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Final

Technical Memorandum
Consensus for No Further Action in Soil and Groundwater
Site 11 - Bone Yard

Naval Weapons Station Yorktown Cheatham Annex
Williamsburg, Virginia

Prepared for

Department of the Navy

Naval Facilities Engineering Command
Mid-Atlantic

Contract No.
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September 2009

Prepared by

CH2MHILL

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1. Introduction

This Technical Memorandum (TM) explains how potentially unacceptable human health and ecological risks identified during previous investigations have been managed or mitigated by the recently completed non time-critical removal action (NTCRA) at Site 11, Bone Yard, Naval Weapons Station (WPNSTA) Yorktown Cheatham Annex (CAX), Williamsburg, Virginia. The NTCRA, conducted in 2009, included removal of impacted soils to address potentially unacceptable ecological risks associated with upper and lower trophic receptor exposure (Shaw, 2009a). Potentially unacceptable human health risks associated with exposure to metals in site groundwater were not addressed as part of this action. This technical memorandum summarizes the mitigation of unacceptable ecological risks and presents a supplemental groundwater evaluation to support consensus for no further action at the site.

2. Site History

Site 11 encompasses an estimated 2.7-acre area located in the south central portion of CAX, south of Antrim Road and the Public Works Facility and west of Penniman Lake (**Figure 1**). Site 11 consists of former Building 269, abandoned Building 268, and an old concrete foundation with a low retaining wall (**Figure 1**). Between 1940 and 1978, Site 11 was reportedly used by public works to store containers of waste-oil, tar and tar cylinders, asphalt, and other scrap materials. Oil, gasoline, petroleum containing tanks, drums, old containers, fence posts, abandoned cars, heavy construction equipment, and various other scrap metals have been observed at the site. It was reported wastes may have been buried at the site; however, previous investigations have not indicated the presence of buried waste. Removal actions, conducted in 1986 and 1997, included the disposal of 77 drums and their contents, tar storage containers, as well as miscellaneous scrap/materials located on the ground surface (Baker, 2000).

Site 11 is mainly an open overgrown grassy field surrounded by mixed-hardwood woodland. The site is bordered on the west by Penniman Lake, and two unnamed tributaries to the north and south. The unnamed tributaries run eastward to Penniman Lake and drain Site 11. In addition to runoff from Site 11, the unnamed tributaries and Penniman Lake receive runoff from surrounding areas. Groundwater flow in the Columbia aquifer at Site 11 is to the east toward Penniman Lake (**Figure 1**).

3. Risk Summary

The Site 11 Remedial Investigation (RI) was completed in April 2007 (Baker, 2007). A human health risk assessment (HHRA) and ecological risk assessment (ERA) were conducted in conjunction with the RI to quantify potential risk to human health and ecological receptors. The RI identified polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and metals in Site 11 media. The results of the HHRA and ERA are summarized below.

3.1 Human Health Risk Assessment

A HHRA was completed for Site 11 to evaluate the risks from current and future human exposure to site media (soil, groundwater, surface water, and sediment). The HHRA is an estimate of the likelihood of health problems occurring if no cleanup action is taken. Potential cancer risks and non-cancer hazards were calculated based on conservative reasonable maximum exposure (RME) concentrations, which portray the highest level of human exposure that could be expected to occur, and central tendency exposure (CTE) calculations based on more reasonable exposures. Potentially unacceptable cancer risks are expressed as the probability that a person has greater than a 1 in 10,000 ($1x10^{-4}$) chance of developing cancer, with an acceptable risk range of 10^{-4} to 10^{-6}. The potential for non-cancer hazards was evaluated by determining the ratio of exposure to toxicity; this ratio is called a hazard quotient (HQ). An HQ greater than 1 indicates that a receptor's exposures may present an unacceptable risk. The hazard index (HI) is generated by adding the HQs for all chemicals that affect the same target organ (for example, the liver) or cause adverse health effects within a medium or across all media to which an individual may reasonably be exposed. For non-cancer, an HI value greater than 1 indicates exposures may present an unacceptable risk.

Exposure point concentrations (EPCs) used to calculate risks for soil, groundwater, surface water, and sediment are summarized in Appendix J, Tables 3.1 through 3.7 of the RI Report (Baker, 2007), and a summary of RME and CTE cancer risks and non-cancer hazards for these media are presented in **Tables 1 and 2**, respectively.

3.1.1 Soil

Potential risks associated with exposure to site soil were quantitatively evaluated for the following receptors: current on-site workers, current adult and adolescent recreational users, current adult and adolescent trespassers, future industrial/commercial workers, future construction workers, future adult and adolescent trespassers, and future adult and child residents. The RME EPCs were calculated as the 95 percent upper confidence limit (95% UCL). The maximum detected concentration was used in place of the 95% UCL when the calculated 95% UCL was greater than the maximum detected value.

All non-cancer hazards and cancer risks for current use scenarios are within or below USEPA's acceptable risk ranges. The RME cancer risks associated with future exposure to soil are within or below USEPA's acceptable risk range for all future receptor scenarios evaluated and the RME non-cancer hazards associated with future exposure to soil are below 1 for the future industrial/commercial workers, future construction workers, future adult and adolescent trespassers, and future adult residents. The RME non-cancer hazard for the future child resident (HI = 2.7) is greater than 1 due primarily to the presence of iron (HQ = 1.2) in Site 11 soil. However, the EPC used to calculate RME risk (26,349 mg/kg) is below the Soil Association 2 background value (30,000 mg/kg) and there are no unacceptable future hazards associated with exposure to site soil based on CTE calculations.

3.1.2 Groundwater

Groundwater in the vicinity of Site 11 is not currently used as a potable water supply, and there is no complete exposure pathway. Exposure to groundwater as a future potable water

supply was quantitatively evaluated as a worst-case scenario for future adult and child residents, and future construction workers. Because of the limited data set and lack of contaminant plume, the RME and CTE EPCs used to calculate risks were the maximum detected concentrations for each COPC identified.

RME cancer risks and non-cancer hazards associated with future construction workers exposed to site groundwater are below USEPA's acceptable risk range. Possible future use of site groundwater as a residential potable water supply may result in a non-cancer hazard and cancer risk above USEPA's acceptable risk levels due to the presence of metals in groundwater, based on RME calculations. RME cancer risks (CR) associated with exposure to arsenic in groundwater are above USEPA's acceptable risk range (10^{-4} to 10^{-6}) for future adult (CR = 1.8×10^{-4}) and child (CR = 1.1×10^{-4}) residents. There are no unacceptable cancer risks associated with future potable use of groundwater based on CTE calculations. Future residential use of groundwater may result in a non-cancer hazard above USEPA's target threshold of 1 due to ingestion of arsenic, iron, and manganese based on RME and CTE calculations (**Tables 1 and 2**). Ingestion of groundwater by a future adult resident may result in a non-cancer hazard of 1.4 based on CTE calculations, although no individual target organ effects are greater than USEPA's target hazard index of 1.

3.1.3 Surface Water and Sediment

Exposure to surface water and sediment for current on-site workers, current adult and adolescent recreational users, current and future adult and adolescent trespassers, and future adult and child residents were quantitatively evaluated for the two unnamed tributaries adjacent to Site 11. All cancer risks and non-cancer hazards associated with current and future exposure to surface water and sediment within the unnamed tributaries are within or below USEPA's acceptable risk ranges.

Surface water and sediment data collected from Penniman Lake was evaluated against screening criteria to identify COPCs; however, risks were not quantitatively evaluated due to an incomplete current exposure pathway and the uncertainty associated with future exposure. COPCs identified for Penniman Lake surface water are trichloroethene (TCE), total arsenic, and total and dissolved thallium. COPCs identified for Penniman lake sediment are methyl cyclohexane, Aroclor®-1260, arsenic, iron, and vanadium.

3.2 Ecological Risk Assessment

An ecological risk assessment (ERA), through Step 3A of the ERA process, was conducted to evaluate the potential risks to ecological receptors in the terrestrial habitat, north tributary aquatic habitat, and south tributary aquatic habitat at Site 11, and in adjacent Penniman Lake.

3.2.1 Soil - Terrestrial Habitats

Potentially unacceptable risks were identified for terrestrial plants and soil invertebrates from exposure to PAHs (total), 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, endrin, copper, iron, lead, mercury, selenium, thallium, and zinc in surface soil (0-6 inches bgs) and/or subsurface soil (6-24 inches bgs). Unacceptable risks to upper trophic level terrestrial receptors from food web exposures were also identified for 4,4'-DDD, 4,4'-DDE, and

mercury. The highest potential risks were associated with the area around samples 11SS16 and 11SS17 (**Figure 2**), although other localized areas contributing to risk were also identified.

3.2.2 Surface Water and Sediment - Site 11

Potentially unacceptable risks associated with Aroclor-1260 were identified for lower trophic level receptors in surface water, surface sediment (0-4 inches bgs), and subsurface sediment (4-8 inches bgs) from the northern tributary. Aroclor-1260 may also pose an unacceptable risk to avian piscivores using the northern tributary. Arsenic and iron were identified as COPCs in the surface water of the southern tributary, although potential risks associated with these metals appear to be minimal. Aroclor-1260 was identified as a COPC in surface and subsurface sediment at one location in the southern tributary near Penniman Lake. The PCBs in the surface water and sediment of both tributaries do not appear to be site-related; the source of the PCBs is not currently known.

3.2.3 Surface Water and Sediment - Penniman Lake

Aroclor-1260 in lake surface water and surface sediment (but not subsurface sediment) was associated with unacceptable risks for both lower and upper trophic level receptors. The PCBs in lake media do not appear to be associated with Site 11. In addition, arsenic was identified as a COPC in Penniman Lake surface water, although potential risks associated with this metal appear to be minimal. The maximum total concentration of arsenic is less than the current freshwater Ambient Water Quality Criteria for the Protection of Aquatic Life and arsenic was not detected in dissolved surface water samples (which best reflect the bioavailability of this metal) from the lake. Lead was identified as a COPC in Penniman Lake surface sediment and may be site related. The soil removal action eliminated the source of lead at Site 11.

4. Removal Action Summary

The removal of impacted soils was conducted in 2009 to provide long-term protection of human health and the environment and to reduce or eliminate chemicals determined to pose potentially unacceptable risk to ecological receptors in focus Areas 1, 2, 3, and 4 (**Figure 2**) (CH2M HILL, 2008). During the development of the EE/CA, preliminary remediation goals (PRGs) were developed based upon their protectiveness to ecological receptors (**Table 3**). Because there is no potentially unacceptable risk to human health from exposure to soil contamination attributable to the site, PRGs were identified as the higher of ecological screening criteria, background soil concentrations, or PRGs previously established at other CAX or WPNSTA Yorktown sites with similar characteristics. PRGs were not established for all ecological COCs identified based on frequency of detections and extent of screening criteria exceedances as discussed in Section 3.2.3 of the EE/CA. The removal of these constituents would be accomplished through the PRGs established for more prominent COCs.

Pre-construction sampling was performed in January and February 2009 to establish horizontal “clean lines” to define the removal areas. Pre-construction sampling results are provided as Appendix B of the Construction Completion Report (CCR) (Shaw, 2009b).

Surface and subsurface (Areas 1 and 2 only) soil samples were collected along the perimeters of each focus area to ensure remediation areas had been fully delineated (**Figure 3**). Samples were analyzed for area specific COCs and results were compared against PRGs. The final removal areas are shown on **Figure 3**.

During development of the Removal Action Work Plan, an additional hotspot for removal (Area 5) was identified due to lead exceeding the ecological soil screening criteria at sample location 11SS12 (**Figure 2**). Although the calculated post-remedial (Areas 1 through 4) site-wide risk associated with lead met the PRG without the Area 5 removal, the USEPA and VDEQ Remedial Project Managers expressed concern at the magnitude of the lead concentration at this location and the lack of nearby bounding samples. Surface and subsurface soil samples were collected in March 2009 to delineate the lateral and vertical extent of Area 5 removal. Samples were collected 10 feet and 30 feet north, south, east, and west of 11SS12 and analyzed for lead. Results were compared to the lead PRG and the final removal boundary was established (**Figure 3**).

Focus area excavation was completed in March 2009. Approximately 2,803 cubic yards of contaminated soil and debris and 89 cubic yards of concrete were excavated from focus Areas 1, 2, 3, 4, and 5. Post-excavation confirmation samples were collected from each focus area for comparison to PRGs. Sample locations and analytical results are presented on **Figure 4**. Raw analytical data is presented in Appendix B of the CCR. Each area was excavated until all sample results met established PRGs. Following removal the site was backfilled with clean fill, covered with 6 inches of top soil, and seeded.

5. Supplemental Groundwater Evaluation

To address potentially unacceptable risks associated with potable use of groundwater due to arsenic, iron, and manganese identified in the RI, a supplemental groundwater evaluation is presented below in consideration of **Attachment 1**, the December 6, 2004 Statement to Tier I Teams in which Tier II encourages flexibility by the partnering teams when assessing beneficial use and potability of groundwater and site-specific cleanup goals.

5.1.1 Background

The HHRA indicated that unacceptable risks from groundwater were due principally to two point locations of elevated dissolved arsenic, iron, and manganese in monitoring wells 11GW01 and 11GW05 (**Figure 5**). Groundwater flow direction at Site 11 is northeast towards Penniman Lake (**Figure 1**); therefore, monitoring wells 11GW01 and 11GW05 are located hydraulically upgradient of historic site activities. Detected concentrations of metals in groundwater from monitoring wells 11GW01 and 11GW05 are representative of background conditions and not historic site activities; therefore, should not be considered when evaluating site risks. Because the maximum detected concentrations were used as EPCs to quantitatively evaluate risks to human health, the removal of monitoring wells 11GW01 and 11GW05 from the site impacted well network would reduce the EPCs (maximum detected) of iron and manganese to levels below the adjusted tap-water RSLs. Arsenic was not detected in site impacted monitoring wells. Therefore, these constituents would not be selected as COPCs for further quantitative evaluation in the risk assessment.

5.1.2 No Discernable Plume

Arsenic was detected in two of eight monitoring wells 11GW01 and 11GW05 (**Figure 5**). Although iron and manganese were detected in several site monitoring wells, concentrations exceeded maximum background concentrations in only 2 of 8 wells. No discernable plume of arsenic, iron, or manganese is present at Site 11.

5.1.3 Aquifer Classification Status

It is anticipated that Cheatham Annex will remain a military installation for the foreseeable future. The Columbia aquifer is not used as a drinking water source at the base and is not anticipated to be used as a drinking water source since other sources of higher quality water are available.

According to the *Guidelines for Ground-Water Classification* (USEPA, 1986), a Class IIB Drinking Water Source is a "potential source of drinking water and water having other beneficial uses." Site 11 may meet the USEPA's guidelines for a Class II drinking water source [total dissolved solids (TDS) less than 10,000 mg/L, treatable constituent concentrations, and yield of 150 gallons/day]. However, the Columbia aquifer at Site 11 does not meet the Virginia Private Well Regulations guidelines for installation of groundwater wells for potable use. Yield from Site 11 wells is not likely to meet the Virginia Private Well Regulation guideline of a yield of 5 gallons per minute (gpm) for 10 minutes. Additionally, according to 12 VAC 5-590-840, the shortest permitted casing length for wells is 50 feet (Class II, Type B), which would extend below the bottom depth of the Columbia aquifer underlying Site 11.

6. Consensus for No Further Action

The 2009 removal action mitigated the unacceptable ecological risk identified in the RI for exposure to soil by removing areas with soil concentrations of COCs exceeding established remediation goals. Therefore, no further actions are warranted to protect ecological receptors from potential exposures to soil. Potentially unacceptable ecological risks associated with exposure to surface water and sediment in the unnamed tributaries and Penniman Lake were identified due to Aroclor-1260. However, data indicate this constituent is not related to historic Site 11 activities and, therefore, PCBs within these tributaries and Penniman Lake will be addressed as part of Penniman Lake investigations.

Although the arsenic, iron, and manganese groundwater concentrations evaluated in the RI result in non-cancer hazards and cancer risks greater than USEPA's acceptable thresholds, with the exception of upgradient monitoring wells 11GW01 and 11GW05, concentrations of iron and manganese detected in site impacted monitoring wells are below background and arsenic is not detected. No discernable metals plume is present at the site. Elevated concentrations of these constituents have been detected in hydraulically upgradient groundwater collected from monitoring wells 11GW01 and 11GW05 and are a reflection of background conditions and not a CERCLA release from historic Site 11 activities. For these reasons, no further action is warranted for groundwater at Site 11.

7. References

Baker. 2000. *Draft Removal Closeout Report, Site 11 – Bone Yard, Naval Weapons Station Yorktown, Cheatham Annex, Williamsburg, Virginia.* April.

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CH2M HILL. 2008. *Engineering Evaluation/Cost Analysis (EE/CA), Site 11 (Bone Yard), Naval Weapons Station Yorktown, Cheatham Annex, Williamsburg, Virginia.* November.

Shaw Environmental, Inc. (Shaw). 2009a. *Final Work Plan, Site 11 Hot Spot Removal Action, Naval Weapons Station Yorktown, Cheatham Annex, Williamsburg, Virginia.* February.

Shaw. 2009b. *Draft Final Construction Completion Report Hot Spot Removal Action at Site 11, Yorktown Naval Weapons Station, Cheatham Annex, Williamsburg, Virginia.* August.

No Further Action Consensus for Site 11

The Navy, in partnership with the USEPA and VDEQ, agree that, based on the lines of evidence presented in this Technical Memorandum "*Consensus for No Further Action in Soil and Groundwater, Site 11 - Bone Yard*", risks associated with PCBs in sediment and surface water will be addressed as part of Penniman Lake and NFA for soil and groundwater are necessary at Site 11 to protect human health and the environment.

Mr. Christopher Murray
NAVFAC Mid-Atlantic

_____ Date _____

Ms. Sue Haug
USEPA Region 3

_____ Date _____

Mr. Wade Smith
Virginia DEQ

_____ Date _____

Tables

TABLE 1
Summary of Reasonable Maximum Exposure Cancer Risks and Hazard Indices
Site 11 NFA Consensus Tech Memo
Cheatham Annex, Williamsburg, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10^{-4}	Hazard Index	Chemicals with HQ>1
Current/Future Trespasser - Adult	Surface Soil	Ingestion	1.5E-06		3.4E-02	
		Dermal Contact	5.2E-07		1.3E-02	
		Inhalation	1.8E-09		8.1E-05	
		Total	2.0E-06		4.7E-02	
	Surface Water (Streams)	Ingestion	3.4E-07		2.0E-03	
		Dermal Contact	1.0E-05		1.4E-04	
		Inhalation	--		--	
		Total	1.1E-05		2.1E-03	
	Sediment (Streams)	Ingestion	1.5E-06		2.4E-02	
		Dermal Contact	2.5E-07		1.7E-03	
		Inhalation	--		--	
		Total	1.8E-06		2.5E-02	
	All Media	Total	1.5E-05		7.0E-02	
Current/Future Trespasser - Adolescent	Surface Soil	Ingestion	8.7E-07		5.4E-02	
		Dermal Contact	8.1E-07		5.2E-02	
		Inhalation	1.0E-09		1.3E-04	
		Total	1.7E-06		1.1E-01	
	Surface Water (Streams)	Ingestion	2.0E-07		3.1E-03	
		Dermal Contact	5.7E-06		2.0E-04	
		Inhalation	--		--	
		Total	5.8E-06		3.3E-03	
	Sediment (Streams)	Ingestion	9.0E-07		3.7E-02	
		Dermal Contact	3.9E-07		6.9E-03	
		Inhalation	--		--	
		Total	1.3E-06		4.4E-02	
	All Media	Total	8.8E-06		1.5E-01	
Current Recreational Users - Adult	Surface Soil	Ingestion	1.5E-06		3.4E-02	
		Dermal Contact	5.2E-07		1.3E-02	
		Inhalation	3.6E-09		1.6E-04	
		Total	2.0E-06		4.7E-02	
	Surface Water (Streams)	Ingestion	8.8E-07		5.1E-03	
		Dermal Contact	8.6E-05		1.1E-03	
		Inhalation	--		--	
		Total	8.6E-05		6.2E-03	
	Sediment (Streams)	Ingestion	1.5E-06		2.4E-02	
		Dermal Contact	2.5E-07		1.7E-03	
		Inhalation	--		--	
		Total	1.8E-06		2.5E-02	
	All Media	Total	9.0E-05		8.0E-02	
Current Recreational Users - Adolescent	Surface Soil	Ingestion	8.7E-07		5.4E-02	
		Dermal Contact	8.1E-07		5.2E-02	
		Inhalation	2.1E-09		2.5E-04	
		Total	1.7E-06		1.1E-01	
	Surface Water (Streams)	Ingestion	5.1E-07		8.0E-03	
		Dermal Contact	1.8E-05		6.3E-04	
		Inhalation	--		--	
		Total	1.9E-05		8.6E-03	
	Sediment (Streams)	Ingestion	9.0E-07		3.7E-02	
		Dermal Contact	3.9E-07		6.9E-03	
		Inhalation	--		--	
		Total	1.3E-06		4.4E-02	
	All Media	Total	2.2E-05		1.6E-01	
Current On-Site Workers	Surface Soil	Ingestion	3.7E-06		8.3E-02	
		Dermal Contact	4.3E-06		1.0E-01	
		Inhalation	3.2E-08		1.4E-03	
		Total	8.1E-06		1.8E-01	
	Surface Water (Streams)	Ingestion	1.7E-06		9.5E-03	
		Dermal Contact	3.0E-05		3.8E-04	
		Inhalation	--		--	
		Total	3.2E-05		9.9E-03	
	Sediment (Streams)	Ingestion	3.8E-06		5.7E-02	
		Dermal Contact	2.1E-06		1.3E-02	
		Inhalation	--		--	
		Total	5.9E-06		7.0E-02	
	All Media	Total	4.6E-05		2.6E-01	

TABLE 2

Summary of Central Tendency Cancer Risks and Hazard Indices

Site 11 NFA Consensus Tech Memo

Cheatham Annex, Williamsburg, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10^{-4}	Hazard Index	Chemicals with HQ>1
Future Residents - Adult	Total Soil	Ingestion	9.7E-07		7.7E-02	
		Dermal Contact	6.0E-07		4.9E-02	
		Inhalation	1.4E-08		2.2E-03	
		Total	1.6E-06		1.3E-01	
	Groundwater - Tap	Ingestion	2.5E-05		**1.4E+00**	
		Dermal Contact	2.7E-08		9.4E-03	
		Inhalation	--		--	
		Total	2.6E-05		**1.4E+00**	
	Surface Water (Streams)	Ingestion	7.6E-08		1.5E-03	
		Dermal Contact	2.1E-06		9.1E-05	
		Inhalation	--		--	
		Total	2.1E-06		1.6E-03	
	Sediment (Streams)	Ingestion	1.7E-07		9.1E-03	
		Dermal Contact	4.9E-08		1.1E-03	
		Inhalation	--		--	
		Total	2.2E-07		1.0E-02	
	All Media	Total	2.9E-05		**1.6E+00**	
Future Residents - Young Child	Total Soil	Ingestion	2.6E-06		7.2E-01	
		Dermal Contact	9.1E-07		2.6E-01	
		Inhalation	1.9E-08		1.0E-02	
		Total	3.5E-06		9.9E-01	
	Groundwater - Tap	Ingestion	2.4E-05		**4.8E+00**	Arsenic (HQ=1.9), Iron (HQ=1.4), Manganese (HQ=1.5)
		Dermal Contact	1.4E-08		1.7E-02	
		Inhalation	--		--	
		Total	2.4E-05		**4.8E+00**	
	Surface Water (Streams)	Ingestion	1.0E-07		7.1E-03	
		Dermal Contact	1.1E-06		1.7E-04	
		Inhalation	--		--	
		Total	1.2E-06		7.2E-03	
	Sediment (Streams)	Ingestion	4.6E-07		8.5E-02	
		Dermal Contact	7.5E-08		6.0E-03	
		Inhalation	--		--	
		Total	5.3E-07		9.1E-02	
	All Media	Total	3.0E-05		**5.9E+00**	
Future Construction Workers	Total Soil	Ingestion	1.2E-06		6.9E-01	
		Dermal Contact	1.5E-07		8.5E-02	
		Inhalation	6.2E-10		6.8E-04	
		Total	1.4E-06		7.8E-01	
	Groundwater	Ingestion	1.3E-07		4.8E-02	
		Dermal Contact	7.6E-11		1.8E-04	
		Inhalation	--		--	
		Total	1.3E-07		4.8E-02	
	All Media	Total	1.5E-06		8.3E-01	

Bold highlighted text indicates cancer risks and non-cancer hazards above USEPA's acceptable thresholds.

TABLE 3
Soil Preliminary Remediation Goals (PRGs)
Site 11 NFA Consensus Tech Memo
Cheatham Annex, Williamsburg, Virginia

Chemical	Proposed PRG	Reference	Applicable Removal Area
Inorganics (mg/kg)			
Copper	70	Ecological Soil Screening Concentration (EPA Ecological Soil Screening Level, 2007)	1 and 3
Iron	46,400	Background Soil Concentration (Yorktown anthropogenic maximum surface soil background value previously used in the CAX Site 11 Baseline Ecological Risk Assessment)	3
Lead	120	Ecological Soil Screening Concentration (EPA Ecological Soil Screening Level, 2005; PRG used at Yorktown Site 30)	1, 3, and 4
Mercury	0.24*	Background Soil Concentration (CAX soil association #1 maximum surface soil background concentration; PRG previously used at CAX Site 1 and Yorktown Sites 4, 21, 23, and 30)	1, 3, and 4
Selenium	1.8	Ecological Soil Screening Concentration (EPA Region 3 Biological Technical Assistance Group, 1995; PRG used at Yorktown Site 30)	3 and 4
Zinc	120	Ecological Soil Screening Concentration (EPA Ecological Soil Screening Level, 2007)	1, 2, 3, and 4
Pesticides (µgkg)			
4,4-DDD	100	Ecological Soil Screening Concentration (EPA Region 3 Biological Technical Assistance Group, 1995)	1, 3, and 4
4,4,-DDE	100	Ecological Soil Screening Concentration (EPA Region 3 Biological Technical Assistance Group, 1995)	1, 3, and 4
Semi-Volatile Organic Compounds (SVOCs) (µg/kg)			
Total Polyaromatic Hydrocarbons (PAHs)	18,000	Ecological Soil Screening Concentration (EPA Ecological Soil Screening Level, 2007)	1

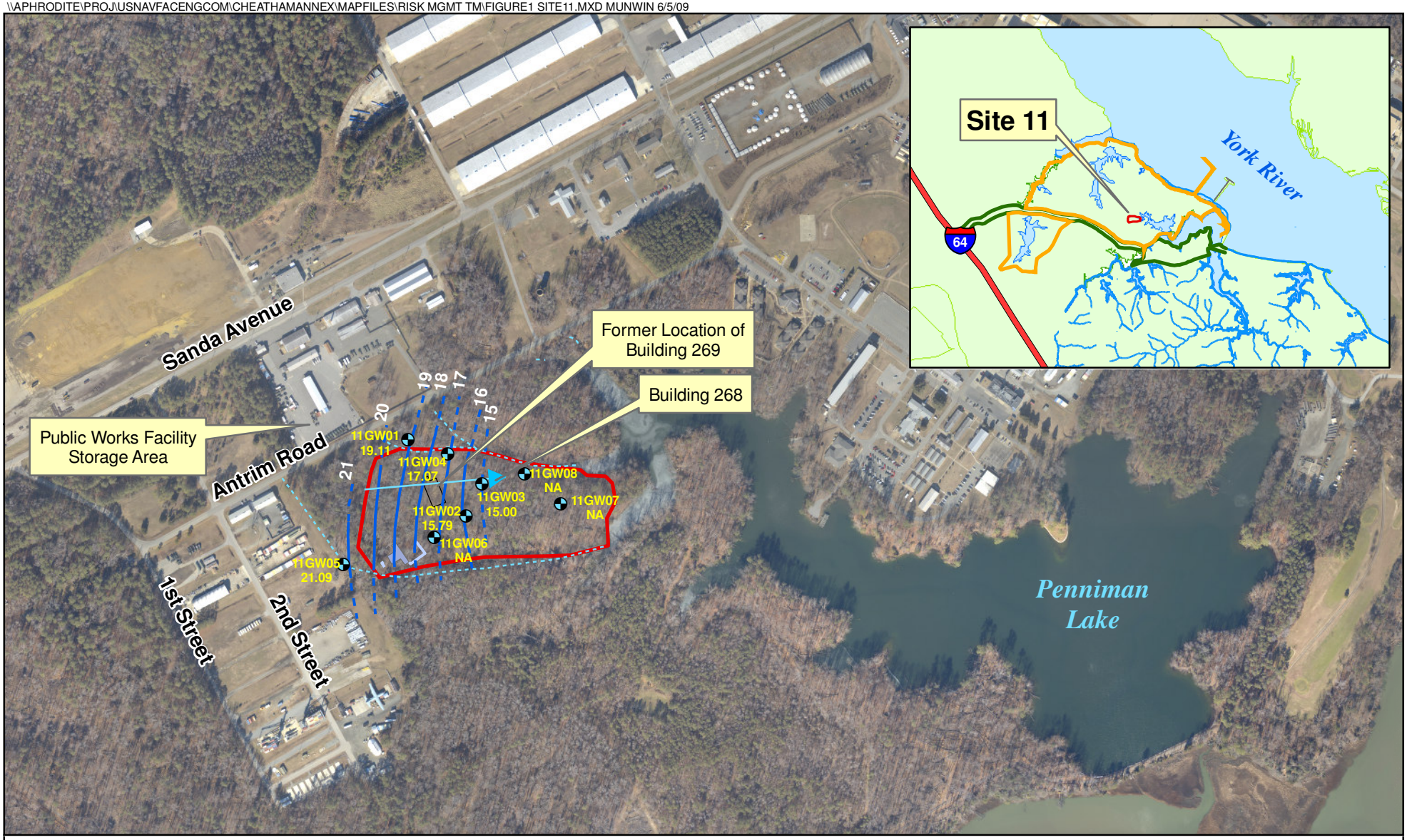
*Mercury PRG is based on a CAX soil association #1 maximum surface soil background value. This value has been approved by the Partnering Team for use at other soil association #2 sites (i.e., CAX Site 1 and Yorktown Sites 4, 21, 23, and 30) based on a risk management decision that originated from work completed at Yorktown Site 21. During the Site 21 Feasibility Study (Baker, 2001; AR#01160), the final remediation goal for mercury was identified as 0.3 ppm based on the calculated ecological uptake goal for a robin receptor. However, during the Record of Decision (Baker, 2003; AR#01374), the Partnering Team agreed that the CAX soil association #1 maximum surface soil background would be used instead as the final remediation goal since it was slightly more conservative than the calculated ecological uptake goal.

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10^{-4}	Hazard Index	Chemicals with HQ>1
Future Residents - Adult	Total Soil	Ingestion	9.9E-06		2.3E-01	
		Dermal Contact	3.5E-06		8.4E-02	
		Inhalation	7.2E-08		3.3E-03	
		Total	1.3E-05		3.2E-01	
	Groundwater - Tap	Ingestion	**1.9E-04**	Arsenic (1.8E-04)	**3.1E+00**	Arsenic (HQ=1.2)
		Dermal Contact	5.0E-07		5.0E-02	
		Inhalation	--		--	
		Total	**1.9E-04**		**3.1E+00**	
	Surface Water (Streams)	Ingestion	2.6E-07		1.5E-03	
		Dermal Contact	8.0E-06		1.0E-04	
		Inhalation	--		--	
		Total	8.3E-06		1.6E-03	
	Sediment (Streams)	Ingestion	1.2E-06		1.8E-02	
		Dermal Contact	1.9E-07		1.3E-03	
		Inhalation	--		--	
		Total	1.4E-06		2.0E-02	
	All Media	Total	**2.1E-04**		**3.5E+00**	
Future Residents - Young Child	Total Soil	Ingestion	2.3E-05		**2.1E+00**	Iron (HQ=1.1)
		Dermal Contact	5.7E-06		5.5E-01	
		Inhalation	8.4E-08		1.5E-02	
		Total	2.9E-05		**2.7E+00**	
	Groundwater - Tap	Ingestion	**1.1E-04**	Arsenic (1.1E-04)	**7.2E+00**	Arsenic (HQ=2.8), Iron (HQ=2.0), Manganese (HQ=2.2)
		Dermal Contact	2.1E-07		8.6E-02	
		Inhalation	--		--	
		Total	**1.1E-04**		**7.3E+00**	
	Surface Water (Streams)	Ingestion	3.0E-07		7.1E-03	
		Dermal Contact	4.6E-06		2.4E-04	
		Inhalation	--		--	
		Total	4.9E-06		7.3E-03	
	Sediment (Streams)	Ingestion	2.8E-06		1.7E-01	
		Dermal Contact	3.1E-07		8.4E-03	
		Inhalation	--		--	
		Total	3.1E-06		1.8E-01	
	All Media	Total	**1.5E-04**		**1.0E+01**	
Future Industrial/Commercial	Total Soil	Ingestion	7.4E-06		1.6E-01	
		Dermal Contact	1.5E-06		3.5E-02	
		Inhalation	2.4E-08		1.0E-03	
		Total	8.9E-06		2.0E-01	
		Total	8.9E-06		2.0E-01	
Future Construction Workers	Total Soil	Ingestion	1.4E-06		7.9E-01	
		Dermal Contact	1.7E-07		1.0E-01	
		Inhalation	2.1E-09		2.3E-03	
		Total	1.6E-06		8.9E-01	
	Groundwater	Ingestion	1.4E-07		5.5E-02	
		Dermal Contact	8.9E-08		2.1E-01	
		Inhalation	--		--	
		Total	2.3E-07		2.6E-01	
	All Media	Total	1.8E-06		**1.2E+00**	

Bold highlighted text indicates cancer risks and non-cancer hazards above USEPA's acceptable thresholds.

Figures

\\APHRODITE\PROJ\USNAVFACENGCOM\CHEATHAMANNEX\MAPFILES\RISK MGMT TM\FIGURE1 SITE11.MXD MUNWIN 6/5/09



Legend

- Study Area Boundary
- Monitoring Well
- Unnamed Tributary
- Old Concrete Foundation
- Groundwater Contour
- Inferred Contour
- Groundwater Flow (June 2002)

NA - casing elevation data not available.

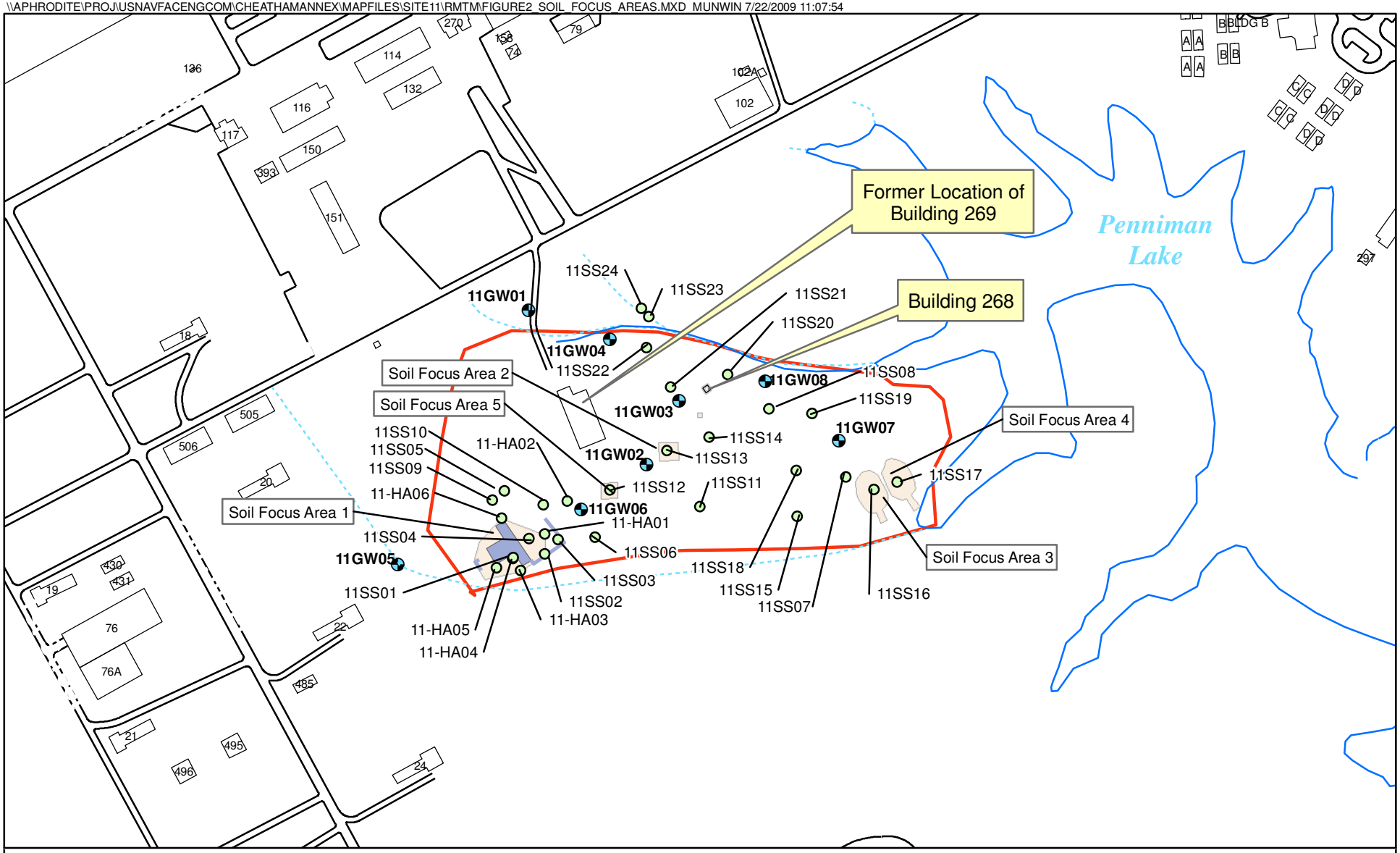
N W E S

0 300 600 Feet

Figure 1
Site Map
Site 11 NFA Consensus Tech Memo
Cheatham Annex
Williamsburg, Virginia

CH2MHILL

\\APHRODITE\PROJ\USNAVFACENGCOM\CHEATHAMANNEX\MAPFILES\SITE11\RMTM\FIGURE2_SOIL_FOCUS_AREAS.MXD MUNWIN 7/22/2009 11:07:54



Legend

- Surface Soil Sample Locations (1999 and 2002)
- Monitoring Well
- Unnamed Tributary
- Old Concrete Foundation
- Estimated Extent of Soil Focus Areas
- Site 11 Study Area Boundary

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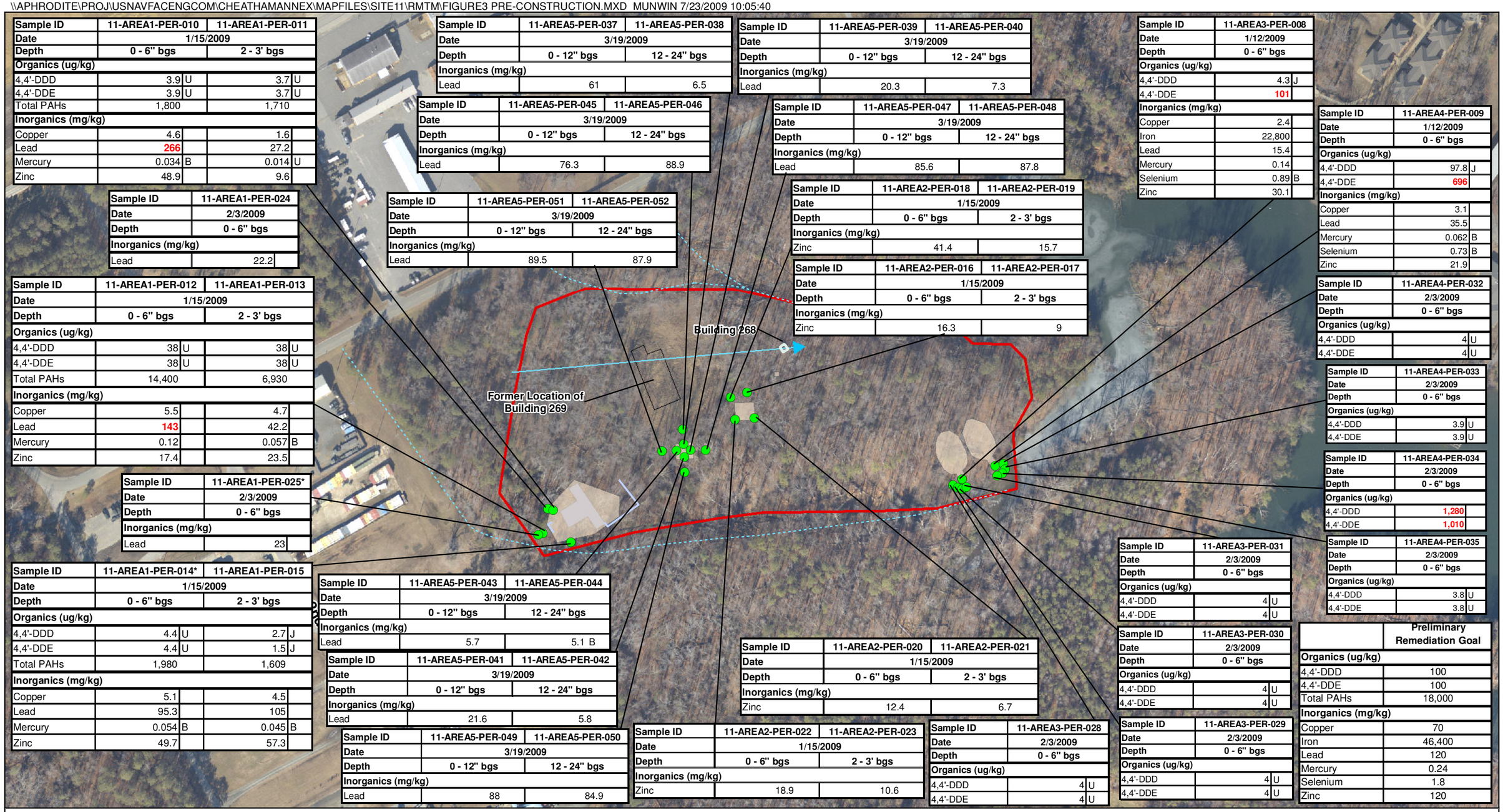
Figure 2
Soil Focus Areas
Site 11 NFA Consensus Tech Memo
Cheatham Annex
Williamsburg, Virginia

CH2MHILL



Sample ID	11-AREA1-PER-010		11-AREA1-PER-011	
Date	1/15/2009			
Depth	0 - 6" bgs		2 - 3' bgs	
Organics (ug/kg)				
4,4'-DDD	3.9	U	3.7	U
4,4'-DDE	3.9	U	3.7	U
Total PAHs	1,800		1,710	
Inorganics (mg/kg)				
Copper	4.6		1.6	
Lead	**266**		27.2	
Mercury	0.034	B	0.014	U
Zinc	48.9		9.6	

Sample ID	11-AREA1-PER-024	
Date	2/3/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Lead	22.2	

Sample ID	11-AREA1-PER-012		11-AREA1-PER-013	
Date	1/15/2009			
Depth	0 - 6" bgs		2 - 3' bgs	
Organics (ug/kg)				
4,4'-DDD	38	U	38	U
4,4'-DDE	38	U	38	U
Total PAHs	14,400		6,930	
Inorganics (mg/kg)				
Copper	5.5		4.7	
Lead	**143**		42.2	
Mercury	0.12		0.057	B
Zinc	17.4		23.5	

Sample ID	11-AREA1-PER-025*	
Date	2/3/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Lead	23	

Sample ID	11-AREA1-PER-014*		11-AREA1-PER-015	
Date	1/15/2009			
Depth	0 - 6" bgs		2 - 3' bgs	
Organics (ug/kg)				
4,4'-DDD	4.4	U	2.7	J
4,4'-DDE	4.4	U	1.5	J
Total PAHs	1,980		1,609	
Inorganics (mg/kg)				
Copper	5.1		4.5	
Lead	95.3		105	
Mercury	0.054	B	0.045	B
Zinc	49.7		57.3	

Sample ID	11-AREA5-PER-037	11-AREA5-PER-038
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	61	6.5

Sample ID	11-AREA5-PER-045	11-AREA5-PER-046
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	76.3	88.9

Sample ID	11-AREA5-PER-051	11-AREA5-PER-052
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	89.5	87.9

Sample ID	11-AREA5-PER-043	11-AREA5-PER-044
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	5.7	5.1 B

Sample ID	11-AREA5-PER-041	11-AREA5-PER-042
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	21.6	5.8

Sample ID	11-AREA5-PER-049	11-AREA5-PER-050
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	88	84.9

Sample ID	11-AREA5-PER-039	11-AREA5-PER-040
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	20.3	7.3

Sample ID	11-AREA5-PER-047	11-AREA5-PER-048
Date	3/19/2009	
Depth	0 - 12" bgs	12 - 24" bgs
Inorganics (mg/kg)		
Lead	85.6	87.8

Sample ID	11-AREA2-PER-018	11-AREA2-PER-019
Date	1/15/2009	
Depth	0 - 6" bgs	2 - 3' bgs
Inorganics (mg/kg)		
Zinc	41.4	15.7

Sample ID	11-AREA2-PER-016	11-AREA2-PER-017
Date	1/15/2009	
Depth	0 - 6" bgs	2 - 3' bgs
Inorganics (mg/kg)		
Zinc	16.3	9

Sample ID	11-AREA2-PER-020	11-AREA2-PER-021
Date	1/15/2009	
Depth	0 - 6" bgs	2 - 3' bgs
Inorganics (mg/kg)		
Zinc	12.4	6.7

Sample ID	11-AREA2-PER-022	11-AREA2-PER-023
Date	1/15/2009	
Depth	0 - 6" bgs	2 - 3' bgs
Inorganics (mg/kg)		
Zinc	18.9	10.6

Sample ID	11-AREA3-PER-028	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4	U

Sample ID	11-AREA3-PER-029	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4	U

Sample ID	11-AREA3-PER-030	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4	U

Sample ID	11-AREA3-PER-031	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4	U

Sample ID	11-AREA3-PER-008	
Date	1/12/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.3	J
4,4'-DDE	**101**	
Inorganics (mg/kg)		
Copper	2.4	
Iron	22,800	
Lead	15.4	
Mercury	0.14	
Selenium	0.89	B
Zinc	30.1	

Sample ID	11-AREA4-PER-009	
Date	1/12/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	97.8	J
4,4'-DDE	**696**	
Inorganics (mg/kg)		
Copper	3.1	
Lead	35.5	
Mercury	0.062	B
Selenium	0.73	B
Zinc	21.9	

Sample ID	11-AREA4-PER-032	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4	U

Sample ID	11-AREA4-PER-033	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.9	U
4,4'-DDE	3.9	U

Sample ID	11-AREA4-PER-034	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	**1,280**	
4,4'-DDE	**1,010**	

Sample ID	11-AREA4-PER-035	
Date	2/3/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U

	Preliminary Remediation Goal
Organics (ug/kg)	
4,4'-DDD	100
4,4'-DDE	100
Total PAHs	18,000
Inorganics (mg/kg)	
Copper	70
Iron	46,400
Lead	120
Mercury	0.24
Selenium	1.8
Zinc	120

Legend

- Pre-Construction Sampling Locations
- Study Area Boundary
- Unnamed Tributary
- Old Concrete Foundation
- Estimated Extent of Soil Focus Areas
- Groundwater Flow (June 2002)

* Duplicate sample collected at this location. Most conservative value reported.
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected.
Red bold text indicates exceedance of PRG.

Note: Total PAHs is a straight summation of all detected PAHs. For any non-detect analytes one-half the laboratory quantitation limit was used as the value in the summation.

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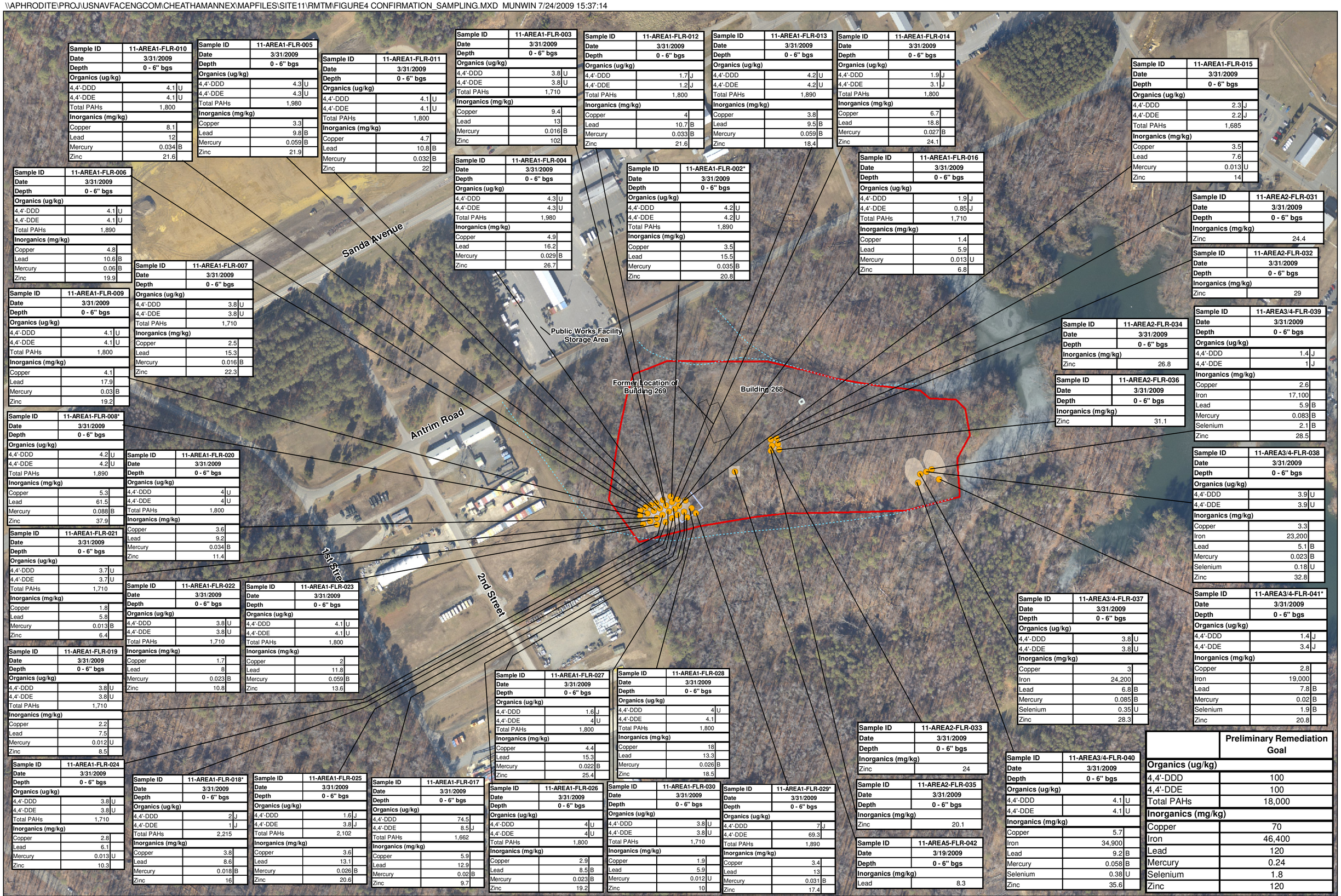
Figure 3
Pre-Construction Sampling
Site 11 NFA Consensus Tech Memo
Cheatham Annex
Williamsburg, Virginia

CH2MHILL



Sample ID	11-AREA1-FLR-010	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.1	U
4,4'-DDE	4.1	U
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	8.1	
Lead	12	
Mercury	0.034	B
Zinc	21.6	

Sample ID	11-AREA1-FLR-005	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.3	U
4,4'-DDE	4.3	U
Total PAHs	1,980	
Inorganics (mg/kg)		
Copper	3.3	
Lead	9.8	B
Mercury	0.059	B
Zinc	21.9	

Sample ID	11-AREA1-FLR-011	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.1	U
4,4'-DDE	4.1	U
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	4.7	
Lead	10.8	B
Mercury	0.032	B
Zinc	22	

Sample ID	11-AREA1-FLR-003	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	9.4	
Lead	13	
Mercury	0.016	B
Zinc	102	

Sample ID	11-AREA1-FLR-012	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	1.7	J
4,4'-DDE	1.2	J
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	4	
Lead	10.7	B
Mercury	0.033	B
Zinc	21.6	

Sample ID	11-AREA1-FLR-013	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.2	U
4,4'-DDE	4.2	U
Total PAHs	1,890	
Inorganics (mg/kg)		
Copper	3.8	
Lead	9.5	B
Mercury	0.059	B
Zinc	18.4	

Sample ID	11-AREA1-FLR-014	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	1.9	J
4,4'-DDE	3.1	J
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	6.7	
Lead	18.8	
Mercury	0.027	B
Zinc	24.1	

Sample ID	11-AREA1-FLR-015	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	2.3	J
4,4'-DDE	2.2	J
Total PAHs	1,685	
Inorganics (mg/kg)		
Copper	3.5	
Lead	7.6	
Mercury	0.013	U
Zinc	14	

Sample ID	11-AREA1-FLR-006	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.1	U
4,4'-DDE	4.1	U
Total PAHs	1,890	
Inorganics (mg/kg)		
Copper	4.8	
Lead	10.6	B
Mercury	0.06	B
Zinc	19.9	

Sample ID	11-AREA1-FLR-004	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.3	U
4,4'-DDE	4.3	U
Total PAHs	1,980	
Inorganics (mg/kg)		
Copper	4.9	
Lead	16.2	
Mercury	0.029	B
Zinc	26.7	

Sample ID	11-AREA1-FLR-002*	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.2	U
4,4'-DDE	4.2	U
Total PAHs	1,890	
Inorganics (mg/kg)		
Copper	3.5	
Lead	15.5	
Mercury	0.035	B
Zinc	20.8	

Sample ID	11-AREA1-FLR-016	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	1.9	J
4,4'-DDE	0.85	J
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	1.4	
Lead	5.9	
Mercury	0.013	U
Zinc	6.8	

Sample ID	11-AREA2-FLR-031	
Date	3/31/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Zinc	24.4	

Sample ID	11-AREA2-FLR-032	
Date	3/31/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Zinc	29	

Sample ID	11-AREA1-FLR-007	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	2.5	
Lead	15.3	
Mercury	0.016	B
Zinc	22.3	

Sample ID	11-AREA1-FLR-009	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.1	U
4,4'-DDE	4.1	U
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	4.1	
Lead	17.9	
Mercury	0.03	B
Zinc	19.2	

Sample ID	11-AREA2-FLR-034	
Date	3/31/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Zinc	26.8	

Sample ID	11-AREA2-FLR-036	
Date	3/31/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Zinc	31.1	

Sample ID	11-AREA3/4-FLR-039	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	1.4	J
4,4'-DDE	1	J
Inorganics (mg/kg)		
Copper	2.6	
Iron	17,100	
Lead	5.9	B
Mercury	0.083	B
Selenium	2.1	B
Zinc	28.5	

Sample ID	11-AREA1-FLR-008*	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.2	U
4,4'-DDE	4.2	U
Total PAHs	1,890	
Inorganics (mg/kg)		
Copper	5.3	
Lead	61.5	
Mercury	0.088	B
Zinc	37.9	

Sample ID	11-AREA1-FLR-020	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4	U
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	3.6	
Lead	9.2	
Mercury	0.034	B
Zinc	11.4	

Sample ID	11-AREA3/4-FLR-038	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.9	U
4,4'-DDE	3.9	U
Inorganics (mg/kg)		
Copper	3.3	
Iron	23,200	
Lead	5.1	B
Mercury	0.023	B
Selenium	0.18	U
Zinc	32.8	

Sample ID	11-AREA1-FLR-021	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.7	U
4,4'-DDE	3.7	U
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	1.8	
Lead	5.8	
Mercury	0.013	B
Zinc	6.4	

Sample ID	11-AREA1-FLR-022	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	1.7	
Lead	8	
Mercury	0.023	B
Zinc	10.8	

Sample ID	11-AREA1-FLR-023	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.1	U
4,4'-DDE	4.1	U
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	2	
Lead	11.8	
Mercury	0.059	B
Zinc	13.6	

Sample ID	11-AREA3/4-FLR-037	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U
Inorganics (mg/kg)		
Copper	3	
Iron	24,200	
Lead	6.8	B
Mercury	0.085	B
Selenium	0.35	U
Zinc	28.3	

Sample ID	11-AREA3/4-FLR-041*	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	1.4	J
4,4'-DDE	3.4	J
Inorganics (mg/kg)		
Copper	2.8	
Iron	19,000	
Lead	7.8	B
Mercury	0.02	B
Selenium	1.9	B
Zinc	20.8	

Sample ID	11-AREA1-FLR-019	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	2.2	
Lead	7.5	
Mercury	0.012	U
Zinc	8.5	

Sample ID	11-AREA1-FLR-027	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	1.6	J
4,4'-DDE	4	U
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	4.4	
Lead	15.3	
Mercury	0.022	B
Zinc	25.4	

Sample ID	11-AREA1-FLR-028	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4.1	
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	18	
Lead	13.3	
Mercury	0.026	B
Zinc	18.5	

Sample ID	11-AREA2-FLR-033	
Date	3/31/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Zinc	24	

Sample ID	11-AREA2-FLR-035	
Date	3/31/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Zinc	20.1	

Sample ID	11-AREA5-FLR-042	
Date	3/19/2009	
Depth	0 - 6" bgs	
Inorganics (mg/kg)		
Lead	8.3	

Sample ID	11-AREA3/4-FLR-040	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4.1	U
4,4'-DDE	4.1	U
Inorganics (mg/kg)		
Copper	5.7	
Iron	34,900	
Lead	9.2	B
Mercury	0.058	B
Selenium	0.38	U
Zinc	35.6	

Sample ID	11-AREA1-FLR-024	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	2.8	
Lead	6.1	
Mercury	0.013	U
Zinc	10.3	

Sample ID	11-AREA1-FLR-018*	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	2	J
4,4'-DDE	1	J
Total PAHs	2,215	
Inorganics (mg/kg)		
Copper	3.8	
Lead	8.6	
Mercury	0.018	B
Zinc	16	

Sample ID	11-AREA1-FLR-025	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	1.6	J
4,4'-DDE	3.8	J
Total PAHs	2,102	
Inorganics (mg/kg)		
Copper	3.6	
Lead	13.1	
Mercury	0.026	B
Zinc	20.6	

Sample ID	11-AREA1-FLR-017	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	74.5	
4,4'-DDE	8.5	J
Total PAHs	1,662	
Inorganics (mg/kg)		
Copper	5.9	
Lead	12.9	
Mercury	0.02	B
Zinc	9.7	

Sample ID	11-AREA1-FLR-026	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	4	U
4,4'-DDE	4	U
Total PAHs	1,800	
Inorganics (mg/kg)		
Copper	2.9	
Lead	8.5	B
Mercury	0.023	B
Zinc	19.2	

Sample ID	11-AREA1-FLR-030	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	3.8	U
4,4'-DDE	3.8	U
Total PAHs	1,710	
Inorganics (mg/kg)		
Copper	1.9	
Lead	5.9	
Mercury	0.012	U
Zinc	10	

Sample ID	11-AREA1-FLR-029*	
Date	3/31/2009	
Depth	0 - 6" bgs	
Organics (ug/kg)		
4,4'-DDD	7	J
4,4'-DDE	69.3	
Total PAHs	1,890	
Inorganics (mg/kg)		
Copper	3.4	
Lead	13	
Mercury	0.031	B
Zinc	17.4	

	Preliminary Remediation Goal
Organics (ug/kg)	
4,4'-DDD	100
4,4'-DDE	100
Total PAHs	18,000
Inorganics (mg/kg)	
Copper	70
Iron	46,400
Lead	120
Mercury	0.24
Selenium	1.8
Zinc	120

Legend

- Confirmation Sampling Locations
- Study Area Boundary
- Estimated Extent of Soil Focus Areas
- Unnamed Tributary
- Old Concrete Foundation

* Duplicate sample collected at this location. Most conservative value reported.
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected

Note: Total PAHs is a straight summation of all detected PAHs. For any non-detect analytes one-half the laboratory quantitation limit was used as the value in the summation.

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Figure 4
Confirmation Sampling
Site 11 NFA Consensus Tech Memo
Cheatham Annex
Williamsburg, Virginia

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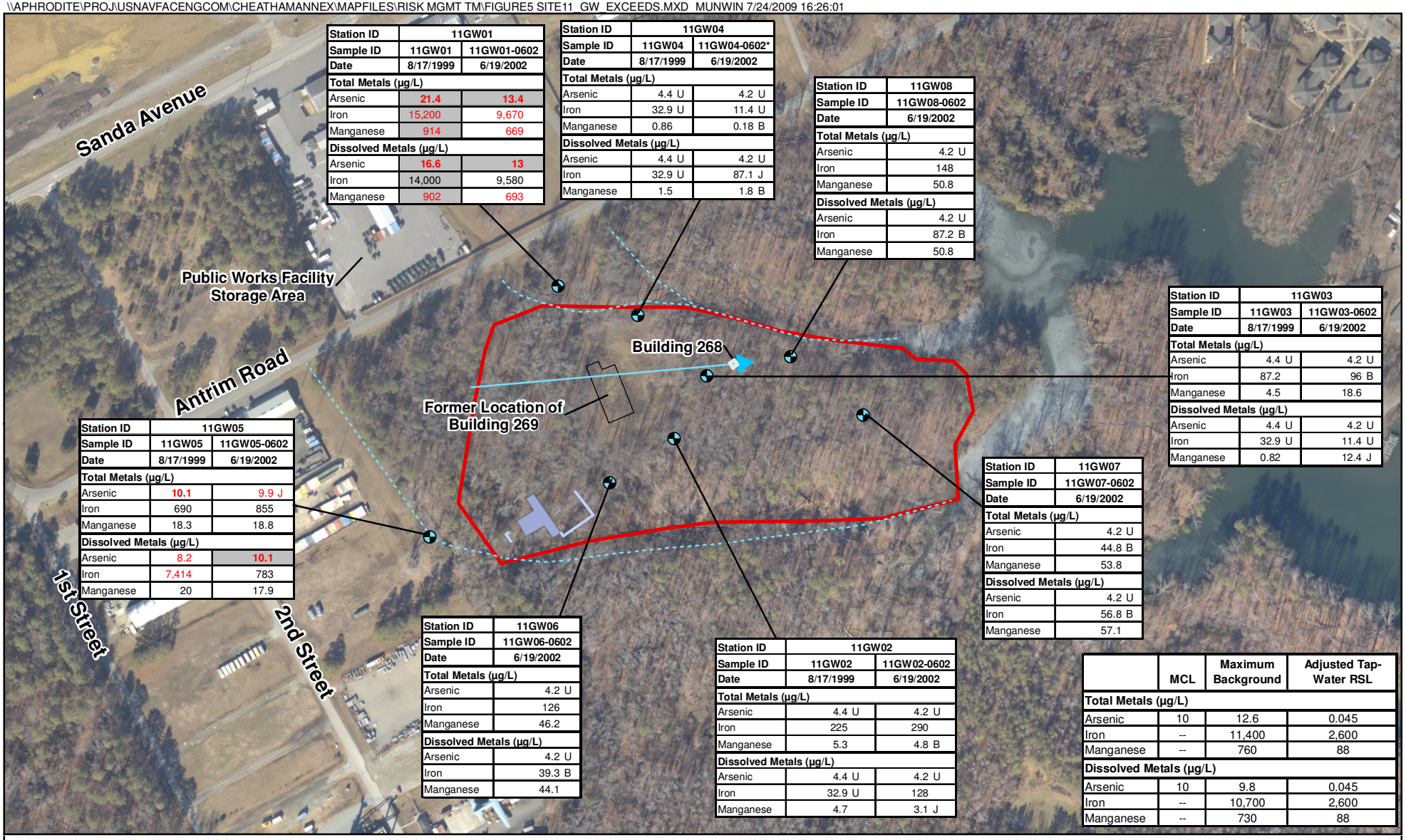
\\APHRODITE\PROJ\USNAVFACENGCOM\CHEATHAMANNEX\MAPFILES\RISK MGMT TM\FIGURE5 SITE11_GW_EXCEEDS.MXD MUNWIN 7/24/2009 16:26:01



Station ID	11GW01	
Sample ID	11GW01	11GW01-0602
Date	8/17/1999	6/19/2002
Total Metals (µg/L)		
Arsenic	**21.4**	**13.4**
Iron	15,200	9,670
Manganese	914	669
Dissolved Metals (µg/L)		
Arsenic	**16.6**	**13**
Iron	14,000	9,580
Manganese	902	693

Station ID	11GW04	
Sample ID	11GW04	11GW04-0602*
Date	8/17/1999	6/19/2002
Total Metals (µg/L)		
Arsenic	4.4 U	4.2 U
Iron	32.9 U	11.4 U
Manganese	0.86	0.18 B
Dissolved Metals (µg/L)		
Arsenic	4.4 U	4.2 U
Iron	32.9 U	87.1 J
Manganese	1.5	1.8 B

Station ID	11GW08
Sample ID	11GW08-0602
Date	6/19/2002
Total Metals (µg/L)	
Arsenic	4.2 U
Iron	148
Manganese	50.8
Dissolved Metals (µg/L)	
Arsenic	4.2 U
Iron	87.2 B
Manganese	50.8

Station ID	11GW03	
Sample ID	11GW03	11GW03-0602
Date	8/17/1999	6/19/2002
Total Metals (µg/L)		
Arsenic	4.4 U	4.2 U
Iron	87.2	96 B
Manganese	4.5	18.6
Dissolved Metals (µg/L)		
Arsenic	4.4 U	4.2 U
Iron	32.9 U	11.4 U
Manganese	0.82	12.4 J

Station ID	11GW05	
Sample ID	11GW05	11GW05-0602
Date	8/17/1999	6/19/2002
Total Metals (µg/L)		
Arsenic	**10.1**	9.9 J
Iron	690	855
Manganese	18.3	18.8
Dissolved Metals (µg/L)		
Arsenic	8.2	**10.1**
Iron	7,414	783
Manganese	20	17.9

Station ID	11GW07
Sample ID	11GW07-0602
Date	6/19/2002
Total Metals (µg/L)	
Arsenic	4.2 U
Iron	44.8 B
Manganese	53.8
Dissolved Metals (µg/L)	
Arsenic	4.2 U
Iron	56.8 B
Manganese	57.1

Station ID	11GW06
Sample ID	11GW06-0602
Date	6/19/2002
Total Metals (µg/L)	
Arsenic	4.2 U
Iron	126
Manganese	46.2
Dissolved Metals (µg/L)	
Arsenic	4.2 U
Iron	39.3 B
Manganese	44.1

Station ID	11GW02	
Sample ID	11GW02	11GW02-0602
Date	8/17/1999	6/19/2002
Total Metals (µg/L)		
Arsenic	4.4 U	4.2 U
Iron	225	290
Manganese	5.3	4.8 B
Dissolved Metals (µg/L)		
Arsenic	4.4 U	4.2 U
Iron	32.9 U	128
Manganese	4.7	3.1 J

	MCL	Maximum Background	Adjusted Tap-Water RSL
Total Metals (µg/L)			
Arsenic	10	12.6	0.045
Iron	--	11,400	2,600
Manganese	--	760	88
Dissolved Metals (µg/L)			
Arsenic	10	9.8	0.045
Iron	--	10,700	2,600
Manganese	--	730	88

Legend

- Study Area Boundary
- Monitoring Well
- Unnamed Tributary
- Old Concrete Foundation
- Groundwater Flow (June 2002)

* Duplicate sample collected at this location. Most conservative vaue reported.
B - Analyte not detected above assocaited blank
J - Reported value is estimated
U - Analyte not detected
-- Vaue not established
Bold text indicates exceedance of MCL
Shading indicates exceedance of maximum background
Red text indicates exceedance of adjusted tap-water RSL

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Figure 5
Groundwater Exceedances of Screening Criteria
Site 11 NFA Consensus Tech Memo
Cheatham Annex
Williamsburg, Virginia

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Attachment 1
Statement to Tier 1 Teams

Statement to Tier 1 Teams December 6, 2004

In cases where teams may be working to assess beneficial use, groundwater potability and/or cleanup goals, there are flexibilities in the process that can be used by each team to develop a strategy in accordance with CERCLA, the NCP and site specific conditions to reach a mutually agreeable solution. It is our expectation that the appropriate technical experts will be brought in to participate in discussions early on to help identify which flexibilities may be appropriate to explore. These flexibilities can be used as part of the overall site assessment process to create lines of evidence that serve as documentation for beneficial use, ground water potability, and/or cleanup goals. The teams will determine the specific site appropriate flexibilities that should be used (number and type) that form the lines of evidence.

Flexibilities may include but are not limited to:

- Background: In many cases, inorganics may be attributable to background conditions. A background assessment can prove to be invaluable to determining whether or not a contaminant is site-related.

- Risk-Range: There is flexibility in determining whether an action needs to be taken as long as the site-related cancer risk falls within EPA's acceptable risk-range (1×10^{-6} to 1×10^{-4} and Hazard Index of 1).

- Source removal/containment & monitoring: Another option to explore if there is not a current user. If the contamination in the groundwater is representative of what is being found in the soils, soil removal and monitoring may be warranted to determine if source removal alone will result in a reduction of contaminant levels in the groundwater.

- Timeframes: Depending on the current use of the groundwater the amount of time needed to reach cleanup goals may be flexible. For example, if groundwater is not currently being used as a drinking water source, and it is not expected to be used as such in the near future, cleanup technologies that may take longer to achieve cleanup goals could be considered. Monitored Natural Attenuation (MNA) is an example. MNA may be used in certain situations when: the processes will allow ARARs to be met in a timeframe comparable to a more active remedy. (NCP Preamble, 55 Fed. Reg. 8734). Additional EPA Guidance is available: *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, 1999. This guidance clarifies that MNA may be used when there is a low potential for plume migration, and when sources have been controlled.

  When evaluating remedial actions that require extended timeframes, additional factors may be considered that lend support to the Timeframe flexibility. For example, existing ground water controls, regulations, ordinances, etc., can be used to demonstrate that current restrictions are in place to manage water usage until the remedial action is complete.

- Is it a Plume? (Consistent/Contiguous): There may be instances where data from one well is driving the site-related risk. A close review of data will help determine whether there truly is a plume or not.

- Sample representativeness: It may be beneficial to review historical data to determine if proper well installation and sampling methodology occurred and verify the current conditions of the wells to ensure that sampling of the wells will generate representative samples.

- Classification: Guidance for assessing groundwater uses is provided in the Preamble to the 1990 NCP Revision (55 Fed Reg. 8666 et seq. (March 1990); recommending that EPA's 1984 "Ground-Water Protection Strategy" and 1986 "Guidelines for Ground-Water Classification" be used to assess future use of ground waters at a particular site.

- Alternate Concentration Limits (ACLs): (only when active restoration to ARARs is not practicable (from the nine criteria analysis). This is not the engineering practicability as used for TI determination.

  CERCLA Section 121(d)(2)(B)(ii) and NCP Section 300.430(e)(2)(i)(F) also allow for the use of Alternate Concentration Limits (ACLS):
  - there are known and projected points of groundwater entry into surface water
  - there are no statistically significant increases in contaminant levels downstream or at any place where contamination is expected to accumulate; and
  - enforceable measures can be taken to prevent human exposure between site and the entry points in surface water

- Technical Impracticability (TI): If from an engineering perspective, it is technically impracticable to comply with an applicable, relevant and/or appropriate requirement (ARAR) (such as meeting MCLs), a TI Waiver may be prepared. EPA's "Guidance for Evaluating the Technical Impracticability of Groundwater Restoration" can be utilized to prepare the supporting TI Waiver documentation.