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Final

Background Investigation Report Addendum for Groundwater

St. Juliens Creek Annex
Chesapeake, Virginia

NAVFAC
Naval Facilities Engineering Command

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Contract No. N62470-02-D-3052
CTO-0012

August 2004

Prepared by

CH2MHILL

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Final

Background Investigation Report Addendum for Groundwater

St. Juliens Creek Annex
Chesapeake, Virginia

Prepared for Navy CLEAN III Program
Contract No. N62470-02-D-3052
Contract Task Order 012

Prepared by

CH2M HILL

August 2004

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Executive Summary

This addendum to the *Final Background Investigation Report for St Juliens Creek Annex* (CH2M HILL, October 2001) has been prepared by CH2M HILL under the Comprehensive Long Term Environmental Action Navy (CLEAN) III Contract No. N62470-02-D-3052. *The Final Background Report for St Juliens Creek Annex* presented analytical results and statistical analysis of background data for surface and subsurface soil at St. Juliens Creek Annex (SJCA). The report also presented analytical results for four Columbia aquifer background groundwater samples collected at the Base. The objective of this additional background investigation is to establish background concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals in shallow groundwater for use in comparison to Installation Restoration Program (IRP) site data to better identify release-related constituents of concern.

The data set generated by samples collected during the 1999 Background Investigation and samples collected from upgradient well SJS03-MW01S during 1997 site investigation was insufficient to establish statistically defensible background groundwater quality at SJCA. Consequently, six (6) additional shallow background wells were installed at the Base. Sampling locations were identified in non-impacted areas (areas of SJCA where no current or historical industrial activities occurred) that represent underlying hydrogeologic conditions, and areas indicative of anthropogenic background/reference conditions at SJCA. Groundwater samples were collected from 11 (5 existing and 6 new) shallow background wells. With inclusion of historical background sample results (1997 and 1999), the background data set consists of 18 groundwater samples. Samples were analyzed for low concentration TCL (target compound list) VOCs, low concentration TCL SVOCs, low concentration TCL pesticides/PCBs, TAL (target analyte list) total and dissolved metals.

Groundwater samples were generally of high quality in comparison to applicable water quality standards, and are consistent with groundwater quality characteristics of the Columbia Aquifer in southeast Virginia as described in the general literature. Inorganic analytes detected which exceeded the applicable risk base concentrations (RBCs) were arsenic, thallium, iron, and manganese. Arsenic was the only inorganic analyte detected at a concentration that exceeded a corresponding maximum contaminant level (MCL). Napthalene and beta-BHC were the only organic compounds detected at concentrations above the tap water RBC in 2003. There were no exceedances of MCLs for organic compounds, and no PCBs were detected in background groundwater samples.

Central tendency and upper tolerance limits were determined for parameters detected in groundwater. The statistical analysis of background data can be used to better identify and assess site related contamination and to more accurately identify and manage site risks. Upper tolerance limits (UTLs) are established for background groundwater for use in comparison to individual IRP Site results. Population (background) to population (Site) comparisons of central tendency (upper confidence limit (UCL) of the mean) evaluations are also conducted to assess if a site-related release has occurred. For site data collected as part of the Site Screening/Site Investigation Process, constituents potentially reflective of a site release (through comparison to background) are qualitative screened for potential risk through comparison of site data to risk screening criteria (Federal and State), including determination of a cumulative apparent hazard index (CAHI) and cumulative apparent cancer risk (CACR).

Within the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Remedial Investigation (RI) process, use of background data for comparison to site data will be addressed in the uncertainty section of the respective quantitative human health risk assessment. An overall summary of site risks and the management of site risks will be presented in the conclusions of the RI or in the Feasibility Study (FS) for the site. The approach for the use of background data to assess uncertainty in the risk assessment is conservative. Management of site risks requires professional judgement and will be conducted by the Navy in partnership with the United States Environmental Protection Agency (USEPA) and Virginia Department of Environmental Quality (VADEQ) and is based on the overall summary of site risks, site operational history, and current site conditions.

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Acronyms and Abbreviations

BTAG	Biological Technical Assistance Group
CACR	Cumulative Apparent Cancer Risk
CAHI	Cumulative Apparent Hazard Index
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COPC	Constituent of Potential Concern
DO	dissolved oxygen
FS	Feasibility Study
HQ	Hazard Quotient
ID	Interior Diameter
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
msl	mean sea level
ntu	nephalometric turbidity unit
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
pH	Unit of Measurement of Acidity or Alkalinity
PVC	polyvinyl chloride
RA	Risk Assessment
RBC	risk-based concentration
RI	Remedial Investigation
SI	Site Investigation
SJCA	St. Juliens Creek Annex
SOP	Standard Operating Procedure
SSP	Site Screening Process
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
UCL	Upper Confidence Limit
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
VADEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound

SECTION 1

Introduction

This addendum to the *Final Background Investigation Report for St Juliens Creek Annex* (CH2M HILL, 2001) has been prepared by CH2M HILL under the Comprehensive Long Term Environmental Action Navy (CLEAN) III Contract No. N62470-02-D-3052. *The Final Background Report for St Juliens Creek Annex* (CH2M HILL, October 2001) presented analytical results and statistical analysis of background data for surface and subsurface soil at St. Juliens Creek Annex (SJCA). The report also presented analytical results for four Columbia aquifer background groundwater samples collected at the Base.

In order to establish a statistically defensible background data set representative of ambient shallow groundwater quality, additional groundwater samples were collected in accordance with the *Groundwater Background Investigation Work Plan* (CH2M HILL, 2003). The objectives of the additional background investigation were to:

- Provide baseline measurements of background concentrations in non-impacted areas to characterize groundwater quality upgradient of SJCA site activities.
- Establish background data sets appropriate for central tendency comparisons (comparison of the means or median concentrations of site and background)
- Establish the upper range of background concentrations through the determination of upper tolerance limits (UTL) for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and metals (total and dissolved) in shallow groundwater.

This addendum is divided into five sections. Section 1 provides background information. Section 2 describes field activities conducted to accomplish the project's objectives. Section 3 summarizes results of the field effort and laboratory analytical results. Section 4 discusses statistical analysis of background data, and Section 5 summarizes additional background investigation conclusions. More detailed descriptions of the history, physical setting, and regional and site-specific hydrogeology for SJCA are provided in Section 1 of the *Final Background Report St. Juliens Creek Annex*, (CH2M HILL, 2001).

1.1 St. Juliens Creek Annex Facility Description and History

The SJCA facility is situated at the confluence of St. Juliens Creek and the Southern Branch of the Elizabeth River in the city of Chesapeake, located in southeastern Virginia (Figure 1-1). SJCA began operations as a naval ammunitions facility in 1849. For a majority of its history, the SJCA facility has been used for the storage and transportation of ammunitions and ordnance. The current primary function of the SJCA facility is to provide radar testing facilities and various administrative and warehousing facilities for the nearby Norfolk Naval Shipyard and other local Navy activities. SJCA also provides administrative offices, light industrial shops and storage facilities for tenant naval commands.

Processes and operations at the SJCA facility have included general ordnance operations involving wartime transfer of ammunitions to various other U.S. Naval facilities throughout the United States and abroad. In addition, the Annex has been involved in specific ordnance operations and processes including those involving black powder operations, smokeless powder operations, projectile loading operations, mine loading, tracer mixing, testing operations, and decontamination operations.

The SJCA facility has also been involved in non-ordnance operations, including degreasing operations, paint shops, machine shops, vehicle and locomotive maintenance shops, pest control shops, battery shops, print shops, electrical shops, boiler plant operations, wash rack operations, potable and salt water fire protection systems, and fire training operations. Many of these operations have been discontinued, such as locomotive maintenance, printing, and pest control.

Materials stored at the SJCA facility have included oil, ordnance materials, non-ordnance chemicals, and disaster preparedness chemicals. Various parts of the facility are used to store small amounts of waste before transfer to accumulation points.

1.2 Physical Setting

The SJCA facility covers approximately 490 acres and includes 221 buildings, 653 feet of wharf, a central heating plant, numerous non-operational industrial facilities, and miscellaneous structures including a housing area. A Dominion-Virginia Power Company power right-of-way runs diagonally across the facility in a northwest-southeast trending direction, splitting the base roughly in half.

The facility is bordered to the north by the Norfolk and Western Railroad, the City of Portsmouth, and residential areas, to the west by residential areas, to the south by St. Juliens Creek, and to the east by the Southern Branch of the Elizabeth River. Most of the surrounding areas are developed, and include residences, schools, recreational areas, and shipping facilities for several large industries.

1.3 Geology, Hydrogeology, and Surface Features

The SJCA facility is a low-lying wedge of land between the Southern Branch of the Elizabeth River and St. Juliens Creek. Elevations range from sea level along the banks of the two bordering waterways, and along Blows Creek located in the northern part of the facility, to 15 feet above mean sea level (msl) northeast of Blows Creek. A northwest-southeast trending ridge generally bisects the area, dividing the St. Juliens Creek drainage basin to the southwest and the Blows Creek drainage basin to the northeast.

The SJCA facility is located in the outer Atlantic Coastal Plain Physiographic Province. The uppermost geologic unit underlying the area around SJCA is the Columbia Group. The Columbia Group is approximately 60 feet thick in southeastern Virginia. The upper 20 to 40 feet make up the unconfined Columbia aquifer, and consist of unconsolidated fine sands and silts with low to moderate permeability. The lower 20 to 40 feet consist of relatively impermeable silt, clay, and sandy clay referred to as the Yorktown Confining Unit.

Columbia Aquifer soils at SJCA generally consist of fine to medium sand with lenses of clay and silt. The top of the Yorktown confining unit is approximately 15 to 20 ft below ground surface at the annex. The confining unit is about 20 to 30 feet thick. The Yorktown aquifer at the site generally consists of sand that coarsens with depth, trace silt and clay, and shell fragments.

Blows Creek and St. Juliens Creek receive the majority of surface water runoff from the Annex. Both creeks are tidally influenced and flow east to empty into the Southern Branch of the Elizabeth River. The remaining runoff from the Annex flows directly into the Southern Branch of the Elizabeth River, or is diverted into storm drains that empty either into the Southern Branch of the Elizabeth River or St. Juliens Creek. The Southern Branch of the Elizabeth River flows through a highly industrialized area that includes ship repair yards, oil storage, cresol facilities, and fertilizer plants. The river, which is part of the Intracoastal Waterway, is used by many recreational boaters during the summer and by larger commercial and naval craft throughout the year. The Southern Branch of the Elizabeth River flows north to discharge into the James River, which flows into the Chesapeake Bay.

1.4 Previous Background Groundwater Sampling

The purpose of the "Final Background Investigation Report" of October 2001 was to establish background concentrations of metals, pesticides, and polycyclic aromatic hydrocarbons (PAHs) in surface soil, subsurface soil and groundwater for comparison to Installation Restoration Program (IRP) site data to better identify release-related constituents of concern. Soil and groundwater samples were evaluated as part of this investigation. The technical approach to the initial background investigation for groundwater is summarized below. Analytical results for the 1999 groundwater investigation are discussed in Section 3.

In order to establish background groundwater quality, samples were collected from four existing water table aquifer (Columbia Aquifer) monitoring wells and three existing Yorktown Aquifer background wells in May 1999. Groundwater samples were analyzed for the full suite of Target Compound List (TCL) organic and Target Analyte List (TAL) metals (total and dissolved).

Previous groundwater sampling data from monitoring well SJS03-MW01S, collected as part of the Site 3 Remedial Investigation (RI), was also included in the 1999 background investigation. This monitoring well is installed in dredge-fill soils located in the Base's northeastern corner, as a Site 3 site-specific upgradient sample location. Although constructed as a site-specific upgradient well along the northern boundary of the Base, SJS03-MW01S reflects background groundwater quality and is considered comparable to existing background wells SJSBK-MW01S through SJSBK-MW04S.

Because of the small sample size, no background UTLs were established for groundwater at SJCA as part of the 1999 background study. However, 1999 investigation analytical results and the additional groundwater sampling data for SJS03-MW01S (July 1997 and November 1997) are included as part of the data set for statistical analysis of background data presented in this addendum.

1.5 References

CH2M HILL, 2001. *Final Background Investigation Report for St Juliens Creek Annex.* St Juliens Creek Annex to the Norfolk Naval Shipyard, Chesapeake, Virginia. October 2001.

CH2M HILL, 2003. *Final Site Specific Work Plan and Sampling and Analysis Plan Basewide Groundwater Background Investigation Report.* St. Juliens Creek Annex to the Norfolk Naval Base, Chesapeake, Virginia. September 2003.

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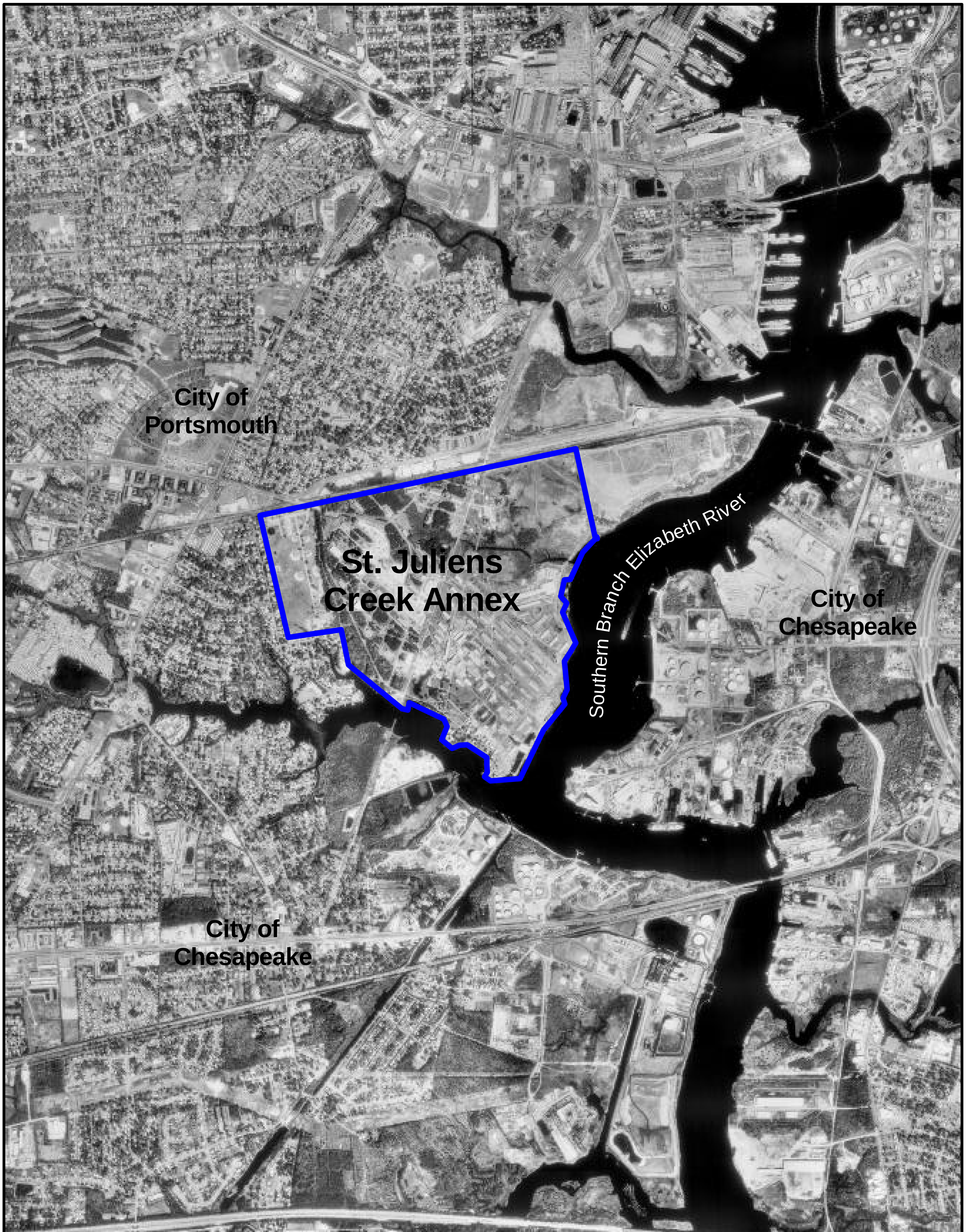

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St. Juliens Creek Annex

N

0 2000 4000 Feet

Figure 1-1
Location of St. Juliens Creek Annex
St. Juliens Creek Annex
Chesapeake, Virginia

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SECTION 2

Site Investigation and Field Activities

This section discusses the technical approach and investigation efforts that were conducted in order to establish background groundwater concentrations at SJCA, and presents the rationale for selection of sample locations.

2.1 Sampling Rationale

In order to distinguish potential site related groundwater contamination from ambient groundwater quality resulting from naturally occurring (those chemicals expected at a site in the absence of human influence) or anthropogenic compounds (chemicals that are present in the environment due to man-made, non-site related sources), a supplemental background groundwater field investigation was conducted at SJCA. Background groundwater monitoring wells were installed in areas that have not been impacted by site related releases.

The specific goal of the groundwater sampling effort at SJCA is to establish background concentrations of naturally occurring and anthropogenic compounds in shallow groundwater (Columbia aquifer) for use in comparison to IRP site data to identify release related constituents of concern. These are the parameters most commonly found to occur naturally or from anthropogenic sources. VOCs and PCBs are not considered naturally occurring or anthropogenic, but were included as part of the full suite of analyses to ensure that the samples reflect non-site impacted conditions.

The deep groundwater (Yorktown aquifer) was not evaluated as part of this investigation since previous investigations at IRP sites have shown no indication of contamination related to the site activities. In addition, a semi-impermeable confining unit has been identified across the base which separates the two aquifers. If future investigations identify contamination in the Yorktown aquifer, the development of background concentrations will be re-evaluated.

2.2 Sampling Locations

To supplement the existing background groundwater data set for shallow groundwater at SJCA, six new background monitoring wells were installed. New (SJSBK-MW05S through SJSBK-MW10S) and existing (SJSBK-MW01S through SJSBK-MW04S and SJS03-MW01S) background wells were sampled and analyzed for low concentration VOCs, low concentration SVOCs, pesticides/PCBs, total metals. The new monitoring well locations were selected based on the following criteria:

- Previous land use
- Distance from and upgradient of known IRP sites
- Soil type (dredged fill vs. native soil)
- Current land use (including other potential sources of contamination)

The locations of existing and newly installed background wells are shown in Figure 2-1.

2.3 Technical Approach and Field Investigation Activities

2.3.1 Field Sampling Activities

Detailed background sampling protocols and procedures are discussed in detail in the *Master Project Plan* (CH2M HILL, July 2003) and the *Groundwater Background Investigation Work Plan* (CH2M HILL, September 2003). Sampling procedures and protocols are summarized below.

2.3.1.1 Monitoring Well Installation and Development

Six (6) shallow background monitoring wells were installed as part of this additional background investigation. Shallow wells were installed using 4.25-inch interior diameter (ID) hollow-stem augers. Continuous four (4) foot macro-core samples were collected from the well borings for lithologic characterization. Soils were logged according to the Unified Soil Classification System (USCS). Descriptions included color, grain size, density, hardness, USCS group symbol, moisture content, and any other observations. Columbia aquifer lithology encountered at the site consisted of fine to coarse silty sand with trace amounts of clay. Borings were advanced to the Yorktown confining unit at three locations to provide further lithologic characterization. The Yorktown confining unit was encountered at a depth of between 18 and 19 feet at each of these locations. Yorktown confining unit lithologic samples consisted of dark greenish gray, fat clay. Lithology was generally consistent with that logged during the installation of existing background wells. Boring logs for existing and new wells are included as Appendix A.

The wells were constructed with 2-inch Schedule 40 polyvinyl chloride (PVC) and 0.010-inch slotted screens with top-of-screen depths ranging from 3 to 5 feet below ground surface. Screens were 10 feet in length. The total depths of the wells ranged from 13 to 15 feet bgs. The annular space surrounding the well was packed with sand to between 1 and 2 feet above the top of the well screen, and sealed with bentonite chips. Flush-mount wells were completed with 8-inch stainless steel covers and a 24" diameter concrete pad. Stick-up wells were completed with 2' tall steel casings, 4'x4' concrete pads and bollards. Monitoring well construction is consistent with that of the previously existing wells. Total depth of existing wells ranges from 14 to 15 feet bgs. A detailed description of installation of existing background wells can be found in Section 2.4.1.2 of the *Background Investigation Report*, St. Juliens Creek Annex, October 2001. Monitoring well construction details for new and existing wells are summarized on Table 2-1. Well construction logs for the new and existing background monitoring wells are provided in Appendix A.

Following installation and prior to collection of groundwater samples, all new and existing wells were developed in accordance with the Standard Operating Procedures (SOPs) provided in the *Master Project Plans* (CH2M HILL, July 2003).

2.3.1.2 Groundwater Sampling

The six newly installed wells, four existing background wells, and the existing Site 3 upgradient well (SJS03-MW01S) were sampled in August 2003. The wells were sampled using the low-flow purge method as detailed in the SOPs in the *Master Project Plans* (CH2M HILL, July 2003). During purging, water quality parameters including pH, conductivity, turbidity, dissolved oxygen (DO), temperature, oxidation/reduction potential, and salinity, were monitored; well purging prior to sampling continued until these parameters stabilized. Results of the field water quality measurements are summarized in Section 3.3.1.

Following purging, groundwater samples were collected directly from disposable plastic tubing into laboratory prepared sample bottles and immediately packed on ice for overnight shipment to the laboratory. Samples were collected for analysis of TCL VOCs (low concentration), TCL SVOCs (low concentration), TCL Pesticides/PCBs (low concentration), TAL total metals, TAL dissolved metals, and cyanide. Analysis of organic and inorganic samples were performed according to Contract Laboratory Program (CLP) methods (CLP OLC02, CLP OLM04, CLP ILM04). Analytical results are discussed in Section 3.

2.3.1.3 Survey of Well Locations and Elevations

Groundwater monitoring wells were surveyed by Baldwin and Gregg, a licensed survey company, on September 11, 2003. Each well was surveyed for both horizontal and vertical control. This included establishing the elevation reference points for wells at the top of the inner PVC casing and a permanent mark designating the elevation point. The ground surface elevation for each well and boring were established to an accuracy of +/-0.01 ft. Horizontal control was established to +/-0.1 ft.

2.3.1.4 Water Level Survey

To characterize groundwater flow at SJCA, water levels were measured in August of 2003 from all new and existing background wells, and in existing IRP wells at Sites 2, 3, 4, 5, 8, and 21. Water levels were measured with an electronic water level indicator. Results of the water level survey are summarized in Section 3.1.3.

2.4 References

CH2M HILL, 2003. *Final Master Project Plans* St. Juliens Creek Annex to the Norfolk Naval Base, Chesapeake, Virginia. July 2003.

CH2M HILL, 2003. *Final Site Specific Work Plan and Sampling and Analysis Plan Basewide Groundwater Background Investigation Report.* St. Juliens Creek Annex to the Norfolk Naval Base, Chesapeake, Virginia. September 2003.

Table 2-1
Summary of Background
Monitoring Well Completion Information
St. Juliens Creek Annex Background Investigation
Chesapeake, Virginia

Well ID	Total Depth Drilled (ft bgs)	Date Installed	Ground Surface Elevation	Top of Casing Elevation	Screen Interval (ft bgs)	Sand pack interval (ft bgs)	Bentonite Seal Interval (ft bgs)
SJSBK-MW01S*	14	04/26/1999	7.2	9.52	3-13	1.5-14	0-1.5
SJSBK-MW02S*	14	04/26/1999	7.06	9.5	3-13	1.5-14	0-1.5
SJSBK-MW03S*	14	04/27/1999	9	11.56	3-13	1.5-14	0-1.5
SJSBK-MW04S*	15	04/26/1999	7.85	10.64	4-14	2-15	0-2
SJSBK-MW05S	14	08/04/2003	13.9	13.79	3-13	2-13	0-2
SJSBK-MW06S	15	08/04/2003	9.4	9.37	5-15	4-15	0-4
SJSBK-MW07S	15	08/05/2003	5.4	8.9	5-15	4-15	0-4
SJSBK-MW08S	22	08/05/2003	6.8	9.35	5-15	4-15	0-4
SJSBK-MW09S	20	08/05/2003	9.7	12.2	4-14	3-14	0-3
SJSBK-MW10S	14	08/06/2003	9.9	12.24	4.5-14.5	2.5-14.5	1-2.5
SJS03-MW01S*	14	07/14/1997	12.01	11.91	3.5-13.5	2-14	1-2

*existing monitoring well
All wells were installed using 2" diameter PVC screen and casing

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- New Monitoring Wells
- Existing Monitoring Wells
- Active IR Sites

N

0 300 600 Feet

Figure 2-1
Background Well Location Map
St. Juliens Creek Annex
Chesapeake, Virginia

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SECTION 3

Field and Analytical Results

This section presents the results from the field investigation activities, including measurements made in the field and laboratory analysis. Sample analytical results include data collected from background wells during the 1999 background investigation and data collected from existing and new wells during the 2003 background investigation. The data set also includes sample results from monitoring well SJS03-MW01S from both background investigations and during the July 1997 and November 1997 Site 3 investigations.

3.1 Results of Field Measurements

3.1.1 Field Water Quality Measurements

Water quality parameters including DO, pH, specific conductance, temperature salinity, oxidation/reduction potential, and turbidity were measured as part of groundwater sampling protocols. Results of field water quality measurements are shown in Table 3-1.

3.1.2 Water Level Survey

Water table elevations were calculated using depth to water measurements and well survey data. Top of casing elevations, depths to water, and water table elevations are shown on Table 3-2. Water table elevations ranged from 11 feet above msl in the northeast corner of the base to nearly sea level along St. Juliens Creek. The gradient across the site is generally very flat, ranging from about 0.001 ft/ft in the central area of the annex to about 0.01 ft/ft in the northeast corner of the Annex.

The groundwater contours indicate that the direction of flow in the northeast corner of the facility (north of Blows Creek) is to the south and east towards the adjacent surface water features of Blows Creek and the Southern Branch of the Elizabeth River. Groundwater in the remainder of the facility (south of Blows Creek) shows a similar trend of flow toward St. Juliens Creek and the Southern Branch of the Elizabeth River. A groundwater contour map is provided as Figure 3-1.

3.2 Volatile Organic Compounds (VOCs)

A summary of VOCs detected in groundwater is provided in Table 3-3. Constituents exceeding screening criteria (tap water risk based concentrations [RBCs] and federal maximum contaminant levels [MCLs]) are highlighted. Complete analytical results for 1997, 1999, and 2003 groundwater samples are provided in Appendix B.

Five VOCs were detected in at least one background sample collected during the 1997 and 1999 investigations. These analytes included acetone, ethylbenzene, toluene, cis 1,2-dichloroethene, and trichloroethene. The chlorinated VOCs cis 1,2-dichloroethene and trichloroethene were detected only in sample MW01S. There were no MCL exceedances and although trichloroethene (0.8 µg/L) exceeded the tap water RBC of 0.026 µg/L, these chlorinated VOCs were not detected in the subsequent 2003 sample. There were no other VOC exceedances of tap water RBCs.

Carbon disulfide, dichlorofluoromethane (Freon-12), ethylbenzene, methyl-tert-butyl ether (MTBE) and total xylenes were detected in at least one groundwater background sample during the 2003 investigation. No detections of VOCs exceeded tap RBCs or MCLs.

3.3 Semivolatile Organic Compounds (SVOCs)

A summary of SVOCs detected in groundwater is provided in Table 3-3. Constituents exceeding screening criteria (tap water RBCs and MCLs) are highlighted. Complete analytical results for 1997, 1999, and 2003 groundwater samples are provided in Appendix B.

Nine SVOCs were detected in groundwater samples from SJS03-MW01S collected during the 1997 and 1999 investigations. There were no detections of SVOCs at other wells sampled during these investigations, and there were no MCL exceedences. SVOCs detected included acenapthene, dibenzofuran, 2-methylnaphthalene, carbazole, fluorene, fluoroanthene, pheneanthrene, bis-2-ethyl hexyl phthalate and naphthalene. Although naphthalene was detected (19 µg/L) in the July 1997 sample in exceedance of the tap water RBC (6.5 µg/L), it was not detected in subsequent 1999 and 2003 sample from this well.

Ten SVOCs were detected in the groundwater sample collected from SJSBK-MW05S during the 2003 background investigation. There were no detections of SVOCs in any other background samples. Analytes detected include 1,1-biphenyl, 2-methylnaphthalene, acenaphthene, anthracene, dibenzofuran, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. The detected concentration of naphthalene was 8.7 µg/L in exceedance of the Tap water RBC of 6.5 µg/L, there is no corresponding MCL value. There were no other exceedances of RBCs and there were no MCL exceedences.

3.4 Pesticides and Polychlorinated Biphenyls (PCBs)

A summary of Pesticides/PCBs detected in groundwater is provided in Table 3-3. Constituents exceeding screening criteria (Tap water RBCs and MCLs) are highlighted. Complete analytical results for 1997, 1999, and 2003 groundwater samples are provided in Appendix B.

There were no detections of Pesticides or PCBs during the 1997 and 1999 investigations. One pesticide was detected in the sample from monitoring well SJSBK-MW05S during the 2003 investigation. Beta-BHC was detected at a concentration of 0.056 µg/L in this sample. This is in exceedance of the tap water RBC of 0.037 µg/L. There is no corresponding MCL for this analyte. PCBs were not detected in any of the background samples.

3.5 Total Metals, Dissolved Metals, and Cyanide

A summary of metals detected in groundwater is provided in Table 3-3. Constituents exceeding screening criteria (Tap water RBCs and MCLs) are highlighted. Complete analytical results for 1997, 1999, and 2003 groundwater samples are provided in Appendix B.

3.5.1 Total Metals and Cyanide

Twenty of the 23 metals analyzed were detected in one or more unfiltered samples collected during the 1997 and 1999 investigations. Thallium, selenium, mercury, and cyanide were not detected in any samples. Concentrations of arsenic, iron, vanadium and manganese exceeded the corresponding tap water RBC in one or more samples. There were no exceedances of MCLs in samples from the 1997 and 1999 investigations.

Sixteen of the 23 metals quantified were detected in one or more unfiltered samples collected during the 2003 background investigation. These analytes included aluminum, arsenic, barium, cadmium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, nickel, potassium, sodium, thallium, and zinc. Following data validation using US Environmental Protection Agency (USEPA) CLP protocols, beryllium and vanadium were reported qualified with a “B” in all detected samples due to blank contamination and treated as non-detects. Cyanide was not detected in any samples. Tap water RBC values for arsenic (0.045 μg/L), iron (11,000 μg/L), manganese (730 μg/L), and thallium (2.6 μg/L) were exceeded in one or more samples.

Concentrations of arsenic exceeded the tap water RBC in samples from wells SJS03-MW01S, SJSBK-MW05S, and SJSBK-MW06S with concentrations of 27.6 μg/L, 4.4 μg/L and 8 μg/L respectively. The MCL for arsenic (10 μg/L) was exceeded in the sample from SJS03-MW01S. This was the only MCL exceedance for total metals and cyanide analyzed during the 2003 investigation. Concentrations of iron exceeded the tap water RBC in five samples, SJS03-MW01S (41,600 μg/L), SJSBK-MW04S (13,200 μg/L), SJSBK-MW05S (107,000 μg/L), SJSBK-MW06S (80,700 μg/L), and SJSBK-MW07S (13,300 μg/L). Concentrations of manganese exceeded the tap water RBC in samples from SJS03-MW01S (2,020 μg/L), SJSBK-MW05S (13,700 μg/L), and SJSBK-MW06S (8,070 μg/L). Concentrations of thallium exceeded the tap water RBC in the samples from SJSBK-MW05S and SJSBK-MW06S with concentrations of 7.6 μg/L and 4.2 μg/L, respectively.

3.5.2 Dissolved Metals

Nineteen of the 23 metals quantified were detected in one or more filtered samples from the 1997 and 1999 investigations. These analytes included aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, nickel, potassium, silver, sodium, vanadium, and zinc. Tap water RBC values for arsenic (0.045 μg/L), iron (11,000 μg/L), and manganese (730 μg/L) were exceeded in one or more samples. There were no dissolved metal exceedances of MCLs based on data from the 1997 and 1999 investigations.

Sixteen of the 23 metals quantified were detected in one or more filtered samples from the 2003 background investigation. These analytes included aluminum, barium, cadmium, calcium, chromium, cobalt, iron, magnesium, manganese, nickel, potassium, silver, sodium, thallium, vanadium, and zinc. Following data validation using USEPA CLP protocols, antimony and beryllium were reported qualified with a “B” in all detected samples due to blank contamination and treated as non-detects. USEPA tap water RBC values for arsenic (0.045μg/L), iron (11,000 μg/L), manganese (730 μg/L), and thallium (2.6 μg/L) were exceeded in one or more samples.

The concentration of arsenic exceeded the tap water RBC in the samples from wells SJS03-MW01S with a concentration of 19.5 μg/L. This was the only MCL exceedance for dissolved metals analyzed during the 2003 investigation. Concentrations of iron exceeded the tap water RBC in five samples, SJS03-MW01S (37,400 μg/L), SJSBK-MW04S (12,700 μg/L), SJSBK-MW05S (94,000 μg/L), SJSBK-MW06S (78,000 μg/L), and SJSBK-MW07S (13,300 μg/L). Concentrations of manganese exceeded the tap water RBC in samples from SJS03-MW01S (1,810 μg/L), SJSBK-MW05S (11,800 μg/L), and SJSBK-MW06S (7,600 μg/L). Concentrations of thallium exceeded the tap water RBC in the samples from SJSBK-MW05S and SJSBK-MW06S with concentrations of 7.1 μg/L and 7.9 μg/L, respectively. The MCL for arsenic (10 μg/L) was exceeded in the sample from SJS03-MW01S.

3.6 References

CDM,1998. *Remedial Investigation and Human Health Risk Assessment Landfill C (Site 3) and Landfill D (Site 4).* St. Juliens Creek Annex, Chesapeake, Virginia. February 1998.

CH2M HILL, 2001. *Final Background Investigation Report*. St. Juliens Creek Annex to the Norfolk Naval Base, Chesapeake, Virginia. October 2001.

Table 3-1
Water Quality Parameter Results
Background Investigation
St Juliens Creek Annex
Chesapeake, Virginia

Station ID	SJS03-MW01S	SJS03-MW01S	SJS03-MW01S	SJSBK-MW01S	SJSBK-MW02S	SJSBK-MW03S	SJSBK-MW04S
Sample ID	SJS03-GW1S-001	SJS03-GW1S-002	SJS03-GW1S-003	SJSBK-GW1S-001	SJSBK-GW2S-001	SJSBK-GW3S-001	SJSBK-GW4S-001
Sample Date	Jul-97	Nov-97	May-99	May-99	May-99	May-99	May-99
Field Parameters							
Dissolved Oxygen (mg/L)	8.1	7.94	NM	NM	NM	NM	NM
Oxidation Reduction Potential (mV)	NM	NM	103	288	267	162	0.071
pH	6.97	5.21	6.12	4.9	5.44	5.75	6.68
Salinity (%)	NM	NM	0.06	0.02	0.10%	NM	0.04
Specific Conductance (ms/cm)	NR	1.36	1.41	0.621	0.333	0.2	0.95
Temperature (C)	21.6	19.4	18.8	15.9	14.5	16.4	16.1
Turbidity (NTU)	1	34	54	15	25	80	36

Station ID	SJS03-MW01S	SJSBK-MW01S	SJSBK-MW02S	SJSBK-MW03S	SJSBK-MW04S	SJSBK-MW5S	SJSBK-MW6S	SJSBK-MW7S	SJSBK-MW8S	SJSBK-MW9S	SJSBK-MW10S
Sample ID	SJS03-MW01S-03C	SJSBK-MW01S-03C	SJSBK-MW02S-03C	SJSBK-MW03S-03C	SJSBK-MW04S-03C	SJSBK-MW05S-03C	SJSBK-MW06S-03C	SJSBK-MW07S-03C	SJSBK-MW08S-03C	SJSBK-MW09S-03C	SJSBK-MW10S-03C
Sample Date	Aug-03	Aug-03	Aug-03	Aug-03	Aug-03	Aug-03	Aug-03	Aug-03	Aug-03	Aug-03	Aug-03
Field Parameters											
Dissolved Oxygen (mg/L)	6.02	0.16	1.23	1.69	0.08	0	0.03	0	0.09	0	4.09
Depth to Water (ft)	1.95	2.95	4.7	5.87	5.53	3.3	1.43	2.95	5.11	4.82	4.93
Oxidation Reduction Potential (mV)	-78	-130	312	254	-154	-35	-94	-130	89	108	320
Flow (GPM)	0.043	0.046	0.056	0.043	0.035	0.054	0.043	0.046	0.038	0.048	0.043
pH	6.24	4.04	4.56	4.47	6.3	6.08	6.16	5.77	5.84	5.4	5.05
Salinity (%)	0.1	0	0	0	0	0.3	0.2	0	0	0	0
Specific Conductance (ms/cm)	1.41	0.209	0.209	0.147	0.67	5.1	4.1	0.564	0.24	0.219	0.113
Temperature (C)	26.1	21.9	21.2	21	19.2	22.7	22.5	20.5	21.2	23.4	21.9
Turbidity (NTU)	NA	90	22	NA	NA	NA	NA	55	38	NA	NA
Volume (gal)	2.5	2	2	2	3	NA	NA	2	2	NA	1.5

Notes:
NA - Not analyzed due to equipment malfunction

Table 3-2
Groundwater Elevations
St. Juliens Creek Annex
Chesapeake, Virginia

		10/02/2003	
Monitoring Well	**Top of PVC Elevation (ft amsl)**	**Depth to Water (ft)**	**Water Elevation (ft amsl)**
Site 2 Landfill B			
SJS02-MW01S	7.72	5.31	2.41
SJS02-MW02S	6.98	6.34	0.64
SJS02-MW03S	7.27	4.82	2.45
SJS02-MW04S	5.53	5.43	0.1
SJS02-MW05S	8.52	5.48	3.04
SJS02-MW01D	7.94	5.6	2.34
SJS02-MW02D	7.04	4.84	2.2
SJS02-MW05D	8.66	6.5	2.16
Site 3 Landfill C			
SJS03-MW01S*	12.55	1.56	10.99
SJS03-MW02S	15.86	4.08	11.78
SJS03-MW03S	14.12	5.46	8.66
SJS03-MW04S	15.73	-----	-----
SJS03-MW05S	12.87	4.18	8.69
SJS03-MW06S	15.88	5.11	10.77
SJS03-MW01D	12.69	9.89	2.8
SJS03-MW02D	15.37	12.38	2.99
Site 4 Landfill D			
SJS04-MW01S	13.66	4.09	9.57
SJS04-MW02S	12.12	4.05	8.07
SJS04-MW03S	7.31	4.28	3.03
SJS04-MW04S	9.24	4.14	5.1
SJS04-MW01D	13.96	11.44	2.52
SJS04-MW03D	6.2	3.68	2.52
Site 5 Burning Grounds			
SJS05-MW01S	9.76	3.63	6.13
SJS05-MW02S	7.89	4.36	3.53
SJS05-MW03S	9.32	-----	-----
SJS05-MW04S	11.09	4.5	6.59
SJS05-MW05S	9.99	4.62	5.37
SJS05-MW01D	9.23	-----	-----
SJS05-MW02D	7.76	5.01	2.75
SJS05-MW04D	10.84	8.07	2.77
Site 8 Cross and Mine			
SJS08-MW01S	5.99	2.14	3.85
SJS08-MW02S	8.77	4.13	4.64
SJS08-MW03S	9.34	4.56	4.78
SJS08-MW04S	9.89	5.58	4.31
Site 21 Soil Staining at Building 187			
SJS21-MW01S	8.53	3.14	5.39
SJS21-MW02S	8.03	4.73	3.3
SJS21-MW03S	7.64	4.74	2.9
SJS21-MW04S	7.34	1.75	5.59
SJS21-MW05S	7.53	1.56	5.97
SJS21-MW06S	7.63	1.98	5.65
SJS21-MW01D	7.37	4.88	2.49
Background			
SJSBK-MW01S	9.52	3.89	5.63
SJSBK-MW02S	9.5	5.21	4.29
SJSBK-MW03S	11.56	5.74	5.82
SJSBK-MW04S	10.64	4.45	6.19
SJSBK-MW05S	13.79	2.48	11.31
SJSBK-MW06S	9.37	1.4	7.97
SJSBK-MW07S	8.9	2.9	6
SJSBK-MW08S	9.35	4.66	4.69
SJSBK-MW09S	12.2	4.91	7.29
SJSBK-MW10S	12.24	5.05	7.19
SJSBK-MW01D	9.72	6.72	3
SJSBK-MW02D	9.22	4.77	4.45
SJSBK-MW03D	11.07	7.01	4.06

----- indicates depth to water not measured.
* background well

Table 3-3
Groundwater Analytical Summary of Detections and Exceedances
July 1997, November 1997, May 1999, and August 2003 Investigations
St. Juliens Creek Annex
Chesapeake, Virginia

Station ID	**RBC-Tap Water**	**MCL-Groundwater**	SJS03-MW01S				SJSBK-MW10S	SJSBK-MW1S		SJSBK-MW2S		SJSBK-MW3S	
Sample ID			SJS03-GW1S-001	SJS03-GW1S-002	SJS03-GW1S-003	SJS03-MW01S-03C	SJSBK-MW10S-03C	SJSBK-GW1S-001	SJSBK-MW01S-03C	SJSBK-GW2S-001	SJSBK-MW02S-03C	SJSBK-GW3S-001	SJSBK-MW03S-03C
Sample Date			07/17/97	11/04/97	05/23/99	08/20/03	08/19/03	05/23/99	08/18/03	05/23/99	08/18/03	05/23/99	08/19/03
Chemical Name													
Volatile Organic Compounds (UG/L)													
Acetone	5,500	--	24	NA	NA	3.6 B	3.3 B	5 U	5 U	5 U	3.9 B	5 U	5 U
Carbon disulfide	1,000	--	1 U	1 U	1.10 B	0.18 J	0.64	1.7 B	0.14 J	1.2 B	0.067 J	1 B	0.048 J
Dichlorodifluoromethane(Freon-12)	350	--	NA	NA	NA	0.5 U	0.5 U	NA	0.5 UJ	NA	0.5 U	NA	0.5 U
Ethylbenzene	1,300	700	0.6 J	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.032 J	1 U	0.5 U
Methyl-tert-butyl ether (MTBE)	2.6	--	NA	NA	NA	0.5 U	0.5 U	NA	0.5 UJ	NA	0.5 U	NA	0.5 U
Toluene	750	1,000	0.2 J	1 U	1 U	0.42 B	0.37 B	1 U	0.35 B	1 U	0.5 B	1 U	0.37 B
Trichloroethene	0.026	5	1 U	1 U	1 U	0.12 B	0.5 U	0.8 J	0.28 B	1 U	0.5 U	1 U	0.5 U
Xylene, total	210	10,000	1	1 U	1 U	0.5 U	0.076 J	1 U	0.5 U	1 U	0.5 U	1 U	0.072 J
cis-1,2-Dichloroethene	61	70	1 U	1 U	1 U	0.5 U	0.5 U	0.2 J	0.5 U	1 U	0.5 U	1 U	0.5 U
Semi-volatile Organic Compounds (UG/L)													
1,1-Biphenyl	300	--	NA	NA	NA	5.1 U	5 U	NA	5.1 UJ	NA	5 UJ	NA	5 U
2-Methylnaphthalene	120	--	1 J	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Acenaphthene	370	--	15	4 J	3 J	1.7 J	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Anthracene	1,800	--	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Carbazole	3.3	--	2 J	10 U	11 U	NA	NA	12 U	NA	11 U	NA	11 U	NA
Dibenzofuran	12	--	8 J	1 J	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Fluoranthene	1,500	--	10 U	1 J	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Fluorene	240	--	9 J	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Naphthalene	6.5	--	19	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Phenanthrene	180	--	5 J	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
Pyrene	180	--	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U
bis(2-Ethylhexyl)phthalate	4.8	6	10 U	10 U	1 J	5.1 U	1 B	12 U	5.1 UJ	11 U	4 B	11 U	5 U
Pesticide/Polychlorinated Biphenyls (UG/L)													
beta-BHC	0.037	--	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U
Total Metals (UG/L)													
Aluminum	37,000	--	4,100 K	1,710	395	33.1 B	163 B	357	345	181 J	116 B	184 J	289
Antimony	15	6	2.2 B	2.3 J	2.70 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.8 U
Arsenic	0.045	10	4.4 J	3.2 U	3.40 J	27.6	2.2 U	2 U	2.2 U	2 U	2.2 U	2 U	2.2 U
Barium	2,600	2,000	176 J	31.1 J	23.1 J	34.7 J	53.5 J	26.1 J	60.1 J	63.5 J	55 J	63.1 J	63.2 J
Beryllium	73	4	1.4 J	0.76 J	0.100 U	0.1 U	0.27 B	0.27 J	0.26 B	0.1 U	0.24 B	0.1 U	0.27 B
Cadmium	18	5	0.5 U	0.4 U	0.420 J	0.5 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U
Calcium	--	--	100,000	92,000	141,000	138,000	13,400	27,900	10,100	21,300	10,700	33,100	10,600
Chromium	110	100	16.1 B	12 B	3.20 J	1.2 J	1.1 U	1.1 U	1.2 J	1.1 U	1.1 U	1.1 U	1.2 J
Cobalt	730	--	8.5 J	8.8 J	2.30 J	2.3 J	6.3 J	13.9 J	7.6 J	8.5 J	7.1 J	5.1 J	1.5 J
Copper	1,500	1,300	7.4 B	6.3 J	5.20 B	3 U	3 U	2.7 B	3 U	3.5 B	3 U	3.5 B	3 U
Iron	11,000	--	31,900	26,200	34,600	41,600	353	18,000	3,780	374	78.1 J	715	417
Lead	15	15	2.4 B	3.5	2.30 J	1.8 U	1.8 U	1 U	1.8 U	1.9 J	1.8 U	1 U	1.8 U
Magnesium	--	--	115,000	34,800	31,600	31,200	868 J	19,600	5,940	5,990	3,960 J	4,860 J	3,170 J
Manganese	730	--	2,000	1,720	1,770	2,020	68.7	912	243	246	159	121	24.1
Nickel	730	--	7 U	14.5 J	4 J	21.2 B	24.3 B	15.1 J	25.9 B	7.9 J	28.7 B	7.6 J	22.8 B
Potassium	--	--	37,300	26,600	27,100	39,800	1,120 B	5,010	3,750 J	1,620 J	2,280 B	1,650 J	1,830 B
Silver	180	--	1.9 J	1.1 U	0.900 U	1.3 UJ	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ
Sodium	--	--	810,000	122,000	132,000	129,000	6,080	52,700	23,200	34,200	27,100	18,600	11,200
Thallium	2.6	2	4.6 B	3.1 B	3.20 U	3.4 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U
Vanadium	11	--	13.7 J	12.2 J	1.5 J	2.7 B	0.6 U	0.79 J	0.6 U	1 J	0.6 U	0.79 J	0.6 U
Zinc	11,000	--	35.3 B	55.2 B	241	10.2 U	13.6 J	89.7	138	44.7	10.2 U	9.5 J	10.2 U
Dissolved Metals (UG/L)													
Aluminum	37,000	--	44 U	64.2 B	67.1 B	29.1 B	83.5 B	399	174 B	38.2 U	89.9 B	38.2 U	263
Antimony	15	6	2 U	3.8 J	2.70 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	3.4 B
Arsenic	0.045	10	3 U	3.2 U	2.40 J	15.4	2.2 U	2 U	2.2 U	2 U	2.2 U	2.1 J	2.2 U
Barium	2,600	2,000	285	26 J	21.4 J	29.6 B	51.4 J	24 J	55.9 J	61.7 J	54.9 J	63.2 J	61.7 J
Beryllium	73	4	1 U	0.58 U	0.100 U	0.1 U	0.32 B	0.31 J	0.25 B	0.1 U	0.23 B	0.1 U	0.31 B
Cadmium	18	5	0.5 U	0.4 U	0.330 J	0.5 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U
Calcium	--	--	148,000	93,500	132,000	116,000	12,900	30,000	9,340	21,400	11,000	34,800	10,500
Chromium	110	100	7 U	5.8 J	1.60 J	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
Cobalt	730	--	8 U	7.7 J	2.10 J	2.8 J	6.3 J	14.4 J	7 J	8 J	7.2 J	4.6 J	2.1 J
Iron	11,000	--	74,800	24,900	31,900	34,200	104	21,100	3,560	65 J	23.4 U	110	262
Lead	15	15	1 U	1.9 B	1 U	1.8 U	1.8 U	2.1 J	1.8 U	1.1 J	1.8 U	1 U	1.8 U

Table 3-3
Groundwater Analytical Summary of Detections and Exceedances
July 1997, November 1997, May 1999, and August 2003 Investigations
St. Juliens Creek Annex
Chesapeake, Virginia

Station ID	RBC-Tap Water	MCL-Groundwater	SJSBK-MW4S		SJSBK-MW5S	SJSBK-MW6S	SJSBK-MW7S	SJSBK-MW8S	SJSBK-MW9S
Sample ID			SJSBK-GW4S-001	SJSBK-MW04S-03C	SJSBK-MW05S-03C	SJSBK-MW06S-03C	SJSBK-MW07S-03C	SJSBK-MW08S-03C	SJSBK-MW09S-03C
Sample Date			05/23/99	08/19/03	08/19/03	08/19/03	08/18/03	08/18/03	08/19/03
Chemical Name									
Volatile Organic Compounds (UG/L)									
Acetone	5,500	--	30.5	3.2 B	4.5 B	7.5 B	3.7 B	2.6 B	4.2 B
Carbon disulfide	1,000	--	2.1 B	0.11 J	0.16 J	0.12 J	0.069 J	0.17 J	0.22 J
Dichlorodifluoromethane(Freon-12)	350	--	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.032 J	0.5 U
Ethylbenzene	1,300	700	1 U	0.5 U	0.14 J	0.5 U	0.5 U	0.037 J	0.5 U
Methyl-tert-butyl ether (MTBE)	2.6	--	NA	0.5 UJ	0.5 U	0.5 U	0.17 J	0.5 U	0.5 U
Toluene	750	1,000	1 U	0.39 B	0.37 B	0.32 B	0.5 B	0.5 B	0.51 B
Trichloroethene	0.026	5	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylene, total	210	10,000	1 U	0.069 J	0.13 J	0.058 J	0.084 J	0.15 J	0.084 J
cis-1,2-Dichloroethene	61	70	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Semi-volatile Organic Compounds (UG/L)									
1,1-Biphenyl	300	--	NA	5 U	1.4 J	5 U	5.4 U	5 UJ	5 U
2-Methylnaphthalene	120	--	11 U	5 U	2.5 J	5 U	5.4 U	5 U	5 U
Acenaphthene	370	--	11 U	5 U	13	5 U	5.4 U	5 U	5 U
Anthracene	1,800	--	11 U	5 U	1.7 J	5 U	5.4 U	5 U	5 U
Carbazole	3.3	--	11 U	NA	NA	NA	NA	NA	NA
Dibenzofuran	12	--	11 U	5 UJ	7.2 J	5 U	5.4 U	5 U	5 U
Fluoranthene	1,500	--	11 U	5 U	1 J	5 U	5.4 U	5 U	5 U
Fluorene	240	--	11 U	5 UJ	7.6 J	5 U	5.4 U	5 U	5 U
Naphthalene	6.5	--	11 U	5 U	8.7	5 U	5.4 U	5 U	5 U
Phenanthrene	180	--	11 U	5 U	8.6	5 U	5.4 U	5 U	5 U
Pyrene	180	--	11 U	5 U	0.72 J	5 U	5.4 U	5 U	5 U
bis(2-Ethylhexyl)phthalate	4.8	6	11 U	9.3 B	3.7 B	5 U	5.4 B	5 UJ	5 U
Pesticide/Polychlorinated Biphenyls (UG/L)									
beta-BHC	0.037	--	NA	0.05 U	0.056 J	0.054 U	0.056 U	0.05 U	0.05 U
Total Metals (UG/L)									
Aluminum	37,000	--	207	26.7 U	1,230	109 B	51.9 B	148 J	89.5 B
Antimony	15	6	2.7 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U
Arsenic	0.045	10	2 J	2.2 U	4.4 J	8 J	2.2 U	2.2 U	2.2 U
Barium	2,600	2,000	58.6 J	13.6 B	38.6 J	58.6 J	45.2 J	39.1 J	77.1 J
Beryllium	73	4	0.1 U	0.1 U	2.7 B	0.1 U	0.1 U	0.1 U	0.25 B
Cadmium	18	5	0.3 U	0.5 U	0.74 J	0.5 U	0.5 U	0.5 U	0.5 U
Calcium	--	--	142,000	125,000	531,000	359,000	83,300	41,600	28,700
Chromium	110	100	1.1 U	1.1 U	3.2 J	1.8 J	1.1 U	1.4 J	1.3 J
Cobalt	730	--	0.84 J	0.7 U	81.6	0.7 U	0.7 U	11.8 J	2.9 J
Copper	1,500	1,300	4.2 B	3 U	3 U	3 U	3 U	3 U	3 U
Iron	11,000	--	8,620	13,200	107,000	80,700	13,300	1,070	2,490
Lead	15	15	1.1 J	1.8 U	2.8 J	1.8 U	1.8 U	1.8 U	1.8 U
Magnesium	--	--	14,900	8,520	296,000	212,000	15,100	4,720 J	6,260
Manganese	730	--	384	315	13,700	8,070	381	210	101
Nickel	730	--	2.7 J	19.1 B	116	19.4 B	21 B	30.9 B	23.4 B
Potassium	--	--	3,830 J	4,800 J	85,400	60,800	4,250 J	1,710 B	5,020
Silver	180	--	0.9 U	1.3 UJ	1.3 UJ	1.3 UJ	1.3 UJ	1.3 UJ	1.3 UJ
Sodium	--	--	53,900	27,500	646,000	487,000	28,200	8,930	11,600
Thallium	2.6	2	3.2 U	3.4 U	7.6 J	4.2 J	3.4 U	3.4 U	3.4 U
Vanadium	11	--	0.91 J	1 B	0.6 U	0.6 U	0.6 U	0.96 B	0.63 B
Zinc	11,000	--	43.7	10.2 U	642	10.2 U	10.2 U	10.2 U	14.6 J
Dissolved Metals (UG/L)									
Aluminum	37,000	--	69.9 J	26.7 U	245 B	46.6 B	55.4 B	26.7 U	81.1 B
Antimony	15	6	2.7 U	2.8 U	2.8 U	27 B	5.2 B	2.8 U	3.8 B
Arsenic	0.045	10	2.2 J	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U
Barium	2,600	2,000	53.2 J	13.7 B	34.1 J	56.4 J	48 J	36.5 J	77.3 J
Beryllium	73	4	0.1 U	0.1 U	1.4 B	0.21 B	0.13 B	0.1 U	0.25 B
Cadmium	18	5	0.3 U	0.5 U	0.78 J	0.57 J	0.5 U	0.5 U	0.5 U
Calcium	--	--	141,000	123,000	464,000	346,000	83,900	41,300	29,100
Chromium	110	100	1.1 U	1.1 U	1.1 U	1.6 J	1.3 J	1.1 U	1.1 U
Cobalt	730	--	0.5 U	0.7 U	71.5	0.7 U	0.7 U	11.2 J	3.5 J
Iron	11,000	--	8,780	12,700	94,000	78,000	13,300	824	2,500
Lead	15	15	1 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U

Table 3-3
Groundwater Analytical Summary of Detections and Exceedances
July 1997, November 1997, May 1999, and August 2003 Investigations
St. Juliens Creek Annex
Chesapeake, Virginia

Station ID	**RBC-Tap Water**	**MCL-Groundwater**	SJS03-MW01S				SJSBK-MW10S	SJSBK-MW1S		SJSBK-MW2S		SJSBK-MW3S	
Sample ID			SJS03-GW1S-001	SJS03-GW1S-002	SJS03-GW1S-003	SJS03-MW01S-03C	SJSBK-MW10S-03C	SJSBK-GW1S-001	SJSBK-MW01S-03C	SJSBK-GW2S-001	SJSBK-MW02S-03C	SJSBK-GW3S-001	SJSBK-MW03S-03C
Sample Date			07/17/97	11/04/97	05/23/99	08/20/03	08/19/03	05/23/99	08/18/03	05/23/99	08/18/03	05/23/99	08/19/03
Chemical Name													
Magnesium	--	--	194,000	35,400	32,900	25,500	788 J	22,400	5,780	5,780	4,050 J	4,890 J	3,090 J
Manganese	730	--	3,070	1,750	1,790	1,650	63.2	1,040	233	234	160	120	22.8
Nickel	730	--	7 U	8.3 B	3.10 J	10.8 B	16.4 B	14.3 J	13.1 B	6.9 J	17.4 B	7.2 J	10.9 B
Potassium	--	--	38,900	27,000	28,400	30,600	877 B	5,620	3,030 J	1,600 J	1,830 B	1,610 J	1,560 B
Silver	180	--	2.4 J	1.5 B	0.900 U	1.3 UJ	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ
Sodium	--	--	1,530,000	125,000	141,000	96,100	5,620	57,700	20,500	33,500	25,400	18,400	10,600
Thallium	2.6	2	2.7 B	2.5 B	3.20 U	3.4 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U
Vanadium	11	--	9 U	7.1 J	1.20 J	2.1 J	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
Zinc	11,000	--	22.4 B	49.7 B	10.5 J	10.2 U	10.2 U	109	105	45.4	10.2 U	9.1 J	10.2 U

Notes:
Exceeds one or more criteria
NA - Not Analyzed
B - not detected above associated blank
J - analyte present, estimated value
K - analyte present, analyte may be biased high
U - not analyzed

Table 3-3
Groundwater Analytical Summary of Detections and Exceedances
July 1997, November 1997, May 1999, and August 2003 Investigations
St. Juliens Creek Annex
Chesapeake, Virginia

Station ID	RBC-Tap Water	MCL-Groundwater	SJSBK-MW4S		SJSBK-MW5S	SJSBK-MW6S	SJSBK-MW7S	SJSBK-MW8S	SJSBK-MW9S
Sample ID			SJSBK-GW4S-001	SJSBK-MW04S-03C	SJSBK-MW05S-03C	SJSBK-MW06S-03C	SJSBK-MW07S-03C	SJSBK-MW08S-03C	SJSBK-MW09S-03C
Sample Date			05/23/99	08/19/03	08/19/03	08/19/03	08/18/03	08/18/03	08/19/03
Chemical Name									
Magnesium	--	--	13,700	8,290	256,000	203,000	15,500	4,570 J	6,250
Manganese	730	--	377	297	11,800	7,600	390	198	99.4
Nickel	730	--	2.2 J	7.6 B	92.3	11.5 B	9.2 B	14.4 B	16 B
Potassium	--	--	3,910 J	4,400 J	73,300	59,200	4,150 J	1,500 B	4,740 J
Silver	180	--	0.9 U	1.3 UJ	1.3 UJ	4.6 B	1.7 J	1.3 UJ	1.3 UJ
Sodium	--	--	49,100	26,500	582,000	462,000	28,200 J	8,560	11,400
Thallium	2.6	2	3.2 U	3.4 U	7.1 J	7.9 J	3.4 U	3.4 U	3.4 U
Vanadium	11	--	0.6 U	0.6 U	0.6 U	0.64 J	0.6 U	0.6 U	0.6 U
Zinc	11,000	--	25.8	10.2 U	532	10.2 U	10.2 U	10.2 U	10.2 U

Notes:
Exceeds one or more criteria
NA - Not Analyzed
B - not detected above associated blank
J - analyte present, estimated value
K - analyte present, analyte may be biased high
U - not analyzed

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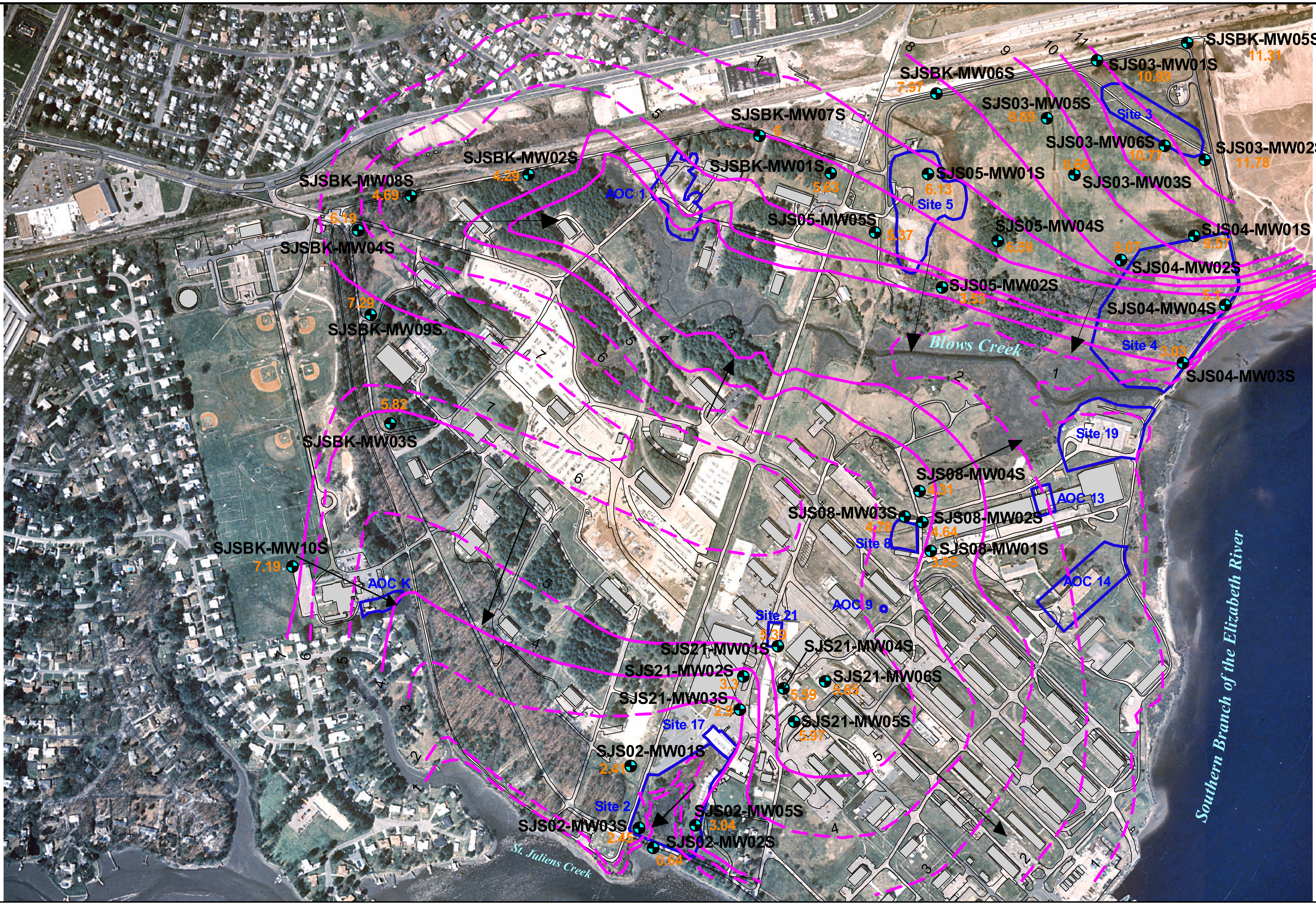

LEGEND

- Monitoring Well Locations
- Site Boundaries
- Inferred Groundwater Contour
- Groundwater Contour
- 7.19 Groundwater Elevation - ft amsl
- Estimated Groundwater Flow Direction

Figure 3-1
Basewide Potentiometric Surface of the Columbia Aquifer and Groundwater Flow Map (October 2, 2003)
St. Juliens Creek Annex
Chesapeake, Virginia

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SECTION 4

Statistical Analysis of Background Data

This section presents the results of statistical analysis of background sample results and addresses how the background data will be used in evaluation of IRP site data.

4.1 Groundwater Sample Set

Groundwater samples were collected in 2003 from 11 background wells screened in the Columbia Aquifer. With inclusion of historical background sample results (1997 and 1999), the background data set consists of 18 samples from the 11 background monitoring well sample locations. Due to the variation in constituents analyzed during each investigation, the size of the sample set for some analytes differs. The sample size for each constituent is indicated in the "frequency of detection" column in Table 4-1. Sixty-three (63) parameters were detected in one or more groundwater samples. Upper tolerance limits were established for parameters with one or more detects. The number of parameters detected for each analytical class is summarized as follows:

Analytical Class	Number of Different Analytes Detected
Dissolved Metals	20
Total Metals and cyanide	21
Pesticides/PCBs	1
SVOCs	12
VOCs	9

The background data available for the evaluations described in this section are presented graphically as scatter plots in Appendices C and D for inorganics and organics, respectively. In these plots, closed circles represent detected concentrations. Open circles represent a proxy of ½ the detection limit for non-detects. The frequency of detection for each parameter is also provided at the top of each plot.

4.2 Consideration of Outliers

Some results, due to their elevated nature, may seem inappropriate for a background data set since they may appear to represent a concentration from another parent population. Six concentrations of different dissolved metal analytes and six concentrations of different total metal analytes were determined to be sufficiently elevated, relative to the other concentrations of the same analytes. Consequently, these results were removed from the background data set. Statistical analyses were performed on the remaining concentrations of each analyte in order to ensure an appropriate background data set for central tendency comparisons and to determine a representative UTL. These data results are presented in Table 4-2. Each of these results is included in the plots shown in Appendices C and D, marked with an "X" symbol. This alternative parent population is not believed to be associated with a site-related release as these results are from sample locations (MW01S and MW05S) upgradient of the Base as shown on Figure 3-1.

4.3 Statistical Distributions

Making an appropriate distributional assumption for the data is an important prerequisite for statistical analyses. A distributional assumption is the best estimate of the distribution of the parent (or target) population. The key determination of the data distribution was based on the results of the Shapiro-Wilk test (see Gilbert 1987 or USEPA 2000 for methodology and examples). Typically at least 10 samples should be available for testing normality. The data set used for this analysis consisted of 18 samples.

A significance level of 0.05 was used for these tests. If the p-value for the Shapiro-Wilk test was greater than or equal to 0.05, the distributional assumption was chosen to be normal. If the number of samples was too small for the test or if the p-value was below 0.05, then the data was treated nonparametrically. Normality p values are shown in Table 4-1. Distributional assumptions for detected constituents are shown in the "Assumed Distribution for UTL," column of Table 4-1. These distributional assumptions were used for the calculation of UTLs detailed in Section 4.4.

4.4 Calculation Background Upper Tolerance Limits

Along with establishing the background data set, calculation of background UTLs from this data set is an important aspect of this study. A 95 confidence/95 coverage background UTL is an upper bound (with 95 percent confidence) of the background 95th percentile. The calculation of the UTLs depends on the distributional assumption. When appropriate, the normal UTL was calculated using the following equation:

$$UTL = \bar{x} + (K \times s),$$

where $\bar{x}$ is the sample mean;
K is the tolerance factor; and
s is the sample standard deviation.

For data sets that did not appear normally distributed, nonparametric UTLs were calculated. A nonparametric UTL is computed by first ranking the concentrations and then choosing the lowest ranked detected concentration that provides a coverage of 95 percent with 95 percent confidence. For data sets with less than 59 concentrations, 95 percent coverage is not possible with 95 percent confidence, even when the maximum concentration is assigned as the UTL. This was the case for the data in this study, so the estimated percentile (95th or lower) associated with the maximum concentration (assuming the magnitude of the maximum concentration appears defensible) was reported. This percentile is calculated using the following equation:

$$p = B_{0.95,n,1}$$

where B is a beta distribution defined by n (the number of sample results) and 1 (since the highest ranked concentration is being used). Calculated percentiles are shown in the

"Percentile Estimated" column of Table 4-1. These UTLs are included in the plots shown in Appendices C and D and in Table 4-1.

4.5 Use of Background Data

The statistical analysis of background data will be used to better identify and assess site-related contamination and for use in the risk management process. Within the CERCLA process, sites are initially addressed in the Site Screening Process (SSP) or Site Investigation (SI) process to determine if a site release has occurred and to qualitatively evaluate site risks. Where a site release is indicated or known to have occurred and the risk present at the site warrants further investigation, sites are addressed in the Remedial Investigation process and risks are quantitatively evaluated. The approach for using background data focuses on application within these CERCLA processes and is discussed below.

4.5.1 Site Screening or Site Investigation Process

Evaluation of site data in the SSP/SI is two-fold, and consists of determining if a site release has occurred and to assess if site media pose a potential human health or environmental risk through a qualitative risk screening process.

4.5.1.1 Comparison to Background

For site data collected as part of the Site Screening/Site Investigation Process, background data can be used to determine if a site release has occurred. Two primary methods of comparing site data to background are available. The first primary method of comparing investigative-site results to background involves a two-sample comparative test of central tendency, sometimes called a mean or median (in the nonparametric case) comparison. A central tendency comparison can determine with statistical confidence, whether the background and site populations, on average, differ from one another. This test is the primary comparison recommended in recent USEPA and Navy guidance (USEPA, 2002; Navy, 2002).

Two-sample comparisons of central tendency include the t-test (performed on either the untransformed or log-transformed data) and the nonparametric Wilcoxon Rank Sum test (performed on the ranks of the data). The appropriate type of central tendency comparison test would be determined based on the assumed statistical distribution of the parent distributions of the two data sets. Such a comparison is performed as a one-tailed test (because it is only of concern if site concentrations exceed ambient concentrations) with the null hypothesis that the site concentrations are equal to or less than the ambient concentrations.

The second comparison is accessing individual site results to determine whether they appear to be part of a similar parent population as the background data. This approach compares the individual site results to the background UTLs. There are two reasons a site may exceed a background UTL. First the elevated site result might merely be an extreme value from a population similar to the background data. Second, the elevated site result may reflect potential contamination due to site-related activities. These individual exceedances are often considered 'hot spots', particularly when the associated comparison of central tendency concludes that there is not an average difference between the two populations.

Consideration is then given to the location of the exceeding concentration(s). These specific locations are identified in order to assess whether exceedance locations cluster in an area or are interspersed throughout the portion of the site being evaluated. Spatial interpretation of background UTL exceedences requires judgmental decisions but is an indication of whether elevated levels suggest a random process as opposed to a specific release. Professional judgement will incorporate site history and operations, current site conditions, and conceptual site models for exposure pathways and receptors. Although the primary determination of whether a constituent exceeds background is based upon the comparison of central tendency, UTL exceedances may also play a part in determining whether background is exceeded. The magnitude of the exceedances and the nature of the constituent will both play into this professional decision.

4.5.1.2 Qualitative Risk Screening

To assess if constituents exceeding background pose a potential risk, a qualitative risk screening can be conducted. Qualitative risk screening evaluation through comparison of site data to risk screening criteria (Federal and State) will identify constituents of potential concern (COPCs). Additionally, the upper confidence limit (UCL) of the mean of the site data can also be compared to a risk based value to assess potential site risks.

For human health, this qualitative risk evaluation will include a comparison using the most current USEPA Region III RBCs to site detected concentrations. The non-carcinogenic RBCs reflected in the Region III table are based on hazard quotients (HQ) of 1, which does not account for exposure of multiple constituents on a common target organ. Therefore, RBCs based on non-carcinogenic effects are adjusted to account for a HQ of 0.1 by dividing the reported RBCs by ten. Groundwater data will be qualitatively screened using the MCL, and the tap water RBC (at a HQ of 0.1).

For each COPC exceeding background, an apparent hazard index (AHI) or apparent cancer risk (ACR) is calculated by dividing the site constituent concentration by the RBC (not adjusted to an HQ of 0.1 for non-cancer effects, as done for the initial screening, but based on the value in the RBC table for both cancer and non-cancer endpoints). Following this calculation, the individual AHIs for non-cancer risks are summed and designated the "Cumulative AHI," or "CAHI" and the individual ACRs are summed and designated the "Cumulative ACR," or "CACR." The CACR is then multiplied by 10^{-6}. If the CAHI for non-cancer risk is less than the hazard index of 0.5 and the CACR for cancer risk is less than the acceptable 10^{-5} risk, no constituents of concern are identified. If the calculated CAHI or CACR exceed the applicable screening criteria, those constituents that are included in the CAHI or CACR calculation are considered COPCs.

Ecological evaluations as part of the Site Screening Process begins with a site conceptual model to assess potential receptors and pathways for contaminant migration for site media. If the site conceptual model suggests the potential for ecological risk, available site data are qualitatively compared to Biological Technical Assistance Group (BTAG) screening values. Based on this qualitative review, the Navy in partnership with the USEPA and Virginia Department of Environmental Quality (VADEQ) will use professional judgement for risk management in the Site Screening Process. If site-specific surface water/sediment reference (upstream/upgradient) data are available, similar qualitative comparisons can be made and site conceptual models revised as appropriate within the Site Screening Process.

Following comparison of site data to background and risk screening of constituents exceeding background, risk management decisions can then be made by the Navy in partnership with the USEPA and VADEQ, which includes assessing site conditions for determination of no further action, limited “hot spot” remedial measures, or whether a remedial investigation is warranted for the site.

4.5.2 Remedial Investigations

Within the CERCLA RI Process, use of background data for comparison to site data will be addressed in the uncertainty section of the respective human health and ecological risk assessments. Until further Navy guidance is released regarding the use of background data in RI quantitative risk assessments, this data will only be used at the end of the quantitative risk assessment as part of the uncertainty section of the risk assessments.

For data collected as part of a RI, a quantitative risk assessment is conducted in accordance with Navy and USEPA guidance. For parameters that are identified risk drivers, background data is used for risk management at the conclusion of the quantitative risk assessment process. In this approach, parameters that may not be related to a site release are carried through the risk assessment process. Once site risks have been quantified, uncertainties in the risk assessment process are addressed. Background quality of environmental media is one of several factors that can contribute to the uncertainty of the risk assessment.

As discussed in the previous section, the background data will be evaluated with two potential comparisons in mind. These include a comparison of central tendency and an individuals comparison. The central tendency comparison (e.g., two sample t-test or Wilcoxon rank sum test) determines with statistical confidence whether the typical (mean or median) site concentration exceeds the typical background concentration. This comparison uses the pooled site and background concentrations rather than focusing primarily on the most elevated concentrations, as the individual comparison does. The most current USEPA and Navy guidances focus on the central tendency comparison as the statistical comparison of choice for background (USEPA 2002; Navy 2002); however, comparison of site concentrations to a background UTL still has applications in environmental testing (e.g., identification of potential hot spots, etc.).

For the individuals case, individual site concentrations are to be compared to a background level (UTL) that is calculated from appropriate background concentrations. The background UTL is a 95 percent upper confidence bound of the 95th percentile of the background data; thus, it is relatively rare for a concentration, sampled from a population equivalent to the background population, to exceed the background UTL.

When the central tendency comparison does not indicate an exceedance and no concentrations exceed the UTL (or any exceedances seem minor based on the constituent and magnitude of the exceedance), then it can be concluded that a site release has not occurred and risk management is warranted. A risk management summary will be addressed either as part of the conclusion of the RI or in the Feasibility Study (FS) for the site.

4.6 References

Gilbert, Richard O., 1987. *Statistical Methods for Environmental Pollution Monitoring*. New York: Van Nostrand Reinhold Company, New York, 1987.

United States Environmental Protection Agency (USEPA). *Guidance for Data Quality Assessment. Practical Methods for Data Analysis*. Office of Research and Development, Washington, D.C. 2000.

United States Environmental Protection Agency (USEPA). Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites, Office of Emergency and Remedial Response, 2002.

Table 4-1
Groundwater Background Summary Statistics
St. Juliens Creek Annex
Chesapeake, Virginia

Parameter	Units	Background UTL	Assumed Distribution for UTL	Percentile Estimated	Mean	Median	Std Dev	Frequency of Detects	Minimum	Minimum Flag	Maximum	Maximum Flag	Normality p-value
Dissolved Metals													
Aluminum	ug/L	399	Nonparametric	85	71.5	32.8	101	3/18	69.9	J	399		0.000
Antimony	ug/L	3.8	Nonparametric	85	2.28	1.4	2.87	1/18	3.8	J	3.8	J	0.000
Arsenic	ug/L	2.4	Nonparametric	84	1.34	1.1	0.457	3/17	2.1	J	2.4	J	0.000
Barium	ug/L	93.3	Normal	95	44	51.4	19.8	15/17	21.4	J	77.3	J	0.386
Beryllium	ug/L	0.31	Nonparametric	85	0.167	0.11	0.179	1/18	0.31	J	0.31	J	0.000
Cadmium	ug/L	0.78	Nonparametric	85	0.277	0.25	0.157	3/18	0.33	J	0.78	J	0.000
Calcium	ug/L	464000	Nonparametric	85	103000	62600	122000	18/18	9340		464000		0.000
Chromium	ug/L	5.8	Nonparametric	85	1.16	0.55	1.38	4/18	1.3	J	5.8	J	0.000
Cobalt	ug/L	15	Normal	95	4.84	4	4.07	12/17	2.1	J	14.4	J	0.126
Iron	ug/L	94000	Nonparametric	85	22300	10700	30000	17/18	65	J	94000		0.000
Lead	ug/L	2.1	Nonparametric	85	0.892	0.9	0.353	2/18	1.1	J	2.1	J	0.000
Magnesium	ug/L	256000	Nonparametric	85	46800	11000	80100	18/18	788	J	256000		0.000
Manganese	ug/L	11800	Nonparametric	85	1720	337	3110	18/18	22.8		11800		0.000
Nickel	ug/L	13.2	Normal	95	6.18	5.75	2.83	5/17	2.2	J	14.3	J	0.077
Potassium	ug/L	73300	Nonparametric	85	16100	4280	22100	14/18	1600	J	73300		0.000
Silver	ug/L	2.4	Nonparametric	85	0.847	0.65	0.613	2/18	1.7	J	2.4	J	0.000
Sodium	ug/L	582000	Nonparametric	84	100000	28200	165000	17/17	5620		582000		0.000
Thallium	ug/L	7.9	Nonparametric	85	2.27	1.7	1.91	2/18	7.1	J	7.9	J	0.000
Vanadium	ug/L	7.1	Nonparametric	85	1.08	0.3	1.83	4/18	0.64	J	7.1	J	0.000
Zinc	ug/L	109	Nonparametric	84	22.8	5.1	33.5	6/17	9.1	J	109		0.000
Pesticide/PCBs													
beta-BHC	ug/L	0.056	Nonparametric	81	0.0276	0.025	0.00821	1/14	0.056	J	0.056	J	0.000
Semivolatiles													
1,1-Biphenyl	ug/L	1.4	Nonparametric	76	2.43	2.5	0.346	1/11	1.4	J	1.4	J	0.000
2-Methylnaphthalene	ug/L	2.5	Nonparametric	85	3.43	2.53	1.56	2/18	1	J	2.5	J	0.000
Acenaphthene	ug/L	15	Nonparametric	85	4.55	2.63	3.7	5/18	1.7	J	15		0.000
Anthracene	ug/L	1.7	Nonparametric	85	3.61	2.55	1.52	1/18	1.7	J	1.7	J	0.000
Carbazole	ug/L	2	Nonparametric	65	5	5.5	1.35	1/7	2	J	2	J	0.001
Dibenzofuran	ug/L	8	Nonparametric	85	3.86	2.55	2.02	3/18	1	J	8	J	0.003
Fluoranthene	ug/L	1	Nonparametric	85	3.35	2.53	1.65	2/18	1	J	1	J	0.002
Fluorene	ug/L	9	Nonparametric	85	4.16	2.63	2.07	2/18	7.6	J	9	J	0.001
Naphthalene	ug/L	19	Nonparametric	85	4.78	2.63	4	2/18	8.7		19		0.000
Phenanthrene	ug/L	8.6	Nonparametric	85	3.99	2.63	1.84	2/18	5	J	8.6		0.001
Pyrene	ug/L	0.72	Nonparametric	85	3.56	2.55	1.61	1/18	0.72	J	0.72	J	0.002
bis(2-Ethylhexyl)phthalate	ug/L	1	Nonparametric	85	3.35	2.55	1.72	1/18	1	J	1	J	0.033
Total Metals													
Aluminum	ug/L	1710	Nonparametric	84	314	181	460	10/17	148	J	1710		0.000
Antimony	ug/L	2.3	Nonparametric	85	1.42	1.4	0.231	1/18	2.3	J	2.3	J	0.000
Arsenic	ug/L	8	Nonparametric	84	2.09	1.1	1.92	5/17	2	J	8	J	0.000
Barium	ug/L	77.1	Nonparametric	84	46.9	53.5	18.4	16/17	23.1	J	77.1	J	0.494
Beryllium	ug/L	1.4	Nonparametric	85	0.271	0.085	0.435	3/18	0.27	J	1.4	J	0.000
Cadmium	ug/L	0.74	Nonparametric	85	0.262	0.25	0.135	2/18	0.42	J	0.74	J	0.000
Calcium	ug/L	531000	Nonparametric	85	106000	62500	136000	18/18	10100		531000		0.000
Chromium	ug/L	3.2	Nonparametric	85	1.83	1.2	2.09	8/18	1.2	J	3.2	J	0.000
Cobalt	ug/L	15.8	Normal	95	5.21	5.1	4.26	14/17	0.84	J	13.9	J	0.114
Copper	ug/L	6.3	Nonparametric	85	2	1.5	1.21	1/18	6.3	J	6.3	J	0.000
Iron	ug/L	107000	Nonparametric	85	21400	10900	29900	18/18	78.1	J	107000		0.000
Lead	ug/L	3.5	Nonparametric	85	1.27	0.9	0.817	5/18	1.1	J	3.5		0.000
Magnesium	ug/L	296000	Nonparametric	85	45200	11700	81600	18/18	868	J	296000		0.000
Manganese	ug/L	13700	Nonparametric	85	1800	348	3510	18/18	24.1		13700		0.000
Nickel	ug/L	20.1	Normal	95	10.2	10.6	3.99	6/17	2.7	J	15.1	J	0.195

Table 4-1
Groundwater Background Summary Statistics
St. Juliens Creek Annex
Chesapeake, Virginia

Parameter	Units	Background UTL	Assumed Distribution for UTL	Percentile Estimated	Mean	Median	Std Dev	Frequency of Detects	Minimum	Minimum Flag	Maximum	Maximum Flag	Normality p-value
Potassium	ug/L	85400	Nonparametric	85	17200	4530	24500	14/18	1620	J	85400		0.000
Silver	ug/L	1.9	Nonparametric	85	0.658	0.65	0.323	1/18	1.9	J	1.9	J	0.000
Sodium	ug/L	810000	Nonparametric	85	146000	31200	241000	18/18	6080		810000		0.000
Thallium	ug/L	7.6	Nonparametric	85	2.16	1.7	1.49	2/18	4.2	J	7.6	J	0.000
Vanadium	ug/L	13.7	Nonparametric	85	1.98	0.49	4.02	7/18	0.79	J	13.7	J	0.000
Zinc	ug/L	241	Nonparametric	84	39.8	13.6	63.2	8/17	9.5	J	241		0.000
Volatiles													
Acetone	ug/L	30.5	Nonparametric	83	5.33	2.38	8.66	2/16	24		30.5		0.000
Carbon disulfide	ug/L	0.64	Nonparametric	85	0.36	0.2	0.298	11/18	0.048	J	0.64		0.017
Dichlorodifluoromethane(Freon-12)	ug/L	0.032	Nonparametric	76	0.23	0.25	0.0657	1/11	0.032	J	0.032	J	0.000
Ethylbenzene	ug/L	0.6	Nonparametric	85	0.323	0.25	0.173	4/18	0.032	J	0.6	J	0.013
Methyl-tert-butyl ether (MTBE)	ug/L	0.17	Nonparametric	76	0.243	0.25	0.0241	1/11	0.17	J	0.17	J	0.000
Toluene	ug/L	0.2	Nonparametric	85	0.306	0.25	0.144	1/18	0.2	J	0.2	J	0.000
Trichloroethene	ug/L	0.8	Nonparametric	85	0.347	0.25	0.181	1/18	0.8	J	0.8	J	0.006
Xylene, total	ug/L	1	Nonparametric	85	0.304	0.25	0.254	9/18	0.058	J	1		0.003
cis-1,2-Dichloroethene	ug/L	0.2	Nonparametric	85	0.331	0.25	0.124	1/18	0.2	J	0.2	J	0.000

Table 4-2
Elevated Concentrations Removed
from the Background Data Set

Parameter	Concentration, ug/L	Qualifer	Sample ID	Date Collected
Dissolved Metals				
Arsenic	15.4		SJS03-MW01S-03C	20-Aug-03
Barium	285		SJS03-GW1S-001	17-Jul-97
Cobalt	71.5		SJSBK-MW05S-03C	19-Aug-03
Nickel	92.3		SJSBK-MW05S-03C	19-Aug-03
Sodium	1530000		SJS03-GW1S-001	17-Jul-97
Zinc	532		SJSBK-MW05S-03C	19-Aug-03
Total Metals				
Aluminum	4100	K	SJS03-GW1S-001	17-Jul-97
Arsenic	27.6		SJS03-MW01S-03C	20-Aug-03
Barium	176	J	SJS03-GW1S-001	17-Jul-97
Cobalt	81.6		SJSBK-MW05S-03C	19-Aug-03
Nickel	116		SJSBK-MW05S-03C	19-Aug-03
Zinc	642		SJSBK-MW05S-03C	19-Aug-03

SECTION 5

Summary

Background groundwater quality was evaluated for use in comparison with CERCLA Site data to identify potential release-related constituents of concern at SJCA. Background groundwater quality is described by summary statistics (central tendency/mean and UTLs) and scatter plots. A summary of background groundwater quality is provided on Table 5-1.

Groundwater samples were generally of high quality in comparison to applicable water quality standards, and are consistent with groundwater quality characteristics of the Columbia Aquifer in southeast Virginia as described in the general literature. Inorganic analytes detected which exceeded the applicable RBCs were arsenic, thallium, iron, and manganese. Arsenic was the only inorganic analyte detected at a concentration that exceeded a corresponding MCL. Napthalene and beta-BHC were the only organic compounds detected at concentrations above the tap water RBC in 2003. There were no exceedances of MCLs for organic compounds, and no PCBs were detected in background groundwater samples.

Background data can be used to better identify and assess site related contamination and to more accurately identify and manage site risks. Upper tolerance limits are established for background groundwater for use in comparison to individual IRP Site results. Population (background) to population (Site) comparisons of central tendency (UCL of the mean) evaluations are also conducted to assess if a site-related release has occurred. For site data collected as part of the Site Screening/Site Investigation Process, constituents potentially reflective of a site release (through comparison to background) are qualitative screened for potential risk through comparison of site data to risk screening criteria (Federal and State), including determination of a CAHI and CACR.

Within the CERCLA RI process, use of background data for comparison to site data will be addressed in the uncertainty section of the respective quantitative human health and ecological risk assessments. An overall summary of site risks and the management of site risks will be presented in the conclusions of the RI or in the FS for the site. The approach for the use of background data to assess uncertainty in the risk assessment is conservative. Management of site risks requires professional judgement and will be conducted by the Navy in partnership with the USEPA and VADEQ and is based on the overall summary of site risks, site operational history, and current site conditions.

Table 5-1
Statistics Summary Table
Groundwater Background Investigation
St. Juliens Creek Annex
Chesapeake, Virginia

Parameter	Units	Frequency of Detection	Mean Concentration	95% Upper Tolerance Limit
Dissolved Metals				
Aluminum	ug/L	3/18	71.5	399
Antimony	ug/L	1/18	2.28	3.8
Arsenic	ug/L	3/17	1.34	2.4
Barium	ug/L	15/17	44	93.3
Beryllium	ug/L	1/18	0.167	0.31
Cadmium	ug/L	3/18	0.277	0.78
Calcium	ug/L	18/18	103000	464000
Chromium	ug/L	4/18	1.16	5.8
Cobalt	ug/L	12/17	4.84	15
Iron	ug/L	17/18	22300	94000
Lead	ug/L	2/18	0.892	2.1
Magnesium	ug/L	18/18	46800	256000
Manganese	ug/L	18/18	1720	11800
Nickel	ug/L	5/17	6.18	13.2
Potassium	ug/L	14/18	16100	73300
Silver	ug/L	2/18	0.847	2.4
Sodium	ug/L	17/17	100000	582000
Thallium	ug/L	2/18	2.27	7.9
Vanadium	ug/L	4/18	1.08	7.1
Zinc	ug/L	6/17	22.8	109
Pesticide/PCBs				
beta-BHC	ug/L	1/14	0.0276	0.056
Semivolatiles				
1,1-Biphenyl	ug/L	1/11	2.43	1.4
2-Methylnaphthalene	ug/L	2/18	3.43	2.5
Acenaphthene	ug/L	5/18	4.55	15
Anthracene	ug/L	1/18	3.61	1.7
Carbazole	ug/L	1/7	5	2
Dibenzofuran	ug/L	3/18	3.86	8
Fluoranthene	ug/L	2/18	3.35	1
Fluorene	ug/L	2/18	4.16	9
Naphthalene	ug/L	2/18	4.78	19
Phenanthrene	ug/L	2/18	3.99	8.6
Pyrene	ug/L	1/18	3.56	0.72
bis(2-Ethylhexyl)phthalate	ug/L	1/18	3.35	1
Total Metals				
Aluminum	ug/L	10/17	314	1710
Antimony	ug/L	1/18	1.42	2.3
Arsenic	ug/L	5/17	2.09	8
Barium	ug/L	16/17	46.9	77.1
Beryllium	ug/L	3/18	0.271	1.4
Cadmium	ug/L	2/18	0.262	0.74
Calcium	ug/L	18/18	106000	531000
Chromium	ug/L	8/18	1.83	3.2
Cobalt	ug/L	14/17	5.21	15.8
Copper	ug/L	1/18	2	6.3
Iron	ug/L	18/18	21400	107000
Lead	ug/L	5/18	1.27	3.5
Magnesium	ug/L	18/18	45200	296000
Manganese	ug/L	18/18	1800	13700

Table 5-1
Statistics Summary Table
Groundwater Background Investigation
St. Juliens Creek Annex
Chesapeake, Virginia

Parameter	Units	Frequency of Detection	Mean Concentration	95% Upper Tolerance Limit
Nickel	ug/L	6/17	10.2	20.1
Potassium	ug/L	14/18	17200	85400
Silver	ug/L	1/18	0.658	1.9
Sodium	ug/L	18/18	146000	810000
Thallium	ug/L	2/18	2.16	7.6
Vanadium	ug/L	7/18	1.98	13.7
Zinc	ug/L	8/17	39.8	241
Volatiles				
Acetone	ug/L	2/16	5.33	30.5
Carbon disulfide	ug/L	11/18	0.36	0.64
Dichlorodifluoromethane(Freon-12)	ug/L	1/11	0.23	0.032
Ethylbenzene	ug/L	4/18	0.323	0.6
Methyl-tert-butyl ether (MTBE)	ug/L	1/11	0.243	0.17
Toluene	ug/L	1/18	0.306	0.2
Trichloroethene	ug/L	1/18	0.347	0.8
Xylene, total	ug/L	9/18	0.304	1
cis-1,2-Dichloroethene	ug/L	1/18	0.331	0.2

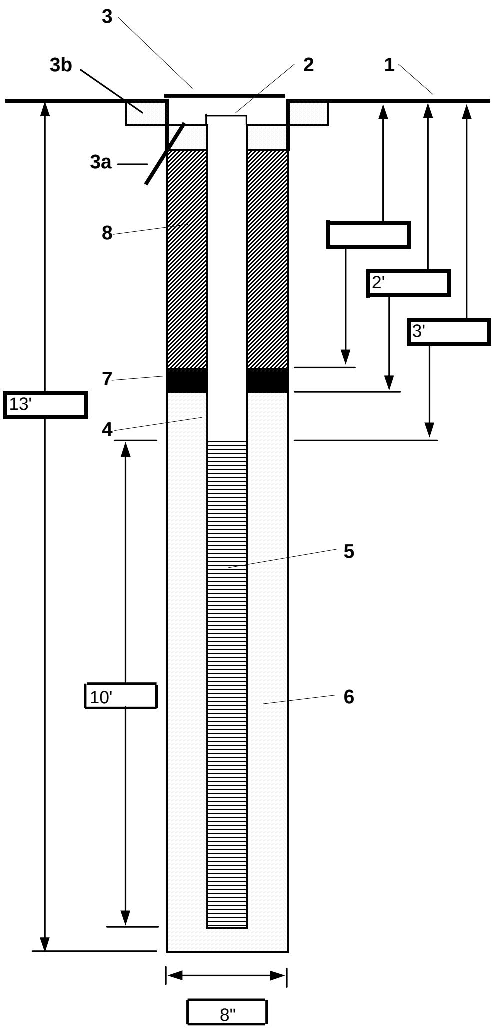
Appendix A

Boring Logs and Well Construction Diagrams

PROJECT NUMBER	WELL NUMBER
180247.FI.FI	SJSBK-MW05S SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex
DRILLING CONTRACTOR : Parratt-Wolff
DRILLING METHOD AND EQUIPMENT USED : Truck Mounted Rotary Drill Rig
WATER LEVELS : START : 08/04/2003 END : 08/04/2003 LOGGER : E. Matthews



1- Ground elevation at well: 13.9' amsl

2- Top of casing elevation: 13.79' amsl

3- Wellhead protection cover type: 8" circular cover
a) drain tube? No
b) concrete pad dimensions: 2' diam

4- Dia./type of well casing: 2" PVC

5- Type/slot size of screen: 10 Slot PVC

6- Type screen filter: DSI #1 sand
a) Quantity used: 5 bags

7- Type of seal: Shur-Plug Bentonite Chips
a) Quantity used: 1/2 bag

8- Grout
a) Grout mix used
b) Method of placement
c) Vol. of well casing grout

Development method: whale pump

Development time: 110 min

Estimated purge volume

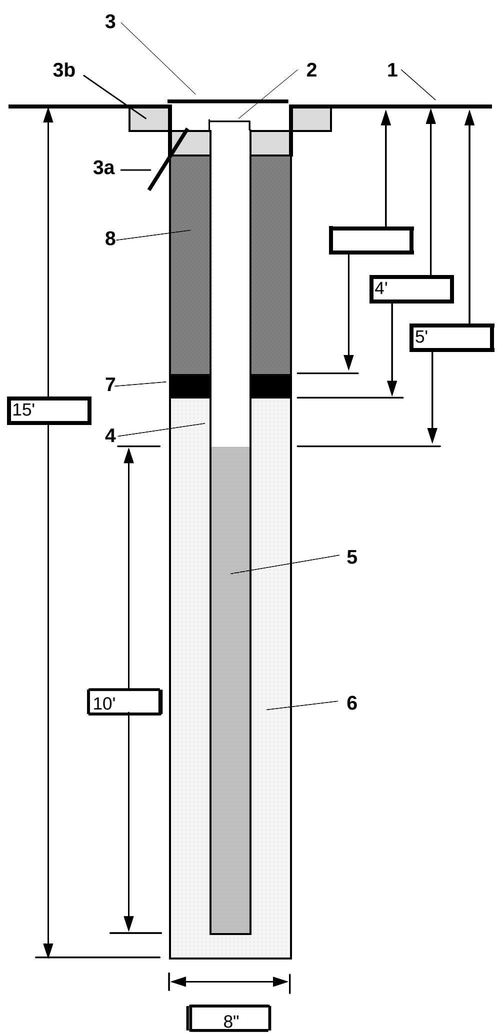
Comments

PROJECT NUMBER	WELL NUMBER		
180247.FI.FI	SJSBK-MW06S	SHEET 1	OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex
DRILLING CONTRACTOR : Parratt-Wolff
DRILLING METHOD AND EQUIPMENT USED : Truck Mounted Rotary Drill Rig
WATER LEVELS : START : 08/04/2003 END : 08/04/2003 LOGGER : E. Matthews



1- Ground elevation at well: 9.4' amsl

2- Top of casing elevation: 9.37' amsl

3- Wellhead protection cover type: 8" circular cover
- a) drain tube?: No
- b) concrete pad dimensions: 2' diam

4- Dia./type of well casing: 2" PVC

5- Type/slot size of screen: 10 Slot PVC

6- Type screen filter: DSI #1 sand
- a) Quantity used: 5.5 bags

7- Type of seal: Shur-Plug Bentonite Chips
- a) Quantity used: 3/4 bag

8- Grout
- a) Grout mix used:
- b) Method of placement:
- c) Vol. of well casing grout:

Development method: whale pump

Development time: 140 min

Estimated purge volume:

Comments:

PROJECT NUMBER	WELL NUMBER
180247.FI.FI	SJSBK-MW07S SHEET 1 OF 1

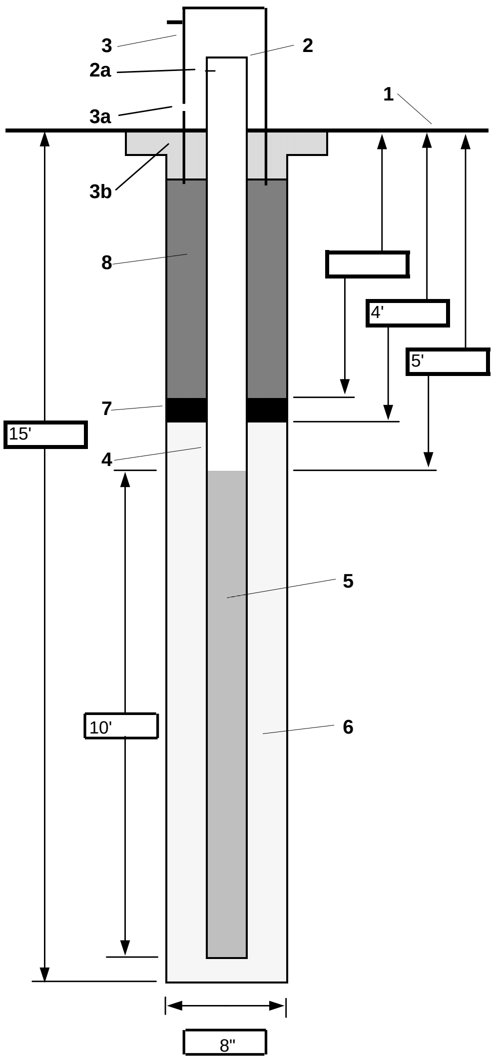
WELL COMPLETION DIAGRAM

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted Rotary Drill Rig

WATER LEVELS : START : 08/05/2003 END : 08/05/2003 LOGGER : E. Matthews



1- Ground elevation at well: 5.4' amsl

2- Top of casing elevation: 8.9' amsl
a) vent hole? No

3- Wellhead protection cover type: 2' steel stick-up
a) weep hole? No
b) concrete pad dimensions: 2' diam

4- Dia./type of well casing: 2" PVC

5- Type/slot size of screen: 10 Slot PVC

6- Type screen filter: DSI #1 Sand
a) Quantity used: 5.5 bags

7- Type of seal: Shur-Plug Bentonite Chips
a) Quantity used: 3/4 bag

8- Grout
a) Grout mix used
b) Method of placement
c) Vol. of well casing grout

Development method: whale pump

Development time: 65 min

Estimated purge volume

Comments

PROJECT NUMBER	WELL NUMBER
180247.FI.FI	SJSBK-MW08S SHEET 1 OF 1

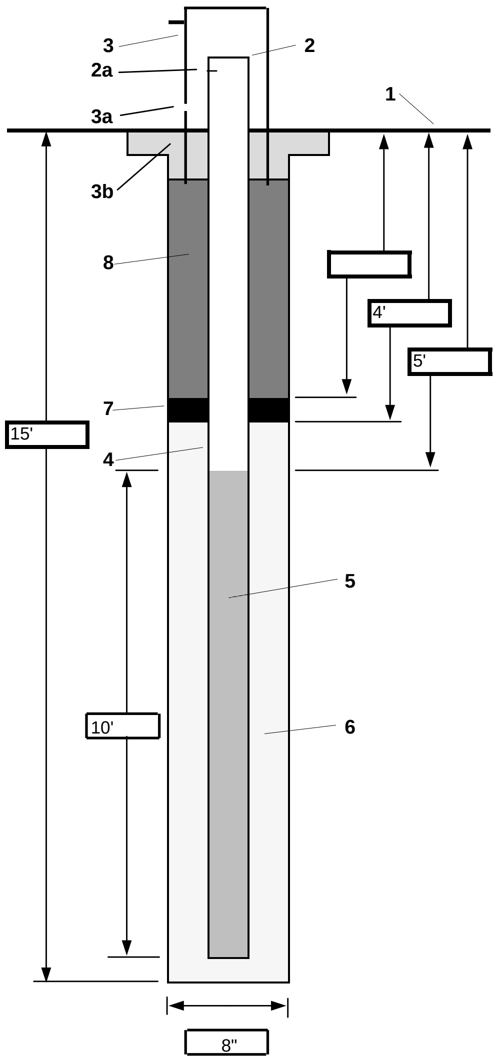
WELL COMPLETION DIAGRAM

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted Rotary Drill Rig

WATER LEVELS : START : 08/05/2003 END : 08/05/2003 LOGGER : E. Matthews



1- Ground elevation at well	6.8' amsl
2- Top of casing elevation	9.35' amsl
a) vent hole?	No
3- Wellhead protection cover type	2' steel stick-up
a) weep hole?	No
b) concrete pad dimensions	2' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	10 Slot PVC
6- Type screen filter	DSI #1 Sand
a) Quantity used	5.5 bags
7- Type of seal	Shur-Plug Bentonite Chips
a) Quantity used	3/4 bag
8- Grout	
a) Grout mix used	
b) Method of placement	
c) Vol. of well casing grout	
Development method	whale pump
Development time	50 min
Estimated purge volume	
Comments	

PROJECT NUMBER	WELL NUMBER
180247.FI.FI	SJSBK-MW09S SHEET 1 OF 1

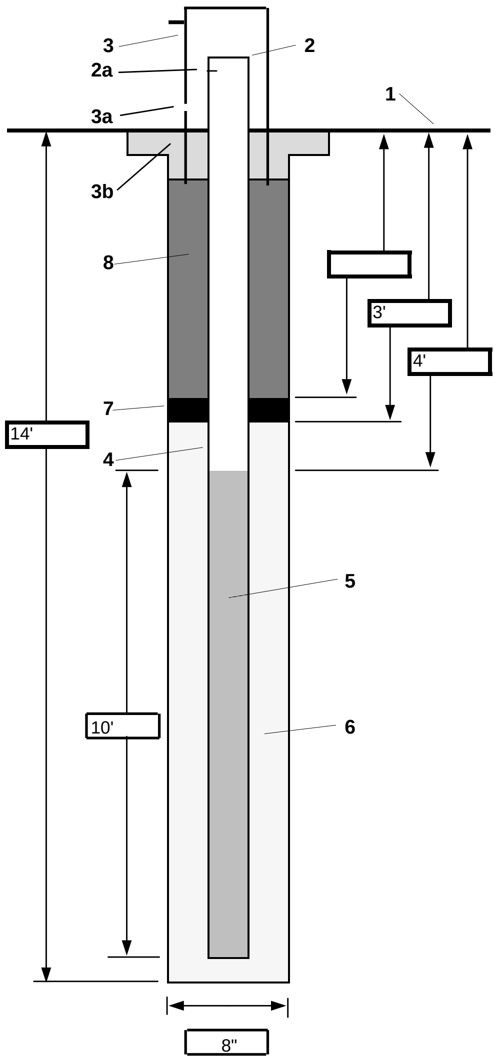
WELL COMPLETION DIAGRAM

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted Rotary Drill Rig

WATER LEVELS : START : 08/05/2003 END : 08/05/2003 LOGGER : E. Matthews



1- Ground elevation at well	9.7' amsl
2- Top of casing elevation	12.2' amsl
a) vent hole?	No
3- Wellhead protection cover type	2' steel stick-up
a) weep hole?	No
b) concrete pad dimensions	2' diam
4- Dia./type of well casing	2" PVC
5- Type/slot size of screen	10 Slot PVC
6- Type screen filter	DSI #1 Sand
a) Quantity used	5 bags
7- Type of seal	Shur-Plug Bentonite Chips
a) Quantity used	1/2 bag
8- Grout	
a) Grout mix used	
b) Method of placement	
c) Vol. of well casing grout	
Development method	whale pump
Development time	67 min
Estimated purge volume	
Comments	

PROJECT NUMBER	WELL NUMBER
180247.FI.FI	SJSBK-MW10S SHEET 1 OF 1

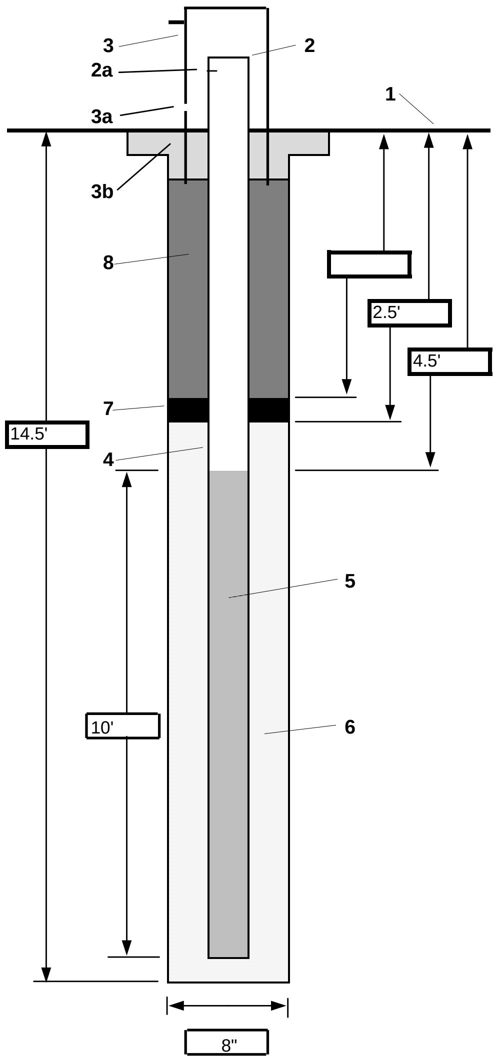
WELL COMPLETION DIAGRAM

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted Rotary Drill Rig

WATER LEVELS : START : 08/06/2003 END : 08/06/2003 LOGGER : B. Francisco



1- Ground elevation at well: 9.9' amsl

2- Top of casing elevation: 12.24' amsl
 a) vent hole?: No

3- Wellhead protection cover type: 2' steel stick-up
 a) weep hole?: No
 b) concrete pad dimensions: 2' diam

4- Dia./type of well casing: 2" PVC

5- Type/slot size of screen: 10 Slot PVC

6- Type screen filter: DSI #1 Sand
 a) Quantity used: 4 bags

7- Type of seal: Shur-Plug Bentonite Chips
 a) Quantity used: 1/2 bag

8- Grout
 a) Grout mix used
 b) Method of placement
 c) Vol. of well casing grout

Development method: whale pump

Development time: 50 minutes

Estimated purge volume: 45 gallons

Comments

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
180247.FI.FI	SJSBK-MW05S	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

ELEVATION : DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted HSA Drill Rig

WATER LEVELS : START : 08/04/2003 END : 08/04/2003 LOGGER : E. Matthews

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	0-2'	7"	1	NA	0-2' fine SAND with little fines (SP); brown (10YR 5/3); medium dense.	PID 0 ppm
	2-6'	3.5'	2		2-3' Same as above, moist. 3-4' fine to medium grained SAND with some fines (SW); grayish brown (10YR 5/2) loose; saturated. 4-5.5' fine SAND with some fines (SP); dark greenish gray (10Y 3/1); saturated; medium dense. 5.5-6' Silty CLAY with some fine sand; dark greenish gray (5G 3/1); saturated; medium dense.	PID 0 ppm Water table encountered at 3.5' bgs.
5	6-10'	3'	3		6-10' Same as above.	PID 0 ppm Noticable petroleum odor at 9-10' bgs.
10	10-14'	4'	4		10-12' Silt with some fine sand; dark greenish gray (5GY 4/1); saturated; medium dense. 12-13' clayey SILT; dark greenish gray (5GY 4/1); saturated; dense. 13-14' silty CLAY with little fine sand; dark greenish gray (5GY 4/1); saturated; very dense.	PID 0 ppm PID 0.2 ppm in breathing zone. Organic material (roots) observed.
15					Boring terminated at 14' bgs. Monitoring well installed at this location.	
20						
25						

PROJECT NUMBER	BORING NUMBER	
180247.FI.FI	SJSBK-MW06S	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

ELEVATION : DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted HSA Drill Rig

WATER LEVELS : START : 08/04/2003 END : 08/04/2003 LOGGER : E. Matthews

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	0-2'	1.5'	1	NA	6"-2' fine SAND with little fines (SP); light olive brown (2.5Y 3/1); moist; loose.	PID 0 ppm 6" of topsoil observed at surface.
	2-6'	4'	2		2-3' fine SAND with some fines (SP); very dark grayish brown (2.5Y 3/2); moist; medium dense. 3-6' silty CLAY with trace fine sand; very dark gray (2.5Y 3/1); moist; dense.	PID 0 ppm
5						
	6-10'	3'	3		6-10' fine SAND with little fines (SP); light olive brown (2.5Y 5/3); saturated; medium dense.	PID 0 ppm Water table at 6' bgs.
10	10-14'	2.5'	4		10-12' fine SAND with trace fines (SP); light olive brown (2.5Y 5/6); wet; medium dense. 12-13' silty CLAY with some fine sand; light olive brown (2.5Y 5/6); wet; dense. 13-14' fine SAND (SP); very dark grayish brown (2.5Y 3/2); saturated; loose.	PID 0 ppm
15					Boring terminated at 14' bgs. Monitoring well installed at this location.	
20						
25						

PROJECT NUMBER	BORING NUMBER	
180247.FI.FI	SJSBK-MW07S	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

ELEVATION : DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted HSA Drill Rig

WATER LEVELS : START : 08/05/2003 END : 08/05/2003 LOGGER : E. Matthews

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	0-2'	2'	1	NA	0-1' fine sand with little fines (SP); dark grayish brown (2.5Y 4/2); moist; loose. 1-2' fine SAND and silty CLAY; light olive brown (2.5Y 5/3); moist; medium dense.	PID 0 ppm
	2-6'	4'	2		2-4' fine SAND and silty CLAY; dark grayish brown (2.5Y 4/2); moist; medium dense.	PID 0 ppm
5					4-5' fine to medium grained SAND (SW); light olive brown (2.5Y 5/6); moist; loose. 5-6' silty CLAY; gray (2.5Y 5/1); wet; dense.	Water table at 5' bgs.
	6-10'	4'	3		6-7' fine to medium grained SAND (SW); gray (2.5Y 5/1); saturated; loose. 7-8' clayey SILT with little fine sand; gray (2.5Y 5/1); wet; medium dense. 8-10' fine to medium grained SAND with little fines (SW); dark gray (2.5Y 4/21); wet; medium dense.	PID 0 ppm
10	10-14'	4'	4		10-12' fine to medium grained SAND with trace fines (SW); gray (2.5Y 5/1); saturated; very loose. 12-14' Same as above, consistency change tc medium dense.	PID 0 ppm
15					Boring terminated at 14' bgs. Monitoring well installed at this location.	
20						

PROJECT NUMBER	BORING NUMBER	
180247.FI.FI	SJSBK-MW08S	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

ELEVATION : DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted HSA Drill Rig

WATER LEVELS : START : 08/05/2003 END : 08/05/2003 LOGGER : E. Matthews

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	0-2'	6"	1	NA	0-2' fine to medium grained SAND with trace fines (SW); light olive brown (2.5Y 5/3); moist; very dense.	PID 0 ppm
	2-6'	2'	2		2-4' Same as above, color change to olive brown (2.5Y 4/4).	PID 0 ppm
5					4-6' Same as above, color change to light brownish gray (2.5Y 6/2).	
	6-10'	3.5'	3		6-10' fine to medium grained SAND (SW); light yellowish brown (2.5Y 6/4); saturated; loose.	PID 0 ppm Water table at 6' bgs.
10	10-14'	4'	4		10-11' fine SAND with trace fines (SP); dark greenish gray (10GY 4/1); wet; medium dense. 11-13' fine SAND and clayey SILT; dark greenish gray (10GY 4/1); saturated; very loose.	PID 0 ppm
					13-14' fine to medium grained SAND (SW); dark greenish gray (10GY 4/1); moist; dense.	Shell frags observed.
15	14-18'	3'	5		14-15' Same as above; wet; loose. 15-17' fine to coarse grained SAND (SW); dark greenish gray (10GY 4/1); saturated; loose. 17-18' fine to medium grained SAND (SW); light yellowish brown (2.5Y 6/3); saturated; loose.	
20	18-22'	3.5'	6		18-22' CLAY; dark greenish gray (10Y 3/1); moist; dense.	Organic material observed in clay from 20-22' bgs.
25					Boring terminated at 22' bgs. Monitoring well installed at this location.	

PROJECT NUMBER	BORING NUMBER	
180247.FI.FI	SJSBK-MW09S	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

ELEVATION : DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted HSA Drill Rig

WATER LEVELS : START : 08/05/2003 END : 08/05/2003 LOGGER : E. Matthews

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	0-4'	4'	1	NA	0-2' fine SAND with little fines (SP); dark brown (10YR 3/3); moist; dense.	PID 0ppm Organic material observed.
					2-4' fine SAND and silty CLAY; light yellowish brown (2.5Y 6/3); moist; very dense.	
5	4-8'	3'	2		4-8' fine to coarse grained SAND (SW); light yellowish brown (2.5Y 6/3); saturated; loose.	PID 0ppm Water table at 4' bgs.
10	8-12'	4'	3		8-12' fine to coarse grained SAND (SW); greenish gray (10GY 5/1); saturated; loose.	PID 0ppm Silty clay layer observed from 9 to 9.5' bgs.
15	12-16'	4'	4		12-16' fine to medium grained SAND (SW); greenish gray (10GY 3/1); saturated; loose.	PID 0ppm Shell frags observed.
	16-20'	4'	5		16-17' fine SAND and clayey SILT; greenish gray (10GY 3/1); saturated; loose.	PID 0ppm
					17-19' SILT with some fine sand; greenish gray (10GY 3/1); saturated; very loose.	Shell frags observed.
20					19-20' Silty CLAY; greenish gray (10GY 3/1); moist; dense.	PID 0ppm Organic material (roots) observed.
25					Boring terminated at 20' bgs. Monitoring well installed at this location.	

PROJECT NUMBER	BORING NUMBER	
180247.FI.FI	**SJSBK-MW10S**	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : CLEAN III, CTO 12 LOCATION : St. Juliens Creek Annex

ELEVATION : DRILLING CONTRACTOR : Parratt-Wolff

DRILLING METHOD AND EQUIPMENT USED : Truck Mounted HSA Drill Rig

WATER LEVELS : START : 08/06/2003 END : 08/06/2003 LOGGER : B. Francisco

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm): Breathing Zone Above Hole
	0-2'	6"	1	NA	0-2' Sandy GRAVEL (GP) with trace fines; greenish gray (5GY 6/1); damp; tight.	PID 0 ppm 1" of topsoil at the surface. Angular gravel is likely fill from adjacent parking lot.
	2-6'	3.5'	2		2-3.5' silty SAND with some angular gravel (SM); olive (5Y 5/3); very moist; soft.	PID 0 ppm
5					3.5'-6' fine to medium grained SAND with som silt (SM); pale olive (5Y 6/3); saturated; tight.	PID 0 ppm Appears to be native soil. Sand becomes coarser and fines content decreases with depth. Water table encountered at 5' bgs.
	6-10'	1'	3		Same as above, color change to yellow (5Y 7/6).	PID 0 ppm
10	10-14'	4'	4		Same as above, color change to dark greenish gray (10GY 4/1).	PID 0 ppm
15	14-18'	4'	5		Same as above.	PID 0 ppm
20	18-22'	4'	6		18-18.5' Same as above. 18.5-22' CLAY (CH); dark greenish gray (5GY 4/1).	PID 0 ppm Clay is the Yorktown confining unit. Wood fragments observed at the contact between sand and clay.
25					Boring terminated at 22' bgs once the depth to the Yorktown confining unit was determined. Monitoring well installed at this location.	

Appendix B

Groundwater Analytical Results

Appendix B
Groundwater Analytical Results
Background Investigation
St Juliens Creek Annex
Chesapeake, Virginia

Station ID	SJS03-MW01S				SJSBK-MW10S	SJSBK-MW1S		SJSBK-MW2S		SJSBK-MW3S		SJSBK-MW4S		SJSBK-MW5S	SJSBK-MW6S	SJSBK-MW7S	SJSBK-MW8S	SJSBK-MW9S
Sample ID	SJS03-GW1S-001	SJS03-GW1S-002	SJS03-GW1S-003	SJS03-MW01S-03C	SJSBK-MW10S-03C	SJSBK-GW1S-001	SJSBK-MW01S-03C	SJSBK-GW2S-001	SJSBK-MW02S-03C	SJSBK-GW3S-001	SJSBK-MW03S-03C	SJSBK-GW4S-001	SJSBK-MW04S-03C	SJSBK-MW05S-03C	SJSBK-MW06S-03C	SJSBK-MW07S-03C	SJSBK-MW08S-03C	SJSBK-MW09S-03C
Sample Date	07/17/97	11/04/97	05/23/99	08/20/03	08/19/03	05/23/99	08/18/03	05/23/99	08/18/03	05/23/99	08/19/03	05/23/99	08/19/03	08/19/03	08/19/03	08/18/03	08/18/03	08/19/03
Chemical Name																		
Volatile Organic Compounds (UG/L)																		
1,1,1-Trichloroethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	NA	NA	0.5 U	0.5 U	NA	0.5 UJ	NA	0.5 U	NA	0.5 U	NA	0.5 UJ	0.5 U	0.5 U	0.11 B	0.5 U	0.5 U
1,1,2-Trichloroethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,3-Trichlorobenzene	NA	NA	NA	0.5 U	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-Trichlorobenzene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromoethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ
1,2-Dichlorobenzene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	1 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	5 U	NA	NA	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	4.1 B	5 U	5 U	5 U
2-Hexanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	24	NA	NA	3.6 B	3.3 B	5 U	5 U	5 U	3.9 B	5 U	5 U	30.5	3.2 B	4.5 B	7.5 B	3.7 B	2.6 B	4.2 B
Benzene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromochloromethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	1 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U
Bromoform	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ
Bromomethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon disulfide	1 U	1 U	1.10 B	0.18 J	0.64	1.7 B	0.14 J	1.2 B	0.067 J	1 B	0.048 J	2.1 B	0.11 J	0.16 J	0.12 J	0.069 J	0.17 J	0.22 J
Carbon tetrachloride	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	1 U	1 U	1 U	0.079 B	0.053 B	1 U	0.5 U	1 U	0.066 B	1 U	0.059 B	1 U	0.067 B	0.07 B	0.056 B	0.07 B	0.065 B	0.074 B
Chloroethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	1 U	1 U	1 U	0.5 U	0.5 U	0.2 B	0.5 U	1 U	0.5 U	0.7 B	0.5 UJ	0.2 B	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloromethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.19 B	1 U	0.5 U	1 U	0.21 B	1 U	0.081 B	0.11 B	0.091 B	0.7 B	0.094 B	0.093 B
Cumene	NA	NA	NA	0.5 U	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Cyclohexane	NA	NA	NA	0.5 U	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 UJ	NA	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U
Dibromochloromethane	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	1 U	0.5 UJ	1 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	0.5 U	0.5 U	NA	0.5 UJ	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.032 J	0.5 U
Ethylbenzene	0.6 J	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.032 J	1 U	0.5 U	1 U	0.5 U	0.14 J	0.5 U	0.5 U	0.037 J	0.5 U
Methyl acetate	NA	NA	NA	0.5 U	0.5 U	NA	0.5 UJ	NA	0.5 U	NA	0.5 U	NA	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl-tert-butyl ether (MTBE)	NA	NA	NA	0.5 U	0.5 U	NA	0.5 UJ	NA	0.5 U	NA	0.5 U	NA	0.5 UJ	0.5 U	0.5 U	0.17 J	0.5 U	0.5 U
Methylcyclohexane	NA	NA	NA	0.5 U	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 UJ	NA	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U
Methylene chloride	2 B	2 B	0.800 B	0.46 B	0.52 B	1 B	0.62 B	1.1 B	0.55 B	1.2 B	0.39 B	1.1 B	0.39 B	0.54 B	0.41 B	0.56 B	0.53 B	0.67 B
Styrene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Toluene	0.2 J	1 U	1 U	0.42 B	0.37 B	1 U	0.35 B	1 U	0.5 B	1 U	0.37 B	1 U	0.39 B	0.37 B	0.32 B	0.5 B	0.5 B	0.51 B
Trichloroethene	1 U	1 U	1 U	0.12 B	0.5 U	0.8 J	0.28 B	1 U	0.5 U	1 U	0.5 U	1 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichlorofluoromethane(Freon-11)	NA	NA	NA	0.5 U	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl chloride	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylene, total	1	1 U	1 U	0.5 U	0.076 J	1 U	0.5 U	1 U	0.5 U	1 U	0.072 J	1 U	0.069 J	0.13 J	0.058 J	0.084 J	0.15 J	0.084 J
cis-1,2-Dichloroethene	1 U	1 U	1 U	0.5 U	0.5 U	0.2 J	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,3-Dichloropropene	1 U	1 U	1 U	0.5 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	1 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Semi-volatile Organic Compounds (UG/L)																		
1,1-Biphenyl	NA	NA	NA	5.1 U	5 U	NA	5.1 UJ	NA	5 UJ	NA	5 U	NA	5 U	1.4 J	5 U	5.4 U	5 UJ	5 U
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	5.1 U	5 U	NA	5.1 U	NA	5 U	NA	5 U	NA	5 U	5 U	5 U	5.4 U	5 U	5 U
1,2,4-Trichlorobenzene	NA	NA	11 U	NA	NA	12 U	NA	11 U	NA	11 U	NA	11 U	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	11 U	NA	NA	12 U	NA	11 U	NA	11 U	NA	11 U	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	11 U	NA	NA	12 U	NA	11 U	NA	11 U	NA	11 U	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	11 U	NA	NA	12 U	NA	11 U	NA	11 U	NA	11 U	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	25 U	25 U	28 U	21 U	20 U	29 U	21 U	27 U	20 U	26 U	20 U	26 U	20 U	20 U	20 U	22 U	20 U	20 U
2,4,6-Trichlorophenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
2,4-Dichlorophenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
2,4-Dimethylphenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
2,4-Dinitrophenol	25 U	25 U	28 U	21 U	20 U	29 U	21 U	27 U	20 U	26 U	20 U	26 U	20 U	20 U	20 U	22 U	20 U	20 U
2,4-Dinitrotoluene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U

Appendix B
Groundwater Analytical Results
Background Investigation
St Juliens Creek Annex
Chesapeake, Virginia

Station ID	SJS03-MW01S				SJSBK-MW10S	SJSBK-MW1S		SJSBK-MW2S		SJSBK-MW3S		SJSBK-MW4S		SJSBK-MW5S	SJSBK-MW6S	SJSBK-MW7S	SJSBK-MW8S	SJSBK-MW9S
Sample ID	SJS03-GW1S-001	SJS03-GW1S-002	SJS03-GW1S-003	SJS03-MW01S-03C	SJSBK-MW10S-03C	SJSBK-GW1S-001	SJSBK-MW01S-03C	SJSBK-GW2S-001	SJSBK-MW02S-03C	SJSBK-GW3S-001	SJSBK-MW03S-03C	SJSBK-GW4S-001	SJSBK-MW04S-03C	SJSBK-MW05S-03C	SJSBK-MW06S-03C	SJSBK-MW07S-03C	SJSBK-MW08S-03C	SJSBK-MW09S-03C
Sample Date	07/17/97	11/04/97	05/23/99	08/20/03	08/19/03	05/23/99	08/18/03	05/23/99	08/18/03	05/23/99	08/19/03	05/23/99	08/19/03	08/19/03	08/19/03	08/18/03	08/18/03	08/19/03
Chemical Name																		
2,6-Dinitrotoluene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
2-Chloronaphthalene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
2-Chlorophenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
2-Methylnaphthalene	1 J	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	2.5 J	5 U	5.4 U	5 U	5 U
2-Methylphenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
2-Nitroaniline	25 U	25 U	28 U	21 U	20 U	29 U	21 U	27 U	20 U	26 U	20 U	26 U	20 U	20 U	20 U	22 U	20 U	20 U
2-Nitrophenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
3,3'-Dichlorobenzidine	10 U	10 U	11 U	5.1 U	5 UJ	12 U	5.1 U	11 U	5 U	11 U	5 UJ	11 U	5 UJ	5 UJ	5 U	5.4 U	5 U	5 UJ
3-Nitroaniline	25 U	25 U	28 U	21 U	20 U	29 U	21 U	27 U	20 U	26 U	20 U	26 U	20 U	20 U	20 U	22 U	20 U	20 U
4,6-Dinitro-2-methylphenol	25 U	25 U	28 U	21 UJ	20 U	29 U	21 UJ	27 U	20 UJ	26 U	20 U	26 U	20 U	20 U	20 U	22 UJ	20 UJ	20 U
4-Bromophenyl-phenylether	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 UJ	5 UJ	5 U	5.4 U	5 U	5 U
4-Chloro-3-methylphenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
4-Chloroaniline	10 U	10 U	11 U	5.1 U	5 UJ	12 U	5.1 U	11 U	5 U	11 U	5 UJ	11 U	5 UJ	5 UJ	5 U	5.4 U	5 U	5 UJ
4-Chlorophenyl-phenylether	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 UJ	5 UJ	5 U	5.4 U	5 U	5 U
4-Methylphenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
4-Nitroaniline	25 U	25 U	28 U	21 U	20 U	29 U	21 U	27 U	20 U	26 U	20 U	26 U	20 U	20 U	20 U	22 U	20 U	20 U
4-Nitrophenol	25 U	25 U	28 U	21 U	20 U	29 U	21 U	27 U	20 U	26 U	20 U	26 U	20 U	20 U	20 U	22 U	20 U	20 U
Acenaphthene	15	4 J	3 J	1.7 J	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	13	5 U	5.4 U	5 U	5 U
Acenaphthylene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Acetophenone	NA	NA	NA	5.1 U	5 U	NA	5.1 U	NA	5 U	NA	5 U	NA	5 U	5 U	5 U	5.4 U	5 U	5 U
Anthracene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	1.7 J	5 U	5.4 U	5 U	5 U
Atrazine	NA	NA	NA	5.1 U	5 U	NA	5.1 U	NA	5 U	NA	5 U	NA	5 U	5 U	5 U	5.4 U	5 U	5 U
Benzaldehyde	NA	NA	NA	5.1 U	5 U	NA	5.1 U	NA	5 U	NA	5 U	NA	5 U	5 U	5 U	5.4 U	5 U	5 U
Benzo(a)anthracene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Benzo(a)pyrene	10 U	10 U	11 U	5.1 UJ	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Benzo(b)fluoranthene	10 U	10 U	11 U	5.1 UJ	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Benzo(g,h,i)perylene	10 U	10 U	11 U	5.1 UJ	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Benzo(k)fluoranthene	10 U	10 U	11 U	5.1 UJ	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Bis(2-chloro-1-methylethyl) ether	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Butylbenzylphthalate	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 UJ	11 U	5 UJ	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Caprolactam	NA	NA	NA	5.1 U	5 U	NA	5.1 UJ	NA	5 UJ	NA	5 U	NA	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Carbazole	2 J	10 U	11 U	NA	NA	12 U	NA	11 U	NA	11 U	NA	11 U	NA	NA	NA	NA	NA	NA
Chrysene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Di-n-butylphthalate	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 UJ	11 U	5 UJ	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Di-n-octylphthalate	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 UJ	11 U	5 UJ	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Dibenz(a,h)anthracene	10 U	10 U	11 U	5.1 UJ	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Dibenzofuran	8 J	1 J	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 UJ	7.2 J	5 U	5.4 U	5 U	5 U
Diethylphthalate	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 UJ	11 U	5 UJ	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Dimethyl phthalate	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 UJ	11 U	5 UJ	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Fluoranthene	10 U	1 J	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	1 J	5 U	5.4 U	5 U	5 U
Fluorene	9 J	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 UJ	7.6 J	5 U	5.4 U	5 U	5 U
Hexachlorobenzene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Hexachlorobutadiene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Hexachlorocyclopentadiene	10 U	10 U	11 U	5.1 U	5 UJ	12 U	5.1 U	11 U	5 U	11 U	5 UJ	11 U	5 UJ	5 UJ	5 U	5.4 U	5 U	5 UJ
Hexachloroethane	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Indeno(1,2,3-cd)pyrene	10 U	10 U	11 U	5.1 UJ	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 UJ	5 U
Isophorone	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Naphthalene	19	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	8.7	5 U	5.4 U	5 U	5 U
Nitrobenzene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Pentachlorophenol	25 U	25 U	28 U	5.1 U	5 U	29 U	5.1 U	27 U	5 U	26 U	5 U	26 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Phenanthrene	5 J	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	8.6	5 U	5.4 U	5 U	5 U
Phenol	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Pyrene	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	0.72 J	5 U	5.4 U	5 U	5 U
bis(2-Chloroethoxy)methane	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
bis(2-Chloroethyl)ether	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
bis(2-Ethylhexyl)phthalate	10 U	10 U	1 J	5.1 U	1 B	12 U	5.1 UJ	11 U	4 B	11 U	5 U	11 U	9.3 B	3.7 B	5 U	5.4 B	5 UJ	5 U
n-Nitroso-di-n-propylamine	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
n-Nitrosodiphenylamine	10 U	10 U	11 U	5.1 U	5 U	12 U	5.1 U	11 U	5 U	11 U	5 U	11 U	5 U	5 U	5 U	5.4 U	5 U	5 U
Pesticide/Polychlorinated Biphenyls (UG/L)																		
4,4'-DDD	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
4,4'-DDE	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
4,4'-DDT	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
Aldrin	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
Aroclor-1016	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	1 U	1.1 U	1.1 U	1 U	1 U
Aroclor-1221	2 U	2 U	2.10 U	2 U	2 U	NA	2 U	NA	2 U	NA	2 U	NA	2 U	2 U	2.2 U	2.2 U	2 U	2 U

Appendix B
Groundwater Analytical Results
Background Investigation
St Juliens Creek Annex
Chesapeake, Virginia

Station ID	SJS03-MW01S				SJSBK-MW10S	SJSBK-MW1S		SJSBK-MW2S		SJSBK-MW3S		SJSBK-MW4S		SJSBK-MW5S	SJSBK-MW6S	SJSBK-MW7S	SJSBK-MW8S	SJSBK-MW9S
Sample ID	SJS03-GW1S-001	SJS03-GW1S-002	SJS03-GW1S-003	SJS03-MW01S-03C	SJSBK-MW10S-03C	SJSBK-GW1S-001	SJSBK-MW01S-03C	SJSBK-GW2S-001	SJSBK-MW02S-03C	SJSBK-GW3S-001	SJSBK-MW03S-03C	SJSBK-GW4S-001	SJSBK-MW04S-03C	SJSBK-MW05S-03C	SJSBK-MW06S-03C	SJSBK-MW07S-03C	SJSBK-MW08S-03C	SJSBK-MW09S-03C
Sample Date	07/17/97	11/04/97	05/23/99	08/20/03	08/19/03	05/23/99	08/18/03	05/23/99	08/18/03	05/23/99	08/19/03	05/23/99	08/19/03	08/19/03	08/19/03	08/18/03	08/18/03	08/19/03
Chemical Name																		
Aroclor-1232	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	1 U	1.1 U	1.1 U	1 U	1 U
Aroclor-1242	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	1 U	1.1 U	1.1 U	1 U	1 U
Aroclor-1248	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	1 U	1.1 U	1.1 U	1 U	1 U
Aroclor-1254	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	1 U	1.1 U	1.1 U	1 U	1 U
Aroclor-1260	1 U	1 U	1 U	1 U	1 U	NA	1 U	NA	1 U	NA	1 U	NA	1 U	1 U	1.1 U	1.1 U	1 U	1 U
Dieldrin	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
Endosulfan I	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
Endosulfan II	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
Endosulfan sulfate	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
Endrin	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
Endrin aldehyde	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
Endrin ketone	0.1 U	0.1 U	0.100 U	0.1 U	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	0.1 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U
Heptachlor	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
Heptachlor epoxide	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
Methoxychlor	0.5 U	0.5 U	0.520 U	0.5 U	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	NA	0.5 U	0.5 U	0.54 U	0.56 U	0.5 U	0.5 U
Toxaphene	5 U	5 U	5.20 U	5 U	5 U	NA	5 U	NA	5 U	NA	5 U	NA	5 U	5 U	5.4 U	5.6 U	5 U	5 U
alpha-BHC	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
alpha-Chlordane	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
beta-BHC	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.056 J	0.054 U	0.056 U	0.05 U	0.05 U
delta-BHC	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
gamma-BHC (Lindane)	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
gamma-Chlordane	0.05 U	0.05 U	0.0520 U	0.05 U	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	NA	0.05 U	0.05 U	0.054 U	0.056 U	0.05 U	0.05 U
Total Metals (UG/L)																		
Aluminum	4,100 K	1,710	395	33.1 B	163 B	357	345	181 J	116 B	184 J	289	207	26.7 U	1,230	109 B	51.9 B	148 J	89.5 B
Antimony	2.2 B	2.3 J	2.70 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U	2.8 U
Arsenic	4.4 J	3.2 U	3.40 J	27.6	2.2 U	2 U	2.2 U	2 U	2.2 U	2 U	2.2 U	2 J	2.2 U	4.4 J	8 J	2.2 U	2.2 U	2.2 U
Barium	176 J	31.1 J	23.1 J	34.7 J	53.5 J	26.1 J	60.1 J	63.5 J	55 J	63.1 J	63.2 J	58.6 J	13.6 B	38.6 J	58.6 J	45.2 J	39.1 J	77.1 J
Beryllium	1.4 J	0.76 J	0.100 U	0.1 U	0.27 B	0.27 J	0.26 B	0.1 U	0.24 B	0.1 U	0.27 B	0.1 U	0.1 U	2.7 B	0.1 U	0.1 U	0.1 U	0.25 B
Cadmium	0.5 U	0.4 U	0.420 J	0.5 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.74 J	0.5 U	0.5 U	0.5 U	0.5 U
Calcium	100,000	92,000	141,000	138,000	13,400	27,900	10,100	21,300	10,700	33,100	10,600	142,000	125,000	531,000	359,000	83,300	41,600	28,700
Chromium	16.1 B	12 B	3.20 J	1.2 J	1.1 U	1.1 U	1.2 J	1.1 U	1.1 U	1.1 U	1.2 J	1.1 U	1.1 U	3.2 J	1.8 J	1.1 U	1.4 J	1.3 J
Cobalt	8.5 J	8.8 J	2.30 J	2.3 J	6.3 J	13.9 J	7.6 J	8.5 J	7.1 J	5.1 J	1.5 J	0.84 J	0.7 U	81.6	0.7 U	0.7 U	11.8 J	2.9 J
Copper	7.4 B	6.3 J	5.20 B	3 U	3 U	2.7 B	3 U	3.5 B	3 U	3.5 B	3 U	4.2 B	3 U	3 U	3 U	3 U	3 U	3 U
Cyanide	5 U	5 U	5 U	NA	NA	5 U	NA	5 U	NA	5 U	NA	5 U	NA	NA	NA	NA	NA	NA
Iron	31,900	26,200	34,600	41,600	353	18,000	3,780	374	78.1 J	715	417	8,620	13,200	107,000	80,700	13,300	1,070	2,490
Lead	2.4 B	3.5	2.30 J	1.8 U	1.8 U	1 U	1.8 U	1.9 J	1.8 U	1 U	1.8 U	1.1 J	1.8 U	2.8 J	1.8 U	1.8 U	1.8 U	1.8 U
Magnesium	115,000	34,800	31,600	31,200	868 J	19,600	5,940	5,990	3,960 J	4,860 J	3,170 J	14,900	8,520	296,000	212,000	15,100	4,720 J	6,260
Manganese	2,000	1,720	1,770	2,020	68.7	912	243	246	159	121	24.1	384	315	13,700	8,070	381	210	101
Mercury	0.69 B	0.12 U	0.100 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	7 U	14.5 J	4 J	21.2 B	24.3 B	15.1 J	25.9 B	7.9 J	28.7 B	7.6 J	22.8 B	2.7 J	19.1 B	116	19.4 B	21 B	30.9 B	23.4 B
Potassium	37,300	26,600	27,100	39,800	1,120 B	5,010	3,750 J	1,620 J	2,280 B	1,650 J	1,830 B	3,830 J	4,800 J	85,400	60,800	4,250 J	1,710 B	5,020
Selenium	3 U	3.3 U	2.60 U	3.2 U	3.2 U	2.6 U	3.2 U	2.6 U	3.2 U	2.6 U	3.2 U	2.6 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U
Silver	1.9 J	1.1 U	0.900 U	1.3 UJ	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	1.3 UJ	1.3 UJ	1.3 UJ	1.3 UJ	1.3 UJ
Sodium	810,000	122,000	132,000	129,000	6,080	52,700	23,200	34,200	27,100	18,600	11,200	53,900	27,500	646,000	487,000	28,200	8,930	11,600
Thallium	4.6 B	3.1 B	3.20 U	3.4 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	7.6 J	4.2 J	3.4 U	3.4 U	3.4 U
Vanadium	13.7 J	12.2 J	1.5 J	2.7 B	0.6 U	0.79 J	0.6 U	1 J	0.6 U	0.79 J	0.6 U	0.91 J	1 B	0.6 U	0.6 U	0.6 U	0.96 B	0.63 B
Zinc	35.3 B	55.2 B	241	10.2 U	13.6 J	89.7	138	44.7	10.2 U	9.5 J	10.2 U	43.7	10.2 U	642	10.2 U	10.2 U	10.2 U	14.6 J
Dissolved Metals (UG/L)																		
Aluminum	44 U	64.2 B	67.1 B	29.1 B	83.5 B	399	174 B	38.2 U	89.9 B	38.2 U	263	69.9 J	26.7 U	245 B	46.6 B	55.4 B	26.7 U	81.1 B
Antimony	2 U	3.8 J	2.70 U	2.8 U	2.8 U	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	3.4 B	2.7 U	2.8 U	2.8 U	27 B	5.2 B	2.8 U	3.8 B
Arsenic	3 U	3.2 U	2.40 J	15.4	2.2 U	2 U	2.2 U	2 U	2.2 U	2.1 J	2.2 U	2.2 J	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U
Barium	285	26 J	21.4 J	29.6 B	51.4 J	24 J	55.9 J	61.7 J	54.9 J	63.2 J	61.7 J	53.2 J	13.7 B	34.1 J	56.4 J	48 J	36.5 J	77.3 J
Beryllium	1 U	0.58 U	0.100 U	0.1 U	0.32 B	0.31 J	0.25 B	0.1 U	0.23 B	0.1 U	0.31 B	0.1 U	0.1 U	1.4 B	0.21 B	0.13 B	0.1 U	0.25 B
Cadmium	0.5 U	0.4 U	0.330 J	0.5 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.78 J	0.57 J	0.5 U	0.5 U	0.5 U
Calcium	148,000	93,500	132,000	116,000	12,900	30,000	9,340	21,400	11,000	34,800	10,500	141,000	123,000	464,000	346,000	83,900	41,300	29,100
Chromium	7 U	5.8 J	1.60 J	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.6 J	1.3 J	1.1 U	1.1 U
Cobalt	8 U	7.7 J	2.10 J	2.8 J	6.3 J	14.4 J	7 J	8 J	7.2 J	4.6 J	2.1 J	0.5 U	0.7 U	71.5	0.7 U	0.7 U	11.2 J	3.5 J
Copper	6 U	5.8 U	2.70 B	3 U	3 U	2.2 B	3 U	3.2 B	3 U	3 B	3 U	3.3 B	3 U	3 U	3 U	3 U	3 U	3 U
Iron	74,800	24,900	31,900	34,200	104	21,100	3,560	65 J	23.4 U	110	262	8,780	12,700	94,000	78,000	13,300	824	2,500
Lead	1 U	1.9 B	1 U	1.8 U	1.8 U	2.1 J	1.8 U	1.1 J	1.8 U	1 U	1.8 U	1 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U
Magnesium	194,000	35,400	32,900	25,500	788 J	22,400	5,780	5,780	4,050 J	4,890 J	3,090 J	13,700	8,290	256,000	203,000	15,500	4,570 J	6,250
Manganese	3,070	1,750	1,790	1,650	63.2	1,040	233	234	160	120	22.8	377	297	11,800	7,600	390	198	99.4
Mercury	0.31 B	0.13 U	0.100 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	7 U	8.3 B	3.10 J	10.8 B	16.4 B	14.3 J	13.1 B	6.9 J	17.4 B	7.2 J	10.9 B	2.2 J	7.6 B	92.3	11.5 B	9.2 B	14.4 B	16 B

Appendix B
Groundwater Analytical Results
Background Investigation
St Juliens Creek Annex
Chesapeake, Virginia

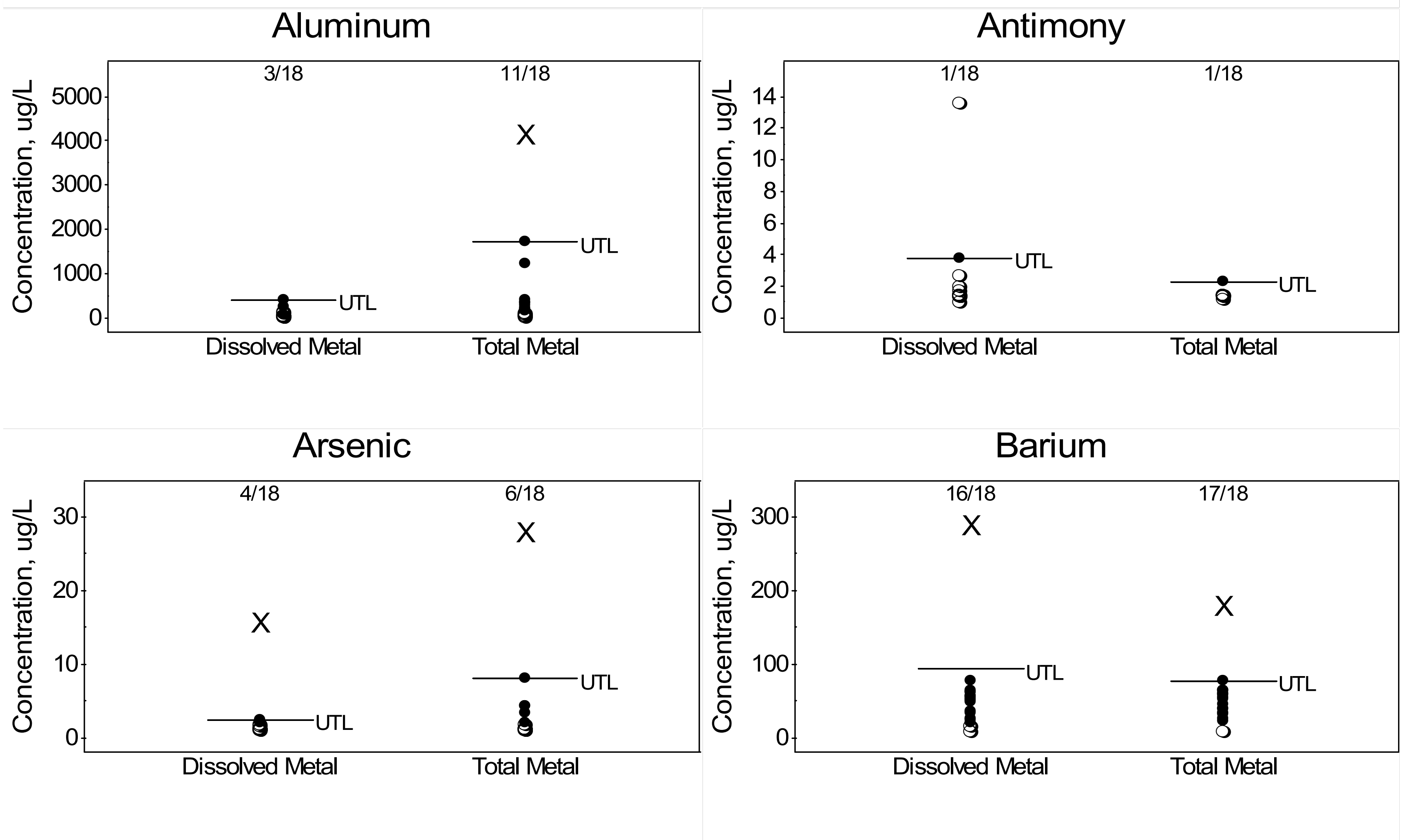
Station ID	SJS03-MW01S				SJSBK-MW10S	SJSBK-MW1S		SJSBK-MW2S		SJSBK-MW3S		SJSBK-MW4S		SJSBK-MW5S	SJSBK-MW6S	SJSBK-MW7S	SJSBK-MW8S	SJSBK-MW9S
Sample ID	SJS03-GW1S-001	SJS03-GW1S-002	SJS03-GW1S-003	SJS03-MW01S-03C	SJSBK-MW10S-03C	SJSBK-GW1S-001	SJSBK-MW01S-03C	SJSBK-GW2S-001	SJSBK-MW02S-03C	SJSBK-GW3S-001	SJSBK-MW03S-03C	SJSBK-GW4S-001	SJSBK-MW04S-03C	SJSBK-MW05S-03C	SJSBK-MW06S-03C	SJSBK-MW07S-03C	SJSBK-MW08S-03C	SJSBK-MW09S-03C
Sample Date	07/17/97	11/04/97	05/23/99	08/20/03	08/19/03	05/23/99	08/18/03	05/23/99	08/18/03	05/23/99	08/19/03	05/23/99	08/19/03	08/19/03	08/19/03	08/18/03	08/18/03	08/19/03
Chemical Name																		
Potassium	38,900	27,000	28,400	30,600	877 B	5,620	3,030 J	1,600 J	1,830 B	1,610 J	1,560 B	3,910 J	4,400 J	73,300	59,200	4,150 J	1,500 B	4,740 J
Selenium	3 U	3.3 U	2.60 U	3.2 U	3.2 U	2.6 U	3.2 U	2.6 U	3.2 U	2.6 U	3.2 U	2.6 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U	3.2 U
Silver	2.4 J	1.5 B	0.900 U	1.3 UJ	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	0.9 U	1.3 UJ	1.3 UJ	4.6 B	1.7 J	1.3 UJ	1.3 UJ
Sodium	1,530,000	125,000	141,000	96,100	5,620	57,700	20,500	33,500	25,400	18,400	10,600	49,100	26,500	582,000	462,000	28,200 J	8,560	11,400
Thallium	2.7 B	2.5 B	3.20 U	3.4 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	3.2 U	3.4 U	7.1 J	7.9 J	3.4 U	3.4 U	3.4 U
Vanadium	9 U	7.1 J	1.20 J	2.1 J	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.64 J	0.6 U	0.6 U	0.6 U
Zinc	22.4 B	49.7 B	10.5 J	10.2 U	10.2 U	109	105	45.4	10.2 U	9.1 J	10.2 U	25.8	10.2 U	532	10.2 U	10.2 U	10.2 U	10.2 U
Wet Chemistry (MG/L)																		
Phosphate	NA	0.56	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phosphorus	0.134 J	NA	0.319	NA	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	0.02 U	NA	NA	NA	NA	NA	NA

Notes:
Represents detections
NA - Not Analyzed
B - not detected above associated blank
J - analyte present, estimated value
K - analyte present, analyte may be biased high
U - not analyzed

Appendix C

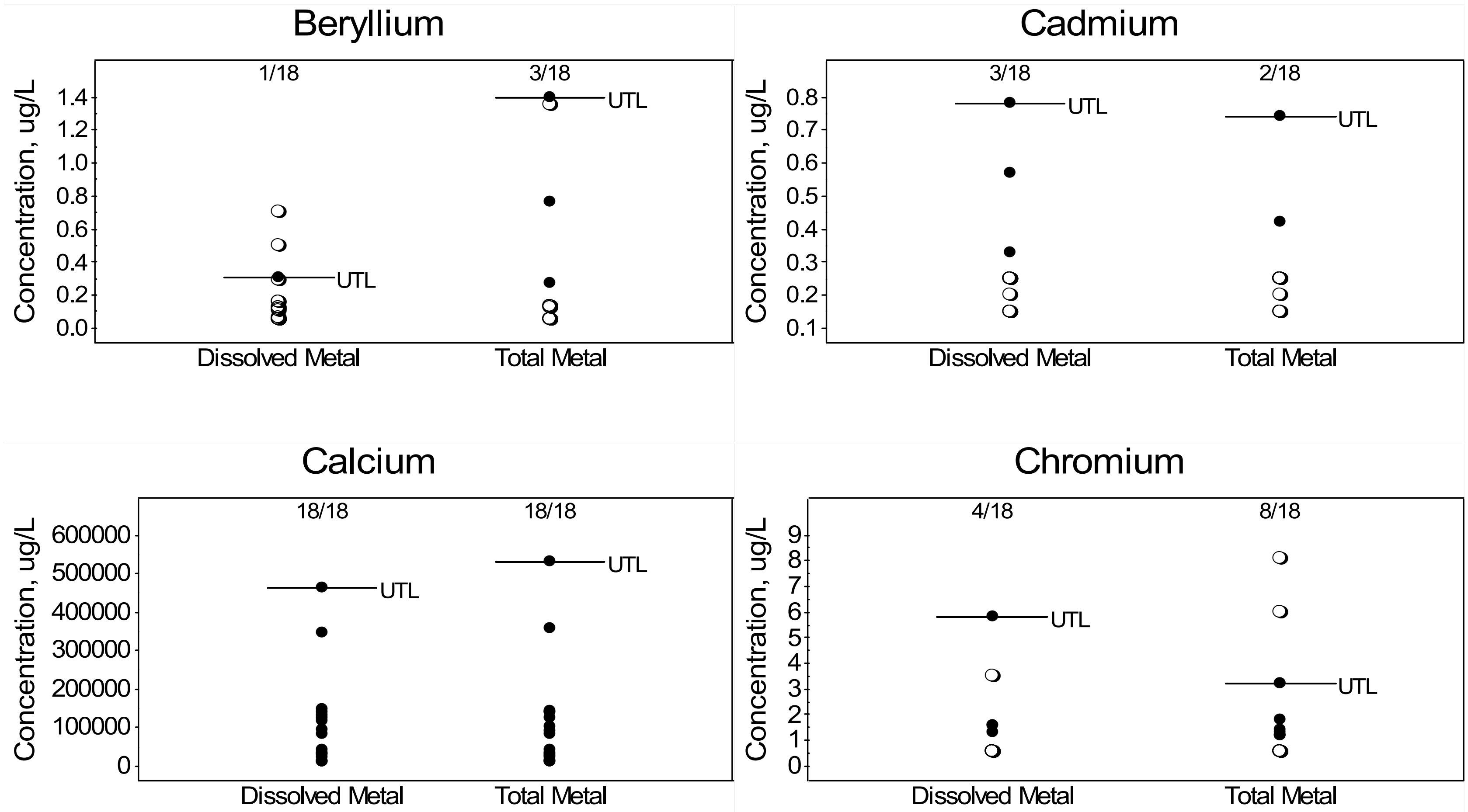
Scatter Plots for Detected Inorganics

Appendix C: Scatter Plots for Detected Inorganics



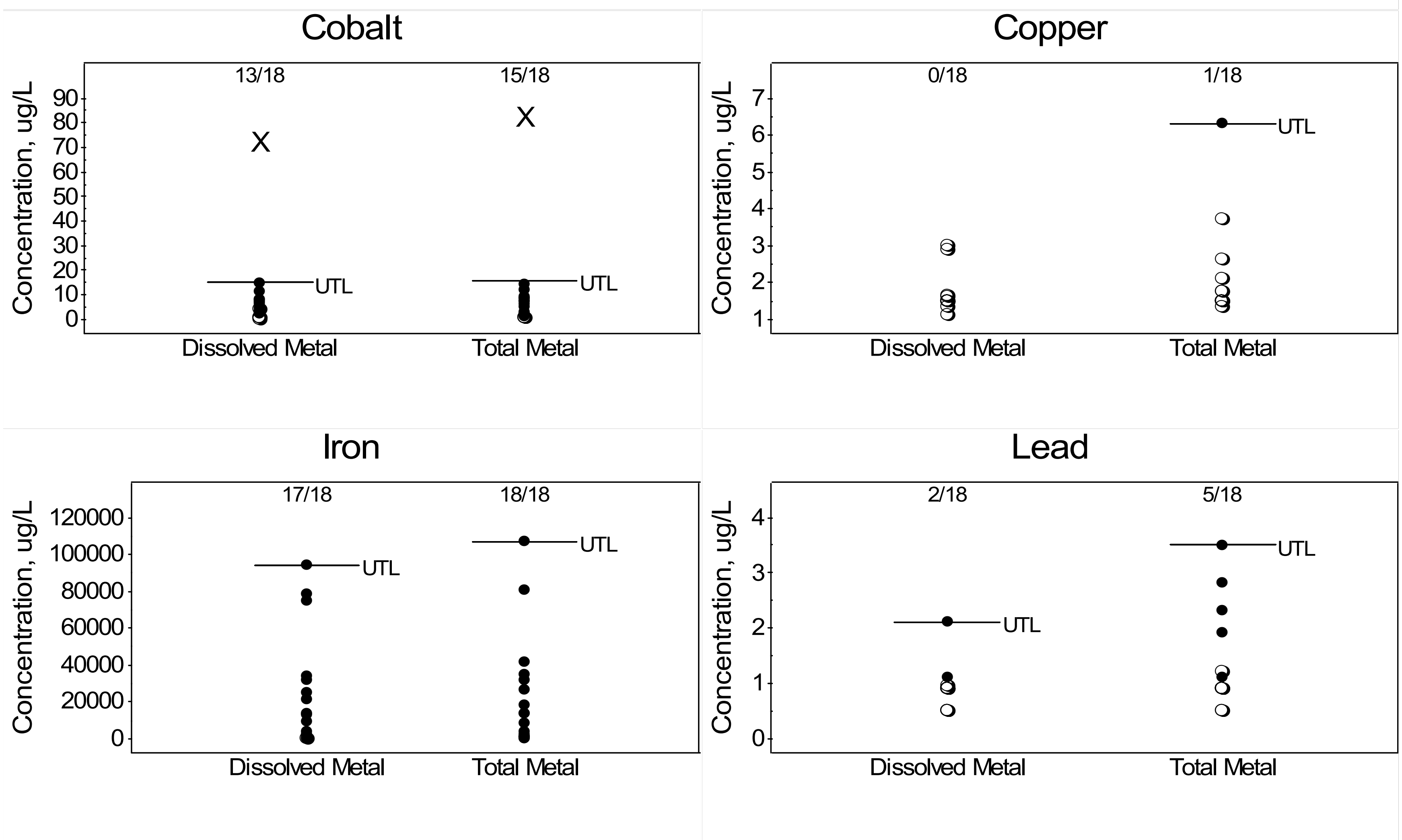
Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix C: Scatter Plots for Detected Inorganics



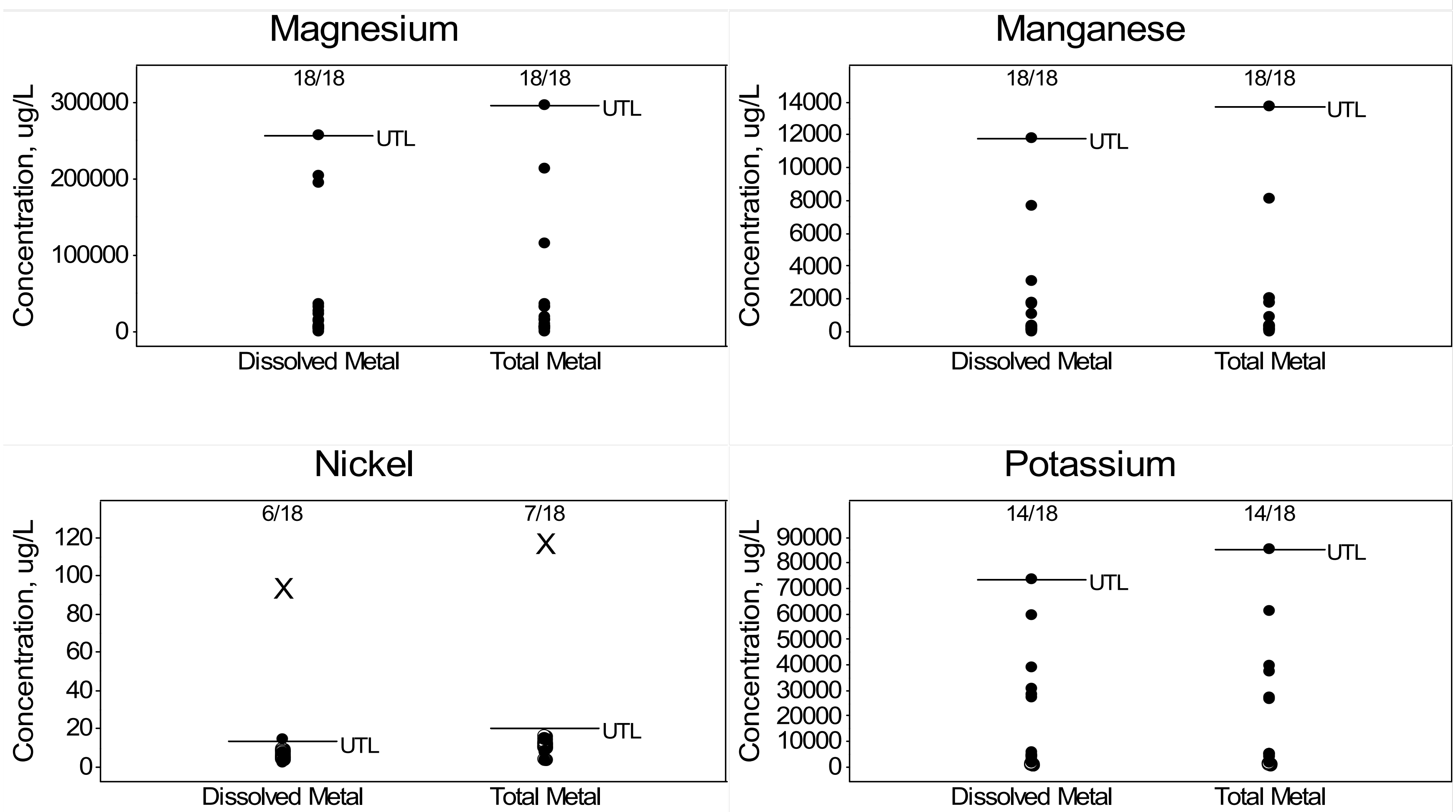
Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix C: Scatter Plots for Detected Inorganics



Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

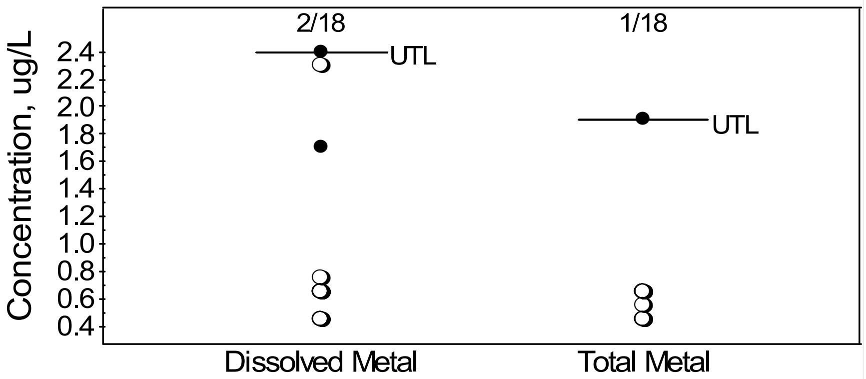
Appendix C: Scatter Plots for Detected Inorganics



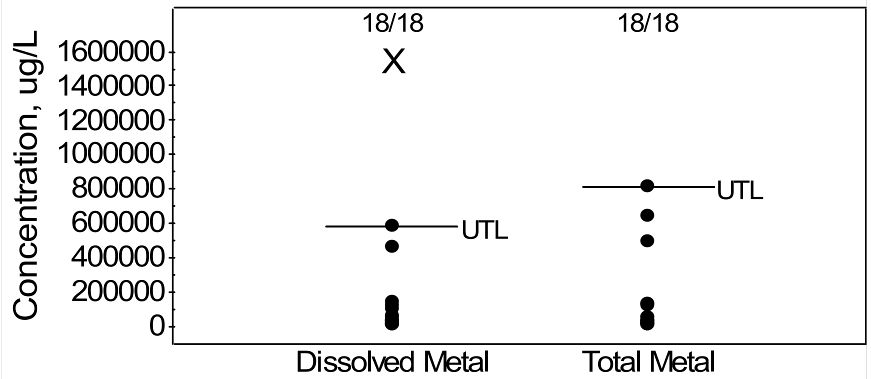
Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix C: Scatter Plots for Detected Inorganics

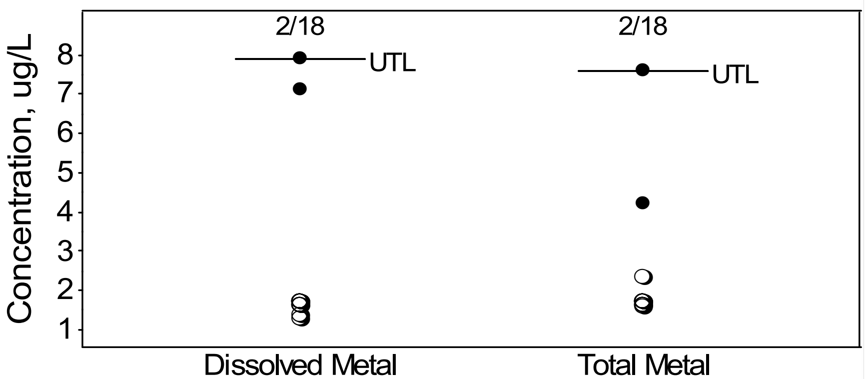
Silver



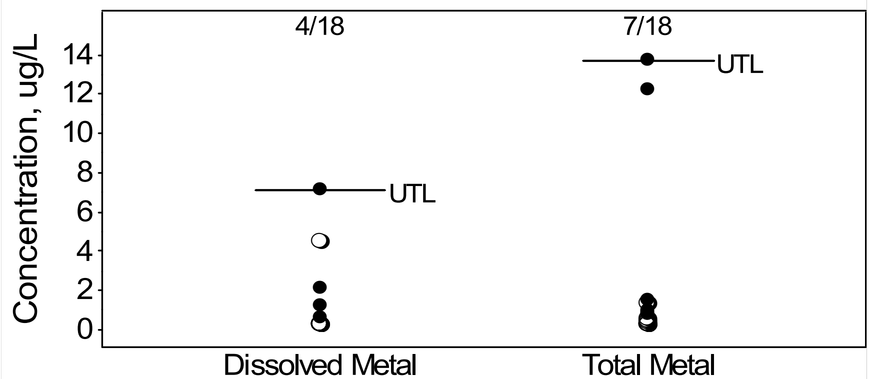
Sodium



Thallium



Vanadium



Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

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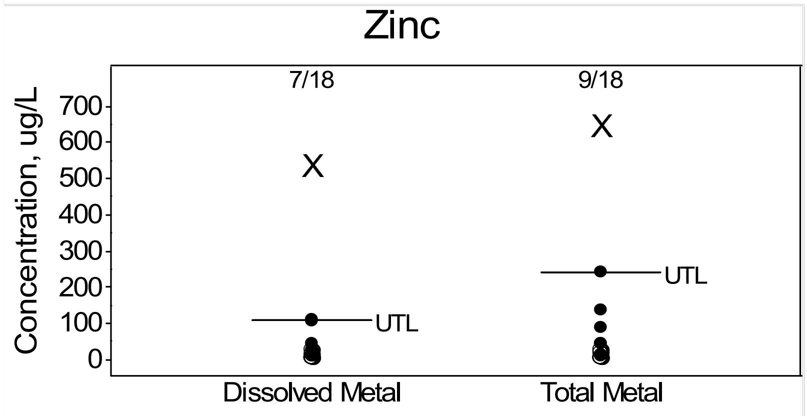
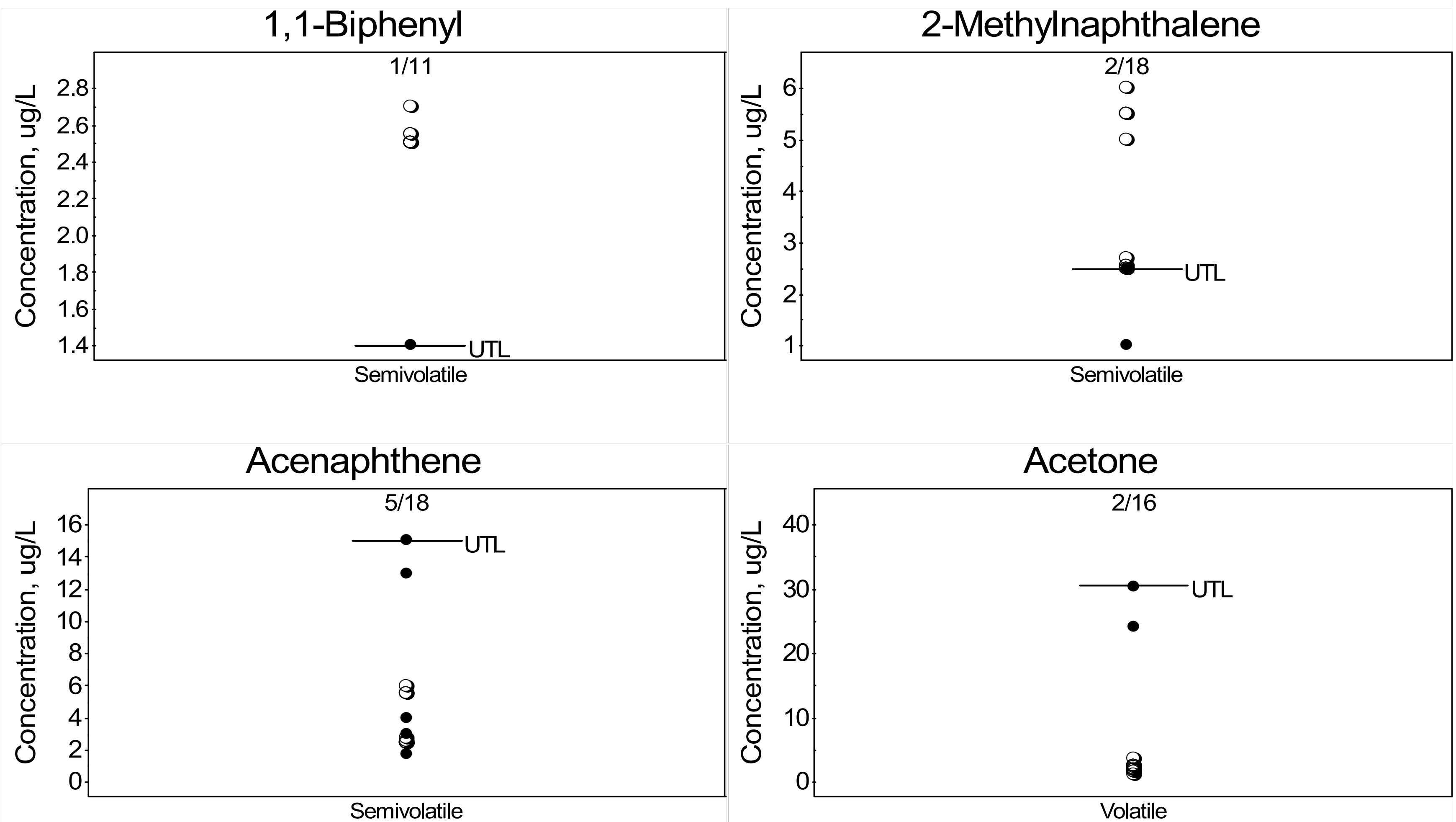


Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix D

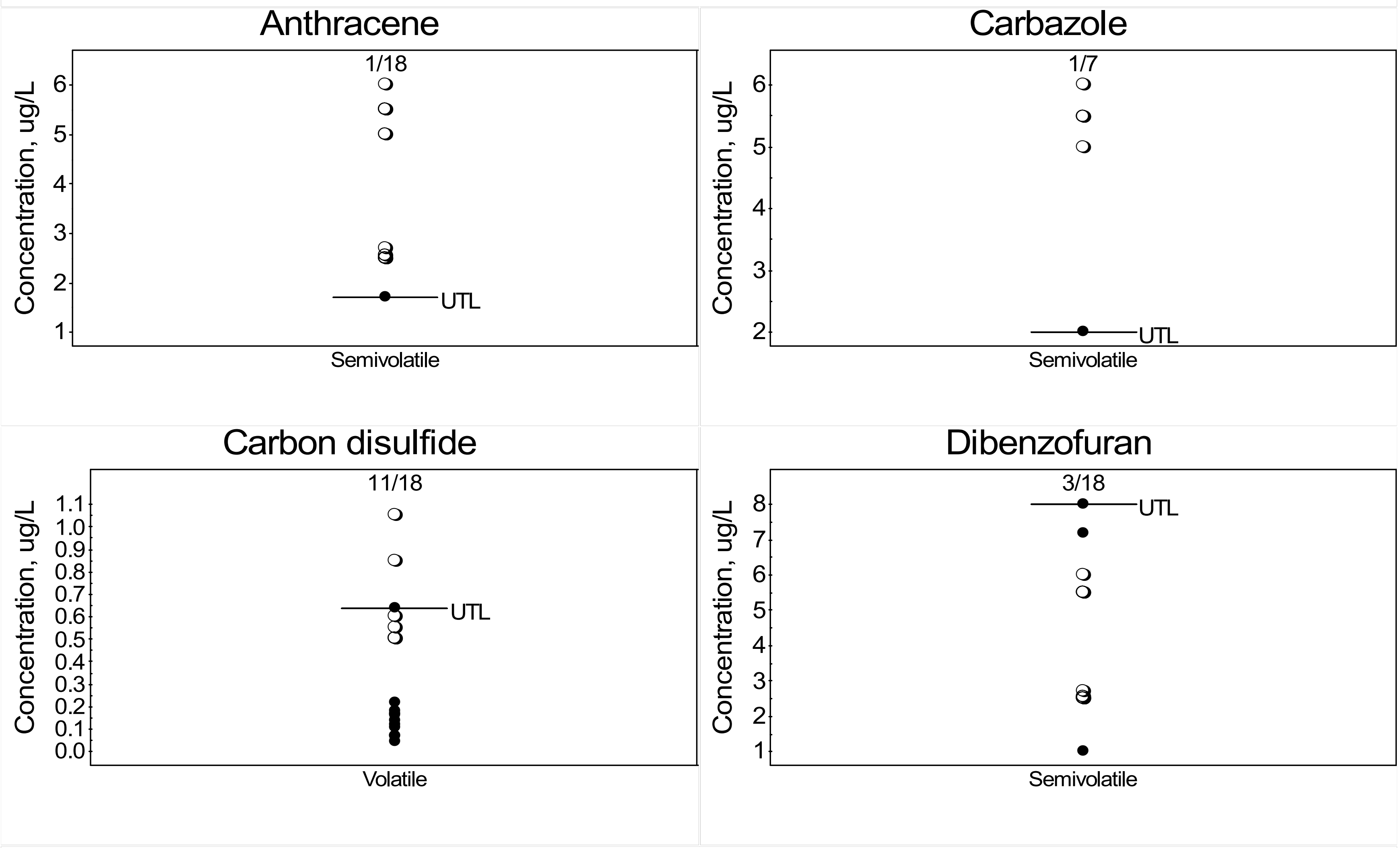
Scatter Plots for Detected Organics

Appendix D: Scatter Plots for Detected Organics



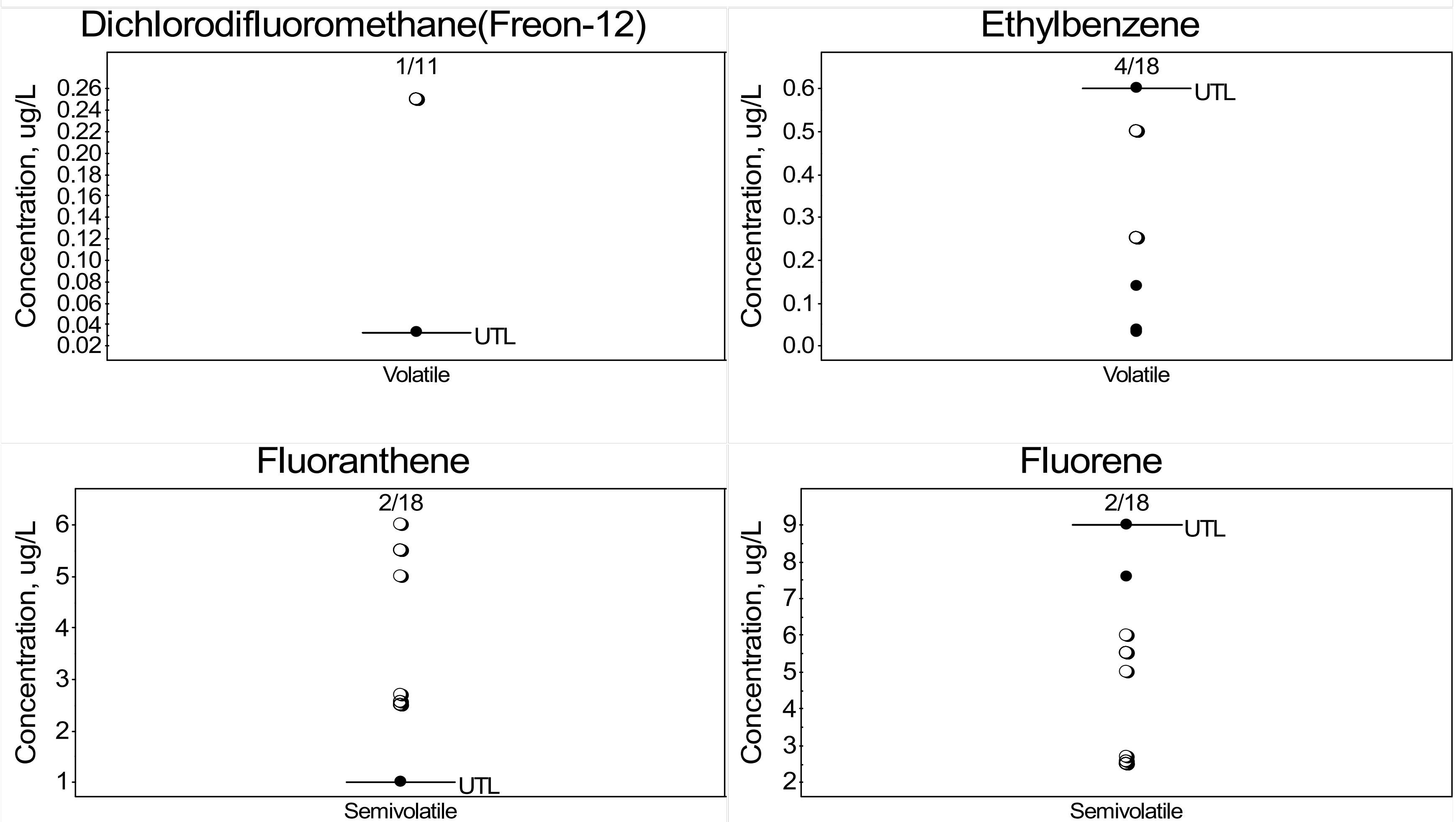
Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix D: Scatter Plots for Detected Organics



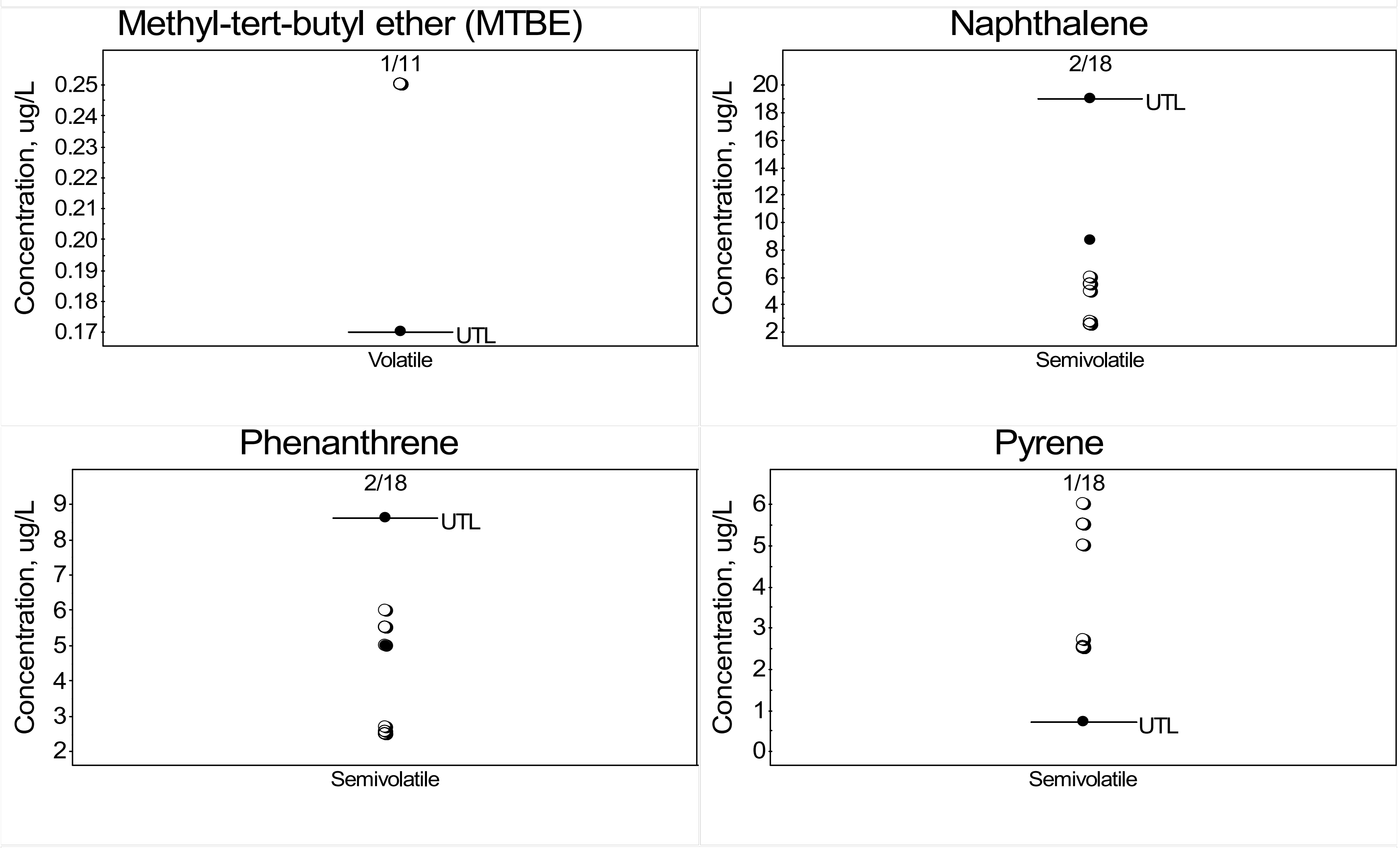
Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix D: Scatter Plots for Detected Organics



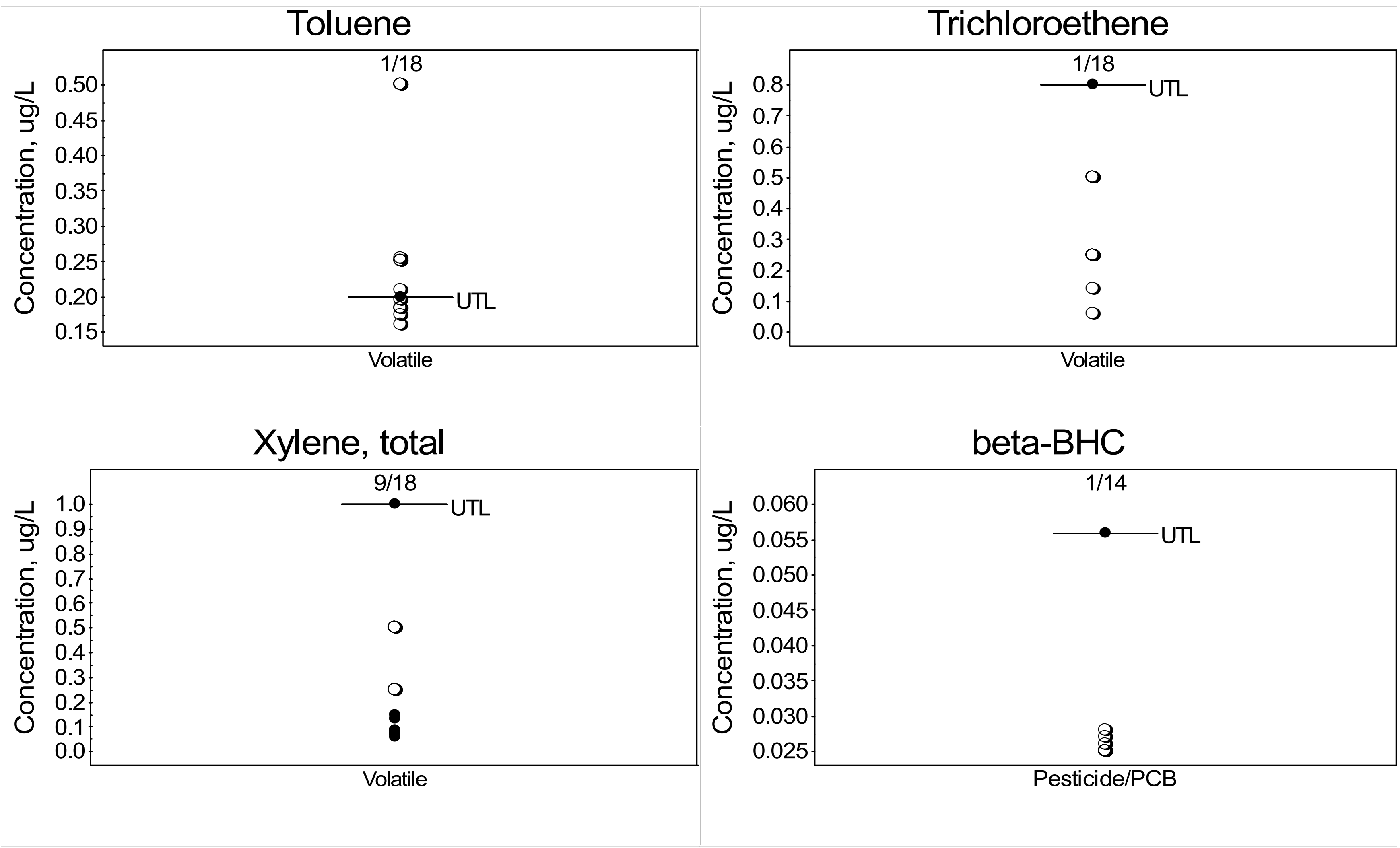
Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix D: Scatter Plots for Detected Organics



Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

Appendix D: Scatter Plots for Detected Organics



Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL

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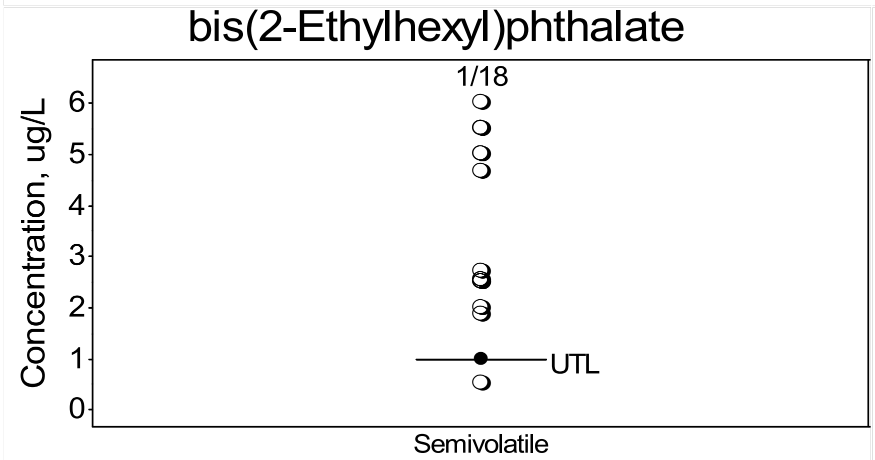

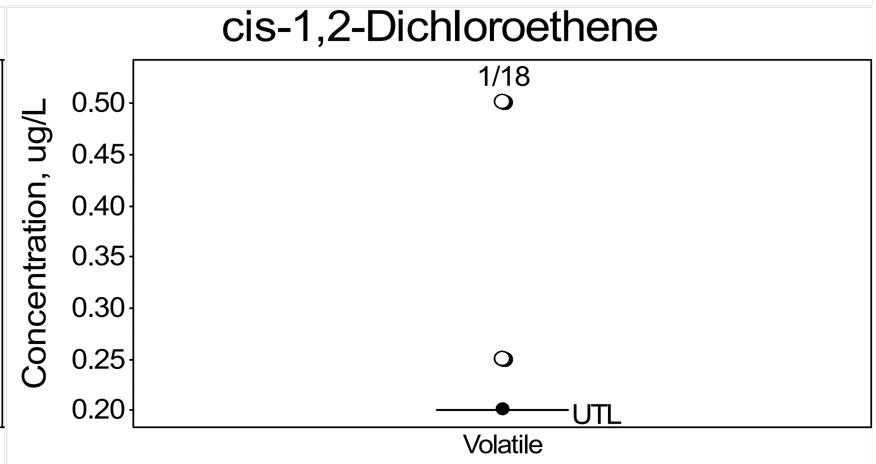

Open Symbol Represents Nondetected Value; Frequency of Detection Provided at Top of Plots
Horizontal Line at Background UTL