REMEDIAL INVESTIGATION ADDENDUM REPORT
FINAL

Kenilworth Park Landfill
National Capital Parks - East
Washington, DC

Prepared for:

National Park Service
National Capital Parks - East
Washington, DC

Project Number 3-0700-11

June 2019

Prepared by:

The Johnson Company

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY **1**

1.0 INTRODUCTION **4**

1.1 NPS CERCLA Authority 5
1.2 Purpose 5
1.3 Report Organization 6

2.0 BACKGROUND **7**

2.1 Site Location and Description 7
2.2 Site History 8
2.3 Summary of Previous Investigations 9
2.3.1 2007 Kenilworth Park North Remedial Investigation 10
2.3.2 2008 Kenilworth Park South Remedial Investigation 11
2.3.3 2010 Supplemental Data Collection Report (SDCR) 12
2.3.4 2012 Feasibility Study 13
2.3.5 2013 Proposed Plan 14

3.0 SITE INVESTIGATION **14**

3.1 Supplemental Groundwater Study 14
3.2 Porewater Study 17
3.3 Groundwater Study 18
3.4 DOEE Seep Characterization 20
3.5 Surficial Soil Sampling and Analysis at KPS 23

4.0 PHYSICAL CHARACTERISTICS OF THE SITE **23**

4.1 Topography 23
4.2 Geology 24
4.3 Hydrology 24
4.4 Hydrogeology 25

5.0 NATURE AND EXTENT OF CONTAMINATION **26**

5.1 Limits of Waste 26
5.2 Surficial Soil 27
5.2.1 KPN 27
5.2.2 KPS 28
5.3 Subsurface Soil and Waste 28
5.4 UXOs and Methane 30
5.5 Groundwater 31
5.6 Sediment 34

6.0 CONCEPTUAL SITE MODEL **34**

7.0 RISK ASSESSMENT SUMMARIES **36**

7.1 Human Health Risk Assessment 36
7.1.1 Surface and Subsurface Soil Exposure Risk 36
7.1.2 Seep Exposure Risk 36

7.2 Screening Level Ecological Risk Assessment 37
8.0 CONCLUSIONS AND RECOMMENDATIONS 39
8.1 Conclusions 39
8.2 Recommendations 39
9.0 REFERENCES 40

FIGURES

Figure 1 Site Area Map
Figure 2 Site Plan
Figure 3 Monitoring Well Location Plan
Figure 4 Site Topography and Drainage
Figure 5 Groundwater Elevation Contours
Figure 6 VOCs in Groundwater Samples
Figure 7 SVOCs in Groundwater and Seep Samples
Figure 8 PCBs in Groundwater and Seep Samples
Figure 9 Pesticides in Groundwater and Seep Samples
Figure 10 Dioxin and Furan TEQ in Groundwater and Seep Samples
Figure 11A Graphical Conceptual Site Model - KPN
Figure 11B Graphical Conceptual Site Model - KPS

APPENDICES

Appendix A November 2016 Supplemental Groundwater Study Report
Appendix B August 2018 Porewater Study Report
Appendix C June 2019 Groundwater Study Report
Appendix D.1 July 2018 Seep Characterization Report
Appendix D.2 Statistical Comparison of Groundwater and Seep Sample Data
Appendix D.3 Human Health Risk Screening for Groundwater Seeps
Appendix E June 2019 Surfical Soil Quality Assessment Report, Kenilworth Park South
Appendix F June 2019 Screening Level Ecological Risk Assessment and Refinement

LIST OF ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or relevant and appropriate requirements
ART	Anacostia Riverwalk Trail
BTVs	Background Threshold Values
BERA	Baseline Ecological Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CFS	cubic feet per second
COC	Contaminants of Concern
cm/sec	centimeter per second
CSM	Conceptual site model
DCMR	District of Columbia Municipal Regulations
DOEE	District of Columbia Department of Energy and Environment
DRO	Diesel Range Organics
EPA	Environmental Protection Agency
ESV	Ecological Screening Value
FS	Feasibility study
ft	Foot or feet
HI	Hazard index
ISM	Incremental sampling methodology
KPL	Kenilworth Park Landfill Site
KPN	Kenilworth Park North
KPS	Kenilworth Park South
LEL	Lower Explosive Limit
MCL	Maximum Contaminant Level
mg/kg	Milligram per kilogram
MSW	Municipal solid waste
NACE	National Capital Parks - East
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPS	National Park Service
OU	Operable Unit

PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
RBC	Risk Based Concentrations
RG	Remediation goal
RI	Remedial Investigation
RSL	Regional Screening Level
SDCR	Supplemental Data Collection Report
SGS	Supplemental Groundwater Study
SLERA	Screening Level Ecological Risk Assessment
SVOC	Semivolatile Organic Compound
TAL	Target analyte list
TEF	Toxic Equivalency Factors
TEQ	Toxic Equivalents
TPH	Total Petroleum Hydrocarbons
UCL	Upper Confidence Limit
µg/L	Microgram per liter
USGS	U.S. Geological Survey
UXO	Unexploded Ordnance
VOC	Volatile organic compound

REMEDIAL INVESTIGATION ADDENDUM REPORT

Kenilworth Park Landfill
Washington, DC

EXECUTIVE SUMMARY

On behalf of the National Park Service (NPS), The Johnson Company, Inc. (JCO) prepared this Remedial Investigation (RI) Addendum Report for the Kenilworth Park Landfill Site (Site) located in Washington, D.C. (Figure 1). The Site is located within Anacostia Park, a unit of National Capital Parks – East (NACE), on the banks of the Anacostia River. The purpose of this RI Addendum Report is to present the findings of field activities, summarized below and presented in detail in the appendices to this Report.

As shown on Figure 2, the Site is subdivided into two areas, Kenilworth Park North (KPN) and Kenilworth Park South (KPS). RIs were completed separately for KPN in 2007 (E&E, 2007) and for KPS in 2008 (E&E, 2008). The 2007/2008 RIs identified potential visitor and site worker exposure risks associated with contamination in surface soil and subsurface soil/buried waste. No exposure risks were identified in the RIs for Site groundwater; however, NPS determined that additional assessment of groundwater was warranted to fill data gaps and reduce uncertainty. Filling data gaps associated with the groundwater migration pathway was the basis for initiating the RI Addendum activities.

In 2010, NPS divided the Site into two Operable Units. Operable Unit 1 (OU1) consists of surface and subsurface soils, including the waste material in the landfill. OU2 consists of the shallow groundwater beneath OU1. NPS established separate Operable Units so remedial measures for OU1 could be identified, selected and implemented while a Supplemental Groundwater Study (SGS) was completed for OU2.

In 2012, NPS published a Feasibility Study (FS) for OU1 that considered remedial alternatives to address contamination found in surface and subsurface soil/waste (JCO, 2012). The FS was followed by a Proposed Plan released for public comment in 2013 (NPS, 2013a). The Proposed Plan identified installation of a 24-inch thick soil cap over most of the area within KPN and KPS as the preferred remedial alternative. Based on public comments and NPS consideration of those comments, NPS determined selection of a remedy for OU1 could be influenced by the additional investigation related to OU2. Therefore, NPS deferred selection of a remedy for OU1 until the RI Addendum activities could be completed for OU2.

The Proposed Plan NPS prepared and released for public comment in 2013 was based on development of KPS for “active” recreational use (e.g., playing fields for organized sports where visitors have a higher likelihood of disturbing and coming into contact with site soils), similar to KPN. Since the release of the Proposed Plan in 2013, NPS has reevaluated future use of KPS. As documented In the NACE Management Plan for Anacostia Park (NPS, 2017), NPS designated KPS as a “Natural Resources Recreation” area, which is designed to protect natural areas and provide passive recreational opportunities that result in relatively little contact with Site soils (i.e., walking, jogging, cycling, and bird watching). The only recreational development currently envisioned for KPS is the planned extension of the Anacostia Riverwalk Trail, a paved walking and cycling trail that currently passes over the northern area of KPN.

The RI addendum activities documented in this Report include assessment of shallow groundwater quality below and migrating from the Site, completed to fill data gaps identified after the 2007 and 2008 RIs. The RI addendum activities also included an updated assessment of surficial soil quality at KPS to better understand potential human health exposure risks in that portion of the Site.

REMEDIAL INVESTIGATION ADDENDUM REPORT

Kenilworth Park Landfill
Washington, DC

RI Addendum activities summarized in this report were carried out during multiple phases of exploration and testing from 2013 to 2018. These activities included drilling and collecting sample cores for geologic characterization, installation of groundwater monitoring wells and piezometers, hydraulic testing, water level monitoring and potentiometric mapping, groundwater sampling and analysis, porewater sampling and analysis, an aerial infrared thermographic survey, groundwater seep sampling (completed by the District's Department of Energy and Environment [DOEE]), and surficial soil sampling at KPS using the incremental sampling methodology (ISM). NPS used the RI Addendum data to update applicable portions of the human health and ecological risk assessments. No data gaps were identified for subsurface soil or buried waste; therefore, no additional subsurface soil or buried waste samples were collected during RI Addendum activities. NPS will continue to rely on the conclusions outlined in the 2007/2008 RIs relative to those media.

The objectives, scope, findings and conclusions of each RI Addendum activity are summarized in this report. This report provides an overview of site conditions; detailed documentation of the RI activities is provided in the report appendices listed below:

- Appendix A - November 2016 Supplemental Groundwater Study Report (JCO, 2016a);
- Appendix B - August 2018 Porewater Study Report (JCO, 2018b);
- Appendix C - June 2019 Groundwater Study Report (JCO, 2019a);
- Appendix D.1 - July 2018 Seep Characterization Report (Tetra Tech, 2018);
- Appendix D.2 - Statistical Comparison of Groundwater and Seep Sample Data (JCO, 2019b)
- Appendix D.3 - May 2019 Human Health Risk Screening for Groundwater Seeps (W&C, 2019a);
- Appendix E - November 2018 Surficial Soil Quality Assessment at Kenilworth Park South (JCO, 2019c); and
- Appendix F - June 2019 Groundwater Discharge Screening Level Ecological Risk Assessment (SLERA) and Refinement (W&C, 2019b).

As a result of these activities and analyses, the data gaps identified following completion of the 2007/2008 RIs have been filled. The nature and extent of contamination at the Site has been characterized such that associated human health and ecological exposure risks can be adequately quantified.

Chemicals in Site groundwater discharge to the Anacostia River; however, with the exception of iron, the levels have not been shown to have the potential for causing unacceptable human or ecological risks in the River. Iron was shown to pose a potential ecological risk but does not require action due to the following:

- Iron in the Anacostia River has been studied for the ARSP and it did not exceed human health or ecological criterion; therefore, iron has not been identified as a contaminant of concern (COC) in the River. Therefore, any excess risk caused by contributions of iron from the Site to the River are inconsequential.
- Iron is not a CERCLA hazardous substance.

According to the 2007 RI, polychlorinated biphenyl (PCB) Aroclors and polycyclic aromatic hydrocarbons (PAHs) in surficial soil at KPN present a potential cumulative excess cancer risk of 3.1×10^{-5} for a residential use scenario involving child/adult visitors who spend 2 hours per visit 350 days per year, for 30 years, which is above the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) point of departure (1×10^{-6}) for assessing potentially unacceptable cancer risks.

Based on the sampling and analysis performed for this RI Addendum, PCB Aroclors and PAHs in surficial soil at KPS present a potential cumulative excess cancer risk of 2×10^{-5} for a residential use scenario involving child/adult visitors who spend 2 hours per visit 350 days per year, for 26 years (updated risk parameters). This level of risk is similar to that which was presented in the 2008 RI and is above the NCP cancer risk point of departure (1×10^{-6}). The estimated cumulative excess cancer risk for outdoor workers (park employees who spend 225 days per year performing maintenance activities over a 25-year period) was 2×10^{-6}.

As indicated in the 2007 and 2008 RI reports, prolonged worker exposure (70 days over the course of one year) to buried soil and waste that is impacted by lead could cause adverse health effects associated with elevated blood lead levels. Excavation within the former landfill areas also requires precautions to be taken due to the potential presence of methane gas (a biproduct of waste decomposition) and potentially buried unexploded ordnance. Based on the 2007/2008 RI and the RI Addendum data, this report recommends preparation of a Feasibility Study (FS) Addendum focusing solely on OU1. The FS Addendum will include a risk management analysis, an updated assessment of Applicable or Relevant and Appropriate Requirements (ARARs) and Criteria to be Considered (TBCs) and development of Remedial Action Objectives (RAOs). As Site conditions have not changed since the 2012 FS was completed, NPS will complete a similarly focused evaluation of remedial alternatives.

1.0 INTRODUCTION

On behalf of the National Park Service (NPS), The Johnson Company, Inc. (JCO) prepared this Remedial Investigation (RI) Addendum Report for the Kenilworth Park Landfill Site (Site) located in Washington, D.C. (Figure 1). The Site is located within Anacostia Park, a unit of National Capital Parks – East (NACE), on the banks of the Anacostia River. The purpose of this RI Addendum Report is to present the findings of field activities conducted to address data gaps primarily associated with groundwater underlying the Site. These findings are summarized below and presented in detail in appendices to this report.

As shown on Figure 2, the Site is subdivided into two areas, Kenilworth Park North (KPN) and Kenilworth Park South (KPS). The RIs were completed separately for KPN in 2007 (E&E, 2007) and for KPS in 2008 (E&E, 2008). The 2007/2008 RIs identified potential visitor and site-worker exposure risks associated with contamination in surface soil and subsurface soil/buried waste at both KPN and KPS. No exposure risks were identified in the RIs for Site groundwater; however, NPS determined that additional groundwater assessment was warranted to fill data gaps associated with the groundwater migration pathway. Filling these data gaps was the basis for initiating RI Addendum activities.

In 2010, NPS divided the Site into two Operable Units (OUs). OU1 consists of surface and subsurface soils, including waste material in the landfill. OU2 consists of shallow groundwater beneath OU1. NPS established separate Operable Units so identifying, selecting, and implementing remedial measures at OU1 could move forward while completing a Supplemental Groundwater Study (SGS) for OU2.

In 2012, NPS prepared a Feasibility Study (FS) for OU1 that considered remedial alternatives to address contamination found in surface and subsurface soil/waste (JCO, 2012). The FS was followed by a Proposed Plan that was released for public comment in 2013 (NPS, 2013a). The Proposed Plan identified installation of a 24-inch thick soil cap over most of the area within KPN and KPS as the preferred alternative. Based on public comments and further internal analysis, NPS determined that the proposed remedy for OU1 could be influenced by additional investigation of OU2. Therefore, NPS deferred selection of a remedy for OU1 until RI Addendum activities could be completed for OU2.

The Proposed Plan NPS prepared and released for public comment in 2013 was based on development of KPS for “active” recreational use (e.g., playing fields for organized sports where visitors have a higher likelihood of disturbing and coming into contact with site soils), similar to KPN. Since the release of the Proposed Plan in 2013, NPS has reevaluated future use of KPS. As documented in the NACE Management Plan for Anacostia Park (NPS, 2017), NPS designated KPS as a “Natural Resources Recreation” area, which is designed to protect natural areas and provide passive recreational opportunities that result in relatively little contact with Site soils (i.e., walking, jogging, cycling, and bird watching). The only recreational development currently envisioned for KPS is the planned extension of the Anacostia Riverwalk Trail, a paved walking and cycling trail that currently passes over the northern area of KPN. The RI Addendum activities documented in this Report include an assessment of shallow groundwater quality below and migrating from the Site, completed to fill data gaps identified after the 2007 and 2008 RIs. Monitoring well locations used to assess groundwater quality are shown on Figure 3. The RI addendum activities also included an updated assessment of surficial soil quality at KPS to better understand potential human health exposure risks in that portion of the Site; as no additional assessment of subsurface soil and buried waste was included in the RI Addendum, NPS will continue to rely upon the associated conclusions from the 2007/2008 RIs relative to those media.

This RI Addendum Report was prepared under JCO BPA Contract P16PA00039, Call Order P17PB00373. Because there were multiple phases of investigation, the RI Addendum activities were conducted under multiple Sampling and Analysis Plans listed below:

- Supplemental Groundwater Study Sampling and Analysis Plan, Operable Unit 2, Kenilworth Park Landfill, Washington, D.C. December 2013 (JCO, 2013)
- RI Addendum – Phase I Field Study Sampling and Analysis Plan, National Capital Parks – East, Kenilworth Park Landfill. December 2016 (JCO, 2016b)
- Sampling and Analysis Plan, RI Addendum - Background Groundwater and Surficial Soil Assessment. August 2017 (JCO, 2017)

In December 2014, NPS completed a report entitled Final Remedial Investigation Addendum, Kenilworth Park Landfill Site, N.E., Washington, D.C. (CDM, 2014). The report was prepared following completion of the 2013 and 2014 field activities that supported the SGS. After completing the 2014 RI Addendum report, NPS determined that additional data collection activities and analysis were warranted. Therefore, this RI Addendum Report, which contains that additional data and analysis, supersedes the 2014 RI Addendum report.

1.1 NPS CERCLA Authority

NPS is authorized under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601 et seq., to investigate and otherwise respond to the release or threatened release of hazardous substances on or from land under the jurisdiction, custody, or control of NPS. This RI Addendum Report was generated in general accordance with the U.S. Environmental Protection Agency's (EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988).

CERCLA's implementing regulations, codified in the NCP, 40 Code of Federal Regulations (CFR) Part 300, establish the framework for responding to hazardous substance releases and threatened releases. The NCP outlines two general processes for responding to releases: a removal action process (including both time-critical and non-time-critical removal actions) and a remedial action process (NCP Sections 300.400 through 300.440). NPS is following the remedial action process at the Kenilworth Site. Under the remedial action process, an RI/FS is performed to characterize the nature and extent of contamination and evaluate remedial alternatives to protect the public health or welfare or the environment from risks posed by the release or threatened release (NCP Section 300.430).

1.2 Purpose

The 2007 (KPN) and 2008 (KPS) RIs concluded that significant contaminant transport in groundwater from the Site was unlikely; however, NPS determined that there were gaps in the assessment of groundwater and that additional investigation was warranted to reduce uncertainty. The primary purpose of this RI Addendum was to expand assessment of groundwater quality migrating from the Site to either confirm or revise the conclusions documented in the 2007/2008 RIs.

Over the course of the RI Addendum study period, NPS observed that KPS has returned to a natural condition with relatively mature vegetation providing soil stability and high-quality wildlife habitat. In its current condition, KPS is serving the purpose for which the Park was established (to preserve the forests, water quality, and recreation value of the Anacostia River corridor). This observation caused NPS to

reconsider the future use assumption of the 2013 Proposed Plan, which proposed to remove vegetation and install a clean soil cap, in favor of leaving the land in its current state. Therefore, a secondary purpose of the RI Addendum was to conduct an updated assessment of surficial soil quality at KPS and update the human health risk assessment for that area.

Ultimately, the overall purpose of this RI Addendum is to fill data gaps related to the nature and extent of contamination at the Site, identify potential human health and ecological exposure risks, and provide the basis for evaluating remedial alternatives. The initial RIs and this RI Addendum provide the basis for a Feasibility Study Addendum, to be completed following publication of this Report.

1.3 Report Organization

This RI Addendum Report includes eight sections; brief descriptions of each section are provided below.

Section 1.0 – Introduction: This section presents the project and report objectives and the project scope.

Section 2.0 – Background: This section provides a summary of investigations completed and documents prepared for the Kenilworth Landfill Site. This section includes a relatively extensive background discussion to provide context for the rationale behind the various investigation activities, the associated findings, and conclusions. This section also includes summaries of the RI Addendum field activities and associated risk assessments, which are documented more thoroughly in six appended stand-alone reports:

- Appendix A: November 2016 Supplemental Groundwater Study Report (JCO, 2016a);
- Appendix B: August 2018 Porewater Study Report (JCO, 2018b);
- Appendix C: June 2019 Groundwater Study Report (JCO, 2019a);
- Appendix D.1: July 2018 Seep Characterization Report (Tetra Tech, 2018);
- Appendix D.2 Statistical Comparison of Groundwater and Seep Sample Data (JCO, 2019b)
- Appendix D.3 – May 2019 Human Health Risk Screening for Groundwater Seeps (W&C, 2019a);
- Appendix E: June 2019 Surficial Soil Quality Assessment at Kenilworth Park South (JCO, 2019c); and
- Appendix F: June 2019 Screening Level Ecological Risk Assessment (SLERA) and Refinement (W&C, 2019b).

Section 3.0 – Site Investigation: This section summarizes key findings and conclusions for each RI Addendum field activity.

Section 4.0 – Physical Characteristics: This section describes physical characteristics of the Site including topography, geology, hydrology, and hydrogeology.

Section 5.0 – Nature and Extent of Contamination: This section describes the nature and extent of contamination, including limits of waste, surficial soil, subsurface soil and waste, unexploded ordnance (UXO) and methane, and groundwater.

Section 6.0 – Conceptual Site Model (CSM): This section presents the conceptual site model (CSM) that illustrates the physical characteristics of the Site, nature and extent of contamination and contaminant transport and exposure pathways.

Section 7.0 – Risk Assessments: This section summarizes the supplemental assessments of human health and ecological risk. The assessments build onto the human health and ecological risk assessments that are documented in the initial 2007 and 2008 RI reports and subsequent documentation included with the 2012 Feasibility Study Report (JCO, 2012). The risk assessment analyses performed for the RI Addendum are limited to human exposure to surficial soil at KPS (addressed in Appendix E) and ecological exposure associated with groundwater discharge to surface water (Appendix F). For completeness, conclusions regarding other human and ecological exposure pathways are summarized with references to the associated documentation.

Section 8.0 – Conclusions and Recommendations: The conclusions of the RI addendum report are presented and recommendations are summarized in this section.

Section 9.0 – References: Documents cited in the text are listed in this section.

2.0 BACKGROUND

As noted above, the CSM for this Site draws on exploration and testing activities completed over a 20-year period. In addition to providing orientation about the Site setting and history, this section summarizes key documents prepared and published prior to 2013 and the initiation of RI Addendum activities.

2.1 Site Location and Description

The Site is located within the Anacostia Park unit of NACE in Washington, District of Columbia (DC) (Figure 1). Access to KPN is from Deane Avenue NE near the intersection with Lee Street NE. Access to KPS is either from the Deane Avenue extension within KPN (currently blocked by jersey barriers) or via the ART with access at the intersection of Foote Place NE and Foote Street NE.

The Site consists of two closed landfills (KPN and KPS) separated by Watts Branch, a tributary of the Anacostia River. The Site occupies approximately 130 acres (KPN is approximately 80 acres and KPS is about 50 acres). As shown on Figure 2, the Anacostia River runs along the west side of both KPN and KPS. Kenilworth Marsh is located to the north of KPN, Watts Branch runs along part of the southern boundary of KPN then intersects KPN and KPS. An unnamed tributary to Watts Branch runs along the east side of KPS.

The former landfills surround a portion of Mayfair Terrace, a multi-family residential neighborhood separated from the Site by Watts Branch and the tributary to Watts Branch. The Eastland Garden residential neighborhood borders the Site to the east and southeast of KPN. The Kenilworth neighborhood is located east and northeast of KPN. The Thomas Elementary School is located about 300 feet southeast of KPS. The Benning Road solid waste transfer station is located to the south of KPS.

KPN consists of grassy open space with buffers or transition zones of trees and shrubs along riparian or marsh boundaries. A large portion of KPN is used for public recreation (e.g., soccer fields, a football field, tennis courts, and basketball courts). In 2016, DC Department of Transportation (DDOT) completed an extension of the asphalt-paved ART over a portion of KPN. The ART will soon be extended within KPN to

a new bridge that will cross the River and tie into the trail network within the National Arboretum. Administrative jurisdiction of KPN and some adjacent areas of the park is expected to be transferred in the future to the District (PL 108-335 § 334) "for the provision of public recreational facilities, open space, or public outdoor recreational opportunities." The District has not published specific plans for development of KPN but continued use for sports facilities is likely.

KPS consists of an open field with well-established grass cover and shrubs, and areas that are more densely vegetated with shrubs and trees. Although KPS is administratively closed, the asphalt paved extension of Deane Avenue NE is used by the public for walking and biking. KPS is also visited by birders who likely explore off-road areas. The ART will eventually include a segment that crosses KPS and joins with the existing trail on KPN. KPS will remain under NPS administrative jurisdiction and has been designated as a Natural Resource Recreation Zone in the NACE Management Plan for Anacostia Park. This designation is designed to preserve and protect natural areas and provide passive recreational opportunities. Recreational facilities at KPS will be limited to the ART; there will be no other facilities (e.g., picnic areas or playgrounds) or trails maintained for public use.

2.2 Site History

As shown on the inset 1910 United States Geological Survey (USGS) topographic map of the area, the Site was previously a low-lying wet area through which tributary streams discharged to the Anacostia River. Upland areas were located to the south and east of the landfill and included an oval horse racing track which is now occupied by the Paradise at Parkside and Mayfair Mansions multi-family apartment buildings.	
As shown in the inset aerial photograph from 1929, the low-lying areas consisted primarily of mud flats (the end of the former race track can be seen in the eastern edge of the photo and the Pepco coal-fired power plant can be seen to the south). The mud flats consist of Holocene epoch clay and silt alluvium.	

As shown on the inset 1945 USGS topographic map, recreational lakes were excavated by the US Army Corps of Engineers within the mud flats/ alluvium in the late 1930s, portions of which are within the footprint of the landfill.	

In June 1942, the District applied for and was issued a permit from the Federal Government (War Department) and began using the eastern portion of KPN as a burning dump. Additional permits for the dump were obtained in the 1950s and early 1960s, expanding the footprint of the facility westward to the Anacostia River and ultimately to the footprint shown on Figure 2. In addition to the burned refuse, the facility received ash from several incinerators located within, and operated by the District. In 1968, open burning was discontinued, and raw municipal solid waste (MSW) was co-disposed with incinerator ash. Historical documents suggest that raw MSW was disposed in KPN for only a few months, but raw MSW and incinerator ash continued to be disposed in KPS until 1970 when the facility closed.

Aerial photographs taken in 1949, 1951, 1957, 1963, 1964, 1968, and 1970 document successive filling activities over the life of the landfill. The filling included the recreational lakes that were excavated in the 1930s and appeared to include two areas of open water along the bank of the Anacostia River and one area of open water next to Kenilworth Marsh. Although documentation is limited, it is possible that waste was disposed below the water line along the river and marsh in these areas.

Following closure, low-permeability soil was placed over the waste to level the ground surface and provide positive drainage toward the surrounding water bodies. Based on drilling logs, the soil cover thickness ranges from approximately 3 to 15 feet (ft).

Following a 1996 soil grading and drainage plan, NPS arranged for soil and fill material to be placed over KPS with the goal of constructing athletic fields for soccer and ultimate frisbee. The filling started in 1997 and was discontinued in 1998 before the final design grades were reached. The soil/fill at KPS contained demolition debris, which presented a physical hazard on the surface. The contractors who placed the fill were required by NPS to remove objectionable material from the Site. The removal included 74 truckloads of asphalt, 66 truckloads of concrete, and five roll-off containers of rebar and other metal materials. After these materials were removed, the landfill surface was re-graded by NPS to improve drainage and limit erosion and seeded in accordance with January 2002 grading and sediment control design plans.

2.3 Summary of Previous Investigations

Beginning in 1998 there have been multiple, increasingly more detailed, investigations of the Site. As summarized in the sections that follow, the 2007 and 2008 KPN and KPS RIs incorporated the findings of prior investigations completed at the Site. The scope, findings, and conclusions of these prior investigations were included in the 2007 and 2008 RIs as detailed below. The RIs were followed by

additional sampling documented in the 2010 Supplemental Data Collection Report (SDCR), the 2012 Feasibility Study (focused on OU1), and the 2013 Proposed Plan (also focused on OU1).

2.3.1 2007 Kenilworth Park North Remedial Investigation

The RI for KPN was summarized in a report dated November 2007 (E&E, 2007). The 2007 RI included an exploration and testing program that built upon the findings of two prior studies. The exploration and testing scopes of the two prior studies and the RI are summarized below.

Kenilworth Park Landfill North Geoprobe Sampling (E&E, 2000b)

- Seven "grab" groundwater samples were collected and analyzed for volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH)-diesel range organics (DRO), pesticides, polychlorinated biphenyls (PCBs), and metals.
- Thirty-six discrete subsurface soil/waste and 19 discrete surficial soil samples were collected and analyzed for VOCs, SVOCs, TPH-DRO, pesticides, PCBs, and metals.

Preliminary Assessment/Site Investigation (E&E, 2002)

- Eight groundwater monitoring wells were installed.
- Seven groundwater samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals.
- Ten discrete subsurface and 15 discrete surficial soil samples were collected and analyzed for SVOCs, pesticides, PCBs, and metals.
- Five sediment samples were collected and analyzed for SVOCs, pesticides, PCBs, and metals.

Additional exploration and testing performed as part of the 2007 RI

- Ten additional groundwater monitoring wells were installed.
- Sixteen groundwater samples were collected from new and previously installed wells and analyzed for VOCs, SVOCs, PCBs, pesticides, TPH, and metals.
- Eleven discrete subsurface and 14 discrete surficial soil samples were collected and analyzed for SVOCs, PCBs, and metals.
- Thirteen sediment samples were collected and analyzed for SVOCs, PCBs, and metals.

Key findings, conclusions and recommendations

- Based on exposure to contaminants found in surficial soil, the estimate of potential excess cancer risk to Site visitors was calculated to be 3.1×10^{-5}, which is above the NCP cancer risk point of departure (1×10^{-6}). The exposure scenario evaluated for visitors was similar to a residential scenario because the park is located very close to residential neighborhoods and is developed for recreational activities.
- Based on exposure to contaminants found in surficial soil, the estimates of non-cancer hazard indices (HIs) for child visitors and utility construction workers were calculated to be 3.5 and 2.8. Although above the HI benchmark of 1.0, the HI estimates were subsequently reevaluated through a target organ analysis and the associated HI was calculated to be less than 1.0.

- Elevated concentrations of lead detected in subsurface soil in some areas suggested that excavation activities in those areas could potentially cause elevated blood lead levels in workers and adverse health effects. The 2013 Proposed Plan identified institutional controls to address this exposure scenario.
- A screening level ecological risk assessment (SLERA) and subsequent Baseline Ecological Risk Assessment (BERA) Problem Formulation indicated a potential for unacceptable ecological risk associated with surface and subsurface soil. The ecological risk was subsequently reevaluated and discounted based on the findings of the 2010 Supplemental Data Collection Report (SDCR) described in Section 2.3.3.
- An assessment of methane in soil gas was recommended. It was subsequently completed and summarized in the 2010 SDCR.
- No VOC plumes were identified, and detections of polycyclic aromatic hydrocarbons (PAHs), pesticides, and PCBs in groundwater did not follow a uniform pattern; significant contaminant transport in groundwater was considered unlikely but was not definitively ruled out.
- All groundwater samples contained iron at concentrations exceeding screening levels, a condition that was attributed to leaching from the landfill waste.

2.3.2 2008 Kenilworth Park South Remedial Investigation

The RI for KPS was summarized in a report dated June 2008 (E&E, 2008). The 2008 RI included an exploration and testing program that built upon the findings of two prior studies. The exploration and testing scopes of the two prior studies and the RI are summarized below.

Kenilworth Park South Sampling (E&E, 1998)

- Eight grab groundwater samples were collected and analyzed for VOCs, TPH, SVOCs, and metals.
- Eight discrete subsurface and 23 discrete surficial soil samples were collected and analyzed for SVOCs, TPH, and metals.
- Five sediment samples were collected and analyzed for SVOCs, TPH, and metals.

Preliminary Assessment/Site Investigation (E&E, 2002)

- Eleven monitoring wells were installed.
- Eighteen groundwater samples were collected (a subset of the wells were sampled twice) and analyzed for VOCs, SVOCs, TPH, pesticides, PCBs, and metals.
- Forty-seven discrete subsurface soil samples were collected and analyzed for VOCs, SVOCs, TPH, pesticides, PCBs, and metals.
- Thirty-four discrete surficial soil samples were collected and analyzed for PAHs, PCBs, and metals (PCB analyses were limited to reference sampling locations).
- Twenty-six sediment samples were collected and analyzed for VOCs, SVOCs, TPH, pesticides, PCBs, and metals.
- Four surface water samples were collected and analyzed for VOCs SVOCs, TPH, pesticides, PCBs, and metals.

Additional Exploration and Testing Performed as Part of the 2008 RI

- Two additional monitoring wells were installed.
- Thirteen groundwater samples were collected from new and previously installed wells and analyzed for VOCs, SVOCs, PCBs, pesticides, TPH, and metals.
- Twenty-four discrete subsurface and 14 discrete surficial soil samples were collected and analyzed for SVOCs, PCBs, and metals (note that PCB analyses were limited to background/reference sampling locations).
- Thirteen sediment samples were collected and analyzed for PCBs, SVOCs, and metals.

Key Findings, Conclusions and Recommendations

- Based on exposure to contaminants found in surficial soil, the estimate of potential excess cancer risk to Site visitors was calculated to be 2.6×10^{-5}, which is above the NCP cancer risk point of departure (1×10^{-6}). The exposure scenario evaluated for visitors was similar to a residential scenario with the expectation that the future use of KPS would include development for recreational activities. As noted above, the Management Plan for Anacostia Park designates KPS as a Natural Resource Recreation Zone, which is designed to protect natural areas and provide passive recreational opportunities. In its current non-landscaped condition with uneven ground, dense vegetation, and steep slopes, KPS does not hold the same attraction for local recreational activity as KPN. Therefore, the exposure scenario considered at the time may be less representative than it is for KPN.
- Based on exposure to contaminants found in surficial soil, the estimates of non-cancer HIs for visitors was 2.3; however, when separated by target organs, no hazard index exceeded 1.0 (HI benchmark).
- Elevated concentrations of lead detected in subsurface soil in some areas suggests that excavation activities in those areas could potentially cause elevated blood lead levels in workers and cause adverse health effects.
- The SLERA and subsequent BERA Problem Formulation identified potential for unacceptable risk to certain ecological receptors due to contaminants in surface and subsurface soil (subsequently reevaluated and discounted based on the findings of the 2010 SDCR described in Section 2.3.3).
- An assessment of methane in soil gas was recommended (subsequently completed and summarized in the 2010 SDCR).
- The main concern related to the landfill was the potential migration of contaminants to surface water via groundwater; however, the migration potential was considered to be "small as suggested by the evidence that only low levels of contamination were found in the groundwater…"

2.3.3 2010 Supplemental Data Collection Report (SDCR)

Supplemental data collection activities were performed and summarized in a report dated February 2010, later released as Appendix A to the 2012 Feasibility Study (JCO, 2012). The supplemental study was completed to:

- Assess the potential for explosive risks from landfill gas (i.e., methane) during implementation of the remedial action as well as to current and future on-Site and adjacent off-Site structures; and
- Assess the bioavailability of contaminants previously detected in surface soils to ecological receptors.

The study included collection of 24 discrete surface soil samples and analysis for pH and total organic carbon. Soil gas samples from 21 locations were collected and analyzed in a laboratory for methane. One indoor air sample from a community center formerly located on KPN was also collected and analyzed for methane.

Methane was not detected inside the former community center building (demolished in 2010 by the District) and methane was not found to pose a risk beyond the boundaries of the Site; however, methane concentrations in subsurface soils were found to present unacceptable risk at several locations within the limits of the former landfill. The potential safety risks would be associated with future construction or utility work or other activities that disturb the subsurface soil and waste material.

Based on the analysis of contaminant bioavailability, NPS concluded that significant ecological risks were not present at the Site.

2.3.4 2012 Feasibility Study

The FS was summarized in a report dated April 2012 (JCO, 2012). The FS evaluated remedial alternatives for OU1 to address the combined KPN and KPS exposure risks associated with surficial soil contamination and to meet applicable or relevant and appropriate requirements (ARARs). The FS considered the following four alternatives:

- Alternative 1: No action;
- Alternative 2: Minor regrading combined with institutional controls and three years of annual perimeter methane monitoring;
- Alternatives 3a and 3b: Soil cap (12-inch cap for Alternative 3a and 24-inch cap for Alternative 3b), localized shallow excavation and off-Site disposal where pre-excavation is required, institutional controls, and perimeter methane monitoring before, during, and after remedial actions; and
- Alternative 4: Removal of all accessible waste material and existing cover soils, localized shallow excavation and off-Site disposal to accommodate a soil cap around existing development, wetlands restoration, and institutional controls.

The four alternatives were evaluated with respect to the CERCLA remedy selection criteria: 1) overall protection of human health and the environment; 2) compliance with ARARs; 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, or volume through treatment; 5) short-term effectiveness; 6) implementability; and 7) cost.

Alternative 3b was subsequently identified as the preferred alternative and presented for public review and comment in the 2013 Proposed Plan (summarized in Section 2.3.5). Both alternatives 3a and 3b were found to effectively address the exposure risk associated with surficial soil contamination. Alternative 3b was preferred over Alternative 3a because it attained Resource Conservation and Recovery Act Subtitle D closure specifications, which were considered at the time to be “relevant and appropriate” based on the expectation that meeting these requirements would reduce the potential for infiltration of precipitation

and reduce the potential for impacts associated with contaminant migration in groundwater. Based on the findings presented in this RI Addendum Report, the impacts of landfill waste on groundwater quality are limited to elevated iron concentrations in porewater. Based on the current body of data, installation of an additional cap to reduce infiltration is unlikely to change this condition.

Section 2 of the FS report includes a summary of previous investigations. The report summarizes an analysis of surface water and sediment data in the vicinity of KPN and KPS that was not included in the prior RI reports. Conclusions from this analysis were that data do not indicate an overall impact from the Site on surface water or sediment in the adjacent surface water bodies (Anacostia River, Watts Branch, and Kenilworth Marsh).

2.3.5 2013 Proposed Plan

The Proposed Plan for OU1 was released for public comment in February 2013 (NPS, 2013a) along with updates to the Administrative Record. A Public Comment Period was held from March 5 through May 6, 2013. The Proposed Plan was also presented at a Public Meeting on April 11, 2013. Public comments on the Proposed Plan and other alternatives evaluated in the FS ranged from support for the comprehensive removal of all landfill material (Alternative 4), support for taking no action (Alternative 1), and support for the preferred alternative (Alternative 3b) (NPS 2013b). In consideration of the public comments, and further internal evaluation, NPS opted to defer selection of a final remedy for OU1 until the potential impacts of contaminant migration to surface water could be more fully assessed.

3.0 SITE INVESTIGATION

As noted in the Introduction to this Report, RI Addendum activities included multiple phases of exploration, testing, and analysis. Each phase is documented in a separate report provided in the appendices. An overview of the scope and key findings of each report is provided below. Details related to the nature and extent of contamination across the Site are consolidated and summarized in Section 5.0.

3.1 Supplemental Groundwater Study

Field work for the SGS was completed in 2014; the results are documented in the SGS report published in November 2016 (JCO, 2016a) and included as Appendix A. The SGS report included a CSM that has since been refined with more recent findings and superseded by the CSM described in this Report.

NPS conducted the SGS to supplement groundwater quality information generated during prior investigations, and to further assess the potential migration of contaminants in groundwater. The scope of the SGS is summarized below.

- Twenty new monitoring wells were installed in 11 locations to assess groundwater quality along the downgradient perimeter of the landfill adjacent to the Anacostia River and Kenilworth Marsh. Nine locations included shallow and deep monitoring well couplets used to assess groundwater quality in the two shallow groundwater flow zones that are, in most areas of the Site, separated by the Holocene silt and clay. Five of the wells were replacements for previously installed wells that were either lost (MW-15N) or considered incapable of yielding representative samples (MW-1 through MW-4).

- Ten new piezometers were installed in five locations (each location included a shallow and deep piezometer) to support an updated hydrogeologic assessment.
- Twenty-seven groundwater samples were collected from the 20 new and seven previously existing wells and analyzed for VOCs, PAHs, PCBs, and the 23 EPA Target Analyte List (TAL) metals. Six of the groundwater samples at KPN were also analyzed for dioxin and furan congeners.
- Site-wide water level gauging was performed from all viable monitoring wells, piezometers, and staff gauges to assess groundwater flow directions and hydraulic gradients.
- Borehole permeability tests were performed on the newly installed monitoring wells to assess the hydraulic conductivity (ease at which groundwater flows through the soil/waste) at various locations across the Site.

Consistent with NPS protocol, the groundwater analytical results were compared to a range of screening levels, including Washington DC DOEE Class G1 Groundwater Criterion, 21 DCMR §1150 (1994), EPA maximum contaminant levels (MCLs), and NPS Ecological Screening Values (ESVs) for surface water (NPS, 2014). The screening levels used for each constituent are provided in the SGS tables (Appendix A).

VOCs were not detected above screening levels in 24 of the 27 monitoring wells sampled as part of the SGS. Two VOCs were detected slightly above their respective screening levels: chlorobenzene in well MW-6N and carbon disulfide in two wells (MW-S-02B and MW-S-04B). Based on these limited detections, NPS concluded that VOCs in groundwater do not present a significant risk and that no further assessment of VOC migration in groundwater (i.e., assessment of VOCs in downgradient porewater) was warranted.

PAHs were not detected above screening levels in 25 of the 27 monitoring wells sampled as part of the SGS. Five PAHs were detected in two of the monitoring wells; both wells are screened in waste and neither well was located adjacent to surface water. Naphthalene, phenanthrene, fluoranthene, and pyrene were detected above screening levels in well MW-8NR. Anthracene and pyrene were detected above screening levels in well MW-6N. Based on these limited detections, NPS concluded PAHs in groundwater do not present a significant risk to surface water and that further assessment of PAH migration in groundwater (i.e., assessment of porewater PAH concentrations) was not warranted.

The SGS results identified several metals above screening levels in the perimeter monitoring wells located adjacent to the Anacostia River and Kenilworth Marsh. NPS concluded there were insufficient data to determine if migration of metals in groundwater from the Site presented a potential risk to the Anacostia River and Kenilworth Marsh. Although not sufficient to support a statistical analysis, some of the historical groundwater sampling data from a background well (MW-11N) suggested the elevated metals concentrations could represent naturally occurring background levels.

The SGS findings supported the conclusion of prior investigations that groundwater impacts from the Site to the Anacostia River, Kenilworth Marsh, and Watts Branch are limited and that remedial action for OU2 may not be warranted. As summarized below, some data gaps remained, and confirmatory investigation activities were recommended.

<u>Data Gaps Identified in the SGS Report</u>

- The ecological risk assessment had not been updated to reflect the 2014 groundwater study data. This data gap is addressed in the 2019 SLERA and Refinement Report (W&C, 2019b) and included as Appendix F.

- The human health risk assessment had not been updated to reflect the ART, which was recently constructed at KPN and is being planned at KPS. The exposure assessment associated with the ART is included in the updated human health risk assessment documented in the Surficial Soil Assessment Report (JCO, 2019b), which is included as Appendix E.

- Porewater quality below Kenilworth Marsh and the Anacostia River had not been characterized, so it was unknown if groundwater quality in nearby monitoring wells was representative of actual ecological exposure conditions. A Porewater Study, which included sampling of both porewater and surface water, was performed to assess the potential for dissolved metals in Site groundwater to migrate and impact surface water. A summary of the porewater study is provided in Section 3.2 and the report is included as Appendix B.

- Water quality data for many of the on-Site wells were limited to one round of sampling. The number of samples was considered insufficient for statistical comparison to background conditions. This data gap was addressed by two additional rounds of groundwater sampling and analysis performed in September and November 2017 and documented in the Groundwater Study Report (JCO, 2019a), which is summarized in Section 3.3 and included as Appendix C.

- It was unknown if increasing groundwater levels in well MW-9 at KPS represented a trend that could lead to future saturation of additional landfill debris and/or future groundwater seeps that could impact surface waters. This data gap was addressed by the transducer study documented in the Groundwater Study Report (Section 3.3 and Appendix C).

- It was uncertain if groundwater levels in well MW-5N reflected actual water table conditions such that groundwater mounding and hydraulic gradient estimates beneath KPN, made using the groundwater elevation at MW-5N, may be lower than previously estimated. This data gap is addressed by the transducer study documented in the Groundwater Study Report (Section 3.3 and Appendix C).

One of the recommendations in the SGS included a step-wise process for assessment of the groundwater to surface water migration pathway. The first step was to collect and analyze porewater samples for metals and perform a SLERA and Refinement. If the SLERA and Refinement identified a potential risk associated with metals in porewater attributable to Site groundwater, then a second step would be taken to assess background groundwater quality. This second step was taken after concentrations of iron and manganese in porewater were identified as a potential ecological exposure risk.

Although not raised as a data gap in the SGS report, or in the subsequent Porewater Study Report, the monitoring well installation at MW-N-05A/B deviated from most of the SGS multi-level well installations in that both screens were in the lower groundwater flow zone (below the Holocene clay and silt deposit). The reason for this deviation was that there was insufficient thickness of granular soil above the clay and silt to install a well in accordance with District of Columbia Department of Energy and Environment (DOEE) specifications. This data gap was recognized during the planning stages for the 2017 Groundwater Study and filled by installing monitoring well MW-N-05AA as documented in the Groundwater Study Report (summarized in Section 3.3).

3.2 Porewater Study

Field work for the Porewater Study was completed in December 2016 and documented in a draft report that was finalized for inclusion in this Report as Appendix B. The Porewater Study was performed to determine if certain metals, present in groundwater within the landfill, are migrating with groundwater to the Anacostia River, and/or the Kenilworth Marsh, at concentrations that may result in an unacceptable ecological exposure risk. The scope of exploration and testing included:

- Collection of 18 saturated sediment samples (six from the Anacostia River, seven from Kenilworth Marsh downgradient of the Site, and five from locations within Kenilworth Marsh considered to represent reference areas that are outside the influence of Site groundwater). Porewater was extracted from the sediment in the laboratory using a centrifuge and analyzed for the 23 EPA TAL metals.
- Collection of 10 surface water samples (seven from the River and three from the marsh) and analysis for TAL metals. The surface water samples were collected at the same time, and from the same general locations, as the sediment porewater samples.

The metals concentration data were evaluated in a SLERA and Refinement. For the SLERA, sample concentrations (maximum detected values) were compared to the most conservative value from a range of screening levels, including DDOE Class D Water Quality Standards, EPA National Recommended Water Quality Criteria (EPA, 2016), and NPS ESVs for surface water (NPS, 2016). Sample concentrations that exceed the most conservative of these screening levels were retained for the refinement analysis (i.e., broader assessment of toxicity, further consideration of exposure scenarios, and comparison to background or reference values). Based on the porewater and surface water data, NPS concluded the only metals migrating from the landfill and posing a potential ecological risk were iron (in porewater along the River) and manganese (in one River porewater location).

Based on data available at the time of the Porewater Study, NPS was not able to conclude if the elevated iron and manganese concentrations were representative of background conditions, or if they were attributable to waste in the landfill. To fill this data gap, one of the Draft Porewater Study recommendations was to assess background groundwater quality by installing two new upgradient monitoring wells (MW-R-01A and MW-R-02A) to complement the one existing side-gradient well (MW-11N) and perform two rounds of Site-wide groundwater sampling and analysis. The recommended activities were included as part of the 2017 Groundwater Study, which is summarized in Section 3.3 and documented in the Groundwater Study Report (Appendix C). As recommended by DOEE, and described in Appendix C, background threshold values (BTVs) were also developed for comparison using data generated by the RI for the nearby Pepco site.

The SLERA and Refinement prepared in support of the Porewater Study has been updated since the draft Porewater Study Report was completed in 2017 to include the 2017 groundwater data and the results of the seep investigation completed by DOEE (Tetra Tech, 2018; Appendix D). The expanded SLERA and Refinement report is summarized in Section 7.2 and included as Appendix F; the 2019 SLERA report is an update to, and supersedes, the 2017 report that focused solely on dissolved metals in porewater and surface water.

3.3 Groundwater Study

Field work for the groundwater study was completed under two separate mobilizations, one under the 2016 RI Addendum – Phase I Field Study Sampling and Analysis Plan (JCO, 2016b) and the other under the 2017 Sampling and Analysis Plan - Background Groundwater and Surficial Soil Assessment (JCO, 2017). The field work was completed during multiple Site mobilizations from December 2016 to November 2017 and is documented in the June 2019 Groundwater Study Report, attached as Appendix C (JCO, 2019a). The monitoring was performed to fill remaining data gaps identified after completion of the SGS and the Porewater Study and to incorporate input provided in interim review comments by DOEE. Specifically, the objectives of this study were to assess:

- the temporal variation of groundwater elevations in certain areas of the Site to refine the CSM for assessment of groundwater migration;
- thermographic anomalies that may represent groundwater seeps for subsequent seep sampling by DOEE and zones of apparent concentrated groundwater discharge to surface water (if present); the temporal variability of VOCs, SVOCs, PCBs, pesticides, and metals and the potential presence and magnitude of dioxins and furans in groundwater within and downgradient of the landfill; and
- whether concentrations of iron and manganese in groundwater are significantly above the levels found in background groundwater samples.

The scope of exploration, testing, and analysis is summarized below.

- Data logging pressure transducers were installed in four monitoring wells and used to collect water level data over a period of approximately six months. Trend analysis was evaluated by plotting water level fluctuations against local rainfall data and assessing for correlations.
- A qualitative aerial infrared thermographic survey was completed to help assess the representativeness of the existing monitoring well network.
- Three new monitoring wells were drilled and installed, two in locations inferred to be upgradient of the Site (MW-R-01A and MW-R-02A), and one (MW-N-5AA) in a downgradient location to complement previously installed wells MW-N-5A and MW-N-5B.
- Water levels were measured, and groundwater elevations were calculated for the accessible monitoring wells located at the Site to support development of a groundwater elevation contour plan and assessment of groundwater flow directions and hydraulic gradients.
- Two rounds of groundwater sampling (September 2017 and November 2017) were completed for the newly installed and selected previously existing monitoring wells (30 wells were sampled in September and 31 wells were sampled in November).
- The first-round groundwater samples were analyzed for VOCs, PAHs, PCBs, metals, and dioxin and furan congeners. The second-round samples were analyzed for VOCs, SVOCs (including PAHs), PCBs, metals, and pesticides.
- Groundwater concentrations associated with wells located within and downgradient of the landfill were compared to BTVs calculated using groundwater quality data from the three near-site monitoring wells (MW-R-01A, MW-R-02A, and MW-11N) and reference/background groundwater quality data generated by others as part of the ongoing Pepco RI. Although collected for the nearby Pepco site, the Pepco background data set includes constituents of interest for the

Kenilworth Park Landfill Site, represents groundwater from the same region and geologic conditions as the Site, and was collected from areas that are considered to be outside the potential influence of the Site. The near-site and Pepco background data helped to provide context in evaluating the concentrations of iron, manganese, and dioxin/furan congeners detected in Site groundwater.

The transducer study indicated groundwater levels at KPS fluctuate seasonally, are not increasing over time, and are not likely to result in new seeps or changed groundwater quality conditions. The transducer study also indicated water levels recorded within monitoring well MW-5N located in KPN represent surface water infiltration to the well, as the well is relatively shallow and was installed within the clay-rich materials. Water levels and samples from MW-5N are not considered representative of Site conditions and will no longer be used for assessment of hydrogeology.

The aerial infrared thermographic survey identified "anomalies" across the Site that represent surface water ponded over the landfill cap, groundwater seeps, and groundwater discharge pathways in the mud flats during low tide. The high-resolution thermographic imaging shows areas along the river bank where groundwater appears to discharge into the River at low tide as small rivulets. These rivulets appear evenly distributed along the River bank and do not suggest significant areas of concentrated groundwater discharge or preferential groundwater flow pathways. The distribution of groundwater seepage along the riverbank is visually evident during low tide.

NPS and DOEE inspected the Site to evaluate which thermographic anomalies potentially represented preferential migration pathways and/or groundwater seeps. Although several seeps were identified in the field, most were within areas where groundwater quality has been characterized. As documented in Appendix D, DOEE collected and analyzed samples from ten seep locations and provided the results for consideration in the SLERA and Refinement. No data gaps were identified as a result of the aerial IR thermographic survey that required expansion of the groundwater monitoring network (i.e., there were no areas of concentrated groundwater discharge that would require additional monitoring wells).

Analytical results of groundwater samples collected during this investigation were generally consistent with results reported from previous investigations. As with previous groundwater studies, the analytical results were compared to a range of screening levels, including DOEE Class G1 GW Criterion (21 DCMR §1150; October 2011), EPA MCLs (EPA 816-F-09-004; May 2009), and NPS ESVs for surface water (NPS, 2016). The results are summarized below.

- A small number of VOCs including carbon disulfide (five locations); chlorobenzene (one location); methylene chloride (one location); and, toluene (two locations) were detected at relatively low concentrations, but above ESVs.
- A small number of SVOCs including anthracene (three locations); benzo(a)anthracene (four locations); benzo(a)pyrene (three locations); fluoranthene (four locations); naphthalene (one location); phenanthrene (one location); phenol (one location); and pyrene (five locations) were detected at relatively low concentrations but above the most conservative of screening levels. SVOCs are not COCs in groundwater at the Site.
- PCB Aroclors were not detected and therefore not considered COCs in groundwater.
- No pesticides were detected above the screening levels; pesticides are not considered COCs in groundwater.

- Dioxin and furan congeners were not detected in 23 of the 27 monitoring wells located within or downgradient of the former landfill; the dioxin and furan congener concentrations that were detected were in the same range as, or below, reference/background concentrations reported for the nearby Pepco Benning Road site and total TEQ (the value used for assessment of human health and ecological risk) concentrations were below the calculated BTVs. According to the SLERA and Refinement (Section 7.2) the dioxin and furan congener concentrations do not pose an ecological exposure threat. Dioxin and furan congeners are not COCs in groundwater at the Site.
- Consistent with prior investigation findings, no groundwater plumes or source areas were identified for the organic constituents.
- Most metals analyzed were detected in groundwater samples at concentrations that were similar to those detected in 2014, and above the ESVs. Metals concentrations that exceeded ESVs in groundwater were the reason NPS completed the porewater study (Appendix B) and subsequent SLERA/Refinement (Appendix F). As summarized in Section 7.2 and in the SLERA/Refinement (Appendix F), only iron and manganese were identified as contaminants of potential ecological concern in porewater. When compared with the near-site background well concentrations and the Pepco background data set, manganese concentrations in Site monitoring wells were similar to background (all but a few sample concentrations were below the calculated BTVs). Iron concentrations were consistently higher than the calculated BTVs. As indicated in Section 7.2, iron is the only metal that represents a potential ecological exposure risk that may be attributable to Site groundwater.

As indicated in Section 3.1, well MW-N-05AA was installed to assess groundwater quality in the upper groundwater flow zone. The wells installed at this location as part of the SGS (MW-N-05A and MW-N-05B) were both screened below the clay and silt alluvium, so assessment of upper groundwater flow zone in this location was considered a minor data gap. Groundwater quality at MW-N-05AA was found to be similar to other areas of the Site; however, iron concentrations were among the lowest detected across the Site. The area around the well is low-lying and flat; the upper groundwater flow zone is only about 1 foot thick and is within the top 3 feet of soil. Therefore, the lower than average iron concentration in well MW-N-05AA is likely attributable to the influence of precipitation and a relatively short residence time in the subsurface.

3.4 DOEE Seep Characterization

As indicated in the CSM described in Section 6.0, groundwater from below the Site generally flows radially away from the landfill and discharges to the surrounding surface water bodies. Groundwater discharge can be observed during low tide as small rivulets that are relatively evenly spaced along the river bank. After reviewing interim project documentation regarding groundwater and porewater investigations, DOEE identified its concern that the quality of seep water emanating from the landfill was a data gap and agreed to perform a seep sampling program to address this gap.

The seep investigation was completed in accordance with the April 2018 NPS-approved DOEE Work Plan (Tetra Tech, 2018). The seep investigation is documented in the 2018 Seep Characterization Report (Tetra Tech, 2018), which is included as Appendix D.1. DOEE seep sampling locations are shown on Figure 3. NPS assessed the results obtained from the seep sampling to determine potential human health and ecological exposure risks as discussed in Sections 7.1 and 7.2 of this report, respectively. More details of the seep sampling program and findings are provided below.

On February 27, 2018, after a period of relatively heavy precipitation, DOEE visited the Site and identified five areas of apparent groundwater seepage around the perimeter of KPN (KPN-S-1 through KPN-S-5) and eleven areas of apparent seepage around the perimeter of KPS (KPS-S-1 through KPS-S-11). On April 30, 2018, DOEE and NPS representatives visited the Site to field verify possible additional seep locations that were identified by the aerial infrared thermographic survey and to select seep sampling locations. As a result, DOEE and NPS identified two additional seep locations at KPN (KPN-S-6 and KPN-S-7) and one additional seep location at KPS (KPS-S-12). Based on the observed conditions DOEE selected ten of the seep locations for sampling (six at KPN and four at KPS). DOEE's contractor collected the seep samples from April 30th through May 1st, 2018. The seep samples were submitted for laboratory analysis of dioxin and furan congeners, TPH-DRO, dissolved metals, pesticides, PCB Aroclors, SVOCs, and pH.

Six of the seep samples (KPN-S-3, KPN-S-4, KPN-S-5, KPN-S-7, KPS-S-4 and KPS-S-7) were collected from topographic depressions; the other four (KPN-S-1, KPN-S-6, KPS-S-1, and KPS-S-12) were collected from locations below the high tide line along the Anacostia River and Watts Branch. The water within the topographic depression at seep KPN-S-3 (near monitoring well couplet MW-N-09A/B) contained orange flocculant; orange staining has also been documented throughout the RI Addendum activities at the location of KPS-S-1 (just downslope from monitoring well couplet MW-S-4A/B). The orange flocculant and staining are characteristic of groundwater seepage from oxygen-depleted environments (typical of landfills) to oxygen-rich environments (e.g., open air). Similar orange staining was not observed in the other seep sampling locations, suggesting the seep water in these areas may not have been resident in the landfill long enough to significantly affect the geochemistry.

Three of the four samples collected from below the tideline (KPN-S-6, KPS-S-1, and KPS-S-12) are in areas where the thermographic survey shows relatively even distribution of groundwater seepage into the river (this is consistent with the seepage observations noted by DOEE representatives who visited the Site); there is no reason to believe these sample locations represent conditions that are unique based on the groundwater migration pathway. As an exception, seep sampling location KPN-S-1 consisted of a visible stream of bank discharge, approximately two to three inches wide; however, it is not possible to determine the pathway through which water seeping from this location traveled. There was no orange staining or flocculant observed in this area and it is equally possible that the discharge represents recent infiltration local to the observed seep.

Five of the seep samples (KPN-S-3, KPN-S-5, KPN-S-6, KPS-S-1, and KPS-S-12) were collected from areas where nearby monitoring wells are located, allowing for comparisons of groundwater and seep water quality. Data comparisons between the groundwater and seep samples are summarized below and in Section 5.5.

The samples were collected by excavating a small hole in the soil or river sediment (on the landfill side of the seep location), allowing it to fill with water, then pumping the water from the holes with a peristaltic pump into sample containers. Samples retained for dissolved metals analysis were field filtered; no field filtering was completed for the samples collected for organic constituents analysis. Field parameters including temperature, pH, dissolved oxygen (DO), and oxygen reduction potential (ORP) were measured and recorded for each sample. Because they were not filtered, the seep samples analyzed for organic constituents represent a mixture of groundwater discharging from the landfill and solid particles that were suspended in the sample holes. Samples collected for metals analysis were field filtered and are therefore considered representative of groundwater in the vicinity of the sample locations.

Dioxin and furan congeners, pesticides, PCB Aroclors, and SVOCs have low solubilities, tend to adsorb to soil particles, and therefore, potential migration in groundwater is limited. These constituents are also commonly found in surficial soil within urban areas because of atmospheric deposition, or other more direct release mechanisms (e.g., placement of contaminated fill, accumulation of contaminated river sediment after flooding, etc.).

As noted in Section 5.5, concentrations of organic constituents detected in seep samples were generally higher than the concentrations found in nearby groundwater monitoring wells. This result is expected considering the high level of turbidity in the seep samples and the resulting sampling bias this introduces. Of the three seep samples where SVOCs were detected above screening levels, two (KPS-S-1 and KPS-S-12) were close to, and downgradient of, monitoring wells where SVOCs have consistently been below screening levels. The third seep sampling location where SVOCs were detected above screening levels (KPN-S-3) is also close to, and downgradient of, existing monitoring wells where SVOCs have been detected above screening levels but not consistently. PCB Aroclors were below detection in all Site monitoring wells, yet they were detected in seven out of ten seep samples. No pesticides were detected above screening levels in the Site monitoring wells, yet they were detected above screening levels in seven out of ten seep sampling locations. Based on comparisons between the groundwater and seep sample data sets, organic constituents detected at elevated concentrations in seep samples are attributed to solids entrained in the samples rather than dissolved constituents migrating in groundwater.

In general, the dissolved metals concentrations detected in seep water samples were within the same range as the dissolved metals detected in groundwater. Box and whisker plots (provided in Appendix D.2) were used to compare the distributions (or grouping) of dissolved metals concentrations in the seep water and groundwater. With a few exceptions (calcium, magnesium, lead, and zinc) the distribution of metals concentrations in seep water were similar to, or lower than the concentrations in groundwater. Findings of the human health and ecological risk assessments indicate that the seep water concentrations of calcium, magnesium, lead, and zinc, discussed in more detail below, are not considered to present a risk to human health or the environment.

- Calcium concentrations detected in six out of the ten seep samples were below NPS ESVs (NPS, 2016).
- Magnesium concentrations detected in nine out of ten seep samples were below the NPS ESVs. The sample location where magnesium was elevated (KPS-S-4) is not proximate to surface water.
- Lead concentrations detected in seven out of the ten seep samples were below the NPS ESVs. As shown on figure in Appendix D2.1, the three seep samples where lead concentrations exceeded ESVs (KPS-S-4, KPN-S-4, and KPN-S-7) were collected from locations that are not proximate to surface water. Lead was not detected above ESVs in porewater samples from the Anacostia River or Kenilworth Marsh.
- Zinc concentrations detected in six out of ten of the seep samples were below the NPS ESVs. As shown on figure in Appendix D2.2 three of the four seep samples where zinc concentrations exceeded ESVs (KPS-S-7, KPN-S-4, KPN-S-5, and KPN-S-7) were collected from locations that are not proximate to surface water. The zinc concentration in sample KPN-S-1 that was collected from the bank of Watts Branch is above the screening levels but based on the risk assessment activities summarized in Section 7, zinc does not pose an elevated risk to human health or the environment.

Although the potential for human and ecological receptor exposure to seep water is limited based on the number and size of the seep areas, these pathways were evaluated as part of the RI Addendum. The potential human health exposure risks to seep water are addressed in Appendix D.3 and summarized in Section 7.1 and the ecological exposure risk is addressed in Appendix D.1 and summarized in Section 7.2.

3.5 Surficial Soil Sampling and Analysis at KPS

The objective of the 2017 surficial soil sampling and analysis was to determine if contaminant concentrations in surficial soil (i.e., soil within 0-6 inches from the surface) overlying KPS pose a potentially unacceptable risk to visitors or Site workers. Chemical parameters included in the assessment were selected based on prior investigation data and included SVOCs, PCB Aroclors, and metals. Note that PCB Aroclors were previously only analyzed in a handful of surficial soil samples from a localized area at KPS.

In November 2017, NPS used Incremental Sampling Methodology (ISM) to collect samples that provided data for a focused human health risk assessment. The risk assessment built on the risk assessment findings published in the 2008 RI report. The ISM program involved dividing KPS into 43 approximate 1-acre sampling areas and collecting three replicates of 40 increments in each area. The replicate samples were used to calculate 95% Upper Confidence Limit (UCL) estimates, which were then used for the assessment of risk. Field methods, laboratory results, and key findings are documented in the June 2019 report included as Appendix E.

The identified distribution of contaminants and range of concentrations reported from the ISM sampling were similar to the discrete sample data presented in the 2008 RI Report[1]. An updated human health risk assessment, using updated toxicological and receptor parameters, reached a similar conclusion regarding the potential non-cancer hazard and cancer risk to the combined child/adult visitor who spends two hours per day on the Site for 350 days per year for 26 years (hazard index less than one when segregated by target organ; excess cancer risk of 2×10^{-5}). The estimated cumulative excess cancer risk for outdoor workers (park employees who spend 225 days per year performing maintenance activities over a 25-year period) was 2×10^{-6}.[2]

4.0 PHYSICAL CHARACTERISTICS OF THE SITE

As summarized in the subsections that follow, the physical characteristics of the Site are dominated by the topography, which is largely the result of the former landfilling activities, and the depositional history associated with the Anacostia River.

4.1 Topography

The Site topography is graded such that surface water generally drains toward the surrounding surface water features. The topography tends to be steeper along the bank of the Anacostia River, Watts Branch and Kenilworth Marsh. There are several relatively small flat and low-lying areas on top of the former landfills where rain water and snowmelt ponds periodically. A series of drainage ditches and

[1] Quantitative statistical comparisons between ISM and discrete data are not possible.

[2] The 2019 Soil Quality Assessment Report and associated updated HHRA do not include the assessment of risks/ hazards from subsurface soil and/or buried waste. These media were evaluated in the 2008 HHRA, which found elevated concentrations of lead detected in subsurface soil in some areas could potentially cause elevated blood lead levels in unprotected construction/utility workers resulting in adverse health effects. NPS will continue to rely on the associated conclusions from the 2007/2008 RIs.

sedimentation ponds were constructed at KPS in the early 2000s for erosion control; these drainage features are evident in the 1-foot contours shown on Figure 4. As noted above, several of the seep sampling locations were collected from topographic depressions (Seep sample KPN-S-3 in particular is located within a small gully).

4.2 Geology

Consistent with the history of filling, the Site stratigraphy consists of fill material at the surface (soil cover placed over the landfills at the time of and subsequent to closure) underlain by landfill waste (incinerator ash, refuse from open burning, raw municipal solid waste) underlain by Holocene alluvial deposits associated with the Anacostia River and its tributaries underlain by a regional sand and gravel deposit (Wicomico Formation) underlain by a thick regional clay deposit (Patapsco Formation).

The Holocene alluvium (former mud flat) underlying the waste is generally clay-rich. It has been found below most areas of the landfill and extends below the Anacostia River and Kenilworth Marsh. The alluvium thins out and is in some places absent within the eastern historically upland areas of KPN. Gravel deposits have been noted within the upper portions of the alluvial deposit, which are attributed primarily to the various alignments of Watts Branch, a higher energy tributary to the River that crossed the mud flats (historical alignments of Watts Branch are shown on Figure 3). The gravel deposits in the upper portion of the Holocene alluvium represent potential preferential pathways for groundwater migration toward surface water.

As is evident from review of the historical aerial photographs, fill materials were deposited up to and in some areas below the water line along the bank of the Anacostia River and the perimeter of Kenilworth Marsh; these areas are considered potential preferential flow pathways as the fill material may be more conductive for groundwater migration. Prior investigators speculated that a low-permeability soil barrier was placed between the landfill waste and the river/marsh based on steep hydraulic gradients and electromagnetic geophysical survey results. Although no, or very limited, waste was observed in borings drilled between the landfill and the river/marsh, the presence of such a barrier has not been verified.

More detailed descriptions of Site geology, including detailed cross sections, are provided in the 2016 SGS report (Appendix A).

4.3 Hydrology

The Site is bordered to the west by the tidal Anacostia River. Kenilworth Marsh to the north is connected to the river and floods with the tide. Watts Branch conveys urban drainage from areas to the east of the Site; the lower portion of Watts Branch is also tidal. An unnamed tributary east of KPS conveys storm water from off-Site urban areas and discharges into the lower reach of Watts Branch. At KPN, surface water generally flows radially away from the landfill toward the surface water bodies. There are a few depressions in the surface of KPN where water ponds periodically. As noted above, a network of drainage ditches, berms, and sedimentation ponds were constructed at KPS to control erosion. The general drainage patterns for the Site are shown on Figure 4.

Due to the Site topography and surrounding surface water features, there are limited sources of surface water running onto the Site other than what is conveyed via Watts Branch and the tributary to Watts Branch. The approximate catchment area for the Site is 130 acres. Annual precipitation for the DC area is approximately 41 inches per year. Although no study has been conducted to estimate the proportion of

precipitation that infiltrates the landfill, based on the relatively thick and low permeability soil cover and the sloping conditions, groundwater recharge from precipitation is estimated to be on the order of 11 inches per year. Using these parameters, groundwater discharge from the Site is estimated to be on the order of 0.2 cubic feet per second (cfs). Although this is a very rough estimate of groundwater flux below the Site, it is in the same order of magnitude as estimates made using analytical and numerical groundwater flow models (Section 4.4).

4.4 Hydrogeology

Shallow zones of contiguous groundwater flow are inferred to exist above and below the Holocene clay and silt. The upper groundwater flow zone consists of the granular high energy stream deposits, landfill waste, and less conductive clays and silts. The lower groundwater flow zone consists of sands and gravels that are characteristic of the Wicomico Formation. The clay and silt alluvium (former mud flat) is considered an "aquitard," which is saturated, but limits the vertical migration of groundwater between the upper and lower flow zones.

With a few exceptions, the monitoring wells that were installed prior to the SGS have screens placed within the upper groundwater flow zone. Wells installed as part of the SGS included screens placed in both the upper and the lower groundwater flow zones. The multi-level wells allow for an assessment of potential contaminant migration from the upper to lower groundwater flow zones.

Inferred groundwater elevation contours and horizontal flow directions for the upper groundwater flow zone are presented on Figure 5. The contours were generated using groundwater level data collected on November 7, 2017. The inferred pattern of groundwater flow is consistent with the pattern presented in the 2016 SGS report. For both landfills, groundwater tends to mound in the interior areas and discharge to the surrounding surface water features (Anacostia River, Kenilworth Marsh, Watts Branch and the tributary to Watts Branch). Groundwater from the lower groundwater flow zone is inferred to discharge directly to the river.

As noted in Section 3.3, the distribution of groundwater discharge along the river bank at low tide can be seen in the aerial infrared thermographic imagery captured to supplement the Groundwater Study and documented in Appendix C. The imagery supports the conceptual model that groundwater flows radially away from the landfill to the River, in a relatively evenly distributed pattern. Horizontal hydraulic gradients vary across the Site but are expected to follow a pattern consistent with ground surface topography (flatter within the interior areas of the landfill and steeper along the perimeter). This pattern is demonstrated by comparing groundwater elevations at MW-8NR, MW-3NR, and MW-N-10A. The horizontal hydraulic gradient between MW-3NR and MW-N-10A is estimated to be approximately 0.03 ft/ft. This estimate represents the upper end of horizontal gradients at the Site and is considered representative of conditions along the bank of the river.

As documented in the SGS Report (Appendix A), the horizontal hydraulic conductivity of the upper and lower groundwater flow zones was estimated using data from borehole permeability (or "slug") tests. The geometric mean hydraulic conductivity estimated for the upper groundwater flow zone was 6×10^{-3} centimeters per second (cm/sec). The geometric mean hydraulic conductivity for the lower groundwater flow zone was 4×10^{-3} cm/sec.

Rough estimates of groundwater flux into the river from the upper groundwater flow zone (the zone containing landfill waste) can be made using a one-dimensional groundwater flow equation applied to a

rectangular vertical plane through which groundwater is inferred to flow. The length of the plane is equal to the length of the river along which groundwater from the Site is inferred to discharge (about 4,000 ft). The saturated thickness of granular material above the clay and silt aquitard varies between the perimeter wells from 0 ft (MW-N-07A) to about 6.5 ft (MW-N-06A); the average saturated thickness of the upper groundwater flow zone along the river is estimated to be about 4 ft. Groundwater flux (Q) from the upper zone is estimated to be about 0.09 cfs, which was estimated using the Darcy equation:

$$Q = KiA$$

Where *K* = hydraulic conductivity (ft/day), *i* = the horizontal hydraulic gradient (ft/ft), and *A* = the cross-sectional area through which groundwater is inferred to flow (3,900 ft x 4 ft). This estimate is within the same order of magnitude as the estimated groundwater recharge to the Site presented in Section 4.3 (0.2 cfs). Considering the level of uncertainty in assumptions used for both estimates, this comparison indicates that groundwater discharge estimates are likely within the right order of magnitude.

Using a 3-dimensional groundwater flow model, DOEE estimated that total groundwater flux to the river from the Kenilworth Park Landfill (KPL; upper and lower groundwater zones combined) is approximately 144,000 gallons per day, or 0.22 cfs (same approximate range as the infiltration estimate and the analytical Darcy equation). The average flow rate of the Anacostia River within this reach is estimated to be 150 cfs (E&E, 2007). Therefore, the volumetric discharge of groundwater from the upper groundwater zone represents approximately 0.06% of the total river flow. The estimated combined flow of groundwater from all zones represents approximately 0.15% of the river flow.

5.0 NATURE AND EXTENT OF CONTAMINATION

As summarized in Section 2.3, the nature and extent of contamination at the Site was established in the 2007 and 2008 RIs, and the 2010 Supplemental Data Collection Report. The subsequent groundwater, porewater and surficial soil assessments filled data gaps that were identified and allowed for a refinement of the CSM. Conclusions related to potential human health and ecological risk presented in the prior RIs and the SDCR were confirmed by the data collected during the RI Addendum activities. The following summary of contaminant nature and extent is considered supplemental to summaries provided in the RIs and the SDCR and primarily focuses on conditions/media addressed by the RI Addendum activities.

5.1 Limits of Waste

The inferred limits of waste shown on Figure 2 are based on the review of historical aerial photographs and topography established as part of the 2007/2008 RIs. As shown, the inferred limits of waste extend up to and along the River bank at KPS and KPN. Language in the 2007 and 2008 RI reports implied that waste was disposed below the water line along the entire perimeter of both landfills ("from the inlet of Kenilworth Aquatic Gardens to the inlet south of the park receiving the discharge of Piney Run just north of the Pepco plant"). The implication that waste was disposed below the water line along the entire River-side boundary contradicts evidence of sequential filling observed in historical aerial photographs and observations made during drilling as part of the SGS. Six out of the eight borings drilled along the bank of the River (MW-S-1A, MW-S-3A, MW-N-5A/B, MW-N-6A/B, MW-N-7A/B, and MW-N-8A/B) identified no waste. Less than 2 ft of waste was observed in the boring for MW-S-2A/B (which was above the approximate high tide line) and approximately 10 ft of waste was observed in the boring for MW-S-4A/B, which is set back from, and elevated above the river bank.

There are three locations identified from the historical aerial photographs where waste may have been disposed below the water line along the bank of the river and perimeter of Kenilworth Marsh. These areas were former inlets to the recreational lakes that were excavated by the US Army Corps of Engineers in the 1930s. Because waste deposits are potentially more permeable than natural soil, the former inlet areas represent potential preferential groundwater flow pathways. For this reason, NPS installed monitoring wells within the former inlets near the landfill perimeter (MW-7N, MW-6N, and MW-9A/B).

5.2 Surficial Soil

Although many of the same constituents are present at both KPN and KPS, the distribution of contaminants in surficial soil is different. For the most part, surficial soil at KPN consists of soil cap material placed when the landfill closed (newer soil fill was brought onto KPN during construction of the football field and running track; c.2006). Surficial soil at KPS consists of soil mixed with demolition debris placed over the 1970s landfill cap in 1997/1998 in accordance with plans to construct soccer and ultimate frisbee fields. Considering the different characteristics of surficial soil, and different future land use scenarios, assessment of surficial soil at the two landfills is described separately.

5.2.1 KPN

No additional surficial soil sampling or analysis has been performed at KPN since the RI was published in 2007. NPS considered conducting an updated assessment of surficial soil quality at KPN using ISM but concluded that the results were unlikely to yield a different risk assessment outcome. For the original RI, NPS compared surficial soil concentrations to relatively conservative screening levels (EPA Region 3 Risk Based Concentrations [RBCs] for residential soil as provided in Tables 5-4 through 5-6 in the 2007 KPN RI Report). Based on the subsequent risk assessments, and as part of the FS for OU1, NPS developed remedial goals (RGs) for various contaminants of concern (COCs) found in soil at concentrations that represent potential human health exposure risks. The distributions of various contaminants detected in surficial soil relative to the screening levels and RGs are summarized below by analyte class. Further context for the surficial soil quality is provided in Section 7.1 Updated Human Health Risk Assessment.

- **VOCs:** No VOCs were detected in surface soil samples collected as part of the Preliminary Assessment/Site Investigation; therefore, no additional VOC analyses were completed during the RI. No VOCs were identified as COCs at the Site.
- **SVOCs:** Concentrations of benzo(a)pyrene exceeded RGs in nearly every surficial soil sample collected. Dibenzo(a,h)anthracene was detected above RGs in three locations. No other SVOCs/PAH COCs were detected above RGs in surficial soil at KPN.
- **PCB Aroclors:** Aroclors 1254 and 1260 were detected above RGs in nearly every surficial soil sample collected at KPN. No other Aroclors were identified as COCs in surficial soil.
- **Pesticides:** Dieldrin and aldrin were detected above screening levels in a few surficial soil samples but were determined not to present an exposure risk due to the limited frequency of detection and were not carried forward as COCs.
- **Metals/Arsenic:** Arsenic, iron and lead were all detected above screening levels in surficial soil samples. Arsenic was found at concentrations considered to be within expected background levels and was not retained as a COC following the 2007 RI and associated risk assessment. Assessment of the dermal exposure to iron resulted in HIs for the child visitor and Site worker greater than one; however, the HI values for all Target organs (e.g., kidney, liver) are less than one; therefore,

iron was not retained as a COC. Although lead is considered a COC at the Site, lead concentrations in surficial soil samples from KPN were all below the associated RG.

5.2.2 KPS

As noted in Section 3.6, the RI Addendum activities included an updated assessment of surficial soil quality at KPS. The results of this assessment are described in the Surficial Soil Quality Assessment Report (JCO, 2018c) included as Appendix E and summarized in Section 3.5. Analytical results for ISM samples collected in 2017 were compared to EPA Regional Screening Levels (RSLs) for residential soil (November 2017). The distributions of various contaminants detected in surficial soil relative to the screening levels are summarized below by analyte class. Due to updated assumptions about visitor exposure frequency, the RGs developed for the 2012 FS may no longer be applicable to KPS. New RGs will be developed as part of the forthcoming FS Addendum. Further context for the surficial soil quality is provided in Section 7.1 Updated Human Health Risk Assessment.

- **SVOCs:** benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene and naphthalene were each detected in at least one ISM sampling area at concentrations that exceeded screening levels. Benzo(a)pyrene was detected above screening levels in every sampling area.
- **PCB Aroclors:** Aroclors 1254 and 1260 were detected in sampling areas at concentrations that exceed screening levels. Aroclor 1260 exceeded screening levels in approximately 50% of the sampling areas. Aroclor 1254 exceeded screening levels in approximately 7% of the sampling areas.
- **Metals/Arsenic:** As shown in the listing below, 12 metals and arsenic were reported at concentrations that exceeded screening levels for at least one of the study sampling areas. Some metals/metalloids such as aluminum, arsenic, cobalt, iron, and manganese exceed screening levels in almost every sampling area; whereas others (e.g., antimony, lead, nickel, silver) exceed screening levels in relatively few areas. A comparison of the ISM sampling results to the historical results reported from analysis of discrete samples indicates that the range (i.e., minimum and maximum) and average detected concentrations of target analytes for the two data sets are largely similar (Surficial Soil Assessment Report, Appendix E).

COPCs (% of sampling areas exceeding RSLs)		
• Aluminum (95%)	• Antimony (2%)	• Arsenic (100%)
• Cobalt (100%)	• Copper (7%)	• Iron (100%)
• Lead (5%)	• Manganese (93-98%)	• Mercury (36-41%)
• Nickel (2%)	• Silver (5%)	• Thallium (73%)
• Vanadium (55-61%)		

5.3 Subsurface Soil and Waste

The assessment of subsurface soil and waste at KPN and KPS has not changed since the 2007 and 2008 RI reports were published. As noted in the RI summary sections (2.3.1 and 2.3.2), relatively extensive subsurface soil sampling and analysis programs were completed at KPN and KPS. Risks identified with subsurface soil contamination are limited to worker exposure to lead during future excavation activities. The distributions of various contaminants detected in subsurface soil are described below by analyte class.

- **VOCs:** VOC concentrations in subsurface samples collected from KPN and KPS were compared to EPA Region 3 Risk-Based Concentrations (RBCs) developed for residential soils. No VOC was elevated above the corresponding RBC; therefore, VOCs were determined to not be a concern in subsurface soil at the Site.
- **TPH-DRO:** TPH-DRO concentrations were relatively low and no pattern of distribution was discovered in subsurface soil at KPN. TPH-DRO concentrations were detected in several soil samples collected from KPS along the river; the maximum concentration was 3,000 milligram per kilogram (mg/kg). There was no evidence of petroleum-related VOCs or PAHs detected in groundwater samples collected from wells located along the perimeter of the Site, and no evidence of petroleum sheens or non-aqueous phase liquid in the Site monitoring wells or purge water. TPH-DRO in subsurface soil/waste is not considered to be a concern at the Site.
- **SVOCs:** Benzo(a)pyrene was the SVOC/PAH most frequently detected above RBCs in KPN soil, but there was no clear pattern to its distribution. The distribution of total PAHs in subsurface soil at KPN was similar to that of benzo(a)pyrene. Total PAH concentrations in subsurface soil/landfill waste at KPN were lower than total PAH concentrations detected in surface soil samples. Benzo(a)pyrene was also detected frequently among other PAHs in subsurface soil at KPS. There was no discernable pattern of PAH distribution except that the concentrations at depth were generally higher than surficial soil concentrations; particularly for a few of the deeper samples that extended through the more recent fill soil and into the former ash landfill. The presence of PAHs in subsurface soils is considered a characteristic of the waste and soil placed in and over the landfill. Human exposure to PAHs in subsurface soil and waste within both KPN and KPS is limited to workers potentially exposed during excavation activities and does not present a human health exposure risk to visitors. There is no evidence of SVOCs/PAHs migrating in groundwater. SVOCs/PAHs in subsurface soil are not considered to be a concern at the Site.
- **Pesticides:** Dieldrin and aldrin were the only pesticides detected in subsurface soil from KPN above RBCs. Dieldrin exceeded RBCs in only two samples and aldrin exceeded in only one. Pesticide concentrations in subsurface soil/landfill waste at KPN were lower than pesticide concentrations detected in surface soil samples. No pesticides were detected above RBCs at KPS. There is no evidence of pesticides migrating in groundwater. Pesticides in subsurface soil are not considered to be a concern at the Site.
- **PCB Aroclors:** PCB Aroclor concentrations were above residential RBCs in several subsurface samples from KPN. Aroclor 1242 was detected more frequently and at higher concentrations than the other Aroclors detected (1248, 1254, and 1260); no discernable pattern of Aroclor 1242 detections was apparent. Except for Aroclor 1242, PCB detections in the subsurface soil were lower than detections in the surface soil samples at KPN. PCBs detected above RBCs in subsurface soil at KPS included Aroclor 1242, 1254, and 1260. There was no distinct pattern of PCB distribution at KPS. There were no human health or ecological risks identified with PCBs in subsurface soil and there is no evidence that PCBs are present or migrating in groundwater. PCBs in subsurface soil are not considered to be a concern at the Site.
- **Metals:** Antimony, arsenic, iron, lead, and manganese were the only metals detected above screening levels in subsurface soil at KPN. There was no pattern to the metals concentrations in subsurface soils at KPN except for lead, which was concentrated in one area along Deane Avenue near the park entrance, and another area along the river just north of Watts Branch. Aluminum, antimony, arsenic, cadmium, iron, lead, and vanadium were the only metals detected above

screening levels in subsurface soil at KPS. There was no pattern to the distribution of metals exceedances at KPS, except that the elevated lead concentrations were only detected in the former landfill material, not in the soil deposited over the landfill cap. There were no human health or ecological risks identified for subsurface metals in soil except for lead. As noted previously, lead concentrations in subsurface soil and waste may present a future excavation worker exposure risk if appropriate protective work procedures are not taken. The only potential risk identified for metals in groundwater was for iron that has been detected at elevated concentrations in downgradient porewater within the river. Similarly, elevated concentrations of iron in porewater have been documented in other reaches of the river that are outside the influence of Site groundwater.

5.4 UXOs and Methane

During installation of an irrigation system in 2006, an unexploded 75-millimeter M1 shrapnel round with 1907 model fuse was discovered. The US Army was called to the scene to remove and destroy it. It was the only UXO discovery on the Site. The Army confirmed they had no records indicating Kenilworth was a formerly used defense site where munitions could potentially have been disposed. According to a US Army representative interviewed about the finding, military munitions are commonly kept as souvenirs later to be discarded in public areas or the trash (US Army, 2011). This explanation fits with the finding; however, the presence of additional UXOs cannot be completely ruled out.

Landfill gas is generated by bacterial decomposition of organic waste within the landfill. Landfill gas is primarily composed of methane (CH4) and carbon dioxide (CO2). In old landfills without gas management systems (collection and use, venting, flaring), landfill gas can migrate into surrounding soils and structures. Public health and safety issues associated with landfill gas arise primarily from its methane content, which at sufficient concentrations could present possible explosion and asphyxiation hazards in structures and confined spaces.

Typically, methane generation in a landfill will peak somewhere between two and seven years after waste placement, depending on the amount and type of organic material in the waste (EPA, 2005; ATSDR, 2001). Most methane production occurs within 20 years after waste is placed although small quantities of gas may continue to be emitted from a landfill for 50 or more years (ATSDR, 2001). The Kenilworth Landfill received raw MSW (the major source of methane generation) from 1968 to 1970 and has been closed for almost 50 years. Given the age of the landfill, methane generation has more than likely peaked some time ago and has been declining for years.

As a follow up to the 2007/2008 RIs, NPS conducted a soil gas survey to assess for the presence and concentrations of methane across the Site. Methane concentrations exceeded the Site worker RG (established in the 2012 FS) at one location within KPN, where it was reported at concentrations of 74% to 81% of the lower explosive limit (LEL). Methane concentrations exceeded the Site worker RG at three soil vapor locations at KPS at concentrations ranging from 46% to 280% of the LEL. These locations likely reflect methane concentrations in landfill material. Methane in soil gas testing near the Neval Thomas Elementary School and D.C. Transfer Station in 2009 did not identify any methane concentrations in excess of the RG, indicating that methane is not migrating beyond the limits of waste disposal and is not a risk to the surrounding community or facilities.

5.5 Groundwater

Relatively few contaminants have been detected in or migrating with groundwater. Most of the organic contaminants typically associated with MSW and MSW incinerator ash (PAHs, dioxin and furan congeners, PCBs, and pesticides) have low solubilities under normal geochemical conditions, which helps explain the low frequency of detections in Site groundwater. Under neutral pH and oxygenated conditions, metals tend to be less mobile; however, it is common for metals to be mobilized either from waste or from natural soils under reduced oxygen conditions that are typical in landfill environments. The concentrations of several metals found in the Site monitoring well samples were elevated, which prompted completion of the porewater sampling program. Due to the low frequency of detection and low detected concentrations, organic constituents were not included in the porewater sample analyses. Groundwater data were used as surrogates for porewater data to assess the potential risk associated with organic constituents.

Because groundwater at the site is not used, and will most likely never be considered for use as a drinking water source, and because the potential for visitor/site worker exposure to seeps is remote, groundwater and seep water quality results are compared in this section to ecological screening levels, rather than human health screening levels. Screening levels for ecological receptors are generally lower (more conservative) than those for human receptors. The potential human health exposure risks posed by contaminants detected in groundwater and seeps are addressed in Appendix D.2 and summarized in Section 7.1. The distribution of contaminants detected in groundwater and seep samples are summarized below. Further context for the groundwater quality is provided in Section 7.

- **VOCs:** As shown on Figure 6, VOCs were not detected above screening levels in 35 out of 43 monitoring wells sampled across the Site over the course of the CERCLA investigations. Carbon disulfide, a compound that could be naturally occurring, was the only VOC detected in four of the eight wells where VOCs were detected above screening levels (MW-S-02B, MW-S-04B, MW-13, and MW-14N). The other screening level exceedances included chloroform in MW-1N, chlorobenzene and toluene in MW-6N, toluene in MW-8NR, and methylene chloride in MW-12N. For perspective, all the VOCs detected were well below the respective drinking water standards. There is no evidence of a VOC source area, nor of a plume of VOCs migrating in groundwater from the Site.
- **SVOCs/PAHs:** As shown on Figure 7, SVOCs were not detected above screening levels in 24 out of the 30 monitoring wells that have been sampled across the Site since the beginning of the SGS. Samples obtained prior to the SGS were not collected following low flow sampling methods. Low flow sampling limits the potential for fine-grained solids to be entrained in the samples that cause higher than ideal turbidity. Because SVOCs/PAHs adhere to solids, high solids content in the sample can lead to false positives, or a high bias to the results. For these reasons, the earlier sampling data are not considered as representative as the data collected in 2014 and later.

  As shown on Figure 7, a subset of PAHs including anthracene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, naphthalene, phenanthrene and pyrene was detected above screening levels intermittently in five monitoring wells (MW-N-05A, MW-6N, MW-8NR, MW-N-09A, and MW-N-09B). The absence of SVOCs/PAHs detected in most wells across the Site and the intermittent nature and relatively low concentrations of the SVOCs/PAHs that were detected, supports the conclusion that there is no concentrated SVOC source area, nor is there a plume of SVOCs migrating in groundwater from the Site.

As shown on Figure 7, SVOCs were not detected above screening levels in seven out of the ten seep samples that were analyzed. Two of the locations where SVOCs were detected above screening levels (KPS-S-1 and KPS-S-12) were close to, and likely downgradient of, existing monitoring wells (MW-S-03A, and MW-S-04A). A few PAHs were detected in these seep samples but were below the detection limits in the groundwater samples from the nearby wells. The higher concentrations of SVOCs/PAHs in the seep samples are likely due to the high solids content of the samples and the likely presence of PAHs in surficial soil and sediment.

The PAH detections in seep sample KPN-S-3 were similar in composition to the PAHs detected in nearby monitoring wells MW-N-9A and MW-N-9B. These wells are located within, or very close to, a former area of open water that was between a former recreational lake and Kenilworth Marsh and represents a potential preferential pathway for groundwater migration. The detection of these PAHs in groundwater were intermittent. As summarized in Section 7.1 and 7.2, the SVOC concentrations in seep samples, including KPN-S-3, do not present a potential human health or ecological exposure risk.

- **PCB Aroclors:** As indicated on Figure 8, PCB Aroclors were below screening levels in all 30 monitoring wells sampled across the Site since the beginning of the SGS. In fact, no PCB Aroclors were identified above laboratory detection limits in the samples collected as part of the RI Addendum. Of the thirteen historical wells that were not sampled as part of the RI Addendum, PCBs were detected in only two. Earlier samples were collected using bailers, which tend to yield samples with greater solids content than those collected using low flow sampling methods. Therefore, the early groundwater data are considered less representative than the data collected as part of, and subsequent to, the SGS. PCBs have low solubilities, tend to adsorb to solid particles and do not typically migrate in groundwater. Therefore, the prior PCB detections are more likely a consequence of high sample solids content than indicative of PCBs dissolved in and migrating with groundwater.

  As shown on Figure 8, PCB Aroclors were not detected above screening levels in eight out of the ten groundwater seep samples that were analyzed. Aroclor 1254 was detected in two seep samples (KPN-S-3 and KPN-S-5). These seep samples are located near existing monitoring wells (MW-N-09A/B, and MW-N-11A/B) where PCB Aroclors have been consistently reported to be below laboratory detection limits during the three rounds of samples collected from these wells to date. The detection of PCBs in these seep samples is likely the result of high sample solids content. As indicated in Sections 7.1 and 7.2, the PCB Aroclor concentrations in seep samples do not present potential human health or ecological exposure risks.

- **Pesticides:** As indicated on Figure 9, pesticides were below screening levels in all 30 monitoring wells that were sampled during the November 2017 monitoring round. This finding is consistent with earlier monitoring data summarized in the 2007 and 2008 RIs, which is why pesticides were not included as a contaminant of potential concern during the SGS and the first round of sampling in 2017.

  As shown on Figure 9, pesticides were detected above screening levels in eight out of the ten seep samples analyzed. Chlordane was the only pesticide detected in samples KPN-S-1, KPN-S-3, KPN-S-5, KPN-S-6, KPN-S-7, and KPS-S-12. 4,4-DDT was the only pesticide detected in KPS-S-4. 4,4-DDD, 4,4-DDT, and chlordane were detected in KPN-S-4. Samples KPN-S-3, KPN-S-5, KPN-S-6, and KPS-S-12 are located near groundwater monitoring wells where pesticides were not detected

above screening levels. Similar to PAHs and PCBs, pesticides tend to adhere to soil particles and to be less mobile in groundwater. The detections of pesticides in seep samples are likely due to high sample solids content and do not represent potential contaminant migration in groundwater. As indicated in Sections 7.1 and 7.2, the pesticide concentrations in seep samples do not present potential human health or ecological exposure risk.

- **Dioxin and Furan Congeners:** As indicated on Figure 10, dioxin and furan congeners were below detection limits in 23 out of the 27 samples analyzed during the September 2017 monitoring round. The potential toxicity of dioxin and furan congeners is evaluated by calculating the "Toxic Equivalents" (TEQ) to the congener 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) using the 2005 Toxic Equivalency Factors (TEFs) established by the Word Health Organization. The concentration of each congener is multiplied by the applicable TEF and summed to obtain the TEQ value, which is then compared to screening levels or used to calculate potential human health and ecological exposure risk. All the TEQ values calculated from detected congener concentrations are above the screening level of 3.0E-09 microgram per liter (µg/L). The dioxin and furan congeners and associated TEQ values were comparable or lower than those identified in the Pepco site's background groundwater quality data set and, as noted in Section 7.2, are not considered to present an ecological exposure risk.

  As indicated on Figure 10, dioxin and furan congeners were detected in all six of the groundwater seep samples for which they were analyzed. Where seep samples were collected near existing groundwater monitoring wells (MW-S-03A, MW-S-04A/B, MW-N-05A/AA/B, and MW-N-09A/B) the TEQ concentrations were higher than the concentrations detected in groundwater. Similar to the SVOCs, PCBs, and pesticides, the higher concentrations in seep samples are attributed to the high solids content of the samples. As indicated in Section 7.2, the dioxin/furan TEQ concentrations in seep samples do not present a potential ecological exposure risk.

- **Metals/Arsenic:** As indicated in Table 6 of the Groundwater Study Report (Appendix C), aluminum, arsenic, barium, copper, iron, and manganese were detected above the ecological screening levels in most Site monitoring wells. This finding is consistent with the SGS, which concluded that the unknown concentrations of metals in porewater downgradient of the landfill was a data gap. Therefore, NPS completed the Porewater Study to assess if metals are migrating through groundwater and creating an ecological exposure risk in sediment and surface water. The initial SLERA and Refinement that accompanied the Porewater Study concluded that iron and manganese concentrations in porewater were above ecological risk thresholds but could potentially be representative of naturally high background groundwater concentrations. As documented in the Groundwater Study report, NPS calculated BTVs using data from the Pepco background groundwater study and from background monitoring wells located near the Site. The BTV analysis, which was taken into consideration in the updated SLERA and Refinement described in Section 7.2, indicates that iron is the only metal linked to Site groundwater that could potentially result in an ecological exposure risk.

  As described in more detail in Section 3.4, dissolved metals and arsenic concentrations detected in seep water samples were within a similar range as those detected in groundwater samples. As detailed in Sections 7.1 and 7.2, the metals and arsenic concentrations in seep samples do not present unacceptable human health or ecological exposure risk.

5.6 Sediment

The 2012 FS concluded that data collected adjacent to the Site (i.e., the Anacostia River, the Watts Branch, and Kenilworth Marsh) do not indicate an overall impact from COCs at the Site on surface water or sediment, although the data are variable and likely influenced by stormwater inputs and tidal fluctuations (JCO, 2012). The Anacostia River Sediment Project is currently evaluating sediment contamination in the River resulting from off-Site sources. The Site does not appear to be a source of sediment contamination in the River.

6.0 CONCEPTUAL SITE MODEL

A CSM is an iterative tool that is used to compile, visualize, and understand the various elements of a contaminated site. The following is a description of the current CSM for the Site, based on information collected to date and summarized in this report. Figures 11a and 11b were prepared to help visualize the stratigraphy, hydrology and hydrogeology of the Site and the slight variations that exist between KPN and KPS.

- **Setting:** Prior to development as a landfill, the Site consisted of low-lying marsh and mud flat areas connected to the Anacostia River. The mud flats consist of Holocene clay and silt alluvium. Recreational lakes were excavated out of the alluvium by the Corps of Engineers in the 1930s. The Anacostia River, Kenilworth Marsh, Watts Branch, and an unnamed tributary to Watts Branch are located next to the Site and dominate the landscape. Over the course of time, the alignment of Watts Branch has varied. Watts Branch is a high energy tributary to the river that has deposited coarse grained material over and within the clay and silt alluvium in some areas of KPN. The more recent recorded alignment of Watts Branch is shown on Figure 3.
- **Operational History:** The District operated a landfill at the Site from 1942 to 1970. Waste materials included ash from District MSW incinerators, MSW that was burned openly and buried on Site, and, in the last few years of operation (1968 to 1970), raw MSW that was buried without burning. Other waste, including construction demolition debris was also likely disposed during District operation of the facility. Clay-rich soil was used to cover the landfill after it was closed in 1970 and the land was developed with recreational facilities. After the landfill had been closed for almost 30 years, approximately 10 to 30 feet of soil and demolition debris fill was placed over KPS. In the early 2000s, surface debris (concrete, asphalt, rebar, etc.) was removed from KPS, surface water drainage improvements were made, and revegetation was initiated.
- **Waste Characteristics:** As is typical of MSW incinerator residue, burned and unburned MSW, waste buried at the Site contains elevated concentrations of metals and PAHs. Evidence of PCBs and dioxin/furan congeners is also present. Unlike some landfills that were operated during the same period, there is very little evidence that VOCs were present in waste disposed at the Site. One UXO was discovered during excavation for an irrigation system; therefore, the presence of buried UXO cannot be ruled out.
- **Site Geology:** The Site stratigraphy at KPN varies slightly from KPS due to the placement of soil/demolition debris fill over KPS in the late 1990s. However, the two landfills are similar in that they were capped in the early 1970s with a clay-rich soil. Waste was placed in the former recreational lakes and, in most areas, over the clay and silt alluvium. The alluvium overlies a regional sand and gravel deposit that is part of the Wicomico formation. The Wicomico formation is underlain by a regional clay deposit that is part of the Patapsco formation.

- **Site Hydrogeology:** Two zones of shallow groundwater flow are present below the Site. The upper zone consists of the soil, waste and high energy stream deposits that are generally above the clay and silt alluvium. The lower zone consists of the Wicomico sand and gravel deposits that overlie the less permeable Patapsco clay. Groundwater in the upper groundwater flow zone is inferred to flow radially from the two landfills and discharges to porewater within the river, marsh, Watts Branch and the tributary to Watts Branch. In some areas, groundwater has been observed to seep from steep side slopes following periods of wet weather, and along the banks of the river and Watts Branch. Groundwater in the lower zone is part of a more regional system that flows across the Site and discharges to the river. The clay and silt alluvium, which is present in most areas of the Site, is considered an aquitard, that limits vertical migration of groundwater between the two shallow flow zones.
- **Surface Water Hydrology:** The Anacostia River and the lower reach of Watts Branch are tidal. Kenilworth Marsh, which is connected to the River also floods with the tides. Watts Branch and its unnamed tributary receive storm water discharge from urban runoff, which results in rapid changes in flow when it rains. Drainage from urban areas also impacts surface water quality. The landfill areas are generally graded to promote surface water runoff. There are a few depressions at KPN where water is observed to collect and pond. There are three sedimentation ponds that were constructed around the perimeter of KPS in the late 1990s as part of the grading plans. There are other low areas within KPS where the surface soil is typically saturated. Surface water that does not run off infiltrates the landfill surface and recharges the shallow groundwater.
- **Sensitive Environments:** The Site is bordered by an elementary school, a daycare center, and residential neighborhoods. The Anacostia River, Kenilworth Marsh, and Watts Branch are considered sensitive environmental receptors and the Site is located within a national park.
- **Contaminants and Media of Concern:** As summarized in more detail within Section 7.0, the COCs for the Site are limited to PCBs and PAHs that are present in surficial soil, lead that is present in the buried soil and waste, methane gas that is present in soil gas within the more central areas of the landfill, UXOs that may have been disposed in the landfill and dissolved iron that is elevated in porewater and likely related to Site groundwater.
- **Migration and Exposure Pathways:** Potential migration pathways are limited to groundwater discharging to porewater, seeps, and surface water. Shallow groundwater flowing below the Site is not a viable source of potable water supply. Visitors and park workers could potentially be exposed to surficial soil, although most areas of the Site are well vegetated, preventing direct contact and dust generation. As identified in the 2007 and 2008 RIs, workers conducting excavation activities could be exposed to contaminants present within buried soil and waste.
- **Future Land Use Scenarios:** Congress directed NPS to transfer administrative jurisdiction of KPN to the District (PL 108-335 § 334) to be used "for the provision of public recreational facilities, open space, or public outdoor recreational opportunities." Detailed plans for recreational development have not been published by the District, but future activities are likely to be consistent with the current use as sports fields. NPS intends on managing KPS as a "Natural Resource Recreation Zone" as defined in the Management Plan for Anacostia Park. The focus of the natural resource recreation zone is to preserve and protect the natural landscape of forests and wetlands in the park; recreation activities that connect visitors to the natural setting will be encouraged where compatible.

7.0 RISK ASSESSMENT SUMMARIES

Portions of the human health and ecological risk assessments were updated with data collected as part of this RI Addendum. The human health risk assessment was updated at KPS to incorporate updated surficial soil quality and to consider alternative exposure scenarios that are aligned with the current vision for future Site use. The human health risk assessment conclusions for KPN have not changed substantially since publication of the 2007 RI report. The ecological risk assessment was updated across the Site to consider the potential impacts of various contaminants present in groundwater and potentially migrating toward surface water.

7.1 Human Health Risk Assessment

7.1.1 Surface and Subsurface Soil Exposure Risk

As documented in the 2007 RI Report, NPS used a residential land use scenario for the initial evaluation of potential visitor exposure risks. Surficial soil at KPN contains PCB Aroclors and PAHs at concentrations that potentially pose a long-term human heath exposure risk under a residential land use scenario. With its mowed fields and sports facilities located close to densely populated neighborhoods, KPN provides opportunities for visitors to use the park regularly and potentially come into direct contact with contaminants present in soil. As indicated in the 2007 RI Report, the estimated potential excess cancer risk to Site visitors (calculated assuming a residential exposure scenario) was 3.1×10^{-5}, which is above the NCP cancer risk point of departure (1×10^{-6}) used to identify potentially unacceptable risk. In addition, elevated concentrations of lead detected in subsurface soil in some areas suggest that future potential excavation activities in those areas could potentially cause elevated blood lead levels in unprotected workers resulting in adverse health effects.

As indicated in Section 3.5, the human health risk assessment for KPS was updated using recent surficial soil analytical data and updated risk assessment parameters (documentation of the updated risk assessment is included as an appendix to the Surficial Soil Quality Assessment Report (Appendix E; JCO, 2019b). The estimated potential excess cancer risk to Site visitors under the residential land use scenario was 2×10^{-5}, which, like at KPN, is above the NCP cancer risk point of departure (1×10^{-6}). The estimated cumulative excess cancer risk for outdoor workers (park employees who spend 225 days per year performing maintenance activities over a 25-year period) was 2×10^{-6} (slightly above the NCP cancer risk point of departure).

7.1.2 Seep Exposure Risk

Human exposure to seep water at the Site is expected to be negligible relative to exposure from other pathways. The seeps are located in topographic depressions along the toe of the landfill slope or out on the mudflats and are in areas that are difficult to access from upland areas of the Park, or from the Anacostia River shoreline. Because the seeps constitute relatively small areas (typically puddles or small channels), exposure is assumed to be limited such that if a recreator does encounter a seep, he or she is most likely to briefly place a hand or foot inadvertently into the seep, rather than wade through it. Exposure, if it occurs, is expected to occur primarily through dermal contact; ingestion of seep water is not anticipated to be a relevant/significant exposure pathway.

In addition to the low potential frequency and duration that visitors or park workers are expected to potentially encounter the seeps, the concentrations of the chemicals detected in seep water samples are

low, with most below the EPA Maximum Contaminant Levels (MCLs) for drinking water. MCLs, which are standards designed to be protective of potable water sources, were used as conservative screening criteria for seep samples. Seep water is not and will never be used as a water supply. Nevertheless, comparison of the seep water concentrations to MCLs indicates that only the following four constituents have maximum detected concentrations that exceed the MCLs:

- Antimony concentrations marginally exceed the MCL of 6 ug/L at one location (KPN S-1), at a concentration of 7.1 ug/L in the primary sample and 8.5 ug/L in the duplicate sample.
- The concentration of BEHP of 9 ug/L in sample KPS S-4 slightly exceeds the MCL of 6 ug/L and the concentration was qualified as an estimated quantity (i.e., J-flagged).
- The benzo(a)pyrene concentration of 0.33 ug/L in sample KPN S-3 slightly exceeds the MCL of 0.2 ug/L.
- The toxic equivalent concentration of TCDD in sample KPN S-3 of 68.6 picograms per liter (pg/L) exceeds the MCL of 30 pg/L.

As noted, given the nature of potential exposure (infrequent, low duration, direct contact), drinking water standards (MCLs) are conservative values to use for evaluating direct contact exposure. To refine the screening for those constituents that were found above the MCLs, NPS used the EPA Regional Screening Level (RSL) Calculator to derive surface water RSLs that are more reflective of recreational exposures (i.e., swimming). These RSLs, which reflect full-body immersion in and incidental ingestion of surface water, are highly conservative benchmarks to apply to exposures at a seep, since swimming would not occur at any of the seeps.

RSLs for each of the four constituents were calculated and then compared to the maximum detected seep sample concentrations in the table below. NPS conservatively assumed that a child and adult recreator could potentially encounter seeps one day per week, year-round, for 50 weeks per year, over a 30-year exposure duration.

Constituent	Maximum Detected Seep Concentration	Recreational RSL
Antimony	8.5 ug/L	54 ug/L
BEHP	9 ug/L	1,110 ug/L
benzo(a)pyrene	0.33 ug/L	3.5 ug/L
TCDD-TEQ	68.6 pg/L	120 pg/L

The maximum detected concentrations of these constituents were well below the calculated recreational RSLs. Because of the relative inaccessibility of the seeps and the relatively low concentrations at which various constituents were detected, human exposure to seep water presents negligible health risk to recreators. Additional exposure assumptions and RSL Calculator documentation are provided in Appendix D.2.

7.2 Screening Level Ecological Risk Assessment

As indicated in Sections 2.3.1 and 2.3.2, the SLERAs and BERA Problem Formulation completed using data presented in the 2007 and 2008 RI reports indicated there was a potential for ecological risk related to contaminants detected in surficial soil. However, these risks were discounted based on the bioavailability assessment performed using pH and organic carbon data reported in the 2010 SDCR (Section 2.3.3).

To assess potential ecological risks associated with porewater, surface water, groundwater and seep data, an updated SLERA and Refinement were completed as part of this RI Addendum and is included as Appendix F (W&C, 2019b). The SLERA and Refinement considered potential impacts to the Anacostia River and Kenilworth Marsh. The SLERA consisted of an initial comparison of contaminants of potential ecological concern to the applicable screening levels. The applied screening levels are generic, literature-based values that indicate little or no potential for risk. Constituents with concentrations below the screening levels are considered to present no potential risk and no need for further action. However, the screening levels are conservative, sometimes within the range of natural "background" conditions. Therefore, the SLERA results were refined to consider additional toxicological data and to consider background and reference data collected as part of the Porewater Study, as well as reference porewater and surface water quality data from the Anacostia River Sediment Project. Groundwater quality data from the Site were also compared to reference groundwater data generated from near-site background wells and the Pepco Benning Road site RI. As noted previously, BTVs were calculated from the near site and Pepco monitoring wells, these calculations are documented in the Groundwater Study Report (Appendix C) and the results were used for comparisons made in the SLERA/Refinement.

As documented in the Porewater Study report, multiple metals were detected in porewater and surface water samples above the screening levels. In addition, the laboratory quantitation limits of several metals were above the screening levels. For the SLERA, all metals detected above the screening level, or with a quantitation limit above the screening levels, were carried forward for further analysis under the Refinement exercise.

The Refinement showed that most of the metals detected either:

- did not exceed water quality or similar criteria;
- were not present at significant levels in shallow shoreline groundwater (indicating that KPL groundwater is not a current source); or
- are consistent with off Site or background concentrations.

The SLERA Refinement concluded that concentrations of iron in porewater may present a risk to ecological receptors in the river adjacent to the Site, particularly in the vicinity of sample location PW-AN-03F, located just above Watts Branch. No potentially unacceptable risks associated with metals migration in groundwater was identified at Kenilworth Marsh.

8.0 CONCLUSIONS AND RECOMMENDATIONS

This RI Addendum Report provides an overview of the CERCLA response activities conducted at the Site since NPS initiated the CERCLA process in 1998. The RI Addendum activities that were initiated in 2013 are documented in the six appended reports.

8.1 Conclusions

The data gaps identified following completion of the 2007/2008 RIs have been filled. The nature and extent of contamination at the Site has been characterized such that associated human health and ecological exposure risks can be adequately quantified. Chemicals in Site groundwater discharge to the Anacostia River; however, with the exception of iron, the levels have not been shown to have the potential for causing unacceptable human or ecological risks in the River. Iron was shown to pose a potential ecological risk but does not require action due to the following:

- Iron in the Anacostia River has been studied for the ARSP and it did not exceed human health or ecological criterion; therefore, iron has not been identified as a contaminant of concern (COC) in the River. Therefore, any excess risk caused by contributions of iron from the Site to the River are inconsequential.
- Iron is not a CERCLA hazardous substance.

According to the 2007 RI, PCB Aroclors and PAHs in surficial soil at KPN present a potential cumulative excess cancer risk of 3.1×10^{-5} for a residential use scenario involving child/adult visitors who spend two hours per visit to the Site, 350 days per year, for 30 years, which is above the NCP cancer risk point of departure (1×10^{-6}) used to identify potentially unacceptable risk.

Based on the sampling and analysis performed for this RI Addendum, PCB Aroclors and PAHs in surficial soil at KPS present a potential cumulative excess cancer risk of 2×10^{-5} for a residential use scenario involving child/adult visitors who spend 2 hours per visit 350 days per year, for 26 years (updated risk parameters). This level of risk is similar to that which was presented in the 2008 RI and is above the NCP cancer risk point of departure (1×10^{-6}). The estimated cumulative excess cancer risk for outdoor workers (park employees who spend 225 days per year performing maintenance activities over a 25-year period) was 2×10^{-6}

As indicated in the 2007 and 2008 RI reports, prolonged worker exposure (70 days over the course of one year) to buried soil and waste that is impacted by lead could cause adverse health effects associated with elevated blood lead levels. Excavation within the former landfill areas also requires precautions to be taken due to the potential presence of methane gas (a byproduct of waste decomposition) and buried unexploded ordnances.

8.2 Recommendations

Based on the 2007/2008 RI and RI Addendum data, no further response action is necessary to address groundwater contaminants in OU2. NPS will prepare a Feasibility Study (FS) Addendum focused solely on addressing risks identified with OU1. The FS Addendum will include a risk management analysis, an updated assessment of ARARs/Criteria to be Considered and development of Remedial Action Objectives. As Site conditions have not changed since the 2012 FS was completed, NPS will complete a similarly focused evaluation of remedial alternatives.

9.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR), 2001. Landfill Gas Primer – An Overview for Environmental Health Professionals. November.

CDM Smith (CDM), 2014. Final Remedial Investigation Addendum, Kenilworth Park Landfill Site, N.E., Washington, D.C. December.

Ecology and Environment (E&E), 1998. Report on Sampling the Kenilworth Site, National Park Service N.E. Washington DC. December.

E&E, 2000b. Kenilworth Park Landfill North Geoprobe Sampling. October.

E&E, 2002. Preliminary Assessment/Site Investigation of Kenilworth Park Landfill North. February.

E&E, 2007. Final Remedial Investigation at the Kenilworth Park Landfill, N.E. Washington, DC. November.

E&E, 2008. Final Remedial Investigation at the Kenilworth Park South Landfill, N.E. Washington, DC. June.

U.S. Environmental Protection Agency (EPA), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. EPA/540/G-89/004. October.

EPA, 1996. Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. EQASOP-GW4. Finalized July 30, 1996; Revised September 19, 2017.

EPA, 2005, Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities. September.

EPA, 2016 National Recommended Water Quality Criteria. Office of Water, Washington, D.C. Accessed at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

EPA, 2017, Regional Screening Levels (RSLs). June. Retrieved from https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017.

National Park Service (NPS), 2013a. Proposed Plan for Cleanup of the Kenilworth Park Landfill Site. February.

NPS, 2013b, Community Fact Sheet, Kenilworth Park Landfill Site, CERCLA Actions. August.

NPS, 2014. NPS protocol for the selection and use of ecological screening values for non-radiological analytes. January.

NPS, 2016. NPS protocol for the selection and use of ecological screening values for non-radiological analytes, Revision 2. February.

Tetra Tech, 2018. Seep Characterization Report, Kenilworth Park Landfill, Washington, D.C. July 17.

The Johnson Company (JCO), 2012. Feasibility Study Report, Kenilworth Park Landfill, Northeast Washington D.C., National Capital Parks – East. April 2012

JCO, 2013. Supplemental Groundwater Study Sampling and Analysis Plan, Operable Unit 2, Kenilworth Park Landfill, Washington, D.C. December 2013.

JCO, 2016a. Supplemental Groundwater Study Report, National Capital Parks – East, Kenilworth Park Landfill. November 18.

JCO, 2016b. RI Addendum – Phase I Field Study Sampling and Analysis Plan, National Capital Parks – East, Kenilworth Park Landfill. December 2016.

JCO, 2017. Sampling and Analysis Plan, RI Addendum – Background Groundwater and Surficial Soil Assessment. August 2017.

JCO, 2018. Porewater Study Report, Kenilworth Park Landfill. November.

JCO, 2019a. Groundwater Study Report, Kenilworth Park Landfill, National Capital Parks – East, Washington, D.C. November. Pending.

JCO, 2019b. Surficial Soil Quality Assessment Report Kenilworth Park Landfill, National Capital Parks – East Washington, D.C. June.

JCO, 2019c. Statistical Comparison of Groundwater and Seep Sample Data, Kenilworth Park Landfill. June.

US Army, 2011. Email Correspondence From J.C. King, COL, Assistant for Munitions and Chemical Matters ODASA (ESOH), Pentagon To Thomas Coleman of DC Appleseed. November.

Woodard & Curran (W&C), 2019a. Human Health Risk Screening for Groundwater Seeps. May.

W&C, 2019b. Groundwater Discharge Screening Level Ecological Risk Assessment and Refinement. June.

FIGURES

FIGURE 1 **SITE AREA MAP**

FIGURE 2 **SITE PLAN**

FIGURE 3 **MONITORING WELL LOCATION PLAN**

FIGURE 4 **SITE TOPOGRAPHY AND DRAINAGE**

FIGURE 5 **GROUNDWATER ELEVATION CONTOURS**

FIGURE 6 **VOCS IN GROUNDWATER SAMPLES**

FIGURE 7 **SVOCS IN GROUNDWATER AND SEEP SAMPLES**

FIGURE 8 **PCBS IN GROUNDWATER AND SEEP SAMPLES**

FIGURE 9 **PESTICIDES IN GROUNDWATER AND SEEP SAMPLES**

FIGURE 10 **DIOXIN AND FURAN TEQ IN GROUNDWATER AND SEEP SAMPLES**

FIGURE 11A **GRAPHICAL CONCEPTUAL SITE MODEL - KPN**

FIGURE 11B **GRAPHICAL CONCEPTUAL SITE MODEL - KPS**

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\SAP\MXDs\Site Area Map.mxd



Legend

KPN and KPS Landfill Boundaries

Approximate Neighborhood Boundary

0 500 1,000 2,000 3,000 4,000

Feet

Aerial photo source: ESRI and DC GIS (2017)

Location in Washington DC



Figure 1: Site Area Map
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

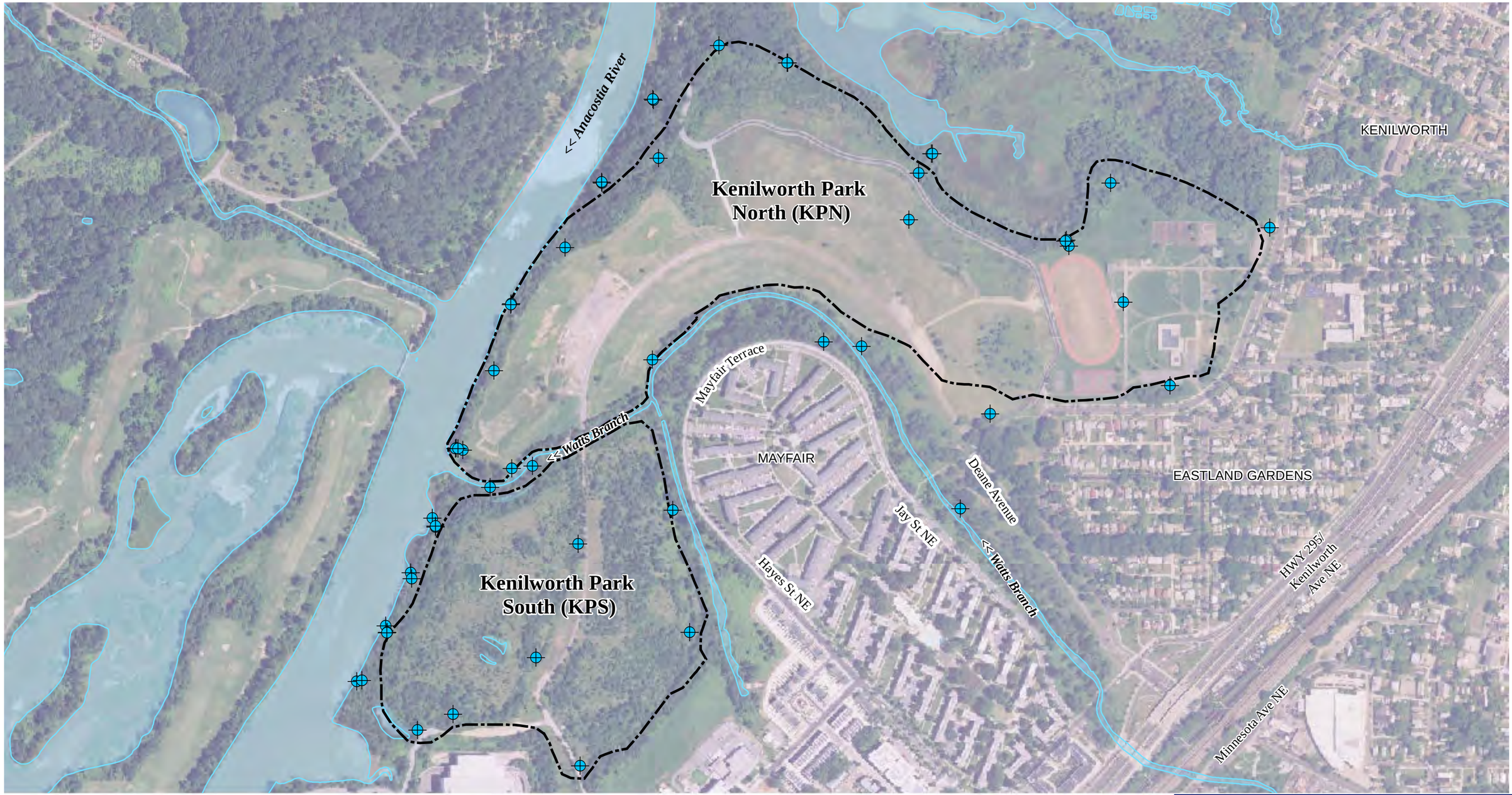
The Johnson Company

100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 8/3/2018
Reviewed by: JO Date: 8/9/2018

Scale: 1 " = 1,000 ' Project: 58345.11

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\SAP\MXDs\Figure 2 SitePlan 20180807.mxd



Legend

- Monitoring Well
- KPN and KPS Landfill Boundaries
- Stream Channel

N

0 125 250 500 750 1,000
Feet

Sources: DC GIS; USGS/NAIP Aerial Photography 2015

Figure 2: Site Plan
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

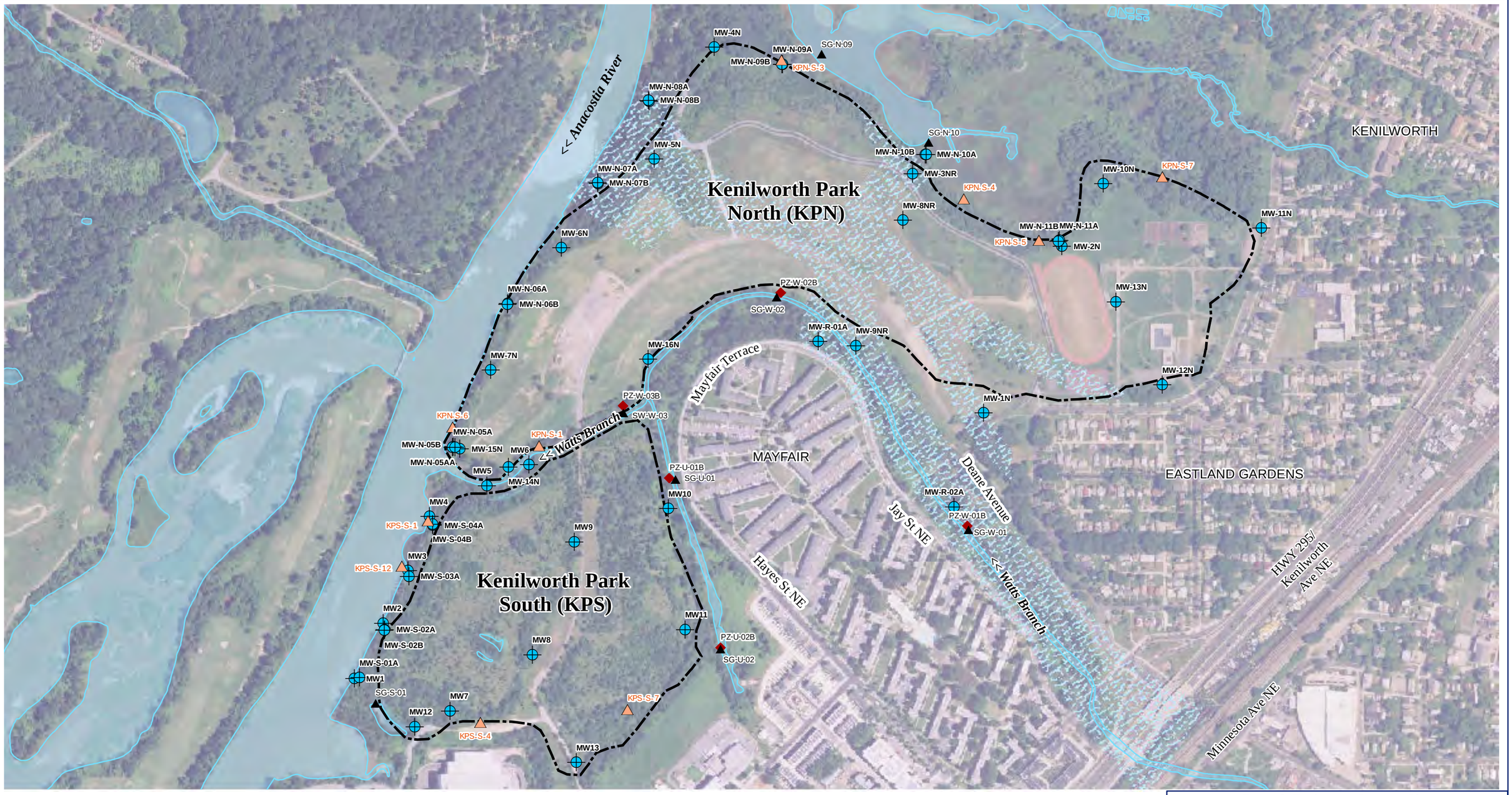
The Johnson Company

100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 08/07/2018
Reviewed by: JO Date: 08/07/2018

Scale: 1 " = 500 ' Project: 58345.11

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\SAP\MXDs\Figure 3 Exploration Location Plan.mxd



Legend

- Seep Sampling Location
- Piezometer
- Staff Gauge
- Monitoring Well
- KPN and KPS Landfill Boundaries
- Stream Channel
- 1806-1979 Watts Branch Channel

N

0 125 250 500 750 1,000
Feet

Notes:
1. Monitoring well location coordinates were obtained by land surveyors following installation. Piezometer and seep sample coordinates were obtained using a global positioning system with sub-meter accuracy. Seep sample coordinates were supplied by the District of Columbia Department of Energy and Environment.
2. Former Watts Branch channel alignment was transcribed from historical NOAA mapping that ranged from 1806 to 1979.
3. Aerial Photo source: USGS/NAIP Aerial Photography, 2015.

Figure 3: Exploration Location Plan
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

The Johnson Company

100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 08/07/2018
Reviewed by: JO Date: 08/07/2018

Scale: 1 " = 500 ' Project: 58345.11

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\SAP\MXDs\Topo_for_RI_Report.mxd



Legend

- Sediment Pond
- Piezometer
- Staff Gauge
- Monitoring Well
- 5 ft Contour (USACE 2000)
- 1 ft Contour (USACE 2000)
- KPN and KPS Landfill Boundaries
- Drainage Flow Direction

N

0 125 250 500 750 1,000

Feet

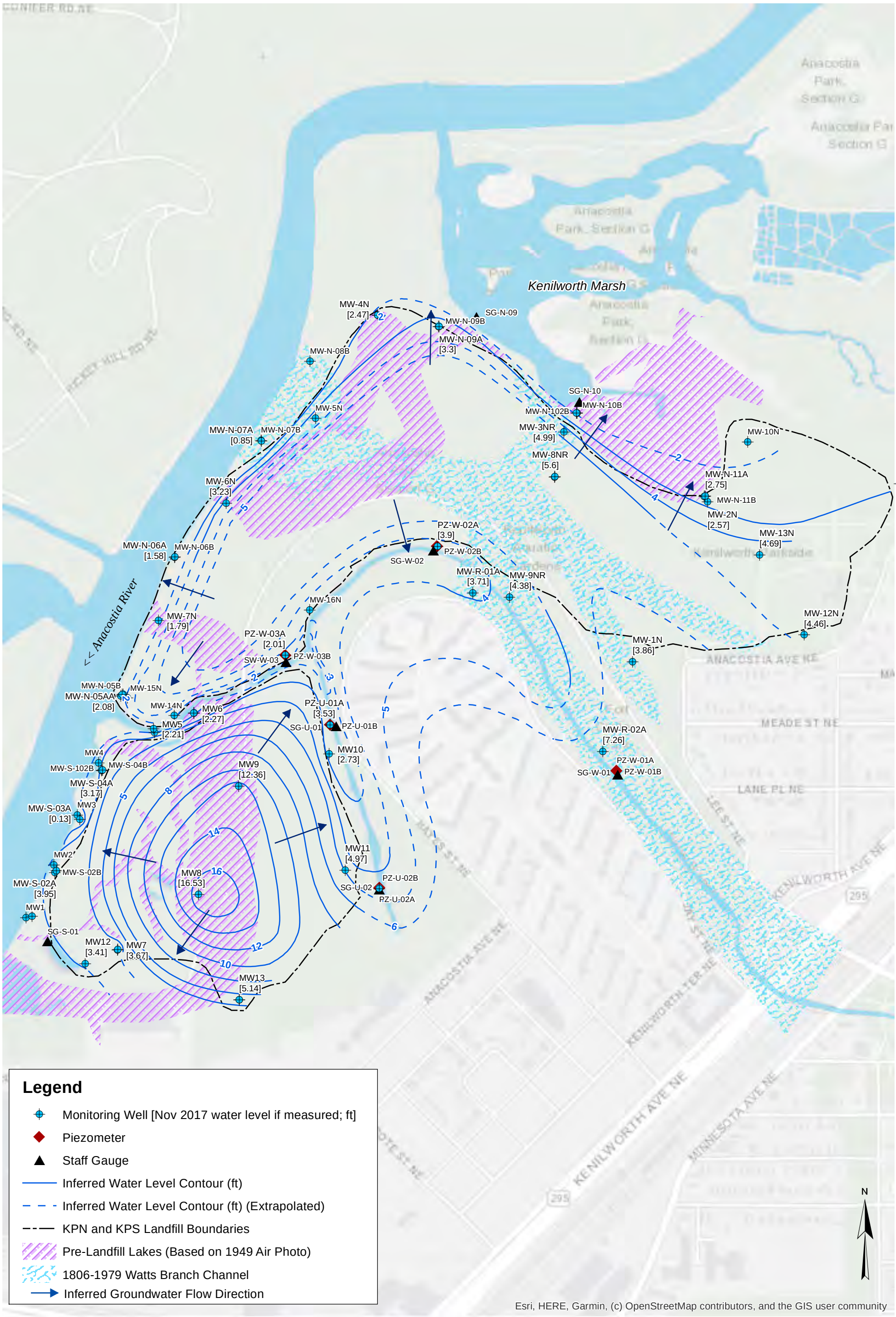
Sources: USACE 2000; ESRI and Open Street Map 2018 (base map).

Figure 4: Site Topography and Drainage
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 06/12/2018
Reviewed by: JO Date: 08/07/2018
Scale: 1 " = 500 ' Project: 58345.11

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\SAP\MXDs\WT_2017.mxd



Legend

- Monitoring Well [Nov 2017 water level if measured; ft]
- Piezometer
- Staff Gauge
- Inferred Water Level Contour (ft)
- Inferred Water Level Contour (ft) (Extrapolated)
- KPN and KPS Landfill Boundaries
- Pre-Landfill Lakes (Based on 1949 Air Photo)
- 1806-1979 Watts Branch Channel
- Inferred Groundwater Flow Direction

0 250 500 1,000 1,500 2,000

Feet

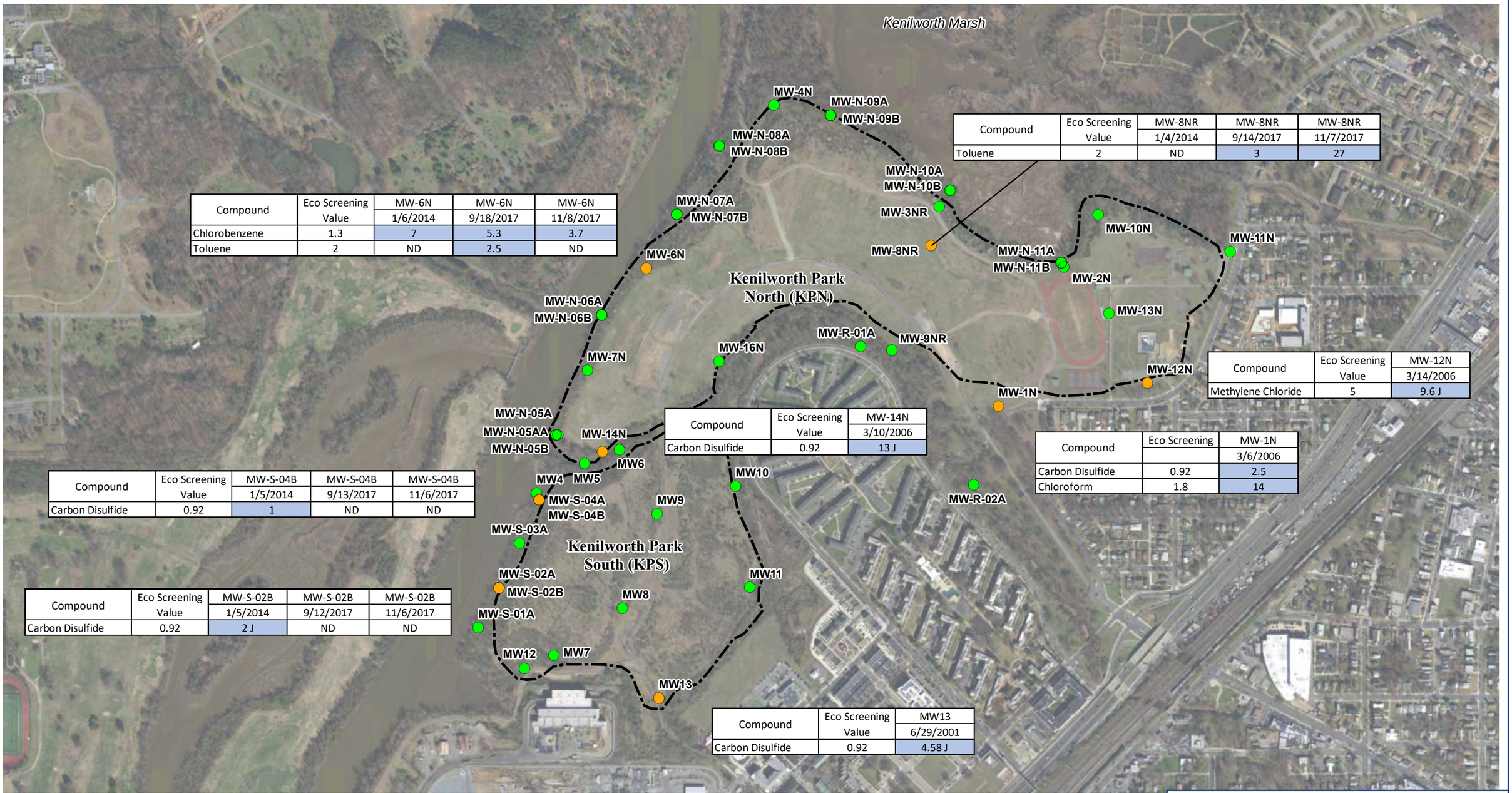
Note: Groundwater elevation data were collected 7 November 2017. Groundwater elevation contours were prepared via linear interpolation of elevations between monitoring wells. Contours were adjusted to fit with the site conceptual model which is based in part on ground surface contours and the locations of historic tributaries that passed through the site. Other interpretations are possible.
Sources: USGS Aerial Photograph, 1949; NOAA maps 1806-1979).

Figure 5: Groundwater Elevation Contours November 2017
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, District of Columbia

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 7/25/2018
Reviewed by: JO Date: 8/9/2018

Scale: 1 " = 500 ' Project: 58345.11



Compound	Eco Screening Value	MW-8NR 1/4/2014	MW-8NR 9/14/2017	MW-8NR 11/7/2017
Toluene	2	ND	3	27

Compound	Eco Screening Value	MW-6N 1/6/2014	MW-6N 9/18/2017	MW-6N 11/8/2017
Chlorobenzene	1.3	7	5.3	3.7
Toluene	2	ND	2.5	ND

Compound	Eco Screening Value	MW-12N 3/14/2006
Methylene Chloride	5	9.6 J

Compound	Eco Screening Value	MW-14N 3/10/2006
Carbon Disulfide	0.92	13 J

Compound	Eco Screening Value	MW-1N 3/6/2006
Carbon Disulfide	0.92	2.5
Chloroform	1.8	14

Compound	Eco Screening Value	MW-S-04B 1/5/2014	MW-S-04B 9/13/2017	MW-S-04B 11/6/2017
Carbon Disulfide	0.92	1	ND	ND

Compound	Eco Screening Value	MW-S-02B 1/5/2014	MW-S-02B 9/12/2017	MW-S-02B 11/6/2017
Carbon Disulfide	0.92	2 J	ND	ND

Compound	Eco Screening Value	MW13 6/29/2001
Carbon Disulfide	0.92	4.58 J

Legend

- Groundwater Sample - No VOC Exceedances
- Groundwater Sample - At least one VOC Exceedance
- KPN and KPS Landfill Boundaries

VOC = volatile organic compounds

Notes:
1. ND = constituent concentration was below the laboratory detection limit.
2. The data presented on this figure generally represents the groundwater monitoring rounds conducted in 2014 and 2017; older data are shown for wells that were not sampled as part of the Supplemental Groundwater Study or subsequent monitoring.
3. Concentrations are in micrograms per liter (ug/L).
4. The eco screening value is the most conservative (lowest) value from a range of screening levels considered in the SLERA, including DDOE Class D Water Quality Standards, EPA National Recommended Water Quality Criteria (WQC), and NPS Ecological Screening Values (ESVs) for surface water (February 2016). Blue shading indicates sample concentration exceeds the eco screening level for that constituent.

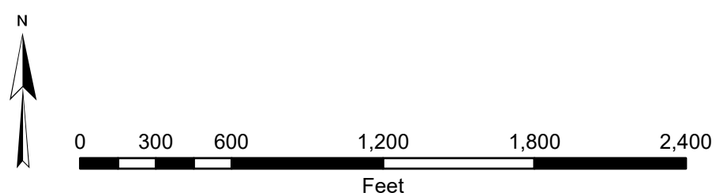
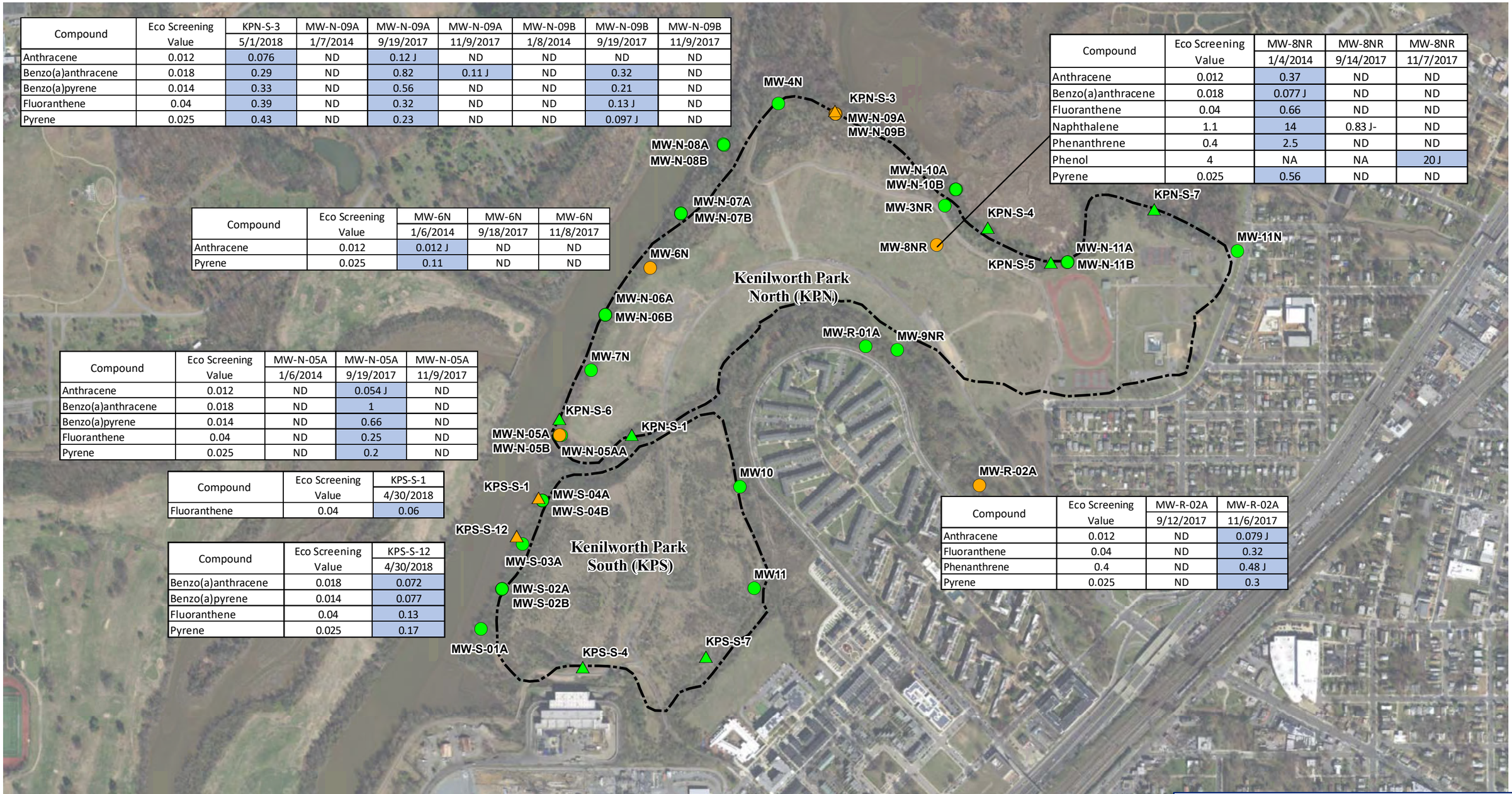


Figure 6: VOCs in Groundwater
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 7/26/2018
Reviewed by: JO Date: 8/9/2018

Scale: 1 " = 600 ' Project: 58345.11



Compound	Eco Screening Value	KPN-S-3	MW-N-09A	MW-N-09A	MW-N-09A	MW-N-09B	MW-N-09B	MW-N-09B
		5/1/2018	1/7/2014	9/19/2017	11/9/2017	1/8/2014	9/19/2017	11/9/2017
Anthracene	0.012	0.076	ND	0.12 J	ND	ND	ND	ND
Benzo(a)anthracene	0.018	0.29	ND	0.82	0.11 J	ND	0.32	ND
Benzo(a)pyrene	0.014	0.33	ND	0.56	ND	ND	0.21	ND
Fluoranthene	0.04	0.39	ND	0.32	ND	ND	0.13 J	ND
Pyrene	0.025	0.43	ND	0.23	ND	ND	0.097 J	ND

Compound	Eco Screening Value	MW-8NR	MW-8NR	MW-8NR
		1/4/2014	9/14/2017	11/7/2017
Anthracene	0.012	0.37	ND	ND
Benzo(a)anthracene	0.018	0.077 J	ND	ND
Fluoranthene	0.04	0.66	ND	ND
Naphthalene	1.1	14	0.83 J-	ND
Phenanthrene	0.4	2.5	ND	ND
Phenol	4	NA	NA	20 J
Pyrene	0.025	0.56	ND	ND

Compound	Eco Screening Value	MW-6N	MW-6N	MW-6N
		1/6/2014	9/18/2017	11/8/2017
Anthracene	0.012	0.012 J	ND	ND
Pyrene	0.025	0.11	ND	ND

Compound	Eco Screening Value	MW-N-05A	MW-N-05A	MW-N-05A
		1/6/2014	9/19/2017	11/9/2017
Anthracene	0.012	ND	0.054 J	ND
Benzo(a)anthracene	0.018	ND	1	ND
Benzo(a)pyrene	0.014	ND	0.66	ND
Fluoranthene	0.04	ND	0.25	ND
Pyrene	0.025	ND	0.2	ND

Compound	Eco Screening Value	KPS-S-1
		4/30/2018
Fluoranthene	0.04	0.06

Compound	Eco Screening Value	KPS-S-12
		4/30/2018
Benzo(a)anthracene	0.018	0.072
Benzo(a)pyrene	0.014	0.077
Fluoranthene	0.04	0.13
Pyrene	0.025	0.17

Compound	Eco Screening Value	MW-R-02A	MW-R-02A
		9/12/2017	11/6/2017
Anthracene	0.012	ND	0.079 J
Fluoranthene	0.04	ND	0.32
Phenanthrene	0.4	ND	0.48 J
Pyrene	0.025	ND	0.3

Legend

- Seep Sample - No SVOC Exceedances
- Seep Sample - At least one SVOC
- SVOC = semi volatile organic compounds
- Groundwater Sample - No SVOC Exceedance
- Groundawter Sample - At least one SVOC
- KPN and KPS Landfill Boundaries

Notes:
1. ND = constituent concentration was below the laboratory detection limit. NA = constituent was not analyzed.
2. The data presented on this figure generally represents the groundwater monitoring rounds conducted in 2014 and 2017; older data are shown for wells that were not sampled as part of the Supplemental Groundwater Study or subsequent monitoring..
3. As indicated in the report, the SVOC bis(2-ethylhexyl)phthalate was detected in several locations but is believed to be a sampling and/or laboratory artifact, not representative of Site groundwater.
4. Concentrations are in micrograms per liter (ug/L).
5. The eco screening value is the most conservative (lowest) value from a range of screening levels considered in the SLERA, including DDOE Class D Water Quality Standards, EPA National Recommended Water Quality Criteria (WQC), and NPS Ecological Screening Values (ESVs) for surface water (February 2016). Blue shading indicates sample concentration exceeds the eco screening level for that constituent.

N

0 300 600 1,200 1,800 2,400

Feet

Figure 7: SVOCs in Groundwater and Seep Samples
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 7/26/2018
Reviewed by: JO Date: 8/9/2018

Scale: 1 " = 600 ' Project: 58345.11

Compound	Eco Screening Value	KPN-S-3
		5/1/2018
PCB-1254	0.033	0.24

Compound	Eco Screening Value	KPN-S-5
		5/1/2018
PCB-1254	0.033	0.04

MW-4N
KPN-S-3
MW-N-09A
MW-N-09B
MW-N-08A
MW-N-08B
MW-N-10A
MW-N-10B
MW-3NR
KPN-S-7
MW-N-07A
MW-N-07B
KPN-S-4
MW-11N
Kenilworth Park North (KPN)
MW-8NR
KPN-S-5
MW-N-11A
MW-N-11B
MW-6N
MW-N-06A
MW-N-06B
MW-R-01A
MW-9NR
MW-7N
KPN-S-6
KPN-S-1
MW-N-05AA
MW-N-05A
MW-N-05B
MW10
MW-R-02A
KPS-S-1
MW-S-04A
MW-S-04B
KPS-S-12
MW-S-03A
Kenilworth Park South (KPS)
MW11
MW-S-02A
MW-S-02B
MW-S-01A
KPS-S-7
KPS-S-4

Legend

- Seep Sample - No PCB Exceedances
- Seep Sample - At least one PCB
- Groundwater Sample - No PCB Exceedances
- KPN and KPS Landfill Boundaries

PCB = Polychlorinated biphenyl

Notes:
1. The data presented on this figure represents the groundwater monitoring rounds conducted in 2014 and 2017.
2. Concentrations are in micrograms per liter (ug/L).
3. The eco screening value is the most conservative (lowest) value from a range of screening levels considered in the SLERA, including DDOE Class D Water Quality Standards, EPA National Recommended Water Quality Criteria (WQC), and NPS Ecological Screening Values (ESVs) for surface water (February 2016). Blue shading indicates sample concentration exceeds the eco screening level for that constituent.

N

0 300 600 1,200 1,800 2,400

Feet

Figure 8: PCBs in Groundwater and Seep Samples
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 7/26/2018
Reviewed by: JO Date: 8/9/2018

Scale: 1 " = 600 ' Project: 58345.11

Compound	Eco Screening Value	KPN-S-3 5/1/2018
Chlordane	0.0043	0.098

Compound	Eco Screening Value	KPN-S-4 5/1/2018
4,4'-DDD	0.011	0.011
4,4-DDT	0.001	0.0014
Chlordane	0.0043	0.031

Compound	Eco Screening Value	KPN-S-7 5/1/2018
Chlordane	0.0043	0.078

Compound	Eco Screening Value	KPN-S-5 5/1/2018
Chlordane	0.0043	0.024

Compound	Eco Screening Value	KPN-S-6 4/30/2018
Chlordane	0.0043	0.031

Compound	Eco Screening Value	KPN-S-1 4/30/2018
Chlordane	0.0043	0.025

Compound	Eco Screening Value	KPS-S-12 4/30/2018
Chlordane	0.0043	0.049

Compound	Eco Screening Value	KPS-S-4 5/1/2018
4,4'-DDT	0.001	0.002

MW-4N, KPN-S-3, MW-N-09A, MW-N-09B, MW-N-08A, MW-N-08B, MW-N-10A, MW-N-10B, MW-N-07A, MW-N-07B, MW-3NR, KPN-S-4, KPN-S-7, MW-8NR, MW-N-11A, MW-N-11B, MW-11N, MW-6N, Kenilworth Park North (KPN), KPN-S-5, MW-N-06A, MW-N-06B, MW-R-01A, MW-9NR, MW-7N, KPN-S-6, KPN-S-1, MW-N-05A, MW-N-05B, MW-N-05AA, MW-10, MW-R-02A, KPS-S-1, MW-S-04A, MW-S-04B, KPS-S-12, MW-S-03A, MW-S-02A, MW-S-02B, MW-11, Kenilworth Park South (KPS), MW-S-01A, KPS-S-4, KPS-S-7

Legend

- Seep Sample - No Pesticide Exceedances
- Seep Sample - At least one Pesticide Exceedance
- Groundwater Sample - No Pesticide Exceedances
- KPN and KPS Landfill Boundaries

Notes:
1. The data presented on this figure represents the groundwater monitoring rounds conducted in 2014 and 2017.
2. Concentrations are in micrograms per liter (ug/L).
3. The eco screening value is the most conservative (lowest) value from a range of screening levels considered in the SLERA, including DDOE Class D Water Quality Standards, EPA National Recommended Water Quality Criteria (WQC), and NPS Ecological Screening Values (ESVs) for surface water (February 2016). Blue shading indicates sample concentration exceeds the eco screening level for that constituent.

N

0 300 600 1,200 1,800 2,400

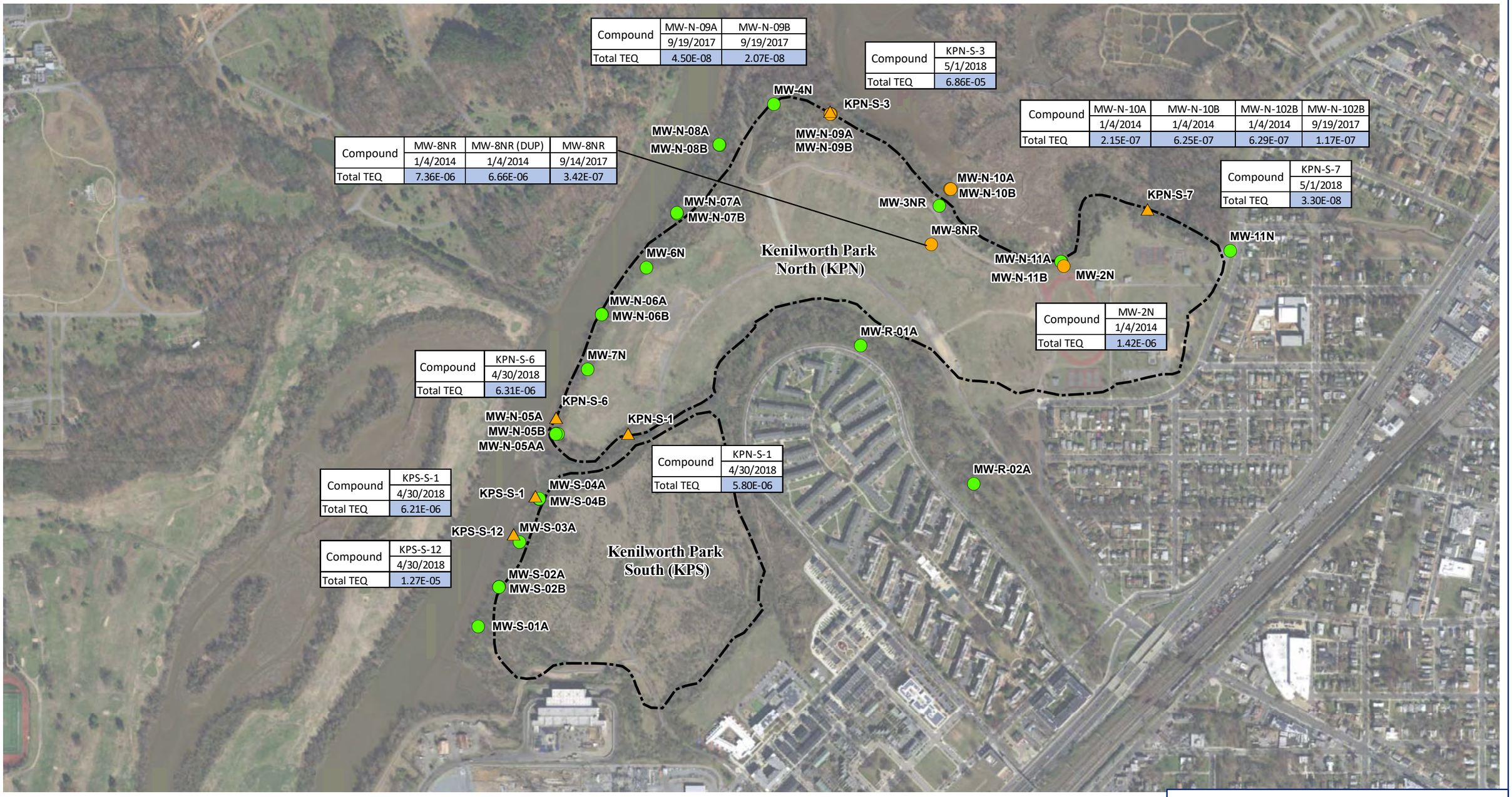
Feet

Figure 9: Pesticides in Groundwater and Seep Samples
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 7/26/2018
Reviewed by: JO Date: 8/9/2018

Scale: 1 " = 600 ' Project: 58345.11



Compound	MW-N-09A	MW-N-09B
	9/19/2017	9/19/2017
Total TEQ	4.50E-08	2.07E-08

Compound	KPN-S-3
	5/1/2018
Total TEQ	6.86E-05

Compound	MW-N-10A	MW-N-10B	MW-N-102B	MW-N-102B
	1/4/2014	1/4/2014	1/4/2014	9/19/2017
Total TEQ	2.15E-07	6.25E-07	6.29E-07	1.17E-07

Compound	MW-8NR	MW-8NR (DUP)	MW-8NR
	1/4/2014	1/4/2014	9/14/2017
Total TEQ	7.36E-06	6.66E-06	3.42E-07

Compound	KPN-S-7
	5/1/2018
Total TEQ	3.30E-08

Compound	MW-2N
	1/4/2014
Total TEQ	1.42E-06

Compound	KPN-S-6
	4/30/2018
Total TEQ	6.31E-06

Compound	KPN-S-1
	4/30/2018
Total TEQ	5.80E-06

Compound	KPS-S-1
	4/30/2018
Total TEQ	6.21E-06

Compound	KPS-S-12
	4/30/2018
Total TEQ	1.27E-05

Legend

- Seep Sample - At least one Dioxin
- Groundwater Sample - At least one Dioxin
- Groundwater Sample - No Dioxin Detections
- KPN and KPS Landfill Boundaries

TEQ = Toxic Equivalence to 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

Notes:
1. The data presented on this figure represents the groundwater monitoring rounds conducted in 2014 and 2017.
2. Concentrations are in micrograms per liter (ug/L).
3. Blue shading indicates sample concentration exceeds the EPA Region 4 Surface Water Screening Value for Hazardous Waste Sites of 3E-9.

N

0 300 600 1,200 1,800 2,400

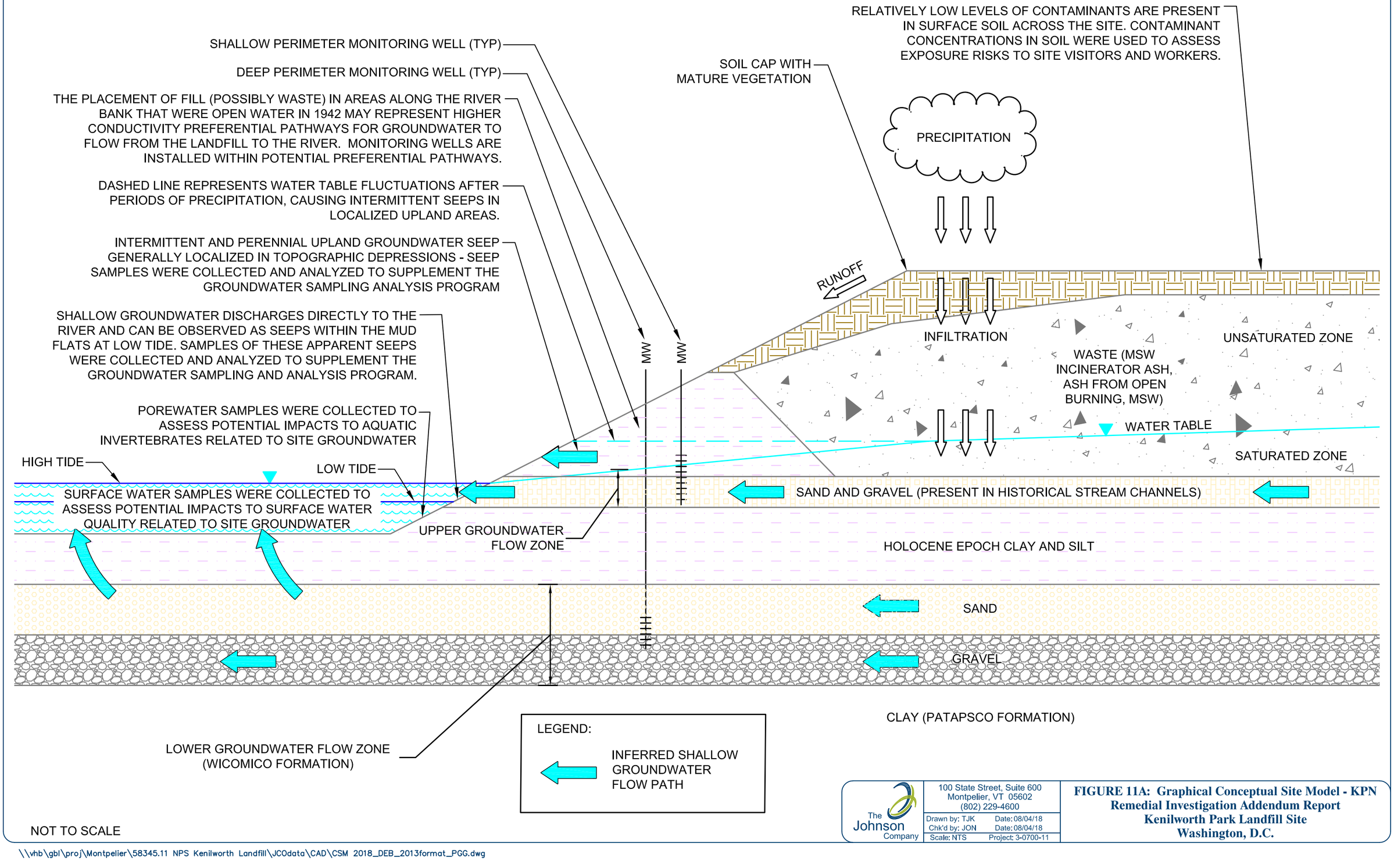
Feet

Figure 10: Dioxin and Furan TEQ in Groundwater and Seep Samples
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602

Drawn by: DEB Date: 7/26/2018
Reviewed by: JO Date: 8/9/2018

Scale: 1 " = 600 ' Project: 58345.11

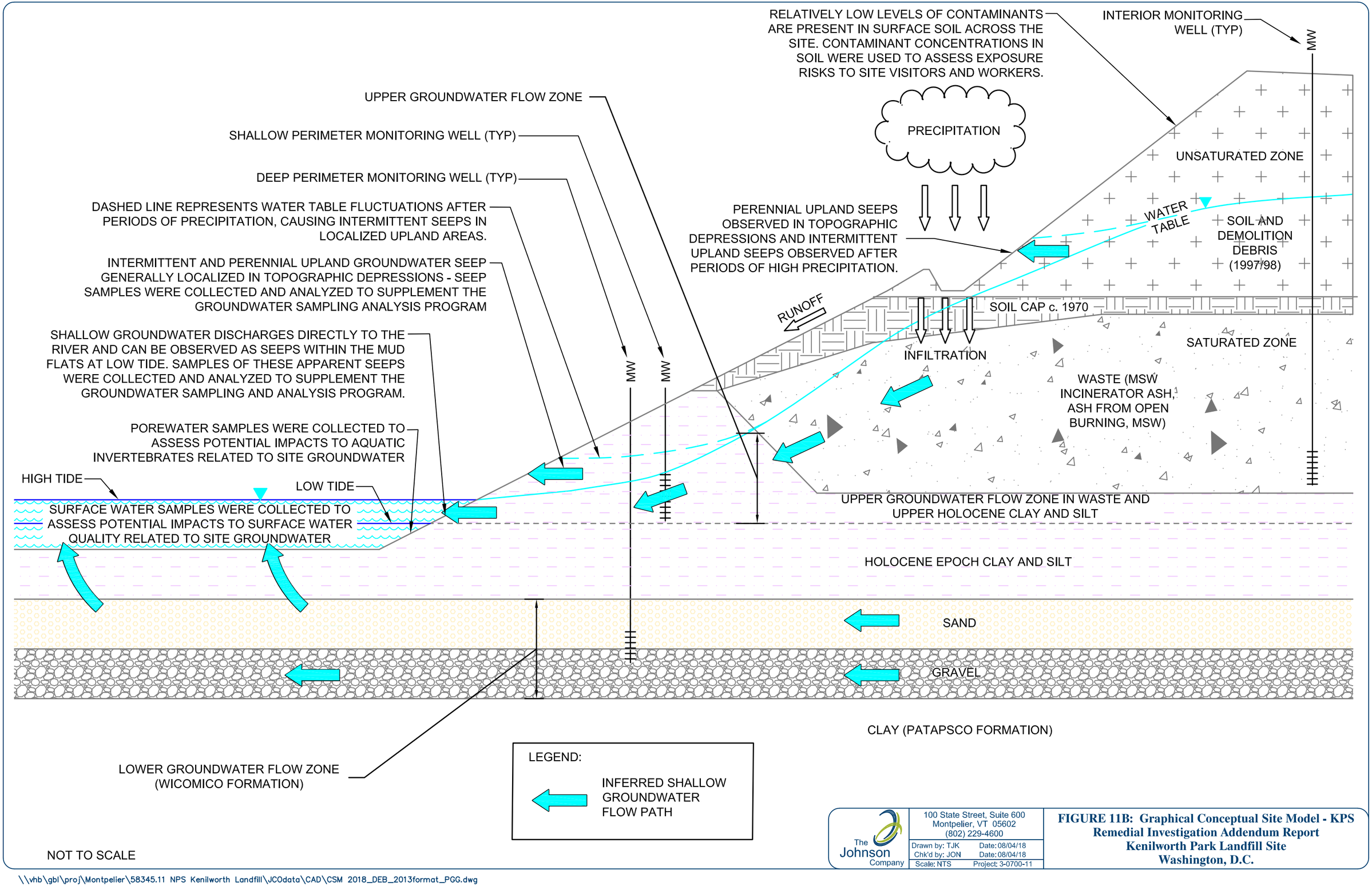


The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: TJK Date: 08/04/18
Chk'd by: JON Date: 08/04/18
Scale: NTS Project: 3-0700-11

FIGURE 11A: Graphical Conceptual Site Model - KPN
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

\\vhb\gbl\proj\Montpelier\58345.11 NPS Kenilworth Landfill\JCOdata\CAD\CSM 2018_DEB_2013format_PGG.dwg



The Johnson Company
100 State Street, Suite 600
Montpelier, VT 05602
(802) 229-4600

Drawn by: TJK	Date: 08/04/18
Chk'd by: JON	Date: 08/04/18
Scale: NTS	Project: 3-0700-11

FIGURE 11B: Graphical Conceptual Site Model - KPS
Remedial Investigation Addendum Report
Kenilworth Park Landfill Site
Washington, D.C.

\\vhb\gbl\proj\Montpelier\58345.11 NPS Kenilworth Landfill\JCOdata\CAD\CSM 2018_DEB_2013format_PGG.dwg

APPENDICES

Copies of the appended reports are attached to this PDF file.