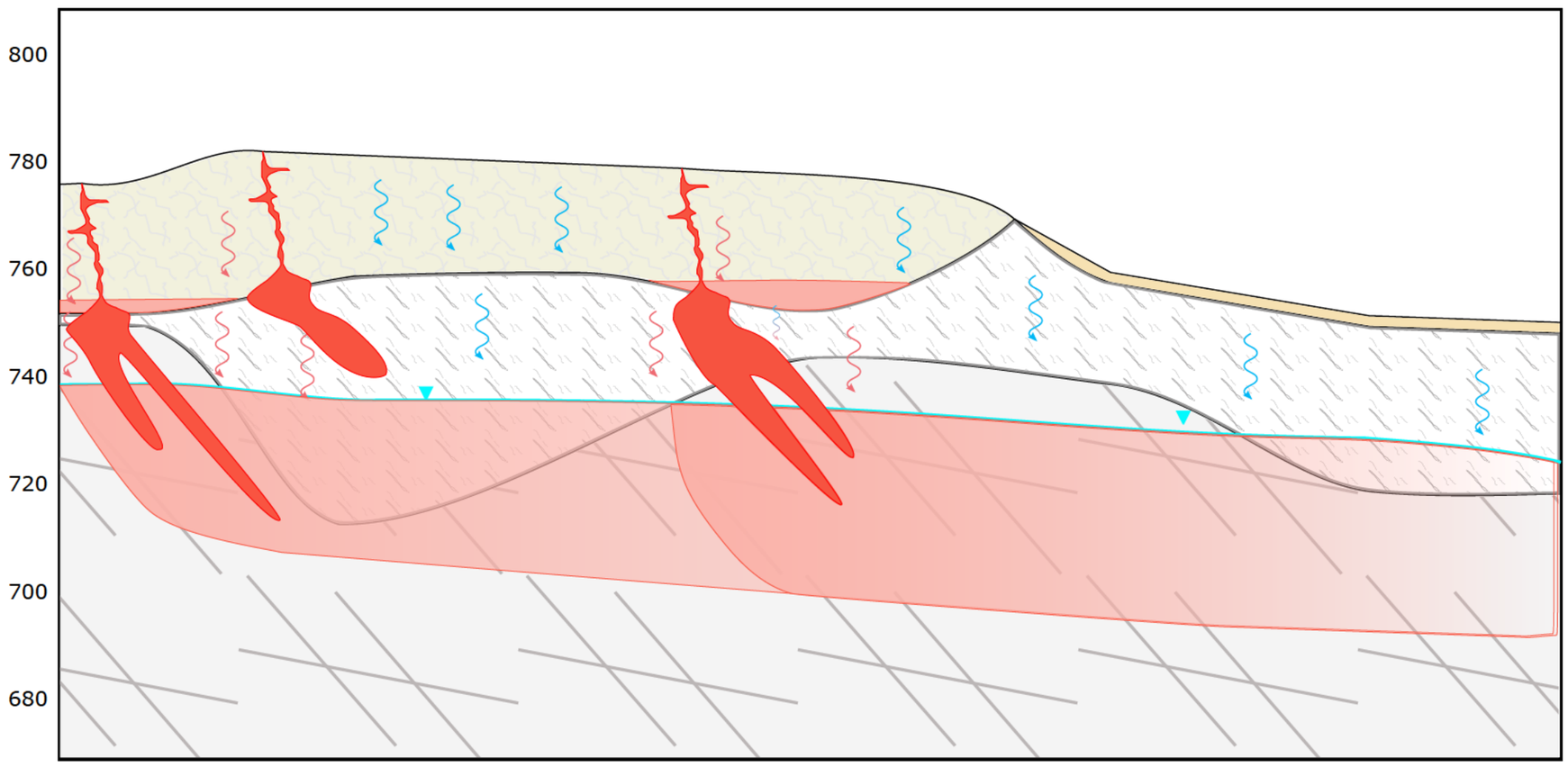
HGL HydroGeoLogic, Inc

Figure 4.3: PCE Mass Removal (LFG-9, LFG-11, LFG-31*, LFG-32*) and EW-6 PCE Concentrations



*Concentrations used in mass removal are from co-located GMP-17 and GMP-22, respectively.

Figure 4.4
CVOC Conceptual Cross-Section
Prior to Landfill Closure



Legend

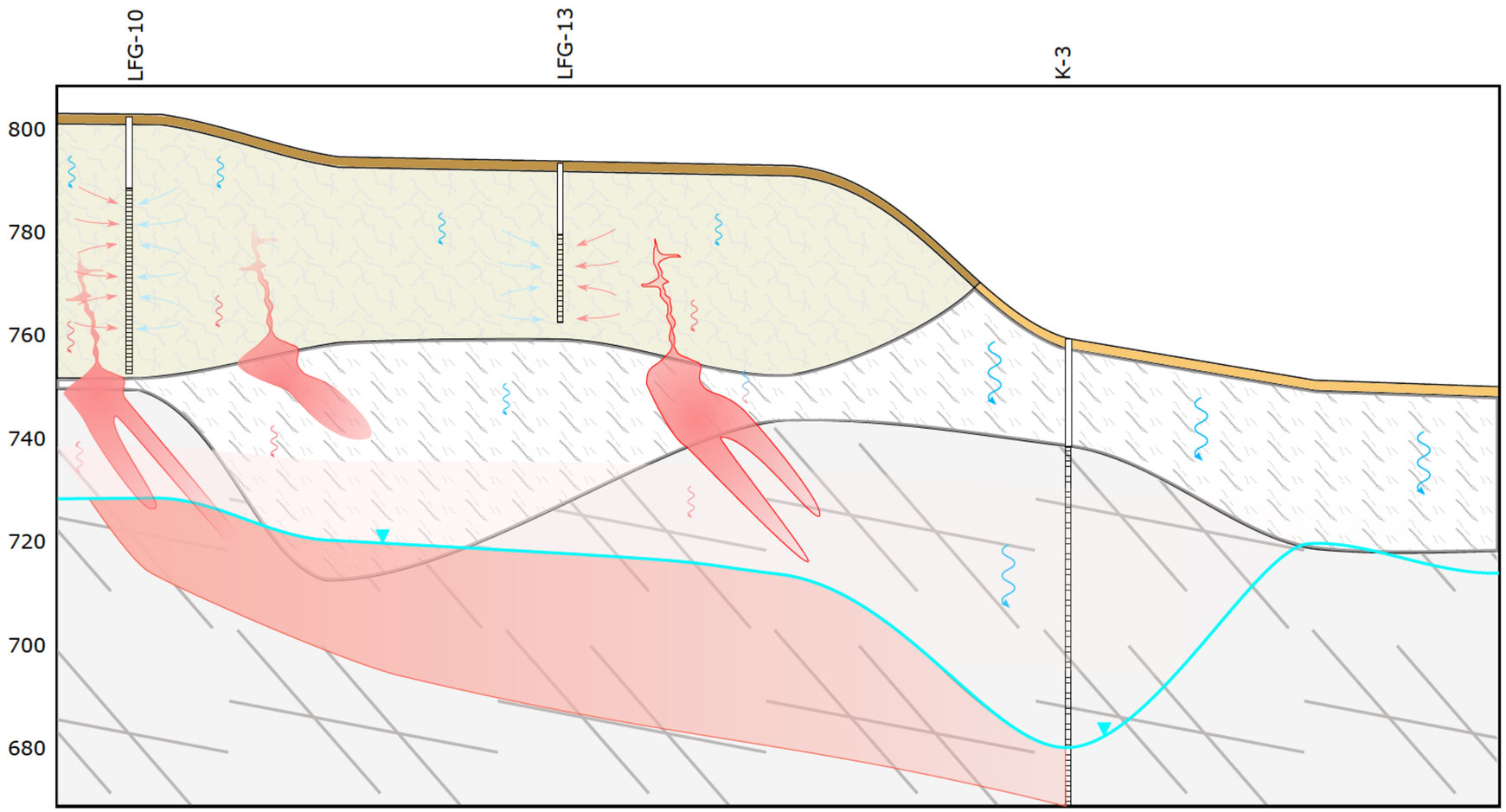
- Waste
- Topsoil
- Saprolite with relic bedrock fractures
- Fracture bedrock
- Original release of CVOCs
- Infiltration (red is contaminated)
- Contaminated groundwater or leachate

DURING LANDFILL OPERATION: Releases occur in multiple spots during landfilling, and CVOC mass from the original releases migrates vertically through waste that is already in place until it reaches the renovating base (not depicted) or top of the saprolite. Mass from the original releases migrates through preferential paths in the waste/saprolite interface and into the saprolite and/or bedrock until it reaches the water table. Depending on the strength and nature of the release, mass from the original release may migrate below the water table. Additionally, in the absence of a cap, precipitation infiltrates through the waste, generating contamianted leachate that pools where waste is deepest. Cotaminated leachate can further infiltrate through the saprolite and/or bedrock until it reaches the water table.

Drawing is conceptual in nature and simplified for presentation purposes. For example, groundwater contamination in fractured bedrock primarily flows through fracutres and is not as difusse as presented. Waste, saprolite, and bedrock are more heterogeneous than depicted.

HGL HydroGeoLogic, Inc

Figure 4.5.
CVOC Conceptual Cross-Section
After ASCR Implementation



AFTER ASCR IMPLEMENTATION: The landfill has been capped by low permeability soil (measured at 4.6×10^{-7} cm/sec), which reduces infiltration within the footprint of the landfill. Pools or mounds of leachate are not present. LFG and ELGE wells have been installed and are operating, and CVOC mass within the waste is removed by vapor extraction. Reducing conditions develop, and CVOCs begin to degrade by reducive dechlorination. Residual CVOC mass remains in the waste, saprolite, and bedrock from the original releases, continuing to contribute contamination to the dissolved plume. The water table has dropped due to reduced infiltration and groundwater extraction. Contamination also remains in the saprolite and bedrock where dissolved contamination was previously present, also contributing contamination to the dissolved plume.

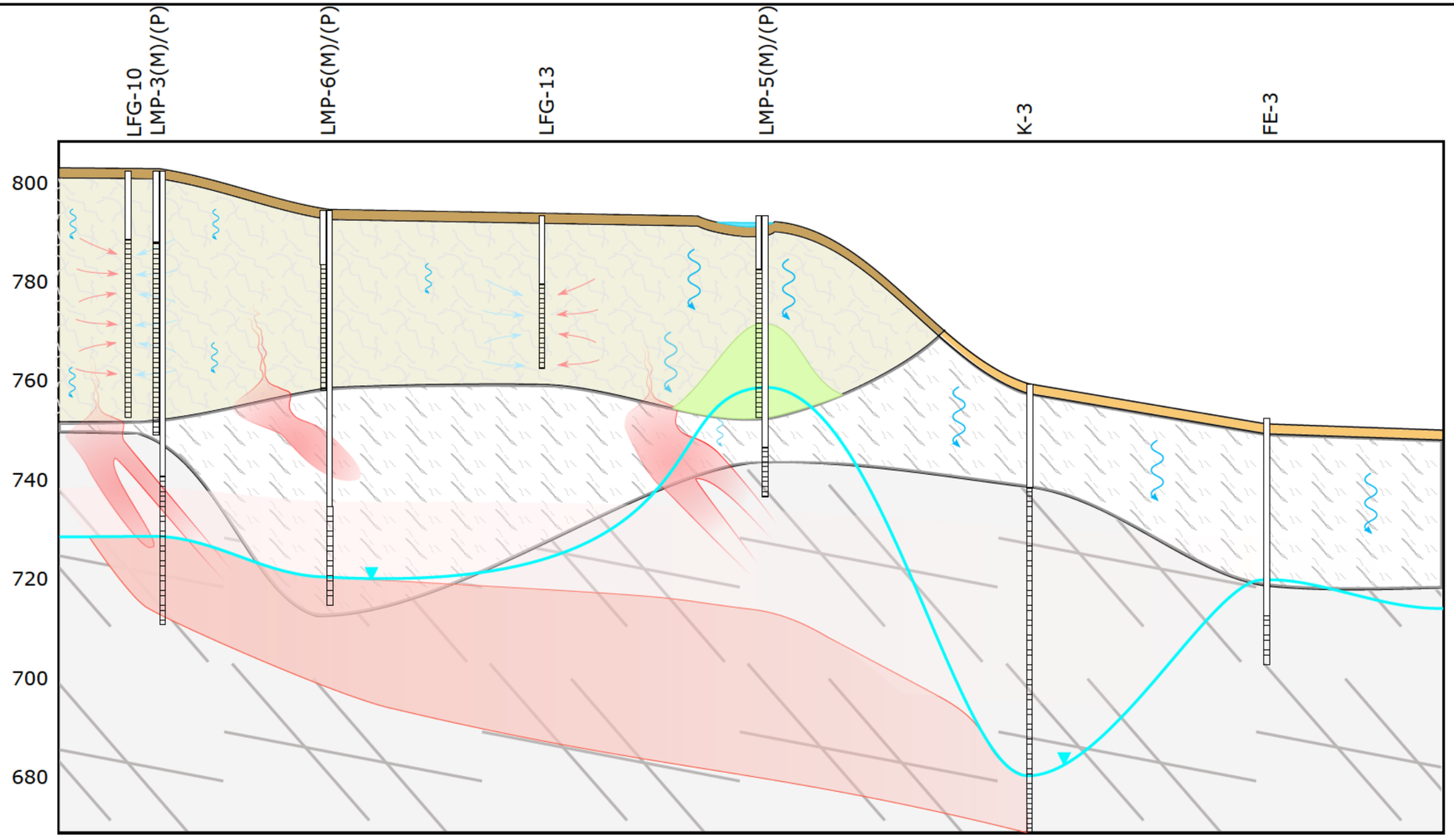
Drawing is conceptual in nature and simplified for presentation purposes. For example, groundwater contamination in fractured bedrock primarily flows through fracutres and is not as difusse as presented. Waste, saprolite, and bedrock are more heterogeneous than depicted.

Legend

- Waste
- Topsoil
- Saprolite with relic bedrock fractures
- Fracture bedrock
- Original release of CVOCs (attenuating due to gas extraction and reductive dechlorination)
- Infiltration (red is contaminated), reduced under landfill cap
- Contaminated groundwater or leachate
- Low permeability landfill cap

HGL HydroGeoLogic, Inc

Figure 4.6
CVOC Conceptual Cross-Section Current Conditions



Legend

- Waste
- Topsoil
- Saprolite with relic bedrock fractures
- Fracture bedrock
- Original release of CVOCs (attenuating due to gas extraction and reductive dechlorination)
- Infiltration (red is contaminated), reduced under landfill cap
- Contaminated groundwater or leachate
- Low permeability landfill cap
- Leachate with high organic content but below leachate performance standards for CVOCs

CURRENT CONDITIONS: The landfill cap continues to function, but depressions caused by subsidence create areas of ponding, which locally increase infiltration. Pools or mounds of leachate develop, such as that observed at LMP-5(M). The leachate is high in organic content, which fosters reductive dechlorination. CVOC concentrations in the pooled leachate are below leachate performance standards as a result of gas extraction and reductive dechlorination. LFG and ELGE continue to operate, and CVOC mass within the waste continues to be removed by vapor extraction. Residual CVOC mass remains in the waste, saprolite, and bedrock from the original releases, continuing to contribute contamination to the dissolved plume. The water table has changed under the influence of local infiltration and groundwater extraction. Contamination may also remain in the saprolite and bedrock where dissolved contamination was previously present, also potentially contributing contamination to the dissolved plume.

Drawing is conceptual in nature and simplified for presentation purposes. For example, groundwater contamination in fractured bedrock primarily flows through fracutres and is not as diffuse as presented. Waste, saprolite, and bedrock are more heterogeneous than depicted. More than one area of ponding has been observed.

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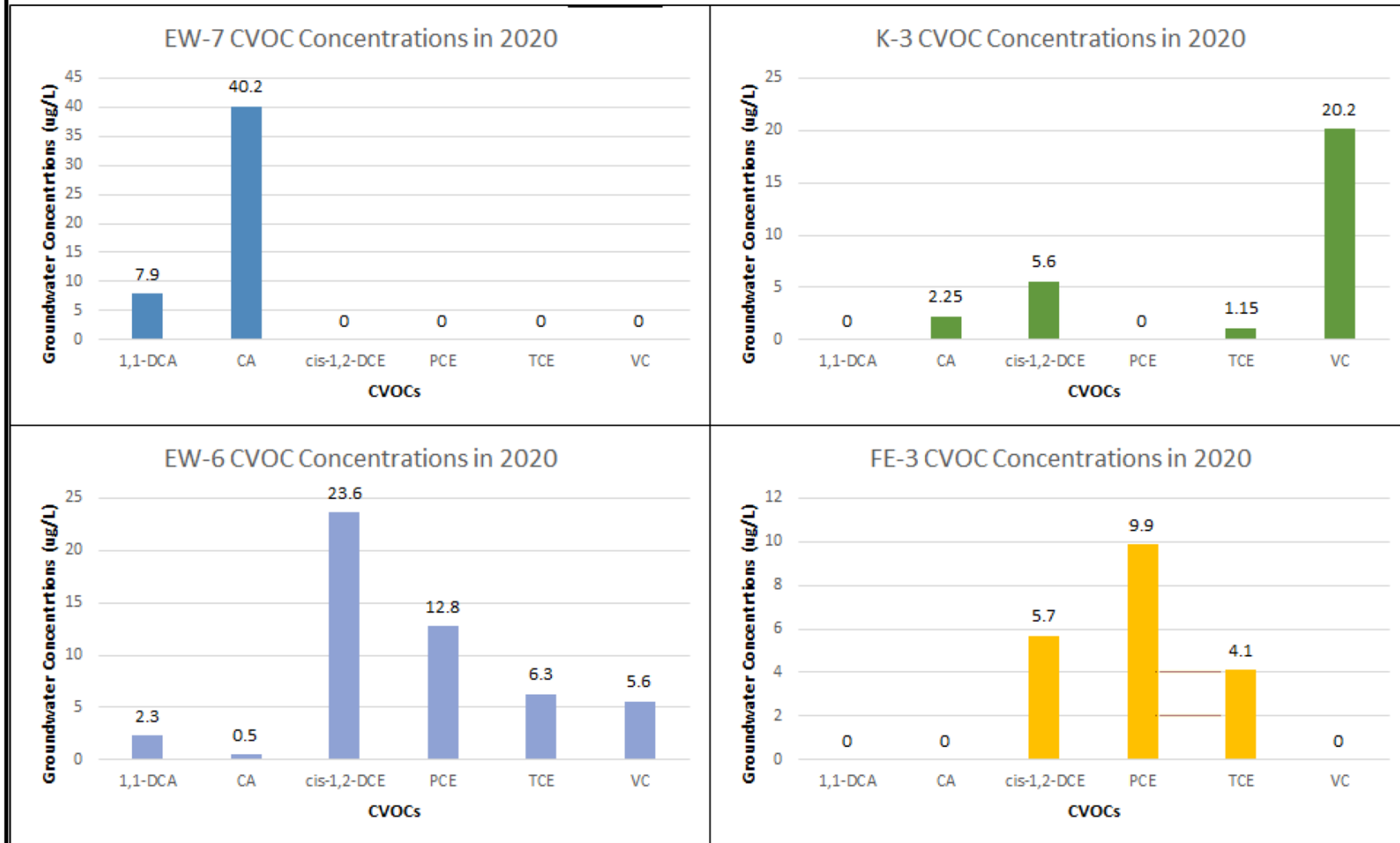
Figure 4.7
CVOC Signatures at EW-7, K-3, EW-6, and FE-3 in 2020



Parameter	Groundwater Cleanup Standard (ug/L)
1,1 Dichloroethane (1,1-DCA)	31
Chloroethane (CA)	22
cis-1,2 Dichloroethene (cis-1,2-DCE)	25
Trichloroethene (TCE)	5
Tetrachloroethene (PCE)	5
Vinyl Chloride (VC)	1

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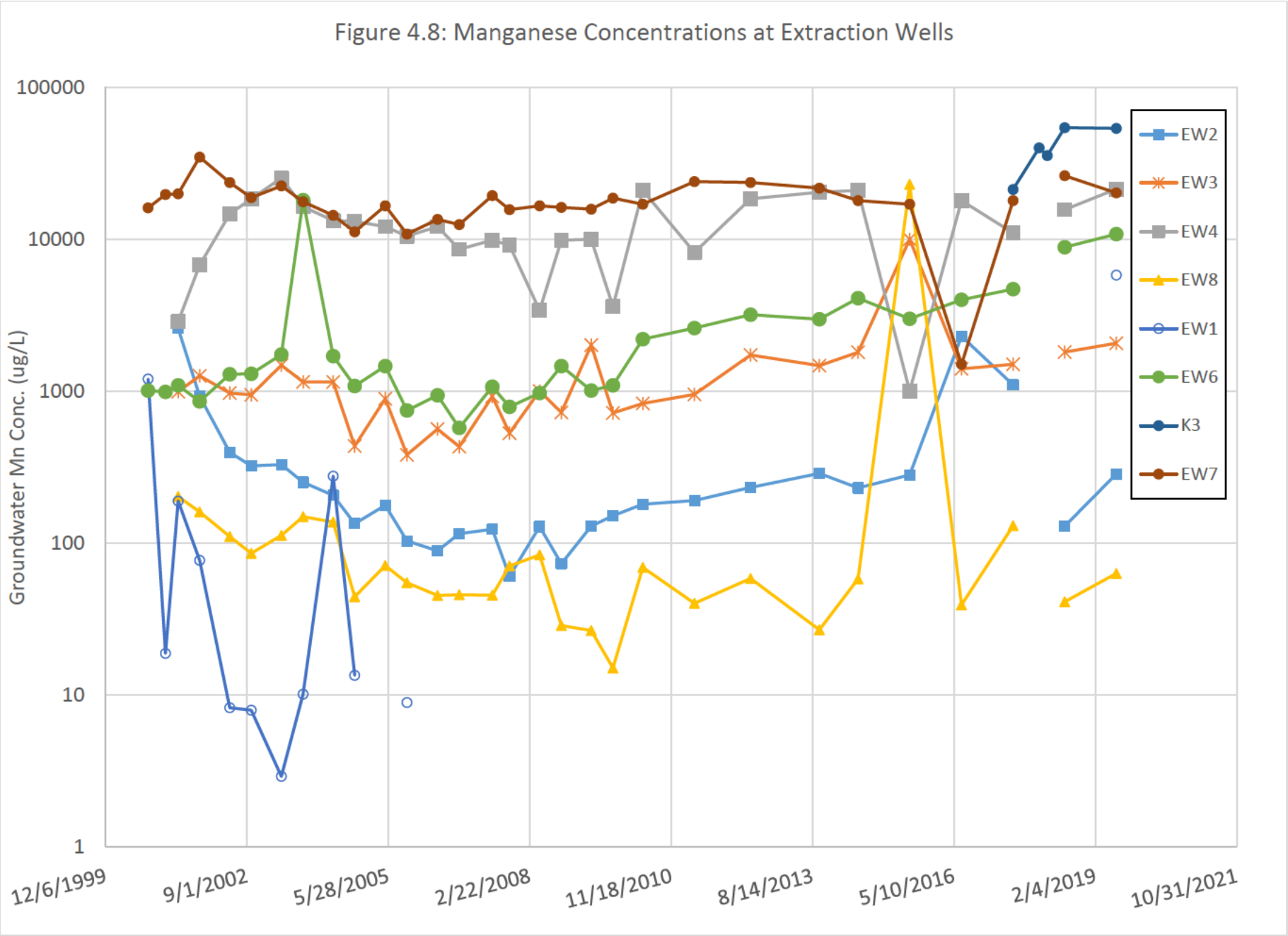
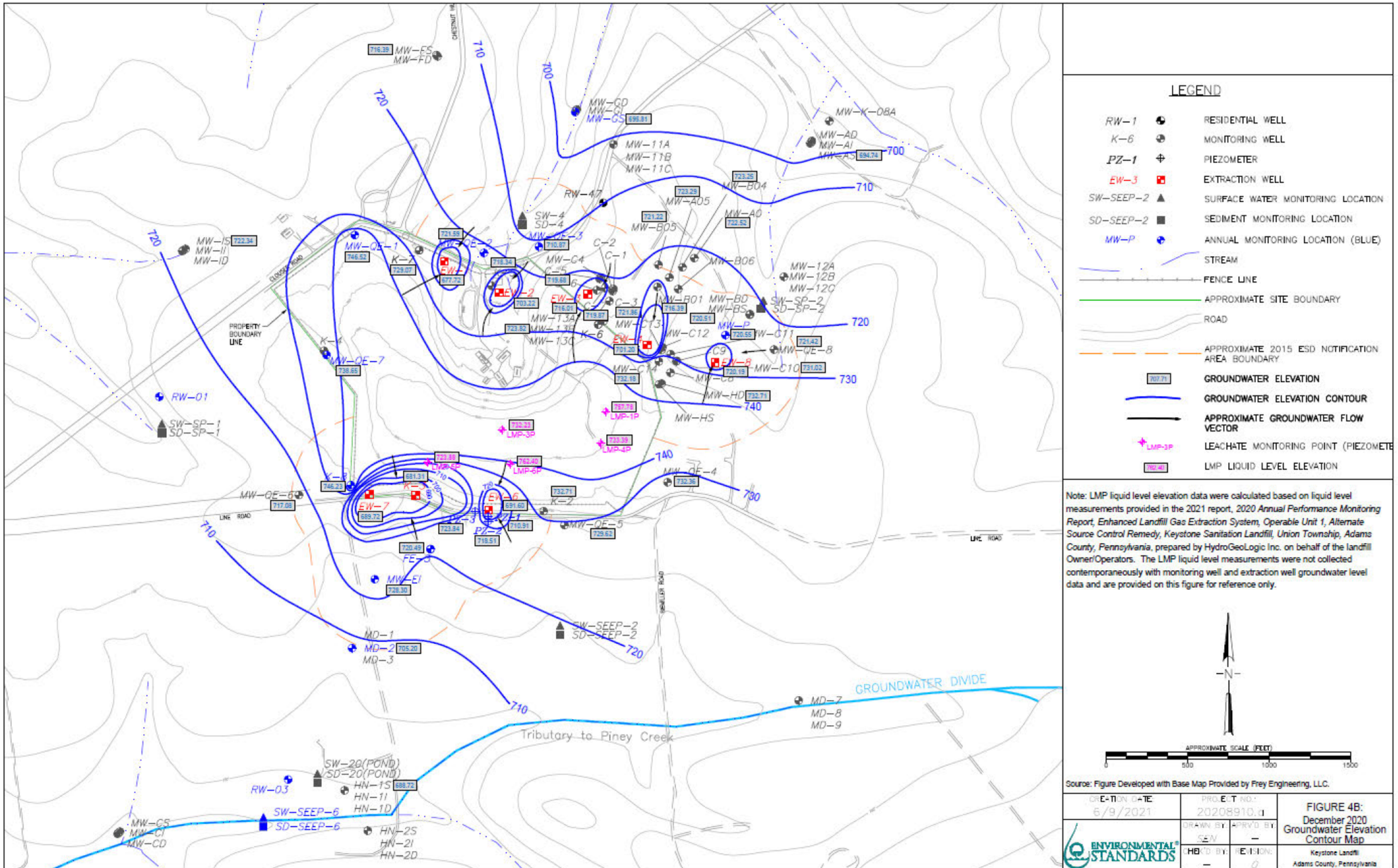


Figure 4.8: Manganese Concentrations at Extraction Wells
Groundwater Mn Conc. (ug/L)
100000
10000
1000
100
10
1
12/6/1999
9/1/2002
5/28/2005
2/22/2008
11/18/2010
8/14/2013
5/10/2016
2/4/2019
10/31/2021
EW2
EW3
EW4
EW8
EW1
EW6
K3
EW7

Figure 6.1 December 2020 Groundwater Elevation Contour Map (extracted from 2020 Annual Monitoring Report, (ESI, 2021))

HGL— Updated CSM, Keystone Sanitation Landfill Superfund Site, Union Township, Adams County, Pennsylvania



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TABLES

TABLE 3.2
2018-2020 GROUNDWATER LEVELS IN THE LMPs
KEYSTONE SANITARY LANDFILL
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

Sample ID	LMP-1(M)	LMP-1(P)	LMP-2(M)	LMP-3(M)	LMP-3(P)	LMP-4(M)	LMP-4(P)	LMP-5(M)	LMP-5(P)	LMP-6(M)	LMP-6(P)
Top of Casing Elevation (ft amsl)	807.00	806.70	803.80	806.66	806.52	800.48	800.53	796.55	796.46	798.81	798.44
Elevation of Ground Surface (ft amsl)	804.50	804.19	801.32	804.17	804.04	797.84	798.00	794.47	794.05	796.29	796.01
Bottom of Waste (ft amsl)	770.5	765.2	762.3	752.2	752.0	761.3	760.5	754.5	754.1	760.2	759.6
Depth to Bottom of Waste (ft bgs)	34.00	38.99	39.02	51.97	52.04	36.54	37.50	39.97	39.95	36.09	36.41
Screen Interval (ft bgs)	25-35	41-51	32-42	14.5-53.5	62-92	10-37	63-73	11-41	47-57	11-36.5	60-80
Bottom of Screen (ft amsl)	769.50	753.19	759.32	750.67	712.04	760.84	725	753.47	737.05	759.79	716.01
Depth to Water Measurements (ft below top of casing)											
January 2018	35.19	47.5	39.35	52.63	74.8	40.75	69.22	28.39	28.12	39.92	73.39
July 2018	35.22	50.31	39.35	53.33	67.82	dry	48.5	33.68	34.3	dry	63.02
November 2018	35.23	48.39	NM	53.75	64.97	36.61	36.14	16.65	34.1	39.5	38.14
June 2019	34.96	47.34	39.33	54.5	66.25	39.24	44.12	17.2	33.43	34.94	58.04
December 2019	34.64	48.39	39.38	53.72	70.92	38.79	59.76	18.3	20.3	39.75	66.31
June 2020	34.55	48.12	39.4	54.54	67.18	38.37	46.9	16.64	33.3	38.56	58.08
December 2020	33.74	48.92	38.83	54.05	74.29	38.26	67.14	20.31	34.06	39.2	74.56
Water Level Elevation (ft amsl)											
January 2018	771.81	759.20	764.45	754.03	731.72	759.73	731.31	768.16	768.34	758.89	725.05
July 2018	771.78	756.39	764.45	753.33	738.70	dry	752.03	762.87	762.16	dry	735.42
November 2018	771.77	758.31	NM	752.91	741.55	763.87	764.39	779.90	762.36	759.31	760.30
June 2019	772.04	759.36	764.47	752.16	740.27	761.24	756.41	779.35	763.03	763.87	740.40
December 2019	772.36	758.31	764.42	752.94	735.60	761.69	740.77	778.25	776.16	759.06	732.13
June 2020	772.45	758.58	764.40	752.12	739.34	762.11	753.63	779.91	763.16	760.25	740.36
December 2020	773.26	757.78	764.97	752.61	732.23	762.22	733.39	776.24	762.40	759.61	723.88

** leachate monitoring points were constructed with a 2-ft sump below the screen interval. Therefore, some water level elevations in the leachate monitoring points may be below the bottom of the screen.*

NM = not measured
LMP - (M) = leachate monitoring point - monitoring well
LMP - (P) = leachate monitoring point - piezometer

TABLE 3.4
LANDFILL MONITORING POINTS AND PIEZOMETERS ANALYTICAL RESULTS (2018-2020)
KEYSTONE SANITARY LANDFILL
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

Sample ID				LMP-1(M)			LMP-1(P)			LMP-2(M)			LMP-3(M)			LMP-3(P)			LMP-4(M)			LMP-4(P)			LMP-5(M)			LMP-5(M)			LMP-5(P)			LMP-6(M)			LMP-6(P)		
Sample Date				1/18/2018			1/18/2018			1/18/2018			1/18/2018			1/18/2018			1/18/2018			1/18/2018			1/17/2018			1/17/2018			1/17/2018			1/18/2018			1/18/2018		
Sample Type				Leachate			Leachate			Leachate			Leachate			Groundwater			Leachate			Groundwater			Leachate			Leachate (Dup)			Groundwater			Leachate			Groundwater		
Parameter	Leachate Performance Standards	Groundwater Performance Standards	Unit	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL
Volatile Organic Compounds																																							
1,4-Dioxane	NS	NS	ug/L	NS			NS			NS			82		6.1	4.7		1.6	NS			270		6.1	270		25	270		25	130		25	NS			6.1	U	6.1
cis-1,2-Dichloroethene	50	25	ug/L										46		6.5	ND	U	1				1.2		1	ND	U	32	ND	U	32	ND	U	32				**66**		6.5
Tetrachloroethene	15	5	ug/L										4.4		2.9	ND	U	1				ND	U	1	ND	U	14	ND	U	14	ND	U	14				**14**		2.9
Trichloroethene	20	5	ug/L										ND	U	3.7	ND	U	1				ND	U	1	ND	U	18	ND	U	18	ND	U	18				**16**		3.7
Vinyl Chloride	20	1	ug/L										ND	U	7.2	ND	U	1				ND	U	1	ND	U	36	ND	U	36	ND	U	36				**23**		7.2

Sample ID				LMP-1(M)			LMP-1(P)			LMP-2(M)			LMP-3(M)			LMP-3(P)			LMP-4(M)			LMP-4(P)			LMP-5(M)			LMP-5(M)			LMP-5(P)			LMP-6(M)			LMP-6(P)		
Sample Date				7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018			7/12/2018		
Sample Type				Leachate			Leachate			Leachate			Leachate			Groundwater			Leachate			Groundwater			Leachate			Leachate (Dup)			Groundwater			Leachate			Groundwater		
Parameter	Leachate Performance Standards	Groundwater Performance Standards	Unit	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL
Volatile Organic Compounds																																							
1,4-Dioxane	NS	NS	ug/L	NS			NS			NS			ND	U	6.1	NS			NS			NS			330		25	330		25	NS			NS			NS		
cis-1,2-Dichloroethene	50	25	ug/L										32		6.5										ND	U	32	ND	U	32									
Tetrachloroethene	15	5	ug/L										ND	U	2.9										ND	U	14	ND	U	14									
Trichloroethene	20	5	ug/L										ND	U	3.7										ND	U	18	ND	U	18									
Vinyl Chloride	20	1	ug/L										ND	U	7.2										ND	U	36	ND	U	36									

Sample ID				LMP-1(M)			LMP-1(P)			LMP-2(M)			LMP-3(M)			LMP-3(P)			LMP-4(M)			LMP-4(P)			LMP-4(P)			LMP-5(M)			LMP-5(P)			LMP-6(M)			LMP-6(P)		
Sample Date				11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018			11/30/2018		
Sample Type				Leachate			Leachate			Leachate			Leachate			Groundwater			Leachate			Leachate (Dup)			Groundwater			Leachate			Groundwater			Leachate			Groundwater		
Parameter	Leachate Performance Standards	Groundwater Performance Standards	Unit	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL
Volatile Organic Compounds																																							
1,4-Dioxane	NS	NS	ug/L	NS			NS			NS			ND	U	31	NS			54		6.1	51		6	NS			290		25	NS			83		6.1	NS		
cis-1,2-Dichloroethene	50	25	ug/L										ND	U	16				ND	U	16	ND	U	16				ND	U	32				ND	U	16			
Tetrachloroethene	15	5	ug/L										ND	U	7.2				ND	U	7.2	ND	U	7.2				ND	U	14				ND	U	7.2			
Trichloroethene	20	5	ug/L										ND	U	9.2				ND	U	9.2	ND	U	9.2				ND	U	18				ND	U	9.2			
Vinyl Chloride	20	1	ug/L										ND	U	18				ND	U	18	ND	U	18				ND	U	36				ND	U	18			

Sample ID				LMP-1(M)			LMP-1(P)			LMP-2(M)			LMP-3(M)			LMP-3(P)			LMP-4(M)			LMP-4(P)			LMP-5(M)			LMP-5(M)			LMP-5(P)			LMP-6(M)			LMP-6(P)		
Sample Date				6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019			6/13/2019		
Sample Type				Leachate			Leachate			Leachate			Leachate			Groundwater			Leachate			Groundwater			Leachate			Leachate (Dup)			Groundwater			Leachate			Groundwater		
Parameter	Leachate Performance Standards	Groundwater Performance Standards	Unit	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL
Volatile Organic Compounds																																							
1,4-Dioxane	NS	NS	ug/L	NS			NS			NS			ND	U	31	NS			NS			NS			250		25	250		25	NS			83		12	NS		
cis-1,2-Dichloroethene	50	25	ug/L										39		16										ND	U	8.1	ND	U	8.1				ND	U	3.2			
Tetrachloroethene	15	5	ug/L										ND	U	7.2										ND	U	3.6	ND	U	3.6				ND	U	1.4			
Trichloroethene	20	5	ug/L										ND	U	9.2										ND	U	4.6	ND	U	4.6				ND	U	1.8			
Vinyl Chloride	20	1	ug/L										ND	U	18										ND	U	9.0	ND	U	9.0				ND	U	3.6			

TABLE 3.4
LANDFILL MONITORING POINTS AND PIEZOMETERS ANALYTICAL RESULTS (2018-2020)
KEYSTONE SANITARY LANDFILL
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

Sample ID				LMP-1(M)			LMP-1(P)			LMP-2(M)			LMP-3(M)			LMP-3(P)			LMP-4(M)			LMP-4(P)			LMP-5(M)			LMP-5(M)			LMP-5(P)			LMP-6(M)			LMP-6(P)		
Sample Date				12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019			12/04/2019		
Sample Type				Leachate			Leachate			Leachate			Leachate			Groundwater			Leachate			Groundwater			Leachate			Leachate (Dup)			Groundwater			Leachate			Groundwater		
Parameter	Leachate Performance Standards	Groundwater Performance Standards	Unit	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL
Volatile Organic Compounds																																							
1,4-Dioxane	NS	NS	ug/L	NS			NS			NS			NS			NS			120		25	NS			380		25	380		25	NS			99		12	NS		
cis-1,2-Dichloroethene	50	25	ug/L																ND	U	8.1				ND	U	16	ND	U	16				ND	U	8.1			
Tetrachloroethene	15	5	ug/L																ND	U	3.6				ND	U	7.2	ND	U	7.2				ND	U	3.6			
Trichloroethene	20	5	ug/L																ND	U	4.6				ND	U	9.2	ND	U	9.2				ND	U	4.6			
Vinyl Chloride	20	1	ug/L																ND	U	9.0				ND	U	18	ND	U	18				ND	U	9.0			

Sample ID				LMP-1(M)			LMP-1(P)			LMP-2(M)			LMP-3(M)			LMP-3(P)			LMP-4(M)			LMP-4(P)			LMP-5(M)			LMP-5(P)			LMP-6(M)			LMP-6(M)			LMP-6(P)		
Sample Date				6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020			6/30/2020		
Sample Type				Leachate			Leachate			Leachate			Leachate			Groundwater			Leachate			Groundwater			Leachate			Groundwater			Leachate			Leachate (Dup)			Groundwater		
Parameter	Leachate Performance Standards	Groundwater Performance Standards	Unit	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL
Volatile Organic Compounds																																							
1,4-Dioxane	NS	NS	ug/L	NS			NS			NS			NS			NS			68		25	NS			210		25	NS			77		12	75		12	NS		
cis-1,2-Dichloroethene	50	25	ug/L																ND	U	8.1				ND	U	16				ND	U	8.1	ND	U	8.1			
Tetrachloroethene	15	5	ug/L																ND	U	3.6				ND	U	7.2				ND	U	3.6	ND	U	3.6			
Trichloroethene	20	5	ug/L																ND	U	4.6				ND	U	9.2				ND	U	4.6	ND	U	4.6			
Vinyl Chloride	20	1	ug/L																ND	U	9.0				ND	U	18				ND	U	9.0	ND	U	9.0			

Sample ID				LMP-1(M)			LMP-1(P)			LMP-2(M)			LMP-3(M)			LMP-3(P)			LMP-4(M)			LMP-4(P)			LMP-5(M)			LMP-5(P)			LMP-6(M)			LMP-6(M)			LMP-6(P)		
Sample Date				12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020			12/02/2020		
Sample Type				Leachate			Leachate			Leachate			Leachate			Groundwater			Leachate			Groundwater			Leachate			Groundwater			Leachate			Leachate (Dup)			Groundwater		
Parameter	Leachate Performance Standards	Groundwater Performance Standards	Unit	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL	Result	Qual	RL
Volatile Organic Compounds																																							
1,4-Dioxane	NS	NS	ug/L	250		49	NS			NS			170		12	NS			NS			NS			390		25	NS			140		12	100		12	NS		
cis-1,2-Dichloroethene	50	25	ug/L	ND	U	32							ND	U	16										ND	U	16				ND	U	16	ND	U	16			
Tetrachloroethene	15	5	ug/L	ND	U	14							ND	U	7.2										ND	U	7.2				ND	U	7.2	ND	U	7.2			
Trichloroethene	20	5	ug/L	ND	U	18							ND	U	9.2										ND	U	9.2				ND	U	9.2	ND	U	9.2			
Vinyl Chloride	20	1	ug/L	ND	U	36							ND	U	18										ND	U	18				ND	U	18	ND	U	18			

Notes:
ug/L= micrograms per liter
NS = not sampled
RL = reporting limit
ND = not detected

TABLE 5.1
SUMMARY OF LANDFILL GAS SAMPLE RESULTS (Five-Year Review 2020)
KEYSTONE SANITARY LANDFILL
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

Contaminant of Concern	2018 Proposed ELGE Standards - Equilibrium Vapor Conc. (ppmv)	GMP10		GMP15		GMP16		GMP-17		GMP18		GMP19		GMP20		GMP21	
		2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)
Trichloroethene	1.4	0.023	0.086	0.19	<0.000035	0.17	0.015	0.013	<0.000035	0.11	0.22	0.086	0.81	0.023	<0.000035	0.098	0.2
Tetrachloroethene	1.4	0.1	0.22	0.19	<0.00020	0.23	<0.00020	0.0044	<0.00020	0.072	<0.00020	0.13	0.99	0.022	<0.00020	0.068	0.63
Vinyl Chloride	890	0.18	0.24	1.5	0.014	0.57	0.093	0.15	0.0315	0.54	2.4	0.29	1	below pql	0.0056	0.12	1.1
Cis-1,2-Dichloroethene	1.7	0.51	0.24	0.71	0.001	0.28	0.0081	0.014	<0.000035	0.39	<0.000035	0.37	3.8	below pql	0.001	0.6	0.91
1,1-Dichloroethene	0.65	below pql	<0.000035	0.015	<0.000035	below pql	<0.000035	below pql	<0.000035	0.039	<0.000035	0.012	0.072	below pql	<0.000035	below pql	0.012
1,1-Dichloroethane	1.6	below pql	0.016	0.11	0.00075	0.26	0.0041	0.006	0.069	0.049	<0.00020	0.029	0.35	below pql	0.0006	below pql	0.0058
Chloroethane	2.9	0.021	0.32	0.15	0.018	below pql	0.05	0.035	0.745	0.29	<0.00050	below pql	0.33	0.014	0.0096	0.019	0.059

Contaminant of Concern	2018 Proposed ELGE Standards - Equilibrium Vapor Conc. (ppmv)	GMP22		GMP23		GMP24		GMP-25		GMP09		LFG1		LFG11		LFG12	
		2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)
Trichloroethene	1.4	0.049	0.0025	0.024	<0.000035	0.081	<0.000035	below pql	<0.000035	0.12	0.026	1.1	0.17	1	<0.000035	0.84	0.094
Tetrachloroethene	1.4	0.047	0.0018	0.11	<0.00020	0.053	<0.00020	0.022	<0.00020	0.19	0.043	0.96	0.21	1.2	0.63	5.1	0.21
Vinyl Chloride	890	0.6	0.022	0.021	0.29	0.16	<0.000035	below pql	0.0013	0.98	4.1	0.27	0.39	2.8	5.1	0.36	1.5
Cis-1,2-Dichloroethene	1.7	0.22	0.012	0.008	<0.000035	0.075	<0.000035	below pql	0.0092	0.34	0.13	3.7	0.27	2	<0.000035	0.75	0.39
1,1-Dichloroethene	0.65	below pql	<0.000035	below pql	<0.000035	0	<0.000035	below pql	<0.000035	below pql	<0.000035	0.098	0.019	0.13	<0.000035	below pql	<0.000035
1,1-Dichloroethane	1.6	0.034	<0.00020	0.075	1.1	2.1	<0.00020	below pql	0.0059	0.091	0.046	0.26	0.88	0.4	<0.00020	0.061	0.15
Chloroethane	2.9	0.2	<0.00050	0.024	<0.00050	0.69	<0.00050	below pql	0.023	0.39	<0.00050	0.22	0.18	0.81	<0.00050	0.049	0.22

TABLE 5.1
SUMMARY OF LANDFILL GAS SAMPLE RESULTS (Five-Year Review 2020)
KEYSTONE SANITARY LANDFILL
UNION TOWNSHIP, ADAMS COUNTY, PENNSYLVANIA

Contaminant of Concern	2018 Proposed ELGE Standards - Equilibrium Vapor Conc. (ppmv)	LFG13		LFG14		LFG5		LFG6R		LFG7		LFG9	
		2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)	2000 RODA Performance Requirement (ppmv)	2019 Result (ppmv)
Trichloroethene	1.4	0.037	1.95	0.073	1.7	0.17	2.7	0.076	0.0475	0.092	<0.000035	0.75	0.094
Tetrachloroethene	1.4	0.18	1.95	0.27	1.1	0.31	5.5	0.24	0.046	0.16	<0.00020	6.6	0.03
Vinyl Chloride	890	1.7	3.2	0.18	17	1.6	2.2	0.38	2.65	0.55	0.35	0.44	0.65
Cis-1,2-Dichloroethene	1.7	0.46	3.85	0.1	8.8	7.6	5.7	1.3	0.0635	0.43	<0.000035	0.34	0.61
1,1-Dichloroethene	0.65	0.044	<0.000035	below pql	0.22	0.033	0.072	0.024	<0.000035	below pql	<0.000035	below pql	<0.000035
1,1-Dichloroethane	1.6	0.22	<0.00020	0.035	0.43	0.016	0.49	0.029	0.16	0.047	<0.00020	0.32	<0.00020
Chloroethane	2.9	0.53	<0.00050	0.11	<0.00050	0.051	0.44	0.17	0.094	0.17	<0.00050	0.18	<0.00050

Notes:
Exceeds 2018 Proposed and 2000 RODA ELGE Standards
Exceeds 2000 RODA ELGE Standards
1) NA = Not available
2) ppmv = parts per million by volume
3) pql = practical quantitation limit

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APPENDIX A

HELP Model Input and Output

Brief Summary of HELP Model Input Parameters

Parameter	Value	Comments
6-inch soil cover parameters		
- Thickness	6-inches	Consistent with the cover design
- Soil Type	SL – Sandy Loam	More conservative than loam or silty loam.
18-inch low permeability layer		
- Thickness	18-inches	Consistent with cover design
- Soil Type	C – Clay (moderate)	Hydraulic conductivity of 6.8×10^{-7} cm/s, which is comparable but higher than the permeability of the clay tested at the site (4.7×10^{-7} cm/s)
Waste layer		
- Thickness	360 inches (30 feet)	Consistent with site conditions
- Type	Municipal Solid Waste (MSW) at 900 pounds per cubic yard	Reasonable representation of MSW
SCS Runoff Curve Number	69.4	Calculated by the HELP model based on a 3% slope, 300 ft runoff length, and fair grass cover. Note that much of the landfill is substantially steeper than 3%.
Fraction of Area Allowing Runoff	100%	This input parameter is inconsequential because only the percentages of infiltration, evapotranspiration, and runoff are used.
Area projected on a horizontal plane	50 acres	This input parameter is inconsequential because only the percentages of infiltration, evapotranspiration, and runoff are used.
Evaporative zone depth	6 inches	The evaporative zone depth is likely deeper, but the HELP model limits this thickness to the thickness of the top layer. This value is therefore conservative.
Remaining General Design and Evaporative Zone Data	Various	Automatically determined by the HELP model.
Station Latitude	39.72 degrees	Actual site latitude
Maximum Leaf Area Index	1	Consistent with poor grass cover. This value is conservative.
Start of Growing Season (Julian Date)	90	Consistent with the end of March or the beginning of April
End of Growing Season (Julian date)	300	Consistent with the end of October

Parameter	Value	Comments
Average wind speed	7.4 mph	Average obtained from averaging daily averages from www.wunderground.com for Littlestown, PA.
Average 1st Quarter Relative Humidity	63%	Average obtained from averaging daily averages from www.wunderground.com for Littlestown, PA.
Average 2nd Quarter Relative Humidity	63%	Average obtained from averaging daily averages from www.wunderground.com for Littlestown, PA.
Average 3rd Quarter Relative Humidity	66%	Average obtained from averaging daily averages from www.wunderground.com for Littlestown, PA.
Average 4th Quarter Relative Humidity	68%	Average obtained from averaging daily averages from www.wunderground.com for Littlestown, PA.
Remaining weather data	Input from the following weather stations: BALTIMORE WASHINGTON INTERNATIONAL AIRPORT, MD US, PHILADELPHIA INTERNATIONAL AIRPORT, PA US, ENOLA 1.7 N, PA US	

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Keystone **Simulated On:** 2/10/2022 18:26

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SL - Sandy Loam
Material Texture Number 6

Thickness	=	6	inches
Porosity	=	0.453	vol/vol
Field Capacity	=	0.19	vol/vol
Wilting Point	=	0.085	vol/vol
Initial Soil Water Content	=	0.4334	vol/vol
Effective Sat. Hyd. Conductivity	=	7.20E-04	cm/sec

Layer 2
Type 3 - Barrier Soil Liner
C (Moderate)
Material Texture Number 29

Thickness	=	18	inches
Porosity	=	0.451	vol/vol
Field Capacity	=	0.419	vol/vol
Wilting Point	=	0.332	vol/vol
Initial Soil Water Content	=	0.451	vol/vol
Effective Sat. Hyd. Conductivity	=	6.80E-07	cm/sec

Layer 3
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	360	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	69.4	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	50	acres
Evaporative Zone Depth	=	6	inches
Initial Water in Evaporative Zone	=	2.601	inches
Upper Limit of Evaporative Storage	=	2.718	inches
Lower Limit of Evaporative Storage	=	0.51	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	115.837	inches
Total Initial Water	=	115.837	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	39.72	Degrees
Maximum Leaf Area Index	=	1	
Start of Growing Season (Julian Date)	=	90	days
End of Growing Season (Julian Date)	=	300	days
Average Wind Speed	=	7.4	mph
Average 1st Quarter Relative Humidity	=	63	%
Average 2nd Quarter Relative Humidity	=	63	%
Average 3rd Quarter Relative Humidity	=	66	%
Average 4th Quarter Relative Humidity	=	68	%

Note: Evapotranspiration data was obtained for Adams County, Pennsylvania

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.69	3.816	3.054	2.768	5.516	3.602
7.408	5.382	3.93	3.528	3.108	4.424

Note: Precipitation was simulated using NOAA data for the following weather stations:
BALTIMORE WASHINGTON INTERNATIONAL AIRPORT, MD US, PHILADELPHIA INTERNA

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
35.6	40.6	45.5	55.8	64.6	74.2
79.7	77.2	71.6	60.6	47.1	39

Note: Temperature was simulated using NOAA data for the following weather stations:
BALTIMORE WASHINGTON INTERNATIONAL AIRPORT, MD US, PHILADELPHIA INTERNA
Solar radiation was simulated using NSRDB data for the following location:
Keystone

TIONAL AIRPORT, PA US, ENOLA 1.7 N, PA US

TIONAL AIRPORT, PA US, ENOLA 1.7 N, PA US

Daily Output for Year 1

Column key: Head #1: drainage from Layer 2

Title: Keystone

Simulated On: 2/10/2022 18:26

Leak #1: leakage thru Layer 2

Leak #2: leakage thru Layer 3

Day	Freezing Status* Air	Freezing Status* Soil	Rain (inches)	Runoff (inches)	ET (inches)	Evap. Zone Water (in/in)	Head #1 (inches)	Drain #1 (inches)	Leak #1 (inches)	Head #2 (inches)	Drain #2 (inches)	Leak #2 (inches)
1			0.00	0.000	0.042	0.4214	5.4762	0.0000	3.02E-02	0.0000	0.0000	3.81E-02
2			0.00	0.000	0.036	0.4104	5.2230	0.0000	2.98E-02	0.0000	0.0000	3.42E-02
3			0.00	0.000	0.038	0.3991	4.9754	0.0000	2.95E-02	0.0000	0.0000	3.01E-02
4			0.00	0.000	0.034	0.3885	4.7808	0.0000	2.93E-02	0.0000	0.0000	3.09E-02
5	*		0.00	0.000	0.000	0.3836	4.6221	0.0000	2.91E-02	0.0000	0.0000	1.67E-02
6	*		0.00	0.000	0.029	0.3739	4.4875	0.0000	2.89E-02	0.0000	0.0000	3.64E-02
7			0.00	0.000	0.036	0.3631	4.3074	0.0000	2.87E-02	0.0000	0.0000	3.53E-02
8			0.01	0.000	0.048	0.3520	4.1009	0.0000	2.84E-02	0.0000	0.0000	2.88E-02
9			0.29	0.000	0.055	0.3864	3.9117	0.0000	2.82E-02	0.0000	0.0000	2.99E-02
10			0.75	0.254	0.066	0.4530	5.2237	0.0000	2.98E-02	0.0000	0.0000	2.87E-02
11			0.00	0.000	0.039	0.4415	5.9011	0.0000	3.07E-02	0.0000	0.0000	2.73E-02
12			0.00	0.000	0.036	0.4304	5.6491	0.0000	3.04E-02	0.0000	0.0000	2.74E-02
13	*		0.00	0.000	0.032	0.4199	5.4129	0.0000	3.01E-02	0.0000	0.0000	1.98E-02
14			0.00	0.000	0.039	0.4085	5.1777	0.0000	2.98E-02	0.0000	0.0000	3.77E-02
15			0.24	0.000	0.053	0.4347	5.1321	0.0000	2.97E-02	0.0000	0.0000	3.46E-02
16			0.03	0.000	0.058	0.4250	5.5117	0.0000	3.02E-02	0.0000	0.0000	2.91E-02
17			0.02	0.000	0.047	0.4155	5.2715	0.0000	2.99E-02	0.0000	0.0000	3.00E-02
18	*		0.00	0.000	0.032	0.4053	5.0414	0.0000	2.96E-02	0.0000	0.0000	1.85E-02
19	*		0.00	0.000	0.000	0.4004	4.8765	0.0000	2.94E-02	0.0000	0.0000	3.71E-02
20	*		0.02	0.000	0.020	0.3955	4.7650	0.0000	2.93E-02	0.0000	0.0000	3.49E-02
21	*		0.00	0.000	0.035	0.3848	4.6250	0.0000	2.91E-02	0.0000	0.0000	2.91E-02
22	*		0.33	0.000	0.027	0.3833	4.4676	0.0000	2.89E-02	0.0000	0.0000	3.02E-02
23	*		1.80	0.000	0.000	0.3818	4.3591	0.0000	2.87E-02	0.0000	0.0000	1.54E-02
24	*		0.00	0.000	0.030	0.3803	4.2694	0.0000	2.86E-02	0.0000	0.0000	3.60E-02
25	*		0.00	0.000	0.025	0.3788	4.2246	0.0000	2.86E-02	0.0000	0.0000	3.56E-02
26			0.00	0.000	0.035	0.3774	4.1889	0.0000	2.85E-02	0.0000	0.0000	2.83E-02
27			0.00	0.006	0.000	0.4530	4.7706	0.0000	2.93E-02	0.0000	0.0000	3.41E-02
28	*		0.00	0.000	0.031	0.4512	5.9844	0.0000	3.08E-02	0.0000	0.0000	1.05E-02

29			0.01	0.018	0.000	0.4530	5.9861	0.0000	3.08E-02	0.0000	0.0000	3.67E-02
30	*		0.00	0.012	0.033	0.4492	5.9675	0.0000	3.08E-02	0.0000	0.0000	3.38E-02
31			0.00	0.318	0.000	0.4530	5.9783	0.0000	3.08E-02	0.0000	0.0000	2.99E-02
32			0.17	1.050	0.000	0.4512	5.9844	0.0000	3.08E-02	0.0000	0.0000	3.09E-02
33			0.00	0.000	0.059	0.4362	5.8313	0.0000	3.06E-02	0.0000	0.0000	2.09E-02
34			0.57	0.383	0.056	0.4530	5.9065	0.0000	3.07E-02	0.0000	0.0000	3.83E-02
35			0.02	0.014	0.076	0.4362	5.8578	0.0000	3.07E-02	0.0000	0.0000	3.38E-02
36			0.12	0.000	0.065	0.4404	5.6281	0.0000	3.04E-02	0.0000	0.0000	3.02E-02
37			0.00	0.000	0.052	0.4266	5.5876	0.0000	3.03E-02	0.0000	0.0000	3.12E-02
38			0.00	0.000	0.052	0.4129	5.2988	0.0000	2.99E-02	0.0000	0.0000	1.96E-02
39			0.04	0.000	0.067	0.4034	4.9848	0.0000	2.95E-02	0.0000	0.0000	3.76E-02
40			0.35	0.000	0.052	0.4482	5.1442	0.0000	2.97E-02	0.0000	0.0000	3.48E-02
41			0.00	0.000	0.045	0.4356	5.7851	0.0000	3.06E-02	0.0000	0.0000	2.85E-02
42	*		0.00	0.000	0.038	0.4242	5.5203	0.0000	3.02E-02	0.0000	0.0000	2.97E-02
43	*		0.00	0.000	0.000	0.4192	5.3231	0.0000	3.00E-02	0.0000	0.0000	1.94E-02
44	*		0.00	0.000	0.000	0.4142	5.2093	0.0000	2.98E-02	0.0000	0.0000	3.75E-02
45	*		0.00	0.000	0.000	0.4093	5.0812	0.0000	2.97E-02	0.0000	0.0000	3.45E-02
46	*	*	0.38	0.000	0.028	0.4050	1.9570	0.0000	2.56E-02	0.0000	0.0000	3.09E-02
47		*	0.77	0.809	0.000	0.4530	2.1596	0.0000	2.59E-02	0.0000	0.0000	7.93E-03
48		*	0.00	0.000	0.000	0.4487	2.2106	0.0000	2.60E-02	0.0000	0.0000	3.85E-02
49		*	0.00	0.000	0.000	0.4446	0.8666	0.0000	2.42E-02	0.0000	0.0000	2.64E-02
50	*	*	0.00	0.000	0.000	0.4406	0.7746	0.0000	2.41E-02	0.0000	0.0000	1.22E-02
51		*	0.00	0.000	0.000	0.4366	0.6831	0.0000	2.40E-02	0.0000	0.0000	3.64E-02
52		*	0.06	0.047	0.006	0.4338	0.6023	0.0000	2.39E-02	0.0000	0.0000	2.85E-02
53		*	0.00	0.000	0.000	0.4299	0.5288	0.0000	2.38E-02	0.0000	0.0000	7.50E-03
54		*	0.60	0.578	0.006	0.4286	0.4611	0.0000	2.37E-02	0.0000	0.0000	4.30E-02
55		*	2.61	2.586	0.006	0.4276	0.4345	0.0000	2.37E-02	0.0000	0.0000	2.15E-02
56		*	0.01	0.001	0.005	0.4243	0.3928	0.0000	2.36E-02	0.0000	0.0000	2.30E-02
57		*	0.00	0.000	0.000	0.4204	0.3123	0.0000	2.35E-02	0.0000	0.0000	1.35E-02
58		*	0.00	0.000	0.000	0.4165	0.2230	0.0000	2.34E-02	0.0000	0.0000	2.46E-02
59		*	0.00	0.000	0.000	0.4126	0.1342	0.0000	2.33E-02	0.0000	0.0000	1.63E-02
60			0.00	0.000	0.116	0.3886	3.7265	0.0000	2.79E-02	0.0000	0.0000	4.44E-02
61			0.00	0.000	0.093	0.3682	4.6942	0.0000	2.92E-02	0.0000	0.0000	6.56E-03
62			0.28	0.000	0.093	0.3946	4.3617	0.0000	2.87E-02	0.0000	0.0000	3.99E-02
63			0.09	0.000	0.074	0.3925	4.5256	0.0000	2.89E-02	0.0000	0.0000	3.53E-02
64			0.07	0.000	0.059	0.3895	4.4496	0.0000	2.88E-02	0.0000	0.0000	2.85E-02

65	0.00	0.000	0.060	0.3746	4.3865	0.0000	2.88E-02	0.0000	0.0000	2.97E-02
66	0.00	0.000	0.079	0.3567	4.1431	0.0000	2.85E-02	0.0000	0.0000	1.50E-02
67	0.00	0.000	0.096	0.3360	3.8843	0.0000	2.81E-02	0.0000	0.0000	3.57E-02
68	0.00	0.000	0.126	0.3103	3.6439	0.0000	2.78E-02	0.0000	0.0000	3.60E-02
69	0.00	0.000	0.141	0.2823	3.2637	0.0000	2.73E-02	0.0000	0.0000	2.52E-02
70	0.00	0.000	0.137	0.2550	2.8492	0.0000	2.68E-02	0.0000	0.0000	2.82E-02
71	0.00	0.000	0.155	0.2248	2.4223	0.0000	2.62E-02	0.0000	0.0000	7.71E-03
72	0.00	0.000	0.082	0.2069	1.9457	0.0000	2.56E-02	0.0000	0.0000	3.95E-02
73	0.55	0.000	0.080	0.2811	1.8220	0.0000	2.55E-02	0.0000	0.0000	2.62E-02
74	0.56	0.000	0.073	0.3579	2.1037	0.0000	2.58E-02	0.0000	0.0000	1.22E-02
75	0.01	0.000	0.093	0.3395	3.5748	0.0000	2.77E-02	0.0000	0.0000	3.81E-02
76	0.00	0.000	0.119	0.3150	3.5362	0.0000	2.77E-02	0.0000	0.0000	3.62E-02
77	0.00	0.000	0.104	0.2932	3.2993	0.0000	2.74E-02	0.0000	0.0000	1.55E-02
78	0.00	0.000	0.118	0.2690	3.0076	0.0000	2.70E-02	0.0000	0.0000	3.38E-02
79	0.22	0.000	0.069	0.2897	2.8089	0.0000	2.67E-02	0.0000	0.0000	2.22E-02
80	0.00	0.000	0.063	0.2748	2.6644	0.0000	2.66E-02	0.0000	0.0000	2.24E-02
81	0.00	0.000	0.103	0.2533	2.4901	0.0000	2.63E-02	0.0000	0.0000	3.24E-02
82	0.00	0.000	0.105	0.2314	2.2757	0.0000	2.61E-02	0.0000	0.0000	2.65E-02
83	0.00	0.000	0.133	0.2049	2.0014	0.0000	2.57E-02	0.0000	0.0000	2.05E-02
84	0.00	0.000	0.155	0.1749	1.6467	0.0000	2.52E-02	0.0000	0.0000	3.33E-02
85	0.01	0.000	0.154	0.1468	1.0651	0.0000	2.45E-02	0.0000	0.0000	2.69E-02
86	0.00	0.000	0.134	0.1205	0.7271	0.0000	2.41E-02	0.0000	0.0000	1.62E-02
87	0.03	0.000	0.095	0.1059	0.2606	0.0000	2.35E-02	0.0000	0.0000	3.49E-02
88	0.28	0.000	0.134	0.1302	0.0024	0.0000	0.00E+00	0.0000	0.0000	1.31E-03
89	0.00	0.000	0.132	0.1081	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
90	0.00	0.000	0.063	0.0975	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
91	0.00	0.000	0.053	0.0886	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
92	0.02	0.000	0.027	0.0874	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
93	0.12	0.000	0.026	0.1031	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
94	0.00	0.000	0.017	0.1002	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
95	0.13	0.000	0.029	0.1170	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
96	0.00	0.000	0.026	0.1126	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
97	0.00	0.000	0.022	0.1088	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
98	0.45	0.000	0.025	0.1796	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
99	0.00	0.000	0.110	0.1612	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
100	0.21	0.000	0.085	0.1820	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

101	0.00	0.000	0.105	0.1645	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
102	0.00	0.000	0.125	0.1438	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
103	0.05	0.000	0.184	0.1214	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
104	0.00	0.000	0.148	0.0967	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
105	0.00	0.000	0.057	0.0872	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
106	0.00	0.000	0.013	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
107	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
108	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
109	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
110	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
111	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
112	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
113	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
114	0.09	0.000	0.017	0.0972	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
115	0.00	0.000	0.012	0.0952	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
116	0.00	0.000	0.015	0.0927	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
117	0.00	0.000	0.017	0.0897	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
118	0.01	0.000	0.021	0.0879	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
119	0.14	0.000	0.020	0.1080	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
120	0.07	0.000	0.015	0.1171	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
121	0.02	0.000	0.020	0.1171	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
122	0.47	0.000	0.020	0.1921	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
123	0.57	0.000	0.025	0.2820	0.0847	0.0000	5.89E-03	0.0000	0.0000	0.00E+00
124	0.07	0.000	0.150	0.2644	1.3167	0.0000	2.48E-02	0.0000	0.0000	2.87E-02
125	0.07	0.000	0.103	0.2547	1.4609	0.0000	2.50E-02	0.0000	0.0000	6.84E-03
126	0.03	0.000	0.089	0.2407	1.4218	0.0000	2.50E-02	0.0000	0.0000	3.73E-02
127	1.11	0.000	0.100	0.4048	1.8510	0.0000	2.55E-02	0.0000	0.0000	2.70E-02
128	0.09	0.000	0.153	0.3895	4.6406	0.0000	2.91E-02	0.0000	0.0000	3.18E-02
129	0.01	0.000	0.213	0.3508	4.3233	0.0000	2.87E-02	0.0000	0.0000	2.93E-02
130	0.00	0.000	0.115	0.3269	3.9034	0.0000	2.81E-02	0.0000	0.0000	1.72E-02
131	0.13	0.000	0.116	0.3246	3.6551	0.0000	2.78E-02	0.0000	0.0000	3.28E-02
132	0.89	0.000	0.108	0.4503	3.8426	0.0000	2.81E-02	0.0000	0.0000	2.52E-02
133	0.00	0.000	0.160	0.4186	5.6773	0.0000	3.04E-02	0.0000	0.0000	3.28E-02
134	0.07	0.000	0.150	0.4003	5.0230	0.0000	2.96E-02	0.0000	0.0000	1.81E-02
135	0.12	0.000	0.168	0.3874	4.5734	0.0000	2.90E-02	0.0000	0.0000	3.71E-02
136	0.00	0.000	0.154	0.3570	4.1959	0.0000	2.85E-02	0.0000	0.0000	3.52E-02

137	0.00	0.000	0.196	0.3196	3.8154	0.0000	2.80E-02	0.0000	0.0000	2.94E-02
138	0.23	0.000	0.125	0.3325	3.5045	0.0000	2.76E-02	0.0000	0.0000	3.03E-02
139	0.00	0.000	0.108	0.3101	3.2443	0.0000	2.73E-02	0.0000	0.0000	2.89E-02
140	0.00	0.000	0.199	0.2724	2.9396	0.0000	2.69E-02	0.0000	0.0000	2.06E-02
141	0.00	0.000	0.217	0.2319	2.5464	0.0000	2.64E-02	0.0000	0.0000	1.71E-02
142	0.44	0.000	0.107	0.2830	2.0431	0.0000	2.58E-02	0.0000	0.0000	3.27E-02
143	0.18	0.000	0.121	0.2887	1.8734	0.0000	2.55E-02	0.0000	0.0000	2.69E-02
144	0.43	0.000	0.200	0.3227	1.9196	0.0000	2.56E-02	0.0000	0.0000	1.85E-02
145	0.01	0.000	0.242	0.2797	2.4197	0.0000	2.62E-02	0.0000	0.0000	3.35E-02
146	0.00	0.000	0.252	0.2333	2.2462	0.0000	2.60E-02	0.0000	0.0000	2.42E-02
147	0.00	0.000	0.243	0.1885	1.8323	0.0000	2.55E-02	0.0000	0.0000	2.02E-02
148	0.00	0.000	0.248	0.1432	1.2051	0.0000	2.47E-02	0.0000	0.0000	3.34E-02
149	0.00	0.000	0.192	0.1072	0.6196	0.0000	2.39E-02	0.0000	0.0000	2.75E-02
150	0.32	0.000	0.087	0.1450	0.0367	0.0000	5.82E-03	0.0000	0.0000	1.12E-03
151	0.00	0.000	0.065	0.1343	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
152	0.00	0.000	0.056	0.1249	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
153	0.00	0.000	0.050	0.1166	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
154	0.00	0.000	0.045	0.1090	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
155	0.02	0.000	0.046	0.1047	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
156	0.00	0.000	0.040	0.0980	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
157	0.33	0.000	0.042	0.1460	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
158	0.00	0.000	0.039	0.1395	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
159	0.04	0.000	0.042	0.1391	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
160	0.00	0.000	0.035	0.1333	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
161	0.00	0.000	0.035	0.1273	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
162	0.00	0.000	0.036	0.1214	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
163	0.00	0.000	0.035	0.1156	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
164	0.00	0.000	0.038	0.1093	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
165	0.00	0.000	0.034	0.1036	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
166	0.00	0.000	0.033	0.0981	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
167	0.18	0.000	0.033	0.1226	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
168	0.63	0.000	0.034	0.2218	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
169	0.00	0.000	0.254	0.1795	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
170	0.00	0.000	0.277	0.1332	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
171	0.00	0.000	0.184	0.1026	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
172	0.00	0.000	0.096	0.0865	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

173	1.03	0.000	0.076	0.2456	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
174	0.00	0.000	0.253	0.2004	0.3883	0.0000	1.78E-02	0.0000	0.0000	2.27E-02
175	0.40	0.000	0.212	0.2277	0.6095	0.0000	2.39E-02	0.0000	0.0000	1.38E-02
176	0.01	0.000	0.193	0.1932	0.5063	0.0000	2.38E-02	0.0000	0.0000	3.51E-02
177	0.00	0.000	0.275	0.1435	0.3893	0.0000	2.36E-02	0.0000	0.0000	9.63E-04
178	0.00	0.000	0.276	0.0955	0.1374	0.0000	1.17E-02	0.0000	0.0000	4.62E-02
179	0.00	0.000	0.063	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	2.85E-03
180	0.56	0.000	0.073	0.1661	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
181	0.00	0.000	0.219	0.1296	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
182	0.00	0.000	0.077	0.1167	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
183	0.69	0.000	0.076	0.2190	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
184	0.00	0.000	0.251	0.1773	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
185	0.00	0.000	0.203	0.1425	0.0019	0.0000	5.78E-03	0.0000	0.0000	0.00E+00
186	0.68	0.000	0.127	0.2336	0.0022	0.0000	6.73E-03	0.0000	0.0000	0.00E+00
187	0.61	0.000	0.229	0.2951	0.3779	0.0000	1.21E-02	0.0000	0.0000	0.00E+00
188	0.00	0.000	0.298	0.2413	1.5290	0.0000	2.51E-02	0.0000	0.0000	2.45E-02
189	0.00	0.000	0.252	0.1951	1.4805	0.0000	2.50E-02	0.0000	0.0000	1.62E-02
190	0.25	0.000	0.240	0.1926	1.2867	0.0000	2.48E-02	0.0000	0.0000	3.78E-02
191	0.00	0.000	0.240	0.1484	0.9794	0.0000	2.44E-02	0.0000	0.0000	2.75E-02
192	0.00	0.000	0.250	0.1037	0.5364	0.0000	1.80E-02	0.0000	0.0000	1.12E-02
193	0.00	0.000	0.110	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
194	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
195	0.47	0.000	0.065	0.1525	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
196	0.00	0.000	0.237	0.1131	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
197	0.00	0.000	0.093	0.0976	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
198	0.32	0.000	0.092	0.1356	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
199	0.00	0.000	0.219	0.0991	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
200	0.12	0.000	0.082	0.1054	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
201	0.00	0.000	0.080	0.0920	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
202	0.00	0.000	0.033	0.0865	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
203	0.00	0.000	0.007	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
204	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
205	0.08	0.000	0.018	0.0954	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
206	0.00	0.000	0.035	0.0895	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
207	0.00	0.000	0.016	0.0868	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
208	0.00	0.000	0.008	0.0854	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

209	0.00	0.000	0.002	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
210	0.65	0.000	0.056	0.1841	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
211	0.41	0.000	0.255	0.2100	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
212	1.80	0.176	0.153	0.4530	1.3976	0.0000	1.34E-02	0.0000	0.0000	2.33E-02
213	0.01	0.000	0.231	0.4111	5.6853	0.0000	3.04E-02	0.0000	0.0000	2.56E-02
214	0.06	0.000	0.205	0.3820	4.8610	0.0000	2.94E-02	0.0000	0.0000	2.68E-02
215	0.00	0.000	0.251	0.3354	4.2098	0.0000	2.85E-02	0.0000	0.0000	3.14E-02
216	0.00	0.000	0.239	0.2910	3.5427	0.0000	2.77E-02	0.0000	0.0000	1.55E-02
217	0.00	0.000	0.240	0.2465	2.8328	0.0000	2.68E-02	0.0000	0.0000	4.37E-02
218	0.00	0.000	0.153	0.2166	2.2308	0.0000	2.60E-02	0.0000	0.0000	8.13E-03
219	0.00	0.000	0.214	0.1767	1.6961	0.0000	2.53E-02	0.0000	0.0000	3.62E-02
220	0.00	0.000	0.231	0.1341	1.0109	0.0000	2.44E-02	0.0000	0.0000	2.71E-02
221	0.00	0.000	0.130	0.1085	0.5019	0.0000	2.38E-02	0.0000	0.0000	1.07E-02
222	0.00	0.000	0.085	0.0933	0.0423	0.0000	5.83E-03	0.0000	0.0000	2.36E-02
223	0.00	0.000	0.050	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	4.37E-04
224	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
225	0.32	0.000	0.058	0.1287	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
226	0.00	0.000	0.075	0.1162	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
227	0.20	0.000	0.100	0.1329	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
228	1.64	0.000	0.105	0.3878	0.0839	0.0000	5.89E-03	0.0000	0.0000	0.00E+00
229	0.00	0.000	0.225	0.3456	4.0504	0.0000	2.83E-02	0.0000	0.0000	2.72E-02
230	1.36	0.427	0.260	0.4530	4.8325	0.0000	2.93E-02	0.0000	0.0000	3.00E-02
231	0.00	0.000	0.228	0.4099	5.6450	0.0000	3.04E-02	0.0000	0.0000	1.51E-02
232	0.00	0.000	0.253	0.3628	4.7659	0.0000	2.93E-02	0.0000	0.0000	3.93E-02
233	0.00	0.000	0.249	0.3167	4.0157	0.0000	2.83E-02	0.0000	0.0000	3.57E-02
234	0.38	0.000	0.162	0.3485	3.5138	0.0000	2.76E-02	0.0000	0.0000	2.50E-02
235	0.00	0.000	0.237	0.3044	3.2139	0.0000	2.73E-02	0.0000	0.0000	1.45E-02
236	0.00	0.000	0.227	0.2622	2.8761	0.0000	2.68E-02	0.0000	0.0000	3.68E-02
237	0.00	0.000	0.220	0.2211	2.3939	0.0000	2.62E-02	0.0000	0.0000	2.50E-02
238	0.00	0.000	0.189	0.1853	1.8148	0.0000	2.55E-02	0.0000	0.0000	1.51E-02
239	0.00	0.000	0.210	0.1462	1.1873	0.0000	2.47E-02	0.0000	0.0000	3.88E-02
240	0.00	0.000	0.180	0.1122	0.6423	0.0000	2.40E-02	0.0000	0.0000	2.78E-02
241	0.00	0.000	0.103	0.0939	0.0802	0.0000	6.31E-03	0.0000	0.0000	1.36E-02
242	0.00	0.000	0.053	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
243	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
244	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

245	0.09	0.000	0.026	0.0957	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
246	0.00	0.000	0.041	0.0889	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
247	0.00	0.000	0.017	0.0860	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
248	0.00	0.000	0.005	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
249	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
250	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
251	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
252	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
253	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
254	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
255	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
256	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
257	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
258	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
259	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
260	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
261	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
262	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
263	0.64	0.000	0.040	0.1850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
264	0.00	0.000	0.032	0.1797	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
265	0.00	0.000	0.033	0.1742	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
266	0.00	0.000	0.033	0.1687	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
267	0.00	0.000	0.031	0.1636	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
268	0.00	0.000	0.028	0.1590	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
269	0.00	0.000	0.027	0.1545	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
270	0.01	0.000	0.030	0.1511	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
271	0.17	0.000	0.045	0.1720	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
272	0.82	0.000	0.040	0.3010	0.0253	0.0000	5.82E-03	0.0000	0.0000	0.00E+00
273	2.11	1.079	0.091	0.4530	4.0523	0.0000	2.83E-02	0.0000	0.0000	1.77E-02
274	0.52	0.501	0.081	0.4375	5.8689	0.0000	3.07E-02	0.0000	0.0000	2.08E-02
275	0.40	0.193	0.083	0.4530	5.8645	0.0000	3.07E-02	0.0000	0.0000	3.84E-02
276	0.01	0.002	0.089	0.4343	5.8412	0.0000	3.06E-02	0.0000	0.0000	3.39E-02
277	0.00	0.000	0.113	0.4104	5.3950	0.0000	3.01E-02	0.0000	0.0000	3.02E-02
278	0.00	0.000	0.088	0.3909	4.9369	0.0000	2.95E-02	0.0000	0.0000	3.22E-02
279	0.00	0.000	0.086	0.3717	4.6242	0.0000	2.91E-02	0.0000	0.0000	1.78E-02
280	0.00	0.000	0.096	0.3510	4.2991	0.0000	2.87E-02	0.0000	0.0000	3.65E-02

281	0.00	0.000	0.101	0.3295	3.9355	0.0000	2.82E-02	0.0000	0.0000	3.55E-02
282	0.18	0.000	0.075	0.3422	3.7076	0.0000	2.79E-02	0.0000	0.0000	2.89E-02
283	0.01	0.000	0.103	0.3221	3.5131	0.0000	2.76E-02	0.0000	0.0000	4.08E-02
284	0.00	0.000	0.088	0.3029	3.2928	0.0000	2.74E-02	0.0000	0.0000	4.49E-03
285	0.00	0.000	0.077	0.2855	3.0606	0.0000	2.71E-02	0.0000	0.0000	3.44E-02
286	0.00	0.000	0.079	0.2678	2.9005	0.0000	2.69E-02	0.0000	0.0000	2.06E-02
287	0.00	0.000	0.050	0.2550	2.7727	0.0000	2.67E-02	0.0000	0.0000	2.25E-02
288	0.00	0.000	0.080	0.2372	2.5275	0.0000	2.64E-02	0.0000	0.0000	3.23E-02
289	0.00	0.000	0.076	0.2202	2.1290	0.0000	2.59E-02	0.0000	0.0000	2.70E-02
290	0.00	0.000	0.073	0.2038	1.9073	0.0000	2.56E-02	0.0000	0.0000	2.03E-02
291	0.00	0.000	0.079	0.1864	1.7122	0.0000	2.53E-02	0.0000	0.0000	3.34E-02
292	0.00	0.000	0.093	0.1666	1.3450	0.0000	2.49E-02	0.0000	0.0000	2.62E-02
293	0.00	0.000	0.095	0.1467	0.9768	0.0000	2.44E-02	0.0000	0.0000	1.69E-02
294	0.00	0.000	0.078	0.1298	0.7930	0.0000	2.41E-02	0.0000	0.0000	3.46E-02
295	0.11	0.000	0.078	0.1311	0.5330	0.0000	2.38E-02	0.0000	0.0000	2.54E-02
296	0.00	0.000	0.050	0.1189	0.3096	0.0000	2.35E-02	0.0000	0.0000	1.29E-02
297	0.00	0.000	0.044	0.1076	0.1271	0.0000	2.33E-02	0.0000	0.0000	2.47E-02
298	0.00	0.000	0.035	0.1011	0.0079	0.0000	3.93E-03	0.0000	0.0000	2.10E-02
299	0.00	0.000	0.035	0.0952	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
300	0.00	0.000	0.034	0.0896	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
301	0.07	0.000	0.049	0.0932	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
302	0.00	0.000	0.013	0.0911	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
303	0.00	0.000	0.016	0.0883	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
304	0.00	0.000	0.015	0.0858	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
305	0.00	0.000	0.003	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
306	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
307	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
308	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
309	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
310	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
311	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
312	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
313	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
314	0.20	0.000	0.021	0.1149	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
315	0.00	0.000	0.008	0.1135	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
316	0.00	0.000	0.013	0.1114	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

317		0.00	0.000	0.013	0.1093	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
318		0.00	0.000	0.015	0.1067	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
319		0.02	0.000	0.025	0.1059	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
320		0.00	0.000	0.015	0.1035	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
321		0.00	0.000	0.015	0.1009	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
322		0.00	0.000	0.015	0.0985	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
323		0.00	0.000	0.012	0.0964	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
324		0.00	0.000	0.011	0.0945	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
325		0.00	0.000	0.009	0.0931	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
326		0.00	0.000	0.013	0.0909	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
327		0.00	0.000	0.013	0.0887	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
328		0.00	0.000	0.014	0.0864	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
329		0.00	0.000	0.006	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
330		0.00	0.000	0.002	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
331		0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
332		0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
333		0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
334		0.32	0.000	0.018	0.1353	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
335		0.97	0.000	0.024	0.2929	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
336		0.09	0.000	0.058	0.2942	1.4796	0.0000	2.50E-02	0.0000	0.0000	0.00E+00
337		0.00	0.000	0.038	0.2836	1.8558	0.0000	2.55E-02	0.0000	0.0000	3.56E-02
338		0.00	0.000	0.037	0.2732	1.8264	0.0000	2.55E-02	0.0000	0.0000	2.66E-02
339		0.06	0.000	0.047	0.2712	1.7645	0.0000	2.54E-02	0.0000	0.0000	1.16E-02
340		0.24	0.000	0.049	0.2989	1.7276	0.0000	2.54E-02	0.0000	0.0000	3.81E-02
341		0.83	0.000	0.047	0.4249	2.8306	0.0000	2.68E-02	0.0000	0.0000	2.61E-02
342		0.01	0.000	0.044	0.4143	5.2671	0.0000	2.99E-02	0.0000	0.0000	3.21E-02
343		0.00	0.000	0.032	0.4040	5.0322	0.0000	2.96E-02	0.0000	0.0000	1.55E-02
344		0.00	0.000	0.028	0.3944	4.8415	0.0000	2.94E-02	0.0000	0.0000	3.70E-02
345	*	0.00	0.000	0.026	0.3852	4.6694	0.0000	2.91E-02	0.0000	0.0000	3.49E-02
346	*	0.00	0.000	0.027	0.3759	4.5006	0.0000	2.89E-02	0.0000	0.0000	2.92E-02
347		0.17	0.000	0.047	0.3917	4.3256	0.0000	2.87E-02	0.0000	0.0000	3.02E-02
348		0.00	0.000	0.033	0.3814	4.4757	0.0000	2.89E-02	0.0000	0.0000	1.47E-02
349		0.00	0.000	0.033	0.3712	4.3176	0.0000	2.87E-02	0.0000	0.0000	3.61E-02
350	*	0.00	0.000	0.026	0.3622	4.1224	0.0000	2.84E-02	0.0000	0.0000	3.55E-02
351	*	0.00	0.000	0.000	0.3575	3.9634	0.0000	2.82E-02	0.0000	0.0000	2.86E-02
352	*	0.58	0.000	0.027	0.3561	3.8868	0.0000	2.81E-02	0.0000	0.0000	3.71E-02

353		0.02	0.000	0.000	0.4436	4.3322	0.0000	2.87E-02	0.0000	0.0000	2.04E-02
354		0.00	0.000	0.028	0.4337	5.6996	0.0000	3.05E-02	0.0000	0.0000	2.79E-02
355	*	0.00	0.000	0.025	0.4245	5.4917	0.0000	3.02E-02	0.0000	0.0000	4.43E-02
356		0.00	0.000	0.028	0.4148	5.2858	0.0000	2.99E-02	0.0000	0.0000	1.42E-02
357		0.00	0.000	0.033	0.4044	5.0500	0.0000	2.96E-02	0.0000	0.0000	2.50E-02
358		0.00	0.000	0.032	0.3942	4.8572	0.0000	2.94E-02	0.0000	0.0000	3.40E-02
359		0.46	0.031	0.046	0.4530	5.1207	0.0000	2.97E-02	0.0000	0.0000	1.69E-02
360		0.00	0.000	0.036	0.4419	5.9049	0.0000	3.07E-02	0.0000	0.0000	3.69E-02
361		0.00	0.000	0.033	0.4313	5.6631	0.0000	3.04E-02	0.0000	0.0000	3.39E-02
362		0.02	0.000	0.057	0.4201	5.4132	0.0000	3.01E-02	0.0000	0.0000	3.03E-02
363		0.00	0.000	0.039	0.4086	5.1361	0.0000	2.97E-02	0.0000	0.0000	3.15E-02
364		0.29	0.000	0.045	0.4445	5.1992	0.0000	2.98E-02	0.0000	0.0000	1.80E-02
365		0.00	0.000	0.033	0.4339	5.7296	0.0000	3.05E-02	0.0000	0.0000	3.71E-02

* = Frozen (air or soil)

Annual Totals for Year 1			
	inches	cubic feet	percent
Precipitation	40.52	7,354,380.0	100.00
Runoff	8.485	1,539,983.2	20.94
Evapotranspiration	26.500	4,809,813.2	65.40
Percolation/Leakage through Layer 2	5.531960	1,004,050.8	13.65
Average Head on Top of Layer 2	1.8710	---	---
Percolation/Leakage through Layer 3	5.539562	1,005,430.6	13.67
Change in Water Storage	-0.0047	-846.9	-0.01
Soil Water at Start of Year	115.8365	##########	285.87
Soil Water at End of Year	115.8318	##########	285.86
Snow Water at Start of Year	0.0000	0.0000	0.00
Snow Water at End of Year	0.0000	0.0000	0.00
Annual Water Budget Balance	0.0000	0.0000	0.00

Daily Output for Year 2

Column key: Head #1: drainage from Layer 2

Title: Keystone

Simulated On: 2/10/2022 18:26

Leak #1: leakage thru Layer 2

Leak #2: leakage thru Layer 3

Day	Freezing Status* Air	Freezing Status* Soil	Rain (inches)	Runoff (inches)	ET (inches)	Evap. Zone Water (in/in)	Head #1 (inches)	Drain #1 (inches)	Leak #1 (inches)	Head #2 (inches)	Drain #2 (inches)	Leak #2 (inches)
1			0.00	0.000	0.046	0.4213	5.4825	0.0000	3.02E-02	0.0000	0.0000	3.40E-02
2			0.43	0.158	0.052	0.4530	5.6812	0.0000	3.04E-02	0.0000	0.0000	3.00E-02
3			0.81	0.801	0.053	0.4406	5.8935	0.0000	3.07E-02	0.0000	0.0000	2.98E-02
4			0.01	0.000	0.054	0.4282	5.6186	0.0000	3.04E-02	0.0000	0.0000	2.03E-02
5			0.00	0.000	0.035	0.4173	5.3593	0.0000	3.00E-02	0.0000	0.0000	3.80E-02
6	*		0.01	0.000	0.042	0.4070	5.1137	0.0000	2.97E-02	0.0000	0.0000	3.44E-02
7	*		0.03	0.000	0.033	0.4016	4.9313	0.0000	2.95E-02	0.0000	0.0000	2.99E-02
8	*		0.00	0.000	0.000	0.3967	4.8223	0.0000	2.93E-02	0.0000	0.0000	3.06E-02
9	*		0.00	0.000	0.000	0.3918	4.7110	0.0000	2.92E-02	0.0000	0.0000	1.67E-02
10	*		0.04	0.000	0.033	0.3881	4.6003	0.0000	2.90E-02	0.0000	0.0000	3.65E-02
11			0.21	0.000	0.055	0.4091	4.5599	0.0000	2.90E-02	0.0000	0.0000	3.52E-02
12			0.03	0.000	0.068	0.3980	4.8500	0.0000	2.94E-02	0.0000	0.0000	2.85E-02
13			0.00	0.000	0.062	0.3827	4.6565	0.0000	2.91E-02	0.0000	0.0000	2.95E-02
14			0.26	0.000	0.048	0.4133	4.5476	0.0000	2.90E-02	0.0000	0.0000	1.61E-02
15			0.00	0.000	0.042	0.4014	4.9527	0.0000	2.95E-02	0.0000	0.0000	3.61E-02
16			0.00	0.000	0.040	0.3899	4.7922	0.0000	2.93E-02	0.0000	0.0000	3.49E-02
17			0.16	0.000	0.053	0.4030	4.5947	0.0000	2.90E-02	0.0000	0.0000	2.92E-02
18			0.00	0.000	0.053	0.3893	4.7267	0.0000	2.92E-02	0.0000	0.0000	2.98E-02
19			0.00	0.000	0.054	0.3755	4.5074	0.0000	2.89E-02	0.0000	0.0000	1.61E-02
20			0.02	0.000	0.050	0.3658	4.2882	0.0000	2.86E-02	0.0000	0.0000	3.62E-02
21			0.00	0.000	0.051	0.3526	4.0562	0.0000	2.83E-02	0.0000	0.0000	3.55E-02
22			0.07	0.000	0.061	0.3494	3.8869	0.0000	2.81E-02	0.0000	0.0000	2.87E-02
23			0.60	0.000	0.056	0.4354	4.2007	0.0000	2.85E-02	0.0000	0.0000	4.09E-02
24			0.01	0.000	0.055	0.4228	5.4983	0.0000	3.02E-02	0.0000	0.0000	4.66E-03
25			0.00	0.000	0.060	0.4078	5.2029	0.0000	2.98E-02	0.0000	0.0000	4.52E-02
26			0.00	0.000	0.056	0.3937	4.8936	0.0000	2.94E-02	0.0000	0.0000	2.60E-02
27			0.00	0.000	0.050	0.3805	4.6666	0.0000	2.91E-02	0.0000	0.0000	1.47E-02
28			0.00	0.000	0.045	0.3683	4.4505	0.0000	2.88E-02	0.0000	0.0000	3.64E-02

29		0.00	0.000	0.045	0.3560	4.2422	0.0000	2.86E-02	0.0000	0.0000	3.54E-02
30		0.00	0.000	0.044	0.3439	4.0089	0.0000	2.83E-02	0.0000	0.0000	2.88E-02
31		0.00	0.000	0.045	0.3318	3.8522	0.0000	2.81E-02	0.0000	0.0000	2.98E-02
32		0.00	0.000	0.052	0.3184	3.6865	0.0000	2.79E-02	0.0000	0.0000	4.16E-02
33		0.00	0.000	0.057	0.3044	3.5135	0.0000	2.76E-02	0.0000	0.0000	7.40E-03
34		0.00	0.000	0.042	0.2928	3.3057	0.0000	2.74E-02	0.0000	0.0000	3.58E-02
35	*	0.00	0.000	0.047	0.2804	3.0458	0.0000	2.70E-02	0.0000	0.0000	3.61E-02
36		0.00	0.000	0.047	0.2682	2.8827	0.0000	2.68E-02	0.0000	0.0000	0.00E+00
37		0.00	0.000	0.063	0.2532	2.7389	0.0000	2.66E-02	0.0000	0.0000	3.61E-02
38		0.00	0.000	0.069	0.2372	2.5018	0.0000	2.63E-02	0.0000	0.0000	2.51E-02
39		0.00	0.000	0.091	0.2177	2.1142	0.0000	2.58E-02	0.0000	0.0000	1.47E-02
40		0.24	0.000	0.062	0.2431	1.8925	0.0000	2.56E-02	0.0000	0.0000	3.91E-02
41	*	0.00	0.000	0.045	0.2314	1.7785	0.0000	2.54E-02	0.0000	0.0000	2.63E-02
42		0.00	0.000	0.065	0.2164	1.6646	0.0000	2.53E-02	0.0000	0.0000	1.21E-02
43		0.22	0.000	0.062	0.2386	1.5483	0.0000	2.51E-02	0.0000	0.0000	3.80E-02
44		0.00	0.000	0.068	0.2230	1.4330	0.0000	2.50E-02	0.0000	0.0000	2.70E-02
45		0.00	0.000	0.055	0.2098	1.3172	0.0000	2.48E-02	0.0000	0.0000	1.07E-02
46		0.00	0.000	0.053	0.1968	1.2049	0.0000	2.47E-02	0.0000	0.0000	3.74E-02
47		0.00	0.000	0.055	0.1836	1.0260	0.0000	2.44E-02	0.0000	0.0000	2.76E-02
48		0.00	0.000	0.061	0.1694	0.9432	0.0000	2.43E-02	0.0000	0.0000	9.38E-03
49		0.00	0.000	0.071	0.1536	0.8769	0.0000	2.43E-02	0.0000	0.0000	3.66E-02
50		0.00	0.000	0.087	0.1351	0.8302	0.0000	2.42E-02	0.0000	0.0000	2.82E-02
51		0.00	0.000	0.096	0.1151	0.5725	0.0000	2.39E-02	0.0000	0.0000	8.29E-03
52		0.00	0.000	0.076	0.0996	0.1465	0.0000	1.75E-02	0.0000	0.0000	3.05E-02
53		0.00	0.000	0.077	0.0867	0.0000	0.0000	0.00E+00	0.0000	0.0000	1.10E-02
54		0.00	0.000	0.010	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
55		0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
56		0.75	0.000	0.036	0.2040	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
57		0.00	0.000	0.069	0.1925	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
58		0.00	0.000	0.062	0.1822	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
59		0.25	0.000	0.091	0.2088	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
60		0.02	0.000	0.095	0.1963	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
61		0.01	0.000	0.106	0.1803	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
62		0.00	0.000	0.068	0.1689	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
63	*	0.00	0.000	0.073	0.1567	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
64	*	0.00	0.000	0.072	0.1436	0.0024	0.0000	6.79E-03	0.0000	0.0000	0.00E+00

65		0.00	0.000	0.076	0.1305	0.0015	0.0000	2.91E-03	0.0000	0.0000	0.00E+00
66		0.06	0.000	0.097	0.1244	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
67		0.00	0.000	0.077	0.1116	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
68		0.00	0.000	0.055	0.1024	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
69		0.13	0.000	0.055	0.1148	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
70	*	0.00	0.000	0.044	0.1075	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
71	*	0.00	0.000	0.040	0.1009	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
72	*	0.28	0.000	0.037	0.1042	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
73		1.12	0.000	0.000	0.2921	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
74	*	0.00	0.000	0.050	0.2922	1.5553	0.0000	1.93E-02	0.0000	0.0000	0.00E+00
75	*	0.00	0.000	0.080	0.2912	2.2414	0.0000	2.60E-02	0.0000	0.0000	4.02E-02
76		0.00	0.000	0.091	0.2794	2.0789	0.0000	2.58E-02	0.0000	0.0000	2.57E-02
77		0.14	0.000	0.097	0.2822	1.9539	0.0000	2.56E-02	0.0000	0.0000	1.34E-02
78		0.27	0.000	0.098	0.3067	1.8558	0.0000	2.55E-02	0.0000	0.0000	3.86E-02
79		0.00	0.000	0.084	0.2884	1.9260	0.0000	2.56E-02	0.0000	0.0000	2.63E-02
80		0.00	0.000	0.109	0.2659	1.8943	0.0000	2.56E-02	0.0000	0.0000	1.20E-02
81		0.00	0.000	0.128	0.2403	1.8898	0.0000	2.56E-02	0.0000	0.0000	3.84E-02
82		0.00	0.000	0.100	0.2195	1.7986	0.0000	2.54E-02	0.0000	0.0000	2.64E-02
83		0.00	0.000	0.091	0.2001	1.6699	0.0000	2.53E-02	0.0000	0.0000	1.20E-02
84		0.00	0.000	0.114	0.1769	1.5032	0.0000	2.51E-02	0.0000	0.0000	3.81E-02
85		0.00	0.000	0.074	0.1604	1.1571	0.0000	2.46E-02	0.0000	0.0000	2.72E-02
86		0.04	0.000	0.109	0.1449	0.9351	0.0000	2.43E-02	0.0000	0.0000	1.04E-02
87		0.30	0.000	0.111	0.1724	0.7480	0.0000	2.41E-02	0.0000	0.0000	3.68E-02
88		0.00	0.000	0.163	0.1413	0.4356	0.0000	2.37E-02	0.0000	0.0000	2.85E-02
89		0.05	0.000	0.090	0.1308	0.1976	0.0000	2.34E-02	0.0000	0.0000	7.64E-03
90		1.40	0.000	0.070	0.3485	0.0651	0.0000	2.32E-02	0.0000	0.0000	3.15E-02
91		0.00	0.000	0.079	0.3309	3.1345	0.0000	2.72E-02	0.0000	0.0000	3.00E-02
92		0.00	0.000	0.144	0.3023	3.1952	0.0000	2.72E-02	0.0000	0.0000	1.62E-02
93		0.12	0.000	0.125	0.2969	2.9284	0.0000	2.69E-02	0.0000	0.0000	4.41E-02
94		0.01	0.000	0.143	0.2704	2.7449	0.0000	2.67E-02	0.0000	0.0000	7.07E-03
95		0.00	0.000	0.177	0.2364	2.4828	0.0000	2.63E-02	0.0000	0.0000	3.67E-02
96		1.45	0.037	0.087	0.4530	2.7441	0.0000	2.67E-02	0.0000	0.0000	2.53E-02
97		0.00	0.000	0.086	0.4336	5.8359	0.0000	3.06E-02	0.0000	0.0000	3.29E-02
98		0.00	0.000	0.145	0.4045	5.3399	0.0000	3.00E-02	0.0000	0.0000	1.71E-02
99		0.00	0.000	0.164	0.3723	4.7756	0.0000	2.93E-02	0.0000	0.0000	3.76E-02
100		0.00	0.000	0.169	0.3394	4.2271	0.0000	2.86E-02	0.0000	0.0000	3.49E-02

101	0.00	0.000	0.201	0.3013	3.6861	0.0000	2.79E-02	0.0000	0.0000	2.99E-02
102	0.00	0.000	0.184	0.2661	3.0759	0.0000	2.71E-02	0.0000	0.0000	3.11E-02
103	0.00	0.000	0.163	0.2345	2.5982	0.0000	2.65E-02	0.0000	0.0000	2.81E-02
104	0.00	0.000	0.165	0.2026	2.0316	0.0000	2.57E-02	0.0000	0.0000	2.30E-02
105	0.36	0.000	0.159	0.2318	1.7207	0.0000	2.53E-02	0.0000	0.0000	1.28E-02
106	0.00	0.000	0.192	0.1957	1.3220	0.0000	2.48E-02	0.0000	0.0000	3.38E-02
107	0.21	0.000	0.083	0.2127	1.0220	0.0000	2.44E-02	0.0000	0.0000	2.61E-02
108	0.00	0.000	0.190	0.1770	0.9242	0.0000	2.43E-02	0.0000	0.0000	1.51E-02
109	0.00	0.000	0.060	0.1629	0.8148	0.0000	2.42E-02	0.0000	0.0000	3.47E-02
110	0.43	0.000	0.056	0.2212	0.7161	0.0000	2.41E-02	0.0000	0.0000	2.49E-02
111	0.00	0.000	0.152	0.1920	0.6141	0.0000	2.39E-02	0.0000	0.0000	1.32E-02
112	0.27	0.000	0.050	0.2247	0.5098	0.0000	2.38E-02	0.0000	0.0000	3.51E-02
113	0.00	0.000	0.161	0.1940	0.4089	0.0000	2.37E-02	0.0000	0.0000	7.71E-04
114	0.12	0.000	0.108	0.1921	0.3106	0.0000	2.35E-02	0.0000	0.0000	3.84E-02
115	0.55	0.000	0.096	0.2638	0.2094	0.0000	2.34E-02	0.0000	0.0000	2.68E-02
116	0.00	0.000	0.132	0.2379	0.5956	0.0000	2.39E-02	0.0000	0.0000	1.13E-02
117	0.00	0.000	0.168	0.2059	0.6751	0.0000	2.40E-02	0.0000	0.0000	3.57E-02
118	0.00	0.000	0.238	0.1622	0.7062	0.0000	2.40E-02	0.0000	0.0000	2.85E-02
119	0.00	0.000	0.189	0.1268	0.6425	0.0000	2.40E-02	0.0000	0.0000	7.47E-03
120	0.00	0.000	0.079	0.1096	0.4074	0.0000	2.37E-02	0.0000	0.0000	3.60E-02
121	0.01	0.000	0.066	0.0984	0.0654	0.0000	1.16E-02	0.0000	0.0000	0.00E+00
122	0.00	0.000	0.053	0.0896	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
123	0.00	0.000	0.028	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
124	0.15	0.000	0.023	0.1062	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
125	1.39	0.000	0.040	0.3312	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
126	0.03	0.000	0.118	0.3122	2.5385	0.0000	2.64E-02	0.0000	0.0000	4.37E-02
127	0.00	0.000	0.133	0.2855	2.7618	0.0000	2.67E-02	0.0000	0.0000	7.99E-03
128	0.00	0.000	0.192	0.2491	2.5708	0.0000	2.64E-02	0.0000	0.0000	3.60E-02
129	0.00	0.000	0.191	0.2130	2.1774	0.0000	2.59E-02	0.0000	0.0000	2.55E-02
130	0.00	0.000	0.149	0.1839	1.7460	0.0000	2.54E-02	0.0000	0.0000	1.40E-02
131	0.56	0.000	0.095	0.2572	1.3801	0.0000	2.49E-02	0.0000	0.0000	3.85E-02
132	0.20	0.000	0.113	0.2677	1.1882	0.0000	2.47E-02	0.0000	0.0000	2.73E-02
133	0.59	0.000	0.114	0.3428	1.5266	0.0000	2.51E-02	0.0000	0.0000	9.99E-03
134	0.00	0.000	0.187	0.3072	2.8350	0.0000	2.68E-02	0.0000	0.0000	3.70E-02
135	0.00	0.000	0.229	0.2645	2.7865	0.0000	2.67E-02	0.0000	0.0000	2.48E-02
136	0.00	0.000	0.229	0.2219	2.3660	0.0000	2.62E-02	0.0000	0.0000	1.53E-02

137	0.00	0.000	0.253	0.1755	1.6976	0.0000	2.53E-02	0.0000	0.0000	3.97E-02
138	0.00	0.000	0.229	0.1333	0.9930	0.0000	2.44E-02	0.0000	0.0000	2.69E-02
139	0.36	0.000	0.253	0.1471	0.4633	0.0000	2.37E-02	0.0000	0.0000	1.11E-02
140	0.00	0.000	0.132	0.1242	0.0161	0.0000	5.80E-03	0.0000	0.0000	0.00E+00
141	0.00	0.000	0.128	0.1029	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
142	0.19	0.000	0.126	0.1136	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
143	0.04	0.000	0.075	0.1078	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
144	0.39	0.000	0.049	0.1646	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
145	1.04	0.000	0.131	0.3152	0.0513	0.0000	5.85E-03	0.0000	0.0000	2.39E-02
146	0.00	0.000	0.141	0.2874	2.1617	0.0000	2.59E-02	0.0000	0.0000	2.80E-02
147	0.02	0.000	0.136	0.2637	2.2929	0.0000	2.61E-02	0.0000	0.0000	8.14E-03
148	0.19	0.000	0.147	0.2665	2.0693	0.0000	2.58E-02	0.0000	0.0000	3.89E-02
149	0.00	0.000	0.201	0.2287	1.9030	0.0000	2.56E-02	0.0000	0.0000	2.61E-02
150	0.10	0.000	0.121	0.2210	1.7506	0.0000	2.54E-02	0.0000	0.0000	1.26E-02
151	0.38	0.000	0.244	0.2395	1.5689	0.0000	2.51E-02	0.0000	0.0000	3.83E-02
152	0.00	0.000	0.267	0.1910	1.2485	0.0000	2.47E-02	0.0000	0.0000	2.70E-02
153	0.00	0.000	0.220	0.1503	0.9363	0.0000	2.43E-02	0.0000	0.0000	1.07E-02
154	0.00	0.000	0.233	0.1074	0.5793	0.0000	2.39E-02	0.0000	0.0000	3.69E-02
155	0.00	0.000	0.135	0.0850	0.0281	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
156	0.14	0.000	0.068	0.0970	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
157	0.00	0.000	0.037	0.0908	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
158	0.00	0.000	0.030	0.0858	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
159	0.00	0.000	0.004	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
160	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
161	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
162	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
163	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
164	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
165	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
166	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
167	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
168	0.04	0.000	0.009	0.0902	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
169	0.00	0.000	0.016	0.0875	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
170	0.91	0.000	0.034	0.2334	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
171	0.00	0.000	0.269	0.1867	0.1265	0.0000	1.17E-02	0.0000	0.0000	0.00E+00
172	0.00	0.000	0.221	0.1460	0.1982	0.0000	2.34E-02	0.0000	0.0000	3.60E-02

173	0.00	0.000	0.178	0.1124	0.1477	0.0000	2.33E-02	0.0000	0.0000	1.96E-02
174	0.16	0.000	0.098	0.1208	0.0329	0.0000	1.16E-02	0.0000	0.0000	6.01E-03
175	0.15	0.000	0.085	0.1316	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
176	0.00	0.000	0.069	0.1201	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
177	0.00	0.000	0.064	0.1094	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
178	0.00	0.000	0.059	0.0996	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
179	0.00	0.000	0.052	0.0909	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
180	0.00	0.000	0.028	0.0862	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
181	0.00	0.000	0.005	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
182	0.35	0.000	0.030	0.1386	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
183	0.00	0.000	0.037	0.1324	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
184	0.00	0.000	0.046	0.1248	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
185	0.32	0.000	0.053	0.1692	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
186	0.02	0.000	0.159	0.1461	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
187	1.54	0.000	0.049	0.3935	0.1743	0.0000	6.01E-03	0.0000	0.0000	0.00E+00
188	0.23	0.000	0.263	0.3833	4.1904	0.0000	2.85E-02	0.0000	0.0000	3.71E-02
189	0.00	0.000	0.259	0.3354	3.9614	0.0000	2.82E-02	0.0000	0.0000	3.56E-02
190	0.00	0.000	0.286	0.2832	3.4158	0.0000	2.75E-02	0.0000	0.0000	2.88E-02
191	0.01	0.000	0.239	0.2406	2.7481	0.0000	2.67E-02	0.0000	0.0000	3.29E-02
192	0.00	0.000	0.227	0.1984	2.0583	0.0000	2.58E-02	0.0000	0.0000	1.27E-02
193	0.00	0.000	0.240	0.1543	1.4104	0.0000	2.49E-02	0.0000	0.0000	2.52E-02
194	0.02	0.000	0.228	0.1156	0.7173	0.0000	2.41E-02	0.0000	0.0000	1.49E-02
195	0.15	0.000	0.119	0.1177	0.1721	0.0000	1.76E-02	0.0000	0.0000	3.15E-02
196	0.00	0.000	0.096	0.1016	0.0000	0.0000	0.00E+00	0.0000	0.0000	9.31E-03
197	0.00	0.000	0.082	0.0880	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
198	0.02	0.000	0.031	0.0862	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
199	0.00	0.000	0.004	0.0855	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
200	0.00	0.000	0.002	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
201	0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
202	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
203	0.07	0.000	0.014	0.0943	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
204	0.41	0.000	0.040	0.1560	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
205	0.03	0.000	0.066	0.1500	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
206	0.00	0.000	0.053	0.1412	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
207	0.00	0.000	0.062	0.1308	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
208	0.00	0.000	0.060	0.1209	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

209	2.58	0.518	0.062	0.4530	1.2246	0.0000	7.36E-03	0.0000	0.0000	0.00E+00
210	1.36	1.175	0.155	0.4530	6.0000	0.0000	3.08E-02	0.0000	0.0000	2.84E-02
211	0.00	0.000	0.263	0.4042	5.5978	0.0000	3.03E-02	0.0000	0.0000	2.26E-02
212	0.00	0.000	0.255	0.3569	4.6704	0.0000	2.91E-02	0.0000	0.0000	3.47E-02
213	0.01	0.000	0.234	0.3149	3.9397	0.0000	2.82E-02	0.0000	0.0000	3.01E-02
214	0.68	0.000	0.234	0.3845	3.5546	0.0000	2.77E-02	0.0000	0.0000	3.14E-02
215	0.38	0.000	0.223	0.4060	4.3320	0.0000	2.87E-02	0.0000	0.0000	2.83E-02
216	0.00	0.000	0.257	0.3582	4.5987	0.0000	2.90E-02	0.0000	0.0000	2.94E-02
217	0.00	0.000	0.236	0.3141	3.9272	0.0000	2.82E-02	0.0000	0.0000	2.13E-02
218	0.00	0.000	0.187	0.2785	3.3250	0.0000	2.74E-02	0.0000	0.0000	2.50E-02
219	0.70	0.000	0.128	0.3693	2.8750	0.0000	2.68E-02	0.0000	0.0000	1.48E-02
220	0.04	0.000	0.217	0.3351	3.6906	0.0000	2.79E-02	0.0000	0.0000	4.02E-02
221	0.00	0.000	0.227	0.2927	3.4423	0.0000	2.76E-02	0.0000	0.0000	3.59E-02
222	0.00	0.000	0.217	0.2521	2.8913	0.0000	2.68E-02	0.0000	0.0000	2.40E-02
223	0.23	0.000	0.186	0.2550	2.4320	0.0000	2.63E-02	0.0000	0.0000	2.81E-02
224	0.54	0.000	0.200	0.3075	2.0174	0.0000	2.57E-02	0.0000	0.0000	8.21E-03
225	0.00	0.000	0.236	0.2639	1.9014	0.0000	2.56E-02	0.0000	0.0000	3.87E-02
226	0.00	0.000	0.158	0.2333	1.8581	0.0000	2.55E-02	0.0000	0.0000	2.63E-02
227	0.76	0.000	0.173	0.3268	1.7695	0.0000	2.54E-02	0.0000	0.0000	1.21E-02
228	0.00	0.000	0.239	0.2826	2.5814	0.0000	2.64E-02	0.0000	0.0000	3.79E-02
229	0.00	0.000	0.199	0.2450	2.4768	0.0000	2.63E-02	0.0000	0.0000	2.52E-02
230	0.44	0.000	0.199	0.2809	2.1736	0.0000	2.59E-02	0.0000	0.0000	1.44E-02
231	0.00	0.000	0.248	0.2354	1.9285	0.0000	2.56E-02	0.0000	0.0000	3.92E-02
232	0.00	0.000	0.220	0.1945	1.8016	0.0000	2.54E-02	0.0000	0.0000	2.63E-02
233	0.02	0.000	0.237	0.1543	1.2898	0.0000	2.48E-02	0.0000	0.0000	1.23E-02
234	0.00	0.000	0.249	0.1087	0.6496	0.0000	2.40E-02	0.0000	0.0000	3.78E-02
235	0.00	0.000	0.141	0.0850	0.0356	0.0000	1.83E-03	0.0000	0.0000	0.00E+00
236	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
237	0.03	0.000	0.026	0.0857	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
238	0.00	0.000	0.002	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
239	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
240	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
241	0.76	0.000	0.066	0.2007	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
242	0.00	0.000	0.172	0.1720	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
243	0.01	0.000	0.170	0.1453	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
244	0.00	0.000	0.145	0.1212	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

245	0.69	0.000	0.092	0.2209	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
246	0.01	0.000	0.142	0.1989	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
247	0.00	0.000	0.197	0.1651	0.0045	0.0000	5.79E-03	0.0000	0.0000	0.00E+00
248	0.64	0.000	0.165	0.2404	0.0226	0.0000	2.32E-02	0.0000	0.0000	3.38E-02
249	0.48	0.000	0.102	0.2995	0.6018	0.0000	2.39E-02	0.0000	0.0000	3.74E-03
250	0.00	0.000	0.177	0.2657	1.7073	0.0000	2.53E-02	0.0000	0.0000	4.05E-02
251	0.00	0.000	0.124	0.2408	1.7224	0.0000	2.53E-02	0.0000	0.0000	2.65E-02
252	0.00	0.000	0.172	0.2080	1.6799	0.0000	2.53E-02	0.0000	0.0000	1.17E-02
253	0.00	0.000	0.167	0.1759	1.4726	0.0000	2.50E-02	0.0000	0.0000	3.80E-02
254	0.00	0.000	0.156	0.1459	1.0687	0.0000	2.45E-02	0.0000	0.0000	2.72E-02
255	0.00	0.000	0.133	0.1197	0.7059	0.0000	2.40E-02	0.0000	0.0000	1.03E-02
256	0.10	0.000	0.119	0.1136	0.2352	0.0000	1.76E-02	0.0000	0.0000	3.02E-02
257	0.01	0.000	0.133	0.0931	0.0000	0.0000	0.00E+00	0.0000	0.0000	1.17E-02
258	0.00	0.000	0.043	0.0859	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
259	0.00	0.000	0.004	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
260	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
261	0.02	0.000	0.020	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
262	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
263	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
264	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
265	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
266	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
267	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
268	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
269	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
270	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
271	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
272	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
273	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
274	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
275	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
276	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
277	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
278	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
279	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
280	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

281		0.02	0.000	0.015	0.0859	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
282		0.63	0.000	0.035	0.1850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
283		0.00	0.000	0.021	0.1816	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
284		0.36	0.000	0.040	0.2350	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
285		0.30	0.000	0.071	0.2692	0.3033	0.0000	2.35E-02	0.0000	0.0000	0.00E+00
286		0.01	0.000	0.058	0.2572	0.8834	0.0000	2.43E-02	0.0000	0.0000	4.25E-02
287		0.00	0.000	0.057	0.2436	0.9618	0.0000	2.44E-02	0.0000	0.0000	2.22E-02
288		0.00	0.000	0.078	0.2264	0.9917	0.0000	2.44E-02	0.0000	0.0000	2.15E-02
289		0.10	0.000	0.109	0.2209	0.9939	0.0000	2.44E-02	0.0000	0.0000	1.61E-02
290		0.00	0.000	0.070	0.2052	0.9663	0.0000	2.44E-02	0.0000	0.0000	3.46E-02
291		0.00	0.000	0.063	0.1907	0.9033	0.0000	2.43E-02	0.0000	0.0000	2.47E-02
292		0.00	0.000	0.072	0.1746	0.8276	0.0000	2.42E-02	0.0000	0.0000	1.39E-02
293		0.00	0.000	0.078	0.1576	0.7301	0.0000	2.41E-02	0.0000	0.0000	3.49E-02
294		0.00	0.000	0.060	0.1437	0.6302	0.0000	2.39E-02	0.0000	0.0000	2.47E-02
295		0.00	0.000	0.050	0.1314	0.5325	0.0000	2.38E-02	0.0000	0.0000	1.28E-02
296		0.05	0.000	0.062	0.1254	0.4363	0.0000	2.37E-02	0.0000	0.0000	2.42E-02
297		0.08	0.000	0.059	0.1249	0.3243	0.0000	2.35E-02	0.0000	0.0000	2.59E-02
298		0.00	0.000	0.037	0.1149	0.1732	0.0000	2.34E-02	0.0000	0.0000	2.65E-02
299		0.00	0.000	0.034	0.1073	0.0258	0.0000	1.16E-02	0.0000	0.0000	1.49E-02
300		0.00	0.000	0.032	0.1020	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
301		0.00	0.000	0.027	0.0975	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
302		1.31	0.000	0.042	0.3089	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
303		0.13	0.000	0.074	0.3139	1.7962	0.0000	2.54E-02	0.0000	0.0000	1.98E-02
304		0.00	0.000	0.063	0.2990	2.4600	0.0000	2.63E-02	0.0000	0.0000	1.86E-02
305		0.00	0.000	0.046	0.2870	2.3414	0.0000	2.61E-02	0.0000	0.0000	3.28E-02
306		0.00	0.000	0.072	0.2706	2.2640	0.0000	2.60E-02	0.0000	0.0000	2.59E-02
307		0.00	0.000	0.068	0.2550	2.0746	0.0000	2.58E-02	0.0000	0.0000	2.00E-02
308		0.46	0.000	0.076	0.3147	1.9439	0.0000	2.56E-02	0.0000	0.0000	3.32E-02
309		0.22	0.000	0.064	0.3363	2.4122	0.0000	2.62E-02	0.0000	0.0000	2.51E-02
310		0.00	0.000	0.067	0.3206	2.9594	0.0000	2.69E-02	0.0000	0.0000	1.88E-02
311		1.11	0.234	0.054	0.4530	4.0909	0.0000	2.84E-02	0.0000	0.0000	4.50E-02
312		0.00	0.000	0.044	0.4406	5.8940	0.0000	3.07E-02	0.0000	0.0000	2.71E-02
313		0.04	0.000	0.054	0.4332	5.6528	0.0000	3.04E-02	0.0000	0.0000	2.86E-02
314		0.00	0.000	0.048	0.4201	5.4354	0.0000	3.01E-02	0.0000	0.0000	2.68E-02
315	*	0.00	0.000	0.036	0.4092	5.1721	0.0000	2.98E-02	0.0000	0.0000	2.95E-02
316		0.00	0.000	0.039	0.3978	4.9239	0.0000	2.95E-02	0.0000	0.0000	1.82E-02

317		0.12	0.000	0.055	0.4038	4.7273	0.0000	2.92E-02	0.0000	0.0000	3.69E-02
318		0.00	0.000	0.039	0.3924	4.6796	0.0000	2.91E-02	0.0000	0.0000	3.51E-02
319		0.00	0.000	0.045	0.3801	4.5479	0.0000	2.90E-02	0.0000	0.0000	2.88E-02
320		0.01	0.000	0.058	0.3672	4.3575	0.0000	2.87E-02	0.0000	0.0000	3.02E-02
321		0.00	0.000	0.047	0.3546	4.1971	0.0000	2.85E-02	0.0000	0.0000	1.51E-02
322		0.00	0.000	0.034	0.3442	3.9688	0.0000	2.82E-02	0.0000	0.0000	3.58E-02
323		0.16	0.000	0.061	0.3561	3.8544	0.0000	2.81E-02	0.0000	0.0000	3.59E-02
324		0.00	0.000	0.044	0.3442	3.6913	0.0000	2.79E-02	0.0000	0.0000	3.66E-02
325		0.00	0.000	0.045	0.3321	3.5316	0.0000	2.77E-02	0.0000	0.0000	0.00E+00
326		0.01	0.000	0.057	0.3196	3.3677	0.0000	2.75E-02	0.0000	0.0000	3.93E-02
327		0.00	0.000	0.037	0.3089	3.2090	0.0000	2.73E-02	0.0000	0.0000	3.63E-02
328		0.00	0.000	0.034	0.2988	3.0407	0.0000	2.70E-02	0.0000	0.0000	1.52E-02
329		0.00	0.000	0.041	0.2875	2.9123	0.0000	2.69E-02	0.0000	0.0000	3.44E-02
330		0.00	0.000	0.047	0.2752	2.7828	0.0000	2.67E-02	0.0000	0.0000	2.11E-02
331		0.00	0.000	0.045	0.2633	2.6502	0.0000	2.65E-02	0.0000	0.0000	2.20E-02
332		0.00	0.000	0.043	0.2516	2.5196	0.0000	2.64E-02	0.0000	0.0000	3.25E-02
333		0.00	0.000	0.050	0.2389	2.3885	0.0000	2.62E-02	0.0000	0.0000	2.63E-02
334		0.02	0.000	0.050	0.2295	2.2158	0.0000	2.60E-02	0.0000	0.0000	2.07E-02
335		0.00	0.000	0.046	0.2176	1.9963	0.0000	2.57E-02	0.0000	0.0000	3.30E-02
336		0.00	0.000	0.035	0.2076	1.8744	0.0000	2.55E-02	0.0000	0.0000	2.62E-02
337		0.03	0.000	0.048	0.2004	1.7650	0.0000	2.54E-02	0.0000	0.0000	1.84E-02
338		0.00	0.000	0.037	0.1901	1.6383	0.0000	2.52E-02	0.0000	0.0000	3.36E-02
339		0.14	0.000	0.052	0.2006	1.4699	0.0000	2.50E-02	0.0000	0.0000	2.56E-02
340		0.00	0.000	0.043	0.1892	1.2790	0.0000	2.48E-02	0.0000	0.0000	1.68E-02
341		0.00	0.000	0.038	0.1788	1.0927	0.0000	2.45E-02	0.0000	0.0000	3.42E-02
342		0.00	0.000	0.035	0.1689	0.9630	0.0000	2.44E-02	0.0000	0.0000	2.54E-02
343		0.25	0.000	0.041	0.1997	0.8699	0.0000	2.42E-02	0.0000	0.0000	1.44E-02
344		0.00	0.000	0.031	0.1906	0.7741	0.0000	2.41E-02	0.0000	0.0000	3.48E-02
345		0.00	0.000	0.035	0.1808	0.6786	0.0000	2.40E-02	0.0000	0.0000	2.48E-02
346		0.00	0.000	0.038	0.1705	0.5831	0.0000	2.39E-02	0.0000	0.0000	1.30E-02
347	*	0.01	0.000	0.032	0.1628	0.4886	0.0000	2.38E-02	0.0000	0.0000	3.52E-02
348		0.00	0.000	0.032	0.1536	0.3953	0.0000	2.36E-02	0.0000	0.0000	6.67E-04
349	*	0.10	0.000	0.030	0.1530	0.3032	0.0000	2.35E-02	0.0000	0.0000	4.07E-02
350	*	0.00	0.000	0.031	0.1523	0.2140	0.0000	2.34E-02	0.0000	0.0000	2.86E-02
351		0.00	0.000	0.033	0.1429	0.1240	0.0000	2.33E-02	0.0000	0.0000	7.48E-03
352		0.00	0.000	0.040	0.1335	0.0323	0.0000	1.65E-02	0.0000	0.0000	3.12E-02

353		0.00	0.000	0.045	0.1260	0.0000	0.0000	0.00E+00	0.0000	0.0000	9.24E-03
354		0.00	0.000	0.045	0.1185	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
355		0.00	0.000	0.032	0.1133	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
356		0.00	0.000	0.034	0.1075	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
357		0.35	0.000	0.055	0.1568	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
358		0.01	0.000	0.045	0.1509	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
359		0.00	0.000	0.033	0.1454	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
360	*	0.00	0.000	0.029	0.1405	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
361	*	0.00	0.000	0.028	0.1359	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
362	*	0.00	0.000	0.000	0.1359	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
363	*	0.00	0.000	0.000	0.1359	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
364	*	0.06	0.000	0.027	0.1391	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
365	*	0.00	0.000	0.013	0.1391	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

* = Frozen (air or soil)

Annual Totals for Year 2			
	inches	cubic feet	percent
Precipitation	38.28	6,947,820.0	100.00
Runoff	2.922	530,295.8	7.63
Evapotranspiration	31.035	5,632,878.7	81.07
Percolation/Leakage through Layer 2	6.091894	1,105,678.8	15.91
Average Head on Top of Layer 2	1.5247	---	---
Percolation/Leakage through Layer 3	6.113251	1,109,555.0	15.97
Change in Water Storage	-1.7901	-324,909.5	-4.68
Soil Water at Start of Year	115.8318	##########	302.59
Soil Water at End of Year	114.0417	##########	297.91
Snow Water at Start of Year	0.0000	0.0000	0.00
Snow Water at End of Year	0.0000	0.0000	0.00
Annual Water Budget Balance	0.0000	0.0000	0.00

Daily Output for Year 3

Column key: Head #1: drainage from Layer 2

Title: Keystone

Simulated On: 2/10/2022 18:26

Leak #1: leakage thru Layer 2

Leak #2: leakage thru Layer 3

Day	Freezing Status* Air	Freezing Status* Soil	Rain (inches)	Runoff (inches)	ET (inches)	Evap. Zone Water (in/in)	Head #1 (inches)	Drain #1 (inches)	Leak #1 (inches)	Head #2 (inches)	Drain #2 (inches)	Leak #2 (inches)
1	*		0.00	0.000	0.000	0.1391	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
2	*		0.00	0.000	0.000	0.1391	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
3	*		0.00	0.000	0.000	0.1391	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
4	*		0.10	0.000	0.031	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
5	*	*	0.00	0.000	0.023	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
6	*	*	0.00	0.000	0.022	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
7	*	*	0.00	0.000	0.004	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
8	*	*	0.06	0.000	0.029	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
9		*	0.00	0.000	0.031	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
10		*	0.00	0.000	0.000	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
11		*	0.00	0.000	0.000	0.1424	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
12		*	0.40	0.019	0.007	0.2048	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
13		*	0.08	0.000	0.007	0.2170	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
14	*	*	0.00	0.000	0.000	0.2170	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
15	*	*	0.00	0.000	0.000	0.2170	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
16	*	*	0.00	0.000	0.000	0.2170	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
17	*	*	0.13	0.000	0.036	0.2170	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
18	*	*	0.00	0.000	0.035	0.2170	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
19		*	0.00	0.000	0.043	0.2196	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
20		*	0.00	0.000	0.000	0.2196	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
21		*	0.00	0.000	0.000	0.2196	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
22		*	0.00	0.000	0.000	0.2196	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
23		*	0.10	0.000	0.006	0.2352	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
24		*	0.00	0.000	0.000	0.2352	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
25		*	0.00	0.000	0.000	0.2352	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
26	*	*	0.00	0.000	0.000	0.2352	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
27		*	0.00	0.000	0.000	0.2352	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
28		*	0.11	0.001	0.006	0.2522	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

29		*	0.00	0.000	0.000	0.2522	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
30		*	0.02	0.000	0.006	0.2546	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
31	*	*	0.00	0.000	0.000	0.2546	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
32		*	0.00	0.000	0.000	0.2546	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
33		*	0.04	0.000	0.006	0.2603	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
34	*	*	0.00	0.000	0.000	0.2603	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
35	*	*	1.19	0.000	0.036	0.2603	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
36		*	0.00	0.000	0.034	0.2603	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
37	*	*	0.00	0.000	0.031	0.2603	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
38		*	0.43	0.157	0.000	0.2978	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
39	*	*	0.00	0.000	0.033	0.2978	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
40	*	*	0.00	0.000	0.031	0.2978	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
41		*	0.88	1.598	0.000	0.3371	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
42		*	1.21	1.177	0.000	0.3624	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
43		*	0.04	0.003	0.005	0.3677	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
44			0.00	0.000	0.061	0.3540	3.1259	0.0000	2.14E-02	0.0000	0.0000	0.00E+00
45			0.03	0.000	0.061	0.3442	3.9559	0.0000	2.82E-02	0.0000	0.0000	3.39E-02
46			0.01	0.000	0.081	0.3278	3.8401	0.0000	2.81E-02	0.0000	0.0000	3.25E-02
47			0.21	0.000	0.079	0.3449	3.6771	0.0000	2.79E-02	0.0000	0.0000	3.51E-02
48			0.57	0.000	0.057	0.4258	3.9273	0.0000	2.82E-02	0.0000	0.0000	8.12E-03
49			0.00	0.000	0.067	0.4096	5.2633	0.0000	2.99E-02	0.0000	0.0000	4.54E-02
50			0.01	0.000	0.060	0.3964	4.9242	0.0000	2.95E-02	0.0000	0.0000	2.53E-02
51			0.00	0.000	0.100	0.3749	4.6601	0.0000	2.91E-02	0.0000	0.0000	1.49E-02
52			0.00	0.000	0.122	0.3498	4.2998	0.0000	2.87E-02	0.0000	0.0000	3.65E-02
53			0.07	0.000	0.075	0.3443	3.9314	0.0000	2.82E-02	0.0000	0.0000	3.55E-02
54			0.20	0.000	0.058	0.3634	3.7475	0.0000	2.79E-02	0.0000	0.0000	2.89E-02
55			0.07	0.000	0.061	0.3602	3.6534	0.0000	2.78E-02	0.0000	0.0000	3.97E-02
56			0.34	0.000	0.066	0.4012	3.9553	0.0000	2.82E-02	0.0000	0.0000	7.08E-03
57			0.00	0.000	0.071	0.3845	4.6401	0.0000	2.91E-02	0.0000	0.0000	3.49E-02
58			0.00	0.000	0.091	0.3645	4.3890	0.0000	2.88E-02	0.0000	0.0000	2.94E-02
59			0.00	0.000	0.085	0.3456	4.0680	0.0000	2.84E-02	0.0000	0.0000	3.06E-02
60			0.45	0.000	0.071	0.4040	3.9745	0.0000	2.82E-02	0.0000	0.0000	1.41E-02
61			0.01	0.000	0.073	0.3886	4.7379	0.0000	2.92E-02	0.0000	0.0000	4.43E-02
62			0.00	0.000	0.093	0.3683	4.5220	0.0000	2.89E-02	0.0000	0.0000	2.94E-02
63			0.00	0.000	0.096	0.3475	4.2003	0.0000	2.85E-02	0.0000	0.0000	2.91E-02
64			0.00	0.000	0.090	0.3279	3.8982	0.0000	2.81E-02	0.0000	0.0000	1.75E-02

65		0.29	0.000	0.063	0.3611	3.6945	0.0000	2.79E-02	0.0000	0.0000	2.26E-02
66		0.25	0.000	0.058	0.3885	3.7672	0.0000	2.80E-02	0.0000	0.0000	4.99E-02
67		0.00	0.000	0.079	0.3706	4.3885	0.0000	2.88E-02	0.0000	0.0000	1.22E-02
68		0.00	0.000	0.069	0.3543	4.1335	0.0000	2.84E-02	0.0000	0.0000	3.49E-02
69		0.00	0.000	0.090	0.3346	3.8872	0.0000	2.81E-02	0.0000	0.0000	3.01E-02
70		0.00	0.000	0.092	0.3145	3.6670	0.0000	2.78E-02	0.0000	0.0000	2.95E-02
71		0.03	0.000	0.062	0.3045	3.4550	0.0000	2.76E-02	0.0000	0.0000	1.36E-02
72		0.00	0.000	0.080	0.2867	3.1892	0.0000	2.72E-02	0.0000	0.0000	3.77E-02
73		0.00	0.000	0.066	0.2712	2.9049	0.0000	2.69E-02	0.0000	0.0000	2.73E-02
74		0.00	0.000	0.072	0.2548	2.7554	0.0000	2.67E-02	0.0000	0.0000	9.55E-03
75		0.00	0.000	0.091	0.2352	2.4992	0.0000	2.63E-02	0.0000	0.0000	4.00E-02
76		0.00	0.000	0.059	0.2211	2.1077	0.0000	2.58E-02	0.0000	0.0000	2.54E-02
77		0.00	0.000	0.110	0.1984	1.8944	0.0000	2.56E-02	0.0000	0.0000	1.41E-02
78		0.00	0.000	0.109	0.1761	1.5977	0.0000	2.52E-02	0.0000	0.0000	3.86E-02
79		0.60	0.000	0.057	0.2625	1.2191	0.0000	2.47E-02	0.0000	0.0000	2.70E-02
80	*	0.50	0.000	0.039	0.2617	1.0136	0.0000	2.44E-02	0.0000	0.0000	1.08E-02
81		0.00	0.000	0.043	0.3186	1.3297	0.0000	2.48E-02	0.0000	0.0000	3.67E-02
82		0.00	0.000	0.119	0.2997	2.4353	0.0000	2.63E-02	0.0000	0.0000	2.69E-02
83		0.00	0.000	0.110	0.2770	2.4031	0.0000	2.62E-02	0.0000	0.0000	1.07E-02
84		0.00	0.000	0.108	0.2547	2.2697	0.0000	2.60E-02	0.0000	0.0000	3.93E-02
85		0.00	0.000	0.114	0.2314	2.0617	0.0000	2.58E-02	0.0000	0.0000	2.57E-02
86		0.01	0.000	0.084	0.2148	1.9147	0.0000	2.56E-02	0.0000	0.0000	1.33E-02
87		0.08	0.000	0.087	0.2095	1.7918	0.0000	2.54E-02	0.0000	0.0000	3.86E-02
88		0.00	0.000	0.110	0.1869	1.6098	0.0000	2.52E-02	0.0000	0.0000	2.66E-02
89		0.03	0.000	0.102	0.1707	1.2973	0.0000	2.48E-02	0.0000	0.0000	1.17E-02
90		0.00	0.000	0.136	0.1440	0.9754	0.0000	2.44E-02	0.0000	0.0000	3.75E-02
91		0.00	0.000	0.117	0.1206	0.7073	0.0000	2.40E-02	0.0000	0.0000	2.81E-02
92		0.07	0.000	0.095	0.1125	0.2531	0.0000	2.35E-02	0.0000	0.0000	8.64E-03
93		0.02	0.000	0.089	0.1010	0.0011	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
94		0.01	0.000	0.085	0.0885	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
95		0.00	0.000	0.016	0.0858	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
96		0.00	0.000	0.004	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
97		0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
98		0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
99		0.01	0.000	0.007	0.0854	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
100		0.00	0.000	0.001	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

101	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
102	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
103	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
104	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
105	0.22	0.000	0.016	0.1190	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
106	1.32	0.000	0.029	0.3341	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
107	0.00	0.000	0.071	0.3179	2.6100	0.0000	2.65E-02	0.0000	0.0000	4.37E-02
108	0.00	0.000	0.150	0.2885	2.8664	0.0000	2.68E-02	0.0000	0.0000	8.14E-03
109	0.00	0.000	0.088	0.2693	2.6985	0.0000	2.66E-02	0.0000	0.0000	3.62E-02
110	0.00	0.000	0.155	0.2390	2.4922	0.0000	2.63E-02	0.0000	0.0000	2.52E-02
111	0.00	0.000	0.156	0.2087	2.0903	0.0000	2.58E-02	0.0000	0.0000	1.46E-02
112	0.00	0.000	0.177	0.1750	1.6550	0.0000	2.53E-02	0.0000	0.0000	3.92E-02
113	0.00	0.000	0.170	0.1426	1.0583	0.0000	2.45E-02	0.0000	0.0000	2.70E-02
114	0.47	0.000	0.113	0.1980	0.8075	0.0000	2.42E-02	0.0000	0.0000	1.09E-02
115	0.54	0.000	0.108	0.2659	0.5693	0.0000	2.39E-02	0.0000	0.0000	3.66E-02
116	0.00	0.000	0.196	0.2294	0.6346	0.0000	2.39E-02	0.0000	0.0000	2.87E-02
117	0.53	0.000	0.130	0.2920	0.8022	0.0000	2.42E-02	0.0000	0.0000	7.16E-03
118	0.01	0.000	0.171	0.2609	1.6488	0.0000	2.52E-02	0.0000	0.0000	3.59E-02
119	0.00	0.000	0.141	0.2333	1.6717	0.0000	2.53E-02	0.0000	0.0000	2.69E-02
120	0.00	0.000	0.184	0.1984	1.5993	0.0000	2.52E-02	0.0000	0.0000	1.09E-02
121	0.00	0.000	0.198	0.1613	1.3194	0.0000	2.48E-02	0.0000	0.0000	3.79E-02
122	0.00	0.000	0.234	0.1182	0.7403	0.0000	2.41E-02	0.0000	0.0000	2.76E-02
123	0.00	0.000	0.193	0.0850	0.1261	0.0000	5.90E-03	0.0000	0.0000	1.40E-02
124	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
125	0.01	0.000	0.010	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
126	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
127	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
128	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
129	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
130	0.01	0.000	0.007	0.0855	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
131	0.00	0.000	0.002	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
132	0.06	0.000	0.008	0.0939	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
133	0.43	0.000	0.025	0.1614	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
134	0.13	0.000	0.028	0.1784	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
135	1.63	0.000	0.032	0.4425	0.8768	0.0000	1.27E-02	0.0000	0.0000	0.00E+00
136	1.33	1.133	0.103	0.4530	5.9254	0.0000	3.07E-02	0.0000	0.0000	2.44E-02

137	0.78	0.776	0.121	0.4284	5.7919	0.0000	3.06E-02	0.0000	0.0000	3.32E-02
138	0.71	0.419	0.113	0.4530	5.8216	0.0000	3.06E-02	0.0000	0.0000	2.04E-02
139	0.66	0.656	0.104	0.4311	5.8149	0.0000	3.06E-02	0.0000	0.0000	3.83E-02
140	0.00	0.000	0.238	0.3865	5.1665	0.0000	2.98E-02	0.0000	0.0000	3.39E-02
141	0.00	0.000	0.256	0.3391	4.3500	0.0000	2.87E-02	0.0000	0.0000	3.13E-02
142	0.19	0.000	0.135	0.3435	3.7918	0.0000	2.80E-02	0.0000	0.0000	3.23E-02
143	0.00	0.000	0.227	0.3011	3.4734	0.0000	2.76E-02	0.0000	0.0000	1.37E-02
144	0.00	0.000	0.251	0.2549	2.9570	0.0000	2.69E-02	0.0000	0.0000	4.39E-02
145	0.00	0.000	0.265	0.2064	2.2893	0.0000	2.61E-02	0.0000	0.0000	7.69E-03
146	0.03	0.000	0.194	0.1749	1.6468	0.0000	2.52E-02	0.0000	0.0000	3.64E-02
147	1.04	0.000	0.084	0.3301	1.1587	0.0000	2.46E-02	0.0000	0.0000	2.71E-02
148	0.00	0.000	0.148	0.3011	2.4576	0.0000	2.63E-02	0.0000	0.0000	1.01E-02
149	0.00	0.000	0.173	0.2678	2.6629	0.0000	2.66E-02	0.0000	0.0000	3.85E-02
150	0.01	0.000	0.187	0.2340	2.4050	0.0000	2.62E-02	0.0000	0.0000	2.51E-02
151	1.15	0.000	0.124	0.4007	2.2321	0.0000	2.60E-02	0.0000	0.0000	1.46E-02
152	0.71	0.146	0.220	0.4530	5.1742	0.0000	2.98E-02	0.0000	0.0000	3.83E-02
153	0.28	0.276	0.199	0.4154	5.6893	0.0000	3.04E-02	0.0000	0.0000	3.46E-02
154	1.74	1.370	0.114	0.4530	5.7970	0.0000	3.06E-02	0.0000	0.0000	2.84E-02
155	0.00	0.000	0.180	0.4179	5.7099	0.0000	3.05E-02	0.0000	0.0000	3.06E-02
156	0.04	0.000	0.161	0.3927	5.0187	0.0000	2.96E-02	0.0000	0.0000	2.03E-02
157	0.00	0.000	0.177	0.3583	4.5427	0.0000	2.90E-02	0.0000	0.0000	3.72E-02
158	0.00	0.000	0.221	0.3168	3.9728	0.0000	2.82E-02	0.0000	0.0000	3.52E-02
159	0.00	0.000	0.217	0.2760	3.3417	0.0000	2.74E-02	0.0000	0.0000	2.97E-02
160	0.00	0.000	0.229	0.2334	2.6518	0.0000	2.65E-02	0.0000	0.0000	3.45E-02
161	0.82	0.000	0.116	0.3464	2.0958	0.0000	2.58E-02	0.0000	0.0000	9.17E-03
162	0.80	0.000	0.147	0.4506	3.9854	0.0000	2.83E-02	0.0000	0.0000	3.56E-02
163	0.00	0.000	0.245	0.4048	5.5674	0.0000	3.03E-02	0.0000	0.0000	2.78E-02
164	0.00	0.000	0.187	0.3688	4.7572	0.0000	2.92E-02	0.0000	0.0000	2.84E-02
165	0.00	0.000	0.297	0.3145	4.0494	0.0000	2.83E-02	0.0000	0.0000	1.75E-02
166	0.00	0.000	0.279	0.2635	3.2425	0.0000	2.73E-02	0.0000	0.0000	3.58E-02
167	0.00	0.000	0.272	0.2138	2.4361	0.0000	2.63E-02	0.0000	0.0000	2.45E-02
168	0.00	0.000	0.184	0.1790	1.7421	0.0000	2.54E-02	0.0000	0.0000	1.60E-02
169	0.00	0.000	0.088	0.1601	1.1837	0.0000	2.47E-02	0.0000	0.0000	3.88E-02
170	0.01	0.000	0.073	0.1456	0.9362	0.0000	2.43E-02	0.0000	0.0000	2.76E-02
171	0.08	0.000	0.062	0.1446	0.8051	0.0000	2.42E-02	0.0000	0.0000	9.44E-03
172	0.00	0.000	0.053	0.1317	0.6135	0.0000	2.39E-02	0.0000	0.0000	3.64E-02

173	0.11	0.000	0.047	0.1383	0.4281	0.0000	2.37E-02	0.0000	0.0000	2.87E-02
174	0.06	0.000	0.047	0.1365	0.2714	0.0000	2.35E-02	0.0000	0.0000	7.20E-03
175	0.08	0.000	0.050	0.1376	0.1099	0.0000	2.33E-02	0.0000	0.0000	3.15E-02
176	0.00	0.000	0.045	0.1298	0.0052	0.0000	1.80E-03	0.0000	0.0000	9.35E-03
177	0.00	0.000	0.044	0.1224	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
178	0.04	0.000	0.042	0.1221	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
179	0.00	0.000	0.043	0.1149	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
180	0.00	0.000	0.044	0.1076	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
181	0.00	0.000	0.043	0.1005	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
182	0.00	0.000	0.045	0.0930	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
183	0.00	0.000	0.042	0.0859	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
184	0.03	0.000	0.014	0.0886	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
185	0.00	0.000	0.004	0.0880	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
186	0.00	0.000	0.011	0.0862	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
187	0.00	0.000	0.004	0.0854	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
188	0.00	0.000	0.002	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
189	0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
190	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
191	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
192	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
193	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
194	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
195	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
196	0.02	0.000	0.008	0.0870	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
197	0.86	0.000	0.031	0.2252	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
198	3.35	1.764	0.204	0.4530	3.0000	0.0000	1.54E-02	0.0000	0.0000	0.00E+00
199	0.00	0.000	0.288	0.4000	5.5626	0.0000	3.03E-02	0.0000	0.0000	4.56E-02
200	0.00	0.000	0.286	0.3475	4.5329	0.0000	2.90E-02	0.0000	0.0000	2.49E-02
201	0.00	0.000	0.263	0.2990	3.7269	0.0000	2.79E-02	0.0000	0.0000	1.56E-02
202	4.79	3.724	0.112	0.4530	4.7457	0.0000	2.92E-02	0.0000	0.0000	4.46E-02
203	0.50	0.494	0.178	0.4192	5.7211	0.0000	3.05E-02	0.0000	0.0000	2.74E-02
204	1.42	1.008	0.178	0.4530	5.8177	0.0000	3.06E-02	0.0000	0.0000	3.71E-02
205	4.07	4.064	0.149	0.4240	5.7600	0.0000	3.05E-02	0.0000	0.0000	2.55E-02
206	0.39	0.011	0.175	0.4530	5.5532	0.0000	3.03E-02	0.0000	0.0000	2.93E-02
207	0.00	0.000	0.270	0.4030	5.5881	0.0000	3.03E-02	0.0000	0.0000	2.69E-02
208	0.97	0.423	0.217	0.4530	5.5747	0.0000	3.03E-02	0.0000	0.0000	2.86E-02

209	0.00	0.000	0.265	0.4038	5.5949	0.0000	3.03E-02	0.0000	0.0000	1.91E-02
210	0.00	0.000	0.263	0.3551	4.6506	0.0000	2.91E-02	0.0000	0.0000	3.82E-02
211	0.27	0.000	0.146	0.3711	4.0022	0.0000	2.83E-02	0.0000	0.0000	3.50E-02
212	0.06	0.000	0.140	0.3532	3.8461	0.0000	2.81E-02	0.0000	0.0000	2.99E-02
213	0.24	0.000	0.227	0.3507	3.6220	0.0000	2.78E-02	0.0000	0.0000	3.42E-02
214	0.28	0.000	0.148	0.3681	3.4842	0.0000	2.76E-02	0.0000	0.0000	1.02E-02
215	0.33	0.000	0.167	0.3906	3.9010	0.0000	2.81E-02	0.0000	0.0000	3.33E-02
216	0.14	0.000	0.264	0.3653	4.2049	0.0000	2.85E-02	0.0000	0.0000	3.37E-02
217	0.08	0.000	0.267	0.3294	3.7599	0.0000	2.80E-02	0.0000	0.0000	2.97E-02
218	0.00	0.000	0.259	0.2818	3.2876	0.0000	2.74E-02	0.0000	0.0000	1.34E-02
219	0.48	0.000	0.233	0.3185	2.8332	0.0000	2.68E-02	0.0000	0.0000	3.73E-02
220	0.00	0.000	0.258	0.2711	2.5679	0.0000	2.64E-02	0.0000	0.0000	2.74E-02
221	0.00	0.000	0.246	0.2257	2.2409	0.0000	2.60E-02	0.0000	0.0000	9.65E-03
222	0.00	0.000	0.239	0.1816	1.7796	0.0000	2.54E-02	0.0000	0.0000	3.92E-02
223	0.00	0.000	0.229	0.1393	1.0982	0.0000	2.45E-02	0.0000	0.0000	2.68E-02
224	0.07	0.000	0.157	0.1208	0.6104	0.0000	2.39E-02	0.0000	0.0000	1.14E-02
225	0.24	0.000	0.128	0.1374	0.1067	0.0000	1.17E-02	0.0000	0.0000	2.99E-02
226	0.02	0.000	0.181	0.1105	0.0000	0.0000	0.00E+00	0.0000	0.0000	1.20E-02
227	0.00	0.000	0.095	0.0946	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
228	0.00	0.000	0.048	0.0866	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
229	0.00	0.000	0.007	0.0854	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
230	0.06	0.000	0.018	0.0924	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
231	0.00	0.000	0.024	0.0884	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
232	0.00	0.000	0.016	0.0857	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
233	1.02	0.000	0.060	0.2456	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
234	0.01	0.000	0.201	0.2108	0.3908	0.0000	1.78E-02	0.0000	0.0000	0.00E+00
235	0.00	0.000	0.231	0.1683	0.6033	0.0000	2.39E-02	0.0000	0.0000	2.86E-02
236	0.00	0.000	0.228	0.1263	0.5015	0.0000	2.38E-02	0.0000	0.0000	7.42E-03
237	0.00	0.000	0.194	0.0920	0.1913	0.0000	1.18E-02	0.0000	0.0000	2.39E-02
238	0.00	0.000	0.042	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
239	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
240	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
241	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
242	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
243	0.87	0.000	0.064	0.2193	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
244	0.01	0.000	0.119	0.1991	0.0284	0.0000	1.16E-02	0.0000	0.0000	0.00E+00

245	0.00	0.000	0.218	0.1614	0.0106	0.0000	8.94E-03	0.0000	0.0000	2.39E-02
246	0.00	0.000	0.240	0.1188	0.0054	0.0000	1.54E-02	0.0000	0.0000	3.01E-02
247	0.00	0.000	0.203	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	1.12E-02
248	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
249	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
250	0.44	0.000	0.046	0.1507	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
251	0.40	0.000	0.061	0.2072	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
252	2.23	0.651	0.084	0.4530	1.9714	0.0000	1.99E-02	0.0000	0.0000	0.00E+00
253	0.04	0.028	0.088	0.4351	5.8483	0.0000	3.06E-02	0.0000	0.0000	2.07E-02
254	0.49	0.240	0.112	0.4530	5.8497	0.0000	3.06E-02	0.0000	0.0000	3.26E-02
255	0.02	0.010	0.117	0.4299	5.8048	0.0000	3.06E-02	0.0000	0.0000	2.12E-02
256	0.04	0.000	0.140	0.4083	5.2879	0.0000	2.99E-02	0.0000	0.0000	3.44E-02
257	0.03	0.000	0.114	0.3893	4.8599	0.0000	2.94E-02	0.0000	0.0000	2.97E-02
258	0.00	0.000	0.135	0.3621	4.5744	0.0000	2.90E-02	0.0000	0.0000	3.13E-02
259	0.00	0.000	0.162	0.3304	4.0793	0.0000	2.84E-02	0.0000	0.0000	1.63E-02
260	0.39	0.000	0.097	0.3745	3.7291	0.0000	2.79E-02	0.0000	0.0000	3.56E-02
261	2.22	1.568	0.151	0.4530	5.4202	0.0000	3.01E-02	0.0000	0.0000	3.63E-02
262	0.00	0.000	0.172	0.4193	5.7220	0.0000	3.05E-02	0.0000	0.0000	1.47E-02
263	0.00	0.000	0.146	0.3900	5.0447	0.0000	2.96E-02	0.0000	0.0000	3.70E-02
264	0.00	0.000	0.096	0.3692	4.6126	0.0000	2.91E-02	0.0000	0.0000	3.47E-02
265	0.04	0.000	0.124	0.3505	4.2529	0.0000	2.86E-02	0.0000	0.0000	2.99E-02
266	0.92	0.198	0.077	0.4530	4.7821	0.0000	2.93E-02	0.0000	0.0000	2.92E-02
267	0.25	0.203	0.082	0.4420	5.9098	0.0000	3.07E-02	0.0000	0.0000	4.51E-02
268	0.20	0.010	0.093	0.4530	5.8318	0.0000	3.06E-02	0.0000	0.0000	1.88E-02
269	0.47	0.380	0.139	0.4398	5.8869	0.0000	3.07E-02	0.0000	0.0000	2.79E-02
270	0.70	0.495	0.095	0.4530	5.9247	0.0000	3.07E-02	0.0000	0.0000	3.26E-02
271	0.30	0.287	0.136	0.4274	5.7831	0.0000	3.06E-02	0.0000	0.0000	2.72E-02
272	0.00	0.000	0.132	0.4004	5.2118	0.0000	2.98E-02	0.0000	0.0000	2.83E-02
273	0.00	0.000	0.121	0.3753	4.7288	0.0000	2.92E-02	0.0000	0.0000	1.87E-02
274	0.00	0.000	0.129	0.3490	4.3168	0.0000	2.87E-02	0.0000	0.0000	3.67E-02
275	0.00	0.000	0.101	0.3275	3.9191	0.0000	2.82E-02	0.0000	0.0000	3.55E-02
276	0.00	0.000	0.141	0.2994	3.5899	0.0000	2.77E-02	0.0000	0.0000	2.91E-02
277	0.19	0.000	0.128	0.3051	3.1597	0.0000	2.72E-02	0.0000	0.0000	4.21E-02
278	0.00	0.000	0.089	0.2859	2.8940	0.0000	2.68E-02	0.0000	0.0000	1.15E-03
279	0.00	0.000	0.072	0.2694	2.7364	0.0000	2.66E-02	0.0000	0.0000	3.38E-02
280	0.00	0.000	0.104	0.2476	2.5883	0.0000	2.65E-02	0.0000	0.0000	2.27E-02

281	0.00	0.000	0.113	0.2244	2.2913	0.0000	2.61E-02	0.0000	0.0000	2.14E-02
282	0.00	0.000	0.102	0.2031	1.9330	0.0000	2.56E-02	0.0000	0.0000	3.29E-02
283	0.00	0.000	0.112	0.1803	1.6723	0.0000	2.53E-02	0.0000	0.0000	2.68E-02
284	0.77	0.000	0.082	0.2907	1.3072	0.0000	2.48E-02	0.0000	0.0000	1.81E-02
285	0.00	0.000	0.100	0.2698	1.5460	0.0000	2.51E-02	0.0000	0.0000	3.42E-02
286	0.06	0.000	0.085	0.2614	1.7122	0.0000	2.53E-02	0.0000	0.0000	2.41E-02
287	0.03	0.000	0.061	0.2520	1.6970	0.0000	2.53E-02	0.0000	0.0000	1.68E-02
288	0.16	0.000	0.071	0.2627	1.6258	0.0000	2.52E-02	0.0000	0.0000	3.37E-02
289	0.00	0.000	0.078	0.2454	1.5154	0.0000	2.51E-02	0.0000	0.0000	2.53E-02
290	0.00	0.000	0.087	0.2267	1.3977	0.0000	2.49E-02	0.0000	0.0000	1.67E-02
291	0.00	0.000	0.079	0.2094	1.2765	0.0000	2.48E-02	0.0000	0.0000	3.41E-02
292	0.01	0.000	0.074	0.1946	1.1576	0.0000	2.46E-02	0.0000	0.0000	2.53E-02
293	0.05	0.000	0.088	0.1843	0.9758	0.0000	2.44E-02	0.0000	0.0000	1.53E-02
294	0.00	0.000	0.067	0.1691	0.9119	0.0000	2.43E-02	0.0000	0.0000	3.46E-02
295	0.00	0.000	0.059	0.1551	0.8184	0.0000	2.42E-02	0.0000	0.0000	2.48E-02
296	0.00	0.000	0.075	0.1386	0.7186	0.0000	2.41E-02	0.0000	0.0000	1.36E-02
297	0.00	0.000	0.059	0.1248	0.6007	0.0000	2.39E-02	0.0000	0.0000	3.50E-02
298	0.00	0.000	0.059	0.1111	0.3918	0.0000	2.36E-02	0.0000	0.0000	1.11E-03
299	0.80	0.000	0.056	0.2312	0.1431	0.0000	2.33E-02	0.0000	0.0000	4.53E-02
300	0.58	0.000	0.058	0.3143	0.5181	0.0000	2.38E-02	0.0000	0.0000	5.76E-03
301	0.04	0.000	0.060	0.3065	2.3316	0.0000	2.61E-02	0.0000	0.0000	3.70E-02
302	0.00	0.000	0.066	0.2911	2.4876	0.0000	2.63E-02	0.0000	0.0000	2.56E-02
303	0.00	0.000	0.068	0.2754	2.3939	0.0000	2.62E-02	0.0000	0.0000	1.35E-02
304	0.00	0.000	0.070	0.2594	2.2481	0.0000	2.60E-02	0.0000	0.0000	3.94E-02
305	0.00	0.000	0.078	0.2422	2.0612	0.0000	2.58E-02	0.0000	0.0000	2.57E-02
306	0.75	0.000	0.079	0.3498	1.9294	0.0000	2.56E-02	0.0000	0.0000	1.33E-02
307	0.02	0.000	0.076	0.3359	3.2793	0.0000	2.73E-02	0.0000	0.0000	3.81E-02
308	0.00	0.000	0.060	0.3212	3.3347	0.0000	2.74E-02	0.0000	0.0000	3.65E-02
309	1.23	0.351	0.060	0.4530	4.3946	0.0000	2.88E-02	0.0000	0.0000	1.44E-02
310	0.92	0.912	0.063	0.4387	5.8777	0.0000	3.07E-02	0.0000	0.0000	3.30E-02
311	0.00	0.000	0.059	0.4238	5.5587	0.0000	3.03E-02	0.0000	0.0000	3.20E-02
312	0.00	0.000	0.069	0.4074	5.2262	0.0000	2.98E-02	0.0000	0.0000	3.20E-02
313	0.59	0.232	0.054	0.4530	5.5475	0.0000	3.03E-02	0.0000	0.0000	1.83E-02
314	0.00	0.000	0.054	0.4388	5.8788	0.0000	3.07E-02	0.0000	0.0000	3.77E-02
315	0.00	0.000	0.046	0.4262	5.5783	0.0000	3.03E-02	0.0000	0.0000	3.39E-02
316	0.43	0.188	0.050	0.4530	5.7519	0.0000	3.05E-02	0.0000	0.0000	3.03E-02

317		0.60	0.593	0.052	0.4404	5.8920	0.0000	3.07E-02	0.0000	0.0000	3.01E-02
318		0.00	0.000	0.048	0.4274	5.6105	0.0000	3.03E-02	0.0000	0.0000	2.04E-02
319		1.33	1.103	0.043	0.4530	5.8588	0.0000	3.07E-02	0.0000	0.0000	3.79E-02
320		0.17	0.163	0.054	0.4401	5.8896	0.0000	3.07E-02	0.0000	0.0000	3.39E-02
321		0.00	0.000	0.048	0.4270	5.6035	0.0000	3.03E-02	0.0000	0.0000	3.00E-02
322		0.00	0.000	0.041	0.4151	5.3299	0.0000	3.00E-02	0.0000	0.0000	3.17E-02
323		0.00	0.000	0.046	0.4025	5.0524	0.0000	2.96E-02	0.0000	0.0000	1.90E-02
324		0.00	0.000	0.048	0.3896	4.8199	0.0000	2.93E-02	0.0000	0.0000	3.71E-02
325		0.00	0.000	0.043	0.3776	4.6063	0.0000	2.90E-02	0.0000	0.0000	3.49E-02
326		0.00	0.000	0.038	0.3665	4.4057	0.0000	2.88E-02	0.0000	0.0000	2.93E-02
327	*	0.00	0.000	0.030	0.3567	4.2193	0.0000	2.86E-02	0.0000	0.0000	3.02E-02
328		1.68	1.029	0.043	0.4530	5.1215	0.0000	2.97E-02	0.0000	0.0000	3.62E-02
329		0.00	0.000	0.050	0.4396	5.8852	0.0000	3.07E-02	0.0000	0.0000	2.79E-02
330		0.42	0.256	0.053	0.4530	5.9231	0.0000	3.07E-02	0.0000	0.0000	2.59E-02
331		0.00	0.000	0.041	0.4411	5.8978	0.0000	3.07E-02	0.0000	0.0000	2.62E-02
332		0.00	0.000	0.037	0.4299	5.6399	0.0000	3.04E-02	0.0000	0.0000	2.97E-02
333		0.00	0.000	0.036	0.4189	5.3985	0.0000	3.01E-02	0.0000	0.0000	1.99E-02
334		0.00	0.000	0.037	0.4077	5.1409	0.0000	2.97E-02	0.0000	0.0000	3.77E-02
335		0.23	0.000	0.045	0.4337	5.1198	0.0000	2.97E-02	0.0000	0.0000	3.46E-02
336		0.16	0.000	0.054	0.4463	5.6323	0.0000	3.04E-02	0.0000	0.0000	2.90E-02
337		0.00	0.000	0.054	0.4323	5.7235	0.0000	3.05E-02	0.0000	0.0000	2.92E-02
338		0.00	0.000	0.041	0.4204	5.4431	0.0000	3.01E-02	0.0000	0.0000	1.98E-02
339		0.00	0.000	0.034	0.4098	5.1956	0.0000	2.98E-02	0.0000	0.0000	3.78E-02
340		0.00	0.000	0.035	0.3991	4.9459	0.0000	2.95E-02	0.0000	0.0000	3.45E-02
341		0.00	0.000	0.036	0.3882	4.7690	0.0000	2.93E-02	0.0000	0.0000	2.97E-02
342	*	0.00	0.000	0.030	0.3784	4.5832	0.0000	2.90E-02	0.0000	0.0000	3.05E-02
343	*	0.00	0.000	0.032	0.3682	4.4048	0.0000	2.88E-02	0.0000	0.0000	1.59E-02
344		0.00	0.000	0.032	0.3581	4.2245	0.0000	2.86E-02	0.0000	0.0000	3.61E-02
345	*	0.00	0.000	0.031	0.3482	4.0122	0.0000	2.83E-02	0.0000	0.0000	3.56E-02
346		0.00	0.000	0.037	0.3374	3.8780	0.0000	2.81E-02	0.0000	0.0000	2.85E-02
347		0.00	0.000	0.040	0.3260	3.7240	0.0000	2.79E-02	0.0000	0.0000	3.19E-02
348		0.22	0.000	0.048	0.3501	3.5672	0.0000	2.77E-02	0.0000	0.0000	1.52E-02
349		2.24	1.538	0.055	0.4530	5.0828	0.0000	2.97E-02	0.0000	0.0000	3.51E-02
350		0.69	0.684	0.051	0.4404	5.8923	0.0000	3.07E-02	0.0000	0.0000	2.78E-02
351		0.00	0.000	0.043	0.4283	5.6176	0.0000	3.03E-02	0.0000	0.0000	2.94E-02
352		0.00	0.000	0.038	0.4168	5.3595	0.0000	3.00E-02	0.0000	0.0000	1.98E-02

353	0.00	0.000	0.034	0.4063	5.1064	0.0000	2.97E-02	0.0000	0.0000	3.76E-02
354	0.78	0.428	0.042	0.4530	5.6066	0.0000	3.03E-02	0.0000	0.0000	3.47E-02
355	0.43	0.424	0.062	0.4385	5.8764	0.0000	3.07E-02	0.0000	0.0000	2.83E-02
356	0.01	0.000	0.051	0.4266	5.5746	0.0000	3.03E-02	0.0000	0.0000	3.07E-02
357	0.01	0.000	0.044	0.4159	5.3124	0.0000	3.00E-02	0.0000	0.0000	1.98E-02
358	0.00	0.000	0.041	0.4042	5.0492	0.0000	2.96E-02	0.0000	0.0000	3.76E-02
359	0.00	0.000	0.037	0.3931	4.8336	0.0000	2.93E-02	0.0000	0.0000	3.47E-02
360	0.00	0.000	0.033	0.3827	4.6435	0.0000	2.91E-02	0.0000	0.0000	2.95E-02
361	0.00	0.000	0.037	0.3718	4.4567	0.0000	2.89E-02	0.0000	0.0000	3.04E-02
362	1.08	0.510	0.053	0.4530	5.2040	0.0000	2.98E-02	0.0000	0.0000	1.49E-02
363	0.00	0.000	0.050	0.4396	5.8850	0.0000	3.07E-02	0.0000	0.0000	3.70E-02
364	0.00	0.000	0.040	0.4278	5.6021	0.0000	3.03E-02	0.0000	0.0000	3.39E-02
365	0.69	0.464	0.044	0.4530	5.8589	0.0000	3.07E-02	0.0000	0.0000	3.01E-02

* = Frozen (air or soil)

Annual Totals for Year 3			
	inches	cubic feet	percent
Precipitation	71.82	##########	100.00
Runoff	32.166	5,838,118.8	44.79
Evapotranspiration	30.812	5,592,466.7	42.90
Percolation/Leakage through Layer 2	6.958402	1,262,949.9	9.69
Average Head on Top of Layer 2	2.4514	---	---
Percolation/Leakage through Layer 3	6.939847	1,259,582.2	9.66
Change in Water Storage	1.9017	345,162.3	2.65
Soil Water at Start of Year	114.0417	##########	158.79
Soil Water at End of Year	115.9434	##########	161.44
Snow Water at Start of Year	0.0000	0.0000	0.00
Snow Water at End of Year	0.0000	0.0000	0.00
Annual Water Budget Balance	0.0000	0.0000	0.00

Daily Output for Year 4

Column key: Head #1: drainage from Layer 2

Title: Keystone

Simulated On: 2/10/2022 18:26

Leak #1: leakage thru Layer 2

Leak #2: leakage thru Layer 3

Day	Freezing Status* Air	Freezing Status* Soil	Rain (inches)	Runoff (inches)	ET (inches)	Evap. Zone Water (in/in)	Head #1 (inches)	Drain #1 (inches)	Leak #1 (inches)	Head #2 (inches)	Drain #2 (inches)	Leak #2 (inches)
1			0.03	0.025	0.067	0.4377	5.8698	0.0000	3.07E-02	0.0000	0.0000	3.02E-02
2			0.00	0.000	0.050	0.4243	5.5516	0.0000	3.03E-02	0.0000	0.0000	2.05E-02
3			0.00	0.000	0.051	0.4109	5.2627	0.0000	2.99E-02	0.0000	0.0000	3.80E-02
4			0.04	0.000	0.049	0.4045	4.9769	0.0000	2.95E-02	0.0000	0.0000	3.45E-02
5			0.02	0.000	0.058	0.3933	4.7980	0.0000	2.93E-02	0.0000	0.0000	2.99E-02
6			0.00	0.000	0.054	0.3794	4.6109	0.0000	2.91E-02	0.0000	0.0000	3.06E-02
7			0.00	0.000	0.042	0.3676	4.4451	0.0000	2.88E-02	0.0000	0.0000	1.60E-02
8			0.16	0.000	0.052	0.3808	4.2683	0.0000	2.86E-02	0.0000	0.0000	3.61E-02
9			0.00	0.000	0.052	0.3674	4.0224	0.0000	2.83E-02	0.0000	0.0000	3.55E-02
10			0.00	0.000	0.040	0.3561	3.9660	0.0000	2.82E-02	0.0000	0.0000	2.86E-02
11	*		0.00	0.000	0.038	0.3450	3.8290	0.0000	2.81E-02	0.0000	0.0000	3.31E-02
12	*		0.16	0.000	0.035	0.3436	3.6931	0.0000	2.79E-02	0.0000	0.0000	1.26E-02
13	*		0.37	0.000	0.030	0.3423	3.5889	0.0000	2.77E-02	0.0000	0.0000	3.37E-02
14	*		0.00	0.000	0.032	0.3410	3.4836	0.0000	2.76E-02	0.0000	0.0000	3.33E-02
15	*		0.00	0.000	0.030	0.3397	3.3788	0.0000	2.75E-02	0.0000	0.0000	2.28E-02
16	*		0.00	0.000	0.031	0.3384	3.2788	0.0000	2.73E-02	0.0000	0.0000	2.63E-02
17			0.06	0.000	0.000	0.3668	3.2975	0.0000	2.74E-02	0.0000	0.0000	3.50E-02
18			0.06	0.000	0.000	0.3920	3.9913	0.0000	2.83E-02	0.0000	0.0000	2.73E-02
19			0.76	0.329	0.050	0.4530	5.3337	0.0000	3.00E-02	0.0000	0.0000	2.97E-02
20			0.24	0.235	0.054	0.4397	5.8862	0.0000	3.07E-02	0.0000	0.0000	1.95E-02
21	*		0.00	0.000	0.000	0.4346	5.6575	0.0000	3.04E-02	0.0000	0.0000	3.47E-02
22	*		0.00	0.000	0.000	0.4296	5.5421	0.0000	3.03E-02	0.0000	0.0000	2.83E-02
23			0.00	0.000	0.048	0.4167	5.3652	0.0000	3.00E-02	0.0000	0.0000	3.10E-02
24			1.01	0.696	0.065	0.4530	5.7976	0.0000	3.06E-02	0.0000	0.0000	1.85E-02
25			0.00	0.000	0.048	0.4399	5.8876	0.0000	3.07E-02	0.0000	0.0000	3.82E-02
26	*		0.00	0.000	0.040	0.4282	5.6091	0.0000	3.03E-02	0.0000	0.0000	3.38E-02
27			0.00	0.000	0.045	0.4157	5.3492	0.0000	3.00E-02	0.0000	0.0000	3.05E-02
28			0.00	0.000	0.050	0.4025	5.0580	0.0000	2.96E-02	0.0000	0.0000	3.15E-02

29	*		0.24	0.000	0.034	0.4008	4.8590	0.0000	2.94E-02	0.0000	0.0000	1.79E-02
30	*		0.00	0.000	0.038	0.3993	4.7483	0.0000	2.92E-02	0.0000	0.0000	3.68E-02
31	*		0.00	0.000	0.027	0.3977	4.6703	0.0000	2.91E-02	0.0000	0.0000	3.50E-02
32	*		0.09	0.000	0.032	0.3961	4.6181	0.0000	2.91E-02	0.0000	0.0000	2.89E-02
33	*	*	0.00	0.000	0.037	0.3919	1.8638	0.0000	2.55E-02	0.0000	0.0000	9.94E-03
34		*	0.00	0.000	0.050	0.3883	0.8683	0.0000	2.42E-02	0.0000	0.0000	4.01E-02
35		*	0.00	0.000	0.030	0.3843	0.7763	0.0000	2.41E-02	0.0000	0.0000	2.80E-02
36		*	0.00	0.000	0.000	0.3803	0.6847	0.0000	2.40E-02	0.0000	0.0000	8.60E-03
37		*	0.12	0.000	0.004	0.3955	0.5936	0.0000	2.39E-02	0.0000	0.0000	3.61E-02
38		*	0.00	0.000	0.000	0.3915	0.5029	0.0000	2.38E-02	0.0000	0.0000	2.87E-02
39		*	0.02	0.000	0.004	0.3902	0.4127	0.0000	2.37E-02	0.0000	0.0000	7.15E-03
40		*	0.00	0.000	0.000	0.3863	0.3229	0.0000	2.35E-02	0.0000	0.0000	3.13E-02
41	*	*	0.07	0.000	0.044	0.3824	0.2335	0.0000	2.34E-02	0.0000	0.0000	9.77E-03
42		*	0.67	0.400	0.000	0.4233	0.1446	0.0000	2.33E-02	0.0000	0.0000	4.11E-02
43		*	0.81	0.773	0.000	0.4255	0.3412	0.0000	2.36E-02	0.0000	0.0000	1.87E-02
44		*	0.00	0.000	0.027	0.4215	0.3384	0.0000	2.36E-02	0.0000	0.0000	2.23E-02
45		*	0.00	0.000	0.000	0.4176	0.2489	0.0000	2.35E-02	0.0000	0.0000	2.43E-02
46		*	0.00	0.000	0.000	0.4137	0.1599	0.0000	2.33E-02	0.0000	0.0000	1.44E-02
47			0.00	0.000	0.084	0.3951	3.7210	0.0000	2.79E-02	0.0000	0.0000	3.67E-02
48			0.21	0.000	0.054	0.4162	4.7651	0.0000	2.93E-02	0.0000	0.0000	3.62E-02
49			0.28	0.000	0.063	0.4474	5.3285	0.0000	3.00E-02	0.0000	0.0000	1.50E-02
50			0.00	0.000	0.067	0.4312	5.7375	0.0000	3.05E-02	0.0000	0.0000	5.45E-02
51			0.74	0.530	0.048	0.4530	5.8796	0.0000	3.07E-02	0.0000	0.0000	1.86E-02
52			0.00	0.000	0.076	0.4352	5.8487	0.0000	3.06E-02	0.0000	0.0000	2.53E-02
53			0.00	0.000	0.080	0.4169	5.4581	0.0000	3.01E-02	0.0000	0.0000	3.20E-02
54			0.17	0.000	0.062	0.4299	5.2504	0.0000	2.99E-02	0.0000	0.0000	1.95E-02
55			0.46	0.227	0.064	0.4530	5.7987	0.0000	3.06E-02	0.0000	0.0000	3.72E-02
56			0.00	0.000	0.094	0.4323	5.8244	0.0000	3.06E-02	0.0000	0.0000	3.40E-02
57			0.00	0.000	0.078	0.4143	5.3980	0.0000	3.01E-02	0.0000	0.0000	2.99E-02
58			0.00	0.000	0.068	0.3981	5.0250	0.0000	2.96E-02	0.0000	0.0000	3.20E-02
59			0.00	0.000	0.087	0.3786	4.7232	0.0000	2.92E-02	0.0000	0.0000	1.80E-02
60			0.74	0.212	0.052	0.4530	5.1546	0.0000	2.98E-02	0.0000	0.0000	3.64E-02
61			0.05	0.046	0.071	0.4367	5.8614	0.0000	3.07E-02	0.0000	0.0000	3.47E-02
62			0.79	0.586	0.075	0.4530	5.9095	0.0000	3.07E-02	0.0000	0.0000	2.80E-02
63			0.01	0.006	0.087	0.4340	5.8386	0.0000	3.06E-02	0.0000	0.0000	3.07E-02
64	*		0.00	0.000	0.076	0.4163	5.4367	0.0000	3.01E-02	0.0000	0.0000	2.06E-02

65	*	0.00	0.000	0.067	0.4002	5.0592	0.0000	2.96E-02	0.0000	0.0000	3.78E-02
66	*	0.00	0.000	0.072	0.3834	4.7747	0.0000	2.93E-02	0.0000	0.0000	3.47E-02
67		0.14	0.000	0.071	0.3900	4.5248	0.0000	2.89E-02	0.0000	0.0000	2.97E-02
68		0.04	0.000	0.092	0.3766	4.3343	0.0000	2.87E-02	0.0000	0.0000	3.05E-02
69		0.46	0.000	0.074	0.4361	4.6280	0.0000	2.91E-02	0.0000	0.0000	1.47E-02
70		0.00	0.000	0.112	0.4125	5.4149	0.0000	3.01E-02	0.0000	0.0000	3.61E-02
71		0.00	0.000	0.114	0.3887	4.9294	0.0000	2.95E-02	0.0000	0.0000	3.44E-02
72		0.00	0.000	0.083	0.3700	4.5801	0.0000	2.90E-02	0.0000	0.0000	3.02E-02
73		0.00	0.000	0.115	0.3461	4.2331	0.0000	2.86E-02	0.0000	0.0000	3.10E-02
74		0.03	0.000	0.135	0.3238	3.8589	0.0000	2.81E-02	0.0000	0.0000	1.50E-02
75		0.00	0.000	0.123	0.2987	3.5258	0.0000	2.77E-02	0.0000	0.0000	5.55E-02
76		0.00	0.000	0.105	0.2767	3.0883	0.0000	2.71E-02	0.0000	0.0000	1.81E-02
77		0.00	0.000	0.095	0.2563	2.8371	0.0000	2.68E-02	0.0000	0.0000	2.14E-02
78		0.00	0.000	0.110	0.2336	2.5166	0.0000	2.64E-02	0.0000	0.0000	1.55E-02
79		0.01	0.000	0.101	0.2142	2.0459	0.0000	2.58E-02	0.0000	0.0000	3.27E-02
80		1.74	0.215	0.066	0.4530	2.5718	0.0000	2.64E-02	0.0000	0.0000	2.59E-02
81		0.11	0.000	0.093	0.4507	5.9800	0.0000	3.08E-02	0.0000	0.0000	1.76E-02
82		0.00	0.000	0.122	0.4253	5.7367	0.0000	3.05E-02	0.0000	0.0000	3.86E-02
83		0.00	0.000	0.116	0.4009	5.1939	0.0000	2.98E-02	0.0000	0.0000	3.39E-02
84		0.00	0.000	0.082	0.3824	4.7717	0.0000	2.93E-02	0.0000	0.0000	3.09E-02
85		0.00	0.000	0.128	0.3563	4.4405	0.0000	2.88E-02	0.0000	0.0000	3.14E-02
86		0.00	0.000	0.118	0.3319	4.0140	0.0000	2.83E-02	0.0000	0.0000	1.58E-02
87		0.00	0.000	0.120	0.3072	3.6827	0.0000	2.79E-02	0.0000	0.0000	3.57E-02
88		0.00	0.000	0.085	0.2885	3.3122	0.0000	2.74E-02	0.0000	0.0000	3.27E-02
89		0.00	0.000	0.139	0.2608	2.9375	0.0000	2.69E-02	0.0000	0.0000	2.88E-02
90		0.02	0.000	0.143	0.2359	2.5873	0.0000	2.65E-02	0.0000	0.0000	1.43E-02
91		0.00	0.000	0.121	0.2114	2.0530	0.0000	2.58E-02	0.0000	0.0000	3.27E-02
92		0.03	0.000	0.092	0.1969	1.8142	0.0000	2.55E-02	0.0000	0.0000	2.69E-02
93		0.00	0.000	0.077	0.1799	1.5427	0.0000	2.51E-02	0.0000	0.0000	1.86E-02
94		0.00	0.000	0.056	0.1664	1.2151	0.0000	2.47E-02	0.0000	0.0000	3.39E-02
95		0.02	0.000	0.052	0.1569	1.0067	0.0000	2.44E-02	0.0000	0.0000	2.61E-02
96		0.00	0.000	0.044	0.1455	0.9385	0.0000	2.43E-02	0.0000	0.0000	1.48E-02
97		0.00	0.000	0.040	0.1348	0.8223	0.0000	2.42E-02	0.0000	0.0000	3.47E-02
98		0.02	0.000	0.040	0.1275	0.6508	0.0000	2.40E-02	0.0000	0.0000	2.50E-02
99		0.00	0.000	0.034	0.1179	0.4397	0.0000	2.37E-02	0.0000	0.0000	1.32E-02
100		0.00	0.000	0.032	0.1086	0.2383	0.0000	2.34E-02	0.0000	0.0000	2.44E-02

101	0.00	0.000	0.030	0.1015	0.0551	0.0000	1.22E-02	0.0000	0.0000	1.83E-02
102	0.04	0.000	0.032	0.1028	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
103	0.10	0.000	0.031	0.1143	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
104	0.00	0.000	0.027	0.1098	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
105	0.40	0.000	0.029	0.1717	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
106	0.00	0.000	0.025	0.1675	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
107	0.00	0.000	0.024	0.1634	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
108	0.00	0.000	0.024	0.1595	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
109	0.35	0.000	0.026	0.2135	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
110	0.01	0.000	0.199	0.1819	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
111	0.00	0.000	0.174	0.1528	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
112	0.00	0.000	0.174	0.1239	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
113	0.00	0.000	0.068	0.1125	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
114	0.00	0.000	0.061	0.1024	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
115	0.01	0.000	0.054	0.0950	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
116	0.44	0.000	0.048	0.1603	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
117	0.02	0.000	0.045	0.1561	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
118	0.02	0.000	0.041	0.1526	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
119	0.00	0.000	0.036	0.1467	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
120	0.00	0.000	0.034	0.1409	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
121	0.00	0.000	0.032	0.1357	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
122	0.82	0.000	0.034	0.2666	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
123	0.02	0.000	0.133	0.2448	0.6244	0.0000	1.82E-02	0.0000	0.0000	0.00E+00
124	0.08	0.000	0.149	0.2293	0.9118	0.0000	2.43E-02	0.0000	0.0000	4.03E-02
125	0.84	0.000	0.100	0.3485	1.1149	0.0000	2.46E-02	0.0000	0.0000	2.78E-02
126	0.00	0.000	0.205	0.3098	3.0935	0.0000	2.71E-02	0.0000	0.0000	8.33E-03
127	0.00	0.000	0.237	0.2658	2.8940	0.0000	2.68E-02	0.0000	0.0000	3.93E-02
128	0.00	0.000	0.137	0.2387	2.5718	0.0000	2.64E-02	0.0000	0.0000	2.47E-02
129	0.00	0.000	0.111	0.2158	2.1249	0.0000	2.59E-02	0.0000	0.0000	1.55E-02
130	0.56	0.000	0.165	0.2775	1.8758	0.0000	2.55E-02	0.0000	0.0000	3.92E-02
131	0.50	0.000	0.157	0.3303	1.8946	0.0000	2.56E-02	0.0000	0.0000	2.63E-02
132	0.76	0.000	0.090	0.4373	3.6282	0.0000	2.78E-02	0.0000	0.0000	3.51E-02
133	0.68	0.467	0.088	0.4530	5.9158	0.0000	3.07E-02	0.0000	0.0000	2.49E-02
134	0.00	0.000	0.128	0.4266	5.7768	0.0000	3.06E-02	0.0000	0.0000	2.62E-02
135	0.00	0.000	0.198	0.3887	5.1161	0.0000	2.97E-02	0.0000	0.0000	3.06E-02
136	0.02	0.000	0.230	0.3489	4.4525	0.0000	2.89E-02	0.0000	0.0000	1.88E-02

137	0.00	0.000	0.203	0.3104	3.8358	0.0000	2.81E-02	0.0000	0.0000	3.64E-02
138	0.24	0.000	0.207	0.3114	3.3381	0.0000	2.74E-02	0.0000	0.0000	3.59E-02
139	0.00	0.000	0.219	0.2704	2.8972	0.0000	2.69E-02	0.0000	0.0000	2.54E-02
140	0.00	0.000	0.241	0.2258	2.4912	0.0000	2.63E-02	0.0000	0.0000	2.92E-02
141	0.00	0.000	0.193	0.1894	1.8247	0.0000	2.55E-02	0.0000	0.0000	1.99E-02
142	0.00	0.000	0.083	0.1714	1.4297	0.0000	2.50E-02	0.0000	0.0000	2.76E-02
143	0.47	0.000	0.068	0.2343	1.1040	0.0000	2.45E-02	0.0000	0.0000	9.37E-03
144	0.00	0.000	0.268	0.1856	0.9412	0.0000	2.43E-02	0.0000	0.0000	3.71E-02
145	0.00	0.000	0.057	0.1720	0.8259	0.0000	2.42E-02	0.0000	0.0000	2.81E-02
146	0.03	0.000	0.056	0.1637	0.7273	0.0000	2.41E-02	0.0000	0.0000	8.47E-03
147	0.00	0.000	0.049	0.1516	0.6298	0.0000	2.39E-02	0.0000	0.0000	3.62E-02
148	0.09	0.000	0.049	0.1545	0.5332	0.0000	2.38E-02	0.0000	0.0000	2.86E-02
149	0.00	0.000	0.043	0.1433	0.4374	0.0000	2.37E-02	0.0000	0.0000	7.28E-03
150	0.40	0.000	0.043	0.1989	0.3424	0.0000	2.36E-02	0.0000	0.0000	3.27E-02
151	0.00	0.000	0.271	0.1498	0.2376	0.0000	2.34E-02	0.0000	0.0000	2.96E-02
152	0.00	0.000	0.042	0.1390	0.1263	0.0000	2.33E-02	0.0000	0.0000	1.45E-02
153	0.54	0.000	0.043	0.2190	0.0334	0.0000	1.69E-02	0.0000	0.0000	1.98E-02
154	0.00	0.000	0.259	0.1759	0.0000	0.0000	0.00E+00	0.0000	0.0000	8.15E-03
155	0.00	0.000	0.246	0.1349	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
156	0.05	0.000	0.177	0.1137	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
157	0.02	0.000	0.091	0.1018	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
158	0.00	0.000	0.070	0.0901	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
159	0.00	0.000	0.028	0.0854	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
160	0.11	0.000	0.031	0.0987	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
161	0.37	0.000	0.025	0.1561	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
162	0.01	0.000	0.050	0.1495	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
163	0.06	0.000	0.052	0.1509	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
164	0.52	0.000	0.043	0.2304	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
165	0.00	0.000	0.232	0.1917	0.0002	0.0000	1.63E-04	0.0000	0.0000	0.00E+00
166	0.00	0.000	0.189	0.1573	0.0117	0.0000	1.74E-02	0.0000	0.0000	0.00E+00
167	0.00	0.000	0.189	0.1219	0.0247	0.0000	2.32E-02	0.0000	0.0000	3.13E-02
168	0.32	0.000	0.210	0.1398	0.0039	0.0000	2.30E-03	0.0000	0.0000	9.76E-03
169	0.37	0.000	0.100	0.1849	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
170	0.10	0.000	0.222	0.1645	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
171	0.10	0.000	0.208	0.1465	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
172	0.01	0.000	0.231	0.1097	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

173	0.00	0.000	0.124	0.0890	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
174	0.00	0.000	0.022	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
175	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
176	0.06	0.000	0.013	0.0929	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
177	0.00	0.000	0.030	0.0879	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
178	0.00	0.000	0.012	0.0859	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
179	0.00	0.000	0.004	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
180	0.31	0.000	0.033	0.1314	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
181	0.00	0.000	0.045	0.1238	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
182	0.00	0.000	0.054	0.1148	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
183	0.49	0.000	0.056	0.1871	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
184	0.00	0.000	0.221	0.1503	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
185	0.99	0.000	0.061	0.3052	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
186	0.02	0.000	0.240	0.2643	1.6088	0.0000	2.52E-02	0.0000	0.0000	2.06E-02
187	0.13	0.000	0.283	0.2345	1.8636	0.0000	2.55E-02	0.0000	0.0000	1.76E-02
188	0.00	0.000	0.233	0.1916	1.7132	0.0000	2.53E-02	0.0000	0.0000	3.35E-02
189	0.75	0.000	0.158	0.2860	1.4817	0.0000	2.50E-02	0.0000	0.0000	2.58E-02
190	0.00	0.000	0.274	0.2362	1.3840	0.0000	2.49E-02	0.0000	0.0000	1.69E-02
191	0.00	0.000	0.283	0.1848	1.4071	0.0000	2.49E-02	0.0000	0.0000	3.41E-02
192	0.35	0.000	0.173	0.2102	1.1913	0.0000	2.47E-02	0.0000	0.0000	2.50E-02
193	0.00	0.000	0.284	0.1589	0.9569	0.0000	2.44E-02	0.0000	0.0000	1.57E-02
194	0.00	0.000	0.288	0.1068	0.5665	0.0000	2.39E-02	0.0000	0.0000	3.46E-02
195	0.00	0.000	0.128	0.0855	0.0143	0.0000	0.00E+00	0.0000	0.0000	1.96E-03
196	0.00	0.000	0.002	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
197	0.02	0.000	0.019	0.0853	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
198	0.41	0.000	0.055	0.1445	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
199	0.00	0.000	0.063	0.1340	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
200	0.00	0.000	0.089	0.1192	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
201	0.00	0.000	0.094	0.1036	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
202	0.00	0.000	0.092	0.0882	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
203	0.11	0.000	0.055	0.0973	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
204	0.58	0.000	0.058	0.1843	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
205	0.00	0.000	0.211	0.1491	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
206	0.00	0.000	0.247	0.1080	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
207	0.00	0.000	0.116	0.0886	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
208	0.00	0.000	0.021	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

209	0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
210	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
211	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
212	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
213	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
214	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
215	0.27	0.000	0.048	0.1220	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
216	0.03	0.000	0.072	0.1150	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
217	0.00	0.000	0.069	0.1035	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
218	0.17	0.000	0.079	0.1187	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
219	0.50	0.000	0.075	0.1895	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
220	0.00	0.000	0.242	0.1491	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
221	0.00	0.000	0.089	0.1343	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
222	0.00	0.000	0.081	0.1208	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
223	0.00	0.000	0.088	0.1061	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
224	0.00	0.000	0.082	0.0924	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
225	0.03	0.000	0.057	0.0880	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
226	0.03	0.000	0.021	0.0894	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
227	0.00	0.000	0.013	0.0873	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
228	0.00	0.000	0.011	0.0855	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
229	0.00	0.000	0.002	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
230	0.01	0.000	0.011	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
231	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
232	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
233	0.07	0.000	0.020	0.0934	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
234	1.21	0.000	0.081	0.2815	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
235	0.07	0.000	0.123	0.2696	1.1693	0.0000	1.89E-02	0.0000	0.0000	0.00E+00
236	0.00	0.000	0.183	0.2349	1.6915	0.0000	2.53E-02	0.0000	0.0000	3.64E-02
237	0.00	0.000	0.221	0.1939	1.5651	0.0000	2.51E-02	0.0000	0.0000	2.68E-02
238	0.00	0.000	0.193	0.1576	1.2186	0.0000	2.47E-02	0.0000	0.0000	1.11E-02
239	0.00	0.000	0.140	0.1303	0.8442	0.0000	2.42E-02	0.0000	0.0000	3.74E-02
240	0.00	0.000	0.112	0.1076	0.4391	0.0000	2.37E-02	0.0000	0.0000	2.84E-02
241	0.00	0.000	0.135	0.0850	0.0290	0.0000	0.00E+00	0.0000	0.0000	1.38E-02
242	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
243	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
244	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

245	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
246	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
247	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
248	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
249	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
250	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
251	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
252	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
253	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
254	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
255	0.12	0.000	0.031	0.0998	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
256	0.03	0.000	0.026	0.1006	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
257	0.00	0.000	0.020	0.0972	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
258	0.00	0.000	0.019	0.0940	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
259	0.00	0.000	0.020	0.0907	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
260	0.00	0.000	0.020	0.0874	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
261	0.00	0.000	0.011	0.0856	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
262	0.00	0.000	0.003	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
263	0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
264	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
265	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
266	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
267	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
268	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
269	0.01	0.000	0.009	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
270	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
271	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
272	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
273	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
274	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
275	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
276	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
277	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
278	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
279	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
280	0.16	0.000	0.021	0.1081	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

281	0.00	0.000	0.006	0.1071	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
282	0.09	0.000	0.025	0.1179	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
283	0.00	0.000	0.011	0.1160	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
284	0.00	0.000	0.010	0.1143	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
285	0.00	0.000	0.010	0.1127	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
286	0.00	0.000	0.010	0.1111	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
287	0.00	0.000	0.010	0.1094	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
288	0.00	0.000	0.011	0.1076	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
289	1.29	0.000	0.028	0.3179	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
290	0.00	0.000	0.070	0.3020	2.1103	0.0000	2.58E-02	0.0000	0.0000	0.00E+00
291	0.00	0.000	0.080	0.2844	2.5402	0.0000	2.64E-02	0.0000	0.0000	3.41E-02
292	0.00	0.000	0.074	0.2677	2.4035	0.0000	2.62E-02	0.0000	0.0000	2.25E-02
293	1.35	0.147	0.064	0.4530	3.0076	0.0000	2.70E-02	0.0000	0.0000	2.00E-02
294	0.00	0.000	0.079	0.4347	5.8445	0.0000	3.06E-02	0.0000	0.0000	4.59E-02
295	0.72	0.513	0.066	0.4530	5.8985	0.0000	3.07E-02	0.0000	0.0000	2.23E-02
296	0.00	0.000	0.082	0.4342	5.8407	0.0000	3.06E-02	0.0000	0.0000	1.85E-02
297	0.00	0.000	0.074	0.4168	5.4442	0.0000	3.01E-02	0.0000	0.0000	3.84E-02
298	0.00	0.000	0.064	0.4012	5.0704	0.0000	2.96E-02	0.0000	0.0000	3.42E-02
299	0.01	0.000	0.066	0.3869	4.8237	0.0000	2.93E-02	0.0000	0.0000	3.03E-02
300	1.27	0.745	0.098	0.4530	5.3754	0.0000	3.00E-02	0.0000	0.0000	2.94E-02
301	0.00	0.000	0.077	0.4350	5.8475	0.0000	3.06E-02	0.0000	0.0000	1.75E-02
302	0.00	0.000	0.060	0.4199	5.4799	0.0000	3.02E-02	0.0000	0.0000	3.83E-02
303	0.34	0.036	0.076	0.4530	5.5292	0.0000	3.02E-02	0.0000	0.0000	3.43E-02
304	0.98	0.877	0.072	0.4530	6.0000	0.0000	3.08E-02	0.0000	0.0000	2.93E-02
305	0.00	0.000	0.072	0.4359	5.8548	0.0000	3.07E-02	0.0000	0.0000	3.01E-02
306	0.00	0.000	0.058	0.4212	5.5023	0.0000	3.02E-02	0.0000	0.0000	2.07E-02
307	0.00	0.000	0.059	0.4063	5.1684	0.0000	2.98E-02	0.0000	0.0000	3.79E-02
308	0.00	0.000	0.057	0.3919	4.8804	0.0000	2.94E-02	0.0000	0.0000	3.46E-02
309	0.00	0.000	0.056	0.3777	4.6433	0.0000	2.91E-02	0.0000	0.0000	2.98E-02
310	0.00	0.000	0.065	0.3621	4.4017	0.0000	2.88E-02	0.0000	0.0000	3.06E-02
311	0.10	0.000	0.056	0.3646	4.1637	0.0000	2.85E-02	0.0000	0.0000	1.54E-02
312	0.00	0.000	0.049	0.3518	3.9417	0.0000	2.82E-02	0.0000	0.0000	3.57E-02
313	0.00	0.000	0.041	0.3403	3.7988	0.0000	2.80E-02	0.0000	0.0000	3.59E-02
314	0.00	0.000	0.048	0.3276	3.6516	0.0000	2.78E-02	0.0000	0.0000	3.84E-02
315	0.00	0.000	0.056	0.3137	3.4868	0.0000	2.76E-02	0.0000	0.0000	0.00E+00
316	0.08	0.000	0.058	0.3128	3.3153	0.0000	2.74E-02	0.0000	0.0000	3.74E-02

317	*	0.00	0.000	0.039	0.3018	3.1583	0.0000	2.72E-02	0.0000	0.0000	3.65E-02
318	*	0.00	0.000	0.036	0.2914	2.9732	0.0000	2.70E-02	0.0000	0.0000	1.48E-02
319		0.00	0.000	0.038	0.2806	2.8699	0.0000	2.68E-02	0.0000	0.0000	3.45E-02
320		0.00	0.000	0.047	0.2683	2.7375	0.0000	2.66E-02	0.0000	0.0000	2.09E-02
321		0.00	0.000	0.040	0.2572	2.6064	0.0000	2.65E-02	0.0000	0.0000	2.18E-02
322		0.10	0.000	0.053	0.2605	2.4774	0.0000	2.63E-02	0.0000	0.0000	3.25E-02
323		0.03	0.000	0.058	0.2515	2.3458	0.0000	2.61E-02	0.0000	0.0000	2.62E-02
324		0.00	0.000	0.049	0.2390	2.2129	0.0000	2.60E-02	0.0000	0.0000	2.05E-02
325		0.00	0.000	0.048	0.2267	2.0492	0.0000	2.58E-02	0.0000	0.0000	3.30E-02
326		0.03	0.000	0.053	0.2185	1.9260	0.0000	2.56E-02	0.0000	0.0000	2.60E-02
327		0.29	0.000	0.048	0.2547	1.8137	0.0000	2.55E-02	0.0000	0.0000	1.86E-02
328		0.46	0.000	0.051	0.3186	1.7033	0.0000	2.53E-02	0.0000	0.0000	3.35E-02
329		0.00	0.000	0.047	0.3063	2.3910	0.0000	2.62E-02	0.0000	0.0000	2.46E-02
330		0.00	0.000	0.046	0.2943	2.4461	0.0000	2.63E-02	0.0000	0.0000	1.84E-02
331		0.01	0.000	0.054	0.2826	2.4094	0.0000	2.62E-02	0.0000	0.0000	3.28E-02
332		0.00	0.000	0.050	0.2700	2.2884	0.0000	2.61E-02	0.0000	0.0000	2.57E-02
333		0.00	0.000	0.043	0.2586	2.1295	0.0000	2.59E-02	0.0000	0.0000	2.02E-02
334		0.00	0.000	0.040	0.2476	1.9660	0.0000	2.57E-02	0.0000	0.0000	3.31E-02
335		0.62	0.000	0.047	0.3388	1.8912	0.0000	2.56E-02	0.0000	0.0000	2.59E-02
336		0.06	0.000	0.046	0.3365	3.0691	0.0000	2.71E-02	0.0000	0.0000	1.75E-02
337		0.00	0.000	0.040	0.3253	3.1218	0.0000	2.71E-02	0.0000	0.0000	3.34E-02
338		0.00	0.000	0.039	0.3143	2.9725	0.0000	2.70E-02	0.0000	0.0000	3.40E-02
339		0.00	0.000	0.041	0.3031	2.9014	0.0000	2.69E-02	0.0000	0.0000	7.32E-03
340		0.00	0.000	0.039	0.2921	2.7756	0.0000	2.67E-02	0.0000	0.0000	4.01E-02
341		0.00	0.000	0.040	0.2811	2.6479	0.0000	2.65E-02	0.0000	0.0000	2.48E-02
342		0.00	0.000	0.033	0.2711	2.5220	0.0000	2.64E-02	0.0000	0.0000	1.53E-02
343		0.89	0.000	0.051	0.4066	2.7402	0.0000	2.67E-02	0.0000	0.0000	3.96E-02
344		0.13	0.000	0.060	0.4135	4.8463	0.0000	2.94E-02	0.0000	0.0000	3.71E-02
345		0.05	0.000	0.043	0.4097	4.9172	0.0000	2.94E-02	0.0000	0.0000	1.29E-02
346		0.00	0.000	0.031	0.3996	4.8707	0.0000	2.94E-02	0.0000	0.0000	4.43E-02
347		0.35	0.000	0.042	0.4460	5.0799	0.0000	2.97E-02	0.0000	0.0000	2.85E-02
348		0.19	0.065	0.052	0.4530	5.9460	0.0000	3.08E-02	0.0000	0.0000	2.93E-02
349		0.00	0.000	0.044	0.4405	5.8927	0.0000	3.07E-02	0.0000	0.0000	2.60E-02
350		0.31	0.162	0.042	0.4530	5.8874	0.0000	3.07E-02	0.0000	0.0000	2.96E-02
351		0.14	0.133	0.044	0.4417	5.9032	0.0000	3.07E-02	0.0000	0.0000	2.04E-02
352		0.00	0.000	0.035	0.4308	5.6563	0.0000	3.04E-02	0.0000	0.0000	3.85E-02

353	*	0.00	0.000	0.027	0.4212	5.4295	0.0000	3.01E-02	0.0000	0.0000	3.40E-02
354	*	0.00	0.000	0.028	0.4116	5.2187	0.0000	2.98E-02	0.0000	0.0000	3.02E-02
355	*	0.00	0.000	0.030	0.4016	4.9888	0.0000	2.95E-02	0.0000	0.0000	3.11E-02
356		0.00	0.000	0.032	0.3913	4.8096	0.0000	2.93E-02	0.0000	0.0000	1.75E-02
357		0.00	0.000	0.035	0.3807	4.6251	0.0000	2.91E-02	0.0000	0.0000	3.67E-02
358		0.00	0.000	0.039	0.3694	4.4344	0.0000	2.88E-02	0.0000	0.0000	3.52E-02
359		0.00	0.000	0.034	0.3589	4.2427	0.0000	2.86E-02	0.0000	0.0000	2.90E-02
360		0.00	0.000	0.036	0.3482	4.0200	0.0000	2.83E-02	0.0000	0.0000	3.01E-02
361		0.00	0.000	0.046	0.3358	3.8783	0.0000	2.81E-02	0.0000	0.0000	1.39E-02
362		0.00	0.000	0.049	0.3231	3.7133	0.0000	2.79E-02	0.0000	0.0000	3.57E-02
363		0.59	0.000	0.052	0.4082	3.6735	0.0000	2.79E-02	0.0000	0.0000	3.65E-02
364		0.24	0.000	0.057	0.4337	5.0323	0.0000	2.96E-02	0.0000	0.0000	1.41E-02
365		0.00	0.000	0.045	0.4211	5.5085	0.0000	3.02E-02	0.0000	0.0000	4.54E-02

* = Frozen (air or soil)

Annual Totals for Year 4			
	inches	cubic feet	percent
Precipitation	38.13	6,920,595.0	100.00
Runoff	7.428	1,348,141.3	19.48
Evapotranspiration	24.752	4,492,535.2	64.92
Percolation/Leakage through Layer 2	6.171175	1,120,068.2	16.18
Average Head on Top of Layer 2	2.0751	---	---
Percolation/Leakage through Layer 3	6.175277	1,120,812.8	16.20
Change in Water Storage	-0.2253	-40,894.3	-0.59
Soil Water at Start of Year	115.9434	##########	304.07
Soil Water at End of Year	115.7181	##########	303.48
Snow Water at Start of Year	0.0000	0.0000	0.00
Snow Water at End of Year	0.0000	0.0000	0.00
Annual Water Budget Balance	0.0000	0.0000	0.00

Daily Output for Year 5

Column key: Head #1: drainage from Layer 2

Title: Keystone

Simulated On: 2/10/2022 18:26

Leak #1: leakage thru Layer 2

Leak #2: leakage thru Layer 3

Day	Freezing Status* Air	Freezing Status* Soil	Rain (inches)	Runoff (inches)	ET (inches)	Evap. Zone Water (in/in)	Head #1 (inches)	Drain #1 (inches)	Leak #1 (inches)	Head #2 (inches)	Drain #2 (inches)	Leak #2 (inches)
1			0.00	0.000	0.050	0.4029	5.1064	0.0000	2.97E-02	0.0000	0.0000	1.64E-02
2			0.00	0.000	0.042	0.3910	4.8472	0.0000	2.94E-02	0.0000	0.0000	3.72E-02
3			0.25	0.000	0.061	0.4176	4.7361	0.0000	2.92E-02	0.0000	0.0000	3.49E-02
4			0.19	0.000	0.066	0.4334	5.2921	0.0000	2.99E-02	0.0000	0.0000	2.88E-02
5			0.00	0.000	0.048	0.4204	5.4504	0.0000	3.01E-02	0.0000	0.0000	2.87E-02
6			0.00	0.000	0.047	0.4076	5.1709	0.0000	2.98E-02	0.0000	0.0000	1.87E-02
7			0.42	0.069	0.049	0.4530	5.3371	0.0000	3.00E-02	0.0000	0.0000	3.72E-02
8			0.00	0.000	0.042	0.4408	5.8957	0.0000	3.07E-02	0.0000	0.0000	3.45E-02
9	*		0.00	0.000	0.038	0.4294	5.6326	0.0000	3.04E-02	0.0000	0.0000	2.86E-02
10			0.00	0.000	0.047	0.4165	5.3733	0.0000	3.00E-02	0.0000	0.0000	3.15E-02
11			0.00	0.000	0.064	0.4010	5.0615	0.0000	2.96E-02	0.0000	0.0000	1.91E-02
12			0.29	0.000	0.088	0.4298	5.0110	0.0000	2.96E-02	0.0000	0.0000	3.71E-02
13			0.00	0.000	0.056	0.4154	5.4041	0.0000	3.01E-02	0.0000	0.0000	3.48E-02
14			0.06	0.000	0.055	0.4112	5.0724	0.0000	2.96E-02	0.0000	0.0000	2.86E-02
15			0.00	0.000	0.059	0.3965	4.8812	0.0000	2.94E-02	0.0000	0.0000	3.11E-02
16			0.00	0.000	0.061	0.3815	4.6597	0.0000	2.91E-02	0.0000	0.0000	1.71E-02
17			0.00	0.000	0.044	0.3692	4.4282	0.0000	2.88E-02	0.0000	0.0000	3.65E-02
18	*		0.35	0.000	0.032	0.3678	4.2574	0.0000	2.86E-02	0.0000	0.0000	3.54E-02
19			0.03	0.000	0.006	0.4166	4.3829	0.0000	2.88E-02	0.0000	0.0000	2.86E-02
20	*		0.00	0.000	0.041	0.4048	5.0513	0.0000	2.96E-02	0.0000	0.0000	3.68E-02
21	*		0.00	0.000	0.039	0.3934	4.8368	0.0000	2.93E-02	0.0000	0.0000	2.16E-02
22	*		0.00	0.000	0.043	0.3814	4.6357	0.0000	2.91E-02	0.0000	0.0000	2.67E-02
23	*		0.00	0.000	0.041	0.3697	4.4320	0.0000	2.88E-02	0.0000	0.0000	3.15E-02
24			0.00	0.000	0.050	0.3567	4.2242	0.0000	2.86E-02	0.0000	0.0000	1.55E-02
25			1.49	0.819	0.063	0.4530	5.0106	0.0000	2.96E-02	0.0000	0.0000	3.59E-02
26			0.00	0.000	0.057	0.4384	5.8763	0.0000	3.07E-02	0.0000	0.0000	3.87E-02
27			0.00	0.000	0.052	0.4247	5.5654	0.0000	3.03E-02	0.0000	0.0000	2.74E-02
28			0.00	0.000	0.052	0.4111	5.2702	0.0000	2.99E-02	0.0000	0.0000	2.80E-02

29		0.00	0.000	0.060	0.3962	4.9633	0.0000	2.95E-02	0.0000	0.0000	1.85E-02
30		0.00	0.000	0.049	0.3832	4.7219	0.0000	2.92E-02	0.0000	0.0000	3.70E-02
31		0.03	0.000	0.055	0.3743	4.5023	0.0000	2.89E-02	0.0000	0.0000	3.51E-02
32		0.11	0.000	0.054	0.3788	4.2827	0.0000	2.86E-02	0.0000	0.0000	2.92E-02
33		0.00	0.000	0.056	0.3647	4.0142	0.0000	2.83E-02	0.0000	0.0000	3.03E-02
34		0.00	0.000	0.070	0.3483	3.9013	0.0000	2.81E-02	0.0000	0.0000	1.39E-02
35		0.06	0.000	0.075	0.3411	3.7195	0.0000	2.79E-02	0.0000	0.0000	3.58E-02
36		0.08	0.000	0.064	0.3392	3.5441	0.0000	2.77E-02	0.0000	0.0000	3.71E-02
37		0.64	0.000	0.053	0.4323	3.8773	0.0000	2.81E-02	0.0000	0.0000	1.87E-02
38		0.66	0.442	0.064	0.4530	5.8801	0.0000	3.07E-02	0.0000	0.0000	1.88E-02
39		0.00	0.000	0.056	0.4386	5.8773	0.0000	3.07E-02	0.0000	0.0000	3.83E-02
40		0.00	0.000	0.059	0.4238	5.5585	0.0000	3.03E-02	0.0000	0.0000	3.38E-02
41		0.29	0.025	0.059	0.4530	5.5701	0.0000	3.03E-02	0.0000	0.0000	3.05E-02
42		0.43	0.331	0.068	0.4530	6.0000	0.0000	3.08E-02	0.0000	0.0000	2.98E-02
43		0.08	0.075	0.070	0.4369	5.8638	0.0000	3.07E-02	0.0000	0.0000	2.04E-02
44		0.20	0.011	0.063	0.4530	5.7612	0.0000	3.05E-02	0.0000	0.0000	3.84E-02
45		0.00	0.000	0.054	0.4388	5.8787	0.0000	3.07E-02	0.0000	0.0000	3.40E-02
46	*	0.00	0.000	0.053	0.4250	5.5688	0.0000	3.03E-02	0.0000	0.0000	2.98E-02
47		0.00	0.000	0.051	0.4115	5.2723	0.0000	2.99E-02	0.0000	0.0000	3.17E-02
48		0.00	0.000	0.081	0.3931	4.9453	0.0000	2.95E-02	0.0000	0.0000	1.88E-02
49		0.00	0.000	0.063	0.3778	4.6584	0.0000	2.91E-02	0.0000	0.0000	3.70E-02
50		0.00	0.000	0.089	0.3581	4.3875	0.0000	2.88E-02	0.0000	0.0000	3.51E-02
51		0.00	0.000	0.060	0.3433	4.0838	0.0000	2.84E-02	0.0000	0.0000	2.92E-02
52	*	0.00	0.000	0.066	0.3277	3.8553	0.0000	2.81E-02	0.0000	0.0000	3.02E-02
53		0.00	0.000	0.075	0.3104	3.6621	0.0000	2.78E-02	0.0000	0.0000	3.27E-02
54		0.00	0.000	0.083	0.2921	3.3835	0.0000	2.75E-02	0.0000	0.0000	1.92E-02
55		0.00	0.000	0.077	0.2748	3.0101	0.0000	2.70E-02	0.0000	0.0000	2.70E-02
56		0.22	0.000	0.069	0.2955	2.8296	0.0000	2.68E-02	0.0000	0.0000	1.02E-02
57		0.12	0.000	0.069	0.2996	2.6876	0.0000	2.66E-02	0.0000	0.0000	4.01E-02
58		0.09	0.000	0.088	0.2955	2.5438	0.0000	2.64E-02	0.0000	0.0000	2.49E-02
59		0.00	0.000	0.064	0.2805	2.3994	0.0000	2.62E-02	0.0000	0.0000	1.50E-02
60		0.00	0.000	0.061	0.2660	2.2575	0.0000	2.60E-02	0.0000	0.0000	3.95E-02
61		0.00	0.000	0.079	0.2485	2.0695	0.0000	2.58E-02	0.0000	0.0000	2.57E-02
62		0.08	0.000	0.093	0.2420	1.9356	0.0000	2.56E-02	0.0000	0.0000	1.33E-02
63		0.05	0.000	0.081	0.2327	1.8223	0.0000	2.55E-02	0.0000	0.0000	3.86E-02
64		0.00	0.000	0.121	0.2082	1.6945	0.0000	2.53E-02	0.0000	0.0000	2.65E-02

65	0.00	0.000	0.098	0.1877	1.5679	0.0000	2.51E-02	0.0000	0.0000	1.17E-02
66	0.16	0.000	0.072	0.1982	1.4149	0.0000	2.49E-02	0.0000	0.0000	3.79E-02
67	0.00	0.000	0.102	0.1771	1.1763	0.0000	2.46E-02	0.0000	0.0000	2.73E-02
68	0.00	0.000	0.097	0.1568	0.9368	0.0000	2.43E-02	0.0000	0.0000	1.02E-02
69	0.00	0.000	0.124	0.1322	0.7932	0.0000	2.41E-02	0.0000	0.0000	3.67E-02
70	0.02	0.000	0.080	0.1182	0.5339	0.0000	2.38E-02	0.0000	0.0000	2.84E-02
71	0.00	0.000	0.059	0.1044	0.2080	0.0000	2.34E-02	0.0000	0.0000	7.87E-03
72	0.00	0.000	0.049	0.0962	0.0064	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
73	0.26	0.000	0.048	0.1316	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
74	0.12	0.000	0.044	0.1443	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
75	0.11	0.000	0.040	0.1559	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
76	0.00	0.000	0.102	0.1389	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
77	0.00	0.000	0.033	0.1335	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
78	0.24	0.000	0.033	0.1680	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
79	0.56	0.000	0.096	0.2453	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
80	0.00	0.000	0.114	0.2223	0.3689	0.0000	2.36E-02	0.0000	0.0000	3.15E-02
81	0.06	0.000	0.155	0.2024	0.5000	0.0000	2.38E-02	0.0000	0.0000	3.29E-02
82	0.00	0.000	0.122	0.1782	0.4971	0.0000	2.38E-02	0.0000	0.0000	1.23E-02
83	0.35	0.000	0.068	0.2213	0.4659	0.0000	2.37E-02	0.0000	0.0000	2.42E-02
84	0.00	0.000	0.099	0.2009	0.3964	0.0000	2.36E-02	0.0000	0.0000	2.89E-02
85	0.30	0.000	0.075	0.2345	0.2982	0.0000	2.35E-02	0.0000	0.0000	1.84E-02
86	0.00	0.000	0.114	0.2117	0.2091	0.0000	2.34E-02	0.0000	0.0000	3.23E-02
87	0.00	0.000	0.123	0.1872	0.1651	0.0000	2.33E-02	0.0000	0.0000	2.20E-02
88	0.65	0.000	0.080	0.2783	0.1842	0.0000	2.34E-02	0.0000	0.0000	1.57E-02
89	0.00	0.000	0.078	0.2611	1.1900	0.0000	2.47E-02	0.0000	0.0000	2.43E-02
90	0.00	0.000	0.140	0.2337	1.4376	0.0000	2.50E-02	0.0000	0.0000	3.63E-02
91	0.09	0.000	0.094	0.2288	1.4178	0.0000	2.50E-02	0.0000	0.0000	1.21E-02
92	0.00	0.000	0.085	0.2105	1.3279	0.0000	2.48E-02	0.0000	0.0000	3.99E-02
93	0.00	0.000	0.142	0.1828	1.1977	0.0000	2.47E-02	0.0000	0.0000	0.00E+00
94	0.00	0.000	0.145	0.1546	1.0132	0.0000	2.44E-02	0.0000	0.0000	4.02E-02
95	0.02	0.000	0.116	0.1346	0.8380	0.0000	2.42E-02	0.0000	0.0000	2.78E-02
96	0.00	0.000	0.140	0.1073	0.4781	0.0000	2.37E-02	0.0000	0.0000	9.14E-03
97	0.00	0.000	0.133	0.0852	0.0246	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
98	0.04	0.000	0.015	0.0893	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
99	0.04	0.000	0.015	0.0935	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
100	0.09	0.000	0.030	0.1035	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00

101	0.00	0.000	0.021	0.0999	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
102	0.00	0.000	0.030	0.0949	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
103	0.21	0.000	0.031	0.1248	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
104	1.97	0.000	0.039	0.4456	0.2264	0.0000	6.07E-03	0.0000	0.0000	2.35E-02
105	0.12	0.000	0.140	0.4371	5.7254	0.0000	3.05E-02	0.0000	0.0000	2.50E-02
106	0.05	0.000	0.160	0.4138	5.4333	0.0000	3.01E-02	0.0000	0.0000	2.64E-02
107	0.00	0.000	0.141	0.3854	4.9023	0.0000	2.94E-02	0.0000	0.0000	3.07E-02
108	0.00	0.000	0.092	0.3652	4.5103	0.0000	2.89E-02	0.0000	0.0000	1.77E-02
109	0.05	0.000	0.120	0.3489	4.1518	0.0000	2.85E-02	0.0000	0.0000	3.63E-02
110	0.00	0.000	0.130	0.3225	3.8700	0.0000	2.81E-02	0.0000	0.0000	3.57E-02
111	0.00	0.000	0.142	0.2943	3.5467	0.0000	2.77E-02	0.0000	0.0000	2.83E-02
112	0.03	0.000	0.124	0.2741	3.0161	0.0000	2.70E-02	0.0000	0.0000	7.46E-03
113	0.00	0.000	0.162	0.2427	2.6780	0.0000	2.66E-02	0.0000	0.0000	4.01E-02
114	0.65	0.000	0.115	0.3276	2.2825	0.0000	2.61E-02	0.0000	0.0000	2.51E-02
115	0.52	0.000	0.090	0.3947	3.0376	0.0000	2.70E-02	0.0000	0.0000	1.44E-02
116	0.03	0.000	0.149	0.3700	4.4157	0.0000	2.88E-02	0.0000	0.0000	3.96E-02
117	0.43	0.000	0.084	0.4228	4.4163	0.0000	2.88E-02	0.0000	0.0000	3.53E-02
118	0.03	0.000	0.104	0.4054	5.1373	0.0000	2.97E-02	0.0000	0.0000	2.84E-02
119	0.00	0.000	0.110	0.3822	4.8128	0.0000	2.93E-02	0.0000	0.0000	2.90E-02
120	0.00	0.000	0.153	0.3519	4.4589	0.0000	2.89E-02	0.0000	0.0000	1.70E-02
121	1.24	0.508	0.095	0.4530	4.9768	0.0000	2.95E-02	0.0000	0.0000	3.60E-02
122	0.10	0.097	0.148	0.4239	5.7590	0.0000	3.05E-02	0.0000	0.0000	3.49E-02
123	0.00	0.000	0.204	0.3850	5.0672	0.0000	2.96E-02	0.0000	0.0000	2.80E-02
124	0.36	0.000	0.171	0.4116	4.6117	0.0000	2.91E-02	0.0000	0.0000	3.23E-02
125	0.04	0.000	0.244	0.3726	4.7687	0.0000	2.93E-02	0.0000	0.0000	1.63E-02
126	0.04	0.000	0.128	0.3533	4.2331	0.0000	2.86E-02	0.0000	0.0000	3.67E-02
127	0.36	0.000	0.084	0.3945	4.0029	0.0000	2.83E-02	0.0000	0.0000	3.56E-02
128	0.00	0.000	0.197	0.3569	4.3622	0.0000	2.87E-02	0.0000	0.0000	2.84E-02
129	0.21	0.000	0.097	0.3711	3.9276	0.0000	2.82E-02	0.0000	0.0000	2.79E-02
130	0.00	0.000	0.125	0.3455	3.8303	0.0000	2.81E-02	0.0000	0.0000	1.66E-02
131	0.00	0.000	0.168	0.3130	3.6351	0.0000	2.78E-02	0.0000	0.0000	3.23E-02
132	0.02	0.000	0.150	0.2868	3.2707	0.0000	2.73E-02	0.0000	0.0000	3.68E-02
133	0.00	0.000	0.150	0.2573	2.8917	0.0000	2.68E-02	0.0000	0.0000	3.28E-02
134	0.00	0.000	0.206	0.2186	2.3965	0.0000	2.62E-02	0.0000	0.0000	0.00E+00
135	0.00	0.000	0.159	0.1879	1.8042	0.0000	2.54E-02	0.0000	0.0000	4.02E-02
136	0.00	0.000	0.190	0.1521	1.2505	0.0000	2.47E-02	0.0000	0.0000	2.66E-02

137	0.00	0.000	0.081	0.1346	0.8630	0.0000	2.42E-02	0.0000	0.0000	1.16E-02
138	0.00	0.000	0.061	0.1204	0.6102	0.0000	2.39E-02	0.0000	0.0000	3.68E-02
139	0.00	0.000	0.052	0.1077	0.2996	0.0000	2.35E-02	0.0000	0.0000	1.83E-02
140	0.00	0.000	0.047	0.0986	0.0428	0.0000	7.73E-03	0.0000	0.0000	9.29E-03
141	0.00	0.000	0.043	0.0914	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
142	0.00	0.000	0.038	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
143	0.36	0.000	0.019	0.1419	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
144	0.19	0.000	0.029	0.1687	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
145	0.00	0.000	0.030	0.1637	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
146	0.00	0.000	0.030	0.1587	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
147	0.00	0.000	0.030	0.1537	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
148	0.00	0.000	0.030	0.1487	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
149	0.08	0.000	0.033	0.1566	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
150	0.00	0.000	0.030	0.1516	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
151	0.00	0.000	0.030	0.1467	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
152	0.00	0.000	0.029	0.1418	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
153	0.00	0.000	0.029	0.1370	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
154	0.00	0.000	0.026	0.1327	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
155	0.00	0.000	0.028	0.1280	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
156	2.18	0.188	0.035	0.4530	0.9358	0.0000	6.99E-03	0.0000	0.0000	0.00E+00
157	0.61	0.377	0.203	0.4530	6.0000	0.0000	3.08E-02	0.0000	0.0000	4.60E-02
158	0.00	0.000	0.259	0.4048	5.6027	0.0000	3.03E-02	0.0000	0.0000	2.20E-02
159	0.00	0.000	0.294	0.3510	4.6248	0.0000	2.91E-02	0.0000	0.0000	1.91E-02
160	0.00	0.000	0.280	0.2996	3.7544	0.0000	2.80E-02	0.0000	0.0000	3.67E-02
161	0.00	0.000	0.250	0.2535	2.9872	0.0000	2.70E-02	0.0000	0.0000	3.60E-02
162	0.09	0.000	0.286	0.2164	2.2762	0.0000	2.61E-02	0.0000	0.0000	3.98E-02
163	0.88	0.000	0.205	0.3247	1.8408	0.0000	2.55E-02	0.0000	0.0000	8.01E-03
164	0.00	0.000	0.294	0.2712	2.3247	0.0000	2.61E-02	0.0000	0.0000	2.80E-02
165	0.00	0.000	0.279	0.2205	2.2047	0.0000	2.60E-02	0.0000	0.0000	8.24E-03
166	0.00	0.000	0.141	0.1927	1.8742	0.0000	2.55E-02	0.0000	0.0000	3.89E-02
167	0.00	0.000	0.202	0.1550	1.3357	0.0000	2.48E-02	0.0000	0.0000	2.66E-02
168	0.00	0.000	0.093	0.1354	0.8879	0.0000	2.43E-02	0.0000	0.0000	1.18E-02
169	0.39	0.000	0.077	0.1836	0.6564	0.0000	2.40E-02	0.0000	0.0000	3.69E-02
170	0.05	0.000	0.072	0.1760	0.4355	0.0000	2.37E-02	0.0000	0.0000	2.86E-02
171	0.02	0.000	0.065	0.1647	0.2833	0.0000	2.35E-02	0.0000	0.0000	7.38E-03
172	0.93	0.000	0.062	0.3055	0.1705	0.0000	2.33E-02	0.0000	0.0000	3.15E-02

173	0.16	0.000	0.279	0.2815	1.6184	0.0000	2.52E-02	0.0000	0.0000	3.19E-02
174	0.00	0.000	0.255	0.2347	1.8153	0.0000	2.55E-02	0.0000	0.0000	1.37E-02
175	0.21	0.000	0.234	0.2265	1.7012	0.0000	2.53E-02	0.0000	0.0000	3.37E-02
176	0.00	0.000	0.248	0.1809	1.4727	0.0000	2.50E-02	0.0000	0.0000	2.55E-02
177	0.17	0.000	0.219	0.1686	1.1101	0.0000	2.46E-02	0.0000	0.0000	1.70E-02
178	0.00	0.000	0.219	0.1281	0.7738	0.0000	2.41E-02	0.0000	0.0000	3.44E-02
179	0.00	0.000	0.204	0.0921	0.2356	0.0000	1.18E-02	0.0000	0.0000	2.49E-03
180	0.00	0.000	0.041	0.0852	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
181	0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
182	0.26	0.000	0.042	0.1214	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
183	0.24	0.000	0.056	0.1521	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
184	0.00	0.000	0.061	0.1419	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
185	0.00	0.000	0.068	0.1305	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
186	0.00	0.000	0.066	0.1195	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
187	0.00	0.000	0.064	0.1089	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
188	1.40	0.000	0.073	0.3300	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
189	0.01	0.000	0.176	0.2979	2.4782	0.0000	2.63E-02	0.0000	0.0000	3.52E-02
190	0.00	0.000	0.298	0.2438	2.6497	0.0000	2.65E-02	0.0000	0.0000	1.97E-02
191	0.00	0.000	0.275	0.1936	2.0542	0.0000	2.58E-02	0.0000	0.0000	2.08E-02
192	0.06	0.000	0.232	0.1609	1.3521	0.0000	2.49E-02	0.0000	0.0000	3.32E-02
193	0.00	0.000	0.238	0.1172	0.7227	0.0000	2.41E-02	0.0000	0.0000	2.79E-02
194	0.02	0.000	0.206	0.0853	0.1057	0.0000	5.88E-03	0.0000	0.0000	1.75E-03
195	0.00	0.000	0.001	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
196	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
197	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
198	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
199	0.01	0.000	0.010	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
200	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
201	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
202	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
203	0.21	0.000	0.043	0.1128	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
204	0.81	0.000	0.064	0.2371	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
205	0.03	0.000	0.226	0.2015	0.0893	0.0000	1.75E-02	0.0000	0.0000	2.30E-02
206	0.14	0.000	0.219	0.1845	0.2019	0.0000	2.34E-02	0.0000	0.0000	1.36E-02
207	0.00	0.000	0.246	0.1396	0.1977	0.0000	2.34E-02	0.0000	0.0000	2.47E-02
208	0.00	0.000	0.246	0.0975	0.0552	0.0000	7.00E-03	0.0000	0.0000	2.01E-02

209	0.00	0.000	0.074	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
210	0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
211	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
212	0.08	0.000	0.018	0.0953	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
213	0.42	0.000	0.059	0.1554	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
214	0.00	0.000	0.063	0.1450	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
215	0.00	0.000	0.087	0.1305	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
216	0.24	0.000	0.080	0.1572	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
217	2.32	0.455	0.083	0.4530	1.2483	0.0000	7.39E-03	0.0000	0.0000	0.00E+00
218	0.00	0.000	0.272	0.4026	5.5848	0.0000	3.03E-02	0.0000	0.0000	2.77E-02
219	0.97	0.440	0.198	0.4530	5.5749	0.0000	3.03E-02	0.0000	0.0000	2.68E-02
220	0.25	0.239	0.186	0.4188	5.7175	0.0000	3.05E-02	0.0000	0.0000	1.89E-02
221	0.00	0.000	0.237	0.3744	4.9497	0.0000	2.95E-02	0.0000	0.0000	3.83E-02
222	0.00	0.000	0.265	0.3255	4.1712	0.0000	2.85E-02	0.0000	0.0000	3.47E-02
223	0.00	0.000	0.287	0.2731	3.3727	0.0000	2.75E-02	0.0000	0.0000	3.07E-02
224	0.00	0.000	0.269	0.2238	2.5445	0.0000	2.64E-02	0.0000	0.0000	7.32E-03
225	3.51	1.840	0.266	0.4530	3.9729	0.0000	2.82E-02	0.0000	0.0000	3.94E-02
226	0.56	0.548	0.189	0.4184	5.7146	0.0000	3.05E-02	0.0000	0.0000	3.59E-02
227	0.49	0.053	0.200	0.4530	5.5322	0.0000	3.02E-02	0.0000	0.0000	3.34E-02
228	0.18	0.095	0.150	0.4371	5.8679	0.0000	3.07E-02	0.0000	0.0000	2.43E-02
229	1.06	0.775	0.159	0.4530	5.9109	0.0000	3.07E-02	0.0000	0.0000	1.79E-02
230	0.26	0.247	0.200	0.4168	5.7012	0.0000	3.05E-02	0.0000	0.0000	3.84E-02
231	0.00	0.000	0.241	0.3718	4.9096	0.0000	2.94E-02	0.0000	0.0000	3.39E-02
232	0.63	0.000	0.224	0.4346	4.6051	0.0000	2.90E-02	0.0000	0.0000	3.12E-02
233	0.00	0.000	0.223	0.3925	5.2758	0.0000	2.99E-02	0.0000	0.0000	2.92E-02
234	0.00	0.000	0.202	0.3541	4.5346	0.0000	2.90E-02	0.0000	0.0000	1.77E-02
235	0.03	0.000	0.231	0.3159	3.9078	0.0000	2.82E-02	0.0000	0.0000	3.64E-02
236	0.15	0.000	0.223	0.2992	3.4260	0.0000	2.75E-02	0.0000	0.0000	3.59E-02
237	0.03	0.000	0.218	0.2633	2.9268	0.0000	2.69E-02	0.0000	0.0000	3.74E-02
238	0.10	0.000	0.225	0.2381	2.4957	0.0000	2.63E-02	0.0000	0.0000	0.00E+00
239	0.00	0.000	0.185	0.2029	1.9376	0.0000	2.56E-02	0.0000	0.0000	3.63E-02
240	0.00	0.000	0.225	0.1612	1.4919	0.0000	2.50E-02	0.0000	0.0000	2.66E-02
241	0.76	0.000	0.152	0.2584	0.9287	0.0000	2.43E-02	0.0000	0.0000	1.18E-02
242	0.15	0.000	0.178	0.2498	0.8267	0.0000	2.42E-02	0.0000	0.0000	3.70E-02
243	0.00	0.000	0.224	0.2084	0.7580	0.0000	2.41E-02	0.0000	0.0000	2.83E-02
244	0.12	0.000	0.105	0.2069	0.7234	0.0000	2.41E-02	0.0000	0.0000	8.07E-03

245	0.01	0.000	0.109	0.1864	0.6806	0.0000	2.40E-02	0.0000	0.0000	3.61E-02
246	0.12	0.000	0.148	0.1778	0.6044	0.0000	2.39E-02	0.0000	0.0000	2.86E-02
247	1.57	0.000	0.144	0.4114	0.8486	0.0000	2.42E-02	0.0000	0.0000	7.36E-03
248	0.00	0.000	0.196	0.3738	4.7057	0.0000	2.92E-02	0.0000	0.0000	4.43E-02
249	0.00	0.000	0.212	0.3338	4.1659	0.0000	2.85E-02	0.0000	0.0000	2.98E-02
250	0.00	0.000	0.199	0.2959	3.5889	0.0000	2.77E-02	0.0000	0.0000	2.86E-02
251	0.00	0.000	0.185	0.2606	3.0078	0.0000	2.70E-02	0.0000	0.0000	1.98E-02
252	0.00	0.000	0.192	0.2243	2.4971	0.0000	2.63E-02	0.0000	0.0000	1.87E-02
253	0.03	0.000	0.168	0.1970	1.8927	0.0000	2.56E-02	0.0000	0.0000	3.27E-02
254	0.63	0.000	0.138	0.2748	1.6563	0.0000	2.53E-02	0.0000	0.0000	2.73E-02
255	0.00	0.000	0.139	0.2475	1.4326	0.0000	2.50E-02	0.0000	0.0000	1.79E-02
256	0.00	0.000	0.114	0.2244	1.3303	0.0000	2.48E-02	0.0000	0.0000	3.40E-02
257	0.00	0.000	0.149	0.1955	1.2807	0.0000	2.48E-02	0.0000	0.0000	2.52E-02
258	0.00	0.000	0.165	0.1639	1.1264	0.0000	2.46E-02	0.0000	0.0000	1.56E-02
259	0.00	0.000	0.125	0.1389	0.9572	0.0000	2.44E-02	0.0000	0.0000	3.44E-02
260	0.00	0.000	0.127	0.1137	0.6151	0.0000	2.39E-02	0.0000	0.0000	2.55E-02
261	0.14	0.000	0.127	0.1130	0.1342	0.0000	1.75E-02	0.0000	0.0000	1.64E-02
262	0.03	0.000	0.155	0.0921	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
263	0.00	0.000	0.033	0.0867	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
264	0.00	0.000	0.007	0.0855	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
265	0.00	0.000	0.002	0.0851	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
266	0.00	0.000	0.001	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
267	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
268	0.00	0.000	0.000	0.0850	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
269	0.14	0.000	0.040	0.1017	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
270	0.96	0.000	0.055	0.2526	0.0000	0.0000	0.00E+00	0.0000	0.0000	0.00E+00
271	0.06	0.000	0.112	0.2410	0.3646	0.0000	1.78E-02	0.0000	0.0000	0.00E+00
272	0.05	0.000	0.146	0.2210	0.6224	0.0000	2.39E-02	0.0000	0.0000	3.81E-02
273	0.65	0.000	0.088	0.3107	0.7016	0.0000	2.40E-02	0.0000	0.0000	2.85E-02
274	0.09	0.000	0.130	0.2997	2.2154	0.0000	2.60E-02	0.0000	0.0000	7.10E-03
275	0.05	0.000	0.111	0.2852	2.3596	0.0000	2.62E-02	0.0000	0.0000	3.78E-02
276	0.11	0.000	0.124	0.2785	2.2189	0.0000	2.60E-02	0.0000	0.0000	2.56E-02
277	0.00	0.000	0.095	0.2583	1.9801	0.0000	2.57E-02	0.0000	0.0000	1.36E-02
278	0.00	0.000	0.086	0.2397	1.8971	0.0000	2.56E-02	0.0000	0.0000	3.87E-02
279	0.03	0.000	0.097	0.2243	1.7754	0.0000	2.54E-02	0.0000	0.0000	2.64E-02
280	0.00	0.000	0.094	0.2045	1.6502	0.0000	2.53E-02	0.0000	0.0000	1.20E-02

281	0.00	0.000	0.097	0.1842	1.5223	0.0000	2.51E-02	0.0000	0.0000	3.80E-02
282	0.00	0.000	0.100	0.1634	1.2721	0.0000	2.48E-02	0.0000	0.0000	2.71E-02
283	0.00	0.000	0.087	0.1449	0.9503	0.0000	2.44E-02	0.0000	0.0000	1.06E-02
284	0.00	0.000	0.070	0.1291	0.7815	0.0000	2.41E-02	0.0000	0.0000	3.68E-02
285	0.63	0.000	0.072	0.2181	0.5496	0.0000	2.38E-02	0.0000	0.0000	2.84E-02
286	0.76	0.000	0.068	0.3295	0.6567	0.0000	2.40E-02	0.0000	0.0000	7.72E-03
287	0.02	0.000	0.072	0.3165	2.6064	0.0000	2.65E-02	0.0000	0.0000	3.57E-02
288	0.00	0.000	0.081	0.2985	2.8083	0.0000	2.67E-02	0.0000	0.0000	3.78E-02
289	0.00	0.000	0.085	0.2799	2.6887	0.0000	2.66E-02	0.0000	0.0000	2.31E-02
290	0.23	0.000	0.067	0.3026	2.5401	0.0000	2.64E-02	0.0000	0.0000	3.44E-02
291	0.00	0.000	0.071	0.2865	2.4067	0.0000	2.62E-02	0.0000	0.0000	4.28E-03
292	0.00	0.000	0.064	0.2715	2.2626	0.0000	2.60E-02	0.0000	0.0000	3.32E-02
293	0.00	0.000	0.056	0.2578	2.0740	0.0000	2.58E-02	0.0000	0.0000	2.52E-02
294	0.00	0.000	0.071	0.2418	1.9453	0.0000	2.56E-02	0.0000	0.0000	1.94E-02
295	0.00	0.000	0.071	0.2258	1.8470	0.0000	2.55E-02	0.0000	0.0000	3.34E-02
296	0.00	0.000	0.074	0.2092	1.7262	0.0000	2.53E-02	0.0000	0.0000	2.57E-02
297	0.00	0.000	0.077	0.1922	1.6050	0.0000	2.52E-02	0.0000	0.0000	1.77E-02
298	0.00	0.000	0.057	0.1786	1.4571	0.0000	2.50E-02	0.0000	0.0000	3.38E-02
299	0.09	0.000	0.058	0.1798	1.2532	0.0000	2.47E-02	0.0000	0.0000	2.56E-02
300	0.00	0.000	0.040	0.1691	1.0453	0.0000	2.45E-02	0.0000	0.0000	1.59E-02
301	0.00	0.000	0.059	0.1553	0.9155	0.0000	2.43E-02	0.0000	0.0000	3.45E-02
302	0.00	0.000	0.058	0.1416	0.8160	0.0000	2.42E-02	0.0000	0.0000	2.50E-02
303	2.21	0.255	0.062	0.4530	1.6235	0.0000	2.52E-02	0.0000	0.0000	1.31E-02
304	0.23	0.139	0.061	0.4530	6.0000	0.0000	3.08E-02	0.0000	0.0000	3.43E-02
305	0.00	0.000	0.048	0.4399	5.8879	0.0000	3.07E-02	0.0000	0.0000	2.88E-02
306	0.40	0.234	0.057	0.4530	5.9216	0.0000	3.07E-02	0.0000	0.0000	3.09E-02
307	0.00	0.000	0.054	0.4389	5.8790	0.0000	3.07E-02	0.0000	0.0000	2.06E-02
308	0.00	0.000	0.058	0.4241	5.5627	0.0000	3.03E-02	0.0000	0.0000	3.85E-02
309	0.00	0.000	0.060	0.4092	5.2437	0.0000	2.99E-02	0.0000	0.0000	3.41E-02
310	0.00	0.000	0.063	0.3939	4.9171	0.0000	2.94E-02	0.0000	0.0000	3.03E-02
311	0.00	0.000	0.067	0.3779	4.6712	0.0000	2.91E-02	0.0000	0.0000	3.11E-02
312	0.00	0.000	0.067	0.3620	4.4134	0.0000	2.88E-02	0.0000	0.0000	1.64E-02
313	0.00	0.000	0.068	0.3460	4.1330	0.0000	2.84E-02	0.0000	0.0000	3.61E-02
314	0.00	0.000	0.069	0.3297	3.8851	0.0000	2.81E-02	0.0000	0.0000	3.57E-02
315	0.00	0.000	0.071	0.3133	3.6914	0.0000	2.79E-02	0.0000	0.0000	2.65E-02
316	1.91	0.975	0.067	0.4530	4.7741	0.0000	2.93E-02	0.0000	0.0000	3.40E-02

317	0.83	0.819	0.065	0.4390	5.8798	0.0000	3.07E-02	0.0000	0.0000	2.54E-02
318	0.01	0.000	0.064	0.4250	5.5712	0.0000	3.03E-02	0.0000	0.0000	2.64E-02
319	0.00	0.000	0.054	0.4109	5.2673	0.0000	2.99E-02	0.0000	0.0000	3.01E-02
320	0.36	0.021	0.056	0.4530	5.3263	0.0000	3.00E-02	0.0000	0.0000	1.84E-02
321	0.00	0.000	0.060	0.4380	5.8724	0.0000	3.07E-02	0.0000	0.0000	3.73E-02
322	0.00	0.000	0.048	0.4250	5.5612	0.0000	3.03E-02	0.0000	0.0000	3.39E-02
323	0.00	0.000	0.040	0.4134	5.2913	0.0000	2.99E-02	0.0000	0.0000	3.05E-02
324	0.00	0.000	0.038	0.4021	5.0337	0.0000	2.96E-02	0.0000	0.0000	3.14E-02
325	0.00	0.000	0.052	0.3885	4.8152	0.0000	2.93E-02	0.0000	0.0000	1.78E-02
326	0.00	0.000	0.050	0.3754	4.5904	0.0000	2.90E-02	0.0000	0.0000	3.68E-02
327	0.00	0.000	0.051	0.3621	4.3696	0.0000	2.87E-02	0.0000	0.0000	3.52E-02
328	0.01	0.000	0.061	0.3489	4.1288	0.0000	2.84E-02	0.0000	0.0000	2.90E-02
329	0.00	0.000	0.044	0.3370	3.9183	0.0000	2.82E-02	0.0000	0.0000	3.01E-02
330	0.01	0.000	0.053	0.3251	3.7569	0.0000	2.80E-02	0.0000	0.0000	3.53E-02
331	0.08	0.000	0.068	0.3225	3.5867	0.0000	2.77E-02	0.0000	0.0000	1.42E-02
332	0.00	0.000	0.051	0.3093	3.4145	0.0000	2.75E-02	0.0000	0.0000	2.44E-02
333	0.00	0.000	0.050	0.2964	3.2485	0.0000	2.73E-02	0.0000	0.0000	3.90E-02
334	0.00	0.000	0.042	0.2849	3.0579	0.0000	2.71E-02	0.0000	0.0000	2.84E-02
335	2.74	1.644	0.059	0.4530	4.4761	0.0000	2.89E-02	0.0000	0.0000	1.91E-02
336	0.00	0.000	0.043	0.4407	5.8950	0.0000	3.07E-02	0.0000	0.0000	1.80E-02
337	0.00	0.000	0.039	0.4291	5.6289	0.0000	3.04E-02	0.0000	0.0000	3.84E-02
338	0.00	0.000	0.038	0.4177	5.3781	0.0000	3.00E-02	0.0000	0.0000	3.41E-02
339	0.29	0.000	0.053	0.4522	5.4404	0.0000	3.01E-02	0.0000	0.0000	3.01E-02
340	0.61	0.523	0.051	0.4530	5.9956	0.0000	3.08E-02	0.0000	0.0000	2.93E-02
341	0.00	0.000	0.038	0.4416	5.9021	0.0000	3.07E-02	0.0000	0.0000	2.01E-02
342	0.00	0.000	0.032	0.4312	5.6570	0.0000	3.04E-02	0.0000	0.0000	3.85E-02
343	0.00	0.000	0.033	0.4206	5.4284	0.0000	3.01E-02	0.0000	0.0000	3.40E-02
344	0.00	0.000	0.034	0.4099	5.1973	0.0000	2.98E-02	0.0000	0.0000	3.02E-02
345	0.00	0.000	0.035	0.3992	4.9466	0.0000	2.95E-02	0.0000	0.0000	3.12E-02
346	0.00	0.000	0.038	0.3880	4.7677	0.0000	2.93E-02	0.0000	0.0000	1.74E-02
347	0.00	0.000	0.043	0.3759	4.5680	0.0000	2.90E-02	0.0000	0.0000	3.67E-02
348	0.00	0.000	0.052	0.3625	4.3551	0.0000	2.87E-02	0.0000	0.0000	3.52E-02
349	1.17	0.549	0.048	0.4530	5.1249	0.0000	2.97E-02	0.0000	0.0000	2.85E-02
350	0.00	0.000	0.033	0.4423	5.9087	0.0000	3.07E-02	0.0000	0.0000	2.69E-02
351	1.42	1.287	0.039	0.4530	5.9398	0.0000	3.08E-02	0.0000	0.0000	1.93E-02
352	0.02	0.013	0.038	0.4428	5.9123	0.0000	3.07E-02	0.0000	0.0000	3.84E-02

353		0.00	0.000	0.032	0.4324	5.6843	0.0000	3.04E-02	0.0000	0.0000	3.38E-02
354	*	0.00	0.000	0.028	0.4227	5.4635	0.0000	3.02E-02	0.0000	0.0000	3.05E-02
355		0.00	0.000	0.034	0.4120	5.2427	0.0000	2.99E-02	0.0000	0.0000	3.14E-02
356		0.02	0.000	0.044	0.4030	4.9899	0.0000	2.95E-02	0.0000	0.0000	1.85E-02
357		0.01	0.000	0.045	0.3923	4.8083	0.0000	2.93E-02	0.0000	0.0000	3.70E-02
358		0.00	0.000	0.036	0.3814	4.6526	0.0000	2.91E-02	0.0000	0.0000	3.50E-02
359		0.65	0.136	0.054	0.4530	5.1269	0.0000	2.97E-02	0.0000	0.0000	2.88E-02
360		0.39	0.337	0.049	0.4486	5.9625	0.0000	3.08E-02	0.0000	0.0000	2.75E-02
361	*	0.00	0.000	0.028	0.4389	5.8178	0.0000	3.06E-02	0.0000	0.0000	1.96E-02
362		0.00	0.000	0.031	0.4287	5.5999	0.0000	3.03E-02	0.0000	0.0000	3.83E-02
363		0.00	0.000	0.038	0.4174	5.3685	0.0000	3.00E-02	0.0000	0.0000	3.41E-02
364		0.00	0.000	0.038	0.4062	5.1116	0.0000	2.97E-02	0.0000	0.0000	3.02E-02
365		0.00	0.000	0.034	0.3956	4.8891	0.0000	2.94E-02	0.0000	0.0000	3.11E-02

* = Frozen (air or soil)

Annual Totals for Year 5			
	inches	cubic feet	percent
Precipitation	57.38	##########	100.00
Runoff	14.564	2,643,324.9	25.38
Evapotranspiration	34.876	6,330,054.0	60.78
Percolation/Leakage through Layer 2	8.062918	1,463,419.6	14.05
Average Head on Top of Layer 2	2.7227	---	---
Percolation/Leakage through Layer 3	8.062386	1,463,323.1	14.05
Change in Water Storage	-0.1225	-22,231.9	-0.21
Soil Water at Start of Year	115.7181	##########	201.67
Soil Water at End of Year	115.5956	##########	201.46
Snow Water at Start of Year	0.0000	0.0000	0.00
Snow Water at End of Year	0.0000	0.0000	0.00
Annual Water Budget Balance	0.0000	0.0000	0.00

Average Annual Totals Summary

Title: Keystone
Simulated on: 2/10/2022 18:26

	Average Annual Totals for Years 1 - 5*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	49.23	[14.96]	8,934,519.0	100.00
Runoff	13.113	[11.432]	2,379,972.8	26.64
Evapotranspiration	29.595	[4.015]	5,371,549.5	60.12
Subprofile1				
Percolation/leakage through Layer 2	6.563270	[0.980384]	1,191,233.5	13.33
Average Head on Top of Layer 2	2.1290	[0.4719]	---	---
Subprofile2				
Percolation/leakage through Layer 3	6.566065	[0.973416]	1,191,740.7	13.34
Water storage				
Change in water storage	-0.0482	[1.311]	-8,744.1	-0.10

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Keystone
Simulated on: 2/10/2022 18:26

	Peak Values for Years 1 - 5*	
	(inches)	(cubic feet)
Precipitation	4.79	869,385.0
Runoff	4.064	737,644.9
Subprofile1		
Percolation/leakage through Layer 2	0.030841	5,597.6
Average head on Layer 2	6.0000	
Subprofile2		
Percolation/leakage through Layer 3	0.055467	10,067.2
Other Parameters		
Snow water	2.0636	374,537.2
Maximum vegetation soil water	0.4530 (vol/vol)	
Minimum vegetation soil water	0.0850 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Keystone
Simulated on: 2/10/2022 18:26
Simulation period: 5 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.3738	0.3956
2	8.1179	0.4510
3	105.1039	0.2920
Snow water	0.0000	---

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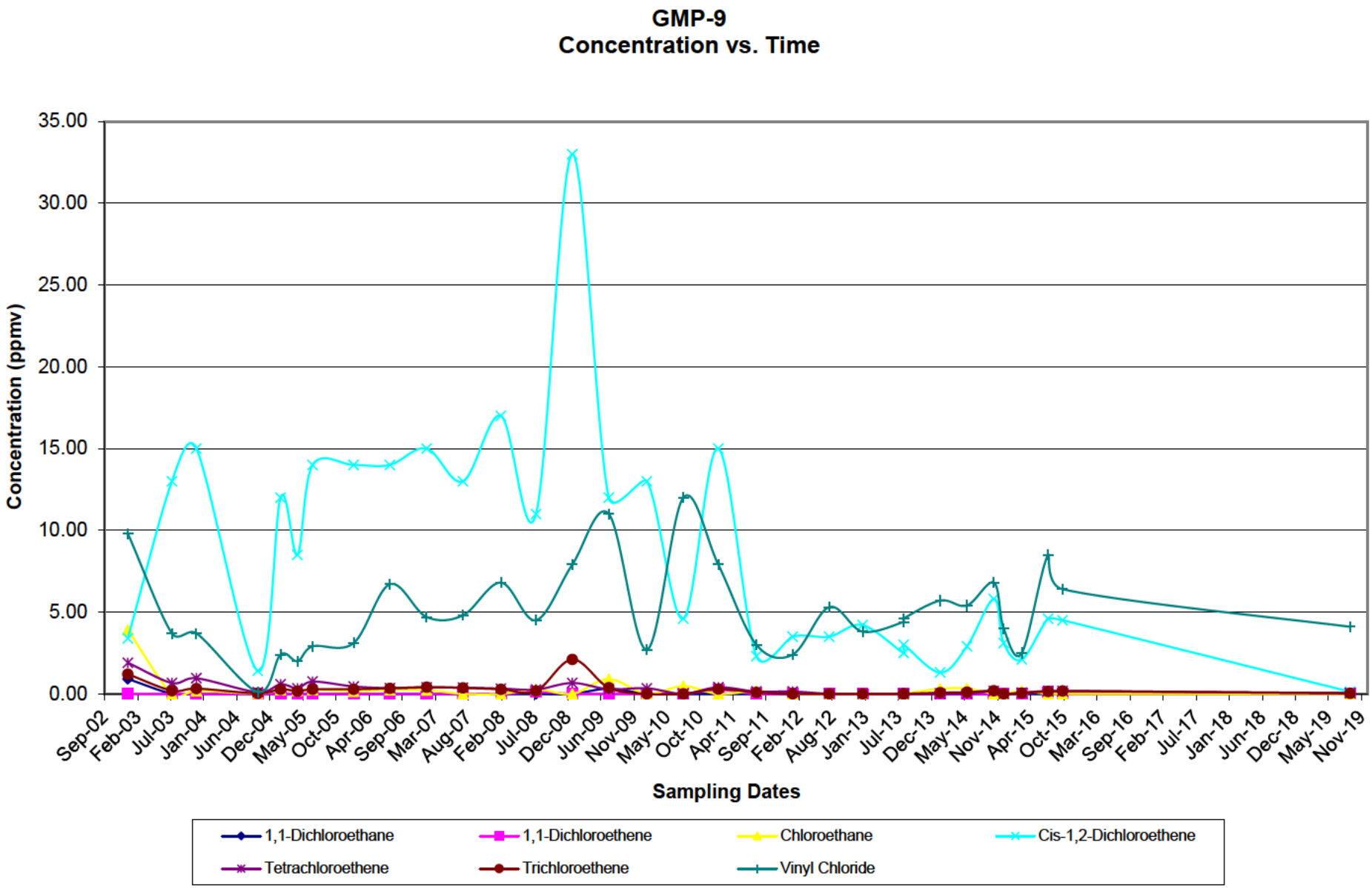
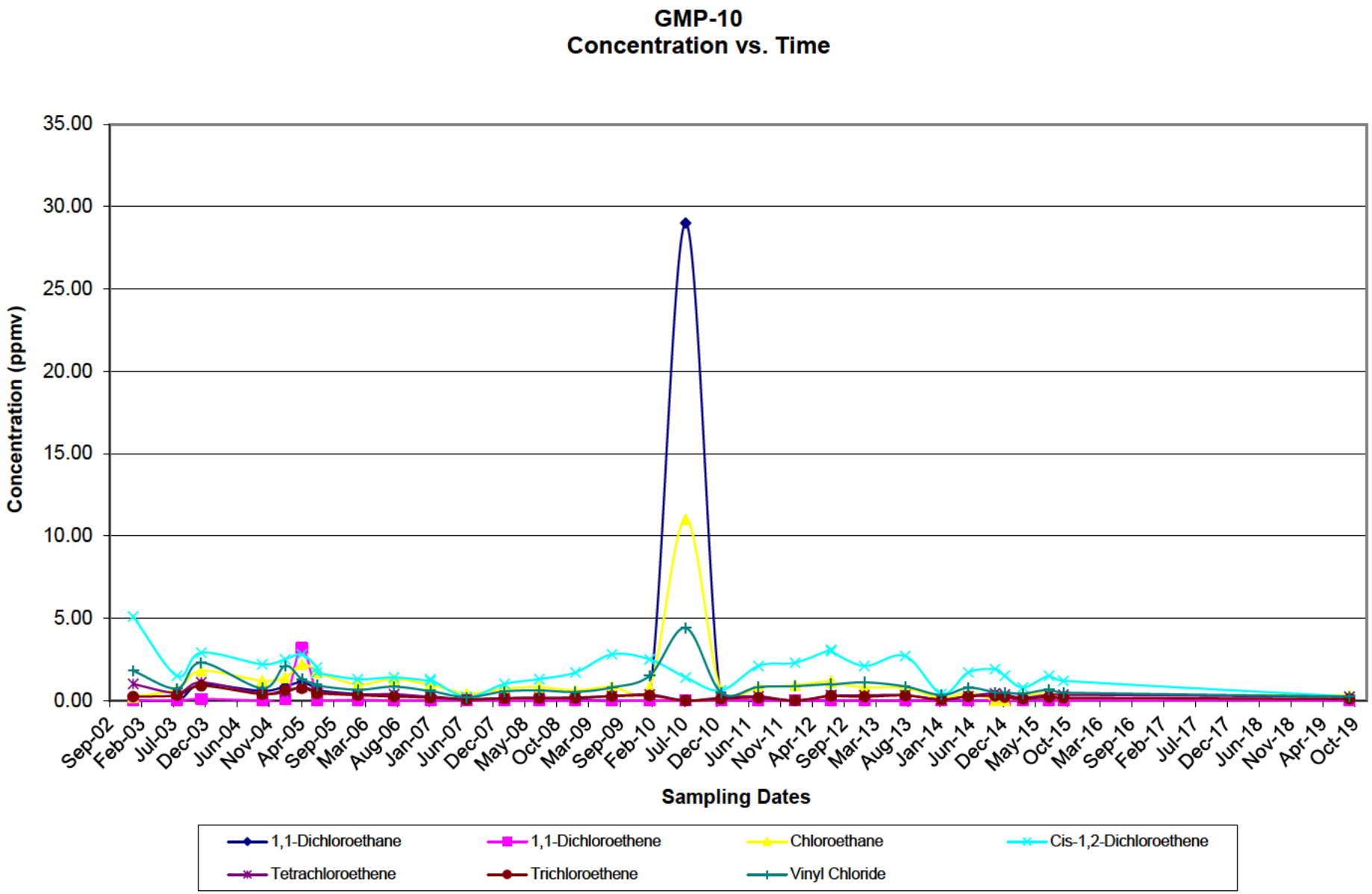
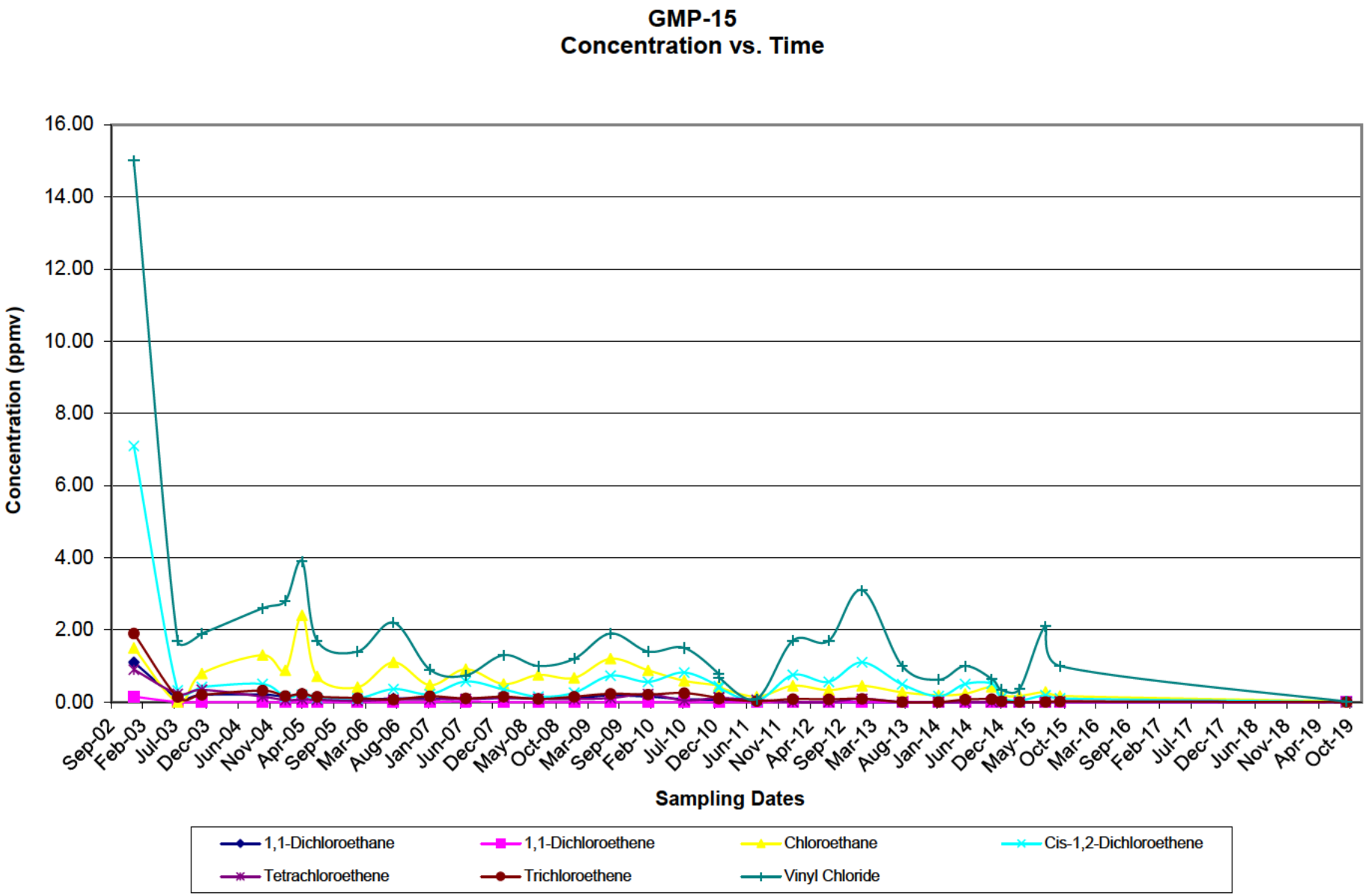
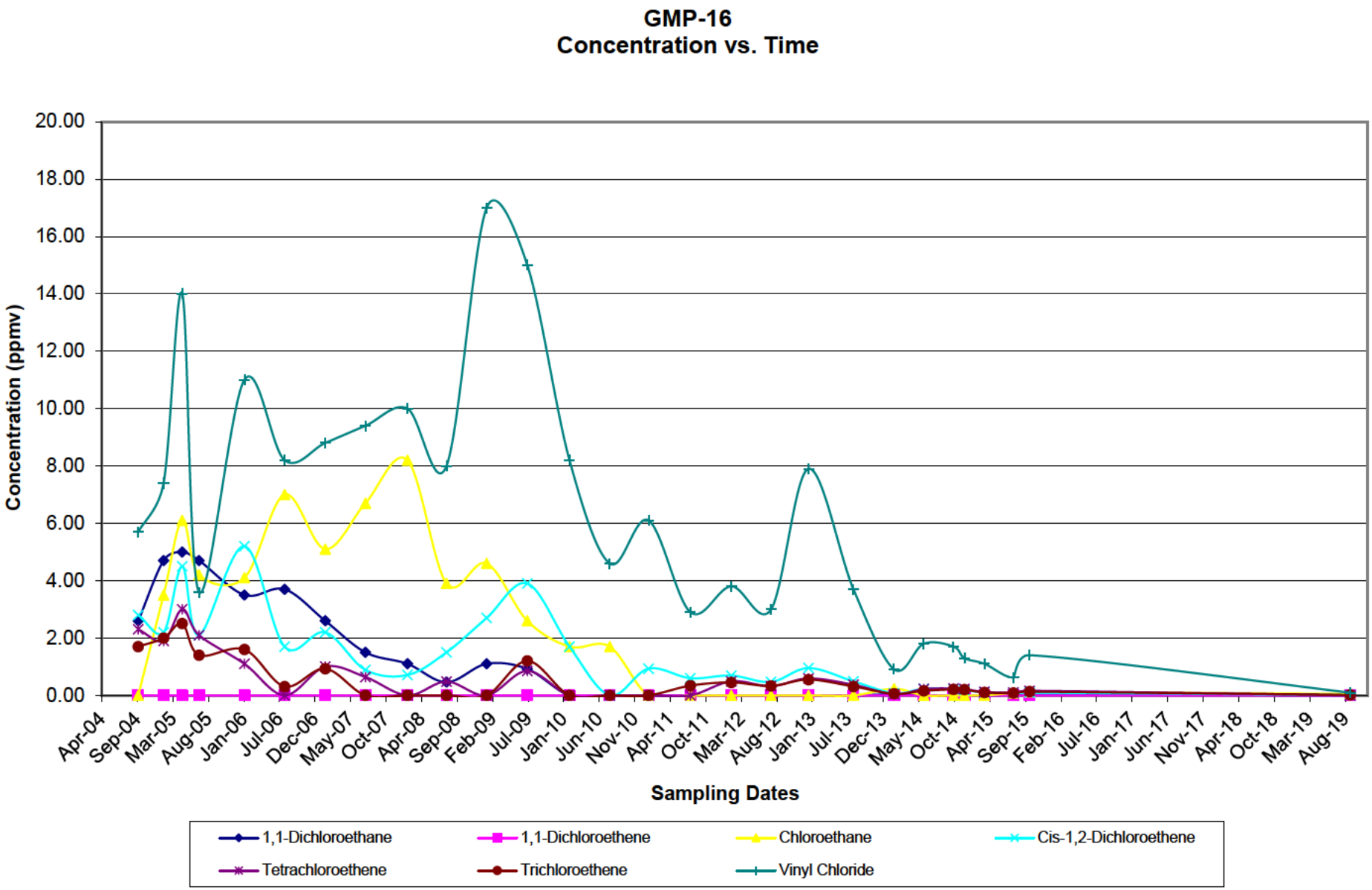
APPENDIX B

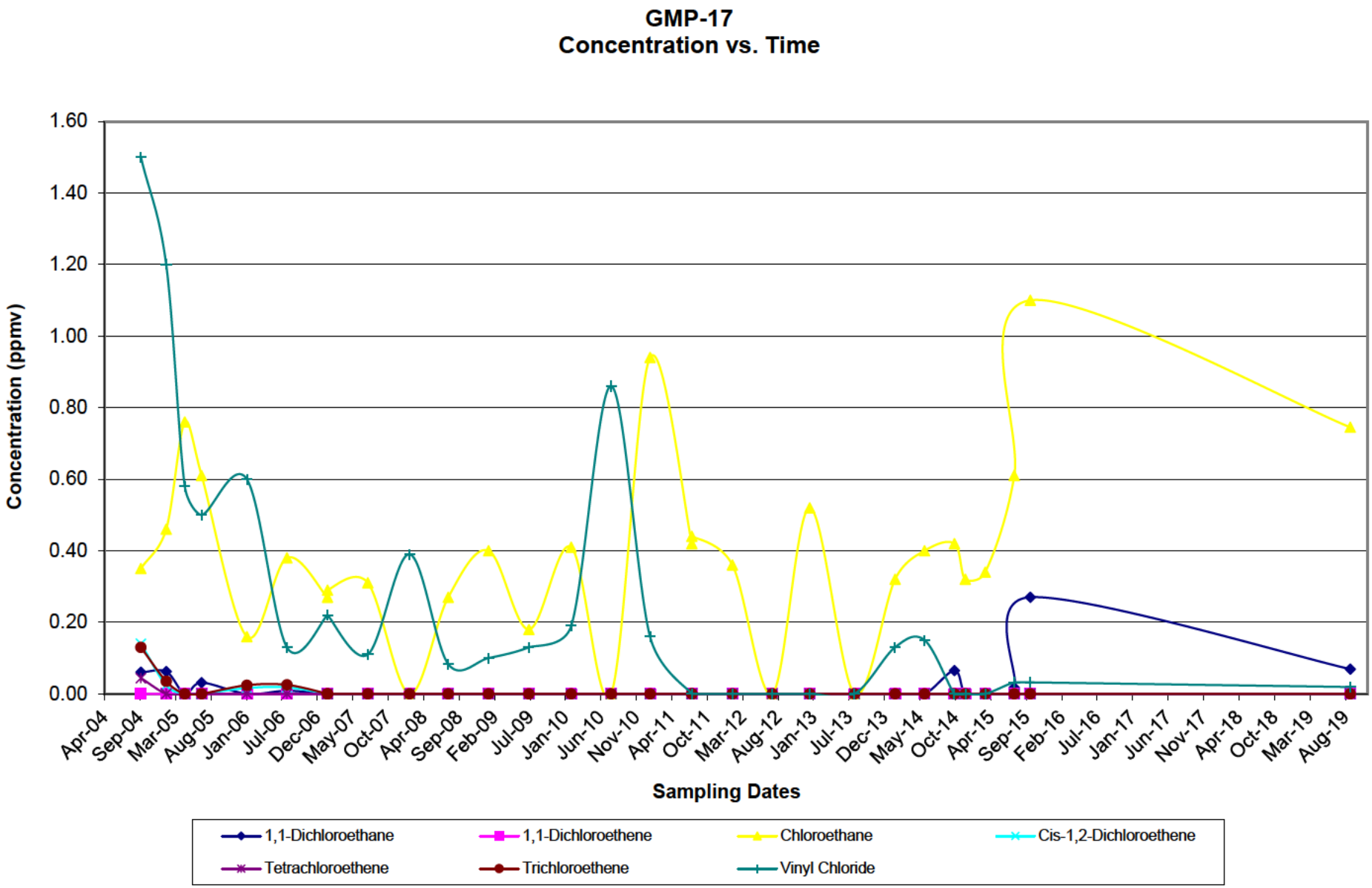
ELGE Vapor Concentration Trends

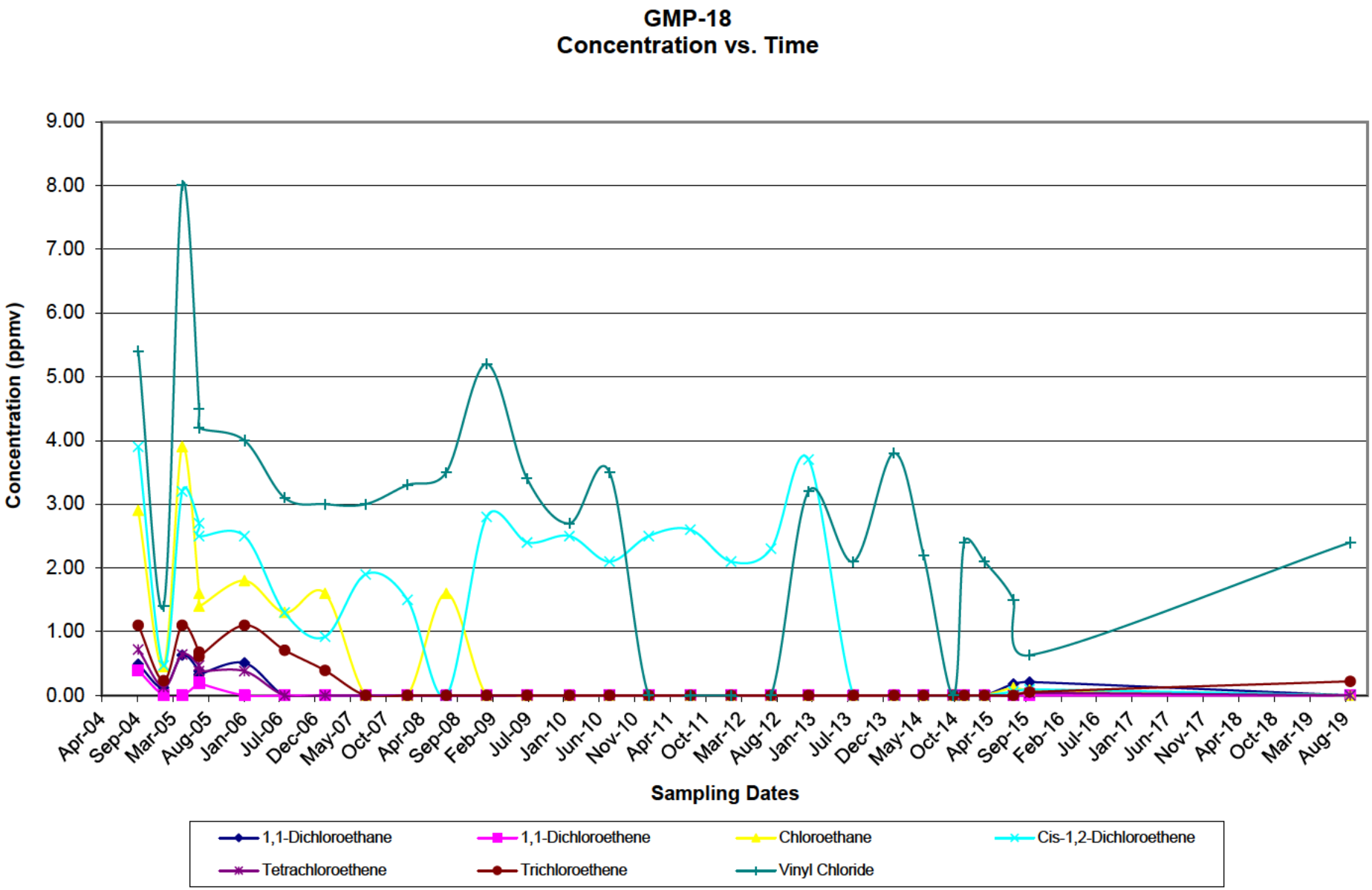

GMP-9
Concentration vs. Time
Concentration (ppmv)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Sep-02
Feb-03
Jul-03
Jan-04
Jun-04
Dec-04
May-05
Oct-05
Apr-06
Sep-06
Mar-07
Aug-07
Feb-08
Jul-08
Dec-08
Jun-09
Nov-09
May-10
Oct-10
Apr-11
Sep-11
Feb-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Nov-14
Apr-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Jan-18
Jun-18
Dec-18
May-19
Nov-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

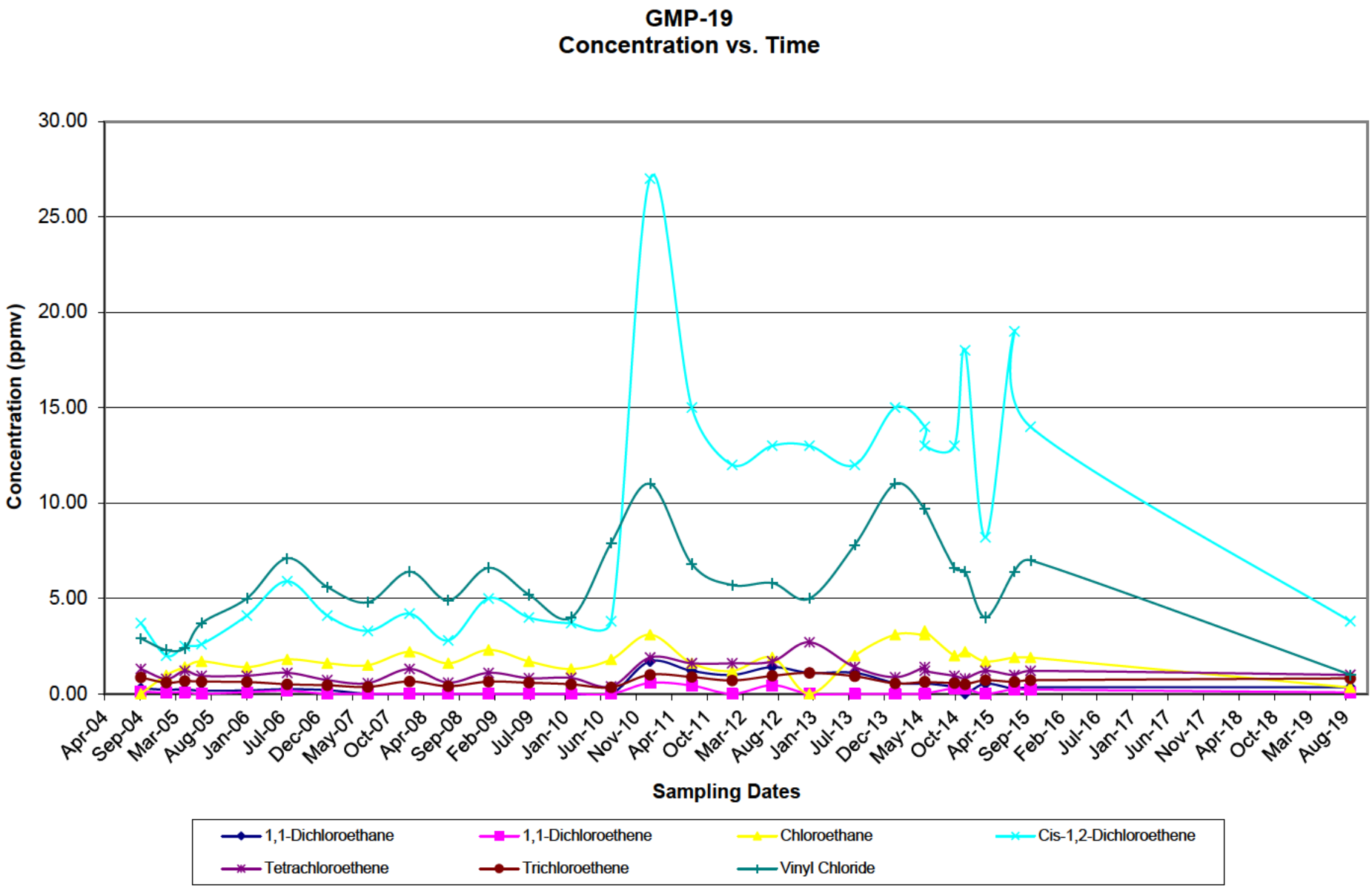

GMP-10
Concentration vs. Time
Concentration (ppmv)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

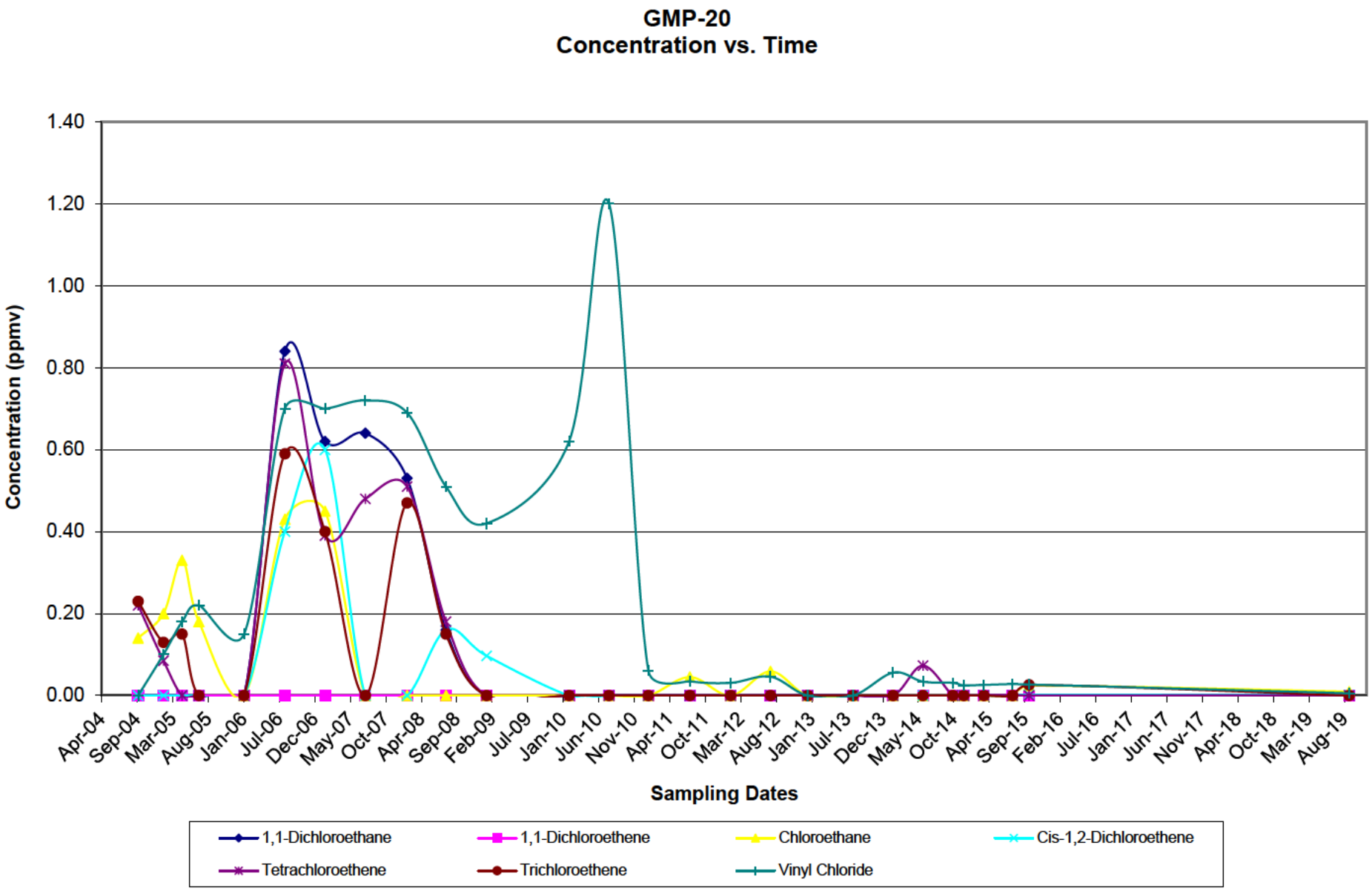

GMP-15
Concentration vs. Time
Concentration (ppmv)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

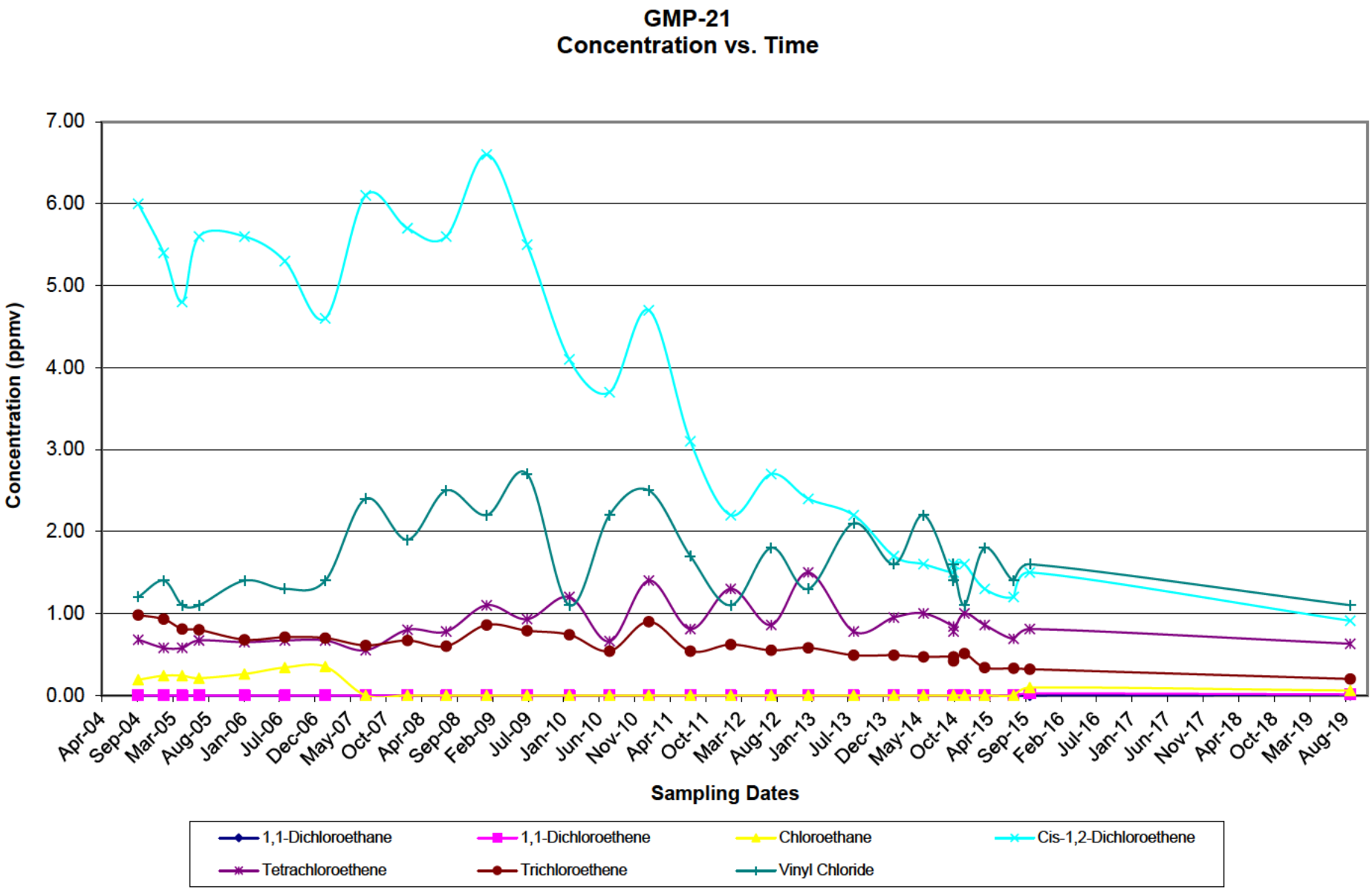

GMP-16
Concentration vs. Time
Concentration (ppmv)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

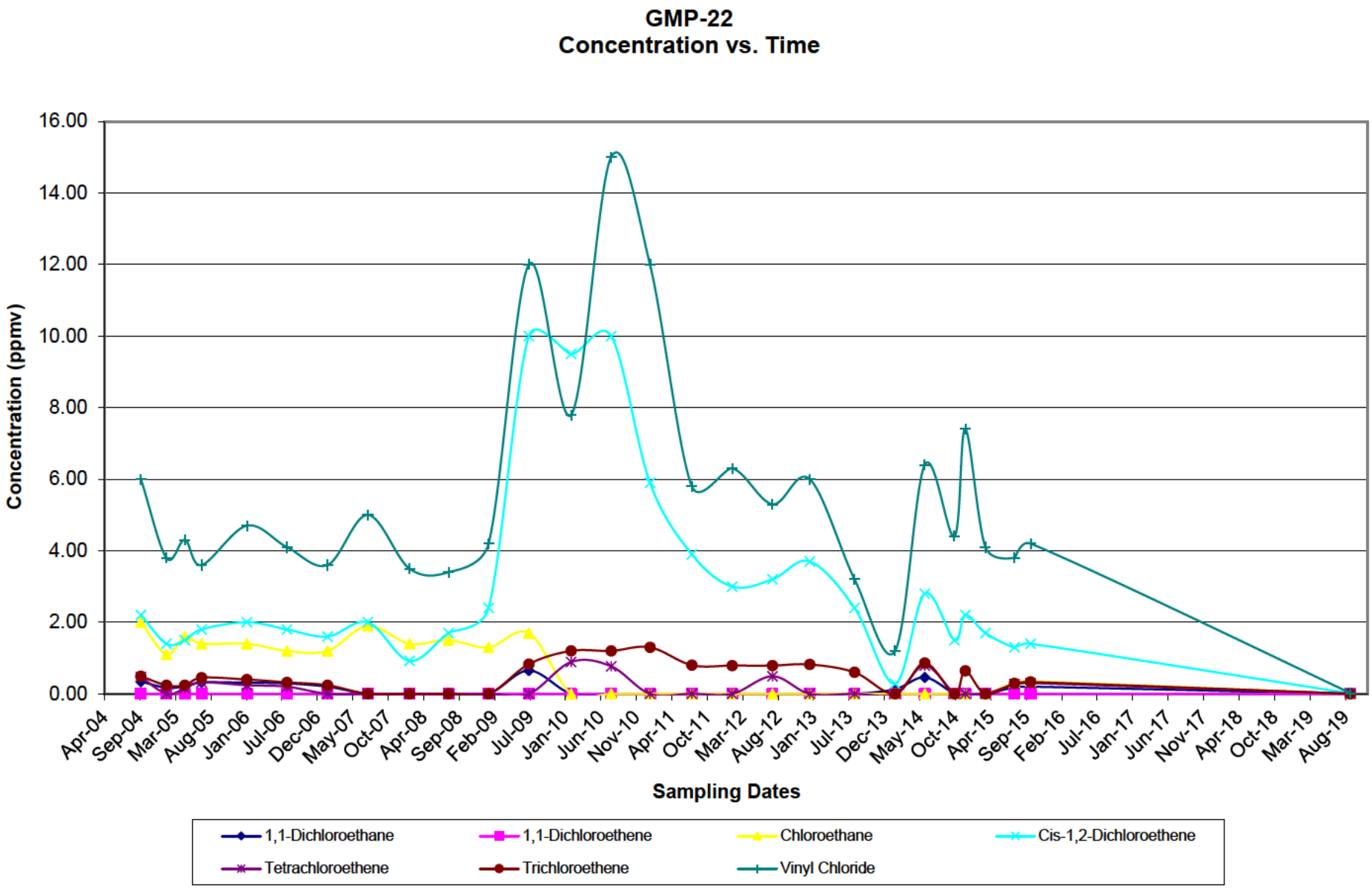

GMP-17
Concentration vs. Time
Concentration (ppmv)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

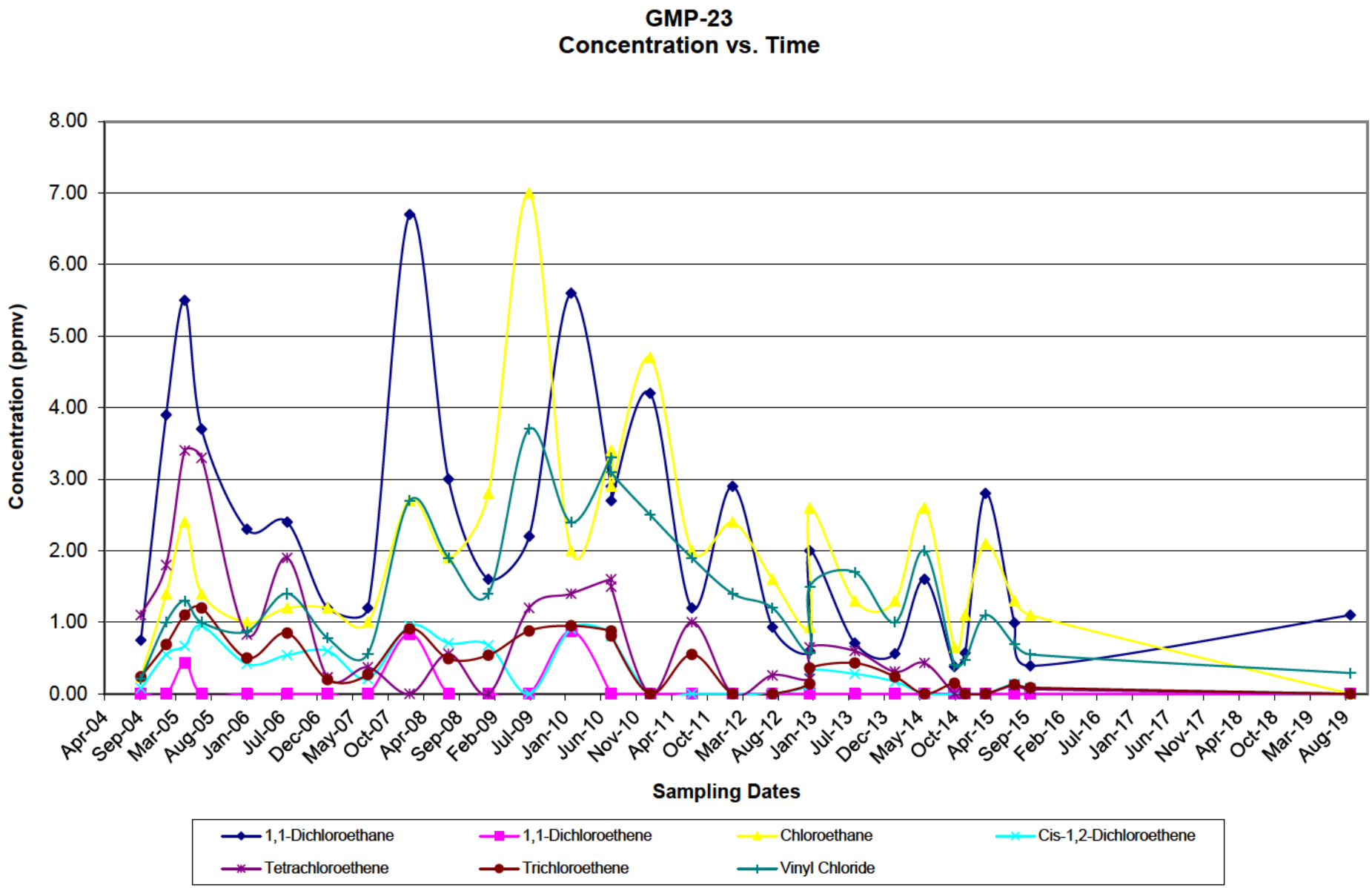

GMP-18
Concentration vs. Time
Concentration (ppmv)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

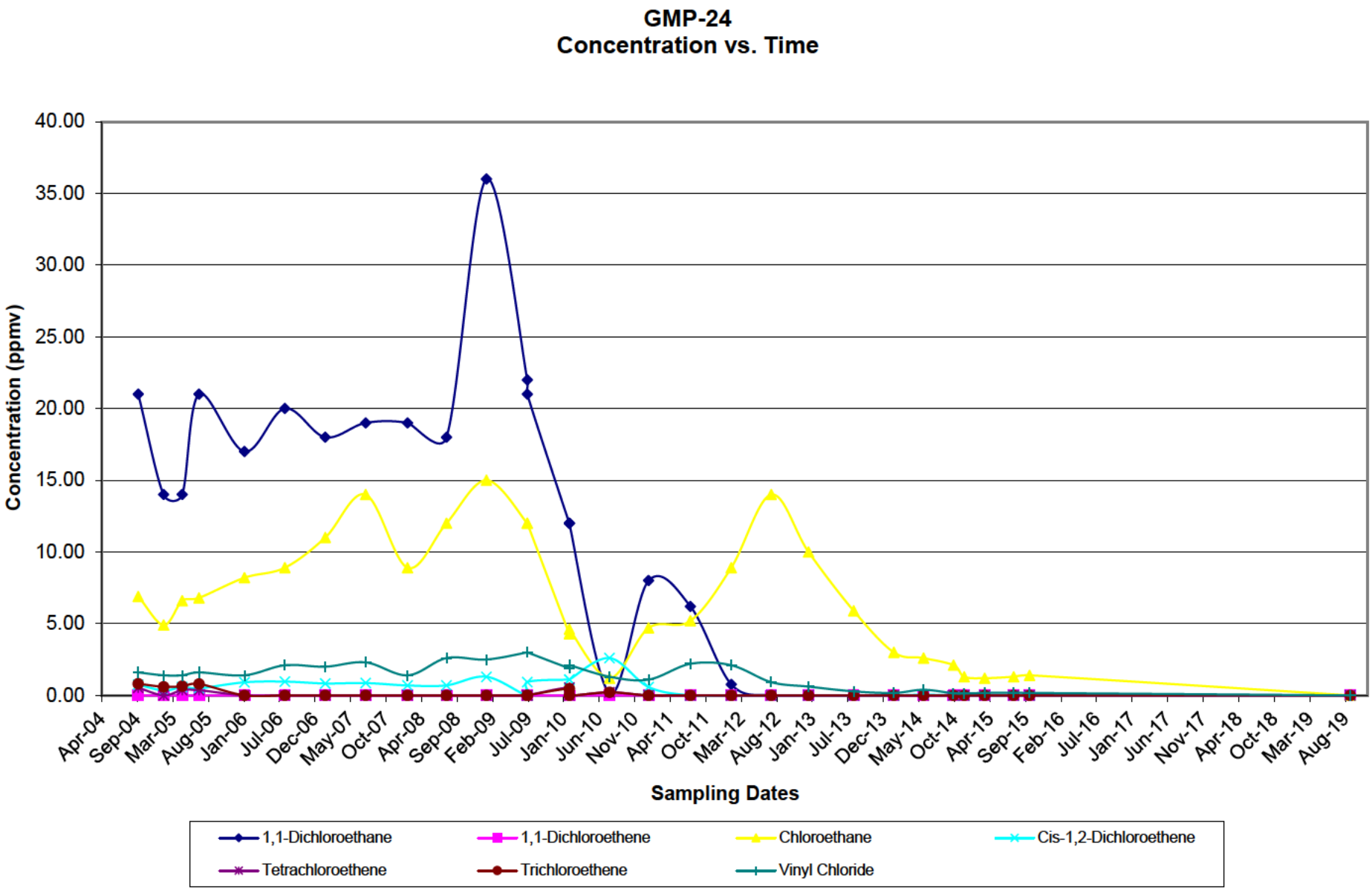

GMP-19
Concentration vs. Time
Concentration (ppmv)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

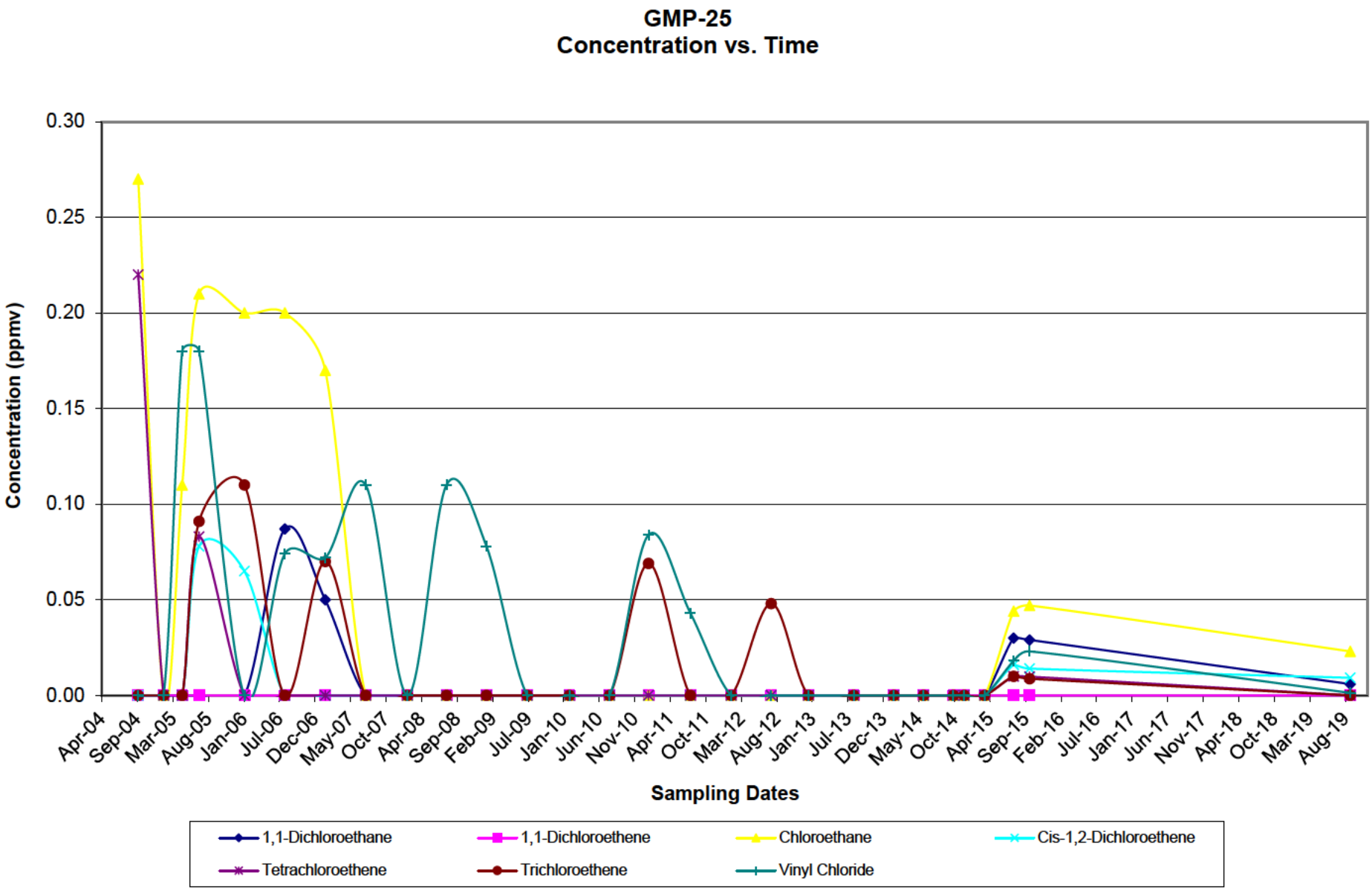

GMP-20
Concentration vs. Time
Concentration (ppmv)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

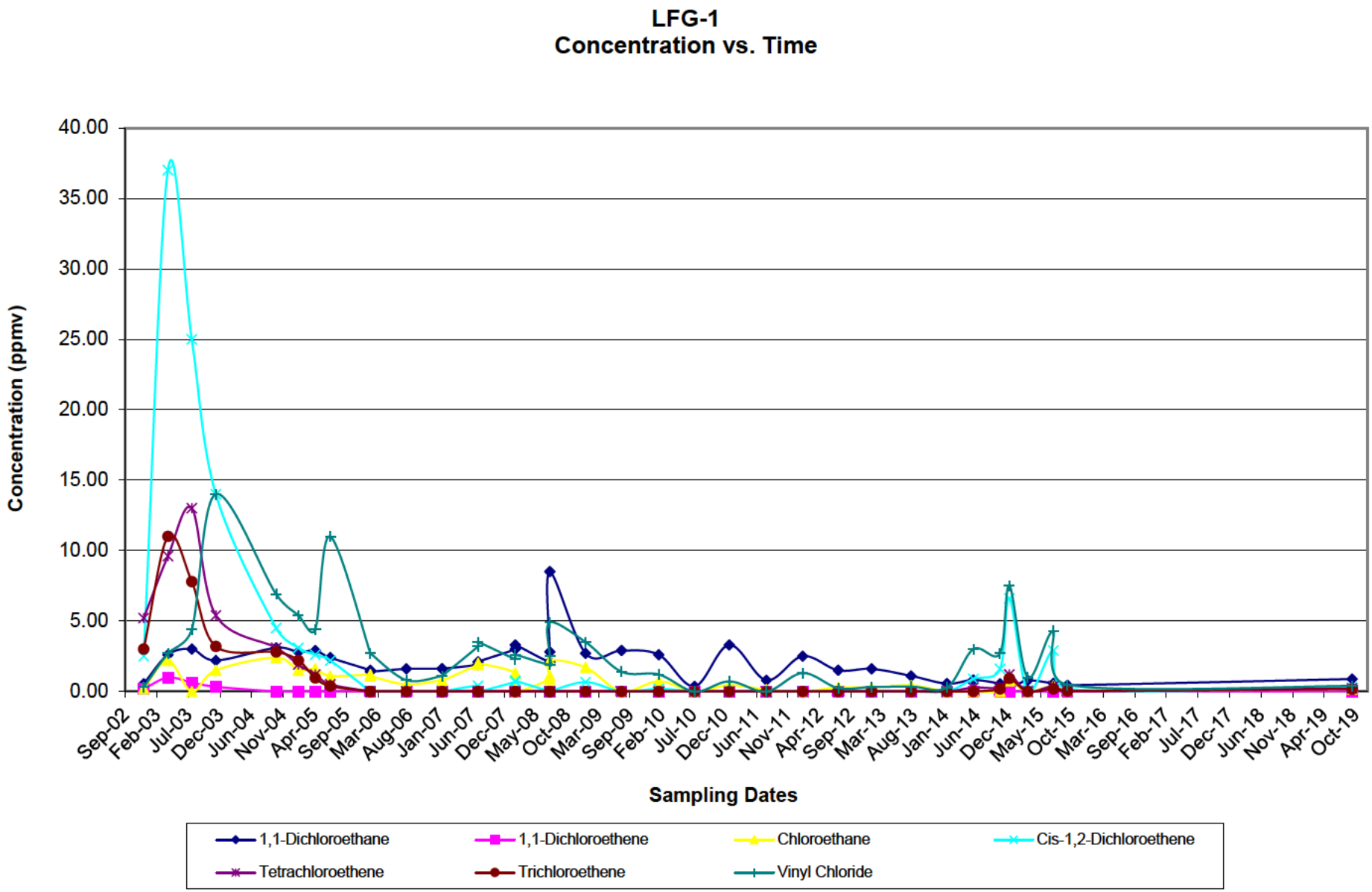

GMP-21
Concentration vs. Time
Concentration (ppmv)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

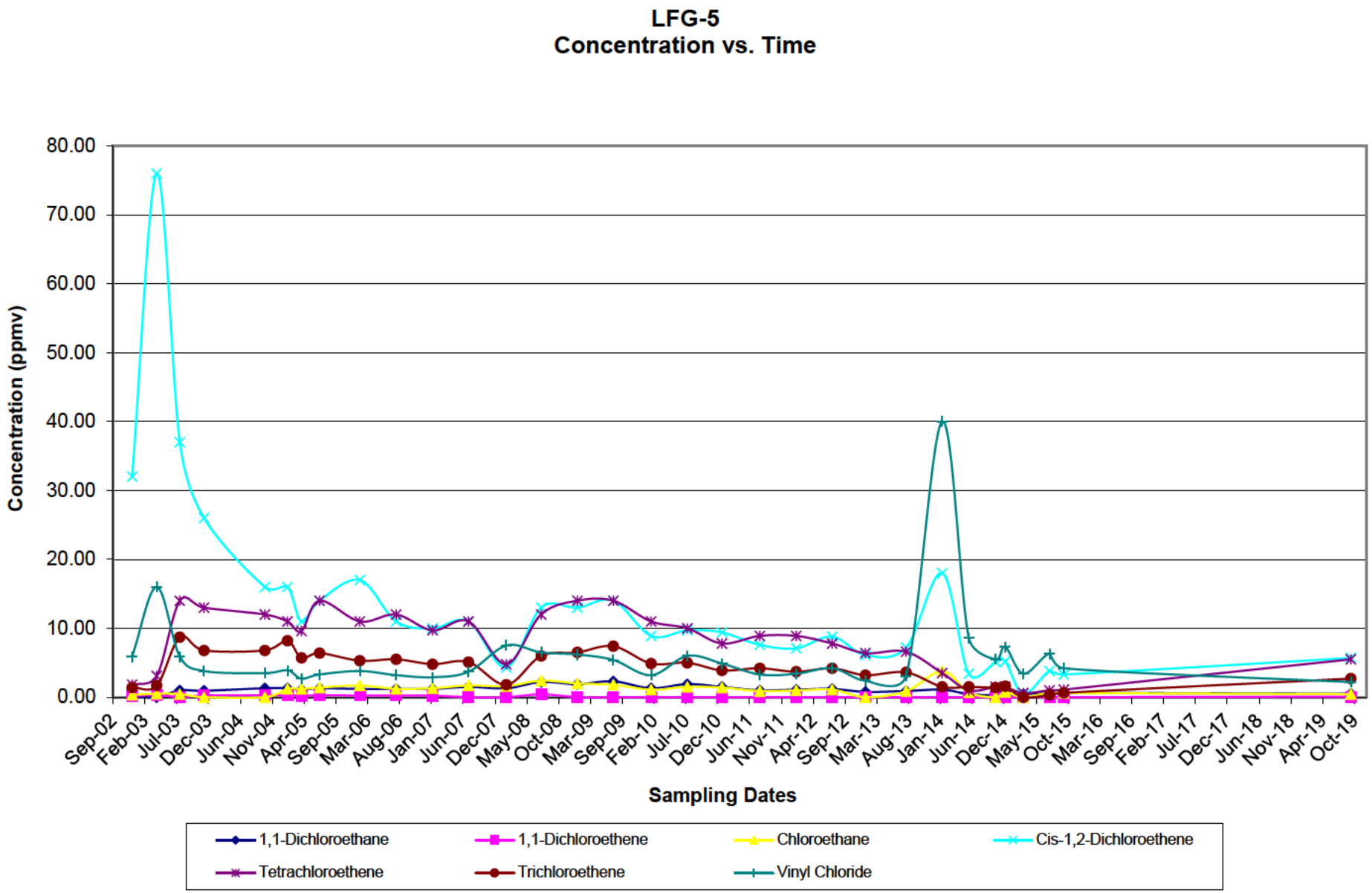

GMP-22
Concentration vs. Time
Concentration (ppmv)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

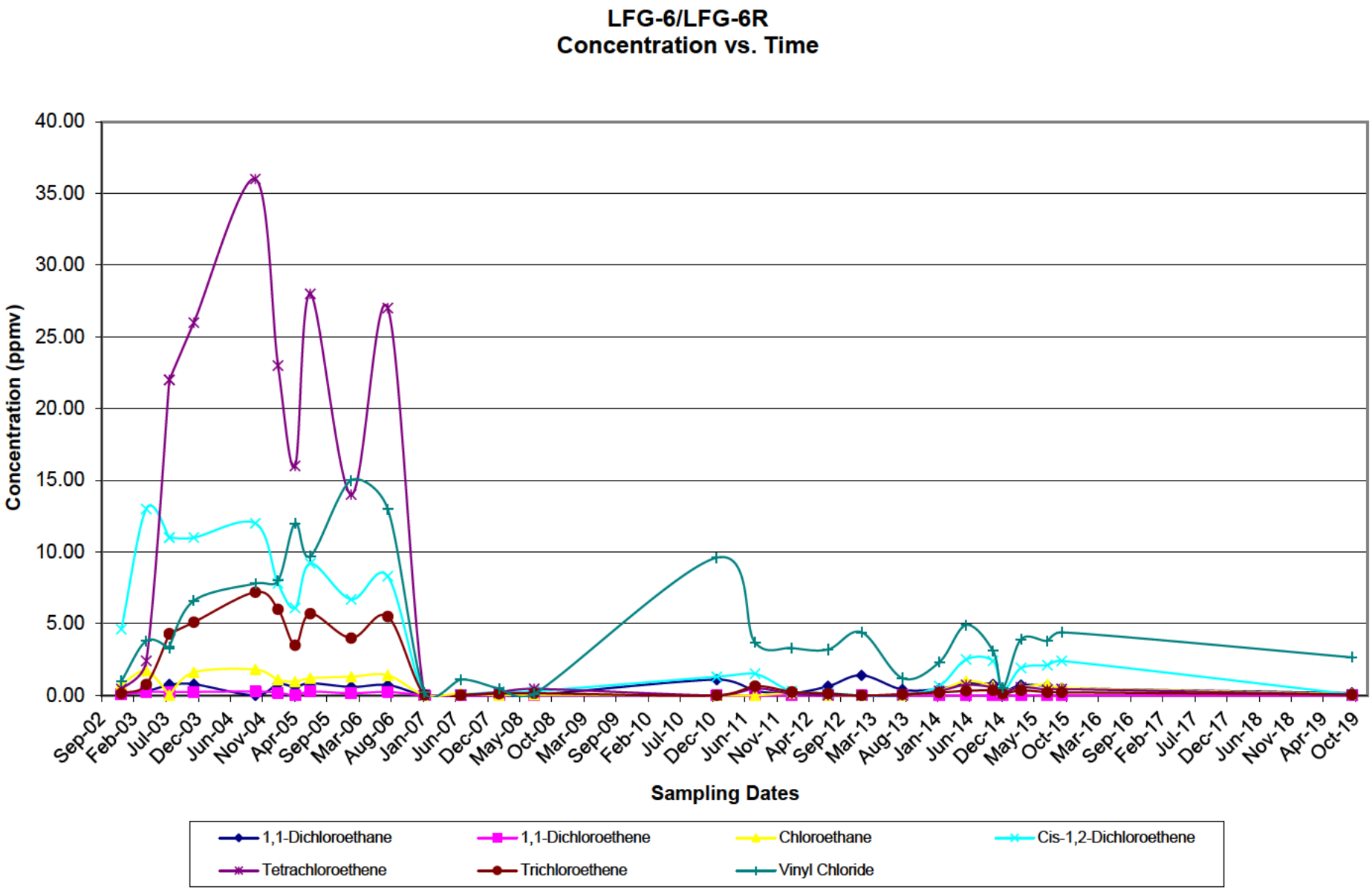

GMP-23
Concentration vs. Time
Concentration (ppmv)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

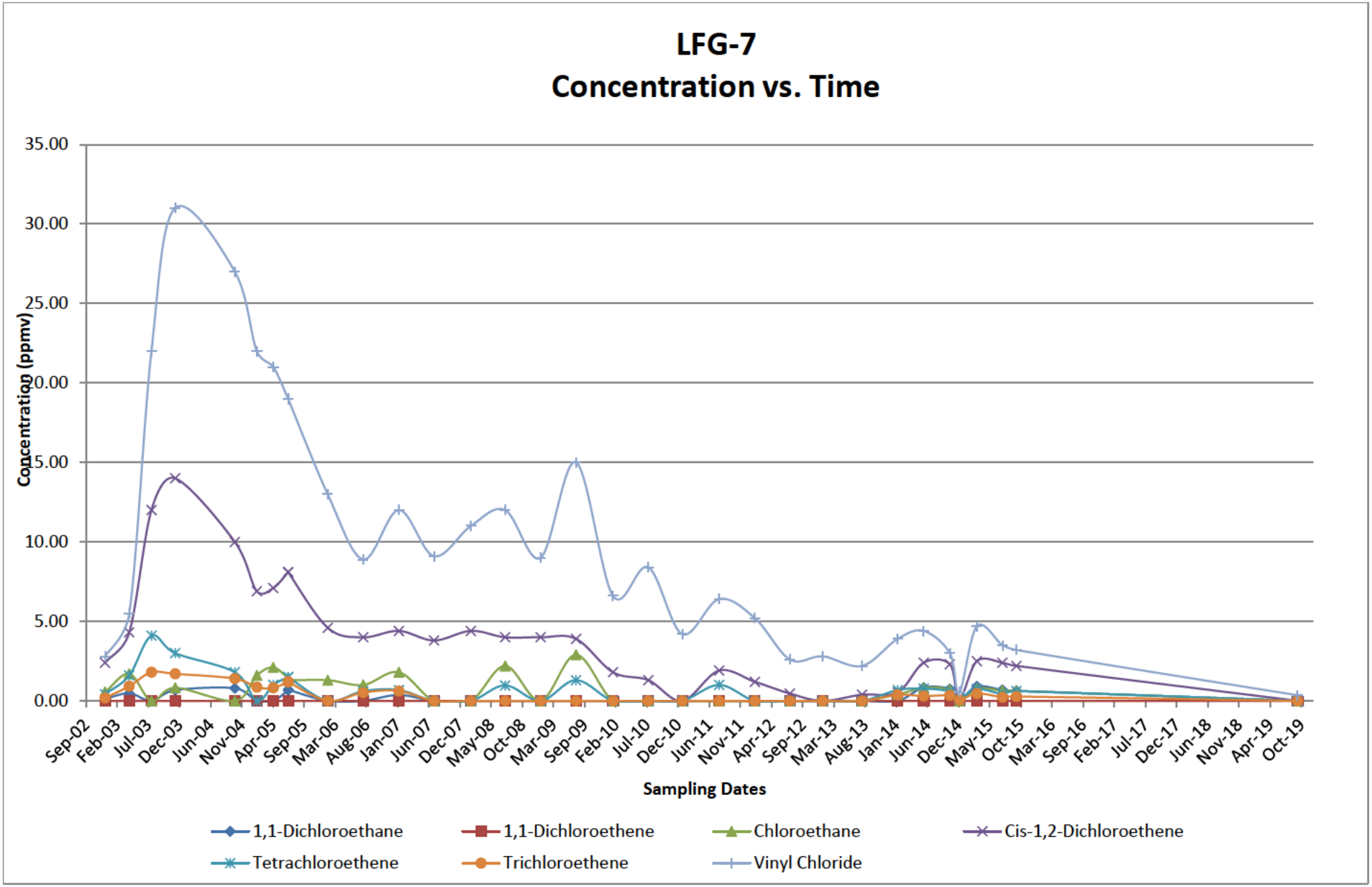

GMP-24
Concentration vs. Time
Concentration (ppmv)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

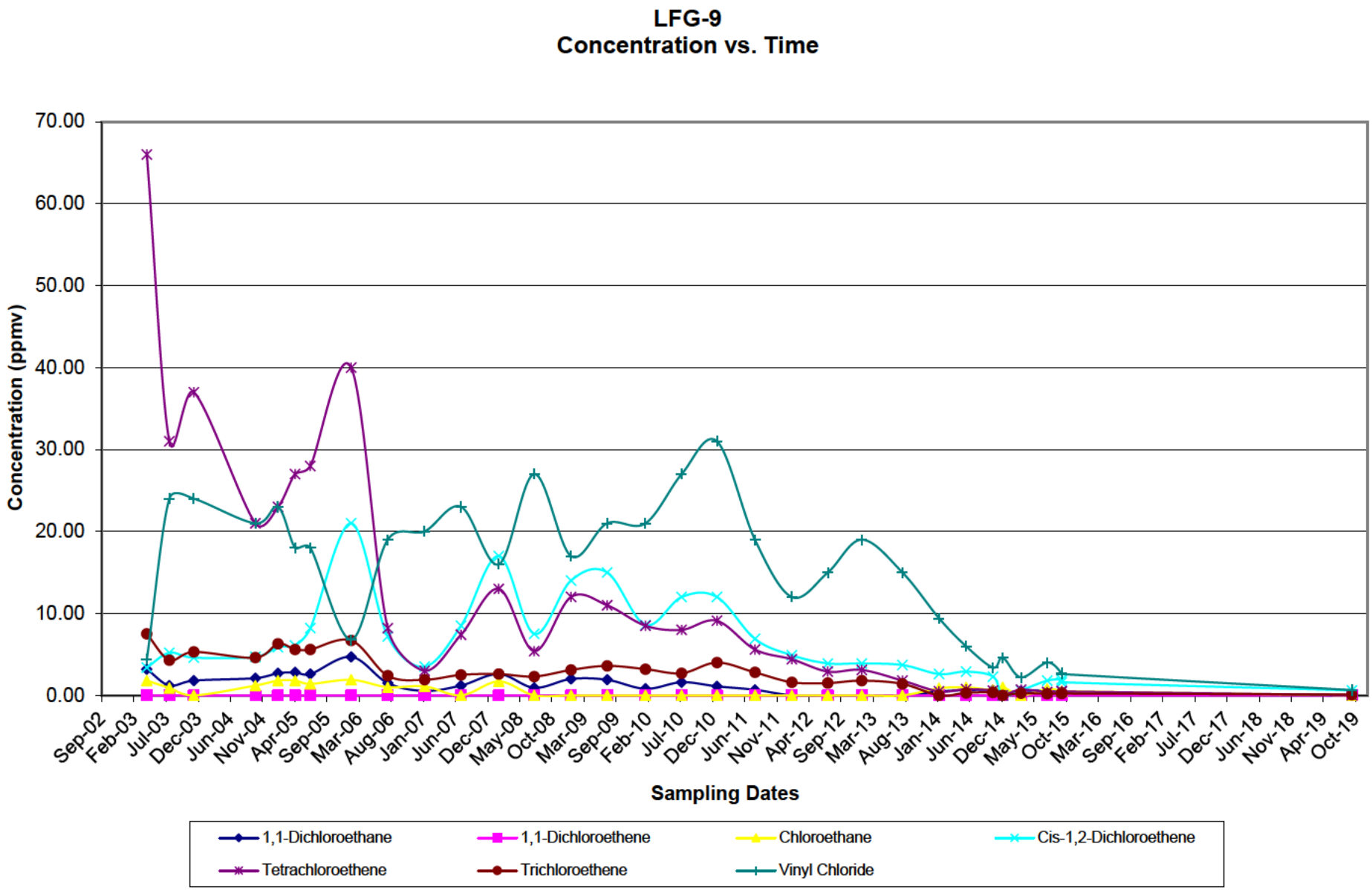

GMP-25
Concentration vs. Time
Concentration (ppmv)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Apr-04
Sep-04
Mar-05
Aug-05
Jan-06
Jul-06
Dec-06
May-07
Oct-07
Apr-08
Sep-08
Feb-09
Jul-09
Jan-10
Jun-10
Nov-10
Apr-11
Oct-11
Mar-12
Aug-12
Jan-13
Jul-13
Dec-13
May-14
Oct-14
Apr-15
Sep-15
Feb-16
Jul-16
Jan-17
Jun-17
Nov-17
Apr-18
Oct-18
Mar-19
Aug-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

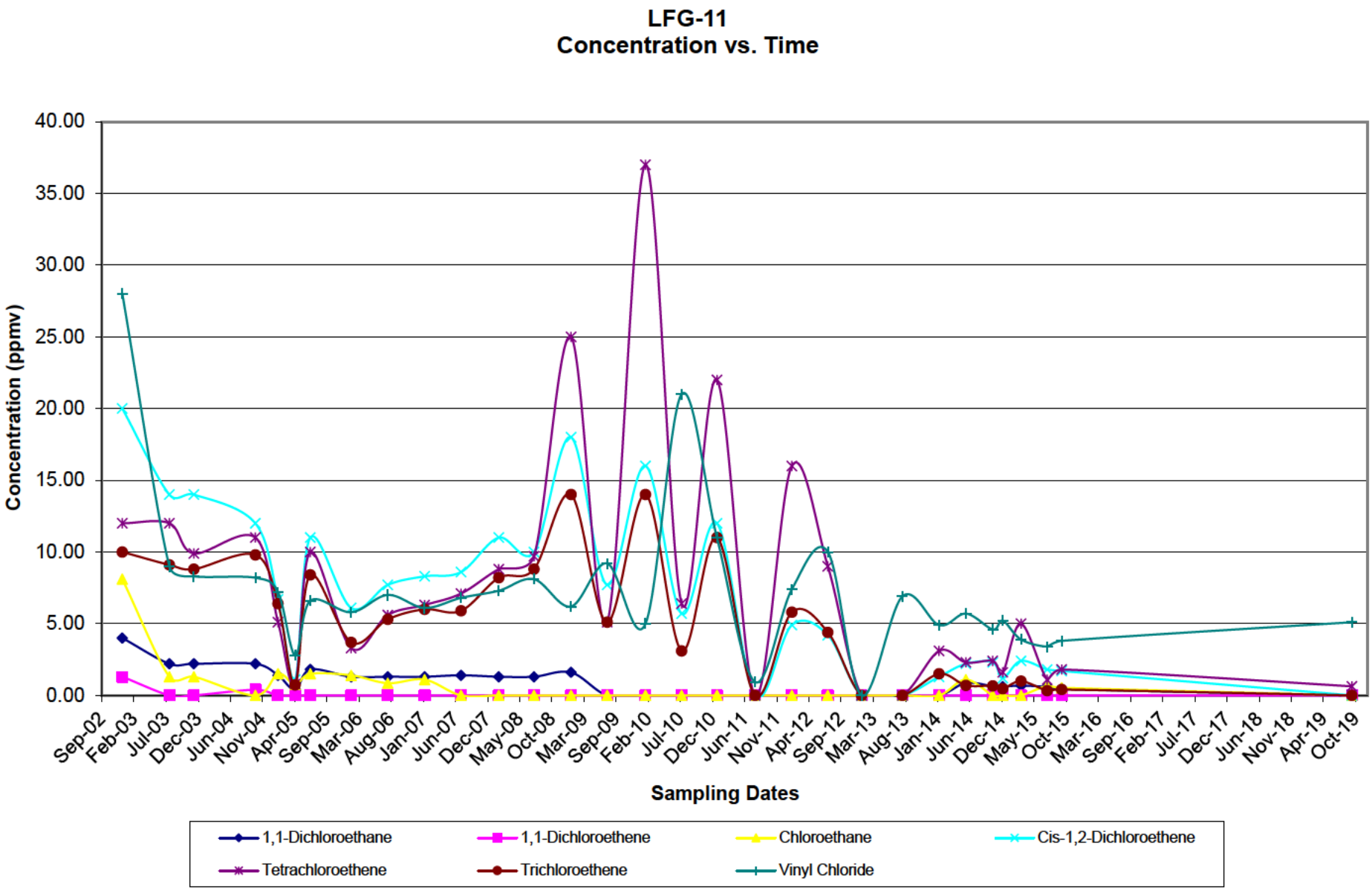

LFG-1
Concentration vs. Time
Concentration (ppmv)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

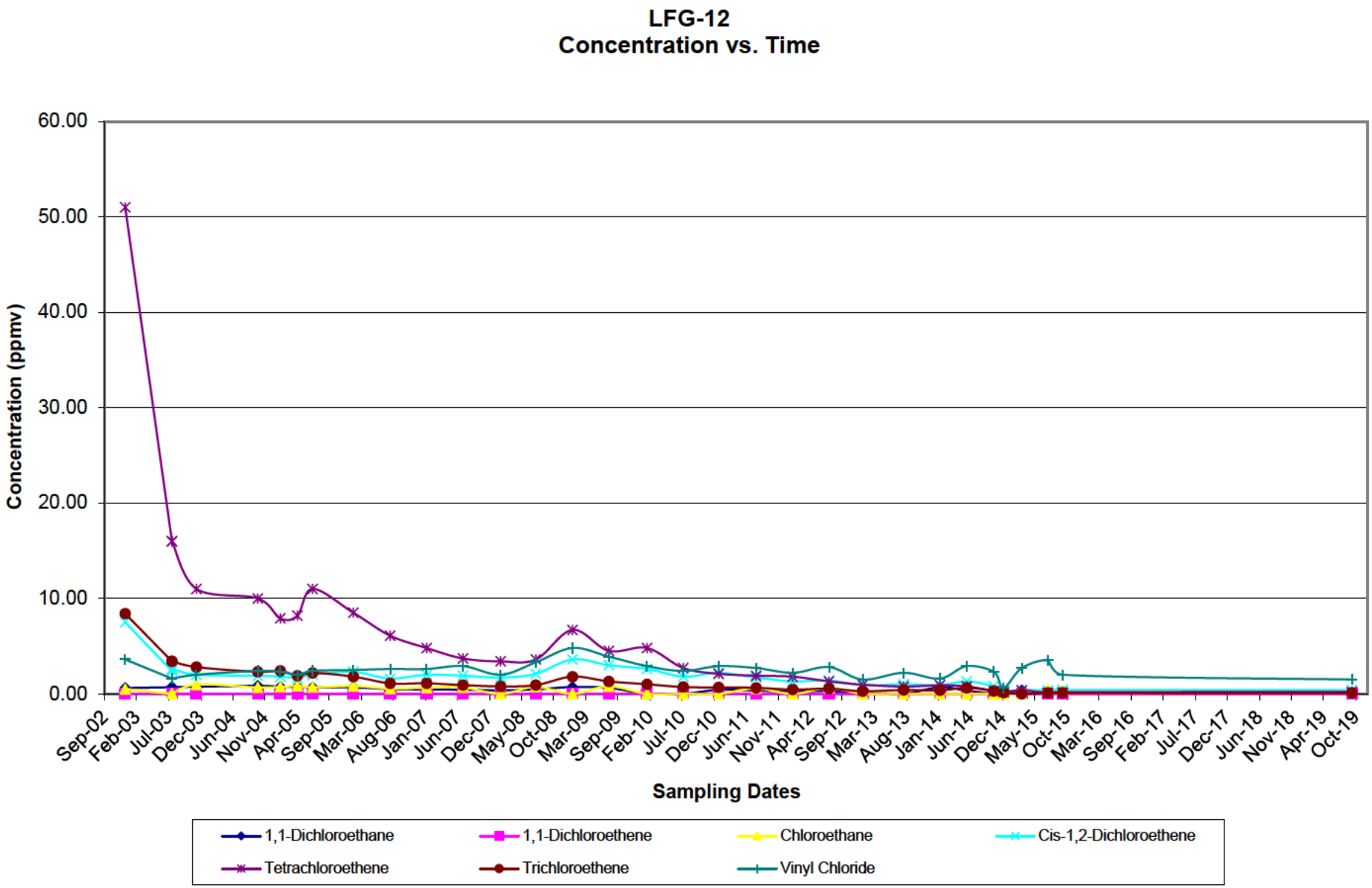

LFG-5
Concentration vs. Time
Concentration (ppmv)
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

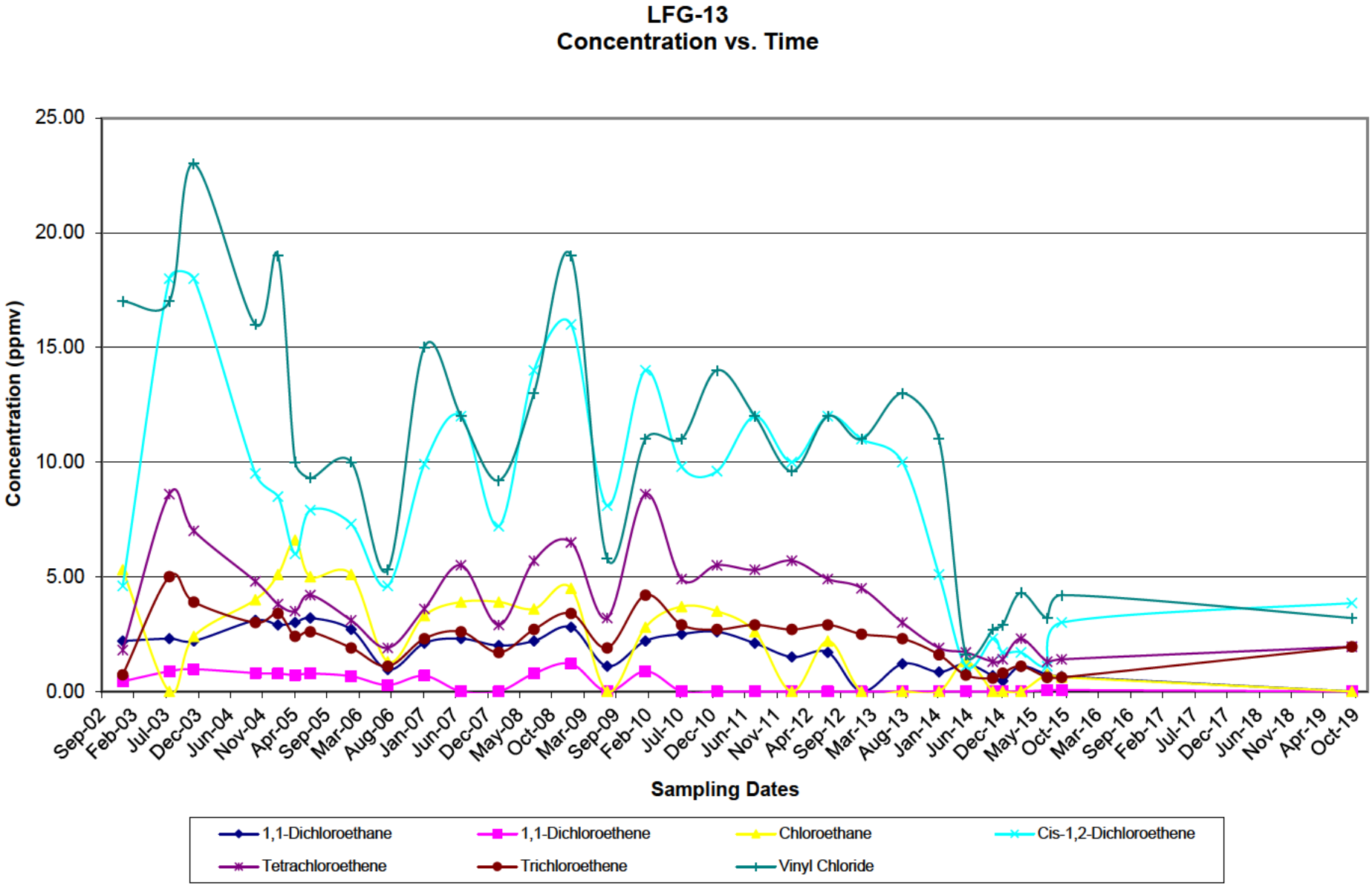

LFG-6/LFG-6R
Concentration vs. Time
Concentration (ppmv)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

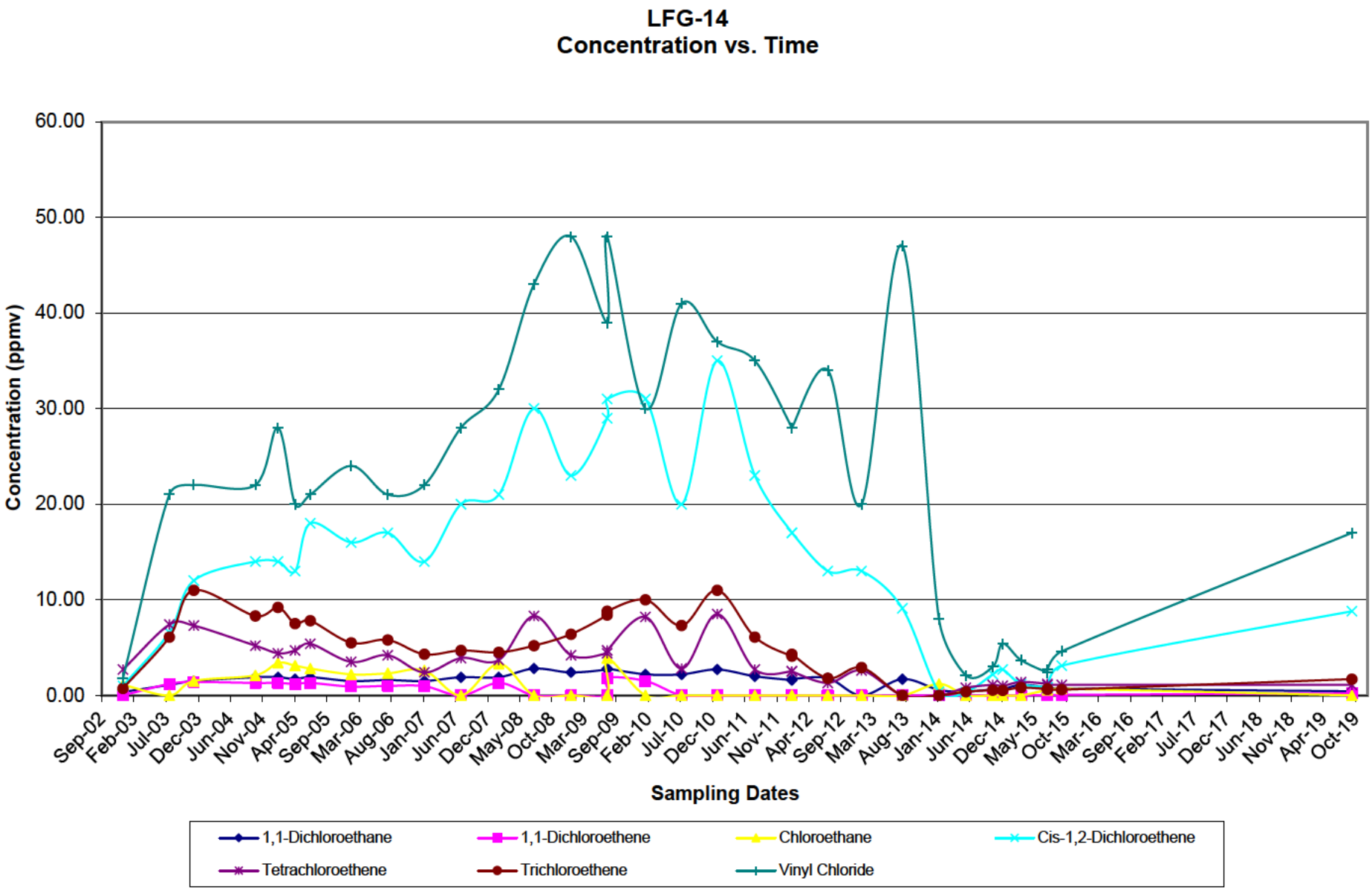

LFG-7
Concentration vs. Time
Concentration (ppmv)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride


LFG-9
Concentration vs. Time
Concentration (ppmv)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride


LFG-11
Concentration vs. Time
Concentration (ppmv)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride


LFG-12
Concentration vs. Time
Concentration (ppmv)
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride


LFG-13
Concentration vs. Time
Concentration (ppmv)
25.00
20.00
15.00
10.00
5.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride


LFG-14
Concentration vs. Time
Concentration (ppmv)
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Sep-02
Feb-03
Jul-03
Dec-03
Jun-04
Nov-04
Apr-05
Sep-05
Mar-06
Aug-06
Jan-07
Jun-07
Dec-07
May-08
Oct-08
Mar-09
Sep-09
Feb-10
Jul-10
Dec-10
Jun-11
Nov-11
Apr-12
Sep-12
Mar-13
Aug-13
Jan-14
Jun-14
Dec-14
May-15
Oct-15
Mar-16
Sep-16
Feb-17
Jul-17
Dec-17
Jun-18
Nov-18
Apr-19
Oct-19
Sampling Dates
1,1-Dichloroethane
1,1-Dichloroethene
Chloroethane
Cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Vinyl Chloride

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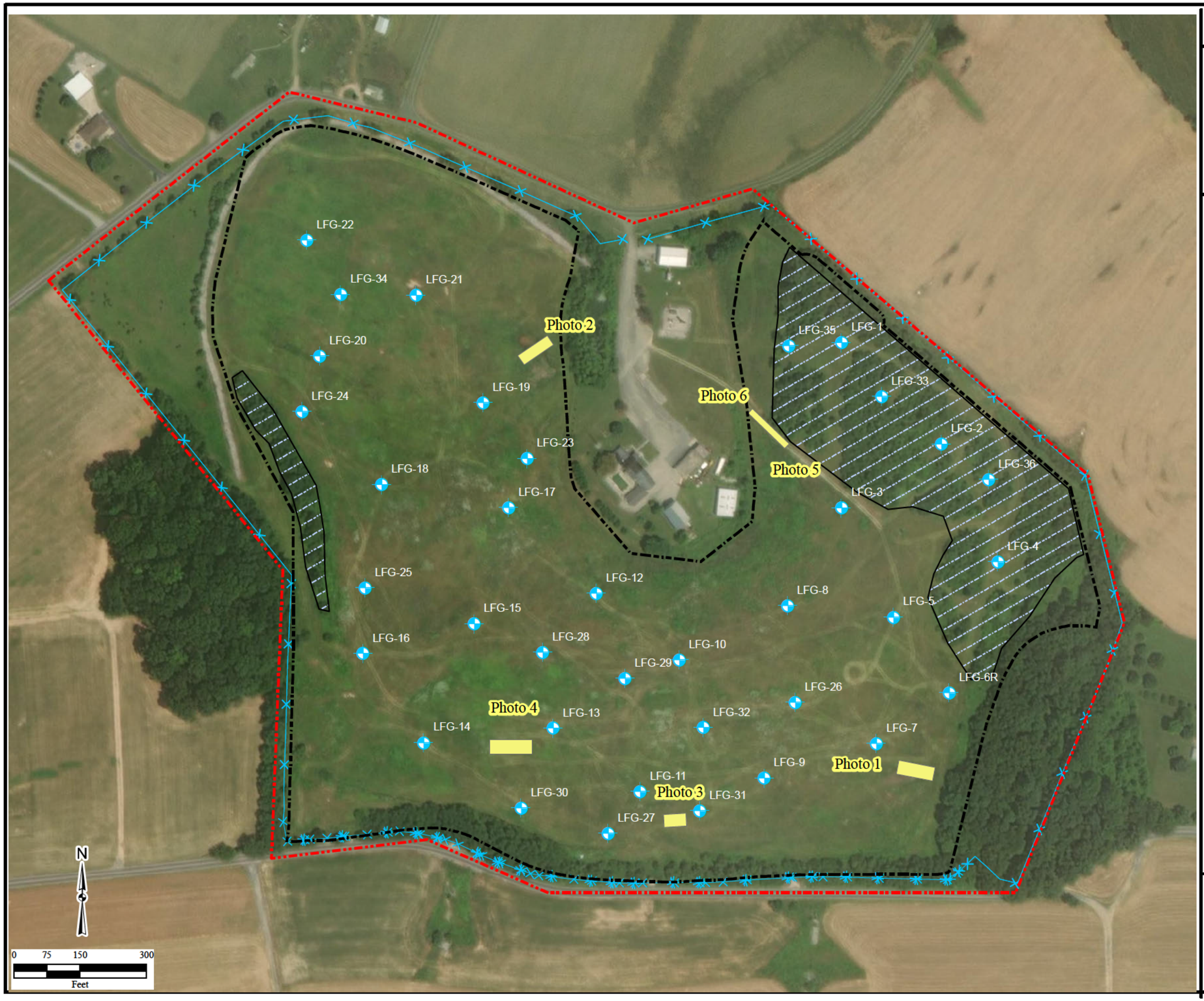
APPENDIX C

October 2020 Landfill Cover Repair Summary

Figure 1
Areas of Subsidence in the Landfill Cover and Road and Proposed Tree Cutting Areas



Legend

- Landfill Gas Wells (LFG)
- Existing Fence
- Limit of Refuse (approximate)
- Site Boundary
- Repaired Areas (approximate, 10/6/20)
- Proposed Tree Cutting Areas

Notes:
The gas monitoring probes and the leachate monitoring points are not projected in this figure. The photos referenced in this figure are included in the corrective action report.

C:\Users\nfyulis\Desktop
Keystone.mxd
10/8/2020 RR
Source: HGL, Golder Associates 2016
ArcGIS Online Imagery

HGL HydroGeoLogic, Inc

Photo 1: Landfill Cover Repair near LFG-7

Photo 2: Landfill Cover Repair near LFG-19

Photo 3: Landfill Cover Repair near LFG-31

Photo 4: Landfill Cover Repair near LFG-13

Photo 5: Landfill Access Road Repair (downhill)

Photo 6: Landfill Access Road Repair (uphill)

APPENDIX B

SAFETY DATA SHEETS

SAFETY DATA SHEET

Version 6.6
Revision Date 07/06/2021
Print Date 01/17/2023

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : Sodium persulfate

Product Number : 71889
Brand : Sigma
CAS-No. : 7775-27-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 SPRUCE ST
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone

Emergency Phone # : 800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Oxidizing solids (Category 3), H272
Acute toxicity, Oral (Category 4), H302
Skin irritation (Category 2), H315
Respiratory sensitization (Category 1), H334
Skin sensitization (Category 1), H317
Specific target organ toxicity - single exposure (Category 3), Respiratory system, H335
Short-term (acute) aquatic hazard (Category 3), H402

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

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Signal word	Danger
Hazard statement(s)	
H272	May intensify fire; oxidizer.
H302	Harmful if swallowed.
H315	Causes skin irritation.
H317	May cause an allergic skin reaction.
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H335	May cause respiratory irritation.
H402	Harmful to aquatic life.
Precautionary statement(s)	
P210	Keep away from heat.
P220	Keep/Store away from clothing/ combustible materials.
P221	Take any precaution to avoid mixing with combustibles.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
P264	Wash skin thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P272	Contaminated work clothing must not be allowed out of the workplace.
P273	Avoid release to the environment.
P280	Wear protective gloves/ eye protection/ face protection.
P285	In case of inadequate ventilation wear respiratory protection.
P301 + P312 + P330	IF SWALLOWED: Call a POISON CENTER/ doctor if you feel unwell. Rinse mouth.
P302 + P352	IF ON SKIN: Wash with plenty of soap and water.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
P333 + P313	If skin irritation or rash occurs: Get medical advice/ attention.
P342 + P311	If experiencing respiratory symptoms: Call a POISON CENTER/ doctor.
P362	Take off contaminated clothing and wash before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

SECTION 3: Composition/information on ingredients

3.1 Substances

Synonyms	:	Sodium peroxodisulfate
Formula	:	Na2S2O8
Molecular weight	:	238.10 g/mol
CAS-No.	:	7775-27-1
EC-No.	:	231-892-1

Component	Classification	Concentration

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disodium peroxodisulphate		
	Ox. Sol. 3; Acute Tox. 4; Skin Irrit. 2; Resp. Sens. 1; Skin Sens. 1; STOT SE 3; Aquatic Acute 3; H272, H302, H315, H334, H317, H335, H402	<= 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice
First aiders need to protect themselves. Show this material safety data sheet to the doctor in attendance.

If inhaled
After inhalation: fresh air. Call in physician.

In case of skin contact
In case of skin contact: Take off immediately all contaminated clothing. Rinse skin with water/ shower. Consult a physician.

In case of eye contact
After eye contact: rinse out with plenty of water. Remove contact lenses.

If swallowed
After swallowing: immediately make victim drink water (two glasses at most). Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media
For this substance/mixture no limitations of extinguishing agents are given.

5.2 Special hazards arising from the substance or mixture

Sulfur oxides
Sodium oxides
Not combustible.
Has a fire-promoting effect due to release of oxygen.
Ambient fire may liberate hazardous vapours.

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5.3 Advice for firefighters
Stay in danger area only with self-contained breathing apparatus. Prevent skin contact by keeping a safe distance or by wearing suitable protective clothing.

5.4 Further information
Suppress (knock down) gases/vapors/mists with a water spray jet. Prevent fire extinguishing water from contaminating surface water or the ground water system.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Advice for non-emergency personnel: Avoid inhalation of dusts. Avoid substance contact. Ensure adequate ventilation. Evacuate the danger area, observe emergency procedures, consult an expert.
For personal protection see section 8.

6.2 Environmental precautions
Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Cover drains. Collect, bind, and pump off spills. Observe possible material restrictions (see sections 7 and 10). Take up carefully. Dispose of properly. Clean up affected area. Avoid generation of dusts.

6.4 Reference to other sections
For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Advice on safe handling
Work under hood. Do not inhale substance/mixture.

Advice on protection against fire and explosion
Keep away from open flames, hot surfaces and sources of ignition.

Hygiene measures
Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions
Tightly closed. Keep locked up or in an area accessible only to qualified or authorized persons. Do not store near combustible materials.
Storage class (TRGS 510): 5.1B: Oxidizing hazardous materials

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

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SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Ingredients with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
disodium peroxodisulphate	7775-27-1	TWA	0.1 mg/m3	USA. ACGIH Threshold Limit Values (TLV)

8.2 Exposure controls

Appropriate engineering controls
Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance.

Personal protective equipment

Eye/face protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU). Safety glasses

Body Protection
protective clothing

Control of environmental exposure
Do not let product enter drains.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: crystalline Color: white
b)	Odor	odorless
c)	Odor Threshold	Not applicable
d)	pH	No data available
e)	Melting point/freezing point	No data available
f)	Initial boiling point and boiling range	No data available
g)	Flash point	()Not applicable
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	The product is not flammable.
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapor pressure	< 0.0001 hPa
l)	Vapor density	No data available
m)	Relative density	1.68 at 20 °C (68 °F) - Regulation (EC) No. 440/2008, Annex,

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		A.3
n)	Water solubility	730 g/l at 25 °C (77 °F) - completely soluble
o)	Partition coefficient: n-octanol/water	Not applicable for inorganic substances
p)	Autoignition temperature	> 600 °C (> 1112 °F)
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	The substance or mixture is classified as oxidizing with the category 3.

9.2 Other safety information
No data available

SECTION 10: Stability and reactivity

10.1 Reactivity
No data available

10.2 Chemical stability
The product is chemically stable under standard ambient conditions (room temperature) .

10.3 Possibility of hazardous reactions
Violent reactions possible with:
Reducing agents
combustible substances
Alcohols
Strong acids
Bases
Heavy metal salts

10.4 Conditions to avoid
Exposure to moisture.
no information available

10.5 Incompatible materials
No data available

10.6 Hazardous decomposition products
In the event of fire: see section 5

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SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - male - 1,200 mg/kg
(OECD Test Guideline 401)
LC50 Inhalation - Rat - 4 h - > 5.1 mg/l
(Regulation (EC) No. 440/2008, Annex, B.2)
LD50 Dermal - Rat - male and female - > 2,000 mg/kg
(US-EPA)

Skin corrosion/irritation
Skin - Rabbit
Result: Skin irritation - 4 h
(OECD Test Guideline 404)

Serious eye damage/eye irritation
Eyes - Rabbit
Result: No eye irritation
(OECD Test Guideline 405)

Respiratory or skin sensitization
Sensitisation test: - Guinea pig
Result: positive
May cause allergic respiratory and skin reactions
(OECD Test Guideline 406)

Germ cell mutagenicity
Test Type: Ames test
Test system: S. typhimurium
Metabolic activation: with and without metabolic activation
Result: negative
Remarks: (ECHA)
Test Type: Ames test
Test system: E. coli
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative

Test Type: Micronucleus test
Species: Mouse

Application Route: Intraperitoneal
Method: OECD Test Guideline 474
Result: negative

Test Type: unscheduled DNA synthesis assay
Species: Rat

Application Route: Oral

Result: negative

Carcinogenicity

IARC: No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

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NTP: No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation.

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

11.2 Additional Information

Repeated dose toxicity - Rat - male and female - Oral - 90 d - NOAEL (No observed adverse effect level) - 91 mg/kg

RTECS: SE0525000
Allergy, Repeated exposure may cause asthma.
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Systemic effects:

Nausea
Vomiting
Headache

Other dangerous properties can not be excluded.

Handle in accordance with good industrial hygiene and safety practice.

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	static test LC50 - Oncorhynchus mykiss (rainbow trout) - 76.3 mg/l - 96 h Remarks: (ECHA)
Toxicity to daphnia and other aquatic invertebrates	static test EC50 - Daphnia magna (Water flea) - 120 mg/l - 48 h Remarks: (ECHA)
Toxicity to algae	static test EC50 - Phaeodactylum tricornutum - 136 mg/l - 72 h (OECD Test Guideline 201)

12.2 Persistence and degradability
The methods for determining biodegradability are not applicable to inorganic substances.

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12.3 Bioaccumulative potential
Bioaccumulation is unlikely.

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
No data available

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product
Waste material must be disposed of in accordance with the national and local regulations. Leave chemicals in original containers. No mixing with other waste. Handle uncleaned containers like the product itself. See www.retrologistik.com for processes regarding the return of chemicals and containers, or contact us there if you have further questions.

SECTION 14: Transport information

DOT (US)
UN number: 1505 Class: 5.1 Packing group: III
Proper shipping name: Sodium persulfate
Reportable Quantity (RQ):
Poison Inhalation Hazard: No

IMDG
UN number: 1505 Class: 5.1 Packing group: III EMS-No: F-A, S-Q
Proper shipping name: SODIUM PERSULPHATE

IATA
UN number: 1505 Class: 5.1 Packing group: III
Proper shipping name: Sodium persulphate

SECTION 15: Regulatory information

SARA 302 Components
This material does not contain any components with a section 302 EHS TPQ.

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Reactivity Hazard, Acute Health Hazard

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

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No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
disodium peroxodisulphate	7775-27-1	2007-03-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
disodium peroxodisulphate	7775-27-1	2007-03-01

SECTION 16: Other information

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

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Version: 6.6 Revision Date: 07/06/2021 Print Date: 01/17/2023

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SAFETY DATA SHEET

Version 6.4
Revision Date 04/26/2022
Print Date 01/15/2023

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : Ethylenediaminetetraacetic acid ferric sodium salt

Product Number : E6760
Brand : Sigma
CAS-No. : 15708-41-5

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 SPRUCE ST
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone

Emergency Phone # : 800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture.

2.2 GHS Label elements, including precautionary statements

Not a hazardous substance or mixture.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

SECTION 3: Composition/information on ingredients

3.1 Substances

Synonyms : Ethylenediaminetetraacetic acidiron(III) sodium salt
Komplexon® II

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Edathamil
EDTAiron(III) sodium salt

Formula	:	$C_{10}H_{12}FeN_2NaO_8$
Molecular weight	:	367.05 g/mol
CAS-No.	:	15708-41-5
EC-No.	:	239-802-2

No components need to be disclosed according to the applicable regulations.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice
Consult a physician. Show this material safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Carbon oxides
Nitrogen oxides (NOx)
Sodium oxides
Iron oxides

5.3 Advice for firefighters

Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information

No data available

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SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. Avoid dust formation. Avoid breathing vapors, mist or gas. Avoid breathing dust.
For personal protection see section 8.

6.2 Environmental precautions

Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up

Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Advice on safe handling
Avoid formation of dust and aerosols.**Advice on safe handling**
Further processing of solid materials may result in the formation of combustible dusts. The potential for combustible dust formation should be taken into consideration before additional processing occurs.

Advice on protection against fire and explosion
Provide appropriate exhaust ventilation at places where dust is formed.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions
Keep container tightly closed in a dry and well-ventilated place.

Storage class
Storage class (TRGS 510): 13: Non Combustible Solids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Ingredients with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

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Personal protective equipment

Eye/face protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the EC approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Choose body protection in relation to its type, to the concentration and amount of dangerous substances, and to the specific work-place., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Do not let product enter drains.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: crystalline Color: yellow, green
b)	Odor	odorless
c)	Odor Threshold	No data available
d)	pH	4.5

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e)	Melting point/freezing point	Melting point/range: 80 °C (176 °F)
f)	Initial boiling point and boiling range	No data available
g)	Flash point	()No data available
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapor pressure	No data available
l)	Vapor density	No data available
m)	Density	1.78 g/cm3 at 20 °C (68 °F) - OECD Test Guideline 109
	Relative density	No data available
n)	Water solubility	72 g/l at 25 °C (77 °F) - OECD Test Guideline 105 - soluble
o)	Partition coefficient: n-octanol/water	No data available
p)	Autoignition temperature	207 °C (405 °F) at 1,013 hPa
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information

Bulk density	0.65 g/l
Surface tension	73.7 mN/m at 22 °C (72 °F)

SECTION 10: Stability and reactivity

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
No data available

10.4 Conditions to avoid
No data available

10.5 Incompatible materials
Strong oxidizing agents

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10.6 Hazardous decomposition products

In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
Acute toxicity estimate Oral - 2,500 mg/kg
(Calculation method)
LD50 Oral - Rat - male and female - > 2,000 mg/kg
(OECD Test Guideline 423)
LC50 Inhalation - Rat - male and female - 4 h - > 2.75 mg/l

(OECD Test Guideline 403)
LD50 Dermal - Rat - male and female - > 2,000 mg/kg
(OECD Test Guideline 402)
No data available

Skin corrosion/irritation
Skin - Rabbit
Result: No skin irritation - 4 h
(OECD Test Guideline 404)

Serious eye damage/eye irritation
Eyes - Rabbit
Result: No eye irritation
(OECD Test Guideline 405)

Respiratory or skin sensitization
- Mouse
Result: Does not cause skin sensitization.
(OECD Test Guideline 429)

Germ cell mutagenicity
Test Type: Ames test
Test system: S. typhimurium
Metabolic activation: with and without metabolic activation
Method: OECD Test Guideline 471
Result: negative

Carcinogenicity

IARC: No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP: No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

Reproductive toxicity
No data available
No data available

Specific target organ toxicity - single exposure
No data available

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Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

11.2 Additional Information

RTECS: AH4900000
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	static test LC50 - Oncorhynchus mykiss (rainbow trout) - > 100 mg/l - 96 h (OECD Test Guideline 203)
Toxicity to daphnia and other aquatic invertebrates	Immobilization EC50 - Daphnia magna (Water flea) - 100.9 mg/l - 48 h (OECD Test Guideline 202)
Toxicity to bacteria	Growth inhibition NOEC - Sludge Treatment - 640 mg/l - 3 h (OECD Test Guideline 209)

12.2 Persistence and degradability
No data available

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Endocrine disrupting properties
No data available

12.7 Other adverse effects
No data available

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product
Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging
Dispose of as unused product.

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SECTION 14: Transport information

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

Further information
Not classified as dangerous in the meaning of transport regulations.

SECTION 15: Regulatory information

SARA 302 Components
This material does not contain any components with a section 302 EHS TPQ.

SARA 313 Components
This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
No SARA Hazards

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Sodium feredetate	15708-41-5	

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Sodium feredetate	15708-41-5	

California Prop. 65 Components
This product does not contain any chemicals known to the State of California to cause cancer, birth, or any other reproductive defects.

SECTION 16: Other information

Further information
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The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See

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Version: 6.4 Revision Date: 04/26/2022 Print Date: 01/15/2023

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SAFETY DATA SHEET

Version 6.6
Revision Date 10/19/2022
Print Date 01/15/2023

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name	:	Sodium hydroxide
Product Number	:	S8045
Brand	:	SIGALD
Index-No.	:	011-002-00-6
CAS-No.	:	1310-73-2

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich Inc. 3050 SPRUCE ST ST. LOUIS MO 63103 UNITED STATES
Telephone	:	+1 314 771-5765
Fax	:	+1 800 325-5052

1.4 Emergency telephone

Emergency Phone #	:	800-424-9300 CHEMTREC (USA) +1-703-527-3887 CHEMTREC (International) 24 Hours/day; 7 Days/week

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Corrosive to Metals (Category 1), H290
Skin corrosion (Category 1A), H314
Serious eye damage (Category 1), H318
Short-term (acute) aquatic hazard (Category 3), H402

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal Word Danger

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Hazard statement(s)

H290	May be corrosive to metals.
H314	Causes severe skin burns and eye damage.
H402	Harmful to aquatic life.

Precautionary statement(s)

P234	Keep only in original container.
P260	Do not breathe dust.
P264	Wash skin thoroughly after handling.
P273	Avoid release to the environment.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340 + P310	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/ doctor.
P305 + P351 + P338 + P310	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/ doctor.
P363	Wash contaminated clothing before reuse.
P390	Absorb spillage to prevent material damage.
P405	Store locked up.
P406	Store in corrosive resistant container with a resistant inner liner.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS - none

SECTION 3: Composition/information on ingredients

3.1 Substances

Synonyms	:	Caustic soda
Formula	:	NaOH
Molecular weight	:	40.00 g/mol
CAS-No.	:	1310-73-2
EC-No.	:	215-185-5
Index-No.	:	011-002-00-6

Component	Classification	Concentration
sodium hydroxide		
	Met. Corr. 1; Skin Corr. 1A; Eye Dam. 1; Aquatic Acute 3; H290, H314, H318, H402 Concentration limits: >= 0.4 %: Met. Corr. 1, H290; >= 5 %: Skin Corr. 1A, H314; 2 - < 5 %: Skin Corr. 1B, H314; 0.5 - < 2 %: Skin Irrit. 2, H315; 0.5 - < 2 %: Eye Irrit. 2,	<= 100 %

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	H319;	

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first-aid measures

General advice
First aiders need to protect themselves. Show this material safety data sheet to the doctor in attendance.

If inhaled
After inhalation: fresh air. Call in physician.

In case of skin contact
In case of skin contact: Take off immediately all contaminated clothing. Rinse skin with water/ shower. Call a physician immediately.

In case of eye contact
After eye contact: rinse out with plenty of water. Immediately call in ophthalmologist. Remove contact lenses.

If swallowed
After swallowing: make victim drink water (two glasses at most), avoid vomiting (risk of perforation). Call a physician immediately. Do not attempt to neutralise.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media
For this substance/mixture no limitations of extinguishing agents are given.

5.2 Special hazards arising from the substance or mixture
Sodium oxides
Not combustible.
Ambient fire may liberate hazardous vapours.

5.3 Advice for firefighters
Stay in danger area only with self-contained breathing apparatus. Prevent skin contact by keeping a safe distance or by wearing suitable protective clothing.

5.4 Further information
Suppress (knock down) gases/vapors/mists with a water spray jet. Prevent fire extinguishing water from contaminating surface water or the ground water system.

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SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Advice for non-emergency personnel: Avoid inhalation of dusts. Avoid substance contact. Ensure adequate ventilation. Evacuate the danger area, observe emergency procedures, consult an expert.
For personal protection see section 8.

6.2 Environmental precautions

Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up

Cover drains. Collect, bind, and pump off spills. Observe possible material restrictions (see sections 7 and 10). Take up dry. Dispose of properly. Clean up affected area. Avoid generation of dusts.

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Storage conditions
No metal containers.
Tightly closed. Dry.

Storage class
Storage class (TRGS 510): 8B: Non-combustible, corrosive hazardous materials

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Ingredients with workplace control parameters

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Component	CAS-No.	Value	Control parameters	Basis
sodium hydroxide	1310-73-2	C	2 mg/m3	USA. ACGIH Threshold Limit Values (TLV)
		C	2 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	2 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		C	2 mg/m3	California permissible exposure limits for chemical contaminants (Title 8, Article 107)

Derived No Effect Level (DNEL)

Application Area	Routes of exposure	Health effect	Value
Workers	Inhalation	Long-term local effects	1 mg/m3
Consumers	Inhalation	Long-term local effects	1 mg/m3

8.2 Exposure controls

Appropriate engineering controls
Immediately change contaminated clothing. Apply preventive skin protection. Wash hands and face after working with substance.

Personal protective equipment

Eye/face protection
Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU). Tightly fitting safety goggles

Skin protection
This recommendation applies only to the product stated in the safety data sheet, supplied by us and for the designated use. When dissolving in or mixing with other substances and under conditions deviating from those stated in EN374 please contact the supplier of CE-approved gloves (e.g. KCL GmbH, D-36124 Eichenzell, Internet: www.kcl.de).
Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:KCL 741 Dermatril® L

This recommendation applies only to the product stated in the safety data sheet, supplied by us and for the designated use. When dissolving in or mixing with other substances and under conditions deviating from those stated in EN374 please contact the supplier of CE-approved gloves (e.g. KCL GmbH, D-36124 Eichenzell, Internet: www.kcl.de).
Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:KCL 741 Dermatril® L

Body Protection
protective clothing

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Respiratory protection
required when dusts are generated.
Our recommendations on filtering respiratory protection are based on the following standards: DIN EN 143, DIN 14387 and other accompanying standards relating to the used respiratory protection system.

Control of environmental exposure
Do not let product enter drains.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: pellets Color: white
b)	Odor	odorless
c)	Odor Threshold	Not applicable
d)	pH	ca.> 14 at 100 g/l at 20 °C (68 °F)
e)	Melting point/freezing point	Melting point/range: 318 °C (604 °F)
f)	Initial boiling point and boiling range	1,390 °C 2,534 °F at 1,013 hPa
g)	Flash point	()Not applicable
h)	Evaporation rate	No data available
i)	Flammability (solid, gas)	The product is not flammable.
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapor pressure	No data available
l)	Vapor density	1.38 - (Air = 1.0)
m)	Density	2.13 g/cm3 at 20 °C (68 °F)
	Relative density	No data available
n)	Water solubility	1,090 g/l at 20 °C (68 °F)
o)	Partition coefficient: n-octanol/water	Not applicable for inorganic substances
p)	Autoignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	none

9.2 Other safety information

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Relative vapor density	1.38 - (Air = 1.0)

SECTION 10: Stability and reactivity

10.1 Reactivity
No data available

10.2 Chemical stability
The product is chemically stable under standard ambient conditions (room temperature) .

10.3 Possibility of hazardous reactions
Violent reactions possible with:
Acetone
Chlorine
Ethylene oxide
Fluorine
Hydrogen halides
Hydrazine hydrate
hydroxylamine
Acid anhydrides
Acrolein
Acid chlorides
Acids
sulfuric acid
Chloroform
Water
hydrogen peroxide
anhydrides
phosphides
halogen-halogen compounds
trichloroethene
can decompose violently in contact with:
Organic Substances
hydrogen sulphide
Risk of ignition or formation of inflammable gases or vapours with:
powdered aluminium
Ammonium salts
persulfates
Sodium borohydride
phosphorus
Oxides of phosphorus
Halogenated hydrocarbon
Light metals
Metals
Risk of explosion/exothermic reaction with:
Bromine
Calcium
in powder form
furfuryl alcohol
Nitromethane
Peroxides
organic nitro compounds

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Nitriles
Acrylic monomers
Chloroform
with
Acetone
Nitrobenzene
with
Methanol
Nitrobenzene
with
salts
magnesium
Zinc
and
Tin
(in the presence of atmospheric oxygen and/or moisture)

10.4 Conditions to avoid
no information available

10.5 Incompatible materials
Aluminum, brass, Metals, metal alloys, Zinc, Tin

10.6 Hazardous decomposition products
In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
Oral: No data available
Symptoms: If ingested, severe burns of the mouth and throat, as well as a danger of perforation of the esophagus and the stomach.
Inhalation: No data available
Inhalation: Corrosive to respiratory system.
Symptoms: burns of mucous membranes, Cough, Shortness of breath, Possible damages:, damage of respiratory tract
Dermal: No data available
No data available

Skin corrosion/irritation
Skin - Rabbit
Result: Causes burns.
Remarks: (Regulation (EC) No 1272/2008, Annex VI)

Serious eye damage/eye irritation
Eyes - Rabbit
Result: Causes serious eye damage.
(OECD Test Guideline 405)
Remarks: (Regulation (EC) No 1272/2008, Annex VI)
Remarks: Causes serious eye damage.

Respiratory or skin sensitization
Patch test: - In vitro study

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Result: negative
Remarks: (ECHA)

Germ cell mutagenicity
No data available

Carcinogenicity

IARC: No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP: No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is on OSHA's list of regulated carcinogens.

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

11.2 Additional Information

RTECS: WB4900000
burning sensation, Cough, wheezing, laryngitis, Shortness of breath, spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Other dangerous properties can not be excluded.

Handle in accordance with good industrial hygiene and safety practice.

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	LC50 - Gambusia affinis (Mosquito fish) - 125 mg/l - 96 h Remarks: (ECOTOX Database)
Toxicity to daphnia and other aquatic invertebrates	EC50 - Ceriodaphnia (water flea) - 40.4 mg/l - 48 h Remarks: (ECHA)
Toxicity to bacteria	EC50 - Photobacterium phosphoreum - 22 mg/l - 15 min Remarks: (External MSDS)

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12.2 Persistence and degradability
The methods for determining the biological degradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential
No data available

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Endocrine disrupting properties
No data available

12.7 Other adverse effects
Harmful effect due to pH shift.
Forms corrosive mixtures with water even if diluted.
Neutralisation possible in waste water treatment plants.
Discharge into the environment must be avoided.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product
Waste material must be disposed of in accordance with the national and local regulations. Leave chemicals in original containers. No mixing with other waste. Handle uncleaned containers like the product itself.

SECTION 14: Transport information

DOT (US)
UN number: 1823 Class: 8 Packing group: II
Proper shipping name: Sodium hydroxide, solid
Reportable Quantity (RQ): 1000 lbs
Poison Inhalation Hazard: No

IMDG
UN number: 1823 Class: 8 Packing group: II EMS-No: F-A, S-B
Proper shipping name: SODIUM HYDROXIDE, SOLID

IATA
UN number: 1823 Class: 8 Packing group: II
Proper shipping name: Sodium hydroxide, solid

SECTION 15: Regulatory information

SARA 302 Components
This material does not contain any components with a section 302 EHS TPQ.

SARA 313 Components

The life science business of Merck KGaA, Darmstadt, Germany
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This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
No SARA Hazards

Massachusetts Right To Know Components
No components are subject to the Massachusetts Right to Know Act.

SECTION 16: Other information

Further information
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

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