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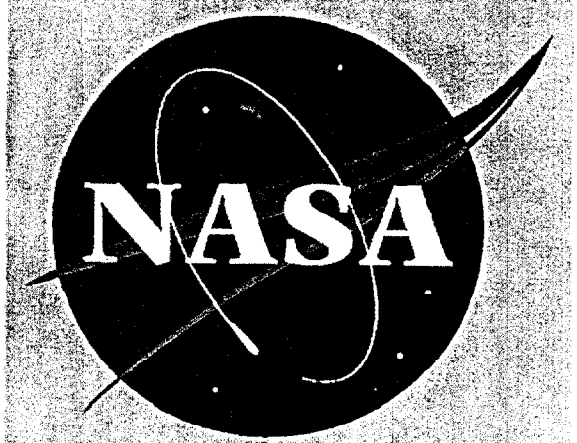
Remedial Investigation/ Feasibility Study Site 16 Waste Oil Dump

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337



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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
WALLOPS FLIGHT FACILITY

Remedial Investigation/Feasibility Study Report
Site 16
NASA Goddard Space Flight Center
Wallops Flight Facility

Prepared for:

National Aeronautics and Space Administration
Goddard Space Flight Center
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REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT
SITE 16
NASA GODDARD SPACE FLIGHT CENTER
WALLOPS FLIGHT FACILITY

1.0 EXECUTIVE SUMMARY

This report presents the results of the Remedial Investigation/Feasibility Study (RI/FS) for Site 16, the former waste oil dump (WOD), at NASA Goddard Space Flight Center, Wallops Fight Facility (WFF), Wallops Island, Virginia. This site appears to not have been ranked because prior reports (Ebasco 1990) indicated that a 1986 soil removal action had remediated the site. The current RI of the Site 16 WOD results from the discovery of solvent and petroleum contaminated groundwater detected in monitoring well WFF15-GW7. This well was originally intended as an upgradient well for the Site 15 RI. Further investigation lead to the discovery of an area of stained soil and stressed vegetation near the end of runway 17-35 at WFF. This area is immediately adjacent to areas where a large volume of soil was removed during the late 1980s. The WOD was later investigated by Ebasco (1990) and Metcalf and Eddy (1992), however, it is apparent that their follow-up investigations missed the current area of investigation.

Cleanup procedures were conducted by NASA from November 12 to December 30, 1986. During this period approximately 180 cubic yards (or 30 truckloads) of contaminated material was removed for the site. VDWM Regional Consultant Harold J. Winer drafted a letter to a NASA representative on October 31, 1986. He stated that WFF need not proceed with any further action or monitor well installation at the site following soils excavation and disposal. No lateral or vertical extent of contaminated soils was recorded during soils removal. These soils were not analyzed for contaminants and no chemical characterization is available. Remaining soils from the WOD site were analyzed during Ebasco's 1989 site investigation.

The WOD is located immediately north or runway 17-35. Waste oils and solvents were disposed of in this area for an unknown period, although probably in the 1940s and 1950s. No records exist to determine substances and quantities disposed or history of site activities. The full areal extent of the former WOD was estimated as approximately 16,000 square yards. However, the remaining remnant of the WOD that is the subject of this RI/FS is approximately 770 square yards. Since the site is located at the end of an active runway, no future activity is planned. No hazardous waste related subsurface anomalies were noted during Ebasco and Metcalf & Eddy site activities at the WOD. Drums, tanks, lagoons or other structures do not

exist at the WOD. These earlier findings were confirmed by Versar visually and through an electromagnetic (EM) survey.

The water table aquifer, known as the Pleistocene aquifer, is unconfined and typically overlain by wind-deposited beach sands, silts, and gravel. The aquifer occurs between depths of 5 and 60 feet below the ground surface. The water table ranges from depths of 0 to 30 feet below the ground surface. Groundwater flow is generally east and north toward nearby creeks and the marsh area that separates Chincoteague Island from the mainland (NASA, 1994). The top of the shallowest confined Miocene aquifer of the Yorktown Formation at WFF is found at depths of approximately 100 feet below the ground surface. It is separated from the overlying Pleistocene aquifer by a 20-30 foot confining layer (aquitard) of clay and silt. Generally potable water supply wells for both the Town of Chincoteague and WFF are screened at the upper portion of the Miocene aquifers, from depths less than 150 feet below ground surface (NASA, 1994). Ten in-service supply wells owned by NASA and the Town of Chincoteague are screened in the Pleistocene aquifer. All of the wells are hydraulically upgradient of Site 16.

Sensitive habitats on and adjacent to the Wallops Island Flight Facility include the Chincoteague National Wildlife Refuge and the Assateague Island National Seashore to the immediate north, and the Wallops Island National Wildlife Refuge, that borders the main base to the west. These refuges are federal and state protected areas for both migratory and nonmigratory wildlife. Other sensitive habitats at the WWF include habitats for federally listed threatened and endangered species and wetlands as well as estuarine habitats such Mosquito Creek, Chincoteague Bay, and Hog Creek.

The location of Site 16, at the end of one of the principal runways for the facility, ensures its ongoing industrial use. The recent commitment by the State of Virginia to establish WFF as a major spaceport greatly increases the likelihood that the facility's mission will remain largely the same as it is today. Additionally, there are technical reasons related to rocket orbital trajectory and economies that can be achieved from launches at the WFF latitude that cannot be achieved from NASA facilities in Texas and Florida. Therefore, base closure appears unlikely.

Specific objectives for the RI/FS at Site 16 were to: (1) install monitoring wells and conduct sampling to determine whether contaminants are present in the groundwater that pose a risk to human health and if discharge of groundwater to surface water presents a risk to the environment; (2) conduct geophysical investigations to determine whether there are any burial areas requiring further characterization via soil sampling that may have escaped detection in

earlier studies, or may be candidates for localized treatment or removal; (3) conduct soil sampling and determine if this pathway poses a risk to human health or the ecological receptors; and (4) determine hydraulic characteristics of the aquifers present at the sites by performing slug tests, potentiometric surface mapping at all sites, and real-time tidal monitoring of the groundwater elevation in select wells.

Remedial Investigation (RI)

During the RI, Versar conducted an EM survey and installed and sampled 27 temporary monitoring wells for volatile organic compounds (VOCs), arsenic, and total petroleum hydrocarbons-gasoline range organics (TPH-GRO) and diesel range organics (TPH-DRO) using a field laboratory for organic analyses and a fixed laboratory on 24-hour turnaround for metals. These data were then used as a screening technique to assist in the placement of six additional permanent monitoring wells. Temporary wells and the six additional monitoring wells were installed using a geoprobe rig. These six wells, plus 3 existing monitoring wells (MW-3, WFF15-GW1, and WFF15-GW7) were sampled for the Target Compound List/Target Analyte List (TCL/TAL) and TPH-DRO/GRO. Versar also collected four shallow and four deep soil samples for TCL/TAL analyses during well installation within the visually impacted area. An additional 17 surface soil samples were collected within and surrounding the stained soil and stressed vegetation areas to characterize the nature and extent of the soil contamination.

Potentiometric surface maps for Site 16 flow toward and discharge into the unnamed tributary flowing along the base of Site 15 and to the marsh along Little Mosquito Creek. The arcuate shape of the contours directly reflects the shape of the peninsula at the end of runway 17-35. In the immediate vicinity of Site 16, groundwater flows northwest toward the unnamed tributary. The hydraulic gradient across the site is approximately 0.01. On the western and northern edge of Site 16, groundwater is much more shallow (approximately 3-8 feet deep), and the presence of numerous seeps located just west of the downgradient monitoring wells at Site 15 establishes the unnamed tributary as a discharge zone for groundwater passing below Site 15.

Average (mean) hydraulic conductivity values calculated for the wells on the Main Base ranged from a high value of 1.02×10^{-2} cm/s at WFF14-GW1 to a low value of 4.87×10^{-4} cm/s at WFF15-GW1. Ebasco obtained a hydraulic conductivity for Site 16 of 2.3×10^{-3} cm/s, which agrees very well with the average hydraulic conductivity measured by Versar for the Columbia Group. These values are consistent with literature values (Freeze and Cherry, 1979) characteristic of silty to clean sands.

Transmissivities for the Columbia Group wells analyzed on the Main Base ranged from a high value of 0.16 square feet minute (ft^2/min) at WWF14-GW1 to a low value of 9.19×10^{-4} ft^2/min at WFF15-GW1.

Contaminant transport velocity of 7.6×10^{-6} cm/s were calculated for Site 16. Converting these metric data to English units result in a velocity of 7.9 ft/yr at Site 16. Given Site 16's position within the groundwater flow field, and the time which has elapsed since it was created (1940s-50s), these velocities indicate that any contaminated groundwater emanating from the site has had ample time to travel the 220 feet required to reach the unnamed tributary of Little Mosquito Creek. Therefore, surface water and sediment data collected for Site 15 already reflects contaminant loading from groundwater discharge emanating from Site 16.

The electromagnetic (EM) survey of Site 16 was conducted on April 28, 1998, by Forrest Environmental Services to determine if there were any areas of buried debris present within the site area. The results of the apparent conductivity and magnetic susceptibility (metal detector mode) noted two anomalies. In both cases, the anomalies were very small (< 10 feet in diameter), suggestive of small amounts of buried reinforced concrete, or a small length of metal pipe. Direct push borings were advanced in the vicinity of these anomalies (DP-2, SB-3, and SB-4), and no indication of buried debris was encountered. The overall conclusion of the EM survey was that no large burial area exists at Site 16.

Chemical analytical data from surface soil, subsurface soil, and ground water collected from Site 16 and parts of nearby Site 15 of WFF during the RI. All data were fully validated. Seven surface soil background samples were collected from off-site locations on the north side of runway 10-28 just beyond the maintained area (approximately 5-10 feet just beyond the "mow line"), west of the wastewater treatment plant. Background samples were analyzed for the same chemicals as on-site samples: TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, cyanide, and total petroleum hydrocarbons. Background surface soil samples had concentrations of DDE, DDT, arsenic, and beryllium that exceeded residential RBCs.

In surface soil samples, a total of 8 organic compounds were detected; 5 were semivolatile organic compounds and 3 were pesticides. Twenty metals, plus TPH-GRO and TPH-DRO were detected. For the human health risk assessment (HHRA), 4 chemicals were selected as COPCs because the maximum concentration detected exceeded Region III for residential soils. These 4 chemicals are benzo(a)pyrene, aluminum, arsenic, and iron. However, of these: (1) the maximum Site 16 concentration for arsenic is less than the background concentration, (2) the

maximum iron concentration for Site 16 (10,700 ppm) only slightly exceeds background (9,180 ppm), and (3) the maximum aluminum concentration detected (10,600 ppm) only slightly exceeds background (9,970 ppm). All detected contaminant concentrations were below industrial RBCs. TPH-GRO/DRO was detected, with the contaminant signature dominated by the DRO fraction (maximum concentrations of 0.22 ppm GRO vs. 870 ppm DRO). These concentrations are well below the 11,000 ppm saturation standard that the Virginia Department of Environmental Quality (VDEQ) uses to evaluate remediation requirements for soil contamination.

For the ecological risk assessment, 13 chemicals were selected as COPCs because the maximum detected concentrations exceeded Region III BTAG concentrations. These chemicals are benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, indeno(1,2,3-cd)pyrene, 4,4'-DDE, 4,4'-DDT, aluminum, beryllium, chromium, iron lead, nickel, vanadium, and zinc. Two chemicals (antimony and silver) were also detected at concentrations which exceed BTAG screening levels, but were not selected as COPCs: silver was not selected due to lack of toxicity information, and antimony was not selected because it was only detected in a single sample. Of these, the maximum detected Site 16 concentrations of 4,4'-DDE, 4,4'-DDT, beryllium, and chromium did not exceed background concentrations.

Subsurface soil samples were not evaluated for the ERA because these samples are beyond the 0-2 foot depth commonly used to evaluate risk to burrowing organisms. A total of 19 organic chemicals were detected: 4 VOCs, 9 SVOCs, and 6 pesticides. Sixteen metals were detected. None of the detected concentrations exceeded Region III residential or industrial RBCs. TPH GRO/DRO concentrations were considerably higher than in surface soil, as expected. TPH-GRO had a maximum detected concentration of 2,300 ppm, and the maximum detected concentration of TPH-DRO was 6,800 ppm. These concentrations are below the 11,000 ppm saturation criteria that VDEQ uses to evaluate remediation requirements for soil contamination where a current drinking water source is not threatened.

The background well for Site 16 is well MW-3 installed by Ebasco. The only organic chemical detected in MW-3 was bis(2-ethylhexyl)phthalate detected at a concentration of 3-18 ppb, which is less than twice the concentration in field blanks. Numerous metals were detected. Of these, only arsenic was detected at concentrations that exceeded Region III tap water RBCs.

A total of 28 samples were collected from 27, 1-inch PVC temporary monitoring wells and well WFF15-GW7 for onsite analysis for chlorinated solvents, and TPH-GRO and TPH-DRO. Arsenic was analyzed on a fast turnaround basis in an offsite laboratory. These results were then used to determine the placement of permanent monitoring wells. These data were not used for risk assessment purposes. Tetrachloroethene was detected in DP1 (15 ppb), WFF15GW-7 (5 ppb), DP7 (10 ppb), and DP18 (5 ppb). TPH-GRO was detected in DP1 (32 ppm), WFF15-GW7 (3 ppm), DP7 (15 ppm), DP9 (4 ppm), and DP18 (18 ppm). TPH-DRO was detected in DP1 (38 ppm), WFF15-GW7 (14 ppm), DP7 (27 ppm), DP9 (8 ppm), and DP18 (210 ppm). Arsenic was not detected on any well (detection limits were 50 ppb). Using these data, WFF16-GW2S and WFF16-GWD were located in the most contaminated direct push borehole, DP18. WFF16-GW3 was located downgradient of the site on a vector connecting DP1 and DP9. Similarly, WFF16-GW5 was located downgradient of the site on a vector connecting DP7/WFF15-GW7 and DP18.

Data from permanent wells collected during three rounds of sampling were pooled to develop the database for the HHRA. A total of 25 organic compounds were detected: 7 VOCs, 15 SVOCs, and 3 pesticides. Twenty-two metals, plus nitrate, sulfate, and sulfide were detected. TPH-GRO and TPH-DRO were also detected. Among the VOCs, the following were identified as COPCs: 1,2-dichloroethene, benzene, ethylbenzene, tetrachloroethene, and toluene. SVOCs identified as COPCs included 2-chlorophenol, 2-methylnaphthalene, 4-methylphenol, dibenzofuran, bis(2ethylhexyl)phthalate, carbazole, naphthalene, and phenanthrene. Pesticide COPCs were 4,4'-DDT and alpha-BHC. The following inorganics were identified as COPCc: aluminum, antimony, arsenic, iron, lead, manganese, potassium, thallium, and vanadium.

Although not treated quantitatively in the HHRA due to lack of toxicity information, TPH-GRO and TPH-DRO were identified as COPCs. TPH-GRO was detected at concentrations of 33 to 4,000 ppb. TPH-DRO was detected at concentrations of 600 to 83,000 ppb. The highest concentrations of these analytes were detected in well WFF15-GW7.

With few exceptions, the highest concentrations of all of the organic COPCs were detected in well WFF15-GW7 which is located with the area of visually stained soil. The only exceptions was 1,2 dichloroethene detected in WFF16-GW2S (also within the area of stained soil), and the 4-4'-DDT detected in WFF15-GW1 (which was only detected in this well). WFF15-GW7 also exhibited the highest concentrations of aluminum. arsenic, and iron.

Ecological Risk Assessment (ERA)

Based on an analysis of the wildlife species associated with WFF and the COPCs detected in environmental media, the following endpoints were selected for evaluation in the ERA:

- Adverse effects to terrestrial plant communities from absorption of chemicals in surface soil through root uptake;
- Adverse effects to terrestrial invertebrate communities (as represented by earthworms) from direct contact with and ingestion of chemicals in surface soil;
- Adverse effects to mammals (as represented by shrews) from exposure to chemicals through bioaccumulation in the food web and ingestion of surface soil;
- Adverse effects to birds (as represented by robins) from exposure to chemicals through bioaccumulation in the food web and ingestion of surface soil.

Conclusions regarding the potential for adverse effects to ecological resources are summarized below. The conclusions focus on the locations and contaminants (only those that are detected above background concentrations) that are responsible for the most significant potential risks to ecological receptors.

Terrestrial plants were selected for evaluation due to their potential for exposure to chemicals in surface soil via root uptake. No applicable toxicity data were available in the scientific literature for organic COPCs. The results of the comparison of maximum detected concentrations in surface soil to available literature-based toxicity values suggest there is a very limited potential for aluminum (EEQ = 212), chromium (EEQ = 11), lead (EEQ - 12), vanadium (EEQ = 9.9), and zinc (EEQ = 1.1) in Site 16 surface soil to adversely affect terrestrial plants. Other chemicals that had EEQs greater than 1 were not detected on site at levels exceeding background concentrations. Of those chemicals with EEQs substantially above 1.0 (aluminum chrominum, and upgradient site concentrations are at or below background concentrations.

Soil invertebrates may be exposed to chemicals in surface soil and were selected for evaluation. Only limited applicable toxicity data were available in the scientific literature for the organic COPCs, and there is uncertainty associated with the lack of toxicity information available for most organic COPCs. The results of the comparison of maximum detected concentrations in surface soil to available literature-based toxicity values suggest there is a very limited potential for chromium (EEQ - 27.5) at Site 16 to adversely affect soil invertebrates. However, chromium was not detected at concentrations which exceed background.

The potential risks to higher level organisms through the terrestrial pathway were modeled using a robin and shrew. Based on the results of comparisons of chemical doses to receptor-specific TRVs, it is reasonable to conclude that carnivorous birds have potential to be adversely affected by aluminum. However, risks from aluminum are not limited to Site 16, or WFF generally, since this is a ubiquitous contaminant and care should be exercised by a risk managers. In addition, there is limited potential for robins to be adversely affected by chromium but site concentrations of chromium do not exceed background.

Human Health Risk Assessment (HHRA)

In the HHRA carcinogenic and noncarcinogenic risks were calculated for all identified receptor populations, exposure routes, and chemicals of potential concern. The current land use scenarios evaluated in this risk assessment are as follows: (1) incidental ingestion and dermal absorption of surface soil by commercial/industrial workers; and (2) incidental ingestion and dermal absorption of surface soil by recreational trespassers (adults and children). Results of this risk assessment suggest that surface soil at Site 16 may pose some health risks to both commercial/industrial workers and recreational trespassers.

Noncarcinogenic risks identified for current scenarios indicated that there were no EPA-designated significant noncarcinogenic human health hazards (i.e., hazards equal to or greater than 1.0) for current soil exposure scenarios at Site 16. Total HIs for commercial/industrial workers and recreational trespassers (adults and children) were 2.2E-02, 7.6E-03 and 6.1E-02, respectively.

The total carcinogenic risk for commercial/industrial workers exposed to surface soil at Site 16 is 1.1E-05. This risk value exceeds the lower limit of EPA's target risk range of 1.0E-06, but was less than the upper limit of 1.0E-04. The majority of the risk is based on dermal absorption and ingestion of benzo(a)pyrene. Arsenic also contributed slightly to the total risk although the individual risk for this chemical did not exceed 1E-06. The total carcinogenic risks for recreational adults and children exposed to surface soil at Site 16 are 5.1E-06 and 2.5E-06, respectively. Although these values are relatively lower than the carcinogenic risk level for commercial/industrial workers, they still exceed the lower limit of EPA's target risk range of 1.0E-06. Similar to the commercial/industrial scenario, the risks are almost entirely due to benzo(a)pyrene with arsenic also contributing slightly to the risk.

Future land use scenarios evaluated in this risk assessment are as follows (all current use scenarios previously described are also considered to be potential future use scenarios);
(1) construction worker inhalation of fugitive dust and volatiles from surface soil;
(2) construction worker incidental ingestion of, and dermal contact with surface soil;
(3) residential adult and child incidental ingestion of, and dermal contact with surface soil;
(4) construction worker incidental ingestion of, and dermal contact with groundwater during excavation/construction activities; (5) construction worker inhalation of volatiles from groundwater during excavation/construction activities; (6) residential adult and child direct ingestion of groundwater; (7) residential adult and child inhalation and dermal absorption of groundwater during showering; and (8) commercial/industrial worker direct ingestion of groundwater.

Results of this risk assessment suggest that, for future exposure scenarios, the groundwater at Site 16 may pose potentially significant health risks to residential adults and children, commercial/industrial workers and construction workers if developed for potable use. In addition, surface soil at Site 16 may pose a health risk to adult and child residents and construction workers.

There were no EPA-designated significant noncarcinogenic human health hazards (i.e., hazards equal to or greater than 1.0) for future soil exposure scenarios at Site 16. Total HIs for residents (adults and children) and construction workers were 5.2E-02, 4.1E-01 and 2.4E-01, respectively.

In contrast to the surface soil results, each groundwater scenario resulted in non-carcinogenic human health hazards (i.e., hazards greater than EPA's target value of 1.0). Adult and child residents had total HIs of 28 and 75, respectively. Ingestion of inorganics such as arsenic, iron, manganese and thallium and inhalation of naphthalene and benzene contributed to the total risk. The HI for construction workers was 190, significantly higher than EPA's target value of 1.0. Most of the risk was based on inhalation of naphthalene, benzene and toluene. Dermal absorption of manganese also contributed slightly to the total risk to construction workers. The HI for commercial/industrial workers of 7 was relatively lower than the hazard level for residents and construction workers but still exceeded EPA's target level of 1.0. This scenario was limited to ingestion of groundwater and the risks were based on ingestion of arsenic, iron and manganese.

The total carcinogenic risk for adult and child residents exposed to surface soil at Site 16 is 3.4E-05 and 1.7E-05, respectively. Both of these values are greater than the lower limit of EPA's range of 1.0E-06 but do not exceed the upper limit of the range of 1.0E-04. Ingestion and dermal absorption of benzo(a)pyrene contributed to the majority of the risk for both receptors. Ingestion of arsenic also contributed slightly to the overall risk. The total risk for construction workers exposed to surface soil at Site 16 is 6.1E-07 which does not exceed 1.0E-06, the lower limit of EPA's target risk range.

The total carcinogenic risk for adult and child residents exposed to groundwater at Site 16 was 2.3E-03 and 8.3E-04, respectively. These values exceed the upper limit of EPA's target risk range of 1.0E-04, in residential adults the carcinogenic risk exceeds the upper limit by more than one order of magnitude. Ingestion of arsenic and dermal absorption of bis(2-ethylhexyl)phthalate was responsible for the majority of the risk. Other risk contributors included ingestion of benzene and bis(2-ethylhexyl)phthalate, inhalation of benzene and dermal absorption of 4,4'-DDT.

Although the total carcinogenic risk to commercial/industrial workers from groundwater ingestion of 4.8E-04 was relatively lower than the risk to residential receptors, this value also exceeded the upper limit of EPA's target risk range. The risk level for this scenario was based primarily on ingestion of arsenic, with ingestion of benzene and bis(2-ethylhexyl)phthalate also contributing to the total risk. Based on evaluation of background inorganic concentrations at Wallops Flight Facility, it was noted that the maximum arsenic concentration in Site 16 groundwater was approximately one order of magnitude greater than the concentration detected in a background location.

The total carcinogenic risk to construction workers from exposure to groundwater was 1.5E-05 which exceeded the lower limit of EPA's risk range of 1.0E-06 but did not exceed the upper limit of the range of 1.0E-04. The risk level for this scenario was based primarily on inhalation of benzene with dermal absorption of bis(2-ethylhexyl)phthalate also contributing to the total risk.

There is a significant risk associated with future use of groundwater at Site 16 as a drinking water source. Carcinogenic risk levels for residents and commercial/industrial workers were greater than the upper limit of EPA's risk range of 1.0E-04. Also, hazard indices for adult and child residents were at least one order of magnitude greater than EPA's target value of 1.0. However, there are no current plans to develop groundwater as a potential drinking water source

at Site 16. If aquifer development does not take place, the groundwater exposure pathways will not be complete and there will be no associated risks.

There were several scenarios involving exposure to surface soil that resulted in risks to residential, recreational, and commercial/industrial receptors that exceeded 1.0E-06 but were less than 1.0E-04, the upper limit of EPA's target risk range. Evaluation of risk levels should consider the present and planned land use at the site. If there is no future residential development at Site 16 there would be no residential receptors present. As a result, the soil exposure pathway would only be complete for commercial/industrial and recreational receptors.

Feasibility Study (FS)

At the outset of the RI/FS process, NASA, VDEQ, and EPA agreed that remedy selection would be based on land use assumptions that the current industrial use of the sites would continue in the future. For Site 16, no unacceptable risks or hazards for human or ecological receptors were identified for the surface soil present at the site. However, unacceptable risks are associated with future groundwater use for the site.

The release which resulted in the Site 16 WOD appears to date from the 1940s and 1950s (Ebasco, 1992). Groundwater flow velocity calculated for the site indicates that the plume has had ample time to reach surface water bodies and is, therefore, fully reflected in the surface water and sediment data collected during the Site 14 and 15 RI/FS. The site history would also suggest that the plume is fully developed and concentrations may reasonably be expected to decline under the influence of naturally occurring indigenous organisms over time.

Contaminant concentrations in downgradient wells WFF16-GW3, WFF16-GW4, and WFF-GW5 drop off precipitously from those detected in the source area wells WFF15-GW7 and WFF16-GW2S/GW2D. Three of the four downgradient wells exhibit no VOCs, no SVOCs (except bis(2-ethylhexyl)phthalate that was detected at very low concentrations consistent with laboratory contamination and background concentrations), and no pesticide/PCBs detected. Downgradient well WFF15-GW1 detected low levels of VOCs, SVOCs, and a single detection of 4'4'-DDT (in a duplicate) but still substantially less than those detected in the source area wells, WFF15-GW7 and WFF16-GW2S/GW2D. Similarly, TPH-GRO and TPH-DRO also are substantially less in downgradient wells (0.92-1.61 ppm) than in the wells located within the source area (1.21-85.4 ppm). As with the other organic compounds, downgradient well WFF15-GW1 had the highest TPH concentrations (0.92-1.61 ppm) with the other downgradient wells

generally less than the 1 ppm VDEQ UST program guidance level, with the exception of WFF-GW3 (1.14 ppm) in the 2000 data.

Metals concentrations, including the risk-driver, arsenic, also decline dramatically in downgradient wells. Arsenic declines from concentrations in the source area wells of 18.2 - 88.2 ppb (across all rounds) to ND(1.6) - 11.1 ppb in downgradient wells (across all rounds). With the single exception of the 1998 arsenic detection for WFF16-GW3 (11.1 ppb), all downgradient well concentrations are less than or equal to the arsenic concentrations detected in the background well, MW-3 (1.6 - 5.4 ppb).

Therefore, it appears that groundwater is only materially impacted where it is direct contact with contaminated soil. In this respect, there is little evidence of a groundwater plume in the traditional sense of the term. It seems likely that a contaminant plume emanating from the WOD once existed, but that past soil excavation activities at the Site 16 WOD and natural attenuation have largely mitigated groundwater risk at the discharge points. Because contaminated groundwater appears to only largely exist within the footprint of the contaminated soil area, this FS focuses on source control measures or measures that would restrict the future use of the groundwater within the site area. Given the nature and extent of groundwater contamination observed at the site, this objective is best met by source control measures to eliminate contact between contaminated soil and groundwater or restrictions on groundwater use.

Four potential remedial technologies remained after FS screening. The following is a summary of the findings presented in the preceding sections and recommendations based on the analysis.

The remedial alternatives remain after the screening are:

- Alternative A - No action,
- Alternative B - Installation of Institutional Controls ($153,800), and
- Alternative C - Soil excavation, transportation, and disposal ($962,176).

The alternatives were screened in the second phase according to effectiveness, implementability, and other pertinent criteria in order to determine suitability of each alternative to achieving the remediation goals. However, effectiveness at reaching and sustaining the remedial action objectives is the ultimate goal of any of these alternatives.

In the third phase, a detailed analysis of each process option was evaluated based on probable achievement of nine CERCLA criteria for selecting remedial alternatives. These criteria are the overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of mobility toxicity, or volume of contaminants; short-term effectiveness; implementability; cost; local government acceptance; and community acceptance. Throughout the feasibility study, the no action alternative was retained for comparison purposes. The no action alternative does not meet remedial action objectives. Neither Alternative B or C apply treatment to reduce toxicity, mobility, or volume through treatment. However, Alternative B will eventually achieve a reduction in toxicity, mobility, and toxicity via natural attenuation and microbial degradation which Alternative C will not since landfilling will limit exposure to percolating groundwater as a source of nutrients/oxygen to indigenous microbes. Alternative C has better short term effectiveness, but significantly higher costs and exposure potential for workers performing the remediation relative to Alternative B.

2.0 INTRODUCTION

This report presents the results of the Remedial Investigation/Feasibility Study (RI/FS) for Site 16, the former waste oil dump (WOD), at NASA Goddard Space Flight Center, Wallops Fight Facility (WFF), Wallops Island, Virginia. In NASA Site Investigations (SI) and self-ranking (Metcalf & Eddy, 1996), this site was not scored under the Hazardous Ranking System (HRS) for inclusion on the National Priorities List (NPL). This site appears to not have been ranked because prior reports (Ebasco 1990) indicated that a 1986 soil removal action had remediated the site. A draft Record of Decision (ROD) was prepared by Metcalf & Eddy (1995) to support this conclusion. However, the 1997-98 Versar RI field activities uncovered significant contamination in this area while installing an upgradient monitoring well for Site 15. Additional soil and groundwater samples were collected during this RI, and data evaluation activities were performed to develop and support remedial action decisions for the site. This investigation is being performed for NASA Goddard Space Flight Center by Versar, Inc., under NASA contract no. NAS5-32288.

WFF is located in Accomack County, Virginia on the Atlantic Coast of the Delmarva Peninsula, approximately 200 miles east of Washington, D.C. (Figure 2-1) and consists of three separate land areas: Wallops Main Base, Wallops Mainland, and Wallops Island (Figure 2-1). The Main Base is approximately 1,800 acres, and is bordered on the east by 4 miles of marshland which separate it from Chincoteague Island. Wallops Pond and Little Mosquito Creek border the Main Base on the west and north. Site 16 is located at Wallops Main Base (Figure 2-2). WFF is responsible for the planning and launching of scientific satellites, sounding rockets, test vehicles, and other payloads. Wallops Main Base consists of several structures used by NASA for various purposes including headquarters, administrative offices, tracking facilities, range control center, rocket and fuel storage depot, inspection facilities, several support shops, housing units, airfield.

The water-bearing formations within the WFF area consist of sedimentary units, ranging in age from Cretaceous to Quaternary. The two uppermost stratigraphic units, the Yorktown Formation and the overlying Columbia Group, are the most important water supply formations for agricultural, domestic, public, and industrial uses. The Yorktown Formation is the uppermost unit in the Chesapeake Group. The formation consists of fine to coarse, greenish gray, glauconitic quartz sand, which is clayey, silty, and in part, shelly. The formation occurs at depths of 60 to 140 feet in Accomack County (NASA, 1994). The Columbia Group consists of sand, sandy clay, and minor amounts of gravel deposited during the sea level fluctuations in the Pleistocene epoch.

The water table aquifer, known as the Pleistocene aquifer, is unconfined and typically overlain by wind-deposited beach sands, silts, and gravel. The aquifer occurs between depths of 5 and 60 feet below the ground surface. The water table ranges from depths of 0 to 30 feet below the ground surface. Groundwater flow is generally east and north toward nearby creeks and the marsh area that separates Chincoteague Island from the mainland (NASA, 1994). The top of the shallowest confined Miocene aquifer of the Yorktown Formation at WFF is found at depths of approximately 100 feet below the ground surface. It is separated from the overlying Pleistocene aquifer by a 20-30 foot confining layer (aquitard) of clay and silt. Generally potable water supply wells for both the Town of Chincoteague and WFF are screened at the upper portion of the Miocene aquifers, from depths less than 150 feet below ground surface (NASA, 1994). Ten in-service supply wells owned by NASA and the Town of Chincoteague are screened in the Pleistocene aquifer. All of the wells are hydraulically upgradient of Site 16.

Sensitive habitats on and adjacent to the Wallops Island Flight Facility include the Chincoteague National Wildlife Refuge and the Assateague Island National Seashore to the immediate north, and the Wallops Island National Wildlife Refuge, that borders the main base to the west. These refuges are federal and state protected areas for both migratory and nonmigratory wildlife. Other sensitive habitats at the WWF include habitats for federally listed threatened and endangered species and wetlands as well as estuarine habitats such Mosquito Creek, Chincoteague Bay, and Hog Creek. The federally listed threatened and endangered species known to occur at Wallops Island are piping plover (*Charadrius melodius*), bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*).

The National Wetlands Inventory (NWI) map overlay for Chincoteague and the Accomack County Wetland Maps for the area of the WFF indicate that both tidal and nontidal wetlands occur at the site. There are three predominant kinds of wetlands at WFF, including marine, estuarine, and palustrine wetlands. The NWI map indicates many large areas of estuarine wetlands adjacent to the main base, with several smaller parcels of palustrine forested wetlands. On Wallops Island, most of the wetlands mapped by NWI are mapped as estuarine.

The anticipated future use for WFF is the same as the current use, an industrial launch facility/airport. The location of Site 16, at the end of one of the principal runways for the facility, ensures its ongoing industrial use. The recent commitment by the State of Virginia to establish WFF as a major spaceport greatly increases the likelihood that the facility's mission will remain largely the same as it is today. Additionally, there are technical reasons related to rocket orbital

trajectory and economies that can be achieved from launches at the WFF latitude that cannot be achieved from NASA facilities in Texas and Florida. Therefore, base closure appears unlikely.

2.1 Purpose and Report Organization

The overall objective of the Remedial Investigation/Feasibility Study (RI/FS) was to gather sufficient chemical, hydrogeological, and ecological data (building upon the earlier SI data) to allow a complete assessment of the presence of onsite contamination, potential for offsite migration of contaminants, and impacts on human health and the environment via baseline human health and ecological risk assessments. A further objective was to generate the required data to determine whether further investigations were required, whether remedial action is required at each site, and estimate the scope of any remediation required.

2.1.1 Objectives

Specific objectives for the RI/FS at Site 16 was to:

- Install monitoring wells and conduct sampling to determine whether contaminants are present in the groundwater that pose a risk to human health and if discharge of groundwater to surface water presents a risk to the environment.

- Conduct geophysical investigations to determine whether there are any burial areas requiring further characterization via soil sampling that may have escaped detection in earlier studies, or may be candidates for localized treatment or removal.

- Conduct soil sampling and determine if this pathway poses a risk to human health or the ecological receptors.

- Determine hydraulic characteristics of the aquifers present at the sites by performing slug tests, potentiometric surface mapping at all sites, and real-time tidal monitoring of the groundwater elevation in select wells.

Data used in the RI and risk assessment included samples for full TCL/TAL parameters with 100% data validation, TPH analyses, and collection of various other analytical parameters (hardness, alkalinity, TDS, TOC, and grain size), and hydrogeological data needed data to evaluate the significance of this data to uptake by receptors.

2.1.2 Report Organization

The format of this report presents data from the Remedial Investigation, Human Health Risk Assessment, Ecological Risk Assessment, and Feasibility Study. The Site Investigation discussion (Section 3.0) addresses a brief discussion of the sampling program, highlighting areas where any modifications to the work plan were encountered or additional procedural information may be helpful; otherwise all field procedures were as documented in the work plans.

Section 4.0 provides the results of the RI. Sections 5.0, 6.0, and 7.0 present the Human Health and Ecological Risk Assessments and Feasibility Study, respectively. Throughout the report, extensive use is made of summary data tables, emphasizing the frequency and magnitude of defected contaminants. More expansive data tables are reserved for the Appendices, and the full Microsoft Access database is provided on CD ROM.

2.2 Site Description and History

The current RI of the Site 16 WOD results from the discovery of solvent and petroleum contaminated groundwater detected in monitoring well WFF15-GW7. This well was originally intended as an upgradient well for the Site 15 RI. Further investigation lead to the discovery of an area of stained soil and stressed vegetation near the end of runway 17-35 at WFF (Figure 2-3). This area is immediately adjacent to areas where a large volume of soil was removed during the late 1980s. The WOD was later investigated by Ebasco (1990) and Metcalf and Eddy (1992), however, it is apparent that their follow-up investigations missed the current area of investigation (Figure 2-3). The following paragraphs discuss these earlier investigations.

The WOD is located immediately north or runway 17-35. Waste oils and solvents were disposed of in this area for an unknown period, although probably in the 1940s and 1950s. No records exist to determine substances and quantities disposed or history of site activities. The full areal extent of the former WOD was estimated as approximately 16,000 square yards. However, the remaining remnant of the WOD that is the subject of this RI/FS is approximately 770 square yards. Since the site is located at the end of an active runway, no future activity is planned. No hazardous waste related subsurface anomalies were noted during Ebasco and Metcalf & Eddy site activities at the WOD. Drums, tanks, lagoons or other structures do not exist at the WOD. These earlier findings were confirmed by Versar visually and through an electromagnetic (EM) survey.

A site inspection was conducted at the WOD by Virginia State Water Control Board (SWCB) Representatives on August 27, 1986. As a result of this inspection, the State of Virginia requested that WFF remove and dispose of the contaminated soils. There was no Environmental Protection Agency (EPA) involvement during these activities. Subsequent correspondence was completed between a WFF Safety Specialist and the Virginia Department of Waste Management (VDWM) Regional Consultant regarding the disposal of contaminated soils. Approval for disposal of contaminated soils in the Wattsville, Virginia landfill was granted by Accomack County on November 10, 1986. Through correspondence with the Commonwealth of Virginia dating October 2, October 31, and November 10, 1986, WFF and the VA SWCB determined what actions were to be taken at the WOD. The VA SWCB Regional Geologist and other technical representatives reinspected the WOD on August 27, 1986. VA SWCB requested that the contaminated soil be disposed at the new Accomack County landfill.

Cleanup procedures were conducted by NASA from November 12 to December 30, 1986. During this period approximately 180 cubic yards (or 30 truckloads) of contaminated material was removed for the site. The areas where soil was removed are shown in Figure 2-3. VDWM Regional Consultant Harold J. Winer drafted a letter to a NASA representative on October 31, 1986. He stated that WFF need not proceed with any further action or monitor well installation at the site following soils excavation and disposal. No lateral or vertical extent of contaminated soils was recorded during soils removal. These soils were not analyzed for contaminants and no chemical characterization is available. Remaining soils from the WOD site were analyzed during Ebasco's 1989 site investigation.

WFF conducted a Preliminary Assessment (PA) in February 1988 in compliance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Section 120, as amended by the Superfund Amendments and Reauthorization Act (SARA). This PA was a mandatory requirement as stated in CERCLA Section 120 because WFF has generated and disposed of hazardous materials. As stipulated in CERCLA, all Federal Facilities generating hazardous waste must complete a PA. The WOD was inspected during this assessment by Ebasco Services, Incorporated. Ebasco recommended that the WFF WOD be sampled for the presence of residual chemicals.

A Site Investigation (SI) was begun in April 1989 as a result of the preliminary investigation recommendations. Results from the SI indicated semi-volatile organic contamination in surface soils and sediments near the site as well as chromium and lead levels exceeding Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) in

groundwater samples (Ebasco 1990b, p.47). A preliminary Hazard Ranking System (HRS) scoring of the WOD was 30.3, which exceeded the National Priorities List (NPL) consideration of 28.5 (Ebasco 1990b, p.49).

The site investigation conducted by Ebasco in January 1990 included two surface soil samples (SS07, 2208), one subsurface sample (SB01) and two sediment samples (SD01, SD02) Figure 2-3. All samples were analyzed for TCL Volatiles, Semivolatiles, Pesticides, Polychlorinated biphenyls (PCB) and TAL metals. Laboratory results are contained in Appendix A-1.

Soil samples SS07 and SS08 showed levels of Methylene Chloride and Acetone which were rejected because the same contaminants were detected in blanks. Phthalate, which is a common laboratory contaminant, appeared in both samples, and toluene was detected at 5 ppb in SS08. Samples were otherwise at very low to non-detect levels of TCL organic contamination. 4'4-DDE was detected at 48 ppb in SS07. This contaminant is a degradation product of 4'4-DDT, which was previously used by ground maintenance for pest control in the general area.

The groundwater table aquifer at the WOD is the Columbia Aquifer and is encountered at 5 to 25 feet below the ground surface. It is a shallow, unconfined aquifer located in Pleistocene sediments. The Columbia Aquifer is locally used as a potable water supply and terminates approximately 60 feet below the ground surface where a 40 foot clay aquitard begins. Groundwater flow at the WOD moves laterally to the north and west towards the adjacent fresh and salt water wetlands. Groundwater then seeps into the wetlands as springs. Hydraulic conductivity within the Columbia aquifer is 2.3×10^{-3} cm/sec (Ebasco 1991b, p. 46).

Two groundwater monitoring well were installed at the WOD (Figure 2-3). These wells were installed by Ebasco Services, Inc., during the 1990 site investigation. One monitor well, MW-3 was installed upgradient to the site and was intended as a background monitoring well. One monitor well, MW-4, was installed downgradient of the areas where soil was removed. MW-3 continues to exist and is a viable monitoring well. Versar was not able to locate MW-4. However, one of the monitoring wells was located upgradient (MW-3), and the other (MW-4) was not in a position to detect contamination from the are currently under investigation (Figure 2-3).

Both wells were sampled during the site investigation conducted by Ebasco in 1990. Acetone was detected in both samples but was rejected because it was also found in blanks.

4-methyl-2-pentanone was detected in the downgradient sample at 18 ppb. Total Other Volatiles (tentatively identified compounds, TICs) were detected at 144 ppb in the upgradient sample and 293 ppb in the downgradient sample. Total Other Semivolatiles (TICs) were detected at 10 ppb in the upgradient sample and at 1,365 ppb in the downgradient sample. Phthalates were also detected but were rejected as laboratory contaminants. No non-aqueous phase liquids (NAPLs) were encountered during the groundwater investigation.

Lead and chromium concentrations exceeded EPA MCLs in both downgradient and background wells. Lead concentrations were 88 ppb in MW-3 and 131 ppb in MW-4 Chromium levels were 96 ppb in MW-3 and 116 ppb in MW-4. Further sampling and analysis conducted by Ebasco Services, Inc., determined that high lead and chromium concentrations were due to naturally occurring particulate matter in the groundwater. Computer Sciences Corporation (CSC) collected groundwater samples in the downgradient well. This sampling was conducted to compare previous laboratory results obtained in 1992. Laboratory analysis was performed on samples of unfiltered groundwater and groundwater filtered through a .45 μg filter. Both samples showed no detection of lead. The unfiltered water sample showed chromium concentrations of 86 ppb and the filtered sample showed chromium levels of 1.2 ppb. These results support findings that the lead and chromium detected in the original site investigation were due to naturally occurring particulate matter.

Two surface water/sediment samples were collected from the wetlands downgradient from the WOD. These samples were collected by Steam Kat Corporation in June 1986 and analyzed by Gascoyne Laboratories for benzene, toluene, xylene, and pH. Water sample WS-2 showed benzene levels of 2 ppb. This concentration does not exceed the EPA MCL of 5 ppb. No other compounds were detected. No reliable survey points were obtained following sampling, therefore surface water data was only estimated. Sediment samples collected indicate levels of Total Other Volatiles (TICs) at 11 ppm and Total Other Semivolatiles (TICs) at 337 ppm for SD01. SD02 showed no levels of Total Other Volatiles (TICs). Subsurface soil samples SS01 showed Total Other Semivolatile (TIC) concentrations of 79 ppm.

3.0 SITE INVESTIGATION

The field activities performed at the WFF Site 16 is described below. At Site 16 groundwater transport is the primary contaminant dispersal mechanism.

The purpose of the RI field activities was to fill critical data gaps for groundwater and soil to provide an adequate characterization of the nature and extent of contamination in the immediate vicinity Site 16. An EM survey was also performed at Site 16 to determine if a burial area exists at Site 16 (Figure 3-1).

During the RI, Versar installed and sampled 27 temporary monitoring wells (Figure 3-2) for volatile organic compounds (VOCs), arsenic, and total petroleum hydrocarbons-gasoline range organics (TPH-GRO) and diesel range organics (TPH-DRO) using a field laboratory for organic analyses and a fixed laboratory on 24-hour turnaround for metals. These data were then used as a screening technique to assist in the placement of six additional permanent monitoring wells. Temporary wells and the six additional monitoring wells were installed using a geoprobe rig. These six wells (Figure 3-2), plus 3 existing monitoring wells (MW-3, WFF15-GW1, and WFF15-GW7) were sampled for the Target Compound List/Target Analyte List (TCL/TAL) and TPH-DRO/GRO. Versar also collected four shallow and four deep soil samples for TCL/TAL analyses during well installation within the visually impacted area. An additional 17 surface soil samples were collected within and surrounding the stained soil and stressed vegetation areas (Figure 3-3) to characterize the nature and extent of the soil contamination.

3.1 Geophysical Investigation

Versar retained a specialty subcontractor to delineate the site electromagnetically. Forest Environmental Services, Inc. (FES) performed a geophysical survey at the NASA Flight Facility Site 16 in Wallops Island, Virginia, on April 28, 1998. The investigation consisted of a electromagnetic (EM) survey to locate suspected metal and nonmetal buried debris.

The EM survey was conducted north of Runway 17-35. Data were collected at 10-foot traverses with stations at 5-foot centers for the EM that covered approximately 500 by 400 feet. This survey location is shown in Figure 3-1. Line 0 East and station 0 North denotes the southwest corner of the survey. The survey boundary was selected by a Versar representative. The Em survey was bordered by Runway 17-35 to the south and the middle of the slope of the hill to the north, east, and west.

The EM survey was performed using an EM-31 induction meter to measure the apparent conductivity of the subsurface. The EM-31 consists of two horizontal coplanar loops, one acting as a transmitter and the other as a receiver. The transmitter induces electrical eddy currents in the earth, which in turn produce a secondary magnetic field. The receiver intercepts the secondary field, and the meter measures the terrain conductivity by comparing the strength of the secondary field to that of the primary field.

The depth of investigation by EM is a function of the intercoil spacing and the orientation of the antenna dipoles. The EM-31 has an intercoil spacing of 12 feet, and used in the vertical dipole mode, has an effective penetration depth of approximately 18 feet, a depth approximately equal to the depth to groundwater over much of the site.

Two readings were obtained from the EM-31 at each measurement station. The EM was connected to a data logger that simultaneously recorded both the quadrature-phase component and the in-phase component. The quadrature-phase component measures the terrain conductivity of the subsurface, and will detect metallic and nonmetallic objects or features with conductivities that deviate from their surroundings. The background terrain conductivity value at the site was approximately 3 millimhos per meter (mmhos/m).

The in-phase component measurements are proportional to an effective, average magnetic susceptibility of the surrounding earth; this mode is sensitive to large metallic objects. The readings do not indicate true magnetic susceptibility because there is an unknown additive constant and multiplying factor that would be required to convert the measured values to magnetic susceptibility.

Generally, negative or low EM values can indicate the areal extent of large, shallow buried metal objects. The EM displays moderate-sized metal objects that are buried deep as areas of high conductivity; therefore, both high and low readings of apparent conductivity can indicate metal. However, high conductivity materials can also be caused by conductive chemical compounds such as acids, sulfates, and salts in the subsurface and by conductive soils such as clay. Low conductivity materials such as wood and oil are generally not detectable by the EM.

Contours of the EM data were generated by computer using Golden Software's SURFER®. Data gridding were performed using 5-foot spacings, and the Kriging algorithm was used for grid interpolation. EM data are located in Appendix B.

3.2 Screening Investigation

Versar advanced 31 geoprobe borings within and surrounding the visually impacted area at the Site 16 WOD and installed 1-inch diameter PVC temporary monitoring wells with 5 foot 0.10 slot screens in 27 of the borings. The temporary wells were installed to depths ranging from 12-30 feet. Most of the borings for the temporary wells were installed by advancing a solid macroprobe to the water table; the water table is evident without lithologic samples by a dramatic reduction in the force necessary to drive the rods when the water table is encountered. Six of the borings were advanced using a coring device so that the samples could be logged for lithology. Logs are contained in Appendix C. In four of these six borings, soil samples were obtained for TCL/TAL and TPH-GRO/DRO analysis.

Before sampling, the temporary monitoring wells were developed to clarity using a peristaltic pump. Groundwater samples were then collected from the wells using dedicated teflon tubing fitted with a stainless steel check valve that was decontaminated between samples. Samples for VOCs and TPH-GRO/DRO were analyzed immediately after collection at a field laboratory using EPA method 8010/8020, and arsenic samples were analyzed in an offsite laboratory using EPA method 6010 under 24-hour turnaround. After sampling was complete, the top of casing for each well was surveyed and depth to water measurements were collected. The temporary wells were then removed and grouted to the surface (except in the 5 locations where permanent wells were later installed).

3.3 Monitoring Well Installation

During the RI, Versar installed monitoring wells at Site 16 to obtain groundwater samples (Figure 3-2). At Site 16, well MW-3 (installed by Ebasco in 1990) was used as a background sampling well. MW-3 was redeveloped by Versar during 1997 Site 15 RI field activities as an added quality control measure.

Permanent monitoring wells were installed for the Site 16 WOD RI using several techniques. Well WFF15-GW7 was constructed of 2-inch I.D. PVC with 10-foot screens using the conventional hollow-stem auger methods specified in the work plan. However, the very shallow groundwater table (1-2 feet deep), rugged terrain, and heavy vegetation of the two sites made installation of the downgradient wells along the unnamed tributary to Mosquito Creek (WFF15-GW1) using a truck-mounted hollow stem auger rig impossible.

Well WFF15-GW1 was installed using a tripod mounted, solid-stem, 2-man power auger. Cuttings were logged. After the auger was removed from the 8-inch bore hold, a 5-foot pre-packed well screen (6-inch) O.D. by 2-inch ID by 0.01 inch slots) and 5-foot 2-inch PVC riser were set into the borehole. These wells were typically constructed with 2-3 feet of stick-up and a 1-foot thick bentonite seal. The wells were installed into sand deposits which collapsed back against the well screen, thereby sealing off the annular space below the water table.

The six new wells installed at Site 16 were constructed within the boreholes cored to obtain soil samples and lithologic data during the direct push investigation. These wells were installed using the geoprobe rig by attaching a stainless steel drive point to the base of 2-inch schedule 80 PVC screen and risers and driving the point using the rods, effectively pulling the well materials to the desired depths. All wells were constructed using 10-foot, 0.10 screen and a natural sandpack. After the well is driven the aquifer materials collapse back against the casing materials to form a tight seal. Because the borehole in which the well is driven is very slightly smaller than the casing materials, minimal disruption to the aquifer occurs. Wells were completed with 2-3 feet of stickup and fitted with locking protective covers. Well logs are contained in Appendix C. All wells were developed as specified in the work plan and development and purge water was treated offsite.

Groundwater samples were collected from the Site 16 monitoring wells for TCL/TAL and TPH-GRO/DRO. Before sampling, the wells were properly purged as specified in the work plan and sampled using single-use disposable teflon bailers. All purge water was contained within 55-gallon drums, and later transported to an approved offsite treatment facility.

3.4 Aquifer Testing

The purpose of slug testing is to assess the hydraulic characteristics (hydraulic conductivity and transmissivity) of the groundwater flow systems (aquifers). These characteristics were determined by performing slug tests on two wells for Sites 14 and 15 on May 8 and 9, 1997. Additionally, Ebasco (1990) also performed aquifer testing in the Site 16 area.

To evaluate aquifer hydraulic conductivity, rising head (slug-out) and falling head (slug-in) slug tests were conducted on select monitoring wells provide data to determine the rate of groundwater flow. Slug tests were performed on monitoring wells WFF-14GW1, WFF-14GW7, WFF15-GW1 and WFF-15GW3. These wells were chosen based on field observations made during well installation and development (i.e., high and low recharge rates to provide a

representative range of values). Data on groundwater flow direction and rate of flow is needed to: (1) identify the most likely contaminant migration pathways; (2) determine potential migration rates and dispersion rates; and (3) provide site-specific data for evaluating treatment options. These data were downloaded, compiled, and analyzed using AQTESOLV 3.0 aquifer testing software. The equipment used, field procedures, data collection methods, and the data analysis techniques were performed as specified in the work plan. Test results are contained in Appendix D.

3.5 Groundwater Tidal Influence Study

A short term groundwater tidal influence study was performed on May 8 and 9, 1997. The tidal influence study was performed to determine if significant changes in groundwater elevations resulted from the daily tidal cycles. Tidally influenced groundwater elevation changes will affect groundwater contaminant transport and migration processes.

The test was run overnight between May 8 and 9, 1997 and used an insitu Troll data logger installed in WFF15-GW7. This test monitored the rising trend in the groundwater table during a series of ongoing precipitation events. The precipitation record at the Wallops Island station measured 0.08-inch of rain between May 7 and May 9, 1997. The station also recorded precipitation every day between May 1 and May 20, 1997 on Wallops Island.

3.6 Soil Sampling

Versar collected 21 surface soil samples for TCL/TAL and TPH-GRO/DRO analysis to characterize the remaining soil contamination at the Site 16 WOD. A visual inspection of the area beyond the end of runway 17-35 revealed no other areas of the former WOD where similar contamination was noted. The samples were collected on a grid to characterize the visually impacted areas (Figure 3-3). All surface soil samples were collected at a depth of 0 to 6 inches using dedicated stainless steel scoops. Four subsurface soil samples were collected using the geoprobe rig. These were collected using sampling rods fitted with dedicated acetate liners. Subsurface samples were collected at the water table; sampling depths for the subsurface samples are given in the analytical results contained in Appendix A-2.

Background surface soil samples were collected at seven locations adjacent to the western end of runway 17-35. These locations were selected to approximate the same geological, topographic, and operational characteristics as Site 16. The samples were collected along a 1500

foot traverse line approximately 5-10 feet beyond the edge of the "mow line" along the runway in an area of low brush and herbaceous vegetation. There is no obvious indication or historical base activity in the background locations other than their obvious proximity to the runway operations they share with Site 16.

4.0 RESULTS FROM THE REMEDIAL INVESTIGATION

This section presents the findings of the remedial investigation. It is divided into two principal sections: 1) physical characteristics, and 2) chemical contaminants detected in environmental media. Physical characterization of the sites involved primarily hydrogeological investigations and an electromagnetic survey of Site 16.

The results of the chemical characterization of the sites presents the data in terms of identifying the contaminants of potential concern for the human health and ecological risk assessments, and the tables contained in this section are summary in nature, indicating the results of screening against Region III risk-based concentrations (RBCs) and Biological Technical Assistance Group (BTAG) criteria or other relevant standards; identifying maximum and minimum concentrations, presenting the 95% upper confidence level used, whether the chemical is a carcinogen, and finally, if the contaminant was selected as a contaminant of potential concern. This approach limits redundancy with Sections 6 and 7, and should serve to focus the reader on the specific chemicals for review in the summary data which is included as Appendix A-2. Full analytical data are provided in a Microsoft Access database on CDROM (Appendix A-3).

4.1 Physical Characteristics

The RI field investigation included two primary areas of physical characterization; 1) a hydrogeological characterization, involving lithologic logging, measuring the potentiometric surface during each sampling round, aquifer testing, determining tidal influences, and calculating contaminant transport velocities, and 2) an electromagnetic survey of Site 16 to determine if any buried debris was present.

4.1.1 Geology

The results of the lithologic logging of the boreholes advanced for the installation of the site monitoring wells was very uniform and singularly unremarkable. Geologic logs are contained in Appendix C. In all but a few cases, the materials encountered were medium- to fine-grained quartz sands with some silt. However, a sandy clay layer was encountered at depths between 10 and 27 feet below ground surface (bgs) in DP-8, DP-16, SB2, SB3, and SB-4. This appears to be the same clay layer detected at approximately 5.5 to 6.0 feet bgs at wells WFF15-GW2, WFF15-GW3, and WFF15-GW4. This clay was consistently detected at the base of the

boreholes logged during the Site 16 RI with exception of SB1, which may not have penetrated deeply enough to reach the clay. This clay may serve as a local lower confining layer for the site. The clay was as much as 5 feet thick in boring DP-16 and SB-4. Soil borings were ended before penetrating this layer.

The lithology identified is consistent with that of the Pleistocene and Holocene Columbia Group which occurs to a depth of approximately 60 feet in the WFF area (NASA, 1994). Sandy clay layers and minor gravel lags typical of the Columbia formation were encountered. No geologic cross-sections are presented in this report because they would be little more than topographic profiles. A more detailed discussion of the hydrogeology of WFF is provided in the WFF "Environmental Resources Document" (NASA, 1994), the companion base-wide background document used for this project.

4.1.2 Tidal Influence Investigation

The tidal influence investigation was conducted at in the vicinity of Sites 15 and 16, because these sites are the most proximal to the tidally influenced Little Mosquito Creek. Figure 4-1 shows the plot of the potentiometric surface in well WFF15- GW7 for the period between May 8 and 9, 1997. There is no discernable tidal influence in the data. The graph of the data shows an apparent response to the second sinusoidal tidal cycle but none was recorded by the first cycle. Thus, the data indicate that the well recorded the change in the water table (rise) from an aquifer recharge event (precipitation). The spikes on the graph at 3:48 A.M. on May 9, 1997 and again at 10:18 A.M. agree with the tidal cycle superimposed on the data when the tidal lag is considered, but were not reproduced during the previous tidal event. The spike in the 10:18 A.M. data corresponds with the precise time that a manual water level measurement was collected from this well. Thus, the displacement recorded by the pressure record is 0.044 feet and is the result of the downward movement of the transducer in the well during the water level measurement. The early 3:48 A.M. spike in the data may be the result of the transducer slippage down the well in a somewhat similar manner.

A displacement corrected graph of the data is presented in Figure 4-2. The primary spike at each time interval has been subtracted out of the data set in both cases. The upward trend in the data beginning at 10:18 A.M. is primarily due to a 0.12-inch precipitation event recorded on May 10, 1997 at the Wallops Island station. There may be a very minor tidal influence evident on the corrected data plot although the precipitation events are masking the response. If the tidal influenced is really present, it is apparently less than 0.05 foot in the data shown. This tidal

response is insignificant as a hydrogeologic factor which could influence groundwater flow direction or contaminant transport and migration processes. Additionally, total dissolved solids data collected for groundwater confirms that these are Class IIB aquifers, uninfluenced by salt water intrusion.

4.1.3 Potentiometric Surface Mapping

Potentiometric surface data presented in this section was collected during the direct push investigation on May 4-6, 1998, and two rounds of monitoring well sampling on May 27-28, 1998, and February 18, 2000.

Potentiometric surface maps for Site 16 are shown in Figures 4-3 and 4-4. Figure 4-3 generated using the data from the 27 temporary wells installed during the direct push investigation, provides the most control on the potentiometric surface. These contours indicate flow toward and discharge into the unnamed tributary flowing along the base of Site 15 and to the marsh along Little Mosquito Creek. The arcuate shape of the contours directly reflects the shape of the peninsula at the end of runway 17-35. In the immediate vicinity of Site 16, groundwater flows northwest toward the unnamed tributary. The hydraulic gradient across the site is approximately 0.01.

On the western and northern edge of Site 16, groundwater is much more shallow (approximately 3-8 feet deep), and the presence of numerous seeps located just west of the downgradient monitoring wells at Site 15 establishes the unnamed tributary as a discharge zone for groundwater passing below Site 15.

4.1.4 Aquifer Testing

The wells analyzed for the sites along the WFF runways (Sites 14, 15, and 16) were constructed in a conventional manner (i.e. 6.25-inch diameter borehole followed by the installation of 2-inch diameter well screen and riser, filtration media, bentonite grout etc.). Most of the wells analyzed on the Main Base were completed with a pre-packed screen driven into a borehole (with the exception of WFF14-GW1, WFF14-GW2, and WFF15-GW7 which were constructed in a conventional manner).

In evaluating the slug testing data, straight lines were fitted to the testing data in order to evaluate the nature of the various aquifer systems. The data analysis is often subject to

interpretation due to slope changes in the water level responses that are observed in the data sets. In most cases, both conventional and prepacked well designs produce similar hydraulic estimates, however, two wells analyzed on Site 14 (WFF14-GW1 [falling head test] and WFF14-GW7 [rising head test] revealed a distinctive "kick" in the response curve. These wells were designed with pre-packed filters in a relatively tight silty-sand matrix. The slug testing data revealed that the aquifer at the Main Base responds under unconfined conditions and showed responses typical of sand aquifers.

The data summary for the aquifer slug testing parameters and results at NASA Wallops Flight Facility is presented in Table 4-1. The data summary lists the parameters that were used for determining the aquifer characteristics. Graphical plots of the slug testing data with the fitted lines for unconfined aquifer conditions are presented in Appendix D. AQTESOLV provides units in English units (feet per minute [ft/min]); Table 4-1 also contain conversion to metric units (centimeters per second [cm/s]) and corresponding transmissivity calculations.

Average (mean) hydraulic conductivity values calculated for the wells on the Main Base ranged from a high value of 1.02×10^{-2} cm/s at WFF14-GW1 to a low value of 4.87×10^{-4} cm/s at WFF15-GW1 (**Table 4-1**). Ebasco obtained a hydraulic conductivity for Site 16 of 2.3×10^{-3} cm/s, which agrees very well with the average hydraulic conductivity measured by Versar for the Columbia Group. These values are consistent with literature values (Freeze and Cherry, 1979) characteristic of silty to clean sands.

Transmissivities for the Columbia Group wells analyzed on the Main Base ranged from a high value of 0.16 square feet minute (ft^2/min) at WWF14-GW1 to a low value of 9.19×10^{-4} ft^2/min at WFF15-GW1.

4.1.5 Contaminant Transport Velocities

Using the measured hydraulic gradient (Section 4.1.3) and hydraulic conductivity Ebasco (1990) incurred for Site 16 (2.3×10^{-3} cm/s) (Section 4.1.4), and assuming an effective porosity of 30 percent for a relatively clean sand to silt (Freeze and Cherry, 1979), a contaminant transport velocity may be calculated according to the formula :

$$v = KI/n,$$

where "v' is the contaminant transport velocity, "K' is the hydraulic conductivity, "I" is the hydraulic gradient, and "n" is the effective porosity.

This formula results in an average contaminant transport velocity of 7.6 x 10^{-6} cm/s for Site 16. Converting these metric data to English units result in a velocity of 7.9 ft/yr at Site 16. Given Site 16's position within the groundwater flow field, and the time which has elapsed since it was created (1940s-50s), these velocities indicate that any contaminated groundwater emanating from the site has had ample time to travel the 220 feet required to reach the unnamed tributary of Little Mosquito Creek. Therefore, surface water and sediment data collected for Site 15 already reflects contaminant loading from groundwater discharge emanating from Site 16.

4.1.6 Results of the Electromagnetic Survey

The electromagnetic (EM) survey of Site 16 was conducted on April 28, 1998, by Forrest Environmental Services to determine if there were any areas of buried debris present within the site area. The results of the apparent conductivity and magnetic susceptibility (metal detector mode) are given in Figure 3-1. Two anomalies were noted. In both cases, the anomalies were very small (< 10 feet in diameter), suggestive of small amounts of buried reinforced concrete, or a small length of metal pipe. Direct push borings were advanced in the vicinity of these anomalies (DP-2, SB-3, and SB-4), and no indication of buried debris was encountered. The overall conclusion of the EM survey was that no large burial area exists at Site 16.

4.2 Chemical Contaminants Detected in Environmental Media

Chemical analytical data from surface soil, subsurface soil, and ground water collected from Site 16 and parts of nearby Site 15 of WFF during the RI. All data were fully validated. A summary of the chemicals identified for further evaluation in the human health and ecological risk assessment (ERA), the data groupings, and the background sample locations are presented for each medium in the discussion below. Data tables in this section are interpretive, providing the results of screening against relevant environmental criteria for Region III. Summary data showing all detected analytes are contained in Appendix A-2.

Quality control samples (duplicates, trip blanks, and equipment blanks) were collected at a rate of approximately 1:20. All duplicates exhibited very good agreement in all media, and trip and equipment blanks were generally very clean with the exception of common laboratory contaminants; no data were rejected during data validation based on the quality control samples.

Summary data for the quality control samples are also contained in Appendix A-2. Data Validation reports will be submitted upon request or at project's end.

4.2.1 Surface Soil

During the RI, Versar collected a total of 21 surface soil samples (between 0 and 6 inches) from Site 16. Locations of surface soil samples are shown in Figure 3-3. Surface soil samples were analyzed for: TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, and cyanide. Surface soil samples collected by Ebasco (1990) and Metcalf & Eddy (1992) were not incorporated into the database used for risk assessment because validated was not available.

4.2.1.1 Surface Soil Background Samples

Seven surface soil background samples were collected from off-site locations on the north side of runway 10-28 just beyond the maintained area (approximately 5-10 feet just beyond the "mow line"), west of the wastewater treatment plant. The concentrations of target analytes detected at those sample locations are presented in Table 4-2. All background surface soil samples were collected using the same sample collection procedures as were used for on-site samples so as to be comparable to on-site samples. Background samples were analyzed for the same chemicals as on-site samples: TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, TAL metals, cyanide, and total petroleum hydrocarbons. Background surface soil samples had concentrations of DDE, DDT, arsenic, and beryllium that exceeded residential RBCs.

4.2.1.2 Results of the Surface Soil Samples

The chemicals detected in surface soil samples (0-6 inches) are presented in Tables 4-3 and 4-4. These tables include a summary of the frequency of detection, range of detections, risk-based concentrations (RBCs) and biological technical assistance group (BTAG) screening levels, a comparison with background concentrations, and a determination of which are chemicals of potential concern (COPCs) for the risk assessments in Sections 5 and 6. A total of 8 organic compounds were detected; 5 were semivolatile organic compounds and 3 were pesticides. Twenty metals, plus TPH-GRO and TPH-DRO were detected.

For the human health risk assessment (HHRA), 4 chemicals were selected as COPCs because the maximum concentration detected exceeded Region III for residential soils (Table 4-3). These 4 chemicals are benzo(a)pyrene, aluminum, arsenic, and iron. However, of these: 1)

the maximum Site 16 concentration for arsenic is less than the background concentration, 2) the maximum iron concentration for Site 16 (10,700 ppm) only slightly exceeds background (9,180 ppm), and 3) the maximum aluminum concentration detected (10,600 ppm) only slightly exceeds background (9,970 ppm). All detected contaminant concentrations were below industrial RBCs. TPH-GRO/DRO was detected, with the contaminant signature dominated by the DRO fraction (maximum concentrations of 0.22 ppm GRO vs. 870 ppm DRO). These concentrations are well below the 11,000 ppm saturation standard that the Virginia Department of Environmental Quality (VDEQ) uses to evaluate remediation requirements for soil contamination.

For the ecological risk assessment, 13 chemicals were selected as COPCs because the maximum detected concentrations exceeded Region III BTAG concentrations (Table-4-4). These chemicals are benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, indeno(1,2,3-cd)pyrene, 4,4'-DDE, 4,4'-DDT, aluminum, beryllium, chromium, iron lead, nickel, vanadium, and zinc. Two chemicals (antimony and silver) were also detected at concentrations which exceed BTAG screening levels, but were not selected as COPCs: silver was not selected due to lack of toxicity information, and antimony was not selected because it was only detected in a single sample. Of these, the maximum detected Site 16 concentrations of 4,4'-DDE, 4,4'-DDT, beryllium, and chromium did not exceed background concentrations. The maximum iron concentration for Site 16 (10,700 ppm) only slightly exceeds background (9,180 ppm), and the maximum aluminum concentration detected (10,600 ppm) only slightly exceeds background (9,970 ppm). Iron was only detected in one sample at a concentration that exceeded background.

4.2.2 Subsurface Soil

Versar collected subsurface soil samples from within the visually stained area of Site 16 Figure 3-3. These sample locations were based on visual cues, and the results of the EM survey and direct push groundwater investigation. The subsurface soil samples were collected at depths of 17-24 feet bgs from zones exhibiting the highest photoionization detector (PID) readings, or in the absence of PID readings (WFF16-SB4S2), at the water table. Generally, the highest PID readings in the other three soil borings were at the water table.

4.2.2.1 Background Subsurface Soil

No separate background data for subsurface soil was collected. Soil samples for each site are screened against the 7 surface soil background samples as was agreed during development of the work plan.

4.2.2.2 Results for Subsurface Soil

Subsurface soil samples were not evaluated for the ERA because these samples are beyond the 0-2 foot depth commonly used to evaluate risk to burrowing organisms. A total of 19 organic chemicals were detected: 4 VOCs, 9 SVOCs, and 6 pesticides. Sixteen metals were detected. None of the detected concentrations exceeded Region III residential or industrial RBCs (Table 4-5). TPH GRO/DRO concentrations were considerably higher than in surface soil, as expected. TPH-GRO had a maximum detected concentration of 2,300 ppm, and the maximum detected concentration of TPH-DRO was 6,800 ppm. These concentrations are below the 11,000 ppm saturation criteria that VDEQ uses to evaluate remediation requirements for soil contamination where a current drinking water source is not threatened.

4.2.3 Groundwater

Versar installed 27 direct push temporary monitoring wells as a screening tool to obtain strong control of potentiometric surface contours, locate potential contaminant plumes, and determine the locations of permanent groundwater monitoring wells. Based on the information garnered during the direct push investigation, Versar installed 6 additional monitoring wells in 5 locations; a shallow/deep well cluster was installed at WFF16-GW2S/GW2D. The Site 16 well installed by Ebasco, MW-3, was used as a background well. Data for two wells installed during the Site 15 RI/FS, WFF15-GW1 and WFF15-GW7, were incorporated into to the Site 16 RI/FS. All metals data is on unfiltered samples.

4.2.3.1 Background Groundwater

The background well for Site 16 is well MW-3 installed by Ebasco. The only organic chemical detected in MW-3 was bis(2-ethylhexyl)phthalate detected at a concentration of 3-18 ppb, which is less than twice the concentration in field blanks. Numerous metals were detected. Of these, only arsenic was detected at concentrations that exceeded Region III tap water RBCs.

4.2.3.2 Results for Groundwater

As a result of the determination that potentially contaminated groundwater had ample time to discharge to surface water, and given the lack of ecological receptors for groundwater, these data were not used in the ERA.

Direct Push Screening Investigation Results

On May 6, 1998, a total of 28 samples were collected from 27, 1-inch PVC temporary monitoring wells and well WFF15-GW7 (Figure 3-2) for onsite analysis for chlorinated solvents, and TPH-GRO and TPH-DRO. Arsenic was analyzed on a fast turnaround basis in an offsite laboratory (Appendix A-4). These results were then used to determine the placement of permanent monitoring wells. These analytes were selected based on the initial results from well WFF15-GW7 where these compounds were detected at elevated levels. These data were not used for risk assessment purposes.

Tetrachloroethene was detected in DP1 (15 ppb), WFF15GW-7 (5 ppb), DP7 (10 ppb), and DP18 (5 ppb). TPH-GRO was detected in DP1 (32 ppm), WFF15-GW7 (3 ppm), DP7 (15 ppm), DP9 (4 ppm), and DP18 (18 ppm). TPH-DRO was detected in DP1 (38 ppm), WFF15-GW7 (14 ppm), DP7 (27 ppm), DP9 (8 ppm), and DP18 (210 ppm). Arsenic was not detected on any well (detection limits were 50 ppb).

Using these data, WFF16-GW2S and WFF16-GWD were located in the most contaminated direct push borehole, DP18. WFF16-GW3 was located downgradient of the site on a vector connecting DP1 and DP9. Similarly, WFF16-GW5 was located downgradient of the site on a vector connecting DP7/WFF15-GW7 and DP18.

Permanent Monitoring Well Sampling Results

Data from permanent wells collected during three rounds of sampling were pooled to develop the database for the HHRA. During the first round data from the Site 15 RI/FS only wells WFF15-GW1, WFF15-GW7, and MW-3 were applicable to Site 16. The Site 16 downgradient well system was installed between rounds 1 and 2, and therefore the second round data includes data from WFF15-GW1, WFF15-GW7, and MW-3 as well as the seven Site 16 monitoring wells (Figure 3-2). During round 3, samples were only collected from the seven Site 16 monitoring wells. In this manner, each well was given equal weight in the pooled data base, although it was later determined by VDEQ that the maximum concentration at each well would be used in the HHRA. Similarly, the maximum detected concentration from WFF16-GW2S/GW2D cluster was treated as a single data point. In Table 4-6, the frequency data is expressed as the number of "hits" per sampling location; a hit being comprised of a detection in any of the rounds. Full analytical results are provided in Appendix A-2.

A total of 25 organic compounds were detected: 7 VOCs, 15 SVOCs, and 3 pesticides. Twenty-two metals, plus nitrate, sulfate, and sulfide were detected. TPH-GRO and TPH-DRO were also detected. Among the VOCs, the following were identified as COPCs: 1,2-dichloroethene, benzene, ethylbenzene, tetrachloroethene, and toluene. SVOCs identified as COPCs included 2-chlorophenol, 2-methylnaphthalene, 4-methylphenol, dibenzofuran, bis(2ethylhexyl)phthalate, carbazole, naphthalene, and phenanthrene. Pesticide COPCs were 4,4'-DDT and alpha-BHC. The following inorganics were identified as COPCc: aluminum, antimony, arsenic, iron, lead, manganese, potassium, thallium, and vanadium.

Although not treated quantitatively in the HHRA due to lack of toxicity information, TPH-GRO and TPH-DRO were identified as COPCs. TPH-GRO was detected at concentrations of 33 to 4,000 ppb. TPH-DRO was detected at concentrations of 600 to 83,000 ppb. The highest concentrations of these analytes were detected in well WFF15-GW7.

With few exceptions, the highest concentrations of all of the organic COPCs were detected in well WFF15-GW7 which is located with the area of visually stained soil. The only exceptions was 1,2 dichloroethene detected in WFF16-GW2S (also within the area of stained soil), and the 4-4'-DDT detected in WFF15-GW1 (which was only detected in this well). WFF15-GW7 also exhibited the highest concentrations of aluminum. arsenic, and iron.

5.0 ECOLOGICAL RISK ASSESSMENT

This Ecological Risk Assessment (ERA) has been prepared to evaluate the probability and magnitude of potential adverse effects on the environment associated with actual or potential exposure to site-related chemicals in surface soil at Site 16 of Wallops Flight Facility (WFF).

Although not listed on the NPL, NASA has directed that this ERA be consistent with Subpart E, Section 300.430(d) of the National Contingency Plan (NCP). This law which directs that a Baseline Risk Assessment be conducted to characterize the current and potential threats to public health and the environment that may be posed by contaminants migrating to groundwater, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain. This ERA is also consistent with USEPA guidance and standards (USEPA, 1986b, c; 1989a, b; 1991a, b; 1992a, b, c, d; 1995b; 1997a, b, c).

The ERA is organized as follows:

- Problem Formulation (Section 5.2). This section summarizes available information about the site history and past land-use activities, the ecological resources and the COPCs associated with the site, and the pathways by which ecological receptors could be exposed to these chemicals. This section culminates in the identification of the ecological resources and the endpoints selected for evaluation in the ERA.

- Exposure Characterization and Development of Exposure Pathway Model (Section 5.3). This section develops chemical exposure point concentrations for each of the ecological receptor groups/organisms selected for evaluation in the ERA.

- Ecotoxicologic Effects Assessment (Section 5.4). This section identifies concentrations and/or doses of the COPCs that are protective of the ecological receptors selected for evaluation.

- Risk Characterization (Section 5.5). This section compares the estimated exposure point concentrations identified in Section 5.3 to the toxicity values identified in Section 5.4 to characterize the potential for adverse effects to ecological resources.

- Limitations and Uncertainties (Section 5.6). This section identifies the major uncertainties associated with each step of the ERA and characterizes the potential effects of those uncertainties on conclusions made in the ERA.

- Ecological Risk Assessment Summary (Section 5.7). This section summarizes the major conclusions made in the ERA.

5.1 Overview

The purpose of the ERA is to assess the potential for adverse effects to ecological receptors resulting from exposure to chemicals in the surface soil Site 16 of WFF. The ERA was conducted in accordance with national and regional USEPA guidance for evaluating ecological risks at hazardous waste sites (USEPA, 1989a; 1989c; 1992c; and 1994a). The site is first characterized by identifying habitats, and individual organisms, populations, or communities likely to occur at Site 16 of WFF. The COPCs were identified in Section 4.2. The potential toxicity of the COPCs to ecological receptors selected for evaluation is then characterized. Finally, information on exposures and toxicity are combined to derive qualitative or quantitative estimates of the potential for adverse effects to ecological receptors at Site 16 of WFF.

5.2 Problem Formulation

This section presents available information about the ecological resources and the pathways by which ecological receptors could be exposed to these chemicals. This section culminates in the identification of the ecological resources and the endpoints selected for evaluation in the ERA. Specifically, Section 5.2.1 provides a general overview of WFF Main Base and the habitats/ecological resources known or likely to occur on site. Section 5.2.2 identifies the COPCs selected for evaluation and the data groupings selected for each medium. Section 5.2.2 identifies the ecological receptor species and potential exposure pathways selected for evaluation. Finally, Section 5.2.3 describes the assessment and measurement endpoints identified for evaluation in the ERA, and the methods and data used for the evaluation of these endpoints.

5.2.1 Characterization of Habitats and Wildlife at Site 16 of WFF

Terrestrial Habitats. The principal cover at the WFF Main Base is developed land, and consists of impervious surfaces such as runways, parking lots, roads, and buildings. Many areas of mowed lawn are also associated with these man-made features. Vegetation within these maintained areas generally consists of planted lawn grasses, with scattered areas of planted landscaping trees and shrubs. Several very small areas of oldfield exist immediately to the north, east, and west of the northern-most section of runway. These areas are dominated by a primarily herbaceous association of switchgrass (*Panicum virgatum*), broomsedge (*Andropogon virginicus*), and fescue grass (*Festuca* sp.). Scattered saplings of loblolly pine (*Pinus taeda*) and sweetgum (*Liquidambar styraciflua*) are also present, along with several species of blackberries

(*Rubus* sp.) and multiflora rose (*Rosa multiflora*). The largest parcel of natural terrestrial habitat at WFF Main Base is a mixed deciduous/pine forest in the northern-most part of the property, bordering Little Mosquito Creek. The forest consists of a dense-canopied stand of pine and oak, with trees averaging about 10 to 14 inches diameter at breast height (dbh), and canopies averaging about 60 feet tall. Primary tree species in the stand include loblolly pine, Virginia pine (*Pinus virginiana*), willow oak (*Quercus phellos*), black oak (*Quercus velutina*), sweetgum, and red maple (*Acer rubrum*). Owing to the dense tree canopy, the shrub and herb layers of the forest are very sparse throughout, except in openings. Principal shrubs include spicebush (*Lindera benzoin*) and Tartarian honeysuckle (*Lonicera tatarica*); numerous saplings of the principal trees were also abundant in the shrub layer, also in the occasional openings. Very few herbs were observed in the forest; species observed throughout included bracken (*Pteridium aquilinum*), partridgeberry (*Mitchella repens*), and several unidentified grasses.

Wetlands and Aquatic Habitats. Freshwater wetlands exist at the WFF Main Base along Little Mosquito Creek and its unnamed tributary. Observed contamination of Site 16 is approximately 200 feet east of aquatic habitats. Wetlands along the edge of Little Mosquito Creek are tidally-influenced and are primarily herbaceous. Principal species in this area include spartina grasses (*Spartina alterniflora, S. patens, and S. cynosuroides)*, and threesquare (*Scirpus pungent*). To the immediate south along the flat delta where the unnamed tributary flows into Little Mosquito Creek is a moderately large area of tidally-influenced wetland scrub/shrub. The wetland is dominated by wax myrtle (*Myrica cerifera*), buttonbush (*Cephalanthus occidentalis*), and groundsel bush (*Baccharia halimifolia*). Scattered small trees are also found in the scrub/shrub wetland, primarily black willow (*Salix nigra*) and red maple. Cinnamon fern (*Osmunda cinnamomea*) and royal fern (*Osmunda regalis*) are the principal herbs in the scrub/shrub. A very narrow margin of deciduous forested wetland exists along most of the length of the unnamed tributary above the scrub/shrub area. The forested wetlands are apparently not tidally-influenced. The forest is dominated by relatively small trees, averaging about 6 to 10 inches dbh, with a 60-foot-tall canopy; primary species are red maple, black willow, and sweetgum. Spicebush is the principal shrub in this wetland forest; the predominant herbs are sensitive fern, royal fern, and cinnamon fern.

Wildlife. The unnamed tributary and Little Mosquito Creek support a diverse group of freshwater aquatic invertebrates. Fish commonly found in the unnamed tributary at the WFF Main Base include several species of darters and mummichogs (*Fundulus* sp.); in Little mosquito Creek, spot (*Leiostomas xanthurus*) and bay anchovy (*Anchoa mitchilli*) are seasonally most common. Common amphibians and reptiles in the area include Fowler's toad (*Bufo*

woodhoussei), green tree frog (*Hyla cinerea*), black rat snake (*Elapha obsoleta*), hognose snake (*Heterodon platyrhinos*), and box turtle (*Terrapine caolina*). A considerable variety of birds are likely to inhabit WFF throughout the year, owing to its location along the primary migratory corridor of the East Coast. Upland bird families expected to utilize WFF habitats include owls, hawks, woodpeckers, flycatchers, swallows, crows and jays, chickadees, nuthatches, wrens, thrushes (including robins), vireos, warblers, blackbirds, and sparrows. Some of the most common terrestrial birds on the facility include red-tailed hawk (*Buteo jamaicensis*), mockingbird (*Mimus polyglottos*), American robin (*Turdus migratorius*), mourning dove (*Zenaida macroura*), starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), and song sparrow (*Melospiza melodia*). Other more aquatic-oriented birds, such as great blue heron (*Ardea herodias*), herring gull (*Larus argentatus*), laughing gull (*Larus atricilla*), and willet (*Catoptrophorus semipalmatus*) are common in the open tidal wetland areas along Little Mosquito Creek. Mammals that are most likely to occur in the vicinity of the WFF Main Base include masked shrew (*Sorex cinereus*), short-tail shrew (*Blarina brevicauda*), gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), marsh rice rat (*Oryzomys palustris*), eastern cottontail (*Sylvilagus floridanus*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*) and white-tailed deer (*Odocoileus virginianus*). It should also be noted that the WFF Main Base possesses a sizable captive white-tailed deer population (i.e., movement restricted by fences).

Threatened and Endangered Species. A data base search for threatened and endangered plant and animal species potentially inhabiting or using the WFF Main Base was conducted for a previous study (Metcalf and Eddy 1994). Information was requested of the Commonwealth of Virginia Department of Game and Inland Fisheries, the Commonwealth of Virginia Department of Agriculture and Consumer Services, the Commonwealth of Virginia department of Conservation and Recreation, Division of Natural Heritage, and the U.S. Fish and Wildlife Service (Metcalf and Eddy 1994). The fauna species identified through the search are listed in Table 5-1. With the exception of bald eagle, none of these species has been identified in the vicinity on the WFF Main Base (the species has nested at one location on Little Mosquito Creek to the north of WFF Main Base). No flora of special concern was identified in the vicinity of the WFF Main Base as a result of the data search.

5.2.2 Identification of Chemicals of Potential Concern

This section presents methodologies used to select COPCs previously identified in Section 4.2. Chemicals are selected for evaluation in the ERA if they: 1) are presumed to be present

because of past activities at the site; and 2) pose potential risks to ecological species. Chemicals associated with sampling or laboratory artifacts were not selected as COPCs.

The following steps, which are in accordance with USEPA (1989c) guidance, were first used to summarize the analytical data for this ERA:

- The samples collected during the RI (RI data have received 100% data validation) were divided into data groupings by environmental medium and potential exposure sources. The creation of these data groupings allows for the characterization of environmental conditions relevant to exposure and helps to determine exposure concentrations for target populations. The grouping of background data is used to determine if chemicals detected at a site are present at naturally occurring levels. The sample data groupings used in the ERA, including background data groupings, are described by environmental medium in the sections below.

- Sample data were compared to blank (laboratory, equipment rinse, field, and trip) concentration data. If the chemical concentration detected in a site-related sample was less than 10 times (for common laboratory chemicals) or five times (for all other compounds) the concentration in the corresponding blank sample, the sample was excluded from the ERA in accordance with USEPA (1989c) guidance. The identification and validation of sampling or laboratory artifacts were performed prior to data summarization. In addition, data that were rejected through laboratory validation (R qualified) were not used in the ERA.

- As required by USEPA (1994a) Region III guidance, the maximum concentration of a pair of duplicate or split samples (taken from the same location on the same date) was used to represent the concentration for that location.

- Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples analyzed.

Once the data were grouped and summarized, chemicals were selected for further evaluation. Chemicals were selected as COPCs if their maximum detected concentrations in environmental media exceeded the screening level concentrations for ecological receptors provided by the USEPA Region III BTAG (USEPA, 1995d). USEPA Region III BTAG Screening Levels are based on chemical concentrations considered to be protective of the most sensitive organism in a medium. Screening levels for some chemicals were available for both flora and fauna, in which case the lower of the two values was used in the ERA. Only chemicals with maximum concentrations below the screening levels were eliminated as COPCs. Chemicals lacking USEPA Region III BTAG Screening Levels were maintained as COPCs.

Essential nutrients for ecological receptors (calcium, magnesium, potassium, and sodium) were not considered as COPCs because they are unlikely to adversely affect potential ecological resources at concentrations that could occur in the environment.

All chemicals not eliminated by the above screening process were identified as COPCs and evaluated in the ERA. However, some inorganic chemicals occurring at concentrations above the USEPA Region III BTAG Screening Levels may not be reflective of site-related contamination, but instead, may indicate widespread contamination or naturally elevated regional concentrations. Accordingly, the identification of chemicals occurring at concentrations below background concentrations may be useful when interpreting the results of the ERA. Inorganic chemicals with maximum concentrations which exceeded USEPA Region III BTAG Screening Levels but were equal to or less than background concentrations were selected as COPCs, but are designated with a "B" in subsequent data tables.

For both the on-site and background sample data sets, the maximum concentration of each inorganic detected at the on-site location was compared to the maximum concentration of that inorganic chemical detected in the background data grouping. If the maximum concentration of an inorganic chemical exceeded the maximum background concentration or if it was not detected in the relevant background data grouping, then that chemical was considered to occur at concentrations above those in the background samples.

The identification of COPCs does not necessarily indicate that the compounds selected pose a risk to ecological receptors. Rather, it indicates that there is a need to evaluate those compounds in the ERA to determine if exposures to them could result in potential risks to ecological receptors.

5.2.3 Identification of Exposure Pathways and Potential Receptors for Analysis

In this section, the potential pathways by which ecological resources may be exposed to the COPCs from Site 16 of WFF are discussed. Exposure pathways were identified based on the consideration of: 1) the source/mechanism of chemical release; 2) the medium (or media) of chemical transport; 3) the point of potential contact by the receptor organism; and 4) the route of exposure at the contact point. Potentially complete exposure pathways and potential receptor groups were identified for evaluation in the ERA based on consideration of the available habitat, and the type, extent, magnitude, and location of potential chemical contamination.

As previously discussed in Section 5.2.1, a variety of terrestrial and aquatic species are associated with WFF. Table 5-2 identifies the potential exposure pathways by which ecological receptors could be exposed to COPCs Site 16 of WFF and, in general terms, the pathways selected for evaluation in the ERA. A brief rationale for the selection/exclusion of each potentially complete exposure pathway is also summarized in this table. The following sections provide a more detailed discussion and evaluation of the pathways by which potential receptors could be exposed to COPCs in surface soil and discuss the exposure pathways selected for evaluation. Direct exposure to chemicals in abiotic media is first discussed, followed by a discussion of the potential for exposure to chemicals through accumulation in the food web.

5.2.3.1 Direct Exposure Pathways and Receptors

5.2.3.1.1 Terrestrial Plants

Terrestrial plants are important components in any ecosystem because they provide food and cover for many wildlife species. WFF supports a variety of different plant species characteristic of coastal areas. Terrestrial plants at Site 16 may be exposed to COPCs in surface soil as a result of direct contact and subsequent uptake via roots or direct foliar uptake. However, only limited toxicity information is available to evaluate the potential for adverse effects to plants, particularly as a result of exposures to organic compounds. In spite of the relative lack of literature-based toxicity values, the potential risks to terrestrial plants from contact with chemicals at Site 16 surface soils were evaluated, in the Risk Characterization (Section 5.5.1) to the extent possible, by comparing site-related data with available toxicity values from scientific literature.

5.2.3.1.2 Soil Invertebrates

Soil invertebrates may be exposed to chemicals in surface soil via dermal absorption and via the ingestion of contaminated soils. Accordingly, the potential for the COPCs to adversely affect soil invertebrates was evaluated in the ERA. Earthworms were selected as the receptor species for evaluating the potential for adverse effects to soil invertebrates for several reasons. Earthworms have direct contact with soil and are sensitive to chemicals in soil, relative to other soil invertebrates. Furthermore, earthworms serve an important ecological role in the aeration of soils and cycling of nutrients, and act as an important food source for carnivorous species (e.g., shrews). Lastly, toxicity data for earthworms are available in the scientific literature.

Potential risks to earthworms were evaluated in the Risk Characterization section by comparing the chemical concentrations measured in surface soil with available toxicity values from the scientific literature.

5.2.3.2 Indirect Exposure Pathways for Surface Soil

The evaluation of indirect exposure pathways is a multiple-step process. This section describes the potential bioaccumulation pathways and discusses the food webs present at WFF. The following paragraphs identify the potential for chemicals to accumulate in the Main Base of WFF based on the physical/chemical properties of the COPCs and their concentrations and distribution in the environment. The potential for chemicals to accumulate in the food web is predominately a function of the characteristics of both the chemicals present and the food web through which they can accumulate.

In order to assess the potential for compounds to bioaccumulate, the octonal/water partition coefficients (expressed as Log K_{ow}) for organics and the bioconcentration factors (BCFs) for inorganics were reviewed. The Log K_{ow} characterizes the propensity of an organic chemical to partition into the lipid fraction of an organism, and thus, the potential for the chemical to bioaccumulate. A Log K_{ow} of greater than 3.5 was considered for further evaluation based on Garten and Trabalka (1983) which indicates such chemicals have the potential to bioaccumulate. Unlike Log K_{ow}s, BCFs are receptor-specific and, as such, are discussed for individual pathways evaluated below.

Earthworms were selected as an indicator of accumulation from surface soil into fauna for several reasons. First, earthworms have direct dermal contact with and ingest large amounts of soil. Further, there is an extensive database of the accumulation potential of chemicals from surface soil into earthworms. Finally, earthworms are an important food source for a number of terrestrial species and represent a potential exposure pathway in the terrestrial food web. Inorganics with earthworm BCFs greater than 1 were conservatively identified for analysis in the terrestrial food web.

PAHs and bis(2-Ethylhexyl)phthalate have Log K_{ow}s above 3.5; therefore, there is the potential for these organic chemicals to bioaccumulate based on the Log K_{ow} screening procedure outlined above. However, information from the scientific literature indicates that PAHs do not readily accumulate in the terrestrial food web because they are metabolized into non-toxic byproducts and eliminated by higher trophic-level species (Eisler 1987a). Information from the

scientific literature also indicates that phthalates, including bis(2-Ethylhexyl)phthalate, do not readily accumulate in the terrestrial food web because they are metabolized by most organisms (ATSDR, 1993a, b). PAHs and phthalates were, therefore, not selected for further evaluation as bioaccumulative compounds.

Most pesticides have chemical properties which enable them to be readily absorbed by biotic tissue, and accordingly have Log K_{ow}s greater than 3.5 and have the potential to bioaccumulate. DDT and its derivatives were evaluated as bioaccumulative compounds in the ERA. DDTr is used as a measure of the total concentration of DDT, DDD, and DDE.

Earthworm BCF data were reviewed to determine which inorganic COPCs had the greatest potential to bioconcentrate from soil to earthworms. Aluminum, chromium, iron, lead, nickel, and vanadium, all of which were identified as COPCs, are metabolically regulated by earthworms (Beyer 1990), while zinc does not readily accumulate in the terrestrial food web (ATSDR 1992f). Antimony and beryllium are considered potentially bioaccumulative compounds (Beyer 1990).

5.2.3.3 Indirect Exposure Receptors

Having identified chemicals in surface soil that can accumulate in the terrestrial environment, the possible pathways by which receptor species could be exposed to chemicals were identified and evaluated. Emphasis was placed on higher trophic-level species because of the potential for these chemicals to bioaccumulate in the food web prior to receptor exposure. Terrestrial and avian wildlife are the primary endpoints of the food webs present at WFF. Although terrestrial and avian wildlife can be directly exposed to chemicals in abiotic media by several pathways including ingestion, dermal absorption, and inhalation, these direct exposure pathways are likely to result only in limited risks. The greatest potential for adverse effects to terrestrial and avian wildlife is likely to result from the additive risk of ingestion of terrestrial and aquatic food items which may concentrate chemicals in conjunction with direct ingestion of chemicals in abiotic media. Accordingly, wildlife receptors will have the most significant impacts from chemicals that can accumulate in the food web.

There are many factors that are important in selecting ecological receptors for analysis in risk assessment. While the predominant assumption is that using the most conservative receptor will present an analysis protective of all receptors, there are many nuances between receptors and exposure pathways. Therefore, the following discussion reviews the selection of receptors and

all those evaluated, including the estimated most-conservative receptors as well as those representing other potentially sensitive wildlife receptors.

Mammals and avian species could be exposed to chemicals in the area of WFF via the ingestion of terrestrial and aquatic prey items that have accumulated chemicals. The predominant sources of food for wildlife on and around WFF are likely to be other avian species and mammals, terrestrial and aquatic invertebrates, and terrestrial plants. Some mammals and avian species represent higher trophic levels in the food web, and thus, have the potential to ingest chemicals that have accumulated/biomagnified in the food web. Terrestrial invertebrates represent a link between the abiotic media and higher trophic levels, and thus, have the potential to serve as a route to accumulate chemicals. Accordingly, the accumulation of these chemicals in soil invertebrates (a subset of terrestrial invertebrates) was selected for evaluation in this assessment.

Among the terrestrial invertebrates potentially occurring on the site are earthworms, which were selected for use in the assessment to represent terrestrial invertebrates. They were selected because they have intimate contact with and ingest large amounts of surface soil, and as such, have some of the greatest potential to accumulate chemicals from surface soil relative to other terrestrial invertebrates. Earthworms represent conservative indicators of the potential for the accumulation of chemicals from surface soil and the transfer of those chemicals to higher trophic-level species.

Shrews were selected as the terrestrial mammal receptor species for evaluating potential effects to small mammals, while robins were selected as the avian receptor species for evaluating potential effects to avian species. These species were selected because: 1) a larger proportion of the diet of both species is comprised of soil invertebrates relative to the other bird and small mammal species at WFF; 2) both species could occur at WFF; and 3) both species have limited foraging ranges, increasing their potential exposure to the potentially bioaccumulative chemicals in surface soil at WFF. For these reasons, the evaluation of these species is a conservative indicator of the potential for adverse effects to terrestrial wildlife from exposure to chemicals in the food web.

5.2.4 Identification of Assessment and Measurement Endpoints

As previously discussed, the potential for adverse effects to ecological resources is dependent on the ecological receptor species and chemicals present on the site, and the pathways

by which the ecological resources could be exposed to the COPCs. Section 5.2.1 preliminarily identified ecological resources occurring on WFF Main Base that could be adversely affected by the presence of chemicals. Section 5.2.2 preliminarily identified the COPCs present in each of the on-site media. Finally, Section 5.2.3 preliminarily identified the potential exposure pathways by which ecological receptors could be exposed to COPCs, based on information about the presence of ecological resources on site and on information about the presence of COPCs in each sampled environmental media. This section summarizes the specific ecological parameters for each of the evaluated receptors by identifying the assessment endpoint, the hypothesis being tested in the investigation, and measurement endpoints selected for the evaluation of the assessment endpoints.

Assessment endpoints are defined as the ecological effects in the receptor species selected for evaluation. The evaluation of the potential for ecological effects to occur is one factor in the decision-making process regarding the need for further investigation and/or remediation (Suter 1993). For example, the reproductive capability of the receptor species and/or population may be an assessment endpoint selected for evaluation. Measurement endpoints are the outcomes of the methods or means by which the assessment endpoints are approximated or represented (Suter 1993). Measurement endpoints are generally surrogates for assessment endpoints and are necessary because, in most cases, assessment endpoints cannot be directly measured or observed. Typically, the measurement endpoints are the result of or outcome of the field and/or laboratory methods used to evaluate the assessment endpoints. For example, the measurement endpoint for the evaluation of the potential for adverse effects to receptor organisms, populations, and/or communities may be the concentration of a chemical measured in an abiotic media to which the receptor species could be exposed compared to an applicable toxicity value, and/or may be the result of a fish population survey from the area of concern.

The assessment and measurement endpoints for each receptor and exposure pathway selected for evaluation in the WFF Main Base ERA are summarized in Table 5-3. In addition, Table 5-3 presents formal testable hypotheses for each of the assessment endpoints.

5.3 Exposure Characterization and Development of Exposure Pathway Model

The purpose of the exposure assessment is to identify the concentration and/or dose of the COPCs to which ecological resources selected for evaluation in the ERA could be exposed. The following sections discuss the evaluation of exposure and identify the exposure concentrations

selected for the evaluation of potential adverse effects to each of the ecological receptor groups/organisms selected for evaluation.

5.3.1 Terrestrial Plants

Chemical concentrations measured in surface soil collected from potential source areas throughout WFF Main Base were used to evaluate the potential for adverse effects to terrestrial plants. Maximum detected concentrations in surface soil samples are presented in Table 4-4. The maximum concentration was used for the evaluation because, based on the immobility of plants, exceedance of a toxicity value at a sample location indicates the potential for adverse effects at that location. If the maximum concentration exceeds the toxicity value, the overall proportion of sample locations where the toxicity value is exceeded is then considered to evaluate the potential for adverse effects at the community level.

5.3.2 Soil Invertebrates

Chemical concentrations measured in surface soil collected from potential source areas throughout WFF Main Base were used to assess the potential for adverse effects to soil invertebrates. Maximum detected concentrations in surface soil are presented in Table 4-4. The maximum concentration was used for the initial evaluation because, based on the relative immobility of most soil invertebrates, exceedance of a toxicity value at a sample location indicates the potential for adverse effects at that location. If the maximum concentration exceeds the toxicity value, the overall proportion of sample locations where the toxicity value is exceeded is then considered to evaluate the potential for adverse effects at the population level.

5.3.3 Wildlife Receptors in the Terrestrial Pathway

The following discussion presents the methods used to calculate the potential ingestion of chemicals by shrews and robins via the ingestion of food (i.e., earthworms) and surface soil. The equations presented below were derived based on equations presented by USEPA (1989c). The following equation was used to calculate the dose of chemicals that a shrew or robin would be expected to obtain from the ingestion of earthworms:

$$Dose_{worm} = FI * C_{diet} \qquad (1)$$

where:

$Dose_{worm}$	=	amount of chemical ingested per day via ingestion of earthworms (mg/kg bw-d);
FI	=	food ingestion rate (kg/kg bw-d); and
C_{diet}	=	estimated chemical concentration in diet (mg/kg).

Food ingestion rates (FI) of 0.620 kg/kg bw-d for adult shrews (Morrison et al. 1957, as cited in USEPA 1993a) and 1.52 kg/kg bw-d for adult robins (Hazelton et al. 1984, as cited in USEPA 1993a) were used in the ERA. These food ingestion rates were selected for use in the ERA because they are the highest average ingestion rates presented by USEPA (1993a) in the *Wildlife Exposure Factors Handbook* and thus are likely to represent conservative estimates of exposure.

The estimated dietary concentration (C_{diet}) was calculated using the following equation:

$$C_{diet} = P_e * C_e \qquad (2)$$

where:

P_e	=	proportion of diet consisting of earthworms (unitless); and
C_e	=	estimated concentration of COPC in earthworms (mg/kg).

The proportion of the diet (P_e) consisting of earthworms was based on information obtained from the scientific literature. Whitaker and Ferraro (1963, as cited in USEPA 1993a) found a shrew's diet to be composed of 31.4% earthworms in a study conducted during the summer in New York state. It was conservatively assumed that shrews ingest this proportion of their diet in earthworms throughout the entire year, even though earthworms are unlikely to be a significant proportion of the diet during the winter.

In a study conducted in the eastern United States, Wheelwright (1986, as cited in USEPA 1993a) reported that robins consume an average of 62.5% invertebrates during the spring and summer months, which is the time during which a robin population would be present at WFF. For the entire year, this would mean an average invertebrate consumption of 31.3% from WFF. No distinction was made about the composition of the soil invertebrates in the diets of these robins. However, based on detailed dietary composition information presented by Howell (1942, as cited in USEPA 1993a), it was further assumed that 57% of the invertebrates consumed were composed of soil invertebrates. This conclusion was based on the assumption that all invertebrates having continuous and/or direct contact with soil (earthworms, sowbugs, millipedes, beetles, ants, and unidentified invertebrates) are soil invertebrates, and that all of

these soil invertebrates have the same potential as earthworms to accumulate chemicals from surface soil. This assumption is highly conservative because earthworms have intimate contact with and ingest surface soil, and therefore, are more likely to accumulate chemicals from surface soil than most other soil invertebrates.

All other invertebrates (spiders, short-horned grasshoppers, lepidopteran larvae) were assumed to have only limited contact with surface soil and to have minimal potential to accumulate chemicals from this medium. Based on the above assumptions, it was estimated that 18% of a robin's total diet is composed of earthworms (calculated by multiplying the average percent invertebrate ingestion in diet over the year by the percent of invertebrates estimated to be soil invertebrates). For both shrews and robins, it was assumed that 100% of the earthworms ingested are from Site 16. Once again, this assumption is conservative and may lead to an over-estimate of potential risks because the sampled areas are likely to reflect the highest concentrations of the COPCs.

The concentration of chemical in an earthworm (C_e) as fresh weight was determined using the following equation:

$$C_e = C_{soil} * BCF \quad (3)$$

where:

C_{soil} = average concentration of COPC detected in surface soil (mg/kg); and
BCF = bioconcentration factor for chemical in earthworms (unitless).

The maximum concentration of chemical was used as the C_{soil} in the model as a conservative measure.

The highest earthworm BCFs found in the scientific literature were conservatively used to calculate the chemical concentrations in earthworms for the ERA. A mean BCF for inorganic chemicals for which there was empirical data (2.7) was conservatively used for those inorganic chemicals for which no BCF was available (antimony and beryllium). DDTr has a BCF of 9.0 (dry weight) (Beyer 1990). The dry weight chemical concentrations in surface soil were adjusted to wet weight concentrations in earthworms by multiplying the result of equation 3 by a factor of 0.16, which was based on a report by Tyler (1973) indicating that 84% of an earthworm's fresh weight is water. The wet weight values need no adjustment. Employing equations 1, 2, and 3, the estimated dose that robins and shrews would receive from ingestion of earthworms is presented in the Risk Characterization section.

In addition to the ingestion of chemicals accumulated in earthworms, shrews and robins also may be exposed to chemicals through the inadvertent ingestion of surface soil while foraging or grooming. The following equation was used to calculate the dose of chemical that shrews and robins would be expected to obtain from the ingestion of surface soil:

$$Dose_{soil} = SI * C_{soil} \qquad (4)$$

where:

$Dose_{soil}$ = amount of chemical ingested per day from soil (mg/kg bw-d);
SI = soil ingestion rate (kg/kg bw-d); and
C_{soil} = average chemical concentration in surface soil (mg/kg).

Based on percent dietary soil ingestion values presented by Beyer et al. (1994), it was assumed that 9.4% of the total mass of a shrew's diet and 10.4% of the total mass of a robin's diet is soil. Specific dietary soil ingestion values were unavailable for robins and shrews. The value for shrews is based on data for opossum, which may be conservative because it is one of the highest values for mammals, presented in Beyer et al. (1994). However, shrews consume great quantities of soil while foraging for earthworms, in a manner similar to opossum (Gardner 1982). The value for robins is based on data for woodcock because both of these avian species forage for earthworms and the soil ingestion rates are most likely similar.

The percent soil ingestion was multiplied by the food ingestion rates (FI) presented earlier for these species to estimate soil ingestion rates (0.058 kg/kg bw-d for shrews and 0.158 kg/kg bw-d for robins). As for the calculation of the chemical concentration in earthworms, the maximum chemical concentration in surface soil was used for C_{soil}. Employing equation 4, the estimated dose robins and shrews would receive from the ingestion of surface soil for each of the COPCs is presented in the Risk Characterization section.

The total dietary exposure levels for shrews and robins to chemicals was determined using the following equation:

$$Dose_{total} = Dose_{worm} + Dose_{soil} \qquad (5)$$

Using equation 5, the estimated total dose robins and shrews would be expected to receive from the ingestion of earthworms and surface soil is presented in the Risk Characterization section. The total dietary intakes are compared to dietary toxicity values to determine if adverse

effects are likely to occur to shrews and robins from the ingestion of COPCs in earthworms and surface soil.

5.4 Ecotoxicologic Effects Assessment

Toxicity criteria have not been developed by USEPA for terrestrial species. Consequently, toxicity data in the scientific literature were reviewed to characterize the toxicity of the COPCs selected for evaluation. Toxicity values selected for the evaluation of the potential for adverse effects are referred to as toxicity reference values (TRVs) and represent concentrations of the COPCs that are protective of the ecological receptors being evaluated. The derivation of TRVs for each of the potential receptors selected for evaluation in the ERA is discussed below.

5.4.1 Terrestrial Plants

TRVs reported by Efroymson et al. (1997a) to be protective of terrestrial plants were used to assess the potential for inorganic chemicals to adversely affect terrestrial plants. TRVs were established at a level associated with a twenty percent reduction in growth or yield, which is consistent with other screening level benchmarks for ecological risk assessment and with the current regulatory approach. Very few toxicity values have been developed for organic chemicals, and the toxicity database is inadequate for the evaluation of potential adverse effects to terrestrial plants from the presence of organic chemicals in surface soil. Accordingly, the potential for adverse effects to terrestrial plants from organic compounds was not evaluated.

There are limitations associated with the toxicity values available for terrestrial plants. The majority of the plant toxicity information available from the scientific literature is for inorganic chemicals and has been based on the evaluation of potential adverse effects to agricultural crops from the presence of inorganic chemicals in surface soil. Furthermore, the types of adverse effects measured to develop these toxicity values range from subtle (such as reduced growth) to severe (such as death). Also, phytotoxicity varies with the plant species and with the availability and form of a given chemical. If a chemical is more bioavailable to a plant for absorption or uptake, the phytotoxic potential of the chemical increases. Availability and chemical form are affected by factors such as soil pH, moisture, temperature, microbial activity, and interaction with other chemicals. In the absence of site-specific information on the bioavailability of the chemicals to plants, it is assumed in this assessment that their availability is similar to studies reported in the literature. Thus, toxicity may be over- or under-estimated depending, in part, on

the extent to which site-specific chemical availability differs from studies reported in the literature.

5.4.2 Soil Invertebrates

TRVs reported by Efroymson et al. (1997b) to be protective of earthworm populations were used when available to assess the potential for inorganic chemicals to adversely affect earthworms. Efroymson et al. (1997b) established these TRVs at a level associated with a twenty percent reduction in growth, reproduction, or activity, which is consistent with other screening level benchmarks for ecological risk assessment and with the current regulatory approach. In the absence of TRVs reported by Efroymson et al. (1997b), toxicity values reported in the scientific literature were used to evaluate the potential for adverse effects to soil invertebrates. Soil invertebrate TRVs could not be found in the scientific literature for the majority of organic compounds; therefore, the potential for organic compounds to adversely affect soil invertebrates was not evaluated fully. Soil invertebrate TRVs also could not be located for the following inorganic compounds: aluminum, iron, and manganese.

There are limitations associated with the toxicity values available for earthworms. The toxicity data base is limited, and the types of adverse effects measured to develop these toxicity values range from subtle (such as reduced growth) to severe (such as death). Furthermore, toxicity varies with the species of earthworm and with the availability and form of a given chemical. The toxic potential of chemicals increase with their bioavailability. Availability and chemical form are affected by factors such as soil pH, moisture, temperature, microbial activity, and interaction with other chemicals. In the absence of site-specific information on the bioavailability of the chemicals, it is assumed in this assessment that their availability is similar to studies reported in the literature. Thus, toxicity may be over- or under-estimated depending in part on the extent to which site-specific chemical availability differs from studies reported in the literature.

5.5 Risk Characterization

In this section, the concentrations of COPCs identified in Section 5.2.2 are compared with the TRVs derived in Section 5.4 to evaluate the potential for adverse effects to ecological resources from exposure to COPCs. Estimated exposure concentrations/doses for the COPCs are compared to TRVs by creating a ratio of the estimated exposure concentration to the TRV. This ratio is termed the Environmental Effects Quotient (EEQ). If the EEQ is less than or equal to 1.0

(indicating the exposure concentration is less than the TRV) then adverse effects are considered unlikely (USEPA 1994a). If the EEQ is greater than 1.0 (indicating the exposure concentration is greater than the TRV), there is a potential for adverse effects to occur. The confidence level of the conclusion increases as the magnitude of the ratio departs from 1.0. For example, there is greater confidence in a risk estimate where the EEQ is 0.1 or 10, than in an EEQ which is closer to 1.0. The uncertainties associated with the risk estimates are briefly discussed below and are discussed in greater detail in Section 5.6.

5.5.1 Terrestrial Plants

A comparison of maximum concentrations of inorganic COPCs detected in Site 16 surface soil to terrestrial plant TRVs is shown in Table 5-4. Of the inorganic COPCs, terrestrial plant TRVs exist for all but iron, but none of the organic COPCs have TRVs. Five inorganics exceeded their respective terrestrial plant TRVs in Site 16 surface soil; aluminum, chromium, lead, vanadium, and zinc. Aluminum had an EEQ of 212 chromium had an EEQ of 11, lead had an EEQ of 1.2, vanadium each had an EEQ of 9.9, and zinc had an EEQ of 1.1. The TRVs for chromium and zinc, both only slightly greater than one, are not likely to present unacceptable risks to plants, and chromium also did not exceed its background concentration.

5.5.2 Soil Invertebrates

Maximum concentrations of organic and inorganic chemicals identified as COPCs in surface soil were compared to available earthworm TRVs in Table 5-5. The only organics for which earthworm TRVs could be found in the scientific literature were DDT and its metabolites. Of the inorganic COPCs, TRVs were obtained for eight of the COPCs, but two other COPCs lack applicable earthworm TRVs (aluminum and iron). The only earthworm TRVs that was exceeded by Site 16 soil was chromium (EEQ of 27.5), but chromium at Site 16 did not exceed its background concentration. Will and Suter (1994b) indicated that earthworm TRVs which do not exceed background concentrations may be a poor measure of risk to the soil invertebrate community.

5.5.3 Wildlife Receptors in the Terrestrial Pathway

Potential adverse effects to shrews and robins from the ingestion of earthworms and surface soil were evaluated by comparing total doses of COPCs to intake-based TRVs. Exposure concentrations were calculated for these compounds using surface soil data from all sample

locations. The results of these comparisons are summarized in Table 5-6 for robins and Table 5-7 for shrews and are discussed below for each of these receptors.

Robins. The EEQ for robins form the ingestion of chemicals in earthworms and surface soil was greater than 1 for aluminum and chromium, thus indicating a potential for adverse effects to robins. The EEQ for aluminum was 17.6 and the EEQ for chromium was 2. However, chromium concentrations at Site 16 did not exceed background concentrations.

Shrews. Only one COPC presents potential risks to shrews. The EEQ for shrews from the ingestion of chemicals in earthworms and surface soil was above 1 for aluminum, thus indicating a potential for adverse effects to shrews. The EEQ for aluminum was 346.9

Although aluminum was selected as a COPC because its maximum site concentration (10,600 ppm) exceeded BTAG values. This concentration only very slightly exceeds the background concentration (9,970 ppm). Therefore, the risk associated with aluminum does not appear to be site-related.

5.6 Limitations and Uncertainties

As in any ERA, the Site 16 incorporates a number of uncertainties associated with the estimates of ecological risk. The general approach in this ERA has been to err on the side of conservatism. Accordingly, the risks in this ERA are likely to be over-estimated rather than under-estimated. However, a complete understanding of the uncertainties associated with the risk estimates is crucial to placing the estimated risks into proper perspective. The main areas of uncertainty associated with the ERA can be grouped under the following categories:

- Environmental Sampling and Analysis and Selection of COPCs;
- Identification of Exposure Pathways/Receptors for Evaluation and Exposure Parameter Estimation;
- Analysis of Toxicological Data; and
- Assessment of Risks.

The major uncertainties in each of these categories are discussed in the following sections.

5.6.1 Environmental Sampling and Analysis and Selection of COPCs

There are uncertainties associated with sampling of several media in WFF Main Base, and each media has its own particularities that may present ambiguity in analysis. Surface soil samples were collected from areas where contamination was anticipated. For this reason, samples are often not representative of site-wide chemical concentrations. Contamination source areas drive the estimated risks to ecological resources. As such, the significance of the levels of contamination should be considered with regard to the frequency of detection and distribution of chemicals throughout Site 16.

Several chemicals that were found to exceed TRVs were present at levels not significantly greater than background concentrations. These chemicals, including aluminum, chromium, and pesticides, are ubiquitous to the WFF region and are not necessarily representative of site-related contamination. Hence, risks from these chemicals may not be limited to WFF or Site 16 and should be considered separately from site-related contaminants by risk managers.

5.6.2 Identification of Exposure Pathways/Receptors for Evaluation and Exposure Parameter Estimation

A number of uncertainties are associated with the identification of potential receptor species and the potential exposure pathways by which these species could be exposed to COPCs. A detailed on-site survey/analysis of the ecological receptors selected for evaluation in the ERA was not conducted. Further, only limited exposure data were available for evaluating many of the potential exposure pathways selected for evaluation in the ERA.

In the absence of detailed information, conservative assumptions had to be made in order to estimate the exposure of potential ecological receptors to COPCs in Site 16 of WFF. For example, it was assumed that shrews and robins obtain all of the soil invertebrates they ingest from Site 16. Risks would be over-estimated if any of these receptors obtains at least a portion of their diet from off-site locations. It was also assumed that all the earthworms obtained by shrews and robins were from areas sampled as part of the WFF Site 16 RI, which are also likely to be the locations having some of the highest chemical concentrations.

5.6.3 Analysis of Toxicological Data

There are a number of uncertainties associated with the toxicity values used for the evaluation of potential adverse effects to ecological receptors. Toxicity data are very limited for many of the COPCs. This was particularly true for toxicity data for evaluating the potential for adverse effects to soil invertebrates and terrestrial plants from the presence of organic chemicals in surface soil. There is also uncertainty associated with the applicability of the available toxicity data to the species occurring within WFF Main Base.

5.6.4 Assessment of Risks

There are uncertainties associated with the assessment of risks in the ERA. The most apparent uncertainty is the extrapolation of assumptions about the potential for adverse effects from individual organisms to populations or communities. For the higher trophic-level terrestrial species, the ERA made conclusions about the potential for adverse effects to individual organisms. Very few models are available to extrapolate the potential for adverse effects from the individual level to the population or community level. Because of the limited availability of such models, certain assumptions had to be made about the overall potential for adverse effects to ecological receptors. It was generally assumed if there is no potential for direct adverse effects to individual organisms, then the potential for direct adverse effects to populations or communities is unlikely. Similarly, it was assumed that if there is the potential for adverse effects to individual organisms, there is also the potential for adverse effects to populations or communities. Risks may have been over-estimated by this latter assumption.

When evaluating the potential for adverse effects, it is important to recognize that risk assessment is based on a number of conservative assumptions. Although necessary because of a lack of more detailed information about the parameters being evaluated, the use of the conservative assumptions may over-estimate the potential for adverse effects. For example, it was conservatively assumed that 100% of the invertebrates ingested by robins and shrews while present in the mid-Atlantic area are from Site 16. Although shrews may feed solely within WFF, robins most likely feed on prey from a greater range than WFF Main Base. Potential risks are over-estimated if wildlife obtain prey from locations outside Site 16. It was also assumed that exposure to chemicals in environmental media occurred at locations where some of the highest chemical concentrations are expected to occur (based on the biased sampling), which may over-estimate exposure and potential risks. Although the estimated risks cannot be discounted based on these conservative assumptions, the context under which the model was run must be

completely understood to allow for appropriate decisions to be made about the need for remediation.

5.7 Ecological Risk Assessment Summary

Based on an analysis of the wildlife species associated with WFF and the COPCs detected in environmental media, the following endpoints were selected for evaluation in the ERA:

- Adverse effects to terrestrial plant communities from absorption of chemicals in surface soil through root uptake;
- Adverse effects to terrestrial invertebrate communities (as represented by earthworms) from direct contact with and ingestion of chemicals in surface soil;
- Adverse effects to mammals (as represented by shrews) from exposure to chemicals through bioaccumulation in the food web and ingestion of surface soil;
- Adverse effects to birds (as represented by robins) from exposure to chemicals through bioaccumulation in the food web and ingestion of surface soil.

Conclusions regarding the potential for adverse effects to ecological resources are summarized below. The conclusions focus on the locations and contaminants (only those that are detected above background concentrations) that are responsible for the most significant potential risks to ecological receptors.

Terrestrial plants were selected for evaluation due to their potential for exposure to chemicals in surface soil via root uptake. No applicable toxicity data were available in the scientific literature for organic COPCs. The results of the comparison of maximum detected concentrations in surface soil to available literature-based toxicity values suggest there is a very limited potential for aluminum (EEQ = 212), chromium (EEQ = 11), lead (EEQ - 12), vanadium (EEQ = 9.9), and zinc (EEQ = 1.1) in Site 16 surface soil to adversely affect terrestrial plants. Other chemicals that had EEQs greater than 1 were not detected on site at levels exceeding background concentrations. Of those chemicals with EEQs substantially above 1.0 (aluminum chrominum, and upgradient site concentrations are at or below background concentrations.

Soil invertebrates may be exposed to chemicals in surface soil and were selected for evaluation. Only limited applicable toxicity data were available in the scientific literature for the organic COPCs, and there is uncertainty associated with the lack of toxicity information available for most organic COPCs. The results of the comparison of maximum detected concentrations in

surface soil to available literature-based toxicity values suggest there is a very limited potential for chromium (EEQ - 27.5) at Site 16 to adversely affect soil invertebrates. However, chromium was not detected at concentrations which exceed background.

The potential risks to higher level organisms through the terrestrial pathway were modeled using a robin and shrew. Based on the results of comparisons of chemical doses to receptor-specific TRVs, it is reasonable to conclude that carnivorous birds have potential to be adversely affected by aluminum. However, risks from aluminum are not limited to Site 16, or WFF generally, since this is a ubiquitous contaminant and care should be exercised by a risk managers. In addition, there is limited potential for robins to be adversely affected by chromium but site concentrations of chromium do not exceed background.

6.0 HUMAN HEALTH RISK ASSESSMENT

This section presents evaluations of risks to the human population posed by chemicals found at Site 16 of the Wallops Flight Facility (WFF). This risk assessment is based on U.S. Environmental Protection Agency (EPA) guidance documents. Site-specific background information for Site 16 is provided in the Remedial Investigation portion (Sections 2.0 through 4.0) of this document.

6.1 Objectives

This human health risk assessment was conducted to determine current potential risks to human health and to predict future potential risks to public health as a result of uncontrolled releases of chemicals from Site 16. This risk assessment will be used to aid in the determination of remedial alternatives, if any, required for the site by identifying potential hazards and quantifying associated risks from exposures to on-site chemicals of potential concern (COPCs).

6.2 Scope of Risk Assessment

The EPA provides guidance and specific procedures for conducting baseline risk assessments. This guidance is found in EPA's Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (RAGS) (EPA, 1989a). Supplemental guidance for performing risk assessments is also periodically issued by EPA (e.g., EPA, 1991). These guidelines, as well as EPA Region III guidance such as the Risk-Based Concentration (RBC) Table (EPA, 2000a) and Assessing Dermal Exposure from Soil (EPA, 2000b) were the primary sources of guidance used to conduct the human health risk assessment for this site.

As indicated in RAGS (EPA, 1989a), there are four major steps involved in conducting a human health risk assessment: (1) data collection and evaluation, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization. Each step is briefly described below.

Data collection and evaluation involve gathering and evaluating site data relevant to human health and identifying those substances present at the site(s) that should be the focus of the risk assessment process (i.e., chemicals of potential concern).

An exposure assessment is conducted to estimate the magnitudes of actual and/or potential human exposures, the frequencies and durations of these exposures, and the pathways by which

humans may be exposed. In this exposure assessment, reasonable maximum estimates of exposure have been developed for both current and, if applicable, future land-use assumptions. Current exposure estimates are used to determine potential doses based on existing exposure conditions at the site. Future exposure estimates are used to provide decision-makers with an understanding of potential future exposures and quantitative estimates of the likelihood of such exposures occurring. Table 6-1 depicts the potential exposure scenarios that have been identified for Site 16 including the media, exposure route, population receptor and scenario timeframe. Conducting an exposure assessment involves analyzing chemical releases; identifying exposed populations; estimating exposure point concentrations for specific pathways, based on both environmental monitoring data and predictive chemical modeling results; and estimating chemical intakes for specific pathways. The results of an exposure assessment are pathway-specific intakes for current and future exposures to individual substances.

A toxicity assessment considers: (1) the types of adverse health effects associated with chemical exposures; (2) the relationships between magnitudes of exposures and potential adverse effects; and (3) related uncertainties such as the weight of evidence of a particular chemical's carcinogenicity in humans. Toxicity assessments have been generally accomplished in two steps. The first step, hazard identification, is the process of determining whether exposure to an agent can cause an increase in the incidence of an adverse health effect (e.g., cancer, birth defects). Hazard identification also involves characterizing the nature and strength of the evidence of causation. The second step, dose-response evaluation, is the process of quantitatively evaluating the toxicity information and characterizing the relationships between the doses of the chemicals administered or received and the incidence of adverse health effects in the exposed population. From those quantitative dose-response relationships, toxicity values have been derived that can be used to estimate the incidence of adverse effects occurring in humans at different exposure levels. Typically, risk assessments rely heavily on existing toxicity values (e.g., Reference Doses for chronic and subchronic exposure [RfDs] and cancer slope factors [SFs]) developed for specific chemicals by EPA.

Risk characterization summarizes and combines outputs of the exposure and toxicity assessments to characterize baseline risks, both in quantitative expressions and qualitative statements. During risk characterization, exposure estimates are combined with chemical-specific toxicity information to determine whether current or future contaminant levels at or near Site 16 may be of potential concern.

6.3 Media of Potential Concern

The media of potential concern identified for Site 16 during the environmental investigation included soil and groundwater. Groundwater samples were collected from eight different monitoring wells, and sampling occurred during three different sampling periods: April 1997, March-May 1998, and February 2000. Most of the monitoring wells were sampled during two of the three sampling periods while one well was sampled during all three periods. Four surface and four subsurface soil samples were collected from soil borings in May 1998. In addition, surface soil samples were collected from seventeen different locations in February 2000. Both groundwater and soil were considered to pose sufficient potential current or future health risks, and as a result, were evaluated in the human health risk assessment.

6.4 Data Collection and Evaluation

Data for the human health risk assessment were collected in phases during the environmental investigation, as described above. A description of the sampling phases is presented in **Section 3.0** of this document. Analytical data obtained from these soil and groundwater samples were evaluated to identify chemicals of potential concern (i.e., target analyte list (TAL) and target compound list (TCL) chemicals), in accordance with EPA Quality Assurance Program protocols. The analytical results are presented in Section 4.0 of this document.

The limitations and uncertainties associated with the analytical results were evaluated as part of the data reporting requirements of the analytical laboratories. Analytical data-related qualifiers identified by the laboratory as well as information provided for all field and laboratory blank samples were taken into consideration in the evaluation process. Only data validated according to the guidelines established by EPA were used in the risk assessment.

This risk assessment addresses site-related chemicals that were considered to pose significant potential threats to human health. These chemicals of potential concern for Site 16 were selected based on a combination of their intrinsic toxicities and their levels of occurrence on site. EPA Headquarters guidance presented in RAGS (EPA, 1989a) and EPA Region III guidance (EPA, 2000a) were followed to determine the chemicals of potential concern. This guidance is shown schematically in Figure 6-1 and is summarized as follows:

- If a chemical was not detected in any of the samples of a particular medium, that chemical was eliminated from consideration.

- If a chemical was believed not to be site-related and was only detected at a frequency of 5 percent or less (with a minimum of 20 samples), that chemical was removed from consideration as a chemical of potential concern.

- Common laboratory contaminants (e.g., acetone, methylene chloride, toluene, 2-butanone and phthalates) were eliminated from further consideration if they were detected at less than 10 times the maximum levels detected in the laboratory, field, or trip blank samples.

- Contaminants not considered by the USEPA to be common laboratory contaminants, as described above, were eliminated from further consideration if they were detected at less than five times the maximum levels detected in the laboratory, field, or trip blank samples.

- Chemicals were compared to EPA Region III Risk-Based Concentrations (RBCs) (EPA, 2000a) for screening purposes. If the maximum detected concentration of a chemical did not exceed the associated RBC value, that chemical was eliminated from further consideration.

The selection of COPCs for surface soil at Site 16 is provided in Table 6-2.1. This table provides descriptive statistics such as minimum and maximum detected concentration and frequency of detection as well as the rationale behind the selection or deletion of a chemical as a COPC. Note that Table 6-2.2 contains identical COPC information as Table 6-2.1, but is distinct with regard to the exposure medium (i.e., air) and exposure point (i.e., air volatilized from surface soil) as indicated in the text box in the upper left hand corner of the table. The selection of COPCs for subsurface soil at Site 16 is provided in Table 6-2.3. This table includes descriptive statistics and a rationale for the selection or deletion of the chemical as a COPC. Table 6-2.4 contains identical COPC information as Table 6-2.3 but is distinct with regard to the exposure medium (i.e., air) and exposure point (i.e., air volatilized from surface soil) as indicated in the text box in the upper left hand corner of the table. As shown in Tables 6-2.3 and 6-2.4, no chemicals in subsurface soil were selected as COPCs, as all chemicals with toxicity data had maximum detected concentrations that were less than the respective RBC concentrations. As a result, subsurface soil was not evaluated further in the human health risk assessment.

The selection of COPCs for groundwater at Site 16 is provided in Table 6-2.5. Similar to the COPC tables for soil and subsurface soil, this table contains information on descriptive statistics and the rationale for selecting or deleting a chemical as a COPC. Table 6-2.6 contains identical COPC information as Table 6-2.5, but is distinct with regard to the exposure medium (i.e., air) and exposure point (i.e., air volatilized from groundwater) as indicated in the text box in the upper left hand corner of the table.

Once the COPCs in surface soil and groundwater were identified, the exposure point concentrations (EPCs) were calculated. In order to calculate the EPC, the site data for each COPC were first tested for normality and lognormality. The Shapiro-Wilk test (Gilbert, 1987) was used to test for distribution characteristics. For the Shapiro-Wilk test, the W statistic was calculated using the following equation:

$$W = \frac{1}{d}\left[\sum_{i=1}^{k} a_i\left(x_{[n-i+1]} - x_{[i]}\right)\right]^2$$

$$k = \frac{n}{2} \quad \text{if } n \text{ is even}$$

$$k = \frac{n-1}{2} \quad \text{if } n \text{ is odd}$$

where:

a	=	coefficients for the Shapiro-Wilk$_W$ test for normality (Gilbert, 1987);
x	=	an individual measurement in the data set;
n	=	number of measurements in a data set; and

$$d = \sum_{i=1}^{n}\left(x_i - \bar{x}\right) = \sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2$$

The calculated W statistic was compared to the 0.05 (or 5%) critical value ($W_{0.05}$) of the null distribution of the W statistic on n observations. If the W statistic exceeded this value, then the null hypothesis (H_0) (i.e., the distribution is normal) was rejected. The calculation of W was also performed for log-transformed data. If W exceeded the appropriate $W_{0.05}$ value, then H_0 (the distribution is lognormal) was rejected (Gilbert, 1987).

If the data were shown to have a normal distribution, the EPC was based on the 95% upper confidence limit (UCL) of the arithmetic mean of the raw (i.e., untransformed data) derived using the following formula:

$$95\%\ UCL\ (normal) = x + t_{\substack{\alpha = 0.05 \\ df = n-1}} \times \frac{st\ dev}{\sqrt{n}}$$

where:

95% UCL (normal)	=	95% upper confidence limit of the arithmetic mean;
x	=	arithmetic mean value of samples;
t	=	t-value (one-tailed) (values provided in Norman and Streiner, 1994);
α	=	probability of a larger value than the upper confidence level;
df	=	degrees of freedom (n-1)
st dev	=	standard deviation; and,
n	=	number of composite samples.

If the Shapiro-Wilk test indicated that the data had a lognormal distribution, the EPC was based on the 95% UCL (lognormal) of the arithmetic mean derived using the following formula:

$$95\%\ UCL\ (lognormal) = \exp\left[x + 0.5 s_y^2 + \frac{s_y H}{\sqrt{n-1}} \right]$$

where:

95% UCL(lognormal)	=	95% upper confidence limit of the arithmetic mean of log-transformed data;
x	=	arithmetic mean value of log-transformed data;
s_y	=	standard deviation of log-transformed data;
H	=	h-statistic (provided in Gilbert, 1987); and
n	=	number of composite samples.

If the Shapiro-Wilk test indicated that the data had neither a normal nor a lognormal distribution, the EPC was based on the maximum detected concentration. The EPC was also based on the maximum detected concentration in cases where the 95 percent UCL (normal or lognormal) exceeded the maximum detected concentration. If a given chemical was detected in some but not all the samples, then for the samples in which the chemical was not detected, one-

half of the sample detection limit for that chemical was used as a proxy concentration in calculating the arithmetic mean and, if appropriate, the 95 percent UCL. This procedure was followed to account for the possibility that one or more COPCs may have been present in a sample at levels below the appropriate detection limits for those chemicals.

When a sample and duplicate were collected at a given sample location during the same sampling period, the two samples were averaged. Averaging duplicate samples reduces any bias that might be introduced by considering the samples separately. This average, representing one sample, was then compared with all other samples collected at the same sampling location during different sampling periods, with the maximum detected concentration (or maximum detection limit for non-detects) selected as the representative concentration for that location. The representative concentration from each sample location was then incorporated into the calculations of arithmetic average, standard deviation, EPC, etc. for the site.

The exposure point concentration summary for surface soil has been provided in Table 6-3.1 with supporting data such as the average and 95 percent UCL calculations provided in Table 6-3.1a and calculation of the data distributions in Table 6-3.1b. Note that Table 6-3.2 contains the same EPC information as Table 6-3.1 with the only distinction being the exposure medium (i.e., air) and exposure point (i.e., air volatilized from surface soil) identified in the text box in the upper left hand corner of the table.

The exposure point concentration summary for groundwater has been provided in Table 6-3.3 with supporting data such as the average calculations provided in Table 6-3.3a and calculations of the data distributions and the 95 percent UCL in Table 6-3.3b. Note that Table 6-3.4 contains the same EPC information as Table 6-3.3 with the only distinction being the exposure medium (i.e., air) and exposure point (i.e., air volatilized from groundwater) identified in the text box in the upper left hand corner of the table.

6.5 Environmental Fate and Transport Mechanisms

The environmental fate and transport mechanisms for the COPCs selected for the human health risk assessment are discussed below.

6.5.1 Physical and Chemical Properties

The physical and chemical properties of chemical substances affect their fate and transport in water and soil at Site 16. These properties include water solubility, specific gravity, vapor pressure, organic carbon distribution coefficient (K_{oc}), and octanol-water partition coefficient (K_{ow}).

Water solubility is the maximum concentration of a chemical that can result when that chemical is dissolved in water at a specified temperature. In general, chemicals with high water solubility values are more readily dispersed throughout the nonlipid components of the environment than chemicals with low water solubility values. Chemicals with high water solubility tend to be mobile in soil and water. Specific gravity is the ratio of the density (weight per unit volume) of a chemical to the density of water. Vapor pressure is the pressure exerted by a chemical vapor in equilibrium with its solid or liquid form at any given temperature. The higher the vapor pressure, the more likely a chemical is to exist in a gaseous state. K_{oc} is a measure of the tendency for organic chemicals to be adsorbed by soil and sediment. Organic chemicals with relatively high values of K_{oc} (i.e., greater than 1,000 ml/g) are likely to be adsorbed to organic carbon in soils to an appreciable extent. K_{ow} provides a measure of the extent of a chemical partitioning between water and octanol at equilibrium. K_{ow} is often used as an indication of a chemical's affinity for lipid soluble materials.

6.5.2 Fate and Transport

Physical, chemical, and biological processes influence the fate and transport of environmental chemicals. The tendencies and rates at which these processes occur for a given substance depend on that substance's physical and chemical properties and site-specific environmental conditions. Important fate and transport processes include, but may not be limited to, the following:

- Physical loss processes, such as volatilization and sorption;
- Transport processes, such as dilution, advection, and dispersion;
- Chemical processes, such as hydrolysis, photolysis, acid-base reactions, and ion pairing or complexes; and

- Degradation by aerobic and anaerobic microbiological processes.

The following paragraphs summarize the primary physical, chemical, and biological processes expected to affect the fate and transport of the COPCs found at Site 16 and adjacent areas. Much of the information in this section was taken either in part or in its entirety from Howard (1989, 1991), EPA (1979), the National Library of Medicine's TOXNET Data Bank, Merck Index 11th edition (1989), and the Agency for Toxic Substances and Disease Registry's (ATSDR) Toxicological Profiles (1997).

Volatile Organic Compounds. The volatile COPCs of concern at Site 16 are 1,2-Dichloroethene (total), benzene, ethylbenzene, tetrachloroethene and toluene. Volatile chemicals readily evaporate from most soils or water. However, volatile chemicals tend to be mobile in soils, and may leach into groundwater under appropriate circumstances. Volatile compounds are also bio- and/or photo-degraded, but the rates at which these processes occur vary with different conditions. In general, volatile chemicals tend to be more lipophilic than hydrophilic, and may bioconcentrate in living tissues.

Semi-Volatile Organic Compounds. The semi-volatile COPCs at Site 16 are polycyclic aromatic hydrocarbons (PAHs), 2-chlorophenol, 4-methylphenol, bis (2-ethylhexyl) phthalate, 4,4'-DDT, alpha-BHC and gamma BHC (lindane).

Polycyclic Aromatic Hydrocarbons (PAHs) of potential concern include: 2-methylnaphthalene, benzo(a)pyrene, carbazole, dibenzofuran, naphthalene and phenanthrene. These PAHs are ubiquitous in the environment from various man-made and naturally occurring thermal combustion/pyrolysis processes. Because of their low solubility, PAHs in aquatic systems are primarily found sorbed to particles. PAHs also tend to adsorb to soil, particularly with increasing organic content and surface area of the sorbent particles. Volatilization of PAHs from water and soil may be a significant process for low molecular weight compounds. PAHs may bioaccumulate in aquatic organisms from surface water and sediments.

2-Chlorophenol. Based on the relatively high vapor pressure of this compound when compared to other chlorophenols, evaporation of 2-chlorophenol from water is anticipated to be a significant transformation process. Notably, log octanol-water (Log_{ow}) partition coefficients for the chlorophenols are all greater than 2; therefore, chlorophenols present in water will also tend to partition into sediments. Both direct photolysis and the reaction of chlorophenols with hydroxyl radicals and singlet oxygen produced by ultraviolet radiation may be important

processes of chlorophenol degradation near the water surface. In addition, based on the bioconcentration value and log octanol-water (Log_{ow}) partition coefficient of 2-chlorophenol, this compound has the potential to accumulate in aquatic organisms.

4-Methylphenol (p-Cresol). Based on their soil adsorption coefficients (K_{oc}), cresols are expected to be fairly mobile in soil. However, the hydroxyl function of cresol is capable of forming relatively strong hydrogen bonds with active sites in the soil; therefore its mobility depends on the degree in which these bonds are formed. In water, the isomeric cresols may eventually volatize to the atmosphere, but volatilization is expected to be a slow process. The degradation pathway of p-cresol in groundwater appears to proceed by oxidation of the methyl group to first give the corresponding benzaldehyde, then benzoic acid. The hydroxybenzoic acid then can be either decarboxylated or dehydroxylated to phenol or benzoic acid, respectively. Experimental bioconcentration factors for o-cresol and m-cresol indicate that the isomers of cresol will not bioconcentrate in fish and aquatic organisms to any significant extent.

Bis (2-ethylhexyl)phthalate (BEHP) is ubiquitous in the environment and originates from various man-made and naturally occurring thermal combustion/pyrolysis processes. BEHP has a strong tendency to adsorb to soils. In groundwater and surface water, BEHP will adsorb to aquatic organisms or sediments, but biodegradation is expected to be the primary fate mechanism.

Hexachlorocyclohexane (HCH) exists in several chemical forms such as alpha-HCH, beta-HCH (i.e., beta-BHC), delta-HCH and gamma-HCH (i.e., lindane), according to the position of the hydrogen atoms. The fate and transport properties discussed here are based on gamma-HCH. Adsorption of gamma-HCH to soil particulates is generally a more important partitioning process than leaching to groundwater. In surface water, gamma-HCH has a tendency to dissolve in the water column. Although gamma-HCH has a relatively high vapor pressure compared with other organochloride insecticides, evaporative loss of gamma-HCH from water is not considered to be significant. Adsorption and desorption studies of gamma-HCH in natural water-sediment systems indicate that the diversity of the natural water-sediment characteristics may affect the sorption/desorption behavior of gamma-HCH in addition to the organic carbon content of the sediments. Gamma-HCH is bioconcentrated to high levels following uptake from surface water by a number of aquatic organisms. However, uptake from soils and bioconcentration by plants and terrestrial organisms appears to be limited.

DDT, DDD and DDE have been shown to persist in soil for long periods. These compounds undergo extensive adsorption to soil particles as predicted by their relatively high organic carbon coefficients (K_{oc}). Despite being strongly bound to soil, DDD, DDE and DDT are bioavailable to plants and soil invertebrates. DDT, DDE and DDD are only slightly soluble in water; therefore, they tend to adsorb to sediments which act as the primary reservoir for excess quantities of the compounds. DDT, DDE and DDD are highly lipid soluble. This, combined with an extremely long half-life, results in bioaccumulation in aquatic and terrestrial species.

Inorganics. The inorganic COPCs at Site 16 are: aluminum, antimony, arsenic, iron, lead, manganese, thallium and vanadium.

Aluminum (Al) occurs widely in nature in silicates such as micas and felspars, complexed with sodium and fluoride as cryolite, and bauxite rock. Aluminum tends to adsorb to clay surfaces which can be a significant factor in controlling aluminum mobility in the environment. In groundwater and surface water, aluminum solubility is controlled to a large extent by equilibrium with a solid phase such as $Al(OH)_3$. Changes in pH or concentrations of other solutes can shift the solubility of aluminum to increase dissolution or precipitation. The potential for bioaccumulation of aluminum may be considered low to moderate.

Antimony (Sb) tends to adsorb to soil, although some studies suggest that antimony is fairly mobile under diverse environmental conditions. Since antimony has an anionic character, it is expected to have little affinity for organic carbon. Antimony is generally present as an oxide or antimonide (3+) salt in surface water and groundwater. In reducing environments, volatile stibine (SbH_3) may be formed. Stibine is a gas at room temperature, and is quite soluble in water; however, it is not stable in aerobic waters or air and is oxidized to form Sb_2O_3. Sorption to clays and minerals is normally the most important mechanism resulting in the removal of antimony from solution, reducing aqueous transport of antimony. Heavy metals in solution also react with antimonide or antimonate (+5) to form insoluble compounds. Bioaccumulation appears to be only a minor fate process for antimony.

Arsenic (As) is ubiquitous in the earth's crust and occurs in hundreds of minerals, often with sulfur. With four possible oxidation states (3-, 0, 3+, and 5+), arsenic's speciation is both complex and important in determining its fate. Interconversions of the 3+ and 5+ states and organic complexion have the greatest impact of any transformations. In comparison to other metals, arsenic is generally mobile in all environments. It tends to cycle through the water column, sediments and biota. The properties of the soil determine the fate of arsenic on land.

Arsenic will mobilize into the groundwater from soils with low sorptive capacity. Bioaccumulation of arsenic by aquatic and terrestrial organisms contributes little to its fate.

Iron (Fe) is present in soils as Fe (III), unless the soil is oxygen deficient in which case the iron occurs more often as Fe(II). The fate of iron compounds in soil is primarily determined by chemical and microbiological reactions in soils and the capacity of soils to sorb iron-organic complexes. Iron is generally not mobile in soils, although mobility can be increased in conditions of low pH. In aquatic media, iron can undergo; chemical reactions including precipitation and oxidation-reduction, photochemical reactions, microbial interactions and sorptive interactions. In most bodies of water, iron is expected to be present largely in the form of suspended particles and sediments although small amounts of dissolved iron may occur.

Lead (Pb) solubility is dependent on the form of lead, pH, temperature, and salt content. Natural compounds of lead have low solubility; therefore, the ratio of lead in suspended soils to dissolved lead is high. Inorganic lead can be biomethylated to tetramethyl lead by benthic micro-organisms. Tetramethyl lead can then be released from sediments and removed by volatilization. Inorganic lead is generally strongly sorbed and retained in the soil. Some lead compounds can leach in acid soils if the organic or clay content is low or if the infiltrating water is acidic. Some lead may also be taken up by plants.

Manganese (Mn) is an important constituent of igneous rocks and is abundant in soil in the United States. The tendency of manganese to adsorb to soils and sediments depends primarily on the cation exchange capacity and organic composition of the soil. The transport and partitioning of manganese in water is controlled by the solubility of the specific chemical form present, which in turn is determined by pH, oxidation-reduction potential, and the characteristics of available anions. Manganese is often transported in surface waters as suspended sediments. Manganese is an essential plant nutrient and is accumulated in plant material.

Thallium exists in two chemical states, thallous and thallic. The thallous form is more common and stable than the thallic form in the environment. Thallium exists in water primarily as a monovalent ion (thallium^{+}); however, thallium may be trivalent (Tl^{3+}) in very oxidizing water. Thallium may precipitate from water as solid mineral phases. However, thallium chloride, sulfate, carbonate, bromide, and hydroxide are very soluble in water. In extremely reducing water, thallium may precipitate as a sulfide (Tl_2S), and in oxidizing water, Tl^{3+} may be removed from solution by the formation of $Tl(OH)_3$. Thallium partitions from water to soils and sediments. Thallium in soil is absorbed by plants and thereby enters the terrestrial food chain.

Vanadium (V) is very abundant in the Earth's crust. It can exist in the +0, +2, +3, +4, and +5 oxidation forms and is generally insoluble in water. Vanadium can bind covalently to organic molecules to yield organo-metallic compounds. The extent to which vanadium is transported in the aqueous medium is largely determined by the chemical species present, its solubility, and the organic materials present. Some bioaccumulation of vanadium can occur; however, in mammals it appears that excess vanadium is rapidly excreted in the urine. Hydrolysis and adsorption are not significant in the vanadium fate process.

6.6 Human Exposure Assessment

Exposure bridges the gap between a potential hazard (i.e., presence of a toxic chemical) and a risk. Exposures to chemicals may occur via inhalation, ingestion, or by dermal absorption routes. The objectives of an exposure assessment are to: (1) identify populations that may potentially be exposed to COPCs; (2) identify the pathways by which such exposures may occur; and (3) quantify chemical intakes, or potential dose, based on the magnitudes, frequencies, and durations of these potential exposures. The exposure assessment thus provides pathway-specific intakes for current and future exposures to site-related COPCs.

The following subsections address, in detail, the identification of potentially exposed populations (Section 6.6.1), the identification of pathways of exposure (Section 6.6.2), and the calculations and assumptions used to quantify potential exposures (Section 6.6.3). Figure 6-2 presents the potentially exposed populations and the pathways/routes by which they may be exposed for the exposure scenarios evaluated. Note that this information has also been provided in tabular format in Table 6-1.

6.6.1 Potentially Exposed Populations

Current Scenarios: Based on background information and site visits there does not appear to be any current facility activity at Site 16. No residential housing exists nearby; therefore, it is unlikely that residential exposure to COPCs occurs at the site. There are no commercial buildings nearby; however, periodic maintenance occurs along Runway 17-35 which is adjacent to Site 16. As a result, potential current receptors evaluated in the risk assessment included commercial/industrial workers that may conduct activities at and in the vicinity of the site, and recreational trespassers (adults and children) that could be exposed to surface soil at the site.

Future Scenarios: Future uses of the site are expected to include the current uses described above. In addition, there is the potential for construction to take place at Site 16. Construction workers would potentially be exposed to surface soils and groundwater during excavation and construction activities. Residential development was also considered as a potential future scenario. As a result, future residents could be exposed to surface soils and groundwater if the aquifer was developed as a potential drinking water source. Commercial/industrial workers could also be exposed to groundwater if the aquifer was developed as a potential drinking water source.

6.6.2 Potential Exposure Pathways

Potential human exposure pathways for soil and groundwater at Site 16 have been identified in the following narrative. As previously mentioned in Section 6.4, the evaluation of soil pathways at Site 16 was limited to surface soil since no COPCs were identified in subsurface soil.

Soil Pathways. Surface soil exposure pathways at Site 16 are considered to be incidental ingestion and dermal absorption for current and future commercial/industrial workers, current and future recreational users (adult and child), future residents (adult and child), and future construction workers. Inhalation of fugitive dust and volatile emissions may also be of concern to construction workers during development/excavation activities. The construction workers are assumed to be engaged in short-term (6 months or less) on-site activities.

Groundwater Pathways. The aquifer under Site 16 is not currently used as a potable water source. Although it is considered unlikely that the aquifer will be used as a potable water source in the future, residential exposure to COPCs in groundwater via direct ingestion, inhalation during showering, and dermal contact during showering were considered as scenarios for potential future use of the site. Future ingestion of groundwater by commercial/industrial workers at the site was also evaluated. In addition, based on the relatively high water table at Site 16, incidental ingestion, inhalation and dermal absorption of groundwater by construction workers during development/excavation activities was evaluated.

Potentially Significant Exposure Pathways and Routes. Based on the above information, the following exposure pathways were considered for the human health risk assessment of Site 16 (Figure 6-2).

Soil:

- Current/Future incidental ingestion and dermal absorption of surface soil by commercial/industrial workers;
- Current/Future incidental ingestion and dermal absorption of surface soil by recreational users (adult and child);
- Future incidental ingestion and dermal absorption of surface soil by residents (adult and child);
- Future inhalation of fugitive dust and volatile emissions from surface soil by construction workers during excavation activities; and
- Future incidental ingestion and dermal absorption of surface soil by construction workers during excavation activities.

Groundwater:

- Future incidental ingestion, inhalation and dermal absorption of water by construction workers during excavation/construction activities;
- Future ingestion of drinking water by commercial/industrial workers;
- Future ingestion of drinking water by adult and child residents; and
- Future inhalation and dermal absorption of water by adult and child residents during showering.

6.6.3 Calculation of Chemical Intakes

The chemical intakes for potential receptors were estimated using the formulas recommended by EPA in Risk Assessment Guidance for Superfund (RAGS), Volume 1 (EPA, 1989a). For each exposure route, chronic daily intakes (CDIs) were calculated in units of milligrams of chemical per kilogram of body weight. For children and construction workers, noncarcinogenic intakes were calculated as subchronic (less than seven years) daily intakes (SDIs). The general equation for these calculations is:

$$\text{CDI/SDI} = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

where:

CDI/SDI = chronic or subchronic daily intake (mg/kg-day),
C = chemical concentration at exposure point (mg/kg or mg/L),
CR = contact rate (kg or L/event),
EF = exposure frequency (events/year),
ED = exposure duration (years),
BW = body weight of exposed individual (kg), and
AT = period of time over which exposure is averaged (days).

For all exposure scenarios, the concentration terms were chemical-specific, and typically the maximum detected concentration or the 95 percent UCL was used. Additional route- and chemical-specific variables were incorporated into the equation, where appropriate, to account for other factors such as the percent of a chemical dermally absorbed by the body; site soil characteristics, and skin surface areas. Intake equations used for each exposure pathway are presented in the remainder of this section. Conservative default values for most of the variables used in the intake equations were recommended by EPA in various guidance documents. The variable default values used in the chemical intake calculations for each exposure scenario are presented in **Tables 6-4.1 through 6-4.14.** These tables also provide the intake factors used in the calculations that account for all the variable default values (with the exception of chemical-specific values).

The remainder of this section presents the intake equations and discusses the exposure variable values used for each exposure scenario in the following order:

- Incidental soil ingestion scenarios,
- Volatile emission and fugitive dust inhalation scenarios (surface soil),
- Dermal absorption from soil scenarios,
- Drinking water and incidental (groundwater) ingestion scenarios,
- Inhalation (groundwater volatiles) during showering scenarios,
- Inhalation (groundwater volatiles) during excavation activities scenario, and
- Dermal absorption (groundwater) during showering scenarios,
- Dermal absorption (groundwater) during excavation activities scenario.

Incidental Ingestion of Site Soils. The equation used to estimate intakes of chemicals via incidental soil ingestion for construction workers (Constr.), commercial/industrial workers (C/I), residents (Res), and recreational users (Rec) is:

$$\text{Intake} = \frac{C_{SOIL} \times IR\text{-}S \times CF \times EF \times ED}{BW \times AT}$$

where:

C_{SOIL} = chemical concentration in soil (mg/kg soil),
IR-S = ingestion rate -soil (mg soil/day),
CF = conversion factor (10^{-6} kg soil/mg soil),
EF = exposure frequency (days/month for Constr., days/year for C/I, Res, & Rec),
ED = exposure duration (months for Constr., years for C/I, Res, & Rec),
BW = body weight (kg), and
AT = averaging time (days).

The default values for recreational adults and children have been provided in Table 6-4.1 and 6-4.2, respectively. The default values used for commercial/industrial workers and construction workers have been provided in Table 6-4.3 and 6-4.4, respectively. Finally, the default values for residential adults and children have been provided in Table 6-4.5 and 6-4.6, respectively.

The ingestion rates for soil (IR) were assumed to be 480 mg/day for construction workers; 50 mg/day for commercial/industrial workers; 100 and 200 mg/day for adult and child recreational users, respectively; and 100 and 200 mg/day for adult and child residents, respectively (EPA, 1991). For residential and recreational adults, an age-adjusted intake of 114.28 mg-yr/kg-day was used for scenarios involving carcinogens, which also includes an exposure duration and body weight adjustment (EPA, 1991). (Note that the age-adjustment results in a lifetime risk estimate since it combines both child and adult exposure). The exposure frequency and duration for construction workers were assumed to be 20 days/month and 6 months, respectively. The exposure frequency for commercial/industrial workers was 250 days/year, and the exposure duration was 25 years (EPA, 1991). For recreational scenarios, the exposure frequency was 52 days/year for both adults and children, while the exposure duration was 30 years for adults and 6 years for children (EPA, 1991). For both residential adults and children, an exposure frequency of 350 days/year was used, with an exposure duration of 30 years for adults and 6 years for children (EPA, 1991). Body weight was assumed to be 70 kg for adults and 15 kg for children for all scenarios. Averaging times for scenarios involving noncarcinogens were 183 days (6 months) for construction workers; 9,125 days (25 years) for commercial/industrial workers, 2,190 days (6 years) for residential and recreational children, and

10,950 days (30 years) for residential and recreational adults. The averaging time for all scenarios involving carcinogens was 25,550 days (70 years).

Inhalation of Airborne Vapor Contaminants and Suspended Particulates. Estimation of airborne vapor contaminant concentration, from known soil concentration, was accomplished using a volatile emissions model taken from the Exposure Model Handbook for Screening of Former Manufactured Gas Sites (GRI, 1988). The mass flux of a chemical was calculated using the following equation:

$$Q_{vapors} = \frac{[k_a \times (P - P_\infty)] \times A_c \times mw \times CF}{RT_p}$$

where:

Q_{vapors}	=	Mass flux of chemical (mg/hr),
k_a	=	Air mass transfer coefficient (m/hr),
P	=	Vapor pressure of the volatile at the soil surface (atm),
P_∞	=	Vapor pressure of the volatile in the bulk of the atmosphere, $P\infty \cong 0$ (atm),
A_c	=	Contaminated area (m^2),
mw	=	Molecular weight of a chemical (g/mole),
CF	=	Conversion factor (1,000 mg/g),
R	=	Gas constant, R = 82.06E-06 atm-m^3/mole-°K, and
T_p	=	Temperature of waste surface; typical value would be 293°K .

The term k_a was calculated using the following equation:

$$k_a = 0.0292 \times (U^{0.78}) (D_p^{-0.11}) (S_c^{-0.67})$$

where:

U	=	Windspeed (m/hr),
D_p	=	Diameter of waste boundary (m), and
S_c	=	Schmidt gas number (unitless).

Fugitive dust emission estimates were based on surface mining observations which involve excavation activities that are similar in nature to construction activities. The fugitive dust estimation model was taken from the Exposure Model Handbook for Screening of Former Manufactured Gas Sites (GRI, 1988). The emission rate of particles less than 10 microns in size (i.e., those particles available for respiration) generated by bulldozers was estimated by the following equation:

$$E_{10(particulate)} = \frac{78.4 \times S^{1.2}}{\Phi^{1.3}}$$

where:

$E_{10(particulate)}$	=	emission rate for soil particles 10 microns and below (lb/hr),
S	=	material silt content (site specific data), and
Φ	=	volumetric water content (site specific data).

Dispersion of the airborne vapor and dust was then estimated using the Near Field Box Model obtained from GRI (1988). The Near Field Box Model was deemed applicable to exposure scenarios where the potential receptor groups were either on site or very close to the site. The model is accurate at short downwind distances.

The equations to estimate dispersion are as follows:

$$C_{AIR} = \frac{C_{soil} \times E_{10(particulate)}}{H_b \times W_b \times u_m \times CF}$$

and

$$C_{AIR} = \frac{C_{soil} \times Q_{(vapors)}}{H_b \times W_b \times u_m \times CF}$$

where:

C_{AIR}	=	Concentration of chemical in ambient air (mg/m^3),
C_{soil}	=	Concentration of chemical in soil (mg/kg),
E_{10}	=	Emission rate of chemical on soil particles (mg/sec),
Q	=	Mass flux of chemical as vapor (mg/sec),
H_b	=	Downwind height of box (m),
W_b	=	Width of box, crosswind dimension of area of concern (m),
u_m	=	Average wind speed through the box (m/sec), and
CF	=	Conversion factor (1,000,000 mg/kg).

The term u_m was calculated using the following equation:

$$U_m = 0.22 \times u_{10} \times \ln (2.5 \times H_b)$$

where:

u_{10} = Annual mean wind speed (m/s).

The annual mean wind speed for Norfolk, VA is 4.7 meters per second (GRI, 1988).

To calculate the exposure resulting from inhalation of vapor and dust, the following equation was used:

$$CDI = \frac{C_{AIR} \times IR \times ET \times EF \times ED}{BW \times AT}$$

where:

CDI	=	Chronic daily intake (mg/kg-day),
C_{AIR}	=	Chemical concentration in air, as calculated above (mg/m^3),
IR	=	Inhalation rate (m^3/hour),
ET	=	Exposure time (hours/day),
EF	=	Exposure frequency (days/month),
ED	=	Exposure duration (months),
BW	=	Body weight (70 kg), and
AT	=	Averaging time (365 days/year * 6 months (0.5 year) for non-carcinogenic intake, and 365 days/year * 70 years for carcinogenic intake).

The default values for the soil inhalation scenario have been provided in Table 6-4.7. Spreadsheets showing the model calculations have been provided in Table 6-4.7a (volatile emissions) and Table 6-4.7b (fugitive dust emissions).

An assumed inhalation rate of 2.5 m^3 per hour was used as the average inhalation rate for males during moderate physical activity (EPA, 1989b) to heavy physical activity (EPA, 1997a). The exposure time for construction workers was assumed to be 8 hours per day. An exposure frequency of 20 days per month, for a duration of 6 months, was assumed for construction workers, which is representative of a typical 40 hour work week. Body weight was assumed to be 70 kg (EPA, 1991) and lifetime was assumed to be 70 years (EPA, 1989b).

Dermal Absorption of Chemicals from Soil. The equation for estimating dose via dermal absorption from soil is:

$$\text{Intake} = \frac{C_{SOIL} \times CF \times SA \times SSAF \times DABS \times EF \times ED}{BW \times AT}$$

where:

C_{SOIL} = chemical concentration in soil (mg/kg soil),
CF = conversion factor (10^{-6} kg soil/mg soil),
SA = skin surface area available for contact (cm^2),
SSAF = soil to skin adherence factor (mg soil/cm^2-event),
DABS = dermal absorption factor (unitless),
EF = exposure frequency (events/month for Constr., events/year for C/I, Res, & Rec),
ED = exposure duration (months for Constr., years for C/I, Res, & Rec),
BW = body weight (kg), and
AT = averaging time (days).

The default values for recreational adults and children have been provided in Table 6-4.1 and 6-4.2, respectively. The default values used for commercial/industrial workers and construction workers have been provided in Table 6-4.3 and 6-4.4, respectively. Finally, the default values for residential adults and children have been provided in Table 6-4.5 and 6-4.6, respectively.

It was assumed that construction, commercial/industrial, residential, and recreational dermal exposure scenarios occur at the same frequency as incidental soil ingestion; therefore, all the variables corresponding to exposure durations, frequencies, and averaging times were identical. Body weights for adults (70 kg) and children (15 kg) were also identical to the soil ingestion scenario. The skin surface areas (SA) exposed were assumed to be 5,800 cm^2 for construction workers, commercial/industrial workers, residential adults, and recreational adults (EPA, 1997a). The exposed skin surface area for children was assumed to be 1,991 cm^2 for both the residential and recreational scenarios (EPA, 1997a). These values represent surface areas of approximately 25 percent of the total body surface areas for the 95th percentile of these population classes. For residential and recreational adults, an age-adjusted skin surface area of 557 mg-yr/kg-event was used for scenarios involving carcinogens, which also includes an adherence factor, an exposure duration and a body weight adjustment. (Note that the age-adjustment results in a lifetime risk estimate since it combines both child and adult exposure).

Exposures are also affected by soil-to-skin adherence. For the purpose of this risk assessment, a soil-to-skin adherence factor (SSAF) of 0.2 mg/cm^2-event was used for recreational, residential and commercial/industrial receptors, and an adherence factor of 0.3

mg/cm^2-event was used for construction workers. These adherence factors were based on information provided in EPA's Exposure Factors Handbook (EPA, 1997a).

Once soil particles have adhered to the skin, it is unlikely that all of the COPCs will be sorbed from the soil into the bloodstream. Semi-volatile chemicals would be expected to sorb at relatively higher rates than inorganic chemicals. Information on soil absorption through the skin is somewhat limited. Absorption factors available for the COPCs were taken from EPA Region III's Assessing Dermal Exposure from Soil (EPA, 2000b).

Groundwater Ingestion. Ingestion of groundwater is a potential route of exposure for future residents, commercial/industrial workers and construction workers. The equation for estimating intakes via groundwater ingestion is:

$$\text{Intake} = \frac{C_{WATER} \times IR\text{-}W \times EF \times ED}{BW \times AT}$$

where:

C_{WATER} = chemical concentration in groundwater (mg/liter),
IR-W = ingestion rate of groundwater (liters/day),
EF = exposure frequency (days/month for Constr., days/year for C/I and Res),
ED = exposure duration (months for Constr., years for C/I and Res.),
BW = body weight (kg), and
AT = averaging time (days).

The default values used for commercial/industrial workers and construction workers have been provided in Table 6-4.8 and 6-4.9, respectively. The default values for residential adults and children have been provided in Table 6-4.10 and 6-4.11, respectively.

Assumptions regarding body weights, exposure frequencies, exposure durations, and averaging times for each receptor were the same as those used for the estimates of exposure via soil ingestion. The ingestion rates were assumed to be 1 and 2 liters per day for commercial/industrial workers and residential adults, respectively, and 1 liter per day for residential children (EPA, 1989a; EPA, 1997a); which are representative of average drinking water ingestion rates. For residential adults, an age-adjusted intake of 1.09 L-yr/kg-day was used for the scenario involving carcinogens, which also includes an exposure duration and a body

weight adjustment. (Note that the age-adjustment results in a lifetime risk estimate since it combines both child and adult exposure). The ingestion rate for construction workers was assumed to be 0.02 liters per day (VADEQ, 2000) based on incidental ingestion of groundwater during excavation activities.

Residential Inhalation of VOCs During Showering with Groundwater

The modeling of VOC concentrations in indoor air during and immediately after showering with VOC-contaminated water was based on the method described by Foster and Chrostowski (1987). In the model, a mass transfer coefficient between a falling droplet of water and the surrounding air is calculated. The resulting rate of VOC generation in indoor air is combined with the physical properties of the shower room to provide a series of data indicating VOC concentrations over time. These data can be integrated to yield an overall inhalation exposure for the time spent in the shower and the time spent in the vicinity of the shower after the water has been shut off.

The mass transfer coefficient (K_L) is calculated for each VOC as follows:

$$K_L = \left(\frac{1}{k_l} + \frac{RT}{Hk_g} \right)^{-1}$$

where

K_L = overall mass transfer coefficient (cm/hr),
H = Henry's Law Constant (atm-m^3/mol K),
RT = 2.4×10^{-2} atm-m^3/mole (gas constant × temperature),
k_g = gas-film mass transfer coefficient (cm/hr), and
k_l = liquid-film mass transfer coefficient (cm/hr).

Values for k_g and k_l can be estimated using typical values for k_g (3000 cm/hr) and k_l (20 cm/hr) for H_2O and CO_2, respectively, and adjusting based on molecular weight as follows:

$$k_l(VOC) = k_l(CO_2)\sqrt{\frac{44}{MW_{VOC}}}$$

$$k_g(VOC) = k_g(H_2O)\sqrt{\frac{18}{MW_{VOC}}}$$

The mass transfer coefficient K_L is adjusted to the shower water temperature T_s using the following semi-empirical equation:

$$K_{aL} = \frac{K_L}{\sqrt{\frac{T_l m_s}{T_s m_l}}}$$

where

K_{aL} = adjusted mass transfer coefficient (cm/hr),
T_l = calibration water temperature of K_L (K),
T_s = shower water temperature (K),
μ_l = water viscosity at T_l (cp), and
μ_s = water viscosity at T_s (cp).

The VOC concentration can be calculated assuming a uniform droplet size and constant time taken for a droplet to fall from the shower head to the floor.

$$C_{wd} = C_{w0}\left(1 - e^{\frac{-K_{aL} t_s}{60d}}\right)$$

where

C_{wd} = VOC concentration leaving droplet of shower water (µg/l),
C_{w0} = VOC concentration in shower water (µg/l),
d = diameter of shower droplet (mm), and
t_s = drop time of shower droplet (sec).

The VOC generation rate can be calculated as

$$S = \frac{C_{wd} FR}{SV}$$

where

S = indoor air VOC generation rate (µg/m^3-min),
FR = shower water flow rate (l/min), and
SV = volume of air in shower room (m^3).

By modeling the shower room as an enclosed space with instantaneous mixing, no decay or outside sources of VOC's, and a known air exchange rate, the VOC concentration over time can be expressed as

$$\frac{dC_a}{dt} = -RC_a + S$$

where

C_a = indoor air VOC concentration (µg/m^3), and
R = air exchange rate (min^{-1}).

Solving the above equation for $C_a(t)$ yields the following expression for the time-dependent VOC concentration in air:

$$C_a(t) = \frac{S}{R}\left(1 - e^{-Rt}\right) \qquad \text{for } t \le D_s$$

$$C_a(t) = \frac{S}{R}\left(e^{-RD_s} - 1\right)\left(e^{-Rt}\right) \qquad \text{for } D_s < t < D_t$$

where

D_s = shower duration (min),

D_t = overall time in shower room (min), and
t = time (min).

The above pair of expressions for indoor air concentrations was used to calculate the time integral of air concentrations for each VOC of concern. The period of time when the shower was on was divided into 20 equal time segments and the period of exposure after the shower was turned off was divided into 80 equal time segments. The integral was calculated as a Riemann sum (a summation of the products of the air concentrations and their corresponding time intervals):

$$\sum_{i=1}^{n} C_a(t) \frac{t_{i+1} - t_{i-1}}{2}$$

where

n = the number of time steps, and
$t_0, t_1, \ldots t_n$ are the time values, in minutes, corresponding to each step.

The resulting value, in units of µg-min/m^3, was converted to mg-min/L and incorporated into the following equation as C_{AIR}:

$$\text{Intake} = \frac{C_{AIR} \times IR \times SF \times EF \times ED}{BW \times AT}$$

where:

C_{AIR} = chemical concentration in air as calculated above (mg-min/L-shower),
IR = inhalation rate (L/min),
SF = shower frequency (showers/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
BW = body weight (kg), and
AT = averaging time (days).

The default values used in the shower inhalation scenario for residential adults and children have been provided in Table 6-4.12 and 6-4.13, respectively. The model calculations have been provided in Table 6-4.12a.

Time in the shower was assumed to be 12 minutes, based on recommendations in RAGS (EPA, 1989a). This represents the 90th percentile time for shower duration. Values for water flow rate (20 L/min) and bathroom volume (6 m^3) and inhalation rate (10 L/min) were based on values recommended by EPA Region III (Hubbard, personal communication). Assumptions regarding body weights, exposure frequencies, exposure durations, and averaging times were the same as those used for the estimates of residential soil ingestion.

Construction Worker Inhalation of VOCs from Groundwater During Excavation Activities

In order to estimate the exposure of construction workers to volatiles from groundwater in a construction/utility trench, a combination of a vadose zone model to estimate volatilization of gases from contaminated groundwater into a trench and a box model to estimate dispersion of the contaminants from the air inside the trench into the above-ground atmosphere was used. This approach has been recommended by Virginia Department of Environmental Quality (VADEQ) in its Voluntary Remediation Program (VRP) Risk Assessment Guidance (VADEQ, 2000). The following description detailing the elements of the models used to estimate exposure to volatiles has been excerpted from Section 3.2.2 of the VRP guidance document (VADEQ, 2000).

The construction worker may be exposed to contaminants in the air inside the trench that would result from volatilization from groundwater pooling in the trench during excavation/construction activities. Airborne concentration of a contaminant in a trench can be estimated using the following equation:

$$C_{trench} = C_{GW} \times VF$$

where:

C_{trench} = concentration of contaminant in the trench ($\mu g/m^3$),
C_{GW} = concentration of contaminant in groundwater ($\mu g/L$), and
VF = volatilization factor (see following equation) (L/m^3).

For modeling purposes, VADEQ assumes that the trench is 3 feet wide by 8 feet long. VADEQ also assumes that the trench would only intercept the groundwater for a few inches since a groundwater pool of more than a few inches would likely require dewatering. Therefore,

the trench depth has been set to 14 ft., which approximates the average depth to groundwater at Site 16.

The volatilization factor (VF) is based on the following equation:

$$VF = (K_i \times A \times F \times 10^{-3} \times 10^{4} \times 3600) / (ACH \times V)$$

where:

K_i	=	overall mass transfer coefficient of contaminant (see following equation)(cm/s),
A	=	area of the trench (m^2),
F	=	fraction of floor through which contaminant can enter (unitless),
ACH	=	air changes per hour (h^{-1}),
V	=	volume of trench (m^3),
10^{-3}	=	conversion factor (L/cm^3),
10^{4}	=	conversion factor (cm^2/m^2), and
3600	=	conversion factor (s/hr).

Studies of urban canyons suggest that if the ratio of trench width -- relative to wind direction -- to trench depth is less than or equal to 1, a circulation cell or cells will be set up within the trench that limits the degree of gas exchange with the atmosphere. In consultation with USEPA Region III, VADEQ has assumed an ACH in this case of 2/hr -- based upon measured ventilation rates of buildings.

$$K_i = 1 / \{(1/k_{iL}) + [(R\ T) / (H_i k_{iG})]\}$$

where:

k_{iL}	=	liquid-phase mass transfer coefficient of i (see following equation) (cm/s),
R	=	ideal gas constant (atm-m^3/mole-°K),
T	=	average system absolute temperature (°K),
H_i	=	Henry's Law constant of i (atm-m^3/mol), and
K_{iG}	=	gas-phase mass transfer coefficient of i (cm/s).

The value for R is 8.2×10^{-5}. A default value of 298°K has been used for the average system absolute temperature.

$$k_{iL} = (MW_{O2}/MW_i)^{0.5} \times (T/298) \times k_L,O_2$$

where:

k_{iL}	=	liquid-phase mass transfer coefficient of component i (cm/s),
MW_{O2}	=	molecular weight of O_2 (g/mol),
Mw_i	=	molecular weight of component i (g/mol), and
kL,O_2	=	liquid-phase mass transfer coefficient of oxygen at 25°C (cm/s).

The value of k_L,O_2 is 0.002 (cm/s).

$$k_{iG} = (MW_{H2O}/MW_i)^{0.335} \times (T/298)^{1.005} \times k_G, H_2O$$

where:

k_{iG}	=	gas-phase mass transfer coefficient of component i (cm/s),
MW_{H2O}	=	molecular weight of water (g/mol), and
k_G,H_2O	=	gas-phase mass transfer coefficient of water vapor at 25°C (cm/s).

The value of k_G, H_2O is 0.833 (cm/s).

To calculate the exposure resulting from inhalation of VOCs during excavation/construction activities, the following equation was used:

$$\text{Intake} = \frac{C_{trench} \times IR\text{-}A \times ET \times EF \times ED}{BW \times AT}$$

where:

C_{trench}	=	chemical concentration in air of trench as calculated above (mg/m^3),
IR-A	=	inhalation rate (m^3/hour),
ET	=	exposure time (hours/day),
EF	=	exposure frequency (days/month),
ED	=	exposure duration (months),

BW = body weight (kg), and
AT = averaging time (days).

The default values used in the inhalation scenario for construction workers has been provided in Table 6-4.14. Table 6-4.14a presents the calculations and the input variables for the equations. As shown in Table 6-4.14, an inhalation rate of 2.5 m^3 per hour was used. This value was based on the average inhalation rate (IR-A) for males during moderate physical activity (EPA, 1989b) to heavy physical activity (EPA, 1997a). The exposure time for construction workers was assumed to be 8 hours per day. Assumptions regarding body weight, exposure frequency, exposure duration, and averaging times were the same as those used for the estimates of construction worker soil ingestion.

Dermal Absorption of Chemicals from Groundwater

For residents, dermal contact with on-site groundwater could occur while showering. In addition, construction workers may come into contact with groundwater during excavation activities due to the high water table. As with groundwater ingestion, it was assumed, as a worst case scenario, that no treatment of the groundwater occurred prior to use.

The following description detailing the methodology used to estimate dermal exposure to organic and inorganic contaminants has been excerpted from Section 3.3.1.1.1 of VADEQ's VRP Risk Assessment Guidance (VADEQ, 2000).

To estimate dermal exposures from groundwater, two values need to be calculated: dermally absorbed dose and an intake factor. To calculate dermally absorbed dose and intake factor from contact with groundwater, use the following equations:

$$DAD = DA_{event} \times IF$$

where:

DAD = dermally absorbed dose (mg/kg-day),
DA_{event} = absorbed dose per event (mg/cm2-event), and
IF = intake factor (event-cm2/kg-day).

The method to calculate DA_{event} depends on whether the contaminant is an inorganic or an organic chemical. Calculating DA_{event} for inorganics is relatively straightforward as shown below:

$$DA_{event} = Kp \times CW \times ET$$

where:

Kp	=	permeability coefficient (cm/hr) (values in Table 3.21 of VADEQ, 2000),
CW	=	concentration of chemical in water (mg/cm3),
		(NOTE: mg/cm3 = 10-6 x µg/L), and
ET	=	exposure time (hours).

To calculate DA_{event} for organic chemicals, the value of t* (time to reach steady-state in hours; values provided in Table 3.21 of VADEQ, 2000) was compared to the exposure time for the particular scenario. If the exposure time (ET) for the scenario was less than t*, the following calculation was used to calculate DA_{event}:

$$DA_{event} = 2 \times Kp \times CW \times SQRT((6 \times tau \times ET)/pi)$$

where:

tau	=	lag time (hours) (values in Table 3.21 of VADEQ, 2000),
SQRT=		square root, and
pi	=	pi, or approximately 3.14.

If ET was greater than or equal to t*, then the following equation was used to calculate DA_{event}:

$$DA_{event} = Kp \times CW \times \{(ET/(1+B)) + (2 \times tau \times [(1 + 3B)/(1 + B)]\}$$

where:

B	=	lipophilic property (unitless) (values in Table 3.21 of VADEQ, 2000)

Once the DA_{event} has been estimated, the intake factor (IF) can be calculated using the following equation:

IF = EV x SA x EF x ED x 1/BW x 1/AT

where:

EV = event frequency (events/day),
SA = skin surface area available for contact (cm2),
EF = exposure frequency (days/year),
ED = exposure duration (years),
BW = body weight (kg), and
AT = averaging time (days).

The default values used in the dermal exposure scenario for construction workers are provided in Table 6-4.9. The model calculations used to estimate DA_{event} for construction workers are shown in Table 6-4.9a. The default values used for adult and child residents are in Table 6-4.10 and 6-4.11, respectively, with model calculations to estimate DA_{event} for both adult and child residents provided in Table 6-4.10a.

Assumptions regarding exposure times, exposure frequencies, exposure durations, body weights, and averaging times for adult and child residents were the same as those used in the shower inhalation scenario. The exposure time for construction workers was assumed to be eight hours per day. Assumptions regarding exposure frequency, exposure duration, body weight and averaging times for construction workers were the same as those used in the groundwater ingestion scenario. Body surface areas for residential adults and children were assumed to be 23,000 cm^2 and 7,960 cm^2, respectively. These values represent the 95th percentile of total surface area for those population classes (EPA, 1997a). For residential adults, an age-adjusted skin surface area of 11,070 cm^2-yr/kg was used for the scenario involving carcinogens, which also includes an exposure duration and a body weight adjustment. (Note that the age-adjustment results in a lifetime risk estimate since it combines both child and adult exposure). The exposed skin surface area for construction workers was assumed to be 5,800 cm^2 (EPA, 1997a).

6.7 Human Toxicity Assessment

Introduction and Approach. The purpose of the toxicity assessment is to evaluate available evidence regarding the potential for site-related chemicals to cause adverse effects in exposed populations and to provide estimates of the relationship between the extent of exposure and the increased likelihood of adverse effects, i.e., dose-response relationships. The results of

the toxicity assessment are integrated with the exposure assessment (Section 6.6) to estimate the cancer risks and noncarcinogenic health impacts in the risk characterization section (Section 6.8).

The toxicity assessment for Site 16 was accomplished in two steps: (1) site data analysis and identification of chemicals of potential concern (hazard identification) and (2) toxicity evaluation.

Toxic responses are generally classified by the EPA as threshold effects and nonthreshold effects. The two principal indices of toxicity are known as Reference Doses (RfDs) and Slope Factors (SFs). The RfDs for chemicals of potential concern (COPCs) are shown in Table 6-5.1 (oral/dermal) and Table 6-5.2 (inhalation). The SFs for the COPCs are shown in Table 6-6.1 (oral/dermal) and Table 6-6.2 (inhalation).

An RfD for a substance is the daily intake or dose per unit body weight (mg/kg/day) that is likely to be without appreciable risk to human populations, including sensitive subgroups. The RfD allows for the existence of a threshold dose, that is, a certain minimum intake of substance below which there will be no observable toxic effects based on the metabolic and detoxifying capacities of exposed individuals. EPA considers exposures to most noncarcinogens to have thresholds below which no toxic effects will occur.

For carcinogens, the EPA assumes no threshold or a zero-threshold. This means there is some finite risk no matter how small the dose. The SF for a given chemical carcinogen is a plausible upper-bound estimate of the probability of a response per unit intake of that chemical over a lifetime. The slope factor is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen. A second important factor for carcinogens is the EPA weight-of-evidence classification, whereby, carcinogens are grouped according to the quality and quantity of data that indicate that an agent is a human carcinogen.

The RfD (oral and inhalation, subchronic, chronic) and SF (oral and inhalation) values used in this risk assessment were obtained from EPA Region III's Risk-Based Concentration (RBC) Table (EPA, 2000a) and EPA's Health Effects Assessment Summary Tables (HEAST) (EPA, 1997b).

All available RfDs and SFs from the above sources are based on oral and inhalation routes of exposure; no RfDs and SFs are available for the dermal route of exposure. EPA (1989a, 1992)

recommends that the oral RfDs and SFs be used to assess the risk of dermally absorbed chemicals. EPA (1992) acknowledges the considerable uncertainty introduced into a risk assessment by this approach. First, the risk associated with point-of-entry (skin) effects for locally acting toxic agents cannot be estimated from oral toxicity data. Second, unlike orally administered compounds, dermally absorbed chemicals are not subjected to first-pass hepatic metabolism before reaching the systemic circulation. Finally, oral dose response relationships are based on administered dose, whereas dermal dose estimates are absorbed doses. Therefore, using oral slope factors and RfDs to extrapolate risks and hazards from dermal exposure is a non-conservative approach.

To partially offset the last area of uncertainty, EPA (1989a) and EPA (1992) indicate that an oral RfD or SF, unadjusted for absorption, can be converted to an absorbed dose that can then be used as the "dermal" RfD or SF, if data concerning the gastrointestinal absorption fraction are available for the compound of interest in the appropriate vehicle. This approach has been recommended by EPA Region III and VADEQ. As a result, oral RfDs and SFs were converted to "dermal" RfDs and SFs in this risk assessment.

Based on the methodology provided in Appendix A of RAGS (EPA, 1989a), the following equations were used to adjust oral toxicity values for carcinogens and noncarcinogens, respectively.

For carcinogens: $SF_d = SF_o / ABS_{gi}$

where:

SF_d = Dermal slope factor (i.e., internal dose cancer slope factor) $(mg/kg\text{-}day)^{-1}$,
SF_o = Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$, and

ABS_{gi} = GI absorption fraction (unitless).

For noncarcinogens: $RfD_d = RfD_o \times ABS_{gi}$

where:

RfD_d = Dermal reference dose (i.e., internal reference dose) (mg/kg-day),
RfD_o = Oral reference dose (mg/kg-day), and
ABS_{gi} = GI absorption fraction (unitless).

GI absorption fractions used were based on values provided in VADEQ's VRP risk assessment guidance document (VADEQ, 2000). Adjusted dermal RfDs and SFs are shown in Tables 6-5.1 and 6-6.1, respectively.

Toxicity Assessment for Noncarcinogenic Effects. Noncarcinogenic effects are generally thought to have a threshold dose below which there are no observable adverse health effects. In developing a toxicity value for noncarcinogenic effects, the approach is to identify the threshold dose or RfD. RfDs are generally calculated by dividing the no-observed-adverse-effect level (NOAEL) from observations in experimental animals by uncertainty factors (which generally range from 10 to 1000). These uncertainty factors or safety margins are intended to account for specific types of uncertainty inherent in deriving a single estimate of toxicity from the available data, including variations in the sensitivity of individuals in a population, extrapolation from animal data to humans, and other limitations and uncertainties.

As discussed above, EPA has developed RfDs for different exposure routes (either ingestion/oral or inhalation) and different durations of exposure (i.e., chronic, subchronic, or single event). EPA defines a chronic RfD as an estimate of a daily exposure level for the human population that is unlikely to result in deleterious effects during a lifetime. A chronic RfD is used to evaluate the potential noncarcinogenic effects associated with exposure periods longer than 7 years. Subchronic RfDs have been developed by EPA to characterize potential noncarcinogenic effects associated with shorter term exposures (i.e., periods between 2 weeks and 7 years). Therefore, identification of appropriate toxicity values must reflect the length of potential exposure. Subchronic RfDs tend to be higher, often by an order-of-magnitude, than chronic RfDs because of assumed shorter exposure duration. Chronic and subchronic RfDs for the chemicals of potential concern are shown in Tables 6-5.1 and 6-5.2. Note that subchronic RfDs were used for construction workers when values were available; however, when subchronic RfDs were not available, chronic RfDs were used. Chronic RfD values were used for children for all scenarios.

Toxicity Assessment for Carcinogenic Effects. In assessing the risk of carcinogens, it is common practice by EPA and other regulatory agencies to assume that any exposure level, however small, poses a finite probability of producing a carcinogenic response. EPA uses a two-part evaluation in which the substance is first assigned a weight-of-evidence classification and then a slope factor is calculated that defines quantitatively the relationship between dose and response. The EPA's weight-of-evidence classification is based on the extent of evidence that chemicals are carcinogenic in humans and experimental animals.

A number of mathematical models and procedures have been developed to extrapolate from carcinogenic responses observed at high doses in experimental animals to responses expected at low doses in humans. EPA uses the linearized multistage model for low-dose extrapolation. This mathematical model is based on the multistage theory of carcinogenesis where the response is assumed to be linear at low doses. EPA further calculates the upper 95th percent confidence limit of the slope of the resulting dose-response curve. This value is known as the slope factor (SF). The SF, as developed by EPA, converts the average daily intake of chemical over a lifetime directly to a cancer risk. The SF is expressed in units of $(mg/kg/day)^{-1}$. The SFs for the chemicals of potential concern are shown in Tables 6-6.1 (oral/dermal) and 6-6.2 (inhalation).

In general, chemicals with high slope factors and low reference doses exhibit higher toxicities than the chemicals with low slope factors and high reference doses. These toxicity indicators are integrated with the exposure assessment results to characterize the human health risks and hazards associated with the chemicals of potential concern at Site 16.

6.8 Human Risk Characterization

6.8.1 Introduction

In risk characterization, the results of the toxicity assessment (slope factors and RfDs) and exposure assessment (chemical intakes for potentially exposed populations) are integrated to arrive at quantitative estimates of carcinogenic risks and Hazard Indices. A general discussion of the measures or indicators of risks and hazards follows in Section 6.8.2. The methodology used for identifying the specific risks and hazards associated with exposure to selected COPCs is presented in Section 6.8.3. The carcinogenic risks and hazard indices for multiple chemicals and pathways are presented in Section 6.8.4.

An integral part of the risk assessment process is the characterization of the uncertainties associated with the exposure and toxicity assessments and underlying assumptions. The key assumptions and major uncertainties associated with this risk assessment are discussed in Section 6.9.

6.8.2 Indicators of Potential Adverse Health Effects and Risks

Human health risks or hazards are generally classified into: (1) incremental risk of cancer and (2) noncancer effects as determined by the Hazard Index. Cancer risks are expressed as incremental lifetime risk, such as 10^{-6} or one in one million chance of developing cancer from exposure to the substance over a lifetime. Cancer risks are the product of the exposure value and the SF. According to the National Oil and Hazardous Substances Contingency Plan (NCP) (EPA, 1988), which provides the framework for the implementation of the Superfund program, the lifetime incremental cancer risk should not exceed the 10^{-6} to 10^{-4} range. Noncancer risk is expressed in terms of Hazard Quotient (HQ) for a single substance or Hazard Index (HI) for multiple substances and/or exposure pathways. These are ratios of particular chemical exposures to RfDs (discussed further below). If a HQ is less than one unit, the hazards are not considered to pose a threat to public health, including sensitive subgroups. Generally speaking, cancer risks higher than 10^{-6} to 10^{-4} and Hazard Indices higher than one are considered to raise a regulatory public health concern.

6.8.3 Quantification of Hazards and Risks

Hazard Index for Noncarcinogenic Effects. The Hazard Quotient (HQ) for a specific chemical was calculated by dividing the estimated daily intake by the reference dose as follows:

$$HQ = CDI(SDI)/ RfD$$

where:

HQ	=	ratio of the chronic (or subchronic) daily intake and the reference dose - a ratio that exceeds 1.0 indicates a potential hazard (unitless),
CDI (or SDI)	=	chronic (or subchronic) daily intake of a substance averaged over the duration of the exposure (mg/kg/day), and
RFD	=	reference dose (mg/kg/day).

The chronic or subchronic daily intake (CDI or SDI) was obtained by using the exposure equations presented in Section 6.6. Copies of all spreadsheets presenting the inputs and results of the calculations for each exposure pathway are provided in Tables 6-4.1 - 6-4.14 and Tables 6-7.1 - 6-7.14, respectively.

The individual chemical Hazard Quotients (HQs) were summed for all chemicals evaluated for a given exposure pathway to provide a Hazard Index (HI) as follows:

$$HI = \Sigma HQ_i$$

where:

HI = hazard index, and
HQ_i = the hazard quotient for the ith noncarcinogenic toxicant, etc.

The total Hazard Index (HI) for a given receptor population was obtained by combining the Hazard Indices for each exposure pathway contributing to the exposure of that population. The total Hazard Index for multiple pathways was calculated as follows:

Total Exposure Hazard Index = Hazard Index ($pathway_1$) + Hazard Index ($pathway_2$).+ Hazard Index ($pathway_i$).

Carcinogenic Risk. Carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the chronic (lifetime) daily intake (CDI) by the risk per unit dose or cancer slope factor (SF) as follows:

$$\text{Cancer Risk} = \text{CDI} \times \text{SF}$$

where:

Risk = likelihood of developing cancer from lifetime exposure (70 years) expressed as unitless probability,
CDI = chronic daily intake of a substance averaged over a lifetime (mg/kg/day), and
SF = slope factor $(mg/kg/day)^{-1}$.

EPA guidance to evaluate cancer risk from simultaneous exposure to several carcinogens assumes that incremental cancer risks are additive. The concept that cancer risks are additive is based on a number of assumptions. If these assumptions are incorrect, over- or under-estimation of the actual risk could result (EPA, 1989a). The total cancer risk is estimated as follows:

$$Risk_T = \Sigma Risk_i$$

where:

$Risk_T$ = total cancer risk and
$Risk_i$ = the risk estimate for the ith carcinogenic toxicant, etc.

EPA policy must be considered in order to interpret the significance of the cancer risk estimates. In the NCP (40 CFR Part 300) (EPA, 1988), EPA states that: For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}. The Agency further states in the preamble to the NCP that the 10^{-6} risk level be used as a point of departure for establishing remediation goals for the risks from constituents at Superfund sites.

Risk Calculation. The cancer risk was calculated by multiplying the chronic daily intake (CDI) by the slope factor, as discussed previously. The CDI was obtained by using the equations presented in Section 6.6. The CDI was then multiplied by the slope factor to determine a numerical estimate of excess lifetime cancer risk. Copies of all spreadsheets presenting the inputs and results for each exposure pathway are provided in Tables 6-4.1 - 6-4.14 and Tables 6-8.1 - 6-8.14, respectively.

The cancer risks were summed for all of the chemicals evaluated for each exposure pathway. To determine the total carcinogenic risk to a given receptor population, all cancer risks were summed. The total carcinogenic risk was calculated as follows:

Total Exposure Cancer Risk = Risk ($pathway_1$) + Risk ($pathway_2$) + Risk ($pathway_i$)

6.8.4 Potential Human Health Carcinogenic Risks and Hazard Indices

The carcinogenic and noncarcinogenic risks were calculated for all identified receptor populations, exposure routes, and chemicals of potential concern using the approach described in Section 6.8.3. Tables 6-7.1 - 6-7.14 provide the estimates of hazard indices for each pathway for the baseline exposure scenarios for soil and groundwater. Tables 6-8.1 - 6-8.14 provide the estimates of carcinogenic risks for each pathway for the baseline exposure scenarios for soil and groundwater. Tables 6-9.1 and 6-9.2 summarize both the carcinogenic and noncarcinogenic risks for soil and groundwater, respectively. (Note that summaries of carcinogenic and non-

carcinogenic risks have also been provided in Tables 6-10.1 - 6-10.7 which include total hazards by target organ). The following sections discuss potential carcinogenic and noncarcinogenic risks for both current and future land use scenarios for the baseline risk assessment.

Current Land Use. The current land use scenarios evaluated in this risk assessment are as follows:

Surface Soil

- Incidental ingestion and dermal absorption of surface soil by commercial/industrial workers.
- Incidental ingestion and dermal absorption of surface soil by recreational trespassers (adults and children).

Results of this risk assessment suggest that surface soil at Site 16 may pose health risks to both commercial/industrial workers and recreational trespassers.

Noncarcinogenic Risks for Current Exposure Scenarios. Noncarcinogenic risks identified for current scenarios are provided by exposure pathway in Tables 6-7.1 - 6-7.3. Table 6-9.1 provides a summary of the total hazards (e.g., summed across pathways) for surface soil. As shown in Table 6-9.1, there were no EPA-designated significant noncarcinogenic human health hazards (i.e., hazards equal to or greater than 1.0) for current soil exposure scenarios at Site 16. Total HIs for commercial/industrial workers and recreational trespassers (adults and children) were 2.2E-02, 7.6E-03 and 6.1E-02, respectively.

Carcinogenic Risks For Current Exposure Scenarios. Carcinogenic risks identified for current scenarios are provided by exposure pathway in Tables 6-8.1 - 6-8.3. The total carcinogenic risk for commercial/industrial workers exposed to surface soil at Site 16 is 1.1E-05 (Table 6-9.1). This risk value exceeds the lower limit of EPA's target risk range of 1.0E-06, but was less than the upper limit of 1.0E-04. The majority of the risk is based on dermal absorption and ingestion of benzo(a)pyrene. Arsenic also contributed slightly to the total risk although the individual risk for this chemical did not exceed 1E-06. The total carcinogenic risks for recreational adults and children exposed to surface soil at Site 16 are 5.1E-06 and 2.5E-06, respectively (Table 6-9.1). Although these values are relatively lower than the carcinogenic risk level for commercial/industrial workers, they still exceed the lower limit of EPA's target risk range of 1.0E-06. Similar to the commercial/industrial scenario, the risks are almost entirely due to benzo(a)pyrene with arsenic also contributing slightly to the risk.

Future Land Use. Future land use scenarios evaluated in this risk assessment are as follows: (please note that all current use scenarios previously described are also considered to be potential future use scenarios)

Surface Soil:

- Construction worker inhalation of fugitive dust and volatiles from surface soil;
- Construction worker incidental ingestion of, and dermal contact with surface soil;
- Residential adult and child incidental ingestion of, and dermal contact with surface soil;

Groundwater:

- Construction worker incidental ingestion of, and dermal contact with groundwater during excavation/construction activities;
- Construction worker inhalation of volatiles from groundwater during excavation/ construction activities;
- Residential adult and child direct ingestion of groundwater;
- Residential adult and child inhalation and dermal absorption of groundwater during showering; and
- Commercial/industrial worker direct ingestion of groundwater.

Results of this risk assessment suggest that, for future exposure scenarios, the groundwater at Site 16 may pose potentially significant health risks to residential adults and children, commercial/industrial workers and construction workers if developed for potable use. In addition, surface soil at Site 16 may pose a health risk to adult and child residents and construction workers.

Noncarcinogenic Risks for Future Exposure Scenarios. Noncarcinogenic risks identified for future scenarios are provided by exposure pathway in Tables 6-7.4 - 6.7-7 (soil) and Tables 6-7.8 - 6-7.14 (groundwater). Table 6-9.1 provides a summary of the total hazards (e.g., summed across pathways) for surface soil. As shown in Table 6-9.1, there were no EPA-designated significant noncarcinogenic human health hazards (i.e., hazards equal to or greater

than 1.0) for future soil exposure scenarios at Site 16. Total HIs for residents (adults and children) and construction workers were 5.2E-02, 4.1E-01 and 2.4E-01, respectively.

Table 6-9.2 provides a summary of the total hazards for future exposure to groundwater. In contrast to the surface soil results, each groundwater scenario resulted in non-carcinogenic human health hazards (i.e., hazards greater than EPA's target value of 1.0) as shown in Table 6-9.2. Adult and child residents had total HIs of 28 and 75, respectively. Ingestion of inorganics such as arsenic, iron, manganese and thallium and inhalation of naphthalene and benzene contributed to the total risk. The HI for construction workers was 190, significantly higher than EPA's target value of 1.0. Most of the risk was based on inhalation of naphthalene, benzene and toluene. Dermal absorption of manganese also contributed slightly to the total risk to construction workers. The HI for commercial/industrial workers of 7 was relatively lower than the hazard level for residents and construction workers but still exceeded EPA's target level of 1.0. This scenario was limited to ingestion of groundwater and the risks were based on ingestion of arsenic, iron and manganese.

Carcinogenic Risks For Future Exposure Scenarios. Carcinogenic risks identified for future scenarios are provided by exposure pathway in Tables 6-8.4 - 6-8.7 for soil and Tables 6-8.8- 6-8.14 for groundwater. In addition, Tables 6-9.1 and 6-9.2 provide a summary of the total future carcinogenic risks (e.g., summed across pathways) for soil and groundwater, respectively. Those scenarios that have risk levels that exceed the lower limit of EPA's target risk range of 1.0E-06 are discussed below.

As shown in Table 6-9.1, the total carcinogenic risk for adult and child residents exposed to surface soil at Site 16 is 3.4E-05 and 1.7E-05, respectively. Both of these values are greater than the lower limit of EPA's range of 1.0E-06 but do not exceed the upper limit of the range of 1.0E-04. Ingestion and dermal absorption of benzo(a)pyrene contributed to the majority of the risk for both receptors. Ingestion of arsenic also contributed slightly to the overall risk. As shown in Table 6-9.1, the total risk for construction workers exposed to surface soil at Site 16 is 6.1E-07 which does not exceed 1.0E-06, the lower limit of EPA's target risk range.

Table 6-9.2 provides a summary of the carcinogenic risk for future exposure to groundwater. As shown in Table 6-9.2, the total carcinogenic risk for adult and child residents exposed to groundwater at Site 16 was 2.3E-03 and 8.3E-04, respectively. These values exceed the upper limit of EPA's target risk range of 1.0E-04, in residential adults the carcinogenic risk exceeds the upper limit by more than one order of magnitude. Ingestion of arsenic and dermal

absorption of bis(2-ethylhexyl)phthalate was responsible for the majority of the risk. Other risk contributors included ingestion of benzene and bis(2-ethylhexyl)phthalate, inhalation of benzene and dermal absorption of 4,4'-DDT.

Although the total carcinogenic risk to commercial/industrial workers from groundwater ingestion of 4.8E-04 was relatively lower than the risk to residential receptors, this value also exceeded the upper limit of EPA's target risk range. The risk level for this scenario was based primarily on ingestion of arsenic, with ingestion of benzene and bis(2-ethylhexyl)phthalate also contributing to the total risk. Based on evaluation of background inorganic concentrations at Wallops Flight Facility, it was noted that the maximum arsenic concentration in Site 16 groundwater was approximately one order of magnitude greater than the concentration detected in a background location.

As shown in Table 6-9.2, the total carcinogenic risk to construction workers from exposure to groundwater was 1.5E-05 which exceeded the lower limit of EPA's risk range of 1.0E-06 but did not exceed the upper limit of the range of 1.0E-04. The risk level for this scenario was based primarily on inhalation of benzene with dermal absorption of bis(2-ethylhexyl)phthalate also contributing to the total risk.

Summary of Risks. There is a significant risk associated with future use of groundwater at Site 16 as a drinking water source. Carcinogenic risk levels for residents and commercial/industrial workers were greater than the upper limit of EPA's risk range of 1.0E-04. Also, hazard indices for adult and child residents were at least one order of magnitude greater than EPA's target value of 1.0. However, there are no current plans to develop groundwater as a potential drinking water source at Site 16. If aquifer development does not take place, the groundwater exposure pathways will not be complete and there will be no associated risks.

There were several scenarios involving exposure to surface soil that resulted in risks to residential, recreational, and commercial/industrial receptors that exceeded 1.0E-06 but were less than 1.0E-04, the upper limit of EPA's target risk range. Evaluation of risk levels should consider the present and planned land use at the site. If there is no future residential development at Site 16 there would be no residential receptors present. As a result, the soil exposure pathway would only be complete for commercial/industrial and recreational receptors.

6.9 Uncertainties and Limitations of Human Risk Assessment

Despite recent advances in risk assessment methodology, uncertainties are inherent in the risk assessment process. In order to appreciate the limitation and significance of the risk estimates, it is important to have an understanding of the sources and magnitudes of uncertainty. Sources of uncertainty in this risk assessment, as in any risk assessment, include:

- Sampling and analysis,
- Chemical transport and fate modeling,
- Toxicity data,
- Exposure assessment, and
- Risk estimates.

Environmental Media Sampling and Analysis

Sampling was conducted using accepted procedures in an attempt to collect samples that were representative of environmental media. Data were subsequently reviewed in a data validation process. However, current analytical procedures may not identify all potentially hazardous contaminants at a site, and analytical errors may have occurred despite stringent QA/QC procedures. In conducting this risk assessment, it was assumed that the reported chemical concentrations were representative of actual site conditions.

Chemical Transport and Fate

The maximum or 95th percentile UCL concentrations of chemicals of potential concern (COPCs) found in soil and groundwater at Site 16 were used as exposure point concentrations. Migration, dispersion, dilution, retardation, degradation, and other attenuation or transformation processes may occur over time that could change the chemical concentrations in various on-site media. It has been conservatively assumed that the concentrations observed at Site 16 will remain relatively unchanged with time because, several of the chemicals of potential concern are relatively persistent in the environment.

Toxicity Data

The available scientific data on chronic and subchronic toxic effects in humans for chemicals of potential concern found at Site 16 are limited. Consequently, varying degrees of

uncertainty surround the assessment of adverse health effects in potentially exposed populations. Sources of uncertainty for toxic effects in humans include:

- Use of dose-response data from experiments on homogenous, sensitive animal populations to predict effects in heterogenous human populations with a wide range of sensitivities (interspecies extrapolation);

- Extrapolation of data from high doses in animals to "real-world" low doses, from acute or subchronic to chronic exposure, and from one route to another, e.g., from ingestion to dermal absorption; and

- Use of single chemical data that do not account for possible antagonistic or synergistic responses from multiple chemical exposures.

Toxicity data are largely derived from laboratory animals. Experimental animal data have historically been relied upon by regulatory agencies and other expert groups to assess the hazards of chemicals to humans. Even though this reliance has been supported by empirical observations, there may be slight or marginal interspecies differences in the absorption, metabolism, excretion, detoxification, and toxic responses to specific chemicals of potential concern. There may also be uncertainties concerning the relevance of animal studies using exposure routes that differ from human exposure routes. In addition, the frequent necessity to extrapolate results of short-term or chronic animal studies to humans exposed over a lifetime has inherent uncertainty. In order to adjust for many of these uncertainties, EPA often adjusts the RfD for noncarcinogenic effects using uncertainty and modifying factors on the most sensitive animal species.

There is also uncertainty as to whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animals, but not in others, raises the possibility that not all animal carcinogens are carcinogenic in humans. EPA assumes that humans are as sensitive to carcinogens as the most sensitive animal species. This policy decision, designed to prevent underestimating risk, may introduce the potential to overestimate carcinogenic risk for some chemicals.

The model used by EPA to determine slope factors is the linearized multistage model that provides a conservative estimate of cancer risk at low doses and may overestimate the actual slope factor. Inadequate knowledge of the validity and accuracy of the linearized multistage model may increase the uncertainty and the tendency to overestimate actual cancer risks.

When dealing with exposures to chemical mixtures, EPA assumes dose additivity and does not account for potential synergisms, antagonisms, differences in target organ specificity, or mechanisms of action.

Despite these many limitations, animal experiments are widely believed to be a necessary part of toxicity assessment, especially in the absence of human epidemiological data. The safety factors used in RfD derivations for single chemicals may compensate for any unknown effects of synergistic exposures.

Exposure Assessment

Exposure assessment is perhaps the most critical step in achieving a reliable estimate of health risks to humans. In this assessment, a number of assumptions were made concerning the human populations that could come into contact with the media at Site 16 and the frequencies and durations of these contacts. The exposure parameters used in this assessment were largely based on EPA's RAGS (EPA, 1989a), EPA's Exposure Factors Handbook (1989b), EPA Dermal Exposure Assessment (1992), the revised EPA Exposure Factors Handbook (1997a) and VADEQ VRP guidance (VADEQ, 2000) and may not be entirely representative of the current and future receptor populations. There is also the presumption that interim and institutional measures at the site would not lead to changes in exposure conditions and receptor behaviors.

In accordance with EPA Headquarters and EPA Region III guidance, reasonable maximum exposures were calculated to provide estimates of potential exposures. Because reasonable maximum exposure estimates are based on a combination of conservative assumptions, these estimates are likely to be overestimates of exposures and risks at Site 16.

Risk Estimates

The actual risks associated with a given exposure result from a complex set of interactions, which are not understood and cannot be quantitatively estimated at the current state of knowledge. Examples of such interactions include synergism or antagonism of different

substances, effects on single versus multiple organ systems, and mechanisms of carcinogenesis. In addition, potential differences in sensitivities of various subpopulations to various chemicals are poorly understood at this time.

Because there may be small individual uncertainties at each step of the risk assessment process, these uncertainties may become magnified in the final risk characterization. The final quantitative estimates of risk may be as much as an order of magnitude different from the actual risk associated with a given site. In an attempt to minimize the consequences of uncertainty, Agency guidance typically relies upon use of conservative estimates of hazard in the absence of comprehensive appropriate data. The overall result is that risk estimates presented in this report are more likely to overestimate the actual risks than to underestimate them.

This assessment has been prepared in a manner consistent with that generally used in the consulting community and Agency guidance at the time it was prepared. It is likely that risk assessment methods and the data identifying and quantifying the toxicity of chemicals will improve with time. Consequently, unsuspected hazards at this site may be identified at a later date. This assessment was based upon available data, using currently available risk assessment methodology.

7.0 FEASIBILITY STUDY

The purpose of the feasibility study (FS) is to identify and screen appropriate and applicable remediation technologies for implementation in impacted areas containing contaminated soil and groundwater located at NASA's Wallops Flight Facility (WWF) Site 16. Prior to developing this FS, a human health and ecological risk assessment was completed to determine current potential risks to human health and to predict future risks as a result of uncontrolled releases of chemicals from Site 16. The Risk Assessment determined values for carcinogenic risks and non-carcinogenic hazards within the acceptable ranges of 10^{-06}, one in one million chance of developing cancer from exposure, to 10^{-04} for carcinogenic risk, and less than 1 for non-carcinogenic Hazard Indices for human health and develops EEQs for evaluation of ecological risk.

Remediation is generally not required where field data produces calculated results that are less than these risk ranges and no applicable or relevant and appropriate requirements (ARARs) are exceeded. However, current EPA guidance (OSWER Directive 9355.0-30, April 22, 1991) also indicates that risk managers may require remedial action at sites with relatively low risks, where ecological risks to sensitive receptors are present, and/ or other factors are deemed significant. Other factors that may affect the decision-making process are proposed standards To-be Considered (TBC's), and community acceptance of the proposed selected remedial action.

At the outset of the RI/FS process, NASA, VDEQ, and EPA agreed that remedy selection would be based on land use assumptions that the current industrial use of the sites would continue in the future. For Site 16, no unacceptable risks or hazards for human or ecological receptors were identified for the surface soil present at the site. However, unacceptable risks are associated with future groundwater use for the site.

The release which resulted in the Site 16 WOD appears to date from the 1940s and 1950s (Ebasco, 1992). Groundwater flow velocity calculated for the site indicates that the plume has had ample time to reach surface water bodies and is, therefore, fully reflected in the surface water and sediment data collected during the Site 14 and 15 RI/FS. The site history would also suggest that the plume is fully developed and concentrations may reasonably be expected to decline under the influence of naturally occurring indigenous organisms over time.

Contaminant concentrations in downgradient wells WFF16-GW3, WFF16-GW4, and WFF-GW5 drop off precipitously from those detected in the source area wells WFF15-GW7 and

WFF16-GW2S/GW2D. Three of the four downgradient wells exhibit no VOCs, no SVOCs (except bis(2-ethylhexyl)phthalate that was detected at very low concentrations consistent with laboratory contamination and background concentrations), and no pesticide/PCBs detected. Downgradient well WFF15-GW1 detected low levels of VOCs, SVOCs, and a single detection of 4'4'-DDT (in a duplicate) but still substantially less than those detected in the source area wells, WFF15-GW7 and WFF16-GW2S/GW2D. Similarly, TPH-GRO and TPH-DRO also are substantially less in downgradient wells (0.92-1.61 ppm) than in the wells located within the source area (1.21-85.4 ppm). As with the other organic compounds, downgradient well WFF15-GW1 had the highest TPH concentrations (0.92-1.61 ppm) with the other downgradient wells generally less than the 1 ppm VDEQ UST program guidance level, with the exception of WFF-GW3 (1.14 ppm) in the 2000 data.

Metals concentrations, including the risk-driver, arsenic, also decline dramatically in downgradient wells. Arsenic declines from concentrations in the source area wells of 18.2 - 88.2 ppb (across all rounds) to ND(1.6) - 11.1 ppb in downgradient wells (across all rounds). With the single exception of the 1998 arsenic detection for WFF16-GW3 (11.1 ppb), all downgradient well concentrations are less than or equal to the arsenic concentrations detected in the background well, MW-3 (1.6 - 5.4 ppb).

Therefore, it appears that groundwater is only materially impacted where it is direct contact with contaminated soil. In this respect, there is little evidence of a groundwater plume in the traditional sense of the term. It seems likely that a contaminant plume emanating from the WOD once existed, but that past soil excavation activities at the Site 16 WOD and natural attenuation have largely mitigated groundwater risk at the discharge points. Because contaminated groundwater appears to only largely exist within the footprint of the contaminated soil area, this FS focuses on source control measures or measures that would restrict the future use of the groundwater within the site area.

Sections 7.1 and 7.2 present ARAR information and background information, and introduce the assumptions upon which the FS is based. Section 7.3 identifies available remedial technologies, develops screening criteria used to select appropriate technologies. Section 7.4 provided a summary and brief conclusions. Appendix E contains cost breakdown sheets..

The FS presented here was established following the format outlined in the U.S. EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under the Federal

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)" (OSWER Directive 9355.3-01; October, 1988).

7.1 Applicable or Relevant and Appropriate Requirements

Applicable or relevant and appropriate requirements are used to determine the extent of site cleanup, to scope and formulate remedial action alternatives, and to govern the implementation and operation of the selected action or actions. The National Contingency Plan (NCP) requires that remedial actions taken under the CERCLA comply with all federal regulations that are applicable or relevant and appropriate to the remedial activities performed at the site, unless specific waivers are granted by the EPA. The remedial action selected under CERCLA Section 121(d) for Site 16 must comply with federal and state environmental laws that are either applicable or relevant and appropriate.

The NCP identifies two categories of remedial action requirements:

- ARARs, and
- Other criteria, advisories, guidance, and proposed standards To-Be Considered.

By definition, an ARAR can either be an "applicable" or "relevant and appropriate" requirement that relates to a remedial action. "Applicable" requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, waste constituent, remedial action, location, or other circumstance at both WFF Site 16.

"Relevant and appropriate" requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that are not "applicable" to circumstances at a site as described previously, but are appropriate for problems or situations sufficiently similar to those encountered at the site. TBCs are federal and state criteria, advisories, guidance, and proposed standards that are not legally binding, but may provide useful information or recommended procedures. TBCs generally fall within four categories:

- Health effects information,
- Technical information,
- Policy, and
- Proposed rules and regulations.

7.1.1 Identification of Potential ARARs and TBCs

ARARs are divided into three categories:

- Chemical-specific,
- Location-specific, and
- Action-specific.

Chemical-specific ARARs are usually health- or risk-based requirements that are often expressed as numerical values and, when applied to site-specific conditions, establish the acceptable quantity (concentration) of a chemical that may be found in, or discharged to the ambient environment.

Location-specific ARARs are requirements that place restrictions either on the concentration of a hazardous substances or the conduct of activity solely, because they are physically present or occurring within specific locations (i.e., wetlands, floodplains, historic sites, etc.).

Action-specific ARARs are usually technology- or activity-based requirements that are triggered by the particular remedial activities that are selected to accomplish a remedy (i.e., controlling air emissions as a result of remedial activities, etc.). ARARs establish a cut-off level for determining how much of a medium must be treated or removed. The ARAR assessment for this FS follows the protocols outlined in the August 8, 1988, interim final version of the U.S. EPA guidance, CERCLA Compliance With Other Laws Manual.

Chemical-specific, location-specific, and action-specific ARARs and TBCs, as they apply to Site 16, are presented and discussed individually in the following sections.

Chemical-Specific ARARs

Chemical-specific ARARs include federal and state requirements regulating contaminant levels in various media. These regulatory levels are necessary for selecting and developing remedial objectives that comply with regulatory requirements or guidance, as appropriate. Only those specific chemicals identified as "chemicals of concern" in the risk assessment for Sites 16 were used for identification of potential chemical-specific ARARs.

Specific cleanup levels for soil have not been developed by the Commonwealth of Virginia with the exception of a 100 ppm TPH guidance level and 11,000 ppm saturation level embraced by the VDEQ UST program. Generally, cleanup levels are established with the goal of minimizing the risks to human health, and are determined on a site-by-site basis. Cleanup levels take into consideration the to soil type and typical background concentrations. While site soils often exceed the 100 ppm TPH guidance level, they do not exceed the 11,000 ppm TPH saturation level used to gauge whether free product would be expected. Additionally, even wells installed within the source area did not detect free product on the groundwater table. With no current groundwater users, the VDEQ UST program generally does not require remediation of site soils. The VDEQ UST program also uses a 1 ppm groundwater guidance level. Although this level is exceeded within the source area wells, WFF15-GW7 and WFF16-GW2S/GW2D, it is not materially exceeded in downgradient wells (a 1.61 ppm maximum concentration in WFF15-GW1 and 1.14 maximum concentration in WFF16-GW3).

Chemical-Specific TBCs

No TBCs were identified.

Location-Specific ARARs

Areas requiring environmental evaluation are those locations that have the potential for releasing contamination to the environment, resulting in an adverse impact to the local environment and human receptors. These activities/conditions include potential hazards associated with exposure to contaminated soil and future use scenarios related to property transfer. No location-sensitive areas were identified on Site 16.

Action-Specific ARARs

No action-based ARARs were identified for Site 16.

7.1.2 Exceptions to ARAR Compliance

According to the Superfund Amendments and Reauthorization Act of 1986 (SARA), requirements may be waived by EPA under five specific conditions, provided that protection of human health and the environment is ensured. The conditions under which waivers are permitted under SARA include the following:

- The selected remedial action is an interim remedy or portion of a total remedy that will attain the standard when complete;

- Compliance with such requirements will result in greater risk to human health and the environment than alternative options;

- Compliance with such requirements is technically impractical from an engineering perspective;

- The selected remedial action will provide an equivalent standard of performance using another approach; and

- The requirement is a state requirement that has been applied inconsistently.

None of the exceptions described above apply to the alternatives investigated for the contaminated soils at either Site 14 or Site 15.

7.2 Basis and Assumptions

In order to develop and screen alternatives and receive information from vendors, several assumptions and generalizations were made. Technology screening and cost estimates are based on these assumptions. Because groundwater risk is present only in areas where groundwater is in contact with contaminated soil, all soil volumes calculated for costing purposes are based on removing or treating the contaminated soil at Site 16 to eliminate its contact with groundwater.

All of the alternative technologies considered in this report are cost-sensitive to the volume or area of contamination. Volumes and areas are based on the assumption that the contamination is located in the areas specified in Sections 3 and 4, and has not migrated extensively to adjacent areas. This assumption is considered valid for the soil type and observed contamination at Site 16. Lateral migration in the subsurface is considered to be negligible based on the environmentally acceptable results of proximal samples.

This FS has been prepared based on the numerical findings of the ERA and human health risk assessment. It specifically does not address the numerous uncertainties discussed in Sections 5 and 6. This FS assumes (indirectly) that the future land use will be continued industrial activity. Therefore, this FS only addresses groundwater remediation via source control measures,

since the lack of a pervasive plume downgradient of the source are largely mitigates the need for active plume management or control. In this respect, institutional controls, such as deed restrictions, are considered the minimally acceptable remedial action.

7.3 Screening and Analysis of Alternatives

The screening and evaluation of process options is typically performed in three phases. The first phase consists of identifying potentially applicable process options and technologies and eliminating from further consideration those shown not to be applicable or potentially cost-effective for the identified contaminant. The second phase, after the initial screening, evaluates the applicability of each option remaining for meeting the remedial action goals. The third phase involves a preparing a detailed evaluation and analysis and a cost breakdown, for each of the remaining alternatives. The overall purpose of the FS screening process is to eliminate from consideration those technologies with a low probability of success or are impractical, when implemented under site specific conditions.

7.3.1 Phase I: Screening of Potential Alternatives

During the initial phase, Versar identified technologies based on site characteristics and contaminant types. In order to develop a remedy for Site 16, the following items were considered:

- **Remedial Action Objectives**

  Remedial action objectives are those levels of cleanup or other measures taken to assure that human health, welfare, and the environment are adequately protected. Remedial action objectives are established based on the environmental media, potential exposure routes, and allowable exposure levels. As discussed earlier, the remedial action objective for Site 16 is to prevent future human exposure to contaminated groundwater. Given the nature and extent of groundwater contamination observed at the site, this objective is best met by source control measures to eliminate contact between contaminated soil and groundwater or restrictions on groundwater use.

- **General Response Actions**

  General response actions are broad categories of responses that satisfy the remedial action goals. General response actions for Site 16 include: no action, institutional controls, containment, and excavation and disposal.

- **Identification of Volumes of Concern**

  The area of contaminated soil for Site 16 was calculated to be approximately 6,925 square feet. Using an average depth to groundwater of 20.5 feet, the volume of contamination is estimated to be approximately 5,300 cubic yards (yd^3) which is approximately 7,950 tons.

- **Identification and Evaluation of Technologies**

Potentially applicable technologies and processes were identified based on remedial action objectives, general response actions, and the volume of contaminated material. An initial evaluation of these technologies in the Phase I screening is made based on implementability, effectiveness, and cost.

Implementability considers both the technical and administrative feasibility of implementing a technology. Technologies that are clearly unworkable are eliminated from further consideration. Effectiveness of a technology is its potential to meet the remedial action objectives. Technologies that are unreliable or that can not achieve response objectives are eliminated from further consideration.

Cost plays a limited role in the initial evaluation of technologies. Technologies that are considered to be prohibitively expensive, or that do not provide benefits commensurate with their costs, are eliminated from further consideration.

Table 7-1 summarizes the results of the Phase I screening of available process options for the soil contamination impacting groundwater at Site 16. Included in the table are general response actions, associated remedial technologies and process options, descriptions of the options, and the associated screening comments. Each technology is discussed individually in the following sections. In cases where a technology is simplistic, common, and well understood,

the discussion is not extensive. Where a technology is innovative or used in an "alternative" application (e.g., for waste treatment and disposal), more detailed discussion is provided.

Some of the technologies identified during screening process may require pilot scale treatability studies to determine full scale treatment parameters. Although a specific technology may appear reasonable based on past experience, its use may require pilot scale verification because of site-specific or other conditions. Treatability testing satisfies a number of purposes, the most important of which is to ensure that the technology is appropriate for the soil type and for the treatment of the metals and pesticides encountered. Another purpose for treatability testing is determining the necessary full scale design parameters. During the remedial design phase, a site-specific design is developed at the bench, pilot, or field scale. These parameters facilitate proper sizing of units and generate measures of effectiveness to ensure that the design is efficient and cost effective.

The following options have been identified and evaluated for addressing contaminated soils at Site 16.

No Action. The no action option can be is easily implemented; however, it would be ineffective in addressing the remedial action objectives. Long-term monitoring of the site would be required. The no action option is retained for comparison purposes only.

Institutional Controls. For human populations, institutional controls effectively accomplish the remedial action objectives by restricting future land use (deed restrictions). This option can easily be implemented, but would require the costs associated with long-term monitoring.

Containment. Containment is accomplished by capping the site with a low permeability material. Low permeability caps minimize surface water infiltration and prevent exposure to the contaminated material. In some cases, caps are used in conjunction with other waste treatment technologies such as slurry walls, enzyme injections, and other in-situ treatment methods. Installing a cap does the following:

- Prevents human or animal exposure by isolating untreated material (unnecessary based on HHRA and ERA);

- Reduces or prevents the vertical infiltration of water through contaminated soil which reduces or eliminates the creation of contaminated groundwater;

- Controls gas emissions from the underlying contaminant (unnecessary based on HHRA and ERA); and

- Creates a land surface to support vegetation or to be used for other purposes (unnecessary since the site is already vegetated).

The design of low permeability caps is site-specific and depends on the intended functions of the system. The caps can be of natural, synthetic, or a composite material. Many construction techniques are available. Caps construction techniques can range from a simplistic one-layer system of vegetated soil or asphalt to a complex multi-layer system composed of soils and geosynthetics liners. The long-term cost of a cap installation could be high because it requires periodic inspections and monitoring to ensure that the integrity of the cover is maintained and that the containment has not been comprised which would result in a contaminant release.

Installation of a cap over the contaminated areas at Site 16 would not be effective in addressing the remedial action objectives because of horizontal flow of groundwater would result in the water table remaining in contact with contaminated soil.

Insitu Treatment. This option involves injecting chemicals, such as hydrogen peroxide or oxygen releasing compounds into the soil to either destroy organic chemicals via chemical reaction or enhance biological activity (bioremediation). In either case, neither of these technologies would address risks associated with the risk driver arsenic and are rejected for failing to achieve remedial action objectives.

Excavation and Disposal. This dual phase option begins with the removal of the contaminated soil utilizing conventional construction and excavation techniques. Following removal, several alternatives for disposal of the contaminated material may be considered. The following discussion separates the alternatives into two categories: off-site treatment and on-site treatment/disposal.

Off-site Disposal. The soils excavated from Site 16 would be transported off site for disposal. For costing purposes, the material has been classified as a special waste due to TPH concentration detected. These soils can not be disposed of in a municipal landfill. If RCRA

testing determines that the soil is hazardous, then there are two options for off-site disposal: hazardous waste landfill or hazardous waste incineration.

- Hazardous Waste/Special Waste Landfill

Disposal of hazardous wastes in a permitted hazardous waste or special waste landfill does not reduce the long-term environmental liability, because it does not permanently destroy the contaminants of concern only relocates them to a more controlled environment. This option is retained, because it is effective in meeting the remedial action objectives and it can be implemented. However, the initial cost may be quite high since this method includes high transportation costs and high associated landfill tipping fees.

- Hazardous Waste Incineration

Incineration at a permitted hazardous waste incinerator minimizes the long-term environmental liability by permanently destroying the some of the contaminants of concern. The ash (burned soil) is disposed of in a hazardous waste landfill, but all liability is assumed by the incinerator owner and operator. This alternative, in many cases may be the most prudent long term option, because incineration would permanently destroy the organic contaminants in the soils, but will not alter the arsenic contamination significantly. However, the final disposal of ash will effectively minimize the long term liability. This option is retained because it is effective in meeting the remedial action objectives and it can be implemented. However, the initial cost will be significant due to both high transportation costs and the thermal treatment costs, and the expense of assuming the liability for the waste.

On-site Treatment Disposal. Limited technologies exist for treating contaminated soil on site:

- Bioremediation

Bioremediation is the biodegradation or bio-oxidation of organic compounds by micro-organisms. A soil bioremediation process normally uses conventional soil management practices to enhance the microbial degradation of organic contaminants. This process may be performed in situ or in tanks, piles, or farms on site. Several different applications of bioremediation are listed in **Table 7-1.** All technologies use the same process of bio-oxidation; however, each variation exposes the soil and micro-organisms to nutrients in a different manner.

Limited treatment data is available for the successful bioremediation of Benzo(a) pyrene, other PAHs, and 4,4-DDT in contaminated soils as found at Site 14. This process would not be effective at treating the arsenic in the soil. This option is rejected from further consideration because it is not proven effective in addressing the remedial action objectives at Site 16 for dealing with arsenic.

- Soil Washing

Soil washing is a physical method that can be used to remove contaminants from soil. In the soil washing process, contaminated soil is fed into a washing unit and then passed into a soil scrubber where it is sprayed with washing fluid that may be composed of water, organic solvents, surfactants, or acids/bases. Following treatment, the contaminated fluid is sent into a treatment system for decontamination and or recycling.

Although this technology is less costly than other processes (hazardous waste landfill and/or incineration), it would require the excavation of the soil to be effective. Additionally, multiple solutions (to address organics and arsenic) would be required. This option is rejected from further consideration because it is difficult to implement and is not effective in addressing the remedial action objectives.

- Vapor Extraction

Vapor extraction involves the installation of extraction wells screened in the vadose (unsaturated) zone. Vacuum extraction pumps are attached to the wells, and soil vapors are extracted from the subsurface and treated prior to release into the atmosphere. This technology is best suited to sites with highly permeable soils and volatile organic contaminants.

This technology may be implemented while the soil is in place or after excavation. Because the contaminants of concern at Site 16 are not exclusively volatile organic compounds, this technology could not be successfully implemented and would not be effective in addressing the remedial action objectives. Hence, this option is rejected from further consideration.

- Stabilization/Solidification

Stabilization/solidification can be performed in situ or through some method of encapsulation in a container or vessel. In situ stabilization/solidification is done by deep soil

mixing and direct application of stabilizing agent into the soil forming a block stabilized material. At the end of the treatment process, the treated block of soil is left in place.

The process of stabilization/solidification reduces the mobility of the hazardous constituents by binding the contaminants into a solid matrix of low permeability and very low leaching potential. Typically, this technology is used for addressing metals contamination. The binding process can be categorized into four major groups based on the type of stabilizing/ solidifying agent used. The main stabilizing/solidifying agents are: cement based, silicate based, thermoplastic based, and organic polymer based.

The short-term environmental impact of the stabilized/solidified waste is small; however, the long-term reliability of the stabilization is unknown. Also, the release from long-term liability is questionable, because the contaminants remain at the site and are only immobilized. This option is rejected from further consideration because while the process addresses the metals in the matrix causing them to become immobile (low leaching potential), it may not entirely address the remedial action objectives for organic compounds and has low long term engineering reliability. The implementation of this process would require either costly deep trenching or large diameter augers (mixing augers) which may not be practical at Site 16 given the airfield operations.

- Solvent Extraction

Solvent extraction uses an organic solvent to separate organic contaminants from soils, sludges, and sediments, thereby reducing the volume of hazardous waste that must be treated. In general, a solvent that preferentially removes hazardous organics is mixed with the contaminated media to transfer contaminants from the media to the solvent phase. The contaminants are then separated from the solvent with a temperature or pressure change and the solvent are then recycled. Solvent extraction does not destroy wastes, but is generally used as one method in a series of unit operations, and can reduce the overall cost of managing the remediation at amenable types of site.

Solvent extraction has been known to work effectively but requires extensive bench- and pilot-scale as treatability studies to determine the most effective solvent and optimum reactor conditions. Treatment is likely to be required for the separated liquids (used solvent) and is a substantial part of the total process costs. The soils at Site 16 were found to contain arsenic and other metals that undergo strong reactions under alkaline conditions and may impact process

feasibility. The technology is still considered to be in innovative stages and further studies are required before its application on a full-scale basis. Solvent extraction is rejected from further consideration because site-specific conditions prevent it from being implemented.

- Vitrification

Vitrification is utilized to create a glass like material by heating a mixture of soil and sand to the melting point and then allowing it to cool. For sites which contain silty clay soils the addition of sand may be required prior to initiating the heating process. An electric current is then applied to the mixture, heating it to the melting point. Once the sand and other soil constituents have melted, the mass is cooled gradually. A solid mass of soil and contaminant is created. This process may be applied both in situ and ex situ. For in-situ processes it should be recognized that during the heating process any volatile organic compounds may be vaporized with potential release to the atmosphere. This use of this method would require that a vapor collection and treatment system be constructed to treat the off-gas vapors generated as part of the process and insitu methods have enormous power requirements to treat soil near the water table.

Like stabilization, this technology does not reduce the volume or long-term liability of the contaminant. Vitrification is rejected from further consideration because it has poor implementability does not meet the remedial action objectives.

- Low Temperature Thermal Treatment

Low temperature thermal treatment is typically used for petroleum related contamination and other volatile organic compounds. Additionally this type of process has the same operational limitations as that of a full thermal incinerator, only to a lesser degree. This option is rejected from further consideration because it does not meet the remedial action objectives (fails to address arsenic).

7.3.2 Phase II: Screening of Process Options

The second phase of the screening process further considers the alternatives that remain after the initial screening process. Within each technology type, the effectiveness, implementability, and cost are evaluated and compared to one another. Emphasis is placed on the effectiveness of the options in addressing the remedial action goals.

In order to further reduce the potential candidate list, alternatives were eliminated from consideration during Phase II screening for the following reasons:

- the technology did not significantly meet the remedial action goals, and
- the technology not feasible due to site-specific conditions, contaminant matrix, or contaminants.

Care was taken to ensure that the surviving technologies did not require additional institutional controls (i.e., restrictions on future land use) or extensive continuing operations and maintenance (O&M) programs.

Table 7-2 presents the results of the Phase II screening of available process options for the soil contamination that impacts groundwater at Site 16. Included in the table are general response actions, remedial technology, process options, and the evaluation of the process options concerning effectiveness, implementability, and relative cost. Each option in the table is discussed below.

No Action. As discussed earlier, no action would not be effective in addressing the remedial action objectives. This option would not reduce the contaminant mobility, volume, toxicity, or future liability of the contaminant. Also, some long-term monitoring would be required. This option is retained for comparison purposes.

Institutional Controls. Implementing institutional controls at Site 16 are easily accomplished. The site is inside of a restricted access facility with a perimeter fence. No additional standard fencing or a natural vegetative brush barrier is required to further limit access to the areas, because no unacceptable risks for surface soil were demonstrated by the HHRA and ERA. Deed restriction equivalents limiting future land use could also be imposed on the property. This option is effective in addressing the remedial action objectives by eliminating future development of groundwater in the site area. It does not reduce the volume, toxicity, or mobility of the contaminant except through natural attenuation. Based on the low levels of contaminants encountered, this option is acceptable. This option requires long term monitoring. This option will be retained for further consideration.

Excavation and Disposal. This dual phase option begins with the removal of the contaminated soil utilizing conventional construction and excavation techniques. Following removal, the contaminated soil would be treated off site.

The soils excavated from Site 16 would be transported off site for disposal at a special waste landfill. This alternative effectively addresses the remedial action objectives by removing the contaminants and the source of future contamination. However, the cost of this alternative is significant due to high transportation requirements along with the high disposal fees. This option, which involves landfilling the waste, does not reduce the long-term environmental liability because it does not permanently destroy the contaminants of concern, only relocates them to a more controlled environment.

7.3.3 Phase III: Detailed Analysis of Alternatives

The detailed analysis of the alternatives involves a comprehensive evaluation of remedial action objectives, general response actions, volume of contaminated material, and cost. The goal of this section is to combine all of these elements into a viable, effective remedial plan. Each alternative that has passed through the initial two phases of screening will be evaluated according to the nine CERCLA criteria for evaluating and selecting remedial alternatives:

- **Overall protection of human health and the environment.** This provides a final check to assess whether each alternative adequately protects human health and the environment.

- **Compliance with ARARs**. This discusses whether alternatives will meet all federal and state ARARs identified for the site. When an alternative meets the ARAR, this criterion describes how compliance is established. When an alternative does not meet an ARAR, the justification for a waiver allowed under CERCLA is discussed.

- **Long-term effectiveness and permanence**. This addresses the results of a remedial action in terms of the risk remaining at the site after remedial objectives are met. Controls required to manage the risk posed by treatment residuals or untreated wastes are described.

- **Reduction of toxicity, mobility, or volume through treatment.** This criterion addresses the statutory preference for selecting remedial actions employing treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances.

- **Short-term effectiveness**. This criterion addresses the effects of the alternatives during the construction and implementation phase until remedial objectives are met. Alternatives are evaluated with respect to their effects on human health and the environment, if applicable, during implementation of the remedial action.

- **Implementability**. The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Technical feasibility addresses construction and operational concerns and the reliability of technologies used. Administrative feasibility addresses activities needed to coordinate with other agencies (e.g., obtaining permits).

- **Cost**. This criterion addresses how total alternative costs, including capital and 0&M expenses, compare to one another.

- **Local government acceptance**. This criterion evaluates the technical and administrative issues and concerns the local government agencies may have regarding each of the remedial alternatives. Actual acceptance will, of course, be dependent upon their response to the proposed plan.

- **Community acceptance**. This criterion evaluates the issues and concerns the public may have regarding each of the alternatives. Actual acceptance will, of course, be dependent on their response to the proposed plan.

After the Phase I and Phase II screening evaluations were performed on potentially applicable remedial technologies, three process options remained for detailed analysis: Alternative A - no action; Alternative B - institutional controls, and Alternative C- excavation and off-site disposal at an approved facility.

The detailed analysis of alternatives consists of the evaluation and presentation of the relevant information needed to select a site remedy. In the detailed analysis, each alternative is

assessed against the nine CERCLA evaluation criteria described previously. The results of this assessment are arrayed to compare the alternatives and identify the key tradeoffs among them. This approach to analyzing alternatives provides information to compare the alternatives, select an appropriate remedy for the site, and demonstrate satisfaction of the CERCLA remedy selection requirements.

The specific statutory requirements for remedial actions that must be supported by this study for Site 16 are listed below. The selected alternative must:

- Be protective of human health and the environment;
- Attain ARARs (or provide grounds for invoking a waiver);
- Be cost-effective;
- Utilize permanent solutions and alternative treatment technologies to the maximum extent practicable; and,
- Satisfy the preference for treatment that reduces the toxicity, mobility, or volume, and/or provide an explanation as to why it does not.

In addition, Section 121(b)(1)(A) of CERCLA emphasizes evaluation of long-term effectiveness and related considerations for each of the remedial alternatives.

Alternative A - No Action

Alternative A consists of taking no remedial action.

Assessment of Alternative A

This alternative is not effective over the long term and has no indications of permanence. The contaminants at Site 16 remains on site in a relatively uncontrolled condition. Other than by natural attenuation over time, no reduction of toxicity, mobility, or volume would be realized in the implementation of the No Action alternative. The areas of concern would essentially remain in their current state or extent. The possibility of contaminant migration exists, thereby decreasing overall contaminant concentrations through dissolution of the original source area.

However downgradient areas will be impacted to a lesser extent, thus increasing the contaminated volumes of materials (soils and groundwater) but at lower concentrations. The short-term effectiveness of this alternative can not be evaluated, because the site remains unchanged. Capital costs associated with this alternative are negligible.

This alternative is technically feasible, with the action proposed requiring no implementation. Capital costs associated with this alternative are negligible. Federal, state, and local agencies and offices may not view this alternative favorably.

Alternative B - Institutional Controls

In this alternative, institutional controls would be installed to prevent development of groundwater within the contaminated areas. Natural attenuation of the organic contaminants would contribute to the breakdown of the source area. This alternative would require some monitoring. Because the risk assessment determined values for carcinogenic risks and non-carcinogenic hazards are within the acceptable range for soils and no groundwater user are threatened, this option is appropriate and protective.

Assessment of Alternative B

This alternative is effective in the long term by eliminating exposure risks and is a permanent solution. The affected areas of concern would have to be remediated in the future, if groundwater use were to be permitted.

Other than natural attenuation of the organic contaminants over time, no significant reduction of toxicity, mobility, or volume of the arsenic would be realized in the implementation of the Institutional Controls alternative. However, microbial action would be expected to reduce organic concentrations. The area of concern would remain in its current state. The possibility of contaminant migration exists; however, given the age of the site and rate of groundwater flow, it is likely that the plume is fully developed and that natural attenuation will drive contaminant concentrations lower. The short-term effectiveness of this alternative is that these controls will limit exposure to humans. Capital costs associated with this alternative are minimal, and the alternative is technically feasible.

Implementation of this option will require long term monitoring. A five-year annual groundwater monitoring program was used for FS costing purposes. If after five years,

contaminant concentrations continue to decline in the source area wells, and increased contaminant concentrations are not detected in downgradient wells, then the monitoring program will have demonstrated (over approximately a decade's time) that effective natural attenuation is occurring and the monitoring program may be ended.

This alternative is easy to implement and should not pose a risk to human health or the environment because the HHRA and ERA determined that risk from the surface soil is negligible. Groundwater poses little risk in its current state since there are no current users, groundwater contamination is limited to the immediate vicinity of the source area, and no high concentration plume (in the traditional sense of the term) appears to currently exist. Although it appears likely that plume existed in the past (given the age of the site dating back to the 1940s to 1950s), it appears to have largely dissipated.

This alternative may be acceptable to local regulatory agencies and the local community because there are no current groundwater users downgradient of the site, the site is located at the end of the airstrip and so no future development seems likely, and site ecological risk is negligible.

Costs for this alternative are based on sampling site wells for full TCL/TAL parameters on an annual basis and preparing an annual monitoring report for five years. Costs are skewed in year one for administrative costs associated with establishing site use restrictions. Net present value for this alternative are $114,928. Considering a 6% cost escalation, total cost to NASA is $ 153,800.

Assessment of Alternative C

This remedial alternative will protect human health and the environment from the contaminated soil. The contaminated soils would be excavated and removed from the site for treatment and disposal. Any existing risk would be reduced by the removal action and will entomb the Site 16 contaminants at a controlled facility.

Remedial Action Objectives will be attained because: (1) contaminated materials will be removed from the site; (2) with the source are removed, groundwater contaminant concentrations should decline rapidly.

Once the contamination is removed from the site and the environmental liability will be assumed by the landfill owner/operator (once the soil is received), thus long-term liability will be eliminated. Once the contaminated soil is removed from the site, there will no longer be source area for the ongoing generation of dissolved phase contamination in groundwater. Also, no future remedial controls will be required to maintain the long-term effectiveness of this remedial alternative.

This alternative would eliminate the toxicity and reduce the volume of the contaminated media at the site by removing and disposing of the soil. A certificate of disposal will be issued by the facility, which removes long-term liability.

Implementation of this alternative should not pose a risk to human health or the environment. During excavation, the soils should be kept moist to minimize the release of potentially contaminated dust particles. Workers performing soil excavation at the site would be properly equipped with personal protective equipment (PPE) and be fully certified for hazardous waste work (according to OSHA regulations in 40 CFR 1910).

This remedial alternative is moderately difficult to implement. Equipment required for the excavation work is available in the area, but restrictions on use may be required to maintain flight operations. OSHA-certified workers will be required for the work. Clean backfill is available from nearby sources and is inexpensive.

This alternative may be acceptable to the local regulatory agencies and the local community, because the excavated contaminated soil will be permanently removed from the property, thereby eliminating any significant hazard or risk to human health and the environment. The material will be managed and disposed according to applicable regulations. Also, the remedial action could be implemented quickly, which the community and local agencies may view favorably. Any existing site restrictions would be eliminated and long term monitoring would not be required.

Many factors affect the cost of this alternative. The cost of soils excavation is greatly dependent on site-specific conditions and soil volume. Excavation depth, surface characteristics, soil type, and health and safety requirements all affect the costs.

Because this alternative requires offsite disposal of the contaminated soil, transportation is necessary. Transportation costs increase in proportion to the number of times the material is

handled. The transportation costs for this alternative are considered to be high. Disposal costs are also generally considered high. Quantity and type of material strongly affects the price. Remedial cost estimates are presented in Appendix E.

Site 16 is situated adjacent to a runway frontage road with good site access and using typical construction equipment. However, the required work activities may impact the operation of the air strip. The Site 16 area is fairly open with only a minimal vegetative cover and moderate existing slopes.

The site is easily accessible and excavation depths are estimated to be 20-25 feet below grade. During remedial activities, workers will wear Level C PPE during excavation. The use of this PPE in the hot environment will reduce worker efficiency by as much as 50 percent, directly affecting the cost.

The cost to complete the scope includes soil excavation via backhoe on a per cubic yard (yd^3) basis of approximately 5,300 yd^3 of contaminated soil; transportation to a licensed facility; landfill disposal at the facility; and backfilling, regrading, and replanting vegetation in these areas. The capital cost, including QA/QC, is $620,758. Adding costs for engineering design (15 percent), construction management (15 percent), startup (10 percent), bonds and permits (2 percent), legal fees (3 percent), and unforeseen contingencies (20 percent) brings the total capital cost for this alternative to $962,176 and no significant additional long term costs are required.

7.4 Summary and Conclusions

Four potential remedial technologies have been described and evaluated. The following is a summary of the findings presented in the preceding sections and recommendations based on the analysis.

The remedial alternatives remain after the screening are:

- Alternative A - No action,
- Alternative B - Installation of Institutional Controls ($153,800), and
- Alternative C - Soil excavation, transportation, and disposal ($962,176).

The alternatives were screened in the second phase according to effectiveness, implementability, and other pertinent criteria in order to determine suitability of each alternative to achieving the remediation goals. However, effectiveness at reaching and sustaining the remedial action objectives is the ultimate goal of any of these alternatives.

In the third phase, a detailed analysis of each process option was evaluated based on probable achievement of nine CERCLA criteria for selecting remedial alternatives. These criteria are the overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long-term effectiveness and permanence; reduction of mobility toxicity, or volume of contaminants; short-term effectiveness; implementability; cost; local government acceptance; and community acceptance. Throughout the feasibility study, the no action alternative was retained for comparison purposes. The no action alternative does not meet remedial action objectives. Neither Alternative B or C apply treatment to reduce toxicity, mobility, or volume through treatment. However, Alternative B will eventually achieve a reduction in toxicity, mobility, and toxicity via natural attenuation and microbial degradation which Alternative C will not since landfilling will limit exposure to percolating groundwater as a source of nutrients/oxygen to indigenous microbes. Alternative C has better short term effectiveness, but significantly higher costs and exposure potential for workers performing the remediation relative to Alternative B.

8.0 REFERENCES

Abassi, S.S., and Soni, R. 1983. Stress-induced Enhancement of Reproduction in Earthworms *Octochaetus pattoni* Exposed to Chromium (VI) and Mercury (II) - Implications in Environmental Management. Int. J. Environ. Stud. 22:43-47.

Agency for Toxic Substances and Disease Registry (ATSDR). 1989. Toxicological Profile for Selenium. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990a. Toxicological Profile for Barium. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990b. Toxicological Profile for Copper. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1990c. Toxicological Profile for Manganese. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991c. Toxicological Profile for Chlordane. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991d. Toxicological Profile for Dieldrin. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991e. Toxicological Profile for Bis(2-ethylhexyl)phthalate. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991f. Toxicological Profile for Heptachlor Epoxide. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991h. Toxicological Profile for Beryllium. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991i. Toxicological Profile for Cadmium. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991j. Toxicological Profile for Chromium VI. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991k. Toxicological Profile for Nickel. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1991l. Toxicological Profile for Lead. U.S. Department of Health and Human Services. Public Health Service. October, 1991.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992c. Toxicological Profile for Antimony. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992d. Toxicological Profile for Mercury. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992e. Toxicological Profile for Vanadium. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992f. Toxicological Profile for Zinc. Draft. U.S. Department of Health and Human Services. Public Health Service. April, 1992.

Agency for Toxic Substances and Disease Registry (ATSDR). 1992g. Toxicological Profile for Aluminum. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993a. Toxicological Profile for Diethyl Phthalate. Draft. U.S. Department of Health and Human Services. Public Health Service. May, 1993.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993b. Toxicological Profile for Di(2-ethylhexyl)phthalate. Draft. U.S. Department of Health and Human Services. Public Health Service. April, 1993.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993c. Toxicological Profile for Chromium. U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Public Health Service. 1997. Toxicological Profiles. CRC Press, Inc.

Andelman, J.B. 1984. Non-ingestion Exposures to Chemicals in Potable Water. Working Paper No. 84-03, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA .

Andelman, J.B. 1985a. Inhalation Exposure in the Home to Volatile Organic Contaminants in Drinking Water. Science of the Total Environment, 47:443-460.

Andelman, J.B. 1985b. Human Exposures to Volatile Halogenated Organic Chemicals in Indoor and Outdoor Air. Environmental Health Perspectives, 62:313-318.

Beyer, W.N. 1990. Evaluating Soil Contamination. USFWS Biological Report. 90(2). July, 1990.

Beyer, W.N., and Stafford, C. 1993. Survey and Evaluation of Contaminants in Earthworms and in Soils Derived from Dredged Material at Confined Disposal Facilities in the Great Lakes Region. Environ. Monit. Assess. 24:151-165.

Beyer, W.N., Conner, E., and Gerould, S. 1994. Estimates of Soil Ingestion by Wildlife. J. Wildl. Manage. 58:375-382.

Beyer, W.N., Cromartie, E., and Moment, G.B. 1985. Accumulation of Methylmercury in the Earthworm, *Eisenia foetida*, and Its Effect on Regeneration. Bull. Environ. Contam. Toxicol. 35:157-162.

CambridgeSoft, 1998. www.chemfinder.com

Clarkson, T.M., and Marsh, D.O. 1982. Mercury Toxicity in Man. Clinical, Biochemical, and Nutritional Aspects of Trace Elements. S. Prasad, ed. Vol. 6. Alan R. Liss, Inc., New York. Pp. 549-568.

CRC Handbook of Chemistry and Physics. 1988-1989. 69th Edition. CRC Press, Inc.,Boca Raton, Florida.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Potential Contaminants of Concern for effects on Terrestrial Plants: 1997 Revision. ES/ER/TM-85/R2.

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997b. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision. ES/ER/TM-126/R2.

Eisler, R. 1987a. Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish Wildl. Serv. Biol. Rep. 85(1.11). 81 pp.

Eisler, R. 1987b. Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Contaminant Hazard Reviews, Biological Report 85. April, 1987.

Elhassani, S.B. 1983. The Many Faces of Methylmercury Poisoning. J. Toxicol. 19:875-906.

Environmental Protection Agency. 1979. Water-Related Environmental Fate of 129 Priority Pollutants. EPA-440/4-79-029a and EPA-440/4-79-029b.

Environmental Protection Agency. 1988. Proposed Revisions to the National Oil and Hazardous Substance Contingency Plan. 53 Federal Register 51394 (December 21, 1988).

Environmental Protection Agency. 1989a. Risk Assessment Guidance for Superfund - Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Solid Waste and Emergency Response. EPA/540/1-89/002.

Environmental Protection Agency. 1989b. Exposure Factors Handbook. EPA/600/8-89/043.

Environmental Protection Agency. 1991. Supplemental Guidance for Human Health Exposure Manual: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response. Memorandum dated March 25, 1991.

Environmental Protection Agency. 1992. Dermal Exposure Assessment: Principles and Applications. Interim Report EPA/600/8-91/011B.

Environmental Protection Agency. 1995. Compilation of Air Pollutant Emission Factors. Fifth edition. EXPOS, AP-42.

Environmental Protection Agency. 1997a. Exposure Factors Handbook. EPA Publication No. EPA/600/P-95/002Fa.

Environmental Protection Agency. 1997b. Health Effects Assessment Summary Tables (HEAST). FY 1997 Update. OERR 9200.6-303 (97-1).

Environmental Protection Agency. 1998a. Integrated Risk Information System (IRIS) Data Base. Washington, D.C. Accessed September 1998.

Environmental Protection Agency, Region III. 1998b. Risk-Based Concentrations Table. April, 1998.

Environmental Protection Agency, Region III. 2000a. Risk-Based Concentration (RBC) Table. http:/www.epa.gov/reg3hwmd/risk/riskmenu.htm.

Environmental Protection Agency, Region III. 2000b. Region III Technical Guidance Manual Risk Assessment - Assessing Dermal Exposure from Soil. http:/www.epa.gov/reg3hwmd/risk/riskmenu.htm.

Ershow, A.C. and K.P. Cantor. 1989. Total Water and Tapwater Intake in the United States: Population-Based Estimates of Quantities and Sources. Life Sciences Research Office, Federation of American Societies for Experimental Biology.

Freeze, R.A. and Cherry. 1979. Groundwater. Prentice Hall.

Foster, S.A. and P.C. Chrostowski. 1987. Inhalation Exposures to Volatile Organic Contaminants in the Shower. Presented at the 80th Annual Meeting of Air Pollution Control and Hazardous Waste Management (APCA), New York, June 21-26, 1987.

Gardner, A.L. 1982. Virginia Opossum (Didelphis virginiana), in Section 1. *Marsupiala, Insectivora, Chiroptera*, and *Xenarthra*. Wild Mammals of North America. Edited by J.A. Chapman and G.A. Feldhamer. The Johns Hopkins University Press.

Garten, C.T., Jr., and Trabalka, J.R. 1983. Evaluation of Models for Predicting Terrestrial Food Chain Behavior of Xenobiotics. Environ. Sci. Technol. 17:590-595.

Gas Research Institute (GRI). 1988. Exposure Model Handbook for Screening of Former Manufactured Gas Sites. Gas Research Institute, March 1988.

Greener, Y., and Kochen, J. A. 1983. Methylmercury Toxicity in the Chick Embryo. Terat. 28:23-28.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York.

Hartenstein, R., Neuhauser, E.F., and Collier, J. 1980. Accumulation of Heavy Metals in the Earthworm, *Eisenia foetida*. J. Environ. Qual. 9:23-26.

Hazelton, P.K., Robel, R.J., and Dayton, A.D. 1984. Preferences and Influences of Paired Food Items on Energy Intake of American Robins (*Turdus migratorius*) and Gray Catbirds (*Dumatella carolinensis*). J. Wildl. Manage 48: 198-202.

Howard, P.H. 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume I- Large Production and Priority Pollutants. Lewis Publication, Inc., Chelsea, Michigan.

Howard, P.H. 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume III Pesticides. Lewis Publication, Inc., Chelsea, Michigan.

Hubbard, J. Personal Communication between Jennifer Hubbard, EPA Region III, and Ann Cyrus, Versar Inc., May 26, 2000.

Howell, J.C. 1942. Notes on the Nesting Habits of the American Robin (*Turdus migratorius*). Am. Mild. Nat. 28:529-603.

Jones, D.S., G.W. Suter II, and R.N. Hull. 1997. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4.

Laird, J.M., and Kroger, M. 1981. Earthworms. CRC Crit. Rev. Env. Cont. 11:189-218.

Long, E.R., and Morgan, L.G. 1990. The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program. National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Seattle, Washington.

Long, E.R., Macdonald, D.D., Smith, S.L., and Calder, F.D. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Env. Manage. 19(1): 81-97.

Lyman, W.J., Reehl, W.F. and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods. McGraw-Hill Book Company, New York.

MacDonald, D.D. 1994. Approach and Assessment of Sediment Quality in Florida Coastal Waters, Florida Department of Environmental Protection, Tallahassee, Florida.

Merck Index 1989. Eleventh Edition. Merck Chemical Company, Rahway, New Jersey.

Metcalf and Eddy 1994. Environmental Resources Document.

Metcalf and Eddy, 1996. Site Inspection Report for Miscellaneous Sites at Wallops Flight Facility.

Morrison, P.R., Pierce, M., and Ryser, F.A. 1957. Food Consumption and Body Weight in the Masked and Short-tailed Shrews (genus *Blarina*) in Kansas, Iowa, and Missouri. Ann. Carnegie Mus. 51:157-180.

National Library of Medicine TOXNET Data Network.

Norman, G.R. and D.L. Streiner. 1994. Biostatistics, the Bare Essentials. Mosby-Year Book Inc., St. Louis, Missouri.

Office of Solid Waste and Emergency Response (OSWER). 1996. ECO Update: Ecotox Thresholds. US Environmental Protection Agency. EPA 540/F-95/038.

Persaud, D., Joagumagi, R., and Hayton, A. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of the Environment and Energy. ISBN 0-7729-9248-7.

T.J. Peterle. 1991. Wildlife Toxicology. Van Nostrand Reinhold, New York, New York.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3.

Sample, B.E., G.W Suter II, R.A Efroymson, and D.S. Jones. 1998. A Guide to the ORNL Ecotoxicological Screening Benchmarks: Background, Development, and Application. ORNL/TM-13615.

Steel, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics: a Biometrical Approach, 2nd Edition. McGraw-Hill, New York, NY.

Superfund Technical Support Center (STSC). Toxicological information provided by STSC, National Center for Environmental Assessment (NCEA), U.S. EPA, Cincinnati. OH. 1998.

Suter, G.W. 1993. Ecological Risk Assessment. Lewis Publishers, Chelsea, MI.

Suter, G.W. 1996. Toxicological Benchmarks for Screening Contaminant of Potential Concern for Effects on Freshwater Biota. Environ. Toxicol. Chem. 15:(7)1232-1241.

Suter, G.W., II and C.L. Tsao. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects of Aquatic Biota: 1996 Revision. ES/ER/TM-96/R2.

Syracuse Research Corporation. 1998. Database. Compilation of physical and chemical properties for selected chemicals.

Syracuse Research Corporation. 1998a. Database. Compilation of physical and chemical properties for selected chemicals.

Syracuse Research Corporation. EPIWIN v2.2 Database, October 1998b.

Tyler, A.V. 1973. Caloric Values of Some North Atlantic Invertebrates. Mar. Biol. 19:258-261.

U.S. Environmental Protection Agency (USEPA). 1986a. Test Methods for Evaluating Solid Waste, USEPA SW-846, Third Edition. September, 1986, with All Current Revisions.

U.S. Environmental Protection Agency (USEPA). 1986b. Guidelines for Carcinogen Risk Assessment. Fed. Reg. 51:33992-34003.

U.S. Environmental Protection Agency (USEPA). 1986c. Guidelines for the Health Risk Assessment of Chemical Mixtures. Fed. Reg. 51:34014-34023.

U.S. Environmental Protection Agency (USEPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. Washington, D.C. OSWER Directive 9355.3-01. EPA/540/G-89/004. October, 1988.

U.S. Environmental Protection Agency (USEPA). 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Part A. Interim Final. USEPA/540/1-89/002. December, 1989.

U.S. Environmental Protection Agency (USEPA). 1989b. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington D.C. July, 1989.

U.S. Environmental Protection Agency (USEPA). 1989c. Risk Assessment Guidance for Superfund. Volume II: Environmental Evaluation Manual. Interim Final. EPA/540/1-89/001. March, 1989.

U.S. Environmental Protection Agency (USEPA). 1990a. Test Methods for Evaluating Solid Waste, USEPA SW-846, Third Edition. 1990 Revision.

U.S. Environmental Protection Agency (USEPA). 1990b. National Oil and Hazardous Substances Pollution Contingency Plan. Fed. Reg. 55:8666-8865 (March 8, 1990).

U.S. Environmental Protection Agency (USEPA). 1990c. Guidance for Data Usability in Risk Assessment. EPA 540/G-90/008.

U.S. Environmental Protection Agency (USEPA). 1991a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual Supplemental Guidance. Standard Default Exposure Factors. Interim Final. Washington, D.C. OSWER Directive 9285.6-03. March 25, 1991.

U.S. Environmental Protection Agency (USEPA). 1991b. Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER Directive 9355.0-30 Memo from Don R. Clay. April 22, 1991.

U.S. Environmental Protection Agency (USEPA). 1992a. Guidelines for Exposure Assessment. Federal Register 57:22888-22938. May 29, 1992.

U.S. Environmental Protection Agency (USEPA). 1992b. Dermal Exposure Assessment: Principles and Applications. Interim Report. Office of Research and Development, Washington, D.C. USEPA/600/8-91/001B. January, 1992.

U.S. Environmental Protection Agency (USEPA). 1992c. Framework for Ecological Risk Assessment. Risk Assessment Forum. Washington, D.C. USEPA/630/R-92-001.

U.S. Environmental Protection Agency (USEPA). 1992d. Supplemental Guidance to RAGS: Calculating the Concentration Term. Office of Solid Waste and Emergency Response. Publication 9285.7-081. May, 1992.

U.S. Environmental Protection Agency (USEPA). 1993a. Wildlife Exposure Factors Handbook. Volume I of II. Office of Research and Development, Washington, D.C. EPA/630/R-93/187a.

U.S. Environmental Protection Agency, Region III (USEPA). 1993b. Sediment Quality Criteria for the Protection of Benthic Organisms: Acenaphthene. Office of Science and Technology, Washington, D.C. EPA/22/R/93/013.

U.S. Environmental Protection Agency, Region III (USEPA). 1994a. Environmental Risk Assessment Guidelines, Draft. EPA III Superfund Technical Support Section.

U.S. Environmental Protection Agency (USEPA). 1995a. Quality Criteria for Water. Prepared by Health and Ecological Criteria Division, Office of Water, Washington, D.C.

U.S. Environmental Protection Agency, Region III (USEPA). 1995b. Region III BTAG Screening Levels. Draft.

U.S. Environmental Protection Agency (USEPA). 1997a. Risk-Based Concentration Table. Region III Technical Guidance Manual, Risk Assessment. Hazardous Waste Management Division, Office of Superfund Programs, Region III, Philadelphia, PA. October 22, 1997.

U.S. Environmental Protection Agency (USEPA). 1997b. Human Health Effects Assessment Summary Tables (HEAST). Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, Ohio. Prepared for Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, Washington, D.C. FY-1997.

U.S. Environmental Protection Agency (USEPA). 1997c. Integrated Resource Information Systems (IRIS). Environmental Criteria and Assessment Office, Cincinnati, Ohio.

Vershueren. 1983. Handbook of Environmental Data for Organic Chemicals. Second Edition. Van Nostrand Reinhold Co., New York.

Wheelwright, N.T. 1986. The Diet of American Robins: An Analysis of U.S. Biological Survey Records. Auk 103:710-725.

Virginia Department of Environmental Quality (VADEQ). 2000. Voluntary Remediation Program (VRP) Risk Assessment Guidance.

Whitaker, J.O., and Ferraro, M.G. 1963. Summer Food of 220 Short-tailed Shrews from Ithaca, New York. J. Mammal. 44:419.

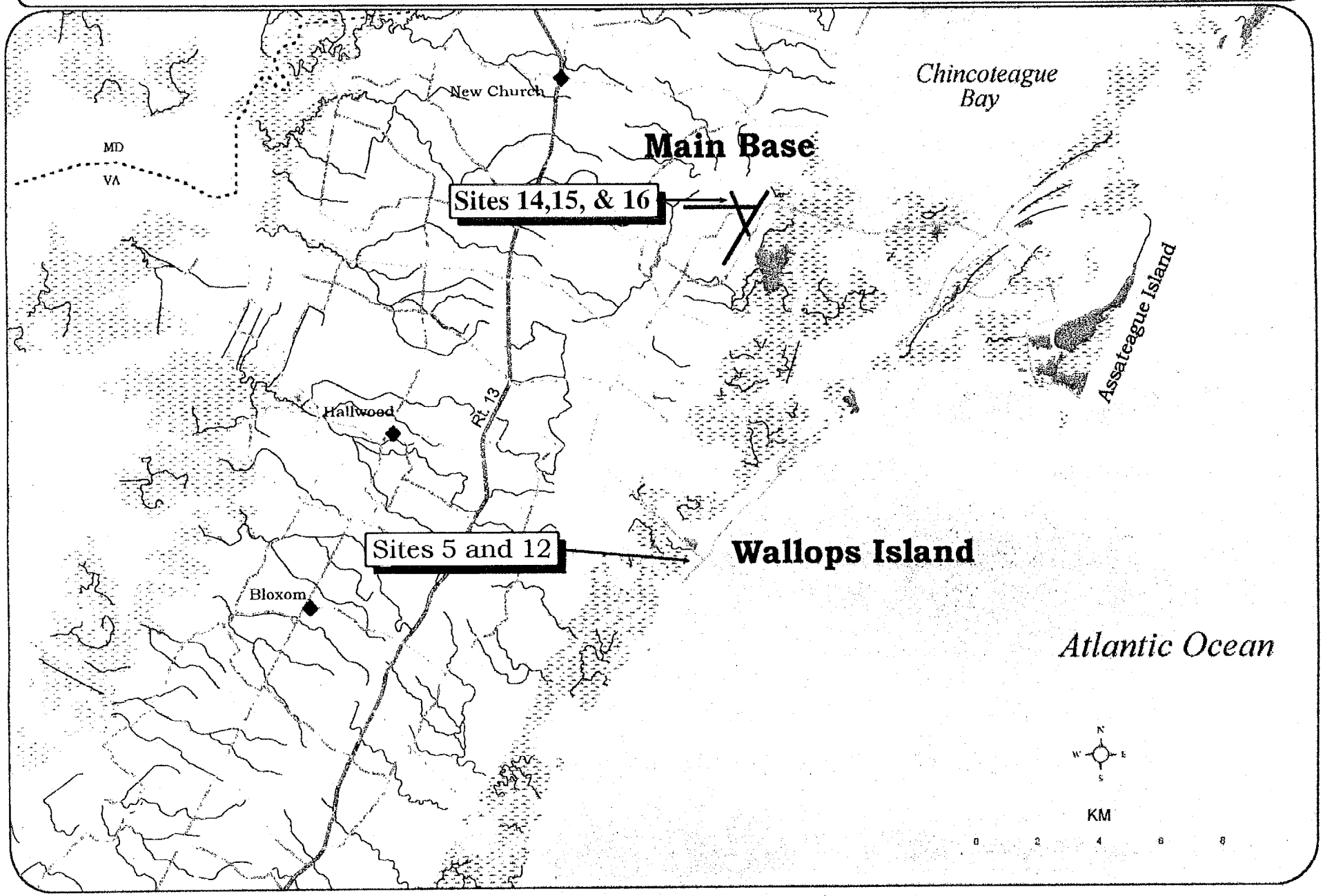
Will, M.E., and Suter, G.W., II. 1994b. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126.

Zar, J.H. 1984. Biostatistical Analysis. Second Edition. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Wallops Flight Facility

Base Map Source : USGS

Figure 2-1
WFF Vicinity Map



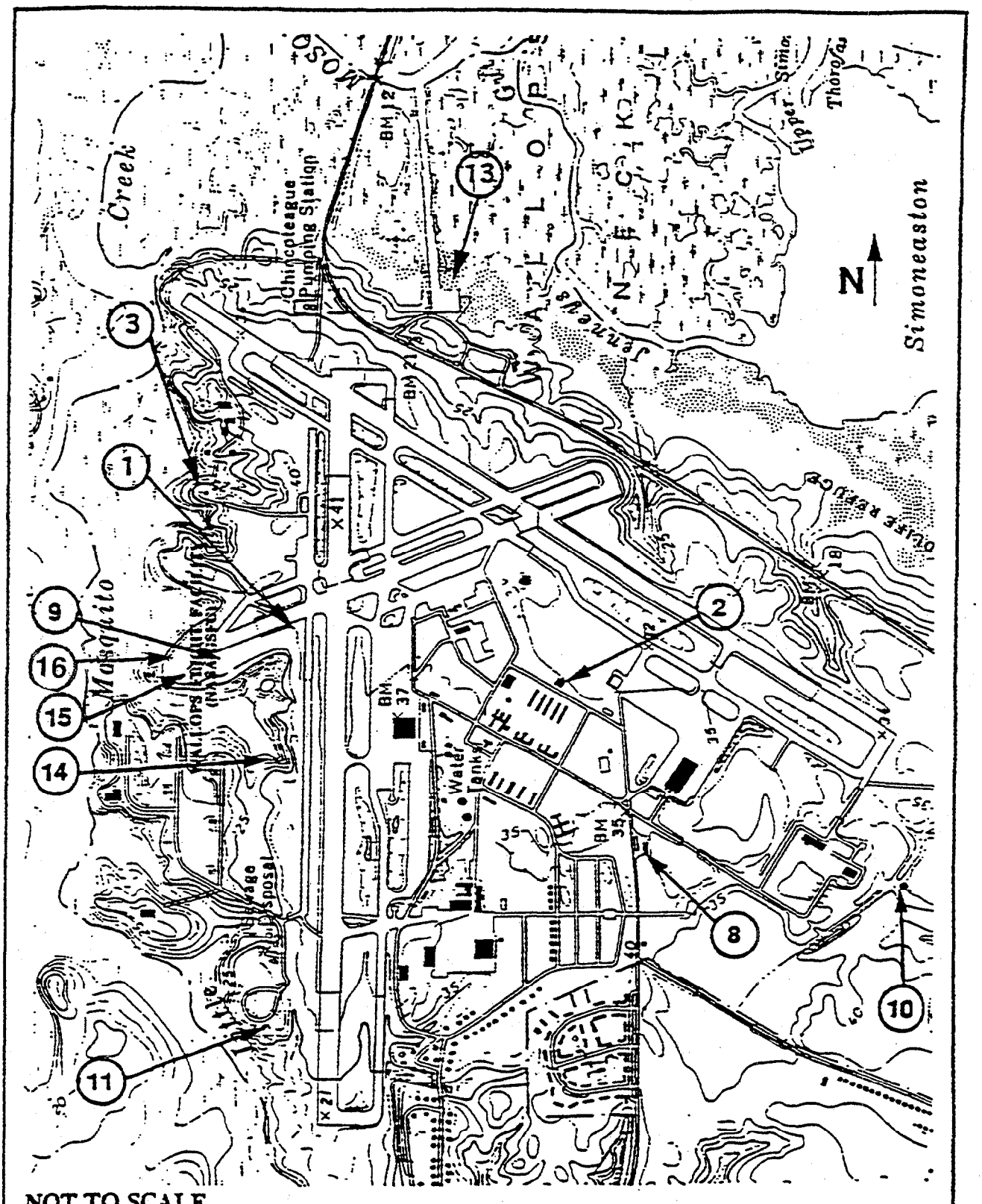
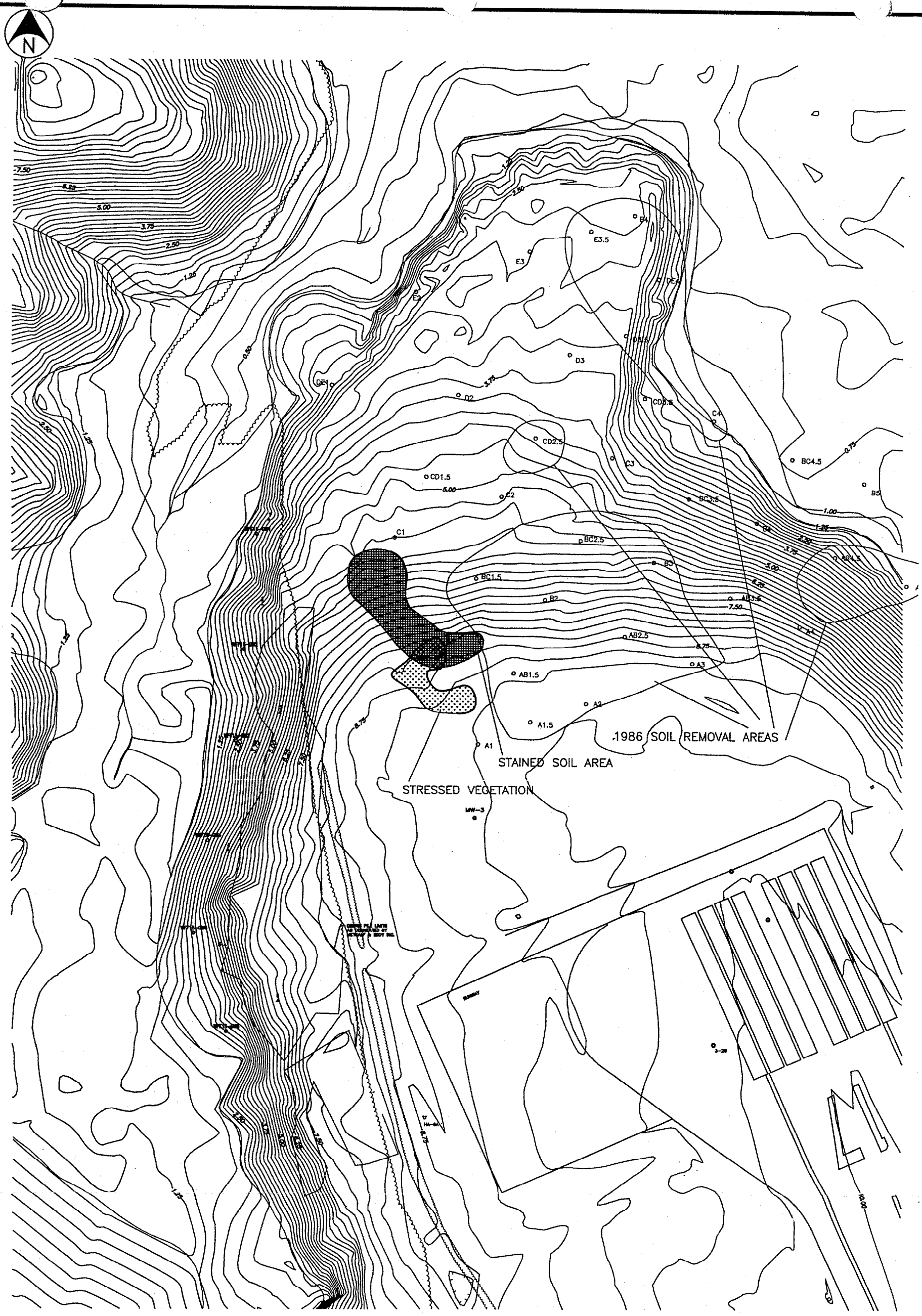


Figure 2-2.

MAIN BASE SITES
SOURCE: USGS



EBASCO (1990) CONFIRMATORY SOIL SAMPLING LOCATIONS

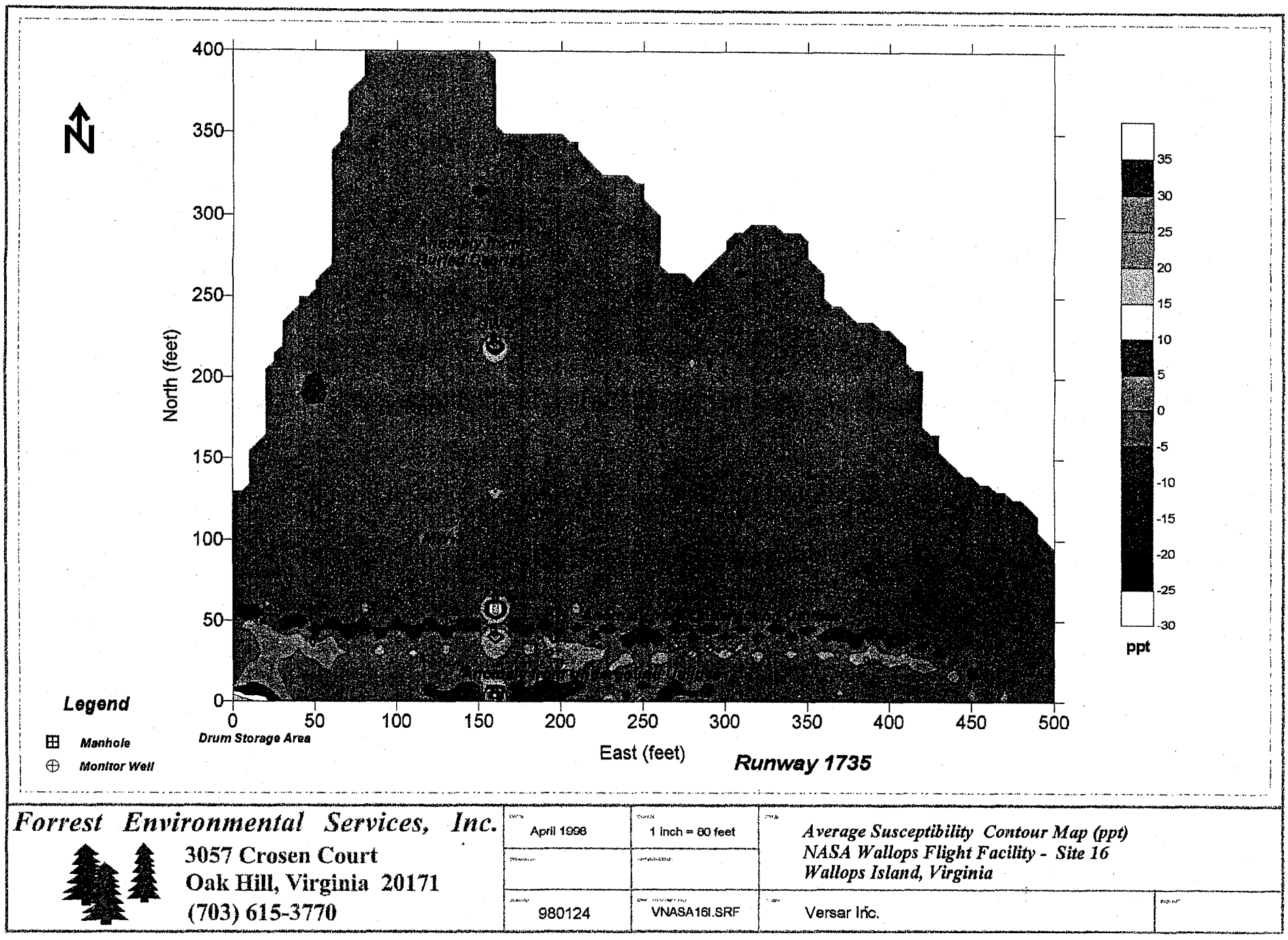
0 40 80 160

SCALE IN FEET

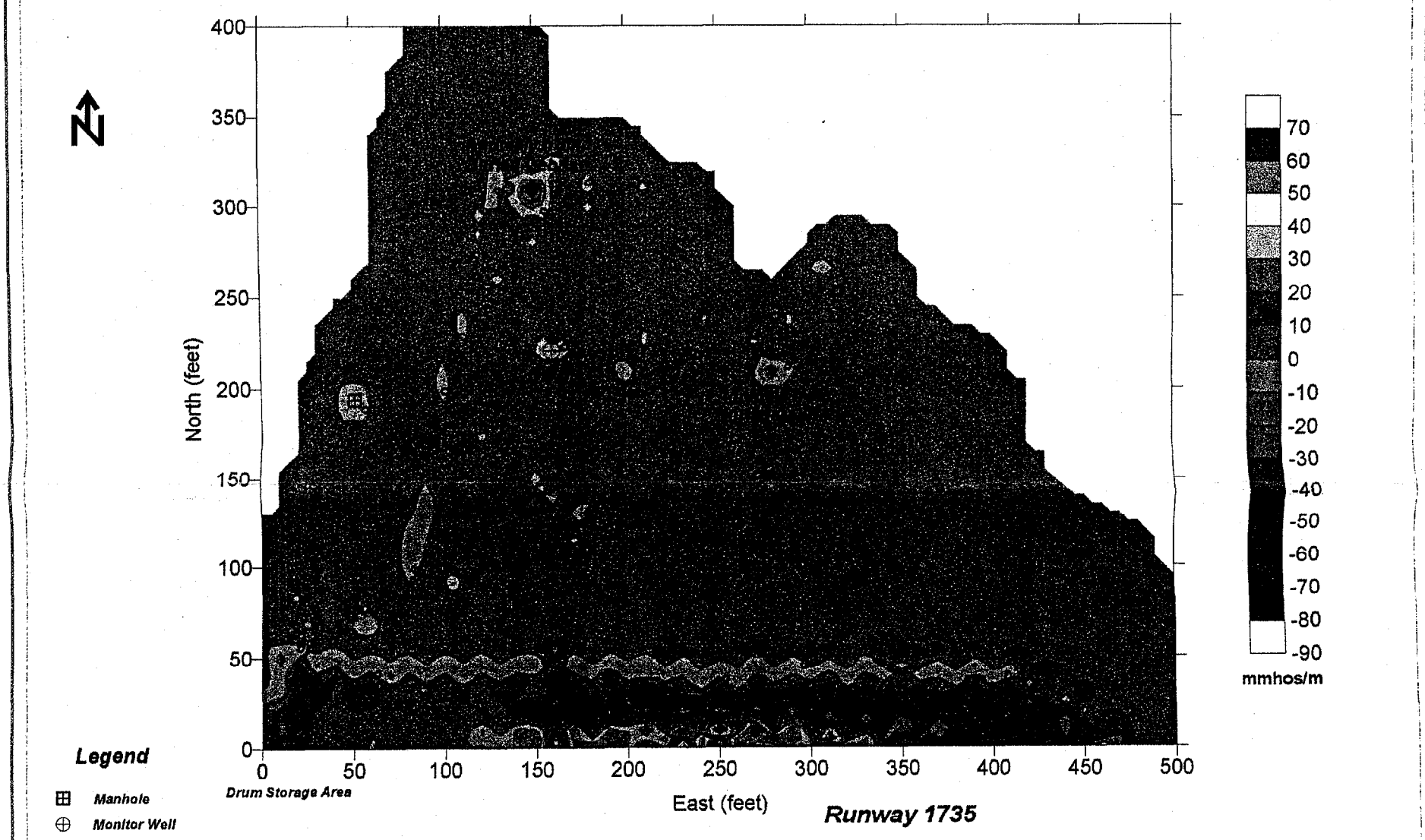
NASA GODDARD SPACE FLIGHT CENTER		
DESIGNED N.S.	DATE 12/20/00	WALLOPS FLIGHT FACILITY SITE 16 FORMER WASTE OIL DUMP
DRAWN K.H.L.	DATE 12/20/00	
Versar INC. 6850 VERSAR CENTER SPRINGFIELD, VIRGINIA 22151 (703) 750-3000		PROJECT NO. DELTEK-# SCALE: AS SHOWN DRAWING NO. 0000-000 FIGURE 2-3

\DIR\DELTEK-#\0000-000.DWG PLOT DATE: 00-00-99

0067CBIZ

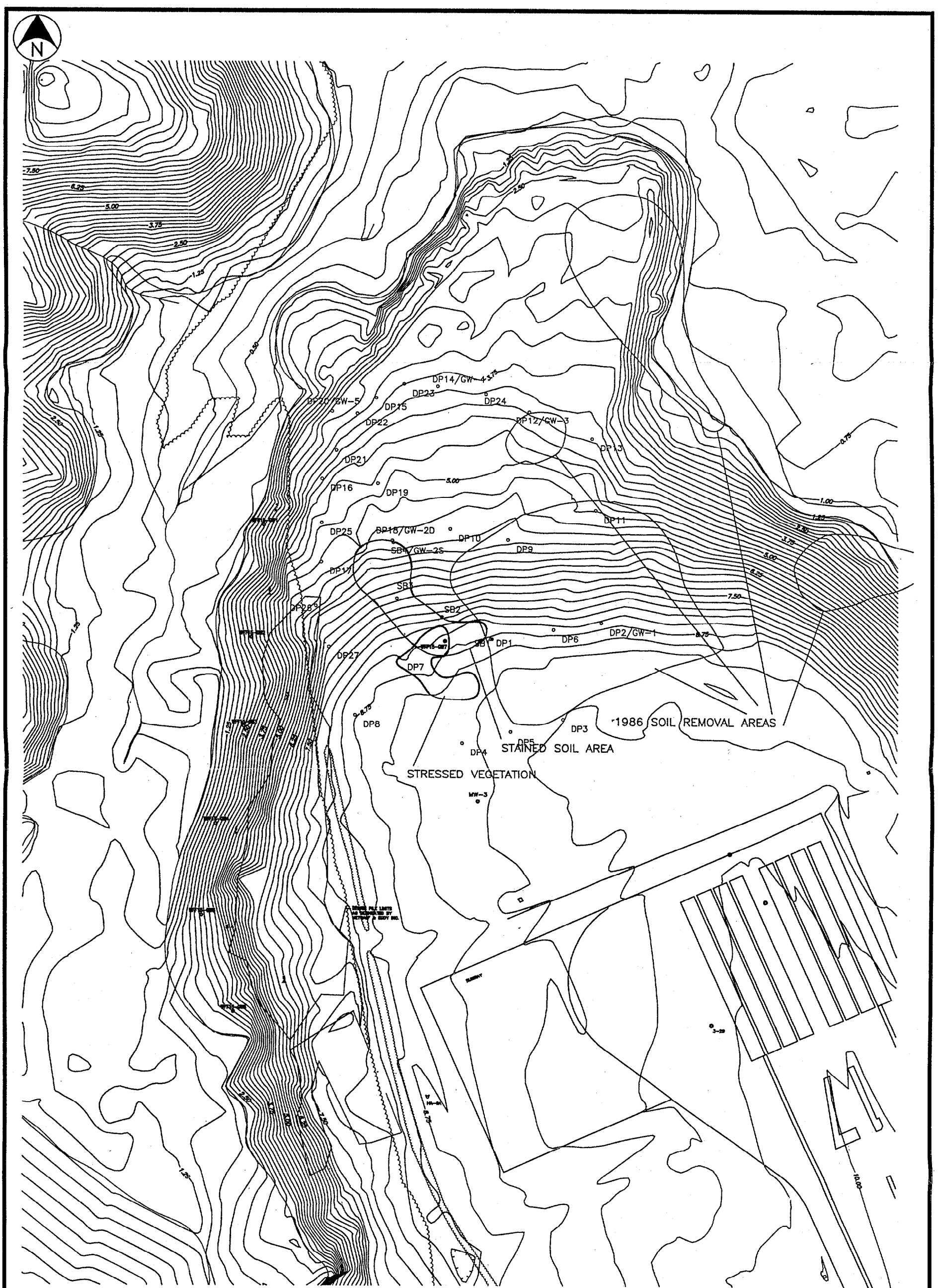


Forrest Environmental Services, Inc. 3057 Crosen Court Oak Hill, Virginia 20171 (703) 615-3770	April 1998	1 inch = 80 feet	*Average Susceptibility Contour Map (ppt)* *NASA Wallops Flight Facility - Site 16* *Wallops Island, Virginia*
	980124	VNASA16I.SRF	Versar Inc.



Forrest Environmental Services, Inc. 3057 Crosen Court Oak Hill, Virginia 20171 (703) 615-3770	April 1998	1 inch = 80 feet	*Apparent Conductivity Contour Map (mmhos/m)* *NASA Wallops Flight Facility - Site 16* *Wallops Island, Virginia*
	980124	VNASA16C.SRF	Versar Inc.

Figure 3-1 Electromagnetic Survey Results, Site 16, Former Waste Oil Dump



NASA GODDARD SPACE FLIGHT CENTER

DESIGNED N.S.	DATE 12/20/00
DRAWN K.H.L.	DATE 12/20/00

Versar INC.
6850 VERSAR CENTER
SPRINGFIELD, VIRGINIA 22151
(703) 750-3000

WALLOPS FLIGHT FACILITY
SITE 16
DIRECT PUSH AND WELL LOCATIONS

PROJECT NO. DELTEK-#	SCALE: AS SHOWN
DRAWING NO. 0000-000	FIGURE 3-2

\DIR\DELTEK-#\0000-000.DWG PLOT DATE: 00-00-99

N

3WFF16-SS13
3WFF16-SS17
3WFF16-SS12
3WFF16-SS8
3WFF16-SS11
3WFF16-SS16
3WFF16-SS7
3WFF16-SS10
3WFF16-SS15
3WFF16-SS6
3WFF16-SS9
3WFF16-SS14
3WFF16-SS5
3WFF16-SS4
3WFF16-SS3
3WFF16-SS2
3WFF16-SS1

1986 SOIL REMOVAL AREAS

STAINED SOIL AREA

STRESSED VEGETATION

MW-3

0 40 80 160

SCALE IN FEET

NASA GODDARD SPACE FLIGHT CENTER

DESIGNED N.S.	DATE 12/20/00
DRAWN K.H.L.	DATE 12/20/00

Versar INC.
6850 VERSAR CENTER
SPRINGFIELD, VIRGINIA 22151
(703) 750-3000

WALLOPS FLIGHT FACILITY
SITE 16
SURFACE SOIL SAMPLING LOCATIONS

PROJECT NO. DELTEK-#	SCALE: AS SHOWN
DRAWING NO. 0000-000	FIGURE 3-3

\DIR\DELTEK-#\0000-000.DWG PLOT DATE: 00-00-99

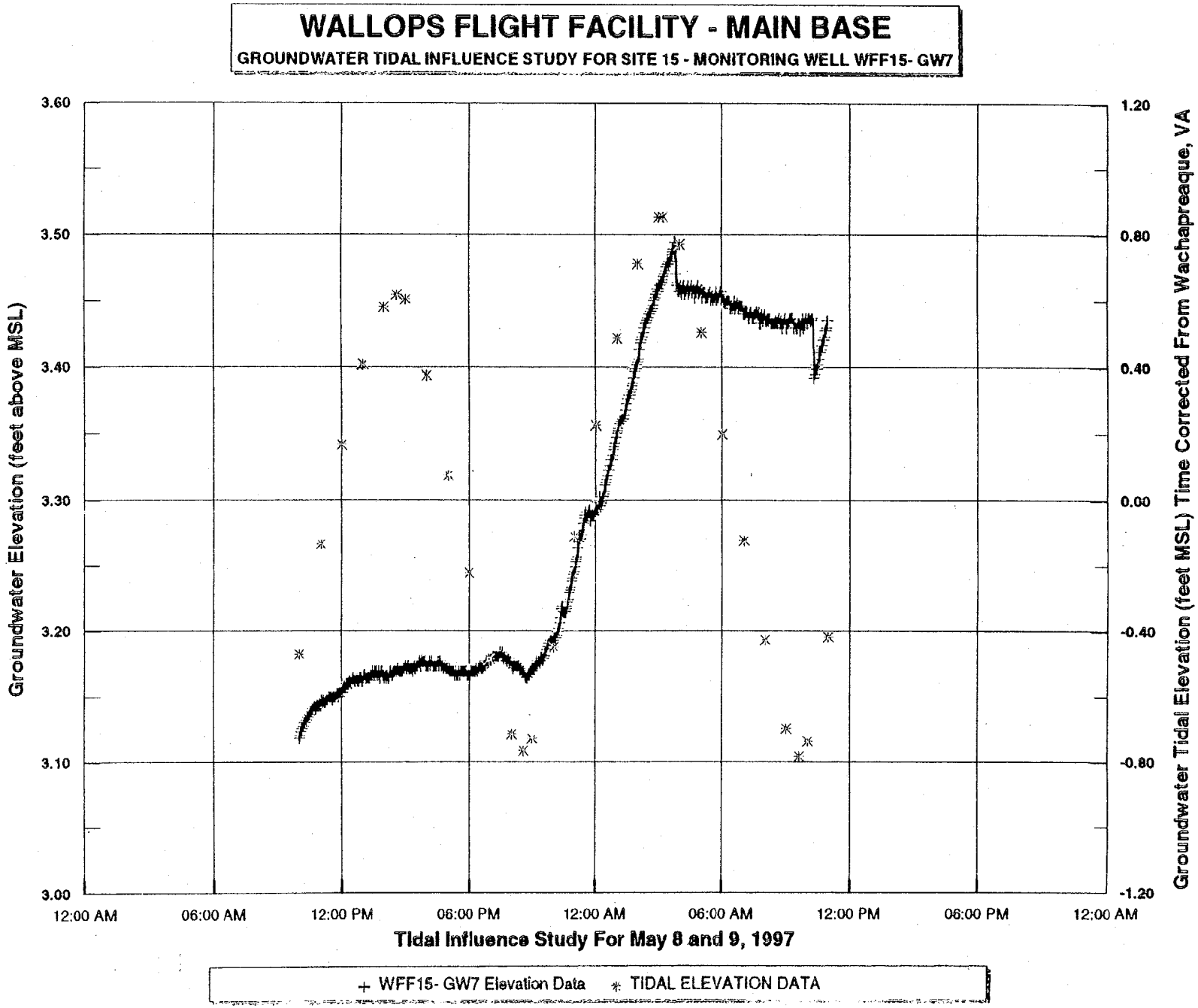


Figure 4-1 Main Base Tidal Influence Study - May 8 and 9, 1997

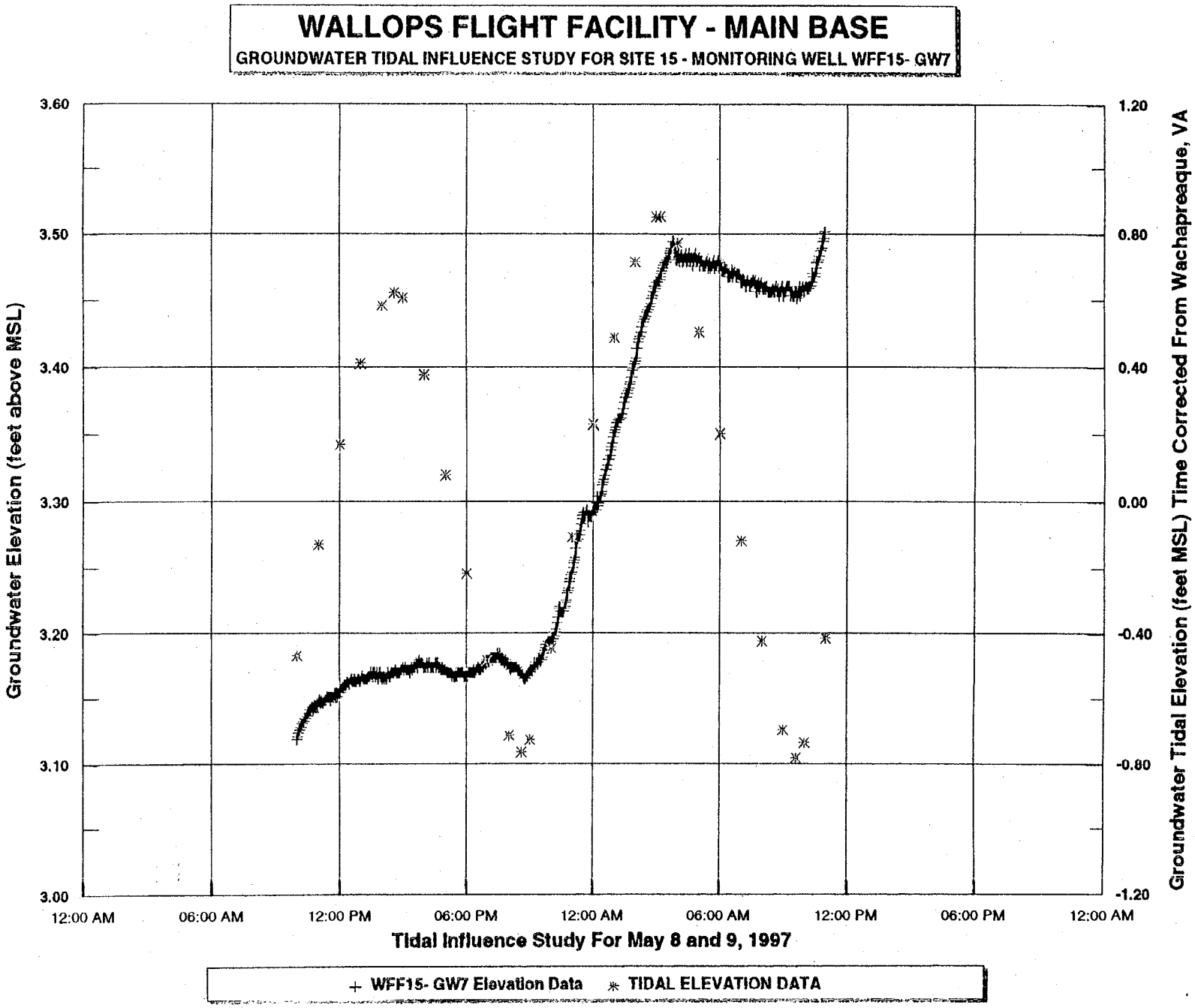
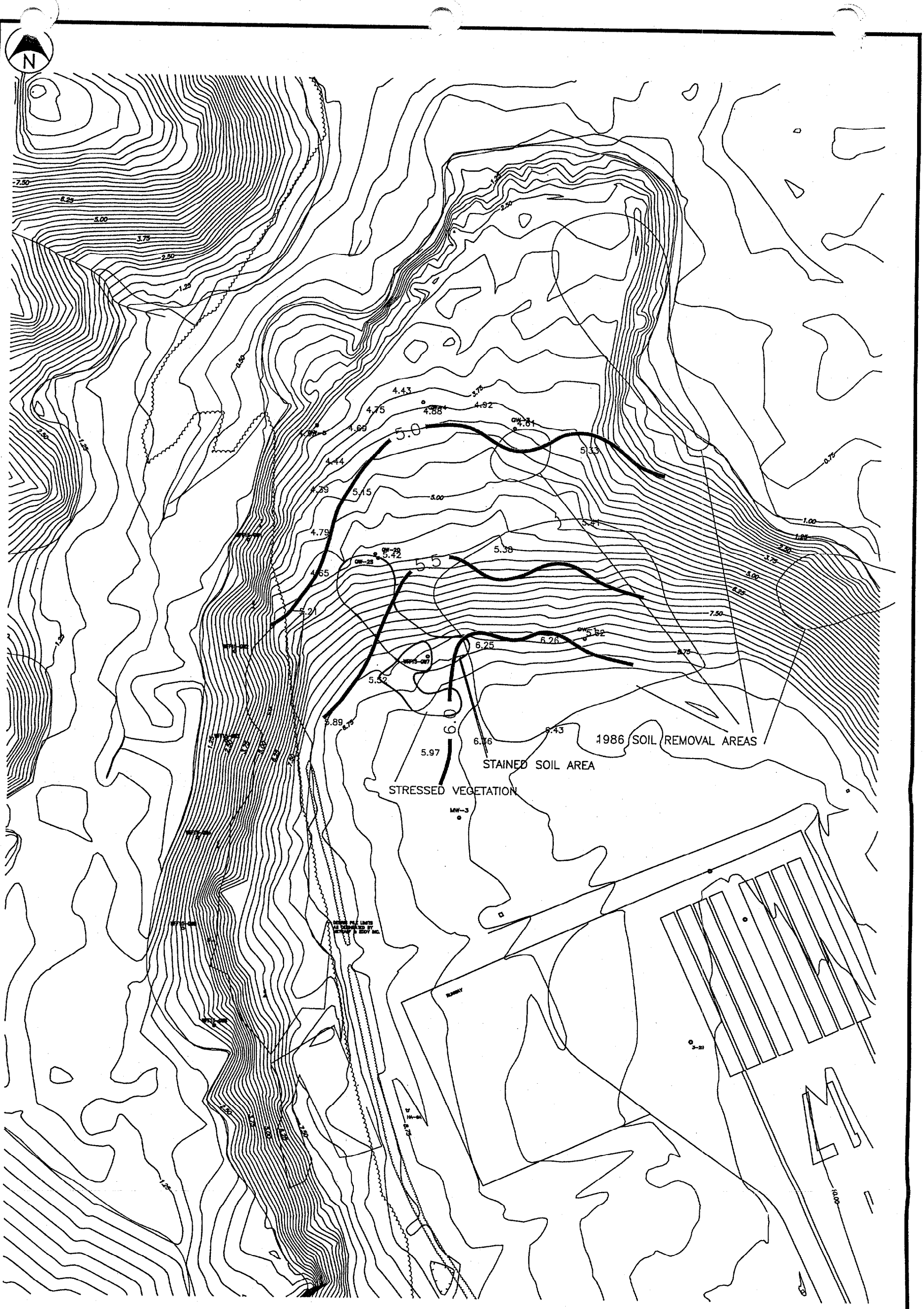


Figure 4-2 Main Base Tidal Influence Study (Displacement Corrected Graph)



\DIR\DELTEK-#\0000-000.DWG PLOT DATE: 00-00-99

NASA GODDARD SPACE FLIGHT CENTER

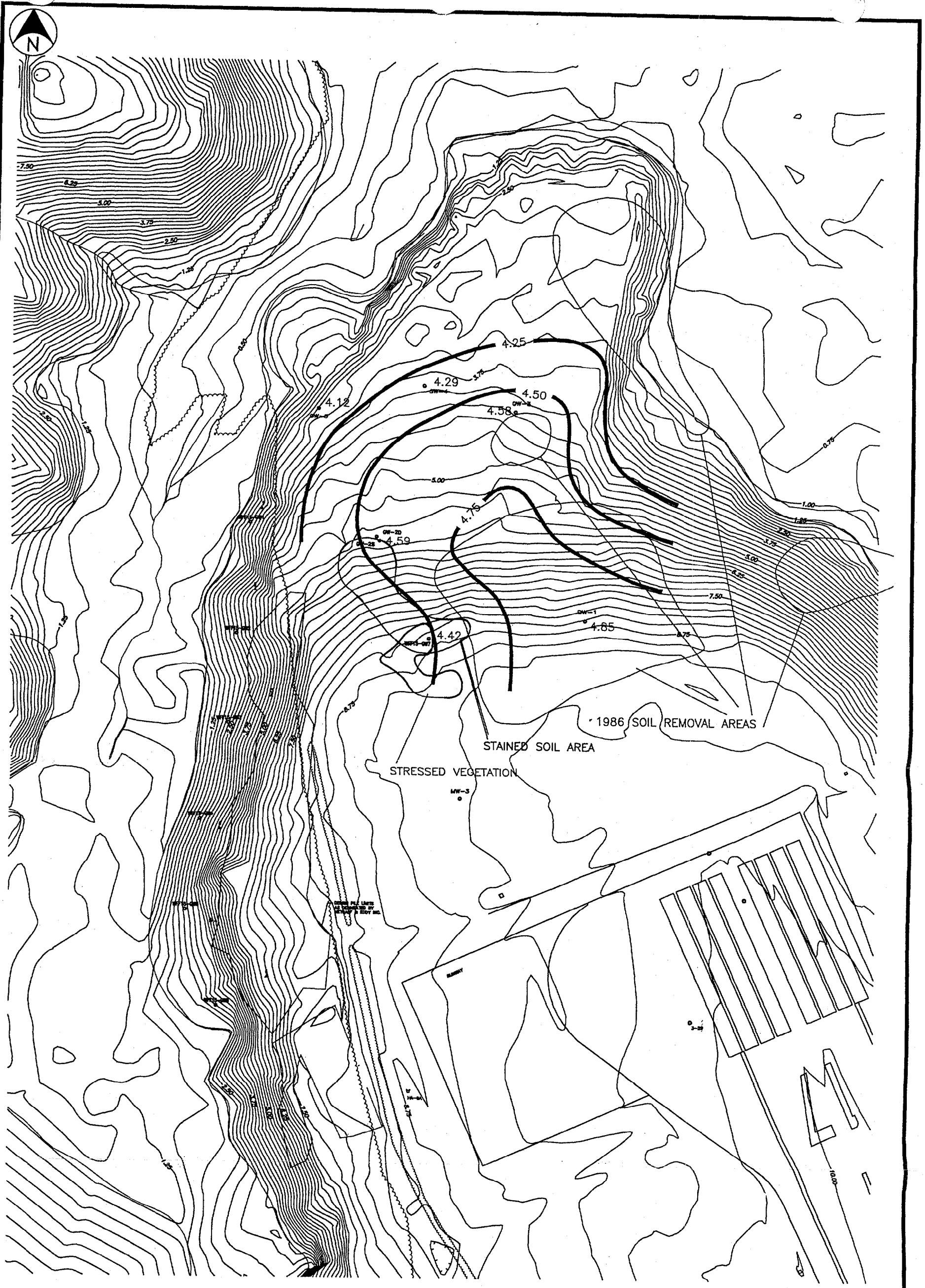
DESIGNED N.S.	DATE 12/20/00
DRAWN K.H.L.	DATE 12/20/00

Versar INC.
6850 VERSAR CENTER
SPRINGFIELD, VIRGINIA 22151
(703) 750-3000

WALLOPS FLIGHT FACILITY
SITE 16
POTENTIOMETRIC SURFACE MAY 1998

PROJECT NO. DELTEK-#	SCALE: AS SHOWN
DRAWING NO. 0000-000	FIGURE 4-3

0067CB2Z



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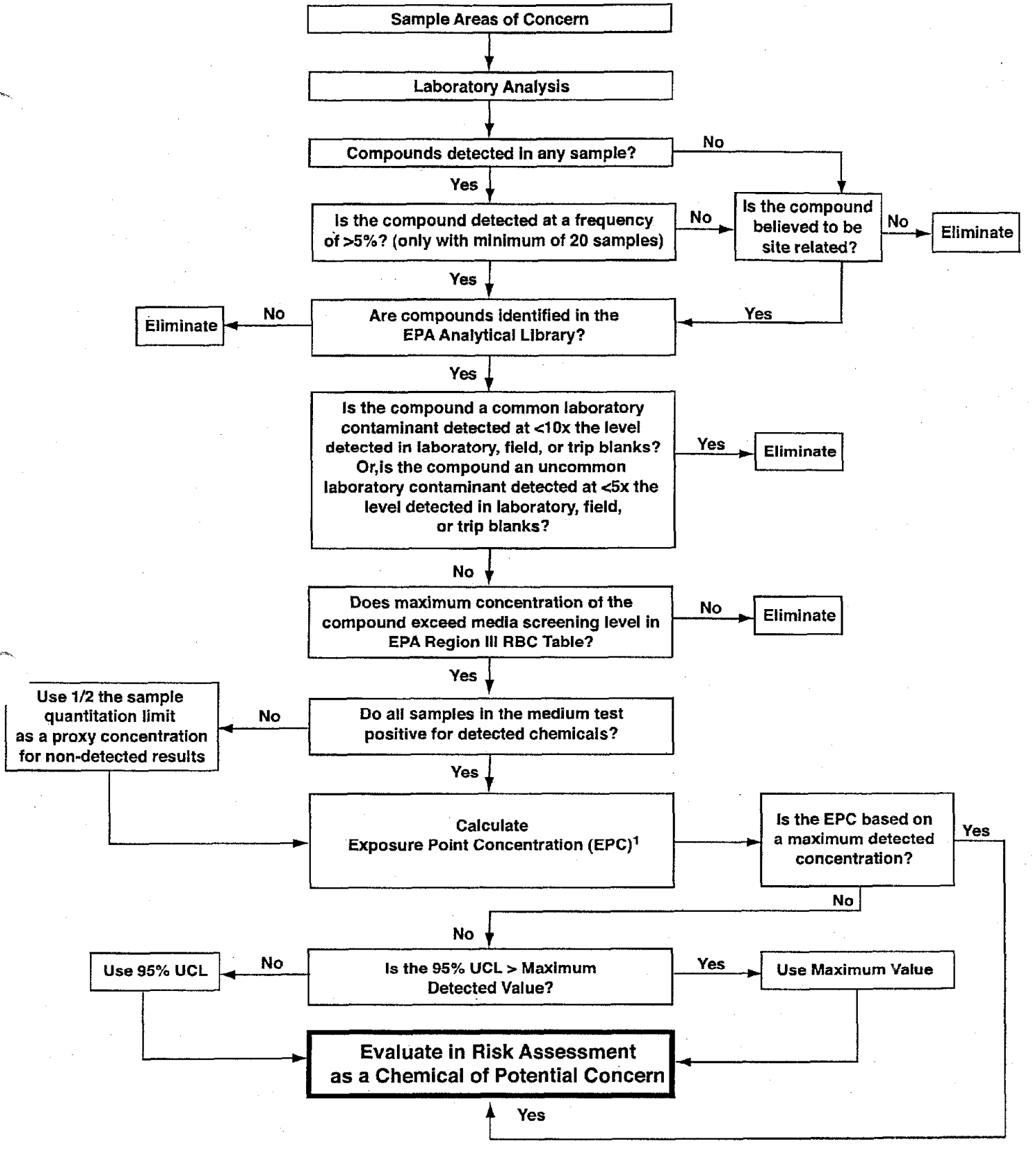
NASA GODDARD SPACE FLIGHT CENTER

DESIGNED N.S.	DATE 12/20/00
DRAWN K.H.L.	DATE 12/20/00

Versar INC.
6850 VERSAR CENTER
SPRINGFIELD, VIRGINIA 22151
(703) 750-3000

WALLOPS FLIGHT FACILITY
SITE 16
POTENTIOMETRIC SURFACE MARCH 2000

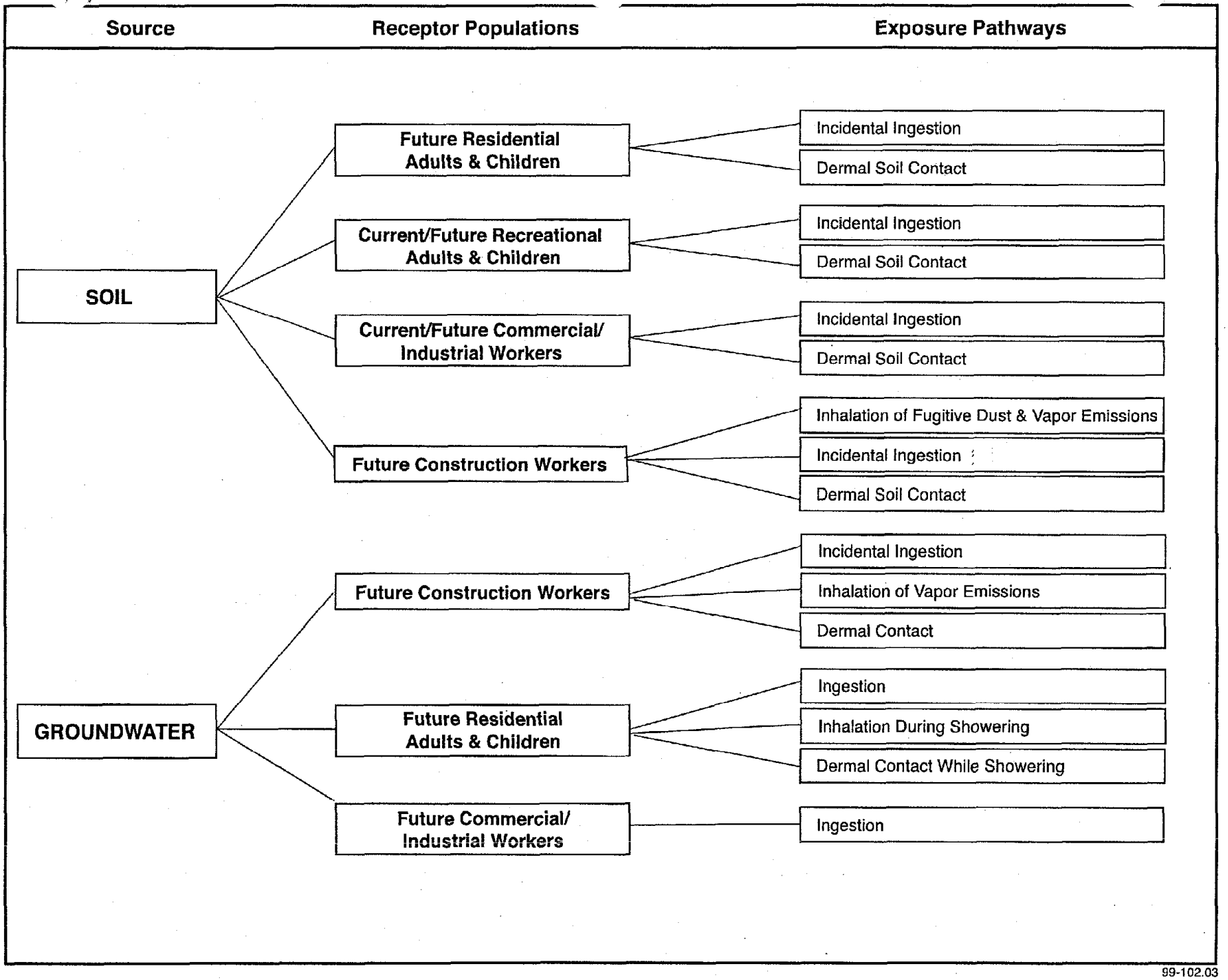
PROJECT NO. DELTEK-#	SCALE: AS SHOWN
DRAWING NO. 0000-000	FIGURE 4-4



1. The Exposure Point Concentration was based on the normal 95% UCL, lognormal 95% UCL or maximum detected concentration according to the distribution of the data.

Figure 6-1 Chemicals of Potential Concern Selection Flowchart for the Wallops Flight Facility (WFF) – Site 16

99-102.04



99-102.03

Figure 6-2 Receptor Populations and Exposure Routes at the Wallops Flight Facility (WFF) – Site 16

Table 4-1. Aquifer Slug Test Data Summary, NASA Wallops Flight Facility

Well Number	Water Level	So (feet)	rc (feet)	rw (feet)	b (feet)	L (feet)	H (feet)	T (ft2/min)	K (ft/min)	K (cm/sec)	Kmean (cm/sec)
WFF5-GW-1	Falling	1.35	0.083	0.33	7.43	5	7.43	1.03E-01	1.39E-02	7.06E-03	8.32E-03
	Rising	1.35	0.0.8	0.33	7.43	5	7.43	1.40E-01	1.89E-02	9.58E-03	
WFF5-GW3	Falling	1.35	0.083	0.33	7.36	5	7.36	9.25E-02	1.26E-02	6.39E-03	5.93E-03
	Rising	1.35	0.083	0.33	7.36	5	7.36	7.94E-02	1.08E-02	5.48E-03	
WFF12-GW1	Falling	1.35	0.083	0.33	7.3	5	7.3	4.85E-02	6.64E-03	3.37E-03	3.97E-03
	Rising	1.35	0.083	0.33	7.3	5	7.3	6.57E-02	9.00E-03	4.57E-03	
WFF12-GW5	Falling	1.35	0.083	0.33	7	5	7	4.44E-02	6.35E-03	3.22E-03	3.36E-03
	Rising	1.35	0.083	0.33	7	5	7	4.82E-02	6.88E-03	3.49E-03	
WFF14-GW1	Falling	1.35	0.083	0.33	13.29	13.29	13.29	1.16E-01	1.80E-02	9.16E-03	1.02E-02
	Rising	1.35	0.083	0.33	13.29	13.29	13.29	1.40E-02	1.55E-03	7.87E-04	
WFF14-GW7	Falling	1.35	0.083	0.33	4.61	4.61	4.61	1.16E-01	4.64E-05	2.36E-05	9.31E-03
	Rising	1.35	0.083	0.33	4.61	4.61	4.61	1.40E-01	3.66E-02	1.86E-02	
WFF15-GW1	Falling	1.35	0.083	0.33	6.79	5	6.79	9.19E-04	1.35E-04	6.88E-05	4.87E-04
	Rising	1.35	0.083	0.33	6.79	5	6.79	1.21E-02	1.78E-03	9.06E-04	
WFF15-GW-3	Falling	1.35	0.083	0.33	7.4	5	7.4	4.68E-03	6.33E-04	3.21E-04	1.81E-04
	Rising	1.35	0.083	0.33	7.4	5	7.4	6.03E-04	8.15E-05	4.14E-05	

Notes:

Falling = slug was lowered into the well at time = 0

Rising = slug was removed from the well at time = 0

So = initial displacement of water

rc = radius of well casing

rw = radius of well (including sand pack)

b = saturated aquifer thickness

L = length of saturated well screen

H = static height of water in well

K = hydraulic conductivity

Kmean = mean of falling and rising head hydraulic conductivity values

TABLE 4-2. Summary of Chemicals Detected in Background Surface Soil Samples for Wallops Flight Facility (Concentrations in ug/kg for organics and mg/kg for inorganics)

Compound	Frequency of Detection (a)	Mean Detection (b)	Detection Limits	Range of Detections	Screening Level Comparison	
					BTAG Screening Level (c)	Background > Screening
Volatile Organics						
Tetrachloroethene	1 / 7	6	12-13	3		
Semivolatile Organics						
Pesticides						
4,4'-DDD	6 / 7	618.5	3.8	2.1-31	<100	No
4,4'-DDE	7 / 7	1073	NU	270-3100	<100	**Yes**
4,4'-DDT	7 / 7	784	NU	74-4300	<100	**Yes**
Inorganics						
Aluminum	7 / 7	6903	NU	5610-9970	1	**Yes**
Antimony	4 / 7	0.30		0.36-0.44	0.48	No
Arsenic	7 / 7	1.62	NU	0.96-3.1	328 (e)	No
Barium	7 / 7	31.0	NU	23.3-39.3	440	No
Beryllium	7 / 7	0.22	NU	0.18-0.26	0.02	**Yes**
Cadmium	3 / 7	0.05	0.04	0.07-0.11	2.5	No
Calcium	7 / 7	588	NU	297-874	NSL	---
Chromium	7 / 7	7.9	NU	6.3-14.1	0.0075 (f)	**Yes**
Chromium VI	2 / 2	0.28	NU	0.27-0.28		---
Cobalt	7 / 7	1.6	NU	1.3-1.9	100	No
Copper	7 / 7	2.9	NU	2-4.5	15	No
Iron	7 / 7	5467	NU	4200-9180	12	**Yes**
Lead	7 / 7	8.6	NU	5.5-13.7	0.01	**Yes**
Magnesium	7 / 7	713	NU	587-1170	NSL	---
Manganese	7 / 7	106	NU	47-173	330	No
Nickel	7 / 7	3.4	NU	2.7-5.3	2	**Yes**
Potassium	7 / 7	406	NU	257-848	NSL	---
Selenium	7 / 7	0.67	NU	0.54-0.86	1.8	No
Silver	2 / 7	0.04	0.04	0.04-0.13		---
Sodium	7 / 7	103.7	NU	69.9-132		---
Vanadium	7 / 7	11.3	NU	8.5-19.3	0.5	**Yes**
Zinc	7 / 7	14.2	NU	9.7-25.6	10	**Yes**

TABLE 4-3
SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL FOR THE HUMAN HEALTH RISK ASSESSMENT
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: surface soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
50-32-8	benzo(a)pyrene	0.91		1.2		mg/kg	3WFF16-SS10	2/21	0.34-7.4	1.2		0.087	C	N/A		yes	ASL
191-24-2	benzo(g,h,i)perylene	0.083	J	0.55		mg/kg	3WFF16-SS10	4/21	0.34-7.4	1		230	N (5)	N/A		no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	0.43		2.8		mg/kg	3WFF16-SS9	18/21	0.34-7.4	2.8		46	C	N/A		no	BSL
218-01-9	chrysene	0.078	J	0.405		mg/kg	3WFF16-SS10	5/21	0.35-7.4	0.405		87	C	N/A		no	BSL
193-39-5	indeno(1,2,3-cd)pyrene	0.12	J	0.14	J	mg/kg	3WFF16-SS9	2/21	0.34-7.4	0.14		0.87	C	N/A		no	BSL
72-54-8	4,4'-DDD	0.012		0.012		mg/kg	3WFF16-SS16	1/21	0.0035-0.038	0.012		2.7	C	N/A		no	BSL
72-55-9	4,4'-DDE	0.0028		0.31	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	0.31		1.9	C	N/A		no	BSL
50-29-3	4,4'-DDT	0.0042	J	0.26	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	0.26		1.9	C	N/A		no	BSL
7429-90-5	aluminum	2850		10600		mg/kg	2WFF16-SB1S1	21/21		10600	9970	7800	N	N/A		yes	ASL
7440-36-0	antimony	0.92		0.92		mg/kg	3WFF16-SS13	1/21	0.29-0.82	0.92	0.44	3.1	N	N/A		no	BSL
7440-38-2	arsenic	0.66		2.9		mg/kg	3WFF16-SS16	18/21	0.55-0.63	2.9	3.1	0.43	C	N/A		yes	ASL
7440-39-3	barium	8.3		33.3		mg/kg	2WFF16-SB1S1	21/21		33.3	39.3	550	N	N/A		no	BSL
7440-41-7	beryllium	0.11		0.2		mg/kg	3WFF16-SS6	7/17	0.1-0.12	0.2	0.26	16	N	N/A		no	BSL
7440-70-2	calcium	41.8		891		mg/kg	3WFF16-SS3	21/21		891	874	N/A		N/A		no	NUT
16065831	chromium (Cr3+) (6)	3.4		11		mg/kg	3WFF16-SS3	21/21		11	14.1	12000	N	N/A		no	BSL
7440-48-4	cobalt	0.6		3.2		mg/kg	3WFF16-SS13	21/21		3.2	1.9	470	N	N/A		no	BSL
7440-50-8	copper	1.4		8.3	K	mg/kg	2WFF16-SB1S1	20/20		8.3	4.5	310	N	N/A		no	BSL
7439-89-6	iron	2340		10700		mg/kg	3WFF16-SS3	21/21		10700	9180	2300	N	N/A		yes	ASL
7439-92-1	lead	5.4		60.5		mg/kg	3WFF16-SS9	21/21		60.5	13.7	400	(7)	N/A		no	BSL
7439-95-4	magnesium	176		874		mg/kg	3WFF16-SS3	21/21		874	1170	N/A		N/A		no	NUT
7439-96-5	manganese	23.5		128		mg/kg	3WFF16-SS13	21/21		128	173	160	N	N/A		no	BSL
7440-02-0	nickel	1.1		5.7		mg/kg	2WFF16-SB1S1	21/21		5.7	5.3	160	N	N/A		no	BSL
7440-09-7	potassium	149		495		mg/kg	2WFF16-SB1S1	21/21		495	848	N/A		N/A		no	NUT
7782-49-2	selenium	0.23		0.65		mg/kg	3WFF16-SS16	12/20	0.18-0.21	0.65	0.86	39	N	N/A		no	BSL
7440-22-4	silver	0.16		0.48		mg/kg	3WFF16-SS8	7/21	0.1-0.16	0.48	0.13	39	N	N/A		no	BSL
7440-23-5	sodium	102		439		mg/kg	3WFF16-SS3	21/21		439	132	N/A		N/A		no	NUT
7440-62-2	vanadium	5.1		19.7		mg/kg	3WFF16-SS3	21/21		19.7	19.3	55	N	N/A		no	BSL
7440-66-6	zinc	5.3		53.2		mg/kg	3WFF16-SS14	21/21		53.2	25.6	2300	N	N/A		no	BSL
	diesel range organics	3	JY	870	Y	mg/kg	3WFF16-SS11	20/21	7.1	870		N/A		N/A		no	NTX
	gasoline range organics	0.03	JZ	0.22	Z	mg/kg	3WFF16-SS15	4/21	0.052-0.059	0.22		N/A		N/A		no	NTX

(1) Minimum/maximum detected concentration.

(2) Background values are maximum concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(5) The RBC for pyrene was used as a surrogate RBC for benzo(g,h,i)perylene.

Definitions:
N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
D = Diluted out
Y = Appears to match a typical fuel pattern
Z = Does not appear to match a typical fuel pattern

TABLE 4-4

SELECTION OF CHEMICALS OF POTENTIAL CONCERN - ECOLOGICAL RISK ASSESSMENT

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Background (2) Value	Site > Background	BTAG Soil Value	Site > Soil Value	Site > BG	COPC	
50-32-8	benzo(a)pyrene	1		1.20		mg/kg	3WFF16-SS10	2/21	0.34-7.4	0	yes	0.10	yes	yes	ASL	
191-24-2	benzo(g,h,i)perylene	0	J	0.55		mg/kg	3WFF16-SS10	4/21	0.34-7.4	0	yes	0.10	yes	yes	ASL	
117-81-7	bis(2-ethylhexyl)phthalate	0		2.80		mg/kg	3WFF16-SS9	18/21	0.34-7.4	0	yes	NA		yes		
218-01-9	chrysene	0	J	0.41		mg/kg	3WFF16-SS10	5/21	0.35-7.4	0	yes	0.10	yes	yes	ASL	
193-39-5	indeno(1,2,3-cd)pyrene	0	J	0.14	J	mg/kg	3WFF16-SS9	2/21	0.34-7.4	0	yes	0.10	yes	yes	ASL	
72-54-8	4,4'-DDD	0		0.01		mg/kg	3WFF16-SS16	1/21	0.0035-0.038	0		0.10	no	yes		
72-55-9	4,4'-DDE	0		0.31	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	3		0.10	yes	no		
50-29-3	4,4'-DDT	0	J	0.26	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	4		0.10	yes	no		
7429-90-5	aluminum	2850		10600.00		mg/kg	2WFF16-SB1S1	21/21		9970		1.00	yes	yes		
7440-36-0	antimony	1		0.92		mg/kg	3WFF16-SS13	1/21	0.29-0.82	0	yes	0.48	yes	yes	IFD	only detected in one sample
7440-38-2	arsenic	1		2.90		mg/kg	3WFF16-SS16	18/21	0.55-0.63	3		328.00	no	no		
7440-39-3	barium	8		33.30		mg/kg	2WFF16-SB1S1	21/21		39		440.00	no	no		
7440-41-7	beryllium	0		0.20		mg/kg	3WFF16-SS6	7/17	0.1-0.12	0		0.02	yes	no		
7440-70-2	calcium	42		891.00		mg/kg	3WFF16-SS3	21/21		874	no	NA		yes		
16065831	chromium (Cr3+) (6)	3		11.00		mg/kg	3WFF16-SS3	21/21		14		0.02	yes	no		
7440-48-4	cobalt	1		3.20		mg/kg	3WFF16-SS13	21/21		2	yes	100.00	no	yes		
7440-50-8	copper	1		8.30	K	mg/kg	2WFF16-SB1S1	20/20		5	yes	15.00	no	yes		
7439-89-6	iron	2340		10700.00		mg/kg	3WFF16-SS3	21/21		9180	yes	3260.00	yes	yes	IFD	above BKG in only 1 sample
7439-92-1	lead	5		60.50		mg/kg	3WFF16-SS9	21/21		14	yes	2.00	yes	yes	ASL	
7439-95-4	magnesium	176		874.00		mg/kg	3WFF16-SS3	21/21		1170		440000.00	no	no		
7439-96-5	manganese	24		128.00		mg/kg	3WFF16-SS13	21/21		173	yes	330.00	no	no		
7440-02-0	nickel	1		5.70		mg/kg	2WFF16-SB1S1	21/21		5		2.00	yes	yes		
7440-09-7	potassium	149		495.00		mg/kg	2WFF16-SB1S1	21/21		848		NA		no		
7782-49-2	selenium	0		0.65		mg/kg	3WFF16-SS16	12/20	0.18-0.21	1		1.80	no	no		
7440-22-4	silver	0		0.48		mg/kg	3WFF16-SS8	7/21	0.1-0.16	0	yes	0.00	yes	yes	NTX	
7440-23-5	sodium	102		439.00		mg/kg	3WFF16-SS3	21/21		132	yes	NA		yes		
7440-62-2	vanadium	5		19.70		mg/kg	3WFF16-SS3	21/21		19	no*	0.50	yes	yes		
7440-66-6	zinc	5		53.20		mg/kg	3WFF16-SS14	21/21		26	yes	10.00	yes	yes	ASL	
	diesel range organics	3	JY	870.00	Y	mg/kg	3WFF16-SS11	20/21	7	73	yes	NA		yes	yes	
	gasoline range organics	0	JZ	0.22	Z	mg/kg	3WFF16-SS15	4/21	0.052-0.059	1		NA		no		

(1) Minimum/maximum detected concentration.

(2) Background values are maximum concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(5) The RBC for pyrene was used as a surrogate RBC for benzo(g,h,i)perylene.

N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
D = Diluted out
Y = Appears to match a typical fuel pattern
Z = Does not appear to match a typical fuel pattern

TABLE 4-5
SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN SUBSURFACE SOIL FOR THE HUMAN HEALTH RISK ASSESSMENT
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: subsurface soil
Exposure Medium: subsurface soil
Exposure Point: subsurface soil excavated to the surface of Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
75-00-3	chloroethane	0.056	K	0.11	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	0.11		2.2E+02	C	N/A		no	BSL
100-41-4	ethylbenzene	1.1	J	2.2	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	2.2		7.8E+02	N	N/A		no	BSL
127-18-4	tetrachloroethene	0.201	J	0.201	J	mg/kg	2WFF16-SB1S2	1/4	0.011-0.12	0.201		1.2E+01	C	N/A		no	BSL
108-88-3	toluene	0.86		1.7	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	1.7		1.6E+03	N	N/A		no	BSL
1330-20-7	xylene (total)	0.064	J	13	J	mg/kg	2WFF16-SB2S2	3/4	0.011	13		1.6E+04	N	N/A		no	BSL
91-57-6	2-methylnaphthalene	0.31	J	29	J	mg/kg	2WFF16-SB2S2	3/4	0.37	29		1.6E+02	N	N/A		no	BSL
83-32-9	acenaphthene	0.054	J	1.8	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.39	1.8		4.7E+02	N	N/A		no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	0.36	B (5)	5.5	B (5)	mg/kg	2WFF16-SB2S2	4/4		5.5		4.6E+01	C	N/A		no	BSL
132-64-9	dibenzofuran	1.1	J	1.1	J	mg/kg	2WFF16-SB2S2	1/4	0.37-0.4	1.1		3.1E+01	N	N/A		no	BSL
86-73-7	fluorene	0.1	J	2.8	J	mg/kg	2WFF16-SB2S2	3/4	0.37	2.8		3.1E+02	N	N/A		no	BSL
91-20-3	naphthalene	2.9	J	7.7	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.4	7.7		1.6E+02	N	N/A		no	BSL
85-01-8	phenanthrene	0.043	J	7.8	J	mg/kg	2WFF16-SB2S2	4/4		7.8		2.3E+02	N (6)	N/A		no	BSL
129-00-0	pyrene	0.26	J	0.58	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.4	0.58		2.3E+02	N	N/A		no	BSL
72-54-8	4,4'-DDD	0.0235		0.0235		mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.0235		2.7E+00	C	N/A		no	BSL
72-55-9	4,4'-DDE	0.0017	J	0.0017	J	mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.0017		1.9E+00	C	N/A		no	BSL
50-29-3	4,4'-DDT	0.00675		0.00675		mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.00675		1.9E+00	C	N/A		no	BSL
309-00-2	aldrin	0.0029	J	0.0048	J	mg/kg	2WFF16-SB4S2	2/4	0.0019	0.0048		3.8E-02	C	N/A		no	BSL
58-89-9	gamma-BHC (lindane)	0.0105	J	0.0105	J	mg/kg	2WFF16-SB1S2	1/4	0.0019-0.002	0.0105		4.9E-01	C	N/A		no	BSL
1024-57-3	heptachlor epoxide	0.0012	J	0.0012	J	mg/kg	2WFF16-SB1S2	2/4	0.0019	0.0012		7.0E-02	C	N/A		no	BSL
7429-90-5	aluminum	1070		2180		mg/kg	2WFF16-SB3S2	4/4		2180	9970	7.8E+03	N	N/A		no	BSL
7440-39-3	barium	2.8		4.4		mg/kg	2WFF16-SB1S2	4/4		4.4	39.3	5.5E+02	N	N/A		no	BSL
7440-70-2	calcium	99.9		102		mg/kg	2WFF16-SB3S2	2/2		102	874	N/A		N/A		no	NUT
16065831	chromium (Cr3+) (7)	1.3		2.25		mg/kg	2WFF16-SB1S2	4/4		2.25	14.1	1.2E+04	N	N/A		no	BSL
7440-48-4	cobalt	0.13		0.13		mg/kg	2WFF16-SB2S2	2/4	0.11	0.13	1.9	4.7E+02	N	N/A		no	BSL
7440-50-8	copper	0.22	B (8)	0.24	B (8)	mg/kg	2WFF16-SB1S2	3/4	0.23	0.24	4.5	3.1E+02	N	N/A		no	BSL
57-12-5	cyanide	0.59		0.59		mg/kg	2WFF16-SB3S2	1/4	0.39-0.48	0.59		1.6E+02	N	N/A		no	BSL
7439-89-6	iron	500		1690		mg/kg	2WFF16-SB3S2	4/4		1690	9180	2.3E+03	N	N/A		no	BSL
7439-92-1	lead	2	B (8)	4.9		mg/kg	2WFF16-SB2S2	4/4		4.9	13.7	4.0E+02	(9)	N/A		no	BSL
7439-95-4	magnesium	43.4		105.1		mg/kg	2WFF16-SB1S2	4/4		105.1	1170	N/A		N/A		no	NUT
7439-96-5	manganese	2.3		6.25		mg/kg	2WFF16-SB1S2	4/4		6.25	173	1.6E+02	N	N/A		no	BSL
7440-09-7	potassium	100	B (8)	136		mg/kg	2WFF16-SB3S2	4/4		136	848	N/A		N/A		no	NUT
7782-49-2	selenium	0.34	K	0.35	K	mg/kg	2WFF16-SB2S2	2/4	0.32	0.35	0.86	3.9E+01	N	N/A		no	BSL
7440-23-5	sodium	70.2		179.5		mg/kg	2WFF16-SB1S2	4/4		179.5	132	N/A		N/A		no	NUT
7440-62-2	vanadium	2		3.6		mg/kg	2WFF16-SB1S2	4/4		3.6	19.3	5.5E+01	N	N/A		no	BSL
7440-66-6	zinc	0.56	B (8)	0.87	B (8)	mg/kg	2WFF16-SB3S2	4/4		0.87	25.6	2.3E+03	N	N/A		no	BSL
	diesel range organics	110		6800	Y	mg/kg	2WFF16-SB2S2	4/4		6800		N/A		N/A		no	NTX
	gasoline range organics	900	Y	2300	Y	mg/kg	2WFF16-SB2S2	3/4	0.057	2300		N/A		N/A		no	NTX

(1) Minimum/maximum detected concentration.

(2) Background values are maximum concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions: N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
B = Present in blank
Y = Appears to match a typical fuel pattern

(5) Even though these samples had positive detects in the equipment blanks, they were retained in the analysis since the site concentrations were greater than 10x the maximum blank concentration.

TABLE 4-6
SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER FOR THE HUMAN HEALTH RISK ASSESSMENT
SITE NAME: Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: groundwater at Site 16

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	(3) Screening Toxicity Value		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	COPC Flag	(5) Rationale for Contaminant Deletion or Selection
540-59-0	1,2-dichloroethene (total)	7	K	8	J	ug/L	WFF16-GW2S	2/7	10	8		5.50E+00	N			yes	ASL
67-64-1	acetone	27	K	27	K	ug/L	WFF15-GW7	1/7	10	27		6.10E+01	N			no	BSL
71-43-2	benzene	2	J	58		ug/L	WFF15-GW7	3/7	10	58		3.20E-01	C	5	MCL	yes	ASL
100-41-4	ethylbenzene	48		280	D	ug/L	WFF15-GW7	2/7	10	280		1.30E+02	N	700	MCL	yes	ASL
127-18-4	tetrachloroethene	4	J	5	J	ug/L	WFF15-GW7	2/7	10	5		1.10E+00	C	5	MCL	yes	ASL
108-88-3	toluene	1400	D	1400	D	ug/L	WFF15-GW7	1/7	10	1400		7.50E+01	N	1000	MCL	yes	ASL
1330-20-7	xylene (total)	4.5	J	1100	D	ug/L	WFF15-GW7	2/7	10	1100		1.20E+03	N	10000	MCL	no	BSL
105-67-9	2,4-dimethylphenol	1	J	1	J	ug/L	WFF16-GW2D	1/7	9-10	1		7.30E+01	N			no	BSL
95-57-8	2-chlorophenol	9		9		ug/L	WFF15-GW7	1/7	9-10	9		3.00E+00	N			yes	ASL
91-57-6	2-methylnaphthalene	3.5	J	200		ug/L	WFF15-GW7	2/7	9-10	200		1.20E+01	N			yes	ASL
95-48-7	2-methylphenol	7	J	7	J	ug/L	WFF15-GW7	1/7	9-10	7		1.80E+02	N			no	BSL
106-44-5	4-methylphenol	42		42		ug/L	WFF15-GW7	1/7	9-10	42		1.80E+01	N			yes	ASL
83-32-9	acenaphthene	2	J	8	L	ug/L	WFF15-GW7	2/7	9-10	8		3.70E+01	N			no	BSL
120-12-7	anthracene	1	J	1	J	ug/L	WFF15-GW7	1/7	9-10	1		1.80E+02	N			no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	39		160		ug/L	WFF15-GW7	2/5	10	160		4.80E+00	C	6	MCL	yes	ASL
86-74-8	carbazole	1	J	6	J	ug/L	WFF15-GW7	3/7	9-10	6		3.30E+00	C			yes	ASL
132-64-9	dibenzofuran	1	J	3	J	ug/L	WFF15-GW7	3/7	9-10	3		2.40E+00	N			yes	ASL
86-73-7	fluorene	2.5	J	12	J	ug/L	WFF15-GW7	3/7	9-10	12		2.40E+01	N			no	BSL
91-20-3	naphthalene	7	J	180		ug/L	WFF15-GW7	2/7	9-10	180		6.50E-01	N			yes	ASL
85-01-8	phenanthrene (6)	2	J	20	L	ug/L	WFF15-GW7	3/7	9-10	20		1.80E+01	N			yes	ASL
108-95-2	phenol	2	J	2	J	ug/L	WFF15-GW7	1/7	9-10	2		2.20E+03	N			no	BSL
129-00-0	pyrene	1	L	1	L	ug/L	WFF15-GW7	1/7	9-10	1		1.80E+01	N			no	BSL
50-29-3	4,4'-DDT	0.23	J	0.23	J	ug/L	WFF15-GW1	1/7	0.095-0.097	0.23		2.00E-01	C			yes	ASL
319-84-6	alpha-BHC	0.029	J	0.029	J	ug/L	WFF15-GW7	1/7	0.048-0.049	0.029		1.10E-02	C			yes	ASL
58-89-9	gamma-BHC (lindane)	0.067	J	0.067	J	ug/L	WFF15-GW7	1/7	0.048-0.049	0.067		5.20E-02	C	0.2	MCL	yes	ASL
7429-90-5	aluminum	679		17100		ug/L	WFF15-GW7	7/7	--	17100	11800	3.70E+03	N			yes	ASL
7440-36-0	antimony	1.4		4.6		ug/L	WFF16-GW3	2/7	1.6-4.2	4.6	--	1.50E+00	N	6	MCL	yes	ASL
7440-38-2	arsenic	2		88.2		ug/L	WFF15-GW7	4/7	2-3.4	88.2	5.1	4.50E-02	C	50	MCL	yes	ASL
7440-39-3	barium	47.5		174		ug/L	WFF16-GW4	6/6	--	174	62.5	2.60E+02	N	2000	MCL	no	BSL
7440-41-7	beryllium	0.25		1.2		ug/L	WFF16-GW3	4/7	0.2-0.6	1.2	0.29	7.30E+00	N	4	MCL	no	BSL
7440-43-9	cadmium	0.44		0.89		ug/L	WFF15-GW7	2/7	0.3-0.6	0.89	0.37	1.80E+00	N	5	MCL	no	BSL
7440-70-2	calcium	2610		50300		ug/L	WFF16-GW5	6/6	--	50300	16200					no	NUT
7440-47-3	chromium (Cr3+) (7)	1.9		17.3		ug/L	WFF15-GW7	7/7	--	17.3	11.2	5.50E+03	N			no	BSL
7440-48-4	cobalt	1.2		8.8		ug/L	WFF15-GW7	4/7	0.6-1	8.8	2	2.20E+02	N			no	BSL
7440-50-8	copper	0.92		6.5		ug/L	WFF15-GW7	6/6	--	6.5	1.9	1.50E+02	N	1300	action level (8)	no	BSL
	ferrous iron	0.05		32.5		ug/L	WFF15-GW7	4/5	0.05	32.5						no	NTX
7439-89-6	iron	3580		58400		ug/L	WFF15-GW7	7/7	--	58400	7660	1.10E+03	N			yes	ASL
7439-92-1	lead	2.8		62.8		ug/L	WFF15-GW7	4/6	2.5	62.8	4.8			15	action level (8)	yes	ASL (9)
7439-95-4	magnesium	2260		35700		ug/L	WFF16-GW5	6/6	--	35700	3510					no	NUT
7439-96-5	manganese	31.6		3510		ug/L	WFF15-GW7	7/7	--	3510	57	7.30E+01	N			yes	ASL
7440-02-0	nickel	2.4		4.5		ug/L	WFF16-GW4	4/6	1.5	4.5	2.2	7.30E+01	N			no	BSL
7440-09-7	potassium	1550		16300		ug/L	WFF16-GW5	6/6	--	16300	1560					yes	NUT

TABLE 4-6
SELECTION OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER FOR THE HUMAN HEALTH RISK ASSESSMENT
SITE NAME: Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: groundwater at Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
7782-49-2	selenium	1.9	L	5	L	ug/L	WFF15-GW7	3/7	1.7-2.6	5	3.1	1.80E+01	N	50	MCL	no	BSL
7440-23-5	sodium	2600		18600		ug/L	WFF15-GW7	6/6	--	18600	4330					no	NUT
7440-28-0	thallium	3.9		3.9		ug/L	WFF16-GW4	1/7	1.6-3.9	3.9		2.60E-01	N	2	MCL	yes	ASL
7440-62-2	vanadium	1.5		31.6		ug/L	WFF16-GW3	5/6	1.1	31.6	17.3	2.60E+01	N			yes	ASL
7440-66-6	zinc	7.4	K	82.3		ug/L	WFF16-GW3	6/6	--	82.3	7	1.10E+03	N			no	BSL
	diesel range organics	600	Y	83000	Y	ug/L	WFF15-GW7	5/7	110-120	83000						yes	NTX
	gasoline range organics	33	JZ	4000		ug/L	WFF15-GW7	5/7	50	4000						yes	NTX
	nitrate, as N	280		370		ug/L	WFF16-GW3	2/5	100	370		5.80E+03	N			no	BSL
	sulfate	5100		44600		ug/L	WFF16-GW5	3/5	5000	44600						no	NTX
	sulfide	2600		2600		ug/L	WFF16-GW2D	1/1	--	2600						no	NTX

(1) Minimum/maximum detected concentration.

(2) Background data are maximum detected concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) ARAR values are provided for informational purposes, screening was based on EPA Region III RBC values (EPA, 2000)

(5) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(6) The RBC for pyrene was used as a surrogate RBC for phenanthrene

Definitions: N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
D = Diluted out
Y = Appears to match a typical fuel pattern
Z = Does not appear to match a typical fuel pattern

TABLE 5-1
FAUNA CONSIDERED STATE OR FEDERAL THREATENED OR ENDANGERED IN THE VICINITY OF THE WFF MAIN BASE AS OF JANUARY 1992 (METCALF AND EDDY 1994)

SCIENTIFIC NAME	COMMON NAME	STATUS
Reptiles		
Caretta caretta	Loggerhead sea turtle	Federal Threatened
Chelonia mydas	Atlantic green sea turtle	Federal Threatened
Dermochelys coriaces	Leatherback sea turtle	Federal Endangered
Eretmochelys imbricata	Hawksbill sea turtle	Federal Endangered
Lepidochelys kempi	Kemp's Ridley sea turtle	Federal Endangered
Birds		
Bartramia longicauda	Upland sandpiper	State Threatened
Charadrius melodus	Piping plover	Federal Endangered
Charadrius wilsonia	Wilson's plover	State Endangered
Falco peregrinus	Peregrine falcon	Federal Threatened
Haliaeetus leucocephalus	Bald eagle	Federal Threatened
Sterna nilotica	Gull-billed tern	State Threatened
Marine Mammals		
Balaenoptera borealis	Sei whale	Federal Endangered
Balaenoptera musculus	Blue whale	Federal Endangered
Balaenoptera physalus	Fin whale	Federal Endangered
Eubalaena glacialis	Northern right whale	Federal Endangered
Megaptera novaeangliae	Humpback whale	Federal Endangered
Physeter catodon	Sperm whale	Federal Endangered

TABLE 5-2. POTENTIAL EXPOSURE PATHWAYS FOR SITE 16 SURFACE SOIL ECOLOGICAL RECEPTORS

Source/Mechanisms of Release	Potential Receptors	Exposure Route	Pathways Evaluated?	Comments
SURFACE SOIL				
Aerial deposition of wastes from past activities; past dumping of wastes	Terrestrial plants	Root uptake	Yes	Pathway potentially complete; selected for quantitative evaluation
		Foliar uptake	No	Not evaluated because applicable exposure and toxicity data could not be found in the scientific literature
	Terrestrial invertebrates (e.g., earthworms)	Ingestion and dermal absorption	Yes	Pathway potentially complete; selected for quantitative evaluation
	Terrestrial wildlife (e.g., mammals, birds)	Ingestion	Yes	Pathway potentially complete; selected for quantitative evaluation
		Dermal absorption	No	Not evaluated because applicable exposure data could not be found in the scientific literature
AIR				
Wind entrainment of surface soil; volatilization of chemicals to air	Terrestrial wildlife	Inhalation	No	Majority of WFF is vegetated, limiting potential exposure via this pathway

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TABLE 5-3. IDENTIFICATION OF MEASUREMENT AND ASSESSMENT ENDPOINTS FOR SITE 16 SURFACE SOIL

Receptor of Concern	Exposure Pathway Evaluated	Assessment Endpoint*	Testable Hypothesis	Measurement Endpoint	Data Available
Terrestrial plants	Absorption of chemicals from surface soil through root uptake	Decline in growth and abundance of terrestrial plants	Ha: The concentration of COPCs in surface soil exceeds a level known to be toxic to terrestrial plants	Compare chemical concentrations in surface soil at potentially impacted locations to toxicity benchmarks in literature	Site-specific surface soil chemical data from potentially impacted locations and background locations
Soil invertebrates (earthworms)	Ingestion and dermal absorption of chemicals from surface soil	Decline in growth, reproduction, or soil aeration activities of soil invertebrates	Ha: The concentration of COPCs in surface soil exceeds a level known to be toxic to soil invertebrates	Compare chemical concentrations in surface soil at potentially impacted locations to toxicity benchmarks in literature.	Site-specific surface soil chemical data from potentially impacted locations and background locations
Small carnivorous mammals (shrews)	Ingestion of chemicals accumulated in earthworms, from surface soil and surface water	Decline in shrew populations	Ha: The ingestion of bioaccumulative chemicals from earthworms, surface soil, and surface water exceeds a level known to be toxic to shrews	Compare dose of bioaccumulative chemicals from ingestion of earthworms and surface soil, estimated by modeling, to toxicity benchmarks in literature	Site-specific surface soil chemical data from potentially impacted locations and background locations.
Small carnivorous birds (robins)	Ingestion of chemicals accumulated in earthworms, from surface soil and surface water	Decline in robin populations	Ha: The ingestion of bioaccumulative chemicals from earthworms, surface soil, and surface water exceeds a level known to be toxic to robins	Compare dose of bioaccumulative chemicals from ingestion of earthworms and surface soil, estimated by modeling, to toxicity benchmarks in literature	Site-specific surface soil chemical data from potentially impacted locations and background locations.

Note: *Assessment endpoints identified for evaluation in the WFF Site 16 ERA are based on the parameters used to derive the toxicity benchmarks (see measurement endpoint column) and are not intended to imply the measurement of these parameters in the field.

TABLE 5-4

COMPARISON OF MAXIMUM SOIL CONCENTRATIONS AT SITE 16 TO TERRESTRIAL PLANT TRVs

Chemical	Maximum Surface Soil Concentration	Terrestrial Plant TRV (a)	Environmental Effects Quotient (b)
Inorganics			
Aluminum	10,600	50	**212**
Antimony	0.92	5	0.18
Beryllium [B]	0.2	10	0.02
Chromium [B]	11	1	**11**
Iron	10,700	NA	No TRV
Lead	60.5	50	**1.2**
Nickel	5.7	30	0.19
Silver	0.48	2	0.24
Vanadium	19.7	2	**9.9**
Zinc	53.2	50	**1.1**

a) TRVs obtained from Efroymson et al (1997a)
b) Environmental Effects Quotient (EEQ) is the ratio of site soil concentration to the TRV;
B - Site 16 maximum concentration did not exceed maximum background concentration.
NA - No TRV Available

TABLE 5-5

COMPARISON OF MAXIMUM SURFACE SOIL CONCENTRATIONS AT SITE 16 TO EARTHWORM TRVs

Chemical	Maximum Surface Soil Concentration	Earthworm TRV (a)		Environmental Effects Quotient (b)
Organics				
4,4'-DDD	12	1,500	(c)	0.01
4,4'-DDE	310	1,500	(c)	0.21
4,4'-DDT	260	1,500	(c)	0.17
Inorganics				
Aluminum	10,600	NA		No TRV
Antimony	0.92	5	(d)	0.2
Beryllium [B]	0.2	1	(e)	0.2
Chromium [B]	11	0.4		**27.5**
Iron	10,700	NA		No TRV
Lead	60.5	500		0.1
Nickel	5.7	200		0.03
Silver	0.48	5	(e)	0.1
Vanadium	19.7	150	(d)	0.1
Zinc	53.2	200		0.3

a) TRVs obtained from Efroymson et al (1997b), unless otherwise indicated.
b) Environmental Effects Quotient (EEQ) is the ratio of site soil concentration to the TRV; TRVs greater than 1 are listed in bold face type.
c) Epidermal effects; 22.5% mortality at 15 mg/kg of DDT in soil (Cathey, 1982, as cited in USEPA, 1985b). To increase protection, 15 mg/kg was divided by 10.
d) Maximum allowable concentrations for the Soviet Union (1984) as cited in Beyer (1990).
e) Cleanup guidelines for the New Jersey Environmental Cleanup Responsibility Act (1987) as cited in Beyer (1990).
B - Site 16 maximum concentration did not exceed maximum background concentration.
NA - No TRV Available

TABLE 5-6

Comparison of Estimated Total Ingested Dose to Robin TRVs for Chemicals of Potential Bioaccumulative Concern at Site 16 - Wallops Island

Chemical	Dose (mg/kg bw-d) Earthworm		Soil	Total	Robin TRV (mg/kg day) (a)		Environmental Effects Quotient (b)
Organics							
Benzo(a)pyrene	1.79E-05	(c)	1.90E-04	2.08E-04	No TRV		No TRV
Benzo(g,h,i)perylene	3.61E-06	(c)	8.69E-05	9.06E-05	No TRV		No TRV
Bis(2-ethylhexyl)phthalate	3.83E-02	(d)	4.43E-04	3.87E-02	1.1		<0.1
Chrysene	7.80E-06	(c)	6.40E-05	7.18E-05	No TRV		No TRV
Indeno(1,2,3-cd)pyrene	2.51E-06	(c)	2.21E-05	2.46E-05	No TRV		No TRV
DDT and metabolites	4.30E-06	(e)	9.20E-05	9.63E-05	0.003		<0.1
Inorganics							
Aluminum	250.57	(c)	1675.65	1926.22	109.7	(h)	**17.6**
Antimony	0.11	(f)	0.15	0.25	No TRV		No TRV
Beryllium [B]	0.02	(f)	0.03	0.06	No TRV		No TRV
Chromium [B]	0.31	(c)	1.74	2.05	1.0		**2**
Iron	370.04	(c)	1691.46	2061.49	No TRV		No TRV
Lead	0.50	(g)	9.56	10.07	1.1	(i)	8.9
Nickel	0.19	(c)	0.90	1.10	77.4		<0.1
Silver	No BCF		0.08	0.08	No TRV		No TRV
Vanadium	No BCF		3.11	3.11	11.4		0.3
Zinc	1.93	(c)	8.41	10.34	14.5		0.7

a) TRVs from Sample et al. 1996, except where otherwise noted.
b) Environmental Effects Quotient (EEQ) is the ratio of total dose to the TRV; TRVs greater than 1 are listed in bold face type.
c) BCFs from Beyer and Stafford (1993).
d) USEPA Region III BTAG BCF.
e) BCF for DDTr was taken from Beyer (1990), using 4,4'-DDT as a surrogate.
f) BCFs from Jeff York, USEPA Region VI Multimedia Planning and Permitting Division (6PD) 1997.
g) BCF from Van hook, 1974.
h) Value for Al2(SO4)2.
i) Value for lead acetate.

TABLE 5-7

Comparison of Estimated Total Ingested Dose to Shrew TRVs for Chemicals of Potential Bioaccumulative Concern at Site 16 - Wallops Island

Chemical	Dose (mg/kg bw-d)			Shrew TRV (mg/kg day) (a)		Environmental Effects Quotient (b)
	Earthworm	Soil	Total			
Organics						
Benzo(a)pyrene	1.27E-05 (c)	6.99E-05	8.26E-05	1.2		<0.1
Benzo(g,h,i)perylene	2.57E-06 (c)	3.21E-05	3.46E-05	1.2	(g)	<0.1
Bis(2-ethylhexyl)phthalate	4.36E-03 (d)	1.63E-04	4.52E-03	21.8		<0.1
Chrysene	5.55E-06 (c)	2.36E-05	2.92E-05	119.0	(g)	<0.1
Indeno(1,2,3-cd)pyrene	1.79E-06 (c)	8.16E-06	9.95E-06	11.9	(g)	<0.1
DDT and metabolites	1.63E-04	3.39E-05	1.97E-04	1.760		<0.1
Inorganics						
Aluminum	178.30 (c)	617.77	796.06	2.3	(h)	**346.9**
Antimony	0.08 (e)	0.05	0.13	0.1		0.9
Beryllium [B]	0.02 (e)	0.01	0.03	1.5		<0.1
Chromium [B]	0.22 (c)	0.64	0.86	7.2	(i)	0.1
Iron	263.30 (c)	623.60	886.90	No TRV		No TRV
Lead	0.36 (e)	3.53	3.88	17.6		0.2
Nickel	0.14 (c)	0.33	0.47	87.9		<0.1
Silver	No BCF	0.03	0.03	No TRV		No TRV
Vanadium	1.66 (f)	1.15	2.80	0.4	(j)	6.6
Zinc	1.38 (c)	3.10	4.48	351.7		<0.1

a) TRVs from Sample et al. 1996, except where otherwise noted.
b) Environmental Effects Quotient (EEQ) is the ratio of total dose to the TRV; TRVs greater than 1 are listed in bold face
c) BCFs from Beyer and Stafford (1993).
d) USEPA Region III BTAG BCF.
e) BCFs from Jeff York, USEPA Region VI Multimedia Planning and Permitting Division (6PD) 1997.
f) Value for sodium metavanadate.
g) TRV for benzo(a)pyrene multiplied by USEPA Region IV PEF or 1.0 when no PEF was available.
h) Value for AlCl3.
i) Value for Cr+6.
j) Value for sodium metavanadate.

TABLE 6-1
SELECTION OF EXPOSURE PATHWAYS
Wallops Flight Facility - Site 16

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 soil	surface soil	surface soil at Site 16	recreational	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	surface soil	air	air volatized from surface soil at Site 16	recreational	adult	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
current/future	surface soil	surface soil	surface soil at Site 16	recreational	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	surface soil	surface soil	surface soil at Site 16	recreational	child	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	surface soil	air	air volatized from surface soil at Site 16	recreational	child	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
current/future	surface soil	surface soil	surface soil at Site 16	recreational	child	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	surface soil	surface soil	surface soil at Site 16	commercial/ind.	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	surface soil	air	air volatized from surface soil at Site 16	commercial/ind.	adult	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
current/future	surface soil	surface soil	surface soil at Site 16	commercial/ind.	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	surface soil	surface soil	surface soil at Site 16	construction worker	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	surface soil	air	air volatized from surface soil at Site 16	construction worker	adult	inhalation	on-site	quantitative	Based on the intrusive nature of excavation activities, inhalation may be a significant pathway for this receptor; as a result this pathway was selected for evaluation.
future	surface soil	surface soil	surface soil at Site 16	construction worker	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	surface soil	surface soil	surface soil at Site 16	resident	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	surface soil	air	air volatized from surface soil at Site 16	resident	adult	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
future	surface soil	surface soil	surface soil at Site 16	resident	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	surface soil	surface soil	surface soil at Site 16	resident	child	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	surface soil	air	air volatized from surface soil at Site 16	resident	child	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
future	surface soil	surface soil	surface soil at Site 16	resident	child	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	recreational	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	subsurface soil	air	air volatized from subsurface soil excavated to the surface at Site 16	recreational	adult	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
current/future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	recreational	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	recreational	child	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.

TABLE 6-1
SELECTION OF EXPOSURE PATHWAYS
Wallops Flight Facility - Site 16

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	subsurface soil	air	air volatized from subsurface soil excavated to the surface at Site 16	recreational	child	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
current/future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	recreational	child	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	commercial/ind.	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
current/future	subsurface soil	air	air volatized from subsurface soil excavated to the surface at Site 16	commercial/ind.	adult	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
current/future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	commercial/ind.	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	construction worker	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	subsurface soil	air	air volatized from subsurface soil excavated to the surface at Site 16	construction worker	adult	inhalation	on-site	quantitative	Based on the intrusive nature of excavation activities, inhalation may be a significant pathway for this receptor; as a result this pathway was selected for evaluation.
future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	construction worker	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	resident	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	subsurface soil	air	air volatized from subsurface soil excavated to the surface at Site 16	resident	adult	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	resident	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	resident	child	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	subsurface soil	air	air volatized from subsurface soil excavated to the surface at Site 16	resident	child	inhalation	on-site	none	Based on site information and exposure potential, inhalation is not anticipated to be a significant pathway for this receptor; therefore pathway not selected for evaluation.
future	subsurface soil	subsurface soil	subsurface soil excavated to the surface at Site 16	resident	child	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	water supply well - tap	commercial/ind.	adult	ingestion	both	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	groundwater at excavation site	construction worker	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	air	air volatilized from groundwater at excavation site	construction worker	adult	inhalation	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	groundwater at excavation site	construction worker	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	water supply well - tap	resident	adult	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	water supply well - vapor from shower head	resident	adult	inhalation	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	water supply well - shower scenario	resident	adult	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	water supply well - tap	resident	child	ingestion	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.

TABLE 6-1
SELECTION OF EXPOSURE PATHWAYS
Wallops Flight Facility - Site 16

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
future	groundwater	groundwater	water supply well - vapor from shower head	resident	child	inhalation	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.
future	groundwater	groundwater	water supply well - shower scenario	resident	child	dermal	on-site	quantitative	Pathway potentially complete; selected for quantitative evaluation.

OCCURRENCE, DISTRIBUTION AND SELEC... OF CHEMICALS OF POTENTIAL CONCERN
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: surface soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	(3) Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	(4) Rationale for Contaminant Deletion or Selection
50-32-8	benzo(a)pyrene	0.91		1.2		mg/kg	3WFF16-SS10	2/21	0.34-7.4	1.2		0.087	C	N/A		yes	ASL
191-24-2	benzo(g,h,i)perylene	0.083	J	0.55		mg/kg	3WFF16-SS10	4/21	0.34-7.4	1		230	N (5)	N/A		no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	0.43		2.8		mg/kg	3WFF16-SS9	18/21	0.34-7.4	2.8		46	C	N/A		no	BSL
218-01-9	chrysene	0.078	J	0.405		mg/kg	3WFF16-SS10	5/21	0.35-7.4	0.405		87	C	N/A		no	BSL
193-39-5	indeno(1,2,3-cd)pyrene	0.12	J	0.14	J	mg/kg	3WFF16-SS9	2/21	0.34-7.4	0.14		0.87	C	N/A		no	BSL
72-54-8	4,4'-DDD	0.012		0.012		mg/kg	3WFF16-SS16	1/21	0.0035-0.038	0.012		2.7	C	N/A		no	BSL
72-55-9	4,4'-DDE	0.0028		0.31	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	0.31		1.9	C	N/A		no	BSL
50-29-3	4,4'-DDT	0.0042	J	0.26	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	0.26		1.9	C	N/A		no	BSL
7429-90-5	aluminum	2850		10600		mg/kg	2WFF16-SB1S	21/21		10600	9970	7800	N	N/A		yes	ASL
7440-36-0	antimony	0.92		0.92		mg/kg	3WFF16-SS13	1/21	0.29-0.82	0.92	0.44	3.1	N	N/A		no	BSL
7440-38-2	arsenic	0.66		2.9		mg/kg	3WFF16-SS16	18/21	0.55-0.63	2.9	3.1	0.43	C	N/A		yes	ASL
7440-39-3	barium	8.3		33.3		mg/kg	2WFF16-SB1S	21/21		33.3	39.3	550	N	N/A		no	BSL
7440-41-7	beryllium	0.11		0.2		mg/kg	3WFF16-SS6	7/17	0.1-0.12	0.2	0.26	16	N	N/A		no	BSL
7440-70-2	calcium	41.8		891		mg/kg	3WFF16-SS3	21/21		891	874	N/A		N/A		no	NUT
16065831	chromium (Cr3+) (6)	3.4		11		mg/kg	3WFF16-SS3	21/21		11	14.1	12000	N	N/A		no	BSL
7440-48-4	cobalt	0.6		3.2		mg/kg	3WFF16-SS13	21/21		3.2	1.9	470	N	N/A		no	BSL
7440-50-8	copper	1.4		8.3	K	mg/kg	2WFF16-SB1S	20/20		8.3	4.5	310	N	N/A		no	BSL
7439-89-6	iron	2340		10700		mg/kg	3WFF16-SS3	21/21		10700	9180	2300	N	N/A		yes	ASL
7439-92-1	lead	5.4		60.5		mg/kg	3WFF16-SS9	21/21		60.5	13.7	400	(7)	N/A		no	BSL
7439-95-4	magnesium	176		874		mg/kg	3WFF16-SS3	21/21		874	1170	N/A		N/A		no	NUT
7439-96-5	manganese	23.5		128		mg/kg	3WFF16-SS13	21/21		128	173	160	N	N/A		no	BSL
7440-02-0	nickel	1.1		5.7		mg/kg	2WFF16-SB1S	21/21		5.7	5.3	160	N	N/A		no	BSL
7440-09-7	potassium	149		495		mg/kg	2WFF16-SB1S	21/21		495	846	N/A		N/A		no	NUT
7782-49-2	selenium	0.23		0.65		mg/kg	3WFF16-SS16	12/20	0.18-0.21	0.65	0.86	39	N	N/A		no	BSL
7440-22-4	silver	0.16		0.48		mg/kg	3WFF16-SS8	7/21	0.1-0.16	0.48	0.13	39	N	N/A		no	BSL
7440-23-5	sodium	102		439		mg/kg	3WFF16-SS3	21/21		439	132	N/A		N/A		no	NUT
7440-62-2	vanadium	5.1		19.7		mg/kg	3WFF16-SS3	21/21		19.7	19.3	55	N	N/A		no	BSL
7440-66-6	zinc	5.3		53.2		mg/kg	3WFF16-SS14	21/21		53.2	25.6	2300	N	N/A		no	BSL
	diesel range organics	3	JY	870	Y	mg/kg	3WFF16-SS11	20/21	7.1	870		N/A		N/A		no	NTX
	gasoline range organics	0.03	JZ	0.22	Z	mg/kg	3WFF16-SS15	4/21	0.052-0.059	0.22		N/A		N/A		no	NTX

(1) Minimum/maximum detected concentration.

(2) Background values are maximum concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST); Frequent Detection (FD); Toxicity Information Available (TX); Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD); Background Levels (BKG); No Toxicity Information (NTX); Essential Nutrient (NUT); Below Screening Level (BSL)

(5) The RBC for pyrene was used as a surrogate RBC for benzo(g,h,i)perylene.

(6) Chromium was evaluated as trivalent chromium since hexavalent chromium was evaluated separately in the analysis.

(7) The lead screening value is based on the OSWER screening value for lead in soils.

Definitions: N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
D = Diluted out
Y = Appears to match a typical fuel pattern
Z = Does not appear to match a typical fuel pattern

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: surface soil
Exposure Medium: air
Exposure Point: air volatilized from surface soil at Site 16

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	1 Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2) Background Value	(3) Screening Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	(4) Rationale for Contaminant Deletion or Selection
50-32-8	benzo(a)pyrene	0.91		1.2		mg/kg	3WFF16-SS10	2/21	0.34-7.4	1.2		0.087	C	N/A		yes	ASL
191-24-2	benzo(g,h,i)perylene	0.083	J	0.55		mg/kg	3WFF16-SS10	4/21	0.34-7.4	1		230	N (5)	N/A		no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	0.43		2.8		mg/kg	3WFF16-SS9	18/21	0.34-7.4	2.8		46	C	N/A		no	BSL
218-01-9	chrysene	0.078	J	0.405		mg/kg	3WFF16-SS10	5/21	0.35-7.4	0.405		87	C	N/A		no	BSL
193-39-5	indeno(1,2,3-cd)pyrene	0.12	J	0.14	J	mg/kg	3WFF16-SS9	2/21	0.34-7.4	0.14		0.87	C	N/A		no	BSL
72-54-8	4,4'-DDD	0.012		0.012	-	mg/kg	3WFF16-SS16	1/21	0.0035-0.038	0.012		2.7	C	N/A		no	BSL
72-55-9	4,4'-DDE	0.0028		0.31	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	0.31		1.9	C	N/A		no	BSL
50-29-3	4,4'-DDT	0.0042	J	0.26	D	mg/kg	3WFF16-SS16	7/21	0.0035-0.038	0.26		1.9	C	N/A		no	BSL
7429-90-5	aluminum	2850		10600		mg/kg	2WFF16-SB1S1	21/21		10600	9970	7800	N	N/A		yes	ASL
7440-36-0	antimony	0.92		0.92		mg/kg	3WFF16-SS13	1/21	0.29-0.82	0.92	0.44	3.1	N	N/A		no	BSL
7440-38-2	arsenic	0.66		2.9		mg/kg	3WFF16-SS16	18/21	0.55-0.63	2.9	3.1	0.43	C	N/A		yes	ASL
7440-39-3	barium	8.3		33.3		mg/kg	2WFF16-SB1S1	21/21		33.3	39.3	550	N	N/A		no	BSL
7440-41-7	beryllium	0.11		0.2		mg/kg	3WFF16-SS6	7/17	0.1-0.12	0.2	0.26	16	N	N/A		no	BSL
7440-70-2	calcium	41.8		891		mg/kg	3WFF16-SS3	21/21		891	874	N/A		N/A		no	NUT
16065831	chromium (Cr3+) (6)	3.4		11		mg/kg	3WFF16-SS3	21/21		11	14.1	12000	N	N/A		no	BSL
7440-48-4	cobalt	0.6		3.2		mg/kg	3WFF16-SS13	21/21		3.2	1.9	470	N	N/A		no	BSL
7440-50-8	copper	1.4		8.3	K	mg/kg	2WFF16-SB1S1	20/20		8.3	4.5	310	N	N/A		no	BSL
7439-89-6	iron	2340		10700		mg/kg	3WFF16-SS3	21/21		10700	9180	2300	N	N/A		yes	ASL
7439-92-1	lead	5.4		60.5		mg/kg	3WFF16-SS9	21/21		60.5	13.7	400	(7)	N/A		no	BSL
7439-95-4	magnesium	176		874		mg/kg	3WFF16-SS3	21/21		874	1170	N/A		N/A		no	NUT
7439-96-5	manganese	23.5		128		mg/kg	3WFF16-SS13	21/21		128	173	160	N	N/A		no	BSL
7440-02-0	nickel	1.1		5.7		mg/kg	2WFF16-SB1S1	21/21		5.7	5.3	160	N	N/A		no	BSL
7440-09-7	potassium	149		495		mg/kg	2WFF16-SB1S1	21/21		495	848	N/A		N/A		no	NUT
7782-49-2	selenium	0.23		0.65		mg/kg	3WFF16-SS16	12/20	0.18-0.21	0.65	0.86	39	N	N/A		no	BSL
7440-22-4	silver	0.16		0.48		mg/kg	3WFF16-SS8	7/21	0.1-0.16	0.48	0.13	39	N	N/A		no	BSL
7440-23-5	sodium	102		439		mg/kg	3WFF16-SS3	21/21		439	132	N/A		N/A		no	NUT
7440-62-2	vanadium	5.1		19.7		mg/kg	3WFF16-SS3	21/21		19.7	19.3	55	N	N/A		no	BSL
7440-66-6	zinc	5.3		53.2		mg/kg	3WFF16-SS14	21/21		53.2	25.6	2300	N	N/A		no	BSL
	diesel range organics	3	JY	870	Y	mg/kg	3WFF16-SS11	20/21	7.1	870		N/A		N/A		no	NTX
	gasoline range organics	0.03	JZ	0.22	Z	mg/kg	3WFF16-SS15	4/21	0.052-0.059	0.22		N/A		N/A		no	NTX

(1) Minimum/maximum detected concentration.

(2) Background values are maximum concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(5) The RBC for pyrene was used as a surrogate RBC for benzo(g,h,i)perylene.

(6) Chromium was evaluated as trivalent chromium since hexavalent chromium was evaluated separately in the analysis.

(7) The lead screening value is based on the OSWER screening value for lead in soils.

Definitions: N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
D = Diluted out
Y = Appears to match a typical fuel pattern
Z = Does not appear to match a typical fuel pattern

OCCURRENCE, DISTRIBUTION AND SEL[illegible] CHEMICALS OF POTENTIAL CONCERN
Wallops Flight [illegible] (WFF) - Site 16

Scenario Timeframe: current/future
Medium: subsurface soil
Exposure Medium: subsurface soil
Exposure Point: subsurface soil excavated to the surface of Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
75-00-3	chloroethane	0.056	K	0.11	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	0.11		2.2E+02	C	N/A		no	BSL
100-41-4	ethylbenzene	1.1	J	2.2	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	2.2		7.8E+02	N	N/A		no	BSL
127-18-4	tetrachloroethene	0.201	J	0.201	J	mg/kg	2WFF16-SB1S2	1/4	0.011-0.12	0.201		1.2E+01	C	N/A		no	BSL
108-88-3	toluene	0.86		1.7	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	1.7		1.6E+03	N	N/A		no	BSL
1330-20-7	xylene (total)	0.064	J	13	J	mg/kg	2WFF16-SB2S2	3/4	0.011	13		1.6E+04	N	N/A		no	BSL
91-57-6	2-methylnaphthalene	0.31	J	29	J	mg/kg	2WFF16-SB2S2	3/4	0.37	29		1.6E+02	N	N/A		no	BSL
83-32-9	acenaphthene	0.054	J	1.8	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.39	1.8		4.7E+02	N	N/A		no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	0.36	B (5)	5.5	B (5)	mg/kg	2WFF16-SB2S2	4/4		5.5		4.6E+01	C	N/A		no	BSL
132-64-9	dibenzofuran	1.1	J	1.1	J	mg/kg	2WFF16-SB2S2	1/4	0.37-0.4	1.1		3.1E+01	N	N/A		no	BSL
86-73-7	fluorene	0.1	J	2.8	J	mg/kg	2WFF16-SB2S2	3/4	0.37	2.8		3.1E+02	N	N/A		no	BSL
91-20-3	naphthalene	2.9	J	7.7	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.4	7.7		1.6E+02	N	N/A		no	BSL
85-01-8	phenanthrene	0.043	J	7.8	J	mg/kg	2WFF16-SB2S2	4/4		7.8		2.3E+02	N (6)	N/A		no	BSL
129-00-0	pyrene	0.26	J	0.58	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.4	0.58		2.3E+02	N	N/A		no	BSL
72-54-8	4,4'-DDD	0.0235		0.0235		mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.0235		2.7E+00	C	N/A		no	BSL
72-55-9	4,4'-DDE	0.0017	J	0.0017	J	mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.0017		1.9E+00	C	N/A		no	BSL
50-29-3	4,4'-DDT	0.00675		0.00675		mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.00675		1.9E+00	C	N/A		no	BSL
309-00-2	aldrin	0.0029	J	0.0048	J	mg/kg	2WFF16-SB4S2	2/4	0.0019	0.0048		3.8E-02	C	N/A		no	BSL
58-89-9	gamma-BHC (lindane)	0.0105	J	0.0105	J	mg/kg	2WFF16-SB1S2	1/4	0.0019-0.002	0.0105		4.9E-01	C	N/A		no	BSL
1024-57-3	heptachlor epoxide	0.0012	J	0.0012	J	mg/kg	2WFF16-SB1S2	2/4	0.0019	0.0012		7.0E-02	C	N/A		no	BSL
7429-90-5	aluminum	1070		2180		mg/kg	2WFF16-SB3S2	4/4		2180	9970	7.8E+03	N	N/A		no	BSL
7440-39-3	barium	2.8		4.4		mg/kg	2WFF16-SB1S2	4/4		4.4	39.3	5.5E+02	N	N/A		no	BSL
7440-70-2	calcium	99.9		102		mg/kg	2WFF16-SB3S2	2/2		102	874	N/A		N/A		no	NUT
16065831	chromium (Cr3+) (7)	1.3		2.25		mg/kg	2WFF16-SB1S2	4/4		2.25	14.1	1.2E+04	N	N/A		no	BSL
7440-48-4	cobalt	0.13		0.13		mg/kg	2WFF16-SB2S2	2/4	0.11	0.13	1.9	4.7E+02	N	N/A		no	BSL
7440-50-8	copper	0.22	B (8)	0.24	B (8)	mg/kg	2WFF16-SB1S2	3/4	0.23	0.24	4.5	3.1E+02	N	N/A		no	BSL
57-12-5	cyanide	0.59		0.59		mg/kg	2WFF16-SB3S2	1/4	0.39-0.48	0.59		1.6E+02	N	N/A		no	BSL
7439-89-6	iron	500		1690		mg/kg	2WFF16-SB3S2	4/4		1690	9180	2.3E+03	N	N/A		no	BSL
7439-92-1	lead	2	B (8)	4.9		mg/kg	2WFF16-SB2S2	4/4		4.9	13.7	4.0E+02	(9)	N/A		no	BSL
7439-95-4	magnesium	43.4		105.1		mg/kg	2WFF16-SB1S2	4/4		105.1	1170	N/A		N/A		no	NUT
7439-96-5	manganese	2.3		6.25		mg/kg	2WFF16-SB1S2	4/4		6.25	173	1.6E+02	N	N/A		no	BSL
7440-09-7	potassium	100	B (8)	136		mg/kg	2WFF16-SB3S2	4/4		136	848	N/A		N/A		no	NUT
7782-49-2	selenium	0.34	K	0.35	K	mg/kg	2WFF16-SB2S2	2/4	0.32	0.35	0.86	3.9E+01	N	N/A		no	BSL
7440-23-5	sodium	70.2		179.5		mg/kg	2WFF16-SB1S2	4/4		179.5	132	N/A		N/A		no	NUT
7440-62-2	vanadium	2		3.6		mg/kg	2WFF16-SB1S2	4/4		3.6	19.3	5.5E+01	N	N/A		no	BSL
7440-66-6	zinc	0.56	B (8)	0.87	B (8)	mg/kg	2WFF16-SB3S2	4/4		0.87	25.6	2.3E+03	N	N/A		no	BSL
	diesel range organics	110		6800	Y	mg/kg	2WFF16-SB2S2	4/4		6800		N/A		N/A		no	NTX
	gasoline range organics	900	Y	2300	Y	mg/kg	2WFF16-SB2S2	3/4	0.057	2300		N/A		N/A		no	NTX

(1) Minimum/maximum detected concentration.

(2) Background values are maximum concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted

(4) Rationale Codes Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Frequent Detection (FD)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)

Deletion Reason:
- Infrequent Detection (IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Essential Nutrient (NUT)
- Below Screening Level (BSL)

Definitions:
- N/A = Not Applicable
- COPC = Chemical of Potential Concern
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- J = Estimated Value
- C = Carcinogenic
- N = Non-Carcinogenic
- B = Present in blank
- Y = Appears to match a typical fuel pattern

(5) Even though these samples had positive detects in the equipment blanks, they were retained in the analysis since the site concentrations were greater than 10x the maximum blank concentration.

(6) The RBC for pyrene was used as a surrogate for phenanthrene.

(7) Chromium was evaluated as trivalent chromium since hexavalent chromium was evaluated separately in the analysis.

(8) Even though these samples had positive detects in the equipment blanks, they were retained in the analysis since the site concentrations were greater than 5x the maximum blank concentration.

(9) The lead screening value is based on the OSWER screening value for lead in soils.

OCCURRENCE, DISTRIBUTION AND SE[illegible] CHEMICALS OF POTENTIAL CONCERN
Wallops Fligh[illegible] (WFF) - Site 16

Scenario Timeframe: current/future
Medium: subsurface soil
Exposure Medium: air
Exposure Point: air volatized from subsurface soil excavated to the surface at Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (4)
75-00-3	chloroethane	0.056	K	0.11	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	0.11		2.2E+02	C	N/A		no	BSL
100-41-4	ethylbenzene	1.1	J	2.2	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	2.2		7.8E+02	N	N/A		no	BSL
127-18-4	tetrachloroethene	0.201	J	0.201	J	mg/kg	2WFF16-SB1S2	1/4	0.011-0.12	0.201		1.2E+01	C	N/A		no	BSL
108-88-3	toluene	0.86		1.7	J	mg/kg	2WFF16-SB2S2	2/4	0.011-0.12	1.7		1.6E+03	N	N/A		no	BSL
1330-20-7	xylene (total)	0.064	J	13	J	mg/kg	2WFF16-SB2S2	3/4	0.011	13		1.6E+04	N	N/A		no	BSL
91-57-6	2-methylnaphthalene	0.31	J	29	J	mg/kg	2WFF16-SB2S2	3/4	0.37	29		1.6E+02	N	N/A		no	BSL
83-32-9	acenaphthene	0.054	J	1.8	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.39	1.8		4.7E+02	N	N/A		no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	0.36	B (5)	5.5	B (5)	mg/kg	2WFF16-SB2S2	4/4		5.5		4.6E+01	C	N/A		no	BSL
132-64-9	dibenzofuran	1.1	J	1.1	J	mg/kg	2WFF16-SB2S2	1/4	0.37-0.4	1.1		3.1E+01	N	N/A		no	BSL
86-73-7	fluorene	0.1	J	2.8	J	mg/kg	2WFF16-SB2S2	3/4	0.37	2.8		3.1E+02	N	N/A		no	BSL
91-20-3	naphthalene	2.9	J	7.7	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.4	7.7		1.6E+02	N	N/A		no	BSL
85-01-8	phenanthrene	0.043	J	7.8	J	mg/kg	2WFF16-SB2S2	4/4		7.8		2.3E+02	N	N/A		no	BSL
129-00-0	pyrene	0.26	J	0.58	J	mg/kg	2WFF16-SB2S2	2/4	0.37-0.4	0.58		2.3E+02	N (6)	N/A		no	BSL
72-54-8	4,4'-DDD	0.0235		0.0235		mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.0235		2.7E+00	C	N/A		no	BSL
72-55-9	4,4'-DDE	0.0017	J	0.0017	J	mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.0017		1.9E+00	C	N/A		no	BSL
50-29-3	4,4'-DDT	0.00675		0.00675		mg/kg	2WFF16-SB1S2	1/4	0.0037-0.004	0.00675		1.9E+00	C	N/A		no	BSL
309-00-2	aldrin	0.0029	J	0.0048	J	mg/kg	2WFF16-SB4S2	2/4	0.0019	0.0048		3.8E-02	C	N/A		no	BSL
58-89-9	gamma-BHC (lindane)	0.0105	J	0.0105	J	mg/kg	2WFF16-SB1S2	1/4	0.0019-0.002	0.0105		4.9E-01	C	N/A		no	BSL
1024-57-3	heptachlor epoxide	0.0012	J	0.0012	J	mg/kg	2WFF16-SB1S2	2/4	0.0019	0.0012		7.0E-02	C	N/A		no	BSL
7429-90-5	aluminum	1070		2180		mg/kg	2WFF16-SB3S2	4/4		2180	9970	7.8E+03	N	N/A		no	BSL
7440-39-3	barium	2.8		4.4		mg/kg	2WFF16-SB1S2	4/4		4.4	39.3	5.5E+02	N	N/A		no	BSL
7440-70-2	calcium	99.9		102		mg/kg	2WFF16-SB3S2	2/2		102	874	N/A		N/A		no	NUT
16065831	chromium (Cr3+) (7)	1.3		2.25		mg/kg	2WFF16-SB1S2	4/4		2.25	14.1	1.2E+04	N	N/A		no	BSL
7440-48-4	cobalt	0.13		0.13		mg/kg	2WFF16-SB2S2	2/4	0.11	0.13	1.9	4.7E+02	N	N/A		no	BSL
7440-50-8	copper	0.22	B (8)	0.24	B (8)	mg/kg	2WFF16-SB1S2	3/4	0.23	0.24	4.5	3.1E+02	N	N/A		no	BSL
57-12-5	cyanide	0.59		0.59		mg/kg	2WFF16-SB3S2	1/4	0.39-0.48	0.59		1.6E+02	N	N/A		no	BSL
7439-89-6	iron	500		1690		mg/kg	2WFF16-SB3S2	4/4		1690	9180	2.3E+03	N	N/A		no	BSL
7439-92-1	lead	2	B (8)	4.9		mg/kg	2WFF16-SB2S2	4/4		4.9	13.7	4.0E+02	(9)	N/A		no	BSL
7439-95-4	magnesium	43.4		105.1		mg/kg	2WFF16-SB1S2	4/4		105.1	1170	N/A		N/A		no	NUT
7439-96-5	manganese	2.3		6.25		mg/kg	2WFF16-SB1S2	4/4		6.25	173	1.6E+02	N	N/A		no	BSL
7440-09-7	potassium	100	B (8)	136		mg/kg	2WFF16-SB3S2	4/4		136	848	N/A		N/A		no	NUT
7782-49-2	selenium	0.34	K	0.35	K	mg/kg	2WFF16-SB2S2	2/4	0.32	0.35	0.86	3.9E+01	N	N/A		no	BSL
7440-23-5	sodium	70.2		179.5		mg/kg	2WFF16-SB1S2	4/4		179.5	132	N/A		N/A		no	NUT
7440-62-2	vanadium	2		3.6		mg/kg	2WFF16-SB1S2	4/4		3.6	19.3	5.5E+01	N	N/A		no	BSL
7440-66-6	zinc	0.56	B (8)	0.87	B (8)	mg/kg	2WFF16-SB3S2	4/4		0.87	25.6	2.3E+03	N	N/A		no	BSL
	diesel range organics	110		6800	Y	mg/kg	2WFF16-SB2S2	4/4		6800		N/A		N/A		no	NTX
	gasoline range organics	900	Y	2300	Y	mg/kg	2WFF16-SB2S2	3/4	0.057	2300		N/A		N/A		no	NTX

(1) Minimum/maximum detected concentration.

(2) Background values are maximum concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: Infrequent Detection (IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

Definitions: N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
B = Present in blank
Y = Appears to match a typical fuel pattern

(5) Even though these samples had positive detects in the equipment blanks, they were retained in the analysis since the site concentrations were greater than 10x the maximum blank concentration.

(6) The RBC for pyrene was used as a surrogate for phenanthrene.

(7) Chromium was evaluated as trivalent chromium since hexavalent chromium was evaluated for separately in the analysis.

(8) Even though these samples had positive detects in the equipment blanks, they were retained in the analysis since the site concentrations were greater than 5x the maximum blank concentration.

(9) The lead screening value is based on the OSWER screening value for lead in soils.

TABLE 6-2.5
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE NAME: Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: groundwater at Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2	Screening Toxicity Value (3)		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
540-59-0	1,2-dichloroethene (total)	7	K	8	J	ug/L	WFF16-GW2S	2/7	10	8		5.50E+00	N			yes	ASL
67-64-1	acetone	27	K	27	K	ug/L	WFF15-GW7	1/7	10	27		6.10E+01	N			no	BSL
71-43-2	benzene	2	J	58		ug/L	WFF15-GW7	3/7	10	58		3.20E-01	C	5	MCL	yes	ASL
100-41-4	ethylbenzene	48		280	D	ug/L	WFF15-GW7	2/7	10	280		1.30E+02	N	700	MCL	yes	ASL
127-18-4	tetrachloroethene	4	J	5	J	ug/L	WFF15-GW7	2/7	10	5		1.10E+00	C	5	MCL	yes	ASL
108-88-3	toluene	1400	D	1400	D	ug/L	WFF15-GW7	1/7	10	1400		7.50E+01	N	1000	MCL	yes	ASL
1330-20-7	xylene (total)	4.5	J	1100	D	ug/L	WFF15-GW7	2/7	10	1100		1.20E+03	N	10000	MCL	no	BSL
105-67-9	2,4-dimethylphenol	1	J	1	J	ug/L	WFF16-GW2D	1/7	9-10	1		7.30E+01	N			no	BSL
95-57-8	2-chlorophenol	9		9		ug/L	WFF15-GW7	1/7	9-10	9		3.00E+00	N			yes	ASL
91-57-6	2-methylnaphthalene	3.5	J	200		ug/L	WFF15-GW7	2/7	9-10	200		1.20E+01	N			yes	ASL
95-48-7	2-methylphenol	7	J	7	J	ug/L	WFF15-GW7	1/7	9-10	7		1.80E+02	N			no	BSL
106-44-5	4-methylphenol	42		42		ug/L	WFF15-GW7	1/7	9-10	42		1.80E+01	N			yes	ASL
83-32-9	acenaphthene	2	J	8	L	ug/L	WFF15-GW7	2/7	9-10	8		3.70E+01	N			no	BSL
120-12-7	anthracene	1	J	1	J	ug/L	WFF15-GW7	1/7	9-10	1		1.80E+02	N			no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	39		160		ug/L	WFF15-GW7	2/5	10	160		4.80E+00	C	6	MCL	yes	ASL
86-74-8	carbazole	1	J	6	J	ug/L	WFF15-GW7	3/7	9-10	6		3.30E+00	C			yes	ASL
132-64-9	dibenzofuran	1	J	3	J	ug/L	WFF15-GW7	3/7	9-10	3		2.40E+00	N			yes	ASL
86-73-7	fluorene	2.5	J	12	J	ug/L	WFF15-GW7	3/7	9-10	12		2.40E+01	N			no	BSL
91-20-3	naphthalene	7	J	180		ug/L	WFF15-GW7	2/7	9-10	180		6.50E-01	N			yes	ASL
85-01-8	phenanthrene (6)	2	J	20	L	ug/L	WFF15-GW7	3/7	9-10	20		1.80E+01	N			yes	ASL
108-95-2	phenol	2	J	2	J	ug/L	WFF15-GW7	1/7	9-10	2		2.20E+03	N			no	BSL
129-00-0	pyrene	1	L	1	L	ug/L	WFF15-GW7	1/7	9-10	1		1.80E+01	N			no	BSL
50-29-3	4,4'-DDT	0.23	J	0.23	J	ug/L	WFF15-GW1	1/7	0.095-0.097	0.23		2.00E-01	C			yes	ASL
319-84-6	alpha-BHC	0.029	J	0.029	J	ug/L	WFF15-GW7	1/7	0.048-0.049	0.029		1.10E-02	C			yes	ASL
58-89-9	gamma-BHC (lindane)	0.067	J	0.067	J	ug/L	WFF15-GW7	1/7	0.048-0.049	0.067		5.20E-02	C	0.2	MCL	yes	ASL
7429-90-5	aluminum	679		17100		ug/L	WFF15-GW7	7/7	--	17100	11800	3.70E+03	N			yes	ASL
7440-36-0	antimony	1.4		4.6		ug/L	WFF16-GW3	2/7	1.6-4.2	4.6	--	1.50E+00	N	6	MCL	yes	ASL
7440-38-2	arsenic	2		88.2		ug/L	WFF15-GW7	4/7	2-3.4	88.2	5.1	4.50E-02	C	50	MCL	yes	ASL
7440-39-3	barium	47.5		174		ug/L	WFF16-GW4	6/6	--	174	62.5	2.60E+02	N	2000	MCL	no	BSL
7440-41-7	beryllium	0.25		1.2		ug/L	WFF16-GW3	4/7	0.2-0.6	1.2	0.29	7.30E+00	N	4	MCL	no	BSL
7440-43-9	cadmium	0.44		0.89		ug/L	WFF15-GW7	2/7	0.3-0.6	0.89	0.37	1.80E+00	N	5	MCL	no	BSL
7440-70-2	calcium	2610		50300		ug/L	WFF16-GW5	6/6	--	50300	16200					no	NUT
7440-47-3	chromium (Cr3+) (7)	1.9		17.3		ug/L	WFF15-GW7	7/7	--	17.3	11.2	5.50E+03	N			no	BSL
7440-48-4	cobalt	1.2		8.8		ug/L	WFF15-GW7	4/7	0.6-1	8.8	2	2.20E+02	N			no	BSL
7440-50-8	copper	0.92		6.5		ug/L	WFF15-GW7	6/6	--	6.5	1.9	1.50E+02	N	1300	action level (8)	no	BSL
	ferrous iron	0.05		32.5		ug/L	WFF15-GW7	4/5	0.05	32.5						no	NTX
7439-89-6	iron	3580		58400		ug/L	WFF15-GW7	7/7	--	58400	7660	1.10E+03	N			yes	ASL
7439-92-1	lead	2.8		62.8		ug/L	WFF15-GW7	4/6	2.5	62.8	4.8			15	action level (8)	yes	ASL (9)
7439-95-4	magnesium	2260		35700		ug/L	WFF16-GW5	6/6	--	35700	3510					no	NUT
7439-96-5	manganese	31.6		3510		ug/L	WFF15-GW7	7/7	--	3510	57	7.30E+01	N			yes	ASL
7440-02-0	nickel	2.4		4.5		ug/L	WFF16-GW4	4/6	1.5	4.5	2.2	7.30E+01	N			no	BSL
7440-09-7	potassium	1550		16300		ug/L	WFF16-GW5	6/6	--	16300	1560					yes	NUT
7782-49-2	selenium	1.9	L	5	L	ug/L	WFF15-GW7	3/7	1.7-2.6	5	3.1	1.80E+01	N	50	MCL	no	BSL

TABLE 6-2.5
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE NAME: Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: groundwater at Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2	Screening Toxicity Value (3)		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
7440-23-5	sodium	2600		18600		ug/L	WFF15-GW7	6/6	--	18600	4330					no	NUT
7440-28-0	thallium	3.9		3.9		ug/L	WFF16-GW4	1/7	1.6-3.9	3.9		2.60E-01	N	2	MCL	yes	ASL
7440-62-2	vanadium	1.5		31.6		ug/L	WFF16-GW3	5/6	1.1	31.6	17.3	2.60E+01	N			yes	ASL
7440-66-6	zinc	7.4	K	82.3		ug/L	WFF16-GW3	6/6	--	82.3	7	1.10E+03	N			no	BSL
	diesel range organics	600	Y	83000	Y	ug/L	WFF15-GW7	5/7	110-120	83000						yes	NTX
	gasoline range organics	33	JZ	4000		ug/L	WFF15-GW7	5/7	50	4000						yes	NTX
	nitrate, as N	280		370		ug/L	WFF16-GW3	2/5	100	370		5.80E+03	N			no	BSL
	sulfate	5100		44600		ug/L	WFF16-GW5	3/5	5000	44600						no	NTX
	sulfide	2600		2600		ug/L	WFF16-GW2D	1/1	--	2600						no	NTX

(1) Minimum/maximum detected concentration.

(2) Background data are maximum detected concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) ARAR values are provided for informational purposes, screening was based on EPA Region III RBC values (EPA, 2000)

(5) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(6) The RBC for pyrene was used as a surrogate RBC for phenanthrene.

(7) Chromium was evaluated as trivalent chromium since hexavalent chromium was evaluated separately in the analysis.

(8) Values are based on action levels

(9) Although no RBC value is available for lead, 15 ug/L was used as a proxy screening value.

Definitions: N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
D = Diluted out
Y = Appears to match a typical fuel pattern
Z = Does not appear to match a typical fuel pattern

TABLE 6-2.6
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE NAME: Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: air volatilized from groundwater at Site 16

CAS Number	Chemical	(1) Minimum Concentration	Minimum Qualifier	(1) Maximum Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	(2 Background Value	(3) Screening Toxicity Value		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	COPC Flag	(5) Rationale for Contaminant Deletion or Selection
540-59-0	1,2-dichloroethene (total)	7	K	8	J	ug/L	WFF16-GW2S	2/7	10	8		5.50E+00	N			yes	ASL
67-64-1	acetone	27	K	27	K	ug/L	WFF15-GW7	1/7	10	27		6.10E+01	N			no	BSL
71-43-2	benzene	2	J	58		ug/L	WFF15-GW7	3/7	10	58		3.20E-01	C	5	MCL	yes	ASL
100-41-4	ethylbenzene	48		280	D	ug/L	WFF15-GW7	2/7	10	280		1.30E+02	N	700	MCL	yes	ASL
127-18-4	tetrachloroethene	4	J	5	J	ug/L	WFF15-GW7	2/7	10	5		1.10E+00	C	5	MCL	yes	ASL
108-88-3	toluene	1400	D	1400	D	ug/L	WFF15-GW7	1/7	10	1400		7.50E+01	N	1000	MCL	yes	ASL
1330-20-7	xylene (total)	4.5	J	1100	D	ug/L	WFF15-GW7	2/7	10	1100		1.20E+03	N	10000	MCL	no	BSL
105-67-9	2,4-dimethylphenol	1	J	1	J	ug/L	WFF16-GW2D	1/7	9-10	1		7.30E+01	N			no	BSL
95-57-8	2-chlorophenol	9		9		ug/L	WFF15-GW7	1/7	9-10	9		3.00E+00	N			yes	ASL
91-57-6	2-methylnaphthalene	3.5	J	200		ug/L	WFF15-GW7	2/7	9-10	200		1.20E+01	N			yes	ASL
95-48-7	2-methylphenol	7	J	7	J	ug/L	WFF15-GW7	1/7	9-10	7		1.80E+02	N			no	BSL
106-44-5	4-methylphenol	42		42		ug/L	WFF15-GW7	1/7	9-10	42		1.80E+01	N			yes	ASL
83-32-9	acenaphthene	2	J	8	L	ug/L	WFF15-GW7	2/7	9-10	8		3.70E+01	N			no	BSL
120-12-7	anthracene	1	J	1	J	ug/L	WFF15-GW7	1/7	9-10	1		1.80E+02	N			no	BSL
117-81-7	bis(2-ethylhexyl)phthalate	39		160		ug/L	WFF15-GW7	2/5	10	160		4.80E+00	C	6	MCL	yes	ASL
86-74-8	carbazole	1	J	6	J	ug/L	WFF15-GW7	3/7	9-10	6		3.30E+00	C			yes	ASL
132-64-9	dibenzofuran	1	J	3	J	ug/L	WFF15-GW7	3/7	9-10	3		2.40E+00	N			yes	ASL
86-73-7	fluorene	2.5	J	12	J	ug/L	WFF15-GW7	3/7	9-10	12		2.40E+01	N			no	BSL
91-20-3	naphthalene	7	J	180		ug/L	WFF15-GW7	2/7	9-10	180		6.50E-01	N			yes	ASL
85-01-8	phenanthrene (6)	2	J	20	L	ug/L	WFF15-GW7	3/7	9-10	20		1.80E+01	N			yes	ASL
108-95-2	phenol	2	J	2	J	ug/L	WFF15-GW7	1/7	9-10	2		2.20E+03	N			no	BSL
129-00-0	pyrene	1	L	1	L	ug/L	WFF15-GW7	1/7	9-10	1		1.80E+01	N			no	BSL
50-29-3	4,4'-DDT	0.23	J	0.23	J	ug/L	WFF15-GW1	1/7	0.095-0.097	0.23		2.00E-01	C			yes	ASL
319-84-6	alpha-BHC	0.029	J	0.029	J	ug/L	WFF15-GW7	1/7	0.048-0.049	0.029		1.10E-02	C			yes	ASL
58-89-9	gamma-BHC (lindane)	0.067	J	0.067	J	ug/L	WFF15-GW7	1/7	0.048-0.049	0.067		5.20E-02	C	0.2	MCL	yes	ASL
7429-90-5	aluminum	679		17100		ug/L	WFF15-GW7	7/7	--	17100	11800	3.70E+03	N			yes	ASL
7440-36-0	antimony	1.4		4.6		ug/L	WFF16-GW3	2/7	1.6-4.2	4.6	--	1.50E+00	N	6	MCL	yes	ASL
7440-38-2	arsenic	2		88.2		ug/L	WFF15-GW7	4/7	2-3.4	88.2	5.1	4.50E-02	C	50	MCL	yes	ASL
7440-39-3	barium	47.5		174		ug/L	WFF16-GW4	6/6	--	174	62.5	2.60E+02	N	2000	MCL	no	BSL
7440-41-7	beryllium	0.25		1.2		ug/L	WFF16-GW3	4/7	0.2-0.6	1.2	0.29	7.30E+00	N	4	MCL	no	BSL
7440-43-9	cadmium	0.44		0.89		ug/L	WFF15-GW7	2/7	0.3-0.6	0.89	0.37	1.80E+00	N	5	MCL	no	BSL
7440-70-2	calcium	2610		50300		ug/L	WFF16-GW5	6/6	--	50300	16200					no	NUT
7440-47-3	chromium (Cr3+) (7)	1.9		17.3		ug/L	WFF15-GW7	7/7	--	17.3	11.2	5.50E+03	N			no	BSL
7440-48-4	cobalt	1.2		8.8		ug/L	WFF15-GW7	4/7	0.6-1	8.8	2	2.20E+02	N			no	BSL
7440-50-8	copper	0.92		6.5		ug/L	WFF15-GW7	6/6	--	6.5	1.9	1.50E+02	N	1300	action level (8)	no	BSL
	ferrous iron	0.05		32.5		ug/L	WFF15-GW7	4/5	0.05	32.5						no	NTX
7439-89-6	iron	3580		58400		ug/L	WFF15-GW7	7/7	--	58400	7660	1.10E+03	N			yes	ASL
7439-92-1	lead	2.8		62.8		ug/L	WFF15-GW7	4/6	2.5	62.8	4.8			15	action level (8)	yes	ASL (9)
7439-95-4	magnesium	2260		35700		ug/L	WFF16-GW5	6/6	--	35700	3510					no	NUT
7439-96-5	manganese	31.6		3510		ug/L	WFF15-GW7	7/7	--	3510	57	7.30E+01	N			yes	ASL
7440-02-0	nickel	2.4		4.5		ug/L	WFF16-GW4	4/6	1.5	4.5	2.2	7.30E+01	N			no	BSL
7440-09-7	potassium	1550		16300		ug/L	WFF16-GW5	6/6	--	16300	1560					yes	NUT
7782-49-2	selenium	1.9	L	5	L	ug/L	WFF15-GW7	3/7	1.7-2.6	5	3.1	1.80E+01	N	50	MCL	no	BSL

TABLE 6-2.6
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE NAME: Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: air volatilized from groundwater at Site 16

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value (3)		Potential ARAR/TBC Value (4)	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection (5)
7440-23-5	sodium	2600		18600		ug/L	WFF15-GW7	6/6	--	18600	4330					no	NUT
7440-28-0	thallium	3.9		3.9		ug/L	WFF16-GW4	1/7	1.6-3.9	3.9		2.60E-01	N	2	MCL	yes	ASL
7440-62-2	vanadium	1.5		31.6		ug/L	WFF16-GW3	5/6	1.1	31.6	17.3	2.60E+01	N			yes	ASL
7440-66-6	zinc	7.4	K	82.3		ug/L	WFF16-GW3	6/6	--	82.3	7	1.10E+03	N			no	BSL
	diesel range organics	600	Y	83000	Y	ug/L	WFF15-GW7	5/7	110-120	83000						yes	NTX
	gasoline range organics	33	JZ	4000		ug/L	WFF15-GW7	5/7	50	4000						yes	NTX
	nitrate, as N	280		370		ug/L	WFF16-GW3	2/5	100	370		5.80E+03	N			no	BSL
	sulfate	5100		44600		ug/L	WFF16-GW5	3/5	5000	44600						no	NTX
	sulfide	2600		2600		ug/L	WFF16-GW2D	1/1	--	2600						no	NTX

(1) Minimum/maximum detected concentration.

(2) Background data are maximum detected concentrations.

(3) Screening values are based on EPA Region III Risk-Based Concentration Table (EPA, 2000) unless otherwise noted.

(4) ARAR values are provided for informational purposes, screening was based on EPA Region III RBC values (EPA, 2000)

(5) Rationale Codes Selection Reason: Infrequent Detection but Associated Historically (HIST)
Frequent Detection (FD)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

(6) The RBC for pyrene was used as a surrogate RBC for phenanthrene

(7) Chromium was evaluated as trivalent chromium since hexavalent chromium was evaluated separately in the analysis.

(8) Values are based on action levels

(9) Although no RBC value is available for lead, 15 ug/L was used as a proxy screening value.

Definitions: N/A = Not Applicable
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

J = Estimated Value
C = Carcinogenic
N = Non-Carcinogenic
D = Diluted out
Y = Appears to match a typical fuel pattern
Z = Does not appear to match a typical fuel pattern

TABLE 6-3.1
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Wallops Flight Facility - Site 16

Scenario Timeframe:	current/future
Medium:	surface soil
Exposure Medium:	surface soil
Exposure Point:	surface soil at Site 16

Chemical of Potential Concern	Units	Arithmetic Mean (1,2)	95% UCL of Normal Data (2)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
benzo(a)pyrene	mg/kg	0.434	7.3E-01	1.2E+00		mg/kg	1.2	Max	data distribution not normal or lognormal			
aluminum	mg/kg	5850	6.7E+03	1.1E+04		mg/kg	6671	95% UCL-N	normal data distribution; 95 UCL< Max			
arsenic	mg/kg	1.21	1.4E+00	2.9E+00		mg/kg	1.44	95% UCL-N	normal data distribution; 95 UCL< Max			
iron	mg/kg	4936	5.8E+03	1.1E+04		mg/kg	5770	95% UCL-N	normal data distribution; 95 UCL< Max			

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

(1) Average concentration based on the detected concentrations and one-half of the detection limit for the non-detects.
(2) Supporting calculations for average and 95 UCL calculations and data distributions are provided in Tables 6-3.1a and 6-3.1b.

Table 6-3.1a Average and 95 UCL (Normal) Calculations for Site 16 Surface Soil COPCs (1,2)

Lab ID	Client ID	Smp Date	Analysis	Analyte	Units	Result	Flag	Value used for EPC calc.
9A02G090-004	3WFF16-SS3	02/25/00	METALS, TOTAL	Aluminum	MG/KG	9350		9350
9A02G090-016	3WFF16-SS15	02/25/00	METALS, TOTAL	Aluminum	MG/KG	8490		8490
9A02G090-010	3WFF16-SS9	02/25/00	METALS, TOTAL	Aluminum	MG/KG	8280		8280
9A02G090-015	3WFF16-SS14	02/25/00	METALS, TOTAL	Aluminum	MG/KG	7270		7270
9A02G090-007	3WFF16-SS6	02/25/00	METALS, TOTAL	Aluminum	MG/KG	6760		6760
9A02G090-003	3WFF16-SS2	02/25/00	METALS, TOTAL	Aluminum	MG/KG	6400		6400
9A02G090-017	3WFF16-SS16	02/25/00	METALS, TOTAL	Aluminum	MG/KG	6350		6350
9A02G090-006	3WFF16-SS5	02/25/00	METALS, TOTAL	Aluminum	MG/KG	6130		6130
9A02G090-002	3WFF16-SS1	02/25/00	METALS, TOTAL	Aluminum	MG/KG	6030		6030
9A02G090-005	3WFF16-SS4	02/25/00	METALS, TOTAL	Aluminum	MG/KG	5960		5960
9A02G090-018	3WFF16-SS17	02/25/00	METALS, TOTAL	Aluminum	MG/KG	4730		4730
9A02G090-009	3WFF16-SS8	02/25/00	METALS, TOTAL	Aluminum	MG/KG	3760		3760
9A02G090-008	3WFF16-SS7	02/25/00	METALS, TOTAL	Aluminum	MG/KG	3560		3560
9A02G090-012	3WFF16-SS11	02/25/00	METALS, TOTAL	Aluminum	MG/KG	3400		3400
9A02G090-014	3WFF16-SS13	02/25/00	METALS, TOTAL	Aluminum	MG/KG	3230		3230
9A02G090-013	3WFF16-SS12	02/25/00	METALS, TOTAL	Aluminum	MG/KG	2850		2850
	3WFF16-SS10	02/25/00	METALS, TOTAL	Aluminum	MG/KG	3960		3960
9805G585-001	2WFF16-SB1S1	07-MAY-98	METALS, TOTAL	Aluminum	mg/Kg	10600		10600
9805G585-002	2WFF16-SB2S1	07-MAY-98	METALS, TOTAL	Aluminum	mg/Kg	6880		6880
9805G585-003	2WFF16-SB3S1	07-MAY-98	METALS, TOTAL	Aluminum	mg/Kg	5560		5560
9805G585-004	2WFF16-SB4S1	07-MAY-98	METALS, TOTAL	Aluminum	mg/Kg	3290		3290
maximum concentration	10600							
number of samples (n)	21							
average concentration (x)	5849.52381							
standard deviation (std dev)	2181.869557							
square root of number of samples ($n^{1/2}$)	4.582575695							
t - value, probability = 0.05, degrees of freedom = 20 (t)	1.725							
95 UCL = x + [t x (std dev/$n^{1/2}$)]	**6670.8**							
9A02G090-017	3WFF16-SS16	02/25/00	METALS, TOTAL	Arsenic	MG/KG	2.9		2.9
9A02G090-004	3WFF16-SS3	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.9		1.9
9A02G090-002	3WFF16-SS1	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.8		1.8
9A02G090-010	3WFF16-SS9	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.6		1.6
9A02G090-014	3WFF16-SS13	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.4		1.4
9A02G090-016	3WFF16-SS15	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.4		1.4
9A02G090-015	3WFF16-SS14	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.3		1.3
9A02G090-003	3WFF16-SS2	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.2		1.2
9A02G090-006	3WFF16-SS5	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.2		1.2
9A02G090-007	3WFF16-SS6	02/25/00	METALS, TOTAL	Arsenic	MG/KG	1.1		1.1
9A02G090-008	3WFF16-SS7	02/25/00	METALS, TOTAL	Arsenic	MG/KG	0.98		0.98
9A02G090-018	3WFF16-SS17	02/25/00	METALS, TOTAL	Arsenic	MG/KG	0.83		0.83
9A02G090-005	3WFF16-SS4	02/25/00	METALS, TOTAL	Arsenic	MG/KG	0.78		0.78
9A02G090-009	3WFF16-SS8	02/25/00	METALS, TOTAL	Arsenic	MG/KG	0.63	U	0.315
9A02G090-012	3WFF16-SS11	02/25/00	METALS, TOTAL	Arsenic	MG/KG	0.58	U	0.29
9A02G090-013	3WFF16-SS12	02/25/00	METALS, TOTAL	Arsenic	MG/KG	0.58	U	0.29
	3WFF16-SS10	02/25/00	METALS, TOTAL	Arsenic	MG/KG	0.523		0.523
9805G585-001	2WFF16-SB1S1	07-MAY-98	METALS, TOTAL	Arsenic	mg/Kg	1.9		1.9
9805G585-002	2WFF16-SB2S1	07-MAY-98	METALS, TOTAL	Arsenic	mg/Kg	1.7		1.7
9805G585-003	2WFF16-SB3S1	07-MAY-98	METALS, TOTAL	Arsenic	mg/Kg	1.1		1.1
9805G585-004	2WFF16-SB4S1	07-MAY-98	METALS, TOTAL	Arsenic	mg/Kg	0.74		0.74
maximum concentration	2.9							
number of samples (n)	21							
average concentration (x)	1.202285714							
standard deviation (std dev)	0.641129639							
square root of number of samples ($n^{1/2}$)	4.582575695							
t - value; probability = 0.05, degrees of freedom = 20 (t)	1.725							
95 UCL = x + [t x (std dev/$n^{1/2}$)]	**1.44**							
9A02G090-010	3WFF16-SS9	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	910		910
9A02G090-015	3WFF16-SS14	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	390	U	195
9A02G090-018	3WFF16-SS17	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	390	U	195
9A02G090-016	3WFF16-SS15	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	380	U	190
9A02G090-017	3WFF16-SS16	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	380	U	190
9A02G090-004	3WFF16-SS3	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	380	U	190
9A02G090-007	3WFF16-SS6	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	380	U	190
9A02G090-009	3WFF16-SS8	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	380	U	190
9A02G090-003	3WFF16-SS2	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	370	U	185
9A02G090-006	3WFF16-SS5	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	370	U	185
9A02G090-002	3WFF16-SS1	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	360	U	180
9A02G090-013	3WFF16-SS12	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	360	U	180
9A02G090-014	3WFF16-SS13	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	360	U	180
9A02G090-008	3WFF16-SS7	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	360	U	180
9A02G090-005	3WFF16-SS4	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	350	U	175
9A02G090-012	3WFF16-SS11	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	340	U	170
9805G585-003	2WFF16-SB3S1	07-MAY-98	SVOC	Benzo(a)pyrene	ug/Kg	7400	UJ	3700
9805G585-001	2WFF16-SB1S1	07-MAY-98	SVOC	Benzo(a)pyrene	ug/Kg	380	UJ	190
9805G585-004	2WFF16-SB4S1	07-MAY-98	SVOC	Benzo(a)pyrene	ug/Kg	350	UJ	175
9805G585-002	2WFF16-SB2S1	07-MAY-98	SVOC	Benzo(a)pyrene	ug/Kg	340	UJ	170
	3WFF16-SS10	02/25/00	SVOC	Benzo(a)pyrene	UG/KG	1200		1200
maximum concentration	3700							
number of samples (n)	21							
average concentration (x)	434.2857143							
standard deviation (std dev)	793.951015							
square root of number of samples ($n^{1/2}$)	4.58							
t - value; probability = 0.05, degrees of freedom = 20 (t)	1.725							
95 UCL = x + [t x (std dev/$n^{1/2}$)]	**733.3**							

Table 6-3.1a Average and 95 UCL (Normal) Calculations for Site 16 Surface Soil COPCs (1,2)

Lab ID	Client ID	Smp Date	Analysis	Analyte	Units	Result	Flag	Value used for EPC calc.
9A02G090-004	3WFF16-SS3	02/25/00	METALS, TOTAL	Iron	MG/KG	10700		10700
9A02G090-016	3WFF16-SS15	02/25/00	METALS, TOTAL	Iron	MG/KG	7130		7130
9A02G090-015	3WFF16-SS14	02/25/00	METALS, TOTAL	Iron	MG/KG	6810		6810
9A02G090-003	3WFF16-SS2	02/25/00	METALS, TOTAL	Iron	MG/KG	6570		6570
9A02G090-010	3WFF16-SS9	02/25/00	METALS, TOTAL	Iron	MG/KG	6100		6100
9A02G090-007	3WFF16-SS6	02/25/00	METALS, TOTAL	Iron	MG/KG	5440		5440
9A02G090-002	3WFF16-SS1	02/25/00	METALS, TOTAL	Iron	MG/KG	5250		5250
9A02G090-017	3WFF16-SS16	02/25/00	METALS, TOTAL	Iron	MG/KG	5070		5070
9A02G090-006	3WFF16-SS5	02/25/00	METALS, TOTAL	Iron	MG/KG	4760		4760
9A02G090-018	3WFF16-SS17	02/25/00	METALS, TOTAL	Iron	MG/KG	3820		3820
9A02G090-005	3WFF16-SS4	02/25/00	METALS, TOTAL	Iron	MG/KG	3700		3700
9A02G090-009	3WFF16-SS8	02/25/00	METALS, TOTAL	Iron	MG/KG	3130		3130
9A02G090-014	3WFF16-SS13	02/25/00	METALS, TOTAL	Iron	MG/KG	3110		3110
9A02G090-008	3WFF16-SS7	02/25/00	METALS, TOTAL	Iron	MG/KG	2720		2720
9A02G090-012	3WFF16-SS11	02/25/00	METALS, TOTAL	Iron	MG/KG	2340		2340
9A02G090-013	3WFF16-SS12	02/25/00	METALS, TOTAL	Iron	MG/KG	2340		2340
	3WFF16-SS10	02/25/00	METALS, TOTAL	Iron	MG/KG	2970		2970
9805G585-001	2WFF16-SB1S1	07-MAY-98	METALS, TOTAL	Iron	mg/Kg	8710		8710
9805G585-002	2WFF16-SB2S1	07-MAY-98	METALS, TOTAL	Iron	mg/Kg	5920		5920
9805G585-003	2WFF16-SB3S1	07-MAY-98	METALS, TOTAL	Iron	mg/Kg	4410		4410
9805G585-004	2WFF16-SB4S1	07-MAY-98	METALS, TOTAL	Iron	mg/Kg	2650		2650
maximum concentration	10700							
number of samples (n)	21							
average concentration (x)	4935.714286							
standard deviation (std dev)	2217.123297							
square root of number of samples ($n^{1/2}$)	4.582575695							
t - value; probability = 0.05, degrees of freedom = 20 (t)	1.725							
95 UCL = x + [t x (std dev/$n^{1/2}$)]	5770.2							

(1) Note, to calculate the exposure point concentrations, non-detects were assumed to equal 1/2 of the detection limit.
(2) t - values were provided in Norman and Streiner (1994)

Table 6-3.1b: Evaluation of Data Distribution - Benzo(a)pyrene

Chemical Name	index	data distribution
Benzo(a)pyrene	1	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_1)$	
1	2WFF16-SB1S1	ug/kg	380	U	190	3700	170	13690000	3530	0.4643	1638.979	370
2	2WFF16-SB2S1	ug/kg	340	U	170	1200	170	1440000	1030	0.3185	328.055	380
3	2WFF16-SB3S1	ug/kg	7400	U	3700	910	175	828100	735	0.2578	189.483	360
4	2WFF16-SB4S1	ug/kg	350	U	175	195	175	38025	20	0.2119	4.238	380
5	3WFF16-SS1	ug/kg	360	U	180	195	180	38025	15	0.1736	2.604	
6	3WFF16-SS2	ug/kg	370	U	185	190	180	36100	10	0.1399	1.399	
7	3WFF16-SS3	ug/kg	380	U	190	190	180	36100	10	0.1092	1.092	
8	3WFF16-SS4	ug/kg	350	U	175	190	180	36100	10	0.0804	0.804	
9	3WFF16-SS5	ug/kg	370	U	185	190	185	36100	5	0.053	0.265	340
10	3WFF16-SS6	ug/kg	380	U	190	190	185	36100	5	0.0263	0.1315	360
11	3WFF16-SS7	ug/kg	360	U	180	190	190	36100	0	0	0	360
12	3WFF16-SS8	ug/kg	380	U	190	185	190	34225				380
13	3WFF16-SS9	ug/kg	910		910	185	190	34225				
14	3WFF16-SS10	ug/kg	1200		1200	180	190	32400				
15	3WFF16-SS11	ug/kg	340	U	170	180	190	32400				340
16	3WFF16-SS12	ug/kg	360	U	180	180	190	32400				360
17	3WFF16-SS13	ug/kg	360	U	180	180	195	32400				360
18	3WFF16-SS14	ug/kg	390	U	195	175	195	30625				390
19	3WFF16-SS15	ug/kg	380	U	190	175	910	30625				380
20	3WFF16-SS16	ug/kg	380	U	190	170	1200	28900				380
21	3WFF16-SS17	ug/kg	390	U	195	170	3700	28900				390

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
9120	8.3E+07	0.048	12607164	10	16567850	4696107.9	2167.0505

W	$W_{0.05}$	Normal ?
0.372	0.908	No

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_1)$
1	2WFF16-SB1S1	ug/kg	380	U	5.2470241	8.2160881	5.1357984	67.504104	3.08	0.4643	1.4301785
2	2WFF16-SB2S1	ug/kg	340	U	5.1357984	7.0900768	5.1357984	50.26919	1.954	0.3185	0.6224377
3	2WFF16-SB3S1	ug/kg	7400	U	8.2160881	6.8134446	5.164786	46.423027	1.649	0.2578	0.4250242
4	2WFF16-SB4S1	ug/kg	350	U	5.164786	5.2729996	5.164786	27.804524	0.108	0.2119	0.0229305
5	3WFF16-SS1	ug/kg	360	U	5.1929569	5.2729996	5.1929569	27.804524	0.08	0.1736	0.0138954
6	3WFF16-SS2	ug/kg	370	U	5.2203558	5.2470241	5.1929569	27.531262	0.054	0.1399	0.007564
7	3WFF16-SS3	ug/kg	380	U	5.2470241	5.2470241	5.1929569	27.531262	0.054	0.1092	0.0059041
8	3WFF16-SS4	ug/kg	350	U	5.164786	5.2470241	5.1929569	27.531262	0.054	0.0804	0.004347
9	3WFF16-SS5	ug/kg	370	U	5.2203558	5.2470241	5.2203558	27.531262	0.027	0.053	0.0014134
10	3WFF16-SS6	ug/kg	380	U	5.2470241	5.2470241	5.2203558	27.531262	0.027	0.0263	0.0007014
11	3WFF16-SS7	ug/kg	360	U	5.1929569	5.2470241	5.2470241	27.531262	0	0	0
12	3WFF16-SS8	ug/kg	380	U	5.2470241	5.2203558	5.2470241	27.252115			
13	3WFF16-SS9	ug/kg	910		6.8134446	5.2203558	5.2470241	27.252115			
14	3WFF16-SS10	ug/kg	1200		7.0900768	5.1929569	5.2470241	26.966801			
15	3WFF16-SS11	ug/kg	340	U	5.1357984	5.1929569	5.2470241	26.966801			
16	3WFF16-SS12	ug/kg	360	U	5.1929569	5.1929569	5.2470241	26.966801			
17	3WFF16-SS13	ug/kg	360	U	5.1929569	5.1929569	5.2729996	26.966801			
18	3WFF16-SS14	ug/kg	390	U	5.2729996	5.164786	5.2729996	26.675014			
19	3WFF16-SS15	ug/kg	380	U	5.2470241	5.164786	6.8134446	26.675014			
20	3WFF16-SS16	ug/kg	380	U	5.2470241	5.1357984	7.0900768	26.376426			
21	3WFF16-SS17	ug/kg	390	U	5.2729996	5.1357984	8.2160881	26.376426			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
116	13447.1	0.048	13.131041	653.46725	6.4231639	2.5343962

W	$W_{0.05}$	Lognormal ?
0.489	0.908	No

Data Summary

	std.	log
Number of Samples	21	
Number of Locations	21	
Mean	434.28571	5.5219743
Std. Deviation	7.94E+02	8.10E-01
Std. Error of Mean	1.73E+02	1.77E-01
t-value for 95% UCL Calculation, n=21	1.725	
Approximate 95% UCL for Mean	733.1	339.3
Coefficient of Variation	182.82%	14.67%
Skewness	3.88E+00	2.60E+00
Median	190	5.2470241
Maximum	3700	8.2160881
Shapiro-Wilk W statistic	3.72E-01	
Data Distribution	Not Normal or Lognormal	

Table 6-3.1b: Evaluation of Data Distribution - Aluminum

Chemical Name	index	data distribution
Aluminum	3	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_1)$
1	2WFF16-SB1S1	mg/kg	10600		10600	10600	2850	112360000	7750	0.4643	3598.325
2	2WFF16-SB2S1	mg/kg	6880		6880	9350	3230	87422500	6120	0.3185	1949.22
3	2WFF16-SB3S1	mg/kg	5560		5560	8490	3290	72080100	5200	0.2578	1340.56
4	2WFF16-SB4S1	mg/kg	3290		3290	8280	3400	68558400	4880	0.2119	1034.072
5	3WFF16-SS1	mg/kg	6030		6030	7270	3560	52852900	3710	0.1736	644.056
6	3WFF16-SS2	mg/kg	6400		6400	6880	3760	47334400	3120	0.1399	436.488
7	3WFF16-SS3	mg/kg	9350		9350	6760	3960	45697600	2800	0.1092	305.76
8	3WFF16-SS4	mg/kg	5960		5960	6400	4730	40960000	1670	0.0804	134.268
9	3WFF16-SS5	mg/kg	6130		6130	6350	5560	40322500	790	0.053	41.87
10	3WFF16-SS6	mg/kg	6760		6760	6130	5960	37576900	170	0.0263	4.471
11	3WFF16-SS7	mg/kg	3560		3560	6030	6030	36360900	0	0	0
12	3WFF16-SS8	mg/kg	3760		3760	5960	6130	35521600			
13	3WFF16-SS9	mg/kg	8280		8280	5560	6350	30913600			
14	3WFF16-SS10	mg/kg	3960		3960	4730	6400	22372900			
15	3WFF16-SS11	mg/kg	3400		3400	3960	6760	15681600			
16	3WFF16-SS12	mg/kg	2850		2850	3760	6880	14137600			
17	3WFF16-SS13	mg/kg	3230		3230	3560	7270	12673600			
18	3WFF16-SS14	mg/kg	7270		7270	3400	8280	11560000			
19	3WFF16-SS15	mg/kg	8490		8490	3290	8490	10824100			
20	3WFF16-SS16	mg/kg	6350		6350	3230	9350	10432900			
21	3WFF16-SS17	mg/kg	4730		4730	2850	10600	8122500			

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
1E+05	1.5E+10	0.048	95211095	10	813766600

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
90042829	9489.09

W	$W_{0.05}$	Normal ?
0.946	0.908	Yes

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_1)$
1	2WFF16-SB1S1	mg/kg	10600		9.2686093	9.2686093	7.9550743	85.907118	1.314	0.4643	0.6098743
2	2WFF16-SB2S1	mg/kg	6880		8.8363739	9.1431316	8.0802374	83.596856	1.063	0.3185	0.3385318
3	2WFF16-SB3S1	mg/kg	5560		8.6233534	9.0466443	8.0986428	81.841773	0.948	0.2578	0.2443948
4	2WFF16-SB4S1	mg/kg	3290		8.0986428	9.0215982	8.1315307	81.389235	0.89	0.2119	0.1886053
5	3WFF16-SS1	mg/kg	6030		8.7045023	8.8915116	8.1775158	79.058978	0.714	0.1736	0.1239497
6	3WFF16-SS2	mg/kg	6400		8.7640533	8.8363739	8.2321742	78.081504	0.604	0.1399	0.0845275
7	3WFF16-SS3	mg/kg	9350		9.1431316	8.8187782	8.2839993	77.770848	0.535	0.1092	0.0583979
8	3WFF16-SS4	mg/kg	5960		8.6928258	8.7640533	8.4616805	76.80863	0.302	0.0804	0.0243108
9	3WFF16-SS5	mg/kg	6130		8.72095	8.7562101	8.6233534	76.671215	0.133	0.053	0.0070414
10	3WFF16-SS6	mg/kg	6760		8.8187782	8.72095	8.6928258	76.054969	0.028	0.0263	0.0007397
11	3WFF16-SS7	mg/kg	3560		8.1775158	8.7045023	8.7045023	75.76836	0	0	0
12	3WFF16-SS8	mg/kg	3760		8.2321742	8.6928258	8.72095	75.56522			
13	3WFF16-SS9	mg/kg	8280		9.0215982	8.6233534	8.7562101	74.362224			
14	3WFF16-SS10	mg/kg	3960		8.2839993	8.4616805	8.7640533	71.600037			
15	3WFF16-SS11	mg/kg	3400		8.1315307	8.2839993	8.8187782	68.624644			
16	3WFF16-SS12	mg/kg	2850		7.9550743	8.2321742	8.8363739	67.768693			
17	3WFF16-SS13	mg/kg	3230		8.0802374	8.1775158	8.8915116	66.871765			
18	3WFF16-SS14	mg/kg	7270		8.8915116	8.1315307	9.0215982	66.121792			
19	3WFF16-SS15	mg/kg	8490		9.0466443	8.0986428	9.0466443	65.588016			
20	3WFF16-SS16	mg/kg	6350		8.7562101	8.0802374	9.1431316	65.290237			
21	3WFF16-SS17	mg/kg	4730		8.4616805	7.9550743	9.2686093	63.283207			

Σx	$(\Sigma x)^2$	1/n	d
180.7	32655.9	0.048	2.9831211

$\Sigma(x^2)$
1558.0253

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
2.8236537	1.6803731

W	$W_{0.05}$	Lognormal ?
0.947	0.908	Yes

Data Summary

	std.	log
Number of Samples	21	
Number of Locations	21	
Mean	5849.5238	8.6052094
Std. Deviation	2.18E+03	3.86E-01
Std. Error of Mean	4.76E+02	8.43E-02
t-value for 95% UCL Calculation, n=21	1.725	
Approximate 95% UCL for Mean	6670.8	6314.4
Coefficient of Variation	37.30%	4.49%
Skewness	4.37E-01	-1.53E-01
Median	6030	8.7045023
Maximum	10600	9.2686093
Shapiro-Wilk W statistic	9.46E-01	
Data Distribution	Normal	

Table 6-3.1b: Evaluation of Data Distribution - Arsenic

Chemical Name	index	data distribution
Arsenic	4	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_i)	x^2	$x-x_i$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_i)$
1	2WFF16-SB1S1	mg/kg	1.9		1.9	2.9	0.29	8.41	2.61	0.4643	1.211823
2	2WFF16-SB2S1	mg/kg	1.7		1.7	1.9	0.29	3.61	1.61	0.3185	0.512785
3	2WFF16-SB3S1	mg/kg	1.1		1.1	1.9	0.315	3.61	1.585	0.2578	0.408613
4	2WFF16-SB4S1	mg/kg	0.74		0.74	1.8	0.66	3.24	1.14	0.2119	0.241566
5	3WFF16-SS1	mg/kg	1.8		1.8	1.7	0.74	2.89	0.96	0.1736	0.166656
6	3WFF16-SS2	mg/kg	1.2		1.2	1.6	0.78	2.56	0.82	0.1399	0.114718
7	3WFF16-SS3	mg/kg	1.9		1.9	1.4	0.83	1.96	0.57	0.1092	0.062244
8	3WFF16-SS4	mg/kg	0.78		0.78	1.4	0.98	1.96	0.42	0.0804	0.033768
9	3WFF16-SS5	mg/kg	1.2		1.2	1.3	1.1	1.69	0.2	0.053	0.0106
10	3WFF16-SS6	mg/kg	1.1		1.1	1.2	1.1	1.44	0.1	0.0263	0.00263
11	3WFF16-SS7	mg/kg	0.98		0.98	1.2	1.2	1.44	0	0	0
12	3WFF16-SS8	mg/kg	0.63	U	0.315	1.1	1.2	1.21			
13	3WFF16-SS9	mg/kg	1.6		1.6	1.1	1.3	1.21			
14	3WFF16-SS10	mg/kg	0.66		0.66	0.98	1.4	0.9604			
15	3WFF16-SS11	mg/kg	0.58	U	0.29	0.83	1.4	0.6889			
16	3WFF16-SS12	mg/kg	0.58	U	0.29	0.78	1.6	0.6084			
17	3WFF16-SS13	mg/kg	1.4		1.4	0.74	1.7	0.5476			
18	3WFF16-SS14	mg/kg	1.3		1.3	0.66	1.8	0.4356			
19	3WFF16-SS15	mg/kg	1.4		1.4	0.315	1.9	0.099225			
20	3WFF16-SS16	mg/kg	2.9		2.9	0.29	1.9	0.0841			
21	3WFF16-SS17	mg/kg	0.83		0.83	0.29	2.9	0.0841			

0.63	
0.58	
0.58	

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma\, a(x-x_i))^2$	$\Sigma\, a(x-x_i)$
25.39	644.398	0.048	8.0526952	10	38.738325	7.6474538	2.765403

W	$W_{0.05}$	Normal ?
0.95	0.908	Yes

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_i)	x^2	$x-x_i$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_i)$
1	2WFF16-SB1S1	mg/kg	1.9		0.6418539	1.0647107	-1.237874	1.133609	2.303	0.4643	1.0690903
2	2WFF16-SB2S1	mg/kg	1.7		0.5306283	0.6418539	-1.237874	0.4119764	1.88	0.3185	0.5986934
3	2WFF16-SB3S1	mg/kg	1.1		0.0953102	0.6418539	-1.155183	0.4119764	1.797	0.2578	0.463276
4	2WFF16-SB4S1	mg/kg	0.74		-0.301105	0.5877867	-0.415515	0.3454932	1.003	0.2119	0.2125997
5	3WFF16-SS1	mg/kg	1.8		0.5877867	0.5306283	-0.301105	0.2815663	0.832	0.1736	0.1443889
6	3WFF16-SS2	mg/kg	1.2		0.1823216	0.4700036	-0.248461	0.2209034	0.718	0.1399	0.1005133
7	3WFF16-SS3	mg/kg	1.9		0.6418539	0.3364722	-0.18633	0.1132136	0.523	0.1092	0.05709
8	3WFF16-SS4	mg/kg	0.78		-0.248461	0.3364722	-0.020203	0.1132136	0.357	0.0804	0.0286767
9	3WFF16-SS5	mg/kg	1.2		0.1823216	0.2623643	0.0953102	0.068835	0.167	0.053	0.0088539
10	3WFF16-SS6	mg/kg	1.1		0.0953102	0.1823216	0.0953102	0.0332412	0.087	0.0263	0.0022884
11	3WFF16-SS7	mg/kg	0.98		-0.020203	0.1823216	0.1823216	0.0332412	0	0	0
12	3WFF16-SS8	mg/kg	0.63	U	-1.155183	0.0953102	0.1823216	0.009084			
13	3WFF16-SS9	mg/kg	1.6		0.4700036	0.0953102	0.2623643	0.009084			
14	3WFF16-SS10	mg/kg	0.66		-0.415515	-0.020203	0.3364722	0.0004081			
15	3WFF16-SS11	mg/kg	0.58	U	-1.237874	-0.18633	0.3364722	0.0347187			
16	3WFF16-SS12	mg/kg	0.58	U	-1.237874	-0.248461	0.4700036	0.061733			
17	3WFF16-SS13	mg/kg	1.4		0.3364722	-0.301105	0.5306283	0.0906643			
18	3WFF16-SS14	mg/kg	1.3		0.2623643	-0.415515	0.5877867	0.1726531			
19	3WFF16-SS15	mg/kg	1.4		0.3364722	-1.155183	0.6418539	1.3344469			
20	3WFF16-SS16	mg/kg	2.9		1.0647107	-1.237874	0.6418539	1.5323329			
21	3WFF16-SS17	mg/kg	0.83		-0.18633	-1.237874	1.0647107	1.5323329			

Σx	$(\Sigma x)^2$	1/n	d
0.625	0.39045	0.048	7.9261342

$\Sigma(x^2)$
7.9447272

$(\Sigma\, a(x-x_i))^2$	$\Sigma\, a(x-x_i)$
7.2117517	2.6854705

W	$W_{0.05}$	Lognormal ?
0.91	0.908	Yes

Data Summary

	std.	log
Number of Samples	21	
Number of Locations	21	
Mean	1.2088095	0.0297554
Std. Deviation	6.35E-01	6.30E-01
Std. Error of Mean	1.38E-01	1.37E-01
t-value for 95% UCL Calculation, n=21	1.725	
Approximate 95% UCL for Mean	1.4	1.3
Coefficient of Variation	52.49%	2115.68%
Skewness	6.96E-01	-8.56E-01
Median	1.2	0.1823216
Maximum	2.9	1.0647107
Shapiro-Wilk W statistic	9.50E-01	
Data Distribution	Normal	

Table 6-3.1b: Evaluation of Data Distribution - Iron

Chemical Name	index	data distribution
Iron	6	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_1)$
1	2WFF16-SB1S1	mg/kg	8710		8710	10700	2340	114490000	8360	0.4643	3881.548
2	2WFF16-SB2S1	mg/kg	5920		5920	8710	2340	75864100	6370	0.3185	2028.845
3	2WFF16-SB3S1	mg/kg	4410		4410	7130	2650	50836900	4480	0.2578	1154.944
4	2WFF16-SB4S1	mg/kg	2650		2650	6810	2720	46376100	4090	0.2119	866.671
5	3WFF16-SS1	mg/kg	5250		5250	6570	2970	43164900	3600	0.1736	624.96
6	3WFF16-SS2	mg/kg	6570		6570	6100	3110	37210000	2990	0.1399	418.301
7	3WFF16-SS3	mg/kg	10700		10700	5920	3130	35046400	2790	0.1092	304.668
8	3WFF16-SS4	mg/kg	3700		3700	5440	3700	29593600	1740	0.0804	139.896
9	3WFF16-SS5	mg/kg	4760		4760	5250	3820	27562500	1430	0.053	75.79
10	3WFF16-SS6	mg/kg	5440		5440	5070	4410	25704900	660	0.0263	17.358
11	3WFF16-SS7	mg/kg	2720		2720	4760	4760	22657600	0	0	0
12	3WFF16-SS8	mg/kg	3130		3130	4410	5070	19448100			
13	3WFF16-SS9	mg/kg	6100		6100	3820	5250	14592400			
14	3WFF16-SS10	mg/kg	2970		2970	3700	5440	13690000			
15	3WFF16-SS11	mg/kg	2340		2340	3130	5920	9796900			
16	3WFF16-SS12	mg/kg	2340		2340	3110	6100	9672100			
17	3WFF16-SS13	mg/kg	3110		3110	2970	6570	8820900			
18	3WFF16-SS14	mg/kg	6810		6810	2720	6810	7398400			
19	3WFF16-SS15	mg/kg	7130		7130	2650	7130	7022500			
20	3WFF16-SS16	mg/kg	5070		5070	2340	8710	5475600			
21	3WFF16-SS17	mg/kg	3820		3820	2340	10700	5475600			

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
1E+05	1.1E+10	0.048	98312714	10	609899500

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
90496808	9512.981

W	$W_{0.05}$	Normal ?
0.92	0.908	Yes

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=21	$a(x-x_1)$
1	2WFF16-SB1S1	mg/kg	8710		9.0722271	9.277999	7.7579062	86.081266	1.52	0.4643	0.7057791
2	2WFF16-SB2S1	mg/kg	5920		8.6860917	9.0722271	7.7579062	82.305304	1.314	0.3185	0.4186112
3	2WFF16-SB3S1	mg/kg	4410		8.39163	8.8720665	7.8823149	78.713564	0.99	0.2578	0.255158
4	2WFF16-SB4S1	mg/kg	2650		7.8823149	8.8261474	7.9083872	77.900878	0.918	0.2119	0.1944734
5	3WFF16-SS1	mg/kg	5250		8.5659834	8.7902691	7.9963172	77.268831	0.794	0.1736	0.13783
6	3WFF16-SS2	mg/kg	6570		8.7902691	8.7160441	8.042378	75.969424	0.674	0.1399	0.0942459
7	3WFF16-SS3	mg/kg	10700		9.277999	8.6860917	8.0487883	75.44819	0.637	0.1092	0.0695935
8	3WFF16-SS4	mg/kg	3700		8.2160881	8.6015343	8.2160881	73.986393	0.385	0.0804	0.0309899
9	3WFF16-SS5	mg/kg	4760		8.4680029	8.5659834	8.2480057	73.376071	0.318	0.053	0.0168528
10	3WFF16-SS6	mg/kg	5440		8.6015343	8.5310961	8.39163	72.779601	0.139	0.0263	0.003668
11	3WFF16-SS7	mg/kg	2720		7.9083872	8.4680029	8.4680029	71.707074	0	0	0
12	3WFF16-SS8	mg/kg	3130		8.0487883	8.39163	8.5310961	70.419454			
13	3WFF16-SS9	mg/kg	6100		8.7160441	8.2480057	8.5659834	68.029598			
14	3WFF16-SS10	mg/kg	2970		7.9963172	8.2160881	8.6015343	67.504104			
15	3WFF16-SS11	mg/kg	2340		7.7579062	8.0487883	8.6860917	64.782993			
16	3WFF16-SS12	mg/kg	2340		7.7579062	8.042378	8.7160441	64.679844			
17	3WFF16-SS13	mg/kg	3110		8.042378	7.9963172	8.7902691	63.941089			
18	3WFF16-SS14	mg/kg	6810		8.8261474	7.9083872	8.8261474	62.542587			
19	3WFF16-SS15	mg/kg	7130		8.8720665	7.8823149	8.8720665	62.130888			
20	3WFF16-SS16	mg/kg	5070		8.5310961	7.7579062	9.0722271	60.185109			
21	3WFF16-SS17	mg/kg	3820		8.2480057	7.7579062	9.277999	60.185109			

Σx	$(\Sigma x)^2$	1/n	d
176.7	31207.8	0.048	3.8535384

$\Sigma(x^2)$
1489.9374

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
3.7141066	1.9272018

W	$W_{0.05}$	Lognormal ?
0.964	0.908	Yes

Data Summary

	std.	log
Number of Samples	21	
Number of Locations	21	
Mean	4935.7143	8.4122468
Std. Deviation	2.22E+03	4.39E-01
Std. Error of Mean	4.84E+02	9.58E-02
t-value for 95% UCL Calculation, n=21	1.725	
Approximate 95% UCL for Mean	5770.3	5310.7
Coefficient of Variation	44.92%	5.22%
Skewness	9.57E-01	1.31E-01
Median	4760	8.4680029
Maximum	10700	9.277999
Shapiro-Wilk W statistic	9.20E-01	
Data Distribution	Normal	

TABLE 6-3.2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Wallops Flight Facility - Site 16

Scenario Timeframe:	current/future
Medium:	surface soil
Exposure Medium:	air
Exposure Point:	air volatilized from surface soil at Site 16

Chemical of Potential Concern	Units	Arithmetic Mean (1,2)	95% UCL of Normal Data (2)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
benzo(a)pyrene	mg/kg	0.434	7.3E-01	1.2E+00		mg/kg	1.2	Max	data distribution not normal or lognormal			
aluminum	mg/kg	5850	6.7E+03	1.1E+04		mg/kg	6671	95% UCL-N	normal data distribution; 95 UCL< Max			
arsenic	mg/kg	1.21	1.4E+00	2.9E+00		mg/kg	1.44	95% UCL-N	normal data distribution; 95 UCL< Max			
iron	mg/kg	4936	5.8E+03	1.1E+04		mg/kg	5770	95% UCL-N	normal data distribution; 95 UCL< Max			

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

(1) Average concentration based on the detected concentrations and one-half of the detection limit for the non-detects.
(2) Supporting calculations for average and 95 UCL calculations and data distributions are provided in Tables 6-3.1a and 6-3.1b.

TABLE 6-3.3
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: groundwater at Site 16

Chemical of Potential Concern	Units	Arithmetic Mean (1,2)	95% UCL of Normal Data (2)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
1,2-dichloroethene (total)	mg/L	5.71E-03	6.60E-03	8.00E-03	J	mg/L	8.00E-03	Max	data distribution not normal or lognormal
benzene	mg/L	1.50E-02	3.00E-02	5.80E-02		mg/L	5.80E-02	Max	lognormal data distribution, 95 UCL-log > max concentration
ethylbenzene	mg/L	5.04E-02	1.26E-01	2.80E-01	D	mg/L	2.80E-01	Max	data distribution not normal or lognormal
tetrachloroethene	mg/L	4.86E-03	5.10E-03	5.00E-03	J	mg/L	5.00E-03	Max	data distribution not normal or lognormal
toluene	mg/L	2.04E-01	5.92E-01	1.40E+00	D	mg/L	1.40E+00	Max	data distribution not normal or lognormal
2-chlorophenol	mg/L	5.50E-03	6.64E-03	9.00E-03		mg/L	9.00E-03	Max	data distribution not normal or lognormal
2-methylnaphthalene	mg/L	3.26E-02	8.68E-02	2.00E-01		mg/L	2.00E-01	Max	data distribution not normal or lognormal
4-methylphenol	mg/L	1.02E-02	2.05E-02	4.20E-02		mg/L	4.20E-02	Max	data distribution not normal or lognormal
bis(2-ethylhexyl)phthalate	mg/L	4.28E-02	1.07E-01	1.60E-01		mg/L	1.60E-01	Max	lognormal data distribution, 95 UCL-log > max concentration
carbazole	mg/L	3.93E-03	5.43E-03	6.00E-03	J	mg/L	6.00E-03	Max	data distribution not normal or lognormal
dibenzofuran	mg/L	3.64E-03	4.86E-03	3.00E-03	J	mg/L	3.00E-03	Max	normal data distribution, 95 UCL-normal > max concentration
naphthalene	mg/L	3.02E-02	7.87E-02	1.80E-01		mg/L	1.80E-01	Max	data distribution not normal or lognormal
phenanthrene	mg/L	6.43E-03	1.09E-02	2.00E-02	L	mg/L	1.45E-02	95% UCL-T	lognormal data distribution, 95 UCL-log < max concentration
4,4'-DDT	mg/L	7.39E-05	1.24E-04	2.30E-04	J	mg/L	2.30E-04	Max	data distribution not normal or lognormal
alpha-BHC	mg/L	2.48E-05	2.62E-05	2.90E-05	J	mg/L	2.90E-05	Max	data distribution not normal or lognormal
gamma-BHC (lindane)	mg/L	3.02E-05	4.21E-05	6.70E-05	J	mg/L	6.70E-05	Max	data distribution not normal or lognormal
aluminum	mg/L	6.62E+00	1.09E+01	1.71E+01		mg/L	1.09E+01	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
antimony	mg/L	1.99E-03	2.94E-03	4.60E-03		mg/L	2.94E-03	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
arsenic	mg/L	1.94E-02	4.30E-02	8.82E-02		mg/L	8.82E-02	Max	lognormal data distribution, 95 UCL-log > max concentration
iron	mg/L	2.10E+01	3.56E+01	5.84E+01		mg/L	3.56E+01	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
lead	mg/L	1.29E-02	3.31E-02	6.28E-02		mg/L	6.28E-02	Max	lognormal data distribution, 95 UCL-log > max concentration
manganese	mg/L	5.79E-01	1.53E+00	3.51E+00		mg/L	3.51E+00	Max	lognormal data distribution, 95 UCL-log > max concentration
thallium	mg/L	1.95E-03	2.67E-03	3.90E-03		mg/L	2.67E-03	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
vanadium	mg/L	1.33E-02	2.31E-02	3.16E-02		mg/L	2.31E-02	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

(1) Average concentration based on the detected concentrations and one-half of the detection limit for the non-detects.
(2) Supporting calculations for average and 95 UCL calculations and data distributions are provided in Tables 6-3.3a and 6-3.3b.

Ta
Average Calculati e 16 GW COPCs

Analyte	WFF15-GW1 Com		F15-GW7 C		FF16-GW1-Co		16-GW2S/2D-		2WFF16-GW3		FF16-GW4-Co		F16-GW5-Com		15-GW1	15-GW7	16-GW1	16-GW2	16-GW3	16-GW4	16-GW5	Average Conc (ug/L)
	Rd 1&2 (with dup		(Rds 1,2&3)		(Rd 2&3)		(Rd 2&3)		27-MAY-98		(Rd 2&3)		Rd 2&3									
VOA (ug/L)																						
1,2-Dichloroethene (total)	10	U	7	K	10	U	8	J	10	U	10	U	10	U	5	7	5	8	5	5	5	5.71E+00
Benzene	2	J	58		10	U	25		10	U	10	U	10	U	2	58	5	25	5	5	5	1.50E+01
Ethylbenzene	10	U	280	D	10	U	48		10	U	10	U	10	U	5	280	5	48	5	5	5	5.04E+01
Tetrachloroethene	4	J	5	J	10	U	10	U	10	U	10	U	10	U	4	5	5	5	5	5	5	4.86E+00
Toluene	10	U	1400	D	10	U	10	U	10	U	10	U	10	U	5	1400	5	5	5	5	5	2.04E+02
SVOC (ug/L)																						
2-Chlorophenol	10	U	9		9	U	10	U	10	U	10	U	10	U	5	9	4.5	5	5	5	5	5.50E+00
2-Methylnaphthalene	10	U	200		9	U	3.5	J	10	U	10	U	10	U	5	200	4.5	3.5	5	5	5	3.26E+01
4-Methylphenol	10	U	42		9	U	10	U	10	U	10	U	10	U	5	42	4.5	5	5	5	5	1.02E+01
bis(2-Ethylhexyl)phthalate			160				39		10	U	10	U	10	U		160		39	5	5	5	4.28E+01
Carbazole	1	J	6	J	9	U	1	J	10	U	10	U	10	U	1	6	4.5	1	5	5	5	3.93E+00
Dibenzofuran	2	J	3	J	9	U	1	J	10	U	10	U	10	U	2	3	4.5	1	5	5	5	3.64E+00
Naphthalene	10	U	180		9	U	7	J	10	U	10	U	10	U	5	180	4.5	7	5	5	5	3.02E+01
Phenanthrene	3.5	J	20	L	9	U	2	J	10	U	10	U	10	U	3.5	20	4.5	2	5	5	5	6.43E+00
PEST/PCB (ug/L)																						
4,4'-DDT	0.23	J	0.097	U	0.095	U	0.097	U	0.095	U	0.096	U	0.095	U	0.23	0.0485	0.0475	0.0485	0.0475	0.048	0.0475	7.39E-02
alpha-BHC	0.048	UJ	0.029	J	0.048	U	0.049	U	0.048	U	0.048	U	0.048	U	0.024	0.029	0.024	0.0245	0.024	0.024	0.024	2.48E-02
gamma-BHC (Lindane)	0.048	UJ	0.067	J	0.048	U	0.049	U	0.048	U	0.048	U	0.048	U	0.024	0.067	0.024	0.0245	0.024	0.024	0.024	3.02E-02
METALS, TOTAL (ug/L)																						
Aluminum	10900	K	17100		2450		5720		7540		679		1930		10900	17100	2450	5720	7540	679	1930	6.62E+03
Antimony	1.6	U	1.4		1.7	U	4.2	U	4.6		4.2	U	4.2	U	0.8	1.4	0.85	2.1	4.6	2.1	2.1	1.99E+00
Arsenic	2		88.2		2	U	30.2		11.1		3.4	U	3.4	U	2	88.2	1	30.2	11.1	1.7	1.7	1.94E+01
Iron	5565		58400		3580		30100		14100		29500		5420		5565	58400	3580	30100	14100	29500	5420	2.10E+04
Lead	4.9	J	62.8				2.5	U	4.5		2.5	U	2.8		4.9	62.8		1.25	4.5	1.25	2.8	1.29E+01
Manganese	186		3510		33.6		122		31.6		61.5		110		186	3510	33.6	122	31.6	61.5	110	5.79E+02
Thallium	2.3	U	3.9	U	1.6	U	3.9	U	3.9	U	3.9		3.9	U	1.15	1.95	0.8	1.95	1.95	3.9	1.95	1.95E+00
Vanadium	15		20.8				10.6		31.6		1.5		1.1	U	15	20.8		10.6	31.6	1.5	0.55	1.33E+01

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
1,2-Dichloroethene (total)	2	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	10	U	5	8	5	64	3	0.6233	1.8699	10
2	1WFF15-GW7 Comp	ug/L	7	K	7	7	5	49	2	0.3031	0.6062	
3	2WFF16-GW1-Comb.	ug/L	10	U	5	5	5	25	0	0.1401	0	10
4	2WFF16-GW2S/2D-Comb	ug/L	8	J	8	5	5	25	0	0	0	
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	7	25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	5	8	25				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
40	1600	0.143	9.4285714	3	238	6.1310712	2.4761

W	$W_{0.05}$	Normal ?
0.65	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	10	U	1.6094379	2.0794415	1.6094379	4.3240771	0.47	0.6233	0.2929533
2	1WFF15-GW7 Comp	ug/L	7	K	1.9459101	1.9459101	1.6094379	3.7865663	0.336	0.3031	0.1019847
3	2WFF16-GW1-Comb.	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	8	J	2.0794415	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	1.9459101	2.5902904			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.6094379	2.0794415	2.5902904			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
12.07	145.746	0.143	0.2412022	21.062095	0.155976	0.394938

W	$W_{0.05}$	Lognormal ?
0.647	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	10.0000	
Maximum Detection Limit	10	
Fraction ND	71%	
Mean	5.7142857	1.7246488
Std. Deviation	1.25E+00	2.01E-01
Std. Error of Mean	4.74E-01	7.58E-02
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	6.6	6.7
Coefficient of Variation	21.94%	11.63%
Skewness	1.45E+00	1.39E+00
Median	5	1.6094379
Maximum	8	2.0794415
Shapiro-Wilk W statistic	6.50E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**5.7142857**
95% UCL of mean	**6.534886**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Benzene	3	Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	2	J	2	58	2	3364	56	0.6233	34.9048	
2	1WFF15-GW7 Comp	ug/L	58		58	25	5	625	20	0.3031	6.062	
3	2WFF16-GW1-Comb.	ug/L	10	U	5	5	5	25	0	0.1401	0	10
4	2WFF16-GW2S/2D-Comb	ug/L	25		25	5	5	25	0	0	0	
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	25	25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	2	58	4				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
105	11025	0.143	2518	3	4093	1678.2787	40.9668

W	$W_{0.05}$	Normal ?
0.667	0.803	No

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	2	J	0.6931472	4.060443	0.6931472	16.487197	3.367	0.6233	2.0988355
2	1WFF15-GW7 Comp	ug/L	58		4.060443	3.2188758	1.6094379	10.361162	1.609	0.3031	0.4878206
3	2WFF16-GW1-Comb.	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	25		3.2188758	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	3.2188758	2.5902904			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	0.6931472	4.060443	0.480453			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
14.41	207.654	0.143	8.0250632	37.689974	6.6907899	2.5866561

W	$W_{0.05}$	Lognormal ?
0.834	0.803	Yes

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	10.0000	
Maximum Detection Limit	10	
Fraction ND	57%	
Mean	15	2.0586025
Std. Deviation	2.05E+01	1.16E+00
Std. Error of Mean	7.74E+00	4.37E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	30.0	108.7
Coefficient of Variation	136.57%	56.18%
Skewness	2.02E+00	1.01E+00
Median	5	1.6094379
Maximum	58	4.060443
Shapiro-Wilk W statistic	8.34E-01	
Data Distribution	Lognormal	

Mean	15
95% UCL of mean	108.69216

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Ethylbenzene	4	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	10	U	5	280	5	78400	275	0.6233	171.4075	10
2	1WFF15-GW7 Comp	ug/L	280	D	280	48	5	2304	43	0.3031	13.0333	
3	2WFF16-GW1-Comb.	ug/L	10	U	5	5	5	25	0	0.1401	0	10
4	2WFF16-GW2S/2D-Comb	ug/L	48		48	5	5	25	0	0	0	
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	48	25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	5	280	25				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
353	124609	0.143	63027.714	3	80829

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
34018.409	184.4408

W	$W_{0.05}$	Normal ?
0.54	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	10	U	1.6094379	5.6347896	1.6094379	31.750854	4.025	0.6233	2.5090017
2	1WFF15-GW7 Comp	ug/L	280	D	5.6347896	3.871201	1.6094379	14.986197	2.262	0.3031	0.6855404
3	2WFF16-GW1-Comb.	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	48		3.871201	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	3.871201	2.5902904			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.6094379	5.6347896	2.5902904			

Σx	$(\Sigma x)^2$	1/n	d
17.55	308.114	0.143	15.672198

$\Sigma(x^2)$
59.688503

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
10.205099	3.1945421

W	$W_{0.05}$	Lognormal ?
0.651	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	10.0000	
Maximum Detection Limit	10	
Fraction ND	71%	
Mean	50.428571	2.5075972
Std. Deviation	1.02E+02	1.62E+00
Std. Error of Mean	3.87E+01	6.11E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	125.7	1758.1
Coefficient of Variation	203.24%	64.45%
Skewness	2.52E+00	1.63E+00
Median	5	1.6094379
Maximum	280	5.6347896
Shapiro-Wilk W statistic	5.40E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**50.428571**
95% UCL of mean	**125.69719**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Tetrachloroethene	5	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	4	J	4	5	4	25	1	0.6233	0.6233	
2	1WFF15-GW7 Comp	ug/L	5	J	5	5	5	25	0	0.3031	0	
3	2WFF16-GW1-Comb.	ug/L	10	U	5	5	5	25	0	0.1401	0	10
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	5	5	5	25	0	0	0	10
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	5	25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	4	5	16				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
34	1156	0.143	0.8571429	3	166	0.3885029	0.6233

W	$W_{0.05}$	Normal ?
0.453	0.803	No

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	4	J	1.3862944	1.6094379	1.3862944	2.5902904	0.223	0.6233	0.1390854
2	1WFF15-GW7 Comp	ug/L	5	J	1.6094379	1.6094379	1.6094379	2.5902904	0	0.3031	0
3	2WFF16-GW1-Comb.	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.3862944	1.6094379	1.9218121			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
11.04	121.946	0.143	0.0426798	17.463554	0.0193447	0.1390854

W	$W_{0.05}$	Lognormal ?
0.453	0.803	No

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	10.0000	
Maximum Detection Limit	10	
Fraction ND	71%	
Mean	4.8571429	1.5775603
Std. Deviation	3.78E-01	8.43E-02
Std. Error of Mean	1.43E-01	3.19E-02
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	5.1	5.2
Coefficient of Variation	7.78%	5.35%
Skewness	-2.65E+00	-2.65E+00
Median	5	1.6094379
Maximum	5	1.6094379
Shapiro-Wilk W statistic	4.53E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**4.8571429**
95% UCL of mean	**5.1347143**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Toluene	6	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2
1	1WFF15-GW1 Comb.	ug/L	10	U	5	1400	5	1960000
2	1WFF15-GW7 Comp	ug/L	1400	D	1400	5	5	25
3	2WFF16-GW1-Comb.	ug/L	10	U	5	5	5	25
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	5	5	5	25
5	2WFF16-GW3	ug/L	10	U	5	5	5	25
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	5	25
7	2WFF16-GW5-Comb	ug/L	10	U	5	5	1400	25

$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1395	0.6233	869.5035
0	0.3031	0
0	0.1401	0
0	0	0

detection limits
10
10
10
10
10
10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
1430	2044900	0.143	1668021.4	3	1960150

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
756036.34	869.5035

W	$W_{0.05}$	Normal ?
0.453	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2
1	1WFF15-GW1 Comb.	ug/L	10	U	1.6094379	7.2442275	1.6094379	52.478832
2	1WFF15-GW7 Comp	ug/L	1400	D	7.2442275	1.6094379	1.6094379	2.5902904
3	2WFF16-GW1-Comb.	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.6094379	7.2442275	2.5902904

$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
5.635	0.6233	3.5121644
0	0.3031	0
0	0.1401	0
0	0	0

Σx	$(\Sigma x)^2$	1/n	d
16.9	285.639	0.143	27.215018

$\Sigma(x^2)$
68.020575

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
12.335298	3.5121644

W	$W_{0.05}$	Lognormal ?
0.453	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	10.0000	
Maximum Detection Limit	10	
Fraction ND	86%	
Mean	204.28571	2.4144079
Std. Deviation	5.27E+02	2.13E+00
Std. Error of Mean	1.99E+02	8.05E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	591.5	54601.6
Coefficient of Variation	258.10%	88.21%
Skewness	2.65E+00	2.65E+00
Median	5	1.6094379
Maximum	1400	7.2442275
Shapiro-Wilk W statistic	4.53E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**204.28571**
95% UCL of mean	**591.49786**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
2-Chlorophenol	9	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	10	U	5	9	4.5	81	4.5	0.6233	2.80485	10
2	1WFF15-GW7 Comp	ug/L	9		9	5	5	25	0	0.3031	0	
3	2WFF16-GW1-Comb.	ug/L	9	U	4.5	5	5	25	0	0.1401	0	9
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	5	5	5	25	0	0	0	10
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	5	25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	4.5	9	20.25				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
38.5	1482.25	0.143	14.5	3	226.25	7.8671835	2.80485

W	$W_{0.05}$	Normal ?
0.543	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	10	U	1.6094379	2.1972246	1.5040774	4.8277958	0.693	0.6233	0.4320386
2	1WFF15-GW7 Comp	ug/L	9		2.1972246	1.6094379	1.6094379	2.5902904	0	0.3031	0
3	2WFF16-GW1-Comb.	ug/L	9	U	1.5040774	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.5040774	2.1972246	2.2622488			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
11.75	138.027	0.143	0.3233461	20.041497	0.1866574	0.4320386

W	$W_{0.05}$	Lognormal ?
0.577	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	9.8333	
Maximum Detection Limit	10	
Fraction ND	86%	
Mean	5.5	1.6783559
Std. Deviation	1.55E+00	2.32E-01
Std. Error of Mean	5.88E-01	8.77E-02
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	6.6	6.7
Coefficient of Variation	28.26%	13.83%
Skewness	2.56E+00	2.48E+00
Median	5	1.6094379
Maximum	9	2.1972246
Shapiro-Wilk W statistic	5.43E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**5.5**
95% UCL of mean	**6.6416478**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
2-Methylnaphthalene	10	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	10	U	5	200	3.5	40000	196.5	0.6233	122.47845	10
2	1WFF15-GW7 Comp	ug/L	200		200	5	4.5	25	0.5	0.3031	0.15155	
3	2WFF16-GW1-Comb.	ug/L	9	U	4.5	5	5	25	0	0.1401	0	9
4	2WFF16-GW2S/2D-Comb	ug/L	3.5	J	3.5	5	5	25	0	0	0	
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	4.5	5	20.25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	3.5	200	12.25				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
228	51984	0.143	32706.214	3	40132.5	15038.117	122.63

W	$W_{0.05}$	Normal ?
0.46	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	10	U	1.6094379	5.2983174	1.252763	28.072167	4.046	0.6233	2.5215941
2	1WFF15-GW7 Comp	ug/L	200		5.2983174	1.6094379	1.5040774	2.5902904	0.105	0.3031	0.0319348
3	2WFF16-GW1-Comb.	ug/L	9	U	1.5040774	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	3.5	J	1.252763	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.5040774	1.6094379	2.2622488			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.252763	5.2983174	1.5694151			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
14.49	210.044	0.143	12.258646	42.264992	6.5205095	2.5535288

W	$W_{0.05}$	Lognormal ?
0.532	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	9.8000	
Maximum Detection Limit	10	
Fraction ND	71%	
Mean	32.571429	2.0704156
Std. Deviation	7.38E+01	1.43E+00
Std. Error of Mean	2.79E+01	5.40E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	86.8	400.2
Coefficient of Variation	226.67%	69.04%
Skewness	2.65E+00	2.60E+00
Median	5	1.6094379
Maximum	200	5.2983174
Shapiro-Wilk W statistic	4.60E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**32.571429**
95% UCL of mean	**86.791901**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
4-Methylphenol	11	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	10	U	5	42	4.5	1764	37.5	0.6233	23.37375	10
2	1WFF15-GW7 Comp	ug/L	42		42	5	5	25	0	0.3031	0	
3	2WFF16-GW1-Comb.	ug/L	9	U	4.5	5	5	25	0	0.1401	0	9
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	5	5	5	25	0	0	0	10
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	5	25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	4.5	42	20.25				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
71.5	5112.25	0.143	1178.9286	3	1909.25

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
546.33219	23.37375

W	$W_{0.05}$	Normal ?
0.463	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	10	U	1.6094379	3.7376696	1.5040774	13.970174	2.234	0.6233	1.392198
2	1WFF15-GW7 Comp	ug/L	42		3.7376696	1.6094379	1.6094379	2.5902904	0	0.3031	0
3	2WFF16-GW1-Comb.	ug/L	9	U	1.5040774	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.5040774	3.7376696	2.2622488			

Σx	$(\Sigma x)^2$	1/n	d
13.29	176.596	0.143	3.9558985

$\Sigma(x^2)$
29.183875

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
1.9382154	1.392198

W	$W_{0.05}$	Lognormal ?
0.49	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	9.8333	
Maximum Detection Limit	10	
Fraction ND	86%	
Mean	10.214286	1.8984195
Std. Deviation	1.40E+01	8.12E-01
Std. Error of Mean	5.30E+00	3.07E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	20.5	26.7
Coefficient of Variation	137.23%	42.77%
Skewness	2.64E+00	2.63E+00
Median	5	1.6094379
Maximum	42	3.7376696
Shapiro-Wilk W statistic	4.63E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**10.214286**
95% UCL of mean	**20.508469**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
bis(2-Ethylhexyl)phthalate	12	Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=5	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L				160	5	25600	155	0.6646	103.013	
2	1WFF15-GW7 Comp	ug/L	160		160	39	5	1521	34	0.2413	8.2042	
3	2WFF16-GW1-Comb.	ug/L				5	5	25	0	0	0	
4	2WFF16-GW2S/2D-Comb	ug/L	39		39	5	39	25				
5	2WFF16-GW3	ug/L	10	U	5	5	160	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5							10
7	2WFF16-GW5-Comb	ug/L	10	U	5							10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
214	45796	0.200	18036.8	2	27196

$(\Sigma\, a(x-x_1))^2$	$\Sigma\, a(x-x_1)$
12369.266	111.2172

W	$W_{0.05}$	Normal ?
0.686	**0.762**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=5	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L				5.0751738	1.6094379	25.757389	3.466	0.6646	2.3033281
2	1WFF15-GW7 Comp	ug/L	160		5.0751738	3.6635616	1.6094379	13.421684	2.054	0.2413	0.4956601
3	2WFF16-GW1-Comb.	ug/L				1.6094379	1.6094379	2.5902904	0	0	0
4	2WFF16-GW2S/2D-Comb	ug/L	39		3.6635616	1.6094379	3.6635616	2.5902904			
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	5.0751738	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379						
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379						

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$
13.57	184.065	0.200	10.13698	46.949944

$(\Sigma\, a(x-x_1))^2$	$\Sigma\, a(x-x_1)$
7.8343346	2.7989881

W	$W_{0.05}$	Lognormal ?
0.773	**0.762**	**Yes**

Data Summary

	std.	log
Number of Samples	5	
Number of Locations	5	
Average Detection Limit	10.0000	
Maximum Detection Limit	10	
Fraction ND	60%	
Mean	42.8	2.7134098
Std. Deviation	6.72E+01	1.59E+00
Std. Error of Mean	3.00E+01	7.12E-01
t-value for 95% UCL Calculation, n=5	2.132	
Approximate 95% UCL for Mean	106.8	21559.1
Coefficient of Variation	156.89%	58.67%
Skewness	1.99E+00	1.03E+00
Median	5	1.6094379
Maximum	160	5.0751738
Shapiro-Wilk W statistic	7.73E-01	
Data Distribution	Lognormal	

Mean	**42.8**
95% UCL of mean	**21559.117**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Carbazole	13	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_i)	x^2
1	1WFF15-GW1 Comb.	ug/L	1	J	1	6	1	36
2	1WFF15-GW7 Comp	ug/L	6	J	6	5	1	25
3	2WFF16-GW1-Comb.	ug/L	9	U	4.5	5	4.5	25
4	2WFF16-GW2S/2D-Comb	ug/L	1	J	1	5	5	25
5	2WFF16-GW3	ug/L	10	U	5	4.5	5	20.25
6	2WFF16-GW4-Comb	ug/L	10	U	5	1	5	1
7	2WFF16-GW5-Comb	ug/L	10	U	5	1	6	1

Shapiro-Wilk Coefs.

$x-x_1$	(a) for n=7	$a(x-x_1)$
5	0.6233	3.1165
4	0.3031	1.2124
0.5	0.1401	0.07005
0	0	0

detection limits
9
10
10
10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
27.5	756.25	0.143	25.214286	3	133.25

$(\Sigma\, a(x-x_1))^2$	$\Sigma\, a(x-x_1)$
19.350761	4.39895

W	$W_{0.05}$	Normal ?
0.767	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_i)	x^2
1	1WFF15-GW1 Comb.	ug/L	1	J	0	1.7917595	0	3.210402
2	1WFF15-GW7 Comp	ug/L	6	J	1.7917595	1.6094379	0	2.5902904
3	2WFF16-GW1-Comb.	ug/L	9	U	1.5040774	1.6094379	1.5040774	2.5902904
4	2WFF16-GW2S/2D-Comb	ug/L	1	J	0	1.6094379	1.6094379	2.5902904
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.5040774	1.6094379	2.2622488
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	0	1.6094379	0
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	0	1.7917595	0

Shapiro-Wilk Coefs.

$x-x_1$	(a) for n=7	$a(x-x_1)$
1.792	0.6233	1.1168037
1.609	0.3031	0.4878206
0.105	0.1401	0.014761
0	0	0

Σx	$(\Sigma x)^2$	1/n	d
8.124	66.0018	0.143	3.8146901

$\Sigma(x^2)$
13.243522

$(\Sigma\, a(x-x_1))^2$	$\Sigma\, a(x-x_1)$
2.6224088	1.6193853

W	$W_{0.05}$	Lognormal ?
0.687	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	9.7500	
Maximum Detection Limit	10	
Fraction ND	57%	
Mean	3.9285714	1.1605929
Std. Deviation	2.05E+00	7.97E-01
Std. Error of Mean	7.75E-01	3.01E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	5.4	12.2
Coefficient of Variation	52.18%	68.70%
Skewness	-1.01E+00	-1.18E+00
Median	5	1.6094379
Maximum	6	1.7917595
Shapiro-Wilk W statistic	7.67E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**3.9285714**
95% UCL of mean	**5.4340393**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Dibenzofuran	14	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	2	J	2	5	1	25	4	0.6233	2.4932	
2	1WFF15-GW7 Comp	ug/L	3	J	3	5	2	25	3	0.3031	0.9093	
3	2WFF16-GW1-Comb.	ug/L	9	U	4.5	5	3	25	2	0.1401	0.2802	9
4	2WFF16-GW2S/2D-Comb	ug/L	1	J	1	4.5	4.5	20.25	0	0	0	
5	2WFF16-GW3	ug/L	10	U	5	3	5	9				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	2	5	4				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	1	5	1				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
25.5	650.25	0.143	16.357143	3	109.25	13.562279	3.6827

W	$W_{0.05}$	Normal ?
0.829	**0.803**	**Yes**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	2	J	0.6931472	1.6094379	0	2.5902904	1.609	0.6233	1.0031627
2	1WFF15-GW7 Comp	ug/L	3	J	1.0986123	1.6094379	0.6931472	2.5902904	0.916	0.3031	0.2777277
3	2WFF16-GW1-Comb.	ug/L	9	U	1.5040774	1.6094379	1.0986123	2.5902904	0.511	0.1401	0.0715667
4	2WFF16-GW2S/2D-Comb	ug/L	1	J	0	1.5040774	1.5040774	2.2622488	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.0986123	1.6094379	1.206949			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	0.6931472	1.6094379	0.480453			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	0	1.6094379	0			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
8.124	66.0018	0.143	2.2916901	11.720522	1.82914	1.352457

W	$W_{0.05}$	Lognormal ?
0.798	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	9.7500	
Maximum Detection Limit	10	
Fraction ND	57%	
Mean	3.6428571	1.1605929
Std. Deviation	1.65E+00	6.18E-01
Std. Error of Mean	6.24E-01	2.34E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	4.9	8.2
Coefficient of Variation	45.32%	53.25%
Skewness	-7.79E-01	-1.34E+00
Median	4.5	1.5040774
Maximum	5	1.6094379
Shapiro-Wilk W statistic	8.29E-01	
Data Distribution	Normal	

Mean	**3.6428571**
95% UCL of mean	**4.8554133**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Naphthalene	15	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	10	U	5	180	4.5	32400	175.5	0.6233	109.38915	10
2	1WFF15-GW7 Comp	ug/L	180		180	7	5	49	2	0.3031	0.6062	
3	2WFF16-GW1-Comb.	ug/L	9	U	4.5	5	5	25	0	0.1401	0	9
4	2WFF16-GW2S/2D-Comb	ug/L	7	J	7	5	5	25	0	0	0	
5	2WFF16-GW3	ug/L	10	U	5	5	5	25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	5	7	25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	4.5	180	20.25				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
211.5	44732.3	0.143	26178.929	3	32569.25

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
12098.977	109.99535

W	$W_{0.05}$	Normal ?
0.462	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	10	U	1.6094379	5.1929569	1.5040774	26.966801	3.689	0.6233	2.2992786
2	1WFF15-GW7 Comp	ug/L	180		5.1929569	1.9459101	1.6094379	3.7865663	0.336	0.3031	0.1019847
3	2WFF16-GW1-Comb.	ug/L	9	U	1.5040774	1.6094379	1.6094379	2.5902904	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	7	J	1.9459101	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.6094379	1.6094379	2.5902904			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.6094379	1.9459101	2.5902904			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	1.5040774	5.1929569	2.2622488			

Σx	$(\Sigma x)^2$	1/n	d
15.08	227.427	0.143	10.88715

$\Sigma(x^2)$
43.376778

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
5.7660654	2.4012633

W	$W_{0.05}$	Lognormal ?
0.53	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	9.8000	
Maximum Detection Limit	10	
Fraction ND	71%	
Mean	30.214286	2.1543851
Std. Deviation	6.61E+01	1.35E+00
Std. Error of Mean	2.50E+01	5.09E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	78.7	286.4
Coefficient of Variation	218.62%	62.53%
Skewness	2.64E+00	2.59E+00
Median	5	1.6094379
Maximum	180	5.1929569
Shapiro-Wilk W statistic	4.62E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**30.214286**
95% UCL of mean	**78.723483**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Phenanthrene	16	Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	3.5	J	3.5	20	2	400	18	0.6233	11.2194	
2	1WFF15-GW7 Comp	ug/L	20	L	20	5	3.5	25	1.5	0.3031	0.45465	
3	2WFF16-GW1-Comb.	ug/L	9	U	4.5	5	4.5	25	0.5	0.1401	0.07005	9
4	2WFF16-GW2S/2D-Comb	ug/L	2	J	2	5	5	25	0	0	0	
5	2WFF16-GW3	ug/L	10	U	5	4.5	5	20.25				10
6	2WFF16-GW4-Comb	ug/L	10	U	5	3.5	5	12.25				10
7	2WFF16-GW5-Comb	ug/L	10	U	5	2	20	4				10

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
45	2025	0.143	222.21429	3	511.5	137.92388	11.7441

W	$W_{0.05}$	Normal ?
0.6207	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	3.5	J	1.252763	2.9957323	0.6931472	8.9744119	2.303	0.6233	1.4352013
2	1WFF15-GW7 Comp	ug/L	20	L	2.9957323	1.6094379	1.252763	2.5902904	0.357	0.3031	0.1081082
3	2WFF16-GW1-Comb.	ug/L	9	U	1.5040774	1.6094379	1.5040774	2.5902904	0.105	0.1401	0.014761
4	2WFF16-GW2S/2D-Comb	ug/L	2	J	0.6931472	1.6094379	1.6094379	2.5902904	0	0	0
5	2WFF16-GW3	ug/L	10	U	1.6094379	1.5040774	1.6094379	2.2622488			
6	2WFF16-GW4-Comb	ug/L	10	U	1.6094379	1.252763	1.6094379	1.5694151			
7	2WFF16-GW5-Comb	ug/L	10	U	1.6094379	0.6931472	2.9957323	0.480453			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
11.274	127.104	0.143	2.8997095	21.0574	2.4275836	1.5580705

W	$W_{0.05}$	Lognormal ?
0.8372	**0.803**	**Yes**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	9.7500	
Maximum Detection Limit	10	
Fraction ND	57%	
Mean	6.4285714	1.6105762
Std. Deviation	6.09E+00	6.95E-01
Std. Error of Mean	2.30E+00	2.63E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	10.9	14.5
Coefficient of Variation	94.67%	43.16%
Skewness	2.46E+00	1.28E+00
Median	5	1.6094379
Maximum	20	2.9957323
Shapiro-Wilk W statistic	8.37E-01	
Data Distribution	Lognormal	

Mean	**6.4285714**
95% UCL of mean	**14.546381**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
4,4'-DDT	19	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	0.23	J	0.23	0.23	0.0475	0.0529	0.183	0.6233	0.1137523	
2	1WFF15-GW7 Comp	ug/L	0.097	U	0.0485	0.0485	0.0475	0.0023523	0.001	0.3031	0.0003031	0.097
3	2WFF16-GW1-Comb.	ug/L	0.095	U	0.0475	0.0485	0.0475	0.0023523	0.001	0.1401	0.0001401	0.095
4	2WFF16-GW2S/2D-Comb	ug/L	0.097	U	0.0485	0.048	0.048	0.002304	0	0	0	0.097
5	2WFF16-GW3	ug/L	0.095	U	0.0475	0.0475	0.0485	0.0022563				0.095
6	2WFF16-GW4-Comb	ug/L	0.096	U	0.048	0.0475	0.0485	0.0022563				0.096
7	2WFF16-GW5-Comb	ug/L	0.095	U	0.0475	0.0475	0.23	0.0022563				0.095

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
0.518	0.26781	0.143	0.0284192	3	0.0666773	0.0130406	0.1141955

W	$W_{0.05}$	Normal ?
0.459	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	0.23	J	-1.469676	-1.469676	-3.0470256	2.1599475	1.577	0.6233	0.983162
2	1WFF15-GW7 Comp	ug/L	0.097	U	-3.0261915	-3.0261915	-3.0470256	9.1578349	0.021	0.3031	0.0063148
3	2WFF16-GW1-Comb.	ug/L	0.095	U	-3.0470256	-3.0261915	-3.0470256	9.1578349	0.021	0.1401	0.0029189
4	2WFF16-GW2S/2D-Comb	ug/L	0.097	U	-3.0261915	-3.0365543	-3.0365543	9.2206618	0	0	0
5	2WFF16-GW3	ug/L	0.095	U	-3.0470256	-3.0470256	-3.0261915	9.2843648			
6	2WFF16-GW4-Comb	ug/L	0.096	U	-3.0365543	-3.0470256	-3.0261915	9.2843648			
7	2WFF16-GW5-Comb	ug/L	0.095	U	-3.0470256	-3.0470256	-1.469676	9.2843648			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
-19.7	388.078	0.143	2.1096903	57.549373	0.9848492	0.9923957

W	$W_{0.05}$	Lognormal ?
0.467	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	0.0958	
Maximum Detection Limit	0.097	
Fraction ND	86%	
Mean	0.0739286	-2.8142414
Std. Deviation	6.88E-02	5.93E-01
Std. Error of Mean	2.60E-02	2.24E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	0.1	0.1
Coefficient of Variation	93.09%	-21.07%
Skewness	2.65E+00	2.64E+00
Median	0.048	-3.0365543
Maximum	0.23	-1.469676
Shapiro-Wilk W statistic	4.59E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**0.0739286**
95% UCL of mean	**0.1244708**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
alpha-BHC	20	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	x-x_1	Shapiro-Wilk Coefs. (a) for n=7	a(x-x_1)	detection limits
1	1WFF15-GW1 Comb.	ug/L	0.048	UJ	0.024	0.029	0.024	0.000841	0.005	0.6233	0.0031165	0.048
2	1WFF15-GW7 Comp	ug/L	0.029	J	0.029	0.0245	0.024	0.0006003	5E-04	0.3031	0.0001516	
3	2WFF16-GW1-Comb.	ug/L	0.048	U	0.024	0.024	0.024	0.000576	0	0.1401	0	0.048
4	2WFF16-GW2S/2D-Comb	ug/L	0.049	U	0.0245	0.024	0.024	0.000576	0	0	0	0.049
5	2WFF16-GW3	ug/L	0.048	U	0.024	0.024	0.024	0.000576				0.048
6	2WFF16-GW4-Comb	ug/L	0.048	U	0.024	0.024	0.0245	0.000576				0.048
7	2WFF16-GW5-Comb	ug/L	0.048	U	0.024	0.024	0.029	0.000576				0.048

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
0.174	0.0301	0.143	2.093E-05	3	0.0043213

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
1.068E-05	0.0032681

W	$W_{0.05}$	Normal ?
0.51	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	x-x_1	Shapiro-Wilk Coefs. (a) for n=7	a(x-x_1)
1	1WFF15-GW1 Comb.	ug/L	0.048	UJ	-3.7297014	-3.5404594	-3.7297014	12.534853	0.189	0.6233	0.1179545
2	1WFF15-GW7 Comp	ug/L	0.029	J	-3.5404594	-3.7090822	-3.7297014	13.75729	0.021	0.3031	0.0062497
3	2WFF16-GW1-Comb.	ug/L	0.048	U	-3.7297014	-3.7297014	-3.7297014	13.910673	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	0.049	U	-3.7090822	-3.7297014	-3.7297014	13.910673	0	0	0
5	2WFF16-GW3	ug/L	0.048	U	-3.7297014	-3.7297014	-3.7297014	13.910673			
6	2WFF16-GW4-Comb	ug/L	0.048	U	-3.7297014	-3.7297014	-3.7090822	13.910673			
7	2WFF16-GW5-Comb	ug/L	0.048	U	-3.7297014	-3.7297014	-3.5404594	13.910673			

Σx	$(\Sigma x)^2$	1/n	d
-25.9	670.709	0.143	0.029946

$\Sigma(x^2)$
95.845508

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
0.0154267	0.1242042

W	$W_{0.05}$	Lognormal ?
0.515	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	0.0482	
Maximum Detection Limit	0.049	
Fraction ND	86%	
Mean	0.0247857	-3.6997213
Std. Deviation	1.87E-03	7.06E-02
Std. Error of Mean	7.06E-04	2.67E-02
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	0.0	0.0
Coefficient of Variation	7.54%	-1.91%
Skewness	2.59E+00	2.58E+00
Median	0.024	-3.7297014
Maximum	0.029	-3.5404594
Shapiro-Wilk W statistic	5.10E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**0.0247857**
95% UCL of mean	**0.0261573**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
gamma-BHC (Lindane)	21	Not Normal or Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	0.048	UJ	0.024	0.067	0.024	0.004489	0.043	0.6233	0.0268019	0.048
2	1WFF15-GW7 Comp	ug/L	0.067	J	0.067	0.0245	0.024	0.0006003	5E-04	0.3031	0.0001516	
3	2WFF16-GW1-Comb.	ug/L	0.048	U	0.024	0.024	0.024	0.000576	0	0.1401	0	0.048
4	2WFF16-GW2S/2D-Comb	ug/L	0.049	U	0.0245	0.024	0.024	0.000576	0	0	0	0.049
5	2WFF16-GW3	ug/L	0.048	U	0.024	0.024	0.024	0.000576				0.048
6	2WFF16-GW4-Comb	ug/L	0.048	U	0.024	0.024	0.0245	0.000576				0.048
7	2WFF16-GW5-Comb	ug/L	0.048	U	0.024	0.024	0.067	0.000576				0.048

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
0.212	0.04473	0.143	0.0015789	3	0.0079693

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
0.0007265	0.0269535

W	$W_{0.05}$	Normal ?
0.46	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	0.048	UJ	-3.7297014	-2.7030627	-3.7297014	7.3065477	1.027	0.6233	0.639904
2	1WFF15-GW7 Comp	ug/L	0.067	J	-2.7030627	-3.7090822	-3.7297014	13.75729	0.021	0.3031	0.0062497
3	2WFF16-GW1-Comb.	ug/L	0.048	U	-3.7297014	-3.7297014	-3.7297014	13.910673	0	0.1401	0
4	2WFF16-GW2S/2D-Comb	ug/L	0.049	U	-3.7090822	-3.7297014	-3.7297014	13.910673	0	0	0
5	2WFF16-GW3	ug/L	0.048	U	-3.7297014	-3.7297014	-3.7297014	13.910673			
6	2WFF16-GW4-Comb	ug/L	0.048	U	-3.7297014	-3.7297014	-3.7090822	13.910673			
7	2WFF16-GW5-Comb	ug/L	0.048	U	-3.7297014	-3.7297014	-2.7030627	13.910673			

Σx	$(\Sigma x)^2$	1/n	d
-25.1	628.036	0.143	0.8977339

$\Sigma(x^2)$
90.617203

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
0.4175146	0.6461537

W	$W_{0.05}$	Lognormal ?
0.465	**0.803**	**No**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	0.0482	
Maximum Detection Limit	0.049	
Fraction ND	86%	
Mean	0.0302143	-3.5800932
Std. Deviation	1.62E-02	3.87E-01
Std. Error of Mean	6.13E-03	1.46E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	0.0	0.0
Coefficient of Variation	53.69%	-10.80%
Skewness	2.65E+00	2.64E+00
Median	0.024	-3.7297014
Maximum	0.067	-2.7030627
Shapiro-Wilk W statistic	4.60E-01	
Data Distribution	Not Normal or Lognormal	

Mean	**0.0302143**
95% UCL of mean	**0.0421275**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Aluminum	24	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	10900	K	10900	17100	679	292410000	16421	0.6233	10235.209	
2	1WFF15-GW7 Comp	ug/L	17100		17100	10900	1930	118810000	8970	0.3031	2718.807	
3	2WFF16-GW1-Comb.	ug/L	2450		2450	7540	2450	56851600	5090	0.1401	713.109	
4	2WFF16-GW2S/2D-Comb	ug/L	5720		5720	5720	5720	32718400	0	0	0	
5	2WFF16-GW3	ug/L	7540		7540	2450	7540	6002500				
6	2WFF16-GW4-Comb	ug/L	679		679	1930	10900	3724900				
7	2WFF16-GW5-Comb	ug/L	1930		1930	679	17100	461041				

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
46319	2.1E+09	0.143	204485618	3	510978441	186790314	13667.125

W	$W_{0.05}$	Normal ?
0.913	**0.803**	**Yes**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	10900	K	9.2965181	9.7468337	6.5206211	95.000768	3.226	0.6233	2.0108983
2	1WFF15-GW7 Comp	ug/L	17100		9.7468337	9.2965181	7.5652753	86.425248	1.731	0.3031	0.5247397
3	2WFF16-GW1-Comb.	ug/L	2450		7.8038433	8.9279775	7.8038433	79.708782	1.124	0.1401	0.1574912
4	2WFF16-GW2S/2D-Comb	ug/L	5720		8.6517241	8.6517241	8.6517241	74.85233	0	0	0
5	2WFF16-GW3	ug/L	7540		8.9279775	7.8038433	8.9279775	60.89997			
6	2WFF16-GW4-Comb	ug/L	679		6.5206211	7.5652753	9.2965181	57.23339			
7	2WFF16-GW5-Comb	ug/L	1930		7.5652753	6.5206211	9.7468337	42.5185			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
58.51	3423.75	0.143	7.5322801	496.63899	7.2529449	2.6931292

W	$W_{0.05}$	Lognormal ?
0.963	**0.803**	**Yes**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	n/a	
Maximum Detection Limit	n/a	
Fraction ND	0%	
Mean	6617	8.3589704
Std. Deviation	5.84E+03	1.12E+00
Std. Error of Mean	2.21E+03	4.23E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	10904.3	50950.5
Coefficient of Variation	88.23%	13.40%
Skewness	9.92E-01	-5.27E-01
Median	5720	8.6517241
Maximum	17100	9.7468337
Shapiro-Wilk W statistic	9.13E-01	
Data Distribution	Normal	

Mean	**6617**
95% UCL of mean	**10904.257**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Antimony	25	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	x-x_1	Shapiro-Wilk Coefs. (a) for n=7	a(x-x_1)	detection limits
1	1WFF15-GW1 Comb.	ug/L	1.6	U	0.8	4.6	0.8	21.16	3.8	0.6233	2.36854	1.6
2	1WFF15-GW7 Comp	ug/L	1.4		1.4	2.1	0.85	4.41	1.25	0.3031	0.378875	
3	2WFF16-GW1-Comb.	ug/L	1.7	U	0.85	2.1	1.4	4.41	0.7	0.1401	0.09807	1.7
4	2WFF16-GW2S/2D-Comb	ug/L	4.2	U	2.1	2.1	2.1	4.41	0	0	0	4.2
5	2WFF16-GW3	ug/L	4.6		4.6	1.4	2.1	1.96				
6	2WFF16-GW4-Comb	ug/L	4.2	U	2.1	0.85	2.1	0.7225				4.2
7	2WFF16-GW5-Comb	ug/L	4.2	U	2.1	0.8	4.6	0.64				4.2

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
13.95	194.603	0.143	9.9121429	3	37.7125

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
8.0967849	2.845485

W	$W_{0.05}$	Normal ?
0.817	0.803	Yes

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	x-x_1	Shapiro-Wilk Coefs. (a) for n=7	a(x-x_1)
1	1WFF15-GW1 Comb.	ug/L	1.6	U	-0.2231436	1.5260563	-0.2231436	2.3288478	1.749	0.6233	1.0902763
2	1WFF15-GW7 Comp	ug/L	1.4		0.3364722	0.7419373	-0.1625189	0.550471	0.904	0.3031	0.2741407
3	2WFF16-GW1-Comb.	ug/L	1.7	U	-0.1625189	0.7419373	0.3364722	0.550471	0.405	0.1401	0.0568057
4	2WFF16-GW2S/2D-Comb	ug/L	4.2	U	0.7419373	0.7419373	0.7419373	0.550471	0	0	0
5	2WFF16-GW3	ug/L	4.6		1.5260563	0.3364722	0.7419373	0.1132136			
6	2WFF16-GW4-Comb	ug/L	4.2	U	0.7419373	-0.1625189	0.7419373	0.0264124			
7	2WFF16-GW5-Comb	ug/L	4.2	U	0.7419373	-0.2231436	1.5260563	0.049793			

Σx	$(\Sigma x)^2$	1/n	d
3.703	13.7098	0.143	2.2111335

$\Sigma(x^2)$
4.1696799

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
2.0198738	1.4212226

W	$W_{0.05}$	Lognormal ?
0.914	0.803	Yes

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	3.1800	
Maximum Detection Limit	4.2	
Fraction ND	71%	
Mean	1.9928571	0.528954
Std. Deviation	1.29E+00	6.07E-01
Std. Error of Mean	4.86E-01	2.29E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	2.9	4.3
Coefficient of Variation	64.50%	114.77%
Skewness	1.57E+00	2.68E-01
Median	2.1	0.7419373
Maximum	4.6	1.5260563
Shapiro-Wilk W statistic	8.17E-01	
Data Distribution	Normal	

Mean	**1.9928571**
95% UCL of mean	**2.9367701**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Arsenic	26	Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	x-x_1	Shapiro-Wilk Coefs. (a) for n=7	a(x-x_1)	detection limits
1	1WFF15-GW1 Comb.	ug/L	2		2	88.2	1	7779.24	87.2	0.6233	54.35176	
2	1WFF15-GW7 Comp	ug/L	88.2		88.2	30.2	1.7	912.04	28.5	0.3031	8.63835	
3	2WFF16-GW1-Comb.	ug/L	2	U	1	11.1	1.7	123.21	9.4	0.1401	1.31694	2
4	2WFF16-GW2S/2D-Comb	ug/L	30.2		30.2	2	2	4	0	0	0	
5	2WFF16-GW3	ug/L	11.1		11.1	1.7	11.1	2.89				
6	2WFF16-GW4-Comb	ug/L	3.4	U	1.7	1.7	30.2	2.89				3.4
7	2WFF16-GW5-Comb	ug/L	3.4	U	1.7	1	88.2	1				3.4

Σx	$(Σx)^2$	1/n	d	k	$Σ(x^2)$	$(Σ a(x-x_1))^2$	Σ a(x-x_1)
135.9	18468.8	0.143	6186.8686	3	8825.27	4135.3967	64.30705

W	$W_{0.05}$	Normal ?
0.668	0.803	No

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	x-x_1	Shapiro-Wilk Coefs. (a) for n=7	a(x-x_1)
1	1WFF15-GW1 Comb.	ug/L	2		0.6931472	4.479607	0	20.066879	4.48	0.6233	2.792139
2	1WFF15-GW7 Comp	ug/L	88.2		4.479607	3.4078419	0.5306283	11.613387	2.877	0.3031	0.8720835
3	2WFF16-GW1-Comb.	ug/L	2	U	0	2.4069451	0.5306283	5.7933848	1.876	0.1401	0.262872
4	2WFF16-GW2S/2D-Comb	ug/L	30.2		3.4078419	0.6931472	0.6931472	0.480453	0	0	0
5	2WFF16-GW3	ug/L	11.1		2.4069451	0.5306283	2.4069451	0.2815663			
6	2WFF16-GW4-Comb	ug/L	3.4	U	0.5306283	0.5306283	3.4078419	0.2815663			
7	2WFF16-GW5-Comb	ug/L	3.4	U	0.5306283	0	4.479607	0			

Σx	$(Σx)^2$	1/n	d	$Σ(x^2)$	$(Σ a(x-x_1))^2$	Σ a(x-x_1)
12.05	145.174	0.143	17.778161	38.517236	15.422071	3.9270945

W	$W_{0.05}$	Lognormal ?
0.867	0.803	Yes

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	2.9333	
Maximum Detection Limit	3.4	
Fraction ND	43%	
Mean	19.414286	1.7212568
Std. Deviation	3.21E+01	1.72E+00
Std. Error of Mean	1.21E+01	6.51E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	43.0	1523.2
Coefficient of Variation	165.40%	100.01%
Skewness	2.14E+00	7.57E-01
Median	2	0.6931472
Maximum	88.2	4.479607
Shapiro-Wilk W statistic	8.67E-01	
Data Distribution	Lognormal	

Mean	**19.414286**
95% UCL of mean	**1523.2024**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Iron	29	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	5565		5565	58400	3580	3.411E+09	54820	0.6233	34169.306	
2	1WFF15-GW7 Comp	ug/L	58400		58400	30100	5420	906010000	24680	0.3031	7480.508	
3	2WFF16-GW1-Comb.	ug/L	3580		3580	29500	5565	870250000	23935	0.1401	3353.2935	
4	2WFF16-GW2S/2D-Comb	ug/L	30100		30100	14100	14100	198810000	0	0	0	
5	2WFF16-GW3	ug/L	14100		14100	5565	29500	30969225				
6	2WFF16-GW4-Comb	ug/L	29500		29500	5420	30100	29376400				
7	2WFF16-GW5-Comb	ug/L	5420		5420	3580	58400	12816400				

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
1E+05	2.2E+10	0.143	2.386E+09	3	5.459E+09	2.025E+09	45003.108

W	$W_{0.05}$	Normal ?
0.849	**0.803**	**Yes**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	5565		8.6242523	10.975071	8.1831181	120.45219	2.792	0.6233	1.7402244
2	1WFF15-GW7 Comp	ug/L	58400		10.975071	10.31228	8.5978511	106.34313	1.714	0.3031	0.5196435
3	2WFF16-GW1-Comb.	ug/L	3580		8.1831181	10.292146	8.6242523	105.92826	1.668	0.1401	0.2336718
4	2WFF16-GW2S/2D-Comb	ug/L	30100		10.31228	9.5539301	9.5539301	91.27758	0	0	0
5	2WFF16-GW3	ug/L	14100		9.5539301	8.6242523	10.292146	74.377727			
6	2WFF16-GW4-Comb	ug/L	29500		10.292146	8.5978511	10.31228	73.923043			
7	2WFF16-GW5-Comb	ug/L	5420		8.5978511	8.1831181	10.975071	66.963422			

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
66.54	4427.39	0.143	6.7808088	639.26535	6.2177405	2.4935397

W	$W_{0.05}$	Lognormal ?
0.917	**0.803**	**Yes**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	n/a	
Maximum Detection Limit	n/a	
Fraction ND	0%	
Mean	20952.143	9.5055212
Std. Deviation	1.99E+04	1.06E+00
Std. Error of Mean	7.54E+03	4.02E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	35596.5	127419.3
Coefficient of Variation	95.17%	11.18%
Skewness	1.21E+00	8.56E-02
Median	14100	9.5539301
Maximum	58400	10.975071
Shapiro-Wilk W statistic	8.49E-01	
Data Distribution	Normal	

Mean	**20952.143**
95% UCL of mean	**35596.468**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Lead	30	Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=6	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	4.9	J	4.9	62.8	1.25	3943.84	61.55	0.6431	39.582805	
2	1WFF15-GW7 Comp	ug/L	62.8		62.8	4.9	1.25	24.01	3.65	0.2806	1.02419	
3	2WFF16-GW1-Comb.	ug/L				4.5	2.8	20.25	1.7	0.0875	0.14875	
4	2WFF16-GW2S/2D-Comb	ug/L	2.5	U	1.25	2.8	4.5	7.84				2.5
5	2WFF16-GW3	ug/L	4.5		4.5	1.25	4.9	1.5625				
6	2WFF16-GW4-Comb	ug/L	2.5	U	1.25	1.25	62.8	1.5625				2.5
7	2WFF16-GW5-Comb	ug/L	2.8		2.8							

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
77.5	6006.25	0.167	2998.0233	3	3999.065	1661.0308	40.755745

W	$W_{0.05}$	Normal ?
0.554	**0.788**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=6	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	4.9	J	1.5892352	4.1399551	0.2231436	17.139228	3.917	0.6431	2.5189015
2	1WFF15-GW7 Comp	ug/L	62.8		4.1399551	1.5892352	0.2231436	2.5256685	1.366	0.2806	0.3833253
3	2WFF16-GW1-Comb.	ug/L				1.5040774	1.0296194	2.2622488	0.474	0.0875	0.0415151
4	2WFF16-GW2S/2D-Comb	ug/L	2.5	U	0.2231436	1.0296194	1.5040774	1.0601161			
5	2WFF16-GW3	ug/L	4.5		1.5040774	0.2231436	1.5892352	0.049793			
6	2WFF16-GW4-Comb	ug/L	2.5	U	0.2231436	0.2231436	4.1399551	0.049793			
7	2WFF16-GW5-Comb	ug/L	2.8		1.0296194						

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
8.709	75.8497	0.167	10.445228	23.086848	8.6656163	2.9437419

W	$W_{0.05}$	Lognormal ?
0.83	**0.788**	**Yes**

Data Summary

	std.	log
Number of Samples	6	
Number of Locations	6	
Average Detection Limit	2.5000	
Maximum Detection Limit	2.5	
Fraction ND	33%	
Mean	12.916667	1.451529
Std. Deviation	2.45E+01	1.45E+00
Std. Error of Mean	1.00E+01	5.90E-01
t-value for 95% UCL Calculation, n=6	2.015	
Approximate 95% UCL for Mean	33.1	566.8
Coefficient of Variation	189.58%	99.57%
Skewness	2.43E+00	1.56E+00
Median	3.65	1.2668484
Maximum	62.8	4.1399551
Shapiro-Wilk W statistic	8.30E-01	
Data Distribution	Lognormal	

Mean	**12.916667**
95% UCL of mean	**566.79052**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Manganese	32	Lognormal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2
1	1WFF15-GW1 Comb.	ug/L	186		186	3510	31.6	12320100
2	1WFF15-GW7 Comp	ug/L	3510		3510	186	33.6	34596
3	2WFF16-GW1-Comb.	ug/L	33.6		33.6	122	61.5	14884
4	2WFF16-GW2S/2D-Comb	ug/L	122		122	110	110	12100
5	2WFF16-GW3	ug/L	31.6		31.6	61.5	122	3782.25
6	2WFF16-GW4-Comb	ug/L	61.5		61.5	33.6	186	1128.96
7	2WFF16-GW5-Comb	ug/L	110		110	31.6	3510	998.56

$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
3478	0.6233	2168.0867
152.4	0.3031	46.19244
60.5	0.1401	8.47605
0	0	0

detection limits

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
4055	1.6E+07	0.143	10038934	3	12387590

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
4940640.7	2222.7552

W	$W_{0.05}$	Normal ?
0.492	**0.803**	**No**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2
1	1WFF15-GW1 Comb.	ug/L	186		5.2257467	8.1633713	3.4531571	66.640631
2	1WFF15-GW7 Comp	ug/L	3510		8.1633713	5.2257467	3.5145261	27.308428
3	2WFF16-GW1-Comb.	ug/L	33.6		3.5145261	4.804021	4.1190372	23.078618
4	2WFF16-GW2S/2D-Comb	ug/L	122		4.804021	4.7004804	4.7004804	22.094516
5	2WFF16-GW3	ug/L	31.6		3.4531571	4.1190372	4.804021	16.966467
6	2WFF16-GW4-Comb	ug/L	61.5		4.1190372	3.5145261	5.2257467	12.351893
7	2WFF16-GW5-Comb	ug/L	110		4.7004804	3.4531571	8.1633713	11.924294

$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
4.71	0.6233	2.9358765
1.711	0.3031	0.518671
0.685	0.1401	0.0959662
0	0	0

Σx	$(\Sigma x)^2$	1/n	d
33.98	1154.66	0.143	15.412921

$\Sigma(x^2)$
180.36485

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
12.606148	3.5505137

W	$W_{0.05}$	Lognormal ?
0.818	**0.803**	**Yes**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	n/a	
Maximum Detection Limit	n/a	
Fraction ND	0%	
Mean	579.24286	4.8543343
Std. Deviation	1.29E+03	1.60E+00
Std. Error of Mean	4.89E+02	6.06E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	1529.2	16974.1
Coefficient of Variation	223.31%	33.02%
Skewness	2.64E+00	1.74E+00
Median	110	4.7004804
Maximum	3510	8.1633713
Shapiro-Wilk W statistic	8.18E-01	
Data Distribution	Lognormal	

Mean	**579.24286**
95% UCL of mean	**16974.067**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Thallium	35	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2
1	1WFF15-GW1 Comb.	ug/L	2.3	U	1.15	3.9	0.8	15.21
2	1WFF15-GW7 Comp	ug/L	3.9	U	1.95	1.95	1.15	3.8025
3	2WFF16-GW1-Comb.	ug/L	1.6	U	0.8	1.95	1.95	3.8025
4	2WFF16-GW2S/2D-Comb	ug/L	3.9	U	1.95	1.95	1.95	3.8025
5	2WFF16-GW3	ug/L	3.9	U	1.95	1.95	1.95	3.8025
6	2WFF16-GW4-Comb	ug/L	3.9		3.9	1.15	1.95	1.3225
7	2WFF16-GW5-Comb	ug/L	3.9	U	1.95	0.8	3.9	0.64

$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
3.1	0.6233	1.93223
0.8	0.3031	0.24248
0	0.1401	0
0	0	0

detection limits
2.3
3.9
1.6
3.9
3.9
3.9

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$
13.65	186.323	0.143	5.765	3	32.3825

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
4.7293636	2.17471

W	$W_{0.05}$	Normal ?
0.82	**0.803**	**Yes**

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2
1	1WFF15-GW1 Comb.	ug/L	2.3	U	0.1397619	1.3609766	-0.2231436	1.8522572
2	1WFF15-GW7 Comp	ug/L	3.9	U	0.6678294	0.6678294	0.1397619	0.4459961
3	2WFF16-GW1-Comb.	ug/L	1.6	U	-0.2231436	0.6678294	0.6678294	0.4459961
4	2WFF16-GW2S/2D-Comb	ug/L	3.9	U	0.6678294	0.6678294	0.6678294	0.4459961
5	2WFF16-GW3	ug/L	3.9	U	0.6678294	0.6678294	0.6678294	0.4459961
6	2WFF16-GW4-Comb	ug/L	3.9		1.3609766	0.1397619	0.6678294	0.0195334
7	2WFF16-GW5-Comb	ug/L	3.9	U	0.6678294	-0.2231436	1.3609766	0.049793

$x-x_1$	Shapiro-Wilk Coefs. (a) for n=7	$a(x-x_1)$
1.584	0.6233	0.9873821
0.528	0.3031	0.1600572
0	0.1401	0
0	0	0

Σx	$(\Sigma x)^2$	1/n	d
3.949	15.5939	0.143	1.4778666

$\Sigma(x^2)$
3.7055679

$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
1.3166169	1.1474393

W	$W_{0.05}$	Lognormal ?
0.891	**0.803**	**Yes**

Data Summary

	std.	log
Number of Samples	7	
Number of Locations	7	
Average Detection Limit	3.2500	
Maximum Detection Limit	3.9	
Fraction ND	86%	
Mean	1.95	0.5641303
Std. Deviation	9.80E-01	4.96E-01
Std. Error of Mean	3.70E-01	1.88E-01
t-value for 95% UCL Calculation, n=7	1.943	
Approximate 95% UCL for Mean	2.7	3.3
Coefficient of Variation	50.27%	87.98%
Skewness	1.33E+00	-1.03E-01
Median	1.95	0.6678294
Maximum	3.9	1.3609766
Shapiro-Wilk W statistic	8.20E-01	
Data Distribution	Normal	

Mean	**1.95**
95% UCL of mean	**2.6698596**

Table 6-3.3b: Evaluation of Data Distribution and 95 UCL Calculations

Chemical Name	index	data distribution
Vanadium	36	Normal

Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=6	$a(x-x_1)$	detection limits
1	1WFF15-GW1 Comb.	ug/L	15		15	31.6	0.55	998.56	31.05	0.6431	19.968255	
2	1WFF15-GW7 Comp	ug/L	20.8		20.8	20.8	1.5	432.64	19.3	0.2806	5.41558	
3	2WFF16-GW1-Comb.	ug/L				15	10.6	225	4.4	0.0875	0.385	
4	2WFF16-GW2S/2D-Comb	ug/L	10.6		10.6	10.6	15	112.36				
5	2WFF16-GW3	ug/L	31.6		31.6	1.5	20.8	2.25				
6	2WFF16-GW4-Comb	ug/L	1.5		1.5	0.55	31.6	0.3025				
7	2WFF16-GW5-Comb	ug/L	1.1	U	0.55							1.1

Σx	$(\Sigma x)^2$	1/n	d	k	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
80.05	6408	0.167	703.11208	3	1771.1125	664.03286	25.768835

W	$W_{0.05}$	Normal ?
0.944	0.788	Yes

Log-Normality Test

	Sample ID	Units	Conc.	Qualifier	U = 1/2 DL (log value)	Descending Values (x)	Ascending Values (x_1)	x^2	$x-x_1$	Shapiro-Wilk Coefs. (a) for n=6	$a(x-x_1)$
1	1WFF15-GW1 Comb.	ug/L	15		2.7080502	3.4531571	-0.597837	11.924294	4.051	0.6431	2.6051943
2	1WFF15-GW7 Comp	ug/L	20.8		3.034953	3.034953	0.4054651	9.2109396	2.629	0.2806	0.7378343
3	2WFF16-GW1-Comb.	ug/L				2.7080502	2.360854	7.3335359	0.347	0.0875	0.0303797
4	2WFF16-GW2S/2D-Comb	ug/L	10.6		2.360854	2.360854	2.7080502	5.5736316			
5	2WFF16-GW3	ug/L	31.6		3.4531571	0.4054651	3.034953	0.164402			
6	2WFF16-GW4-Comb	ug/L	1.5		0.4054651	-0.597837	3.4531571	0.3574091			
7	2WFF16-GW5-Comb	ug/L	1.1	U	-0.597837						

Σx	$(\Sigma x)^2$	1/n	d	$\Sigma(x^2)$	$(\Sigma a(x-x_1))^2$	$\Sigma a(x-x_1)$
11.36	129.155	0.167	13.038363	34.564212	11.379883	3.3734083

W	$W_{0.05}$	Lognormal ?
0.873	0.788	Yes

Data Summary

	std.	log
Number of Samples	6	
Number of Locations	6	
Average Detection Limit	1.1000	
Maximum Detection Limit	1.1	
Fraction ND	17%	
Mean	13.341667	1.8941071
Std. Deviation	1.19E+01	1.61E+00
Std. Error of Mean	4.84E+00	6.59E-01
t-value for 95% UCL Calculation, n=6	2.015	
Approximate 95% UCL for Mean	23.1	2855.1
Coefficient of Variation	88.88%	85.26%
Skewness	4.91E-01	-9.16E-01
Median	12.8	2.5344521
Maximum	31.6	3.4531571
Shapiro-Wilk W statistic	9.44E-01	
Data Distribution	Normal	

Mean	**13.341667**
95% UCL of mean	**23.096654**

TABLE 6-3.4
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: air volatilized from groundwater at Site 16

Chemical of Potential Concern	Units	Arithmetic Mean (1,2)	95% UCL of Normal Data (2)	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
1,2-dichloroethene (total)	mg/L	5.71E-03	6.60E-03	8.00E-03	J	mg/L	8.00E-03	Max	data distribution not normal or lognormal
benzene	mg/L	1.50E-02	3.00E-02	5.80E-02		mg/L	5.80E-02	Max	lognormal data distribution, 95 UCL-log > max concentration
ethylbenzene	mg/L	5.04E-02	1.26E-01	2.80E-01	D	mg/L	2.80E-01	Max	data distribution not normal or lognormal
tetrachloroethene	mg/L	4.86E-03	5.10E-03	5.00E-03	J	mg/L	5.00E-03	Max	data distribution not normal or lognormal
toluene	mg/L	2.04E-01	5.92E-01	1.40E+00	D	mg/L	1.40E+00	Max	data distribution not normal or lognormal
2-chlorophenol	mg/L	5.50E-03	6.64E-03	9.00E-03		mg/L	9.00E-03	Max	data distribution not normal or lognormal
2-methylnaphthalene	mg/L	3.26E-02	8.68E-02	2.00E-01		mg/L	2.00E-01	Max	data distribution not normal or lognormal
4-methylphenol	mg/L	1.02E-02	2.05E-02	4.20E-02		mg/L	4.20E-02	Max	data distribution not normal or lognormal
bis(2-ethylhexyl)phthalate	mg/L	4.28E-02	1.07E-01	1.60E-01		mg/L	1.60E-01	Max	lognormal data distribution, 95 UCL-log > max concentration
carbazole	mg/L	3.93E-03	5.43E-03	6.00E-03	J	mg/L	6.00E-03	Max	data distribution not normal or lognormal
dibenzofuran	mg/L	3.64E-03	4.86E-03	3.00E-03	J	mg/L	3.00E-03	Max	normal data distribution, 95 UCL-normal > max concentration
naphthalene	mg/L	3.02E-02	7.87E-02	1.80E-01		mg/L	1.80E-01	Max	data distribution not normal or lognormal
phenanthrene	mg/L	6.43E-03	1.09E-02	2.00E-02	L	mg/L	1.45E-02	95% UCL-T	lognormal data distribution, 95 UCL-log < max concentration
4,4'-DDT	mg/L	7.39E-05	1.24E-04	2.30E-04	J	mg/L	2.30E-04	Max	data distribution not normal or lognormal
alpha-BHC	mg/L	2.48E-05	2.62E-05	2.90E-05	J	mg/L	2.90E-05	Max	data distribution not normal or lognormal
gamma-BHC (lindane)	mg/L	3.02E-05	4.21E-05	6.70E-05	J	mg/L	6.70E-05	Max	data distribution not normal or lognormal
aluminum	mg/L	6.62E+00	1.09E+01	1.71E+01		mg/L	1.09E+01	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
antimony	mg/L	1.99E-03	2.94E-03	4.60E-03		mg/L	2.94E-03	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
arsenic	mg/L	1.94E-02	4.30E-02	8.82E-02		mg/L	8.82E-02	Max	lognormal data distribution, 95 UCL-log > max concentration
iron	mg/L	2.10E+01	3.56E+01	5.84E+01		mg/L	3.56E+01	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
lead	mg/L	1.29E-02	3.31E-02	6.28E-02		mg/L	6.28E-02	Max	lognormal data distribution, 95 UCL-log > max concentration
manganese	mg/L	5.79E-01	1.53E+00	3.51E+00		mg/L	3.51E+00	Max	lognormal data distribution, 95 UCL-log > max concentration
thallium	mg/L	1.95E-03	2.67E-03	3.90E-03		mg/L	2.67E-03	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration
vanadium	mg/L	1.33E-02	2.31E-02	3.16E-02		mg/L	2.31E-02	95% UCL-N	normal data distribution, 95 UCL-normal < max concentration

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

(1) Average concentration based on the detected concentrations and one-half of the detection limit for the non-detects.
(2) Supporting calculations for average and 95 UCL calculations and data distributions are provided in Tables 6-3.3a and 6-3.3b.

TABLE 6-4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: recreational
Receptor Age: adult

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	(1)	--			
Ingestion	IR-S	Ingestion rate of soil	mg/day	100	EPA, 1991			
Ingestion	CF	Conversion factor	kg/mg	0.000001				
Ingestion	EF	Exposure Frequency	days/year	52				
Ingestion	ED	Exposure Duration	years	30				
Ingestion	BW	Body Weight	kg	70	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	10,950				
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	2.0E-07	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic (2)	mg/kg-day	2.3E-07	calculated			
Dermal	CS	Chemical concentration in soil	mg/kg	(1)	--			
Dermal	SA	Skin surface area available for contact	cm2	5800	EPA, 1997			
Dermal	CF	Conversion factor	kg/mg	0.000001				
Dermal	SSAF	Soil to skin adherence factor	mg/cm2/event	0.2	EPA, 1997			
Dermal	EF	Exposure Frequency	events/year	52				
Dermal	ED	Exposure Duration	years	30				
Dermal	DABS	Dermal absorption factor (3)	--	chemical-specific	EPA, 2000			
Dermal	BW	Body Weight	kg	70	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	10,950				
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic (4)	mg/kg-day	2.4E-06	calculated			
Dermal	IF-C	Intake Factor - carcinogenic (4,5)	mg/kg-day	1.1E-06	calculated			

(1) Chemical concentrations in soil are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Tables 6-3.1 and 6-3.2.

(2) This calculation was age-adjusted using a factor of 114 mg-yr/kg-day. This age-adjusted factor accounted for ingestion rate, exposure duration and body weight in the calculation.

(3) Absorption factors for COPCs provided in EPA Region III Memorandum Assessing Dermal Exposure from Soil (EPA, 2000b).

Absorption factors are as follows; benzo(a)pyrene - 0.1; aluminum - 0.01, arsenic - 0.032, and iron - 0.01.

(4) The noncarcinogenic and carcinogenic intake factors were adjusted by the dermal absorption factor for the specific chemical.

(5) This calculation was age-adjusted using a factor of 557 mg-yr/kg-event. This age-adjusted factor accounted for surface area, adherence factor, duration and body weight in the calculation.

TABLE 6-4.2
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: recreational
Receptor Age: child

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	(1)	--			
Ingestion	IR-S	Ingestion rate of soil	mg/day	200	EPA, 1991			
Ingestion	CF	Conversion factor	kg/mg	0.000001				
Ingestion	EF	Exposure Frequency	days/year	52				
Ingestion	ED	Exposure Duration	years	6	EPA, 1991			
Ingestion	BW	Body Weight	kg	15	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	2,190	EPA, 1989			
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	1.9E-06	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic	mg/kg-day	1.6E-07	calculated			
Dermal	CS	Chemical concentration in soil	mg/kg	(1)	--			
Dermal	SA	Skin surface area available for contact	cm2	1991	EPA, 1997			
Dermal	CF	Conversion factor	kg/mg	0.000001				
Dermal	SSAF	Soil to skin adherence factor	mg/cm2/event	0.2	EPA, 1997			
Dermal	EF	Exposure Frequency	events/year	52				
Dermal	ED	Exposure Duration	years	6	EPA, 1991			
Dermal	DABS	Dermal absorption factor (2)	--	chemical-specific	EPA, 2000			
Dermal	BW	Body Weight	kg	15	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	2,190	EPA, 1989			
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic (3)	mg/kg-day	3.8E-06	calculated			
Dermal	IF-C	Intake Factor - carcinogenic (3)	mg/kg-day	3.2E-07	calculated			

(1) Chemical concentrations in soil are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Tables 6-3.1 and 6-3.2.

(2) Absorption factors for COPCs provided in EPA Region III Memorandum Assessing Dermal Exposure from Soil (EPA, 2000b).
Absorption factors are as follows; benzo(a)pyrene - 0.1; aluminum - 0.01, arsenic - 0.032, and iron - 0.01.

(3) The noncarcinogenic and carcinogenic intake factors were adjusted by the dermal absorption factor for the specific chemical.

TABLE 6-4.3
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: commercial/industrial
Receptor Age: adult

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	(1)	--			
Ingestion	IR-S	Ingestion rate of soil	mg/day	50	EPA, 1991			
Ingestion	CF	Conversion factor	kg/mg	0.000001				
Ingestion	EF	Exposure Frequency	days/year	250	EPA, 1991			
Ingestion	ED	Exposure Duration	years	25	EPA, 1991			
Ingestion	BW	Body Weight	kg	70	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	9,125	EPA, 1989			
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	4.9E-07	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic	mg/kg-day	1.7E-07	calculated			
Dermal	CS	Chemical concentration in soil	mg/kg	(1)	--			
Dermal	SA	Skin surface area available for contact	cm2	5800	EPA, 1997			
Dermal	CF	Conversion factor	kg/mg	0.000001				
Dermal	SSAF	Soil to skin adherence factor	mg/cm2/event	0.2	EPA, 1997			
Dermal	EF	Exposure Frequency	events/year	250	EPA, 1991			
Dermal	ED	Exposure Duration	years	25	EPA, 1991			
Dermal	DABS	Dermal absorption factor (2)	--	chemical-specific	EPA, 2000 (2)			
Dermal	BW	Body Weight	kg	70	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	9,125	EPA, 1989			
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic (3)	mg/kg-day	1.1E-05	calculated			
Dermal	IF-C	Intake Factor - carcinogenic (3)	mg/kg-day	4.1E-06	calculated			

(1) Chemical concentrations in soil are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Tables 6-3.1 and 6-3.2.

(2) Absorption factors for COPCs provided in EPA Region III Memorandum Assessing Dermal Exposure from Soil (EPA, 2000b).

Absorption factors are as follows; benzo(a)pyrene - 0.1; aluminum - 0.01, arsenic - 0.032, and iron - 0.01.

(3) The noncarcinogenic and carcinogenic intake factors were adjusted by the dermal absorption factor for the specific chemical.

TABLE 6-4.4
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: construction worker
Receptor Age: adult

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	(1)	--			
Ingestion	IR-S	Ingestion rate of soil	mg/day	480	EPA, 1992			
Ingestion	CF	Conversion factor	kg/mg	0.000001				
Ingestion	EF	Exposure Frequency	days/month	20				
Ingestion	ED	Exposure Duration	months	6				
Ingestion	BW	Body Weight	kg	70	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	183				
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	4.5E-06	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic	mg/kg-day	3.2E-08	calculated			
Dermal	CS	Chemical concentration in soil	mg/kg	(1)	--			
Dermal	SA	Skin surface area available for contact	cm2	5800	EPA, 1997			
Dermal	CF	Conversion factor	kg/mg	0.000001				
Dermal	SSAF	Soil to skin adherence factor	mg/cm2/event	0.3	EPA, 1997			
Dermal	EF	Exposure Frequency	events/month	20				
Dermal	ED	Exposure Duration	months	6				
Dermal	DABS	Dermal absorption factor (2)	--	chemical-specific	EPA, 2000			
Dermal	BW	Body Weight	kg	70	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	183				
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic (3)	mg/kg-day	1.6E-05	calculated			
Dermal	IF-C	Intake Factor - carcinogenic (3)	mg/kg-day	1.2E-07	calculated			

(1) Chemical concentrations in soil are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Tables 6-3.1 and 6-3.2.

(2) Absorption factors for COPCs provided in EPA Region III Memorandum Assessing Dermal Exposure from Soil (EPA, 2000b).

Absorption factors are as follows: benzo(a)pyrene - 0.1; aluminum - 0.01, arsenic - 0.032, and iron - 0.01.

(3) The noncarcinogenic and carcinogenic intake factors were adjusted by the dermal absorption factor for the specific chemical.

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VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: resident
Receptor Age: adult

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	(1)	--			
Ingestion	IR-S	Ingestion rate of soil	mg/day	100	EPA, 1991			
Ingestion	CF	Conversion factor	kg/mg	0.000001				
Ingestion	EF	Exposure Frequency	days/year	350	EPA, 1991			
Ingestion	ED	Exposure Duration	years	30				
Ingestion	BW	Body Weight	kg	70	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	10,950				
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	1.4E-06	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic (2)	mg/kg-day	1.6E-06	calculated			
Dermal	CS	Chemical concentration in soil	mg/kg	(1)	--			
Dermal	SA	Skin surface area available for contact	cm2	5800	EPA, 1997			
Dermal	CF	Conversion factor	kg/mg	0.000001				
Dermal	SSAF	Soil to skin adherence factor	mg/cm2/event	0.2	EPA, 1997			
Dermal	EF	Exposure Frequency	events/year	350	EPA, 1991			
Dermal	ED	Exposure Duration	years	30				
Dermal	DABS	Dermal absorption factor (3)	--	chemical-specific	EPA, 2000			
Dermal	BW	Body Weight	kg	70	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	10,950				
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic (4)	mg/kg-day	1.6E-05	calculated			
Dermal	IF-C	Intake Factor - carcinogenic (4,5)	mg/kg-day	7.6E-06	calculated			

(1) Chemical concentrations in soil are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Tables 6-3.1 and 6-3.2.

(2) This calculation was age-adjusted using a factor of 114 mg*yr/kg*day. This age-adjusted factor accounted for ingestion rate, exposure duration and body weight in the calculation.

(3) Absorption factors for COPCs provided in EPA Region III Memorandum Assessing Dermal Exposure from Soil (EPA, 2000b).

Absorption factors are as follows; benzo(a)pyrene - 0.1; aluminum - 0.01, arsenic - 0.032, and iron - 0.01.

(4) The noncarcinogenic and carcinogenic intake factors were adjusted by the dermal absorption factor for the specific chemical.

(5) This calculation was age-adjusted using a factor of 557 mg-yr/kg-event. This age-adjusted factor accounted for surface area, adherence factor, duration and body weight in the calculation.

TABLE 6-4.6
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: resident
Receptor Age: child

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CS	Chemical concentration in soil	mg/kg	(1)	--			
Ingestion	IR-S	Ingestion rate of soil	mg/day	200	EPA, 1991			
Ingestion	CF	Conversion factor	kg/mg	0.000001				
Ingestion	EF	Exposure Frequency	days/year	350	EPA, 1991			
Ingestion	ED	Exposure Duration	years	6	EPA, 1991			
Ingestion	BW	Body Weight	kg	15	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	2,190	EPA, 1989			
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	1.3E-05	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic	mg/kg-day	1.1E-06	calculated			
Dermal	CS	Chemical concentration in soil	mg/kg	(1)	--			
Dermal	SA	Skin surface area available for contact	cm2	1991	EPA, 1997			
Dermal	CF	Conversion factor	kg/mg	0.000001				
Dermal	SSAF	Soil to skin adherence factor	mg/cm2/event	0.2	EPA, 1997			
Dermal	EF	Exposure Frequency	events/year	350	EPA, 1991			
Dermal	ED	Exposure Duration	years	6	EPA, 1991			
Dermal	DABS	Dermal absorption factor (2)	--	chemical-specific	EPA, 2000 (2)			
Dermal	BW	Body Weight	kg	15	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	2,190	EPA, 1989			
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic (3)	mg/kg-day	2.5E-05	calculated			
Dermal	IF-C	Intake Factor - carcinogenic (3)	mg/kg-day	2.2E-06	calculated			

(1) Chemical concentrations in soil are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Tables 6-3.1 and 6-3.2.

(2) Absorption factors for COPCs provided in EPA Region III Memorandum Assessing Dermal Exposure from Soil (EPA, 2000b).
Absorption factors are as follows; benzo(a)pyrene - 0.1; aluminum - 0.01, arsenic - 0.032, and iron - 0.01.

(3) The noncarcinogenic and carcinogenic intake factors were adjusted by the dermal absorption factor for the specific chemical.

TABLE 6-4.7
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: air
Exposure Point: air volatilized from surface soil at Site 16
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CS	Chemical concentration in soil	mg/kg	(1)	–			
Inhalation	CA	Chemical concentration in air - volatiles (modeled)	mg/m3	(2)	GRI, 1988			Volatile emissions model
Inhalation	CA	Chemical concentration in air - particulates (modeled)	mg/m3	(2)	GRI, 1988; EPA, 1995			Fugitive dust estimation model
Inhalation	IR	Inhalation rate	m3/hr	2.5	EPA, 1997			
Inhalation	ET	Exposure time	hr/day	8				
Inhalation	EF	Exposure Frequency	days/month	20				
Inhalation	ED	Exposure Duration	months	6				
Inhalation	BW	Body Weight	kg	70	EPA, 1991			
Inhalation	AT-N	Averaging Time (non-cancer)	days	183				
Inhalation	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Inhalation	IF-N	Intake Factor - noncarcinogenic	m3/kg-day	1.9E-01	calculated			
Inhalation	IF-C	Intake Factor - carcinogenic	m3/kg-day	1.3E-03	calculated			

(1) Chemical concentrations in soil are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Tables 6-3.1 and 6-3.2.

(2) Calculations for volatile and particulate air concentrations are provided in Table 6-4.7a and 6-4.7b, respectively.

Table 6-4.7a - Surface Soils Site 16
Estimation of Mass Flux of Chemical per Unit Area

COMPOUND	Constant[a]	Mean Windspeed U[a] (m/hr)	Diameter of Waste Boundary Dp[b] (m)	Schmidt Gas Number Sc[a] (unitless)	Air Mass Transfer Coefficient ka (m/hr)	Vapor Pressure P[c] (atm)	Gas Constant R[a] (atm-m3/mole-°K)	Temperature of Soil Surface T[a] (°K)	Mass Flux Q/Ac (moles/m2-hr)
Benzo(a)pyrene	0.0292	16920	40	2.8	19.396	7.20E-12	8.21E-05	293	5.81E-09
Aluminum	0.0292	16920	40	#N/A	#N/A	#N/A	8.21E-05	293	#N/A
Arsenic	0.0292	16920	40	#N/A	#N/A	#N/A	8.21E-05	293	#N/A
Iron	0.0292	16920	40	#N/A	#N/A	#N/A	8.21E-05	293	#N/A

(a) Default values provided in Exposure Model Handbook for the Screening of Former Manufactured Gas Sites, 1988.
(b) Site-specific data
(c) Chemical-specific data, Syracuse Research Corporation (SRC), 1998.

Table 6-4.7a (cont.) - Site 16 Surface Soils
Estimation of Volatile Emissions from Soil Surface

COMPOUND	Soil Concentration (mg/kg)	Mass Flux Q/Ac (moles/m2-hr)	Molecular Weight[a] (g/mole)	Contaminated Area[b] (m2)	Conversion Factor (mg/g)	Conversion Factor (hr/sec)	Conversion Factor (kg/mg)	Height Hb[c] (m)	Width Wb[c] (m)	Average Wind Speed Um[c] (m/sec)	10-meter Wind Speed U10[c] (m/sec)	Modeled Air Concentration (mg/m3)
Benzo(a)pyrene	1.20E+00	5.81E-09	252.32	500	1.00E+03	2.78E-04	1.00E-06	6.2	100	2.83E+00	4.7	1.39E-13
Aluminum	6.67E+03	#N/A	#N/A	500	1.00E+03	2.78E-04	1.00E-06	6.2	100	2.83E+00	4.7	#N/A
Arsenic	1.45E+00	#N/A	#N/A	500	1.00E+03	2.78E-04	1.00E-06	6.2	100	2.83E+00	4.7	#N/A
Iron	5.77E+03	#N/A	#N/A	500	1.00E+03	2.78E-04	1.00E-06	6.2	100	2.83E+00	4.7	#N/A

(a) Chemical-specific data provided in SRC, 1998.
(b) Site-specific data
(c) Default values provided in Exposure Model Handbook for the Screening of Former Manufactured Gas Sites, 1988.

Table 6-4.7b - Site 16 Surface Soils
Emission Rates for Fugitive Dust Emissions from Construction Activities

COMPOUND	Soil Concentration (mg/kg)	Silt Content[a] (%)	Volumetric Water Content[a] (%)	Emission Rate[b] (kg/sec)	Height Hb (m)	Width Wb (m)	Average Wind Speed Um (m/sec)	10-meter Wind Speed U10[a] (m/sec)	Modeled Air Concentration (mg/m3)
Benzo(a)pyrene	1.20E+00	1.50E+01	1.50E+01	1.23E-04	6.20E+00	1.00E+02	2.83E+00	4.7	8.39E-08
Aluminum	6.67E+03	1.50E+01	1.50E+01	1.23E-04	6.20E+00	1.00E+02	2.83E+00	4.7	4.67E-04
Arsenic	1.45E+00	1.50E+01	1.50E+01	1.23E-04	6.20E+00	1.00E+02	2.83E+00	4.7	1.01E-07
Iron	5.77E+03	1.50E+01	1.50E+01	1.23E-04	6.20E+00	1.00E+02	2.83E+00	4.7	4.04E-04

(a) Default values provided in Exposure Model Handbook for the Screening of Former Manufactured Gas Sites, 1988.
(b) Derived from: Compilation of Air Pollutant Emission Factors, EPA, OAQPS, 1995.

TABLE 6-4.8
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: commercial/industrial
Receptor Age: adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical concentration in groundwater	mg/L	(1)	--			
Ingestion	IR-W	Ingestion rate of groundwater	L/day	1				
Ingestion	EF	Exposure Frequency	days/year	250				
Ingestion	ED	Exposure Duration	years	25				
Ingestion	BW	Body Weight	kg	70	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	9,125				
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989a			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	9.8E-03	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic	mg/kg-day	3.5E-03	calculated			

(1) Chemical concentrations in groundwater are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Table 6-3.3.

TABLE 6-4.9
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - excavation site
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical concentration in groundwater	mg/L	(1)	--			
Ingestion	IR-W	Ingestion rate of groundwater	L/day	0.02	VDEQ, 2000			
Ingestion	EF	Exposure Frequency	days/month	20				
Ingestion	ED	Exposure Duration	months	6				
Ingestion	BW	Body Weight	kg	70	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	183				
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	1.9E-04	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic	mg/kg-day	1.3E-06	calculated			
Dermal	DA_{event}	Absorbed Dose per Event	mg/cm2-event	chemical-specific (2)				
Dermal	CF	Conversion factor	L/cm2	0.001				
Dermal	SA	Skin surface area available for contact	cm2	5800	EPA, 1997			
Dermal	EV	Event Frequency	events/day	1				
Dermal	EF	Exposure Frequency	days/month	20				
Dermal	ED	Exposure Duration	months	6				
Dermal	BW	Body Weight	kg	70	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	183				
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic	event-cm2/kg-day	5.4E+01	calculated			
Dermal	IF-C	Intake Factor - carcinogenic	event-cm2/kg-day	3.9E-01	calculated			

(1) Chemical concentrations in groundwater are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Table 6-3.3.

(2) Absorbed Dose per Event (DA_{event}) for the COPCs is chemical-specific and has been calculated in Table 6-4.9a

TABLE 6-4.9a

Construction Worker Exposure to Groundwater at Site 16 - Calculation of Absorbed Dose per Event

Wallops Flight Facility (WFF) - Site 16

COPCs	Units	Medium EPC	Permeability Coefficient (1)	Exposure Time	tau (1)	t* (1)	B (1)		Calculation of DAevent if ET > t* (2)							Calculation of DAevent if ET < t* (2)				Calculation of DA_{event} for Inorganics
		Value	Kp (cm/hr)	ET (hours)	t (hours)	(hours)	(unitless)	Is ET < t*	1+3B	1+B	[(1+3B)/(1+B)]	2t	ET/(1+B)	$DA_{event} = K_p C_w$ [ET/(1+B) + 2t [(1+3B)/(1+B)]	$DA_{event} = K_p C_w$ [ET(1+B) +2t [(1+3B)/(1+B)]	(6tET)	[(6tET)/pi]$^{1/2}$	DAevent = $2K_pC_w$ * [(6tET)/pi]$^{1/2}$	DAevent = $2K_pC_w$ * [(6tET)/pi]$^{1/2}$	$DA_{event} = K_p$*C_w*ET
1,2-dichloroethene (total)	mg/L	8.00E-03	1.00E-02	8	0.34	0.82	0.003	no	1.009	1.003	1.005982054	0.68	7.576071785	0.000692811	6.93E-07	16.32	2.279792146	3.65E-04		
benzene	mg/L	5.80E-02	2.10E-02	8	0.26	0.63	0.013	no	1.039	1.013	1.025666338	0.52	7.69733465	0.01026857	1.03E-05					
ethylbenzene	mg/L	2.80E-01	7.40E-02	8	0.39	1.3	0.14	no	1.42	1.14	1.245614035	0.78	7.01754386	0.165534625	1.66E-04					
tetrachloroethene	mg/L	5.00E-03	4.80E-02	8	0.9	4.3	0.25	no	1.75	1.25	1.4	1.8	6.4	0.0021408	2.14E-06					
toluene	mg/L	1.40E+00	4.50E-02	8	0.32	0.77	0.054	no	1.162	1.054	1.102466793	0.64	7.590132827	0.522629829	5.23E-04					
2-chlorophenol	mg/L	9.00E-03	1.10E-02	8	0.53	1.3	0.014	no	1.042	1.014	1.027613412	1.06	7.889546351	0.000888903	8.89E-07					
2-methylnaphthalene	mg/L	2.00E-01	6.90E-02	8	0.53	2.2	0.2	no	1.6	1.2	1.333333333	1.06	6.666666667	0.111504	1.12E-04					
4-methylphenol	mg/L	4.20E-02	1.00E-02	8	0.4	0.96	0.0087	no	1.0261	1.0087	1.017249926	0.8	7.931000297	0.003672816	3.67E-06					
bis(2-ethylhexyl)phthalate	mg/L	1.60E-01	3.30E-02	8	21	100	13	yes								1008	17.91700612	1.89E-01	1.89E-04	
carbazole	mg/L	6.00E-03	7.97E-02	8	-	-	-													
dibenzofuran	mg/L	3.00E-03	1.51E-01	8	-	-	-													
naphthalene	mg/L	1.80E-01	6.90E-02	8	0.53	2.2	0.2	no	1.6	1.2	1.333333333	1.06	6.666666667	0.1003536	1.00E-04					
phenanthrene	mg/L	1.45E-02	2.30E-01	8	1.1	5.6	2.9	no	9.7	3.8	2.487179487	2.2	2.051282051	0.025069462	2.51E-05					
4,4'-DDT	mg/L	2.30E-04	4.30E-01	8	13	60	230	yes								624	14.09702503	2.78E-03	2.78E-06	
alpha-BHC	mg/L	2.90E-05	1.60E-02	8	-	-	-													
gamma-BHC (lindane)	mg/L	6.70E-05	1.40E-02	8	5.2	35	0.52	yes								249.6	8.915741464	1.67E-05	1.67E-08	
auminum	mg/L	1.09E+01	1.00E-03	8																8.72E-02
antimony	mg/L	2.94E-03	1.00E-03	8																2.35E-05
arsenic	mg/L	8.82E-02	1.00E-03	8																7.06E-04
iron	mg/L	3.56E+01	1.00E-03	8																2.85E-01
lead	mg/L	6.28E-02	4.00E-06	8																2.01E-06
manganese	mg/L	3.51E+00	1.00E-03	8																2.81E-02
thallium	mg/L	2.67E-03	1.00E-03	8																2.14E-05
vanadium	mg/L	2.31E-02	1.00E-03	8																1.85E-04

(1) Values provided in VDEQ's Voluntary Remediation Program (VRP) Guidance, 2000.

(2) Steady and non-steady state equations for the calculation of DA_{event} were provided in EPA, 1992.

TABLE 6-4.10
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: resident
Receptor Age: adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical concentration in groundwater	mg/L	(1)	--			
Ingestion	IR-W	Ingestion rate of groundwater	L/day	2				
Ingestion	EF	Exposure Frequency	days/year	350				
Ingestion	ED	Exposure Duration	years	30				
Ingestion	BW	Body Weight	kg	70	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	10,950				
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	2.7E-02	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic (2)	mg/kg-day	1.5E-02	calculated			
Dermal	DA_{event}	Absorbed Dose per Event (3)	mg/cm2-event	chemical-specific				
Dermal	SA	Skin surface area available for contact	cm2	23000	EPA, 1997			
Dermal	EV	Event Frequency	events/day	1				
Dermal	EF	Exposure Frequency	days/year	350				
Dermal	ED	Exposure Duration	years	30				
Dermal	BW	Body Weight	kg	70	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	10,950				
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic	event-cm2/kg-day	3.2E+02	calculated			
Dermal	IF-C	Intake Factor - carcinogenic (4)	event-cm2/kg-day	1.5E+02	calculated			

(1) Chemical concentrations in groundwater are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Table 6-3.3.

(2) This calculation was age-adjusted using a factor of 1.086 L-yr/day-kg. This age-adjusted factor accounted for ingestion rate, exposure duration and body weight in the calculation.

(3) Absorbed Dose per Event (DA_{event}) for the COPCs is chemical-specific and has been calculated in Table 6-4.10a

(4) This calculation was age-adjusted using a factor of 11070 cm2-yr/kg. This age-adjusted factor accounted for skin surface area, exposure duration and body weight in the calculation.

TABLE 6-4.10a

Adult/Child Resident Exposure to Groundwater at Site 16 - Calculation of Absorbed Dose per Event

Wallops Flight Facility (WFF) - Site 16

COPCs	Units	Medium EPC	Permeability Coefficient (1)	Exposure Time	tau (1)	t* (1)	B (1)		Calculation of DAevent if ET > t* (2)							Calculation of DAevent if ET < t* (2)				Calculation of DA_{event} for Inorganics
		Value	Kp (cm/hr)	ET (hours)	t (hours)	(hours)	(unitless)	Is ET < t*	1+3B	1+B	[(1+3B)/(1+B)]	2t	ET/(1+B)	$DA_{event} = K_p C_w [ET/(1+B) + 2t [(1+3B)/(1+B)]$	$DA_{event} = K_p C_w [ET/(1+B) + 2t [(1+3B)/(1+B)]$ (3)	(6tET)	$[(6tET)/p]^{1/2}$	$DAevent = 2K_p C_w * [(6tET)/p]^{1/2}$	$DAevent = 2K_p C_w * [(6tET)/p]^{1/2}$ (3)	$DA_{event} = K_p * C_w * ET$ (3)
1,2-dichloroethene (total)	mg/L	8.00E-03	1.00E-02	0.2	0.34	0.62	0.003	yes								0.408	0.360466789	5.77E-05	5.77E-08	
benzene	mg/L	5.80E-02	2.10E-02	0.2	0.26	0.63	0.013	yes								0.312	0.315219062	7.68E-04	7.68E-07	
ethylbenzene	mg/L	2.80E-01	7.40E-02	0.2	0.38	1.3	0.14	yes								0.456	0.38606293	1.60E-02	1.60E-05	
tetrachloroethene	mg/L	5.00E-03	4.80E-02	0.2	0.9	4.3	0.25	yes								1.08	0.586471691	2.82E-04	2.82E-07	
toluene	mg/L	1.40E+00	4.50E-02	0.2	0.32	0.77	0.054	yes								0.384	0.349704152	4.41E-02	4.41E-05	
2-chlorophenol	mg/L	9.00E-03	1.10E-02	0.2	0.53	1.3	0.014	yes								0.636	0.450053075	6.91E-05	6.91E-08	
2-methylnaphthalene	mg/L	2.00E-01	6.90E-02	0.2	0.53	2.2	0.2	yes								0.636	0.450053075	1.24E-02	1.24E-05	
4-methylphenol	mg/L	4.20E-02	1.00E-02	0.2	0.4	0.96	0.0087	yes								0.48	0.380981127	3.26E-04	3.26E-07	
bis(2-ethylhexyl)phthalate	mg/L	1.60E-01	3.30E-02	0.2	21	100	13	yes								25.2	2.832927409	2.99E-02	2.99E-05	
carbazole	mg/L	6.00E-03	7.97E-02	0.2	-	-	-									#VALUE!	#VALUE!	#VALUE!	#VALUE!	
dibenzofuran	mg/L	3.00E-03	1.51E-01	0.2	-	-	-									#VALUE!	#VALUE!	#VALUE!	#VALUE!	
naphthalene	mg/L	1.80E-01	6.90E-02	0.2	0.53	2.2	0.2	yes								0.636	0.450053075	1.12E-02	1.12E-05	
phenanthrene	mg/L	1.45E-02	2.30E-01	0.2	1.1	5.6	2.9	yes								1.32	0.64836885	4.32E-03	4.32E-06	
4,4'-DDT	mg/L	2.30E-04	4.30E-01	0.2	13	60	230	yes								15.6	2.228935368	4.41E-04	4.41E-07	
alpha-BHC	mg/L	2.90E-05	1.60E-02	0.2	-	-	-									#VALUE!	#VALUE!	#VALUE!	#VALUE!	
gamma-BHC (lindane)	mg/L	6.70E-05	1.40E-02	0.2	5.2	35	0.92	yes								6.24	1.409702503	2.64E-06	2.64E-09	
aluminum	mg/L	1.09E+01	1.00E-03	0.2																2.18E-06
antimony	mg/L	2.94E-03	1.00E-03	0.2																5.88E-10
arsenic	mg/L	8.82E-02	1.00E-03	0.2																1.76E-08
iron	mg/L	3.56E+01	1.00E-03	0.2																7.12E-06
lead	mg/L	6.28E-02	4.00E-06	0.2																6.02E-11
manganese	mg/L	3.51E+00	1.00E-03	0.2																7.02E-07
thallium	mg/L	2.67E-03	1.00E-03	0.2																5.34E-10
vanadium	mg/L	2.31E-02	1.00E-03	0.2																4.62E-09

(1) Values provided in VDEQ's Voluntary Remediation Program (VRP) Guidance, 2000.

(2) Steady and non-steady state equations for the calculation of DA_{event} were provided in EPA, 1992.

(3) Calculation of DAevent includes a conversion factor of 0.001 L/cm3.

TABLE 6-4.11
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: resident
Receptor Age: child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical concentration in groundwater	mg/L	(1)	--			
Ingestion	IR-W	Ingestion rate of groundwater	L/day	1				
Ingestion	EF	Exposure Frequency	days/year	350				
Ingestion	ED	Exposure Duration	years	6				
Ingestion	BW	Body Weight	kg	15	EPA, 1991			
Ingestion	AT-N	Averaging Time (non-cancer)	days	2,190				
Ingestion	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Ingestion	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	6.4E-02	calculated			
Ingestion	IF-C	Intake Factor - carcinogenic	mg/kg-day	5.5E-03	calculated			
Dermal	DA_{event}	Absorbed Dose per Event (2)	mg/cm2-event	chemical-specific				
Dermal	SA	Skin surface area available for contact	cm2	7960	EPA, 1997			
Dermal	EV	Event Frequency	events/day	1				
Dermal	EF	Exposure Frequency	days/year	350				
Dermal	ED	Exposure Duration	years	6				
Dermal	BW	Body Weight	kg	15	EPA, 1991			
Dermal	AT-N	Averaging Time (non-cancer)	days	2,190				
Dermal	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Dermal	IF-N	Intake Factor - noncarcinogenic	event-cm2/kg-day	5.1E+02	calculated			
Dermal	IF-C	Intake Factor - carcinogenic	event-cm2/kg-day	4.4E+01	calculated			

(1) Chemical concentrations in groundwater are the reasonable maximum exposure (RME) exposure point concentration (EPC) values provided in Table 6-3.3.

(2) Absorbed Dose per Event (DA_{event}) for the COPCs is chemical-specific and has been calculated in Table 6-4.10a

TABLE 6-4.12
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: water supply well - vapor from shower head
Receptor Population: resident
Receptor Age: adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Chemical concentration in air	mg-min/L-shower	(1)	--			Foster and Chrostowski, 1987
Inhalation	IR	Inhalation rate	L/min	10				
Inhalation	SF	Shower Frequency	showers/day	1				
Inhalation	EF	Exposure Frequency	days/year	350				
Inhalation	ED	Exposure Duration	years	30				
Inhalation	BW	Body Weight	kg	70	EPA, 1991			
Inhalation	AT-N	Averaging Time (non-cancer)	days	10,950				
Inhalation	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Inhalation	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	1.4E-01	calculated			
Inhalation	IF-C	Intake Factor - carcinogenic	mg/kg-day	5.9E-02	calculated			

(1) Chemical concentrations in air are based on results from the Foster and Chrostowski model (Foster and Chrostowski, 1987) provided in Table 6-4.12a.

TABLE 6-4.12a

CAS No.: 71432	Name: Benzene		
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.00555 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	14.373495 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	78 g/mol		molecular weight of VOC
k_l(VOC)	15.021352 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	1441.1534 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	19.009996 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	27.222728 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	58 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	90.742427 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)\,dt$	13510.1 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.00193 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

Benzene

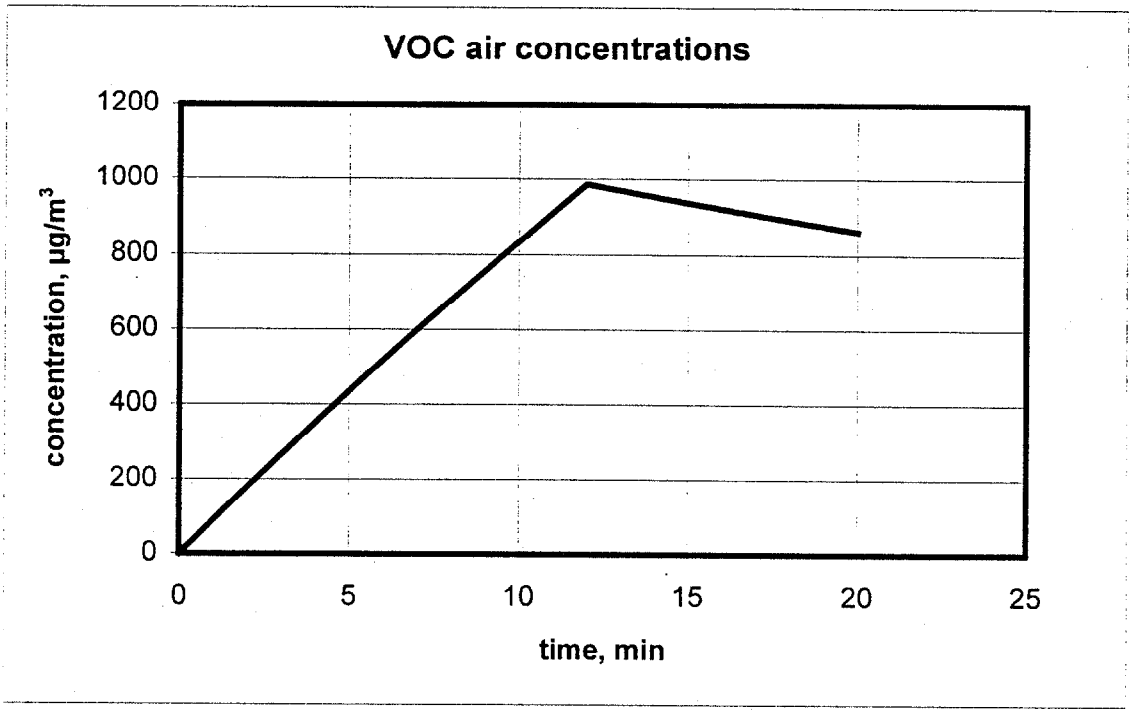


TABLE 6-4.12a

CAS No.: 95578	Name: 2-Chlorophenol		
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.000391 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	7.14E+00 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	128.56 g/mol		molecular weight of VOC
k_l(VOC)	11.700473 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	1122.5471 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	9.4370536 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	2.4290651 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	9 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	8.0968836 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)$ dt	1205.4968 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.0001722 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

2-Chlorophenol

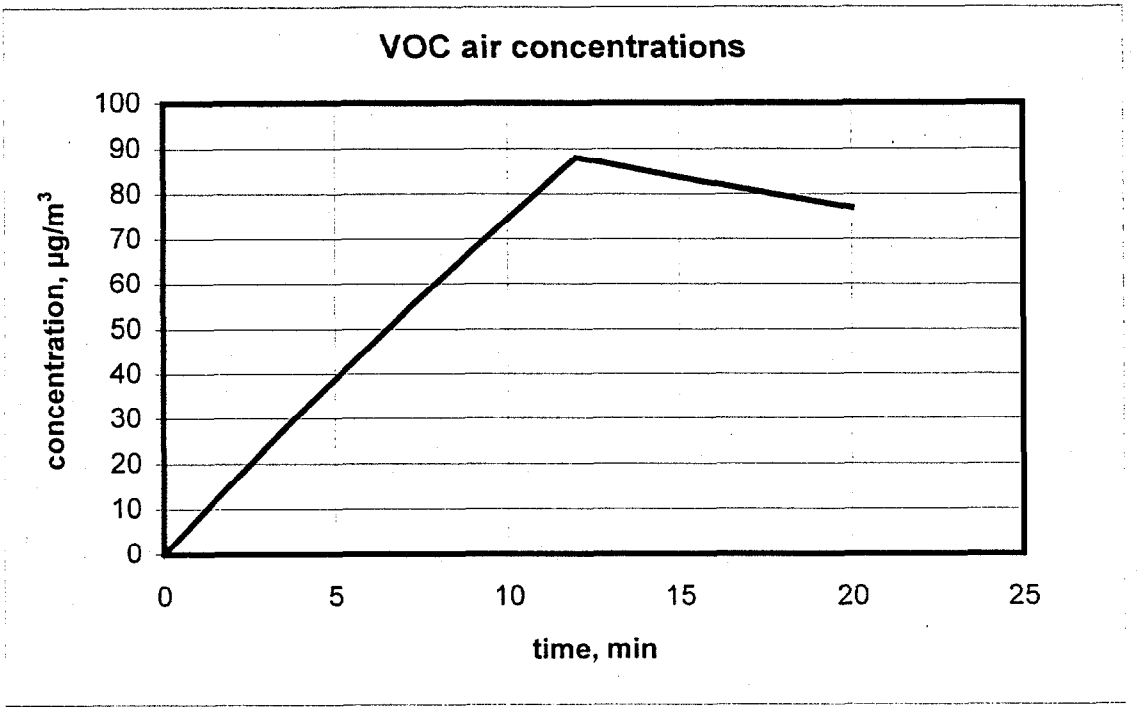


TABLE 6-4.12a

CAS No.: 127184		Name: Tetrachloroethene	
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.0184 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	1.02E+01 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	166 g/mol		molecular weight of VOC
k_l(VOC)	10.2968 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	987.87834 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	13.435607 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	1.8050088 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	5 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	6.0166959 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)\,dt$	895.79007 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.000128 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

Tetrachloroethene

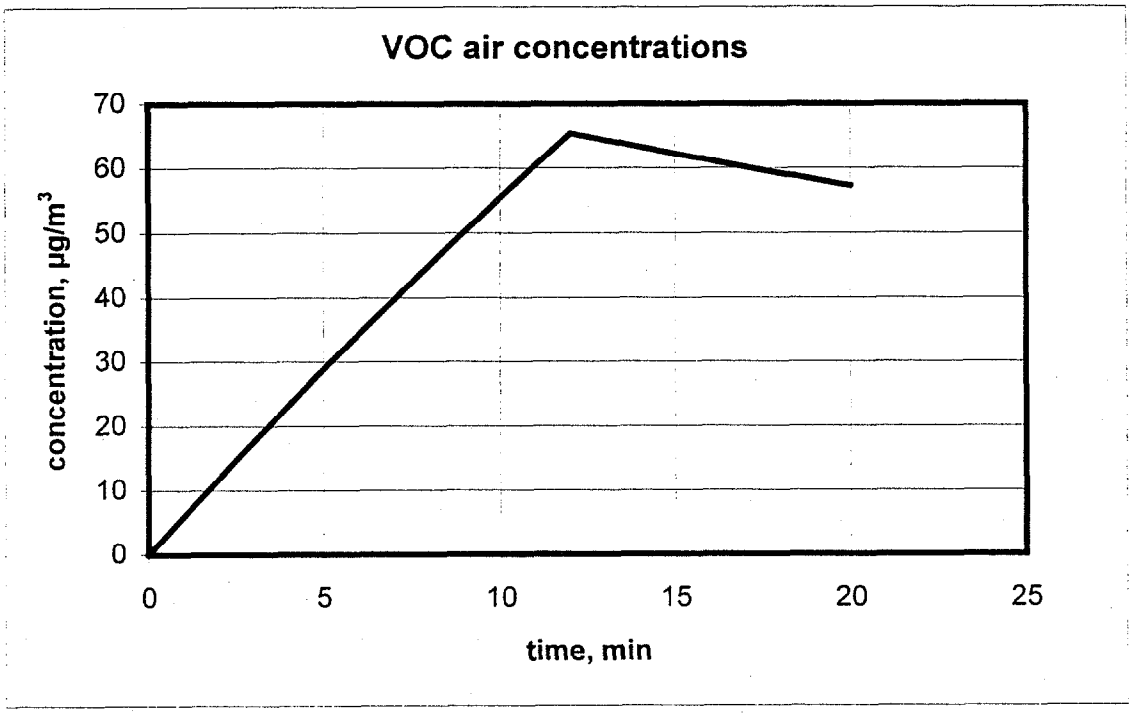


TABLE 6-4.12a

CAS No.: 132649		Name: Dibenzofuran	
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.0000126 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	4.91E-01 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	168.2 g/mol		molecular weight of VOC
k_l(VOC)	10.229239 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	981.39652 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	0.6487565 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	0.0641792 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	3 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	0.2139307 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)\,dt$	31.850865 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	4.55E-06 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

Dibenzofuran

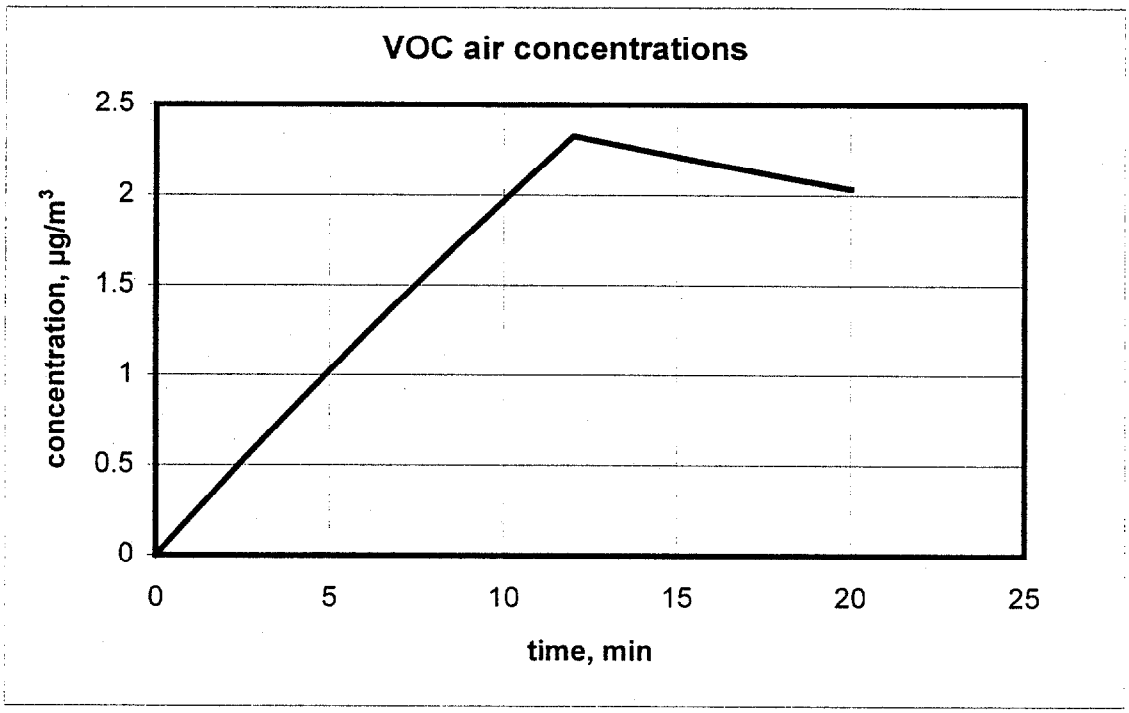


TABLE 6-4.12a

CAS No.: 100414		Name: Ethylbenzene	
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.00788 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	1.25E+01 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	106.168 g/mol		molecular weight of VOC
k_l(VOC)	12.875364 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	1235.2666 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	16.504658 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	118.47913 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	280 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	394.93044 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)\,dt$	58798.844 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.0083998 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

Ethylbenzene

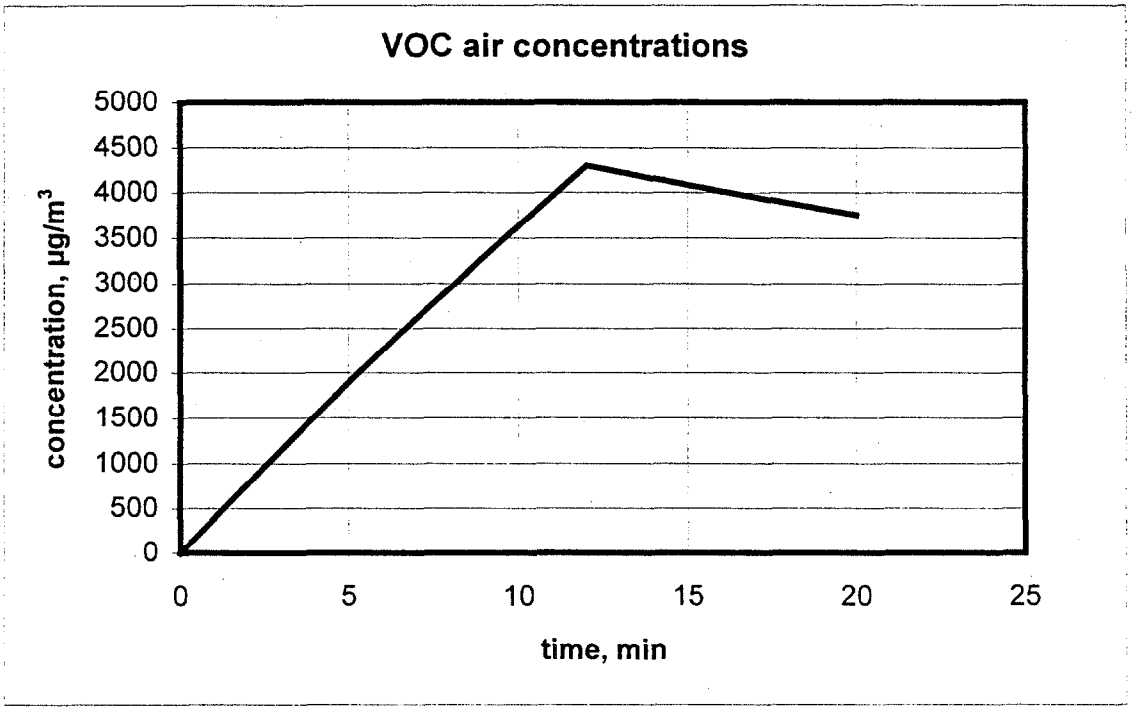


TABLE 6-4.12a

CAS No.: 91576		Name: 2-Methylnaphthalene	
k_l (CO_2)	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
k_g (H_2O)	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.000517 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	7.50E+00 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	142 g/mol		molecular weight of VOC
k_l (VOC)	11.132999 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g (VOC)	1068.1035 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	9.9229074 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	56.325002 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	200 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	187.75001 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)$ dt	27952.982 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.0039933 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

2-Methylnaphthalene

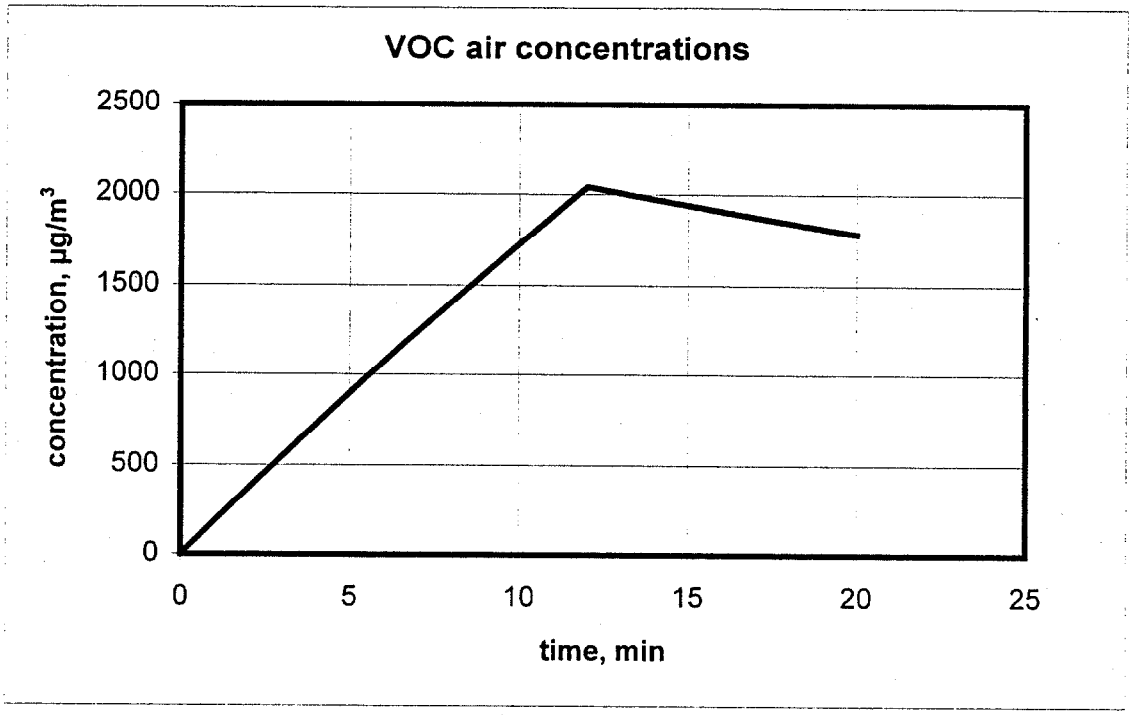


TABLE 6-4.12a

CAS No.: 540590		Name: 1,2-Dichloroethene (total)	
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.00938 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	1.31E+01 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	96.944 g/mol		molecular weight of VOC
k_l(VOC)	13.473979 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	1292.6979 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	17.357415 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	3.5144503 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{wo}	8 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	11.714834 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)\,dt$	1744.152 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.0002492 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

1,2-Dichloroethene (total)

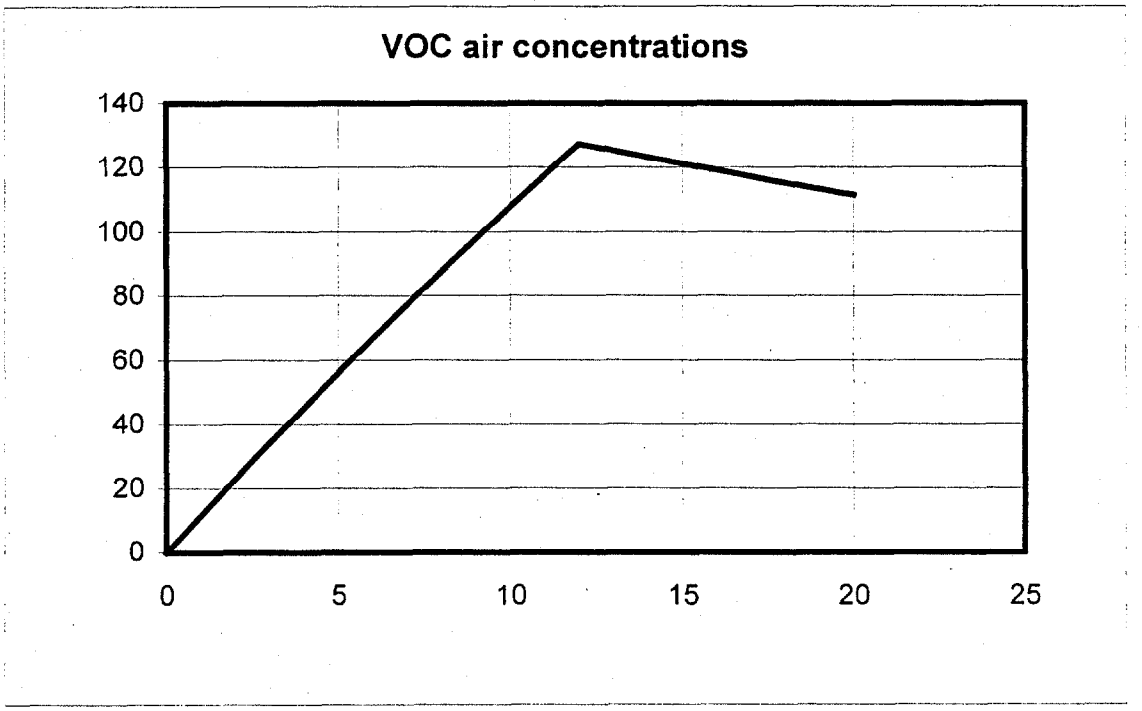


TABLE 6-4.12a

CAS No.: 91203	Name: Naphthalene		
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.000483 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	7.72E+00 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	128.18 g/mol		molecular weight of VOC
k_l(VOC)	11.717803 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	1124.2098 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	10.209791 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	51.923151 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	180 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	173.07717 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)$ dt	25768.43 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.0036812 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

Naphthalene

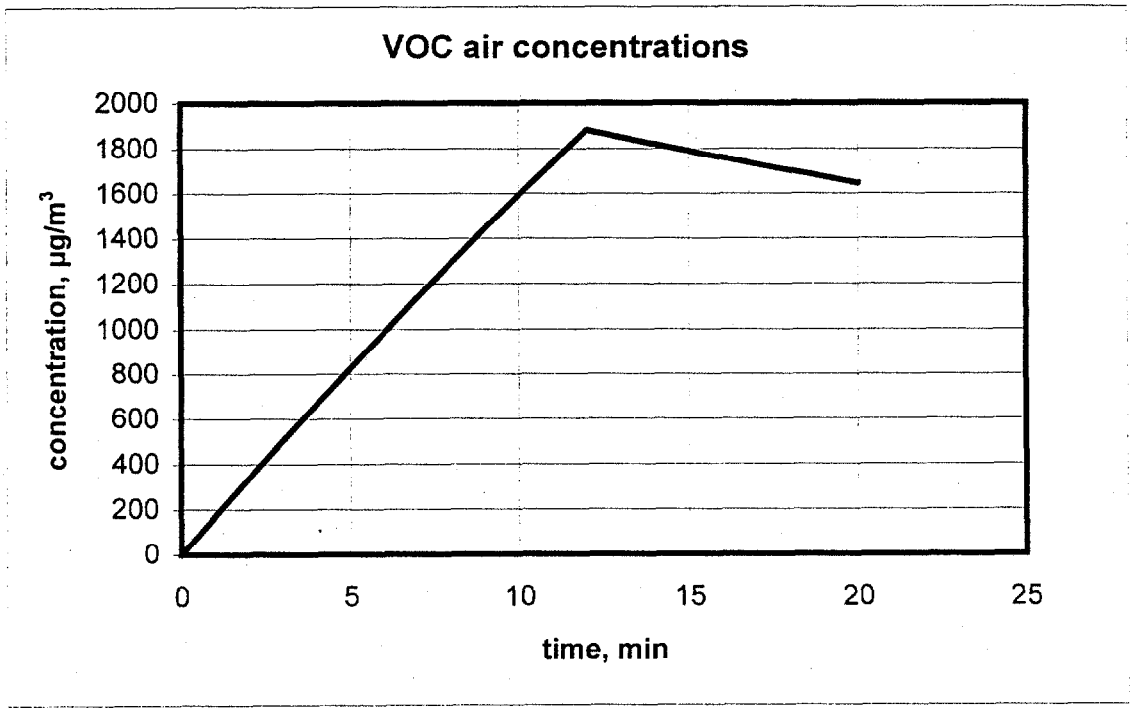


TABLE6-4.12a

CAS No.: 108883	Name: Toluene		
k_l (CO_2)	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
k_g (H_2O)	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.00664 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	1.33E+01 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	92.141 g/mol		molecular weight of VOC
k_l (VOC)	13.820695 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g (VOC)	1325.9619 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	17.61524 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	621.74608 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	1400 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	2072.4869 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)$ dt	308560.25 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	0.04408 mg/kg/shower		inhalation exposure per shower

TABLE6-4.12a

Toluene

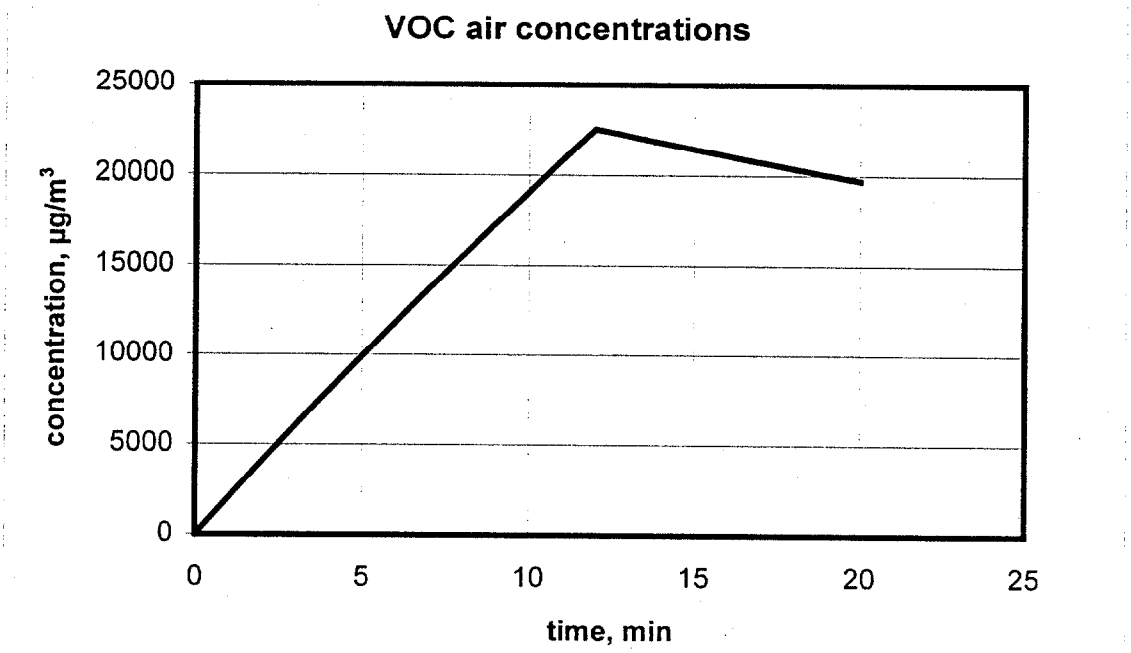


TABLE 6-4.12a

CAS No.: 106445	Name: 4-Methylphenol		
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.000001 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	5.06E-02 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	108.94 g/mol		molecular weight of VOC
k_l(VOC)	12.7105 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	1219.4495 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	0.0669329 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	0.0936016 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	42 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	0.3120053 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)$ dt	46.452614 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	6.636E-06 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

4-Methylphenol

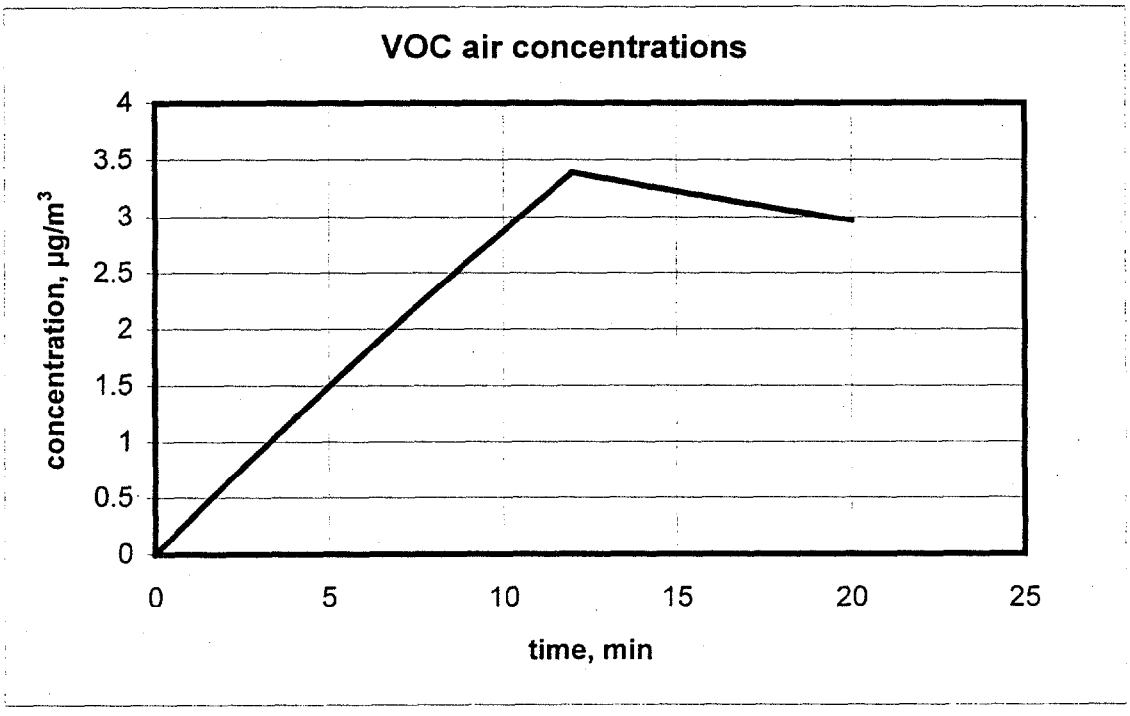


TABLE 6-4.12a

CAS No.: 117817		Name: bis(2-Ethylhexyl)phthalate	
k_l (CO_2)	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
k_g (H_2O)	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	1.02E-07 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	2.74E-03 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	390.5 g/mol		molecular weight of VOC
k_l (VOC)	6.7134509 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g (VOC)	644.09064 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	0.0036189 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	0.0192997 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	160 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	0.0643324 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)$ dt	9.5780692 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	1.368E-06 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

bis(2-Ethylhexyl)phthalate

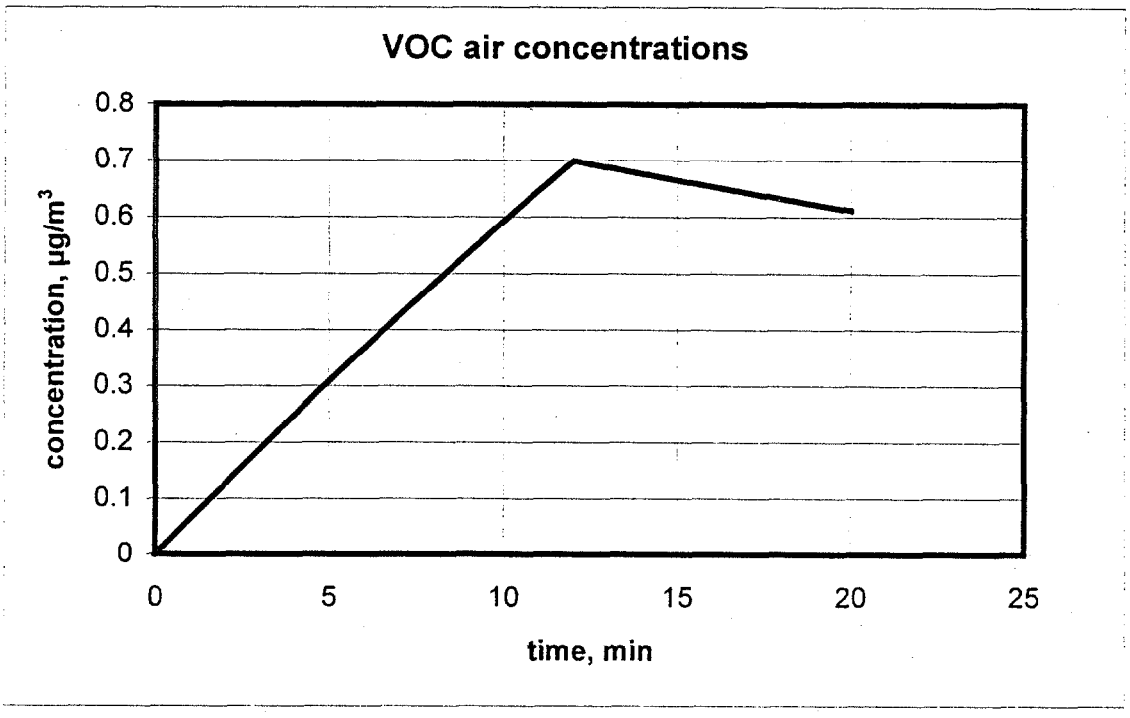


TABLE 6-4.12a

CAS No.: 86748		Name: Carbazole	
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	1.53E-08 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	6.27E-04 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	167.21 g/mol		molecular weight of VOC
k_l(VOC)	10.259477 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	984.2975 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	0.0008299 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	0.000166 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	6 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	0.0005532 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)\,dt$	0.0823665 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	1.177E-08 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

Carbazole

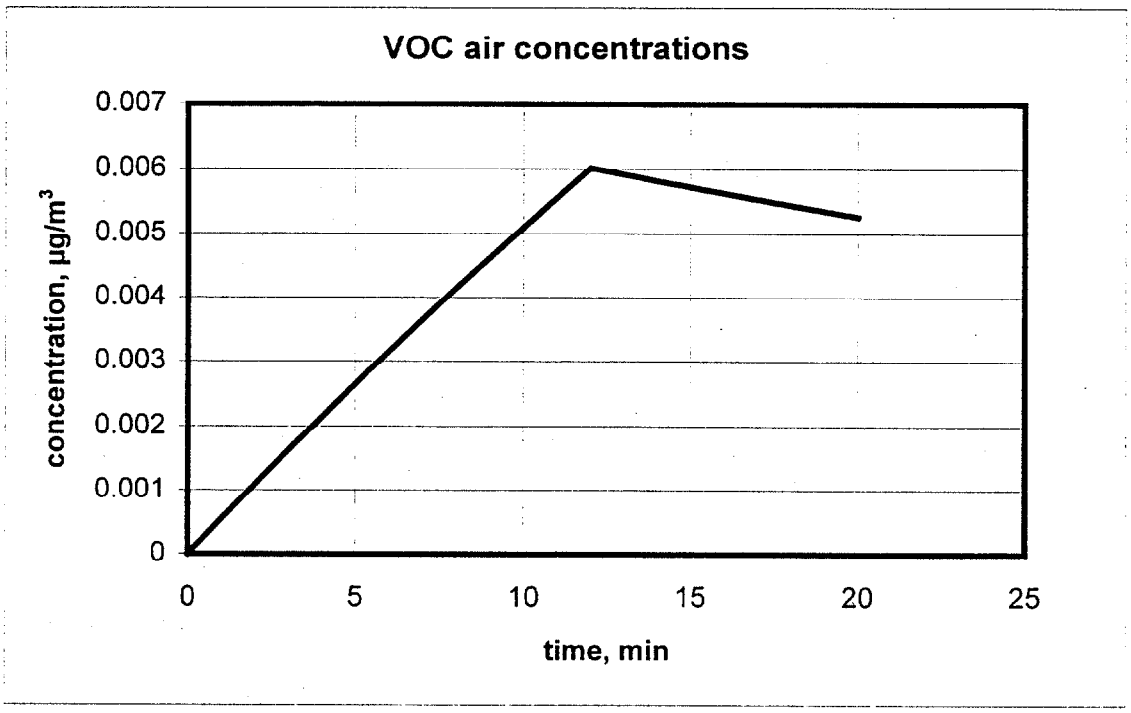


TABLE 6-4.12a

CAS No.: 85018		Name: Phenanthrene	
$k_l(CO_2)$	20 cm/hr	(est., p.3)	liquid-film mass transfer coefficient
$k_g(H_2O)$	3000 cm/hr	(est., p.3)	gas-film mass transfer coefficient
RT	2.40E-02 atm-m^3/mol	(p.3)	gas constant × temperature
H	0.000039 atm-m^3/mol-°K	(p.3)	Henry's Law constant
K_L	1.34E+00 cm/hr	(Eqn. 1, p.3)	overall mass transfer coefficient
MW_{VOC}	178.233 g/mol		molecular weight of VOC
k_l(VOC)	9.9371598 cm/hr	(Eqn. 3, p.3)	liquid-film mass transfer coefficient
k_g(VOC)	953.37432 cm/hr	(Eqn. 2, p.3)	gas-film mass transfer coefficient
K_{aL}	1.7726176 cm/hr	(Eqn. 4, p.3)	adjusted mass transfer coefficient
T_l	293 °K		calibration temperature of K_L
T_s	316 °K		shower water temperature
μ_l	1.002 cp	(lookup)	viscosity of water at T_l
μ_s	0.6178 cp	(lookup)	viscosity of water at T_s
C_{wd}	0.8319445 µg/L	(Eqn. 5, p.3)	concentration leaving droplet at time t_s
C_{w0}	14.5 µg/L		shower water VOC concentration
d	0.25 mm		shower droplet diameter
t_s	0.5 sec		shower droplet drop time
S	2.7731483 µg-m^3/min	(Eqn. 6, p.4)	VOC generation rate
FR	20 L/min		shower water flow rate
SV	6 m^3		shower room air volume
D_s	12 min		shower duration
D_t	20 min		time period to show in chart
R	0.016666 min^{-1}		air exchange rate
$C_a(t)$ dt	412.87755 µg-min/m^3		integral of concentration vs time
BW	70 kg		body weight
VR	10 l/min		ventilation rate (inhalation rate)
E_{inh}	5.898E-05 mg/kg/shower		inhalation exposure per shower

TABLE 6-4.12a

Phenanthrene

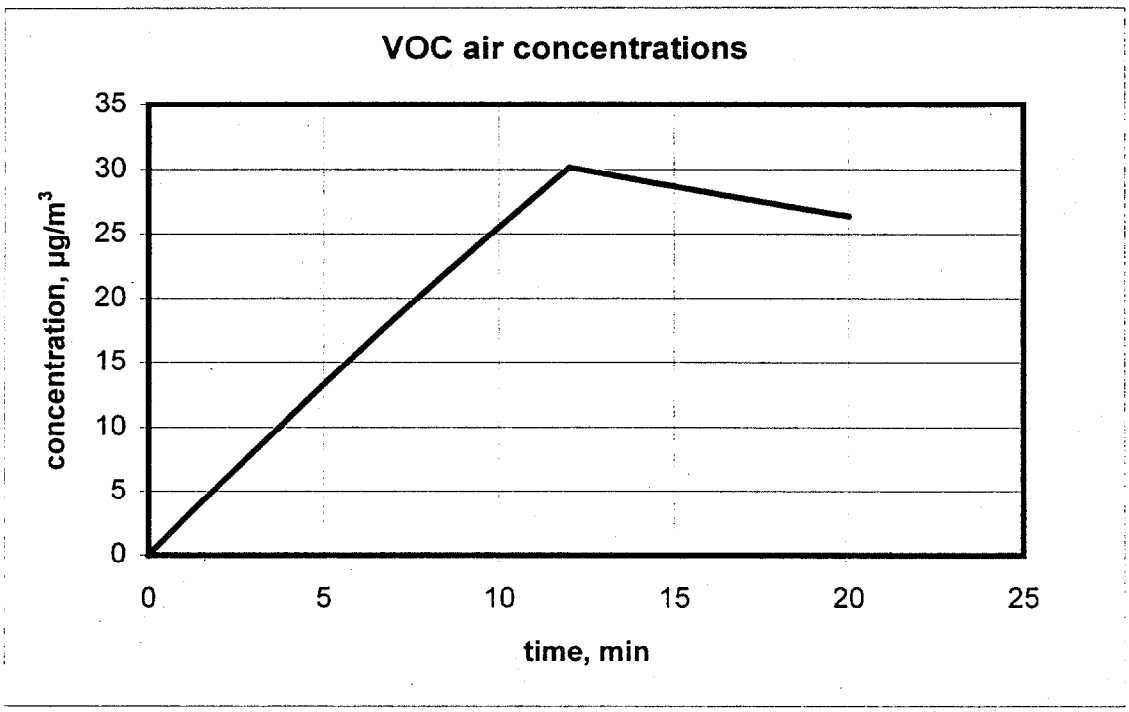


TABLE 6-4.13
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: water supply well - vapor from shower head
Receptor Population: resident
Receptor Age: child

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Chemical concentration in air	mg-min/L-shower	(1)	--			Foster and Chrostowski, 1987
Inhalation	IR	Inhalation rate	L/min	10	EPA, 1991			
Inhalation	SF	Shower Frequency	showers/day	1				
Inhalation	EF	Exposure Frequency	days/year	350				
Inhalation	ED	Exposure Duration	years	6				
Inhalation	BW	Body Weight	kg	15	EPA, 1991			
Inhalation	AT-N	Averaging Time (non-cancer)	days	2,190				
Inhalation	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Inhalation	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	6.4E-01	calculated			
Inhalation	IF-C	Intake Factor - carcinogenic	mg/kg-day	5.5E-02	calculated			

(1) Chemical concentrations in air are based on results from the Foster and Chrostowski model (Foster and Chrostowski, 1987) provided in Table 6-4.12a.

TABLE 6-4.14
VALUES USED FOR DAILY INTAKE CALCULATIONS
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: air volatilized from groundwater at excavation site
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Chemical concentration in air	mg/m3	(1)	--			VDEQ VRP Guidance, Table 3.8
Inhalation	IR-A	Inhalation rate of air	m3/hr	2.5	EPA, 1991			
Inhalation	ET	Exposure Time	hrs/day	8				
Inhalation	EF	Exposure Frequency	days/month	20				
Inhalation	ED	Exposure Duration	months	6				
Inhalation	BW	Body Weight	kg	70	EPA, 1991			
Inhalation	AT-N	Averaging Time (non-cancer)	days	183				
Inhalation	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989			
Inhalation	IF-N	Intake Factor - noncarcinogenic	mg/kg-day	1.9E-01	calculated			
Inhalation	IF-C	Intake Factor - carcinogenic	mg/kg-day	1.3E-03	calculated			

(1) Chemical concentrations in air are based on results from the model provided in Table 3.8 of the VDEQ VRP Guidance (VDEQ, 2000) shown in Table 6-4.14a.

TABLE 6-4.14a
Variables and Calculations for Construction Worker Exposure to Air in Trench

For Mass-Transfer Coefficients			For Emission Flux and Concentration in Trench			Trench dimensions		
Kg,H2O	0.833	cm/s	CF1	1.00E-03	L/cm3	Length	8	ft
MWH2O	18		CF2	1.00E+04	cm2/m2		2.44	m
Kg,O2	0.002	cm/s	CF3	3600	s/hr	Width	3	ft
MWO2	32		F	1			0.91	m
T	77	F	ACH	2	hr-1	Depth	14	ft
T	298	K					4.27	m
R	8.20E-05	atm-m3/mol-K				Width/Depth	0.21	

Table 3.8 Exposure-point concentrations (inhalation) for construction/utility workers in a trench; Groundwater less than 15 feet deep

	CAS No.	Molecular Weight MW g/mol	Henry's Law Constant H atm-m3/mol	Gas-Phase Mass Transfer Coefficient KG cm/s	Liquid-Phase Mass Transfer Coefficient KL cm/s	Overall Mass Transfer Coefficient KI cm/s	Concentration of Contaminant in Groundwater Cgw ug/L	Volatilization Factor VF L/m3	Concentration of Contaminant in Trench Ctrench ug/m3
Volatile Organic Compounds (VOCs)									
Benzene	71-43-2	78.11	5.55E-03	5.09E-01	1.28E-03	1.27E-03	5.80E+01	5.34E+00	3.10E+02
Dichloroethene-Total 1,2	540-59-0	96.94	9.38E-03	4.74E-01	1.15E-03	1.14E-03	8.00E+00	4.82E+00	3.85E+01
Ethylbenzene	100-41-4	106.17	7.88E-03	4.60E-01	1.10E-03	1.09E-03	2.80E+02	4.60E+00	1.29E+03
Tetrachloroethene	127-18-4	165.83	1.84E-02	3.96E-01	8.79E-04	8.76E-04	5.00E+00	3.70E+00	1.85E+01
Toluene	108-88-3	92.14	6.64E-03	4.82E-01	1.18E-03	1.17E-03	1.40E+03	4.93E+00	6.90E+03
Semivolatile Organic Compounds (SVOCs)									
bis-(2-Ethylhexyl)phthalate	117-81-7	390.56	1.02E-07	2.97E-01	5.72E-04	1.24E-06	1.60E+02	5.22E-03	8.35E-01
Carbazole	86-74-8	167.21	1.53E-08	3.95E-01	8.75E-04	2.47E-07	6.00E+00	1.04E-03	6.25E-03
Chlorophenol-2	95-57-8	128.56	3.91E-04	4.31E-01	9.98E-04	8.72E-04	9.00E+00	3.68E+00	3.31E+01
Dibenzofuran	132-64-9	168.19	1.26E-05	3.94E-01	8.72E-04	1.65E-04	3.00E+00	6.95E-01	2.09E+00
Methylnaphthalene-2	91-57-6	142.20	5.17E-04	4.17E-01	9.49E-04	8.57E-04	2.00E+02	3.61E+00	7.23E+02
Methylphenol-4	106-44-5	108.14	1.00E-06	4.67E-01	1.09E-03	1.84E-05	4.20E+01	7.75E-02	3.26E+00
Naphthalene	91-20-3	128.17	4.83E-04	4.32E-01	9.99E-04	8.95E-04	1.80E+02	3.77E+00	6.79E+02
Phenanthrene	85-01-8	178.23	3.90E-05	3.86E-01	8.47E-04	3.57E-04	1.45E+01	1.51E+00	2.18E+01
Pesticides/Polychlorinated Biphenyls (PCBs)									
alpha-BHC	319-84-6	290.83	1.06E-05	3.28E-01	6.63E-04	1.17E-04	2.90E-02	4.94E-01	1.43E-02
gamma-BHC	58-89-9	290.83	1.40E-05	3.28E-01	6.63E-04	1.46E-04	6.70E-02	6.18E-01	4.14E-02
DDT-4,4	50-29-3	354.48	8.10E-06	3.07E-01	6.01E-04	8.70E-05	2.30E-01	3.67E-01	8.44E-02

TABLE 6-5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

Wallops Flight Facility (WFF) - Site 16

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD	Units	Primary Target Organ (2)	Sources of RfD:	Dates of RfD:
1,2-Dichloroethene (total)	chronic/subchronic	9.00E-03	mg/kg-day	1.0E+00	9.0E-03	mg/kg-day	liver	Region III RBC, HEAST	Oct-00; Jul-97
Benzene	chronic	3.00E-03	mg/kg-day	1.0E+00	3.0E-03	mg/kg-day	blood, immune system	Region III RBC	Oct-00
Ethylbenzene	chronic	1.00E-01	mg/kg-day	9.2E-01	9.2E-02	mg/kg-day	liver, kidney	Region III RBC	Oct-00
Tetrachloroethene	chronic	1.00E-02	mg/kg-day	1.0E+00	1.0E-02	mg/kg-day	liver	Region III RBC	Oct-00
Tetrachloroethene	subchronic	1.00E-01	mg/kg-day	1.0E+00	1.0E-01	mg/kg-day	liver	HEAST	Jul-97
Toluene	chronic	2.00E-01	mg/kg-day	1.0E+00	2.0E-01	mg/kg-day	liver, kidney	Region III RBC	Oct-00
Toluene	subchronic	2.00E+00	mg/kg-day	1.0E+00	2.0E+00	mg/kg-day	liver, kidney	HEAST	Jul-97
2-Chlorophenol	chronic	5.00E-03	mg/kg-day	1.0E+00	5.0E-03	mg/kg-day	reproductive	Region III RBC	Oct-00
2-Chlorophenol	subchronic	5.00E-02	mg/kg-day	1.0E+00	5.0E-02	mg/kg-day	reproductive	HEAST	Jul-97
2-Methylnaphthalene	chronic	2.00E-02	mg/kg-day	8.0E-01	1.6E-02	mg/kg-day		Region III RBC	Oct-00
4-Methylphenol	chronic	5.00E-03	mg/kg-day	6.5E-01	3.3E-03	mg/kg-day	CNS, respiratory	Region III RBC	Oct-00
Benzo(a)pyrene		N/A		4.0E-01	N/A				
Bis(2-ethylhexyl)phthalate	chronic	2.00E-02	mg/kg-day	5.5E-01	1.1E-02	mg/kg-day	liver	Region III RBC	Oct-00
Carbazole		N/A		4.0E-01	N/A				
Dibenzofuran	chronic	4.00E-03	mg/kg-day	7.0E-01	2.8E-03	mg/kg-day		Region III RBC	Oct-00
Naphthalene	chronic	2.00E-02	mg/kg-day	8.0E-01	1.6E-02	mg/kg-day	whole body (decreased weight), kidney, thymus	Region III RBC	Oct-00
Phenanthrene (3)	chronic	3.00E-02	mg/kg-day	6.4E-01	1.9E-02	mg/kg-day	kidney	Region III RBC	Oct-00
4,4'-DDT	chronic/subchronic	5.00E-04	mg/kg-day	7.0E-01	3.5E-04	mg/kg-day	liver	Region III RBC, HEAST	Oct-00; Jul-97
Alpha-BHC		N/A		9.70E-01	N/A				
Gamma-BHC (lindane)	chronic	3.00E-04	mg/kg-day	9.9E-01	3.0E-04	mg/kg-day	liver, kidney	Region III RBC	Oct-00
Gamma-BHC (lindane)	subchronic	3.00E-03	mg/kg-day	9.9E-01	3.0E-03	mg/kg-day	liver, kidney	HEAST	Jul-97
Aluminum	chronic	1.00E+00	mg/kg-day	2.7E-01	2.7E-01	mg/kg-day	developmental nervous system	Region III RBC	Oct-00
Antimony	chronic/subchronic	4.00E-04	mg/kg-day	1.0E-01	4.0E-05	mg/kg-day	blood	Region III RBC, HEAST	Oct-00; Jul-97
Arsenic	chronic/subchronic	3.00E-04	mg/kg-day	9.5E-01	2.9E-04	mg/kg-day	skin, vascular	Region III RBC, HEAST	Oct-00; Jul-97
Iron	chronic	3.00E-01	mg/kg-day	1.0E+00	3.0E-01	mg/kg-day	blood, liver, GI tract	Region III RBC	Oct-00
Lead		N/A		2.0E-01	N/A				
Manganese	chronic	2.00E-02	mg/kg-day	3.0E-02	6.0E-04	mg/kg-day	central nervous system	Region III RBC	Oct-00
Thallium	chronic	7.00E-05	mg/kg-day	1.0E+00	7.0E-05	mg/kg-day	liver, blood, hair	Region III RBC	Oct-00
Vanadium	chronic/subchronic	7.00E-03	mg/kg-day	2.0E-02	1.4E-04	mg/kg-day	liver	Region III RBC, HEAST	Oct-00; Jul-97

N/A = Not Applicable

(1) Oral to dermal adjustment factors provided in VADEQ VRP Guidance, Table 4.1 (VADEQ, 2000)

(2) Primary target information provided in VADEQ VRP Guidance (VADEQ, 2000) and EPA's HEAST (EPA, 1997b).

(3) Toxicity data for pyrene were used as a surrogate for phenanthrene.

TABLE 6-5 2

NON-CANCER TOXICITY DATA -- INHALATION

Wallops Flight Facility (WFF) Site 16

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfD (1)	Units	Primary Target Organ (2)	Sources of RfD:	Dates
1,2-Dichloroethene (total)		N/A				
Benzene	chronic	1.70E-03	mg/kg-day	blood	Region III RBC	Oct-00
Ethylbenzene	chronic	2.90E-01	mg/kg-day	reproductive	Region III RBC	Oct-00
Tetrachloroethene	chronic	1.40E-01	mg/kg-day	liver, kidney	Region III RBC	Oct-00
Toluene	chronic	1.14E-01	mg/kg-day	nervous system	Region III RBC	Oct-00
2-Chlorophenol		N/A				
2-Methylnaphthalene		N/A				
4-Methylphenol		N/A				
Benzo(a)pyrene						
Bis(2-ethylhexyl)phthalate		N/A				
Carbazole		N/A				
Dibenzofuran		N/A				
Naphthalene	chronic	9.00E-04	mg/kg-day	respiratory tract	Region III RBC	Oct-00
Phenanthrene (3)		N/A				
4,4'-DDT		N/A				
Alpha-BHC		N/A				
Gamma-BHC (lindane)		N/A				
Aluminum	chronic	1.00E-03	mg/kg-day		Region III RBC	Oct-00
Antimony		N/A				
Arsenic		N/A				
Iron		N/A				
Lead		N/A				
Manganese	chronic	1.40E-05	mg/kg-day	central nervous system	Region III RBC	Oct-00
Thallium		N/A				
Vanadium		N/A				

N/A = Not Applicable

(1) Toxicity data provided in EPA Region III's Risk-based concentration (RBC) table (10/2000).

(2) Primary target organ information provided in VDEQ's VRp Guidance (10/2000).

TABLE 6-6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

Wallops Flight Facility (WFF) - Site 16

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description (1)	Source Target Organ	Date
1,2-Dichloroethene (total)	N/A	1.00E+00	N/A				
Benzene	5.5E-02	1.00E+00	5.5E-02	1/(mg/kg-day)	A	Region III RBC	Oct-00
Ethylbenzene	N/A	9.20E-01	N/A		D		
Tetrachloroethene	5.2E-02	1.00E+00	5.2E-02	1/(mg/kg-day)	C	Region III RBC	Oct-00
Toluene	N/A	1.00E+00	N/A		D		
2-Chlorophenol	N/A	1.00E+00	N/A				
2-Methylnaphthalene	N/A	8.00E-01	N/A				
4-Methylphenol	N/A	6.50E-01	N/A				
Benzo(a)pyrene	7.3E+00	4.00E-01	1.8E+01	1/mg/kg-day	B2	Region III RBC	Oct-00
Bis(2-ethylhexyl)phthalate	1.4E-02	5.50E-01	2.5E-02	1/mg/kg-day	B2	Region III RBC	Oct-00
Carbazole	2.0E-02	4.00E-01	5.0E-02	1/mg/kg-day		Region III RBC	Oct-00
Dibenzofuran	N/A	7.00E-01	N/A		D		
Naphthalene	N/A	8.00E-01	N/A		C		
Phenanthrene (2)	N/A	6.40E-01	N/A		D		
4,4'-DDT	3.4E-01	7.00E-01	4.9E-01	1/mg/kg-day	B2	Region III RBC	Oct-00
Alpha-BHC	6.3E+00	9.70E-01	6.5E+00	1/mg/kg-day	B2	Region III RBC	Oct-00
Gamma-BHC (lindane)	1.3E+00	9.90E-01	1.3E+00	1/mg/kg-day	C	Region III RBC	Oct-00
Aluminum	N/A	2.70E-01	N/A				
Antimony	N/A	1.00E-01	N/A				
Arsenic	1.5E+00	9.50E-01	1.6E+00	1/mg/kg-day	A	Region III RBC	Oct-00
Iron	N/A	1.00E+00	N/A				
Lead	N/A	2.00E-01	N/A				
Manganese	N/A	3.00E-02	N/A		D		
Thallium	N/A	1.00E+00	N/A		D		
Vanadium	N/A	2.00E-02	N/A				

(1) Data provided in VDEQ's VRP Guidance (10/2000) Table 4.2

(2) Oral to dermal adjustment factor for pyrene was used as a surrogate for phenanthrene

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

TABLE 6-6.2

CANCER TOXICITY DATA -- INHALATION

Wallops Flight Facility (WFF) - Site 16

Chemical of Potential Concern	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description (1)	Source	Date
1,2-Dichloroethene (total)	N/A				
Benzene	2.90E-02	1/mg/kg-day	A	Region III RBC	Oct-00
Ethylbenzene	N/A		D		
Tetrachloroethene	2.00E-03	1/mg/kg-day	C	Region III RBC	Oct-00
Toluene	N/A		D		
2-Chlorophenol	N/A				
2-Methylnaphthalene	N/A				
4-Methylphenol	N/A				
Benzo(a)pyrene	3.10E+00	1/mg/kg-day	B2	Region III RBC	Oct-00
Bis(2-ethylhexyl)phthalate	1.40E-02	1/mg/kg-day	B2	Region III RBC	Oct-00
Carbazole	N/A				
Dibenzofuran	N/A		D		
Naphthalene	N/A		C		
Phenanthrene (2)	N/A		D		
4,4'-DDT	3.40E-01	1/mg/kg-day	B2	Region III RBC	Oct-00
Alpha-BHC	6.30E+00	1/mg/kg-day	B2	Region III RBC	Oct-00
Gamma-BHC (lindane)	N/A				
Aluminum	N/A				
Antimony	N/A				
Arsenic	1.51E+01	1/mg/kg-day	A	Region III RBC	Oct-00
Iron	N/A				
Lead	N/A				
Manganese	N/A		D		
Thallium	N/A		D		
Vanadium	N/A				

(1) Weight of evidence data provided in VDEQ's VRP Guidance (2000).

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

TABLE 6-7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: recreational
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	2.0E-07	mg/kg-day					
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	2.0E-07	mg/kg-day	1.0E+00	mg/kg-day			1.4E-03
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	2.0E-07	mg/kg-day	3.0E-04	mg/kg-day			9.7E-04
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	2.0E-07	mg/kg-day	3.0E-01	mg/kg-day			3.9E-03
ingestion	**Ingestion Total**												**6.2E-03**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	2.4E-07	mg/kg-day					
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	2.4E-08	mg/kg-day	2.7E-01	mg/kg-day			5.8E-04
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	7.5E-08	mg/kg-day	2.9E-04	mg/kg-day			3.7E-04
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	2.4E-08	mg/kg-day	3.0E-01	mg/kg-day			4.5E-04
dermal	**Dermal Total**												**1.41E-03**
								Total Hazard Index Across All Exposure Routes/Pathways					**7.6E-03**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.2.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: recreational
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.9E-06	mg/kg-day					
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.9E-06	mg/kg-day	1.0E+00	mg/kg-day			1.3E-02
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.9E-06	mg/kg-day	3.0E-04	mg/kg-day			9.1E-03
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.9E-06	mg/kg-day	3.0E-01	mg/kg-day			3.7E-02
ingestion	**Ingestion Total**												**5.8E-02**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	3.8E-07	mg/kg-day					
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	3.8E-08	mg/kg-day	2.7E-01	mg/kg-day			9.3E-04
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.2E-07	mg/kg-day	2.9E-04	mg/kg-day			6.0E-04
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	3.8E-08	mg/kg-day	3.0E-01	mg/kg-day			7.3E-04
dermal	**Dermal Total**												**2.26E-03**
												Total Hazard Index Across All Exposure Routes/Pathways	**6.1E-02**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.3.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: commercial/industrial
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	4.9E-07	mg/kg-day					
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	4.9E-07	mg/kg-day	1.0E+00	mg/kg-day			3.3E-03
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	4.9E-07	mg/kg-day	3.0E-04	mg/kg-day			2.3E-03
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	4.9E-07	mg/kg-day	3.0E-01	mg/kg-day			9.4E-03
ingestion	**Ingestion Total**												**1.5E-02**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.1E-06	mg/kg-day					
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.1E-07	mg/kg-day	2.7E-01	mg/kg-day			2.8E-03
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	3.6E-07	mg/kg-day	2.9E-04	mg/kg-day			1.8E-03
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.1E-07	mg/kg-day	3.0E-01	mg/kg-day			2.2E-03
dermal	**Dermal Total**												**6.79E-03**
												Total Hazard Index Across All Exposure Routes/Pathways	**2.2E-02**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.4.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	4.5E-06	mg/kg-day					
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	4.5E-06	mg/kg-day	1.0E+00	mg/kg-day			3.0E-02
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	4.5E-06	mg/kg-day	3.0E-04	mg/kg-day			2.2E-02
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	4.5E-06	mg/kg-day	3.0E-01	mg/kg-day			8.7E-02
ingestion	**Ingestion Total**												**1.4E-01**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.6E-06	mg/kg-day					
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.6E-07	mg/kg-day	2.7E-01	mg/kg-day			4.0E-03
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	5.2E-07	mg/kg-day	2.9E-04	mg/kg-day			2.6E-03
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.6E-07	mg/kg-day	3.0E-01	mg/kg-day			3.1E-03
dermal	**Dermal Total**												**9.75E-03**
												Total Hazard Index Across All Exposure Routes/Pathways	**1.5E-01**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.5.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: air
Exposure Point: air volatilized from surface soil at Site 16
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
inhalation - particulate	benzo(a)pyrene	1.20E+00	mg/kg	8.39E-08	mg/m3	R	1.9E-01	m3/kg-day					
inhalation - particulate	aluminum	6.67E+03	mg/kg	4.67E-04	mg/m3	R	1.9E-01	m3/kg-day	1.0E-03	mg/kg-day	3.50E-03	mg/m3	8.8E-02
inhalation - particulate	arsenic	1.44E+00	mg/kg	1.01E-07	mg/m3	R	1.9E-01	m3/kg-day					
inhalation - particulate	iron	5.77E+03	mg/kg	4.04E-04	mg/m3	R	1.9E-01	m3/kg-day					
inhalation - volatile (2)	benzo(a)pyrene	1.20E+00	mg/kg	1.39E-13	mg/m3	R	1.9E-01	m3/kg-day					
								Total Hazard Index Across All Exposure Routes/Pathways					8.8E-02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Note: benzo(a)pyrene was the only COPC evaluated for the inhalation-volatile pathway.

TABLE 6-7.6.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: resident
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.4E-06	mg/kg-day					
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.4E-06	mg/kg-day	1.0E+00	mg/kg-day			9.1E-03
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.4E-06	mg/kg-day	3.0E-04	mg/kg-day			6.6E-03
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.4E-06	mg/kg-day	3.0E-01	mg/kg-day			2.6E-02
ingestion	**Ingestion Total**												**4.2E-02**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.6E-06	mg/kg-day					
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.6E-07	mg/kg-day	2.7E-01	mg/kg-day			3.9E-03
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	5.1E-07	mg/kg-day	2.9E-04	mg/kg-day			2.5E-03
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.6E-07	mg/kg-day	3.0E-01	mg/kg-day			3.1E-03
dermal	**Dermal Total**												**9.51E-03**

Total Hazard Index Across All Exposure Routes/Pathways **5.2E-02**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.7.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: resident
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.3E-05	mg/kg-day					
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.3E-05	mg/kg-day	1.0E+00	mg/kg-day			8.5E-02
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.3E-05	mg/kg-day	3.0E-04	mg/kg-day			6.1E-02
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.3E-05	mg/kg-day	3.0E-01	mg/kg-day			2.5E-01
ingestion	**Ingestion Total**												**3.9E-01**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	2.5E-06	mg/kg-day					
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	2.5E-07	mg/kg-day	2.7E-01	mg/kg-day			6.3E-03
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	8.1E-07	mg/kg-day	2.9E-04	mg/kg-day			4.0E-03
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	2.5E-07	mg/kg-day	3.0E-01	mg/kg-day			4.9E-03
dermal	**Dermal Total**												**1.52E-02**
												Total Hazard Index Across All Exposure Routes/Pathways	**4.1E-01**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.8.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: commercial/industrial
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	9.8E-03	mg/kg-day	9.0E-03	mg/kg-day			8.7E-03
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	9.8E-03	mg/kg-day	3.0E-03	mg/kg-day			1.9E-01
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	9.8E-03	mg/kg-day	1.0E-01	mg/kg-day			2.7E-02
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	9.8E-03	mg/kg-day	1.0E-02	mg/kg-day			4.9E-03
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	9.8E-03	mg/kg-day	2.0E-01	mg/kg-day			6.8E-02
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	9.8E-03	mg/kg-day	5.0E-03	mg/kg-day			1.8E-02
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	9.8E-03	mg/kg-day	2.0E-02	mg/kg-day			9.8E-02
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	9.8E-03	mg/kg-day	5.0E-03	mg/kg-day			8.2E-02
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	9.8E-03	mg/kg-day	2.0E-02	mg/kg-day			7.8E-02
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	9.8E-03	mg/kg-day	N/A	mg/kg-day			
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	9.8E-03	mg/kg-day	4.0E-03	mg/kg-day			7.3E-03
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	9.8E-03	mg/kg-day	2.0E-02	mg/kg-day			8.8E-02
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	9.8E-03	mg/kg-day	3.0E-02	mg/kg-day			4.7E-03
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	9.8E-03	mg/kg-day	5.0E-04	mg/kg-day			4.5E-03
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	9.8E-03	mg/kg-day	N/A	mg/kg-day			
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	9.8E-03	mg/kg-day	3.0E-04	mg/kg-day			2.2E-03
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	9.8E-03	mg/kg-day	1.0E+00	mg/kg-day			1.1E-01
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	9.8E-03	mg/kg-day	4.0E-04	mg/kg-day			7.2E-02
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	9.8E-03	mg/kg-day	3.0E-04	mg/kg-day			2.9E+00
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	9.8E-03	mg/kg-day	3.0E-01	mg/kg-day			1.2E+00
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	9.8E-03	mg/kg-day	N/A	mg/kg-day			
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	9.8E-03	mg/kg-day	2.0E-02	mg/kg-day			1.7E+00
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	9.8E-03	mg/kg-day	7.0E-05	mg/kg-day			3.7E-01
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	9.8E-03	mg/kg-day	7.0E-03	mg/kg-day			3.2E-02
												Total Hazard Index Across All Exposure Routes/Pathways	7.0E+00

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.9.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - excavation site
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Absorbed Dose Per Event (Dermal only)	Absorbed Dose Per Event Units (Dermal only)	Hazard Quotient
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	1.9E-04	mg/kg-day	9.0E-03	mg/kg-day			1.7E-04
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	1.9E-04	mg/kg-day	3.0E-03	mg/kg-day			3.6E-03
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	1.9E-04	mg/kg-day	1.0E-01	mg/kg-day			5.2E-04
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	1.9E-04	mg/kg-day	1.0E-01	mg/kg-day			9.4E-06
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	1.9E-04	mg/kg-day	2.0E+00	mg/kg-day			1.3E-04
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	1.9E-04	mg/kg-day	5.0E-02	mg/kg-day			3.4E-05
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	1.9E-04	mg/kg-day	2.0E-02	mg/kg-day			1.9E-03
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	1.9E-04	mg/kg-day	5.0E-03	mg/kg-day			1.6E-03
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	1.9E-04	mg/kg-day	2.0E-02	mg/kg-day			1.5E-03
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	1.9E-04	mg/kg-day	N/A	mg/kg-day			
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	1.9E-04	mg/kg-day	4.0E-03	mg/kg-day			1.4E-04
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	1.9E-04	mg/kg-day	2.0E-02	mg/kg-day			1.7E-03
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	1.9E-04	mg/kg-day	3.0E-02	mg/kg-day			9.0E-05
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	1.9E-04	mg/kg-day	5.0E-04	mg/kg-day			8.6E-05
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	1.9E-04	mg/kg-day	N/A	mg/kg-day			
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	1.9E-04	mg/kg-day	3.0E-03	mg/kg-day			4.2E-06
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	1.9E-04	mg/kg-day	1.0E+00	mg/kg-day			2.0E-03
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	1.9E-04	mg/kg-day	4.0E-04	mg/kg-day			1.4E-03
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	1.9E-04	mg/kg-day	3.0E-04	mg/kg-day			5.5E-02
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	1.9E-04	mg/kg-day	3.0E-01	mg/kg-day			2.2E-02
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	1.9E-04	mg/kg-day	N/A	mg/kg-day			
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	1.9E-04	mg/kg-day	2.0E-02	mg/kg-day			3.3E-02
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	1.9E-04	mg/kg-day	7.0E-05	mg/kg-day			7.1E-03
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	1.9E-04	mg/kg-day	7.0E-03	mg/kg-day			6.2E-04
ingestion	**TOTAL INGESTION**												**1.3E-01**
dermal	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	5.4E+01	event-cm^2/kg-day	9.0E-03	mg/kg-day	6.93E-07	mg/cm2-event	4.2E-03
dermal	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	5.4E+01	event-cm^2/kg-day	3.0E-03	mg/kg-day	1.03E-05	mg/cm2-event	1.9E-01
dermal	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	5.4E+01	event-cm^2/kg-day	9.2E-02	mg/kg-day	1.66E-04	mg/cm2-event	9.8E-02
dermal	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	5.4E+01	event-cm^2/kg-day	1.0E-01	mg/kg-day	2.14E-06	mg/cm2-event	1.2E-03
dermal	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	5.4E+01	event-cm^2/kg-day	2.0E+00	mg/kg-day	5.23E-04	mg/cm2-event	1.4E-02
dermal	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	5.4E+01	event-cm^2/kg-day	5.0E-02	mg/kg-day	8.89E-07	mg/cm2-event	9.7E-04
dermal	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	5.4E+01	event-cm^2/kg-day	1.6E-02	mg/kg-day	1.12E-04	mg/cm2-event	3.8E-01
dermal	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	5.4E+01	event-cm^2/kg-day	3.3E-03	mg/kg-day	3.67E-06	mg/cm2-event	6.1E-02
dermal	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	5.4E+01	event-cm^2/kg-day	1.1E-02	mg/kg-day	1.89E-04	mg/cm2-event	9.3E-01
dermal	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	5.4E+01	event-cm^2/kg-day		mg/kg-day		mg/cm2-event	
dermal	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	5.4E+01	event-cm^2/kg-day	2.8E-03	mg/kg-day		mg/cm2-event	0.0E+00
dermal	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	5.4E+01	event-cm^2/kg-day	1.6E-02	mg/kg-day	1.00E-04	mg/cm2-event	3.4E-01
dermal	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	5.4E+01	event-cm^2/kg-day	1.9E-02	mg/kg-day	2.51E-05	mg/cm2-event	7.1E-02
dermal	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	5.4E+01	event-cm^2/kg-day	3.5E-04	mg/kg-day	2.79E-06	mg/cm2-event	4.3E-01
dermal	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	5.4E+01	event-cm^2/kg-day		mg/kg-day		mg/cm2-event	
dermal	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	5.4E+01	event-cm^2/kg-day	3.0E-03	mg/kg-day	1.67E-08	mg/cm2-event	3.1E-04
dermal	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	5.4E+01	event-cm^2/kg-day	2.7E-01	mg/kg-day	8.72E-05	mg/cm2-event	1.8E-02
dermal	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	5.4E+01	event-cm^2/kg-day	4.0E-05	mg/kg-day	2.35E-08	mg/cm2-event	3.2E-02
dermal	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	5.4E+01	event-cm^2/kg-day	2.9E-04	mg/kg-day	7.06E-07	mg/cm2-event	1.3E-01
dermal	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	5.4E+01	event-cm^2/kg-day	3.0E-01	mg/kg-day	2.85E-04	mg/cm2-event	5.2E-02
dermal	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	5.4E+01	event-cm^2/kg-day		mg/kg-day	2.01E-09	mg/cm2-event	
dermal	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	5.4E+01	event-cm^2/kg-day	6.0E-04	mg/kg-day	2.81E-05	mg/cm2-event	2.5E+00
dermal	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	5.4E+01	event-cm^2/kg-day	7.0E-05	mg/kg-day	2.14E-08	mg/cm2-event	1.7E-02
dermal	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	5.4E+01	event-cm^2/kg-day	1.4E-04	mg/kg-day	1.85E-07	mg/cm2-event	7.2E-02
dermal	**TOTAL DERMAL**												**5.4E+00**
												Total Hazard Index Across All Exposure Routes/Pathways	**5.5E+00**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation

TABLE 6-7.10.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: air volatilized from groundwater at excavation site
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Hazard Quotient
inhalation	1,2-dichloroethene (total)	8.00E-03	mg/L	3.85E-02	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	benzene	5.80E-02	mg/L	3.10E-01	mg/m^3	R	1.9E-01	mg/kg-day	1.7E-03	mg/kg-day	3.41E+01
inhalation	ethylbenzene	2.80E-01	mg/L	1.29E+00	mg/m^3	R	1.9E-01	mg/kg-day	2.9E-01	mg/kg-day	8.32E-01
inhalation	tetrachloroethene	5.00E-03	mg/L	1.85E-02	mg/m^3	R	1.9E-01	mg/kg-day	1.4E-01	mg/kg-day	2.47E-02
inhalation	toluene	1.40E+00	mg/L	6.90E+00	mg/m^3	R	1.9E-01	mg/kg-day	1.1E-01	mg/kg-day	1.13E+01
inhalation	2-chlorophenol	9.00E-03	mg/L	3.31E-02	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	2-methylnaphthalene	2.00E-01	mg/L	7.23E-01	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	4-methylphenol	4.20E-02	mg/L	3.26E-03	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	8.35E-04	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	carbazole	6.00E-03	mg/L	6.25E-06	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	dibenzofuran	3.00E-03	mg/L	2.09E-03	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	naphthalene	1.80E-01	mg/L	6.79E-01	mg/m^3	R	1.9E-01	mg/kg-day	9.0E-04	mg/kg-day	1.41E+02
inhalation	phenanthrene	1.45E-02	mg/L	2.18E-02	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	4,4'-DDT	2.30E-04	mg/L	8.44E-05	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	alpha-BHC	2.90E-05	mg/L	1.43E-05	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	gamma-BHC (lindane)	6.70E-05	mg/L	4.14E-05	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	aluminum	1.09E+01	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	1.0E-03	mg/kg-day	0.00E+00
inhalation	antimony	2.94E-03	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	arsenic	8.82E-02	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	iron	3.56E+01	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	lead	6.28E-02	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	manganese	3.51E+00	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	1.4E-05	mg/kg-day	0.00E+00
inhalation	thallium	2.67E-03	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
inhalation	vanadium	2.31E-02	mg/L	0.00E+00	mg/m^3	R	1.9E-01	mg/kg-day	N/A		
											1.87E+02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7 11.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: resident
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Absorbed Dose Per Event (Dermal only)	Absorbed Dose Per Event Units (Dermal only)	Hazard Quotient
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	2.7E-02	mg/kg-day	9.0E-03	mg/kg-day			2.4E-02
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	2.7E-02	mg/kg-day	3.0E-03	mg/kg-day			5.3E-01
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	2.7E-02	mg/kg-day	1.0E-01	mg/kg-day			7.7E-02
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	2.7E-02	mg/kg-day	1.0E-02	mg/kg-day			1.4E-02
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	2.7E-02	mg/kg-day	2.0E-01	mg/kg-day			1.9E-01
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	2.7E-02	mg/kg-day	5.0E-03	mg/kg-day			4.9E-02
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	2.7E-02	mg/kg-day	2.0E-02	mg/kg-day			2.7E-01
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	2.7E-02	mg/kg-day	5.0E-03	mg/kg-day			2.3E-01
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	2.7E-02	mg/kg-day	2.0E-02	mg/kg-day			2.2E-01
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	2.7E-02	mg/kg-day	N/A				
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	2.7E-02	mg/kg-day	4.0E-03	mg/kg-day			2.1E-02
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	2.7E-02	mg/kg-day	2.0E-02	mg/kg-day			2.5E-01
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	2.7E-02	mg/kg-day	3.0E-02	mg/kg-day			1.3E-02
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	2.7E-02	mg/kg-day	5.0E-04	mg/kg-day			1.3E-02
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	2.7E-02	mg/kg-day	N/A				
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	2.7E-02	mg/kg-day	3.0E-04	mg/kg-day			6.1E-03
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	2.7E-02	mg/kg-day	1.0E+00	mg/kg-day			3.0E-01
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	2.7E-02	mg/kg-day	4.0E-04	mg/kg-day			2.0E-01
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	2.7E-02	mg/kg-day	3.0E-04	mg/kg-day			8.1E+00
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	2.7E-02	mg/kg-day	3.0E-01	mg/kg-day			3.3E+00
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	2.7E-02	mg/kg-day	N/A				
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	2.7E-02	mg/kg-day	2.0E-02	mg/kg-day			4.8E+00
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	2.7E-02	mg/kg-day	7.0E-05	mg/kg-day			1.0E+00
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	2.7E-02	mg/kg-day	7.0E-03	mg/kg-day			9.0E-02
ingestion	**Ingestion Total**												**2.0E+01**
dermal	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	3.2E+02	event-cm^2/kg-day	9.0E-03	mg/kg-day	5.77E-08	mg/cm^2-event	2.0E-03
dermal	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	3.2E+02	event-cm^2/kg-day	3.0E-03	mg/kg-day	7.68E-07	mg/cm^2-event	8.1E-02
dermal	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	3.2E+02	event-cm^2/kg-day	9.2E-02	mg/kg-day	1.60E-05	mg/cm^2-event	5.5E-02
dermal	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	3.2E+02	event-cm^2/kg-day	1.0E-02	mg/kg-day	2.82E-07	mg/cm^2-event	8.9E-03
dermal	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	3.2E+02	event-cm^2/kg-day	2.0E-01	mg/kg-day	4.41E-05	mg/cm^2-event	6.9E-02
dermal	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	3.2E+02	event-cm^2/kg-day	5.0E-03	mg/kg-day	8.91E-08	mg/cm^2-event	5.6E-03
dermal	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	3.2E+02	event-cm^2/kg-day	1.6E-02	mg/kg-day	1.24E-05	mg/cm^2-event	2.4E-01
dermal	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	3.2E+02	event-cm^2/kg-day	3.3E-03	mg/kg-day	3.28E-07	mg/cm^2-event	3.2E-02
dermal	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	3.2E+02	event-cm^2/kg-day	1.1E-02	mg/kg-day	2.99E-05	mg/cm^2-event	8.6E-01
dermal	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	3.2E+02	event-cm^2/kg-day					
dermal	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	3.2E+02	event-cm^2/kg-day	2.8E-03	mg/kg-day			
dermal	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	3.2E+02	event-cm^2/kg-day	1.6E-02	mg/kg-day	1.12E-05	mg/cm^2-event	2.2E-01
dermal	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	3.2E+02	event-cm^2/kg-day	1.9E-02	mg/kg-day	4.32E-06	mg/cm^2-event	7.1E-02
dermal	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	3.2E+02	event-cm^2/kg-day	3.5E-04	mg/kg-day	4.41E-07	mg/cm^2-event	4.0E-01
dermal	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	3.2E+02	event-cm^2/kg-day					
dermal	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	3.2E+02	event-cm^2/kg-day	3.0E-04	mg/kg-day	2.64E-09	mg/cm^2-event	2.8E-03
dermal	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	3.2E+02	event-cm^2/kg-day	2.7E-01	mg/kg-day	2.18E-06	mg/cm^2-event	2.5E-03
dermal	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	3.2E+02	event-cm^2/kg-day	4.0E-05	mg/kg-day	5.88E-10	mg/cm^2-event	4.6E-03
dermal	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	3.2E+02	event-cm^2/kg-day	2.9E-04	mg/kg-day	1.76E-08	mg/cm^2-event	1.9E-02
dermal	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	3.2E+02	event-cm^2/kg-day	3.0E-01	mg/kg-day	7.12E-06	mg/cm^2-event	7.5E-03
dermal	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	3.2E+02	event-cm^2/kg-day			5.02E-11	mg/cm^2-event	
dermal	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	3.2E+02	event-cm^2/kg-day	6.0E-04	mg/kg-day	7.02E-07	mg/cm^2-event	3.7E-01
dermal	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	3.2E+02	event-cm^2/kg-day	7.0E-05	mg/kg-day	5.34E-10	mg/cm^2-event	2.4E-03
dermal	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	3.2E+02	event-cm^2/kg-day	1.4E-04	mg/kg-day	4.62E-09	mg/cm^2-event	1.0E-02
dermal	**Dermal Total**												**2.5E+00**
												Total Hazard Index Across All Exposure Routes/Pathways	**2.2E+01**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.12.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: water supply well - vapor from shower head
Receptor Population: resident
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Hazard Quotient
inhalation - volatile	1,2-dichloroethene (total)	8.00E-03	mg/L	1.74E-03	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	benzene	5.80E-02	mg/L	1.35E-02	mg-min/L-shower	R	1.4E-01	mg/kg-day	1.7E-03	mg/kg-day	1.09E+00
inhalation - volatile	ethylbenzene	2.80E-01	mg/L	5.88E-02	mg-min/L-shower	R	1.4E-01	mg/kg-day	2.9E-01	mg/kg-day	2.78E-02
inhalation - volatile	tetrachloroethene	5.00E-03	mg/L	8.96E-04	mg-min/L-shower	R	1.4E-01	mg/kg-day	1.4E-01	mg/kg-day	8.77E-04
inhalation - volatile	toluene	1.40E+00	mg/L	3.09E-01	mg-min/L-shower	R	1.4E-01	mg/kg-day	1.1E-01	mg/kg-day	3.71E-01
inhalation - volatile	2-chlorophenol	9.00E-03	mg/L	1.21E-03	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	2-methylnaphthalene	2.00E-01	mg/L	2.80E-02	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	4-methylphenol	4.20E-02	mg/L	4.65E-05	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	9.58E-06	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	carbazole	6.00E-03	mg/L	8.24E-08	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	dibenzofuran	3.00E-03	mg/L	3.19E-05	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	naphthalene	1.80E-01	mg/L	2.58E-02	mg-min/L-shower	R	1.4E-01	mg/kg-day	9.0E-04	mg/kg-day	3.93E+00
inhalation - volatile	phenanthrene	1.45E-02	mg/L	4.13E-04	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	4,4'-DDT	2.30E-04	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	alpha-BHC	2.90E-05	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	gamma-BHC (lindane)	6.70E-05	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	aluminum	1.09E+01	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	1.0E-03	mg/kg-day	
inhalation - volatile	antimony	2.94E-03	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	arsenic	8.82E-02	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	iron	3.56E+01	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	lead	6.28E-02	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	manganese	3.51E+00	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	1.4E-05	mg/kg-day	
inhalation - volatile	thallium	2.67E-03	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation - volatile	vanadium	2.31E-02	mg/L	N/A	mg-min/L-shower	R	1.4E-01	mg/kg-day	N/A	mg/kg-day	
											5.42E+00

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.13.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: resident
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Absorbed Dose Per Event (Dermal only)	Absorbed Dose Per Event Units (Dermal only)	Hazard Quotient
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	6.4E-02	mg/kg-day	9.0E-03	mg/kg-day			5.7E-02
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	6.4E-02	mg/kg-day	3.0E-03	mg/kg-day			1.2E+00
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	6.4E-02	mg/kg-day	1.0E-01	mg/kg-day			1.8E-01
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	6.4E-02	mg/kg-day	1.0E-02	mg/kg-day			3.2E-02
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	6.4E-02	mg/kg-day	2.0E-01	mg/kg-day			4.5E-01
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	6.4E-02	mg/kg-day	5.0E-03	mg/kg-day			1.2E-01
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	6.4E-02	mg/kg-day	2.0E-02	mg/kg-day			6.4E-01
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	6.4E-02	mg/kg-day	5.0E-03	mg/kg-day			5.4E-01
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	6.4E-02	mg/kg-day	2.0E-02	mg/kg-day			5.1E-01
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	6.4E-02	mg/kg-day	N/A				
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	6.4E-02	mg/kg-day	4.0E-03	mg/kg-day			4.8E-02
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	6.4E-02	mg/kg-day	2.0E-02	mg/kg-day			5.8E-01
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	6.4E-02	mg/kg-day	3.0E-02	mg/kg-day			3.1E-02
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	6.4E-02	mg/kg-day	5.0E-04	mg/kg-day			2.9E-02
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	6.4E-02	mg/kg-day	N/A				
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	6.4E-02	mg/kg-day	3.0E-04	mg/kg-day			1.4E-02
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	6.4E-02	mg/kg-day	1.0E+00	mg/kg-day			7.0E-01
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	6.4E-02	mg/kg-day	4.0E-04	mg/kg-day			4.7E-01
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	6.4E-02	mg/kg-day	3.0E-04	mg/kg-day			1.9E+01
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	6.4E-02	mg/kg-day	3.0E-01	mg/kg-day			7.6E+00
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	6.4E-02	mg/kg-day	N/A				
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	6.4E-02	mg/kg-day	2.0E-02	mg/kg-day			1.1E+01
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	6.4E-02	mg/kg-day	7.0E-05	mg/kg-day			2.4E+00
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	6.4E-02	mg/kg-day	7.0E-03	mg/kg-day			2.1E-01
ingestion	**Ingestion Total**												**4.6E+01**
dermal	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	5.1E+02	event-cm^2/kg-day	9.0E-03	mg/kg-day	5.77E-08	mg/cm^2-event	3.3E-03
dermal	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	5.1E+02	event-cm^2/kg-day	3.0E-03	mg/kg-day	7.68E-07	mg/cm^2-event	1.3E-01
dermal	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	5.1E+02	event-cm^2/kg-day	9.2E-02	mg/kg-day	1.60E-05	mg/cm^2-event	8.9E-02
dermal	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	5.1E+02	event-cm^2/kg-day	1.0E-02	mg/kg-day	2.82E-07	mg/cm^2-event	1.4E-02
dermal	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	5.1E+02	event-cm^2/kg-day	2.0E-01	mg/kg-day	4.41E-05	mg/cm^2-event	1.1E-01
dermal	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	5.1E+02	event-cm^2/kg-day	5.0E-03	mg/kg-day	8.91E-08	mg/cm^2-event	9.1E-03
dermal	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	5.1E+02	event-cm^2/kg-day	1.6E-02	mg/kg-day	1.24E-05	mg/cm^2-event	3.9E-01
dermal	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	5.1E+02	event-cm^2/kg-day	3.3E-03	mg/kg-day	3.28E-07	mg/cm^2-event	5.1E-02
dermal	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	5.1E+02	event-cm^2/kg-day	1.1E-02	mg/kg-day	2.99E-05	mg/cm^2-event	1.4E+00
dermal	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	5.1E+02	event-cm^2/kg-day					
dermal	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	5.1E+02	event-cm^2/kg-day	2.8E-03	mg/kg-day			
dermal	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	5.1E+02	event-cm^2/kg-day	1.6E-02	mg/kg-day	1.12E-05	mg/cm^2-event	3.6E-01
dermal	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	5.1E+02	event-cm^2/kg-day	1.9E-02	mg/kg-day	4.32E-06	mg/cm^2-event	1.1E-01
dermal	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	5.1E+02	event-cm^2/kg-day	3.5E-04	mg/kg-day	4.41E-07	mg/cm^2-event	6.4E-01
dermal	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	5.1E+02	event-cm^2/kg-day					
dermal	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	5.1E+02	event-cm^2/kg-day	3.0E-04	mg/kg-day	2.64E-09	mg/cm^2-event	4.5E-03
dermal	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	5.1E+02	event-cm^2/kg-day	2.7E-01	mg/kg-day	2.18E-06	mg/cm^2-event	4.1E-03
dermal	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	5.1E+02	event-cm^2/kg-day	4.0E-05	mg/kg-day	5.88E-10	mg/cm^2-event	7.5E-03
dermal	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	5.1E+02	event-cm^2/kg-day	2.9E-04	mg/kg-day	1.76E-08	mg/cm^2-event	3.1E-02
dermal	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	5.1E+02	event-cm^2/kg-day	3.0E-01	mg/kg-day	7.12E-06	mg/cm^2-event	1.2E-02
dermal	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	5.1E+02	event-cm^2/kg-day			5.02E-11	mg/cm^2-event	
dermal	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	5.1E+02	event-cm^2/kg-day	6.0E-04	mg/kg-day	7.02E-07	mg/cm^2-event	6.0E-01
dermal	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	5.1E+02	event-cm^2/kg-day	7.0E-05	mg/kg-day	5.34E-10	mg/cm^2-event	3.9E-03
dermal	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	5.1E+02	event-cm^2/kg-day	1.4E-04	mg/kg-day	4.62E-09	mg/cm^2-event	1.7E-02
dermal	**Dermal Total**												**4.0E+00**
												Total Hazard Index Across All Exposure Routes/Pathways	**5.0E+01**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-7.14.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: water supply well - vapor from shower head
Receptor Population: resident
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Hazard Quotient
inhalation-volatile	1,2-dichloroethene (total)	8.00E-03	mg/L	1.74E-03	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	benzene	5.80E-02	mg/L	1.35E-02	mg-min/L-shower	R	6.4E-01	mg/kg-day	1.7E-03	mg/kg-day	5.08E+00
inhalation-volatile	ethylbenzene	2.80E-01	mg/L	5.88E-02	mg-min/L-shower	R	6.4E-01	mg/kg-day	2.9E-01	mg/kg-day	1.30E-01
inhalation-volatile	tetrachloroethene	5.00E-03	mg/L	8.96E-04	mg-min/L-shower	R	6.4E-01	mg/kg-day	1.4E-01	mg/kg-day	4.09E-03
inhalation-volatile	toluene	1.40E+00	mg/L	3.09E-01	mg-min/L-shower	R	6.4E-01	mg/kg-day	1.1E-01	mg/kg-day	1.73E+00
inhalation-volatile	2-chlorophenol	9.00E-03	mg/L	1.21E-03	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	2-methylnaphthalene	2.00E-01	mg/L	2.80E-02	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	4-methylphenol	4.20E-02	mg/L	4.65E-05	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	9.58E-06	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	carbazole	6.00E-03	mg/L	8.24E-08	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	dibenzofuran	3.00E-03	mg/L	3.19E-05	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	naphthalene	1.80E-01	mg/L	2.58E-02	mg-min/L-shower	R	6.4E-01	mg/kg-day	9.0E-04	mg/kg-day	1.83E+01
inhalation-volatile	phenanthrene	1.45E-02	mg/L	4.13E-04	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	4,4'-DDT	2.30E-04	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	alpha-BHC	2.90E-05	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	gamma-BHC (lindane)	6.70E-05	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	aluminum	1.09E+01	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	1.0E-03	mg/kg-day	
inhalation-volatile	antimony	2.94E-03	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	arsenic	8.82E-02	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	iron	3.56E+01	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	lead	6.28E-02	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	manganese	3.51E+00	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	1.4E-05	mg/kg-day	
inhalation-volatile	thallium	2.67E-03	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
inhalation-volatile	vanadium	2.31E-02	mg/L	N/A	mg-min/L-shower	R	6.4E-01	mg/kg-day	N/A	mg/kg-day	
											2.53E+01

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

TABLE 6-8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: recreational
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	2.3E-07	mg/kg-day	7.3E+00	1/(mg/kg-day)	2.0E-06
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	2.3E-07	mg/kg-day			
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	2.3E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	5.0E-07
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	2.3E-07	mg/kg-day			
ingestion	**Ingestion Total**										**2.5E-06**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.1E-07	mg/kg-day	1.8E+01	1/(mg/kg-day)	2.4E-06
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.1E-08	mg/kg-day			
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	3.6E-08	mg/kg-day	1.6E+00	1/(mg/kg-day)	8.3E-08
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.1E-08	mg/kg-day			
dermal	**Dermal Total**										**2.5E-06**
										Total Risk Across All Exposure Routes/Pathways	**5.1E-06**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.2.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: recreational
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.6E-07	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.4E-06
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.6E-07	mg/kg-day			
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.6E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	3.5E-07
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.6E-07	mg/kg-day			
ingestion	**Ingestion Total**										**1.8E-06**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	3.2E-08	mg/kg-day	1.8E+01	1/(mg/kg-day)	7.0E-07
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	3.2E-09	mg/kg-day			
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.0E-08	mg/kg-day	1.6E+00	1/(mg/kg-day)	2.4E-08
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	3.2E-09	mg/kg-day			
dermal	**Dermal Total**										**7.2E-07**
										Total Risk Across All Exposure Routes/Pathways	**2.5E-06**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.3.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: current/future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: commercial/industrial
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.7E-07	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.5E-06
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.7E-07	mg/kg-day			
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.7E-07	mg/kg-day	1.5E+00	1/(mg/kg-day)	3.8E-07
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.7E-07	mg/kg-day			
ingestion	**Ingestion Total**										**1.9E-06**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	4.1E-07	mg/kg-day	1.8E+01	1/(mg/kg-day)	8.7E-06
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	4.1E-08	mg/kg-day			
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.3E-07	mg/kg-day	1.6E+00	1/(mg/kg-day)	3.0E-07
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	4.1E-08	mg/kg-day			
dermal	**Dermal Total**										**9.0E-06**
										Total Risk Across All Exposure Routes/Pathways	**1.1E-05**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.4.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	3.2E-08	mg/kg-day	7.3E+00	1/(mg/kg-day)	2.8E-07
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	3.2E-08	mg/kg-day			
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	3.2E-08	mg/kg-day	1.5E+00	1/(mg/kg-day)	6.9E-08
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	3.2E-08	mg/kg-day			
ingestion	**Ingestion Total**										**3.5E-07**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.2E-08	mg/kg-day	1.8E+01	1/(mg/kg-day)	2.5E-07
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.2E-09	mg/kg-day			
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	3.7E-09	mg/kg-day	1.6E+00	1/(mg/kg-day)	8.5E-09
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.2E-09	mg/kg-day			
dermal	**Dermal Total**										**2.6E-07**
										Total Risk Across All Exposure Routes/Pathways	**6.1E-07**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.5.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: air
Exposure Point: air volatilized from surface soil at Site 16
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
inhalation - particulate	benzo(a)pyrene	1.20E+00	mg/kg	8.39E-08	mg/m3	R	1.3E-03	m3/kg-day	3.1E+00	1/(mg/kg-day)	3.5E-10
inhalation - particulate	aluminum	6.67E+03	mg/kg	4.67E-04	mg/m3	R	1.3E-03	m3/kg-day			
inhalation - particulate	arsenic	1.44E+00	mg/kg	1.01E-07	mg/m3	R	1.3E-03	m3/kg-day	1.5E+01	1/(mg/kg-day)	2.0E-09
inhalation - particulate	iron	5.77E+03	mg/kg	4.04E-04	mg/m3	R	1.3E-03	m3/kg-day			
inhalation - volatile	benzo(a)pyrene (2)	1.20E+00	mg/kg	1.39E-13	mg/m3	R	1.3E-03	m3/kg-day	3.1E+00	1/(mg/kg-day)	5.8E-16
										Total Risk Across All Exposure Routes/Pathways	**2.4E-09**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

(2) Note: benzo(a)pyrene was the only COPC evaluated for the inhalation-volatile pathway.

TABLE 6-8.6.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: resident
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.6E-06	mg/kg-day	7.3E+00	1/(mg/kg-day)	1.4E-05
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.6E-06	mg/kg-day			
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.6E-06	mg/kg-day	1.5E+00	1/(mg/kg-day)	3.4E-06
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.6E-06	mg/kg-day			
ingestion	**Ingestion Total**										**1.7E-05**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	7.6E-07	mg/kg-day	1.8E+01	1/(mg/kg-day)	1.6E-05
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	7.6E-08	mg/kg-day			
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	2.4E-07	mg/kg-day	1.6E+00	1/(mg/kg-day)	5.6E-07
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	7.6E-08	mg/kg-day			
dermal	**Dermal Total**										**1.7E-05**
										Total Risk Across All Exposure Routes/Pathways	**3.4E-05**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.7.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: soil
Exposure Medium: surface soil
Exposure Point: surface soil at Site 16
Receptor Population: resident
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
ingestion	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	1.1E-06	mg/kg-day	7.3E+00	1/(mg/kg-day)	9.6E-06
ingestion	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	1.1E-06	mg/kg-day			
ingestion	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	1.1E-06	mg/kg-day	1.5E+00	1/(mg/kg-day)	2.4E-06
ingestion	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	1.1E-06	mg/kg-day			
ingestion	**Ingestion Total**										**1.2E-05**
dermal	benzo(a)pyrene	1.20E+00	mg/kg	1.20E+00	mg/kg	M	2.2E-07	mg/kg-day	1.8E+01	1/(mg/kg-day)	4.7E-06
dermal	aluminum	6.67E+03	mg/kg	6.67E+03	mg/kg	M	2.2E-08	mg/kg-day			
dermal	arsenic	1.44E+00	mg/kg	1.44E+00	mg/kg	M	7.0E-08	mg/kg-day	1.6E+00	1/(mg/kg-day)	1.6E-07
dermal	iron	5.77E+03	mg/kg	5.77E+03	mg/kg	M	2.2E-08	mg/kg-day			
dermal	**Dermal Total**										**4.9E-06**
										Total Risk Across All Exposure Routes/Pathways	**1.7E-05**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.8.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: commercial/industrial
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	3.49E-03	mg/kg-day	5.5E-02	1/(mg/kg-day)	1.11E-05
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	3.49E-03	mg/kg-day	5.2E-02	1/(mg/kg-day)	9.07E-07
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	3.49E-03	mg/kg-day	1.4E-02	1/(mg/kg-day)	7.82E-06
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	3.49E-03	mg/kg-day	2.0E-02	1/(mg/kg-day)	4.19E-07
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	3.49E-03	mg/kg-day	3.4E-01	1/(mg/kg-day)	2.73E-07
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	3.49E-03	mg/kg-day	6.3E+00	1/(mg/kg-day)	6.38E-07
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	3.49E-03	mg/kg-day	1.3E+00	1/(mg/kg-day)	3.04E-07
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	3.49E-03	mg/kg-day	1.5E+00	1/(mg/kg-day)	4.62E-04
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	3.49E-03	mg/kg-day	N/A	1/(mg/kg-day)	
										Total Risk Across All Exposure Routes/Pathways	**4.83E-04**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.9.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - excavation site
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Absorbed Dose Per Event (Dermal only)	Absorbed Dose Per Event Units (Dermal only)	Cancer Risk
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	1.34E-06	mg/kg-day	5.5E-02	1/(mg/kg-day)			4.27E-09
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	1.34E-06	mg/kg-day	5.2E-02	1/(mg/kg-day)			3.48E-10
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	1.34E-06	mg/kg-day	1.4E-02	1/(mg/kg-day)			3.00E-09
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	1.34E-06	mg/kg-day	2.0E-02	1/(mg/kg-day)			1.61E-10
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	1.34E-06	mg/kg-day	3.4E-01	1/(mg/kg-day)			1.05E-10
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	1.34E-06	mg/kg-day	6.3E+00	1/(mg/kg-day)			2.45E-10
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	1.34E-06	mg/kg-day	1.3E+00	1/(mg/kg-day)			1.17E-10
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	1.34E-06	mg/kg-day	1.5E+00	1/(mg/kg-day)			1.77E-07
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	1.34E-06	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	**Ingestion Total**												**1.86E-07**
dermal	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	6.93E-07	mg/cm2-event	
dermal	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	3.89E-01	event-cm^2/kg-day	5.5E-02	1/(mg/kg-day)	1.03E-05	mg/cm2-event	2.20E-07
dermal	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.66E-04	mg/cm2-event	
dermal	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	3.89E-01	event-cm^2/kg-day	5.2E-02	1/(mg/kg-day)	2.14E-06	mg/cm2-event	4.33E-08
dermal	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.23E-04	mg/cm2-event	
dermal	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	8.89E-07	mg/cm2-event	
dermal	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.12E-04	mg/cm2-event	
dermal	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	3.67E-06	mg/cm2-event	
dermal	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	3.89E-01	event-cm^2/kg-day	2.5E-02	1/(mg/kg-day)	1.89E-04	mg/cm2-event	1.87E-06
dermal	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	3.89E-01	event-cm^2/kg-day	5.0E-02	1/(mg/kg-day)		mg/cm2-event	
dermal	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)		mg/cm2-event	
dermal	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.00E-04	mg/cm2-event	
dermal	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.51E-05	mg/cm2-event	
dermal	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	3.89E-01	event-cm^2/kg-day	4.9E-01	1/(mg/kg-day)	2.79E-06	mg/cm2-event	5.27E-07
dermal	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	3.89E-01	event-cm^2/kg-day	6.5E+00	1/(mg/kg-day)		mg/cm2-event	
dermal	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	3.89E-01	event-cm^2/kg-day	1.3E+00	1/(mg/kg-day)	1.67E-08	mg/cm2-event	8.53E-09
dermal	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	8.72E-05	mg/cm2-event	
dermal	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.35E-08	mg/cm2-event	
dermal	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	3.89E-01	event-cm^2/kg-day	1.6E+00	1/(mg/kg-day)	7.06E-07	mg/cm2-event	4.34E-07
dermal	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.85E-04	mg/cm2-event	
dermal	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.01E-09	mg/cm2-event	
dermal	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.81E-05	mg/cm2-event	
dermal	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.14E-08	mg/cm2-event	
dermal	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	3.89E-01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.85E-07	mg/cm2-event	
dermal	**Dermal Total**												**3.10E-06**
										Total Risk Across All Exposure Routes/Pathways			**3.29E-06**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.10.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: air volatilized from groundwater at excavation site
Receptor Population: construction worker
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
inhalation - volatile	1,2-dichloroethene (total)	8.00E-03	mg/L	3.85E-02	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	benzene	5.80E-02	mg/L	3.10E-01	mg/m3	R	1.34E-03	mg/kg-day	2.9E-02	1/(mg/kg-day)	1.20E-05
inhalation - volatile	ethylbenzene	2.80E-01	mg/L	1.29E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	tetrachloroethene	5.00E-03	mg/L	1.85E-02	mg/m3	R	1.34E-03	mg/kg-day	2.0E-03	1/(mg/kg-day)	4.96E-08
inhalation - volatile	toluene	1.40E+00	mg/L	6.90E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	2-chlorophenol	9.00E-03	mg/L	3.31E-02	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	2-methylnaphthalene	2.00E-01	mg/L	7.23E-01	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	4-methylphenol	4.20E-02	mg/L	3.26E-03	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	8.35E-04	mg/m3	R	1.34E-03	mg/kg-day	1.4E-02	1/(mg/kg-day)	1.57E-08
inhalation - volatile	carbazole	6.00E-03	mg/L	6.25E-06	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	dibenzofuran	3.00E-03	mg/L	2.09E-03	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	naphthalene	1.80E-01	mg/L	6.79E-01	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	phenanthrene	1.45E-02	mg/L	2.18E-02	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	4,4'-DDT	2.30E-04	mg/L	8.44E-05	mg/m3	R	1.34E-03	mg/kg-day	3.4E-01	1/(mg/kg-day)	3.85E-08
inhalation - volatile	alpha-BHC	2.90E-05	mg/L	1.43E-05	mg/m3	R	1.34E-03	mg/kg-day	6.3E+00	1/(mg/kg-day)	1.21E-07
inhalation - volatile	gamma-BHC (lindane)	6.70E-05	mg/L	4.14E-05	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	aluminum	1.09E+01	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	antimony	2.94E-03	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	arsenic	8.82E-02	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	1.5E+01	1/(mg/kg-day)	
inhalation - volatile	iron	3.56E+01	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	lead	6.28E-02	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	manganese	3.51E+00	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	thallium	2.67E-03	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	vanadium	2.31E-02	mg/L	0.00E+00	mg/m3	R	1.34E-03	mg/kg-day	N/A	1/(mg/kg-day)	
										Total Risk Across All Exposure Routes/Pathways	**1.23E-05**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.11.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: resident
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Absorbed Dose Per Event (Dermal only)	Absorbed Dose Per Event Units (Dermal only)	Cancer Risk
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	1.49E-02	mg/kg-day	5.5E-02	1/(mg/kg-day)			4.75E-05
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	1.49E-02	mg/kg-day	5.2E-02	1/(mg/kg-day)			3.87E-06
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	1.49E-02	mg/kg-day	1.4E-02	1/(mg/kg-day)			3.34E-05
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	1.49E-02	mg/kg-day	2.0E-02	1/(mg/kg-day)			1.79E-06
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	1.49E-02	mg/kg-day	3.4E-01	1/(mg/kg-day)			1.17E-06
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	1.49E-02	mg/kg-day	6.3E+00	1/(mg/kg-day)			2.72E-06
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	1.49E-02	mg/kg-day	1.3E+00	1/(mg/kg-day)			1.30E-06
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	1.49E-02	mg/kg-day	1.5E+00	1/(mg/kg-day)			1.97E-03
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	1.49E-02	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	**Ingestion Total**												**2.08E-03**
dermal	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.77E-08	mg/cm2-event	
dermal	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	1.52E+02	event-cm^2/kg-day	5.5E-02	1/(mg/kg-day)	7.68E-07	mg/cm2-event	6.40E-06
dermal	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.60E-05	mg/cm2-event	
dermal	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	1.52E+02	event-cm^2/kg-day	5.2E-02	1/(mg/kg-day)	2.82E-07	mg/cm2-event	2.22E-06
dermal	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	4.41E-05	mg/cm2-event	
dermal	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	8.91E-08	mg/cm2-event	
dermal	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.24E-05	mg/cm2-event	
dermal	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	3.28E-07	mg/cm2-event	
dermal	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	1.52E+02	event-cm^2/kg-day	2.5E-02	1/(mg/kg-day)	2.99E-05	mg/cm2-event	1.15E-04
dermal	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	1.52E+02	event-cm^2/kg-day	5.0E-02	1/(mg/kg-day)			
dermal	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)			
dermal	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.12E-05	mg/cm2-event	
dermal	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	4.32E-06	mg/cm2-event	
dermal	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	1.52E+02	event-cm^2/kg-day	4.9E-01	1/(mg/kg-day)	4.41E-07	mg/cm2-event	3.25E-05
dermal	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	1.52E+02	event-cm^2/kg-day	6.5E+00	1/(mg/kg-day)			
dermal	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	1.52E+02	event-cm^2/kg-day	1.3E+00	1/(mg/kg-day)	2.64E-09	mg/cm2-event	5.26E-07
dermal	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.18E-06	mg/cm2-event	
dermal	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.88E-10	mg/cm2-event	
dermal	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	1.52E+02	event-cm^2/kg-day	1.6E+00	1/(mg/kg-day)	1.76E-08	mg/cm2-event	4.21E-06
dermal	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	7.12E-06	mg/cm2-event	
dermal	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.02E-11	mg/cm2-event	
dermal	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	7.02E-07	mg/cm2-event	
dermal	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.34E-10	mg/cm2-event	
dermal	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	1.52E+02	event-cm^2/kg-day	N/A	1/(mg/kg-day)	4.62E-09	mg/cm2-event	
dermal	**Dermal Total**												**1.61E-04**
										Total Risk Across All Exposure Routes/Pathways			**2.22E-03**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation

TABLE 6-8.12.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: water supply well - vapor from shower head
Receptor Population: resident
Receptor Age: adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
inhalation - volatile	1,2-dichloroethene (total)	8.00E-03	mg/L	1.74E-03	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	benzene	5.80E-02	mg/L	1.35E-02	mg-min/L-shower	R	5.87E-02	mg/kg-day	2.9E-02	1/(mg/kg-day)	2.30E-05
inhalation - volatile	ethylbenzene	2.80E-01	mg/L	5.88E-02	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	tetrachloroethene	5.00E-03	mg/L	8.96E-04	mg-min/L-shower	R	5.87E-02	mg/kg-day	2.0E-03	1/(mg/kg-day)	1.05E-07
inhalation - volatile	toluene	1.40E+00	mg/L	3.09E-01	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	2-chlorophenol	9.00E-03	mg/L	1.21E-03	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	2-methylnaphthalene	2.00E-01	mg/L	2.80E-02	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	4-methylphenol	4.20E-02	mg/L	4.65E-05	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	9.58E-06	mg-min/L-shower	R	5.87E-02	mg/kg-day	1.4E-02	1/(mg/kg-day)	7.87E-09
inhalation - volatile	carbazole	6.00E-03	mg/L	8.24E-08	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	dibenzofuran	3.00E-03	mg/L	3.19E-05	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	naphthalene	1.80E-01	mg/L	2.58E-02	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	phenanthrene	1.45E-02	mg/L	4.13E-04	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	4,4'-DDT	2.30E-04	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	3.4E-01	1/(mg/kg-day)	
inhalation - volatile	alpha-BHC	2.90E-05	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	6.3E+00	1/(mg/kg-day)	
inhalation - volatile	gamma-BHC (lindane)	6.70E-05	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	aluminum	1.09E+01	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	antimony	2.94E-03	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	arsenic	8.82E-02	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	1.5E+01	1/(mg/kg-day)	
inhalation - volatile	iron	3.56E+01	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	lead	6.28E-02	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	manganese	3.51E+00	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	thallium	2.67E-03	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	vanadium	2.31E-02	mg/L	N/A	mg-min/L-shower	R	5.87E-02	mg/kg-day	N/A	1/(mg/kg-day)	
										Total Risk Across All Exposure Routes/Pathways	**2.31E-05**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.13.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: groundwater
Exposure Point: Site 16 groundwater - water supply well
Receptor Population: resident
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Absorbed Dose Per Event (Dermal only)	Absorbed Dose Per Event Units (Dermal only)	Cancer Risk
ingestion	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	5.48E-03	mg/kg-day	5.5E-02	1/(mg/kg-day)			1.75E-05
ingestion	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	5.48E-03	mg/kg-day	5.2E-02	1/(mg/kg-day)			1.42E-06
ingestion	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	5.48E-03	mg/kg-day	1.4E-02	1/(mg/kg-day)			1.23E-05
ingestion	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	5.48E-03	mg/kg-day	2.0E-02	1/(mg/kg-day)			6.68E-07
ingestion	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	5.48E-03	mg/kg-day	3.4E-01	1/(mg/kg-day)			4.29E-07
ingestion	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	5.48E-03	mg/kg-day	6.3E+00	1/(mg/kg-day)			1.00E-06
ingestion	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	5.48E-03	mg/kg-day	1.3E+00	1/(mg/kg-day)			4.77E-07
ingestion	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	5.48E-03	mg/kg-day	1.5E+00	1/(mg/kg-day)			7.25E-04
ingestion	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	5.48E-03	mg/kg-day	N/A	1/(mg/kg-day)			
ingestion	**Ingestion Total**												**7.59E-04**
dermal	1,2-dichloroethene (total)	8.00E-03	mg/L	8.00E-03	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.77E-08	mg/cm2-event	
dermal	benzene	5.80E-02	mg/L	5.80E-02	mg/L	M	4.36E+01	event-cm^2/kg-day	5.5E-02	1/(mg/kg-day)	7.68E-07	mg/cm2-event	1.84E-06
dermal	ethylbenzene	2.80E-01	mg/L	2.80E-01	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.60E-05	mg/cm2-event	
dermal	tetrachloroethene	5.00E-03	mg/L	5.00E-03	mg/L	M	4.36E+01	event-cm^2/kg-day	5.2E-02	1/(mg/kg-day)	2.82E-07	mg/cm2-event	6.39E-07
dermal	toluene	1.40E+00	mg/L	1.40E+00	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	4.41E-05	mg/cm2-event	
dermal	2-chlorophenol	9.00E-03	mg/L	9.00E-03	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	8.91E-08	mg/cm2-event	
dermal	2-methylnaphthalene	2.00E-01	mg/L	2.00E-01	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.24E-05	mg/cm2-event	
dermal	4-methylphenol	4.20E-02	mg/L	4.20E-02	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	3.28E-07	mg/cm2-event	
dermal	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	1.60E-01	mg/L	M	4.36E+01	event-cm^2/kg-day	2.5E-02	1/(mg/kg-day)	2.99E-05	mg/cm2-event	3.32E-05
dermal	carbazole	6.00E-03	mg/L	6.00E-03	mg/L	M	4.36E+01	event-cm^2/kg-day	5.0E-02	1/(mg/kg-day)			
dermal	dibenzofuran	3.00E-03	mg/L	3.00E-03	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)			
dermal	naphthalene	1.80E-01	mg/L	1.80E-01	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	1.12E-05	mg/cm2-event	
dermal	phenanthrene	1.45E-02	mg/L	1.45E-02	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	4.32E-06	mg/cm2-event	
dermal	4,4'-DDT	2.30E-04	mg/L	2.30E-04	mg/L	M	4.36E+01	event-cm^2/kg-day	4.9E-01	1/(mg/kg-day)	4.41E-07	mg/cm2-event	9.34E-06
dermal	alpha-BHC	2.90E-05	mg/L	2.90E-05	mg/L	M	4.36E+01	event-cm^2/kg-day	6.5E+00	1/(mg/kg-day)			
dermal	gamma-BHC (lindane)	6.70E-05	mg/L	6.70E-05	mg/L	M	4.36E+01	event-cm^2/kg-day	1.3E+00	1/(mg/kg-day)	2.64E-09	mg/cm2-event	1.51E-07
dermal	aluminum	1.09E+01	mg/L	1.09E+01	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	2.18E-06	mg/cm2-event	
dermal	antimony	2.94E-03	mg/L	2.94E-03	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.88E-10	mg/cm2-event	
dermal	arsenic	8.82E-02	mg/L	8.82E-02	mg/L	M	4.36E+01	event-cm^2/kg-day	1.6E+00	1/(mg/kg-day)	1.76E-08	mg/cm2-event	1.21E-06
dermal	iron	3.56E+01	mg/L	3.56E+01	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	7.12E-06	mg/cm2-event	
dermal	lead	6.28E-02	mg/L	6.28E-02	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.02E-11	mg/cm2-event	
dermal	manganese	3.51E+00	mg/L	3.51E+00	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	7.02E-07	mg/cm2-event	
dermal	thallium	2.67E-03	mg/L	2.67E-03	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	5.34E-10	mg/cm2-event	
dermal	vanadium	2.31E-02	mg/L	2.31E-02	mg/L	M	4.36E+01	event-cm^2/kg-day	N/A	1/(mg/kg-day)	4.62E-09	mg/cm2-event	
dermal	**Dermal Total**												**4.84E-05**
										Total Risk Across All Exposure Routes/Pathways			**8.05E-04**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-8.14.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Wallops Flight Facility (WFF) - Site 16

Scenario Timeframe: future
Medium: groundwater
Exposure Medium: air
Exposure Point: water supply well - vapor from shower head
Receptor Population: resident
Receptor Age: child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
inhalation - volatile	1,2-dichloroethene (total)	8.00E-03	mg/L	1.74E-03	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	benzene	5.80E-02	mg/L	1.35E-02	mg-min/L-shower	R	5.48E-02	mg/kg-day	2.9E-02	1/(mg/kg-day)	2.15E-05
inhalation - volatile	ethylbenzene	2.80E-01	mg/L	5.88E-02	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	tetrachloroethene	5.00E-03	mg/L	8.96E-04	mg-min/L-shower	R	5.48E-02	mg/kg-day	2.0E-03	1/(mg/kg-day)	9.82E-08
inhalation - volatile	toluene	1.40E+00	mg/L	3.09E-01	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	2-chlorophenol	9.00E-03	mg/L	1.21E-03	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	2-methylnaphthalene	2.00E-01	mg/L	2.80E-02	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	4-methylphenol	4.20E-02	mg/L	4.65E-05	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	bis(2-ethylhexyl)phthalate	1.60E-01	mg/L	9.58E-06	mg-min/L-shower	R	5.48E-02	mg/kg-day	1.4E-02	1/(mg/kg-day)	7.35E-09
inhalation - volatile	carbazole	6.00E-03	mg/L	8.24E-08	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	dibenzofuran	3.00E-03	mg/L	3.19E-05	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	naphthalene	1.80E-01	mg/L	2.58E-02	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	phenanthrene	1.45E-02	mg/L	4.13E-04	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	4,4'-DDT	2.30E-04	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	3.4E-01	1/(mg/kg-day)	
inhalation - volatile	alpha-BHC	2.90E-05	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	6.3E+00	1/(mg/kg-day)	
inhalation - volatile	gamma-BHC (lindane)	6.70E-05	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	aluminum	1.09E+01	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	antimony	2.94E-03	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	arsenic	8.82E-02	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	1.5E+01	1/(mg/kg-day)	
inhalation - volatile	iron	3.56E+01	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	lead	6.28E-02	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	manganese	3.51E+00	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	thallium	2.67E-03	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
inhalation - volatile	vanadium	2.31E-02	mg/L	N/A	mg-min/L-shower	R	5.48E-02	mg/kg-day	N/A	1/(mg/kg-day)	
										Total Risk Across All Exposure Routes/Pathways	**2.16E-05**

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for risk calculation.

TABLE 6-9.1. Total Hazard Indices and Carcinogenic Risks in Site 16 Surface Soil

Receptors	Hazard Indices				Carcinogenic Risks			
	Ingestion	Inhalation	Dermal Contact	TOTAL	Ingestion	Inhalation	Dermal Contact	TOTAL (1)
Recreational Adults	6.2E-03	--	1.4E-03	7.6E-03	2.5E-06	--	2.5E-06	5.1E-06
Recreational Children	5.8E-02	--	2.3E-03	6.1E-02	1.8E-06	--	7.2E-07	2.5E-06
Commercial/Industrial Workers	1.5E-02	--	6.8E-03	2.2E-02	1.9E-06	--	9.0E-06	1.1E-05
Construction Workers	1.4E-01	8.8E-02	9.8E-03	2.4E-01	3.5E-07	2.4E-09	2.6E-07	6.1E-07
Residential Adults	4.2E-02	--	9.5E-03	5.2E-02	1.7E-05	--	1.7E-05	3.4E-05
Residential Children	3.9E-01	--	1.5E-02	4.1E-01	1.2E-05	--	4.9E-06	1.7E-05

Note: Shaded pathways indicate current/future scenarios. Unshaded pathways depict future scenarios.

(1) Any noted discrepancies between pathway totals and overall totals are due to rounding.

TABLE 6-9.2. Total Hazard Indices and Carcinogenic Risks in Site 16 Groundwater

Receptors	Hazard Indices				Carcinogenic Risks			
	Ingestion	Inhalation	Dermal Contact	TOTAL	Ingestion	Inhalation	Dermal Contact	TOTAL (1)
Commercial/Industrial Workers	7.0E+00	--	--	7.0E+00	4.8E-04	--	--	4.8E-04
Residential Adults	2.0E+01	5.4E+00	2.5E+00	2.8E+01	2.1E-03	2.3E-05	1.6E-04	2.3E-03
Residential Children	4.6E+01	2.5E+01	4.0E+00	7.5E+01	7.6E-04	2.2E-05	4.6E-05	8.3E-04
Construction Workers	1.3E-01	1.9E+02	5.4E+00	1.9E+02	1.9E-07	1.2E-05	3.1E-06	1.5E-05

Note: All pathways shown are future scenarios

(1) Any noted discrepancies between pathway totals and overall totals are due to rounding.

TABLE 6-10.1.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Wallops Flight Facility (WFF) Site 16

Scenario Timeframe: current/future
Receptor Population: recreational
Receptor Age: adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
soil	surface soil	surface soil at Site 16	benzo(a)pyrene	2.0E-06		2.4E-06	4.5E-06	benzo(a)pyrene		0.0E+00		0.0E+00	0.0E+00
			aluminum	0.0E+00		0.0E+00	0.0E+00	aluminum	nervous system	1.4E-03		5.8E-04	1.9E-03
			arsenic	5.0E-07		8.3E-08	5.8E-07	arsenic	skin vascular	9.7E-04		3.7E-04	1.3E-03
			iron	0.0E+00		0.0E+00	0.0E+00	iron	blood,liver,GI tract	3.9E-03		4.5E-04	4.4E-03
						Total Risk Across[Soil]	5.1E-06		Total Hazard Index Across All Media and All Exposure Routes				7.6E-03
						Total Risk Across All Media and All Exposure Routes	5.1E-06						

Total [nervous system] HI =	1.9E-03
Total [skin,vascular] HI =	1.3E-03
Total [blood] HI =	4.4E-03
Total [liver] HI =	4.4E-03
Total [GI tract] HI =	4.4E-03

TABLE 6-10.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Wallops Flight Facility (WFF) Site 16

Scenario Timeframe: current/future
Receptor Population: recreational
Receptor Age: child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
soil	surface soil	surface soil at Site 16	benzo(a)pyrene	1.4E-06		7.0E-07	2.1E-06	benzo(a)pyrene		0.0E+00		0.0E+00	0.0E+00
			aluminum	0.0E+00		0.0E+00	0.0E+00	aluminum	nervous system	1.3E-02		9.3E-04	1.4E-02
			arsenic	3.5E-07		2.4E-08	3.7E-07	arsenic	skin vascular	9.1E-03		6.0E-04	9.7E-03
			iron	0.0E+00		0.0E+00	0.0E+00	iron	blood,liver,GI tract	3.7E-02		7.3E-04	3.7E-02
							Total Risk Across[Soil]	2.5E-06					Total Hazard Index Across All Media and All Exposure Routes	6.1E-02
							Total Risk Across All Media and All Exposure Routes	2.5E-06						

Total [nervous system] HI =	1.4E-02
Total [skin,vascular] HI =	9.7E-03
Total [blood] HI =	3.7E-02
Total [liver] HI =	3.7E-02
Total [GI tract] HI =	3.7E-02

TABLE 6-10.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Wallops Flight Facility (WFF) Site 16

Scenario Timeframe: current
Receptor Population: commercial/industrial
Receptor Age: adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
soil	surface soil	surface soil at Site 16	benzo(a)pyrene	1.5E-06		8.7E-06	1.0E-05	benzo(a)pyrene		0.0E+00		0.0E+00	0.0E+00
			aluminum	0.0E+00		0.0E+00	0.0E+00	aluminum	nervous system	3.3E-03		2.8E-03	6.1E-03
			arsenic	3.8E-07		3.0E-07	6.7E-07	arsenic	skin vascular	2.3E-03		1.8E-03	4.1E-03
			iron	0.0E+00		0.0E+00	0.0E+00	iron	blood,liver,GI tract	9.4E-03		2.2E-03	1.2E-02
							Total Risk Across[Soil]	1.1E-05					Total Hazard Index Across All Media and All Exposure Routes	2.2E-02
							Total Risk Across All Media and All Exposure Routes	1.1E-05						

Total [nervous system] HI =	6.1E-03
Total [skin,vascular] HI =	4.1E-03
Total [blood] HI =	1.2E-02
Total [liver] HI =	1.2E-02
Total [GI tract] HI =	1.2E-02

TA .RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Wallops Flight Facility (WFF) Site 16

Scenario Timeframe: future
Receptor Population: commercial/industria
Receptor Age: adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
soil	surface soil	surface soil at Site 16	benzo(a)pyrene	1.5E-06		8.7E-06	1.0E-05	benzo(a)pyrene		0.0E+00		0.0E+00	0.0E+00
			aluminum	0.0E+00		0.0E+00	0.0E+00	aluminum	nervous system	3.3E-03		2.8E-03	6.1E-03
			arsenic	3.8E-07		3.0E-07	6.7E-07	arsenic	skin, vascular	2.3E-03		1.8E-03	4.1E-03
			iron	0.0E+00		0.0E+00	0.0E+00	iron	blood,liver,GI tract	9.4E-03		2.2E-03	1.2E-02
			TOTAL SOIL RISKS				1.1E-05	TOTAL SOIL HAZARDS					2.2E-02
groundwater	groundwater	groundwater at Site 16 - water supply well	1,2-dichloroethene (total)	0.0E+00			0.0E+00	1,2-dichloroethene (total)	liver	8.7E-03			8.7E-03
			benzene	1.1E-05			1.1E-05	benzene	blood, immune syste	1.9E-01			1.9E-01
			ethylbenzene	0.0E+00			0.0E+00	ethylbenzene	liver, kidney	2.7E-02			2.7E-02
			tetrachloroethene	9.1E-07			9.1E-07	tetrachloroethene	liver	4.9E-03			4.9E-03
			toluene	0.0E+00			0.0E+00	toluene	liver, kidney	6.8E-02			6.8E-02
			2-chlorophenol	0.0E+00			0.0E+00	2-chlorophenol	reproductive	1.8E-02			1.8E-02
			2-methylnaphthalene	0.0E+00			0.0E+00	2-methylnaphthalene	--	9.8E-02			9.8E-02
			4-methylphenol	0.0E+00			0.0E+00	4-methylphenol	CNS, respiratory	8.2E-02			8.2E-02
			bis(2-ethylhexyl)phthalate	7.8E-06			7.8E-06	bis(2-ethylhexyl)phthalate	liver	7.8E-02			7.8E-02
			carbazole	4.2E-07			4.2E-07	carbazole		0.0E+00			0.0E+00
			dibenzofuran	0.0E+00			0.0E+00	dibenzofuran	--	7.3E-03			7.3E-03
			naphthalene	0.0E+00			0.0E+00	naphthalene	kidney, thymus	8.8E-02			8.8E-02
			phenanthrene	0.0E+00			0.0E+00	phenanthrene	kidney	4.7E-03			4.7E-03
			4,4'-DDT	2.7E-07			2.7E-07	4,4'-DDT	liver	4.5E-03			4.5E-03
			alpha-BHC	6.4E-07			6.4E-07	alpha-BHC		0.0E+00			0.0E+00
			gamma-BHC (lindane)	3.0E-07			3.0E-07	gamma-BHC (lindane)	liver, kidney	2.2E-03			2.2E-03
			aluminum	0.0E+00			0.0E+00	aluminum	nervous system	1.1E-01			1.1E-01
			antimony	0.0E+00			0.0E+00	antimony	blood	7.2E-02			7.2E-02
			arsenic	4.6E-04			4.6E-04	arsenic	skin, vascular	2.9E+00			2.9E+00
			iron	0.0E+00			0.0E+00	iron	blood,liver,GI tract	1.2E+00			1.2E+00
			lead	0.0E+00			0.0E+00	lead		0.0E+00			0.0E+00
			manganese	0.0E+00			0.0E+00	manganese	nervous system	1.7E+00			1.7E+00
			thallium	0.0E+00			0.0E+00	thallium	liver, blood, hair	3.7E-01			3.7E-01
			vanadium	0.0E+00			0.0E+00	vanadium	liver	3.2E-02			3.2E-02
								TOTAL GW HAZARDS					7.0E+00

Total Risk Across[Groundwater]	4.8E-04
Total Risk Across All Media and All Exposure Routes	4.9E-04

Total Hazard Index Across All Media and All Exposure Routes	7.0E+00

Total [nervous system] HI =	1.9E+00
Total [skin,vascular] HI =	2.9E+00
Total [blood] HI =	1.8E+00
Total [liver] HI =	1.8E+00
Total [GItract] HI =	1.2E+00
Total [kidney] HI =	1.9E-01
Total [reproduction] HI =	1.8E-02

TABLE 6-10 5.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Wallops Flight Facility (WFF) Site 16

Scenario Timeframe: future
Receptor Population: construction worker
Receptor Age: adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
soil	surface soil	surface soil at Site 16	benzo(a)pyrene	2.8E-07	3.5E-10	2.5E-07	5.3E-07	benzo(a)pyrene		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			aluminum	0.0E+00	0.0E+00	0.0E+00	0.0E+00	aluminum	nervous system	3.0E-02	8.8E-02	4.0E-03	1.2E-01
			arsenic	6.9E-08	2.0E-09	8.5E-09	8.0E-08	arsenic	skin, vascular	2.2E-02	0.0E+00	2.6E-03	2.4E-02
			iron	0.0E+00	0.0E+00	0.0E+00	0.0E+00	iron	blood,liver,GI tract	8.7E-02	0.0E+00	3.1E-03	9.0E-02
			TOTAL SOIL RISKS				6.1E-07	TOTAL SOIL HAZARDS					2.4E-01
groundwater	groundwater	groundwater at Site 16 - water supply well	1,2-dichloroethene (total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1,2-dichloroethene (total)	liver	1.7E-04	0.0E+00	4.2E-03	4.3E-03
			benzene	4.3E-09	1.2E-05	2.2E-07	1.2E-05	benzene	blood, immune system	3.6E-03	3.4E+01	1.9E-01	3.4E+01
			ethylbenzene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	ethylbenzene	liver, kidney	5.2E-04	8.3E-01	9.8E-02	9.3E-01
			tetrachloroethene	3.5E-10	5.0E-08	4.3E-08	9.3E-08	tetrachloroethene	liver	9.4E-06	2.5E-02	1.2E-03	2.6E-02
			toluene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	toluene	liver, kidney	1.3E-04	1.1E+01	1.4E-02	1.1E+01
			2-chlorophenol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2-chlorophenol	reproductive	3.4E-05	0.0E+00	9.7E-04	1.0E-03
			2-methylnaphthalene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2-methylnaphthalene	--	1.9E-03	0.0E+00	3.8E-01	3.8E-01
			4-methylphenol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4-methylphenol	CNS, respiratory	1.6E-03	0.0E+00	6.1E-02	6.3E-02
			bis(2-ethylhexyl)phthalate	3.0E-09	1.6E-08	1.9E-06	1.9E-06	bis(2-ethylhexyl)phthalate	liver	1.5E-03	0.0E+00	9.3E-01	9.3E-01
			carbazole	1.6E-10	0.0E+00	0.0E+00	1.6E-10	carbazole		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			dibenzofuran	0.0E+00	0.0E+00	0.0E+00	0.0E+00	dibenzofuran	--	1.4E-04	0.0E+00	0.0E+00	1.4E-04
			naphthalene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	naphthalene	kidney, thymus	1.7E-03	1.4E+02	3.4E-01	1.4E+02
			phenanthrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	phenanthrene	kidney	9.0E-05	0.0E+00	7.1E-02	7.1E-02
			4,4'-DDT	1.0E-10	3.8E-08	5.3E-07	5.7E-07	4,4'-DDT	liver	8.6E-05	0.0E+00	4.3E-01	4.3E-01
			alpha-BHC	2.4E-10	1.2E-07	0.0E+00	1.2E-07	alpha-BHC		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			gamma-BHC (lindane)	1.2E-10	0.0E+00	8.5E-09	8.6E-09	gamma-BHC (lindane)	liver, kidney	4.2E-06	0.0E+00	3.1E-04	3.1E-04
			aluminum	0.0E+00	0.0E+00	0.0E+00	0.0E+00	aluminum	nervous system	2.0E-03	0.0E+00	1.8E-02	2.0E-02
			antimony	0.0E+00	0.0E+00	0.0E+00	0.0E+00	antimony	blood	1.4E-03	0.0E+00	3.2E-02	3.3E-02
			arsenic	1.8E-07	0.0E+00	4.3E-07	6.1E-07	arsenic	skin, vascular	5.5E-02	0.0E+00	1.3E-01	1.9E-01
			iron	0.0E+00	0.0E+00	0.0E+00	0.0E+00	iron	blood,liver,GI tract	2.2E-02	0.0E+00	5.2E-02	7.4E-02
			lead	0.0E+00	0.0E+00	0.0E+00	0.0E+00	lead		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			manganese	0.0E+00	0.0E+00	0.0E+00	0.0E+00	manganese	nervous system	3.3E-02	0.0E+00	2.5E+00	2.6E+00
			thallium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	thallium	liver, blood, hair	7.1E-03	0.0E+00	1.7E-02	2.4E-02
			vanadium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	vanadium	liver	6.2E-04	0.0E+00	7.2E-02	7.2E-02
								TOTAL GW HAZARDS					1.9E+02

Total Risk Across[Groundwater]	1.6E-05
Total Risk Across All Media and All Exposure Routes	1.6E-05

Total Hazard Index Across All Media and All Exposure Routes	1.9E+02

Total [nervous system] HI =	2.8E+00
Total [skin,vascular] HI =	2.1E-01
Total [blood] HI =	3.5E+01
Total [liver] HI =	1.4E+01
Total [GItract] HI =	1.6E-01
Total [kidney] HI =	1.5E+02
Total [reproduction] HI =	1.0E-03

TABLE 6-10.6.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Wallops Flight Facility (WFF) Site 16

Scenario Timeframe: future
Receptor Population: resident
Receptor Age: adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
soil	surface soil	surface soil at Site 16	benzo(a)pyrene	1.4E-05		1.6E-05	3.0E-05	benzo(a)pyrene		0.0E+00		0.0E+00	0.0E+00
			aluminum	0.0E+00		0.0E+00	0.0E+00	aluminum	nervous system	9.1E-03		3.9E-03	1.3E-02
			arsenic	3.4E-06		5.6E-07	3.9E-06	arsenic	skin, vascular	6.6E-03		2.5E-03	9.1E-03
			iron	0.0E+00		0.0E+00	0.0E+00	iron	blood,liver,GI tract	2.6E-02		3.1E-03	2.9E-02
			TOTAL SOIL RISKS				3.4E-05	TOTAL SOIL HAZARDS					5.2E-02
groundwater	groundwater	groundwater at Site 16 - water supply well	1,2-dichloroethene (total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1,2-dichloroethene (total)	liver	2.4E-02	0.0E+00	2.0E-03	2.6E-02
			benzene	4.8E-05	2.3E-05	6.4E-06	7.7E-05	benzene	blood, immune system	5.3E-01	1.1E+00	8.1E-02	1.7E+00
			ethylbenzene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	ethylbenzene	liver, kidney	7.7E-02	2.8E-02	5.5E-02	1.6E-01
			tetrachloroethene	3.9E-06	1.1E-07	2.2E-06	6.2E-06	tetrachloroethene	liver	1.4E-02	8.8E-04	8.9E-03	2.3E-02
			toluene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	toluene	liver, kidney	1.9E-01	3.7E-01	6.9E-02	6.3E-01
			2-chlorophenol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2-chlorophenol	reproductive	4.9E-02	0.0E+00	5.6E-03	5.5E-02
			2-methylnaphthalene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2-methylnaphthalene	--	2.7E-01	0.0E+00	2.4E-01	5.2E-01
			4-methylphenol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4-methylphenol	CNS, respiratory	2.3E-01	0.0E+00	3.2E-02	2.6E-01
			bis(2-ethylhexyl)phthalate	3.3E-05	7.9E-09	1.2E-04	1.5E-04	bis(2-ethylhexyl)phthalate	liver	2.2E-01	0.0E+00	8.6E-01	1.1E+00
			carbazole	1.8E-06	0.0E+00	0.0E+00	1.8E-06	carbazole		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			dibenzofuran	0.0E+00	0.0E+00	0.0E+00	0.0E+00	dibenzofuran	--	2.1E-02	0.0E+00	0.0E+00	2.1E-02
			naphthalene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	naphthalene	kidney, thymus	2.5E-01	3.9E+00	2.2E-01	4.4E+00
			phenanthrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	phenanthrene	kidney	1.3E-02	0.0E+00	7.1E-02	8.4E-02
			4,4'-DDT	1.2E-06	0.0E+00	3.2E-05	3.4E-05	4,4'-DDT	liver	1.3E-02	0.0E+00	4.0E-01	4.1E-01
			alpha-BHC	2.7E-06	0.0E+00	0.0E+00	2.7E-06	alpha-BHC		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			gamma-BHC (lindane)	1.3E-06	0.0E+00	5.3E-07	1.8E-06	gamma-BHC (lindane)	liver, kidney	6.1E-03	0.0E+00	2.8E-03	8.9E-03
			aluminum	0.0E+00	0.0E+00	0.0E+00	0.0E+00	aluminum	nervous system	3.0E-01	0.0E+00	2.5E-03	3.0E-01
			antimony	0.0E+00	0.0E+00	0.0E+00	0.0E+00	antimony	blood	2.0E-01	0.0E+00	4.6E-03	2.1E-01
			arsenic	2.0E-03	0.0E+00	4.2E-06	2.0E-03	arsenic	skin, vascular	8.1E+00	0.0E+00	1.9E-02	8.1E+00
			iron	0.0E+00	0.0E+00	0.0E+00	0.0E+00	iron	blood,liver,GI tract	3.3E+00	0.0E+00	7.5E-03	3.3E+00
			lead	0.0E+00	0.0E+00	0.0E+00	0.0E+00	lead		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			manganese	0.0E+00	0.0E+00	0.0E+00	0.0E+00	manganese	nervous system	4.8E+00	0.0E+00	3.7E-01	5.2E+00
			thallium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	thallium	liver, blood, hair	1.0E+00	0.0E+00	2.4E-03	1.0E+00
			vanadium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	vanadium	liver	9.0E-02	0.0E+00	1.0E-02	1.0E-01
								TOTAL GW HAZARDS					2.8E+01
						Total Risk Across{Groundwater}	2.2E-03					Total Hazard Index Across All Media and All Exposure Routes	2.8E+01
						Total Risk Across All Media and All Exposure Routes	2.3E-03						

Total [nervous system] HI =	5.8E+00
Total [skin,vascular] HI =	8.1E+00
Total [blood] HI =	6.2E+00
Total [liver] HI =	6.8E+00
Total [GItract] HI =	3.3E+00
Total [kidney] HI =	5.3E+00
Total [reproduction] HI =	5.5E-02

TABLE 6-10.7.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Wallops Flight Facility (WFF) Site 16

Scenario Timeframe: future
Receptor Population: resident
Receptor Age: child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
soil	surface soil	surface soil at Site 16	benzo(a)pyrene	9.6E-06		4.7E-06	1.4E-05	benzo(a)pyrene		0.0E+00		0.0E+00	0.0E+00
			aluminum	0.0E+00		0.0E+00	0.0E+00	aluminum	nervous system	8.5E-02		6.3E-03	9.1E-02
			arsenic	2.4E-06		1.6E-07	2.5E-06	arsenic	skin, vascular	6.1E-02		4.0E-03	6.5E-02
			iron	0.0E+00		0.0E+00	0.0E+00	iron	blood,liver,GI tract	2.5E-01		4.9E-03	2.5E-01
			TOTAL SOIL RISKS				1.7E-05	TOTAL SOIL HAZARDS					4.1E-01
groundwater	groundwater	groundwater at Site 16 - water supply well	1,2-dichloroethene (total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1,2-dichloroethene (total)	liver	5.7E-02	0.0E+00	3.3E-03	6.0E-02
			benzene	1.7E-05	2.1E-05	1.8E-06	4.1E-05	benzene	blood, immune system	1.2E+00	5.1E+00	1.3E-01	6.4E+00
			ethylbenzene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	ethylbenzene	liver, kidney	1.8E-01	1.3E-01	8.9E-02	4.0E-01
			tetrachloroethene	1.4E-06	9.8E-08	6.4E-07	2.2E-06	tetrachloroethene	liver	3.2E-02	4.1E-03	1.4E-02	5.0E-02
			toluene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	toluene	liver, kidney	4.5E-01	1.7E+00	1.1E-01	2.3E+00
			2-chlorophenol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2-chlorophenol	reproductive	1.2E-01	0.0E+00	9.1E-03	1.2E-01
			2-methylnaphthalene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2-methylnaphthalene	--	6.4E-01	0.0E+00	3.9E-01	1.0E+00
			4-methylphenol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4-methylphenol	CNS, respiratory	5.4E-01	0.0E+00	5.1E-02	5.9E-01
			bis(2-ethylhexyl)phthalate	1.2E-05	7.3E-09	3.3E-05	4.5E-05	bis(2-ethylhexyl)phthalate	liver	5.1E-01	0.0E+00	1.4E+00	1.9E+00
			carbazole	6.6E-07	0.0E+00	0.0E+00	6.6E-07	carbazole		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			dibenzofuran	0.0E+00	0.0E+00	0.0E+00	0.0E+00	dibenzofuran	--	4.8E-02	0.0E+00	0.0E+00	4.8E-02
			naphthalene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	naphthalene	kidney, thymus	5.8E-01	1.8E+01	3.6E-01	1.9E+01
			phenanthrene	0.0E+00	0.0E+00	0.0E+00	0.0E+00	phenanthrene	kidney	3.1E-02	0.0E+00	1.1E-01	1.5E-01
			4,4'-DDT	4.3E-07	0.0E+00	9.3E-06	9.8E-06	4,4'-DDT	liver	2.9E-02	0.0E+00	6.4E-01	6.7E-01
			alpha-BHC	1.0E-06	0.0E+00	0.0E+00	1.0E-06	alpha-BHC		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			gamma-BHC (lindane)	4.8E-07	0.0E+00	1.5E-07	6.3E-07	gamma-BHC (lindane)	liver, kidney	1.4E-02	0.0E+00	4.5E-03	1.9E-02
			aluminum	0.0E+00	0.0E+00	0.0E+00	0.0E+00	aluminum	nervous system	7.0E-01	0.0E+00	4.1E-03	7.0E-01
			antimony	0.0E+00	0.0E+00	0.0E+00	0.0E+00	antimony	blood	4.7E-01	0.0E+00	7.5E-03	4.8E-01
			arsenic	7.3E-04	0.0E+00	1.2E-06	7.3E-04	arsenic	skin, vascular	1.9E+01	0.0E+00	3.1E-02	1.9E+01
			iron	0.0E+00	0.0E+00	0.0E+00	0.0E+00	iron	blood,liver,GI tract	7.6E+00	0.0E+00	1.2E-02	7.6E+00
			lead	0.0E+00	0.0E+00	0.0E+00	0.0E+00	lead		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			manganese	0.0E+00	0.0E+00	0.0E+00	0.0E+00	manganese	nervous system	1.1E+01	0.0E+00	6.0E-01	1.2E+01
			thallium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	thallium	liver, blood, hair	2.4E+00	0.0E+00	3.9E-03	2.4E+00
			vanadium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	vanadium	liver	2.1E-01	0.0E+00	1.7E-02	2.3E-01
								TOTAL GW HAZARDS					7.5E+01

Total Risk Across[Groundwater]	8.3E-04
Total Risk Across All Media and All Exposure Routes	8.4E-04

Total Hazard Index Across All Media and All Exposure Routes	7.5E+01

Total [nervous system] HI =	1.3E+01
Total [skin,vascular] HI =	1.9E+01
Total [blood] HI =	1.7E+01
Total [liver] HI =	1.6E+01
Total [GItract] HI =	7.8E+00
Total [kidney] HI =	2.2E+01
Total [reproduction] HI =	1.2E-01

Versar INC

TABLE 7-1. INITIAL SCREENING OF ALTERNATIVES

Alternate Number	Effectiveness	Implementability	Cost	Retained for Detailed Analysis of Alternatives	Rationale for Exclusion from Detailed Analysis of Alternatives
No Action	Does not reduce the toxicity of mobility of contaminants; no risk during cleanup.	Not acceptable to the regulators and/or the community.	None	Yes	Not applicable
Institutional Controls (deed restrictions/ fence)	Effective in addressing remedial action objectives, limits access of potential receptors to the site; limited reduction in toxicity or mobility of contaminants	Requires legally binding deed restriction be added; long term monitoring.	Minor capital cost, minor O&M costs	Yes	Not applicable
Clay/Sand Composite Cap	Not effective in addressing remedial action objectives; will not prevent further degradation of groundwater; minimal risk during cleanup.	Requires long-term monitoring	Moderate capital and O&M costs	No	Not effective in isolating contaminated soil from groundwater.
Excavation and Off-site Disposal	Effective in addressing remedial action objectives; effective and reliable in removing contamination; minimal risk during excavation.	If the soil is shown to be a hazardous waste, it would have to be taken to a RCRA-permitted.	High capital costs, no O&M costs	Yes	Not applicable
Soil Washing	Potentially effective in addressing remedial action objectives; effective and reliable for treatment of organics and metals; treatability testing would be required; instate would require additional (probably off-site) treatment; minimal risk during cleanup.	Multiple treatments would be required for organics and metals	Moderate capital and O&M costs	No	Difficult to implement due to multiple solutions required.
Stabilization	Potentially effective in addressing remedial action objectives; effective and reliable for treatment of organics and metals; minimal risk during cleanup.	Readily implementable.	Low treatment costs	No	Poor long term reliability.

TABLE 7-1. INITIAL SCREENING OF ALTERNATIVES

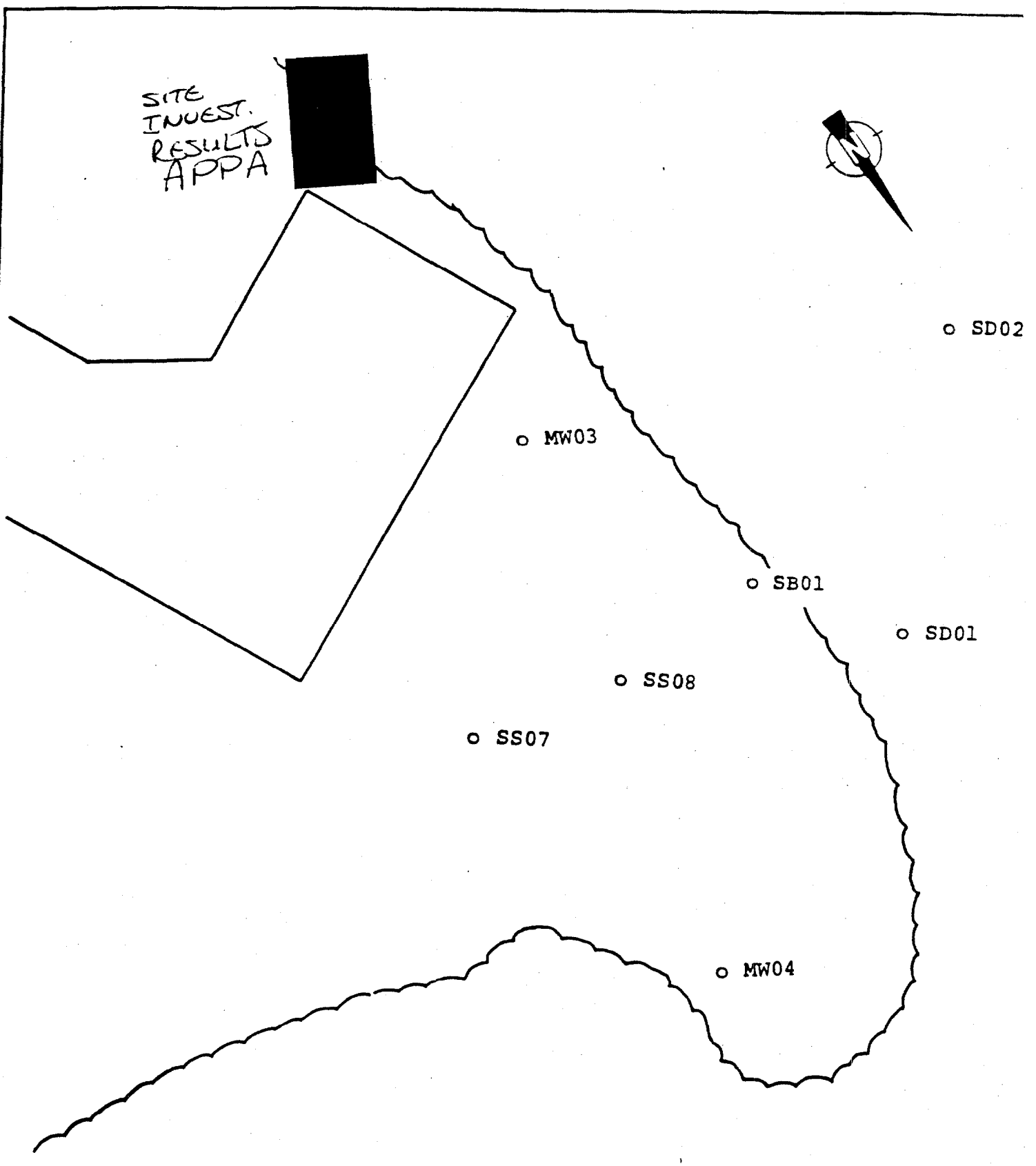
Alternate Number	Effectiveness	Implementability	Cost	Retained for Detailed Analysis of Alternatives	Rationale for Exclusion from Detailed Analysis of Alternatives
Vapor Extraction	Not effective in addressing remedial action objectives; effective and reliable for treatment of some organic contaminants; will not effectively reduce the toxicity or mobility of pesticides or metals; minimal risk during cleanup.	Not implementable; will not effectively treat metals	Moderate capital and O&M costs	No	The technology will not effectively reduce the toxicity, mobility, or volume of wastes containing metals.
In Situ Bioremediation	Not effective in addressing remedial action objectives; effective and reliable for treatment of some organic contaminants; will not effectively reduce the toxicity or mobility of metals; minimum risk during cleanup.	Not implementable; will not effectively treat metals.	Moderate capital and O&M costs	No	The technology will not effectively reduce the toxicity, mobility, or volume of wastes containing metals.
On-Site Incineration	Not effective in addressing remedial action objectives; effective and reliable for treatment of organic contaminants; will not effectively reduce the toxicity or mobility of metals; high risk during cleanup.	May not be acceptable to the regulators and/or the community.	High treatment costs	No	The technology will not effectively reduce the toxicity or mobility of wastes containing organics or metals; the technology is very costly; technology would be very difficult to implement.
Low Temperature Thermal Treatment	Not effective in addressing remedial action objectives; effective and reliable for treatment of some organic contaminants; will not effectively reduce the toxicity or mobility of metals; moderate to high risk during cleanup.	May not be acceptable to the regulators and/or the community.	High treatment costs	No	The technology will not effectively reduce the toxicity or mobility of wastes containing organics or metals; the technology is relatively costly; technology could be difficult to implement.

Versar INC

TABLE 7-2. ALTERNATIVES COMPARISON SUMMARY TABLE

Criteria	Alternative No Action	Alternative Institutional Controls	Alternative Excavation and Disposal
Overall Protection of Human Health and the Environment	No reduction in risk. Not considered adequate protection at Site 16.	This alternative is considered adequately protective.	This alternative would provide a high degree of protection to human health and the environment.
Compliance with ARARs	This alternatives does not comply with chemical-specific ARARs.	Institutional controls will meet ARARs and RAOs.	ARARs and RAOs would be met by this alternative.
Reduction of Toxicity, Mobility, and Volume (Through Treatment)	None.	Limited reduction in toxicity, mobility, or volume via natural attenuation and microbial degradation.	Remediated to the fullest extent possible, and the CODs are eliminated.
Short-Term Effectiveness	None.	Minimal worker precautions required. No adverse short-term impacts expected from implementation.	Worker precautions required. Short-term impact on wildlife due to excavation operations is expected. RAOs met in several months.
Long-Term Effectiveness and Permanence	Potential exposure to contaminants would remain unabated.	Potential exposure limited while natural degradation occurs. Limits potential exposure while collecting data to confirm that active remediation of Site is not required.	Provides high degree of long-term effectiveness and permanence.
Implementability	No construction or operation/maintenance required.	Readily implementable. Monitoring program readily implementable.	Moderate implementation problems. Requires transportation of affected soils over large distances. No future monitoring required.
Total Worth Costs	Negligible	$153,800	$962,176

COC = chemical of concern; RAO = remedial action objectives; ARARs - Applicable or Relevant and Appropriate Requirements



SS - Surface Soil Sample
MW - Groundwater (Monitoring Well) Sample
SB - Subsurface Soil Sample (Soil Boring)
SD - Sediment Sample

135 0 135
SCALE IN FEET

NATIONAL AERONAUTICS & SPACE ADMINISTRATION

SITE INSPECTION

FIGURE 2-2
WASTE OIL DUMP
LOCATION OF SAMPLING POINTS

EBASCO SERVICES INCORPORATED

TABLE 3-3B
NASA
WALLOPS FLIGHT FACILITY - SITE INSPECTION
WASTE OIL DUMP

	EPA MCL ug/l	MCLG ug/l	SS07 ug/kg	SS08 ug/kg	SD01 ug/kg	SD02 ug/kg	SB01 ug/kg	MW03 ug/l	MW04 ug/l
TCL PESTICIDES/PCBs									
4' 4' DDE			48	U	U	110	U	U	U
TCL METALS									
ALUMINUM			104008J	U	86708J	201008J	19508J	229000	276000
ANTIMONY			U	U	U	U	U	U	U
ARSENIC	50		14	U	U	12	U	U	U
BARIUM	1000		U	U	U	U	U	674	711
BERYLLIUM			U	U	U	U	U	10	10
CADMIUM	10		U	U	U	U	U	U	U
CALCIUM			U	U	U	U	U	51300	22400
CHROMIUM	50		51J	4.9J	22J	20J	4.2J	96	116
COBALT			U	U	U	U	U	U	U
COPPER		1000	158	7.4	47	U	U	71	83
IRON		300	6350	1670	4260	14900	2260	244000	115000
LEAD	50		462J	476J	65J	23J	2.4J	88	131
MAGNESIUM			U	U	U	U	U	18300	11100
MANGANESE		50	180	24	U	41	6.5	1435	476
MERCURY	2		0.41J	U	U	U	U	R	R
NICKEL			U	U	U	U	U	158	120
POTASSIUM			U	U	U	U	U	10100	9260
SELENIUM	10		U	U	U	U	U	U	U
SILVER	50		U	U	U	U	U	U	U
SODIUM			U	U	16700	U	U	8290	18300
THALLIUM			U	U	U	U	U	U	U
VANADIUM			17J	15J	U	45J	U	R	R
ZINC		5000	19	17	U	10	U	117	226
CYANIDE			U	U	U	U	U	U	U

NOTES:

1. U - Undetected
   J - Estimate
   R - Rejected
   B - Detected in blank
2. MCL Maximum Contaminent Level
   MCLG Maximum Contaminent Level Goal (not enforceable)
   MCLs and MCLGs apply to water only. Chemicals for which MCL/MCLGs are not shown, do not have standards.
3. TCL pesticides and PCBs not shown were not detected.
4. SS - Surface Soil Sample
   SD - Sediment Sample
   SB - Subsurface Soil Sample
   MW - Monitoring Well Sample

TABLE

NASA
WALLOPS FLIGHT FACILITY - SITE INSPECTION
WASTE OIL DUMP

	EPA MCL ug/l	MCLG ug/l	SS07 ug/kg	SS08 ug/kg	SD01 ug/kg	SD02 ug/kg	SB01 ug/kg	MW03 ug/l	MW04 ug/l
TCL VOLATILES									
METHYLENE CHLORIDE			10	3J	89	U	U	U	U
ACETONE			U	19B	1300B	240B	85B	71B	150B
TOLUENE			U	5	U	U	U	U	U
4-METHYL-2-PENTANONE			U	U	U	U	U	U	18
TOTAL OTHER VOLATILES			U	U	11880	U	U	144	293
TCL SEMIVOLATILES									
BIS(2-ETHYLHEXYL) PHTHALATE			290J	168427	U	U	300J	110	94
DI-N-OCTYL PHTHALATE			U	U	U	U	U	U	168
TOTAL OTHER SEMIVOLATILES			2417700	312300	337220	1440000	78790	10	1365

NOTES:

1. U - Undetected
   J - Estimate
   B - Detected in blank
   R - Rejected

2. TCL organic compounds not shown were not detected.

3. SS - Surface Soil Sample
   SD - Sediment Sample
   SB - Subsurface Soil Sample(Soil Boring)
   MW - Monitoring Well Sample(Groundwater)

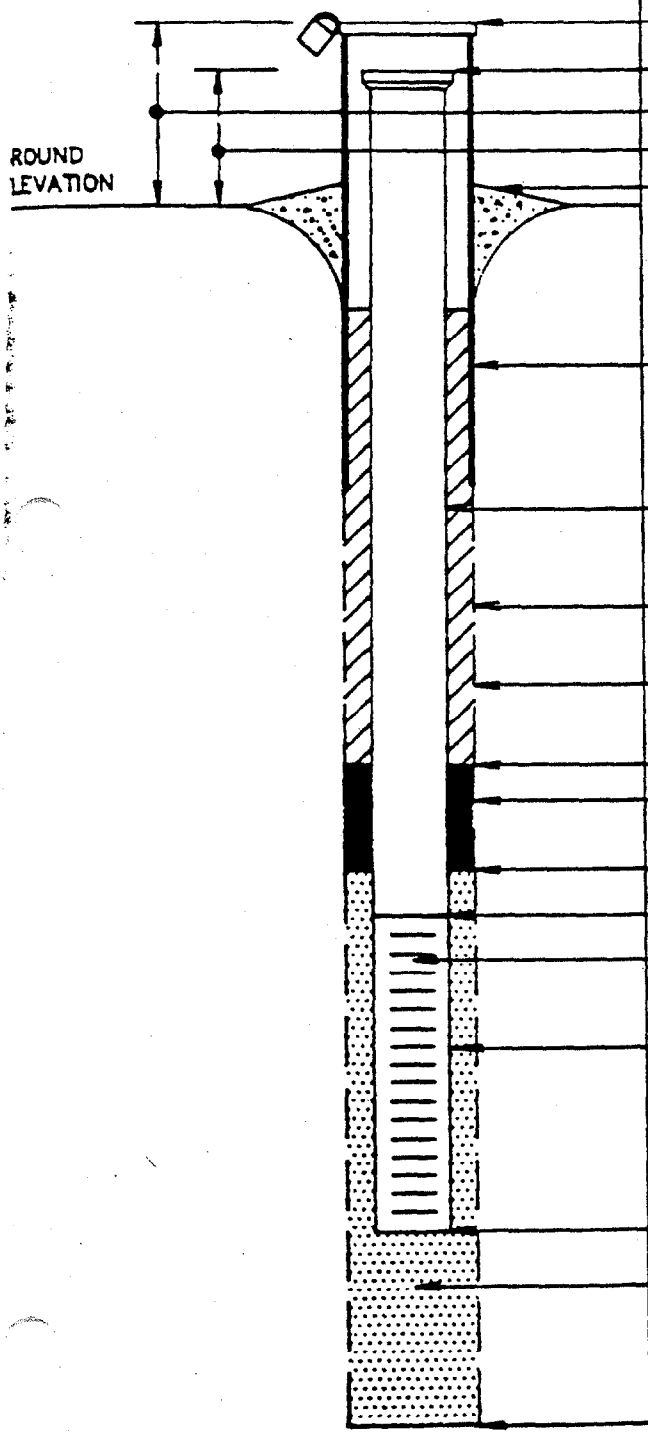
4. MCLs and MCLGs are not applicable for these compounds.

WELL NO. MW04

OVERBURDEN
MONITORING WELL SHEET

PROJECT NASA/Site Inspection (WFF)
PROJECT NO. NASW-4301 BORING NO. MW04
ELEVATION 10.38' (MSL) DATE April 12, 1989
FIELD GEOLOGIST L. Moy

DRILLER Hardin-Huber, Inc.
DRILLING METHOD Hollow Stem Auger
DELVELOPMENT METHOD Air Lifting



ELEVATION OF TOP OF SURFACE CASING: 10.38'
ELEVATION OF TOP OF RISER PIPE: _____
STICK-UP TOP OF SURFACE CASING: _____
STICK-UP RISER PIPE: _____
TYPE OF SURFACE SEAL: Concrete

I.D. OF SURFACE CASING: 4'
TYPE OF SURFACE CASING: Steel

RISER PIPE I.D. 2"
TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 6"

TYPE OF BACKFILL: Grout-90% Cement
10% Bentonite

ELEVATION/DEPTH TOP OF SEAL: (1.5')
TYPE OF SEAL: Bentonite Pellets

DEPTH TOP OF SAND PACK: (2.8')
ELEVATION/DEPTH TOP OF SCREEN: (3')
TYPE OF SCREEN: PVC
SLOT SIZE X LENGTH: .010 x 10'
TYPE OF SAND PACK: Grade #2 Sand

ELEVATION/DEPTH BOTTOM OF SCREEN: (23')
ELEVATION/DEPTH BOTTOM OF SAND PACK: (23')
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____
ELEVATION/DEPTH OF HOLE (23')

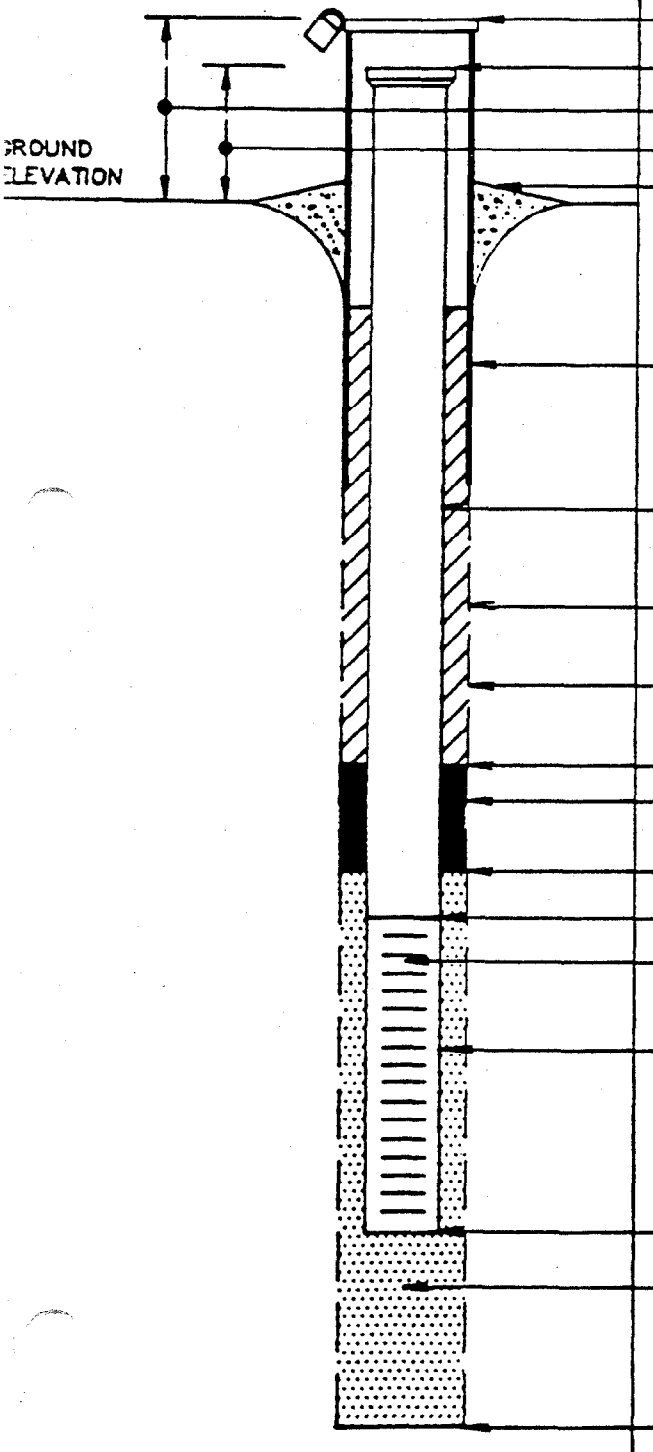
NOT TO SCALE

WELL NO. MW03

OVERBURDEN
MONITORING WELL SHEET

PROJECT NASA/Site Inspection (WFF)
PROJECT NO. NASW-4301 BORING NO. MW03
ELEVATION 33.96' (MSL) DATE April 12, 1989
FIELD GEOLOGIST H. Chernoff

DRILLER Hardin-Huber, Inc.
DRILLING METHOD Hollow Stem Auger
DELVELOPMENT METHOD Air Lifting



ELEVATION OF TOP OF SURFACE CASING: 33.96'
ELEVATION OF TOP OF RISER PIPE: _____
STICK-UP TOP OF SURFACE CASING: _____
STICK-UP RISER PIPE: _____
TYPE OF SURFACE SEAL: Concrete

I.D. OF SURFACE CASING: 4'
TYPE OF SURFACE CASING: Steel

RISER PIPE I.D. 2"
TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 6"

TYPE OF BACKFILL: Grout-90% Cement
10% Bentonite

ELEVATION/DEPTH TOP OF SEAL: (6')
TYPE OF SEAL: Bentonite Pellets

DEPTH TOP OF SAND PACK: (8')
ELEVATION/DEPTH TOP OF SCREEN: (10').
TYPE OF SCREEN: PVC
SLOT SIZE X LENGTH: .010 x 10'
TYPE OF SAND PACK: Grade #2 Sand

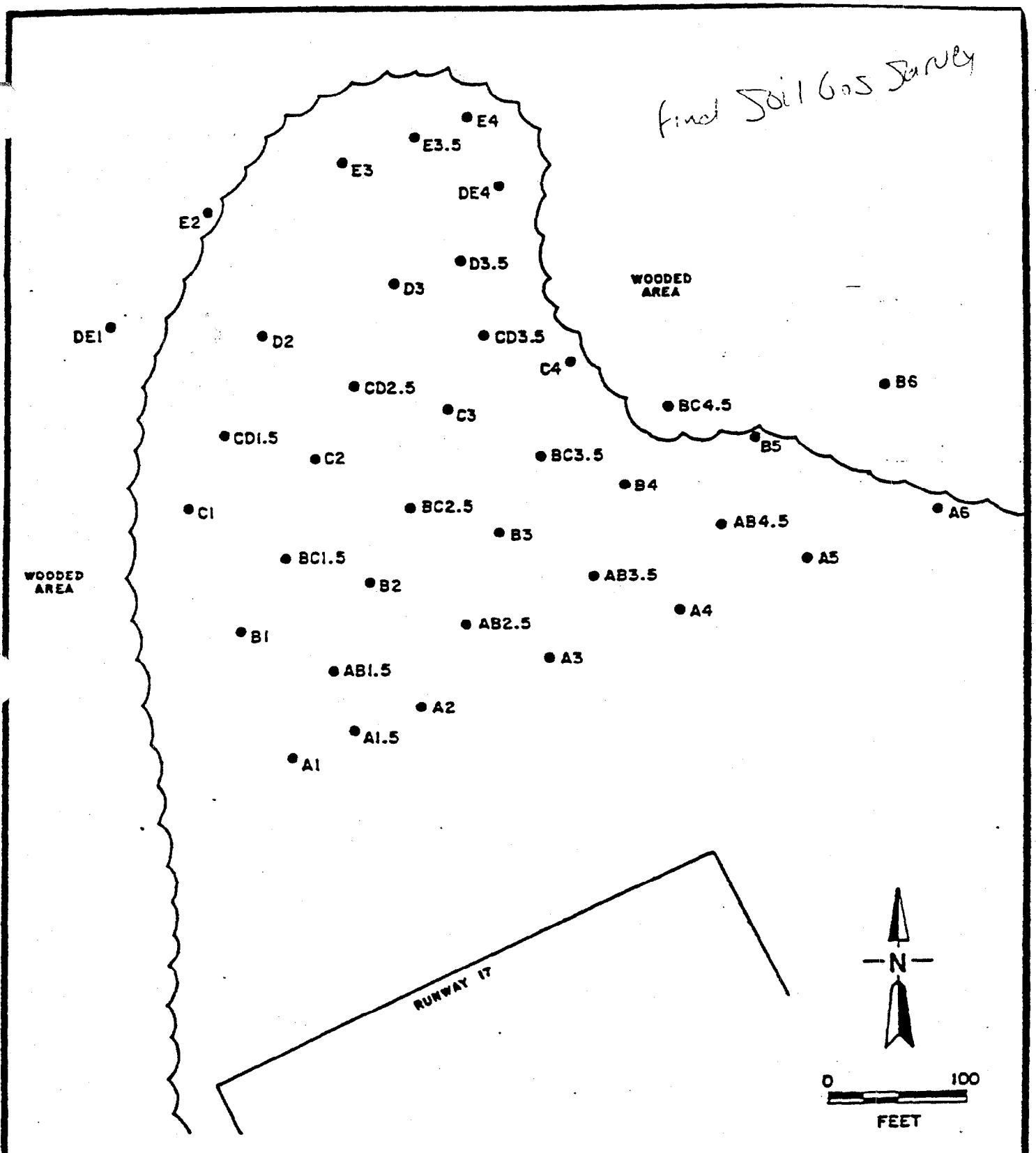
ELEVATION/DEPTH BOTTOM OF SCREEN: (30')
ELEVATION/DEPTH BOTTOM OF SAND PACK: (30')
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION/DEPTH OF HOLE (30')

NOT TO SCALE

APPENDIX B

SOIL GAS RESULTS



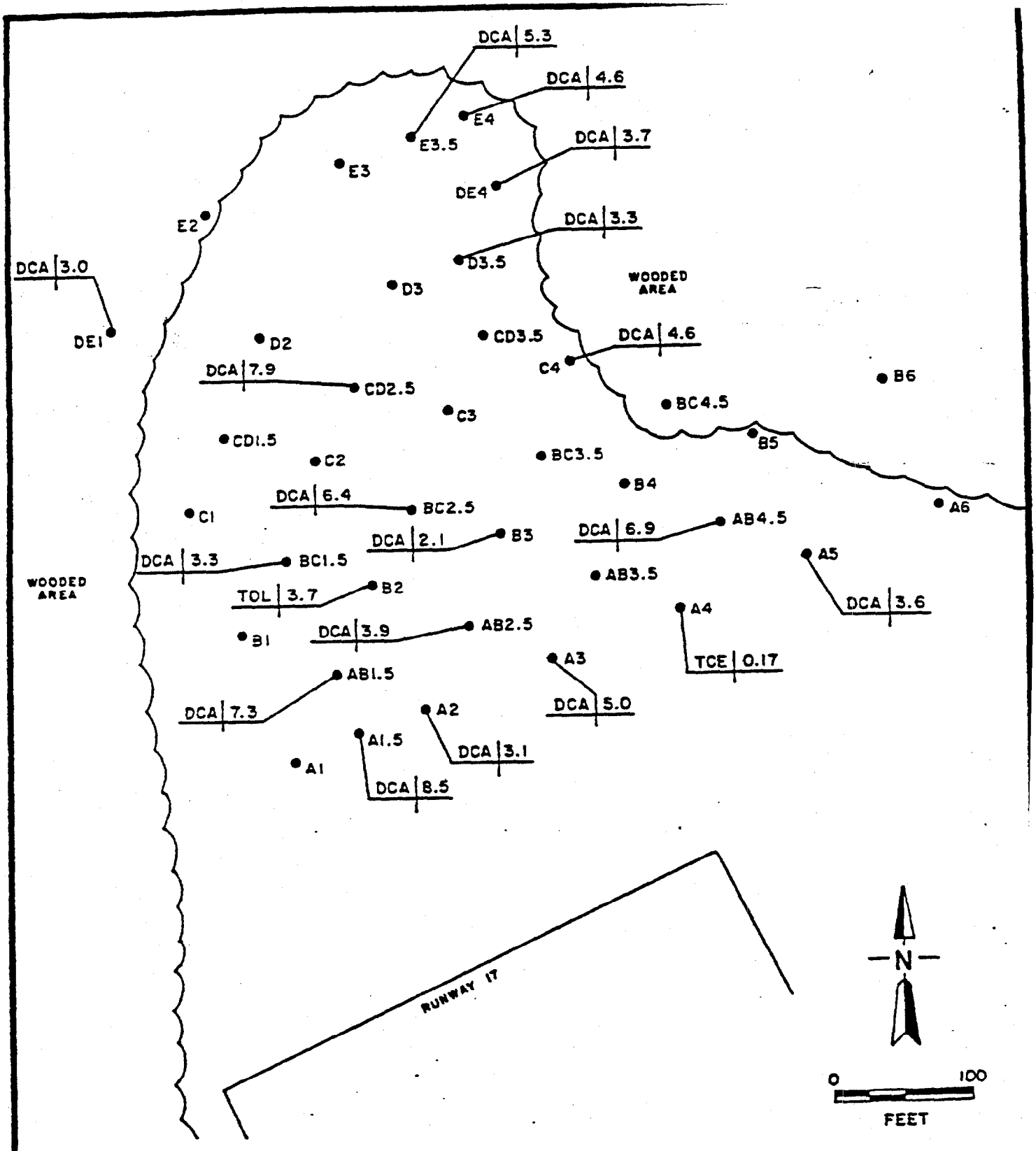
LEGEND

- ● Soil Gas Sampling Location
- Wooded Area Boundary

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
WALLOPS FLIGHT FACILITY

FIGURE 1
WASTE OIL DUMP
LOCATION OF SOIL GAS SAMPLING POINTS

EBASCO SERVICES INCORPORATED



LEGEND

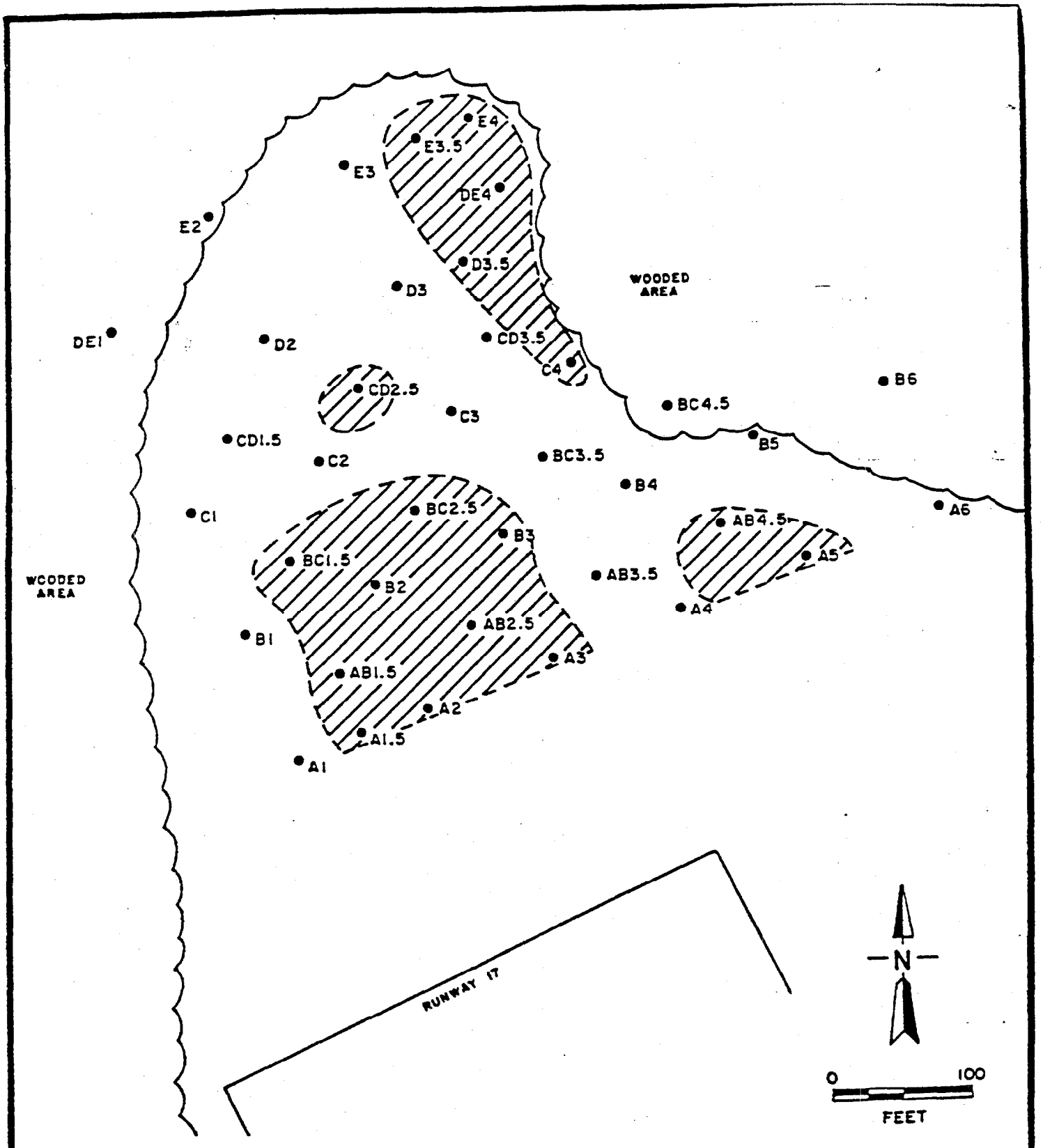
- Soil Gas Sampling Location
- Wooded Area Boundary
- DCA | 7.9 — Concentration ppm (ug Analyte/l Air); Target Analyte

DCA - Dichloroethane
TCE - Trichloroethylene
TOL - Toluene

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
WALLOPS FLIGHT FACILITY

FIGURE 2
WASTE OIL DUMP
SOIL GAS DETECTIONS

EBASCO SERVICES INCORPORATED



LEGEND

- Soil Gas Sampling Location
- Wooded Area Boundary
- Suspected Areal Extent of Soil Contamination

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WALLOPS FLIGHT FACILITY

FIGURE 3
WASTE OIL DUMP
SUSPECTED AREAL EXTENT OF SOIL CONTAMINATION

EBASCO SERVICES INCORPORATED

SOIL GAS ANALYSIS RESULTS
TABLE 1
Site: Old Waste Oil Dump

SAMPLE NUMBER	CONCENTRATIONS (ppm)							
	DCE	DCA	TCA	TCE	BENZENE	PCE	TOLUENE	XYLENE
	dl=0.02	dl=2.0	dl=3.3	dl=0.01	dl=1.0	dl=.05	dl=1.0	dl=1.0
A-1						0.12		
A-1						0.10		
A-1.5		8.1				0.24		
A-1.5		8.5				0.23		
A-2		3.1				0.11		
A-3		5.0				0.14		
A-4				0.17				1.6
A-5		3.6				0.11		
A-6						0.06		
AB-1.5		7.3				0.22		
AB-2.5		3.9				0.14		
AB-3.5						0.09		
AB-4.5		6.9				0.11		
B-1						0.14		
B-2							3.7	1.8
B-2								1.1
B-3		2.1				0.09		
B-4								
B-5						0.09		
B-6								
BC-1.5		3.3				0.07		
BC-1.5		6.7				0.18		
BC-2.5		6.4				0.10		
BC-3.5						0.17		
BC-3.5						0.12		
BC-4.5								
C-1				0.01				
C-2						0.16		
C-3						0.18		
C-4		4.6				0.14		

NOTES:

A blank cell indicates that concentrations were below detection limit (<dl)

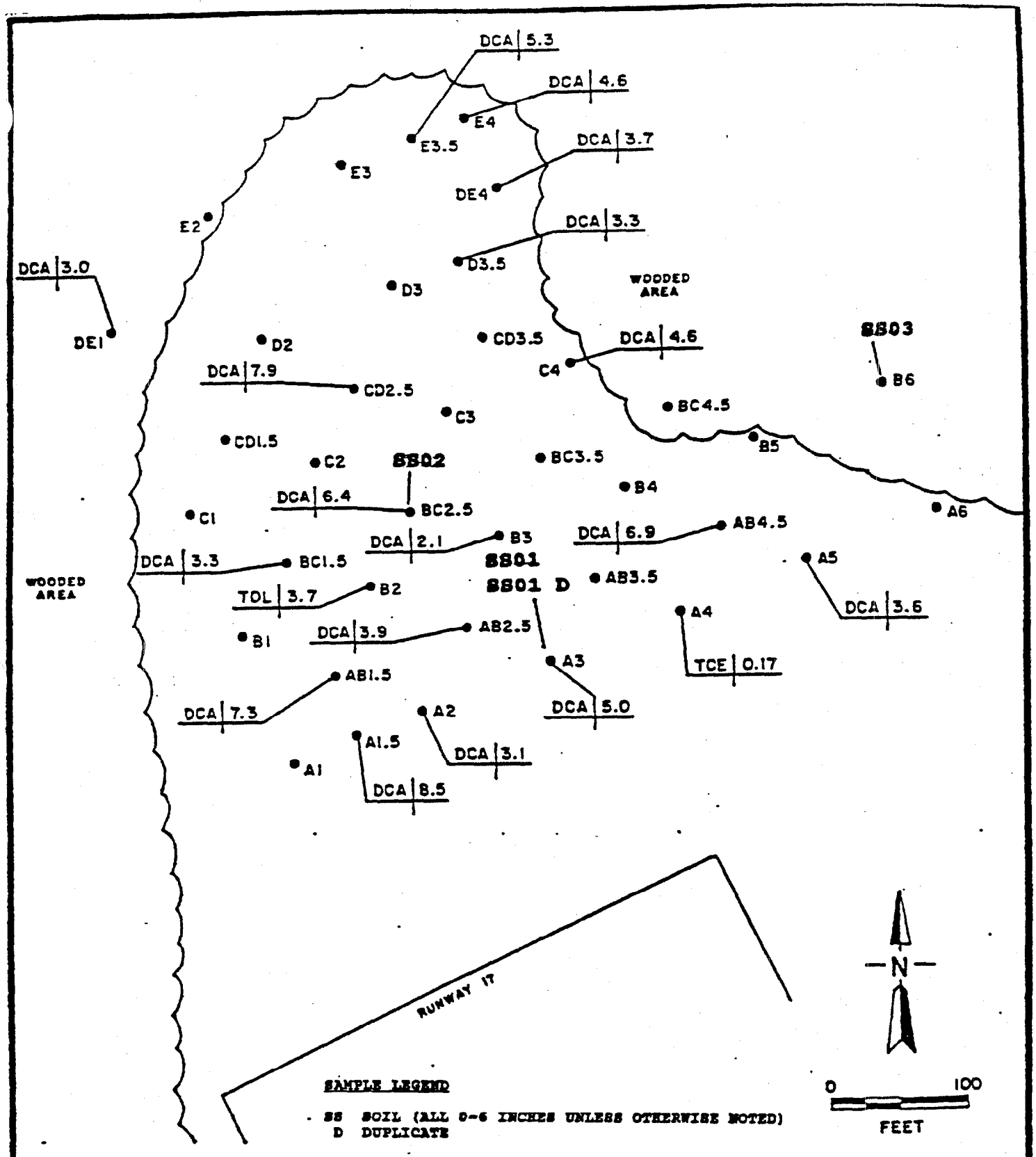
A sample listed twice is a field duplicate.

The acronym ppm stands for parts per million.

SOIL GAS ANALYSIS RESULTS
TABLE 1
Site: Old Waste Oil Dump

SAMPLE NUMBER	CONCENTRATIONS (ppm) DCE	DCA	TCA	TCE	BENZENE	PCE	TOLUENE	XYLENE
	dl=0.02	dl=2.0	dl=3.3	dl=0.01	dl=1.0	dl=.05	dl=1.0	dl=1.0
CD-1.5						0.09		
CD-2.5		7.9						
CD-3.5						0.14		
D-1								
D-3						0.15		
D-3.5		3.3						
DE-1		3.0		0.07				
DE-4		2.2		0.01				
DE-4		3.7						
E-2								
E-3					1.5			
E-3.5		5.3				0.12		
E-4		4.6				0.13		

NOTES:
A blank cell indicates that concentrations were below detection limit (<dl)
A sample listed twice is a field duplicate.
The acronym ppm stands for parts per million.



LEGEND

- Soil Gas Sampling Location
- Wooded Area Boundary
- DCA | 7.9 — Concentration ppm (ug Analyte/l Air); Target Analyte

DCA - Dichloroethane
TCE - Trichloroethylene
TOL - Toluene

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
WALLOPS FLIGHT FACILITY

FIGURE 6-1
WASTE OIL DUMP
SOIL GAS DETECTIONS

EBASCO SERVICES INCORPORATED

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >AF294
Lab Sample Name: HE6984 WFFWODSSS0101
Matrix: Soil
Dilution Factor: 1.1
Sample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/5GMs P

Method Number: 8240
Date Analyzed: 900628
Date Collected: 900620
Date Received: 900621

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Chloromethane		11	U
Vinyl Chloride		11	U
Bromomethane		11	U
Chloroethane		11	U
Trichlorofluoromethane		6	U
Acetone	49	11	
1,1-Dichloroethene		6	U
Methylene Chloride	30	11	
Carbon Disulfide		6	U
trans-1,2-Dichloroethene		6	U
Vinyl Acetate		11	U
1,1-Dichloroethane		6	U
2-Butanone		11	U
cis-1,2-Dichloroethene		6	U
Chloroform		6	U
1,1,1-Trichloroethane	4	6	J
Carbon Tetrachloride		6	U
1,2-Dichloroethane		6	U
Benzene		6	U
Trichloroethene	4	6	J
1,2-Dichloropropane		6	U
Bromodichloromethane		6	U
2-Chloroethylvinylether		6	U
4-Methyl-2-Pentanone		11	U
trans-1,3-Dichloropropene		6	U
Toluene		6	U
cis-1,3-Dichloropropene		6	U
1,1,2-Trichloroethane		6	U
2-Hexanone		11	U
Tetrachloroethene		6	U
Dibromochloromethane		6	U
Chlorobenzene		6	U

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Data File: >AF294
Lab Sample Name: HE6984 WFFWODSSS0101
Matrix: Soil
Dilution Factor: 1.1
Sample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/5GMs P

Method Number: 8240
Date Analyzed: 900628
Date Collected: 900620
Date Received: 900621

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Ethylbenzene		6	U
m + p-Xylenes		6	U
o-Xylene		6	U
Styrene		6	U
Bromoform		6	U
1,1,2,2-Tetrachloroethane		6	U
1,3-Dichlorobenzene		6	U
1,4-Dichlorobenzene		6	U
1,2-Dichlorobenzene		6	U

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >AF295
Lab Sample Name: HE6985 WFFWODDSS0101
Matrix: Soil
Dilution Factor: 1.1
Sample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/5GMs P

Method Number: 8240
Date Analyzed: 900628
Date Collected: 900620
Date Received: 900621

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Chloromethane		11	U
Vinyl Chloride		11	U
Bromomethane		11	U
Chloroethane		6	U
Trichlorofluoromethane		11	U
Acetone	39	11	
1,1-Dichloroethene		6	U
Methylene Chloride	16	11	
Carbon Disulfide		6	U
trans-1,2-Dichloroethene		6	U
Vinyl Acetate		11	U
1,1-Dichloroethane		6	U
2-Butanone		11	U
cis-1,2-Dichloroethene		6	U
Chloroform		6	U
1,1,1-Trichloroethane	4	6	J
Carbon Tetrachloride		6	U
1,2-Dichloroethane		6	U
Benzene		6	U
Trichloroethene		6	U
1,2-Dichloropropane		6	U
Bromodichloromethane		6	U
2-Chloroethylvinylether		6	U
4-Methyl-2-Pentanone		11	U
trans-1,3-Dichloropropene		6	U
Toluene		6	U
cis-1,3-Dichloropropene		6	U
1,1,2-Trichloroethane		6	U
2-Hexanone		11	U
Tetrachloroethene		6	U
Dibromochloromethane		6	U
Chlorobenzene		6	U

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

L__ Data File:	>AF295	Method Number:	8240
ab Sample Name:	HE6985 WFFWODDSS0101	Date Analyzed:	900628
..atrix:	Soil	Date Collected:	900620
Dilution Factor:	1.1	Date Received:	900621

'ample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/5GMs P

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Ethylbenzene		6	U
m + p-Xylenes		6	U
o-Xylene		6	U
Styrene		6	U
Bromoform		6	U
1,1,2,2-Tetrachloroethane		6	U
1,3-Dichlorobenzene		6	U
1,4-Dichlorobenzene		6	U
2-Dichlorobenzene			

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >AF296
Lab Sample Name: HE6986 WFFWODSSS0201
Matrix: Soil
Dilution Factor: 1.1
Sample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/5GMs P

Method Number: 8240
Date Analyzed: 900628
Date Collected: 900620
Date Received: 900621

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Chloromethane		11	U
Vinyl Chloride		11	U
Bromomethane		11	U
Chloroethane		11	U
Trichlorofluoromethane		6	U
Acetone	53	11	
1,1-Dichloroethene		6	U
Methylene Chloride	14	11	
Carbon Disulfide		6	U
trans-1,2-Dichloroethene		6	U
Vinyl Acetate		11	U
1,1-Dichloroethane		6	U
2-Butanone		11	U
cis-1,2-Dichloroethene		6	U
Chloroform		6	U
1,1,1-Trichloroethane	5	6	J
Carbon Tetrachloride		6	U
1,2-Dichloroethane		6	U
Benzene		6	U
Trichloroethene		6	U
1,2-Dichloropropane		6	U
Bromodichloromethane		6	U
2-Chloroethylvinylether		11	U
4-Methyl-2-Pentanone		6	U
trans-1,3-Dichloropropene		6	U
Toluene		6	U
cis-1,3-Dichloropropene		6	U
1,1,2-Trichloroethane		11	U
2-Hexanone		6	U
Tetrachloroethene		6	U
Dibromochloromethane		6	U
Chlorobenzene			

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >AF296
Lab Sample Name: HE6986 WFFWODSSS0201
Matrix: Soil
Dilution Factor: 1.1
Sample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/5GMs P

Method Number: 8240
Date Analyzed: 900628
Date Collected: 900620
Date Received: 900621

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Ethylbenzene		6	U
m + p-Xylenes		6	U
o-Xylene		6	U
Styrene		6	U
Bromoform		6	U
1,1,2,2-Tetrachloroethane		6	U
1,3-Dichlorobenzene		6	U
1,4-Dichlorobenzene		6	U
,2-Dichlorobenzene		6	U

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

ab Data File: >AF306
ab Sample Name: HE6987 WFFWODSSS0301
Matrix: Soil
ilution Factor: 2.6
ample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/2GMs P

Method Number: 8240
Date Analyzed: 900629
Date Collected: 900621
Date Received: 900621

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Chloromethane		26	U
Vinyl Chloride		26	U
Bromomethane		26	U
Chloroethane		26	U
Trichlorofluoromethane		13	U
Acetone	300	26	
1,1-Dichloroethene		13	U
Methylene Chloride	120	26	
rbon Disulfide		13	U
ans-1,2-Dichloroethene		13	U
Vinyl Acetate		26	U
1,1-Dichloroethane		13	U
2-Butanone		26	U
cis-1,2-Dichloroethene		13	U
Chloroform		13	U
1,1,1-Trichloroethane	9	13	J
Carbon Tetrachloride		13	U
1,2-Dichloroethane		13	U
Benzene		13	U
Trichloroethene	31	13	
1,2-Dichloropropane		13	U
Bromodichloromethane		13	U
2-Chloroethylvinylether		13	U
4-Methyl-2-Pentanone		26	U
trans-1,3-Dichloropropene		13	U
Toluene		13	U
cis-1,3-Dichloropropene		13	U
1,1,2-Trichloroethane		13	U
2-Hexanone		26	U
Tetrachloroethene		13	U
Dibromochloromethane		13	U
Chlorobenzene		13	U

HITTMAN EBASCO ASSOCIATES, Inc.
VOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >AF306
Lab Sample Name: HE6987 WFFWODSSS0301
Matrix: Soil
Dilution Factor: 2.6
Sample Info.: GC/MS A,LB,ESI0 0306,5ul IS-28, ,10ul SS-27/2GMs P

Method Number: 8240
Date Analyzed: 900629
Date Collected: 900621
Date Received: 900621

U = not detected
J = estimated value, below detection limit
MS = Matrix Spike compound

Compound	Concentration ug/kg	Detection Limit	
Ethylbenzene		13	U
m + p-Xylenes		13	U
o-Xylene		13	U
Styrene		13	U
Bromoform		13	U
1,1,2,2-Tetrachloroethane		13	U
1,3-Dichlorobenzene		13	U
1,4-Dichlorobenzene		13	U
,2-Dichlorobenzene		13	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >DG050
Lab Sample Name: HE#8195 WFFWODSSS012
Matrix: Soil
Dilution Factor: 103.0
Method Number: CLPQC
Sample Info.: GC/MS D,RC,1ul inj. ESIO-0306 (DIL 3X)

Date Analyzed: 900720
Date Collected: 900716
Date Received: 900716
Date Extracted: 900719
BTL# 2

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
N-Nitroso-di-methylamine		1000	U
Phenol		1000	U
Aniline		1000	U
bis(2-Chloroethyl)ether		1000	U
2-Chlorophenol		1000	U
1,3-Dichlorobenzene		1000	U
1,4-Dichlorobenzene		1000	U
enzyl alcohol		1000	U
2-Dichlorobenzene		1000	U
-Methylphenol		1000	U
bis(2-Chloroisopropyl)ether		1000	U
4-Methylphenol	75	1000	J
N-Nitroso-di-n-propylamine		1000	U
Hexachloroethane		1000	U
Nitrobenzene		1000	U
Isophorone		1000	U
2-Nitrophenol		1000	U
2,4-Dimethylphenol		1000	U
Benzoic acid		5200	U
bis(2-Chloroethoxy)methane		1000	U
2,4-Dichlorophenol		1000	U
1,2,4-Trichlorobenzene		1000	U
Naphthalene		1000	U
4-Chloroaniline		1000	U
Hexachlorobutadiene		1000	U
4-Chloro-3-methylphenol		1000	U
2-Methylnaphthalene		1000	U
Hexachlorocyclopentadiene		1000	U
2,4,6-Trichlorophenol		5200	U
,4,5-Trichlorophenol			
2-Chloronaphthalene		1000	U
2-Nitroaniline		5200	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >DG050
Lab Sample Name: HE#8195 WFFWODSSS012
Matrix: Soil
Dilution Factor: 103.0
Method Number: CLPQC
Sample Info.: GC/MS D,RC,1ul inj. ESIO-0306 (DIL 3X)

Date Analyzed: 900720
Date Collected: 900716
Date Received: 900716
Date Extracted: 900719
BTL# 2

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Dimethylphthalate	390	1000	J
Acenaphthylene		1000	U
2,6-Dinitrotoluene		1000	U
3-Nitroaniline		5200	U
Acenaphthene		1000	U
2,4-Dinitrophenol		5200	U
4-Nitrophenol		5200	U
Dibenzofuran		1000	U
2,4-Dinitrotoluene		1000	U
Diethylphthalate		1000	U
4-Chlorophenyl-phenylether		1000	U
Fluorene		1000	U
4-Nitroaniline		5200	U
4,6-Dinitro-2-methylphenol		5200	U
N-Nitrosodiphenylamine		1000	U
1,2-Diphenyl Hydrazine		1000	U
4-Bromophenyl-phenylether		1000	U
Hexachlorobenzene		1000	U
Pentachlorophenol		5200	U
Phenanthrene		1000	U
Anthracene		1000	U
Di-n-butylphthalate		1000	U
Fluoranthene		1000	U
Benzidine		1000	U
Pyrene	210	1000	J
Butylbenzylphthalate		1000	U
3,3'-Dichlorobenzidine		2100	U
Benzo(a)anthracene	220	1000	J
Chrysene		1000	U
bis(2-Ethylhexyl)phthalate	16000	1000	
Di-n-octylphthalate		1000	U
Benzo(b)fluoranthene		1000	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File:	>DG050		
Lab Sample Name:	HE#8195 WFFWODSSS012	Date Analyzed:	900720
Matrix:	Soil	Date Collected:	900716
Dilution Factor:	103.0	Date Received:	900716
Method Number:	CLPQC	Date Extracted:	900719
Sample Info.: GC/MS D,RC,1ul inj. ESIO-0306 (DIL 3X)			BTL# 2

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Benzo(k)fluoranthene		1000	U
Benzo(a)pyrene	340	1000	J
Indeno(1,2,3-cd)pyrene		1000	U
Dibenz(a,h)anthracene		1000	U
Benzo(g,h,i)perylene		1000	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >BG048
Lab Sample Name: HE7006 WFFWODDSS0101
Matrix: Soil
Dilution Factor: 70.0
Method Number: CLPQC
Sample Info.: GC/MS B,LB,1ul inj, ESI0-0306

Date Analyzed: 900711
Date Collected: 900621
Date Received: 900621
Date Extracted: 900628
BTL# 9

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
N-Nitroso-Di-Methylamine		700	U
Phenol		700	U
Aniline		700	U
bis(-2-Chloroethyl)Ether		700	U
2-Chlorophenol		700	U
1,3-Dichlorobenzene		700	U
1,4-Dichlorobenzene		700	U
Benzyl Alcohol		700	U
1,2-Dichlorobenzene		700	U
2-Methylphenol		700	U
bis(2-chloroisopropyl)Ether		700	U
4-Methylphenol		700	U
N-Nitroso-Di-n-Propylamine		700	U
Hexachloroethane		700	U
Nitrobenzene		700	U
Isophorone		700	U
2-Nitrophenol		700	U
2,4-Dimethylphenol		3500	U
Benzoic Acid		700	U
bis(-2-Chloroethoxy)Methane		700	U
2,4-Dichlorophenol		700	U
1,2,4-Trichlorobenzene		700	U
Naphthalene		700	U
4-Chloroaniline		700	U
Hexachlorobutadiene		700	U
4-Chloro-3-Methylphenol		700	U
2-Methylnaphthalene		700	U
Hexachlorocyclopentadiene		700	U
2,4,6-Trichlorophenol		3500	U
2,4,5-Trichlorophenol		700	U
2-Chloronaphthalene		3500	U
2-Nitroaniline			

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

ab Data File: >BG048
Lab Sample Name: HE7006 WFFWODDSS0101
Matrix: Soil
)ilution Factor: 70.0
Method Number: CLPQC
Sample Info.: GC/MS B,LB,1ul inj, ESI0-0306

Date Analyzed: 900711
Date Collected: 900621
Date Received: 900621
Date Extracted: 900628
BTL# 9

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Dimethyl Phthalate		700	U
Acenaphthylene		700	U
3-Nitroaniline		3500	U
Acenaphthene		700	U
2,4-Dinitrophenol		3500	U
4-Nitrophenol		3500	U
Dibenzofuran		700	U
4-Dinitrotoluene		700	U
6-Dinitrotoluene		700	U
Diethylphthalate		700	U
4-Chlorophenyl-phenylether		700	U
Fluorene		700	U
4-Nitroaniline		3500	U
4,6-Dinitro-2-Methylphenol		3500	U
N-Nitrosodiphenylamine		700	U
1,2-Diphenyl Hydrazine		700	U
4-Bromophenyl-phenylether		700	U
Hexachlorobenzene		700	U
Pentachlorophenol		3500	U
Phenanthrene		700	U
Anthracene		700	U
Di-n-Butylphthalate		700	U
Fluoranthene		700	U
Benzidine		700	U
Pyrene		700	U
Butylbenzylphthalate		700	U
3,3'-Dichlorobenzidine		1400	U
Benzo(a)Anthracene	140	700	J
bis(2-Ethylhexyl)Phthalate		700	U
Chrysene		700	U
Di-n-Octyl Phthalate		700	U
Benzo(b)Fluoranthene		700	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File:	>BG048		
Lab Sample Name:	HE7006 WFFWODDSS0101	Date Analyzed:	900711
Matrix:	Soil	Date Collected:	900621
Dilution Factor:	70.0	Date Received:	900621
Method Number:	CLPQC	Date Extracted:	900628
Sample Info.: GC/MS	B,LB,1ul inj, ESI0-0306		BTL# 9

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Benzo(k)Fluoranthene		700	U
Benzo(a)Pyrene	360	700	J
Indeno(1,2,3-cd)Pyrene		700	U
Dibenzo(a,h)Anthracene		700	U
Benzo(g,h,i)Perylene		700	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >BG049
Lab Sample Name: HE7007 WFFWODSSS0201
Matrix: Soil
Dilution Factor: 78.0
Method Number: CLPQC
Sample Info.: GC/MS B,LB,1ul inj, ESI0-0306

Date Analyzed: 900711
Date Collected: 900621
Date Received: 900621
Date Extracted: 900628
BTL#10

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
N-Nitroso-Di-Methylamine		780	U
Phenol		780	U
Aniline		780	U
bis(-2-Chloroethyl)Ether		780	U
2-Chlorophenol		780	U
1,3-Dichlorobenzene		780	U
4-Dichlorobenzene		780	U
Benzyl Alcohol		780	U
1,2-Dichlorobenzene		780	U
2-Methylphenol		780	U
bis(2-chloroisopropyl)Ether		780	U
4-Methylphenol		780	U
N-Nitroso-Di-n-Propylamine		780	U
Hexachloroethane		780	U
Nitrobenzene		780	U
Isophorone		780	U
2-Nitrophenol		780	U
2,4-Dimethylphenol		3900	U
Benzoic Acid		780	U
bis(-2-Chloroethoxy)Methane		780	U
2,4-Dichlorophenol		780	U
1,2,4-Trichlorobenzene		780	U
Naphthalene		780	U
4-Chloroaniline		780	U
Hexachlorobutadiene		780	U
4-Chloro-3-Methylphenol		780	U
2-Methylnaphthalene		780	U
Hexachlorocyclopentadiene		780	U
2,4,6-Trichlorophenol		3900	U
2,4,5-Trichlorophenol		780	U
2-Chloronaphthalene		3900	U
2-Nitroaniline			

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File: >BG049
Lab Sample Name: HE7007 WFFWODSSS0201
Matrix: Soil
Dilution Factor: 78.0
Method Number: CLPQC
Sample Info.: GC/MS B,LB,1ul inj, ESI0-0306

Date Analyzed: 900711
Date Collected: 900621
Date Received: 900621
Date Extracted: 900628
BTL#10

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Dimethyl Phthalate		780	U
Acenaphthylene		780	U
3-Nitroaniline		3900	U
Acenaphthene		780	U
2,4-Dinitrophenol		3900	U
4-Nitrophenol		3900	U
benzofuran		780	U
,4-Dinitrotoluene		780	U
2,6-Dinitrotoluene		780	U
Diethylphthalate		780	U
4-Chlorophenyl-phenylether		780	U
Fluorene		780	U
4-Nitroaniline		3900	U
4,6-Dinitro-2-Methylphenol		3900	U
N-Nitrosodiphenylamine		780	U
1,2-Diphenyl Hydrazine		780	U
4-Bromophenyl-phenylether		780	U
Hexachlorobenzene		780	U
Pentachlorophenol		3900	U
Phenanthrene		780	U
Anthracene		780	U
Di-n-Butylphthalate		780	U
Fluoranthene		780	U
Benzidine		780	U
Pyrene		780	U
Butylbenzylphthalate		780	U
3,3'-Dichlorobenzidine		1600	U
Benzo(a)Anthracene		780	U
bis(2-Ethylhexyl)Phthalate		780	U
Chrysene		780	U
Di-n-Octyl Phthalate		780	U
Benzo(b)Fluoranthene		780	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File:	>BG049		
Lab Sample Name:	HE7007 WFFWODSSS0201	Date Analyzed:	900711
Matrix:	Soil	Date Collected:	900621
Dilution Factor:	78.0	Date Received:	900621
Method Number:	CLPQC	Date Extracted:	900628
Sample Info.: GC/MS	B,LB,1ul inj, ESI0-0306		BTL#10

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Benzo(k)Fluoranthene		780	U
Benzo(a)Pyrene		780	U
Indeno(1,2,3-cd)Pyrene		780	U
Dibenzo(a,h)Anthracene		780	U
Benzo(g,h,i)Perylene		780	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

ab Data File:	>BG050		
Lab Sample Name:	HE7008 WFFWODSSS0301	Date Analyzed:	900711
Matrix:	Soil	Date Collected:	900621
ilution Factor:	72.0	Date Received:	900621
Method Number:	CLPQC	Date Extracted:	900628
Sample Info.: GC/MS	B,LB,1ul inj, ESI0-0306		BTL#11

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
N-Nitroso-Di-Methylamine		720	U
Phenol		720	U
Aniline		720	U
bis(-2-Chloroethyl)Ether		720	U
2-Chlorophenol		720	U
1,3-Dichlorobenzene		720	U
1,4-Dichlorobenzene		720	U
enzyl Alcohol		720	U
,2-Dichlorobenzene		720	U
2-Methylphenol		720	U
bis(2-chloroisopropyl)Ether		720	U
4-Methylphenol		720	U
N-Nitroso-Di-n-Propylamine		720	U
Hexachloroethane		720	U
Nitrobenzene		720	U
Isophorone		720	U
2-Nitrophenol		720	U
2,4-Dimethylphenol		3600	U
Benzoic Acid		720	U
bis(-2-Chloroethoxy)Methane		720	U
2,4-Dichlorophenol		720	U
1,2,4-Trichlorobenzene		720	U
Naphthalene		720	U
4-Chloroaniline		720	U
Hexachlorobutadiene		720	U
4-Chloro-3-Methylphenol		720	U
2-Methylnaphthalene		720	U
Hexachlorocyclopentadiene		720	U
2,4,6-Trichlorophenol		3600	U
2,4,5-Trichlorophenol		720	U
2-Chloronaphthalene		3600	U
2-Nitroaniline			

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File:	>BG050		
Lab Sample Name:	HE7008 WFFWODSSS0301	Date Analyzed:	900711
Matrix:	Soil	Date Collected:	900621
Dilution Factor:	72.0	Date Received:	900621
Method Number:	CLPQC	Date Extracted:	900628
Sample Info.: GC/MS	B,LB,1ul inj, ESI0-0306		BTL#11

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Dimethyl Phthalate		720	U
Acenaphthylene		720	U
3-Nitroaniline		3600	U
Acenaphthene		720	U
2,4-Dinitrophenol		3600	U
4-Nitrophenol		3600	U
Dibenzofuran		720	U
2,4-Dinitrotoluene		720	U
2,6-Dinitrotoluene	1000	720	
Diethylphthalate		720	U
4-Chlorophenyl-phenylether		720	U
Fluorene		720	U
4-Nitroaniline		3600	U
4,6-Dinitro-2-Methylphenol		3600	U
N-Nitrosodiphenylamine		720	U
1,2-Diphenyl Hydrazine		720	U
4-Bromophenyl-phenylether		720	U
Hexachlorobenzene		720	U
Pentachlorophenol		3600	U
Phenanthrene		720	U
Anthracene		720	U
Di-n-Butylphthalate		720	U
Fluoranthene		720	U
Benzidine		720	U
Pyrene		720	U
Butylbenzylphthalate		720	U
3,3'-Dichlorobenzidine		1400	U
Benzo(a)Anthracene		720	U
bis(2-Ethylhexyl)Phthalate	110	720	J
Chrysene		720	U
Di-n-Octyl Phthalate		720	U
Benzo(b)Fluoranthene		720	U

HITTMAN EBASCO ASSOCIATES, Inc.
SEMIVOLATILE ORGANIC ANALYSIS - TABULATED REPORT

Lab Data File:	>BG050		
Lab Sample Name:	HE7008 WFFWODSSS0301	Date Analyzed:	900711
Matrix:	Soil	Date Collected:	900621
Dilution Factor:	72.0	Date Received:	900621
Method Number:	CLPQC	Date Extracted:	900628
Sample Info.: GC/MS	B,LB,1ul inj, ESI0-0306		BTL#11

U = not detected
J = estimated value, below detection limit

Compound	Concentration ug/Kg	Detection Limit	
Benzo(k)Fluoranthene		720	U
Benzo(a)Pyrene		720	U
Indeno(1,2,3-cd)Pyrene		720	U
Dibenzo(a,h)Anthracene		720	U
Benzo(g,h,i)Perylene		720	U

Laboratory Name HITTMAN EBASCO ASSOCIATES, INC.

Case No ES10 0306

Sample Number
WFF-WODS-SSD1-2

HCAI # 8195

Organics Analysis Data Sheet
(Page 3)

Pesticide/PCBs

Concentration (Low) Medium (Circle One)

GPC Cleanup ☒ Yes ☐ No

Date Extracted Prepared 07/20/90

Separatory Funnel Extraction ☐ Yes

Continuous Liquid - Liquid Extraction ☐ Yes

Date Analyzed 07/25/90

Conc/ Dil Factor 1

Percent Moisture (decanted) 3.94

CAS Number	Compound	ug/Kg
319-84-6	Alpha-BHC	4.2 U
319-85-7	Beta-BHC	4.2 U
319-86-8	Delta-BHC	4.2 U
58-89-9	Gamma-BHC(Lindane)	4.2 U
76-44-8	Heptachlor	4.2 U
309-00-2	Aldrin	4.2 U
1024-57-3	Heptachlor Epoxide	4.2 U
959-98-9	Endosulfan I	4.2 U
60-57-1	Dieldrin	8.4 U
72-55-9	4 4-DDE	7.5 J
72-20-8	Endrin	8.4 U
33213-65-9	Endosulfan II	8.4 U
72-54-8	4 4-DDD	8.4 U
1031-07-8	Endosulfan Sulfate	8.4 U
50-29-3	4 4-DDT	15
72-43-5	Methoxychlor	42 U
53494-70-5	Endrin Ketone	8.4 U
57-74-9	Chlordane	42 U
8001-35-2	Toxaphene	83 U
12674-11-2	Aroclor-1016	42 U
11104-28-2	Aroclor-1221	42 U
11141-16-5	Aroclor-1232	42 U
53469-21-9	Aroclor-1242	42 U
12672-29-6	Aroclor-1248	42 U
11097-69-1	Aroclor-1254	83 U
11096-82-5	Aroclor-1260	83 U

V_I = Volume of extract injected (ul)
V_S = Volume of water extracted (ml)
W_S = Weight of sample extracted (g)
V_T = Volume of total extract (ul)

V_S _____ or W_S 30.02 V_T 10,000 V_I 1.0

FORM I

Laboratory Name HITTMAN EBASCO ASSOCIATES, INC.

Case No ESIO-0306

Sample Number
WFFWCDS-SS02-01

HEAI # 7007

Organics Analysis Data Sheet (Page 3)

Pesticide/PCBs

Concentration (Low) Medium (Circle One)

GPC Cleanup [X] Yes [ ] No

Date Extracted Prepared 06/28/90

Separatory Funnel Extraction [ ] Yes

Date Analyzed 07/09/90

Continuous Liquid - Liquid Extraction [ ] Yes

Conc/ Dil Factor 1

Percent Moisture (decanted) 12.4

CAS Number	Compound	ug/L or ug/Kg
319-84-6	Alpha-BHC	18 U
319-85-7	Beta-BHC	18 U
319-86-8	Delta-BHC	18 U
58-89-9	Gamma-BHC(Lindane)	18 U
76-44-8	Heptachlor	18 U
309-00-2	Aldrin	18 U
1024-57-3	Heptachlor Epoxide	18 U
959-98-9	Endosulfan I	18 U
60-57-1	Dieldrin	36 U
72-55-9	4 4-DDE	36 U
72-20-8	Endrin	36 U
33213-65-9	Endosulfan II	36 U
72-54-8	4 4-DDD	36 U
1031-07-8	Endosulfan Sulfate	36 U
50-29-3	4 4-DDT	36 U
72-43-5	Methoxychlor	180 U
53494-70-5	Endrin Ketone	36 U
57-74-9	Chlordane	180 U
8001-35-2	Toxaphene	360 U
12674-11-2	Aroclor-1016	180 U
11104-28-2	Aroclor-1221	180 U
11141-16-5	Aroclor-1232	180 U
53469-21-9	Aroclor-1242	180 U
12672-29-6	Aroclor-1248	180 U
11097-69-1	Aroclor-1254	360 U
11096-82-5	Aroclor-1260	360 U

V_I = Volume of extract injected (ul)
V_S = Volume of water extracted (ml)
W_S = Weight of sample extracted (g)
V_T = Volume of total extract (ul)

V_S _____ or W_S 30.54 V_T 2,000 V_I 1.0

FORM I

TTMAN EBASCO ASSOCIATES, INC.

INORGANIC DATA ANALYSIS

CLIENT: NASA WALLOPS
SOW #: 789
LAB SAMPLE ID #: 7032
SAMPLE ID #: WFFWOODS-SS01-01

DATE: 13-Jul-90
CASE #: ES10-0306
RECEIPT DATE: 6/21/90
QC REPORT #: N/A

ELEMENTS IDENTIFIED AND MEASURED

CONCENTRATION: LOW ✓ MEDIUM _____
MATRIX: WATER _____ SOIL ✓ SLUDGE _____ OTHER _____
ug/l or mg/kg DRY WEIGHT (CIRCLE ONE)

1.ALUMINUM	4270 *	13.MAGNESIUM	< 1000
2.ANTIMONY	< 12 N	14.MANGANESE	72 *
3.ARSENIC	7.3	15.MERCURY	< 0.1
4.BARIUM	< 40	16.NICKEL	< 8
5.BERYLLIUM	< 1	17.POTASSIUM	< 1000
6.CADMIUM	< 1	18.SELENIUM	< 1
7.CALCIUM	< 1000	19.SILVER	< 2
8.CHROMIUM	6.1 N	20.SODIUM	< 1000
9.COBALT	< 10	21.THALLIUM	< 2
10.COPPER	< 5	22.VANADIUM	13
11.IRON	4050 *	23.ZINC	19
12.LEAD	25 *	PCT. SOLIDS	99.8
CYANIDE	~~< 0.1~~ R 7/20/90 < 1.0		

FOOTNOTES: FOR REPORTING RESULTS TO EPA, STANDARD RESULT QUALIFIERS ARE USED AS DEFINED ON COVER PAGE. ADDITIONAL FLAGS OR FOOTNOTES EXPLAINING RESULTS ARE ENCOURAGED. DEFINITION OF SUCH FLAGS MUST BE EXPLICIT AND CONTAINED ON COVER PAGE.

COMMENTS: _____

LAB MANAGER _____

FORM I

ITHAN EBASCO ASSOCIATES, INC.

INORGANIC DATA ANALYSIS

CLIENT: NASA WALLOPS
SOW #: 789
LAB SAMPLE ID #: 7035
SAMPLE ID #: WFFWOOS-SS03-01

DATE: 13-Jul-90
CASE #: ES10-0306
RECEIPT DATE: 6/21/90
QC REPORT #: N/A

ELEMENTS IDENTIFIED AND MEASURED

CONCENTRATION: LOW ✓ MEDIUM _____
MATRIX: WATER _____ SOIL ✓ SLUDGE _____ OTHER _____
ug/l or mg/kg DRY WEIGHT (CIRCLE ONE)

1.ALUMINUM	4210 *	13.MAGNESIUM	< 1050
2.ANTIMONY	< 13 N	14.MANGANESE	358 *
3.ARSENIC	6.8	15.MERCURY	< 0.11
4.BARIUM	44	16.NICKEL	12
5.BERYLLIUM	< 1.1	17.POTASSIUM	< 1050
6.CADMIUM	1.5	18.SELENIUM	< 1.1
7.CALCIUM	1900	19.SILVER	< 2.1
8.CHROMIUM	7.7 N	20.SODIUM	< 1050
9.COBALT	< 11	21.THALLIUM	< 2.1
10.COPPER	8.6	22.VANADIUM	14
11.IRON	17800 *	23.ZINC	22
12.LEAD	18 *	PCT. SOLIDS	94.9
CYANIDE	< 1		

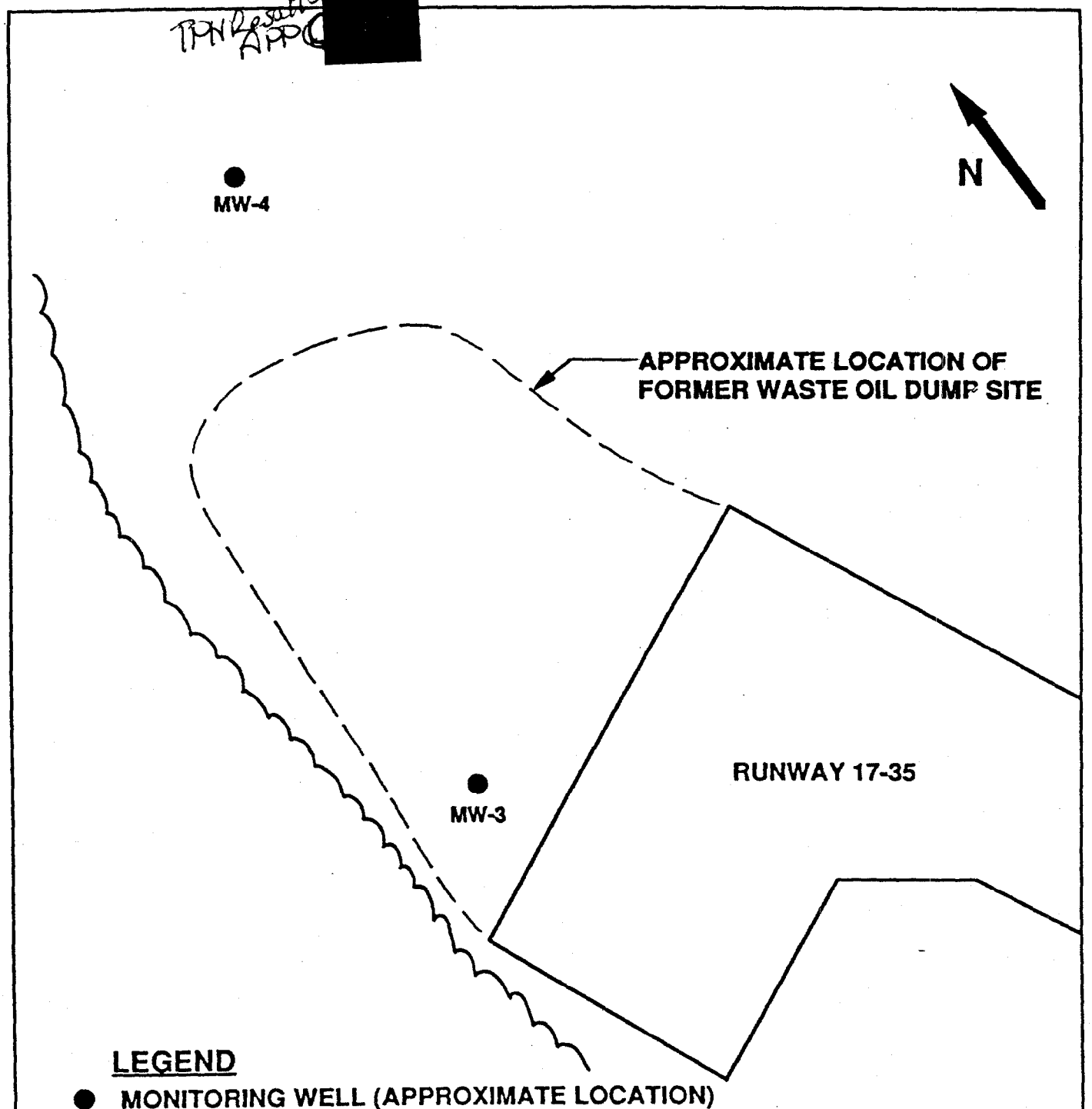
FOOTNOTES: FOR REPORTING RESULTS TO EPA, STANDARD RESULT QUALIFIERS ARE USED AS DEFINED ON COVER PAGE. ADDITIONAL FLAGS OR FOOTNOTES EXPLAINING RESULTS ARE ENCOURAGED. DEFINITION OF SUCH FLAGS MUST BE EXPLICIT AND CONTAINED ON COVER PAGE.

COMMENTS: _____

LAB MANAGER _____

M&E

TPH Results APPC



SCALE IN FEET

135 0 135

BASE MAP SOURCE:

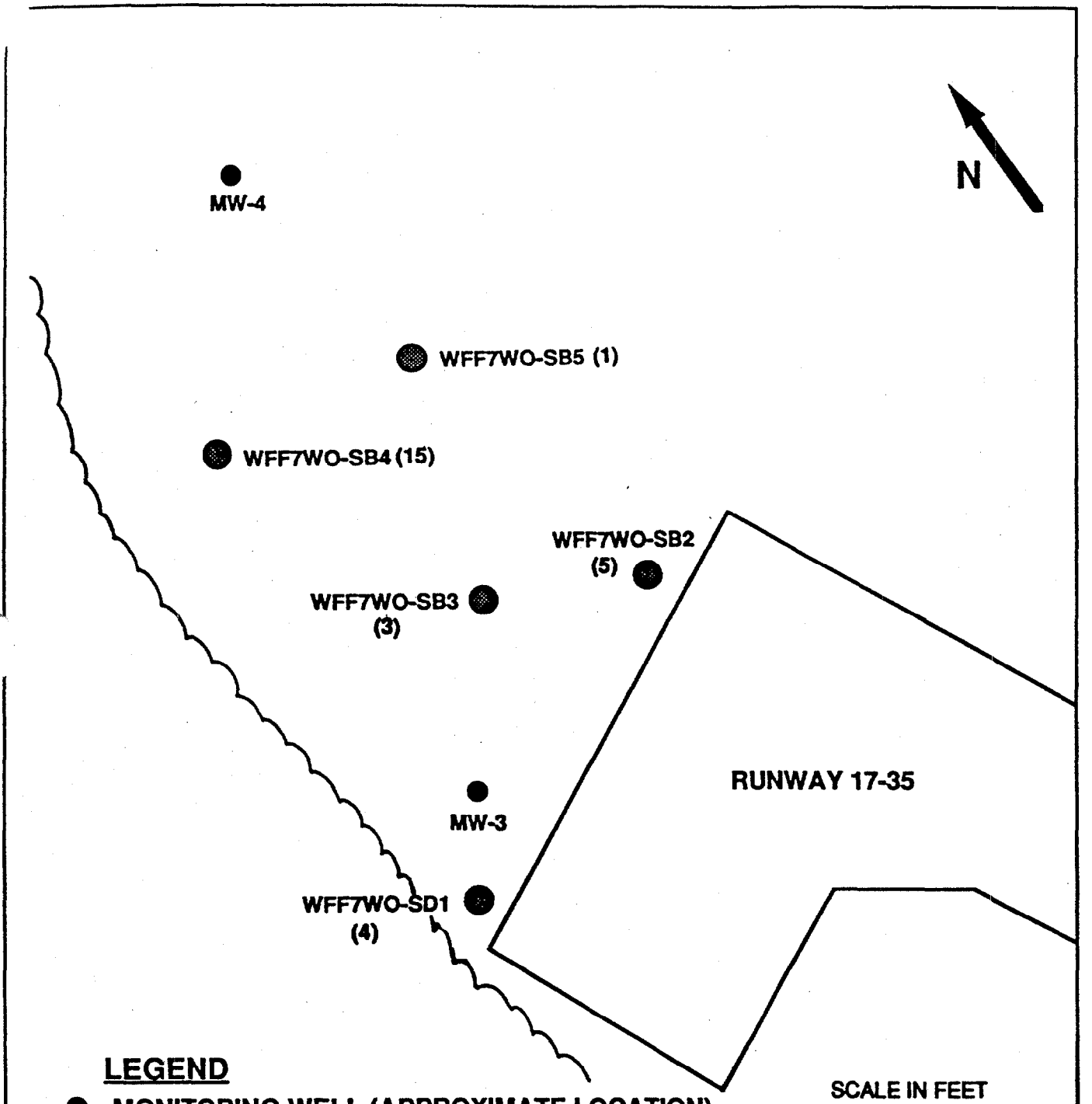
SITE INSPECTION REPORT
JANUARY 1990
EBASCO SERVICES, INC.

Metcalf & Eddy

SCALE: AS SHOWN, APPROXIMATE

FIGURE 1B3-3
WASTE OIL DUMP
SOURCE AREA MAP

REVISION OF SITE INVESTIGATION
NASA/WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA



BASE MAP SOURCE:

SITE INSPECTION REPORT
JANUARY 1990
EBASCO SERVICES, INC.

Metcalf & Eddy

SCALE: AS SHOWN, APPROXIMATE

FIGURE 2I - 2
WASTE OIL DUMP
SAMPLING LOCATIONS

REVISION OF SITE INVESTIGATION
NASA/WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VIRGINIA

Total Petroleum Hydrocarbons
GC/FID - EPA Method 8015 Modified

Client: METCALF & EDDY, INC./NASA 007
Client Sample ID: WFF7WO--SD1
SPECTRALYTIX Sample ID: MET92-001-92050672 Sample Type: Soil
Date Sampled : 05/20/92 Date Received: 05/21/92
Date Analyzed : 05/30/92

Analyte	Result	Detection Limit	Units
Total Petroleum Hydrocarbons	ND	1.0	mg/kg

Units of mg/kg are equivalent to ppm.
ND = Compound not detected at or above the listed detection limit.

Total Petroleum Hydrocarbons
GC/FID - EPA Method 8015 Modified

Client: METCALF & EDDY, INC./NASA 007
Client Sample ID: WFF7WO-SB2
SPECTRALYTIX Sample ID: MET92-001-92050673 Sample Type: Soil
Date Sampled : 05/20/92 Date Received: 05/21/92
Date Analyzed : 05/30/92

Analyte	Result	Detection Limit	Units
Total Petroleum Hydrocarbons	ND	1.0	mg/kg

Units of mg/kg are equivalent to ppm.
ND = Compound not detected at or above the listed detection limit.

Total Petroleum Hydrocarbons
GC/FID - EPA Method 8015 Modified

Client: METCALF & EDDY, INC./NASA 007
Client Sample ID: WFF7WO-SB3
SPECTRALYTIX Sample ID: MET92-001-92050674 Sample Type: Soil
Date Sampled : 05/20/92 Date Received: 05/21/92
Date Analyzed : 05/30/92

Analyte	Result	Detection Limit	Units
Total Petroleum Hydrocarbons	ND	1.0	mg/kg

Units of mg/kg are equivalent to ppm.
ND = Compound not detected at or above the listed detection limit.

Total Petroleum Hydrocarbons
GC/FID - EPA Method 8015 Modified

Client: METCALF & EDDY, INC./NASA 007
Client Sample ID: WFF7WO-SB4
SPECTRALYTIX Sample ID: MET92-001-92050675 Sample Type: Soil
Date Sampled : 05/20/92 Date Received: 05/21/92
Date Analyzed : 05/30/92

Analyte	Result	Detection Limit	Units
Total Petroleum Hydrocarbons	ND	1.0	mg/kg

Units of mg/kg are equivalent to ppm.
ND = Compound not detected at or above the listed detection limit.

Total Petroleum Hydrocarbons
GC/FID - EPA Method 8015 Modified

Client: METCALF & EDDY, INC./NASA 007
Client Sample ID: WFF7WO-SB5
SPECTRALYTIX Sample ID: MET92-001-92050676 Sample Type: Soil
Date Sampled : 05/20/92 Date Received: 05/21/92
Date Analyzed : 05/30/92

Analyte	Result	Detection Limit	Units
Total Petroleum Hydrocarbons	ND	1.0	mg/kg

Units of mg/kg are equivalent to ppm.
ND = Compound not detected at or above the listed detection limit.

Lancaster Laboratories
Where quality is a science.

LLI Sample No. WW 2089405
Collected: 2/16/94 at 10:40 by MB

Submitted: 2/18/94 Reported: 3/17/94
Discard: 3/25/94

Sampling Point 1 Unfiltered Grab Water Sample
W.O.D. / D-9

Account No: 06620
Nat'l Aeronautics & Space Adm
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

P.O. S-09815F/719
Rel.

CAT NO.	ANALYSIS NAME	AS RECEIVED RESULTS	LIMIT OF QUANTITATION	UNITS
0255	Lead	N.D.	0.050	mg/l
1051	Chromium (furnace method)	0.0862	0.0050	mg/l

1 COPY TO Nat'l Aeronautics & Space Adm ATTN: Ms. Brenda Hall

Questions? Contact your Client Services Representative
Eileen R. Hostetler at (717) 656-2301
02:34:12 D 0001 8 0 0 409816
603 15.00 00006400 ASR000

Respectfully Submitted
Michele McClarin, B.A.
Group Leader, GC/MS Volatiles

Lancaster Laboratories
Where quality is a science.

LLI Sample No. WW 2089406
Collected: 2/16/94 at 10:40 by MB

Submitted: 2/18/94 Reported: 3/17/94
Discard: 3/25/94

Sampling Point 1 Filtered Grab Water Sample
W.O.D. / D-9

Account No: 06620
Nat'l Aeronautics & Space Adm
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

P.O. S-09815F/719
Rel.

CAT NO.	ANALYSIS NAME	AS RECEIVED RESULTS	LIMIT OF QUANTITATION	UNITS
0255	Lead	N.D.	0.050	mg/l
1051	Chromium (furnace method)	0.0012	0.0010	mg/l

This sample was field filtered for dissolved metals.

1 COPY TO Nat'l Aeronautics & Space Adm ATTN: Ms. Brenda Hall

Questions? Contact your Client Services Representative
Eileen R. Hostetler at (717) 656-2301
02:34:17 D 0001 8 0 0 409816
603 15.00 00006400 ASR000

Respectfully Submitted
Michele McClarin, B.A.
Group Leader, GC/MS Volatiles

Lancaster Laboratories, Inc.
2425 New Holland Pike
Lancaster, PA 17601-5994

Analyte	9704G324-001 1WFFMB-BGSS1 22-APR-97		9704G324-002 1WFFMB-BGSS2 22-APR-97		9704G324-003 1WFFMB-BGSS3 22-APR-97		9704G324-004 1WFFMB-BGSS4 22-APR-97		9704G324-005 1WFFMB-BGSS5 22-APR-97	
VOA (ug/kg)										
1,1,1-Trichloroethane	12	U	12	U	13	U	13	U	13	U
1,1,2,2-Tetrachloroethane	12	U	12	U	13	U	13	U	13	U
1,1,2-Trichloroethane	12	U	12	U	13	U	13	U	13	U
1,1-Dichloroethane	12	U	12	U	13	U	13	U	13	U
1,1-Dichloroethene	12	U	12	U	13	U	13	U	13	U
1,2-Dichloroethane	12	U	12	U	13	U	13	U	13	U
1,2-Dichloroethene (total)	12	U	12	U	13	U	13	U	13	U
1,2-Dichloropropane	12	U	12	U	13	U	13	U	13	U
2-Butanone	12	U	12	U	13	U	13	U	13	U
2-Hexanone	12	U	12	U	13	U	13	U	13	U
4-Methyl-2-pentanone	12	U	12	U	13	U	13	U	13	U
Acetone	12	U	12	U	13	U	13	U	13	U
Benzene	12	U	12	U	13	U	13	U	13	U
Bromodichloromethane	12	U	12	U	13	U	13	U	13	U
Bromoform	12	U	12	U	13	U	13	U	13	U
Bromomethane	12	U	12	U	13	U	13	U	13	U
Carbon Disulfide	12	U	12	U	13	U	13	U	13	U
Carbon Tetrachloride	12	U	12	U	13	U	13	U	13	U
Chlorobenzene	12	U	12	U	13	U	13	U	13	U
Chloroethane	12	U	12	U	13	U	13	U	13	U
Chloroform	12	U	12	U	13	U	13	U	13	U
Chloromethane	12	U	12	U	13	U	13	U	13	U
cis-1,3-Dichloropropene	12	U	12	U	13	U	13	U	13	U
Dibromochloromethane	12	U	12	U	13	U	13	U	13	U
Ethylbenzene	12	U	12	U	13	U	13	U	13	U
Methylene Chloride	12	U	12	U	13	U	13	U	13	U
Styrene	12	U	12	U	13	U	13	U	13	U
Tetrachloroethene	3	J	12	U	13	U	13	U	13	U
Toluene	12	U	12	U	13	U	13	U	13	U
trans-1,3-Dichloropropene	12	U	12	U	13	U	13	U	13	U

Analyte	9704G324-001 1WFFMB-BGSS1 22-APR-97		9704G324-002 1WFFMB-BGSS2 22-APR-97		9704G324-003 1WFFMB-BGSS3 22-APR-97		9704G324-004 1WFFMB-BGSS4 22-APR-97		9704G324-005 1WFFMB-BGSS5 22-APR-97	
Trichloroethene	12	U	12	U	13	U	13	U	13	U
Vinyl chloride	12	U	12	U	13	U	13	U	13	U
Xylene (total)	12	U	12	U	13	U	13	U	13	U
SVOC (ug/kg)										
1,2,4-Trichlorobenzene	410	U	380	U	420	U	420	U	440	U
1,2-Dichlorobenzene	410	U	380	U	420	U	420	U	440	U
1,3-Dichlorobenzene	410	U	380	U	420	U	420	U	440	U
1,4-Dichlorobenzene	410	U	380	U	420	U	420	U	440	U
2,2'-oxybis(1-Chloropropane)	410	U	380	U	420	U	420	U	440	U
2,4,5-Trichlorophenol	1000	U	940	U	1000	U	1100	U	1100	U
2,4,6-Trichlorophenol	410	U	380	U	420	U	420	U	440	U
2,4-Dichlorophenol	410	U	380	U	420	U	420	U	440	U
2,4-Dimethylphenol	410	U	380	U	420	U	420	U	440	U
2,4-Dinitrophenol	1000	UJ	940	UJ	1000	UJ	1100	UJ	1100	UJ
2,4-Dinitrotoluene	410	U	380	U	420	U	420	U	440	U
2,6-Dinitrotoluene	410	U	380	U	420	U	420	U	440	U
2-Chloronaphthalene	410	U	380	U	420	U	420	U	440	U
2 Chlorophenol	410	U	380	U	420	U	420	U	440	U
2-Methylnaphthalene	410	U	380	U	420	U	420	U	440	U
2-Methylphenol	410	U	380	U	420	U	420	U	440	U
2-Nitroaniline	1000	U	940	U	1000	U	1100	U	1100	U
2-Nitrophenol	410	U	380	U	420	U	420	U	440	U
3,3'-Dichlorobenzidine	410	U	380	U	420	U	420	U	440	U
3-Nitroaniline	1000	U	940	U	1000	U	1100	U	1100	U
4,6-Dinitro-2-methylphenol	1000	U	940	U	1000	U	1100	U	1100	U
4-Bromophenyl-phenylether	410	U	380	U	420	U	420	U	440	U
4-Chloro-3-methylphenol	410	U	380	U	420	U	420	U	440	U
4-Chloroaniline	410	U	380	U	420	U	420	U	440	U
4-Chlorophenyl-phenylether	410	U	380	U	420	U	420	U	440	U
4-Methylphenol	410	U	380	U	420	U	420	U	440	U
4-Nitroaniline	1000	U	940	U	1000	U	1100	U	1100	U

Analyte	9704G324-001 1WFFMB-BGSS1 22-APR-97	9704G324-002 1WFFMB-BGSS2 22-APR-97	9704G324-003 1WFFMB-BGSS3 22-APR-97	9704G324-004 1WFFMB-BGSS4 22-APR-97	9704G324-005 1WFFMB-BGSS5 22-APR-97
4-Nitrophenol	1000 U	940 U	1000 U	1100 U	1100 U
Acenaphthene	410 U	380 U	420 U	420 U	440 U
Acenaphthylene	410 U	380 U	420 U	420 U	440 U
Anthracene	410 U	380 U	420 U	420 U	440 U
Benzo(a)anthracene	410 U	380 U	420 U	420 U	440 U
Benzo(a)pyrene	410 U	380 U	420 U	420 U	440 U
Benzo(b)fluoranthene	410 U	380 U	420 U	420 U	440 U
Benzo(g,h,i)perylene	410 U	380 U	420 U	420 U	440 U
Benzo(k)fluoranthene	410 U	380 U	420 U	420 U	440 U
bis(2-Chloroethoxy)methane	410 U	380 U	420 U	420 U	440 U
bis(2-Chloroethyl)ether	410 U	380 U	420 U	420 U	440 U
bis(2-Ethylhexyl)phthalate	410 U	380 U	420 U	420 U	440 U
Butylbenzylphthalate	410 U	380 U	420 U	420 U	440 U
Carbazole	410 U	380 U	420 U	420 U	440 U
Chrysene	410 U	380 U	420 U	420 U	440 U
Di-n-butylphthalate	410 U	380 U	420 U	420 U	440 U
Di-n-octylphthalate	410 U	380 U	420 U	420 U	440 U
Dibenzo(a,h)anthracene	410 U	380 U	420 U	420 U	440 U
Dibenzofuran	410 U	380 U	420 U	420 U	440 U
Diethylphthalate	410 U	380 U	420 U	420 U	440 U
Dimethylphthalate	410 U	380 U	420 U	420 U	440 U
Fluoranthene	410 U	380 U	420 U	420 U	440 U
Fluorene	410 U	380 U	420 U	420 U	440 U
Hexachlorobenzene	410 U	380 U	420 U	420 U	440 U
Hexachlorobutadiene	410 U	380 U	420 U	420 U	440 U
Hexachlorocyclopentadiene	410 U	380 U	420 U	420 U	440 U
Hexachloroethane	410 U	380 U	420 U	420 U	440 U
Indeno(1,2,3-cd)pyrene	410 U	380 U	420 U	420 U	440 U
Isophorone	410 U	380 U	420 U	420 U	440 U
N-Nitroso-di-n-propylamine	410 U	380 U	420 U	420 U	440 U
N-Nitrosodiphenylamine (1)	410 U	380 U	420 U	420 U	440 U
Naphthalene	410 U	380 U	420 U	420 U	440 U

Analyte	9704G324-001 1WFFMB-BGSS1 22-APR-97		9704G324-002 1WFFMB-BGSS2 22-APR-97		9704G324-003 1WFFMB-BGSS3 22-APR-97		9704G324-004 1WFFMB-BGSS4 22-APR-97		9704G324-005 1WFFMB-BGSS5 22-APR-97	
Nitrobenzene	410	U	380	U	420	U	420	U	440	U
Pentachlorophenol	1000	U	940	U	1000	U	1100	U	1100	U
Phenanthrene	410	U	380	U	420	U	420	U	440	U
Phenol	410	U	380	U	420	U	420	U	440	U
Pyrene	410	U	380	U	420	U	420	U	440	U
PEST/PCB (ug/kg)										
4,4'-DDD	31	J	3.8	U	6	J	5.5	J	4.8	J
4,4'-DDE	3100	CD	340	CD	850	CD	1200	CD	650	CD
4,4'-DDT	4300	CD	83	D	230	D	320	D	200	D
Aldrin	2	U	1.9	U	2.1	U	2.1	U	2.2	U
alpha-BHC	2	U	1.9	U	2.1	U	2.1	U	2.2	U
alpha-Chlordane	2	U	1.9	U	2.1	U	2.1	U	2.2	U
Aroclor-1016	40	U	38	U	42	U	42	U	44	U
Aroclor-1221	81	U	76	U	85	U	84	U	88	U
Aroclor-1232	40	U	38	U	42	U	42	U	44	U
Aroclor-1242	40	U	38	U	42	U	42	U	44	U
Aroclor-1248	40	U	38	U	42	U	42	U	44	U
Aroclor-1254	40	U	38	U	42	U	42	U	44	U
Aroclor-1260	40	U	38	U	42	U	42	U	44	U
beta-BHC	2	U	1.9	U	2.1	U	2.1	U	2.2	U
delta-BHC	2	U	1.9	U	2.1	U	2.1	U	2.2	U
Dieldrin	4	U	3.8	U	4.2	U	4.2	U	4.4	U
Endosulfan I	2	U	1.9	U	2.1	U	2.1	U	2.2	U
Endosulfan II	4	U	3.8	U	4.2	U	4.2	U	4.4	U
Endosulfan sulfate	4	U	3.8	U	4.2	U	4.2	U	4.4	U
Endrin	4	U	3.8	U	4.2	U	4.2	U	4.4	U
Endrin aldehyde	4	U	3.8	U	4.2	U	4.2	U	4.4	U
Endrin ketone	4	U	3.8	U	4.2	U	4.2	U	4.4	U
gamma-BHC (Lindane)	2	U	1.9	U	2.1	U	2.1	U	2.2	U
gamma-Chlordane	2	U	1.9	U	2.1	U	2.1	U	2.2	U
Heptachlor	2	U	1.9	U	2.1	U	2.1	U	2.2	U

Analyte	9704G324-001 1WFFMB-BGSS1 22-APR-97		9704G324-002 1WFFMB-BGSS2 22-APR-97		9704G324-003 1WFFMB-BGSS3 22-APR-97		9704G324-004 1WFFMB-BGSS4 22-APR-97		9704G324-005 1WFFMB-BGSS5 22-APR-97	
Heptachlor epoxide	2	U	1.9	U	2.1	U	2.1	U	2.2	U
Methoxychlor	20	U	19	U	21	U	21	U	22	U
Toxaphene	200	U	190	U	210	U	210	U	220	U
METALS, TOTAL (mg/kg)										
Aluminum	9970		6140		5610		6160		7100	
Antimony	0.3	U	0.43		0.36		0.32	U	0.35	U
Arsenic	3.1		1.3		0.96		1.2		1.4	
Barium	26.1		31.1		32.1		32.2		23.3	
Beryllium	0.18		0.25		0.23		0.24		0.18	
Cadmium	0.04	U	0.04	U	0.07		0.04	U	0.04	U
Calcium	297		342		836		376		559	
Chromium	14.1		7.1		6.3		6.6		7.1	
Cobalt	1.7		1.6		1.4		1.6		1.3	
Copper	4.5		2		2.4		2.3		2.3	
Cyanide	0.55	U	0.5	U	0.5	U	0.57	U	0.53	U
Iron	9180		4480		4200		4930		4460	
Lead	13.7		6.3		6.2		6.6		5.5	
Magnesium	1170		589		587		635		593	
Manganese	47		98.1		82.8		98.4		71.7	
Mercury	0.05	U	0.04	U	0.05	U	0.05	U	0.05	U
Nickel	5.3		2.9		2.7		3		2.9	
Potassium	848		344		292		257		394	
Selenium	0.79	K	0.57	K	0.57	K	0.54	K	0.86	K
Silver	0.04		0.04	U	0.04	U	0.04	U	0.04	U
Sodium	132		111		88.8		112		69.9	
Thallium	0.35	U	0.35	U	0.39	U	0.38	U	0.41	U
Vanadium	19.3		9.3		8.5		9.8		10.2	
Zinc	14.7		9.7		10.9		11.5		11.3	

Analyte	9704G324-001 1WFFMB-BGSS1 22-APR-97		9704G324-002 1WFFMB-BGSS2 22-APR-97		9704G324-003 1WFFMB-BGSS3 22-APR-97		9704G324-004 1WFFMB-BGSS4 22-APR-97		9704G324-005 1WFFMB-BGSS5 22-APR-97	
OTHERS										
% Solids (Percent)	81.1		86.2		77.1		77.2		74.2	
Chromium VI (mg/kg)	0.27	L	0.23	R	0.28	L	0.25	R	0.27	R
Diesel Range Organics (mg/kg)	25		7.2	U	5.8	J	73		7.7	J
Gasoline Range Organics (mg/kg)	62	U	58	U	84		65	U	300	

Analyte	9704G324-006 IWFFMB-BGSS6 22-APR-97		9704G324-007 IWFFMB-BGSS7 17-APR-97	
VOA (ug/kg)				
1,1,1-Trichloroethane	13	U	12	U
1,1,2,2-Tetrachloroethane	13	UJ	12	U
1,1,2-Trichloroethane	13	U	12	U
1,1-Dichloroethane	13	U	12	U
1,1-Dichloroethene	13	U	12	U
1,2-Dichloroethane	13	U	12	U
1,2-Dichloroethene (total)	13	U	12	U
1,2-Dichloropropane	13	U	12	U
2-Butanone	13	U	12	U
2-Hexanone	13	UJ	12	U
4-Methyl-2-pentanone	13	UJ	12	U
Acetone	13	U	12	U
Benzene	13	U	12	U
Bromodichloromethane	13	U	12	U
Bromoform	13	U	12	U
Bromomethane	13	U	12	U
Carbon Disulfide	13	U	12	U
Carbon Tetrachloride	13	U	12	U
Chlorobenzene	13	UJ	12	U
Chloroethane	13	U	12	U
Chloroform	13	U	12	U
Chloromethane	13	U	12	U
cis-1,3-Dichloropropene	13	U	12	U
Dibromochloromethane	13	U	12	U
Ethylbenzene	13	UJ	12	U
Methylene Chloride	13	U	12	U
Styrene	13	UJ	12	U
Tetrachloroethene	13	UJ	12	U
Toluene	13	UJ	12	U
trans-1,3-Dichloropropene	13	U	12	U

Analyte	9704G324-006 1WFFMB-BGSS6 22-APR-97		9704G324-007 1WFFMB-BGSS7 17-APR-97	
Trichloroethene	13	U	12	U
Vinyl chloride	13	U	12	U
Xylene (total)	13	UJ	12	U
SVOC (ug/kg)				
1,2,4-Trichlorobenzene	420	U	410	U
1,2-Dichlorobenzene	420	U	410	U
1,3-Dichlorobenzene	420	U	410	U
1,4-Dichlorobenzene	420	U	410	U
2,2'-oxybis(1-Chloropropane)	420	U	410	U
2,4,5-Trichlorophenol	1000	U	1000	U
2,4,6-Trichlorophenol	420	U	410	U
2,4-Dichlorophenol	420	U	410	U
2,4-Dimethylphenol	420	U	410	U
2,4-Dinitrophenol	1000	UJ	1000	UJ
2,4-Dinitrotoluene	420	U	410	U
2,6-Dinitrotoluene	420	U	410	U
2-Chloronaphthalene	420	U	410	U
2-Chlorophenol	420	U	410	U
2-Methylnaphthalene	420	U	410	U
2-Methylphenol	420	U	410	U
2-Nitroaniline	1000	U	1000	U
2-Nitrophenol	420	U	410	U
3,3'-Dichlorobenzidine	420	U	410	U
3-Nitroaniline	1000	U	1000	U
4,6-Dinitro-2-methylphenol	1000	U	1000	U
4-Bromophenyl-phenylether	420	U	410	U
4-Chloro-3-methylphenol	420	U	410	U
4-Chloroaniline	420	U	410	U
4-Chlorophenyl-phenylether	420	U	410	U
4-Methylphenol	420	U	410	U
4-Nitroaniline	1000	U	1000	U

Analyte	9704G324-006 1WFFMB-BGSS6 22-APR-97		9704G324-007 1WFFMB-BGSS7 17-APR-97	
4-Nitrophenol	1000	U	1000	U
Acenaphthene	420	U	410	U
Acenaphthylene	420	U	410	U
Anthracene	420	U	410	U
Benzo(a)anthracene	420	U	410	U
Benzo(a)pyrene	420	U	410	U
Benzo(b)fluoranthene	420	U	410	U
Benzo(g,h,i)perylene	420	U	410	U
Benzo(k)fluoranthene	420	U	410	U
bis(2-Chloroethoxy)methane	420	U	410	U
bis(2-Chloroethyl)ether	420	U	410	U
bis(2-Ethylhexyl)phthalate	420	U	410	U
Butylbenzylphthalate	420	U	410	U
Carbazole	420	U	410	U
Chrysene	420	U	410	U
Di-n-butylphthalate	420	U	410	U
Di-n-octylphthalate	420	U	410	U
Dibenzo(a,h)anthracene	420	U	410	U
Dibenzofuran	420	U	410	U
Diethylphthalate	420	U	410	U
Dimethylphthalate	420	U	410	U
Fluoranthene	420	U	410	U
Fluorene	420	U	410	U
Hexachlorobenzene	420	U	410	U
Hexachlorobutadiene	420	U	410	U
Hexachlorocyclopentadiene	420	U	410	U
Hexachloroethane	420	U	410	U
Indeno(1,2,3-cd)pyrene	420	U	410	U
Isophorone	420	U	410	U
N-Nitroso-di-n-propylamine	420	U	410	U
N-Nitrosodiphenylamine (1)	420	U	410	U
Naphthalene	420	U	410	U

Analyte	9704G324-006 1WFFMB-BGSS6 22-APR-97		9704G324-007 1WFFMB-BGSS7 17-APR-97	
Nitrobenzene	420	U	410	U
Pentachlorophenol	1000	U	1000	U
Phenanthrene	420	U	410	U
Phenol	420	U	410	U
Pyrene	420	U	410	U
PEST/PCB (ug/kg)				
4,4'-DDD	2.1	J	4	J
4,4'-DDE	270	D	1100	CD
4,4'-DDT	74	D	280	D
Aldrin	2.1	U	2	U
alpha-BHC	2.1	U	2	U
alpha-Chlordane	2.1	U	2	U
Aroclor-1016	42	U	40	U
Aroclor-1221	84	U	81	U
Aroclor-1232	42	U	40	U
Aroclor-1242	42	U	40	U
Aroclor-1248	42	U	40	U
Aroclor-1254	42	U	40	U
Aroclor-1260	42	U	40	U
beta-BHC	2.1	U	2	U
delta-BHC	2.1	U	2	U
Dieldrin	4.2	U	4	U
Endosulfan I	2.1	U	2	U
Endosulfan II	4.2	U	4	U
Endosulfan sulfate	4.2	U	4	U
Endrin	4.2	U	4	U
Endrin aldehyde	4.2	U	4	U
Endrin ketone	4.2	U	4	U
gamma-BHC (Lindane)	2.1	U	2	U
gamma-Chlordane	2.1	U	2	U
Heptachlor	2.1	U	2	U

Analyte	9704G324-006 1WFFMB-BGSS6 22-APR-97		9704G324-007 1WFFMB-BGSS7 17-APR-97	
Heptachlor epoxide	2.1	U	2	U
Methoxychlor	21	U	20	U
Toxaphene	210	U	200	U
METALS, TOTAL (mg/kg)				
Aluminum	6840		6500	
Antimony	0.39		0.44	
Arsenic	1.9		1.5	
Barium	33.2		39.3	
Beryllium	0.21		0.26	
Cadmium	0.09		0.11	
Calcium	874		829	
Chromium	7.2		6.7	
Cobalt	1.9		1.9	
Copper	2.9		3.8	
Cyanide	0.57	U	0.5	U
Iron	5580		5440	
Lead	12		9.6	
Magnesium	693		723	
Manganese	173		168	
Mercury	0.05	U	0.06	U
Nickel	3.4		3.4	
Potassium	334		374	
Selenium	0.8	K	0.54	K
Silver	0.04	U	0.13	
Sodium	94.1		118	
Thallium	0.4	U	0.38	U
Vanadium	11.1		10.6	
Zinc	15.4		25.6	

Analyte	9704G324-006 1WFFMB-BGSS6 22-APR-97		9704G324-007 1WFFMB-BGSS7 17-APR-97	
OTHERS				
% Solids (Percent)	77.9		80.7	
Chromium VI (mg/kg)	0.25	R	0.25	R
Diesel Range Organics (mg/kg)	5.8		23	
Gasoline Range Organics (mg/kg	530		0.062	U

Site Total Results

Analyte	9805G585-001 2WFF16-SB1S1 07-MAY-98		9805G585-002 2WFF16-SB2S1 07-MAY-98		9805G585-003 2WFF16-SB3S1 07-MAY-98		9805G585-004 2WFF16-SB4S1 07-MAY-98		9805G585-005 2WFF16-SB1S2 07-MAY-98		9805G585-009 2WFF16-SB1S2DUP 07-MAY-98	
VOA (ug/kg)												
Chloroethane	11	U	10	U	11	U	11	U	56	K	120	U
Ethylbenzene	11	U	10	U	11	U	11	U	1200	J	1000	
Tetrachloroethene	11	U	10	U	11	U	11	U	320		81	J
Toluene	11	U	10	U	11	U	11	U	1400		320	
Xylene (total)	11	U	10	U	11	U	11	U	9200	J	6600	J
SVOC (ug/kg)												
2-Methylnaphthalene	380	UJ	340	UJ	7400	UJ	350	UJ	16000	J	22000	J
Acenaphthene	380	UJ	340	UJ	7400	UJ	350	UJ	380	UJ	390	UJ
Benzo(a)pyrene	380	UJ	340	UJ	7400	UJ	350	UJ	380	UJ	390	UJ
Benzo(g,h,i)perylene	380	UJ	83	J	7400	UJ	350	UJ	380	UJ	390	UJ
bis(2-Ethylhexyl)phthalate	480	B	340	UJ	7400	UJ	350	UJ	2900	B	4600	B
Chrysene	380	UJ	78	J	7400	UJ	350	UJ	380	UJ	390	UJ
Dibenzofuran	380	UJ	340	UJ	7400	UJ	350	UJ	380	UJ	390	UJ
Fluorene	380	UJ	340	UJ	7400	UJ	350	UJ	380	UJ	2100	J
Indeno(1,2,3-cd)pyrene	380	UJ	340	UJ	7400	UJ	350	UJ	380	UJ	390	UJ
Naphthalene	380	UJ	340	UJ	7400	UJ	350	UJ	2900	J	390	UJ
Phenanthrene	380	UJ	340	UJ	7400	UJ	350	UJ	4100	J	5700	J
Pyrene	380	UJ	340	UJ	7400	UJ	350	UJ	230	J	290	J
PEST/PCB (ug/kg)												
4,4'-DDD	3.8	U	17	U	18	U	3.5	U	21		26	
4,4'-DDE	3.8	U	17	U	7.4	K	3.5	U	1.5	J	1.9	J
4,4'-DDT	3.8	U	6.3	J	7.4	J	4.2	J	8.8		4.7	
Aldrin	1.9	U	8.7	U	9.3	U	1.8	U	2.7	J	3.1	J
gamma-BHC (Lindane)	1.9	U	8.7	U	9.3	U	1.8	U	10	JN	11	J
Heptachlor epoxide	1.9	U	8.7	U	9.3	U	1.8	U	1.9	U	1.2	J
METALS, TOTAL (mg/kg)												
Aluminum	10600		6880		5560		3290		917		2930	J
Antimony	0.32	U	0.29	U	0.29	U	0.29	U	0.31	U	0.33	U
Arsenic	1.9		1.7		1.1		0.74		0.37	U	0.38	U
Barium	33.3		16.6		14.2		9.8		2.9		5.9	
Beryllium	0.16	B	0.05	B	0.07	B	0.04	B	0.04	U	0.04	U

Site 16 Soil Results

Analyte	9805G585-001 2WFF16-SB1S1 07-MAY-98		9805G585-002 2WFF16-SB2S1 07-MAY-98		9805G585-003 2WFF16-SB3S1 07-MAY-98		9805G585-004 2WFF16-SB4S1 07-MAY-98		9805G585-005 2WFF16-SB1S2 07-MAY-98		9805G585-009 2WFF16-SB1S2DUP 07-MAY-98	
Calcium	627		146		84.2		91.6		32.5	B	148	
Chromium	10.5		8.4		6.7		3.6		1.4		3.1	
Cobalt	2.7		1		0.85		0.74		0.11	U	0.11	U
Copper	8.3	K	3.3	K	2.7	K	1.5	B	0.22	U	0.24	B
Cyanide	0.5	U	0.46	U	0.45	U	0.43	U	0.42	U	0.44	U
Iron	8710		5920		4410		2650		516		1520	
Lead	7.5		30.6		37.1		7.4		2.6	B	4.4	
Magnesium	703		443		352		204		43.2		167	
Manganese	89.9		34.8		27.3		29.8		4.7		7.8	
Nickel	5.7		3.1		2.6		1.1		0.18	U	0.19	U
Potassium	495		410		307		189		85.8	B	168	
Selenium	0.56	B	0.52	K	0.38	K	0.61	K	0.31	U	0.33	U
Silver	0.11	U	0.1	U	0.1	U	0.1	U	0.11	U	0.11	U
Sodium	345		224		172		102		109		250	
Vanadium	16.3		14.8		13.2		5.9		1.8		5.4	
Zinc	29.6		13.8		9.7		7.9		0.41	B	1.2	B
OTHERS												
% Solids (Percent)												
TPH - DRO (mg/kg)	7.1	U	260	Y	440	Y	12	Y	3,300	Y	5,100	Y
TPH - GRO (ug/kg)	57	U	52	U	56	U	43	JZ	1,100,000	Y	1,000,000	Y

Site 16 Soil Results

Analyte	9805G585-007 2WFF16-SB2S2 07-MAY-98		9805G585-006 2WFF16-SB3S2 07-MAY-98		9805G585-008 2WFF16-SB4S2 07-MAY-98		9A02G090-002 3WFF16-SS1 02/25/00		9A02G090-003 3WFF16-SS2 02/25/00		9A02G090-004 3WFF16-SS3 02/25/00	
VOA (ug/kg)												
Chloroethane	110	J	11	U	120	U	11	U	11	U	12	U
Ethylbenzene	2200	J	11	U	120	U	11	U	11	U	12	U
Tetrachloroethene	110	UJ	11	U	120	U	11	U	11	U	12	U
Toluene	1700	J	11	U	120	U	11	U	11	U	12	U
Xylene (total)	13000	J	11	U	64	J	11	U	11	U	12	U
SVOC (ug/kg)												
2-Methylnaphthalene	29000	J	370	UJ	310	J	360	U	370	U	380	U
Acenaphthene	1800	J	370	UJ	54	J	360	U	370	U	380	U
Benzo(a)pyrene	3700	UJ	370	UJ	400	UJ	360	U	370	U	380	U
Benzo(g,h,i)perylene	3700	UJ	370	UJ	400	UJ	360	U	370	U	380	U
bis(2-Ethylhexyl)phthalate	5500	B	360	B	940	B	2100		1600		1800	
Chrysene	3700	UJ	370	UJ	400	UJ	360	U	370	U	380	U
Dibenzofuran	1100	J	370	UJ	400	UJ	360	U	370	U	380	U
Fluorene	2800	J	370	UJ	100	J	360	U	370	U	380	U
Indeno(1,2,3-cd)pyrene	3700	UJ	370	UJ	400	UJ	360	U	370	U	380	U
Naphthalene	7700	J	370	UJ	400	UJ	360	U	370	U	380	U
Phenanthrene	7800	J	43	J	290	J	360	U	370	U	380	U
Pyrene	580	J	370	UJ	400	UJ	360	U	370	U	380	U
PEST/PCB (ug/kg)												
4,4'-DDD	3.7	U	3.8	U	4	U	36	U	3.7	U	3.8	U
4,4'-DDE	3.7	U	3.8	U	4	U	36	U	3.7	U	4.2	
4,4'-DDT	3.7	U	3.8	U	4	U	36	U	3.7	U	3.8	U
Aldrin	1.9	U	1.9	U	4.8	J	18	U	1.8	U	1.9	U
gamma-BHC (Lindane)	1.9	U	1.9	U	2	U	18	U	1.8	U	1.9	U
Heptachlor epoxide	1.9	U	1.9	U	1.2	J	18	U	1.8	U	1.9	U
METALS, TOTAL (mg/kg)												
Aluminum	1070		2180		1220	J	6030		6400		9350	
Antimony	0.3	U	0.32	U	0.32	U	0.79	U	0.8	U	0.78	U
Arsenic	0.35	U	0.37	U	0.38	U	1.8		1.2		1.9	
Barium	2.8		4.1		3.7		23.6		18.8		31	
Beryllium	0.04	U	0.04	U	0.04	U	0.15		0.11	U	0.17	

Site 16 Soil Results

Analyte	9805G585-007 2WFF16-SB2S2 07-MAY-98		9805G585-006 2WFF16-SB3S2 07-MAY-98		9805G585-008 2WFF16-SB4S2 07-MAY-98		9A02G090-002 3WFF16-SS1 02/25/00		9A02G090-003 3WFF16-SS2 02/25/00		9A02G090-004 3WFF16-SS3 02/25/00	
Calcium	23.4	B	102		99.9		143		372		891	
Chromium	1.3		2.2		1.9		6.5		8.5		11	
Cobalt	0.13		0.13		0.11	U	1.4		1.3		2.7	
Copper	0.24	B	0.22	B	0.23	U	2.9		4.4		3.5	
Cyanide	0.39	U	0.59		0.48	U	0.5	U	0.27	U	0.36	U
Iron	500		1690		828	J	5250		6570		10700	
Lead	4.9		2	B	2.3	B	37		27.9		8.7	
Magnesium	43.4		100		68.6		402		440		874	
Manganese	2.3		4.7		3.9		60.1		47.8		87.1	
Nickel	0.18	U	0.19	U	0.19	U	3.2		3.3		5.1	
Potassium	100	B	136		107	B	241		369		409	
Selenium	0.35	K	0.32	U	0.34	K	0.18	U	0.2	U	0.21	U
Silver	0.11	U	0.11	U	0.11	U	0.15	U	0.15	U	0.15	U
Sodium	70.2		132		83		293		273		439	
Vanadium	2		3.4		2.7		12.6		12.6		19.7	
Zinc	0.56	B	0.87	B	0.78	B	12.9		18.3		15.1	
OTHERS												
% Solids (Percent)							90.4		89.3		85.8	
TPH - DRO (mg/kg)	6,800	Y	110		1,200	Y	590	Y	270	Y	4	JY
TPH - GRO (ug/kg)	2,300,000	Y	57	U	900,000	Y	55	U	56	U	58	U

Analyte	9A02G090-005 3WFF16-SS4 02/25/00		9A02G090-006 3WFF16-SS5 02/25/00		9A02G090-007 3WFF16-SS6 02/25/00		9A02G090-008 3WFF16-SS7 02/25/00		9A02G090-009 3WFF16-SS8 02/25/00		9A02G090-010 3WFF16-SS9 02/25/00	
VOA (ug/kg)												
Chloroethane	11	U	11	U	12	U	11	U	11	U	11	U
Ethylbenzene	11	U	11	U	12	U	11	U	11	U	11	U
Tetrachloroethene	11	U	11	U	12	U	11	U	11	U	11	U
Toluene	11	U	11	U	12	U	11	U	11	U	11	U
Xylene (total)	11	U	11	U	12	U	11	U	11	U	11	U
SVOC (ug/kg)												
2-Methylnaphthalene	350	U	370	U	380	U	360	U	380	U	370	U
Acenaphthene	350	U	370	U	380	U	360	U	380	U	370	U
Benzo(a)pyrene	350	U	370	U	380	U	360	U	380	U	910	
Benzo(g,h,i)perylene	350	U	370	U	380	U	360	U	380	U	430	
bis(2-Ethylhexyl)phthalate	820		1000		640		940		560		2800	
Chrysene	350	U	370	U	380	U	360	U	380	U	390	
Dibenzofuran	350	U	370	U	380	U	360	U	380	U	370	U
Fluorene	350	U	370	U	380	U	360	U	380	U	370	U
Indeno(1,2,3-cd)pyrene	350	U	370	U	380	U	360	U	380	U	140	J
Naphthalene	350	U	370	U	380	U	360	U	380	U	370	U
Phenanthrene	350	U	370	U	380	U	360	U	380	U	370	U
Pyrene	350	U	370	U	380	U	360	U	380	U	370	U
PEST/PCB (ug/kg)												
4,4'-DDD	3.5	U	3.7	U	3.8	U	3.7	U	3.8	U	36	U
4,4'-DDE	3.5	U	3.7	U	3.8	U	3.7	U	3.4	J	36	U
4,4'-DDT	3.5	U	3.7	U	3.8	U	3.7	U	4.5		36	U
Aldrin	1.8	U	1.8	U	1.9	U	1.8	U	1.9	U	18	U
gamma-BHC (Lindane)	1.8	U	1.8	U	1.9	U	1.8	U	1.9	U	18	U
Heptachlor epoxide	1.8	U	1.8	U	1.9	U	1.8	U	1.9	U	18	U
METALS, TOTAL (mg/kg)												
Aluminum	5960		6130		6760		3560		3760		8280	
Antimony	0.73	U	0.77	U	0.76	U	0.73	U	0.78	U	0.78	U
Arsenic	0.78		1.2		1.1		0.98		0.63	U	1.6	
Barium	12		16.8		26.8		14.3		15		22.9	
Beryllium	0.1	U	0.11		0.2		0.1	U	0.11	U	0.15	

Site 16 Soil Results

Analyte	9A02G090-005 3WFF16-SS4 02/25/00		9A02G090-006 3WFF16-SS5 02/25/00		9A02G090-007 3WFF16-SS6 02/25/00		9A02G090-008 3WFF16-SS7 02/25/00		9A02G090-009 3WFF16-SS8 02/25/00		9A02G090-010 3WFF16-SS9 02/25/00	
Calcium	41.8		110		354		231		342		213	
Chromium	4.5		5.9		6.6		4		4.5		9.3	
Cobalt	0.89		1.8		1.8		1		0.84		1.3	
Copper	1.4		2.3		7.8		1.9		2.9		3.6	
Cyanide	0.41	U	0.49	U	0.47	U	0.27	U	0.5	U	0.54	U
Iron	3700		4760		5440		2720		3130		6100	
Lead	23.5		9.3		10.5		5.4		12		60.5	
Magnesium	218		372		515		269		274		507	
Manganese	28		58.2		87.6		55.5		43.2		48.5	
Nickel	2.8		3.3		3.7		1.5		2.6		4.1	
Potassium	183		259		283		204		220		437	
Selenium	0.18	U	0.27		0.21	U	0.2	U	0.2	U	0.18	U
Silver	0.14	U	0.15	U	0.16		0.14	U	0.48		0.15	U
Sodium	189		277		378		187		165		296	
Vanadium	7.1		9.3		11.1		5.7		9.2		15.4	
Zinc	5.3		12.6		26.1		11		14.1		13.5	
OTHERS												
% Solids (Percent)	93.3		90		86.1		90.5		87.9		90.1	
TPH - DRO (mg/kg)	3	JY	4	JY	6	JY	98	Y	56	Y	520	Y
TPH - GRO (ug/kg)	54	U	56	U	58	U	55	U	57	U	56	U

Analyte	9A02G090-011 3WFF16-SS10 02/25/00		9A02G090-019 3WFF16-SS10DUP 02/25/00		9A02G090-012 3WFF16-SS11 02/25/00		9A02G090-013 3WFF16-SS12 02/25/00		9A02G090-014 3WFF16-SS13 02/25/00		9A02G090-015 3WFF16-SS14 02/25/00	
VOA (ug/kg)												
Chloroethane	11	U	10	U	10	U	11	U	11	U	12	U
Ethylbenzene	11	U	10	U	10	U	11	U	11	U	12	U
Tetrachloroethene	11	U	10	U	10	U	11	U	11	U	12	U
Toluene	11	U	10	U	10	U	11	U	11	U	12	U
Xylene (total)	11	U	10	U	10	U	11	U	11	U	12	U
SVOC (ug/kg)												
2-Methylnaphthalene	350	U	350	U	340	U	360	U	360	U	390	U
Acenaphthene	350	U	350	U	340	U	360	U	360	U	390	U
Benzo(a)pyrene	1300		1100		340	U	360	U	360	U	390	U
Benzo(g,h,i)perylene	510		590		340	U	360	U	360	U	390	U
bis(2-Ethylhexyl)phthalate	920		950		1500		740		430		1800	
Chrysene	400		410		230	J	360	U	360	U	390	U
Dibenzofuran	350	U	350	U	340	U	360	U	360	U	390	U
Fluorene	350	U	350	U	340	U	360	U	360	U	390	U
Indeno(1,2,3-cd)pyrene	110	J	130	J	340	U	360	U	360	U	390	U
Naphthalene	350	U	350	U	340	U	360	U	360	U	390	U
Phenanthrene	350	U	350	U	340	U	360	U	360	U	390	U
Pyrene	350	U	350	U	340	U	360	U	360	U	390	U
PEST/PCB (ug/kg)												
4,4'-DDD	35	U	35	U	35	U	3.5	U	3.6	U	3.9	U
4,4'-DDE	35	U	35	U	35	U	2.8	J	3.9		3.9	U
4,4'-DDT	35	U	35	U	35	U	3.5	U	12		3.9	U
Aldrin	17	U	17	U	17	U	1.7	U	1.8	U	2	U
gamma-BHC (Lindane)	17	U	17	U	17	U	1.7	U	1.8	U	2	U
Heptachlor epoxide	17	U	17	U	17	U	1.7	U	1.8	U	2	U
METALS, TOTAL (mg/kg)												
Aluminum	4020		3900		3400		2850		3230		7270	
Antimony	0.76	U	0.68	U	0.71	U	0.71	U	0.92		0.82	U
Arsenic	0.77		0.55	U	0.58	U	0.58	U	1.4		1.3	
Barium	9.4		10		8.3		12.6		13.5		25.3	
Beryllium	0.11	U	0.1	U	0.1	U	0.1	U	0.1	U	0.12	U

Site 1c ... Results

Analyte	9A02G090-011 3WFF16-SS10 02/25/00		9A02G090-019 3WFF16-SS10DUP 02/25/00		9A02G090-012 3WFF16-SS11 02/25/00		9A02G090-013 3WFF16-SS12 02/25/00		9A02G090-014 3WFF16-SS13 02/25/00		9A02G090-015 3WFF16-SS14 02/25/00	
Calcium	79.4		75.1		67.4		170		406		633	
Chromium	4.7		4.6		3.9		3.4		3.8		7.8	
Cobalt	0.68		0.65		0.6		0.71		3.2		1.9	
Copper	2.1		1.9		1.4		1.8		2.9		8.3	
Cyanide	0.47	U	0.47	U	0.51	U	0.48	U	0.52	U	0.4	U
Iron	2920		3020		2340		2340		3110		6810	
Lead	25.4		22		23.3		5.4		12		9.2	
Magnesium	256		253		201		176		214		537	
Manganese	23.9		23.1		27.7		33.8		128		72.1	
Nickel	2.9		2.6		1.6		1.2		1.6		4.2	
Potassium	228		221		180		149		177		354	
Selenium	0.19	U	0.65		0.23		0.27		0.47		0.43	
Silver	0.36		0.24		0.14	U	0.24		0.16		0.16	U
Sodium	222		155		174		153		161		356	
Vanadium	14.1		13.7		7.6		5.1		6.2		12	
Zinc	10.7		10.3		6.7		13.2		11.1		53.2	
OTHERS												
% Solids (Percent)	94.1		94.7		96.3		92.9		91.7		84.9	
TPH - DRO (mg/kg)	800	Y	790	Y	870	Y	17	Y	9	Y	6	Y
TPH - GRO (ug/kg)	53	U	53	U	52	U	54	U	54	U	59	U

Analyte	9A02G090-016 3WFF16-SS15 02/25/00		9A02G090-017 3WFF16-SS16 02/25/00		9A02G090-018 3WFF16-SS17 02/25/00	
VOA (ug/kg)						
Chloroethane	11	U	12	U	12	U
Ethylbenzene	11	U	12	U	12	U
Tetrachloroethene	11	U	12	U	12	U
Toluene	11	U	12	U	12	U
Xylene (total)	11	U	12	U	12	U
SVOC (ug/kg)						
2-Methylnaphthalene	380	U	380	U	390	U
Acenaphthene	380	U	380	U	390	U
Benzo(a)pyrene	380	U	380	U	390	U
Benzo(g,h,i)perylene	200	J	380	U	390	U
bis(2-Ethylhexyl)phthalate	1100		1400		980	
Chrysene	180	J	380	U	390	U
Dibenzofuran	380	U	380	U	390	U
Fluorene	380	U	380	U	390	U
Indeno(1,2,3-cd)pyrene	380	U	380	U	390	U
Naphthalene	380	U	380	U	390	U
Phenanthrene	380	U	380	U	390	U
Pyrene	380	U	380	U	390	U
PEST/PCB (ug/kg)						
4,4'-DDD	38	U	12		3.9	U
4,4'-DDE	38	U	310	D	3.5	J
4,4'-DDT	38	U	260	D	4.2	
Aldrin	19	U	1.9	U	1.9	U
gamma-BHC (Lindane)	19	U	1.9	U	1.9	U
Heptachlor epoxide	19	U	1.9	U	1.9	U
METALS, TOTAL (mg/kg)						
Aluminum	8490		6350		4730	
Antimony	0.7	U	0.71	U	0.73	U
Arsenic	1.4		2.9		0.83	
Barium	27.4		33.3		18.7	
Beryllium	0.2		0.19		0.1	U

Site 16 Soil Results

Analyte	9A02G090-016 3WFF16-SS15 02/25/00		9A02G090-017 3WFF16-SS16 02/25/00		9A02G090-018 3WFF16-SS17 02/25/00	
Calcium	184		374		351	
Chromium	8.2		7.4		5.2	
Cobalt	1.9		1.5		1.1	
Copper	3.6		4.3		2.6	
Cyanide	0.4	U	0.47	U	0.52	U
Iron	7130		5070		3820	
Lead	10.2		19.1		15.2	
Magnesium	646		570		357	
Manganese	80.7		105		56.5	
Nickel	4.6		3.4		2.4	
Potassium	358		324		252	
Selenium	0.6		0.65		0.46	
Silver	0.32		0.13	U	0.28	
Sodium	334		392		260	
Vanadium	14.1		11.4		8.6	
Zinc	16.6		15.9		21.6	
OTHERS						
% Solids (Percent)	87.5		86.8		84.7	
TPH - DRO (mg/kg)	24	Y	11	Y	34	Y
TPH - GRO (ug/kg)	220	Z	63	Z	30	JZ

Analyte	9704G359-001 1WFF15-GW1 25-APR-97		9704G359-015 1WFF15-GW7 25-APR-97		9704G359-017 1WFF15-MW3 25-APR-97		9803G845-003 2WFF15-GW1 18-MAR-98		9803G845-010 2WFF15-GW1DUP 18-MAR-98		9803G845-009 2WFF15-GW7 18-MAR-98	
VOA (ug/L)												
1,2-Dichloroethene (total)	10	U	6	J	10	U	10	U	10	U	7	K
Acetone	10	U	10	U	10	U	10	U	10	U	27	K
Benzene	10	U	42		10	U	2	J	10	U	23	K
Ethylbenzene	10	U	280	D	10	U	10	U	10	U	120	K
Tetrachloroethene	3	J	5	J	10	U	4	J	4	J	5	K
Toluene	10	U	1400	D	10	U	10	U	10	U	200	D
Xylene (total)	10	U	1100	D	10	U	10	U	10	U	310	K
SVOC (ug/L)												
2,4-Dimethylphenol	9	U	10	U	9	U	10	U	10	U	9	UJ
2-Chlorophenol	9	U	10	U	9	U	10	U	10	U	9	
2-Methylnaphthalene	9	U	120	D	9	U	10	U	10	U	160	D
2-Methylphenol	9	U	7	J	9	U	10	U	10	U	9	U
4-Methylphenol	9	U	14		9	U	10	U	10	U	42	
Acenaphthene	9	U	4	J	9	U	10	U	10	U	8	L
Anthracene	9	U	1	J	9	U	10	U	10	U	9	UL
bis(2-Ethylhexyl)phthalate	12	B	12	B	3	B	12	B	10	B	9	B
Carbazole	9	U	6	J	9	U	1	J	1	J	9	UL
Dibenzofuran	9	U	3	J	9	U	2	J	2	J	9	UL
Fluorene	9	U	10	UJ	9	U	5	J	4	J	12	J
Naphthalene	9	U	110	D	9	U	10	U	10	U	140	D
Phenanthrene	9	U	9	J	9	U	4	J	3	J	20	L
Phenol	9	U	2	J	9	U	10	U	10	U	9	U
Pyrene	9	U	10	U	9	U	10	U	10	U	1	L
PEST/PCB (ug/L)												
4,4'-DDT	0.095	UJ	0.096	UJ	0.094	UJ	0.095	U	0.23	J	0.095	U
alpha-BHC	0.048	UJ	0.029	J	0.047	UJ	0.048	U	0.047	U	0.048	U
gamma-BHC (Lindane)	0.048	UJ	0.067	J	0.047	UJ	0.048	U	0.047	U	0.048	U
METALS, TOTAL (ug/L)												
Aluminum	5170	K	10100	K	11800	K	12500	K	9300	K	6670	K
Antimony	1.6	U	1.6	U	1.6	U	1.4	U	1.4	U	1.4	
Arsenic	1.8	U	68.8		5.1		1.6	U	2		88.2	

Analyte	9704G359-001 1WFF15-GW1 25-APR-97		9704G359-015 1WFF15-GW7 25-APR-97		9704G359-017 1WFF15-MW3 25-APR-97		9803G845-003 2WFF15-GW1 18-MAR-98		9803G845-010 2WFF15-GW1DUP 18-MAR-98		9803G845-009 2WFF15-GW7 18-MAR-98	
Barium	31.2		87.1		41.2		81.6		78.1		101	
Beryllium	0.1	U	0.23		0.2		0.26		0.23		0.42	
Cadmium	0.2	U	0.88		0.37		0.44		0.4	U	0.89	
Calcium	7500		7080		13400		12400		12300		7500	
Chromium	4.2		10.5		11.2		11.4		8.7		8.3	
Cobalt	1.8		6.5		2		3.1		2.5		8.8	
Copper	0.92		4.1		1.9		5.9	B	5	B	12.4	B
Ferrous Iron												
Iron	2660	K	48800	K	7660	K	6290		4840		58400	
Lead	4.9	J	43	J	4.8	J	12.8	B	12.2	B	29.7	
Magnesium	7290		8230		3510		10700		10300		7460	
Manganese	67.5		2920		57		190		182		3510	
Nickel	1.8		2.9		2.2		3		2.1		1.6	
Potassium	1680	J	3080	J	1560	J	1990	J	1790	J	2530	J
Selenium	1.9	U	4.5	K	3.1	K	1.8	UL	1.9	L	5	L
Sodium	3830		8480		4330		4340		4210		6700	
Thallium	1.9	U	1.9	U	1.9	U	2.3	U	2.3	U	2.3	U
Vanadium	7		15.8		17.3		16.5		13.4		11	
Zinc	7.4	K	8.5	K	7	K	16.3	K	10.9	B	11.7	B
OTHERS												
Alkalinity (mg/L)	49.9		103		39.1		67.6		60.2		133	
Chloride (mg/L)												
TPH - DRO (mg/L)	0.76		7.8		0.12	U	1.2	Y	1.2	Y	83	Y
TPH - GRO (ug/L)	160		4000		50	U	370	Y	410	Y	2400	Y
Hardness (Calculated) (ug/L)												
Nitrate, as N (mg/L)												
Sulfate (mg/L)												
Sulfide (mg/L)												
TOC Test 2 (mg/L)												
Total Dissolved Solids (mg/L)	80		290		160		100		110		210	
Total Organic Carbon (mg/L)												

Analyte	9803G863-010 2WFF15-MW3 19-MAR-98		9805G890-009 2WFF16-GW1 27-MAY-98		9805G890-010 2WFF16-GW2S 28-MAY-98		9805G890-015 2WFF16-GW2D 28-MAY-98		9805G890-014 2WFF16-GW2DDUP 28-MAY-98	
VOA (ug/L)										
1,2-Dichloroethene (total)	10	U	10	U	7	J	3	J	3	J
Acetone	10	U	10	U	10	U	10	U	10	U
Benzene	10	U	10	U	10	U	22		23	
Ethylbenzene	10	U	10	U	10	U	36		39	
Tetrachloroethene	10	U	10	U	10	U	10	U	10	U
Toluene	10	U	10	U	10	U	10	U	10	U
Xylene (total)	10	U	10	U	10	U	5	J	4	J
SVOC (ug/L)										
2,4-Dimethylphenol	10	U	9	U	9	U	1	J	9	U
2-Chlorophenol	10	U	9	U	9	U	10	U	9	U
2-Methylnaphthalene	10	U	9	U	1	J	4	J	3	J
2-Methylphenol	10	U	9	U	9	U	10	U	9	U
4-Methylphenol	10	U	9	U	9	U	10	U	9	U
Acenaphthene	10	U	9	U	2	J	1	J	1	J
Anthracene	10	U	9	U	9	U	10	U	9	U
bis(2-Ethylhexyl)phthalate	18	B	1	B	3	B	1	B	3	B
Carbazole	10	U	9	U	9	U	1	J	1	J
Dibenzofuran	10	U	9	U	9	U	1	J	1	J
Fluorene	10	U	9	U	2	J	3	J	2	J
Naphthalene	10	U	9	U	9	U	8	J	6	J
Phenanthrene	10	U	9	U	2	J	2	J	2	J
Phenol	10	U	9	U	9	U	10	U	9	U
Pyrene	10	U	9	U	9	U	10	U	9	U
PEST/PCB (ug/L)										
4,4'-DDT	0.096	UL	0.095	U	0.095	U	0.095	U	0.094	U
alpha-BHC	0.048	UL	0.048	U	0.048	U	0.048	U	0.047	U
gamma-BHC (Lindane)	0.048	UL	0.048	U	0.048	U	0.048	U	0.047	U
METALS, TOTAL (ug/L)										
Aluminum	1500		2450		5720		27.8	B	57.7	B
Antimony	1.4	U	1.7	U	1.7	U	1.7	U	1.7	U
Arsenic	1.6	U	2	U	11		27.5		29.2	

Analyte	9803G863-010 2WFF15-MW3 19-MAR-98		9805G890-009 2WFF16-GW1 27-MAY-98		9805G890-010 2WFF16-GW2S 28-MAY-98		9805G890-015 2WFF16-GW2D 28-MAY-98		9805G890-014 2WFF16-GW2DDUP 28-MAY-98	
Barium	62.5		32.2	B	131		49.9	B	52.2	B
Beryllium	0.29		0.2	U	0.2	U	0.2	U	0.2	U
Cadmium	0.4	U	0.3	U	0.3	U	0.3	U	0.3	U
Calcium	16200		10800	B	26500	B	9070	B	9360	B
Chromium	2.3		9.3		14		0.7	U	0.7	U
Cobalt	0.62		0.6	U	2		0.6	U	0.6	U
Copper	3.8	B	6.5	B	3.2	B	1.2	U	1.2	U
Ferrous Iron										
Iron	688		3580		11900		29100		29900	
Lead	4.2	B	3.6	B	9.9	B	1.5	B	1.8	B
Magnesium	3060		3990	B	6810	B	7200	B	7430	B
Manganese	30.1		33.6		64.2		118		121	
Nickel	0.6	U	1.3	B	2.5	B	1	U	1	U
Potassium	948	J	1920	B	2780	B	2210	B	2290	B
Selenium	1.8	U	1.7	UL	1.7	UL	1.7	UL	1.7	UL
Sodium	4170		6500	B	4070	B	12200	B	12700	B
Thallium	2.3	U	1.6	U	1.6	U	1.6	U	1.6	U
Vanadium	2.4		4.6	B	10.6		0.5	U	0.5	U
Zinc	4.3	B	17	B	53.1	B	5.2	B	4.9	B
OTHERS										
Alkalinity (mg/L)	41.6		40.9		110		113		112	
Chloride (mg/L)										
TPH - DRO (mg/L)	0.13	Z	0.11	U	0.85	Y	1.4	Y	1.4	Y
TPH - GRO (ug/L)	50	U	50	U	360	Y	360	Y	390	Y
Hardness (Calculated) (ug/L)			43.4		94.2		52.3		54	
Nitrate, as N (mg/L)										
Sulfate (mg/L)										
Sulfide (mg/L)										
TOC Test 2 (mg/L)										
Total Dissolved Solids (mg/L)	20									
Total Organic Carbon (mg/L)										

Analyte	9805G890-001 2WFF16-GW3 27-MAY-98		9805G890-011 2WFF16-GW4 28-MAY-98		9805G890-012 2WFF16-GW5 27-MAY-98		9A02G021-006 / 3WFF15-GW7 02/18/00		9A02G021-007 3WFF16-GW1 02/18/00		9A02G021-001 3WFF16-GW2S 02/18/00	
VOA (ug/L)												
1,2-Dichloroethene (total)	10	U	10	U	10	U	7	J	10	U	8	J
Acetone	10	U	10	U	10	U	10	U	10	U	10	U
Benzene	10	U	10	U	10	U	58		10	U	10	U
Ethylbenzene	10	U	10	U	10	U	230		10	U	10	U
Tetrachloroethene	10	U	10	U	10	U	10	U	10	U	10	U
Toluene	10	U	10	U	10	U	460		10	U	10	U
Xylene (total)	10	U	10	U	10	U	520		10	U	10	U
SVOC (ug/L)												
2,4-Dimethylphenol	10	U	10	U	10	U	10	U			10	U
2-Chlorophenol	10	U	10	U	10	U	10	U			10	U
2-Methylnaphthalene	10	U	10	U	10	U	200				10	U
2-Methylphenol	10	U	10	U	10	U	10	U			10	U
4-Methylphenol	10	U	10	U	10	U	10	U			10	U
Acenaphthene	10	U	10	U	10	U	6	J			2	J
Anthracene	10	U	10	U	10	U	10	U			10	U
bis(2-Ethylhexyl)phthalate	10	U	14	B	2	B	160				39	
Carbazole	10	U	10	U	10	U	6	J			10	U
Dibenzofuran	10	U	10	U	10	U	10	U			10	U
Fluorene	10	U	10	U	10	U	9	J			2	J
Naphthalene	10	U	10	U	10	U	180				10	U
Phenanthrene	10	U	10	U	10	U	15				10	U
Phenol	10	U	10	U	10	U	10	U			10	U
Pyrene	10	U	10	U	10	U	10	U			10	U
PEST/PCB (ug/L)												
4,4'-DDT	0.095	U	0.095	U	0.095	U	0.097	U			0.096	U
alpha-BHC	0.048	U	0.048	U	0.048	U	0.049	U			0.048	U
gamma-BHC (Lindane)	0.048	U	0.048	U	0.048	U	0.049	U			0.048	U
METALS, TOTAL (ug/L)												
Aluminum	7540		352	B	1930		17100				871	
Antimony	4.5		1.7	U	1.7	U	4.2	U			4.2	U
Arsenic	11.1		2	U	2	U	60.4				18.2	

Analyte	9805G890-001 2WFF16-GW3 27-MAY-98		9805G890-011 2WFF16-GW4 28-MAY-98		9805G890-012 2WFF16-GW5 27-MAY-98		9A02G021-006 / 3WFF15-GW7 02/18/00		9A02G021-007 3WFF16-GW1 02/18/00		9A02G021-001 3WFF16-GW2S 02/18/00	
Barium	64.7	B	43.4	B	49.9	B	107				98.8	
Beryllium	0.95		0.2	U	0.2	U	0.6	U			0.7	
Cadmium	0.3	U	0.3	U	0.3	U	0.6	U			0.6	U
Calcium	8910	B	7660	B	40500	B	13100				20400	
Chromium	8.4		0.7	U	1.9		17.3				2.9	
Cobalt	0.74		0.6	U	0.6	U	3.1				1.4	
Copper	4.9	B	1.2	U	1.8	B	6.5				2.6	
Ferrous Iron							32.5				1	
Iron	14100		466		2280		58400				11200	
Lead	8.5	B	1	U	1.1	B	62.8				2.5	U
Magnesium	2960	B	5760	B	29000		13400				7130	
Manganese	31.6		6.5	B	103		1590				43.3	
Nickel	2.6	B	1	U	1	U	3				1.5	U
Potassium	2470	B	2370	B	16300		5890				2220	
Selenium	1.7	UL	1.7	UL	1.7	UL	2.6	U			2.8	
Sodium	6070	B	3720	B	8020	B	18600				4070	
Thallium	1.6	U	1.6	U	1.6	U	3.9	U			3.9	U
Vanadium	31.6		0.5	U	2.1	B	20.8				1.4	
Zinc	25	B	10.5	B	114	B	13.7				25.7	
OTHERS												
Alkalinity (mg/L)	24.4		39.9		227		130				77	
Chloride (mg/L)							54.6				10.7	
TPH - DRO (mg/L)	0.12	U	0.12	U	0.11	JY	54	Y			2	Y
TPH - GRO (ug/L)	50	U	50	U	33	JZ	2000	Y			320	Y
Hardness (Calculated) (ug/L)	34.4		42.8		221							
Nitrate, as N (mg/L)							0.1	U			0.1	U
Sulfate (mg/L)							5	U			5	U
Sulfide (mg/L)							0				1	U
TOC Test 2 (mg/L)							32.5				8.9	
Total Dissolved Solids (mg/L)							190				140	
Total Organic Carbon (mg/L)							31.9				8.6	

Analyte	9A02G021-002 3WFF16-GW2D 02/18/00		9A02G021-003 3WFF16-GW3 02/18/00		9A02G021-004 3WFF16-GW4 02/18/00		9A02G021-005 3WFF16-GW5 02/18/00	
VOA (ug/L)								
1,2-Dichloroethene (total)	10	U	10	U	10	U	10	U
Acetone	10	U	10	U	10	U	10	U
Benzene	25		10	U	10	U	10	U
Ethylbenzene	48		10	U	10	U	10	U
Tetrachloroethene	10	U	10	U	10	U	10	U
Toluene	10	U	10	U	10	U	10	U
Xylene (total)	10	U	10	U	10	U	10	U
SVOC (ug/L)								
2,4-Dimethylphenol	10	U	10	U	10	U	10	U
2-Chlorophenol	10	U	10	U	10	U	10	U
2-Methylnaphthalene	10	U	10	U	10	U	10	U
2-Methylphenol	10	U	10	U	10	U	10	U
4-Methylphenol	10	U	10	U	10	U	10	U
Acenaphthene	10	U	10	U	10	U	10	U
Anthracene	10	U	10	U	10	U	10	U
bis(2-Ethylhexyl)phthalate	11		10	U	10	U	10	U
Carbazole	10	U	10	U	10	U	10	U
Dibenzofuran	10	U	10	U	10	U	10	U
Fluorene	10	U	10	U	10	U	10	U
Naphthalene	10	U	10	U	10	U	10	U
Phenanthrene	10	U	10	U	10	U	10	U
Phenol	10	U	10	U	10	U	10	U
Pyrene	10	U	10	U	10	U	10	U
PEST/PCB (ug/L)								
4,4'-DDT	0.097	U	0.095	U	0.096	U	0.094	U
alpha-BHC	0.049	U	0.048	U	0.048	U	0.047	U
gamma-BHC (Lindane)	0.049	U	0.048	U	0.048	U	0.047	U
METALS, TOTAL (ug/L)								
Aluminum	2120		6430		679		792	
Antimony	4.2	U	4.6		4.2	U	4.2	U
Arsenic	30.2		5.4		3.4	U	3.4	U

Analyte	9A02G021-002 3WFF16-GW2D 02/18/00		9A02G021-003 3WFF16-GW3 02/18/00		9A02G021-004 3WFF16-GW4 02/18/00		9A02G021-005 3WFF16-GW5 02/18/00	
Barium	53.8		140		174		47.5	
Beryllium	0.8		1.2		0.6	U	0.6	U
Cadmium	0.6	U	0.6	U	0.6	U	0.6	U
Calcium	9060		9200		2610		50300	
Chromium	2.9		11.4		5.3		1.5	
Cobalt	1	U	1.2		1	U	1	U
Copper	2.4		6		5.2		3.1	
Ferrous Iron	3.5		0.05		0.05	U	0.3	
Iron	30100		12500		29500		5420	
Lead	2.5	U	4.5		2.5	U	2.8	
Magnesium	7140		2450		2260		35700	
Manganese	122		30.7		61.5		110	
Nickel	1.5	U	2.4		4.5		1.5	U
Potassium	2590		2440		1550		15700	
Selenium	4.5		2.6	U	2.6	U	2.6	U
Sodium	10100		4250		2600		8500	
Thallium	3.9	U	3.9	U	3.9		3.9	U
Vanadium	2.5		16.6		1.5		1.1	U
Zinc	18		82.3		28.4		42.2	
OTHERS								
Alkalinity (mg/L)	80.7		27.9		7.9		263	
Chloride (mg/L)	17.2		15.6		18.8		18.7	
TPH - DRO (mg/L)	1.9	Y	1.1	Y	0.12	U	0.6	Y
TPH - GRO (ug/L)	390	Y	39	Y	50	U	33	Z
Hardness (Calculated) (ug/L)								
Nitrate, as N (mg/L)	0.1	U	0.37		0.28		0.1	U
Sulfate (mg/L)	5	U	5.1		5.2		44.6	
Sulfide (mg/L)	2.6		0		0		0	
TOC Test 2 (mg/L)	10.6		1.9		1	U	3.6	
Total Dissolved Solids (mg/L)	130		84		68		340	
Total Organic Carbon (mg/L)	10.5		2		1	U	3.6	

Analyte	9805G890-013 2WFF16-EQB 08-MAY-98		9805G585-011 2WFF16-EQB 27-MAY-98		9805G585-010 TB032698 27-MAY-98		9805G890-007 TB052198 27-MAY-98		9805G890-016 2WFF16-FB1 27-MAY-98	
VOA (ug/L)										
1,1,1-Trichloroethane	10	U	10	U	10	UL	10	U	10	U
1,1,2,2-Tetrachloroethane	10	U	10	U	10	UL	10	U	10	U
1,1,2-Trichloroethane	10	U	10	U	10	UL	10	U	10	U
1,1-Dichloroethane	10	U	10	U	10	UL	10	U	10	U
1,1-Dichloroethene	10	U	10	U	10	UL	10	U	10	U
1,2-Dichloroethane	10	U	10	U	10	UL	10	U	10	U
1,2-Dichloroethene (total)	10	U	10	U	10	UL	10	U	10	U
1,2-Dichloropropane	10	U	10	U	10	UL	10	U	10	U
2-Butanone	10	U	10	U	10	UL	10	U	10	U
2-Hexanone	10	U	10	U	10	UL	10	U	10	U
4-Methyl-2-pentanone	10	U	10	U	10	UL	10	U	10	U
Acetone	10	U	10	U	10	UL	10	U	10	U
Benzene	10	U	10	U	10	UL	10	U	10	U
Bromodichloromethane	10	U	10	U	10	UL	10	U	10	U
Bromoform	10	U	10	U	10	UL	10	U	10	U
Bromomethane	10	U	10	U	10	UL	10	U	10	U
Carbon Disulfide	10	U	10	U	10	UL	10	U	10	U
Carbon Tetrachloride	10	U	10	U	10	UL	10	U	10	U
Chlorobenzene	10	U	10	U	10	UL	10	U	10	U
Chloroethane	10	U	10	U	10	UL	10	U	10	U
Chloroform	3	J	5	J	10	UL	10	U	3	J
Chloromethane	10	U	10	U	10	UL	10	U	10	U
cis-1,3-Dichloropropene	10	U	10	U	10	UL	10	U	10	U
Dibromochloromethane	10	U	10	U	10	UL	10	U	10	U
Ethylbenzene	10	U	10	U	10	UL	10	U	10	U
Methylene Chloride	10	U	10	U	10	UL	10	U	10	U
Styrene	10	U	10	U	10	UL	10	U	10	U
Tetrachloroethene	10	U	10	U	10	UL	10	U	10	U
Toluene	10	U	10	U	10	UL	10	U	10	U
trans-1,3-Dichloropropene	10	U	10	U	10	UL	10	U	10	U

Analyte	9805G890-013 2WFF16-EQB 08-MAY-98		9805G585-011 2WFF16-EQB 27-MAY-98		9805G585-010 TB032698 27-MAY-98		9805G890-007 TB052198 27-MAY-98		9805G890-016 2WFF16-FB1 27-MAY-98	
Trichloroethene	10	U	10	U	10	UL	10	U	10	U
Vinyl chloride	10	U	10	U	10	UL	10	U	10	U
Xylene (total)	10	U	10	U	10	UL	10	U	10	U
SVOC (ug/L)										
1,2,4-Trichlorobenzene	9	U	10	U						
1,2-Dichlorobenzene	9	U	10	U						
1,3-Dichlorobenzene	9	U	10	U						
1,4-Dichlorobenzene	9	U	10	U						
2,2'-oxybis(1-Chloropropane)	9	U	10	U						
2,4,5-Trichlorophenol	24	U	24	U						
2,4,6-Trichlorophenol	9	U	10	U						
2,4-Dichlorophenol	9	U	10	U						
2,4-Dimethylphenol	9	U	10	U						
2,4-Dinitrophenol	24	U	24	U						
2,4-Dinitrotoluene	9	U	10	U						
2,6-Dinitrotoluene	9	U	10	U						
2-Chloronaphthalene	9	U	10	U						
2-Chlorophenol	9	U	10	U						
2-Methylnaphthalene	9	U	10	U						
2-Methylphenol	9	U	10	U						
2-Nitroaniline	24	U	24	U						
2-Nitrophenol	9	U	10	U						
3,3'-Dichlorobenzidine	9	U	10	U						
3-Nitroaniline	24	U	24	U						
4,6-Dinitro-2-methylphenol	24	U	24	U						
4-Bromophenyl-phenylether	9	U	10	U						
4-Chloro-3-methylphenol	9	U	10	U						
4-Chloroaniline	9	U	10	U						
4-Chlorophenyl-phenylether	9	U	10	U						
4-Methylphenol	9	U	10	U						
4-Nitroaniline	24	U	24	U						

Analyte	9805G890-013 2WFF16-EQB 08-MAY-98		9805G585-011 2WFF16-EQB 27-MAY-98		9805G585-010 TB032698 27-MAY-98		9805G890-007 TB052198 27-MAY-98		9805G890-016 2WFF16-FB1 27-MAY-98	
4-Nitrophenol	24	U	24	U						
Acenaphthene	9	U	10	U						
Acenaphthylene	9	U	10	U						
Anthracene	9	U	10	U						
Benzo(a)anthracene	9	U	10	U						
Benzo(a)pyrene	9	U	10	U						
Benzo(b)fluoranthene	9	U	10	U						
Benzo(g,h,i)perylene	9	U	10	U						
Benzo(k)fluoranthene	9	U	10	U						
bis(2-Chloroethoxy)methane	9	U	10	U						
bis(2-Chloroethyl)ether	9	U	10	U						
bis(2-Ethylhexyl)phthalate	1	BJ	10	J						
Butylbenzylphthalate	9	U	10	U						
Carbazole	9	U	10	U						
Chrysene	9	U	10	U						
Di-n-butylphthalate	9	U	10	U						
Di-n-octylphthalate	9	U	10	U						
Dibenzo(a,h)anthracene	9	U	10	U						
Dibenzofuran	9	U	10	U						
Diethylphthalate	9	U	10	U						
Dimethylphthalate	9	U	10	U						
Fluoranthene	9	U	10	U						
Fluorene	9	U	10	U						
Hexachlorobenzene	9	U	10	U						
Hexachlorobutadiene	9	U	10	U						
Hexachlorocyclopentadiene	9	U	10	U						
Hexachloroethane	9	U	10	U						
Indeno(1,2,3-cd)pyrene	9	U	10	U						
Isophorone	9	U	10	U						
N-Nitroso-di-n-propylamine	9	U	10	U						
N-Nitrosodiphenylamine (1)	9	U	10	U						
Naphthalene	9	U	10	U						

Analyte	9805G890-013 2WFF16-EQB 08-MAY-98		9805G585-011 2WFF16-EQB 27-MAY-98		9805G585-010 TB032698 27-MAY-98		9805G890-007 TB052198 27-MAY-98		9805G890-016 2WFF16-FB1 27-MAY-98	
Nitrobenzene	9	U	10	U						
Pentachlorophenol	24	U	24	U						
Phenanthrene	9	U	10	U						
Phenol	9	U	10	U						
Pyrene	9	U	10	U						
PEST/PCB (ug/L)										
4,4'-DDD	0.094	U	0.095	U						
4,4'-DDE	0.094	U	0.095	U						
4,4'-DDT	0.094	U	0.095	U						
Aldrin	0.047	U	0.048	U						
alpha-BHC	0.047	U	0.048	U						
alpha-Chlordane	0.047	U	0.048	U						
Aroclor-1016	0.94	U	0.95	U						
Aroclor-1221	1.9	U	1.9	U						
Aroclor-1232	0.94	U	0.95	U						
Aroclor-1242	0.94	U	0.95	U						
Aroclor-1248	0.94	U	0.95	U						
Aroclor-1254	0.94	U	0.95	U						
Aroclor-1260	0.94	U	0.95	U						
beta-BHC	0.047	U	0.048	U						
delta-BHC	0.047	U	0.048	U						
Dieldrin	0.094	U	0.095	U						
Endosulfan I	0.047	U	0.048	U						
Endosulfan II	0.094	U	0.095	U						
Endosulfan sulfate	0.094	U	0.095	U						
Endrin	0.094	U	0.095	U						
Endrin aldehyde	0.094	U	0.095	U						
Endrin ketone	0.094	U	0.095	U						
gamma-BHC (Lindane)	0.047	U	0.048	U						
gamma-Chlordane	0.047	U	0.048	U						
Heptachlor	0.047	U	0.048	U						

Analyte	9805G890-013 2WFF16-EQB 08-MAY-98		9805G585-011 2WFF16-EQB 27-MAY-98		9805G585-010 TB032698 27-MAY-98		9805G890-007 TB052198 27-MAY-98		9805G890-016 2WFF16-FB1 27-MAY-98	
Heptachlor epoxide	0.047	U	0.048	U						
Methoxychlor	0.47	U	0.48	U						
Toxaphene	4.7	U	4.8	U						
METALS, TOTAL (ug/L)										
Aluminum	156		14.3	U						
Antimony	1.7	U	1.7	U						
Arsenic	2	U	2	U						
Barium	19.4		0.41							
Beryllium	0.2	U	0.28							
Cadmium	0.3	U	0.3	U						
Calcium	21400		32.9							
Chromium	0.7	U	0.7	U						
Cobalt	0.6	U	0.6	U						
Copper	25		1.2	U						
Cyanide	10	U	3.5							
Iron	16.6	UL	10	U						
Lead	3.7		16.6	UL						
Magnesium	3140		1	U						
Manganese	2.6		12.6	U						
Mercury	0.1	U	0.4	U						
Nickel	1.6		0.1							
Potassium	1910		1	U						
Selenium	1.7	U	120							
Silver	0.6	U	1.7	U						
Sodium	5520		0.6	U						
Thallium	1.6	U	295	U						
Vanadium	0.5	U	1.6	U						
Zinc	92.3		0.5	U						

Analyte	9805G890-013 2WFF16-EQB 08-MAY-98		9805G585-011 2WFF16-EQB 27-MAY-98		9805G585-010 TB032698 27-MAY-98		9805G890-007 TB052198 27-MAY-98		9805G890-016 2WFF16-FB1 27-MAY-98	
OTHERS										
Alkalinity (ug/L)	34.9									
Chromium VI (mg/L)	0.02	R	0.02	UL						
TPH - DRO (mg/L)	0.12	U	0.12	U						
TPH - GRO (ug/L)	31	JZ	50	U						
Hardness (Calculated) (ug/L)	66.5									

Analyte	9A02G090-001 3WFF16-FB 02/25/00		9A02G021-008 Trip Blank 02/18/00		9A02G090-020 3WFF16-TB 02/25/00	
VOA (ug/L)						
1,1,1-Trichloroethane	10	U	10	U	10	U
1,1,2,2-Tetrachloroethane	10	U	10	U	10	U
1,1,2-Trichloroethane	10	U	10	U	10	U
1,1-Dichloroethane	10	U	10	U	10	U
1,1-Dichloroethene	10	U	10	U	10	U
1,2-Dichloroethane	10	U	10	U	10	U
1,2-Dichloroethene (total)	10	U	10	U	10	U
1,2-Dichloropropane	10	U	10	U	10	U
2-Butanone	10	U	10	U	10	U
2-Hexanone	10	U	10	U	10	U
4-Methyl-2-pentanone	10	U	10	U	10	U
Acetone	10	U	10	U	10	U
Benzene	10	U	10	U	10	U
Bromodichloromethane	10	U	10	U	10	U
Bromoform	10	U	10	U	10	U
Bromomethane	10	U	10	U	10	U
Carbon Disulfide	10	U	10	U	10	U
Carbon Tetrachloride	10	U	10	U	10	U
Chlorobenzene	10	U	10	U	10	U
Chloroethane	10	U	10	U	10	U
Chloroform	10	U	10	U	10	U
Chloromethane	10	U	10	U	10	U
cis-1,3-Dichloropropene	10	U	10	U	10	U
Dibromochloromethane	10	U	10	U	10	U
Ethylbenzene	10	U	10	U	10	U
Methylene Chloride	10	U	10	U	10	U
Styrene	10	U	10	U	10	U
Tetrachloroethene	10	U	10	U	10	U
Toluene	10	U	10	U	10	U
trans-1,3-Dichloropropene	10	U	10	U	10	U
Trichloroethene	10	U	10	U	10	U
Vinyl chloride	10	U	10	U	10	U
Xylene (total)	10	U	10	U	10	U
SVOC (ug/L)						
1,2,4-Trichlorobenzene	10	U				
1,2-Dichlorobenzene	10	U				
1,3-Dichlorobenzene	10	U				
1,4-Dichlorobenzene	10	U				
2,2'-oxybis(1-Chloropropane)	10	U				
2,4,5-Trichlorophenol	24	U				
2,4,6-Trichlorophenol	10	U				
2,4-Dichlorophenol	10	U				
2,4-Dimethylphenol	10	U				

Analyte	9A02G090-001 3WFF16-FB 02/25/00		9A02G021-008 Trip Blank 02/18/00		9A02G090-020 3WFF16-TB 02/25/00	
2,4-Dinitrophenol	24	U				
2,4-Dinitrotoluene	10	U				
2,6-Dinitrotoluene	10	U				
2-Chloronaphthalene	10	U				
2-Chlorophenol	10	U				
2-Methylnaphthalene	10	U				
2-Methylphenol	10	U				
2-Nitroaniline	24	U				
2-Nitrophenol	10	U				
3,3'-Dichlorobenzidine	10	U				
3-Nitroaniline	24	U				
4,6-Dinitro-2-methylphenol	24	U				
4-Bromophenyl-phenylether	10	U				
4-Chloro-3-methylphenol	10	U				
4-Chloroaniline	10	U				
4-Chlorophenyl-phenylether	10	U				
4-Methylphenol	10	U				
4-Nitroaniline	24	U				
4-Nitrophenol	24	U				
Acenaphthene	10	U				
Acenaphthylene	10	U				
Anthracene	10	U				
Benzo(a)anthracene	10	U				
Benzo(a)pyrene	10	U				
Benzo(b)fluoranthene	10	U				
Benzo(g,h,i)perylene	10	U				
Benzo(k)fluoranthene	10	U				
bis(2-Chloroethoxy)methane	10	U				
bis(2-Chloroethyl)ether	10	U				
bis(2-Ethylhexyl)phthalate	10	U				
Butylbenzylphthalate	10	U				
Carbazole	10	U				
Chrysene	10	U				
Di-n-butylphthalate	10	U				
Di-n-octylphthalate	10	U				
Dibenzo(a,h)anthracene	10	U				
Dibenzofuran	10	U				
Diethylphthalate	10	U				
Dimethylphthalate	10	U				
Fluoranthene	10	U				
Fluorene	10	U				
Hexachlorobenzene	10	U				
Hexachlorobutadiene	10	U				
Hexachlorocyclopentadiene	10	U				
Hexachloroethane	10	U				
Indeno(1,2,3-cd)pyrene	10	U				

Analyte	9A02G090-001 3WFF16-FB 02/25/00		9A02G021-008 Trip Blank 02/18/00		9A02G090-020 3WFF16-TB 02/25/00	
Isophorone	10	U				
N-Nitroso-di-n-propylamine	10	U				
N-Nitrosodiphenylamine (1)	10	U				
Naphthalene	10	U				
Nitrobenzene	10	U				
Pentachlorophenol	24	U				
Phenanthrene	10	U				
Phenol	10	U				
Pyrene	10	U				
PEST/PCB (ug/L)						
4,4'-DDD	0.095	U				
4,4'-DDE	0.095	U				
4,4'-DDT	0.095	U				
Aldrin	0.048	U				
alpha-BHC	0.048	U				
alpha-Chlordane	0.048	U				
Aroclor-1016	0.95	U				
Aroclor-1221	1.9	U				
Aroclor-1232	0.95	U				
Aroclor-1242	0.95	U				
Aroclor-1248	0.95	U				
Aroclor-1254	0.95	U				
Aroclor-1260	0.95	U				
beta-BHC	0.048	U				
delta-BHC	0.048	U				
Dieldrin	0.095	U				
Endosulfan I	0.048	U				
Endosulfan II	0.095	U				
Endosulfan sulfate	0.095	U				
Endrin	0.095	U				
Endrin aldehyde	0.095	U				
Endrin ketone	0.095	U				
gamma-BHC (Lindane)	0.048	U				
gamma-Chlordane	0.048	U				
Heptachlor	0.048	U				
Heptachlor epoxide	0.048	U				
Methoxychlor	0.48	U				
Toxaphene	4.8	U				
METALS, TOTAL (ug/L)						
Aluminum	46.4	U				
Antimony	4.2	U				
Arsenic	3.4	U				
Barium	0.7	U				
Beryllium	0.6	U				

Analyte	9A02G090-001 3WFF16-FB 02/25/00		9A02G021-008 Trip Blank 02/18/00		9A02G090-020 3WFF16-TB 02/25/00	
Cadmium	0.6	U				
Calcium	54.8					
Chromium	1.2	U				
Cobalt	1	U				
Copper	1.2	U				
Cyanide	10	U				
Iron	39.4	U				
Lead	2.5	U				
Magnesium	42.5	U				
Manganese	0.8	U				
Mercury	0.1	U				
Nickel	1.5	U				
Potassium	116					
Selenium	2.6	U				
Silver	0.8	U				
Sodium	355	U				
Thallium	3.9	U				
Vanadium	1.1	U				
Zinc	3					
OTHERS						
Chromium VI (mg/L)	0.02	U				
Diesel Range Organics (mg/L)	0.12	U				
Gasoline Range Organics (ug/L)	50	U				

Versar INC

APPENDIX A-3

FULL VERSAR MICROSOFT ACCESS DATABASE

Laboratory Services

VERSAR
WALLOPS ISLAND

SUNSTAR PROJECT #C-1

VOLATILE HALOGENATED AND AROMATIC AND TOTAL PETROLEUM HYDROCARBONS (EPA Method 8010/8020/8015) ANALYSES OF WATER

Sample ID	BLANK	2WFF16-DP1	2WFF16-DP2	2WFF16-DP3	2WFF16-DP4
Date	5/4/98	5/4/98	5/4/98	5/4/98	5/4/98
Dilution Factor	1	1	1	1	1
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND
1,1-DICHLORO ETHANE	ND	ND	ND	ND	ND
1,2-DICHLORO ETHANE	ND	ND	ND	ND	ND
1,1-DICHLORO ETHENE	ND	ND	ND	ND	ND
CIS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND
TRANS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND
DICHLOROMETHANE	ND	ND	ND	ND	ND
TETRACHLORO ETHENE	ND	15	ND	ND	ND
1,1,1,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND
1,1,1-TRICHLORO ETHANE	ND	ND	ND	ND	ND
1,1,2-TRICHLORO ETHANE	ND	ND	ND	ND	ND
TRICHLORO ETHENE	ND	ND	ND	ND	ND
1,1,2-TRICHLOROTRIFLUOROETHANE (FR113)	ND	ND	ND	ND	ND
GASOLINE RANGE ORGANICS	ND	32	ND	ND	ND
DIESEL RANGE ORGANICS	ND	38	ND	ND	ND
SURROGATES					
CHLOROBENZENE-d5	85%	88%	96%	92%	92%
1,4-DICHLOROBENZENE-d4	91%	85%	87%	88%	90%

ND INDICATES NOT DETECTED AT A DETECTION LIMIT OF 5.0 UG/L FOR EACH COMPOUND, .5 PPM FOR GRO AND DRO

Reviewed and Approved by: _____ Date: 6/19/98

Laboratory Services

VERSAR
WALLOPS ISLAND

SUNSTAR PROJECT #C-1

VOLATILE HALOGENATED AND AROMATIC AND TOTAL PETROLEUM HYDROCARBONS (EPA Method 8010/8020/8015) ANALYSES OF WATER

Sample ID	2WFF16-DUP	2WFF16-DP5	2WFF16-DP6	2WFF15-GW7	2WFF16-DP7
Date	5/4/98	5/4/98	5/4/98	5/4/98	5/4/98
Dilution Factor	1	1	1	1	1
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND
1,1-DICHLORO ETHANE	ND	ND	ND	ND	ND
1,2-DICHLORO ETHANE	ND	ND	ND	ND	ND
1,1-DICHLORO ETHENE	ND	ND	ND	ND	ND
CIS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND
TRANS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND
DICHLOROMETHANE	ND	ND	ND	ND	ND
TETRACHLORO ETHENE	ND	ND	ND	5.0	10
1,1,1,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND
1,1,1-TRICHLORO ETHANE	ND	ND	ND	ND	ND
1,1,2-TRICHLORO ETHANE	ND	ND	ND	ND	ND
TRICHLORO ETHENE	ND	ND	ND	ND	ND
1,1,2-TRICHLOROTRIFLUOROETHANE (FR113)	ND	ND	ND	ND	ND
GASOLINE RANGE ORGANICS	ND	ND	ND	3.0	15
DIESEL RANGE ORGANICS	ND	ND	ND	14	27
SURROGATES					
CHLOROBENZENE-d5	91%	92%	97%	91%	93%
1,4-DICHLOROBENZENE-d4	85%	86%	93%	86%	85%

ND INDICATES NOT DETECTED AT A DETECTION LIMIT OF 5.0 UG/L FOR EACH COMPOUND, .5 PPM FOR GRO AND DRO

Reviewed and Approved by: _____ Date: 6/19/98

Laboratory Services

VERSAR
WALLOPS ISLAND

SUNSTAR PROJECT #C-2

VOLATILE HALOGENATED AND AROMATIC AND TOTAL PETROLEUM HYDROCARBONS (EPA Method 8010/8020/8015) ANALYSES OF WATER

Sample ID	BLANK	2WFF16-DP8	2WFF16-DP9	2WFF16-DP10	2WFF16-DP11	2WFF16-DP12
Date	5/5/98	5/5/98	5/5/98	5/5/98	5/5/98	5/5/98
Dilution Factor	1	1	1	1	1	1
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND	ND
1,1-DICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,2-DICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
CIS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
TRANS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
DICHLOROMETHANE	ND	ND	ND	ND	ND	ND
TETRACHLORO ETHENE	ND	ND	ND	ND	ND	ND
1,1,1,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,1-TRICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLORO ETHANE	ND	ND	ND	ND	ND	ND
TRICHLORO ETHENE	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLOROTRIFLUOROETHANE (FR113)	ND	ND	ND	ND	ND	ND
GASOLINE RANGE ORGANICS	ND	ND	4.0	ND	ND	ND
DIESEL RANGE ORGANICS	ND	ND	8.0	ND	ND	ND
SURROGATES						
CHLOROBENZENE-d5	96%	90%	88%	89%	89%	91%
1,4-DICHLOROBENZENE-d4	92%	87%	85%	84%	85%	83%

ND INDICATES NOT DETECTED AT A DETECTION LIMIT OF 5.0 UG/L FOR EACH COMPOUND, .5 PPM FOR GRO AND DRO

Reviewed and Approved by: _____ Date: 6/19/98

Laboratory Services

VERSAR
WALLOPS ISLAND

SUNSTAR PROJECT #C-2

VOLATILE HALOGENATED AND AROMATIC AND TOTAL PETROLEUM HYDROCARBONS (EPA Method 8010/8020/8015) ANALYSES OF WATER

Sample ID	2WFF16-DP13	2WFF16-DP14	2WFF15-GW15	2WFF16-DP16	2WFF16-DP17	2WFF16-DP18
Date	5/5/98	5/5/98	5/5/98	5/5/98	5/5/98	5/5/98
Dilution Factor	1	1	1	1	1	1
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND	ND
1,1-DICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,2-DICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
CIS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
TRANS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
DICHLOROMETHANE	ND	ND	ND	ND	ND	ND
TETRACHLORO ETHENE	ND	ND	ND	ND	ND	5.0
1,1,1,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,1-TRICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLORO ETHANE	ND	ND	ND	ND	ND	ND
TRICHLORO ETHENE	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLOROTRIFLUOROETHANE (FR113)	ND	ND	ND	ND	ND	ND
GASOLINE RANGE ORGANICS	ND	ND	ND	ND	ND	18
DIESEL RANGE ORGANICS	ND	ND	ND	ND	ND	210
SURROGATES						
CHLOROBENZENE-d5	87%	92%	93%	91%	90%	86%
1,4-DICHLOROBENZENE-d4	82%	88%	87%	88%	85%	82%

ND INDICATES NOT DETECTED AT A DETECTION LIMIT OF 5.0 UG/L FOR EACH COMPOUND, .5 PPM FOR GRO AND DRO

Reviewed and Approved by: _____ Date: 6/19/98

Laboratory Services

VERSAR
WALLOPS ISLAND

SUNSTAR PROJECT #C-3

VOLATILE HALOGENATED AND AROMATIC AND TOTAL PETROLEUM HYDROCARBONS (EPA Method 8010/8020/8015) ANALYSES OF WATER

Sample ID	BLANK	2WFF16-DP20	2WFF16-DP19	2WFF16-DP21	2WFF16-DP22	2WFF16-DP23
Date	5/6/98	5/6/98	5/6/98	5/6/98	5/6/98	5/6/98
Dilution Factor	1	1	1	1	1	1
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND	ND
1,1-DICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,2-DICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
CIS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
TRANS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND	ND
DICHLOROMETHANE	ND	ND	ND	ND	ND	ND
TETRACHLORO ETHENE	ND	ND	ND	ND	ND	ND
1,1,1,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,1-TRICHLORO ETHANE	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLORO ETHANE	ND	ND	ND	ND	ND	ND
TRICHLORO ETHENE	ND	ND	ND	ND	ND	ND
1,1,2-TRICHLOROTRIFLUOROETHANE (FR113)	ND	ND	ND	ND	ND	ND
GASOLINE RANGE ORGANICS	ND	ND	ND	ND	ND	ND
DIESEL RANGE ORGANICS	ND	ND	ND	ND	ND	ND
SURROGATES						
CHLOROBENZENE-d5	104%	98%	99%	97%	97%	93%
1,4-DICHLOROBENZENE-d4	97%	91%	95%	91%	92%	89%

ND INDICATES NOT DETECTED AT A DETECTION LIMIT OF 5.0 UG/L FOR EACH COMPOUND, .5 PPM FOR GRO AND DRO

Reviewed and Approved by: _____ Date: 6/19/00

Laboratory Services

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WALLOPS ISLAND

SUNSTAR PROJECT #C-3

VOLATILE HALOGENATED AND AROMATIC AND TOTAL PETROLEUM HYDROCARBONS (EPA Method 8010/8020/8015) ANALYSES OF WATER

Sample ID	2WFF16-DP24	2WFF16-DUP2	2WFF15-GW25	2WFF16-DP26	2WFF16-DP27
Date	5/6/98	5/6/98	5/6/98	5/6/98	5/6/98
Dilution Factor	1	1	1	1	1
CARBON TETRACHLORIDE	ND	ND	ND	ND	ND
CHLOROFORM	ND	ND	ND	ND	ND
1,1-DICHLORO ETHANE	ND	ND	ND	ND	ND
1,2-DICHLORO ETHANE	ND	ND	ND	ND	ND
1,1-DICHLORO ETHENE	ND	ND	ND	ND	ND
CIS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND
TRANS-1,2-DICHLORO ETHENE	ND	ND	ND	ND	ND
DICHLOROMETHANE	ND	ND	ND	ND	ND
TETRACHLORO ETHENE	ND	ND	ND	ND	ND
1,1,1,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND
1,1,2,2-TETRACHLORO ETHANE	ND	ND	ND	ND	ND
1,1,1-TRICHLORO ETHANE	ND	ND	ND	ND	ND
1,1,2-TRICHLORO ETHANE	ND	ND	ND	ND	ND
TRICHLORO ETHENE	ND	ND	ND	ND	ND
1,1,2-TRICHLOROTRIFLUOROETHANE (FR113)	ND	ND	ND	ND	ND
GASOLINE RANGE ORGANICS	ND	ND	ND	ND	ND
DIESEL RANGE ORGANICS	ND	ND	ND	ND	ND
SURROGATES					
CHLOROBENZENE-d5	92%	97%	93%	93%	94%
1,4-DICHLOROBENZENE-d4	89%	90%	89%	87%	85%

ND INDICATES NOT DETECTED AT A DETECTION LIMIT OF 5.0 UG/L FOR EACH COMPOUND, .5 PPM FOR GRO AND DRO

Reviewed and Approved by: _____ Date: 6/19/00

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: Method Blank
Date Sampled: NA
Date Received: NA
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

6010

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP1
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP2
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP3
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP4
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP5
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP6
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-GW7
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DUP1
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP8
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP9
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP10
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP11
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP12
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP13
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP14
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP7
Date Sampled: 5/4/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP15
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

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SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP16
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP17
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	50	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP18
Date Sampled: 5/5/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP19
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	60	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP20
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	90	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP21
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	80	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP22
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	60	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP23
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	50	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP24
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP25
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP26
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DP27
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

SunStar Laboratories, Inc.

TTLC METAL ANALYSIS

Client: Versar
Project Manager: Noel Simmons

Project Name
Wallops Island

Sample I.D.: 2WFF16-DUP2
Date Sampled: 5/6/98
Date Received: 5/11/98
Date Extracted: 5/20/98
Date Analyzed: 5/20/98
Batch: T-545 Matrix: Water
Conc. Unit: µg/L

Metal Analysis by I.C.P.

Element	Results	R.L.
Arsenic	ND	50

TTLC= Total Threshold Limit Concentration.

Reviewed and Approved by: _____ Date: 5/22/98

3002 Dow Avenue, Suite 406, Tustin, Ca. 92780 Phone: (714) 505-4010 Fax: (714) 505-4028

NASA Wallops Flight Facility - Site 16 - Wallops Island, Virginia

LINE: 0+00E Direction: N
Date: 28- 4-98 Time: 9: 0
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 110

Station	Cond.[mS/m]	Inphase [ppt]
0.000	9.720	20.856
—> Comment : NASA		
5.000	10.020	14.883
10.000	7.260	-0.012
15.000	1.560	-3.142
20.000	0.300	-4.154
25.000	-0.360	-4.840
30.000	-3.060	-3.829
35.000	4.800	-0.433
40.000	8.700	-0.024
45.000	8.160	0.000
50.000	6.180	-0.313
55.000	4.080	-1.854
60.000	3.840	-1.818
65.000	2.400	-2.625
70.000	1.140	-3.323
75.000	0.900	-3.191
80.000	0.240	-3.492
85.000	0.660	-3.456
90.000	0.600	-3.419
95.000	0.660	-3.443
100.000	0.480	-3.456
105.000	0.600	-3.468
110.000	0.660	-3.431

LINE: 0+10E Direction: N
Date: 28- 4-98 Time: 9: 6
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 125 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
125.000	0.540	-3.468
120.000	0.480	-3.456
115.000	0.660	-3.443
110.000	0.480	-3.456
105.000	0.420	-3.407
100.000	0.480	-3.468
95.000	0.480	-3.456
90.000	0.660	-3.395
85.000	0.480	-3.456
80.000	0.660	-3.371
75.000	0.720	-3.407
70.000	1.440	-3.034
65.000	1.860	-2.673
60.000	7.140	-0.168
55.000	-9.300	-31.092
50.000	-14.220	3.142
—> Comment : MH		
45.000	-9.660	1.192
40.000	-4.920	-2.853
35.000	-6.840	-4.587
30.000	-3.120	-3.648
25.000	7.260	-0.987
20.000	16.920	2.480
15.000	21.060	4.262
10.000	22.140	5.515
5.000	17.940	7.490
0.000	17.940	17.027

LINE: 0+20E Direction: N
Date: 28- 4-98 Time: 9: 8
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 5 Final station: 110

Station	Cond.[mS/m]	Inphase [ppt]
5.000	14.100	9.103
10.000	13.380	4.443
15.000	12.420	1.601
20.000	12.420	1.071
25.000	12.780	1.107
30.000	13.680	1.300
35.000	16.860	3.275
40.000	18.960	5.214
45.000	16.140	3.588
50.000	0.900	-2.059
55.000	-6.540	-2.456
60.000	5.460	1.168
65.000	6.600	-0.541
70.000	3.060	-2.504
75.000	1.620	-3.010
80.000	1.200	-3.154
85.000	0.840	-3.215
90.000	0.600	-3.215
95.000	0.660	-3.251

100.000	0.660	-3.299
105.000	0.600	-3.347
110.000	0.480	-3.347

LINE: 0+30E Direction: N
Date: 28- 4-98 Time: 9: 9
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 160 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
160.000	0.840	-3.311
155.000	0.660	-3.299
150.000	0.780	-3.347
145.000	0.660	-3.335
140.000	0.420	-3.335
135.000	0.480	-3.347
130.000	0.660	-3.323
125.000	0.720	-3.323
120.000	0.660	-3.335
115.000	0.600	-3.311
110.000	0.720	-3.287
105.000	0.660	-3.335
100.000	0.780	-3.299
95.000	0.780	-3.299
90.000	0.780	-3.275
85.000	0.840	-3.311
80.000	1.080	-3.215
75.000	1.380	-3.082
70.000	1.740	-2.938
65.000	2.340	-2.721
60.000	3.660	-2.263
55.000	3.900	-2.227
50.000	-5.040	-5.816
45.000	-10.020	-7.249
40.000	8.639	1.420
35.000	18.540	5.129
30.000	14.100	1.432
25.000	10.920	-0.252
20.000	9.480	-0.349
15.000	8.880	-0.168
10.000	9.180	0.541
5.000	7.140	1.204
0.000	4.680	5.623

LINE: 0+40E Direction: N
Date: 28- 4-98 Time: 9:11
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 215

Station	Cond.[mS/m]	Inphase [ppt]
0.000	0.780	-1.324
5.000	0.000	-2.745
10.000	4.500	-1.408
15.000	9.240	0.120
20.000	8.400	-0.602
25.000	7.800	-0.903
30.000	8.520	-0.578
35.000	9.840	0.493
40.000	11.040	2.191
45.000	2.520	-2.613
50.000	-10.260	-8.429
55.000	-2.100	-4.262
60.000	8.580	-0.457
65.000	5.460	-1.830
70.000	2.760	-2.637
75.000	1.560	-2.938
80.000	1.140	-3.082
85.000	0.900	-3.142
90.000	1.020	-3.191
95.000	1.020	-3.227
100.000	0.840	-3.287
105.000	0.840	-3.251
110.000	0.660	-3.263
115.000	0.720	-3.299
120.000	0.780	-3.275
125.000	0.720	-3.323
130.000	0.660	-3.323
135.000	0.660	-3.299
140.000	0.840	-3.323
145.000	0.720	-3.347
150.000	0.840	-3.323
155.000	0.840	-3.311
160.000	0.840	-3.323
165.000	0.780	-3.383
170.000	0.780	-3.552
175.000	0.540	-3.383
180.000	0.900	-3.371
185.000	1.560	-3.383
190.000	1.500	-3.383
195.000	1.260	-3.275
200.000	1.440	-3.022

205.000	1.440	-3.167
210.000	1.320	-3.239
215.000	1.200	-3.335

LINE: 0+50E Direction: N
Date: 28- 4-98 Time: 9:12
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 235 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
235.000	1.380	-3.323
230.000	1.500	-3.263
225.000	1.440	-3.130
220.000	1.080	-3.203
215.000	1.200	-3.191
210.000	1.020	-3.239
205.000	1.260	-3.407
200.000	-2.940	-6.912
195.000	-3.900	-5.479
190.000	-8.580	-15.100
185.000	-0.780	-5.804
180.000	1.500	-2.516
175.000	0.960	-3.191
170.000	0.840	-3.323
165.000	0.780	-3.251
160.000	0.660	-3.299
155.000	0.840	-3.299
150.000	0.960	-3.347
145.000	0.840	-3.311
140.000	0.900	-3.275
135.000	0.780	-3.251
130.000	0.780	-3.215
125.000	0.960	-3.215
120.000	0.900	-3.227
115.000	0.780	-3.215
110.000	0.600	-3.154
105.000	0.660	-3.191
100.000	0.840	-3.167
95.000	1.080	-3.106
90.000	1.080	-3.142
85.000	1.200	-3.106
80.000	1.260	-3.010
75.000	1.500	-2.926
70.000	1.800	-2.805
65.000	2.580	-2.661
60.000	3.960	-2.251
55.000	6.000	-1.553
50.000	1.620	-3.480
45.000	-9.720	-7.586
40.000	-6.180	-4.864
35.000	12.060	3.118
30.000	14.160	2.312
25.000	10.560	-0.156
20.000	8.219	-0.710
15.000	7.620	-0.638
10.000	7.800	-0.457
5.000	6.060	-1.348
0.000	0.120	-3.889

LINE: 0+60E Direction: N
Date: 28- 4-98 Time: 9:14
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 245

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-0.240	-3.564
--> Comment : F.OPTIC		
5.000	-0.780	-3.889
10.000	2.640	-2.179
15.000	8.639	-0.132
20.000	9.420	0.096
25.000	10.620	0.517
30.000	11.940	0.867
35.000	12.360	2.203
40.000	8.100	0.999
45.000	-4.860	-5.129
50.000	-7.980	-6.803
55.000	7.800	-0.650
60.000	10.080	-0.156
65.000	6.000	-1.565
70.000	3.780	-2.191
75.000	3.000	-2.456
80.000	2.520	-2.697
85.000	2.100	-2.793
90.000	1.920	-2.878
95.000	1.140	-3.335
100.000	0.780	-3.010
105.000	1.260	-2.950
110.000	1.380	-3.106
115.000	1.200	-3.070
120.000	1.140	-3.046

125.000	1.140	-3.070
130.000	0.900	-3.058
135.000	1.320	-3.046
140.000	1.320	-3.082
145.000	1.020	-3.082
150.000	1.020	-3.179
155.000	1.200	-3.142
160.000	1.140	-3.203
165.000	1.020	-3.167
170.000	1.080	-3.130
175.000	1.260	-3.154
180.000	1.200	-3.167
185.000	1.020	-3.142
190.000	1.020	-3.154
195.000	0.960	-3.154
200.000	0.900	-3.167
205.000	0.960	-3.191
210.000	1.140	-3.191
215.000	1.200	-3.347
220.000	1.140	-3.684
225.000	1.380	-3.106
230.000	1.500	-2.902
235.000	1.560	-3.118
240.000	0.840	-3.395
245.000	1.680	-3.371

LINE: 0+70E Direction: N
Date: 28- 4-98 Time: 9:16
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 260 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
260.000	1.620	-3.311
255.000	1.620	-3.299
250.000	1.500	-3.203
245.000	1.260	-3.480
240.000	1.440	-3.371
235.000	1.620	-3.323
230.000	1.680	-3.191
225.000	1.560	-3.167
220.000	1.620	-3.167
215.000	1.560	-3.142
210.000	1.440	-3.130
205.000	1.200	-3.142
200.000	1.140	-3.167
195.000	1.380	-3.082
190.000	1.320	-3.070
185.000	1.380	-3.094
180.000	1.380	-3.118
175.000	1.260	-3.070
170.000	1.380	-3.106
165.000	1.740	-3.082
160.000	1.560	-3.106
155.000	1.500	-3.022
150.000	1.200	-2.938
145.000	1.380	-3.046
140.000	1.620	-3.022
135.000	1.920	-2.962
130.000	2.220	-2.805
125.000	1.980	-2.733
120.000	2.100	-2.661
115.000	2.220	-2.576
110.000	2.460	-2.540
105.000	2.580	-2.444
100.000	3.000	-2.300
95.000	3.300	-2.287
90.000	3.180	-2.312
85.000	2.880	-2.432
80.000	3.060	-2.420
75.000	2.820	-2.673
70.000	2.280	-2.974
65.000	2.340	-3.191
60.000	2.280	-3.251
55.000	3.960	-2.637
50.000	4.020	-2.865
45.000	-7.140	-7.068
40.000	-13.560	-8.236
35.000	1.620	-0.830
30.000	10.140	0.228
25.000	6.780	-2.420
20.000	3.960	-2.769
15.000	3.780	-2.360
10.000	3.780	-2.275
5.000	3.780	-2.300
0.000	4.200	-2.203

LINE: 0+80E Direction: N
Date: 28- 4-98 Time: 9:17
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 350

Station	Cond.[mS/m]	Inphase [ppt]
0.000	4.320	-2.203
5.000	4.440	-2.251
10.000	4.260	-2.263
15.000	4.260	-2.251
20.000	4.980	-1.974
25.000	6.000	-1.709
30.000	7.860	-1.204
35.000	9.720	0.325
40.000	4.500	-0.686
45.000	-8.940	-6.815
50.000	-7.260	-6.731
55.000	10.020	0.686
60.000	11.160	0.722
65.000	6.240	-1.192
70.000	4.380	-1.830
75.000	3.420	-2.095
80.000	2.820	-2.348
85.000	2.040	-2.685
90.000	0.480	-3.347
95.000	-0.600	-3.901
100.000	-1.500	-4.359
105.000	-1.860	-4.600
110.000	-1.620	-4.551
115.000	-1.080	-4.515
120.000	-0.780	-4.286
125.000	-0.120	-3.853
130.000	0.960	-3.347
135.000	2.280	-2.613
140.000	3.000	-2.336
145.000	3.420	-2.408
150.000	3.240	-2.372
155.000	3.060	-2.300
160.000	2.760	-2.769
165.000	2.580	-2.661
170.000	2.520	-2.589
175.000	2.340	-2.709
180.000	2.160	-2.745
185.000	2.400	-2.733
190.000	2.400	-2.721
195.000	2.160	-2.781
200.000	2.160	-2.805
205.000	2.220	-2.853
210.000	2.040	-2.950
215.000	1.920	-3.022
220.000	1.920	-3.022
225.000	1.800	-3.058
230.000	1.800	-3.383
235.000	1.440	-3.311
240.000	1.440	-3.263
245.000	1.380	-3.323
250.000	1.440	-3.287
255.000	1.500	-3.203
260.000	1.500	-3.299
265.000	1.620	-3.299
270.000	1.500	-3.191
275.000	1.440	-3.203
280.000	1.500	-3.203
285.000	1.440	-3.275
290.000	1.260	-3.371
295.000	1.200	-3.239
300.000	1.500	-3.179
305.000	1.500	-3.251
310.000	1.260	-3.154
315.000	1.560	-3.239
320.000	1.920	-3.311
325.000	1.800	-3.347
330.000	1.980	-3.203
335.000	2.040	-3.215
340.000	2.100	-3.323
345.000	2.100	-3.275
350.000	1.980	-3.203

LINE: 0+90E Direction: N
Date: 28- 4-98 Time: 9:19
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 385 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
385.000	1.560	-3.058
380.000	1.800	-3.130
375.000	1.740	-3.142
370.000	2.100	-3.263
365.000	2.160	-3.239
360.000	2.220	-3.419
355.000	2.220	-3.456
350.000	1.980	-3.323
345.000	2.100	-3.167
340.000	1.740	-3.191

335.000	1.440	-3.239
330.000	1.380	-3.371
325.000	1.740	-3.251
320.000	1.860	-3.191
315.000	1.800	-3.167
310.000	1.800	-3.227
305.000	1.800	-3.263
300.000	1.680	-3.299
295.000	1.020	-3.335
290.000	1.320	-3.179
285.000	1.500	-3.022
280.000	0.060	-3.480
275.000	0.780	-3.371
270.000	1.560	-3.191
265.000	1.260	-3.215
260.000	1.380	-3.191
255.000	1.740	-2.986
250.000	2.160	-3.046
245.000	2.160	-3.046
240.000	2.040	-2.986
235.000	2.520	-2.878
230.000	2.580	-2.853
225.000	2.460	-2.817
220.000	2.340	-2.769
215.000	2.400	-2.757
210.000	2.280	-2.721
205.000	2.280	-2.697
200.000	2.520	-2.649
195.000	2.760	-2.576
190.000	2.760	-2.504
185.000	2.880	-2.528
180.000	2.700	-2.625
175.000	2.460	-2.685
170.000	2.280	-2.817
165.000	1.500	-3.311
160.000	0.900	-3.696
155.000	0.600	-3.781
150.000	0.240	-4.058
145.000	-0.540	-4.383
140.000	-1.380	-4.672
135.000	-1.860	-4.889
130.000	-1.500	-4.551
125.000	-0.840	-4.142
120.000	-0.360	-4.070
115.000	0.060	-3.817
110.000	0.360	-3.624
105.000	0.540	-3.443
100.000	1.800	-2.793
95.000	2.700	-2.312
90.000	2.820	-2.300
85.000	3.120	-2.191
80.000	3.240	-2.251
75.000	3.360	-2.287
70.000	3.300	-2.251
65.000	3.780	-2.107
60.000	4.800	-1.782
55.000	6.600	-1.168
50.000	7.200	-1.168
45.000	-2.220	-5.310
40.000	-10.320	-7.237
35.000	4.140	0.204
30.000	12.420	1.107
25.000	9.059	-1.420
20.000	5.940	-2.035
15.000	4.740	-2.203
10.000	4.260	-2.312
5.000	4.200	-2.396
0.000	4.500	-2.239

LINE: 1+00E Direction: N
Date: 28- 4-98 Time: 9:22
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 400

Station	Cond.[mS/m]	Inphase [ppt]
0.000	6.840	-1.661
5.000	5.760	-1.950
10.000	5.460	-2.071
15.000	5.040	-2.155
20.000	5.040	-2.119
25.000	5.580	-2.023
30.000	7.320	-1.565
35.000	9.180	-0.433
40.000	4.500	-0.662
45.000	-8.700	-6.562
50.000	-7.140	-6.574
55.000	7.860	-0.553
60.000	8.460	-0.602
65.000	4.620	-1.974

70.000	3.000	-2.480
75.000	2.340	-2.649
80.000	2.100	-2.805
85.000	1.860	-2.865
90.000	1.740	-2.890
95.000	1.800	-2.853
100.000	1.740	-2.878
105.000	1.500	-2.938
110.000	1.680	-2.865
115.000	1.740	-2.878
120.000	1.980	-2.829
125.000	2.100	-2.793
130.000	2.160	-2.793
135.000	2.280	-2.709
140.000	2.580	-2.661
145.000	2.640	-2.540
150.000	3.000	-2.432
155.000	3.240	-2.312
160.000	3.240	-2.275
165.000	3.120	-2.360
170.000	2.760	-2.432
175.000	2.580	-2.528
180.000	2.460	-2.540
185.000	1.740	-2.890
190.000	0.720	-3.516
195.000	-0.240	-4.070
200.000	-1.080	-4.696
205.000	-1.200	-4.876
210.000	-0.720	-4.612
215.000	0.060	-4.202
220.000	1.020	-3.841
225.000	2.040	-3.130
230.000	3.180	-2.324
235.000	3.600	-1.998
240.000	3.540	-2.167
245.000	3.300	-2.336
250.000	2.760	-2.649
255.000	2.580	-2.649
260.000	2.580	-2.637
265.000	2.340	-2.781
270.000	2.100	-2.805
275.000	1.920	-2.926
280.000	1.620	-2.974
285.000	1.920	-2.878
290.000	1.140	-2.878
295.000	-0.600	-2.853
300.000	1.440	-2.998
305.000	1.620	-3.299
310.000	1.260	-3.419
315.000	2.100	-3.094
320.000	1.980	-3.094
325.000	1.980	-3.082
330.000	2.160	-3.094
335.000	2.100	-3.034
340.000	1.980	-3.082
345.000	2.160	-3.130
350.000	2.220	-3.239
355.000	2.340	-3.142
360.000	1.920	-3.022
365.000	1.380	-3.263
370.000	1.440	-2.986
375.000	2.580	-3.106
380.000	2.940	-3.287
385.000	3.000	-3.227
390.000	3.120	-3.082
395.000	3.120	-3.022
400.000	2.880	-3.058

LINE: 1+10E Direction: N
Date: 28- 4-98 Time: 9:24
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 400 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
400.000	2.520	-3.046
395.000	2.940	-3.010
390.000	3.360	-3.022
385.000	3.120	-3.070
380.000	3.180	-3.094
375.000	3.000	-3.046
370.000	2.220	-3.299
365.000	1.500	-3.154
360.000	1.380	-2.986
355.000	2.280	-3.142
350.000	2.400	-3.287
345.000	2.640	-3.094
340.000	2.700	-3.034
335.000	2.460	-3.022
330.000	2.400	-2.986

325.000	2.340	-3.010
320.000	2.520	-2.998
315.000	2.820	-2.890
310.000	2.460	-2.878
305.000	2.520	-2.757
300.000	2.760	-2.709
295.000	2.700	-2.324
290.000	2.640	-2.287
285.000	2.520	-2.468
280.000	2.640	-2.552
275.000	2.700	-2.360
270.000	2.880	-2.275
265.000	3.240	-2.215
260.000	4.020	-2.095
255.000	4.080	-2.119
250.000	2.520	-2.986
245.000	0.660	-3.949
240.000	-0.840	-4.768
235.000	-0.960	-4.575
230.000	-0.540	-4.274
225.000	-0.060	-3.865
220.000	1.800	-2.950
215.000	2.520	-2.564
210.000	3.120	-2.119
205.000	3.420	-2.131
200.000	3.060	-2.348
195.000	3.180	-2.420
190.000	3.000	-2.444
185.000	2.640	-2.552
180.000	2.460	-2.576
175.000	2.280	-2.649
170.000	2.100	-2.745
165.000	2.160	-2.829
160.000	1.860	-2.841
155.000	1.620	-2.890
150.000	1.560	-2.998
145.000	1.560	-3.010
140.000	1.620	-3.022
135.000	1.440	-3.046
130.000	1.440	-3.118
125.000	1.500	-3.130
120.000	1.560	-3.106
115.000	1.380	-3.142
110.000	1.320	-3.191
105.000	1.320	-3.142
100.000	1.260	-3.179
95.000	1.320	-3.203
90.000	1.380	-3.154
85.000	1.560	-3.082
80.000	1.560	-3.034
75.000	1.800	-2.962
70.000	2.280	-2.853
65.000	2.820	-2.637
60.000	3.960	-2.155
55.000	5.640	-1.577
50.000	5.100	-2.263
45.000	-4.560	-6.334
40.000	-11.280	-7.526
35.000	0.540	-1.228
30.000	12.360	1.276
25.000	10.500	-1.011
20.000	7.320	-1.818
15.000	6.300	-1.890
10.000	5.520	-2.167
5.000	0.900	-3.456
0.000	-1.080	-3.745

LINE: 1+20E Direction: N
Date: 28- 4-98 Time: 9:26
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 395

Station	Cond.[mS/m]	Inphase [ppt]
0.000	5.580	-2.745
5.000	-8.219	-6.189
10.000	-12.240	-6.502
15.000	4.800	-1.673
20.000	11.040	-0.746
25.000	8.100	-1.625
30.000	7.500	-1.601
35.000	8.280	-0.927
40.000	4.680	-0.915
45.000	-7.980	-6.141
50.000	-8.160	-7.225
55.000	6.600	-1.276
60.000	9.360	-0.349
65.000	5.220	-1.986
70.000	3.060	-2.564
75.000	2.280	-2.757

80.000	1.920	-2.926
85.000	1.680	-3.058
90.000	1.440	-3.154
95.000	1.380	-3.167
100.000	1.200	-3.275
105.000	1.320	-3.179
110.000	1.260	-3.227
115.000	1.140	-3.191
120.000	1.140	-3.130
125.000	1.080	-3.239
130.000	1.080	-3.191
135.000	1.140	-3.179
140.000	1.140	-3.227
145.000	1.020	-3.227
150.000	0.960	-3.215
155.000	1.200	-3.239
160.000	1.200	-3.275
165.000	1.260	-3.239
170.000	1.320	-3.203
175.000	1.260	-3.191
180.000	1.320	-3.106
185.000	1.320	-3.142
190.000	1.380	-3.142
195.000	1.440	-3.094
200.000	1.380	-3.034
205.000	1.500	-3.034
210.000	1.440	-2.998
215.000	1.560	-2.938
220.000	1.680	-2.829
225.000	1.740	-2.781
230.000	2.040	-2.817
235.000	2.100	-2.865
240.000	2.100	-2.841
245.000	2.340	-2.601
250.000	2.400	-2.504
255.000	2.400	-2.564
260.000	2.280	-2.528
265.000	1.320	-2.312
270.000	-0.180	-2.263
275.000	0.960	-2.685
280.000	0.120	-3.588
285.000	-0.540	-4.347
290.000	0.240	-3.576
295.000	-0.960	-4.443
300.000	0.240	-4.347
305.000	0.540	-3.913
310.000	1.860	-2.950
315.000	2.580	-2.215
320.000	3.240	-1.866
325.000	4.020	-1.854
330.000	3.540	-2.504
335.000	3.600	-2.589
340.000	3.660	-2.408
345.000	3.840	-2.300
350.000	4.260	-2.191
355.000	4.500	-2.203
360.000	4.800	-2.131
365.000	5.100	-2.047
370.000	4.200	-2.010
375.000	1.620	-1.589
380.000	-0.180	-1.685
385.000	1.500	-2.781
390.000	3.600	-3.227
395.000	4.380	-2.143

LINE: 1+30E Direction: N
Date: 28- 4-98 Time: 9:29
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 400 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
400.000	6.780	-2.649
395.000	5.040	-1.866
390.000	6.060	-3.504
385.000	6.300	-2.829
380.000	3.600	-1.782
375.000	3.780	-1.866
370.000	5.040	-2.191
365.000	5.040	-2.023
360.000	4.980	-1.986
355.000	4.680	-2.227
350.000	4.020	-2.492
345.000	3.300	-2.576
340.000	3.480	-2.576
335.000	3.900	-2.420
330.000	3.300	-2.757
325.000	0.000	-4.214
320.000	-2.160	-4.901
315.000	-1.800	-4.503

310.000	-1.680	-4.009
305.000	-0.240	-3.841
300.000	-0.360	-3.997
295.000	1.560	-2.673
290.000	2.340	-1.986
285.000	2.580	-1.986
280.000	2.820	-2.528
275.000	2.640	-2.432
270.000	2.280	-2.480
265.000	0.780	-2.576
260.000	-1.080	-2.263
255.000	0.600	-2.637
250.000	1.800	-2.853
245.000	1.980	-2.974
240.000	1.860	-3.010
235.000	1.680	-3.046
230.000	1.680	-3.094
225.000	1.620	-3.106
220.000	1.380	-3.191
215.000	1.080	-3.227
210.000	1.380	-3.215
205.000	1.500	-3.227
200.000	1.380	-3.275
195.000	1.140	-3.275
190.000	1.140	-3.287
185.000	1.140	-3.359
180.000	1.020	-3.335
175.000	1.020	-3.347
170.000	1.020	-3.299
165.000	1.080	-3.347
160.000	0.900	-3.456
155.000	0.960	-3.456
150.000	0.960	-3.456
145.000	0.960	-3.431
140.000	1.020	-3.395
135.000	1.020	-3.395
130.000	0.840	-3.407
125.000	1.020	-3.383
120.000	1.080	-3.371
115.000	1.020	-3.323
110.000	1.500	-3.022
105.000	2.220	-2.625
100.000	1.500	-3.142

—> Comment : MW-3

95.000	1.380	-3.154
90.000	1.320	-3.191
85.000	1.440	-3.142
80.000	1.800	-3.154
75.000	2.220	-3.142
70.000	2.520	-2.998
65.000	3.240	-2.673
60.000	4.500	-2.203
55.000	6.900	-1.312
50.000	6.960	-1.818
45.000	-5.100	-6.827
40.000	-9.360	-6.394
35.000	6.660	0.770
30.000	12.840	0.409
25.000	9.780	-1.445
20.000	8.040	-1.721
15.000	9.180	-1.228
10.000	7.980	-1.432
5.000	-8.280	-6.045
0.000	-10.860	-6.177

LINE: 1+40E Direction: N
Date: 28- 4-98 Time: 9:32
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 400

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-5.820	-5.406
5.000	-13.020	-7.381
10.000	-16.620	-7.453
15.000	7.800	-0.409
20.000	14.160	0.108
25.000	9.900	-1.445
30.000	8.700	-1.553
35.000	9.599	-0.830
40.000	5.520	-0.999
45.000	-8.040	-6.490
50.000	-5.280	-6.213
55.000	8.700	-0.626
60.000	8.219	-0.891
65.000	4.380	-2.275
70.000	3.000	-2.733
75.000	2.400	-2.926
80.000	2.040	-3.034
85.000	1.860	-3.167

90.000	1.860	-3.227
95.000	1.740	-3.142
100.000	2.340	-2.781
105.000	1.800	-3.142
110.000	1.260	-3.299
115.000	1.080	-3.287
120.000	1.020	-3.347
125.000	1.020	-3.359
130.000	0.900	-3.371
135.000	0.840	-3.431
140.000	0.840	-3.383
145.000	0.780	-3.395
150.000	0.660	-3.407
155.000	0.720	-3.407
160.000	0.720	-3.371
165.000	0.660	-3.407
170.000	0.660	-3.419
175.000	0.720	-3.359
180.000	0.720	-3.359
185.000	0.840	-3.311
190.000	1.020	-3.311
195.000	1.140	-3.395
200.000	1.080	-3.443
205.000	0.960	-3.419
210.000	0.960	-3.371
215.000	1.200	-3.419
220.000	1.260	-3.239
225.000	1.200	-3.516
230.000	1.320	-3.443
235.000	1.440	-3.371
240.000	1.380	-3.323
245.000	1.440	-3.323
250.000	1.140	-3.239
255.000	1.080	-3.359
260.000	1.560	-3.215
265.000	1.020	-3.552
270.000	-0.060	-3.624
275.000	0.660	-3.287
280.000	0.600	-3.299
285.000	2.100	-3.022
290.000	2.100	-2.769
295.000	1.440	-2.986
300.000	-0.420	-2.781
305.000	-1.620	-3.672
310.000	0.840	-2.239
315.000	-0.780	-3.106
320.000	2.460	-2.986
325.000	3.480	-2.528
330.000	3.240	-2.613
335.000	3.600	-2.589
340.000	3.600	-2.275
345.000	3.840	-1.806
350.000	3.420	-2.191
355.000	4.860	-2.324
360.000	4.980	-2.155
365.000	5.280	-2.203
370.000	5.760	-2.107
375.000	7.260	-2.010
380.000	8.940	-2.878
385.000	9.780	-4.684
390.000	2.160	-4.527
395.000	1.980	-1.168
400.000	16.320	0.842

LINE: 1+50E Direction: N
Date: 28- 4-98 Time: 12:17
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 335

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-19.400	-7.947

—> Comment : NASA

5.000	-23.600	-7.887
10.000	-10.000	-4.876
15.000	11.800	1.119
20.000	14.000	-0.108
25.000	10.600	-1.216
30.000	8.600	-0.999
35.000	7.000	-0.939
40.000	1.600	-1.721
45.000	-10.200	-6.791
50.000	-4.200	-5.756
55.000	8.400	-0.457
60.000	7.800	-0.758
65.000	4.000	-2.143
70.000	2.400	-2.456
75.000	2.000	-2.817
80.000	1.000	-2.938
85.000	0.800	-3.046

90.000	0.400	-3.094
95.000	0.600	-3.106
100.000	1.400	-3.130
105.000	1.000	-3.191
110.000	0.600	-3.118
115.000	0.600	-3.251
120.000	0.200	-3.311
125.000	0.400	-3.287
130.000	0.200	-3.311
135.000	0.200	-3.275
140.000	0.200	-3.251
145.000	0.000	-3.227
150.000	-0.200	-3.275
155.000	0.000	-3.335
160.000	0.400	-3.275
165.000	0.200	-3.251
170.000	0.200	-3.335
175.000	0.200	-3.263
180.000	0.200	-3.251
185.000	0.400	-3.263
190.000	0.400	-3.251
195.000	0.400	-3.275
200.000	0.200	-3.299
205.000	0.400	-3.239
210.000	0.400	-3.239
215.000	0.600	-3.191
220.000	0.400	-3.191
225.000	0.400	-3.179
230.000	0.400	-3.179
235.000	0.400	-3.142
240.000	0.600	-3.227
245.000	0.800	-3.275
250.000	0.800	-3.239
255.000	0.800	-3.179
260.000	0.800	-3.191
265.000	0.800	-3.154
270.000	1.000	-3.203
275.000	0.600	-3.492
280.000	-0.400	-3.130
285.000	0.200	-3.142
290.000	1.400	-5.358
295.000	0.800	-4.852
300.000	-13.400	-5.358
305.000	-30.600	0.782
310.000	-59.800	-3.684
315.000	-9.600	-9.489
320.000	5.200	-2.745
325.000	0.800	-2.348
330.000	0.400	-3.058
335.000	2.200	-2.914

LINE: 1+60E Direction: N
Date: 28- 4-98 Time: 12:19
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 335 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
335.000	2.400	-3.130
330.000	1.200	-5.105
325.000	-2.800	-3.588
320.000	-1.000	-3.130
315.000	1.600	-3.853
310.000	1.200	-2.938
305.000	0.800	-3.022
300.000	0.800	-2.950
295.000	1.400	-3.540
290.000	2.000	-3.167
285.000	1.400	-2.902
280.000	0.800	-3.070
275.000	0.600	-3.046
270.000	0.000	-3.010
265.000	0.200	-3.480
260.000	1.000	-3.359
255.000	0.800	-3.347
250.000	1.200	-3.046
245.000	1.400	-3.094
240.000	1.200	-3.142
—> Comment : GW-7		
235.000	1.000	-3.227
230.000	0.800	-3.239
225.000	0.600	-3.299
220.000	-9.400	23.445
215.000	3.000	6.261
210.000	7.200	1.445
205.000	1.800	-3.492
200.000	0.600	-3.492
195.000	0.400	-3.335
190.000	0.600	-3.383
185.000	1.000	-2.890

180.000	0.400	-3.383
175.000	0.400	-3.383
170.000	0.400	-3.359
165.000	0.400	-3.359
160.000	0.600	-3.383
155.000	0.400	-3.359
150.000	0.400	-3.347
145.000	0.200	-3.275
140.000	-0.200	-3.395
135.000	0.000	-3.311
130.000	10.200	5.876
125.000	6.000	0.313
120.000	0.000	-3.624
115.000	3.200	-1.059
110.000	1.800	-2.456
105.000	0.400	-3.323
100.000	0.600	-3.275
95.000	1.000	-3.130
90.000	1.200	-2.950
85.000	0.800	-3.046
80.000	1.200	-3.046
75.000	2.000	-3.046
70.000	2.600	-2.589
65.000	3.000	-2.143
60.000	9.800	18.424
55.000	26.800	18.857
50.000	15.800	1.505
45.000	2.600	-2.263
40.000	20.400	20.001
35.000	11.400	2.143
30.000	13.000	1.493
25.000	7.600	-0.361
20.000	10.400	-1.143
15.000	9.600	-0.240
10.000	11.600	3.576
5.000	36.400	44.579
0.000	34.600	36.679

LINE: 1+70E Direction: N
Date: 28- 4-98 Time: 12:22
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 335

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-10.000	-6.057
5.000	-13.200	-7.357
10.000	-22.200	-7.851
15.000	7.600	-1.866
20.000	13.800	-0.204
25.000	9.600	-0.915
30.000	14.200	-1.457
35.000	13.200	-0.084
40.000	5.400	-0.240
45.000	-10.800	-7.574
50.000	-6.400	-6.358
55.000	6.800	-1.059
60.000	7.400	-1.023
65.000	4.800	-2.227
70.000	2.400	-2.757
75.000	2.200	-2.962
80.000	1.200	-3.118
85.000	0.600	-3.167
90.000	1.000	-3.251
95.000	0.400	-3.311
100.000	0.600	-3.311
105.000	0.400	-3.275
110.000	0.200	-3.395
115.000	-0.200	-3.564
120.000	0.200	-3.564
125.000	0.200	-3.468
130.000	0.000	-3.516
135.000	0.200	-3.504
140.000	0.400	-3.407
145.000	0.000	-3.456
150.000	0.200	-3.468
155.000	0.200	-3.419
160.000	0.400	-3.480
165.000	0.000	-3.504
170.000	0.200	-3.383
175.000	0.400	-3.492
180.000	0.400	-3.383
185.000	0.400	-3.468
190.000	0.200	-3.456
195.000	0.400	-3.516
200.000	0.600	-3.516
205.000	1.000	-3.492
210.000	1.000	-3.516
215.000	0.400	-3.407
220.000	0.400	-3.263

225.000	1.000	-3.251
230.000	1.200	-3.263
235.000	1.000	-3.167
240.000	2.600	-2.444
245.000	1.600	-3.203
250.000	1.400	-3.383
255.000	1.000	-3.443
260.000	0.600	-3.480
265.000	0.800	-3.419
270.000	1.000	-3.383
275.000	1.200	-3.311
280.000	0.800	-3.383
285.000	1.200	-3.395
290.000	1.400	-3.371
295.000	1.400	-3.371
300.000	1.600	-3.359
305.000	1.600	-3.323
310.000	1.600	-3.371
315.000	1.400	-3.323
320.000	1.200	-3.167
325.000	0.800	-3.335
330.000	0.200	-3.167
335.000	1.800	-3.070

LINE: 1+80E Direction: N
Date: 28- 4-98 Time: 12:24
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 335 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
335.000	2.400	-2.974
330.000	1.800	-3.010
325.000	0.800	-3.215
320.000	0.200	-3.179
315.000	-0.400	-3.239
310.000	-0.800	-3.431
305.000	0.800	-3.251
300.000	-0.800	-3.203
295.000	0.400	-3.106
290.000	1.400	-3.395
285.000	1.000	-3.383
280.000	1.000	-3.251
275.000	0.600	-3.492
270.000	0.200	-3.997
265.000	0.400	-3.745
260.000	1.000	-3.383
255.000	0.800	-3.371
250.000	0.600	-3.383
245.000	0.800	-3.383
240.000	1.000	-3.335
235.000	1.200	-3.383
230.000	0.800	-3.275
225.000	0.800	-3.203
220.000	1.000	-3.227
215.000	0.400	-3.203
210.000	0.200	-3.239
205.000	1.000	-3.347
200.000	1.000	-3.371
195.000	0.800	-3.395
190.000	0.400	-3.395
185.000	0.200	-3.371
180.000	0.400	-3.347
175.000	0.400	-3.395
170.000	0.400	-3.371
165.000	0.600	-3.443
160.000	0.600	-3.407
155.000	0.200	-3.383
150.000	0.200	-3.395
145.000	0.400	-3.359
140.000	0.400	-3.371
135.000	0.000	-3.443
130.000	0.200	-3.383
125.000	0.400	-3.347
120.000	0.200	-3.371
115.000	0.400	-3.323
110.000	0.400	-3.516
105.000	0.800	-3.323
100.000	0.600	-3.383
95.000	0.200	-3.456
90.000	0.800	-3.299
85.000	1.800	-3.251
80.000	1.200	-3.167
75.000	1.200	-2.974
70.000	1.200	-2.902
65.000	2.000	-2.709
60.000	4.200	-2.203
55.000	7.000	-1.445
50.000	8.000	-1.131
45.000	-3.400	-6.767

40.000	-7.000	-5.575
35.000	7.200	1.143
30.000	10.000	0.602
25.000	13.000	-1.469
20.000	12.800	-0.987
15.000	9.200	-2.131
10.000	23.600	-1.613
5.000	0.000	-9.537
0.000	-24.800	-12.005

LINE: 1+90E Direction: N
Date: 28- 4-98 Time: 12:28
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 335

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-19.400	-12.174
5.000	-28.600	-15.136
10.000	-14.400	-10.825
15.000	17.000	-1.216
20.000	22.200	-0.144
25.000	10.400	-1.083
30.000	10.200	-0.578
35.000	14.400	-0.156
40.000	12.000	1.107
45.000	-7.000	-5.840
50.000	-6.800	-6.442
55.000	6.800	-1.360
60.000	7.400	-1.228
65.000	4.800	-2.263
70.000	3.400	-2.865
75.000	2.400	-2.986
80.000	1.000	-3.130
85.000	1.200	-3.299
90.000	1.200	-3.167
95.000	1.000	-3.323
100.000	1.000	-3.263
105.000	0.600	-3.335
110.000	0.400	-3.323
115.000	0.800	-3.347
120.000	0.600	-3.407
125.000	0.400	-3.419
130.000	0.400	-3.468
135.000	0.400	-3.443
140.000	0.200	-3.407
145.000	0.400	-3.407
150.000	0.400	-3.504
155.000	0.400	-3.419
160.000	0.400	-3.431
165.000	0.200	-3.480
170.000	0.400	-3.588
175.000	0.800	-3.419
180.000	0.600	-3.443
185.000	0.400	-3.456
190.000	0.600	-3.395
195.000	0.600	-3.395
200.000	0.800	-3.480
205.000	0.800	-3.504
210.000	0.800	-3.335
215.000	0.000	-2.914
220.000	0.000	-2.841
225.000	0.400	-3.142
230.000	0.800	-3.094
235.000	1.000	-3.106
240.000	1.400	-3.311
245.000	1.400	-3.431
250.000	0.800	-3.359
255.000	0.800	-3.480
260.000	1.000	-3.540
265.000	1.000	-3.660
270.000	1.400	-2.528
275.000	1.400	-2.384
280.000	1.400	-2.360
285.000	1.600	-2.336
290.000	1.600	-2.468
295.000	1.600	-2.384
300.000	1.600	-2.372
305.000	1.600	-2.107
310.000	1.600	-2.263
315.000	2.200	-2.215
320.000	2.000	-1.974
325.000	1.800	-2.035
330.000	2.200	-2.107
335.000	2.400	-2.155

LINE: 2+00E Direction: N
Date: 28- 4-98 Time: 12:32
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 335 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]

335.000	2.400	-3.167
330.000	2.600	-3.058
325.000	2.400	-3.034
320.000	1.800	-2.926
315.000	2.000	-2.938
310.000	2.000	-2.926
305.000	1.800	-2.817
300.000	1.600	-2.938
295.000	1.600	-3.058
290.000	1.600	-3.034
285.000	1.400	-3.046
280.000	1.400	-2.926
275.000	1.400	-3.058
270.000	1.200	-2.697
265.000	0.800	-2.516
260.000	0.800	-2.263
255.000	0.400	-2.263
250.000	1.000	-2.239
245.000	1.200	-2.167
240.000	1.000	-2.336
235.000	1.400	-2.227
230.000	1.400	-2.143
225.000	1.200	-2.215
220.000	1.000	-1.938
215.000	0.000	-1.914
210.000	-1.000	-1.637
205.000	-0.400	-1.469
200.000	1.000	-1.842
195.000	1.200	-2.155
190.000	1.000	-2.191
185.000	0.800	-2.179
180.000	0.600	-2.107
175.000	0.600	-2.107
170.000	0.600	-2.010
165.000	0.600	-1.962
160.000	0.800	-2.010
155.000	0.400	-1.962
150.000	0.400	-1.974
145.000	0.600	-2.035
140.000	0.400	-2.010
135.000	0.600	-2.010
130.000	0.400	-2.143
125.000	0.400	-2.155
120.000	0.600	-2.035
115.000	0.200	-1.998
110.000	0.600	-1.950
105.000	0.600	-1.926
100.000	0.800	-1.986
95.000	0.800	-2.035
90.000	1.600	-1.998
85.000	1.200	-1.902
80.000	1.600	-1.746
75.000	1.600	-1.673
70.000	1.600	-1.577
65.000	2.600	-1.420
60.000	3.200	-1.119
55.000	6.200	-0.216
50.000	5.400	-0.578
45.000	-7.400	-5.527
40.000	-9.400	-4.551
35.000	7.600	3.046
30.000	11.600	1.529
25.000	6.200	-0.541
20.000	13.800	0.120
15.000	18.800	-1.047
10.000	-9.800	-6.045
5.000	-11.000	-9.476
0.000	-8.600	-4.310

LINE: 2+10E Direction: N
Date: 28- 4-98 Time: 12:35
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 310

Station	Cond.[mS/m]	Inphase [ppt]
0.000	29.200	0.879
5.000	-1.800	-3.588
10.000	-25.200	-9.621
15.000	2.200	-3.167
20.000	24.800	1.420
25.000	15.400	1.156
30.000	14.600	0.457
35.000	14.600	2.023
40.000	-4.400	-3.142
45.000	-10.200	-6.117
50.000	-5.400	-4.720
55.000	8.800	0.686
60.000	8.800	0.433
65.000	4.800	-0.818

70.000	3.400	-1.445
75.000	2.000	-1.649
80.000	1.200	-1.758
85.000	1.400	-1.758
90.000	1.000	-1.830
95.000	0.800	-1.938
100.000	0.800	-1.938
105.000	0.800	-1.854
110.000	1.000	-1.758
115.000	1.200	-1.914
120.000	1.200	-1.938
125.000	0.600	-1.938
130.000	0.800	-1.902
135.000	0.800	-1.938
140.000	0.800	-1.926
145.000	0.600	-1.902
150.000	0.600	-1.926
155.000	0.600	-1.998
160.000	0.800	-1.890
165.000	0.600	-1.890
170.000	0.600	-1.938
175.000	0.600	-1.938
180.000	0.600	-2.010
185.000	0.600	-2.047
190.000	0.800	-2.047
195.000	0.800	-2.047
200.000	0.600	-2.047
205.000	1.000	-1.986
210.000	1.000	-2.023
215.000	1.000	-1.926
220.000	0.400	-1.673
225.000	-0.200	-1.432
230.000	-0.200	-1.601
235.000	0.400	-1.878
240.000	1.000	-1.866
245.000	1.000	-1.914
250.000	0.600	-1.649
255.000	0.800	-1.709
260.000	0.800	-2.191
265.000	1.200	-2.251
270.000	1.400	-2.287
275.000	1.200	-2.010
280.000	1.200	-2.191
285.000	1.000	-2.215
290.000	1.400	-2.155
295.000	1.600	-2.251
300.000	1.800	-2.119
305.000	1.600	-2.275
310.000	-0.600	-3.395

LINE: 2+20E Direction: N
Date: 28- 4-98 Time: 12:38
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 310 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
310.000	0.200	-2.721
305.000	2.200	-2.023
300.000	1.800	-2.155
295.000	1.600	-2.167
290.000	1.600	-2.203
285.000	1.400	-2.661
280.000	1.000	-2.589
275.000	1.000	-2.914
270.000	1.000	-2.552
265.000	1.200	-2.251
260.000	0.800	-3.179
255.000	1.000	-2.853
250.000	0.600	-2.853
245.000	0.200	-2.853
240.000	0.200	-2.950
235.000	0.400	-3.118
230.000	0.800	-3.251
225.000	1.000	-3.179
220.000	1.000	-3.251
215.000	1.000	-3.215
210.000	0.600	-3.263
205.000	0.600	-3.191
200.000	0.800	-3.203
195.000	0.800	-3.167
190.000	0.400	-3.191
185.000	0.400	-3.154
180.000	0.400	-3.142
175.000	0.400	-3.167
170.000	0.600	-3.130
165.000	1.000	-3.118
160.000	1.000	-3.142
155.000	0.600	-3.203
150.000	0.600	-3.191

145.000	0.600	-3.167
140.000	0.400	-3.215
135.000	0.600	-3.167
130.000	0.400	-3.130
125.000	0.400	-3.130
120.000	1.000	-3.179
115.000	0.800	-3.070
110.000	1.000	-3.118
105.000	1.200	-3.058
100.000	1.000	-3.046
95.000	0.800	-3.058
90.000	1.200	-3.154
85.000	0.800	-2.890
80.000	1.000	-2.841
75.000	1.600	-2.793
70.000	2.000	-2.805
65.000	2.400	-2.613
60.000	3.000	-2.312
55.000	5.400	-1.770
50.000	7.400	-1.493
45.000	0.800	-4.455
40.000	-10.000	-7.658
35.000	3.400	-0.565
30.000	19.000	3.793
25.000	14.400	-0.457
20.000	12.400	-2.227
15.000	17.000	-1.986
10.000	10.200	-2.613
5.000	-16.400	-4.587
0.000	-3.600	-4.310

LINE: 2+30E Direction: N
Date: 28- 4-98 Time: 12:41
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 310

Station	Cond.[mS/m]	Inphase [ppt]
0.000	57.400	6.466
5.000	24.000	1.083
10.000	-29.400	-6.442
15.000	13.000	-0.722
20.000	27.400	0.505
25.000	14.000	-0.421
30.000	8.800	-1.107
35.000	10.200	0.132
40.000	-1.000	-2.890
45.000	-7.400	-7.538
50.000	-2.400	-4.648
55.000	13.200	0.975
60.000	8.400	-0.794
65.000	4.200	-2.239
70.000	2.000	-2.721
75.000	1.200	-2.781
80.000	2.000	-2.685
85.000	1.400	-2.998
90.000	1.200	-2.926
95.000	1.600	-3.142
100.000	0.800	-3.070
105.000	0.800	-3.046
110.000	0.600	-3.167
115.000	0.800	-3.118
120.000	0.600	-3.010
125.000	0.600	-3.058
130.000	1.000	-3.094
135.000	0.600	-3.130
140.000	0.800	-3.082
145.000	0.600	-3.154
150.000	0.600	-3.130
155.000	0.200	-3.215
160.000	0.400	-3.167
165.000	0.800	-3.106
170.000	0.800	-3.154
175.000	0.600	-3.203
180.000	0.600	-3.154
185.000	0.800	-3.130
190.000	0.800	-3.154
195.000	1.000	-3.142
200.000	0.800	-3.094
205.000	0.600	-3.154
210.000	0.800	-3.154
215.000	1.000	-3.130
220.000	1.000	-3.082
225.000	1.200	-3.082
230.000	1.400	-3.070
235.000	1.000	-3.094
240.000	1.000	-3.142
245.000	1.000	-3.130
250.000	1.000	-3.142
255.000	0.800	-3.227

260.000	1.000	-3.203
265.000	1.000	-3.130
270.000	1.200	-3.191
275.000	1.000	-3.179
280.000	1.200	-3.191
285.000	1.200	-3.383
290.000	1.400	-3.648
295.000	1.400	-3.516
300.000	1.600	-3.564
305.000	2.000	-3.383
310.000	2.000	-3.287

LINE: 2+40E Direction: N
Date: 28- 4-98 Time: 12:44
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 310 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
310.000	2.600	-3.371
305.000	2.200	-3.311
300.000	2.200	-3.359
295.000	1.800	-3.323
290.000	1.800	-3.335
285.000	1.400	-3.323
280.000	1.000	-3.443
275.000	1.200	-3.359
270.000	1.000	-3.335
265.000	1.000	-3.287
260.000	1.000	-3.154
255.000	1.000	-3.323
250.000	1.200	-3.275
245.000	1.000	-3.335
240.000	1.000	-3.371
235.000	1.000	-3.383
230.000	1.200	-3.359
225.000	1.600	-3.407
220.000	1.600	-3.371
215.000	0.800	-2.938
210.000	0.200	-3.443
205.000	0.800	-3.997
200.000	1.400	-3.419
195.000	1.600	-3.227
190.000	1.400	-3.311
185.000	1.000	-3.311
180.000	0.600	-3.299
175.000	0.800	-3.227
170.000	0.800	-3.287
165.000	1.000	-3.311
160.000	0.800	-3.251
155.000	0.600	-3.251
150.000	0.600	-3.299
145.000	0.800	-3.275
140.000	0.600	-3.287
135.000	0.600	-3.251
130.000	0.600	-3.299
125.000	0.400	-3.335
120.000	0.800	-3.215
115.000	0.800	-3.191
110.000	0.400	-3.191
105.000	0.800	-3.167
100.000	1.400	-3.215
95.000	1.400	-3.227
90.000	1.400	-3.191
85.000	1.000	-3.130
80.000	0.800	-3.058
75.000	1.800	-2.902
70.000	1.600	-2.733
65.000	2.400	-2.661
60.000	3.400	-2.552
55.000	3.800	-2.239
50.000	6.200	-1.589
45.000	5.200	-1.998
40.000	-8.200	-6.514
35.000	-10.600	-6.610
30.000	7.000	0.830
25.000	18.600	1.854
20.000	16.000	-1.408
15.000	14.200	-1.854
10.000	13.800	-1.818
5.000	-14.000	-7.550
0.000	-22.800	-5.575

LINE: 2+50E Direction: N
Date: 28- 4-98 Time: 12:47
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 260

Station	Cond.[mS/m]	Inphase [ppt]
0.000	63.800	9.934
5.000	16.000	-0.602
10.000	-35.200	-8.597

15.000	9.200	-2.059
20.000	27.000	-0.048
25.000	15.200	-1.396
30.000	14.000	-0.674
35.000	8.800	-4.214
40.000	-1.200	-6.948
45.000	-8.800	-7.345
50.000	7.400	-0.903
55.000	10.400	-0.072
60.000	6.400	-1.758
65.000	4.000	-2.468
70.000	1.800	-2.733
75.000	1.600	-2.865
80.000	1.000	-3.010
85.000	0.800	-2.914
90.000	1.800	-2.878
95.000	1.200	-3.022
100.000	0.800	-3.022
105.000	0.600	-3.058
110.000	1.000	-3.106
115.000	0.600	-3.154
120.000	0.800	-3.130
125.000	1.000	-3.070
130.000	0.600	-3.167
135.000	0.800	-3.251
140.000	0.600	-3.251
145.000	0.600	-3.227
150.000	0.800	-3.203
155.000	0.600	-3.191
160.000	0.600	-3.227
165.000	0.600	-3.239
170.000	0.800	-3.215
175.000	1.000	-3.179
180.000	1.000	-3.287
185.000	0.800	-3.323
190.000	1.000	-3.275
195.000	1.200	-3.227
200.000	1.400	-3.251
205.000	1.400	-3.275
210.000	1.200	-3.383
215.000	0.600	-3.227
220.000	0.000	-3.118
225.000	2.000	-3.191
230.000	1.600	-3.154
235.000	1.400	-3.179
240.000	1.200	-3.227
245.000	1.000	-3.287
250.000	1.400	-3.311
255.000	1.200	-3.154
260.000	1.200	-3.311

LINE: 2+60E Direction: N
Date: 28- 4-98 Time: 12:49
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 250 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
250.000	1.000	-3.275
245.000	1.400	-3.263

—> Comment : *

240.000	1.200	-3.263
235.000	1.400	-3.335
230.000	1.400	-3.215
225.000	1.800	-3.058
220.000	2.000	-2.926
215.000	1.800	-3.130
210.000	0.600	-3.600
205.000	0.000	-3.636
200.000	1.600	-3.082
195.000	1.800	-2.986
190.000	1.400	-3.010
185.000	1.000	-3.022
180.000	1.000	-3.058
175.000	1.000	-2.998
170.000	1.000	-3.010
165.000	0.800	-3.094
160.000	0.800	-3.022
155.000	0.600	-2.998
150.000	0.600	-2.998
145.000	0.400	-3.010
140.000	0.400	-2.938
135.000	0.400	-3.034
130.000	0.800	-2.914
125.000	0.800	-2.902
120.000	0.800	-2.986
115.000	1.000	-3.010
110.000	1.000	-2.950
105.000	1.200	-2.902
100.000	1.600	-2.890

95.000	1.000	-2.926
90.000	0.800	-2.986
85.000	1.400	-2.890
80.000	1.800	-2.733
75.000	2.200	-2.649
70.000	2.200	-2.649
65.000	2.600	-2.324
60.000	3.800	-2.300
55.000	5.200	-1.830
50.000	6.200	-1.601
45.000	2.600	-3.311
40.000	-9.400	-6.177
35.000	-9.000	-5.491
30.000	9.200	1.866
25.000	16.800	2.432
20.000	16.200	-1.950
15.000	15.200	-2.589
10.000	13.200	-2.745
5.000	-16.600	-6.081
0.000	-36.400	-9.067

LINE: 2+70E Direction: N
Date: 28- 4-98 Time: 13:26
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 245

Station	Cond.[mS/m]	Inphase [ppt]
0.000	3.000	-2.035
5.000	-18.200	-5.467
10.000	-35.400	-8.080
15.000	-3.600	-3.889
20.000	23.400	-1.023
25.000	18.200	-1.505
30.000	13.200	-1.047
35.000	10.600	0.879
40.000	1.600	-2.540
45.000	-9.600	-7.742
50.000	-3.800	-5.539
55.000	8.400	-1.095
60.000	7.400	-1.577
65.000	4.200	-2.528
70.000	2.600	-2.865
75.000	1.800	-3.034
80.000	1.800	-3.106
85.000	1.600	-3.203
90.000	1.200	-3.287
95.000	1.000	-3.311
100.000	0.800	-3.359
105.000	0.800	-3.359
110.000	1.000	-3.395
115.000	0.600	-3.419
120.000	0.600	-3.395
125.000	0.600	-3.407
130.000	0.600	-3.407
135.000	0.600	-3.419
140.000	0.400	-3.395
145.000	0.600	-3.407
150.000	0.400	-3.443
155.000	0.600	-3.431
160.000	0.600	-3.443
165.000	0.400	-3.431
170.000	0.400	-3.468
175.000	0.600	-3.443
180.000	0.600	-3.443
185.000	0.600	-3.443
190.000	0.600	-3.395
195.000	0.800	-3.395
200.000	1.200	-3.431
205.000	1.600	-3.419
210.000	1.800	-3.347
215.000	2.400	-3.311
220.000	2.000	-3.480
225.000	-0.600	-2.914
230.000	0.600	-3.034
235.000	-0.200	-2.962
240.000	1.200	-2.974
245.000	1.800	-3.275

LINE: 2+80E Direction: N
Date: 28- 4-98 Time: 13:29
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 245 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
245.000	2.000	-3.275
240.000	1.800	-3.251
235.000	0.600	-3.142
230.000	0.400	-3.118
225.000	0.000	-2.757
220.000	2.800	-3.130
215.000	-0.400	-2.059

210.000	-19.200	1.637
205.000	-10.800	0.060
200.000	4.200	-2.853
195.000	3.600	-3.395
190.000	1.200	-3.383
185.000	0.800	-3.383
180.000	0.600	-3.431
175.000	0.400	-3.431
170.000	0.600	-3.407
165.000	0.400	-3.371
160.000	0.400	-3.407
155.000	0.400	-3.456
150.000	0.400	-3.431
145.000	0.600	-3.407
140.000	0.600	-3.371
135.000	0.800	-3.335
130.000	0.600	-3.359
125.000	0.600	-3.359
120.000	0.800	-3.299
115.000	0.800	-3.335
110.000	1.000	-3.299
105.000	1.200	-3.299
100.000	1.200	-3.299
95.000	1.000	-3.299
90.000	1.200	-3.239
85.000	1.200	-3.203
80.000	1.600	-3.251
75.000	2.000	-3.167
70.000	2.200	-3.034
65.000	2.600	-2.805
60.000	4.200	-2.468
55.000	6.000	-1.914
50.000	8.400	-1.348
45.000	1.800	-4.166
40.000	-8.800	-7.682
35.000	0.600	-2.312
30.000	12.000	1.782
25.000	14.400	-0.999
20.000	14.800	-2.083
15.000	18.600	-1.746
10.000	16.200	-2.287
5.000	-23.200	-6.863
0.000	-6.600	-2.396

LINE: 2+90E Direction: N
Date: 28- 4-98 Time: 13:31
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 245

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-4.200	-2.769
5.000	-24.800	-6.297
10.000	-28.400	-6.863
15.000	16.600	-1.649
20.000	24.400	-1.047
25.000	15.600	-1.734
30.000	12.400	-0.927
35.000	9.600	0.903
40.000	0.600	-3.034
45.000	-9.600	-7.947
50.000	-0.800	-4.323
55.000	11.000	-0.385
60.000	8.000	-1.565
65.000	4.200	-2.564
70.000	2.800	-2.781
75.000	2.000	-2.986
80.000	1.800	-3.082
85.000	1.000	-3.191
90.000	1.000	-3.239
95.000	1.200	-3.239
100.000	0.400	-3.612
105.000	0.400	-3.468
110.000	0.600	-3.335
115.000	1.000	-3.215
120.000	1.000	-3.311
125.000	1.000	-3.335
130.000	0.600	-3.395
135.000	0.800	-3.383
140.000	0.600	-3.335
145.000	0.600	-3.371
150.000	0.600	-3.371
155.000	0.600	-3.359
160.000	0.600	-3.371
165.000	0.600	-3.371
170.000	0.600	-3.359
175.000	0.600	-3.347
180.000	0.600	-3.359
185.000	0.600	-3.323
190.000	1.000	-3.383

195.000	1.400	-3.335
200.000	1.800	-3.504
205.000	0.200	-5.262
210.000	-2.000	-5.743
215.000	4.000	-3.227
220.000	8.400	-1.962
225.000	5.200	-2.829
230.000	2.800	-3.251
235.000	-0.200	-3.263
240.000	-0.400	-3.118
245.000	2.800	-3.395

LINE: 3+00E Direction: N
Date: 28- 4-98 Time: 13:32
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 250 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
250.000	1.000	-3.239
245.000	1.200	-3.215
240.000	1.600	-3.263
235.000	1.600	-3.287
230.000	1.400	-3.335
225.000	2.200	-3.227
220.000	2.200	-3.142
215.000	2.000	-3.167
210.000	2.000	-3.142
205.000	2.000	-3.179
200.000	1.800	-3.203
195.000	1.400	-3.215
190.000	1.200	-3.347
185.000	1.000	-3.323
180.000	0.800	-3.311
175.000	0.600	-3.311
170.000	0.600	-3.311
165.000	0.600	-3.335
160.000	0.400	-3.359
155.000	0.800	-3.311
150.000	0.600	-3.311
145.000	0.600	-3.323
140.000	0.600	-3.335
135.000	0.800	-3.347
130.000	0.800	-3.347
125.000	1.000	-3.323
120.000	1.000	-3.323
115.000	1.000	-3.299
110.000	1.000	-3.263
105.000	1.200	-3.239
100.000	1.000	-3.287
95.000	1.200	-3.287
90.000	1.200	-3.251
85.000	1.600	-3.167
80.000	1.400	-3.142
75.000	1.600	-3.094
70.000	2.000	-2.998
65.000	2.600	-2.853
60.000	3.600	-2.601
55.000	5.200	-1.878
50.000	8.000	-1.216
45.000	3.000	-3.781
40.000	-8.600	-7.658
35.000	3.000	-1.685
30.000	13.400	2.504
25.000	14.200	-0.517
20.000	14.200	-2.203
15.000	16.800	-2.083
10.000	23.600	-1.264
5.000	2.400	-4.058
0.000	0.600	-1.649

LINE: 3+10E Direction: N
Date: 28- 4-98 Time: 13:34
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 280

Station	Cond.[mS/m]	Inphase [ppt]
0.000	26.600	3.371
5.000	-23.000	-5.731
10.000	-5.600	-4.070
15.000	26.200	-1.071
20.000	19.200	-1.830
25.000	13.400	-2.095
30.000	12.400	-1.192
35.000	10.600	0.999
40.000	4.800	-2.251
45.000	-8.200	-7.742
50.000	2.800	-3.082
55.000	11.800	-0.361
60.000	8.000	-1.589
65.000	4.800	-2.468
70.000	3.200	-2.793

75.000	2.800	-2.986
80.000	2.200	-3.046
85.000	2.000	-3.118
90.000	1.800	-3.179
95.000	1.600	-3.263
100.000	1.200	-3.395
105.000	1.000	-3.504
110.000	1.200	-3.323
115.000	1.200	-3.407
120.000	1.000	-3.323
125.000	1.000	-3.371
130.000	1.000	-3.347
135.000	1.000	-3.311
140.000	0.800	-3.323
145.000	0.800	-3.395
150.000	0.800	-3.407
155.000	0.800	-3.383
160.000	0.800	-3.335
165.000	0.600	-3.371
170.000	0.400	-3.383
175.000	0.600	-3.383
180.000	0.800	-3.359
185.000	1.000	-3.347
190.000	1.000	-3.395
195.000	1.000	-3.335
200.000	1.200	-3.407
205.000	1.400	-3.335
210.000	1.600	-3.347
215.000	1.600	-3.359
220.000	1.600	-3.323
225.000	1.600	-3.335
230.000	1.800	-3.323
235.000	1.800	-3.371
240.000	1.800	-3.383
245.000	1.600	-3.395
250.000	1.800	-3.359
255.000	1.800	-3.395
260.000	1.200	-4.046
265.000	-2.000	-5.984
270.000	0.200	-4.034
275.000	1.800	-2.902
280.000	1.400	-3.299

LINE: 3+20E Direction: N
Date: 28- 4-98 Time: 13:36
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 280 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
280.000	1.400	-3.371
275.000	1.600	-3.263
270.000	1.600	-3.106
265.000	1.800	-3.082
260.000	1.800	-3.022
255.000	2.000	-3.179
250.000	1.800	-3.323
245.000	1.800	-3.323
240.000	1.600	-3.347
235.000	1.600	-3.311
230.000	1.800	-3.299
225.000	1.800	-3.263
220.000	1.800	-3.383
215.000	1.800	-3.407
210.000	1.600	-3.335
205.000	1.400	-3.383
200.000	1.400	-3.359
195.000	1.000	-3.395
190.000	1.000	-3.395
185.000	0.800	-3.443
180.000	0.800	-3.359
175.000	0.800	-3.299
170.000	0.600	-3.371
165.000	0.800	-3.371
160.000	0.800	-3.383
155.000	0.800	-3.299
150.000	0.800	-3.335
145.000	1.000	-3.347
140.000	1.000	-3.383
135.000	0.800	-3.395
130.000	1.000	-3.371
125.000	1.000	-3.347
120.000	1.000	-3.347
115.000	1.200	-3.299
110.000	1.400	-3.371
105.000	1.200	-3.347
100.000	1.200	-3.263
95.000	1.400	-3.215
90.000	1.600	-3.191
85.000	1.800	-3.215

80.000	2.000	-3.179
75.000	2.200	-3.130
70.000	2.600	-3.022
65.000	3.400	-2.841
60.000	4.600	-2.528
55.000	6.000	-2.119
50.000	8.200	-1.649
45.000	5.200	-3.167
40.000	-8.600	-7.417
35.000	-6.000	-5.093
30.000	11.400	2.613
25.000	14.600	0.553
20.000	14.000	-2.287
15.000	15.000	-2.396
10.000	18.400	-1.962
5.000	7.600	-2.841
0.000	-18.600	-4.816

LINE: 3+30E Direction: N
Date: 28- 4-98 Time: 13:37
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 280

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-13.200	-2.432
5.000	-10.400	-3.094
10.000	13.200	-1.517
15.000	26.800	-1.372
20.000	17.800	-2.203
25.000	13.200	-2.360
30.000	11.600	-1.445
35.000	9.800	0.734
40.000	2.400	-2.420
45.000	-9.400	-7.815
50.000	-2.800	-4.901
55.000	11.000	-0.662
60.000	9.400	-1.384
65.000	5.200	-2.444
70.000	3.800	-2.805
75.000	3.000	-2.974
80.000	2.400	-3.058
85.000	2.000	-3.154
90.000	1.800	-3.215
95.000	1.800	-3.335
100.000	1.600	-3.275
105.000	1.400	-3.251
110.000	1.200	-3.323
115.000	1.200	-3.383
120.000	1.000	-3.371
125.000	1.000	-3.431
130.000	1.000	-3.468
135.000	1.000	-3.431
140.000	0.800	-3.395
145.000	0.800	-3.395
150.000	0.800	-3.395
155.000	0.600	-3.371
160.000	0.800	-3.431
165.000	0.800	-3.383
170.000	0.800	-3.359
175.000	0.800	-3.383
180.000	1.000	-3.371
185.000	1.000	-3.335
190.000	1.000	-3.371
195.000	1.000	-3.383
200.000	1.000	-3.407
205.000	1.200	-3.359
210.000	1.400	-3.431
215.000	1.600	-3.395
220.000	1.600	-3.371
225.000	1.600	-3.371
230.000	1.600	-3.335
235.000	1.800	-3.347
240.000	1.600	-3.359
245.000	1.800	-3.275
250.000	1.600	-3.335
255.000	1.400	-3.287
260.000	1.400	-3.299
265.000	1.400	-3.347
270.000	1.600	-3.347
275.000	1.400	-3.347
280.000	1.600	-3.371

LINE: 3+40E Direction: N
Date: 28- 4-98 Time: 13:39
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 275 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
275.000	1.800	-3.431
270.000	1.600	-3.407
265.000	1.400	-3.407

260.000	1.400	-3.371
255.000	1.400	-3.419
250.000	1.600	-3.443
245.000	1.800	-3.431
240.000	1.800	-3.383
235.000	2.000	-3.383
230.000	2.000	-3.431
225.000	2.000	-3.407
220.000	1.800	-3.492
215.000	1.800	-3.443
210.000	1.600	-3.456
205.000	1.600	-3.468
200.000	1.400	-3.395
195.000	1.400	-3.419
190.000	1.200	-3.456
185.000	1.200	-3.431
180.000	1.200	-3.431
175.000	1.200	-3.407
170.000	1.200	-3.443
165.000	1.000	-3.456
160.000	1.000	-3.407
155.000	1.000	-3.335
150.000	0.800	-3.395
145.000	0.800	-3.371
140.000	0.800	-3.407
135.000	0.800	-3.431
130.000	1.200	-3.395
125.000	1.200	-3.443
120.000	1.200	-3.552
115.000	1.200	-3.504
110.000	1.400	-3.395
105.000	1.400	-3.395
100.000	1.600	-3.431
95.000	1.800	-3.311
90.000	1.800	-3.263
85.000	2.000	-3.239
80.000	2.200	-3.239
75.000	2.800	-3.191
70.000	3.000	-3.058
65.000	3.800	-2.914
60.000	5.000	-2.649
55.000	6.800	-2.107
50.000	9.200	-1.697
45.000	3.600	-3.853
40.000	-8.400	-7.502
35.000	2.400	-2.697
30.000	14.000	2.709
25.000	14.400	-0.987
20.000	13.600	-2.938
15.000	13.800	-2.673
10.000	16.800	-2.179
5.000	21.600	-1.288
0.000	15.600	-1.156

LINE: 3+50E Direction: N
Date: 28- 4-98 Time: 13:41
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 245

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-2.600	-2.805
5.000	9.800	-0.409
10.000	30.200	0.216
15.000	23.000	-1.962
20.000	14.400	-2.564
25.000	11.600	-2.408
30.000	10.000	-1.276
35.000	8.000	0.493
40.000	5.400	-4.130
45.000	-5.800	-7.971
50.000	7.400	-1.697
55.000	14.800	0.228
60.000	8.400	-1.854
65.000	4.800	-2.769
70.000	3.600	-2.950
75.000	3.000	-3.094
80.000	2.600	-3.203
85.000	2.200	-3.275
90.000	2.000	-3.335
95.000	1.800	-3.311
100.000	1.600	-3.431
105.000	1.400	-3.480
110.000	1.200	-3.504
115.000	1.200	-3.516
120.000	1.200	-3.456
125.000	1.200	-3.480
130.000	1.200	-3.456
135.000	1.000	-3.419
140.000	1.000	-3.456

145.000	1.000	-3.419
150.000	0.800	-3.468
155.000	0.800	-3.564
160.000	0.800	-3.371
165.000	0.800	-3.504
170.000	1.000	-3.504
175.000	1.000	-3.456
180.000	1.000	-3.431
185.000	1.200	-3.431
190.000	1.200	-3.492
195.000	1.400	-3.528
200.000	1.400	-3.504
205.000	1.400	-3.456
210.000	1.600	-3.504
215.000	1.800	-3.468
220.000	1.800	-3.492
225.000	1.800	-3.540
230.000	1.800	-3.492
235.000	1.800	-3.468
240.000	1.800	-3.492
245.000	1.800	-3.456

LINE: 3+60E Direction: N
Date: 28- 4-98 Time: 13:42
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 225 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
225.000	2.200	-3.480
220.000	2.200	-3.407
215.000	2.000	-3.383
210.000	2.000	-3.395
205.000	2.200	-3.443
200.000	2.000	-3.431
195.000	2.200	-3.419
190.000	2.000	-3.407
185.000	1.800	-3.468
180.000	1.800	-3.516
175.000	1.000	-3.456
170.000	0.000	-3.937
165.000	1.200	-3.480
160.000	1.400	-3.492
155.000	1.400	-3.492
150.000	1.200	-3.456
145.000	1.200	-3.431
140.000	1.200	-3.431
135.000	1.200	-3.443
130.000	1.200	-3.468
125.000	1.200	-3.419
120.000	1.200	-3.419
115.000	1.200	-3.395
110.000	1.400	-3.468
105.000	1.400	-3.480
100.000	1.600	-3.359
95.000	1.800	-3.371
90.000	1.800	-3.407
85.000	2.200	-3.371
80.000	2.400	-3.299
75.000	2.600	-3.239
70.000	3.200	-3.179
65.000	3.800	-2.998
60.000	5.000	-2.745
55.000	6.600	-2.384
50.000	8.000	-2.179
45.000	4.200	-3.576
40.000	-7.000	-6.936
35.000	2.000	-4.130
30.000	17.600	3.564
25.000	15.200	-0.180
20.000	15.200	-3.383
15.000	14.200	-2.853
10.000	15.600	-2.312
5.000	20.600	-1.300
0.000	11.600	-1.697

LINE: 3+70E Direction: N
Date: 28- 4-98 Time: 13:44
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 225

Station	Cond.[mS/m]	Inphase [ppt]
0.000	-8.000	-3.540
5.000	20.400	1.156
10.000	28.400	-0.216
15.000	19.200	-2.336
20.000	13.800	-2.601
25.000	12.200	-1.914
30.000	9.600	0.325
35.000	5.600	-1.806
40.000	-4.800	-7.598
45.000	-8.400	-6.827

50.000	9.200	-1.216
55.000	13.000	-0.686
60.000	7.200	-2.275
65.000	4.600	-2.890
70.000	3.600	-3.082
75.000	3.000	-3.179
80.000	2.600	-3.215
85.000	2.200	-3.287
90.000	2.000	-3.323
95.000	1.800	-3.359
100.000	1.600	-3.395
105.000	1.600	-3.347
110.000	1.600	-3.443
115.000	1.200	-3.383
120.000	1.200	-3.431
125.000	1.200	-3.359
130.000	1.200	-3.456
135.000	1.400	-3.492
140.000	1.200	-3.492
145.000	0.400	-3.443
150.000	0.600	-3.383
155.000	1.400	-3.371
160.000	1.400	-3.431
165.000	1.200	-3.419
170.000	1.200	-3.395
175.000	1.400	-3.480
180.000	1.600	-3.395
185.000	1.600	-3.443
190.000	1.600	-3.443
195.000	1.800	-3.443
200.000	2.200	-3.407
205.000	2.400	-3.383
210.000	2.600	-3.431
215.000	2.400	-3.383
220.000	2.600	-3.540
225.000	2.800	-3.468

LINE: 3+80E Direction: N
Date: 28- 4-98 Time: 13:46
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 225 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
225.000	3.200	-3.407
220.000	3.400	-3.419
215.000	3.000	-3.395
210.000	3.000	-3.468
205.000	3.000	-3.395
200.000	2.600	-3.468
195.000	2.400	-3.540
190.000	2.400	-3.456
185.000	2.200	-3.443
180.000	2.000	-3.528
175.000	1.800	-3.431
170.000	1.600	-3.395
165.000	1.600	-3.395
160.000	1.800	-3.395
155.000	1.600	-3.468
150.000	1.600	-3.456
145.000	1.600	-3.407
140.000	1.600	-3.431
135.000	1.400	-3.419
130.000	1.400	-3.456
125.000	1.600	-3.395
120.000	1.600	-3.407
115.000	1.600	-3.480
110.000	1.600	-3.443
105.000	1.600	-3.468
100.000	1.800	-3.395
95.000	2.000	-3.383
90.000	2.200	-3.407
85.000	2.200	-3.468
80.000	2.200	-3.395
75.000	2.600	-3.311
70.000	3.000	-3.275
65.000	3.400	-3.191
60.000	4.400	-2.974
55.000	6.000	-2.781
50.000	9.000	-2.047
45.000	8.200	-2.432
40.000	-5.400	-6.249
35.000	-7.400	-6.936
30.000	17.000	1.396
25.000	16.400	2.865
20.000	14.800	-2.372
15.000	14.800	-3.323
10.000	15.200	-2.625
5.000	17.600	-1.770
0.000	17.800	-0.565

LINE: 3+90E Direction: N
Date: 28- 4-98 Time: 14:13
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 215

Station	Cond.[mS/m]	Inphase [ppt]
0.000	10.400	-1.107
5.000	12.800	-0.951
10.000	19.600	-1.216
15.000	17.000	-2.528
20.000	14.200	-2.974
25.000	13.200	-1.866
30.000	11.800	1.926
35.000	13.200	1.734
40.000	-1.000	-6.334
45.000	-12.400	-7.923
50.000	4.200	-2.733
55.000	11.800	-1.156
60.000	7.200	-2.420
65.000	4.600	-2.926
70.000	3.600	-3.094
75.000	3.400	-3.215
80.000	2.800	-3.335
85.000	2.200	-3.395
90.000	2.000	-3.468
95.000	1.800	-3.419
100.000	1.800	-3.359
105.000	1.600	-3.419
110.000	1.600	-3.468
115.000	1.600	-3.480
120.000	1.400	-3.516
125.000	1.600	-3.468
130.000	1.600	-3.468
135.000	1.400	-3.516
140.000	1.600	-3.516
145.000	1.400	-3.516
150.000	1.400	-3.480
155.000	1.400	-3.588
160.000	1.200	-3.588
165.000	0.800	-3.492
170.000	0.400	-4.431
175.000	1.800	-3.600
180.000	1.800	-3.588
185.000	1.800	-3.588
190.000	2.200	-3.528
195.000	2.200	-3.540
200.000	2.600	-3.468
205.000	2.600	-3.528
210.000	2.800	-3.492
215.000	3.000	-3.480

LINE: 4+00E Direction: N
Date: 28- 4-98 Time: 14:15
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 210 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
210.000	3.400	-3.552
205.000	3.400	-3.468
200.000	3.200	-3.431
195.000	2.800	-3.516
190.000	2.600	-3.468
185.000	2.400	-3.480
180.000	2.000	-3.456
175.000	2.000	-3.480
170.000	2.000	-3.419
165.000	2.000	-3.456
160.000	2.200	-3.468
155.000	2.000	-3.528
150.000	1.800	-3.552
145.000	12.400	-2.263
140.000	5.000	-2.890
135.000	1.200	-3.564
130.000	1.800	-3.540
125.000	2.000	-3.504
120.000	1.800	-3.504
115.000	2.000	-3.468
110.000	2.000	-3.419
105.000	2.200	-3.431
100.000	2.000	-3.456
95.000	2.000	-3.443
90.000	2.200	-3.395
85.000	2.400	-3.419
80.000	2.400	-3.456
75.000	2.800	-3.359
70.000	3.000	-3.299
65.000	3.600	-3.179
60.000	4.400	-3.010
55.000	6.000	-2.661
50.000	7.800	-2.227

45.000	7.000	-2.781
40.000	-6.000	-6.394
35.000	-6.800	-6.743
30.000	18.200	0.313
25.000	16.600	3.540
20.000	14.200	-0.975
15.000	15.600	-3.480
10.000	16.000	-2.757
5.000	18.000	-1.457
0.000	16.800	-0.879

LINE: 4+10E Direction: N
Date: 28- 4-98 Time: 14:17
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 170

Station	Cond.[mS/m]	Inphase [ppt]
0.000	8.200	-0.915
5.000	15.000	-0.782
10.000	17.800	-1.818
15.000	15.400	-2.914
20.000	14.200	-2.384
25.000	11.000	1.264
30.000	12.400	0.867
35.000	10.600	-4.876
40.000	-7.200	-7.875
45.000	-0.600	-4.094
50.000	12.200	-0.903
55.000	9.800	-1.794
60.000	4.600	-3.022
65.000	4.200	-3.082
70.000	3.200	-3.227
75.000	2.800	-3.311
80.000	2.800	-3.383
85.000	2.600	-3.371
90.000	2.400	-3.359
95.000	2.200	-3.371
100.000	2.200	-3.443
105.000	2.000	-3.504
110.000	2.000	-3.528
115.000	2.000	-3.492
120.000	2.000	-3.504
125.000	2.000	-3.492
130.000	1.800	-3.528
135.000	1.400	-3.528
140.000	1.600	-3.540
145.000	1.800	-3.528
150.000	1.800	-3.516
155.000	1.800	-3.552
160.000	2.000	-3.480
165.000	2.000	-3.576
170.000	2.000	-3.564

LINE: 4+20E Direction: N
Date: 28- 4-98 Time: 14:18
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 145 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
145.000	1.800	-3.624
140.000	1.800	-3.492
135.000	1.800	-3.552
130.000	1.800	-3.564
125.000	1.800	-3.504
120.000	2.000	-3.492
115.000	2.000	-3.492
110.000	2.000	-3.480
105.000	2.200	-3.528
100.000	2.200	-3.516
95.000	2.200	-3.468
90.000	2.600	-3.456
85.000	2.600	-3.419
80.000	2.600	-3.431
75.000	2.600	-3.383
70.000	2.600	-3.528
65.000	2.800	-3.407
60.000	3.800	-3.191
55.000	4.600	-3.094
50.000	5.800	-2.853
45.000	8.400	-2.251
40.000	8.400	-2.552
35.000	-3.800	-5.984
30.000	2.800	-4.768
25.000	24.200	4.238
20.000	18.600	2.817
15.000	18.800	-3.022
10.000	16.400	-3.383
5.000	14.600	-2.649
0.000	10.800	-2.312

LINE: 4+30E Direction: N
Date: 28- 4-98 Time: 14:19

Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 135

Station	Cond.[mS/m]	Inphase [ppt]
0.000	3.800	-3.720
5.000	11.800	-3.154
10.000	16.200	-2.697
15.000	15.400	-2.456
20.000	14.600	-0.036
25.000	9.600	-0.638
30.000	2.600	-8.188
35.000	3.000	-4.250
40.000	17.400	0.349
45.000	13.000	-1.143
50.000	7.200	-2.468
55.000	4.600	-2.938
60.000	4.000	-3.106
65.000	3.400	-3.287
70.000	3.000	-3.443
75.000	2.600	-3.468
80.000	2.400	-3.468
85.000	2.400	-3.480
90.000	2.400	-3.468
95.000	2.200	-3.468
100.000	2.200	-3.528
105.000	2.000	-3.504
110.000	2.000	-3.516
115.000	1.600	-3.636
120.000	1.800	-3.600
125.000	1.600	-3.564
130.000	1.600	-3.528
135.000	2.000	-3.552

LINE: 4+40E Direction: N
Date: 28- 4-98 Time: 14:20
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 125 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
125.000	1.600	-3.576
120.000	1.800	-3.516
115.000	1.800	-3.492
110.000	2.200	-3.492
105.000	2.200	-3.504
100.000	1.800	-3.540
95.000	2.200	-3.504
90.000	1.800	-3.456
85.000	2.600	-3.443
80.000	2.400	-3.443
75.000	2.400	-3.480
70.000	2.800	-3.431
65.000	3.000	-3.287
60.000	3.400	-3.359
55.000	3.200	-3.287
50.000	4.000	-3.179
45.000	5.000	-2.974
40.000	6.600	-2.661
35.000	8.000	-2.528
30.000	4.200	-3.973
25.000	-7.800	-6.984
20.000	17.400	0.590
15.000	23.400	4.154
10.000	22.600	-2.769
5.000	19.800	-3.708
0.000	15.400	-2.878

LINE: 4+50E Direction: N
Date: 28- 4-98 Time: 14:21
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 120

Station	Cond.[mS/m]	Inphase [ppt]
0.000	12.000	0.012
5.000	14.000	1.878
10.000	15.400	-0.602
15.000	5.600	-7.321
20.000	-4.200	-7.297
25.000	13.800	-0.529
30.000	19.800	0.541
35.000	11.200	-1.673
40.000	6.200	-2.649
45.000	4.600	-2.950
50.000	3.800	-3.082
55.000	3.200	-3.191
60.000	2.600	-3.335
65.000	2.600	-3.419
70.000	2.200	-3.456
75.000	2.200	-3.347
80.000	2.000	-3.468
85.000	1.800	-3.492
90.000	2.000	-3.468
95.000	1.600	-3.504

100.000	2.000	-3.516
105.000	2.200	-3.492
110.000	1.800	-3.359
115.000	1.800	-3.516
120.000	1.600	-3.480

LINE: 4+60E Direction: N
Date: 28- 4-98 Time: 14:22
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 115 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
115.000	2.000	-3.540
110.000	1.800	-3.480
105.000	1.800	-3.443
100.000	2.200	-3.480
95.000	2.000	-3.468
90.000	2.000	-3.516
85.000	2.200	-3.443
80.000	2.200	-3.552
75.000	2.800	-3.540
70.000	2.200	-3.540
65.000	2.000	-3.480
60.000	2.400	-3.383
55.000	2.800	-3.383
50.000	3.200	-3.407
45.000	3.200	-3.287
40.000	4.000	-3.154
35.000	4.600	-3.106
30.000	5.200	-2.986
25.000	7.000	-2.576
20.000	9.600	-2.095
15.000	11.400	-1.661
10.000	6.800	-4.070
5.000	16.800	-3.142
0.000	38.400	0.096

LINE: 4+70E Direction: N
Date: 28- 4-98 Time: 14:23
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 115

Station	Cond.[mS/m]	Inphase [ppt]
0.000	19.800	0.349
5.000	20.200	0.457
10.000	18.200	-0.036
15.000	13.400	-1.071
20.000	9.200	-1.950
25.000	6.200	-2.528
30.000	5.000	-2.914
35.000	4.000	-3.058
40.000	3.000	-3.227
45.000	2.800	-3.323
50.000	2.400	-3.359
55.000	2.200	-3.335
60.000	2.000	-3.443
65.000	2.200	-3.407
70.000	2.200	-3.323
75.000	2.000	-3.468
80.000	2.000	-3.431
85.000	1.800	-3.419
90.000	2.000	-3.504
95.000	2.000	-3.359
100.000	1.800	-3.215
105.000	1.800	-3.492
110.000	1.800	-3.468
115.000	1.800	-3.480

LINE: 4+80E Direction: N
Date: 28- 4-98 Time: 14:24
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 105 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
105.000	1.800	-3.564
100.000	2.400	-3.456
95.000	2.600	-3.395
90.000	2.600	-3.359
85.000	2.400	-3.383
80.000	2.400	-3.407
75.000	2.400	-3.395
70.000	2.200	-3.516
65.000	2.200	-3.492
60.000	2.400	-3.468
55.000	2.600	-3.383
50.000	3.000	-3.383
45.000	3.000	-3.275
40.000	3.200	-3.299
35.000	2.800	-3.335
30.000	3.000	-3.275
25.000	3.000	-3.239
20.000	3.600	-3.058
15.000	4.600	-3.010

10.000	5.400	-2.865
5.000	6.200	-2.661
0.000	8.200	-2.155

LINE: 4+90E Direction: N
Date: 28- 4-98 Time: 14:26
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 70

Station	Cond.[mS/m]	Inphase [ppt]
0.000	4.200	-3.046
5.000	4.200	-3.022
10.000	3.600	-3.118
15.000	3.600	-3.154
20.000	2.600	-3.299
25.000	2.800	-3.335
30.000	2.800	-3.347
35.000	2.600	-3.383
40.000	2.400	-3.407
45.000	2.600	-3.383
50.000	2.400	-3.588
55.000	2.400	-3.576
60.000	2.200	-3.516
65.000	2.200	-3.516
70.000	2.200	-3.480

LINE: 5+00E Direction: N
Date: 28- 4-98 Time: 14:28
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 30

Station	Cond.[mS/m]	Inphase [ppt]
0.000	3.400	-3.311
5.000	3.400	-3.263
10.000	2.800	-3.347
15.000	2.800	-3.383
20.000	2.800	-3.383
25.000	2.600	-3.383
30.000	2.400	-3.456

Versar INC

APPENDIX C

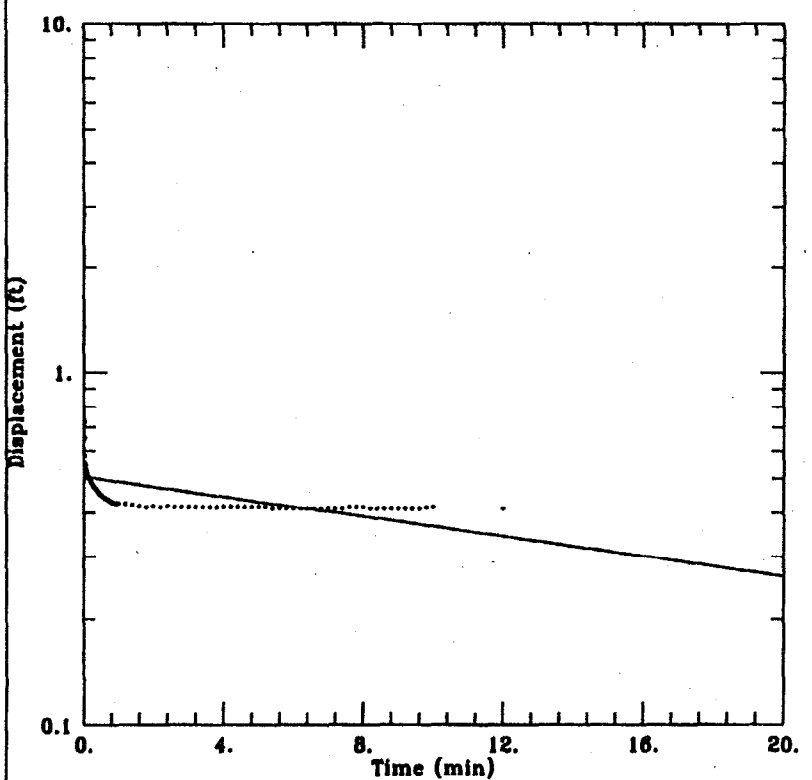
GEOLOGIC LOGS

APPENDIX D

AQUIFER TEST RESTS

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 14**	Project: **3394.004**

WFF14GW7 FALLING HEAD SLUG TEST



DATA SET:
14GW7F.COR
07/23/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

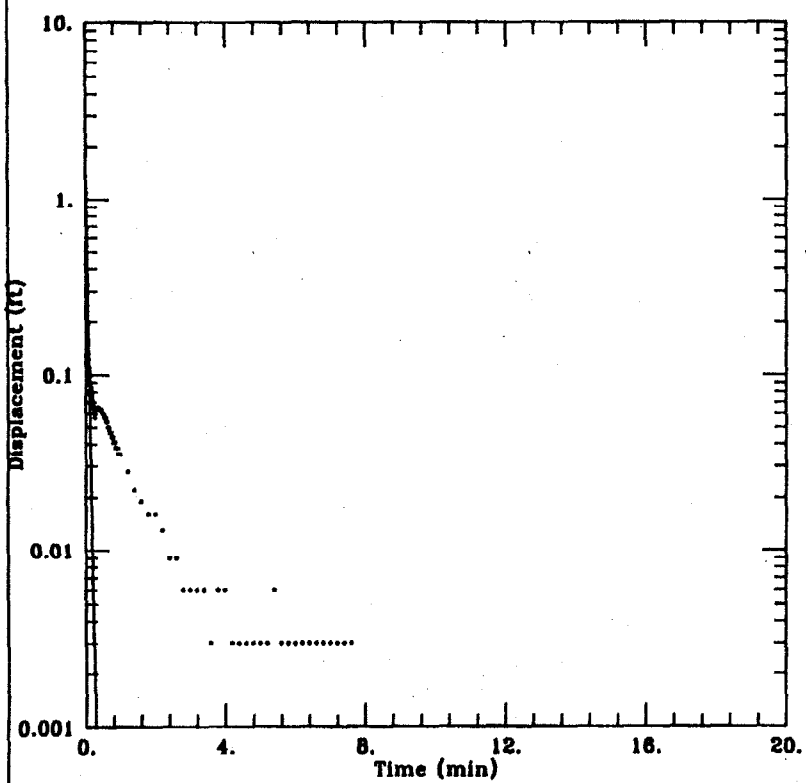
TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.33 ft
L = 4.61 ft
b = 4.61 ft
H = 4.61 ft

PARAMETER ESTIMATES:
K = 4.639E-05 ft/min
y0 = 0.5055 ft

AQTESOLV

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 14**	Project: **3394.004**

WFF14GW7 RISING HEAD SLUG TEST



DATA SET:
14GW7R.COR
07/23/97

AQUIFER MODEL:
Unconfined
SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

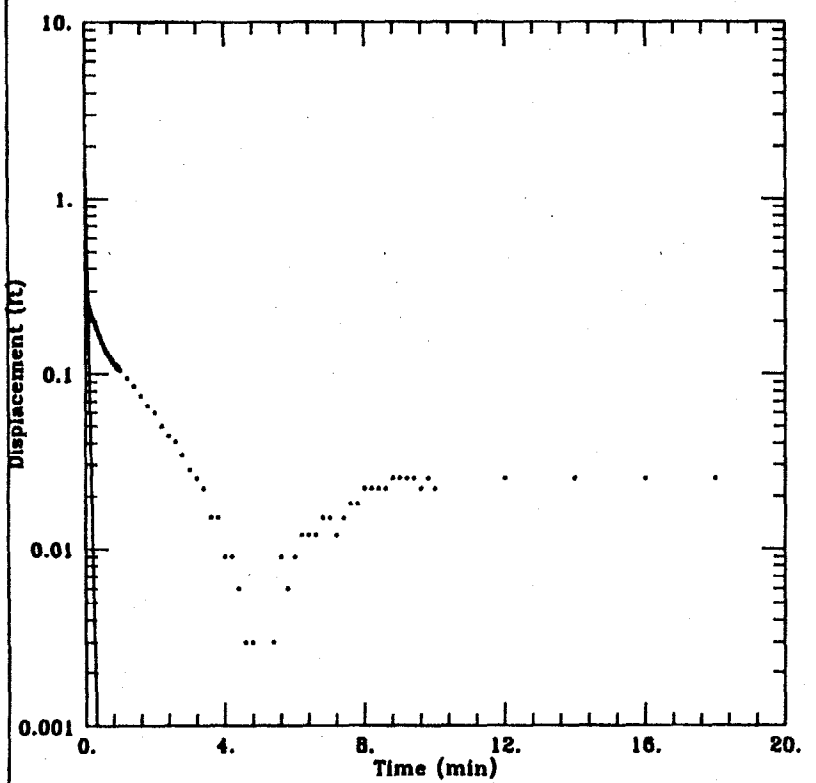
TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.33 ft
L = 4.61 ft
b = 4.61 ft
H = 4.61 ft

PARAMETER ESTIMATES:
K = 0.03662 ft/min
y0 = 1.296 ft

AQTESOLV

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 14**	Project: **3394.004**

WFF14GW1 FALLING HEAD SLUG TEST



DATA SET:
14GW1F.COR
07/23/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

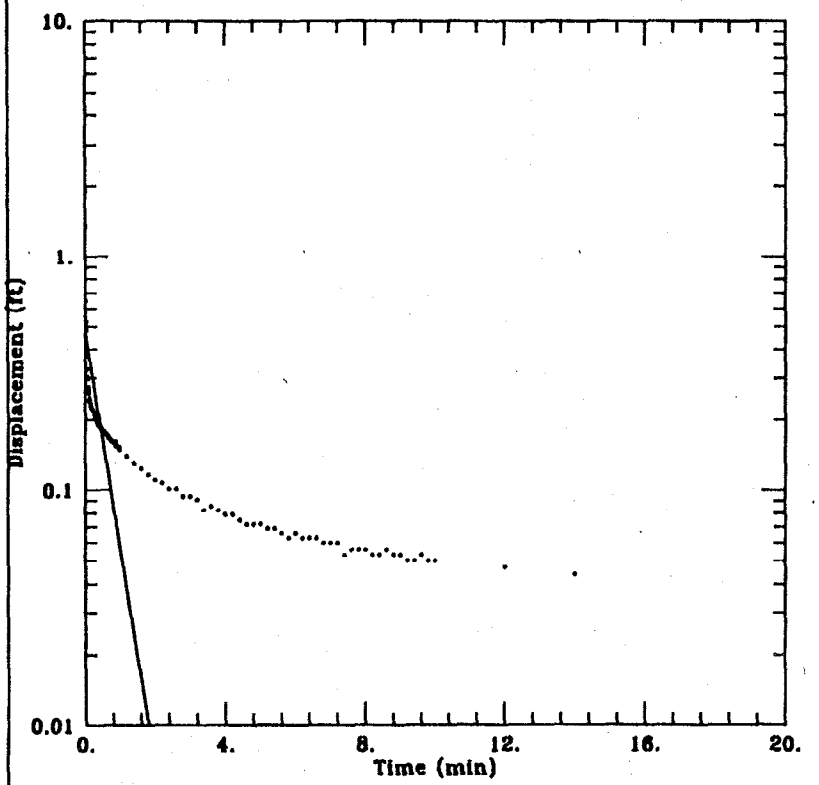
TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.33 ft
L = 13.29 ft
b = 13.29 ft
H = 13.29 ft

PARAMETER ESTIMATES:
K = 0.01803 ft/min
y0 = 1.929 ft

AQTESOLV

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 14**	Project: **3394.004**

WFF14GW1 RISING HEAD SLUG TEST



DATA SET:
14GW1R.COR
07/23/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

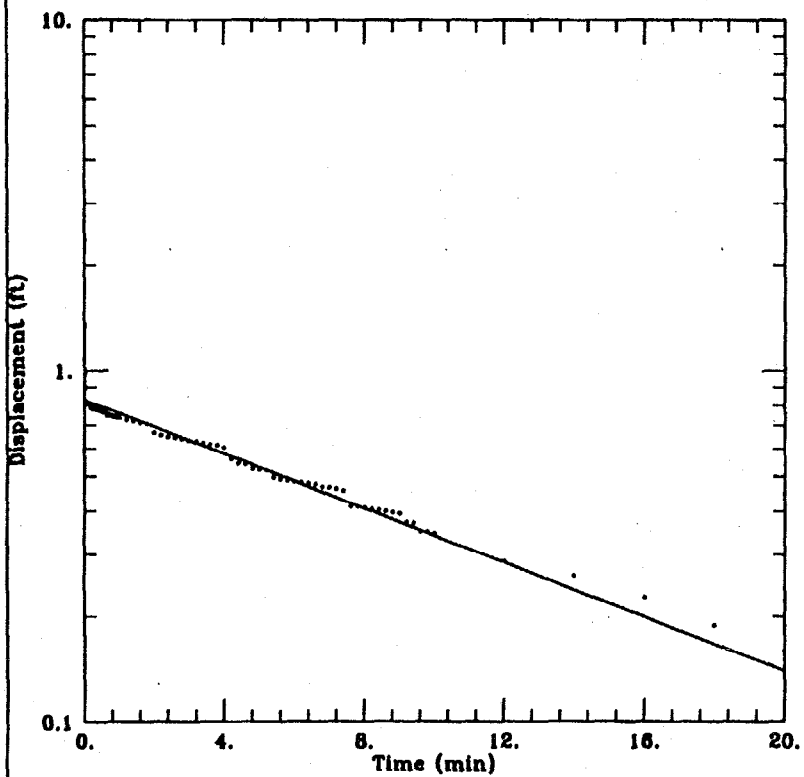
TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.33 ft
L = 13.29 ft
b = 13.29 ft
H = 13.29 ft

PARAMETER ESTIMATES:
K = 0.001549 ft/min
y0 = 0.4728 ft

AQTESOLV

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 15**	Project: **3394.002**

WFF15GW3 FALLING HEAD SLUG TEST



DATA SET:
15GW3F.COR
07/23/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

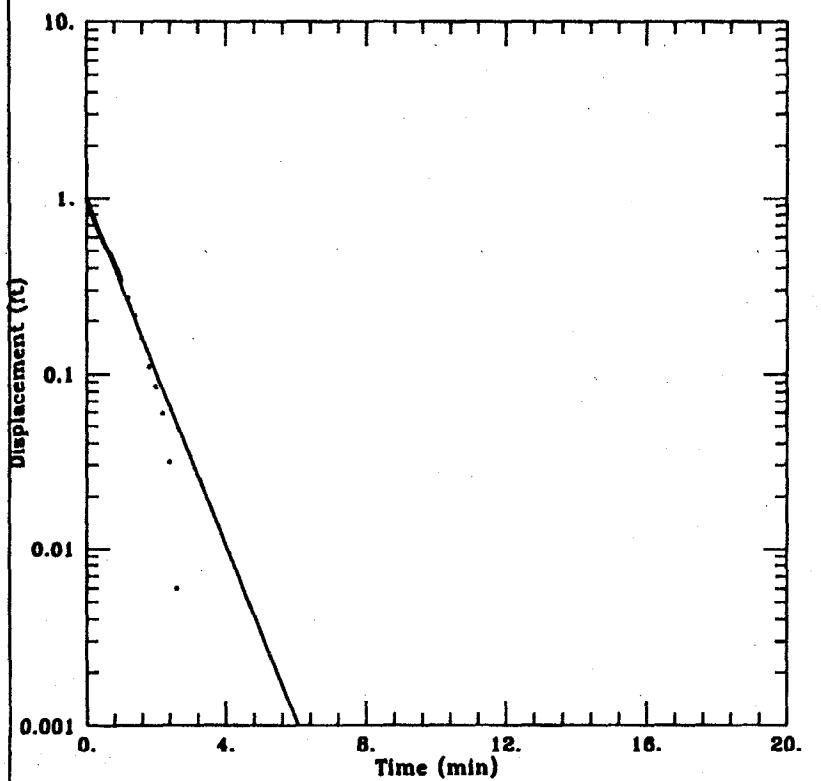
TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.33 ft
L = 5. ft
b = 7.4 ft
H = 7.4 ft

PARAMETER ESTIMATES:
K = 0.0001354 ft/min
y0 = 0.8295 ft

AQTESOLV

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 15**	Project: **3394.005**

WFF15GW1 RISING HEAD SLUG TEST



DATA SET:
15GW1R.COR
07/23/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

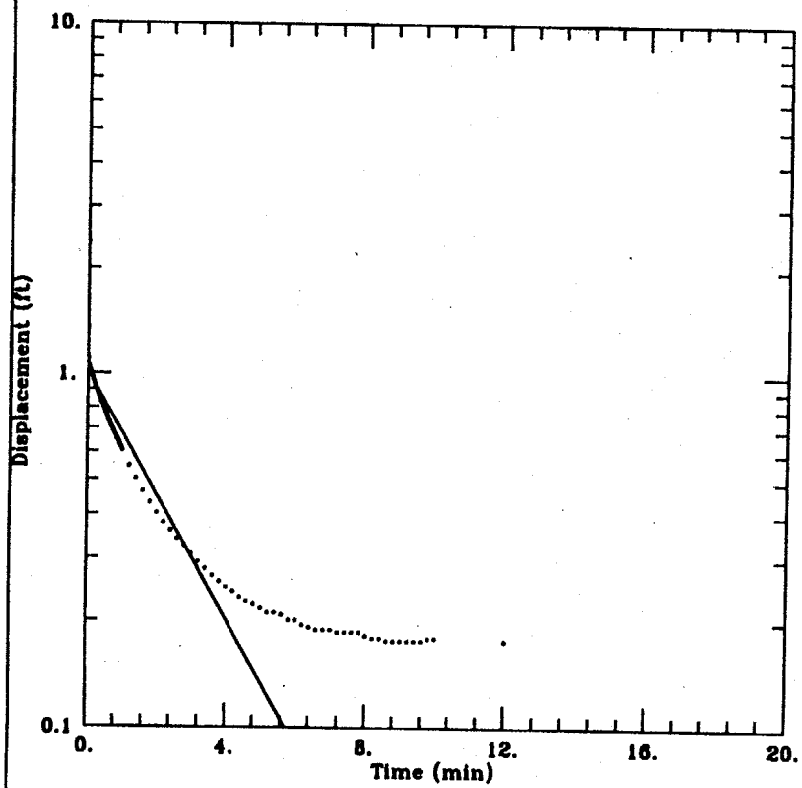
TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.29 ft
L = 5. ft
b = 6.79 ft
H = 6.79 ft

PARAMETER ESTIMATES:
K = 0.001783 ft/min
y0 = 0.9977 ft

AQTESOLV

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 15**	Project: **3394.005**

WFF15G1 FALLING HEAD SLUG TEST



DATA SET:
15GW1F.COR
07/23/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

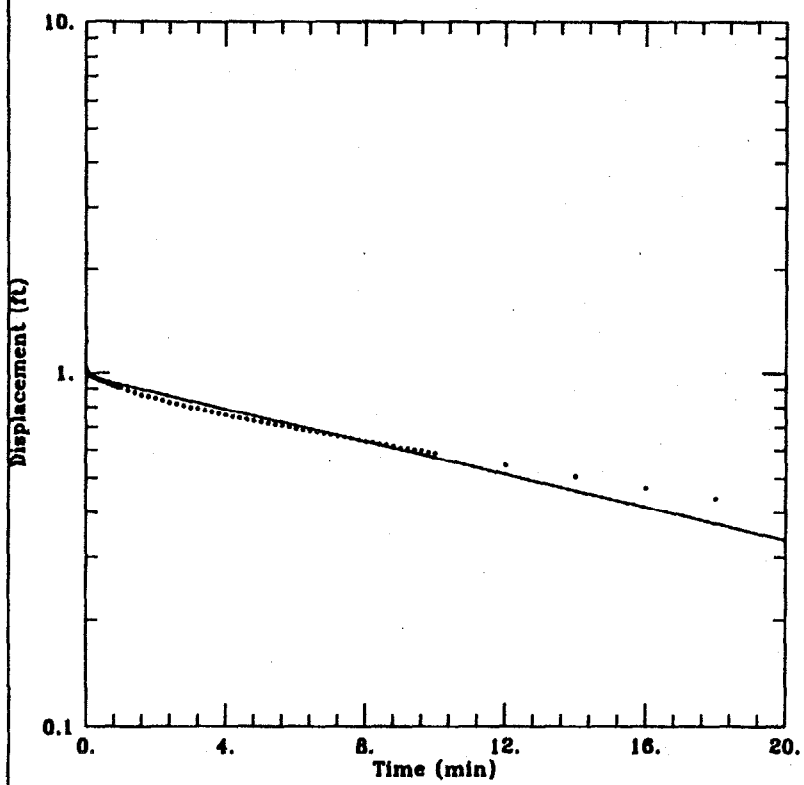
TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.29 ft
L = 5. ft
b = 6.79 ft
H = 6.79 ft

PARAMETER ESTIMATES:
K = 0.0006325 ft/min
y0 = 1.016 ft

AQTESOLV

Client: **NASA WALLOPS FLIGHT FACILITY**	Company: **VERSAR INC.**
Location: **SITE 15**	Project: **3394.002**

WFF15GW3 RISING HEAD SLUG TEST



DATA SET:
15GW3R.COR
07/23/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

PROJECT DATA:
test date: MAY 8, 1997

TEST DATA:
H0 = 1.35 ft
rc = 0.083 ft
rw = 0.33 ft
L = 5. ft
b = 7.4 ft
H = 7.4 ft

PARAMETER ESTIMATES:
K = 8.148E-05 ft/min
y0 = 0.9764 ft

AQTESOLV

Versar INC

APPENDIX E

FEASIBILITY STUDY COSTING WORKSHEET

WALLOPS FLIGHT FACILITY

SITE 16 ENGINEERING COST ESTIMATE

ITEM DESCRIPTION	UNITS	MATERIAL	LABOR	EQUIP.	TOTAL	QUANTITY	BASE COST
ALTERNATIVE Long Term Monitoring							
Site 16 - Alternative							
Environmental Sampler(s) to Sample 9 Wells Annual	HR		70		70	40	$ 2,800.00
Travel Expenses Meals/Lodging	Day	30			30	2	$ 60.00
Personal Protective Equipment for Samplers including Gloves/Suits	Day	30			30	2	$ 60.00
Sampling Equipment Small Hand Tools, Well Purge Pumps, Disposable Tubing, Bailers	Well			60	60	9	$ 540.00
Vehicle Rental for Field Sampling Team	Day			60	60	2	$ 120.00
Shipping of Samples from Field to Laboratory per Cooler	EA	40			40	11	$ 440.00
Laboratory Analysis TCLP, TAL, TPH-GRO for 9 Wells plus Dupe and Blank	Sample	1200			1200	11	$ 13,200.00
Geologist to Prepare and Update Annual Monitoring Report	HR		85		85	40	$ 3,400.00
Senior QA/QC Review Annual Monitoring Report	HR		125		125	2	$ 250.00
Subtotal of Base Costs							**$ 20,870.00**
Adjustments for Engineering, Management, Bonding, Permitting, and Legal Work							**$ 4,174.00**
Deed Restriction Fixed Cost (Initial Year Only)							**$ 10,000.00**
Initial Year Project Cost							**$ 35,044.00**
Present Value (Monitoring) (5 Years with a 6% Annual Adjustment)							**$114,928.44**
Total Project Cost							**$153,800.18**

WALLOPS FLIGHT FACILITY

SITE 16 ENGINEERING COST ESTIMATE

ITEM DESCRIPTION	UNITS	MATERIAL	LABOR	EQUIP.	TOTAL	QUANTITY	BASE COST
ALTERNATIVE REMOVAL AND DISPOSAL							
Site 16 - Alternative 6975sf x avg depth of 20.5 ft (5300 CY or 7975 Tons)							
Laborers (Assume 2 Laborers for the Crew for 8-Weeks)	HR		45		45	640	$ 28,800.00
Project Foreman (Assumes 4 Weeks to Excavate Soil and 4 Weeks Backfill)	HR		95		95	320	$ 30,400.00
Small Hand Tools	Day			50	50	40	$ 2,000.00
Field Office Trailer 50'x10'	MONTH	300			300.00	3	$ 900.00
Field Storage Box 28'x10'	MONTH	95			95.00	3	$ 285.00
Field Porta Potties	Week	100			100	8	$ 800.00
Property Survey With Corner Stakeout of Boundary	LS	1500			1500	1	$ 1,500.00
Excavator Mob/Demob Fee	LS	600			600	1	$ 600.00
Excavator with Operator 1CY with a Production Rate of 300 CY/Day (5,300 CY)	Week	500	2600	1500	4600	4	$ 18,400.00
Chemical Profile of Soil TCLP For Disposal with QA/QC samples 1per100CY estimated	SAMPLE			840	840.00	53	$ 44,520.00
Hauling and Disposal of Contaminated Soil to Landfill 20 Mile Round Trip 20CY Truck	Tons	30	3.00	7	40.00	7950	$ 318,000.00
Bulldozer Mob/Demob Fee	LS	600			600	1	$ 600.00
Bulldozer 140 hp with Articulating Blade and Operator for Regrading	Week	660	2600	1800	5060	4	$ 20,240.00
Roller 9 Ton Mob/Demob Fee	LS	600			600	1	$ 600.00
Roller 9 Ton for Compaction	Week	660	1800	1200	3660	4	$ 14,640.00
Backfill Excavation with Compacted Clean Engineered Select Fill 5300CY x 1.2 Fluff	CY	20		0.63	20.63	6360	$ 131,206.80
Chemical Profile of Backfilled Soil By TCLP	SAMPLE			840	840.00	1	$ 840.00
Soil Testing 2 samples/12" lift Density/Moisture Assume 20 Lifts	SAMPLE		15.00	50	65.00	40	$ 2,600.00
Top Soil Addition 4" for Vegetative Cover	CY	20		0.5	20.5	86	$ 1,763.00
Hydroseeding of Area with Tall Grass	SY	0.15		0.21	0.36	775	$ 279.00
Mulching with Oat Straw and Poly-Mesh	SY	0.35		0.25	0.6	775	$ 465.00
Watering by Truck for Plant Establishment	Event	50	180	100	330	4	$ 1,320.00
Subtotal of Base Costs							**$ 620,758.80**
Adjustments for Engineering, Management, Bonding, Permitting, and Legal Work							**$ 341,417.34**
Total Project Cost							**$ 962,176.14**