N61414.PF.001542
NAB LITTLE CREEK
5090.3b

TECHNICAL MEMORANDUM REGARDING FINAL RISK ASSESSMENT UPDATE FOR EVALUATION OF FUTURE POTABLE USE OF GROUNDWATER AND GROUNDWATER DISCHARGE TO SURFACE WATER SWMU 3 PIER 10 SANDBLAST YARD NAB LITTLE CREEK VA

12/20/2011

CH2M HILL

Risk Assessment Update—Evaluation of Future Potable Use of Groundwater and Groundwater Discharge to Surface Water at SWMU 3—Pier 10 Sandblast Yard Joint Expeditionary Base (JEB) Little Creek, Virginia Beach, Virginia

PREPARED FOR: JEB Little Creek Partnering Team

PREPARED BY: CH2M HILL

DATE: December 20, 2011

Introduction

This Technical Memorandum (TM) presents revisions to the baseline Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) conducted as part of the 2005 Remedial Investigation (RI) (CH2M HILL, 2005) and revised as part of the 2007 Supplemental Remedial Investigation (SRI) (CH2M HILL, 2009) for Environmental Restoration Program (ERP) Solid Waste Management Unit (SWMU) 3—Pier 10 Sandblast Yard, Joint Expeditionary Base (JEB) Little Creek, Virginia Beach, Virginia. The revisions presented here are based upon updates to the conceptual site model (CSM) and include the following:

- An evaluation of the viability of the future potable use scenario as an applicable exposure pathway for shallow groundwater.
- An a evaluation of the human health risks resulting from groundwater discharge to surface water utilizing groundwater data as part of the 1998 Site Investigation (SI) (CH2M HILL, 1999), 2005 RI, and 2007 SRI.
- An update to the 2005 baseline ERA evaluation of risks associated with groundwater discharge to surface water to include groundwater data collected as part of the 2007 SRI and include an evaluation of bioaccumulation potential.

Although all site media have been evaluated as part of previous investigations, this TM will focus on groundwater, the transport pathway to surface water, and associated risk evaluations.

Updated Conceptual Site Model

SWMU 3, the Pier 10 Sandblast Yard, is located in a developed area on Little Creek Harbor's western side (**Figure 1**). SWMU 3 was used for sandblasting boats between 1962 and 1984 (RGH, 1984). Sandblasting activities took place on a concrete pad located to the west of Building 1263. After 1984, anchors and chains were sandblasted on the concrete pad. The

sandblast material was periodically characterized using extraction procedure (EP) toxicity testing protocols, and removed from the site for disposal. Results of the EP toxicity tests indicated the sandblast residue was not a hazardous waste. In 1982, a fence was installed around the sandblasting area to limit access to the site and prevent windblown sandblast materials from migrating outside the fenced area. However, during a 1984 site visit, paint chips and grit were observed covering the unpaved ground south of the pad to the water's edge and the near-shore bottom of Little Creek Harbor (RGH, 1984). The fence is generally closed and locked outside working hours. Aerial photographs taken in 1993 indicate the area within the fence had been covered with asphalt except for a very small strip of land east of the sandblasting pit and a small area in the northeastern corner. Little or no vegetation covers these unpaved areas. In 1995, the concrete pad was taken out of service, and a new sandblasting area was constructed in the northwestern corner of the site. The new sandblasting area consisted of a concrete pad surrounded by a 4-to-5-foot-high concrete wall. All sandblasting operations at SWMU 3 ceased in 1996 when the new indoor sandblasting facility (CB125), located adjacent to Desert Cove and ERP Site SWMU 7b, was completed. The CSM is presented on **Figure 2**.

Historical releases from SWMU 3 likely occurred when sandblasting residue was lying directly on the ground surface. Prior to 1993, runoff from sandblasting operations occurred as sheet flow to Little Creek Harbor. In 1993, a catch basin with a regulated outfall was constructed. Surface water drainage from the sandblasting area flows to this catch basin and empties into Little Creek Harbor at the Virginia Department of Environmental Quality (VDEQ)-permitted Outfall 008 (Permit Number VA0079928) located under Pier 10, about 35 feet from its easternmost edge (**Figure 1**). Under the VDEQ permit, Outfall 8 has no monitoring requirements. Some runoff from other areas of SWMU 3 may continue to flow directly into Little Creek Harbor.

The land where SWMU 3 is located and the surrounding area were created from the placement of dredge spoils between 1937 and 1954 (**Figure 3**), thus the shallow geology and underlying surficial aquifer are not representative of the upper Holocene and Pleistocene unconsolidated fine sand and silt deposits of the Columbia aquifer (CH2M HILL, 2009). The lower impermeable silt, clay, and sandy clay deposits of the Yorktown confining unit are noted beneath the site. For the purpose of this discussion the saturated soils underlying SWMU 3 will be referred to as the surficial aquifer. The surficial aquifer extends to a depth of between 13.0 to 23.5 feet below ground surface (bgs) across the site and shallow groundwater is generally encountered at 5 feet bgs. Groundwater flow across the site is south/southeast discharging to Little Creek Harbor (**Figure 4**).

Groundwater geochemistry in the surficial aquifer beneath SWMU 3 is generally brackish, and is a transition zone where upgradient fresh water mixes with seawater intrusion. Brackish water has a typical total dissolved solids (TDS) concentration that ranges from 1,000 to 10,000 milligrams per liter (mg/L). Although TDS has not been directly measured at SWMU 3, it was estimated using the sum of the major cations (calcium, magnesium, potassium, and sodium) and anions (bicarbonate [alkalinity], carbonate, chloride, and sulfate) which typically make up ninety percent of the dissolved solids in groundwater (**Table 1**). Estimated TDS concentrations in groundwater at SWMU 3 range from 380 mg/L (LW03-MW08) to 2,896 (LW03-MW03) mg/L. Groundwater from 5 of the 15 monitoring wells had estimated TDS concentrations less than 1,000 mg/L, however, with the exception

of groundwater from LW03-MW07, all of these samples were collected from monitoring wells generally located within the northern portion of the site where the shoreline is constructed with a bulkhead wall and groundwater/surface water interaction is hindered. The highest TDS concentrations occurred from groundwater collected along the rip-rap shoreline. Additionally, a comparison of estimated TDS values in SWMU 3 groundwater to estimated TDS values at upland Site 11 (**Table 1**), where estimated TDS concentrations range from 61 mg/L (LS11-MW21D) to 376 mg/L (LS11-MW22D), further indicates groundwater underlying SWMU 3 is a freshwater/seawater transition zone.

Most of the aquatic activities within the SWMU 3 boundary are associated with the Pier 10 dry dock area and the recreational marina. The Pier 10 dry dock area of Little Creek Harbor is used for dive team training and boat maintenance activities. The recreational marina, used by military dependents and former active-duty members, is located to the south of the Pier 10 dry dock. A fueling station and fish-cleaning station are located south of the boat slips. For security purposes, recreational swimming, fishing, and crabbing are not permitted in Little Creek Harbor.

Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total and dissolved metals have been detected in groundwater (CH2M HILL, 2009). Pesticides and polychlorinated biphenyls (PCBs) are not related to historic site activities and were not sampled for during site investigations. Chlorinated VOCs PCE, trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride were detected in groundwater above MCLs. The maximum concentration of parent product PCE was detected in upgradient monitoring well LW03-MW06 in 2002. Maximum concentrations of breakdown products TCE, cis-1,2-DCE, and vinyl chloride were detected at monitoring well LW03-MW12 in 2007 and are likely the result of degradation of PCE and advection of daughter products over time. No source of VOCs has been identified at the site. SVOCs were detected in one monitoring well (LW03-MW04) in 1998 and were not sampled for during subsequent site investigations. Total and dissolved metals have been detected above background values across the site during each site investigation. Detected soil concentrations of VOCs, SVOCs, and metals do not indicate any continuing source of contamination is present in the site soil.

The results of the HHRA conducted as part of the RI indicated there was no unacceptable risk to human health associated with exposure to surface water based on detected concentrations of VOCs, SVOCs, and metals in this media. The results of the revised groundwater HHRA conducted as part of the SRI indicate there are no unacceptable human health risks associated with construction worker exposure to groundwater. However, the SRI concluded the theoretical potable use of shallow groundwater may result in unacceptable cancer risks and non-cancer hazards for future industrial workers and hypothetical future residents, primarily due to the presence of PCE, vinyl chloride, dibenzofuran, arsenic, iron, manganese, and thallium (CH2M HILL, 2009). Additionally, due to the presence of VOCs in groundwater, and the uncertainties associated with quantifying risks associated with the potential future vapor intrusion pathway, it is assumed vapor intrusion from shallow groundwater into indoor air could pose unacceptable risks to future receptors. There is no current vapor intrusion exposure pathway.

The results of the ERA conducted as part of the RI indicate, based upon a qualitative evaluation of groundwater concentrations (detected during the 1998 SI and 2005 RI) to

surface water screening criteria, groundwater discharge is not a significant contaminant transport pathway to Little Creek Harbor (CH2M HILL, 2005). Additionally, no unacceptable risk associated with ecological receptor exposure to surface water was identified based on detected concentrations of VOCs, SVOCs, and metals in this media.

The following sections present revisions to the results of the human health and ecological risk assessments conducted as part of the 2005 RI and 2007 SRI. Results of the 2005 HHRA were based upon concentrations of detected constituents directly measured within each media evaluated. No unacceptable risks were identified in the surface water; therefore no further evaluation of this media was conducted as part of the SRI. The risk evaluation of surface water in the RI did not take into account concentrations detected in groundwater discharging to surface water. The HHRA is updated in the following sections to account for this exposure pathway. Additionally, although the 2005 ERA evaluated groundwater discharge to surface water, it did not include data collected as part of the SRI, and will be updated. Bioaccumulation risks to benthic organisms and fish were evaluated during the 2005 ERA, however, this evaluation was conducted utilizing sediment and surface water data and did not take into consideration concentrations of constituents present in groundwater that may discharge to surface water and sediment.

Potable Use of Groundwater Evaluation

According to the *Guideline for Ground-Water Classification under the EPA Ground-Water Protection Strategy* (USEPA, 1986), the United States Environmental Protection Agency (USEPA) does not allow for potable use of groundwater characterized as having a high-to-intermediate degree of interconnection with an adjacent surface water body. According to the guidance, "high interconnection is assumed to occur…where groundwater discharges into adjacent surface waters". Based upon USEPA's guidance and the CSM, groundwater underlying SWMU 3 is not a viable potable water supply. Specifically:

- Due to the reclamation of land with dredge spoils, the surficial aquifer at SWMU 3 is not a true aquifer because it is present within the dredge spoils.
- Due to the presence of Little Creek Harbor, there is no potential for downgradient potable use of the groundwater.
- Due to its high TDS content it is likely groundwater underlying SWMU 3 has a high interconnection with the adjacent surface water.

Therefore the calculation of potential human health risk associated with this exposure scenario is not an accurate depiction of site characterization, and the future residential and industrial worker potable use receptor scenarios evaluated as part of the SWMU 3 2005 HHRA and updated 2007 HHRA are not applicable exposure pathways.

Although potable use is not an applicable exposure pathway at SWMU 3, VDEQ's antidegradation policy (9 VAC 25-280-30), considers all groundwater a potential potable resource and requires that all groundwater be restored to beneficial use or that present and potential future uses of groundwater be preserved and protected. Therefore, because concentrations of contaminants above groundwater standards (MCLs) were detected, land use restrictions prohibiting the potable use of shallow groundwater at SWMU 3 until it is

demonstrated that concentrations of contaminants are below the MCLs would be necessary for the protection of potential future potable use receptors.

Groundwater Discharge to Surface Water Evaluation

Groundwater discharging to the surface water in Little Creek Harbor is considered a potentially complete exposure pathway for both human health and ecological receptors; therefore, an evaluation of human health and ecological risks associated with groundwater discharge to surface water was completed. This exposure pathway has not been previously evaluated for human health risk; however, with regards to ecological risk will be evaluated using similar methodology as applied in the RI with the inclusion of groundwater data collected as part of the subsequent SRI (January and September), as well as an additional evaluation of bioaccumulation potential utilizing groundwater data collected as part of the 1998 SI, 2005 RI, and 2007 SRI (January and September). Risk assessment methodology, assumptions, and results are summarized below.

Human Health Risk Assessment

This section provides a human health risk evaluation of the groundwater to surface water discharge pathway at SWMU 3. Although the HHRA included in the 2005 RI concluded there was no unacceptable risk from human exposure to surface water, the risk assessment did not take into consideration concentrations of constituents detected in groundwater migrating and eventually discharging to surface water. This revised evaluation utilizes the methodology and assumptions employed during the surface water risk evaluation prepared in the 2005 RI, and provides an evaluation of direct exposure from groundwater discharge to surface water using USEPA Tap Water Regional Screening Levels (RSLs) (USEPA, 2009).

A conservative human health risk assessment was conducted assuming the maximum detected concentrations in groundwater are equal to the concentrations that would be present in the surface water based on the groundwater-to-surface water transport pathway. The comparison of maximum groundwater concentrations with surface water screening criteria is very conservative and likely significantly overestimates potential human health risks from exposure to groundwater discharged to surface water as groundwater discharge to the harbor is expected to be diffuse rather than concentrated at particular points and groundwater is also unlikely to be discharged undiluted. A more realistic assessment of risk would evaluate mean concentrations across the site or concentrations calculated using a dilution factor.

The groundwater data set evaluated in the 2007 SRI HHRA was used to evaluate the groundwater to surface water exposure scenario. Risk calculation tables, presented in USEPA's *Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)* (USEPA, 2001) format, are included as **Attachment A**. Initially, groundwater data were screened to select the chemicals of potential concern (COPCs) for quantitative evaluation in the risk assessment. Following USEPA Region III risk assessment methodology, the maximum detected concentrations of VOCs, SVOCs, and dissolved metals were compared to ten times the adjusted USEPA Tap Water RSLs (USEPA, 2009) (RSLs that are based on non-carcinogenic effects were divided by ten to account for exposure to multiple constituents) to

select the COPCs. Therefore, for surface water, RSLs that are based on non-carcinogenic effects were used as presented in USEPA's RSL table. RSLs based on carcinogenic effects were multiplied by ten. The screening is presented in **Attachment A, Table A.2.1** and the COPCs identified are shown in **Table 2**.

The exposure scenarios evaluated for surface water in the 2005 RI and included in this evaluation are:

- Current/future worker exposure to surface water in Little Creek Harbor through incidental ingestion and dermal contact during scuba diving practice and training
- Current/future recreational adult and adolescent exposure to surface water in Little Creek Harbor through incidental ingestion and dermal contact while swimming and boating in the harbor (it should be noted, swimming is currently not permitted in the harbor).
- Current/future maintenance worker exposure to surface water in Little Creek Harbor through incidental ingestion and dermal contact while performing maintenance activities in the harbor.

Additionally, the same exposure parameters included in the 2005 RI to calculate chemical intakes for these receptors were used (**Attachment A, Tables A.4.1.RME and A.4.1.CTE**). The toxicity values used to calculate the cancer risks and non-cancer hazards for the current assessment were updated to current values, if necessary. Toxicity values are included in **Attachment A, Tables A.5.1, A.5.2, A.6.1, and A.6.2.** Risks are calculated in **Attachment A, Tables A.7.1.RME through A.7.1.CTE** and summarized in **Attachment A, Tables A.9.1.RME through A.9.1.CTE**. Reasonable maximum exposure (RME) risks were calculated for all scenarios, and central tendency exposure (CTE) risks were calculated for those scenarios with cancer risks or non-cancer hazards that exceeded USEPA's acceptable levels (cancer risk greater than 10^{-4} and non-cancer hazard index above 1.0).

The calculated risks for each of the receptors evaluated in this assessment are summarized on **Table 3** (RME) and **Table 4** (CTE). With the exception of the carcinogenic risk to the current/future recreational adult, potential risks/hazards associated with receptor exposure to surface water are within or below USEPA target levels based on RME calculations. All receptor risks/hazards are below USEPA target levels under CTE calculations.

The cancer risk to the recreational adult (1.5×10^{-4}) is primarily associated dermal contact with PCE in groundwater discharging to the harbor. PCE was detected in 6 of the 67 groundwater samples included in the evaluation. The maximum detected concentration of PCE (210 micrograms per liter [µg/L]) used in the risk calculations was detected in groundwater collected in 2002 from LW03-MW06, located approximately 250 feet upgradient of Little Creek Harbor. During the 2007 SRI, groundwater samples were collected from all previously sampled as well as newly installed monitoring wells. PCE was not detected in groundwater collected from LW03-MW06. Additionally, following the 2002 RI sampling, PCE has been detected in only 2 of 46 groundwater samples collected. In both instances, concentrations were below 0.3 µg/L. Exposure to 0.3 µg/L of PCE in the surface water would not result in unacceptable risks. Therefore, based on current site conditions, there is no unacceptable risk associated with exposure to surface water.

As stated above, the use of maximum detected concentrations in groundwater provides for a very conservative evaluation of risks resulting from groundwater discharge. A more realistic way to calculate an exposure point concentration for this scenario would be to use mean groundwater concentrations and an appropriate dilution factor, however since no unacceptable risks were identified when using maximum groundwater concentrations, further evaluation using the more realistic concentrations was not performed.

Ecological Risk Assessment

This section provides a revised ecological risk evaluation of the groundwater to surface water discharge pathway at SWMU 3. Based upon a comparison of groundwater data collected in 1998 and 2002 to ecological surface water screening values, background concentrations, and upgradient concentrations, the Baseline Ecological Risk Assessment (BERA) included as part of the 2005 RI concluded groundwater was not a significant transport pathway from the site to Little Creek Harbor for potential ecological exposures. This revised evaluation expands upon the 2005 RI evaluation through the inclusion of groundwater data collected in 2007, as well as an evaluation of bioaccumulation potential. The components of this revised evaluation are as follows:

- An evaluation of direct exposure from groundwater discharge to pore water and surface water using marine-based surface water screening values.
- An evaluation of bioaccumulation in fish tissue.
- An evaluation of bioaccumulation in benthic invertebrate tissue.

Direct Exposure

The maximum and mean concentrations of all VOCs, SVOCs, and dissolved metals detected in at least one groundwater sample from all site monitoring wells during 1998, 2002, and 2007 were used in this evaluation. Only dissolved metals data are considered in this evaluation because chemicals in groundwater are most likely to travel dissolved in water rather than adhered to particles since they must travel through soil pores or fractured rock. Similarly, when groundwater discharges to a water body (at which time ecological exposures become possible), the bulk of the discharged chemicals are likely to be dissolved in water since the discharge must pass through the pores in the underlying sediments. Thus, the dissolved concentrations are likely to be more representative of what would be transported via the groundwater than the total concentrations. Once discharged, the dissolved metal fraction in water (filtered samples) is more representative of the bioavailable fraction to aquatic receptors than the total metal fraction (unfiltered samples) (USEPA, 1996). This is reflected in how the most recent Ambient Water Quality Criteria have been developed for many metals, that is, they are based upon the dissolved fraction.

Although ecological receptors do not typically have direct exposure to groundwater, surface water screening values were compared to analytical groundwater data (with and without dilution factors) in order to provide a conservative evaluation of the potential for significant contaminant transport via groundwater to Little Creek Harbor. In the absence of site-specific dilution factors for groundwater, Buchman (1999) recommends using a dilution factor of 10 to account for the dilution expected during migration and upon discharge of groundwater to surface water.

Due to the salinity of the receiving water body (Little Creek Harbor), marine screening values were used in the groundwater evaluation, where available. The screening values for chemicals known to bioaccumulate in aquatic food webs were based upon the final chronic value (rather than the final residue value) as per USEPA (1996, 2006). The use of final chronic values is intended to protect aquatic receptors from direct exposure to chemicals in water, rather than from exposure via food webs. Potential risks related to bioaccumulation (tissue residues) were evaluated separately.

Site-specific upgradient concentrations and basewide background concentrations were also considered in the evaluation. Upgradient groundwater concentrations were derived from monitoring wells hydrologically upgradient of the site (MW01, MW06, MW14, and MW15). Background concentrations for groundwater were obtained from the NAB Little Creek Background Study (CH2M HILL, 2000).

Groundwater concentrations were compared with surface water screening values to derive risk estimates using the hazard quotient (HQ) method. HQs were calculated by dividing the constituent concentration in groundwater by the corresponding constituent-specific marine surface water screening value. HQs exceeding one indicate the potential for unacceptable risk since the constituent concentration (exposure) exceeds the screening value (effect). HQs less than or equal to one indicate that unacceptable risks are unlikely.

Initial COPCs were identified using a comparison of maximum groundwater concentrations to surface water screening values (**Attachment B, Table B-1)** and are shown on **Table 2**. Based upon this comparison, six metals (barium, copper, iron, manganese, nickel, and silver), three SVOCs (fluoranthene, fluorene, and phenanthrene), and two VOCs (1,1-dichloroethane and PCE) had HQs exceeding 1 and were identified as initial COPCs. Additionally, 1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113), chloroethane, cyclohexane, and methylcyclohexane were identified as initial COPCs because they were detected and a screening value was not available.

The comparison of maximum undiluted groundwater concentrations with surface water screening values is very conservative and likely significantly overestimates potential ecological exposures to sediment pore water in the biologically active zone and, especially, in the water column. The mean concentration is likely to provide a more realistic estimate of potential transport/exposure because, although cracks or joints in the bulkhead could potentially channel discharge at spatially restricted points, groundwater discharge to the harbor is expected to be diffuse rather than concentrated at particular points. Groundwater is also unlikely to be discharged undiluted. In the absence of site-specific dilution factors, Buchman (1999) recommends using a dilution factor of 10 to account for the dilution expected during migration to surface water bodies.

Mean chemical concentrations in groundwater for the initial COPCs, identified on **Table 2**, are compared with screening values in **Attachment B, Table B-2**. This comparison was done assuming no dilution as well as using a dilution factor of 10. The initial COPCs are also evaluated relative to upgradient and background groundwater concentrations. Of the initial COPCs identified with screening values, only iron, manganese, and silver had an HQ that exceeded one when a dilution factor of 10 was applied to the maximum detected concentration. The magnitude of the HQ for manganese and silver was low (1.15 and 1.17, respectively). The HQ based upon mean concentrations detected in groundwater exceeded

one for copper, iron, manganese, silver, and fluorene if no dilution factor is considered, however, no HQ exceeded one when a dilution factor of 10 was applied. Maximum detected concentrations of manganese and silver are consistent with background and upgradient concentrations and the maximum detected concentration of copper, a sediment contaminant of concern (COC) at SWMU 3, is consistent with upgradient concentrations. Iron was detected above the background upper tolerance limit (UTL) in two monitoring wells, however the mean concentration of iron across the site is an order of magnitude below the background UTL.

1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113), chloroethane, cyclohexane, and methylcyclohexane were identified as initial COPCs because they were detected and a screening value was not available. The maximum concentration of chloroethane (220 µg/L) did not exceed marine-based screening values for other chlorinated ethanes (which ranged from 312 to 1,130 µg/L; **Table B-1**). Similarly, the maximum concentrations of the other three VOCs (all less than or equal to 5 µg/L) were lower than marine-based screening values for other VOCs (**Table B-1**). Based upon the results of this evaluation, groundwater does not appear to be a significant transport route for site related constituents to Little Creek Harbor.

Bioaccumulation Potential (Fish Tissue)

Concentrations of metals and VOCs detected in groundwater samples collected in 1998, 2002, and 2007, and included on the bioaccumulative chemicals list used for food web modeling in the 2005 RI, were used in this evaluation, which is summarized in **Attachment B, Table B-3**. Fish tissue-based screening values were derived for these constituents and were compared with estimated whole-body fish tissue concentrations modeled using mean groundwater concentrations, a dilution factor of 10, and whole-body fish bioaccumulation factors (BAFs) from the literature. Because exposure for fish would be mostly confined to the water column (surface water), mean concentrations and a dilution factor of 10 were used for this evaluation; this methodology was identical to that previously used for similar evaluations at Little Creek Sites 9 and 10. HQs for all chemicals did not exceed one based upon this evaluation.

The whole-body fish tissue concentrations modeled from groundwater (converted to dry weight) were also compared to the fish tissue concentrations developed during food web modeling (from sediment) in the 2005 RI (**Attachment B, Table B-3**). The whole-body fish tissue concentrations modeled from groundwater are similar to, or less than, food web model fish tissue concentrations from the 2005 RI, which concluded that all food web-related risks were acceptable with the exception of mercury (Lowest Observed Adverse Effect Level [LOAEL] HQ of 2.85). The tissue ratio (modeled groundwater-based tissue concentration divided by the food web-based tissue concentration) for mercury was 0.09, which corresponds to a LOAEL HQ of 0.26 and a No Observed Adverse Effect Level (NOAEL) HQ of 0.77 based upon groundwater concentrations, which is within the acceptable risk range. Thus, there are no unacceptable risks related to the fish bioaccumulation pathway, either to the fish themselves or to receptors which may consume them.

Bioaccumulation Potential (Benthic Invertebrate Tissue)

Concentrations of metals and VOCs detected in groundwater samples collected in 1998, 2002, and 2007 and included on the bioaccumulative chemicals list used for food web modeling in the 2005 RI were used in this evaluation, which is summarized in **Attachment B, Table B-4**. Invertebrate tissue-based screening values were derived for these constituents and were compared with estimated whole-body invertebrate tissue concentrations modeled using mean groundwater concentrations and whole-body invertebrate BAFs from the literature. Because invertebrates could be exposed to sediment pore water and the water column (surface water), the comparison was conducted both with and without a dilution factor of 10.

When no dilution factor was used, the HQs for selenium (1.74) and copper (2.36) exceeded one. There were no exceedances when a dilution factor of 10 was applied. Selenium is not known to be associated with sandblasting activities and concentrations in groundwater (ranging from 2.2 to 12.9 µg/L) are similar to the background UTL (9 µg/L). Copper, a sediment COC, is related to sandblasting activities; however, groundwater concentrations for copper are consistent with upgradient concentrations, which suggests the incremental contribution of groundwater to total copper concentrations in sediment, pore water, or the water column is insignificant relative to transport pathways (surface runoff and wind) related to the use of ABM at the site (the focus of the remedial actions related to sediment currently being developed at SWMU 3).

The whole-body benthic invertebrate tissue concentrations modeled from groundwater (converted to dry weight) were also compared to the benthic invertebrate tissue concentrations developed during food web modeling (from sediment) in the 2005 RI (**Attachment B, Table B-4**). The results of the 2005 RI indicated acceptable risks for non-piscivores (raccoon), that is, receptors that might consume benthic invertebrates. The comparison was done both with and without the application of a dilution factor of 10. With dilution, concentrations modeled from groundwater are similar to, or less than, those from the 2005 RI food web models for benthic invertebrates. Without the application of a dilution factor of 10, concentrations modeled from groundwater were elevated relative to those from the 2005 RI food web models for cadmium, chromium, mercury, and selenium. For cadmium, the 2005 RI NOAEL HQ (raccoon) was 0.01. The calculated tissue ratio of 13.5 from **Attachment B, Table B-4** corresponds to a NOAEL HQ of 0.14 based upon groundwater concentrations, which is within the acceptable risk range. For chromium, the 2005 RI NOAEL HQ (raccoon) was 0.05. The calculated tissue ratio of 3.16 corresponds to a NOAEL HQ of 0.16 based upon groundwater concentrations, which is within the acceptable risk range. For mercury, the 2005 RI NOAEL HQ (raccoon) was 0.04. The calculated tissue ratio of 17.8 corresponds to a NOAEL HQ of 0.71 based upon groundwater concentrations, which is within the acceptable risk range. For selenium, the 2005 RI NOAEL and LOAEL HQs (raccoon) were 0.15 and 0.09, respectively. The calculated tissue ratio of 7.34 corresponds to a NOAEL HQ of 1.10 and LOAEL HQ of 0.66 based upon groundwater concentrations, which is within the acceptable risk range. In addition, selenium is not known to be associated with sandblasting activities and concentrations in groundwater are similar to background. Thus, there are no unacceptable risks related to the benthic invertebrate bioaccumulation pathway, either to the invertebrates themselves or to receptors which may consume them.

Summary and Conclusion

The Navy, in partnership with USEPA and VDEQ, agree potable use of groundwater is not a viable exposure scenario for risk evaluation at SWMU 3 based on the following rationale:

- Aquifer Characteristics
  - Groundwater underlying SWMU 3 is situated within a layer of fill material (dredge spoils)
  - Groundwater representative of a freshwater/seawater transition zone
- Realistic Receptor Scenarios
  - No potential for downgradient users
  - USEPA does not allow for potable use of groundwater characterized as having a high-to-intermediate degree of interconnection with an adjacent surface water body

Therefore, the future residential and industrial worker potable use receptor scenario evaluated as part of the SWMU 3 RI and SRI is not an applicable exposure pathway at this site.

An evaluation of human health and ecological risks associated with groundwater discharge to Little Creek Harbor was conducted using maximum (human health risk scenarios only) and mean (both ecological and human health risk scenarios) concentrations of VOCs, SVOCs, and dissolved metals in groundwater. Results of the evaluations concluded that discharge of groundwater (based upon the chemical concentrations from existing data) does not represent an unacceptable incremental increase in risks to aquatic receptors in Little Creek Harbor. Therefore, the Navy, in partnership with USEPA and VDEQ, agree no further evaluation of the groundwater to surface water transport pathway at SWMU 3 is warranted.

References

Buchman, M.F. 1999. *NOAA screening quick reference tables.* NOAA HAZMAT Report 99-1, Seattle, WA. 12 pp.

CH2M HILL. 1999. *Final Site Investigation Report, SWMU 3 and IR Site 8, NAB Little Creek, Virginia Beach, Virginia.* December.

CH2M HILL. 2000. *Final Background investigation for Naval Amphibious Base Little Creek, Virginia Beach, Virginia.* December.

CH2M HILL. 2005. *Final Remedial Investigation/Human Health Risk Assessment/Ecological Risk Assessment for SWMU 3, NAB Little Creek, Virginia Beach, Virginia.* August.

CH2M HILL. 2009. *Final Supplemental Remedial Investigation, Human Health Risk Assessment, and Ecological Risk Assessment for SWMU 3, Pier 10 Sandblast Yard, NAB Little Creek, Virginia Beach, Virginia.* August.

Rogers, Golden, and Halpern (RGH). 1984. *Initial Assessment Study of Naval Amphibious Base Little Creek, Norfolk, Virginia*. December.

United States Environmental Protection Agency (USEPA). 1986. *Guideline for Ground-Water Classification under the EPA Ground-Water Protection Strategy*. December.

USEPA. 1996a. *Ecotox thresholds.* Eco Update, Volume 3, Number 2. EPA/540/F-95/038. 12 pp.

USEPA 2001. *Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments) Final.* Publication 9285.7-47. December.

USEPA. 2006. National recommended water quality criteria - 2006.

USEPA 2009. *Regional Screening Level Table.* May 19.

Table 1
SWMU 3 and Site 11 Groundwater Geochemistry
SWMU 3 Groundwater Discharge to Surface Water Evaluation
JEB Little Creek
Virginia Beach, Virginia

SWMU 3															
Parameters (mg/L)	**LW03-MW01**	**LW03-MW02**	**LW03-MW03**	**LW03-MW04**	**LW03-MW05**	**LW03-MW06**	**LW03-MW07**	**LW03-MW08**	**LW03-MW09**	**LW03-MW10**	**LW03-MW11**	**LW03-MW12**	**LW03-MW13**	**LW03-MW14**	**LW03-MW15**
Cations															
Calcium	68	66	89	88	22	34	37	59	54	36	10	87	56	52	30
Magnesium	85	87	102	225	59	62	35	23	25	41	25	34	34	39	69
Potassium	48	46	48	116	42	30	27	9	10	14	29	19	47	15	36
Sodium	744	582	851	1,930	723	522	175	111	105	347	499	125	330	229	746
Cation Sum	***944***	***780***	***1,090***	***2,359***	***846***	***648***	***274***	***201***	***194***	***438***	***563***	***265***	***467***	***334***	***881***
Anions															
Chloride	1,580	1,260	1,610	51.7	1,280	968	161	132	154	604	813	165	610	181	1,300
Sulfate	27.4	26.9	196	465	61.9	135	105	46.5	36.4	133	35.3	169	37.5	79.6	78
Bicarbonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anion Sum	***1,607***	***1,287***	***1,806***	***517***	***1,342***	***1,103***	***266***	***179***	***190***	***737***	***848***	***334***	***648***	***261***	***1,378***
Total Dissolved Solids (TDS)															
Estimated Minimum TDS	**2,552**	**2,067**	**2,896**	**2,876**	**2,188**	**1,751**	**540**	**380**	**385**	**1,175**	**1,411**	**599**	**1,115**	**595**	**2,259**

Site 11																
Parameters (mg/L)	**LS11-MW06D**	**LS11-MW15D**	**LS11-MW16D**	**LS11-MW20D**	**LS11-MW21D**	**LS11-MW22D**	**LS11-MW31D**	**LS11-MW32D**	**LS11-MW33D**	**LS11-MW34D**	**LS11-MW35D**	**LS11A-MW36D**	**LS11A-MW37D**	**LS11A-MW38D**	**LS11A-MW39D**	**LS11A-MW40D**
Cations																
Calcium	50	56	11	13	3	35	9	18	12	36	24	13	30	8	7	15
Magnesium	3	6	7	7	2	15	7	12	8	16	8	6	5	5	2	6
Potassium	1	2	2	2	1	3	2	2	3	3	2	2	2	1	1	2
Sodium	17	33	34	24	15	57	41	36	22	56	27	17	21	23	16	16
Cation Sum	***71***	***97***	***54***	***46***	***21***	***110***	***59***	***68***	***45***	***111***	***61***	***38***	***58***	***37***	***26***	***39***
Anions																
Chloride	21.9	50.7	46.6	28.6	23.9	62.3	40	42.4	19.4	34	13.8	18.3	22.3	36	18.3	17.6
Sulfate	13.7	24.2	55.5	58.8	7.03	183	98.2	102	57.2	79.5	30.4	51.9	44	30.6	13.9	39.3
Bicarbonate	120	165	19	20.5	9.18	20.7	6.56	18.1	18.6	19.3	23.5	13	60.2	17.4	19.2	31.6
Carbonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anion Sum	***155.6***	***239.9***	***121.1***	***107.9***	***40.1***	***266.0***	***144.8***	***162.5***	***95.2***	***132.8***	***67.7***	***83.2***	***126.5***	***84.0***	***51.4***	***88.5***
TDS																
Estimated Minimum TDS	**227**	**337**	**175**	**154**	**61**	**376**	**204**	**231**	**140**	**244**	**129**	**121**	**185**	**121**	**77**	**128**

Table 2
Summary of Chemicals of Potential Concern
SWMU 3 Groundwater Discharge to Surface Water Evaluation
JEB Little Creek
Virginia Beach, Virginia

Groundwater to Surface Water Pathway	
Human Health	***Ecological***
1,1-Dichloroethane	1,1-Dichloroethane
1,2-Dichloroethane	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)
Tetrachloroethene	Chloroethane
Trichloroethene	Cyclohexane
Vinyl chloride	Methylcyclohexane
Aluminum	Tetrachloroethene
Arsenic	Fluoranthene
Cobalt	Fluorene
Iron	Phenanthrene
Manganese	Barium
Thallium	Copper
	Iron
	Manganese
	Nickel
	Silver

Table 3
Summary of RME Cancer Risks and Hazard Indices
SWMU 3 Groundwater Discharge to Surface Water Evaluation
JEB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $>10^{-4}$	Chemicals with Cancer Risks $>10^{-5}$ and $<10^{-4}$	Chemicals with Cancer Risks $>10^{-6}$ and $<10^{-5}$	Hazard Index	Chemicals with HI>1
Current/Future Other Worker Adult	Surface Water	Ingestion	1.1E-05			PCE, Vinyl chloride, arsenic	0.063	
		Dermal Contact	2.2E-05		PCE		0.026	
		Inhalation	NA				NA	
		Total	3.3E-05				0.089	
Current/Future Recreational Adult	Surface Water	Ingestion	1.4E-05			PCE, Vinyl chloride, arsenic	0.089	
		Dermal Contact	**1.4E-04**	PCE		Vinly chloride	0.15	
		Inhalation	NA				NA	
	All Media	Total	**1.5E-04**	PCE			0.24	
Current/Future Recreational Adolescent	Surface Water	Ingestion	7.4E-06			PCE, Vinyl chloride, arsenic	0.12	
		Dermal Contact	5.3E-05		PCE	Vinly chloride	0.15	
		Inhalation	NA				NA	
	All Media	Total	6.1E-05				0.28	
Current/Future Maintenance Worker	Groundwater	Ingestion	4.4E-06			PCE	0.026	
		Dermal Contact	1.0E-05			PCE	0.012	
		Inhalation	NA				NA	
	All Media	Total	1.5E-05				0.039	

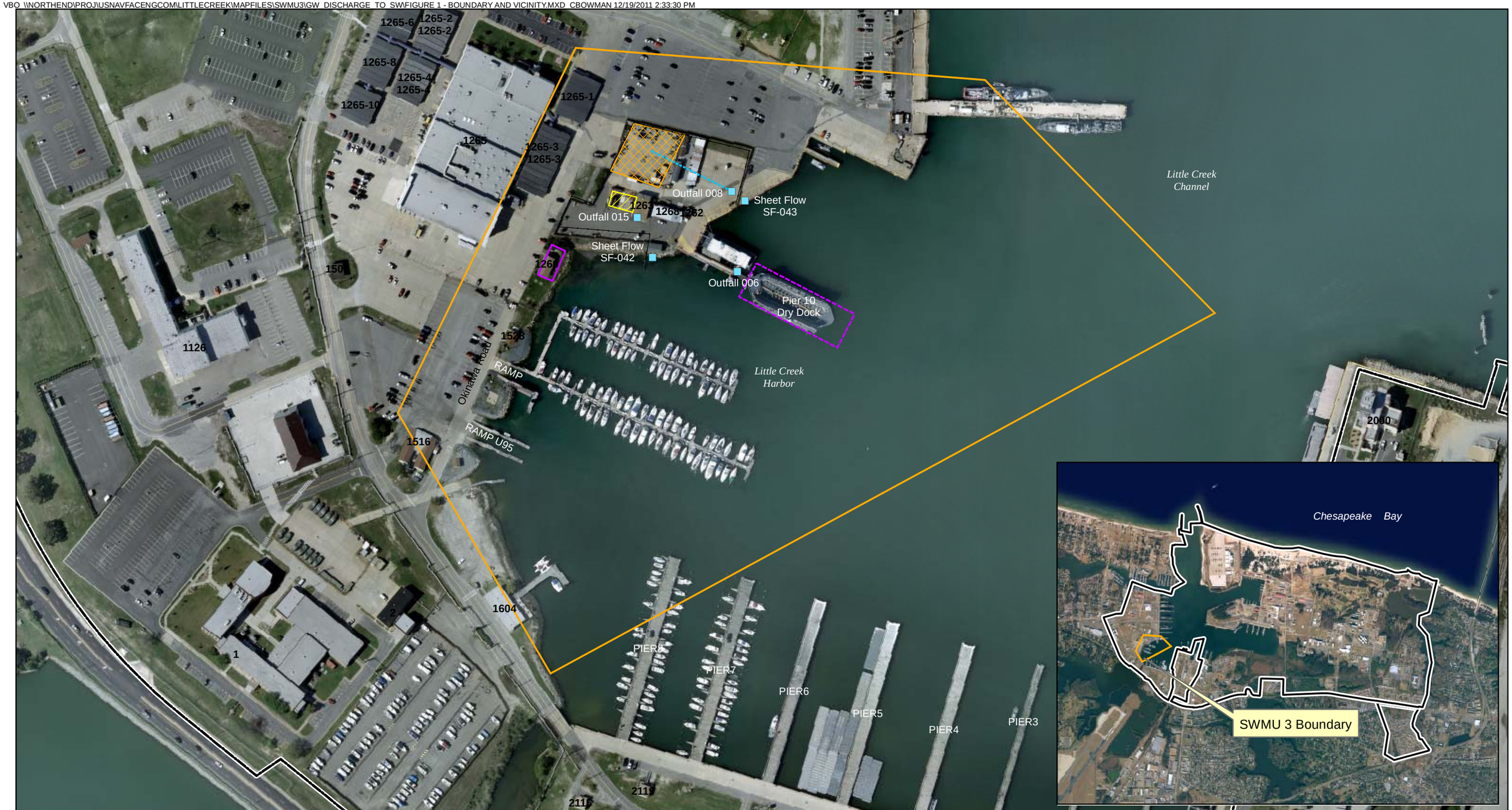
NA - Not applicable, pathway incomplete.

Table 4
Summary of CTE Cancer Risks and Hazard Indices
SWMU 3 Groundwater Discharge to Surface Water Evaluation
JEB Little Creek
Virginia Beach, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $>10^{-4}$	Chemicals with Cancer Risks $>10^{-5}$ and $<10^{-4}$	Chemicals with Cancer Risks $>10^{-6}$ and $<10^{-5}$	Hazard Index	Chemicals with HI>1
Current/Future	Groundwater	Ingestion	2.7E-06			PCE	0.045	
Recreational		Dermal Contact	2.3E-05		PCE		0.067	
Adult		Inhalation	NA				NA	
	All Media	Total	2.6E-05				0.11	

NA - Not applicable, pathway incomplete.

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\LITTLECREEK\MAPFILES\SWMU3\GW_DISCHARGE_TO_SW\FIGURE 1 - BOUNDARY AND VICINITY.MXD CBOWMAN 12/19/2011 2:33:30 PM



Legend

- Outfall Locations
- Underground Drain Pipe
- Fenced Area
- Picnic Area
- 1995 Dredging Limits
- SWMU 3 Boundary
- Former Sandblasting Area (1962-1995)
- More Recent Sandblasting Area (1995-1996)
- Installation Boundary

N
W E
S

0 200 400
Feet

Figure 1
SWMU 3 Boundary and Immediate Vicinity
SWMU 3 Groundwater Discharge to Surface Water Evaluation
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

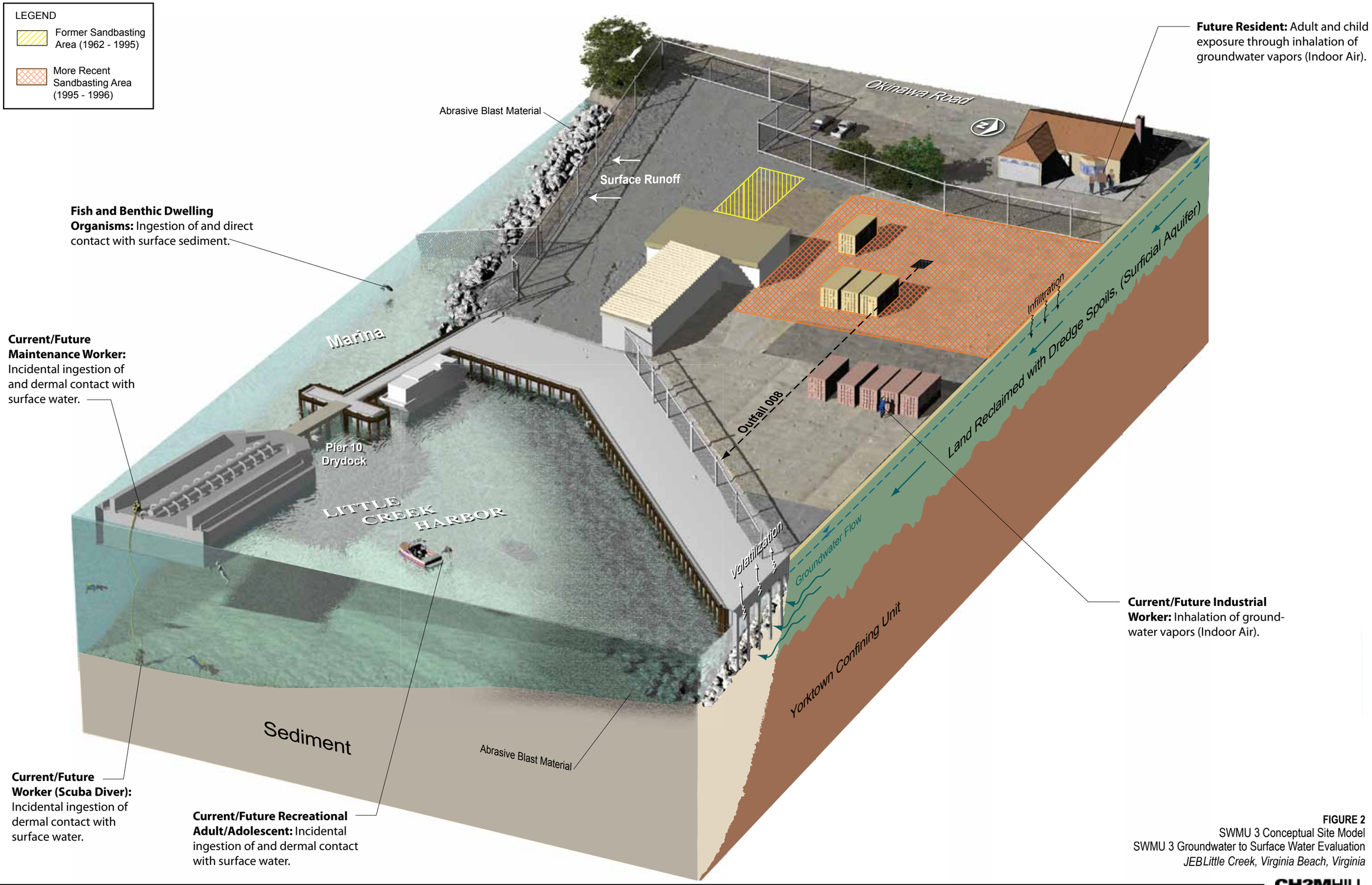
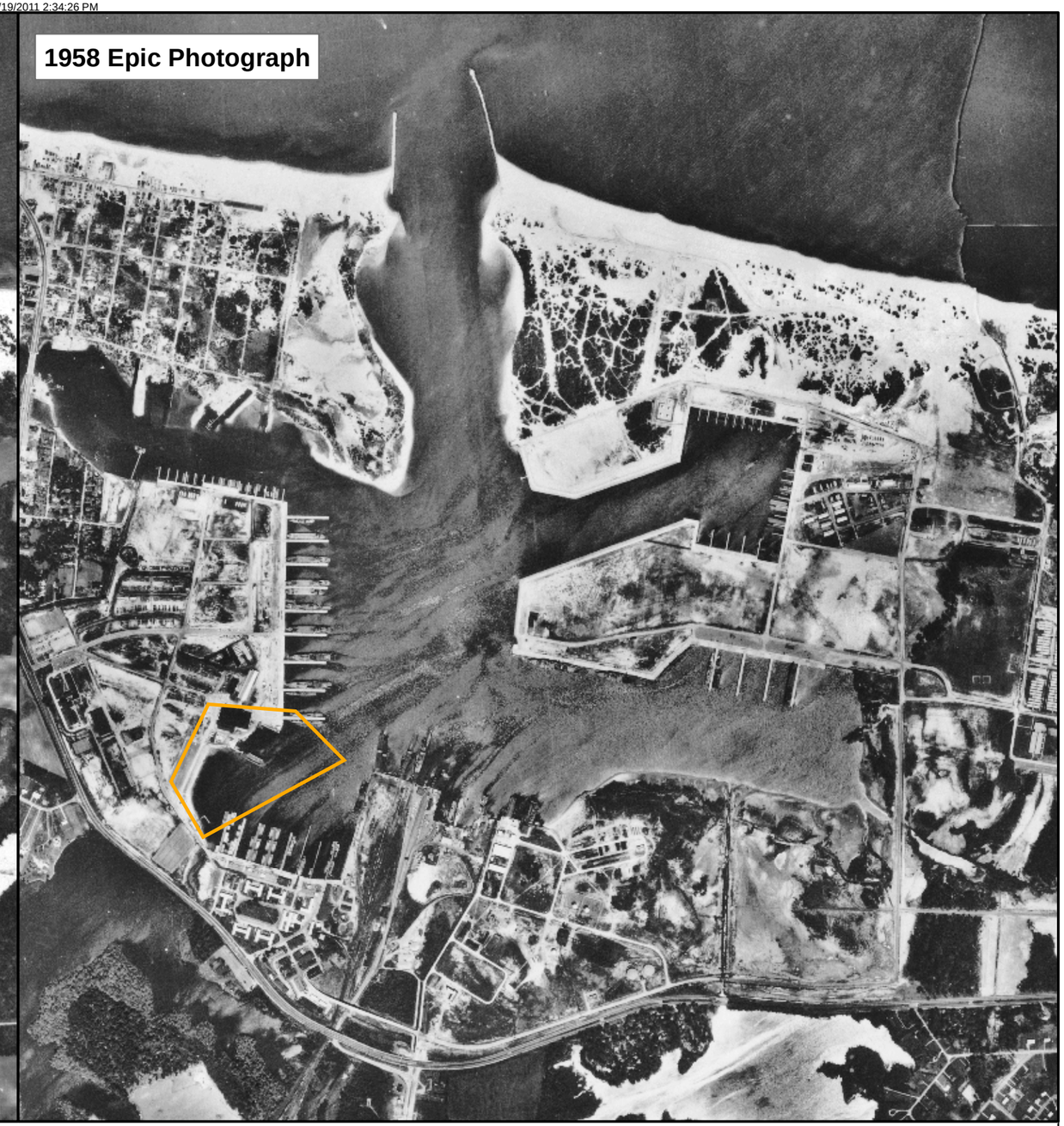


FIGURE 2
SWMU 3 Conceptual Site Model
SWMU 3 Groundwater to Surface Water Evaluation
JEBLittle Creek, Virginia Beach, Virginia



Legend

SWMU 3 Boundary

N
W E
S

0 1,300 2,600
Feet

Figure 3
Epic Photographs of SWMU 3 Area - 1937 and 1958
SWMU 3 Groundwater Discharge to Surface Water Evaluation
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\LITTLECREEK\MAPFILES\SWMU3\GW_DISCHARGE_TO_SW\FIGURE 4 - GW FLOW MAP SEPT 2007.MXD CBOWMAN 12/19/2011 2:24:25 PM

Legend

- Monitoring Well
- Potentiometric Surface
- Inferred Potentiometric Surface
- Fenced Area
- SWMU 3 Boundary
- Groundwater Flow Direction
- Former Sandblasting Area (1962-1995)
- More Recent Sandblasting Area (1995-1996)
- Picnic Area

* Unable to resurvey well. Groundwater elevation may not be accurate.
Location not used to generate potentiometric surface.

N
W E
S

0 50 100
Feet

Figure 4
Groundwater Flow Map (September 2007)
SWMU 3 Groundwater Discharge to
Surface Water Evaluation
JEB Little Creek
Virginia Beach, Virginia

CH2MHILL

Attachment A
Human Health Risk Assessment Tables

TABLE A.1

SELECTION OF EXPOSURE PATHWAYS

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Water	Surface Water	Little Creek Harbor	Other Worker	Adult	Dermal Absorption	On-site	Quant	Harbor may be used for scuba diving practice and training.
						Ingestion	On-site	Quant	Harbor may be used for scuba diving practice and training.
				Recreational	Adult	Dermal Absorption	On-site	Quant	Harbor could be used for swimming by site trespasser/visitor.
						Ingestion	On-site	Quant	Harbor could be used for swimming by site trespasser/visitor.
					Adolescent	Dermal Absorption	On-site	Quant	Harbor could be used for swimming by site trespasser/visitor.
						Ingestion	On-site	Quant	Harbor could be used for swimming by site trespasser/visitor.
				Maintenance Worker	Adult	Dermal Absorption	On-site	Quant	Site worker may contact sediment at harbor during maintenance activities.
						Ingestion	On-site	Quant	Site worker may contact sediment at harbor during maintenance activities.

Table A.2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SWMU 3
JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Little Creek Harbor	71-55-6	1,1,1-Trichloroethane	2.5E-01 J	2.4E+01	UG_L	LW03-MW08-05-02C	4/67	0.5 - 10	2.4E+01	NA	9.1E+03 n	NA	NA	NO	BSL
	76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1.4E-01 J	5.0E+00 J	UG_L	LW03-MW11-15-07C	4/62	0.5 - 10	5.0E+00	NA	5.9E+04 n	NA	NA	NO	BSL
	75-34-3	**1,1-Dichloroethane**	**1.3E-01 J**	**8.7E+01**	**UG_L**	**LW03-MW08-05-02C**	**24/67**	**0.5 - 10**	**8.7E+01**	**NA**	**2.4E+01 c**	**NA**	**NA**	**YES**	**ASL**
	75-35-4	1,1-Dichloroethene	1.2E-01 J	2.0E+00 J	UG_L	LW03-MW12-07A	9/67	0.5 - 10	2.0E+00	NA	3.4E+02 n	NA	NA	NO	BSL
	95-50-1	1,2-Dichlorobenzene	2.4E-01 J	2.4E-01 J	UG_L	LW03-MW03-05-02C	1/62	0.5 - 10	2.4E-01	NA	3.7E+02 n	NA	NA	NO	BSL
	107-06-2	**1,2-Dichloroethane**	**1.5E+00**	**1.5E+00**	**UG_L**	**LW03-MW08-05-02C LW03-MW08-15-02C**	**2/67**	**0.5 - 10**	**1.5E+00**	**NA**	**1.5E+00 c**	**NA**	**NA**	**YES**	**ASL**
	78-93-3	2-Butanone	3.6E-01 J	3.0E+00 J	UG_L	LW03-MW08-15-02C	4/53	5 - 10	3.0E+00	NA	7.1E+03 n	NA	NA	NO	BSL
	67-64-1	Acetone	4.0E+00 J	4.0E+00 J	UG_L	LW03-MW05-13-07C	1/62	5 - 10	4.0E+00	NA	2.2E+04 n	NA	NA	NO	BSL
	71-43-2	Benzene	2.3E-01 J	1.3E+00	UG_L	LW03-MW07-15-02C	6/67	0.5 - 10	1.3E+00	NA	4.1E+00 c	NA	NA	NO	BSL
	75-15-0	Carbon disulfide	1.0E-01 J	7.6E-01	UG_L	LW03-MW03-05-02C	12/67	0.5 - 10	7.6E-01	NA	1.0E+03 n	NA	NA	NO	BSL
	75-00-3	Chloroethane	2.1E-01 J	2.2E+02	UG_L	LW03-MW08-05-02C LW03-MW08-15-02C	8/67	0.5 - 10	2.2E+02	NA	2.1E+04 n	NA	NA	NO	BSL
	67-66-3	Chloroform	1.3E-01 J	1.3E+00	UG_L	LW03-MW14-07A	7/67	0.5 - 10	1.3E+00	NA	1.9E+00 c	NA	NA	NO	BSL
	74-87-3	Chloromethane	1.1E-01 J	1.5E-01 J	UG_L	LW03-MW02-05-02C	4/67	0.5 - 10	1.5E-01	NA	1.9E+02 n	NA	NA	NO	BSL
	110-82-7	Cyclohexane	1.5E-01 J	5.6E-01	UG_L	LW03-MW08-05-02C	4/62	0.5 - 10	5.6E-01	NA	1.3E+04 n	NA	NA	NO	BSL
	98-82-8	Isopropylbenzene	1.1E-01 J	6.2E-01	UG_L	LW03-MW08-05-02C	6/62	0.5 - 10	6.2E-01	NA	6.8E+02 n	NA	NA	NO	BSL
	1634-04-4	Methyl-tert-butyl ether (MTBE)	1.4E-01 J	1.5E-01 J	UG_L	LW03-MW10-13-07C	3/62	0.5 - 10	1.5E-01	NA	1.2E+02 c	NA	NA	NO	BSL
	108-87-2	Methylcyclohexane	1.7E-01 J	2.0E+00 J	UG_L	LW03-MW12-07A LW03-MW12P-07A	7/62	0.5 - 10	2.0E+00	NA	NA	NA	NA	NO	NTX
	75-09-2	Methylene chloride	1.0E+00 J	1.0E+00 J	UG_L	LW03-MW12-07A LW03-MW12P-07A	1/67	0.5 - 10	1.0E+00	NA	4.8E+01 c	NA	NA	NO	BSL
	100-42-5	Styrene	1.0E-01 J	1.1E-01 J	UG_L	LW03-MW08-05-02C	2/67	0.5 - 10	1.1E-01	NA	1.6E+03 n	NA	NA	NO	BSL
	127-18-4	**Tetrachloroethene**	**1.0E-01 J**	**2.1E+02**	**UG_L**	**LW03-MW06-18-02C**	**6/67**	**0.5 - 10**	**2.1E+02**	**NA**	**1.1E+00 c**	**NA**	**NA**	**YES**	**ASL**
	79-01-6	**Trichloroethene**	**2.9E-01 J**	**1.8E+02**	**UG_L**	**LW03-MW06-18-02C LW03-MW06P-18-02C**	**14/67**	**0.5 - 10**	**1.8E+02**	**NA**	**1.7E+01 c**	**NA**	**NA**	**YES**	**ASL**
	75-01-4	**Vinyl chloride**	**1.4E-01 J**	**5.6E+01 J**	**UG_L**	**LW03-MW12-07A**	**15/67**	**0.5 - 10**	**5.6E+01**	**NA**	**1.6E-01 c**	**NA**	**NA**	**YES**	**ASL**
	156-59-2	cis-1,2-Dichloroethene	1.2E-01 J	2.6E+02	UG_L	LW03-MW12P-07A	28/67	0.5 - 20	2.6E+02	NA	3.7E+03 n	NA	NA	NO	BSL
	10061-01-5	cis-1,3-Dichloropropene	1.0E-01 J	1.0E-01 J	UG_L	LW03-MW02-07A	1/67	0.5 - 10	1.0E-01	NA	4.3E+00 c	NA	NA	NO	BSL
	156-60-5	trans-1,2-Dichloroethene	1.6E-01 J	7.9E+01	UG_L	LW03-MW12-07A	22/67	0.5 - 10	7.9E+01	NA	1.1E+02 n	NA	NA	NO	BSL
	10061-02-6	trans-1,3-Dichloropropene	1.1E-01 J	2.6E-01 J	UG_L	LW03-MW08-05-02C	2/67	0.5 - 10	2.6E-01	NA	4.3E+00 c	NA	NA	NO	BSL
	132-64-9	Dibenzofuran	2.8E+01	2.8E+01	UG_L	LW03-MW04-98C	1/5	10 - 10	2.8E+01	NA	3.7E+01 n	NA	NA	NO	BSL
	206-44-0	Fluoranthene	2.7E+01	2.7E+01	UG_L	LW03-MW04-98C	1/5	10 - 10	2.7E+01	NA	1.5E+03 n	NA	NA	NO	BSL
	86-73-7	Fluorene	2.2E+01	2.2E+01	UG_L	LW03-MW04-98C	1/5	10 - 10	2.2E+01	NA	1.5E+03 n	NA	NA	NO	BSL
	85-01-8	Phenanthrene	1.0E+01	1.0E+01	UG_L	LW03-MW04-98C	1/5	10 - 10	1.0E+01	NA	1.1E+04 n	NA	NA	NO	BSL
	7429-90-5	**Aluminum**	**323**	**39,100**	**UG_L**	**LW03-MW04-98C**	**16/36**	**200 - 200**	**3.9E+04**	**NA**	**3.7E+04 n**	**NA**	**NA**	**YES**	**ASL**
	7440-36-0	Antimony	4.9	5.1	UG_L	LW03-MW04-98C	5/36	2 - 60	5.1E+00	NA	1.5E+01 n	NA	NA	NO	BSL
	7440-38-2	**Arsenic**	**1.4 K**	**27.6**	**UG_L**	**LW03-MW08-15-02C**	**23/36**	**1 - 10**	**2.8E+01**	**NA**	**4.5E-01 c**	**NA**	**NA**	**YES**	**ASL**
	7440-39-3	Barium	9.3 J	333	UG_L	LW03-MW03-15-02C	30/36	10 - 200	3.3E+02	NA	7.3E+03 n	NA	NA	NO	BSL
	7440-41-7	Beryllium	0.4 J	1.8	UG_L	LW03-MW04-98C	4/36	1 - 5	1.8E+00	NA	7.3E+01 n	NA	NA	NO	BSL
	7440-43-9	Cadmium	0.25 J	1.2 K	UG_L	LW03-MW04-98C	6/36	1 - 5	1.2E+00	NA	1.8E+01 n	NA	NA	NO	BSL
	7440-70-2	Calcium	9,640	273,000	UG_L	LW03-MW02-05-02C LW03-MW02P-15-02C	28/36	5000 - 5000	2.7E+05	NA	N/A	NA	NA	NO	NUT
	7440-47-3	Chromium	0.7 J	29.9	UG_L	LW03-MW07-05-02C	9/36	2 - 10	3.0E+01	NA	1.1E+02 n	NA	NA	NO	BSL

Table A.2.1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
	7440-48-4	**Cobalt**	**0.19 J**	**23.1 J**	**UG_L**	**LW03-MW10-07A**	**23/36**	**1 - 50**	**2.3E+01**	**NA**	**1.1E+01 n**	**NA**	**NA**	**YES**	**ASL**
	7440-50-8	Copper	6.8 J	35.6 J	UG_L	LW03-MW08-07A	4/36	2 - 25	3.6E+01	NA	1.5E+03 n	NA	NA	NO	BSL
	57-12-5	Cyanide	2 J	35.9	UG_L	LW03-MW13-07A	5/36	10 - 10	3.6E+01	NA	7.3E+02 n	NA	NA	NO	BSL
	7439-89-6	**Iron**	**248**	**35,500**	**UG_L**	**LW03-MW04-98C**	**34/36**	**100 - 100**	**3.6E+04**	**NA**	**2.6E+04 n**	**NA**	**NA**	**YES**	**ASL**
	7439-92-1	**Lead**	**0.41 J**	**35.3**	**UG_L**	**LW03-MW04-98C**	**4/36**	**1 - 5**	**3.5E+01**	**NA**	**1.5E+01**	**NA**	**NA**	**YES**	**ASL**
	7439-95-4	Magnesium	20,000	999,000	UG_L	LW03-MW02P-15-02C	31/36	5000 - 250000	1.0E+06	NA	N/A	NA	NA	NO	NUT
	7439-96-5	**Manganese**	**26**	**1,020**	**UG_L**	**LW03-MW08-05-02C**	**31/36**	**1 - 15**	**1.0E+03**	**NA**	**8.8E+02 n**	**NA**	**NA**	**YES**	**ASL**
	7439-97-6	Mercury	0.2 UL	0.2 L	UG_L	LW03-MW05-98C LW03-MW04-98C	1/36	0.2 - 0.2	2.0E-01	NA	1.1E+01 n	NA	NA	NO	BSL
	7440-02-0	Nickel	0.55 J	22 J	UG_L	LW03-MW07-05-02C	18/36	1 - 40	2.2E+01	NA	7.3E+02 n	NA	NA	NO	BSL
	7440-09-7	Potassium	8,520 J	486,000	UG_L	LW03-MW02P-15-02C	35/36	5000 - 250000	4.9E+05	NA	N/A	NA	NA	NO	NUT
	7782-49-2	Selenium	1.8 J	14	UG_L	LW03-MW04-07A	13/36	5 - 25	1.4E+01	NA	1.8E+02 n	NA	NA	NO	BSL
	7440-22-4	Silver	11.5 J	11.5 J	UG_L	LW03-MW03-98C	1/35	1 - 10	1.2E+01	NA	1.8E+02 n	NA	NA	NO	BSL
	7440-23-5	Sodium	155 J	8,700,000 J	UG_L	LW03-MW02P-15-02C	35/36	5000 - 250000	8.7E+06	NA	N/A	NA	NA	NO	NUT
	7440-28-0	**Thallium**	**2.5 J**	**5.5 J**	**UG_L**	**LW03-MW06-08-02C**	**6/36**	**1 - 10**	**5.5E+00**	**NA**	**2.4E+00 n**	**NA**	**NA**	**YES**	**ASL**
	7440-62-2	Vanadium	0.61 J	11.5 J	UG_L	LW03-MW03-98C	22/36	1 - 50	1.2E+01	NA	1.8E+02 n	NA	NA	NO	BSL
	7440-66-6	Zinc	13.1	37.5	UG_L	LW03-MW09-07A	7/36	2 - 20	3.8E+01	NA	1.1E+04 n	NA	NA	NO	BSL

[1] Minimum/Maximum detected concentrations.Unfiltered results used to identify inorganic COPCs.

[2] Maximum concentration is used for screening.

[3] Background data not applicable for this evaluation.

[4] Oak Ridge National Laboratory (ORNL). May 19, 2008. Regional Screening Levels for Chemical Contaminants at Superfund Sites. [Online]. Available: http://epa-prgs.ornl.gov/chemicals/index.shtml
10 x the adjusted Tap Water RSL used to screen the groundwater to surface water exposure pathway
The adjusted value of 37 ug/L for dibenzofuran in surface water was calculated based on the exposure equations and assumptions used for development of RSLs (ORNL, 2008) for tap water x 10.
RSL value for 1,3-dichloropropene used as a surrogate for cis-1,3-dichloropropene and trans-1,3-dichloropropene.
RSL value for anthracene used as surrogate for phenanthrene.
RSL value for manganese (water) used as surrogate for manganese.
RSL value for mercury (inorganic salts) used as surrogate for mercury.
Screening value for lead is Safe Drinking Water Act lead action level of 15 ug/L.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
c = Carcinogenic
n = Noncarcinogenic

Table A.3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
SWMU 3
JEB Little Creek, Virginia Beach, VA

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)		Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Little Creek Harbor										
	1,1-Dichloroethane	UG/L	4.9E+00	N/A	8.7E+01		8.7E+01	UG/L	Max	1
	1,2-Dichloroethane	UG/L	1.7E+00	N/A	1.5E+00		1.5E+00	UG/L	Max	1
	Tetrachloroethene	UG/L	7.6E+00	N/A	2.1E+02		2.1E+02	UG/L	Max	1
	Trichloroethene	UG/L	7.5E+00	N/A	1.8E+02		1.8E+02	UG/L	Max	1
	Vinyl chloride	UG/L	4.7E+00	N/A	5.6E+01	J	5.6E+01	UG/L	Max	1
	Aluminum	UG/L	1.7E+03	N/A	3.9E+04		3.9E+04	UG/L	Max	1
	Arsenic	UG/L	5.6E+00	N/A	2.8E+01		2.8E+01	UG/L	Max	1
	Cobalt	UG/L	2.6E+00	N/A	2.3E+01		2.3E+01	UG/L	Max	1
	Iron	UG/L	6.3E+03	N/A	3.6E+04		3.6E+04	UG/L	Max	1
	Lead	UG/L	1.6E+00	N/A	3.5E+01		3.5E+01	UG/L	Max	1
	Manganese	UG/L	2.6E+02	N/A	1.0E+03		1.0E+03	UG/L	Max	1
	Thallium	UG/L	1.7E+00	N/A	5.5E+00	J	5.5E+00	UG/L	Max	1

1. Maximum detected groundwater concentration conservatively used as EPC to represent highest possible concentration of surface water (based on groundwater discharge to surface water) that receptor could contact.

N/A - not applicable, not calculated since maximum detected concentration used as EPC

TABLE A.4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
SWMU 3
JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Other Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	4	hr/day	(1)	1/BW x 1/AT
				EF	Exposure Frequency	12	days/year	(2)	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
	Recreational	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	2.6	hr/day	EPA, 1989	1/BW x 1/AT
				EF	Exposure Frequency	26	days/year	(3)	
				ED	Exposure Duration	24	years	EPA, 1991	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	EPA, 1989	
	Recreational	Adolescent	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	2.6	hr/day	EPA, 1989	1/BW x 1/AT
				EF	Exposure Frequency	26	days/year	(3)	
				ED	Exposure Duration	9	years	(4)	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	51	kg	EPA, 1997,(5)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
	Maintenance Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.7.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	4	hr/day	(1)	1/BW x 1/AT
				EF	Exposure Frequency	5	days/year	(9)	
				ED	Exposure Duration	25	years	EPA, 1991	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	

TABLE A.4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Other Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	4	hr/event	(1)	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	5,300	cm^2	EPA, 1997, (6)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	12	days/year	(2)	
				ED	Exposure Duration	25	years	EPA, 1991	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	
	Recreational	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	2.6	hr/day	EPA, 1989	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	20,000	cm^2	EPA, 1997, (7)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	26	days/year	(3)	
				ED	Exposure Duration	24	years	EPA, 1991	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	8,760	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	

TABLE A.4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Recreational	Adolescents	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	2.6	hr/day	EPA, 1989	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	15,000	cm^2	EPA, 1997, (8)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	26	days/year	(3)	
				ED	Exposure Duration	9	years	(4)	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	51	kg	EPA, 1997,(5)	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	
	Maintenance Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	15000	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	4	hr/event	(1)	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	6,000	cm^2	EPA, 1997, (10)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	5	days/year	(9)	
				ED	Exposure Duration	25	years	EPA, 1991	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	9,125	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	

TABLE A.4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name

Notes:

(1) Professional Judgement assuming 4 hours per day, and 5 days per year.

(2) Professional Judgment assuming 1 day per month per year.

(3) Professional Judgement assuming 1 day per week for one-half the year.

(4) Professional Judgment assuming adolescents from 9 to 18 years of age.

(5) Body weight is average value for the 9 year old and 18 year old male body weight.

(6) SA includes head, hands, forearms, and lower legs, assuming diver wears short sleeve and short pant wet suit and water shoes.

(7) Skin surface area in contact with surface water are based on ranges. For total adult male surface area ranges from 17,000 to 23,000 cm2, with a mean of 20,000 cm2.

(8) Total surface area for a 12-15 year old male. The total body surface area ranges from 12,000 to 19,000 cm2 ; the mean value of 15,000 cm2 is used for the RME.

(9) Professional Judgement assuming 5 days per year.

(10) Skin surface area in contact with surface water based on contact while wading. Assumed 30 percent of total surface area (hands, forearms, lower legs, and feet).

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2001: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

TABLE A.4.1.CT

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDANCY

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Other Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	4	hr/day	(1)	1/BW x 1/AT
				EF	Exposure Frequency	6	days/year	(2)	
				ED	Exposure Duration	6.6	years	EPA, 1993	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,409	days	EPA, 1989	
	Recreational	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	2.6	hr/day	EPA, 1989	1/BW x 1/AT
				EF	Exposure Frequency	13	days/year	(2)	
				ED	Exposure Duration	9	years	EPA, 1993	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
	Recreational	Adolescent	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	2.6	hr/day	EPA, 1989	1/BW x 1/AT
				EF	Exposure Frequency	13	days/year	(2)	
				ED	Exposure Duration	9	years	(3)	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	51	kg	EPA, 1997,(4)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
	Maintenance Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-SW	Ingestion Rate of Surface Water	0.08	l/hour	EPA, 1989	CSW x IR-SW x ET x EF x ED x CF1 x
				ET	Exposure Time	4	hr/day	(1)	1/BW x 1/AT
				EF	Exposure Frequency	5	days/year	(8)	
				ED	Exposure Duration	6.6	years	EPA, 1993	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,409	days	EPA, 1989	

TABLE A.4.1.CT

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDANCY

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Other Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	4	hr/event	(1)	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	5,300	cm^2	EPA, 1997, (5)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	6	days/year	(2)	
				ED	Exposure Duration	6.6	years	EPA, 1993	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	2,409	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	
	Recreational	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	2.6	hr/day	EPA, 1989	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	18,000	cm^2	EPA, 1997, (6)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	13	days/year	(2)	
				ED	Exposure Duration	9	years	EPA, 1993	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	

TABLE A.4.1.CT

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDANCY

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Recreational	Adolescents	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	see Table 3.1.RME	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	2.6	hr/day	EPA, 1989	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	12,000	cm^2	EPA, 1997, (7)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	13	days/year	(2)	
				ED	Exposure Duration	9	years	(3)	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	51	kg	EPA, 1997,(4)	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	3,285	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	
	Maintenance Worker	Adult	Little Creek Harbor	CSW	Chemical Concentration in Surface Water	1	µg/l	- -	CDI (mg/kg-day) =
				DAevent	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	calculated	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				FA	Fraction absorbed water	chemical specific	dimensionless	EPA, 2001	
				Kp	Permeability Coefficient	chemical specific	cm/hr	EPA, 2001	Inorganics: DAevent (mg/cm^2-event) =
				τ	Lag Time	chemical specific	hr/event	EPA, 2001	Kp x CW x t_{event} x CF1 x CF2
				t*	Time to Reach Steady-state	chemical specific	hours	EPA, 2001	
				B	Ratio of Permeability of Stratum Corneum to Epidermis	chemical specific	dimensionless	EPA, 2001	Organics :
				t_{event}	Event Time	4	hr/event	(1)	t_{event}<t*: DAevent (mg/cm^2-event) =
				SA	Skin Surface Area Available for Contact	6,000	cm^2	EPA, 1997, (9)	2 x FA x Kp x CW x (sqrt((6 xτ x t_{event})/π))
				EV	Event Frequency	1	events/day	EPA, 2001	x CF1 x CF2
				EF	Exposure Frequency	5	days/year	(8)	
				ED	Exposure Duration	6.6	years	EPA, 1993	t_{event}>t*: DAevent (mg/cm^2-event) =
				BW	Body Weight	70	kg	EPA, 1991	FA x Kp x CW x (t_{event}/(1+B) + 2 x τ x
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	((1 + 3B + $3B^2$)/$(1+B)^2$)) x CF1 x CF2
				AT-N	Averaging Time (Non-Cancer)	2,409	days	EPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/µg	- -	
				CF2	Conversion Factor 2	0.001	l/cm^3	- -	

TABLE A.4.1.CT

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDANCY

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name

Notes:

(1) Professional Judgement assuming 4 hours per day.

(2) Professional Judgement assuming 1/2 of the RME value for the CT.

(3) Professional Judgment assuming adolescents from 9 to 18 years of age.

(4) Body weight is average value for the 9 year old and 18 year old male body weight.

(5) SA includes head, hands, forearms, and lower legs, assuming diver wears short sleeve and short pant wet suit and water shoes.

(6) Skin surface area in contact with surface water are based on ranges. For total adult male surface area ranges from 17,000 to 23,000 cm2, with a mean of 20,000 cm2.

(7) Total surface area for a 12-15 year old male. The total body surface area ranges from 12,000 to 19,000 cm2 ; 12,000 cm2 is used for the CT value.

(8) Professional Judgement assuming 5 days per year.

(9) Skin surface area in contact with surface water based on contact while wading. Assumed 30 percent of total surface area (hands, forearms, lower legs, and feet).

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 2001: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

TABLE A.5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

SWMU 3

JEB Little Creek, Virginia Beach, VA

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
1,1-Dichlorothane	Chronic	2.0E-01	mg/kg-day	Generally >50%	2.0E-01	mg/kg-day	Kidney	3000	PPRTV	9/27/2006
	Subchronic	N/A			N/A		N/A			
1,2-Dichlorothane	Chronic	2.0E-02	mg/kg-day	Generally >50%	2.0E-02	mg/kg-day	Kidney	3000	PPRTV	10/31/2002
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethene	Chronic	1.0E-02	mg/kg-day	Generally >50%	1.0E-02	mg/kg-day	Liver, Whole body	1000/1	IRIS	8/11/2009
	Subchronic	1.0E-01	mg/kg-day	Generally >50%	1.0E-01	mg/kg-day	Liver, Whole body	100	HEAST	7/1/1997
Trichloroethene	Chronic	N/A			N/A		N/A			
	Subchronic	N/A			N/A		N/A			
Vinyl chloride	Chronic	3.0E-03	mg/kg-day	Generally >50%	3.0E-03	mg/kg-day	Liver	30/1	IRIS	8/11/2009
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	1.0E+00	mg/kg-day	N/A	1.0E+00	mg/kg-day	Neurological	100	PPRTV	10/23/2006
	Subchronic	N/A			N/A		N/A			
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin, Vascular	3/1	IRIS	8/11/2009
	Subchronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Skin, Vascular	3	HEAST	7/1/1997
Cobalt	Chronic	3.0E-04	mg/kg-day	N/A	3.0E-04	mg/kg-day	Thyroid	3000	PPRTV	8/25/2008
	Subchronic	3.0E-03	mg/kg-day	N/A	3.0E-03	mg/kg-day	Thyroid	300	PPRTV	8/25/2008
Iron	Chronic	7.0E-01	mg/kg/day	N/A	7.0E-01	mg/kg/day	Gastrointestinal	1	PPRTV	07/29/05
	Subchronic	7.0E-01	mg/kg/day	N/A	7.0E-01	mg/kg/day	Gastrointestinal	1	PPRTV	07/29/05
Manganese (water)	Chronic	2.4E-02	mg/kg-day	4%	9.6E-04	mg/kg-day	CNS	1/1	IRIS	10/31/2002
	Subchronic	N/A			N/A		N/A			
Thallium	Chronic	6.5E-05	mg/kg-day	100%	6.5E-05	mg/kg-day	Liver, Blood, Hair	300/1	IRIS	8/11/2009
	Subchronic	N/A			N/A		N/A			

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (Final).

Section 4.2 and Exhibit 4-1. USEPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%.

Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.

(2) Adjusted Dermal RfD = RfD (oral) x Absorption Efficiency or ABS_{GI}

(3) For IRIS values, the date IRIS was searched.

For NCEA values, the date of the NCEA article.

For PPRTV values, the date of the PPRTV article.

For HEAST values, the date of HEAST document.

NOAEL = No adverse effect level

CNS = Central Nervous System

IRIS = Integrated Risk Information System

TABLE A.5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

SWMU 3

JEB Little Creek, Virginia Beach, VA

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)

HEAST= Health Effects Assessment Summary Tables

NA = Not Applicable

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Assessment

TABLE A.5.2

NON-CANCER TOXICITY DATA -- INHALATION

SWMU 3

JEB Little Creek, Virginia Beach, VA

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ (2)	Dates (3) (MM/DD/YY)
1,1-Dichloroethane	Chronic	N/A		N/A		N/A			
	Subchronic	N/A		N/A		N/A			
1,2-Dichloroethane	Chronic	2.4E+00	mg/m^3	7.0E-01	mg/kg-day	Blood, Kidney, Liver	NA	ATSDR	9/1/2001
	Subchronic	N/A		N/A		N/A			
Tetrachloroethene	Chronic	2.7E-01	mg/m^3	8.0E-02	mg/kg-day	Kidney, Liver	NA	ATSDR	9/1/1997
	Subchronic	N/A		N/A		N/A			
Trichloroethene	Chronic	N/A		N/A		N/A			
	Subchronic	N/A		N/A		N/A			
Vinyl chloride	Chronic	1.0E-01	mg/m^3	2.8E-02	mg/kg-day	Liver	30/1	IRIS	8/11/2009
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum	Chronic	5.0E-03	mg/m^3	1.4E-03	mg/kg-day	Neurological	300	PPRTV	10/23/2006
	Subchronic	N/A		N/A		N/A			
Arsenic	Chronic	1.5E-05	mg/m^3	4.3E-06	mg/kg-day	Development, Cardiovascular system, Nervous system	N/A	CalEPA	8/11/2009
	Subchronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cobalt	Chronic	6.0E-06	mg/m^3	1.7E-06	mg/kg-day	Respiratory	300	PPRTV	8/25/2008
	Subchronic	2.0E-05	mg/m^3	5.7E-06	mg/kg-day	Respiratory	100	PPRTV	8/25/2008
Iron	Chronic	N/A		N/A		N/A			
	Subchronic	N/A		N/A		N/A			
Manganese	Chronic	5.0E-05	mg/m^3	1.4E-05	mg/kg-day	CNS	1000/1	IRIS	8/11/2009
	Subchronic	N/A		N/A		N/A			
Thallium	Chronic	N/A		N/A		N/A			
	Subchronic	N/A		N/A		N/A			

N/A = Not Applicable

(1) Provide equation used for derivation in text.

(2) HEAST, Alternative Methods used as source of barium values.

Chromium and cadmium values were withdrawn from HEAST, but available in Region III RBC Table.

(3) For IRIS values, provide the date IRIS was searched.

For HEAST values, provide the date of HEAST.

For NCEA values, provide the date of the ATSDR toxicity profile.

For ATSDR values, provide the date of the article provided by NCEA.

ATSDR = Agency for Toxic Substances and Disease Registry

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

HEAST Table 2 = Health Effects Assessment Summary Tables, Alternate Methods

HEAST Table 3 = Health Effects Assessment Summary Tables, Carcinogenicity

HEAST(4)= Health Effects Assessment Summary Tables, Withdrawn

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Value

TABLE A.6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

SWMU 3

JEB Little Creek, Virginia Beach, VA

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	EPA Carcinogen Group	Source	Date (2) (MM/DD/YY)
1,1-Dichloroethane	5.7E-03	Generally > 50%	5.7E-03	(mg/kg-day) $^{-1}$	C	CalEPA	8/11/2009
1,2-Dichloroethane	9.1E-02	Generally > 50%	9.1E-02	(mg/kg-day) $^{-1}$	B2	IRIS	8/11/2009
Tetrachloroethene	5.4E-01	Generally > 50%	5.4E-01	(mg/kg-day) $^{-1}$	2A	CalEPA	8/11/2009
Trichloroethene	1.3E-02	Generally > 50%	1.3E-02	(mg/kg-day) $^{-1}$	2A	CalEPA	8/11/2009
Vinyl chloride	7.2E-01	Generally > 50%	7.2E-01	(mg/kg-day) $^{-1}$	A	IRIS	8/11/2009
Aluminum	N/A		N/A				
Arsenic	1.5E+00	95%	1.5E+00	(mg/kg-day) $^{-1}$	A	IRIS	8/11/2009
Cobalt	N/A		N/A				
Iron	N/A		N/A				
Manganese	N/A		N/A				
Thallium	N/A		N/A				

N/A-Not available

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

PPRTV = Provisional Peer-Reviewed Toxicity Value

(1) Refer to RAGS, Part E. July 2004.

(2) For IRIS values, provide the date IRIS was searched.
For CalEPA values, provide the date database was searched.
For HEAST values, provide the date of HEAST.
For NCEA values, provide article date provided by NCEA.
For RBC values, provide the date of last change in the Tables.

EPA Carcinogen Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

2A - The agent is probably carcinogenic to humans

TABLE A.6.2

CANCER TOXICITY DATA -- INHALATION

SWMU 3

JEB Little Creek, Virginia Beach, VA

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guidance Description	Source	Date (2) (MM/DD/YY)
1,1-Dichloroethane	1.6E-06	$(ug/m3)^{-1}$	3500	5.6E-03	$(mg/kg\text{-}day)^{-1}$	C	CalEPA	8/11/2009
1,2-Dichloroethane	2.6E-05	$(ug/m3)^{-1}$	3500	9.1E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	8/11/2009
Tetrachloroethene	5.9E-06	$(ug/m3)^{-1}$	3500	2.1E-02	$(mg/kg\text{-}day)^{-1}$	2A	CalEPA	8/11/2009
Trichloroethene	2.0E-06	$(ug/m3)^{-1}$	3500	7.0E-03	$(mg/kg\text{-}day)^{-1}$	2A	CalEPA	8/11/2009
Vinyl chloride (lifetime from adult)	4.4E-06	$(ug/m3)^{-1}$	3500	1.5E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	8/11/2009
Aluminum	N/A			N/A				
Arsenic	4.0E-03	$(ug/m3)^{-1}$	3500	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	8/11/2009
Cobalt	9.0E-03	$(ug/m3)^{-1}$	3500	3.2E+01	$(mg/kg\text{-}day)^{-1}$	likely to be carcinogenic to humans by the inhalation route	PPRTV	8/25/2008
Iron	N/A			N/A				
Manganese	N/A			N/A				
Thallium	N/A			N/A				

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
PPRTV = Provisional Peer-Reviewed Toxicity Value
N/A = Not Available

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor = 70kg x 1/20m3/day x 1000ug/mg

(2) For IRIS values, provide the date IRIS was searched.
For HEAST values, provide the date of HEAST.
For PPRTV values, provide the date of the article provided by PPRTV.
For RBC values, provide the date of last change in the Tables.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity
2A - The agent is probably carcinogenic to humans

(3) Trichloroethene slope factor is a range from 0.02 to 0.4 kg-d/mg. The median of 0.21 may be used for general populations, 0.4 for sensitive populations.

TABLE A.7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Receptor Population: Other Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Surface Water	Little Creek Harbor	Ingestion	1,1-Dichloroethane	8.7E+01	ug/L	4.7E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	2.7E-08	1.3E-05	mg/kg/day	2.0E-01	mg/kg/day	6.5E-05
				1,2-Dichloroethane	1.5E+00	ug/L	8.1E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	7.3E-09	2.3E-07	mg/kg/day	2.0E-02	mg/kg/day	1.1E-05
				Tetrachloroethene	2.1E+02	ug/L	1.1E-05	mg/kg/day	5.4E-01	1/(mg/kg-day)	6.1E-06	3.2E-05	mg/kg/day	1.0E-02	mg/kg/day	3.2E-03
				Trichloroethene	1.8E+02	ug/L	9.7E-06	mg/kg/day	1.3E-02	1/(mg/kg-day)	1.3E-07	2.7E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	3.0E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	2.2E-06	8.4E-06	mg/kg/day	3.0E-03	mg/kg/day	2.8E-03
				Aluminum	3.9E+04	ug/L	2.1E-03	mg/kg/day	NA	NA	NA	5.9E-03	mg/kg/day	1.0E+00	mg/kg/day	5.9E-03
				Arsenic	2.8E+01	ug/L	1.5E-06	mg/kg/day	1.5E+00	1/(mg/kg-day)	2.3E-06	4.2E-06	mg/kg/day	3.0E-04	mg/kg/day	1.4E-02
				Cobalt	2.3E+01	ug/L	1.2E-06	mg/kg/day	NA	NA	NA	3.5E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Iron	3.2E+04	ug/L	1.7E-03	mg/kg/day	NA	NA	NA	4.8E-03	mg/kg/day	7.0E-01	mg/kg/day	6.8E-03
				Manganese	1.0E+03	ug/L	5.5E-05	mg/kg/day	NA	NA	NA	1.5E-04	mg/kg/day	2.4E-02	mg/kg/day	6.5E-03
				Thallium	5.5E+00	ug/L	3.0E-07	mg/kg/day	NA	NA	NA	8.3E-07	mg/kg/day	6.5E-05	mg/kg/day	1.3E-02
			Exp. Route Total								1.1E-05					6.3E-02
			Dermal Absorption	1,1-Dichloroethane	8.7E+01	ug/L	2.4E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	1.4E-08	6.8E-06	mg/kg/day	2.0E-01	mg/kg/day	3.4E-05
				1,2-Dichloroethane	1.5E+00	ug/L	2.7E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	2.4E-09	7.4E-08	mg/kg/day	2.0E-02	mg/kg/day	3.7E-06
				Tetrachloroethene	2.1E+02	ug/L	3.8E-05	mg/kg/day	5.4E-01	1/(mg/kg-day)	2.1E-05	1.1E-04	mg/kg/day	1.0E-02	mg/kg/day	1.1E-02
				Trichloroethene	1.8E+02	ug/L	9.9E-06	mg/kg/day	1.3E-02	1/(mg/kg-day)	1.3E-07	2.8E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	1.2E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	8.9E-07	3.5E-06	mg/kg/day	3.0E-03	mg/kg/day	1.2E-03
				Aluminum	3.9E+04	ug/L	1.4E-04	mg/kg/day	NA	NA	NA	3.9E-04	mg/kg/day	1.0E+00	mg/kg/day	3.9E-04
				Arsenic	2.8E+01	ug/L	1.0E-07	mg/kg/day	1.5E+00	1/(mg/kg-day)	1.5E-07	2.8E-07	mg/kg/day	3.0E-04	mg/kg/day	9.3E-04
				Cobalt	2.3E+01	ug/L	3.3E-08	mg/kg/day	NA	NA	NA	9.2E-08	mg/kg/day	3.0E-04	mg/kg/day	3.1E-04
				Iron	3.2E+04	ug/L	1.1E-04	mg/kg/day	NA	NA	NA	3.2E-04	mg/kg/day	7.0E-01	mg/kg/day	4.5E-04
				Manganese	1.0E+03	ug/L	3.7E-06	mg/kg/day	NA	NA	NA	1.0E-05	mg/kg/day	9.6E-04	mg/kg/day	1.1E-02
				Thallium	5.5E+00	ug/L	2.0E-08	mg/kg/day	NA	NA	NA	5.5E-08	mg/kg/day	6.5E-05	mg/kg/day	8.4E-04
			Exp. Route Total								2.2E-05					2.6E-02
		Exposure Point Total									3.3E-05					8.9E-02
	Exposure Medium Total										3.3E-05					8.9E-02
Medium Total											3.3E-05					8.9E-02
									Total of Receptor Risks Across All Media		3.3E-05			Total of Receptor Hazards Across All Media		8.9E-02

Table A.7.1. Supplement A
Calculation of DAevent
Worker, Surface Water
SWMU 3 - JEB Little Creek, Virginia Beach, Virginia

Chemical of Potential Concern	Surface Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ_{event}) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
1,1-Dichloroethane	8.7E+01	6.7E-03	2.6E-02	3.8E-01	9.2E-01	1.0E+00	4	2.8E-06	3
1,2-Dichloroethane	1.5E+00	4.2E-03	1.6E-02	3.8E-01	9.2E-01	1.0E+00	4	3.0E-08	3
Tetrachloroethene	2.1E+02	3.3E-02	1.7E-01	9.1E-01	2.2E+00	1.0E+00	4	4.3E-05	3
Trichloroethene	1.8E+02	1.2E-02	5.1E-02	5.8E-01	1.4E+00	1.0E+00	4	1.1E-05	3
Vinyl chloride	5.6E+01	5.6E-03	1.7E-02	2.4E-01	5.7E-01	1.0E+00	4	1.4E-06	3
Aluminum	3.9E+04	1.0E-03	NA	NA	NA	NA	4	1.6E-04	1
Arsenic	2.8E+01	1.0E-03	NA	NA	NA	NA	4	1.1E-07	1
Cobalt	2.3E+01	4.0E-04	NA	NA	NA	NA	4	3.7E-08	1
Iron	3.2E+04	1.0E-03	NA	NA	NA	NA	4	1.3E-04	1
Manganese	1.0E+03	1.0E-03	NA	NA	NA	NA	4	4.1E-06	1
Thallium	5.5E+00	1.0E-03	NA	NA	NA	NA	4	2.2E-08	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
tevent<t*: DAevent (mg/cm2-event) =
2 x FA x Kp x CW x (sqrt((6 x τ_{event} x tevent)/π)) x 0.001 mg/ug x 0.001 l/cm^3 (eq 2)

tevent>t*: DAevent (mg/cm2-event) =
FA x Kp x CW x (tevent/(1+B) + 2 x τ_{event} x ((1 + 3xB + $3xB^2$)/$(1+B)^2$) x 0.001 mg/ug x 0.001 l/cm3 (eq 3)

Notes:
Permeability constants from EPA 2001, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R/99/005.
NA - not applicable.

TABLE A.7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Receptor Population: Recreational
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Surface Water	Little Creek Harbor	Ingestion	1,1-Dichloroethane	8.7E+01	ug/L	6.3E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	3.6E-08	1.8E-05	mg/kg/day	2.0E-01	mg/kg/day	9.2E-05
				1,2-Dichloroethane	1.5E+00	ug/L	1.1E-07	mg/kg/day	9.1E-02	1/(mg/kg-day)	9.9E-09	3.2E-07	mg/kg/day	2.0E-02	mg/kg/day	1.6E-05
				Tetrachloroethene	2.1E+02	ug/L	1.5E-05	mg/kg/day	5.4E-01	1/(mg/kg-day)	8.2E-06	4.4E-05	mg/kg/day	1.0E-02	mg/kg/day	4.4E-03
				Trichloroethene	1.8E+02	ug/L	1.3E-05	mg/kg/day	1.3E-02	1/(mg/kg-day)	1.7E-07	3.8E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	4.1E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	2.9E-06	1.2E-05	mg/kg/day	3.0E-03	mg/kg/day	4.0E-03
				Aluminum	3.9E+04	ug/L	2.8E-03	mg/kg/day	NA	NA	NA	8.3E-03	mg/kg/day	1.0E+00	mg/kg/day	8.3E-03
				Arsenic	2.8E+01	ug/L	2.0E-06	mg/kg/day	1.5E+00	1/(mg/kg-day)	3.0E-06	5.9E-06	mg/kg/day	3.0E-04	mg/kg/day	2.0E-02
				Cobalt	2.3E+01	ug/L	1.7E-06	mg/kg/day	NA	NA	NA	4.9E-06	mg/kg/day	3.0E-04	mg/kg/day	1.6E-02
				Iron	3.2E+04	ug/L	2.3E-03	mg/kg/day	NA	NA	NA	6.7E-03	mg/kg/day	7.0E-01	mg/kg/day	9.6E-03
				Manganese	1.0E+03	ug/L	7.5E-05	mg/kg/day	NA	NA	NA	2.2E-04	mg/kg/day	2.4E-02	mg/kg/day	9.1E-03
				Thallium	5.5E+00	ug/L	4.0E-07	mg/kg/day	NA	NA	NA	1.2E-06	mg/kg/day	6.5E-05	mg/kg/day	1.8E-02
			Exp. Route Total								1.4E-05					8.9E-02
			Dermal Absorption	1,1-Dichloroethane	8.7E+01	ug/L	1.4E-05	mg/kg/day	5.7E-03	1/(mg/kg-day)	7.8E-08	4.0E-05	mg/kg/day	2.0E-01	mg/kg/day	2.0E-04
				1,2-Dichloroethane	1.5E+00	ug/L	1.5E-07	mg/kg/day	9.1E-02	1/(mg/kg-day)	1.3E-08	4.3E-07	mg/kg/day	2.0E-02	mg/kg/day	2.2E-05
				Tetrachloroethene	2.1E+02	ug/L	2.4E-04	mg/kg/day	5.4E-01	1/(mg/kg-day)	1.3E-04	7.1E-04	mg/kg/day	1.0E-02	mg/kg/day	7.1E-02
				Trichloroethene	1.8E+02	ug/L	5.8E-05	mg/kg/day	1.3E-02	1/(mg/kg-day)	7.5E-07	1.7E-04	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	6.7E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	4.8E-06	2.0E-05	mg/kg/day	3.0E-03	mg/kg/day	6.5E-03
				Aluminum	3.9E+04	ug/L	7.1E-04	mg/kg/day	NA	NA	NA	2.1E-03	mg/kg/day	1.0E+00	mg/kg/day	2.1E-03
				Arsenic	2.8E+01	ug/L	5.1E-07	mg/kg/day	1.5E+00	1/(mg/kg-day)	7.6E-07	1.5E-06	mg/kg/day	3.0E-04	mg/kg/day	4.9E-03
				Cobalt	2.3E+01	ug/L	1.7E-07	mg/kg/day	NA	NA	NA	4.9E-07	mg/kg/day	3.0E-04	mg/kg/day	1.6E-03
				Iron	3.2E+04	ug/L	5.8E-04	mg/kg/day	NA	NA	NA	1.7E-03	mg/kg/day	7.0E-01	mg/kg/day	2.4E-03
				Manganese	1.0E+03	ug/L	1.9E-05	mg/kg/day	NA	NA	NA	5.5E-05	mg/kg/day	9.6E-04	mg/kg/day	5.7E-02
				Thallium	5.5E+00	ug/L	1.0E-07	mg/kg/day	NA	NA	NA	2.9E-07	mg/kg/day	6.5E-05	mg/kg/day	4.5E-03
			Exp. Route Total								1.4E-04					1.5E-01
		Exposure Point Total									1.5E-04					2.4E-01
	Exposure Medium Total										1.5E-04					2.4E-01
Medium Total											1.5E-04					2.4E-01
									Total of Receptor Risks Across All Media		1.5E-04			Total of Receptor Hazards Across All Media		2.4E-01

Table A.7.2. Supplement A
Calculation of DAevent
Recreational Adult/Adolescent, Surface Water
SWMU 3 - JEB Little Creek, Virginia Beach, Virginia

Chemical of Potential Concern	Surface Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ_{event}) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
1,1-Dichloroethane	8.7E+01	6.7E-03	2.6E-02	3.8E-01	9.2E-01	1.0E+00	2.6	2.0E-06	3
1,2-Dichloroethane	1.5E+00	4.2E-03	1.6E-02	3.8E-01	9.2E-01	1.0E+00	2.6	2.1E-08	3
Tetrachloroethene	2.1E+02	3.3E-02	1.7E-01	9.1E-01	2.2E+00	1.0E+00	2.6	3.5E-05	3
Trichloroethene	1.8E+02	1.2E-02	5.1E-02	5.8E-01	1.4E+00	1.0E+00	2.6	8.2E-06	3
Vinyl chloride	5.6E+01	5.6E-03	1.7E-02	2.4E-01	5.7E-01	1.0E+00	2.6	9.6E-07	3
Aluminum	3.9E+04	1.0E-03	NA	NA	NA	NA	2.6	1.0E-04	1
Arsenic	2.8E+01	1.0E-03	NA	NA	NA	NA	2.6	7.3E-08	1
Cobalt	2.3E+01	4.0E-04	NA	NA	NA	NA	2.6	2.4E-08	1
Iron	3.2E+04	1.0E-03	NA	NA	NA	NA	2.6	8.2E-05	1
Manganese	1.0E+03	1.0E-03	NA	NA	NA	NA	2.6	2.7E-06	1
Thallium	5.5E+00	1.0E-03	NA	NA	NA	NA	2.6	1.4E-08	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
tevent<t*: DAevent (mg/cm2-event) =
2 x FA x Kp x CW x (sqrt((6 x τ_{event} x tevent)/π)) x 0.001 mg/ug x 0.001 l/cm^3 (eq 2)

tevent>t*: DAevent (mg/cm2-event) =
FA x Kp x CW x (tevent/(1+B) + 2 x τ_{event} x ((1 + 3xB + $3xB^2$)/$(1+B)^2$) x 0.001 mg/ug x 0.001 l/cm3 (eq 3)

Notes:
Permeability constants from EPA 2001, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R/99/005.
NA - not applicable.

TABLE A.7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Receptor Population: Recreational
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Surface Water	Little Creek Harbor	Ingestion	1,1-Dichloroethane	8.7E+01	ug/L	3.2E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	1.9E-08	2.5E-05	mg/kg/day	2.0E-01	mg/kg/day	1.3E-04
				1,2-Dichloroethane	1.5E+00	ug/L	5.6E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	5.1E-09	4.4E-07	mg/kg/day	2.0E-02	mg/kg/day	2.2E-05
				Tetrachloroethene	2.1E+02	ug/L	7.8E-06	mg/kg/day	5.4E-01	1/(mg/kg-day)	4.2E-06	6.1E-05	mg/kg/day	1.0E-02	mg/kg/day	6.1E-03
				Trichloroethene	1.8E+02	ug/L	6.7E-06	mg/kg/day	1.3E-02	1/(mg/kg-day)	8.7E-08	5.2E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	2.1E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	1.5E-06	1.6E-05	mg/kg/day	3.0E-03	mg/kg/day	5.4E-03
				Aluminum	3.9E+04	ug/L	1.5E-03	mg/kg/day	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Arsenic	2.8E+01	ug/L	1.0E-06	mg/kg/day	1.5E+00	1/(mg/kg-day)	1.6E-06	8.1E-06	mg/kg/day	3.0E-04	mg/kg/day	2.7E-02
				Cobalt	2.3E+01	ug/L	8.6E-07	mg/kg/day	NA	NA	NA	6.7E-06	mg/kg/day	3.0E-04	mg/kg/day	2.2E-02
				Iron	3.2E+04	ug/L	1.2E-03	mg/kg/day	NA	NA	NA	9.2E-03	mg/kg/day	7.0E-01	mg/kg/day	1.3E-02
				Manganese	1.0E+03	ug/L	3.8E-05	mg/kg/day	NA	NA	NA	3.0E-04	mg/kg/day	2.4E-02	mg/kg/day	1.2E-02
				Thallium	5.5E+00	ug/L	2.1E-07	mg/kg/day	NA	NA	NA	1.6E-06	mg/kg/day	6.5E-05	mg/kg/day	2.5E-02
			Exp. Route Total								7.4E-06					1.2E-01
			Dermal Absorption	1,1-Dichloroethane	8.7E+01	ug/L	5.3E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	3.0E-08	4.1E-05	mg/kg/day	2.0E-01	mg/kg/day	2.0E-04
				1,2-Dichloroethane	1.5E+00	ug/L	5.7E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	5.2E-09	4.4E-07	mg/kg/day	2.0E-02	mg/kg/day	2.2E-05
				Tetrachloroethene	2.1E+02	ug/L	9.4E-05	mg/kg/day	5.4E-01	1/(mg/kg-day)	5.1E-05	7.3E-04	mg/kg/day	1.0E-02	mg/kg/day	7.3E-02
				Trichloroethene	1.8E+02	ug/L	2.2E-05	mg/kg/day	1.3E-02	1/(mg/kg-day)	2.9E-07	1.7E-04	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	2.6E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	1.9E-06	2.0E-05	mg/kg/day	3.0E-03	mg/kg/day	6.7E-03
				Aluminum	3.9E+04	ug/L	2.7E-04	mg/kg/day	NA	NA	NA	2.1E-03	mg/kg/day	1.0E+00	mg/kg/day	2.1E-03
				Arsenic	2.8E+01	ug/L	2.0E-07	mg/kg/day	1.5E+00	1/(mg/kg-day)	2.9E-07	1.5E-06	mg/kg/day	3.0E-04	mg/kg/day	5.1E-03
				Cobalt	2.3E+01	ug/L	6.5E-08	mg/kg/day	NA	NA	NA	5.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.7E-03
				Iron	3.2E+04	ug/L	2.2E-04	mg/kg/day	NA	NA	NA	1.7E-03	mg/kg/day	7.0E-01	mg/kg/day	2.5E-03
				Manganese	1.0E+03	ug/L	7.2E-06	mg/kg/day	NA	NA	NA	5.6E-05	mg/kg/day	9.6E-04	mg/kg/day	5.8E-02
				Thallium	5.5E+00	ug/L	3.9E-08	mg/kg/day	NA	NA	NA	3.0E-07	mg/kg/day	6.5E-05	mg/kg/day	4.6E-03
			Exp. Route Total								5.3E-05					1.5E-01
		Exposure Point Total									6.1E-05					2.8E-01
	Exposure Medium Total										6.1E-05					2.8E-01
Medium Total											6.1E-05					2.8E-01
									Total of Receptor Risks Across All Media		6.1E-05			Total of Receptor Hazards Across All Media		2.8E-01

TABLE A.7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Surface Water	Little Creek Harbor	Ingestion	1,1-Dichloroethane	8.7E+01	ug/L	1.9E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	1.1E-08	5.4E-06	mg/kg/day	2.0E-01	mg/kg/day	2.7E-05
				1,2-Dichloroethane	1.5E+00	ug/L	3.4E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	3.1E-09	9.4E-08	mg/kg/day	2.0E-02	mg/kg/day	4.7E-06
				Tetrachloroethene	2.1E+02	ug/L	4.7E-06	mg/kg/day	5.4E-01	1/(mg/kg-day)	2.5E-06	1.3E-05	mg/kg/day	1.0E-02	mg/kg/day	1.3E-03
				Trichloroethene	1.8E+02	ug/L	4.0E-06	mg/kg/day	1.3E-02	1/(mg/kg-day)	5.2E-08	1.1E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	1.3E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	9.0E-07	3.5E-06	mg/kg/day	3.0E-03	mg/kg/day	1.2E-03
				Aluminum	3.9E+04	ug/L	8.7E-04	mg/kg/day	NA	NA	NA	2.4E-03	mg/kg/day	1.0E+00	mg/kg/day	2.4E-03
				Arsenic	2.8E+01	ug/L	6.3E-07	mg/kg/day	1.5E+00	1/(mg/kg-day)	9.4E-07	1.8E-06	mg/kg/day	3.0E-04	mg/kg/day	5.8E-03
				Cobalt	2.3E+01	ug/L	5.2E-07	mg/kg/day	NA	NA	NA	1.4E-06	mg/kg/day	3.0E-04	mg/kg/day	4.8E-03
				Iron	3.2E+04	ug/L	7.1E-04	mg/kg/day	NA	NA	NA	2.0E-03	mg/kg/day	7.0E-01	mg/kg/day	2.8E-03
				Manganese	1.0E+03	ug/L	2.3E-05	mg/kg/day	NA	NA	NA	6.5E-05	mg/kg/day	2.4E-02	mg/kg/day	2.7E-03
				Thallium	5.5E+00	ug/L	1.2E-07	mg/kg/day	NA	NA	NA	3.4E-07	mg/kg/day	6.5E-05	mg/kg/day	5.3E-03
			Exp. Route Total								4.4E-06					2.6E-02
			Dermal Absorption	1,1-Dichloroethane	8.7E+01	ug/L	1.2E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	6.6E-09	3.2E-06	mg/kg/day	2.0E-01	mg/kg/day	1.6E-05
				1,2-Dichloroethane	1.5E+00	ug/L	1.3E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	1.1E-09	3.5E-08	mg/kg/day	2.0E-02	mg/kg/day	1.8E-06
				Tetrachloroethene	2.1E+02	ug/L	1.8E-05	mg/kg/day	5.4E-01	1/(mg/kg-day)	9.8E-06	5.1E-05	mg/kg/day	1.0E-02	mg/kg/day	5.1E-03
				Trichloroethene	1.8E+02	ug/L	4.7E-06	mg/kg/day	1.3E-02	1/(mg/kg-day)	6.1E-08	1.3E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	5.8E-07	mg/kg/day	7.2E-01	1/(mg/kg-day)	4.2E-07	1.6E-06	mg/kg/day	3.0E-03	mg/kg/day	5.4E-04
				Aluminum	3.9E+04	ug/L	6.6E-05	mg/kg/day	NA	NA	NA	1.8E-04	mg/kg/day	1.0E+00	mg/kg/day	1.8E-04
				Arsenic	2.8E+01	ug/L	4.7E-08	mg/kg/day	1.5E+00	1/(mg/kg-day)	7.0E-08	1.3E-07	mg/kg/day	3.0E-04	mg/kg/day	4.4E-04
				Cobalt	2.3E+01	ug/L	1.5E-08	mg/kg/day	NA	NA	NA	4.3E-08	mg/kg/day	3.0E-04	mg/kg/day	1.4E-04
				Iron	3.2E+04	ug/L	5.3E-05	mg/kg/day	NA	NA	NA	1.5E-04	mg/kg/day	7.0E-01	mg/kg/day	2.1E-04
				Manganese	1.0E+03	ug/L	1.7E-06	mg/kg/day	NA	NA	NA	4.8E-06	mg/kg/day	9.6E-04	mg/kg/day	5.0E-03
				Thallium	5.5E+00	ug/L	9.2E-09	mg/kg/day	NA	NA	NA	2.6E-08	mg/kg/day	6.5E-05	mg/kg/day	4.0E-04
			Exp. Route Total								1.0E-05					1.2E-02
		Exposure Point Total									1.5E-05					3.9E-02
	Exposure Medium Total										1.5E-05					3.9E-02
Medium Total											1.5E-05					3.9E-02
									Total of Receptor Risks Across All Media		1.5E-05			Total of Receptor Hazards Across All Media		3.9E-02

TABLE A.7.1.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

SWMU 3

JEB Little Creek, Virginia Beach, Virginia

Scenario Timeframe: Current/Future
Receptor Population: Recreational
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Surface Water	Little Creek Harbor	Ingestion	1,1-Dichloroethane	8.7E+01	ug/L	1.2E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	6.7E-09	9.2E-06	mg/kg/day	2.0E-01	mg/kg/day	4.6E-05
				1,2-Dichloroethane	1.5E+00	ug/L	2.0E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	1.9E-09	1.6E-07	mg/kg/day	2.0E-02	mg/kg/day	7.9E-06
				Tetrachloroethene	2.1E+02	ug/L	2.9E-06	mg/kg/day	5.4E-01	1/(mg/kg-day)	1.5E-06	2.2E-05	mg/kg/day	1.0E-02	mg/kg/day	2.2E-03
				Trichloroethene	1.8E+02	ug/L	2.4E-06	mg/kg/day	1.3E-02	1/(mg/kg-day)	3.2E-08	1.9E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	7.6E-07	mg/kg/day	7.2E-01	1/(mg/kg-day)	5.5E-07	5.9E-06	mg/kg/day	3.0E-03	mg/kg/day	2.0E-03
				Aluminum	3.9E+04	ug/L	5.3E-04	mg/kg/day	NA	NA	NA	4.1E-03	mg/kg/day	1.0E+00	mg/kg/day	4.1E-03
				Arsenic	2.8E+01	ug/L	3.8E-07	mg/kg/day	1.5E+00	1/(mg/kg-day)	5.7E-07	3.0E-06	mg/kg/day	3.0E-04	mg/kg/day	9.9E-03
				Cobalt	2.3E+01	ug/L	3.1E-07	mg/kg/day	NA	NA	NA	2.4E-06	mg/kg/day	3.0E-04	mg/kg/day	8.1E-03
				Iron	3.2E+04	ug/L	4.3E-04	mg/kg/day	NA	NA	NA	3.4E-03	mg/kg/day	7.0E-01	mg/kg/day	4.8E-03
				Manganese	1.0E+03	ug/L	1.4E-05	mg/kg/day	NA	NA	NA	1.1E-04	mg/kg/day	2.4E-02	mg/kg/day	4.5E-03
				Thallium	5.5E+00	ug/L	7.5E-08	mg/kg/day	NA	NA	NA	5.8E-07	mg/kg/day	6.5E-05	mg/kg/day	9.0E-03
			Exp. Route Total								2.7E-06					4.5E-02
			Dermal Absorption	1,1-Dichloroethane	8.7E+01	ug/L	2.3E-06	mg/kg/day	5.7E-03	1/(mg/kg-day)	1.3E-08	1.8E-05	mg/kg/day	2.0E-01	mg/kg/day	9.0E-05
				1,2-Dichloroethane	1.5E+00	ug/L	2.5E-08	mg/kg/day	9.1E-02	1/(mg/kg-day)	2.3E-09	1.9E-07	mg/kg/day	2.0E-02	mg/kg/day	9.7E-06
				Tetrachloroethene	2.1E+02	ug/L	4.1E-05	mg/kg/day	5.4E-01	1/(mg/kg-day)	2.2E-05	3.2E-04	mg/kg/day	1.0E-02	mg/kg/day	3.2E-02
				Trichloroethene	1.8E+02	ug/L	9.7E-06	mg/kg/day	1.3E-02	1/(mg/kg-day)	1.3E-07	7.6E-05	mg/kg/day	NA	NA	NA
				Vinyl chloride	5.6E+01	ug/L	1.1E-06	mg/kg/day	7.2E-01	1/(mg/kg-day)	8.1E-07	8.8E-06	mg/kg/day	3.0E-03	mg/kg/day	2.9E-03
				Aluminum	3.9E+04	ug/L	1.2E-04	mg/kg/day	NA	NA	NA	9.3E-04	mg/kg/day	1.0E+00	mg/kg/day	9.3E-04
				Arsenic	2.8E+01	ug/L	8.6E-08	mg/kg/day	1.5E+00	1/(mg/kg-day)	1.3E-07	6.7E-07	mg/kg/day	3.0E-04	mg/kg/day	2.2E-03
				Cobalt	2.3E+01	ug/L	2.8E-08	mg/kg/day	NA	NA	NA	2.2E-07	mg/kg/day	3.0E-04	mg/kg/day	7.3E-04
				Iron	3.2E+04	ug/L	9.7E-05	mg/kg/day	NA	NA	NA	7.5E-04	mg/kg/day	7.0E-01	mg/kg/day	1.1E-03
				Manganese	1.0E+03	ug/L	3.2E-06	mg/kg/day	NA	NA	NA	2.5E-05	mg/kg/day	9.6E-04	mg/kg/day	2.6E-02
				Thallium	5.5E+00	ug/L	1.7E-08	mg/kg/day	NA	NA	NA	1.3E-07	mg/kg/day	6.5E-05	mg/kg/day	2.0E-03
			Exp. Route Total								2.3E-05					6.7E-02
		Exposure Point Total									2.6E-05					1.1E-01
	Exposure Medium Total										2.6E-05					1.1E-01
Medium Total											2.6E-05					1.1E-01
									Total of Receptor Risks Across All Media		2.6E-05			Total of Receptor Hazards Across All Media		1.1E-01

Table A.7.1.CTE Supplement A
Calculation of DAevent
Recreational Adult/Adolescent, Surface Water
SWMU 3 - JEB Little Creek, Virginia Beach, Virginia

Chemical of Potential Concern	Surface Water Concentration (CW) (µg/L)	Permeability Coefficient (Kp) (cm/hr)	B (dimensionless)	Lag Time (τ_{event}) (hr)	t* (hr)	Fraction Absorbed Water (FA) (dimensionless)	Duration of Event (tevent) (hr)	DAevent (mg/cm^2-event)	Eq
1,1-Dichloroethane	8.7E+01	6.7E-03	2.6E-02	3.8E-01	9.2E-01	1.0E+00	2.6	2.0E-06	3
1,2-Dichloroethane	1.5E+00	4.2E-03	1.6E-02	3.8E-01	9.2E-01	1.0E+00	2.6	2.1E-08	3
Tetrachloroethene	2.1E+02	3.3E-02	1.7E-01	9.1E-01	2.2E+00	1.0E+00	2.6	3.5E-05	3
Trichloroethene	1.8E+02	1.2E-02	5.1E-02	5.8E-01	1.4E+00	1.0E+00	2.6	8.2E-06	3
Vinyl chloride	5.6E+01	5.6E-03	1.7E-02	2.4E-01	5.7E-01	1.0E+00	2.6	9.6E-07	3
Aluminum	3.9E+04	1.0E-03	NA	NA	NA	NA	2.6	1.0E-04	1
Arsenic	2.8E+01	1.0E-03	NA	NA	NA	NA	2.6	7.3E-08	1
Cobalt	2.3E+01	4.0E-04	NA	NA	NA	NA	2.6	2.4E-08	1
Iron	3.2E+04	1.0E-03	NA	NA	NA	NA	2.6	8.2E-05	1
Manganese	1.0E+03	1.0E-03	NA	NA	NA	NA	2.6	2.7E-06	1
Thallium	5.5E+00	1.0E-03	NA	NA	NA	NA	2.6	1.4E-08	1

Inorganics: DAevent (mg/cm2-event) =
Kp x CW x tevent x 0.001 mg/ug x 0.001 l/cm^3 (eq 1)

Organics: DAevent (mg/cm2-event) =
tevent<t*: DAevent (mg/cm2-event) =
2 x FA x Kp x CW x (sqrt((6 x τ_{event} x tevent)/π)) x 0.001 mg/ug x 0.001 l/cm^3 (eq 2)

tevent>t*: DAevent (mg/cm2-event) =
FA x Kp x CW x (tevent/(1+B) + 2 x τ_{event} x ((1 + 3xB + 3xB^2)/(1+B)^2) x 0.001 mg/ug x 0.001 l/cm3 (eq 3)

Notes:
Permeability constants from EPA 2001, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R/99/005.
NA - not applicable.

TABLE A.9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SWMU 3, JEB Little Creek, Virginia Beach, VA

Scenario Timeframe: Current/Future
Receptor Population: Other Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Surface Water	Little Creek Harbor										
			1,1-Dichloroethane	2.7E-08	N/A	1.4E-08	4.1E-08	Kidney	6.5E-05	N/A	3.4E-05	1.0E-04
			1,2-Dichloroethane	7.3E-09	N/A	2.4E-09	9.7E-09	Kidney	1.1E-05	N/A	3.7E-06	1.5E-05
			Tetrachloroethene	6.1E-06	N/A	2.1E-05	2.7E-05	Liver, Whole body	3.2E-03	N/A	1.1E-02	1.4E-02
			Trichloroethene	1.3E-07	N/A	1.3E-07	2.5E-07	N/A	NA	N/A	NA	0.0E+00
			Vinyl chloride	2.2E-06	N/A	8.9E-07	3.1E-06	Liver	2.8E-03	N/A	1.2E-03	4.0E-03
			Aluminum	NA	N/A	NA	0.0E+00	Neurological	5.9E-03	N/A	3.9E-04	6.3E-03
			Arsenic	2.3E-06	N/A	1.5E-07	2.4E-06	Skin, Vascular	1.4E-02	N/A	9.3E-04	1.5E-02
			Cobalt	NA	N/A	NA	0.0E+00	Thyroid	1.2E-02	N/A	3.1E-04	1.2E-02
			Iron	NA	N/A	NA	0.0E+00	Gastrointestinal	6.8E-03	N/A	4.5E-04	7.3E-03
			Manganese	NA	N/A	NA	0.0E+00	CNS	6.5E-03	N/A	1.1E-02	1.7E-02
			Thallium	NA	N/A	NA	0.0E+00	Liver, Blood, Hair	1.3E-02	N/A	8.4E-04	1.4E-02
			Chemical Total	1.1E-05	0.0E+00	2.2E-05	3.3E-05		6.3E-02	0.0E+00	2.6E-02	8.9E-02
		Exposure Point Total					3.3E-05					8.9E-02
	Exposure Medium Total						3.3E-05					8.9E-02
Medium Total							3.3E-05					8.9E-02
Receptor Total							3.3E-05				Receptor HI Total	8.9E-02

HI - Hazard Index
CNS = Central Nervous System

Total Blood HI Across All Media =	1.4E-02
Total CNS/Nerulogical HI Across All Media =	2.3E-02
Total Gastrointestinal HI Across All Media =	7.3E-03
Total Hair HI Across All Media =	1.4E-02
Total Kidney HI Across All Media =	1.1E-04
Total Liver HI Across All Media =	3.1E-02
Total Skin HI Across All Media =	1.5E-02
Total Thyroid HI Across All Media =	1.2E-02
Total Vascular HI Across All Media =	1.5E-02
Total Whole Body HI Across All Media =	1.4E-02

TABLE A.9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SWMU 3, JEB Little Creek, Virginia Beach, VA

Scenario Timeframe: Current/Future
Receptor Population: Recreational
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Surface Water	Little Creek Harbor										
			1,1-Dichloroethane	3.6E-08	N/A	7.8E-08	1.1E-07	Kidney	9.2E-05	N/A	2.0E-04	2.9E-04
			1,2-Dichloroethane	9.9E-09	N/A	1.3E-08	2.3E-08	Kidney	1.6E-05	N/A	2.2E-05	3.7E-05
			Tetrachloroethene	8.2E-06	N/A	1.3E-04	1.4E-04	Liver, Whole body	4.4E-03	N/A	7.1E-02	7.5E-02
			Trichloroethene	1.7E-07	N/A	7.5E-07	9.2E-07	N/A	NA	N/A	NA	0.0E+00
			Vinyl chloride	2.9E-06	N/A	4.8E-06	7.7E-06	Liver	4.0E-03	N/A	6.5E-03	1.0E-02
			Aluminum	NA	N/A	NA	0.0E+00	Neurological	8.3E-03	N/A	2.1E-03	1.0E-02
			Arsenic	3.0E-06	N/A	7.6E-07	3.8E-06	Skin, Vascular	2.0E-02	N/A	4.9E-03	2.5E-02
			Cobalt	NA	N/A	NA	0.0E+00	Thyroid	1.6E-02	N/A	1.6E-03	1.8E-02
			Iron	NA	N/A	NA	0.0E+00	Gastrointestinal	9.6E-03	N/A	2.4E-03	1.2E-02
			Manganese	NA	N/A	NA	0.0E+00	CNS	9.1E-03	N/A	5.7E-02	6.6E-02
			Thallium	NA	N/A	NA	0.0E+00	Liver, Blood, Hair	1.8E-02	N/A	4.5E-03	2.2E-02
			Chemical Total	1.4E-05	0.0E+00	1.4E-04	1.5E-04		8.9E-02	0.0E+00	1.5E-01	2.4E-01
		Exposure Point Total					1.5E-04					2.4E-01
	Exposure Medium Total						1.5E-04					2.4E-01
Medium Total							1.5E-04					2.4E-01
Receptor Total							1.5E-04				Receptor HI Total	2.4E-01

HI - Hazard Index
CNS = Central Nervous System

Total Blood HI Across All Media =	2.2E-02
Total CNS/Nerulogical HI Across All Media =	7.6E-02
Total Gastrointestinal HI Across All Media =	1.2E-02
Total Hair HI Across All Media =	2.2E-02
Total Kidney HI Across All Media =	3.3E-04
Total Liver HI Across All Media =	1.1E-01
Total Skin HI Across All Media =	2.5E-02
Total Thyroid HI Across All Media =	1.8E-02
Total Vascular HI Across All Media =	2.5E-02
Total Whole Body HI Across All Media =	7.5E-02

TABLE A.9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SWMU 3, JEB Little Creek, Virginia Beach, VA

Scenario Timeframe: Current/Future
Receptor Population: Recreational
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Surface Water	Little Creek Harbor										
			1,1-Dichloroethane	1.9E-08	N/A	3.0E-08	4.9E-08	Kidney	1.3E-04	N/A	2.0E-04	3.3E-04
			1,2-Dichloroethane	5.1E-09	N/A	5.2E-09	1.0E-08	Kidney	2.2E-05	N/A	2.2E-05	4.4E-05
			Tetrachloroethene	4.2E-06	N/A	5.1E-05	5.5E-05	Liver, Whole body	6.1E-03	N/A	7.3E-02	7.9E-02
			Trichloroethene	8.7E-08	N/A	2.9E-07	3.8E-07	N/A	NA	N/A	NA	0.0E+00
			Vinyl chloride	1.5E-06	N/A	1.9E-06	3.4E-06	Liver	5.4E-03	N/A	6.7E-03	1.2E-02
			Aluminum	NA	N/A	NA	0.0E+00	Neurological	1.1E-02	N/A	2.1E-03	1.3E-02
			Arsenic	1.6E-06	N/A	2.9E-07	1.9E-06	Skin, Vascular	2.7E-02	N/A	5.1E-03	3.2E-02
			Cobalt	NA	N/A	NA	0.0E+00	Thyroid	2.2E-02	N/A	1.7E-03	2.4E-02
			Iron	NA	N/A	NA	0.0E+00	Gastrointestinal	1.3E-02	N/A	2.5E-03	1.6E-02
			Manganese	NA	N/A	NA	0.0E+00	CNS	1.2E-02	N/A	5.8E-02	7.1E-02
			Thallium	NA	N/A	NA	0.0E+00	Liver, Blood, Hair	2.5E-02	N/A	4.6E-03	2.9E-02
			Chemical Total	7.4E-06	0.0E+00	5.3E-05	6.1E-05		1.2E-01	0.0E+00	1.5E-01	2.8E-01
		Exposure Point Total					6.1E-05					2.8E-01
	Exposure Medium Total						6.1E-05					2.8E-01
Medium Total							6.1E-05					2.8E-01
Receptor Total							6.1E-05				Receptor HI Total	2.8E-01

HI - Hazard Index
CNS = Central Nervous System

Total Blood HI Across All Media =	2.9E-02
Total CNS/Nerulogical HI Across All Media =	8.4E-02
Total Gastrointestinal HI Across All Media =	1.6E-02
Total Hair HI Across All Media =	2.9E-02
Total Kidney HI Across All Media =	3.8E-04
Total Liver HI Across All Media =	1.2E-01
Total Skin HI Across All Media =	3.2E-02
Total Thyroid HI Across All Media =	2.4E-02
Total Vascular HI Across All Media =	3.2E-02
Total Whole Body HI Across All Media =	7.9E-02

TABLE A.9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SWMU 3, JEB Little Creek, Virginia Beach, VA

Scenario Timeframe: Current/Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Surface Water	Little Creek Harbor										
			1,1-Dichloroethane	1.1E-08	N/A	6.6E-09	1.8E-08	Kidney	2.7E-05	N/A	1.6E-05	4.3E-05
			1,2-Dichloroethane	3.1E-09	N/A	1.1E-09	4.2E-09	Kidney	4.7E-06	N/A	1.8E-06	6.4E-06
			Tetrachloroethene	2.5E-06	N/A	9.8E-06	1.2E-05	Liver, Whole body	1.3E-03	N/A	5.1E-03	6.4E-03
			Trichloroethene	5.2E-08	N/A	6.1E-08	1.1E-07	N/A	NA	N/A	NA	0.0E+00
			Vinyl chloride	9.0E-07	N/A	4.2E-07	1.3E-06	Liver	1.2E-03	N/A	5.4E-04	1.7E-03
			Aluminum	NA	N/A	NA	0.0E+00	Neurological	2.4E-03	N/A	1.8E-04	2.6E-03
			Arsenic	9.4E-07	N/A	7.0E-08	1.0E-06	Skin, Vascular	5.8E-03	N/A	4.4E-04	6.3E-03
			Cobalt	NA	N/A	NA	0.0E+00	Thyroid	4.8E-03	N/A	1.4E-04	5.0E-03
			Iron	NA	N/A	NA	0.0E+00	Gastrointestinal	2.8E-03	N/A	2.1E-04	3.0E-03
			Manganese	NA	N/A	NA	0.0E+00	CNS	2.7E-03	N/A	5.0E-03	7.7E-03
			Thallium	NA	N/A	NA	0.0E+00	Liver, Blood, Hair	5.3E-03	N/A	4.0E-04	5.7E-03
			Chemical Total	4.4E-06	0.0E+00	1.0E-05	1.5E-05		2.6E-02	0.0E+00	1.2E-02	3.9E-02
		Exposure Point Total					1.5E-05					3.9E-02
	Exposure Medium Total						1.5E-05					3.9E-02
Medium Total							1.5E-05					3.9E-02
Receptor Total							1.5E-05				Receptor HI Total	3.9E-02

HI - Hazard Index
CNS = Central Nervous System

Total Blood HI Across All Media =	5.7E-03
Total CNS/Nerulogical HI Across All Media =	1.0E-02
Total Gastrointestinal HI Across All Media =	3.0E-03
Total Hair HI Across All Media =	5.7E-03
Total Kidney HI Across All Media =	5.0E-05
Total Liver HI Across All Media =	1.4E-02
Total Skin HI Across All Media =	6.3E-03
Total Thyroid HI Across All Media =	5.0E-03
Total Vascular HI Across All Media =	6.3E-03
Total Whole Body HI Across All Media =	6.4E-03

TABLE A.9.1.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SWMU 3, JEB Little Creek, Virginia Beach, VA

Scenario Timeframe: Current/Future
Receptor Population: Recreational
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Surface Water	Little Creek Harbor										
			1,1-Dichloroethane	6.7E-09	N/A	1.3E-08	2.0E-08	Kidney	4.6E-05	N/A	9.0E-05	1.4E-04
			1,2-Dichloroethane	1.9E-09	N/A	2.3E-09	4.1E-09	Kidney	7.9E-06	N/A	9.7E-06	1.8E-05
			Tetrachloroethene	1.5E-06	N/A	2.2E-05	2.4E-05	Liver, Whole body	2.2E-03	N/A	3.2E-02	3.4E-02
			Trichloroethene	3.2E-08	N/A	1.3E-07	1.6E-07	N/A	NA	N/A	NA	0.0E+00
			Vinyl chloride	5.5E-07	N/A	8.1E-07	1.4E-06	Liver	2.0E-03	N/A	2.9E-03	4.9E-03
			Aluminum	NA	N/A	NA	0.0E+00	Neurological	4.1E-03	N/A	9.3E-04	5.1E-03
			Arsenic	5.7E-07	N/A	1.3E-07	7.0E-07	Skin, Vascular	9.9E-03	N/A	2.2E-03	1.2E-02
			Cobalt	NA	N/A	NA	0.0E+00	Thyroid	8.1E-03	N/A	7.3E-04	8.9E-03
			Iron	NA	N/A	NA	0.0E+00	Gastrointestinal	4.8E-03	N/A	1.1E-03	5.9E-03
			Manganese	NA	N/A	NA	0.0E+00	CNS	4.5E-03	N/A	2.6E-02	3.0E-02
			Thallium	NA	N/A	NA	0.0E+00	Liver, Blood, Hair	9.0E-03	N/A	2.0E-03	1.1E-02
			Chemical Total	2.7E-06	0.0E+00	2.3E-05	2.6E-05		4.5E-02	0.0E+00	6.7E-02	1.1E-01
		Exposure Point Total					2.6E-05					1.1E-01
	Exposure Medium Total						2.6E-05					1.1E-01
Medium Total							2.6E-05					1.1E-01
Receptor Total							2.6E-05				Receptor HI Total	1.1E-01

HI - Hazard Index
CNS = Central Nervous System

Total Blood HI Across All Media =	1.1E-02
Total CNS/Nerulogical HI Across All Media =	3.5E-02
Total Gastrointestinal HI Across All Media =	5.9E-03
Total Hair HI Across All Media =	1.1E-02
Total Kidney HI Across All Media =	1.5E-04
Total Liver HI Across All Media =	5.0E-02
Total Skin HI Across All Media =	1.2E-02
Total Thyroid HI Across All Media =	8.9E-03
Total Vascular HI Across All Media =	1.2E-02
Total Whole Body HI Across All Media =	3.4E-02

Attachment B
Ecological Risk Assessment Tables

Table B-1
Initial Screening Statistics - SWMU 3 Groundwater - Detected Constituents
JEB Little Creek, Virginia Beach, VA

Chemical	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	Screening Value	Reference	Maximum Hazard Quotient	Frequency of Exceedance	Initial COPC?
Dissolved Metals (UG/L)											
Aluminum	7.60 - 202	2 / 36	12.5	LW03-MW02-98C	20.6	19.4	87.0 *	USEPA 2006a	0.14	0 / 36	NO
Antimony	1.70 - 8.50	1 / 36	4.90	LW03-MW05-98C	1.41	1.00	500	USEPA 2006b	0.010	0 / 36	NO
Arsenic	0.45 - 3.80	27 / 36	25.2	LW03-MW08-05-02C	4.95	5.84	36.0	USEPA 2006a	0.70	0 / 36	NO
Barium	9.20 - 386	30 / 36	316	LW03-MW03-05-02C	82.5	83.7	200	Buchman 2008	1.58	5 / 36	**YES**
Beryllium	0.20 - 2.00	2 / 36	0.40	LW03-MW01-98C	0.33	0.27	100	Buchman 2008	0.004	0 / 36	NO
Cadmium	0.069 - 2.00	4 / 36	0.50	LW03-MW01-98C	0.35	0.25	8.80	USEPA 2006a	0.06	0 / 36	NO
Calcium [1]	26,500 - 66,400	34 / 36	281,000	LW03-MW02-15-02C	92,643	72,692	NSV	--	NSV	-- / --	NO
Chromium	0.082 - 4.00	12 / 36	11.7	LW03-MW13-07A	1.05	2.04	50.0	USEPA 2006a	0.23	0 / 36	NO
Cobalt	0.11 - 0.96	22 / 36	22.8	LW03-MW10-07A	2.30	5.09	23.0 *	USEPA 2006b	0.99	0 / 36	NO
Copper	0.80 - 18.7	12 / 36	25.9	LW03-MW04-07A	4.01	6.03	3.10	USEPA 2006a	8.35	12 / 36	**YES**
Iron	75.9 - 1,840	30 / 36	30,400	LW03-MW08-15-02C	4,502	7,884	1,000 *	USEPA 2006a	30.4	17 / 36	**YES**
Lead	0.019 - 2.40	3 / 36	2.40	LW03-MW01-98C	0.58	0.52	8.10	USEPA 2006a	0.30	0 / 36	NO
Magnesium [1]	107,000 - 595,000	32 / 36	957,000	LW03-MW02-15-02C	151,458	230,055	NSV	--	NSV	-- / --	NO
Manganese	0.20 - 151	32 / 36	1,150	LW03-MW10-07A	308	369	100	Buchman 2008	11.5	22 / 36	**YES**
Mercury	0.10 - 0.20	8 / 36	0.20	LW03-MW05-98C	0.077	0.031	0.94	USEPA 2006a	0.21	0 / 36	NO
Nickel	0.65 - 7.80	19 / 36	13.7	LW03-MW10-07A	2.83	3.10	8.20	USEPA 2006a	1.67	3 / 36	**YES**
Potassium [1]	94,200 - 239,000	33 / 36	471,000	LW03-MW02-15-02C	96,060	124,094	NSV	--	NSV	-- / --	NO
Selenium	0.89 - 4.80	12 / 36	12.9	LW03-MW04-07A	2.49	2.36	71.0	USEPA 2006a	0.18	0 / 36	NO
Silver	0.50 - 1.20	2 / 21	2.70	LW03-MW05-98C	0.51	0.67	0.23	USEPA 2006b	11.7	2 / 21	**YES**
Sodium [1]	1,060,000 - 1,700,000	34 / 36	8,370,000	LW03-MW02-15-02C	1,156,242	1,982,827	NSV	--	NSV	-- / --	NO
Thallium	0.012 - 4.20	6 / 36	9.00	LW03-MW02-15-02C	1.79	1.91	21.3	USEPA 2006b	0.42	0 / 36	NO
Vanadium	0.029 - 2.00	16 / 36	6.80	LW03-MW13-07A	1.05	1.50	50.0	Buchman 2008	0.14	0 / 36	NO
Zinc	1.20 - 28.5	7 / 36	31.8	LW03-MW14-07A	8.15	8.28	81.0	USEPA 2006a	0.39	0 / 36	NO
Semivolatile Organic Compounds (UG/L)											
Dibenzofuran	10.0 - 10.0	1 / 5	28.0	LW03-MW04-98C	9.60	10.3	65.0	USEPA 2006b	0.43	0 / 5	NO
Fluoranthene	10.0 - 10.0	1 / 5	27.0	LW03-MW04-98C	9.40	9.84	11.0	USEPA 1996a	2.45	1 / 5	**YES**
Fluorene	10.0 - 10.0	1 / 5	22.0	LW03-MW04-98C	8.40	7.60	2.50	USEPA 2006b	8.80	1 / 5	**YES**
Phenanthrene	10.0 - 10.0	1 / 5	10.0	LW03-MW04-98C	6.00	2.24	8.30	USEPA 1996a	1.20	1 / 5	**YES**
Volatile Organic Compounds (UG/L)											
1,1,1-Trichloroethane	0.50 - 10.0	4 / 67	24.0	LW03-MW08-05-02C	2.29	4.24	312	USEPA 2006b	0.08	0 / 67	NO
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	0.50 - 10.0	4 / 62	5.00	LW03-MW11-15-07C	1.64	2.17	NSV	--	NSV	-- / --	**YES**
1,1-Dichloroethane	0.50 - 10.0	24 / 67	87.0	LW03-MW08-05-02C	4.90	14.3	47.0 *	USEPA 2006b	1.85	2 / 67	**YES**
1,1-Dichloroethene	0.50 - 10.0	9 / 67	2.00	LW03-MW12-07A	1.60	2.03	2,240	USEPA 2006b	0.001	0 / 67	NO
1,2-Dichlorobenzene	0.50 - 10.0	1 / 62	0.24	LW03-MW03-05-02C	1.71	2.21	42.0	USEPA 2006b	0.01	0 / 62	NO

NSV - No Screening Value
1 - Macronutrient - Not considered to be a COPC

Table B-1
Initial Screening Statistics - SWMU 3 Groundwater - Detected Constituents
JEB Little Creek, Virginia Beach, VA

Chemical	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	Screening Value	Reference	Maximum Hazard Quotient	Frequency of Exceedance	Initial COPC?
1,2-Dichloroethane	0.50 - 10.0	2 / 67	1.50	LW03-MW08-05-02C	1.65	2.13	1,130	USEPA 2006b	0.0013	0 / 67	NO
2-Butanone	5.00 - 10.0	4 / 53	3.00	LW03-MW08-15-02C	3.32	1.33	14,000 *	USEPA 2006b	0.00021	0 / 53	NO
Acetone	2.20 - 39.0	1 / 62	4.00	LW03-MW05-13-07C	4.00	3.21	564,000	USEPA 2006b	0.000007	0 / 62	NO
Benzene	0.50 - 10.0	6 / 67	1.30	LW03-MW07-15-02C	1.67	2.12	110	USEPA 2006b	0.012	0 / 67	NO
Carbon disulfide	0.10 - 10.0	12 / 67	0.76	LW03-MW03-05-02C	1.58	2.18	0.92 *	USEPA 2006b	0.83	0 / 67	NO
Chloroethane	0.50 - 10.0	8 / 67	220	LW03-MW08-05-02C	9.22	37.8	NSV	--	NSV	-- / --	**YES**
Chloroform	0.50 - 10.0	7 / 67	1.30	LW03-MW14-07A	1.65	2.13	815	USEPA 2006b	0.0016	0 / 67	NO
Chloromethane	0.30 - 10.0	4 / 67	0.15	LW03-MW02-05-02C	1.62	2.15	2,700	USEPA 2006b	0.00006	0 / 67	NO
Cyclohexane	0.50 - 10.0	4 / 62	0.56	LW03-MW08-05-02C	1.71	2.20	NSV	--	NSV	-- / --	**YES**
Isopropylbenzene	0.50 - 10.0	6 / 62	0.62	LW03-MW08-05-02C	1.71	2.20	2.60 *	USEPA 2006b	0.24	0 / 62	NO
Methyl-tert-butyl ether (MTBE)	0.10 - 10.0	3 / 62	0.15	LW03-MW10-13-07C	1.67	2.23	5,000	Buchman 2008	0.00003	0 / 62	NO
Methylcyclohexane	0.50 - 10.0	7 / 62	2.00	LW03-MW12-07A	1.67	2.16	NSV	--	NSV	-- / --	**YES**
Methylene chloride	0.11 - 10.0	1 / 67	1.00	LW03-MW12-07A	1.57	2.11	2,560	USEPA 2006b	0.0004	0 / 67	NO
Styrene	0.50 - 10.0	2 / 67	0.11	LW03-MW08-05-02C	1.61	2.15	910	USEPA 2006b	0.0001	0 / 67	NO
Tetrachloroethene	0.50 - 10.0	6 / 67	210	LW03-MW06-18-02C	7.59	34.1	45.0	USEPA 2006b	4.67	2 / 67	**YES**
Trichloroethene	0.15 - 10.0	14 / 67	180	LW03-MW06-18-02C	7.47	29.8	1,940	USEPA 2006b	0.093	0 / 67	NO
Vinyl chloride	0.50 - 10.0	15 / 67	56.0	LW03-MW12-07A	4.65	9.46	930 *	USEPA 2006b	0.060	0 / 67	NO
cis-1,2-Dichloroethene	0.50 - 10.0	28 / 67	260	LW03-MW12-07A	13.3	38.7	680	USEPA 2006b	0.38	0 / 67	NO
cis-1,3-Dichloropropene	0.10 - 10.0	1 / 67	0.10	LW03-MW02-07A	1.60	2.15	7.90	USEPA 2006b	0.01	0 / 67	NO
trans-1,2-Dichloroethene	0.50 - 10.0	22 / 67	79.0	LW03-MW12-07A	5.00	13.3	680	USEPA 2006b	0.12	0 / 67	NO
trans-1,3-Dichloropropene	0.50 - 10.0	2 / 67	0.26	LW03-MW08-05-02C	1.61	2.15	7.90	USEPA 2006b	0.03	0 / 67	NO

* Marine screening value unavailable; a freshwater value is used

NSV - No Screening Value
1 - Macronutrient - Not considered to be a COPC

Table B-2
Refined Screening Statistics - SWMU 3 Groundwater - All Wells - Detected Constituents
JEB Little Creek, Virginia Beach, VA

Chemical	All Monitoring Wells									Upgradient[1]					Background			Refined COPC?
	Frequency of Detection	Maximum Concentration Detected	Arithmetic Mean	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	Maximum HQ With Dilution	Mean Hazard Quotient	Mean HQ With Dilution	Frequency of Detection	Maximum	Maximum Ratio to Upgradient	Mean	Mean Ratio to Upgradient	UTL	Maximum Ratio to UTL	Mean Ratio to UTL	
Dissolved Metals (UG/L)																		
Barium	30 / 36	316	82.5	200	5 / 36	1.58	0.16	0.41	0.04	7 / 9	113	2.80	38.4	2.15	55,000	0.01	0.002	NO
Copper	12 / 36	25.9	4.01	3.10	12 / 36	8.35	0.84	1.29	0.13	4 / 9	24.9	1.04	5.36	0.75	NA	--	--	NO
Iron	30 / 36	30,400	4,502	1,000 *	17 / 36	30.4	3.04	4.50	0.45	8 / 9	5,650	5.38	1,568	2.87	17,100	1.78	0.26	NO
Manganese	32 / 36	1,150	308	100	22 / 36	11.5	1.15	3.08	0.31	8 / 9	957	1.20	281	1.10	1,500	0.77	0.21	NO
Nickel	19 / 36	13.7	2.83	8.20	3 / 36	1.67	0.17	0.35	0.03	4 / 9	8.40	1.63	2.69	1.05	14.0	0.98	0.20	NO
Silver	2 / 21	2.70	0.51	0.23	2 / 21	11.7	1.17	2.24	0.22	1 / 5	2.30	1.17	0.66	0.78	2.00	1.35	0.26	NO
Semivolatile Organic Compounds (UG/L)																		
Fluoranthene	1 / 5	27.0	9.40	11.0	1 / 5	2.45	0.25	0.85	0.09	0 / 1	--	--	5.00	1.88	--	--	--	NO
Fluorene	1 / 5	22.0	8.40	2.50	1 / 5	8.80	0.88	3.36	0.34	0 / 1	--	--	5.00	1.68	--	--	--	NO
Phenanthrene	1 / 5	10.0	6.00	8.30	1 / 5	1.20	0.12	0.72	0.07	0 / 1	--	--	5.00	1.20	--	--	--	NO
Volatile Organic Compounds (UG/L)																		
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	4 / 62	5.00	1.64	NSV	-- / --	NSV	NSV	NSV	NSV	0 / 17	--	--	1.37	1.20	--	--	--	NO
1,1-Dichloroethane	24 / 67	87.0	4.90	47.0 *	2 / 67	1.85	0.19	0.10	0.01	4 / 18	9.90	8.79	2.41	2.03	--	--	--	NO
Chloroethane	8 / 67	220	9.22	NSV	-- / --	NSV	NSV	NSV	NSV	2 / 18	0.26	846	1.32	7.00	--	--	--	NO
Cyclohexane	4 / 62	0.56	1.71	NSV	-- / --	NSV	NSV	NSV	NSV	1 / 17	0.15	3.73	1.36	1.26	--	--	--	NO
Methylcyclohexane	7 / 62	2.00	1.67	NSV	-- / --	NSV	NSV	NSV	NSV	2 / 17	0.17	11.8	1.36	1.23	--	--	--	NO
Tetrachloroethene	6 / 67	210	7.59	45.0	2 / 67	4.67	0.47	0.17	0.02	3 / 18	210	1.00	23.5	0.32	--	--	--	NO

* Marine screening value unavailable; a freshwater value is used
1 - Monitoring wells 1, 6, 14, and 15

NSV - No Screening Value

Table B-3
Comparison of Fish Tissue Concentrations Modeled From Groundwater With Tissue-Based Screening Values and RI BERA Modeled Results - SWMU 3
JEB Little Creek, Virginia Beach, VA

Chemical	Mean Dissolved Groundwater Concentration (ug/L)	Dilution Factor	Adjusted Groundwater Concentration (ug/L)	Whole-body Fish BAF (ww)	Reference	Whole-body Fish Tissue Concentration (mg/kg ww)	Screening Value (mg/kg ww)	Fish Species	Reference	Hazard Quotient	Whole-body Fish Tissue Concentration (mg/kg dw)	Whole-body Fish Tissue Concentration (mg/kg dw) From RI BERA Food Web Model	Ratio
Dissolved Metals													
Arsenic	4.95	10	0.495	114	USEPA 1999	0.056	1.80	Bluegill	Jarvinen and Ankley 1999	0.03	0.226	0.947	0.24
Cadmium	0.35	10	0.035	907	USEPA 1999	0.031	2.50	Seabass	Jarvinen and Ankley 1999	0.01	0.125	0.102	1.23
Chromium	1.05	10	0.105	19.0	USEPA 1999	0.002	0.58	Rainbow trout	Jarvinen and Ankley 1999	0.003	0.008	2.18	0.004
Copper	4.01	10	0.401	710	USEPA 1999	0.285	3.40	Brook trout	Jarvinen and Ankley 1999	0.08	1.138	65.3	0.02
Mercury	0.077	10	0.008	3,530	USEPA 1999	0.027	0.20	Multiple	Bechvar et al. 2005	0.14	0.109	1.26	0.09
Nickel	2.83	10	0.283	78.0	USEPA 1999	0.022	0.82	Rainbow trout	Jarvinen and Ankley 1999	0.03	0.088	119	0.001
Selenium	2.49	10	0.249	129	USEPA 1999	0.032	0.80	Chinook salmon	Jarvinen and Ankley 1999	0.04	0.128	2.03	0.06
Zinc	8.15	10	0.815	2,059	USEPA 1999	1.678	60.0	Atlantic salmon	Jarvinen and Ankley 1999	0.03	6.713	294	0.02
Volatile Organic Compounds													
1,2-Dichlorobenzene	0.24	10	0.024	95.0	USEPA 1996b	0.002	0.67	Rainbow trout	Jarvinen and Ankley 1999	0.003	0.009	0.019	0.48

Table B-4
Comparison of Benthic Invertebrate Tissue Concentrations Modeled From Groundwater With Tissue-Based Screening Values and RI BERA Modeled Results - SWMU 3
JEB Little Creek, Virginia Beach, VA

Chemical	Mean Dissolved Groundwater Concentration (ug/L)	Dilution Factor	Adjusted Groundwater Concentration (ug/L)	Invertebrate BAF (ww)	Reference	Invertebrate Tissue Concentration (mg/kg ww)	Adjusted Invertebrate Tissue Concentration (mg/kg ww)	Screening Value (mg/kg ww)	Species	Reference	Hazard Quotient Without Dilution	Hazard Quotient With Dilution	Invertebrate Tissue Concentration (mg/kg dw)	Adjusted Invertebrate Tissue Concentration (mg/kg dw)	Invertebrate Tissue Concentration (mg/kg dw) From RI BERA Food Web Model	Ratio Without Dilution	Ratio With Dilution
Dissolved Metals																	
Arsenic	4.95	10	0.495	73.0	USEPA 1999	0.36	0.036	1.28	Grass shrimp	Jarvinen and Ankley 1999	0.28	0.03	1.72	0.172	3.50	0.49	0.05
Cadmium	0.35	10	0.035	3,461	USEPA 1999	1.19	0.119	4.50	*Neanthes*	Jarvinen and Ankley 1999	0.27	0.03	5.69	0.569	0.42	13.5	1.35
Chromium	1.05	10	0.105	3,000	USEPA 1999	3.16	0.316	4.42	*Neanthes*	Jarvinen and Ankley 1999	0.71	0.07	15.0	1.503	4.76	3.16	0.32
Copper	4.01	10	0.401	3,718	USEPA 1999	14.9	1.490	6.32	*Neanthes*	Jarvinen and Ankley 1999	2.36	0.24	70.9	7.095	601	0.12	0.01
Mercury	0.077	10	0.008	20,184	USEPA 1999	1.56	0.156	4.00	Limpet	Jarvinen and Ankley 1999	0.39	0.04	7.44	0.744	0.42	17.8	1.78
Nickel	2.83	10	0.283	28.0	USEPA 1999	0.08	0.008	79.0	Bivalve	Jarvinen and Ankley 1999	0.001	0.0001	0.38	0.038	15.9	0.02	0.002
Selenium	2.49	10	0.249	1,262	USEPA 1999	3.14	0.314	1.80	*Daphnia*	Jarvinen and Ankley 1999	1.74	0.17	14.9	1.493	2.03	7.34	0.73
Zinc	8.15	10	0.815	4,578	USEPA 1999	37.3	3.732	53.6	*Hyalella*	Jarvinen and Ankley 1999	0.70	0.07	178	17.77	1,909	0.09	0.01
Volatile Organic Compounds																	
1,2-Dichlorobenzene	0.24	10	0.024	95.0	USEPA 1996b	0.023	0.002	17.3	*Daphnia*	Jarvinen and Ankley 1999	0.001	0.0001	0.109	0.011	0.223	0.49	0.05