FOLLOW-UP ON SPRING VALLEY HEALTH STUDY

ENVIRONMENT ASSESSMENT TECHNICAL REPORT

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A summary report can be found at: www.jhsph.edu/springvalley
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Contents

ACRONYMS

CAA – Clean Air Act
CSF – cancer slope factor
D.C. - District of Columbia
DDOE – District of Columbia Department of the Environment
EPA – United States Environmental Protection Agency
HAPs – Hazardous Air Pollutants
HI – hazard index
HQ – hazard quotient
IRIS – EPA Integrated Risk Information System
MCL – Maximum Contaminant Limit
NAAQS – National Ambient Air Quality Standards
NAICS - North American Industry Classification System
NATA - National-scale Air Toxics Assessment
NPDES – National Pollution Discharge Elimination System
ppm – parts per million
ppmv – parts per million by volume
ppb – parts per billion
ppbv – parts per billion by volume
RAGS – EPA Risk Assessment Guidance for Superfund
USACE – United States Army Corps of Engineers

Introduction and Overview

In the 2007 Johns Hopkins Spring Valley Public Health Scoping Study, an exposure profile for arsenic covering indoor and outdoor air, water, soil, and food exposure pathways was presented. In this 2013 follow-up study, we examine multiple facets of the environment in which the 20016 and 20015 ZIP Codes are situated and describe the manner in which ambient and site-related pollution may contribute to environmental contaminant exposures to residents.[1]

First, we conduct a comparative portrait of environmental quality in the 20016 and 20015 ZIP Codes. In this comparison we attempt to characterize environmental pollution unrelated to the FUDS site in 20016 and 20015 ZIP Codes. The comparative portrait spans environmental media and pollutants (air toxics, criteria pollutants, and drinking water) and also examines the density of industrial facilities in operation in the two ZIP Codes.

Next, based on United States Environmental Protection Agency (EPA) guidance, we propose a framework for understanding exposures to site-related contamination and compare it to conceptual site models used in both the US Army Corp of Engineers (USACE) and Johns Hopkins previous site assessments. We also quantitatively characterize risks related to exposure to contaminants present in onsite surface waters, were they to be used for swimming or other recreational purposes. The adequacy and rigor of the USACE's water sampling protocols, as well as the data generated under these protocols, are assessed in this report.

An Environmental Health Portrait for ZIP Codes 20016 and 20015

A Comparative Industrial Profile

The environmental quality of an area is a function of a host of factors, ranging from weather and natural geographic features to population density and human activities. To begin to understand the influence of human activity on health, we reviewed available data on industry facilities within the 20016 and 20015 ZIP Codes.

Envirofacts (http://www.epa.gov/enviro/) is a US EPA public, integrated data warehouse covering facilities in the United States that are required to report activity that may affect the quality of air, water, and land. Environmental data for the District of Columbia (D.C.) are collected and submitted by the District of Columbia Department of the Environment (DDOE), e.g., DDOE maintains the air monitors and processes the air monitoring data for submission to EPA for public release in *Envirofacts*. *Envirofacts* allows users to search multiple environmental databases for facility information, including hazardous waste sites and releases, water discharge permit compliance, toxic chemical releases, and air emissions. Users can query the database by ZIP Code, City and State, or County and State to generate tables and

[1] Throughout this report, the communities within the ZIP Code of 20016 and ZIP Code of 20015 are compared. While 20016 encompasses the entirety of Spring Valley, it is important to note that the Chevy Chase neighborhood includes additional ZIP Codes beyond 20015, which were not examined in this report.

maps of information on environmental activities that may affect air, water, and land in communities (United States Environmental Protection Agency 2013e, f). *Envirofacts* is a repository for multiple types of environmental data for multiple geographic areas facilitating data gathering and development of comparisons.

We performed a multisystem search of the *Envirofacts* database to obtain information on the industry activities within the 20016 and 20015 ZIP Codes (United States Environmental Protection Agency 2013g). We queried by geography looking for facilities that were an exact match to the 20016 and 20015 ZIP Codes, which resulted in the identification of 74 and 24 facilities, respectively. Our results reflect data available in *Envirofacts* as of March 2013. Subsequently, we viewed the facility detail report from the Facility Registry System to determine the North American Industry Classification System (NAICS) Code for each of these facilities. The NAICS is the standard system used by the Federal government to classify US business establishments and analyze information related to the economy (United States Census Bureau 2013). We sorted facilities based on their industrial sector, which is indicated by the first two digits of their NAICS Code, to determine the types of industrial activities occurring in each ZIP Code (TABLE E-1).

Based on the information obtained from *Envirofacts*, we found that economic activities are similarly distributed across industry sector for both ZIP Codes. The top three industry sectors in both 20016 and 20015 are Other Services (except Public Administration) (34% vs. 25%); Unknown (No Codes Returned) (6% vs 17%); and Real Estate and Rental and Leasing (15% vs. 13%). All but two of the businesses classified as Other Services in 20016 ZIP Code provide dry cleaning and laundry services (non-coin operated). Differences between the two ZIP Codes include that 20016 does not have any reporting businesses in the Arts, Entertainment and Recreation sector whereas 20015 has one such facility. Unlike the 20016 ZIP Code, 20015 does not have any reporting businesses in three sectors: Health Care and Social Assistance; Information; and Mining, Quarrying and Oil, and Gas Extraction. It is important to note that the facility in 20016 ZIP Code identified as a “Mining, Quarrying and Oil and Gas Extraction” facility is a gas station with a service garage; we suspect that the NAICS Code assigned to this facility was done so in error. The Spring Valley FUDS is the only facility in the two ZIP Codes that is being addressed under the requirements of the National Contingency Plan[2]. It is important to reiterate that this industrial profile is based on our query of *Envirofacts*, which captures facilities that are required to report to either a state or the Federal government and are therefore captured in one of the multiple environmental data systems. Similar businesses to those identified in our query may – and likely do – exist in the 20016 and 20015 ZIP Codes. These businesses, however, have not triggered complex reporting requirements (not described herein), and, therefore, are not captured in *Envirofacts* or in our profile.

[2] National Oil and Hazardous Substances Pollution Contingency Plan Overview, Available: http://www.epa.gov/osweroe1/content/lawsregs/ncpover.htm

Table E-1. Regulated Industrial Facilities in *Envirofacts* in the 20016 and 20015 ZIP Codes by NAICS Industry Sector

NAICS Industry Sector	**<u>ZIP Code 20016</u>** **# of Reporting Facilities in Sector (% out of total in Sector)**	**<u>ZIP Code 20015</u>** **# of Reporting Facilities in Sector (% out of total in Sector)**
Arts, Entertainment and Recreation	-	1 (4.17%)
Educational Services	8 (10.81%)	1 (4.17%)
Finance and Insurance	2 (2.70%)	1 (4.17%)
Health Care and Social Assistance	2 (2.70%)	-
Information	2 (2.70%)	-
Mining, Quarrying, and Oil and Gas Extraction	1^ (1.35%)	-
Other Services (except Public Administration)	25 (33.78%)	6 (25.00%)
Professional, Scientific, and Technical Services	1 (1.35%)	2 (8.33%)
Public Administration	1 (1.35%)	-
Real Estate and Rental and Leasing	11 (14.86%)	3 (12.50%)
Retail Trade	8 (10.81%)	4 (16.67%)
Transportation and Warehousing	1 (1.35%)	2 (8.33%)
Utilities	3 (4.05%)	-
Unknown - No Codes Returned	12 (16.22%)	4 (16.67%)
Total*	74	24

*Note: totals do not sum because some facilities are assigned more than one NAICS Code
^ This facility is a gas station with a service garage.

To understand the impact of these industrial activities, we examined the reported releases among EPA-regulated facilities listed in *Envirofacts* for each ZIP Code (TABLE E-2). *Envirofacts* organizes reports into topic areas of Air, Toxics, Waste, Radiation and Water.

Air

Air Major are stationary sources or groups of sources that have actual or potential emissions of air pollutants above 10 tons or more per year of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants. Air Minor facilities or an “Area Source” is any stationary source of hazardous air pollutants that is not a Major Source. Air Minors do not include motor vehicles. There were five times more facilities in 20016 than 20015 that reported producing and releasing air pollutants (35 vs. 7).

Toxics

US facilities in various industrial sectors that manufacture, process, or use chemicals in amounts above established levels must report on the recycling, energy recovery, treatment, and release of such chemicals into the environment. A toxic release is an emission of a chemical into air, water or land (United States Environmental Protection Agency 2012b). There was one business, Physicians Committee for Responsible Medicine, in 20016 and no facilities in 20015 that reports to the EPA under the Toxic Substances Control Act.

Waste

A hazardous waste generator is any person or site whose processes and actions create hazardous waste. Generators are divided into three categories based upon the quantity of waste they produce: Large Quantity Generators (LQGs), Small Quantity Generators (SQGs), and Conditionally Exempt Small Quantity Generators (CESQGs). LQGs generate 1,000 kilograms per month or more of hazardous waste, more than 1 kilogram per month of acutely hazardous waste, or more than 100 kilograms per month of acute spill residue or soil. SQGs generate more than 100 kilograms, but less than 1,000 kilograms, of hazardous waste per month. CESQGs generate 100 kilograms or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste, or less than 100 kilograms per month of acute spill residue or soil. Our review of operating facilities identified one large quantity generator of hazardous materials in 20016. The 20016 ZIP Code has 28 small quantity generators of hazardous waste, more than double the number of facilities that reported generating small quantities of hazardous waste activities in the 20015 ZIP Code (13).

Radiation

Neither ZIP Code has facilities regulated by EPA for radiation or radioactivity. It is likely, however, that Sibley Memorial Hospital and American University have x-ray or other radiation facilities that are regulated by the District of Columbia Department of Health.[3]

Water

Under the Clean Water Act, all industrial, municipal, and other facilities that discharge pollutants into waters of the United States must obtain a National Pollutant Discharge Elimination System (NPDES) permit. Smaller dischargers are known as “Non-Majors” (United States Environmental Protection Agency 2013h). The 20016 ZIP Code has four facilities with NPDES permits and discharges to US waters, which includes one NPDES Non-Major facility and one NPDES Major facility. In comparison, the 20015 ZIP Code has no facilities with NPDES permits and discharges to US waters.

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[3] DCDOH Radiation Protection. http://doh.dc.gov/service/radiation-protection

Table E-2: EPA-Regulated Facilities with Reported Releases in 20016 and 20015 ZIP Codes per *Envirofacts*

	ZIP Code 20016	**ZIP Code 20015**
AIR		
Facilities that produce and release air pollutants	35	7
Air Major Source	2	0
Air Minor Source	33	7
TOXICS		
Facilities that have reported toxic releases	1	0
WASTE		
Facilities that have reported hazardous waste activities	54	22
Large Quantity Generators	1	0
Small Quantity Generators	28	13
Conditionally Exempt Small Quantity Generators	28	13
Other Hazardous Waste Activities	1	2
Unspecified Universe	21	5
Number of sites dealing with generation/management and minimization of hazardous waste	0	0
Number of CERCLIS Sites	1	0
RADIATION		
Regulated by EPA for radiation/radioactivity	0	0
WATER		
Facilities with permits and discharges to US waters	4	0
NPDES Non-Majors	1	0
NPDES Major	1	0

Notes: (1) The data in this table are produced based on a Multisystem search of *Envirofacts* database for ZIP Codes 20016 and 20015. (2) Air Major are stationary sources or groups of sources that have actual or potential emissions of air pollutants above 10 tons or more per year of any hazardous air pollutant or 25 tons per year or more of any combination of hazardous air pollutants. Air Minor facilities or an "Area Source" is any stationary source of hazardous air pollutants that is not a Major Source. Air Minors do not include motor vehicles. (3) US facilities in various industrial sectors that manufacture, process, or use chemicals in amounts above established levels must report on the recycling, energy recovery, treatment and release of such chemicals into the environment. A Toxic Release is an emission of a chemical into air, water or land. (4) A hazardous waste generator is any person or site whose processes and actions create hazardous waste. Generators are divided into three categories based upon the quantity of waste they produce. Large Quantity Generators (LQG) are facilities that generate 1,000 kilograms per month or more of hazardous waste, or more than 1 kilogram per month of acutely hazardous waste. Conditionally Exempt Small Quantity Generators (CESQG) are facilities that generate 100 kilograms or less per month of hazardous waste, or 1 kilogram or less per month of acutely hazardous waste. Small Quantity Generators (SQG) are facilities that generate more than 100 kilograms, but less than 1,000 kilograms, of hazardous waste per month. Each class of generator must comply with its own set of requirements. (5) CERCLIS, Comprehensive Environmental Response, Compensation, and Liability Information System. (6) Under the Clean Water Act, all industrial, municipal, and other facilities that discharge pollutants into waters of the United States must obtain a National Pollutant Discharge Elimination System (NPDES) permit. Smaller dischargers are known as "Non-Majors."

Comparative Industrial Profile – Findings and Implications

The comparative industrial profile revealed a number of key differences between the 20016 and 20015 ZIP Codes. To start, the 20016 ZIP Code has a larger land area at 4.5 square miles and 20015 totals 3.4 square miles. The 20016 ZIP Code has threefold more facilities that report to EPA under federal statute. This alone does not necessarily mean that environmental pollutant releases (and thus localized environmental pollution) are meaningfully different between ZIP Codes, though further examination of the industrial presence in these areas provides some insight to potential disparities. Generally, we found that the distribution of reporting entities was similar across ZIP Codes, with the exception of a select group of industry types (Health Care and Social Assistance – 20016 only, Information – 20016 only, and Arts, Entertainment and Recreation – 20015 only) occurring in one ZIP Code but not the other. We suspect that these types of facilities, despite being reportable to the EPA, are not contributing substantially to localized pollution, though without higher resolution data on facility emissions (which were not available to us), we cannot verify this claim with absolute certainty. In terms of environmental media-specific reporting, the 20016 ZIP Code had more facilities reporting air, hazardous waste, and water releases. Estimating the specifics of increases of localized environmental pollution is not possible from these data, though based on facility information at hand, it is reasonable to consider that industrial facilities may contribute more to ambient environmental pollutant exposures in the 20016 ZIP Code than in the 20015 ZIP Code. Emissions of air toxics will be addressed in the next section.

Comparative Industrial Profile - Findings

- 20016 ZIP Code has a greater density (per square mile) of facilities that report to EPA than does the 20015 ZIP Code. The greater density of facilities in 20016 ZIP Code may contribute more to ambient environmental pollutant concentrations and population exposures. However, most facilities in both areas are minor sources (air pollutants) or small quantity generators (hazardous waste).

Air Quality

While both air toxics, or hazardous air pollutants (HAPs), and criteria pollutants pose health and environmental concerns, EPA's regulatory approach differs considerably across the two classifications of pollutants. Criteria pollutants are emitted from an extremely diverse set of sources (e.g., power plants, fossil fuel combustion of any type, lead smelting, and other industrial sources) and are frequently found in measurable concentrations in ambient air across the country. In contrast, the sources of HAPs are often industry-specific and thus, the distribution of HAPs is more sporadic. Another important distinction between HAPs and criteria pollutants is how they are regulated. Based on health risks, national ambient air quality standards (NAAQS) have been established individually for each of the criteria pollutants. In contrast, technology- or performance-based standards are used to reduce air toxics emissions. Lead is regulated as both a criteria pollutant and an air toxic (United States Environmental Protection Agency 2013n). Given the differential regulatory (and data management) approaches to the two types of air pollutants, they are described separately in this report. We identified air quality monitoring stations and examined air quality monitoring data produced by the Metropolitan Washington Council of Governments' Department of Environmental Programs. We also compared cancer risks and non-cancer hazards from air toxics based on data from the EPA's 2005 National-scale Air Toxics Assessment.

Criteria Pollutants

Background on Criteria Pollutants and NAAQS

The Clean Air Act (CAA) requires the EPA to set National Ambient Air Quality Standards (NAAQS) for six pollutants considered harmful to public health and the environment. These compounds (carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter [PM] and sulfur dioxide), termed "criteria pollutants" are emitted from many diverse sources and are pervasive in the environment. There are two types of NAAQS – primary and secondary standards. Both types of standards establish air concentration levels of pollutants that should not be exceeded during a specified time frame (e.g., 8-hours or annually). Primary standards are intended to protect public health and include a margin of safety to ensure susceptible subgroups such as children, the elderly, and individuals with underlying medical conditions or those who are immune-compromised are protected. Secondary standards establish limits for criteria pollutants in order to protect “public welfare” and the environment including ecosystems, agricultural production (e.g., crops, vegetation, and animals), and infrastructure. In some instances, no secondary standard has been established while in other cases the primary and secondary standards are the same (Table E-3) (United States Environmental Protection Agency 2013j).

Air Quality in Washington, D.C. Region

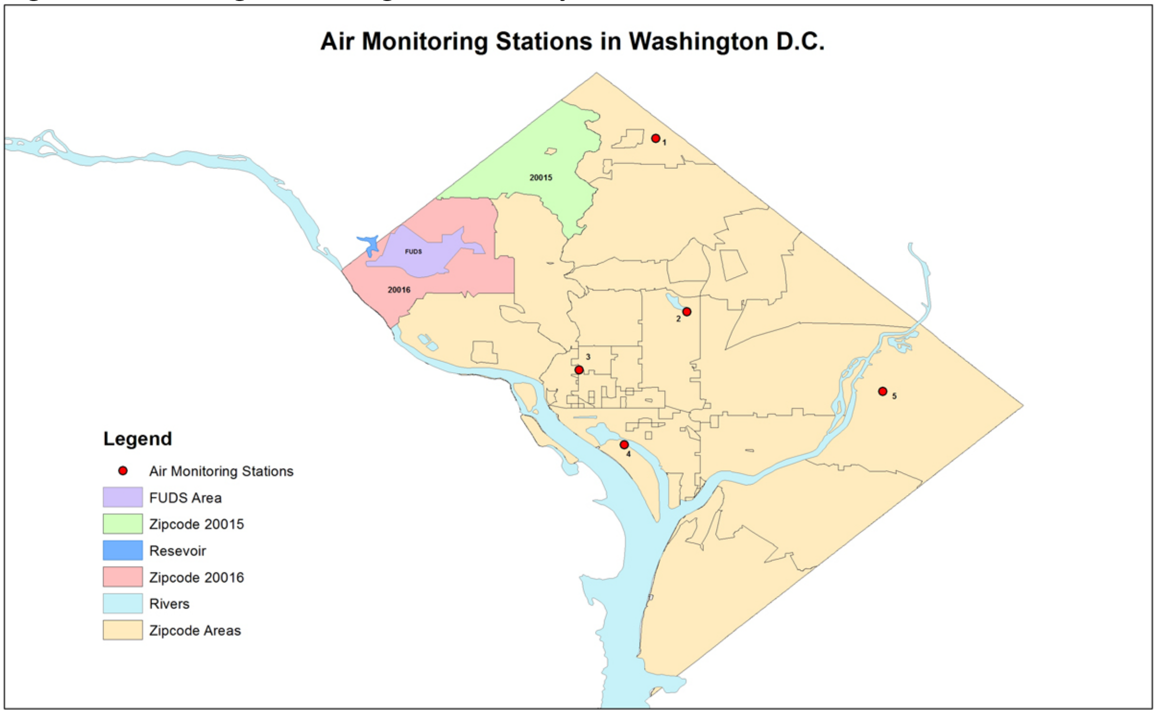
The District of Columbia region continuously monitors outdoor ground-level concentrations of criteria pollutants and air toxics, with the exception of lead, which is no longer monitored because its levels are consistently sufficiently below its acceptable standard (Metropolitan Washington Council of Governments Department of Environmental Programs 2005). Unfortunately, it is not possible to compare the air quality of the 20015 and 20016 ZIP Codes because monitoring is conducted at a regional level; thus, the locations of the monitoring stations do not allow for direct comparisons between the ZIP Codes of interest. The five air monitoring stations in DC are located at the McMillan Reservoir, River Terrace, Takoma Park, Verizon Center, and Haines Point. The locations of these monitors relative to the 20016 and 20015 ZIP Codes are displayed in Figure E-1.

Table E-3. National Ambient Air Quality Standards (NAAQS) for Criteria Pollutants

Pollutant		Type of Standard	Averaging Time	Standard	Criteria
Carbon Monoxide (CO)		Primary	8-hour 1-hour	9 ppm 35 ppm	Not to be exceeded more than once per year
Lead (Pb)		Primary and secondary	Rolling 3 month average	0.15 $\mu g/m^3$	Not to be exceeded
Nitrogen Dioxide (NO_2)		Primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		Primary and secondary	Annual	53 ppb	Annual mean
Ozone (O_3)		Primary and secondary	8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particulate Matter	$PM_{2.5}$	Primary	Annual	12 $\mu g/m^3$	Annual mean, averaged over 3 years
		Secondary	Annual	15 $\mu g/m^3$	Annual mean, averaged over 3 years
		Primary and Secondary	24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over three years
Sulfur Dioxide (SO_2)		Primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Adapted from: http://www.epa.gov/air/criteria.html

Figure E-1. Washington, DC Region Air Quality Monitor Locations



Note: Numbers denote the following monitoring locations: 1 – Takoma School (AQS 11-001-0025, O_3, NO_x); 2 – McMillan Reservoir (AQS 11-001-0043, O3, $PM_{2.5}$, NO_x); 3 – Verizon Telephone (AQS 11-001-0023, CO); 4 – U.S. Park Services (AQS 11-001-0042, $PM_{2.5}$); 5 – River Terrace Site (AQS 11-001-0041, O_3, NO_x, SO_2, CO, PM_{10}, $PM_{2.5}$)

Ambient concentrations of criteria pollutants in the metropolitan Washington D.C. region have improved over the past decade. The region meets NAAQS for 4 of the 5 currently monitored criteria pollutants (TABLE E-4) (United States Environmental Protection Agency 2013b). Any area where criteria pollutant levels regularly exceed the primary or secondary ambient air quality standards is said to be in "non-attainment" (United States Environmental Protection Agency 2013i). The Washington, D.C. region is designated as in non-attainment with the 2008 8-hour ozone standard. For the 8-hour ozone standard, non-attainment is categorized by the magnitude by which the standard is exceeded. In increasing order of excess these classifications, which are defined by a range of ozone concentrations above the NAAQS, are: marginal, moderate, serious, severe 15, severe 17 and extreme non-attainment. As of December 2012, the Washington, D.C. area is in marginal non-attainment with the 2008 8-hour ozone standard. In comparison the New York-North New Jersey-Long Island (NY-NJ-CT) and the Philadelphia-Wilmington-Atlantic City (PA-DE-MD-NJ) areas were also in marginal non-attainment, while Baltimore, Maryland was in moderate non-attainment of the 2008 8-hour ozone standard (United States Environmental Protection Agency 2013c). Areas with ozone concentrations greater than 0.076 parts per million (ppm) up to but not including 0.086 ppm are in marginal non-attainment. Moderate non-attainment is defined as having an ozone concentration of 0.086 up to but not including 0.100 ppm (United States Environmental Protection Agency 2013i). A full report on the air quality data for the Washington, D.C. region from 1993-2004 is available from the Metropolitan Washington Council of Governments (Metropolitan Washington Council of Governments Department of Environmental Programs 2005).

Air Quality Findings

Criteria pollutants are harmful to both public health and the environment. Ozone is a respiratory system irritant, which causes symptoms including coughing, shortness of breath and pain on deep inhalation

(Kelly and Fussell 2011). Elevated levels of ozone in 20016 and 20015 could potentially increase resident's susceptibility to infection, as well as worsen reactions to allergens and other pollutants. Ozone exposure has been associated with worsen attacks in those who have asthma and increased hospital admissions (Kelly and Fussell 2011). Consequently, ozone levels in 20016 and 20015 may exacerbate asthma symptoms of individuals residing in these areas.

Criteria Air Pollutants - Findings

- Air pollutants are monitored at a regional level; therefore, ambient data specific to the 20016 and 20015 ZIP Codes is not available.
- Air quality in the Washington, D.C. area has improved over the past 10 years.
- Ozone is the only criteria air pollutant found above national standards in the Washington, D.C. area.
    - Ozone is a regional pollutant and concentrations measured in the study areas can develop from precursor pollutants emitted elsewhere.
    - Ozone exposure could potentially increase D.C. resident's susceptibility to infection, as well as worsen reactions to allergens and other pollutants.
    - Approximately half of the criteria pollution in the District comes from on-road vehicles, and another 20% from off-road engines (not specific to either study area).[4]

[4] District of Columbia Department of Environment. 2007. Air Emissions Inventory. (Personal communication, Mr. James Sweeney.)

Table E-4. Criteria Pollutant Concentrations for the Metropolitan Washington Region, 2005-2012

Year	Carbon Monoxide		NO_2	Ozone		SO_2		Particulate Matter				Lead
								$PM_{2.5}$		PM_{10}		
	2nd Max 1-hr	**2nd Max 8-hr**	**98th %ile 1-hr**	**2nd Max 1-hr**	**4th Max 8-hr**	**99th %ile 1-hr**	**2nd Max 24-hr**	**98th %ile 24-hr**	**Wtd Mean 24-hr**	**2nd Max 24-hr**	**Mean 24-hr**	**Mean 24-hr**
2012	4.3	2.5	65	0.11	**0.090**	17	5	29	11.8	37	17	0
2011	4.2	2.4	55	0.11	**0.087**	20	8	27	11.8	41	17	0
2010	3.7	3.1	59	0.11	**0.089**	21	11	28	12.1	85	22	0
2009	4.2	3.8	63	0.1	0.072	39	17	26	10.7	47	19	0
2008	4	3.1	61	0.12	**0.085**	37	16	**35**	12.9	47	20	0
2007	3.8	2.7	58	0.12	**0.089**	42	13	**48**	14.4	52	23	0
2006	4	3.3	60	0.14	**0.095**	50	17	**39**	14.3	63	27	0
2005	3.8	3.2	71	0.11	**0.092**	**78**	20	**38**	15.7*	72	36	0.01

Source: Adapted from: http://www.epa.gov/airdata/ad_rep_con.html.

Notes: (1) **Bold font** indicates levels of criteria pollutant are not in compliance with NAAQS (non-attainment); (2) * indicates standard has changed since 1997; Pollutant was in compliance when these data were collected; (3) Annual statistics for 2012 are not final until May 1, 2013; (4) Carbon monoxide (CO) and ozone (O_3) are measured in parts per million by volume (ppmv); (5) Nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) are measured in in parts per billion by volume (ppbv); (6) Particulate matter is measured in in micrograms per cubic meter; (7) CO 1-hr 2nd Max for carbon monoxide is the 2nd highest 1-hour measurement in the year; (8) CO 8-hr 2nd Max for carbon monoxide is the 2nd highest non-overlapping 8-hour average in the year; (9) NO_2 98th %ile for nitrogen dioxide is the 98th percentile of the daily max 1-hour measurements in the year (10) O_3 1-hr 2nd Max for ozone, the 2nd highest daily max 1-hour measurement in the year; (11) O_3 8-hr 4th Max for ozone is the 4th highest daily max 8-hour average in the year; (12) SO_2 99th %ile for sulfur dioxide is the 99th percentile of the daily max 1-hour measurements in the year; (13) SO_2 24-hr 2nd Max for sulfur dioxide is the 2nd highest 24-hour average measurement in the year; (14) $PM_{2.5}$ 98th %ile for $PM_{2.5}$, the 98th percentile of the daily average measurements in the year; (15) $PM_{2.5}$ Wtd Mean for $PM_{2.5}$ is the Weighted Annual Mean (mean weighted by calendar quarter) for the year; and (16)PM_{10} 24-hr 2nd Max for PM_{10} is the 2nd highest 24-hour average measurement in the year.

Air Toxics

Background on Air Toxics

Air toxics are pollutants known or suspected to cause serious environmental and health effects including cancer, and neurological, reproductive, developmental, respiratory and other health effects (United States Environmental Protection Agency 2013a). Title III of the CAA Amendments of 1990 identifies 187 air toxics or HAPs for which the EPA is required to regulate emissions (United States Environmental Protection Agency 2013d). Air toxics are primarily released into the air by human-made sources, including both stationary sources such as factories, refineries and power plants, and mobile sources (e.g., motor vehicles and non-road equipment such as tractors). Natural sources such as volcanic eruptions and forest fires also release air toxics.

EPA's 2005 National-scale Air Toxics Assessment

A screening and analytical tool called the National-scale Air Toxics Assessment (NATA) was developed to guide efforts to reduce air toxic emissions. The NATA aims to help users understand potential risk from exposure to air toxics and prioritize pollutants, emission sources, and locations for further assessment. In 2011, the US EPA released the fourth version of the NATA tool, which is based on emissions from the 2005 calendar year. The 2005 National-scale Air Toxics Assessment includes data on 177 of the 187 air toxics defined in the Clean Air Act, as well as non-cancerous effects of diesel particulate matter (PM). Criteria pollutants are not addressed in the NATA (United States Environmental Protection Agency 2011c).

The NATA was developed using a four-step risk assessment process. First, the National Emissions Inventory was compiled (United States Environmental Protection Agency 2013k). This inventory includes outdoor stationary and mobile sources of air toxics, as well as events such as wildfires. Second, ambient concentrations of air toxics are estimated using dispersion models. Air concentrations for each toxic pollutant are estimated at both the county and census tract level. Next, human exposure to air toxics through breathing is modeled. Lastly, health risks including cancer and non-cancer health effects resulting from inhaling outdoor sources of air toxics are characterized. Population health risks were estimated using available health effect-based reference values. NATA estimates that there are over 80 air toxics associated with cancer, over 40 associated with respiratory disease, and more than 20 associated with neurological outcomes (United States Environmental Protection Agency 2011e).

NATA is used by the US EPA, states, tribes and local jurisdictions to prioritize further study or remediation of specific air toxics, emission sources, and geographic areas. It is also used to inform local monitoring and risk assessments and to guide future research (United States Environmental Protection Agency 2011d). It is important to note that NATA uses models to provide screening-level estimates of the risk and hazards associated with air toxics exposure; however, NATA *cannot be used to identify health risks for individuals.* Lifetime cancer risk represents the probability of developing cancer over a 70 year lifetime as a result of combined inhalation exposure to various air toxics. The combined risks for health effects other than cancer are represented by a hazard index (HI). This metric approximates the combined effect of individual air toxics that affect the same organ or organ systems. The 2005 NATA includes both respiratory and neurological hazard indices. A HI of < 1 indicates that adverse health effects are unlikely to occur.

Air Toxics Findings and Public Health Implications

Based on the 2005 NATA, for cancer and non-cancer outcomes, the Spring Valley and Chevy Chase study areas[5] had lower exposures and risks than the District of Columbia (Table E-5). Exposures to air toxics associated with neurological outcomes are below levels of concern for both ZIP Codes and the US overall. In contrast, there is the potential for adverse respiratory outcomes as result of exposures to air toxics for all of these geographic areas. This is typical of major urban areas. The estimated lifetime cancer risks from air toxics are within the EPA's acceptable range. Two-thirds of the US population has risks similar to the persons living in the study areas.

Table E-5. Cancer risks and non-cancer hazards from Air Toxics (2005 NATA)

Outcome	Spring Valley area[a]	Chevy Chase area[b]	District of Columbia	US
Lifetime Cancer Risk	6.6 cases per 100,000 population	6.6 cases per 100,000 population	7.7 cases per 100,000 population	5 cases per 100,000 population
Respiratory Hazard Index	3.3	3.3	4.4	2.3
Neurological Hazard Index	0.06	0.07	0.08	0.06

[a] Defined by census tracts: 801, 901, 1001, 1002
[b] Defined by census tracts: 1100, 1401, 1402, 1500

Air Toxics – Findings

- Exposures and risks from air toxics in the study areas are higher than the US average and lower than D.C. but typical of US urban areas.
- There is potential for all District residents to have adverse respiratory outcomes due to air toxics concentrations in ambient air.
- Estimated cancer risks from air toxics are within EPA's acceptable range.
- Air toxics identified as the highest risk for the D.C. area are primarily from on-road and off-road engines.

Water Quality

Water Source and Treatment

Drinking water in both Spring Valley (20016) and Chevy Chase (20015) is sourced from the Potomac River, a surface water supply. The U.S. Army Corps of Engineers Washington Aqueduct treats water obtained from the Potomac at the Dalecarlia and McMillian Treatment Plants. The regional utility company, DC Water, then distributes this water to residents in the district; in Fairfax and Loudoun Counties of Virginia; and in Montgomery and Prince George's Counties of Maryland. DC Water is responsible for the quality of water once it leaves the treatment plants while it travels in public water mains. Groundwater is not used as a drinking water source in either community (District of Columbia

[5] Air toxics data are available by census tract. For the analysis of air toxics the Spring Valley area is represented by DC census tracts 801, 901, 1001, and 1002; and the Chevy Chase area is represented by DC census tracts 1100, 1401, 1402, and 1500.

Water and Sewer Authority 2012). A figure of the areas served by DC Water is presented in Supplement A.

Water Quality Assessment

Drinking water can contain measurable quantities of chemical contaminants. The presence of contaminants does not necessarily mean that drinking water is unsafe. To ensure that water is safe for consumption, the EPA has established drinking water standards for specific contaminants. Data produced by the USACE Washington Aqueduct were reviewed and compared to federal and state standards for the water quality assessment. Water treated by the Washington Aqueduct is in compliance with all EPA drinking water standards (District of Columbia Water and Sewer Authority 2012). In 2011, the Washington Aqueduct tested the Potomac River raw water supply for a variety of contaminants including arsenic and perchlorate. The highest level of arsenic that is allowed in drinking water is 10 parts per billion (ppb) (District of Columbia Water and Sewer Authority 2012). In raw water from the Potomac River, arsenic levels ranged from below the limit of detection (queries for the limit of detection were unsuccessful) to less than one ppb. In treated water, arsenic levels ranged from less than the limit of detection to 0.8 ppb at the Dalecarlia Water Treatment plant and less than the limit of detection to 0.7 ppb at the McMillan plant (United States Army Corps of Engineers 2011).

In the raw water supply, perchlorate levels ranged from 0.3-0.8 ppb. Perchlorate levels remained the same in finished water (United States Army Corps of Engineers 2011). While there is no federal drinking water standard established for perchlorate, the EPA is engaged in developing regulation addressing perchlorate in drinking water (United States Environmental Protection Agency 2011b). The state of California, however, regulates perchlorate as a drinking water contaminant; the Maximum Contaminant Limit (MCL) is currently 6 ppb (California Environmental Protection Agency Office of Environmental Health Hazard Assessment 2004). The California Office of Environmental Health Hazard Assessment within the California Environmental Protection Agency (Cal EPA) recently proposed to reduce this public health goal for perchlorate in drinking water to 1 ppb (California Environmental Protection Agency Office of Environmental Health Hazard Assessment 2011). Additionally, the state of Massachusetts has established a drinking water perchlorate MCL of 2 ppb (Massachussetts Department of Environmental Protection 2006). Levels of perchlorate in DC water are in compliance with the existing Massachusetts and California drinking water standards, as well as the new proposed standard for California.

Further information about water quality in the metropolitan, DC region can be found in the Washington Aqueduct Annual water analysis reports[6]. Current water quality test results are available at http://dcwater.com/testresults.

Water Quality Findings and Public Health Implications

A public health goal is a level of a drinking water contaminant (such as perchlorate) at which adverse health effects are not expected to result from a lifetime of exposure. Given that perchlorate levels in the Washington, D.C. region's raw and treated water remain below both Massachusetts' and California's existing public health goals, as well as California's proposed more stringent goal, it is unlikely that exposure to perchlorate through drinking water would result in adverse health effects to the residents of Spring Valley or Chevy Chase. Water monitoring also revealed that the levels of arsenic in drinking water were considerably below current EPA standards, suggesting that drinking water arsenic is not of concern.

Water Quality Findings

- Both the 20016 and 20015 ZIP Codes are served by the public water system.

[6] Water analysis reports available: http://washingtonaqueduct.nab.usace.army.mil/water_quality.htm

- Levels of perchlorate and arsenic in drinking water are below existing state[7] (perchlorate) and national (arsenic) standards.

Development of an Exposure Pathway Framework/Site Conceptual Model

Background on site conceptual models

Site conceptual models provide a useful way for visualizing the pathways through which humans and the environment may become exposed to chemicals.

In order for an exposure pathway to be considered complete (and thus worthy of consideration for risk analysis), it must satisfy five criteria. A completed exposure pathway must include the following:

1. A **source** of contamination;
2. A **transport medium** through which the chemical travels through in the environment (e.g. air, water, food, or soil);
3. An **exposure point**, where people come into contact with the contaminated transport medium;
4. An **exposure route**, or how the chemical enters the body (e.g. inhalation, ingestion, or dermal absorption); and
5. **Receptor(s)**, or the person(s) or population(s) exposed to the chemical.

Site conceptual models can facilitate the quantitative estimation of exposure to (and risk from) environmental chemicals, which in turn can enable decision-makers to examine options to mitigate risk. In addition, analyses can be conducted to compare the relative importance of the different pathways in contributing to human exposure.

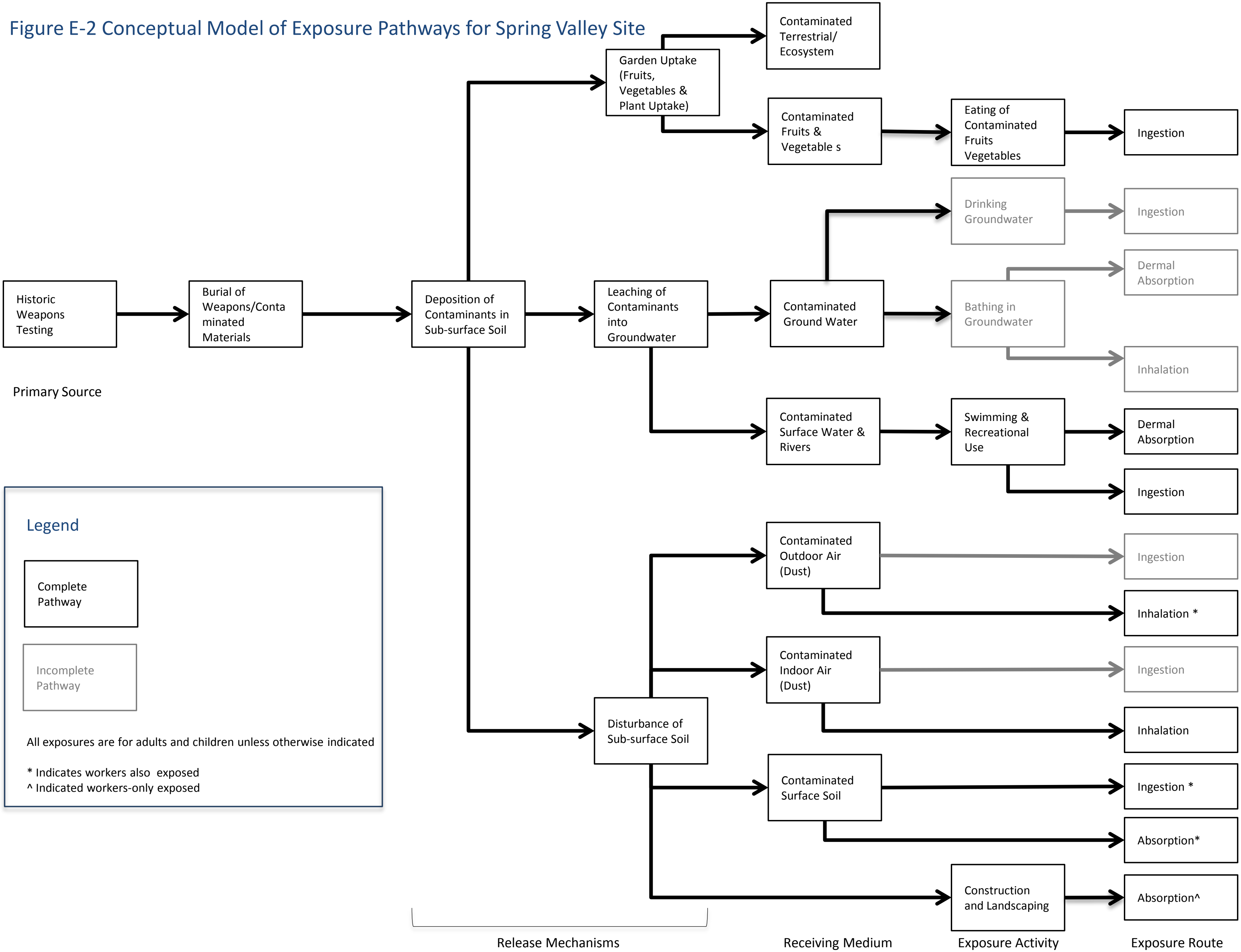
As illustrated through an exposure pathway model, there may be multiple sources of chemicals in the environment and numerous pathways by which populations are expected to be exposed to site-related contaminants. The extent to which people are exposed to a chemical (or multiple chemicals) is dependent on their specific activities and behaviors.

JHSPH site conceptual model

The construction of our site conceptual model (FIGURE E-2) is based upon the Risk Assessment Guidance for Superfund (RAGS) technical documents from the EPA (United States Environmental Protection Agency 2013l). In its assessment of site-related exposures, USACE employed the EPA RAGS approach to develop its own site conceptual model. While RAGS is a useful framework for understanding sites and the potential for human contact with site-related contamination, it is not cookbook; judgment is an inherent component of the assessment. As such, while we also developed a site conceptual model using RAGS that looks much like the one proposed by USACE, our model has a number of variations from the USACE model that we believe are important to consider. The following text compares the site conceptual models and provides a rationale for these additional considerations. It should be noted, however, that the development of the JHSPH site conceptual model was conducted prior to examining the USACE model. In doing this, we attempted to avoid biasing our evaluation of risk assessment needs by viewing what had already been done.

[7] California and Massachusetts have drinking water standards for perchlorate.

Figure E-2 Conceptual Model of Exposure Pathways for Spring Valley Site



For our site conceptual model, we assumed the primary sources of contamination to be surface-level testing of chemical weapons and subsurface chemical weapon disposal pits. It is possible that construction and other onsite activities have disrupted disposal pits and contributed to additional surface contamination. With these sources in mind, we anticipate that site-origined contamination is present and potentially capable of migrating into site environmental media, including surface and subsurface soils, as well as surface and ground water. Due to activity on sites, we also anticipate that site contamination could be entrained into the air as dust. It is possible, depending on the crop, that vegetables or fruit grown on site may accumulate arsenic from soils and water. With few exceptions, such as rice, mushrooms, carrots and ferns (Francesconi et al. 2002; Helgesen and Larsen 1998; Larsen et al. 1998; Meharg and Rahman 2002; Zhao et al. 2002), arsenic accumulation in edible plants is generally believed to be minimal, though for many crops, the literature examining arsenic accumulation is fairly thin.

Given that contamination has been shown to exist on residential properties, our model reflects the possibility of human exposure at numerous points. Persons spending time on residential properties with a history of site contamination may be exposed to site-related contaminants when coming into contact with surface or subsurface soils (via incidental ingestion, dermal contact, and inhalation of entrained dust), or surface water (via incidental ingestion or dermal contact, especially in the case of recreational water use). Consumption of produce grown onsite may contribute to intake of site-related contaminants through the settling of dust on the produce surface, or through accumulation of contaminants in plant tissue.

Based on our previous work in the scoping study, we have developed a list of likely receptors, or persons who would spend time on contaminated sites. Once these groups of people have been identified, it is possible to construct reasonable scenarios under which these persons would have contact with site contamination. Since the contaminated site is largely encompassed by residential properties, it is reasonable to assume that residents of all ages (adults, children, infants, etc.) could spend time on the site. In addition to residents, it is possible that construction workers and landscape workers will spend time on sites. In our model, we have chosen to distinguish between these types of workers because we anticipate that their site activities and the amount of time they spend onsite would differ substantially.

Key similarities and differences between the JHSPH and USACE site conceptual models

The site conceptual models developed by JHSPH and USACE were generally similar, with a couple of key differences, outlined below.

<u>Receptor considerations</u> – The USACE model considered adults, children and a construction worker receptor. In addition to these receptors, we believe landscape workers are also a relevant population in the scenario at hand, since landscape work is common in the Spring Valley area, and the nature of contact with environmental media is likely significantly different between these persons and other receptors.

<u>Exposure pathway considerations</u> – For the resident receptors, USACE evaluated exposure pathways for incidental soil ingestion, dermal contact while gardening, and ingestion of homegrown vegetables. The USACE model did not include consideration of particulate inhalation for residents; the rationale used to substantiate this decision was a belief that local vegetation trapped particulates and prevented the completion of this exposure pathway. The JHSPH model did consider particulate inhalation for residents. For construction workers, pathways were evaluated for incidental soil ingestion, dermal contact, and particulate inhalation. In both the USACE and JHSPH site conceptual models, pathways involving groundwater were not evaluated since the area is supplied with water by the municipal authority, making completion of these pathways highly unlikely. Surface water data were not available at the time that USACE constructed its site conceptual model and completed its initial screening. These data have since become available, however, and as such, surface water exposure pathways have been included in our site conceptual model.

Since landscape workers were not examined in the USACE model, we included in our site conceptual model specific consideration of dermal contact and inhalation exposure. We also adjusted the model inputs for exposure estimation to reflect differences in site-based activities between construction workers and landscape workers.

Pathway-specific risk evaluation

The 2007 Scoping Study assessed exposures and risks to contaminants in soil. The technical report issued as part of this previous analysis (available upon request) included a detailed description of the sources of data as well as the models and associated assumptions used to calculate risk. The data employed in our assessment were pre-remediation. Since that time, residential soil remediation has been completed. Further evaluation of soil was outside the scope of the current follow-up project.

The following exposure pathways were considered in our previous assessment:

- Ingestion of arsenic and other chemicals in soil
- Ingestion of arsenic in municipally-supplied drinking water
- Dermal exposure to arsenic and other chemicals in soil
- Inhalation of chemicals attached to particulate matter (both outdoors and indoors)

Exposures to chemicals occurring at workplaces or outside the study area were not considered.

A total of five exposure scenarios were developed: adult and child average, adult and child high-end, and adult worker (landscaper). A potential worst-case child scenario, a child with pica, was considered and is discussed below. Pica is a medical condition characterized by habitual eating of non-food items, such as soil (Moya et al. 2004). Inputs to the exposure scenario calculations include a number of variables, such as concentration of arsenic in soil and bioavailability of arsenic from soil, and assumptions, such as years lived in the residence. For example, the EPA's standard assumptions of average length of residence for adults and children (assumed to be 9 years) and the high-end length of residence (assumed to be 30 years) were used.

Data on the concentrations of arsenic and other chemicals in soil were obtained from the USACE sampling program. Subsets of the soil sampling data were also used in the risk assessment, including from the Child Development Center, Lot 18, Boundaries-of-Interest (BOI), and the specialty sampling for the chemical weapons and their breakdown products. The arithmetic average concentration with 95% confidence interval was calculated for each subset of data. Average exposure scenarios are calculated with the average concentration. The high-end scenarios use the upper confidence limit on the average.

Risk Assessment Results

Location-specific cancer risks were calculated to reflect the range of soil arsenic levels measured within the study area. All of the site-related cancer risks for an adult resident fell within the EPA Superfund program acceptable risk range of 0.1 to 10 per 100,000. For a child resident, site-related incremental cancer risks were elevated on the basis of sampling data from the Child Development Center and from high-end exposures to soils sampled at Lot 18.

For non-cancer risk for associated with arsenic, a hazard quotient (HQ) was used to evaluate exposure. If the HQ is greater than 1, exposures exceed a dose level of health concern. All adult HQs, including the occupational landscaper, were also less than 1. Shaded cells of Table E-5 indicate results below levels of concern. For a child resident in the “high-end” exposure scenario, arsenic in soil at the Child Development Center and Lot 18 exceed the level of concern.

Table E-5. Non-cancer Hazard Quotient results for arsenic exposures at selected locations

Location/Data subset	Adult “Average”	Adult “High-end”	Land-scaper	Child “Average”	Child “High-end”
Background	<1	<1	<1	<1	<1
Boundaries-of-Interest	<1	<1	<1	<1	<1
Lot 18	<1	<1	<1	<1	>1
Child Dev. Ctr.	<1	<1	<1	<1	>1

For the landscaper scenario, site-related cancer risks associated with arsenic were about 30 per 100,000, which were less than the occupational maximum “acceptable” risk of 100 per 100,000, but higher than the site-related risks of the adult resident. Non-cancer risks associated with arsenic for the landscaper were below the level of concern.

This analysis found cancer risks for adults and children to be within EPA’s acceptable risk range. It also found no elevated exposures for the adult scenarios and an “average” child for any of the non-cancer health effects. Only one potential mixture exposure is of concern for the child resident at a high-end exposure. The potential mixture associated with effects on blood had a HI exceeding 1.

Scoping Study Risk Assessment Key Findings

- The assessment corroborates recommendations reached previously by the Mayor’s Science Advisors and the ATSDR that, although arsenic may be the most reliable indicator of chemical contamination, other contaminants sampled in Spring Valley may contribute to exposures of potential concern for health.

- In the worst case, children’s exposures to pre-remediation levels and related cancer and non-cancer risks are elevated, but the probability of adverse effects is small.

- Ingestion of soil is the most important pathway of exposure for the child exposure scenarios, contributing about 60% or more to exposure estimates. Reducing soil ingestion can be achieved with common sense precautions such as hand washing after outdoor activities and before eating.

Risk assessment update – additional pathways

Introduction and Background

Since the release of the 2007 Scoping Study, additional data have become available that allow for the assessment of risks resulting from additional exposure pathways. These pathways were noted in the original Scoping Study, but were not able to be considered quantitatively because contaminant data for specific environmental media were unavailable.

We requested water monitoring (including groundwater and surface water) data in December 2011 and were given 2005 – 2011 data by a USACE contractor for both media. At a Spring Valley Partners meeting in May 2012, we were given hard copies of additional, more recent ground and surface water data from February 2012. Thus, our analysis includes the year of quarterly monitoring data that was initiated in 2011.

Since the span of available data includes both pre- and post- soil remediation sampling, we decided as a first pass to use data from the entire time period to assess risks. We believe this approach to be fairly conservative, and thus protective of current residents, given that the data used include samples from before residential soil remediation was completed. If risks estimated using this approach are not of concern, we would assume that risks calculated using only post-remediation data would be negligible.

Methods for Screening Assessment

The purpose of this assessment is to examine recreational exposure of adults and children to contaminants found in surface water present at the impacted site. We did not consider other receptors for these pathways, as they are unlikely to use surface water recreationally. It is important to clarify that surface waters present in the community are largely shallow creeks and other unswimmable, small bodies of water. While we believe it is unlikely that these surface waters will be used for recreational purposes, we present an assessment of risks related to this nature of use, understanding that resulting risk calculations will likely be overestimates.

Persons swimming may be exposed to water-borne contaminants by two pathways. Swimmers have skin contact with water and are also assumed to ingest small amounts of water while swimming. For our assessment, both of these pathways were considered for chemicals shown to be present in USACE surface water testing.

While groundwater data were made available, we believe it is unlikely that residents of the impacted area will have contact with the water, since the area is served by the public water system (see Environmental Health Portrait, above). Since contact with groundwater under other circumstances seems unlikely, we assume that no completed exposure pathways with groundwater exist, and as such, none are quantified here.

A list of contaminants found in surface water sampling (and thus considered in the assessment) is included in Supplement B. In most cases, levels of specific contaminants in the surface water were below quantifiable limits, implying either that the chemicals were not present in the water samples or that they were present at levels that are likely of negligible health concern. Samples with non-detect measurements were excluded from the analysis. In the event that a chemical was present above the detection limit in some samples, but below in others, only the levels above the detection limit were included in the analysis.

In addition to the aforementioned EPA guidance documents for conducting risk assessment, EPA's Risk Assessment Guidance for Superfund, Part E: Supplemental Guidance for Dermal Risk Assessment (United States Environmental Protection Agency 2013m) was used to quantify dermal exposure doses. General assumptions about water contact and ingestion were derived from EPA's recently updated Exposure Factors Handbook (United States Environmental Protection Agency 2011a).

We modeled separate average and high exposure scenarios for each receptor/pathway combination. The average scenario assumed typical swimming behavior in a swimmable water body, with a person swimming for 45 minutes 7 times per year. The high exposure scenario assumed that a person would swim 70 days a year (for 3 hours a day). This scenario was utilized with both adults and children.

Results of surface water screening assessment

The results of the risk analyses under the high exposure scenario are presented in Table E-6. Shading in Table E-6 indicates results below levels of concern.

Table E-6. Risk and non-cancer hazard estimates from recreational use of surface water (swimming)

	High exposure					
Adult	**Risk***	**HQ**		**Child**	**Risk***	**HQ**
Dermal	0.07	0.03		Dermal	0.08	0.04
Ingestion	0.00	0.02		Ingestion	0.01	0.09
Total	0.07	0.05		Total	0.09	0.13

*Cancer risks are presented as number of expected cases per 100,000 exposed persons

For purposes of interpretation, EPA considers a lifetime excess cancer risk of 10^{-6} to 10^{-4} to be "acceptable" for a redeveloped Superfund site, and considers a HQ of < 1 to suggest that non-cancer adverse effects are unlikely to occur. For both adults and children under the high exposure scenario, which assumes a number of hypothetical circumstances that are extremely unlikely to occur, cancer risk estimates and HQs were not of concern.

Since the high exposure scenario results indicate that exposures to surface water are not concerning, the results for the average exposure scenario are not presented (since the risks and HQs are far lower).

Risk Assessment Considerations

Since the publication of the 2007 Spring Valley Scoping Study, a number of developments have occurred that are worthy of mention in light of the risk analyses presented here.

The first of these changes is an update to the EPA toxicological characterization of cancer risk from inorganic arsenic. In 2010, the EPA Integrated Risk Information System (IRIS) issued a draft re-assessment of its toxicological assessment of inorganic arsenic for its carcinogenic potential. As part of this reassessment, the Agency revised its cancer slope factor (CSF), which is its quantitative estimate of the relationship between arsenic exposure and the risk of developing certain cancers Based on an examination of the epidemiologic literature describing rates of cancer in Taiwanese persons exposed to inorganic arsenic in drinking water, the EPA proposed changing its CSF from 1.5 to 25.7 (mg/kgBW-day)$^{-1}$; this change translates to a draft EPA position that inorganic arsenic is 17 times more potent as a carcinogen than it previously assumed (United States Environmental Protection Agency 2010). In addition to the change to the CSF, the corresponding carcinogenic endpoint of interest has shifted from skin cancer to cancers of the lung and bladder, which have higher mortality rates. The draft cancer assessment has received some criticisms from the regulated industry and other federal agencies. EPA IRIS is also currently developing a draft revision of the non-cancer toxicological assessment for inorganic arsenic. While the Agency had previously forecasted a release of a draft document in late 2012, it has since removed estimates of its release. According to the IRIS program, both the draft cancer and non-cancer toxicological assessments are currently being reviewed by a National Research Council subcommittee (National Research Council Board on Environmental Studies and Toxicology 2013), who will provide recommendations to the Agency in the coming years. Until EPA takes final action on the reassessment of inorganic arsenic, its original position (a CSF of 1.5$[mg/kgBW\text{-}day]^{-1}$) remains intact, as demonstrated in the IRIS database (United States Environmental Protection Agency 2012a).

The other noteworthy advance in the field of risk assessment is the updating of the EPA Exposure Factors Handbook (EFH), which was finalized in 2011 (United States Environmental Protection Agency 2011a). The new EFH updates a prior iteration of the document released in 1997 and refines many of the default values used in the exposure assessment step of a risk analysis based on new science that has become available about how people spend time or come into contact with environmental media. The EFH contains updated EPA recommendations for a variety of factors, including drinking water consumption, soil ingestion, inhalation rates, dermal factors including skin area and soil adherence factors, consumption of fruits and vegetables, fish, meats, dairy products, homegrown foods, human milk intake, human activity factors, consumer product use, and building characteristics.

The previously submitted Scoping Study was completed prior to the reassessment of inorganic arsenic and the release of the updated EFH. While the consideration of the surface water pathways included in this report employs recommendations from the new EFH, updating the Scoping Study risk assessment to consider the new EFH was beyond the scope of this report. It is our belief, however, that the refinement of the original Scoping Study using exposure factors from the 2011 EFH would not result in substantial changes to the estimates of risk or the conclusions of the previous work.

The reassessment of arsenic, when finalized, will likely change the CSF in an upward fashion. Accordingly, estimated risks associated with site contamination would increase. True risk of arsenic exposure has not changed and remains unknown. With advanced methods, we aim to increase our understanding of the risk and improve approaches to arsenic risk assessment and management. Further, the risk assessments in the Scoping Study were conducted using data that predated remediation activities. Thus, it is anticipated that any change in the CSF of arsenic would be counterbalanced by the reduced arsenic content in site environmental media.

Exposure Pathway Framework and Risk Assessment Findings

- The site conceptual models developed by JHSPH and USACE were generally similar, with two exceptions:
    - JHSPH included and evaluated a landscaper worker (2007 Scoping Study)
    - JHSPH included and evaluated particulate inhalation as an exposure pathway for residents (2007 Scoping Study)

- Incidental and recreational exposure to surface water was evaluated; no increased risk was indicated considering sampling data for arsenic, perchlorate and other contaminants detected.

Evaluation of Spring Valley Water Monitoring Plans

Background and Approach

Water monitoring was underway but results were not yet available for analysis at the time of the 2007 Scoping Study and related plans and data were not evaluated at that time. The analysis of the water monitoring plans and related data in this update provide an important complement to the previous 2007 work focused on soil contamination. In this section, the overall plans for water monitoring are reviewed.

Water sampling data were included in the exposure assessment to complete the evaluation of relevant exposure pathways (see "Risk assessment update – additional pathways" section).

Information reviewed

The water monitoring study is implemented by URS Group, a USACE contractor. URS Group prepared the planning documents that we received from the USACE. The following documents were reviewed:

Spring Valley FUDS, Washington, D.C. Groundwater Study: Work Management Plan (Feb 2005)
Spring Valley FUDS, Washington, D.C. Groundwater Study: Work Management Plan, Appendix G Quality Assurance Project Plan (July 2005)
Spring Valley FUDS, Washington, D.C. Phase 3 Deep Groundwater Study: Work Management Plan Addendum Three (Sept 2009)
Spring Valley FUDS, Washington, D.C. Phase 3 Deep Groundwater Study: Quality Assurance Project Plan Addendum Three (Oct 2009)

Approach to review

The water monitoring study review was organized around the following questions:

- Are approaches and plans for the water monitoring study adequate for site characterization? Include consideration of well location, chemical analysis, and data quality and data analysis.
- Are there any data gaps or limitations in the water study plans?

The water study is ongoing and the analysis below focused on the planning documents listed above and may not fully capture work currently underway.

<u>Results: Approaches and Plans for Water Study</u>

Overall approach of the water study

As described in the planning documents, the overall approach of the water study includes measurements of chemical contaminants and water quality data from wells, hydraulic measurements, and geophysical tests to determine aquifer transport characteristics. The 2005 document listed the general objective of determining whether AUES or FUDS activities have impacted groundwater and several objectives related to the groundwater flow system around the reservoir. The 2009 document included additional objectives but with the same overarching concern: overall characterization of groundwater impacts of the FUDS (with particular attention to perchlorate). The water study has developed over time as data were collected, analyzed and interpreted, e.g., new wells were planned near areas where elevated perchlorate and arsenic have been detected (Groundwater Study Update presented to the Restoration Advisory Board meeting, February 12, 2013).

While groundwater is the main emphasis of the water study, several surface water sampling locations have been monitored, as has the Sibley sump pump.

Well location

The plans reviewed described the initial strategy for well location as largely driven by consideration of historical site activities (i.e., proximity to known and suspected sources) as well as accessibility, given the current residential neighborhood conditions. Although there are a number of systematic approaches for selecting well locations; it did not appear that they were used and no explanation was provided in the documents reviewed regarding the choice of the site-driven strategy in lieu of other strategies. Available systematic strategies for design of monitoring systems are described in Aziz et al. (2003), Reed et al. (2007), and Meyer et al. (1994). These systematic approaches apply statistical methods to distribute monitoring wells. The statistical methods are combined with site-specific knowledge of hydrologic gradients with the intent to capture expected and unexpected plume migration.

Chemical Analysis, Data Analysis and Integration of Data Sources

The chemical analysis methods for perchlorate and arsenic and data quality and data management protocols used for site characterization are adequate and consistent with applicable EPA guidance (EPA 2002). Although the overall approach is sound, the documents reviewed did not clearly describe how the various types of data would be analyzed to address the study objectives. For example, to predict potential contaminant transport the recommended analysis would integrate what is known about subsurface hydrology through measurements of hydraulic gradient and geophysical tests with water quality data. EPA offers models for this type of analysis through the Center for Subsurface Modeling Support.[8] Other models are available as well (Cygan et al. 2007).

Data Gaps

The study plans reviewed did not examine the potential role of likely biogeochemical processes that can influence contaminant transport. There are many possible factors to explore. For example, perchlorate reducing bacteria in groundwater can, in the presence of low oxygen, degrade perchlorate. Dissolved arsenic as arsenate can bind to iron oxides in sediments. Push-pull tests and laboratory batch experiments with these sediments could better predict the role of these biogeochemical processes. Understanding the potential role of biogeochemical processes may assist in interpreting sampling results and may be informative for longer-term planning and site maintenance.

Because the Spring Valley community uses piped city water supplies, there is a low level of public health concern for human exposure to groundwater. Areas of possible concern are places where the groundwater seeps onto surfaces, such as in riverbanks or in basements of buildings, where humans may come into contact with arsenic or perchlorate contaminated water or dust. If there is potential for contaminated groundwater to seep onto surfaces, soil in these areas should be sampled.

<u>Water Study Plan Review – Findings</u>

- The types of data and general approaches developed for the water study are adequate to address the stated objectives, however the methods for analyzing and integrating the data were unclear.
- Data gaps included:
    - Lack of information on biogeochemical processes that may influence contaminant fate and transport; and
    - Potential for contaminated groundwater to seep onto surfaces

[8] Center for Subsurface Modeling Support, Available: http://www.epa.gov/ada/csmos/ [accessed April 4, 2013].

Environment Assessment Discussion

The purpose of the presented assessment was to examine available data that may allow for insights into the potential contributions of site-related and ambient pollution to environmental exposures incurred by residents of the 20016 and 20015 ZIP Codes. Understanding these exposures allows us to draw inferences about their influence on risks.

We were able to draw from a number of different data sources in order to examine differences in factors that influence environmental exposures for persons living or working in the 20016 and 20015 ZIP Codes. Our examination of the clustering of facilities required to report to the EPA revealed that the 20016 ZIP Code had a higher density of reportable industrial facilities. This may suggest that the frequency or magnitude of release of environmental pollution may be greater in 20016, potentially corresponding to increases in localized pollution (and more exposure). Using the EPA NATA tool, we were able to make comparisons in risk and non-cancer hazard associated with HAP exposure in both study areas. These data indicate very similar risks and hazards across the study areas; in fact, both areas had lower cancer risks from HAP exposure than the greater Washington, DC population.

For some environmental media, existing data did not support the comparison of risks and hazards between ZIP Codes. These data, however, can facilitate an exploration of the influence of those media on the collective exposure of residents in both ZIP Codes. The placement of air monitors capable of recording data on criteria pollutant concentrations does not allow for the specific estimation of exposure in either ZIP Code, but rather permits only conclusions about the Washington, DC metropolitan area as a whole. Of the data that are available for this region, it is clear that air quality in the region is comparable to other major metropolitan areas around the US. One criteria pollutant (ozone) was out of compliance for the most recent year data were available; ozone exposures have been linked to respiratory outcomes like asthma exacerbation, which tend to occur frequently in urban areas.

Data limitations also precluded comparisons across ZIP Code for drinking water quality, as the entire Washington DC metropolitan area is served by the USACE Washington Aqueduct. Despite these limitations, all water quality measures indicated that pollutant concentrations were below federal standards, suggesting that pollutant exposure through drinking water is of little or no concern.

In addition to examination of non-site related ambient pollution, we also considered the influence of site contamination on environmental exposures to residents of the 20016 ZIP Code. In this assessment, we compared site conceptual models to examine how our list pathway/receptor combinations that we felt were important to quantify matched with those used by the USACE in previous assessments. The emphasis of the current analysis was to extend the 2007 Scoping Study with data from the water monitoring study. Using these data, we modeled scenarios that were highly conservative, using assumptions regarding residential surface water recreational use that were highly unrealistic and likely to dramatically overestimate use. Under these artificial circumstances, we found that chemical exposures incurred would still be within acceptable limits for cancer risks and non-cancer hazards.

The review of plans for the water study indicated that the general approach was sound. Concerns were identified regarding: 1) how well locations were determined; 2) the methods and approach to integrate and interpret data to address stated objectives; 3) potential for biogeochemical processes to influence contaminant fate and transport; and 4) potential for contaminated groundwater to seep onto surfaces. As with many of the Spring Valley FUDS activities, the water study is ongoing and presents something of a ‘moving target’. It can be challenging to get a full understanding of water study activities at any given time. USACE and contractors present data and analyses as they become available but the final results and implications are unknown at present. The recommendations below may be helpful as water study documents are prepared and data analyses are conducted.

Water Study Recommendations

- Provide explanation of site-driven well location strategy, i.e., document why a site-driven strategy was preferred over a systematic approach;
- Assess the role of biogeochemical processes on contamination fate and transport; and
- Evaluate the potential for groundwater seepage onto surfaces and sample soil if seepage is indicated.

References

Aziz, J.J. et al., 2003. MAROS: A decision support system for optimizing monitoring plans. Ground Water, 41(3), pp.355–367.

California Environmental Protection Agency Office of Environmental Health Hazard Assessment. 2004. Announcement of Publication of the Final Technical Support Document for the Public Health Goal for Perchlorate in Drinking Water and Responses to Major Comments on the Technical Support Document: Public Health Goal for Perchlorate in Drinking Water. Available: http://www.oehha.ca.gov/water/phg/perchphg31204.html [accessed 25 March 2013].

California Environmental Protection Agency Office of Environmental Health Hazard Assessment. 2011. ANNOUNCEMENT OF FIRST PUBLIC COMMENT PERIOD AND WORKSHOP DRAFT TECHNICAL SUPPORT DOCUMENT ON PROPOSED PUBLIC HEALTH GOAL FOR PERCHLORATE IN DRINKING WATER. Available: http://www.oehha.ca.gov/water/phg/010711perchlorate.html [accessed 25 March 2013].

Cygan, R.T. et al., 2007. Research Activities at U.S. Government Agencies in Subsurface Reactive Transport Modeling. Vadose Zone Journal., 6(4), p.805.

District of Columbia Water and Sewer Authority. 2012. 2012 Drinking Water Quality Report. Available: https://www.dcwater.com/news/publications/DC_Water_Annual_WQReport_2012.pdf. [accessed

Francesconi K, Visoottiviseth P, Sridokchan W, Goessler W. 2002. Arsenic species in an arsenic hyperaccumulating fern,< i> Pityrogramma calomelanos</i>: a potential phytoremediator of arsenic-contaminated soils. Science of The Total Environment 284(1):27-35.
Helgesen H, Larsen EH. 1998. Bioavailability and speciation of arsenic in carrots grown in contaminated soil. ANALYST-LONDON-SOCIETY OF PUBLIC ANALYSTS THEN ROYAL SOCIETY OF CHEMISTRY- 123:791-796.

Kelly FJ, Fussell JC. 2011. Air pollution and airway disease. Clinical & Experimental Allergy 41(8):1059-1071.

Larsen EH, Hansen M, Gössler W. 1998. Speciation and health risk considerations of arsenic in the edible mushroom Laccaria amethystina collected from contaminated and uncontaminated locations. Applied Organometallic Chemistry 12(4):285-291.

Massachussetts Department of Environmental Protection. 2006. Inorganic Chemical Maximum Contaminant Levels, Monitoring Requirements and Analytical Methods. Available: http://www.mass.gov/dep/water/laws/perchlorate-310CMR22-07282006.pdf. [accessed

Meharg AA, Rahman MM. 2002. Arsenic Contamination of Bangladesh Paddy Field Soils: Implications for Rice Contribution to Arsenic Consumption. Environmental Science & Technology 37(2):229-234.
Metropolitan Washington Council of Governments Department of Environmental Programs. 2005. Air Quality Trends: Metropolitan Washington, D.C. Region 1993-2004. Available: http://www.mwcog.org/uploads/pub-documents/8VtWXg20050921105555.pdf. [accessed

Meyer, P.D., Valocchi, A.J. & Eheart, J.W., 1994. Monitoring network design to provide initial detection of groundwater contamination. Water Resources Research, 30(9), pp.2647–2659.

Moya J, Bearer CF, Etzel RA. 2004. Children's Behavior and Physiology and How It Affects Exposure to Environmental Contaminants. Pediatrics 113(Supplement 3):996-1006.

National Research Council Board on Environmental Studies and Toxicology. 2013. Review of EPA's IRIS Toxicological Assessments of Inorganic Arsenic. Available: http://dels.nas.edu/Study-In-Progress/Review-IRIS-Toxicological/DELS-BEST-12-01?bname=best [accessed 8 March 2013].

Reed, P., Kollat, J.B. & Devireddy, V.K., 2007. Using interactive archives in evolutionary multiobjective optimization: A case study for long-term groundwater monitoring design. Environmental Modelling & Software, 22(5), pp.683–692.

United States Army Corps of Engineers. 2011. Washington Aqueduct: Annual Report of Water Analysis 2011. Available: http://www.nab.usace.army.mil/Portals/63/docs/Washington_Aqueduct/2011AqueductWaterQuality.pdf. [accessed

United States Census Bureau. 2013. North American Industry Classification System. Available: http://www.census.gov/eos/www/naics/ [accessed 25 March 2013].

U.S. Environmental Protection Agency (EPA) 2002. Guidance on Choosing a Sampling Design for Environmental Data Collection. EPA/240/R-02/005. Available: http://www.epa.gov/quality/qs-docs/g5s-final.pdf

United States Environmental Protection Agency. 2010. IRIS Toxicological Review of Inorganic Arsenic (Cancer) (2010 External Review Draft). EPA/635/R-10/001. Washington, DC. Available: http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=219111. [accessed 24 October 2012].

United States Environmental Protection Agency. 2011a. Exposure Factors Handbook 2011 Edition (Final). EPA/600/R-09/052F. Available: http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252. [accessed 8 March 2013].

United States Environmental Protection Agency. 2011b. Fact Sheet: Final Regulatory Determination for Perchlorate. Available: http://water.epa.gov/drink/contaminants/unregulated/upload/FactSheet_PerchlorateDetermination.pdf. [accessed 1 May 2013].

United States Environmental Protection Agency. 2011c. List of Air Toxics in the 2005 NATA Assessment. Available: http://www.epa.gov/airtoxics/nata2005/05pdf/2005polls.pdf [accessed 25 March 2013].

United States Environmental Protection Agency. 2011d. National-Scale Air Toxics Assessment for 2005 Fact Sheet. Available: http://www.epa.gov/airtoxics/nata2005/05pdf/nata2005_factsheet.pdf. [accessed

United States Environmental Protection Agency. 2011e. An Overview of Methods for EPA's National-Scale Air Toxics Assessment. Available: http://www.epa.gov/ttn/atw/nata2005/05pdf/nata_tmd.pdf. [accessed

United States Environmental Protection Agency. 2012a. Arsenic, inorganic (CASRN 7440-38-2). Available: http://www.epa.gov/iris/subst/0278.htm [accessed 26 March 2013].

United States Environmental Protection Agency. 2012b. Factors to Consider When Using Toxics Release Inventory Data. Available: http://www.epa.gov/tri/triprogram/FactorsToConPDF.pdf. [accessed

United States Environmental Protection Agency. 2013a. About Air Toxics. Available: http://www.epa.gov/ttn/atw/allabout.html [accessed 28 March 2013].

United States Environmental Protection Agency. 2013b. AirData: Air Quality Statistics Report. Available: http://www.epa.gov/airdata/ad_rep_con.html [accessed 25 March 2013].

United States Environmental Protection Agency. 2013c. Classifications of 8-Hour Ozone (2008) Nonattainment Areas. Available: http://www.epa.gov/airquality/greenbook/hnc.html [accessed 25 March 2013].

United States Environmental Protection Agency. 2013d. The Clear Air Act Amendments of 1990 List of Hazardous Air Pollutants. Available: http://www.epa.gov/ttn/atw/orig189.html [accessed 25 March 2013].

United States Environmental Protection Agency. 2013e. Envirofacts API. Available: http://epa.gov/developer/ef_api.html [accessed 25 March 2013].

United States Environmental Protection Agency. 2013f. Envirofacts: About the Data. Available: http://www.epa.gov/enviro/facts/qmr.html [accessed 25 March 2013].

United States Environmental Protection Agency. 2013g. Envirofacts: Multisystem Search. Available: http://www.epa.gov/enviro/facts/multisystem.html [accessed 25 March 2013].

United States Environmental Protection Agency. 2013h. Facilities and Enforcement Activities related to the Clean Water Act National Pollutant Discharge Elimination System (NPDES) Program. Available: http://www.epa.gov/compliance/data/results/performance/cwa/index.html#a [accessed 25 March 2013].

United States Environmental Protection Agency. 2013i. Green Book: Designations. Available: http://www.epa.gov/oaqps001/greenbk/define.html#Designations [accessed 25 March 2013].

United States Environmental Protection Agency. 2013j. National Ambient Air Quality Standards (NAAQS). Available: http://www.epa.gov/air/criteria.html [accessed 25 March 2013].

United States Environmental Protection Agency. 2013k. The National Emissions Inventory. Available: http://www.epa.gov/ttn/chief/net/2008inventory.html [accessed 25 March 2013].

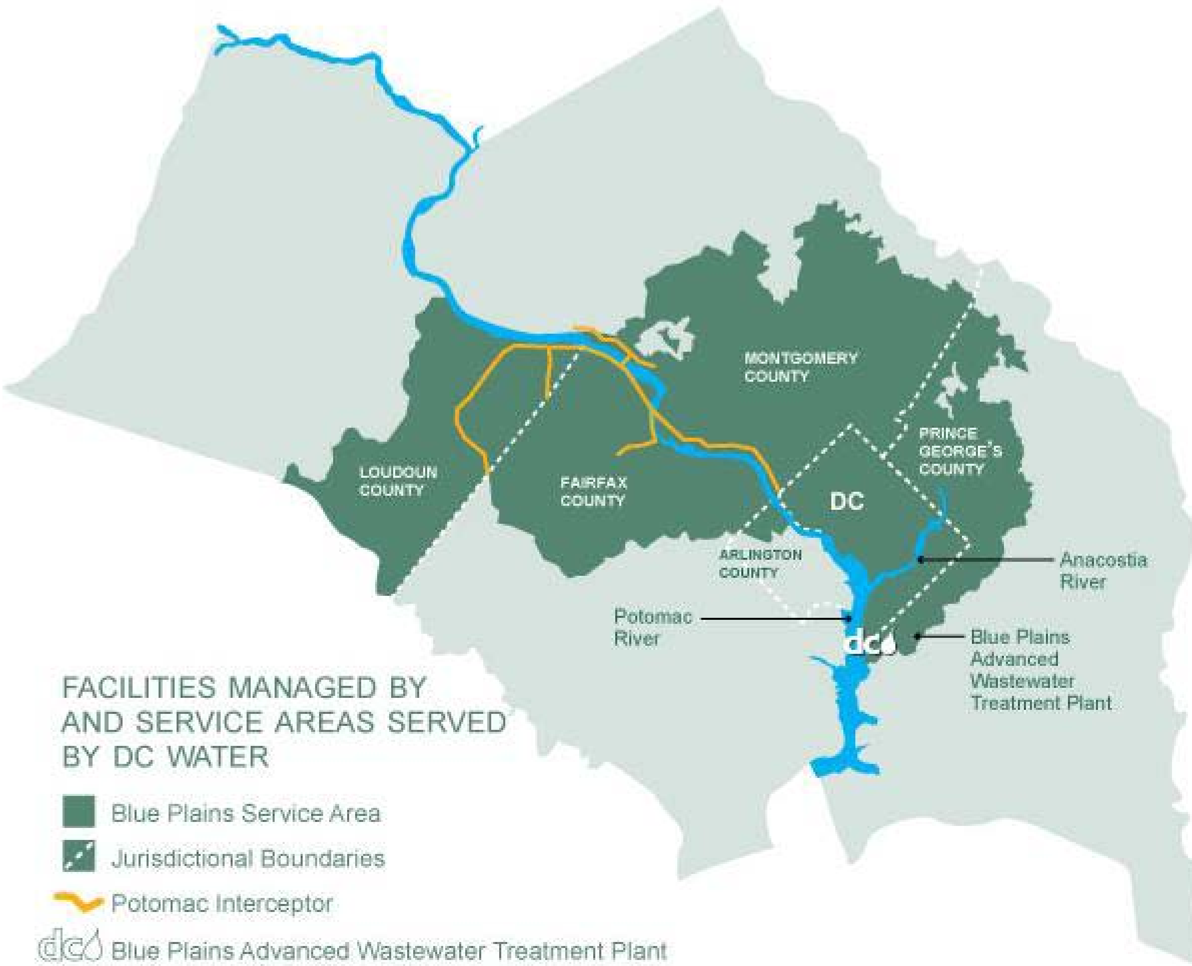
United States Environmental Protection Agency. 2013l. Risk Assessment Guidance for Superfund (RAGS) Part A. Available: http://www.epa.gov/oswer/riskassessment/ragsa/. [accessed 8 March 2013].

United States Environmental Protection Agency. 2013m. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. Available: http://www.epa.gov/oswer/riskassessment/ragse/index.htm. [accessed 8 March 2013].

United States Environmental Protection Agency. 2013n. Technology Transfer Network Air Toxics Web Site: Overview by Section of CAA. Available: http://www.epa.gov/ttnatw01/overview.html [accessed 25 March 2013].

Zhao F, Dunham S, McGrath S. 2002. Arsenic hyperaccumulation by different fern species. New Phytologist 156(1):27-31.

Supplement A – Areas Served by DC Water



Source: DC Water

Supplement B – Chemicals Included in Analysis of Surface Water Sampling Data

4-methylphenol
Acetone
Aluminum
Antimony
Arsenic
Barium
Benzoic acid
Beryllium
Bis(2-ethylhexyl) phthalate
Bromide
Cadmium
Chloride
Cobalt
Copper
Di-n-butyl phthalate
Hexamethylcyclotrisiloxane
Iodate
Lead
Manganese
Nickel
Perchlorate
Silver
Strontium
Tellurium
Titanium
Vanadium
Zinc
Zirconium