02.06-05/26/94-00615

ACTION MEMORANDUM

SITES 2 AND 9 AND
SITE SCREENING AREA (SSA) 4
NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINIA

ACTION MEMORANDUM

Sites 2 and 9 and Site Screening Area (SSA) 4
Naval Weapons Station Yorktown
Yorktown, Virginia

DATE: 25 May 1994

FROM: Commander, Atlantic Division, Naval Facilities Engineering Command

TO: Commanding Officer, Naval Weapons Station Yorktown

SUBJECT: Removal Actions at Sites 2 and 9 and SSA 4, Naval Weapons Station Yorktown

I. PURPOSE

The purpose of this Action Memorandum is to document the request for approval of the proposed removal actions at Sites 2 (Turkey Road Landfill) and 9 (Plant 1 Explosives-Contaminated Wastewater Discharge Area) and SSA 4 (Weapons Casing/Drum Disposal Area), Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia.

II. SITE CONDITIONS AND BACKGROUND

Surficial debris present at Sites 2 and 9 and SSA 4 have been determined to be a potential source of contamination of the groundwater, surface water, soils, and sediments at these sites, based on available data and visual observation. Nitramine compounds, heavy metals, and base/neutral acid extractable compounds (BNAs) have been detected in at least one of these media at Sites 2 and 9 which may be attributable in part to the surficial waste materials. Although extensive sampling has not been performed at SSA 4, similar disposal areas at WPNSTA Yorktown have shown contamination of various media.

The removal actions proposed for Sites 2 and 9 and SSA 4 are non-time-critical removals. By definition, this means that the action may be delayed for a period of six months before cleanup is initiated, without harm to human health and/or the environment. During this six-month

planning period, potential removal alternatives have been evaluated for 1) effectiveness in minimizing or stabilizing the threat to public health, 2) consistency with the anticipated final remedial action, 3) consistency with Applicable or Relevant and Appropriate Requirements (ARARs), and 4) cost effectiveness. This evaluation is presented in the "Engineering Evaluation/Cost Analysis (EE/CA), Sites 2 and 9 and Site Screening Area (SSA) 4 Removal Actions, Naval Weapons Station Yorktown, Yorktown, Virginia" (Baker/WESTON, April 1994).

The following subsections present a brief summary of the site conditions and background for Sites 2 and 9 and SSA 4.

A. SITE DESCRIPTIONS

1. Removal Site Evaluation

An Initial Assessment Study (IAS) conducted at WPNSTA Yorktown and summarized in a report published in July 1984 identified Sites 2 and 9 as potential areas of concern. These sites were subsequently studied as part of the Confirmation Studies in 1986 and 1987 and as part of the Round One Remedial Investigation (RI) activities performed in 1992. These studies indicated that the surface water, sediment, groundwater, and soils have been impacted by the previous disposal activities at the sites.

SSA 4 was discovered by WPNSTA Yorktown personnel in December 1991. Surface water and sediment samples were collected from SSA 4 on March 19, 1993 by the Commonwealth of Virginia. These results did not indicate the presence of any compounds above the detection limits. No further surface soil or groundwater investigations have been conducted to date at SSA 4.

A sample of a hardened yellow substance was removed from one of the 55-gallon drums and analyzed by WPNSTA Yorktown personnel using X-ray fluorescence (XRF). The analysis showed a composition containing zinc, chromium, and iron. The yellow substance is believed

to be yellow stripe paint which in the past was used to mark weapons.

2. Physical Location

The land surrounding the three areas is a mixture of residential and light industrial. Sites 2 and 9 and SSA 4 are located in the central and east central portion of WPNSTA Yorktown; the population in the vicinity of the sites is limited to the station personnel and military residents.

Site 2, the Turkey Road Landfill, is located in the central portion of WPNSTA Yorktown, along the southern branch of Felgates Creek. This site is situated between two drainage ways which are tributaries to the creek.

Site 9, the Plant 1 Explosives-Contaminated Wastewater Discharge Area, is located in the east central part of WPNSTA Yorktown, near Bollman Road. Site 9 drains directly into Lee Pond. Immediately south of Site 9 is Site 19, the Conveyor Belt Soils at Building 10, which is another site in the RI/FS program at WPNSTA Yorktown. A concrete drainage way flows under the conveyor belt at Site 19 and drains into Site 9.

SSA 4, the Weapons Casing/Drum Disposal Area, is also located in the east central part of WPNSTA Yorktown near the intersection of Bypass Road and Main Road. SSA 4 is located at the head of a drainage way that discharges into Roosevelt Pond.

3. Site Characteristics

WPNSTA Yorktown is a federally-owned facility. As such, the Department of the Navy (DON) has the responsibility and authority for conducting response actions. The removals being proposed herein are being initiated as response actions at these sites.

Site 2 is a two- to three-acre landfill located east of Turkey Road in a wetland adjacent to the southern branch of Felgates Creek. Operations at the landfill are believed to have begun some

time in the 1940s and ceased in 1981. Wastes disposed at Site 2 were reported to have included mercury and zinc-carbon batteries, tree stumps and limbs, construction rubble, weapons hardware (e.g., wings, fins, and power packs), electrical devices, and unidentified types of drums and/or tanks. Waste quantities were estimated at 8 tons per year for more than 30 years, totaling 240 tons of waste disposed. However, this estimate appears low based upon the size of the landfill.

Geophysical investigations performed during the Round One RI program for Site 2 indicated that the waste materials appear to be located primarily on the banks of the landfill. There was little indication of disturbed areas within the interior of the landfill.

The removal actions for Site 2 proposed in the EE/CA and summarized in this Action Memorandum are intended to address only the surficial waste materials and batteries disposed along the banks of Felgates Creek. Any contaminated media will be addressed as part of future remedial investigation/feasibility study (RI/FS) work at this site.

Site 9 is located east of Lee Pond which is a manmade impoundment located upgradient of the eastern branch of Felgates Creek. Site 9 has been used as the drainage way for Plant 1 (Building 10) nitramine-contaminated wastewater and possibly for organic solvents. Located along the drainage way prior to flowing under Bollman Road is a disposal area where railroad ties and weapons casings were discarded along the bank. On the other side of Bollman Road and Lee Pond, several drums have been discarded along the drainage way. No information is available regarding the date(s) this material was disposed. Site 9 was reportedly used from the late 1930s to 1975. Based on estimated average discharges of 100 parts per million (ppm) for 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and 30 ppm for octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) at five gallons per minute (gpm) for two hours per workday for forty years, an estimated 5,200 pounds of TNT and RDX and 1,600 pounds of HMX may have been discharged to the site. Solvents such as trichloroethylene (TCE) may have been discharged from Plant 1 with the nitramine wastewater. Contaminants from Plant 1 may have migrated via surface flow into Lee Pond or across the upper soils via

overland flow into the pond. Lee Pond empties into the eastern branch of Felgates Creek, which in turn flows northward to the York River, located approximately 1.5 miles from Site 9.

In 1975 a carbon adsorption tower was installed to treat the contaminated wastewater prior to discharge into the drainage way. A National Pollutant Discharge Elimination System (NPDES) permit was granted by EPA Region III to allow the discharge. In 1986, the effluent from the tower was diverted to the sanitary sewer and ultimately to the Hampton Roads Sanitation District.

The removal actions proposed in the EE/CA and summarized in this Action Memorandum are intended to address only the railroad ties and drums disposed along the drainage way at Site 9. The nitramine-contaminated media will be addressed as part of future RI/FS work at this site.

SSA 4 lies on the north side of Bypass Road on a steep embankment that drains to Roosevelt Pond. The level area adjacent to Bypass Road and SSA 4 consists of fill material and debris that presumably was placed to accommodate the construction of Bypass Road. The approximately one-acre embankment area was used as a disposal location for batteries, depth charges and underwater mine casings, World War II weapon casings, construction debris, cans, and other waste materials. The Explosives Ordnance Disposal (EOD) group at WPNSTA Yorktown conducted a preliminary review and established that these casings are inert and/or empty. Five- and 55-gallon drums, some containing solid materials, were also disposed in the area. Surface water from Bypass Road (in addition to surface water from other areas) flows through the disposal area via drain pipes. The drain pipes emerge on the north side of the SSA 4 fill area at a drainage outfall. The outfall empties into a drainage way that conveys the surface water to Roosevelt Pond. Scattered waste materials line the drainage way.

The removal actions proposed in the EE/CA and summarized in this Action Memorandum are intended to address only the surficial weapons casings and drums present at SSA 4. Any

contaminated media that may be present will be addressed in future characterization/remediation activities.

4. Release or Threatened Release into the Environment of a Hazardous Substance, Pollutant, or Contaminant

Previous investigations have detected contaminated media at Sites 2 and 9. Heavy metals, nitramine compounds, and BNAs are the most prevalent constituents. Several of these compounds are hazardous substances as defined by Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the remaining constituents are pollutants and/or contaminants as defined by Section 101(33) of CERCLA. Some of the levels of metals, including barium, cadmium, chromium, iron, lead, manganese, mercury, and nickel, were present in the groundwater above the Virginia Groundwater Standards (VGS) and/or the federal Maximum Contaminant Levels (MCLs). Metals concentrations in the surface waters adjacent to these sites were also above state and federal standards.

The surficial wastes present at these three locations pose a threat of release from the potential leaking of containers and drums. The batteries also present a threat of continued release from leaching of the materials and surface runoff.

5. National Priorities List (NPL) Status

WPNSTA Yorktown was placed on the National Priorities List (NPL) on October 15, 1992. The Station received a Hazard Ranking System (HRS) score of 50, exceeding the threshold score of 28.5 which determines NPL status. Remedial investigation activities are currently in progress at WPNSTA Yorktown (see Subsection II.B.2)

6. Figures and Illustrations

Figure A-1 provides the location of WPNSTA Yorktown. Figures A-2, A-3, and A-4 provide the presently identified areal extents of Sites 2 and 9 and SSA 4, respectively.

B. OTHER ACTIONS TO DATE

1. Previous Actions

A Community Relations Plan was established for WPNSTA Yorktown in September 1991. Community relations brochures were distributed as part of the community relations plan to provide local residents with details on the investigation activities conducted to date and on proposed activities. Information repositories have been set up at the WPNSTA Yorktown Library, Building 705; the Newport News City Public Library, Virgil Grissom branch; Gloucester Public Library; Jamestown-Williamsburg Public Library; and York County Public Library. These repositories house copies of reports detailing previous studies, historic information, and the Community Relations Plan.

2. Current Actions

WPNSTA Yorktown is currently undergoing a Remedial Investigation (RI) being conducted in accordance with the CERCLA and Superfund Amendments and Reauthorization Act of 1986 (SARA) guidance. The current RI process at WPNSTA Yorktown began in May 1992 with the issuance of the Round One RI Work Plans. The RI studies are expected to be completed in March 1998 for Site 9 and February 1999 for Site 2; the investigation of SSA 4 is scheduled for completion in May 1998. Full-scale remedial activities at WPNSTA Yorktown are currently scheduled to be initiated in October 2000 for Site 9 and August 2001 for Site 2. No remedial action schedule has been developed for SSA 4; a remediation schedule will be developed if the investigation of the site deems it necessary.

C. FEDERAL, STATE AND LOCAL AUTHORITIES' ROLE

1. Federal, State and Local Actions to Date

The Virginia Department of Environmental Quality (VDEQ) has reviewed and provided comments on the EE/CA prepared for the removal actions at Sites 2 and 9 and SSA 4. In addition, since WPNSTA Yorktown is currently on the NPL, the EPA has been involved in the review and comment process for the removals proposed at the three sites. The VDEQ has the responsibility for determining the applicable State ARARs. The Department of the Navy, after working closely with the EPA, has the responsibility for determining Federal ARARs.

2. Potential for Continued Federal/State/Local Response

The involvement of the State and EPA in the removal actions is primarily to provide advisory information as the Navy is the lead agency for the removal actions. However, since the proposed removal actions include the collection of environmental samples, EPA and the VDEQ will have the role of reviewing and approving the field sampling plan and the quality assurance project plan prepared for these activities, in accordance with 40 CFR Part 300, Section 300.415. The VDEQ has the responsibility to contact other appropriate state agencies to establish the following:

- The presence of any threatened or endangered species at the three areas and what precautions will need to be taken during the proposed removal action to protect such species.

- The potential impact the removal actions may have on the Virginia Coastal Zone and what actions will need to be undertaken to protect the coastal area.

- The compliance requirements for the land disturbing activities in accordance with the Virginia Stormwater Management Regulations.

In addition, the disposal facility selected to receive any hazardous wastes must be approved by EPA. The determination of "acceptable facilities" means that the facility must be evaluated by EPA and found acceptable to receive CERCLA wastes. After this occurs, such a facility can continue to receive CERCLA wastes until otherwise notified (i.e., a separate evaluation is not required for each CERCLA waste). The Navy will notify EPA in a timely manner when the determination of the off-site disposal facility has been made.

III. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT

A. Threats to Public Health or Welfare

The surficial waste materials present at Sites 2 and 9 and SSA 4 currently do not pose a threat to public health or welfare as these areas are restricted by limited access to WPNSTA Yorktown. Sites 2 and 9 are not located immediately adjacent to the residential areas of the Station, so the potential for contact with the waste by children is minimal. There is a dwelling (Quarters J, Building-1441) approximately 500 feet upgradient from SSA 4. As noted in previous pages, there is no evidence of the presence of any compounds above detection limits. Future action and studies will continue with the location of this dwelling being so noted. WPNSTA Yorktown personnel may be required to conduct routine working activities in the vicinity of the areas. However, the waste materials on the surface, for the most part, are located away from these areas, and direct contact is not anticipated to be a concern.

Although the concentration of metals in the groundwater exceed state and/or federal standards, ingestion of groundwater presently is not a threat to public health or welfare as on-site groundwater is not used as a drinking water source. WPNSTA Yorktown receives its drinking water from a public water supply fed by surface water reservoirs. However, the potential does exist for continued contamination of the groundwater due to the presence of these materials on the surface and their potential to provide an ongoing source of contamination.

B. Threats to the Environment

Potential receptors, including benthic macroinvertebrates, birds, small mammals, and other aquatic and terrestrial life, may be exposed to chemical constituents (both hazardous substances and pollutants) in the soils, surface water, and sediment. The surficial wastes at Sites 2 and 9 and SSA 4 present a continued source of contamination at these sites via surface runoff, leaching or direct release of contaminants.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances from Sites 2 and 9 and SSA 4, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to public health, welfare, and/or the environment.

V. PROPOSED ACTION AND ESTIMATED COSTS

A. PROPOSED ACTIONS

1. Proposed Action Description

The proposed action is the excavation and disposal of surficial debris. Contaminated material will be disposed in a hazardous waste (RCRA Subtitle C) landfill. Hazardous materials will be determined through sampling to be performed during the removal activities. Materials (wastes and/or soils) that are found not to be hazardous, but are still classified as wastes, will be recycled and/or disposed at a sanitary or industrial landfill as deemed appropriate. The following quantities of wastes and soils have been estimated for the removal actions to be performed at the three locations:

- Hazardous Wastes (i.e., batteries, drums and associated soils) - 180 cubic yards.

- Solid wastes (i.e., drums and surficial wastes) - 325 cubic yards.

The proposed actions will utilize conventional equipment and removal methods that will be effective in removing the threat to human health and the environment. Efforts will be made to minimize impacts to wetlands during the removal actions; wetland areas will be restored to mitigate impacts to disturbed areas.

Confirmation sampling will be performed following excavation. The analytical results from these samples will be used in future RI activities (e.g., baseline risk assessment).

2. Contribution to Remedial Performance

The implementation of the proposed removal actions will also have a positive affect on future remedial actions at the areas. The disposal of the surficial waste materials (e.g., mine casings, construction debris) will make the areas more accessible to equipment and personnel for any remedial activities to be performed. The removal and disposal of the other surficial wastes (drums and batteries) will also remove the potential for further contamination due to the existence of these source areas. This will aid in protecting the environment until the long-term remedial activities are implemented.

3. Description of Alternative Technologies

Alternatives that were considered but not retained for evaluation included those that do not involve off-site land disposal: containment, on-site treatment, and on-site disposal. These alternatives were not retained in the decision process due to their inability to alleviate the threat to human health and the environment in a timely or cost-effective manner. In addition, other removal scenarios (addressing surficial debris and associated soils) were considered. These alternatives did not meet the objectives of the removal actions, and were eliminated from the evaluation process. The EE/CA prepared for these locations presents the alternatives considered and their associated costs.

4. EE/CA

A 30-day public comment period was held between December 26, 1993 and January 26, 1994. During this period, comments were received from EPA and VDEQ regarding the draft final EE/CA for the three locations. These comments have been incorporated, as appropriate, into the Final EE/CA for Sites 2 and 9 and SSA 4. Attachment B provides these comments and the responses prepared to address the agency concerns. A copy of the Final EE/CA for Sites 2 and 9 and SSA 4 is included as Attachment C.

5. Applicable or Relevant and Appropriate Requirements (ARARs)

Federal and State ARARs that have been determined to be applicable to these areas include:

- Virginia Hazardous Waste Regulations (VR 672-10-1)
- Virginia Solid Waste Regulations (VR 672-20-10)
- Virginia Air Pollution Control Regulations (VR 120-01)
- Fish and Wildlife Coordination Act (16 USC 661, *et seq.* [40 CFR 6.302])
- Occupational Safety and Health Administration (OSHA) Requirements for Hazardous Waste Workers (29 CFR 1910)
- Department of Transportation Rules for Transport of Hazardous Materials
- Endangered Species Act (16 USC 1531 *et seq.* [50 CFR 200, 50 CFR 402])
- Coastal Zone Management Act (16 USC 1451 *et seq.*)
- National Historic Preservation Act (16 USC 469 [36 CFR 65] and 16 USC 470 *et seq.* [36 CFR 800])
- RCRA Land Disposal Restriction Regulations (40 CFR 268)
- Virginia Stormwater Management Act, Code of Virginia (section 10.1-603.1 *et seq.*)(Virginia Stormwater Management Regulations [VR 215-02-00], the Virginia Erosion and Sediment Control Law, Code of Virginia Section 10.1-560 *et seq.* and the Virginia Erosion and Sediment Control Regulations [VR 625-02-00]).

6. Project Schedule

The proposed project schedule for the removal actions at Sites 2 and 9 and SSA 4 is:

- Action Memorandum approved — 26 May 1994
- Contractor mobilization — 1 August 1994
- Removal Actions completed — 28 October 1994

B. ESTIMATED COSTS

The estimated cost for this proposed action is $1,188,300. Details on the cost estimate are provided in the EE/CA.

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

Contamination is expected to continue, via surface runoff or leaching through the ground surface. This would potentially impact the surface water, sediment, soils, and shallow groundwater in the vicinity of these locations.

VII. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues associated with this removal action.

VIII. ENFORCEMENT

The Navy, as the lead agency for this removal action, will perform the proposed removal action in a timely and efficient manner.

IX. RECOMMENDATION

Conditions at the site meet the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) section 300.415(b)(2) criteria for a removal action; therefore, a proposed removal action is submitted for approval. Response actions should commence as soon as practical due the potential for the continued migration of contaminants from these areas into the surrounding media. The approval of the proposed removal action at Sites 2 and 9 and SSA 4 at WPNSTA Yorktown is thereby recommended.

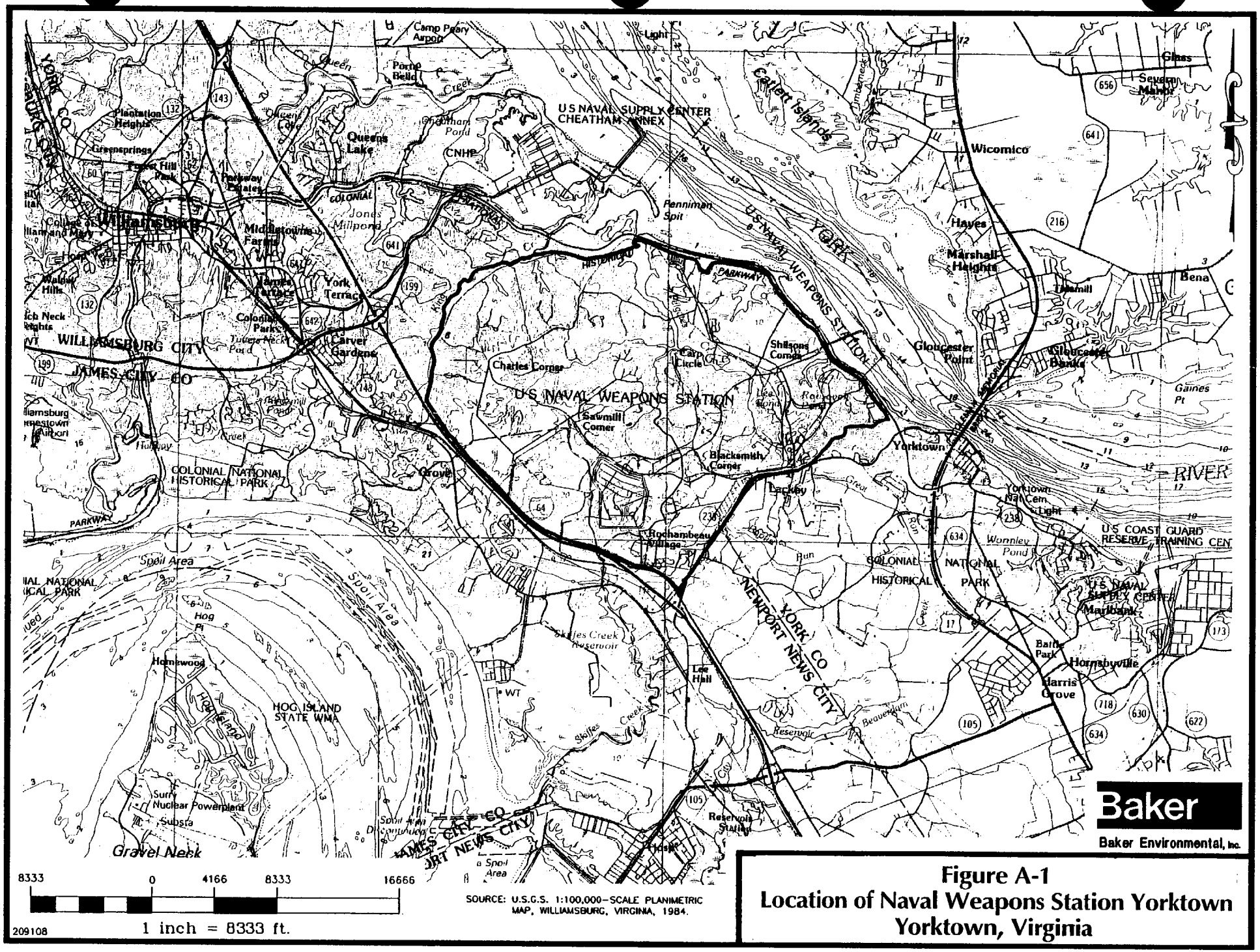
Approval by: R. C. SCHOLES, CDR, USNR, Acting Commanding Officer

Commanding Officer, Naval Weapons Station Yorktown: RJC Sch

Date: 26 MAY 1994

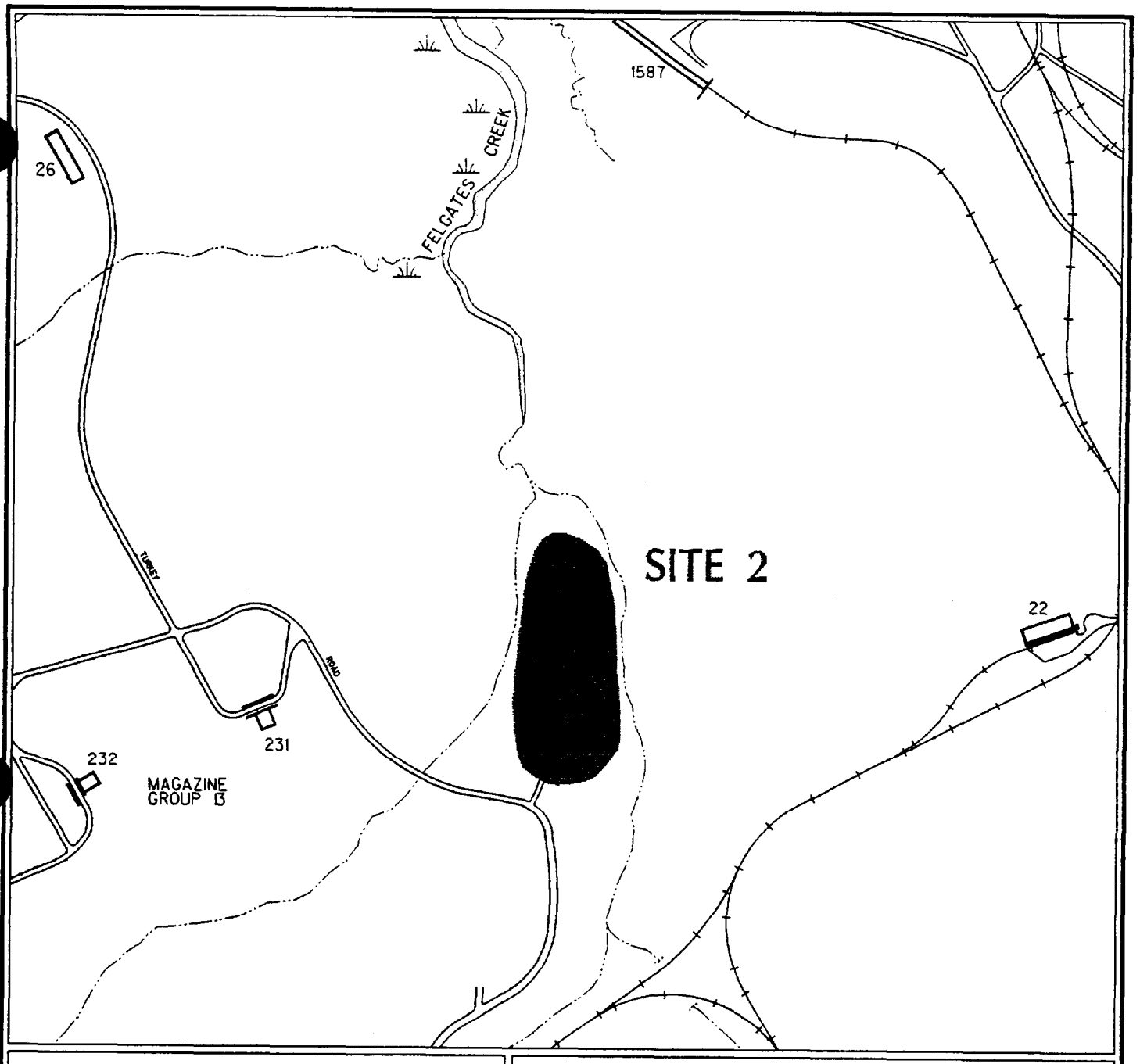
ATTACHMENT A

FIGURES

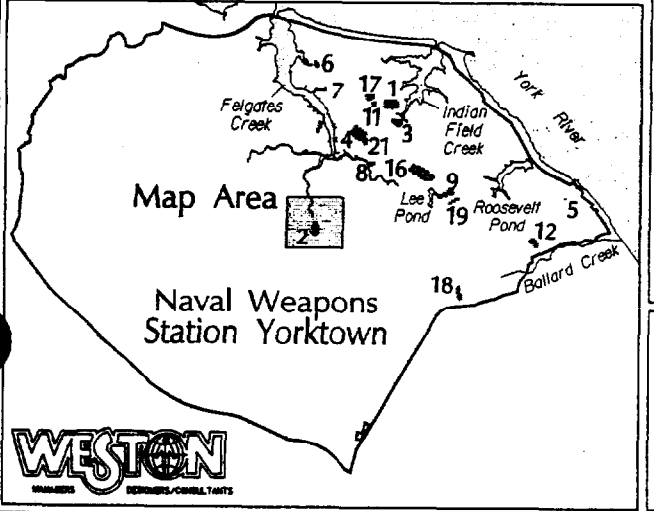


SOURCE: U.S.G.S. 1:100,000–SCALE PLANIMETRIC MAP, WILLIAMSBURG, VIRGINIA, 1984.

Figure A-1
Location of Naval Weapons Station Yorktown
Yorktown, Virginia



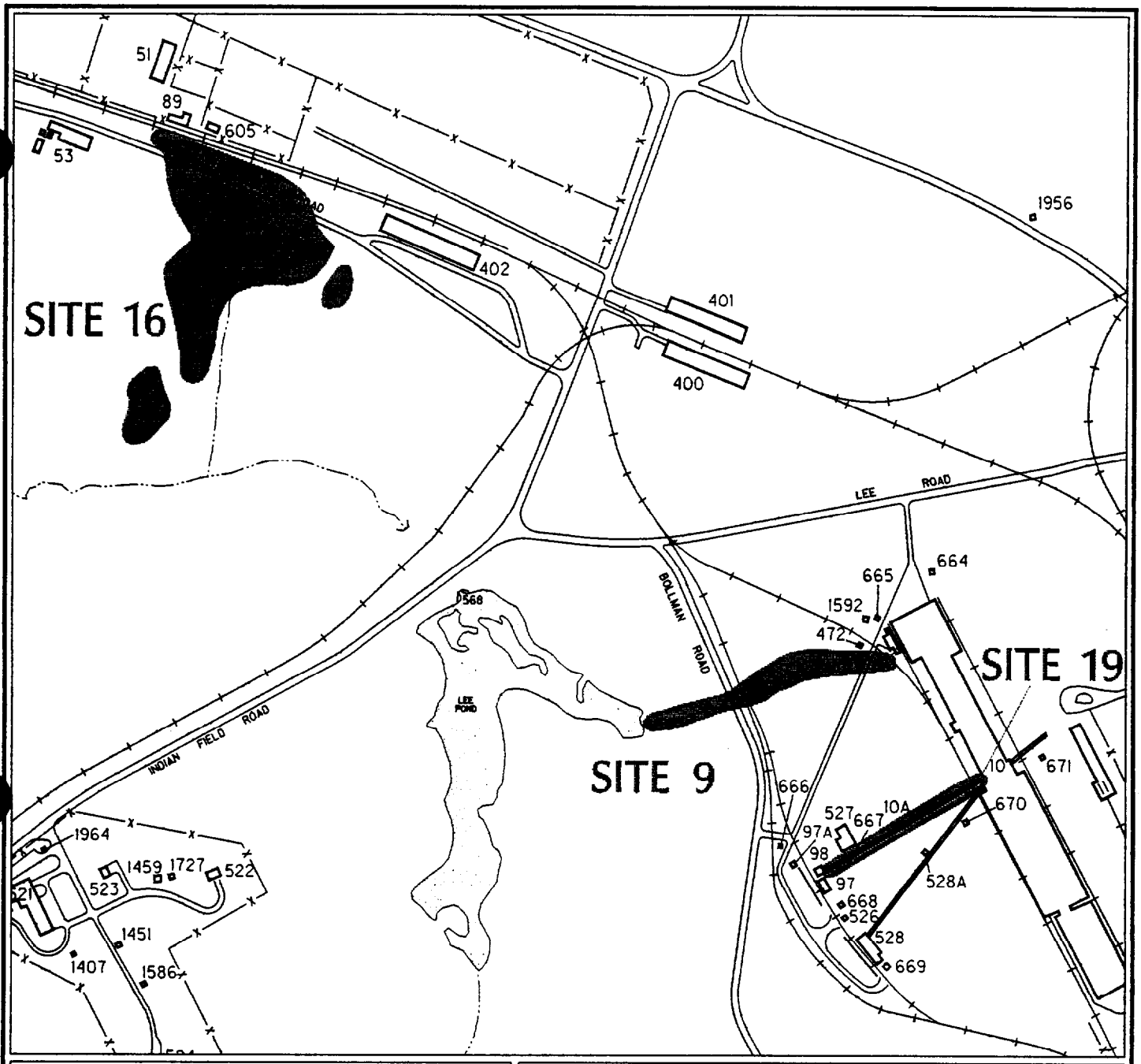
U. S. Navy
Naval Weapons Station Yorktown
Yorktown, VA – April, 1994



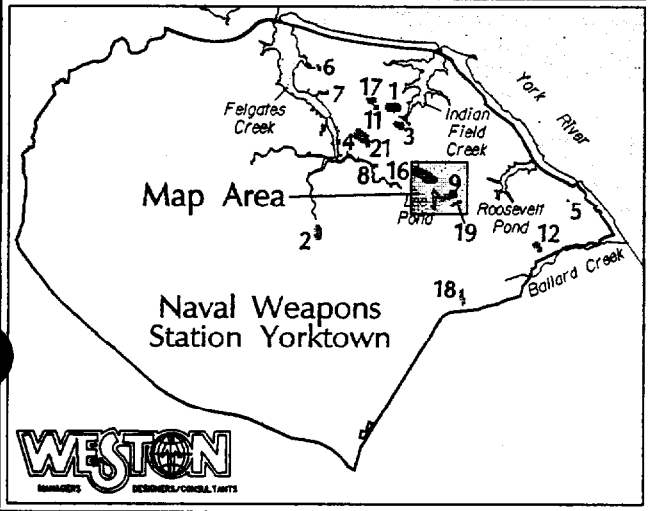
Installation Boundary
Edge of Pavement
Railroad
Fence
Drainage
268 Structure, Facility Number
Marsh, Water
SITE 2 Remedial Investigation Site
N
0 meters 100
0 feet 400

Figure A–2
Site 2
Turkey Road Landfill

05-APR-1994



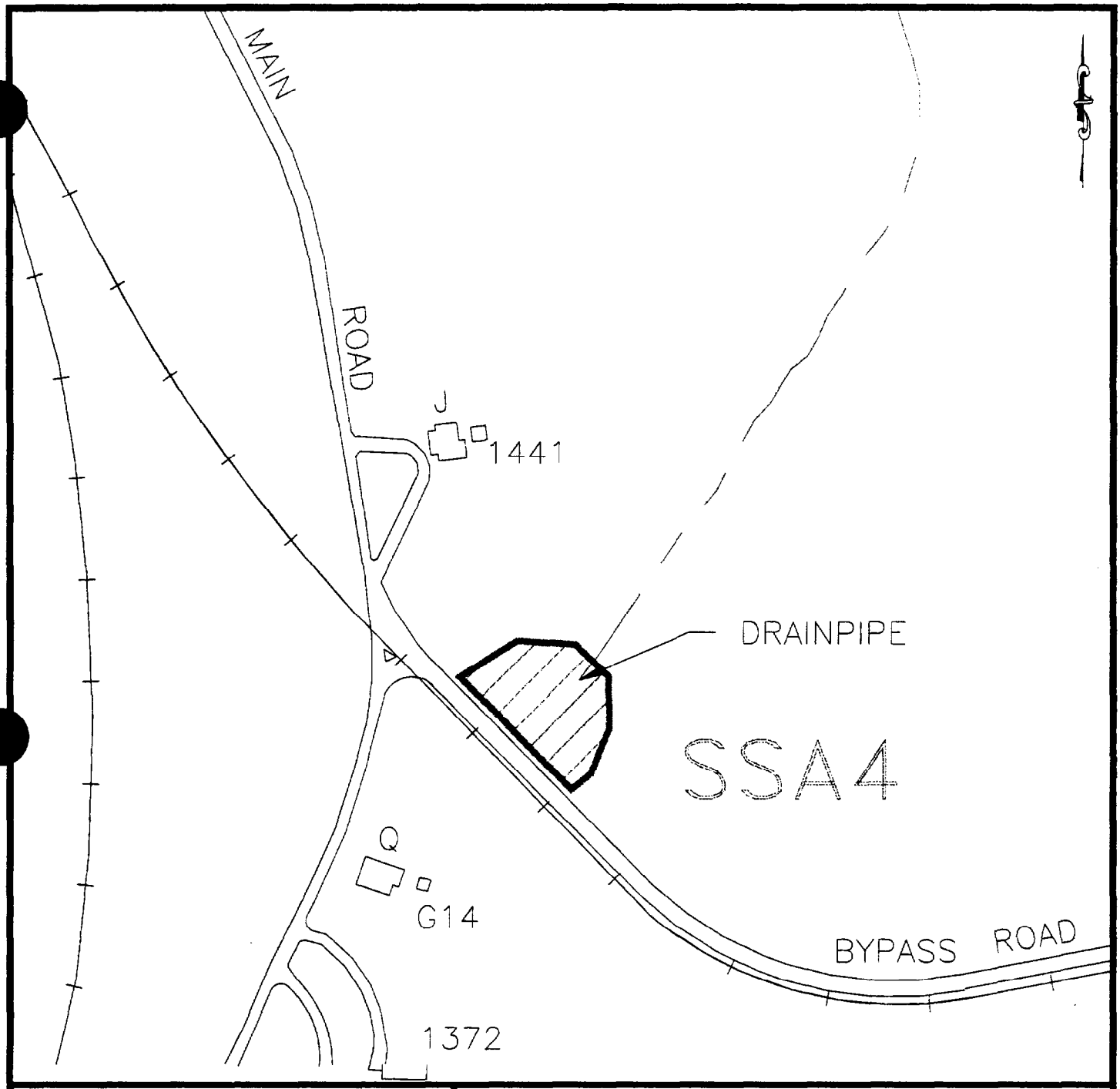
U. S. Navy
Naval Weapons Station Yorktown
Yorktown, VA – April, 1994



Installation Boundary
Edge of Pavement
Railroad
Fence
Drainage
268 Structure, Facility Number
Marsh, Water
SITE 9 Remedial Investigation Site
N
0 meters 100
0 feet 400

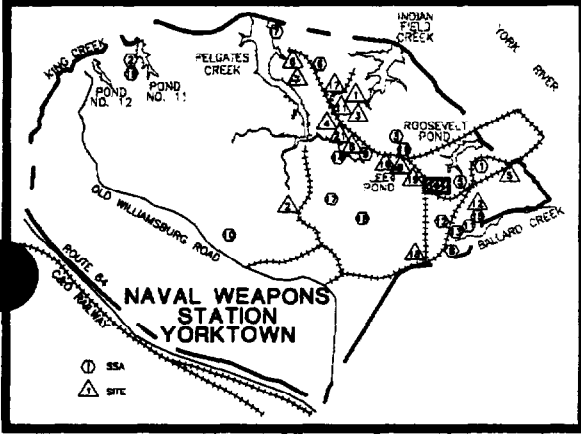
Figure A–3
Site 9
Plant 1 Explosives – Contaminated Wastewater Discharge Area

05-APR-1994



200 0 100 200

1 inch = 200 ft.



- BOUNDARY
- DRAINAGE
- EDGE OF PAVEMENT
- MARSH
- RAILROAD
- FENCE
- STRUCTURE
- SITE SCREENING AREA

209-500

FIGURE A-4
SSA 4
WEAPONS CASING/DRUM DISPOSAL AREA

NAVAL WEAPONS STATION YORKTOWN YORKTOWN, VIRGINIA

ATTACHMENT B

RESPONSIVENESS SUMMARY

RESPONSE TO UNITED STATES ENVIRONMENTAL PROTECTION AGENCY COMMENTS ON THE DRAFT ENGINEERING EVALUATION/COST ANALYSIS FOR SITES 2 AND 9 AND SITE SCREENING AREA 4 NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA

Environmental Protection Agency (EPA), Region III, regarding the "Draft Final Engineering Evaluation/Cost Analysis (EE/CA) for Sites 2 and 9 and Site Screening Area (SSA) 4, Naval Weapons Station Yorktown, Yorktown, Virginia". The comments were received by Mrs. Brenda Norton, P.E., of the Naval Facilities Engineering Command (NAVFACENGCOM), Atlantic Division (LANTDIV), from EPA on January 14, 1994.

Comment 1: In general, the objectives stated on page 3-1 are reasonable and practicable for this non-time critical removal action. The selected non-time critical removal action, however goes beyond the objectives to remove batteries which are not now known to exist. The quantities of batteries which could be encountered by the selected removal action have no basis. The Navy should be cautioned that the cost analysis is very deceiving because of the unknown nature of the batteries. The degree of error with the cost analysis for Alternative 1 is much less than the degree of error for Alternative 2. In concept, Alternative 2 is better than Alternative 1, however the cost estimates are not precise which limits any comparison between the two alternatives.

The statement that the exact quantity of batteries present at these sites is not known is correct. The quantities of batteries that were presented in the cost estimates were based upon information provided by the Navy and from the data gathered during previous investigations (e.g., geophysical surveys, historical property usage). At sites where the batteries are present (Site 2 and SSA 4), it appears that the battery disposal practices were limited for the most part to surficial dumping. While a specific comparison between the two costs cannot be performed accurately due to the limited volume information available, the cost estimates do accurately estimate that Alternative 2 will be more expensive than Alternative 1. The selection of Alternative 2 was not only based on cost, but also due to the fact that the second alternative serves to achieve the objectives more comprehensively - to remove the potential source of environmental contamination (the batteries).

Comment 2. For site 9, it is unclear if areas of soil explosive contamination are to be removed under this planned non-time critical removal action. Since EPA is under the assumption that bioremediation of explosive-contaminated soil is under consideration by the Navy, EPA does not recommend that any explosive-contaminated soil be removed from the WPNSTA under the auspices of a non-time critical removal action, unless that non-time critical removal action is the performance of soil bioremediation.

The removal actions to be performed at site 9 are limited to the removal of the railroad ties, drums, and weapons casings that are disposed along the embankment of the

tributary of Lee Pond, on the east side of Bollman Road. The explosive-contaminated

Comment 3. The selected alternative assumes no cost for weapons removal and disposal because military EOD personnel will be performing this function. This evaluation should include the role of an Unexploded Ordnance (UXO) Specialist. The UXO Specialist could survey the suspected weapons or casings and determine if they are safe to move, or if EOD personnel must be brought to the site to "Blow-in-Place" or "Render Safe". The UXO Specialist may use a variety of techniques, including geophysical surveys as well as visual identification to locate and identify unexploded ordnance.

WPNSTA UXO personnel have already conducted a preliminary review of the sites where there are several mine casings and missile hardware present on the surface. These casings and other hardware were determined to be empty or inert. It is believed that all of the weapons casings that will be encountered are inert or empty; however, EOD personnel will survey all casings prior to their removal.

Comment 4. Chapters 4 and 5 refer to removal of "batteries and associated soils". It is unclear what is meant by "associated soils". Please define what is meant by associated soils.

"Associated soils" means any soils that are excavated incidental to the battery removal. The removal action selected is intended to address the removal of hard wastes only. Any contamination that remains on the ground will be addressed as part of the continuing RI/FS process for these sites.

Comment 5. Appendix D Appendix D does not contain the correct tables for use with the EPA technical document entitled "Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening", EPA/903/R-93-001, January 1993. Please insert the correct tables into the Appendix, insuring that all tables contained in Appendix D correspond to the January, 1993 document.

The January 1993 document included tables that were dated 26 October 1992; these tables will remain as previously issued.

RESPONSE TO COMMONWEALTH OF VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY COMMENTS ON THE DRAFT ENGINEERING EVALUATION/COST ANALYSIS FOR SITES 2 AND 9 AND SSA 4 NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA

These responses have been prepared to address comments received from the Commonwealth of Virginia, Department of Environmental Quality (VDEQ), regarding the "Draft Final Engineering Evaluation/Cost Analysis (EE/CA) for Sites 2 and 9 and Site Screening Area (SSA) 4, Naval Weapons Station, Yorktown, Virginia." The comments were received by Mrs. Brenda Norton, P.E., of the Naval Engineering Facilities Command (NAVFACENGCOM), Atlantic Division (LANTDIV), from VDEQ on February 1, 1994.

Comment 1. It would be helpful if Figure 2-1 included a North arrow and a scale.

Figure 2-1 will be revised to include a north arrow and scale.

Comment 2. On page 2-5, Buildings 120, 352, 304, and 28 are identified as the buildings where four wells are located. On the following page, a well decommissioned at building 353 is identified. It is unclear if the well is located at building 352 or 353. Please make necessary corrections.

The correct building is 352. The text will be revised to incorporate this change.

Comment 3. The description of Site 9 on page 2-15 states that drums are located on the "other side of Bollman Road and Lee Pond". If the drums are on the other side of Lee Pond in the drainage way, then why was this area not sampled in the Round One RI?

This area was sampled as part of the Round One RI activities. Sediment and surface water sampling station 9SW/SD01 was located at the confluence of the tributary with Lee Pond; soil sampling station 9S20 was located along the banks of the tributary. It should also be noted that these drums are isolated, and that there are no concentrated drum disposal areas on this side of the road.

Comment 5. On page 4-5, it is described how drums will be disposed. Please be more specific about what will be done with any liquids drained from the drums. Include this information for all the alternatives.

Any liquids that are encountered in drums will be removed from the drums and placed in clean, new drums. These liquids will be tested to determine their composition, and then will be disposed of accordingly. The text will be modified to include this description in the appropriate sections.

Comment 6. Please provide a figure which depicts SSA 4 in Section 2.3.5.

A figure will be added to Subsection 2.3.5 to illustrate SSA 4.

Comment 7. Will the drain pipes located at SSA 4 present a problem during excavation? Please discuss this possibility. Also, the drain pipes should be included with the figure mentioned previously.

It is not anticipated that the drain pipes will present a problem during the removal activities to be performed at SSA 4. The removal of the debris present at SSA 4 will not be conducted in such a manner as to disturb the drain pipes. The approximate location of the drain pipes at SSA 4 will be included on the new figure to be added to Subsection 2.3.5.

Comment 8. Please update the EPA Region III Risk-Based Concentrations Table in Appendix D. The most recent table is dated October 15, 1993.

As per conversations with Mr. Robert Thomson, EPA Region III Remedial Project Manager, the January 1993 guidance document and accompanying tables are to be used for the removal actions at WPNSTA Yorktown.

Comment 9. It is stated throughout the document that for the purposes of this EE/CA, it is assumed that no transformers or light ballasts, possibly containing PCBs, will be encountered at the surface or within 1 ft bgs excavation depth. If there is any possibility of discovering PCB-containing equipment, there should be a provision for this within the EE/CA.

There is always a possibility of encountering various types of wastes when excavating disposal areas. However, based on the types of wastes noted on the surfaces of these sites, and the historical information available about the sites, no PCB-containing equipment is anticipated to be encountered as part of these removal actions. If any waste (PCB included) is encountered that is not covered by the work plan for the removal action, work will be halted until appropriate actions are determined.

Comment 10. Regarding location-specific ARARs, the VDEQ will contact the Virginia Department of Game and Inland Fisheries and the Department of Conservation and Recreation to confirm that the removal action will not impact threatened or endangered species. A similar inquiry will be made pertaining to activities in the coastal zone, subject to the Coastal Zone Management Act. We will let you know the outcome of this contact.

Comment acknowledged. See attached letters from various natural resource trustees.

Comment 11. Table 2-3: The Virginia Water Quality Standards, VR 680-21-00, were updated on May 20, 1992. You might want to refer to these updated regulations for consideration as ARARs for any remedial action. Also, reference to the standards as criteria can cause confusion. As you have stated, criteria are not enforceable, while standards are enforceable.

The text in Subsection 2.3.3.2 will be modified to reflect the updated regulations. In addition, clarification will be made to discern between enforceable and nonenforceable guidance.

Comment 12. Any activity that takes place in a tidal wetland in the Commonwealth of Virginia may come under the administration of the Virginia Marine Resources Commission (VMRC). The VMRC will be asked to comment on the activities at this site. A copy of this report will be forwarded to them.

Comment acknowledged. See attached letter.

Comment 13. With reference to page 3-12, because Virginia administers an authorized state RCRA program, the Virginia Hazardous Waste Management Regulations (VHWMR) will serve as the governing ARAR in place of the RCRA regulations contained in 40 CFR Parts, except for the Land Disposal Restrictions of 40 CFR Part 268. Additionally, the Virginia Solid Waste Management Regulations, VR 672-20-10 were revised on January 21, 1993. You might want to refer to these updated regulations for consideration as ARARs for any remedial action.

Clarification will be made to the text to identify the Virginia Hazardous Waste Management Regulations as the enforceable regulations at WPNSTA Yorktown for the removal actions proposed along with the Land Disposal Restrictions of 40 CFR Part 268. In addition, the updated solid waste regulations will be referenced.

Comment 14. The footnote to Table 3-1 references the State Water Control Board, which is now the Water Division of the Department of Environmental Quality. The permit regulations VR 680-14-1 were revised and effective September 27, 1989.

The title of the governing agency will be changed to reflect the above comment. The revised regulations will also be referenced.

Comment 15. With reference to excavation in tidal wetlands, you are strongly advised to

Permits are not requried for CERCLA activities conducted on-site; however, the cleanup must comply with the substantive requirements that would otherwise be included in a permit. As noted above, the Virginia Marine Resources Commission will have the opportunity to comment on the removal activities. WPNSTA Yorktown will provide VMRC with notification upon the initiation of the removal activities that will occur near wetlands.

Robert Hicks, Jr.
Director

Administration
Natural Heritage
Planning & Recreation Resources
Soil & Water Conservation
State Parks

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 302
TDD (804) 786-2121 Richmond, Virginia 23219-2010 (804) 786-6124 FAX:(804) 786-6141

February 28, 1994

K.C. Das, Ph.D., P.E.
Office of the Superfund Program
Department of Environmental Quality
629 E. Main Street, 4th Floor
Richmond, Virginia 23219

re: Remedial Activities at Sites 2 and 9 and Site Screening Area 4 on Yorktown Naval Weapons Station

Dear Mr. Das:

The Department of Conservation and Recreation (DCR) has reviewed the subject project and offers the following comments.

The proposed project is not anticipated to have any adverse impacts on existing or planned recreational facilities nor will it impact any streams on the National Park Service Nationwide Inventory-Final List of Rivers, potential State Scenic Rivers or existing or potential State Scenic Byways.

DCR has searched its Biological and Conservation Datasystem (BCD) for occurrences of natural heritage resources from the area outlined on the submitted map. Natural heritage resources (NHR's) are defined as the habitat of rare, threatened or endangered plant and animal species, unique or exemplary natural communities and significant geologic formations.

According to the information currently in our files, there are no natural heritage resources documented in the project area. The absence of data may indicate that the project area has not been surveyed, rather than confirm that the area lacks natural heritage resources. New and updated information is continually added to BCD. Please contact DCR for an update on this natural heritage information if a significant amount of time passes before it is utilized.

Thank you for the opportunity to comment on this project.

Sincerely,

John R. Davy, Jr.
Planning Bureau Manager

JRD:ikr

ATTACHMENT C

FINAL EE/CA FOR SITES 2 AND 9 AND SSA 4

FINAL

ENGINEERING EVALUATION/ COST ANALYSIS (EE/CA)

SITES 2 AND 9 AND SITE SCREENING AREA (SSA) 4 REMOVAL ACTIONS NAVAL WEAPONS STATION YORKTOWN, YORKTOWN, VIRGINIA

CONTRACT TASK ORDER 0089

Prepared for:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under:

LANTDIV CLEAN PROGRAM
Contract N62470-89-D-4814

Prepared by:

BAKER ENVIRONMENTAL, INC.
Coraopolis, Pennsylvania

ROY F. WESTON, INC.
West Chester, Pennsylvania

W.O. No.: 06629-001-012-9999-00

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LIST OF ACRONYMS AND ABBREVIATIONS

AET	-	Apparent Effects Threshold
AOC	-	Area of concern
APHA	-	American Public Health Association
ARAR	-	Applicable or relevant and appropriate requirement
ASTM	-	American Society for Testing and Materials
AWWA	-	American Water Works Association
BAT	-	Best available technology
Baker	-	Baker Environmental, Inc.
bgs	-	Below ground surface
BNA	-	Base/neutral/acid extractable organic compounds
CAA	-	Clean Air Act
CDI	-	Chronic daily intake
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	-	Code of Federal Regulations
CLEAN	-	Comprehensive Long-Term Environmental Actions Navy
CLP	-	Contract Laboratory Program
CO	-	Carbon monoxide
CRZ	-	Contamination reduction zone
CTO	-	Contract task order
CTV	-	Critical toxicity value
CWA	-	Clean Water Act
DCA	-	Dichloroethane

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

DCE	-	Dichloroethylene (or dichloroethene)
DEQPPM	-	Defense Environmental Quality Program Policy Memorandum
DNAPL	-	Dense nonaqueous phase liquid
DNT	-	Dinitrotoluene
DOD	-	Department of Defense
DOT	-	Department of Transportation
E&S	-	Erosion and sedimentation
EDB	-	Ethylene dibromide
EE/CA	-	Engineering Evaluation/Cost Analysis
EIC	-	Engineer-in-Charge
EM	-	Electromagnetic
EOD	-	Explosive Ordnance Disposal
EPA	-	U.S. Environmental Protection Agency
ER-L	-	Effects Range — Low
ER-M	-	Effects Range — Median
exp	-	Exponential function
°F	-	Degrees Fahrenheit
FFA	-	Federal Facilities Agreement
FS	-	Feasibility study
FSO	-	Field Safety Officer
FSP	-	Field Sampling Procedures
ft	-	Feet

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

ft^3/sec	-	Cubic feet per second
gpd/ft	-	Gallons per day per foot
gpd/mi^2	-	Gallons per day per square mile
gpm	-	Gallons per minute
gpm/ft	-	Gallons per minute per foot
GPR	-	Ground-penetrating radar
GS	-	Ground surface
HASP	-	Health and Safety Plan
HI	-	Hazard index
HMX	-	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	-	Hazard quotient
HSDB	-	Hazardous substance database
HW	-	Hazardous waste
IAS	-	Initial Assessment Study
ICR	-	Ignitability, corrosivity, reactivity
i.d.	-	Inside diameter
IR	-	Installation Restoration
IRP	-	Installation Restoration Program
LANTDIV	-	Atlantic Division
LFL	-	Lower flammability limit
LOEL	-	Lowest observed effect level
MCL	-	Maximum contaminant level

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

MEK	-	Methyl ethyl ketone
MIBK	-	Methyl isobutyl ketone
μg/kg	-	Micrograms per kilogram
μg/L	-	Micrograms per liter
mgd	-	Million gallons per day
mg/kg	-	Milligrams per kilogram
MSL	-	Mean sea level
NAAQS	-	National Ambient Air Quality Standards
NACIP	-	Navy Assessment and Control of Installation Pollutants
NAVFACENGCOM	-	Naval Facilities Engineering Command
NCP	-	National Oil and Hazardous Substances Pollution Contingency Plan
NEDED	-	Naval Explosives Development Engineering Department
NEESA	-	Naval Energy and Environmental Support Activity
NEPA	-	National Environmental Policy Act of 1969
NOAA	-	National Oceanic and Atmospheric Administration
NOC	-	Naval Ordnance Center
NPDES	-	National Pollutant Discharge Elimination System
NPL	-	National Priorities List
NSC	-	Naval Supply Center
O_3	-	Ozone
O&M	-	Operations and maintenance
OSHA	-	Occupational Safety and Health Administration

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

OSWER	-	Office of Solid Waste Emergency Response
OVA	-	Organic vapor analyzer
OWTU	-	Outdoor water treatment unit
PA	-	Preliminary Assessment
PAH	-	Polynuclear aromatic hydrocarbon
PCB	-	Polychlorinated biphenyl
P.E.	-	Professional Engineer
PM	-	Project Manager
PMCL	-	Proposed maximum contaminant level
POC	-	Point of contact
PPE	-	Personal protective equipment
ppm	-	Parts per million
ppt	-	Parts per thousand
PVC	-	Polyvinyl chloride
QA	-	Quality assurance
QAPP	-	Quality Assurance Project Plan
QA/QC	-	Quality assurance/quality control
QSAR	-	Quantitative Structural Activity Relationships database
R&D	-	Research and development
RAGS	-	Risk Assessment Guidance for Superfund
RCRA	-	Resource Conservation and Recovery Act
RDX	-	Hexahydro-1,3,5-trinitro-1,3,5-triazine

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

RI	-	Remedial investigation
RI/FS	-	Remedial investigation/feasibility study
ROD	-	Record of Decision
SARA	-	Superfund Amendments and Reauthorization Act of 1986
SC	-	Specific conductance
SDWA	-	Safe Drinking Water Act
SI	-	Site Inspection
SMCL	-	Secondary maximum contaminant level
SO_2	-	Sulfur dioxide
SOP	-	Standard operating procedure
SOW	-	Statement of Work
SSA	-	Site Screening Area
SWMF	-	Solid waste management facility
SWMU	-	Solid waste management unit
TAL	-	Target Analyte List
TBC	-	To-Be-Considered
TCA	-	Trichloroethane
TCDD	-	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TCE	-	Trichloroethylene
TCL	-	Target Compound List
TCLP	-	Toxicity Characteristic Leachate Procedure
TDS	-	Total dissolved solids

TNB	-	Trinitrobenzene
TNT	-	Trinitrotoluene
TOC	-	Total organic carbon
TPH	-	Total petroleum hydrocarbons
tpy	-	Tons per year
TRC	-	Technical Review Committee
TSCA	-	Toxic Substances Control Act
USC	-	United States Code
USCS	-	Unified Soil Classification System
USDA	-	United States Department of Agriculture
UTM	-	Universal Transverse Mercator
VDEQ	-	Virginia Department of Environmental Quality
VDMR	-	Virginia Division of Mineral Resources
VDOT	-	Virginia Department of Transportation
VGS	-	Virginia Groundwater Standards
VHWR	-	Virginia Hazardous Waste Management Regulations
VOC	-	Volatile organic compound
VPDES	-	Virginia Pollutant Discharge Elimination System
VWCB	-	Virginia State Water Control Board
VWQS	-	Virginia Water Quality Standards
WESTON	-	Roy F. Weston, Inc.
WPCF	-	Water Pollution Control Federation

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

WPNSTA	-	Naval Weapons Station
XRF	-	X-ray fluorescence

SECTION 1
INTRODUCTION

This Engineering Evaluation/Cost Analysis (EE/CA) contains a comparative evaluation of removal alternatives for removing various contaminants and debris present at Sites 2 and 9 and Site Screening Area (SSA) 4 located at the Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. Sites 2 and 9 were included as part of the Round One Remedial Investigation (RI) activities. These sites have undergone extensive soil, sediment, surface water, and groundwater investigations. The results of those activities are described in detail in the "Final Round One Remedial Investigation Report for Sites 1-9, 11, 12, 16-19, and 21, Naval Weapons Station, Yorktown, Virginia" (Baker/WESTON, July 1993). SSA 4 was not part of the Round One RI activities. SSA 4 has undergone visual inspections, the results of which are presented in Appendix A (Site Visit Report for SSA 4) of this EE/CA.

Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, or Superfund) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) provide that removal actions are part of the response process and are often the first response to a release or threatened release. A removal action is considered appropriate when hazardous substances, pollutants, or contaminants in bulk storage containers, such as drums or barrels, pose a threat of release. Prior to performing a non-time-critical removal action, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires the lead agency to conduct an EE/CA when a removal action for a site or sites has a planning period of 6 months or more.

The EE/CA is a brief analysis of removal alternatives considered for a site or sites prepared to document the removal action alternative evaluation and selection process. Submittal of this document will fulfill the requirements of the National Environmental Policy Act of 1969 (NEPA) for non-time-critical actions and the requirements defined by CERCLA, SARA, the NCP, and the Superfund Removal Procedures. Non-time-critical removal actions are defined by the U.S. Environmental Protection Agency (EPA) as actions that may be delayed for 6 months or more before on-site cleanup is initiated (i.e., 6-month planning period).

This EE/CA has been prepared in accordance with the "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (EPA Office of Solid Waste Emergency Response (OSWER), August 1993) and the "Navy/Marine Corps Installation Restoration Manual" (U.S. Department of the Navy and U.S. Marine Corps, February 1992).

This EE/CA has been prepared by Roy F. Weston, Inc. (WESTON®) under subcontract to Baker Environmental, Inc. (Baker) as part of the Comprehensive Long-Term Environmental Actions Navy (CLEAN) Program. The Naval Facilities Engineering Command (NAVFACENGCOM), Atlantic Division (LANTDIV) has contracted the Baker Team (Baker/WESTON) to prepare the EE/CA for Sites 2 and 9 and SSA 4 at WPNSTA Yorktown.

1.1 OBJECTIVE AND GOALS

At Sites 2 and 9 and SSA 4, various types of surface and subsurface waste materials are present. These waste materials, which include batteries, scrap metal, drums, construction debris, and other wastes (such as weapons casings present primarily at Site 2 and SSA 4, and telephone poles and railroad ties at Site 9), may pose a threat to human health and/or the environment due to physical and chemical dangers (e.g., obstacles, release of potentially hazardous substances, etc.). The removal of these wastes would alleviate the potential for harm to humans and the environment from these sources. Therefore, this EE/CA has been developed to evaluate removal action alternatives and select the alternative that best fulfills the ultimate goal of the removal action: protection of humans and the environment through mitigation of potentially hazardous conditions.

The objective of this document is to evaluate removal alternatives for Sites 2 and 9 and SSA 4. Individual goals of this EE/CA are to: 1) satisfy environmental review and public relations requirements for removal actions; 2) satisfy administrative record requirements for improved documentation of removal action selection; 3) compile the analytical results from

the various rounds of sampling for each site; and 4) provide a framework for evaluating and selecting alternative technologies. The following information is presented within this EE/CA:

- An overall and specific site description, including details of previous RI findings and analytical data.
- Identification of the removal action objectives for Sites 2 and 9 and SSA 4.
- Identification of removal actions and technologies.
- Recommendation of a preferred removal alternative.
- Schedule for the selected removal alternative.

The removal actions and technologies considered in this EE/CA will be compared on a basis of technical feasibility, institutional requirements, human health and environmental issues, and cost to provide a framework for selecting the appropriate alternative. For the purposes of this document, removal actions are defined as removal of surface and/or subsurface waste materials at Sites 2 and 9 and SSA 4. Remediation of additional contaminants will be evaluated as part of the WPNSTA Yorktown Feasibility Study (FS) to be conducted upon completion of the RI. The scope of removal actions is discussed further in Section 3 of this EE/CA, entitled "Identification of Removal Action Objectives".

A Remediation Contractor will be selected to perform the removal actions as described in this EE/CA. It will be the responsibility of the Remediation Contractor to: 1) ensure compliance with the applicable regulatory requirements (e.g., Erosion and Sedimentation (E&S) Plan) and waste disposal approvals; 2) provide personnel to inspect the material at the sites to determine its potential for recycling and disposal requirements; 3) track and document all removals, sampling and analysis reports, disposal manifests, and restoration activities; 4) develop and implement a Health and Safety Plan (HASP); and 5) maintain the necessary E&S controls following the removal activities for a specified time period.

The administrative record requirements for non-time-critical removals include preparation and approval of the EE/CA as well as preparation of the Notice of Availability to the Public, a response summary to public comments following the 30-day comment period, and preparation of the Action Memorandum.

SECTION 2
SITE CHARACTERIZATION

2.1 BASE HISTORY/CURRENT MISSION

WPNSTA Yorktown, Virginia (originally named the U.S. Mine Depot), was established in 1918 to support the laying of mines in the North Sea during World War I. The establishment of the depot was the culmination of a search process, begun in 1917 at the request of Congress, to locate an Atlantic coast site for a weapons handling and storage facility. For 20 years after World War I, the depot received, reclaimed, stored, and issued mines, depth charges, and related materials. During World War II, the facility was expanded to include three additional trinitrotoluene (TNT) loading plants and new torpedo overhaul facilities. A research and development (R&D) laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the activity, which included the design and development of depth charges and advanced underwater weapons. On 7 August 1959, the U.S. Mine Depot was redesignated the U.S. Naval Weapons Station. The primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

2.2 INSTALLATION DESCRIPTION

WPNSTA Yorktown is a 10,624-acre facility located in both York and James City Counties, and in the City of Newport News, Virginia, on the York-James Peninsula (see Figure 2-1). The York-James Peninsula occupies an area of approximately 1,752 square miles (of which WPNSTA Yorktown covers approximately 16 square miles). The peninsula is bordered on the southwest by the James River, on the northeast by the York River, and on the southeast by the confluence of the James River and the Chesapeake Bay. At WPNSTA Yorktown, the peninsula is approximately 6 miles wide. The facility is bounded on the northwest by the Naval Supply Center (NSC) Cheatham Annex; on the northeast by the York River and

the Colonial National Historical Parkway; on the southwest by State Route 143 and Interstate 64; and on the southeast by State Route 238 and the community of Lackey.

2.2.1 Local Topography at WPNSTA Yorktown

The local terrain is gently rolling and dissected by ravines and stream valleys trending predominantly northeastward toward the York River. Ground elevations at WPNSTA Yorktown range from sea level along the eastern boundary, which borders the York River, to a maximum elevation of approximately 90 feet (ft) above mean sea level (MSL) near the central portions of the York-James Peninsula, roughly coincident with the Old Williamsburg Road. Valleys consisting of 40- to 60-ft ravines with steep slopes (slopes exceeding 10:1 gradient) occur along several of the creeks that drain WPNSTA Yorktown, particularly in the northern section of the installation along the York River.

2.2.2 Local Hydrogeology at WPNSTA Yorktown

The shallow lithology at WPNSTA Yorktown consists of an upper sand, a clay-silt unit, basal gravel/shell, and sediment of the Pliocene and Pleistocene ages. Deposits range in thickness from 20 ft at the western end of the peninsula to approximately 150 ft at the seaward end in the vicinity of WPNSTA Yorktown. The sand and gravel/shell units are both water-bearing and are commonly separated by the clay-silt layer, which may function as a confining or semiconfining unit. Collectively, these units form the shallow aquifer system at WPNSTA Yorktown.

In the shallow aquifer system of York County, Brockman and Richardson (1992) differentiate between the Columbia aquifer and the Cornwallis Cave aquifer based on the presence or absence of artesian conditions. Deep drainages present in the northern part of WPNSTA Yorktown occasionally breach the clay-silt layer of the Cornwallis Cave confining unit and expose the underlying units to atmospheric pressures. Therefore, the sand unit and the lower gravel and shell unit generally exist under water table conditions. The gravel and shell unit may be present as a confined unit in the easternmost part of the station, consistent

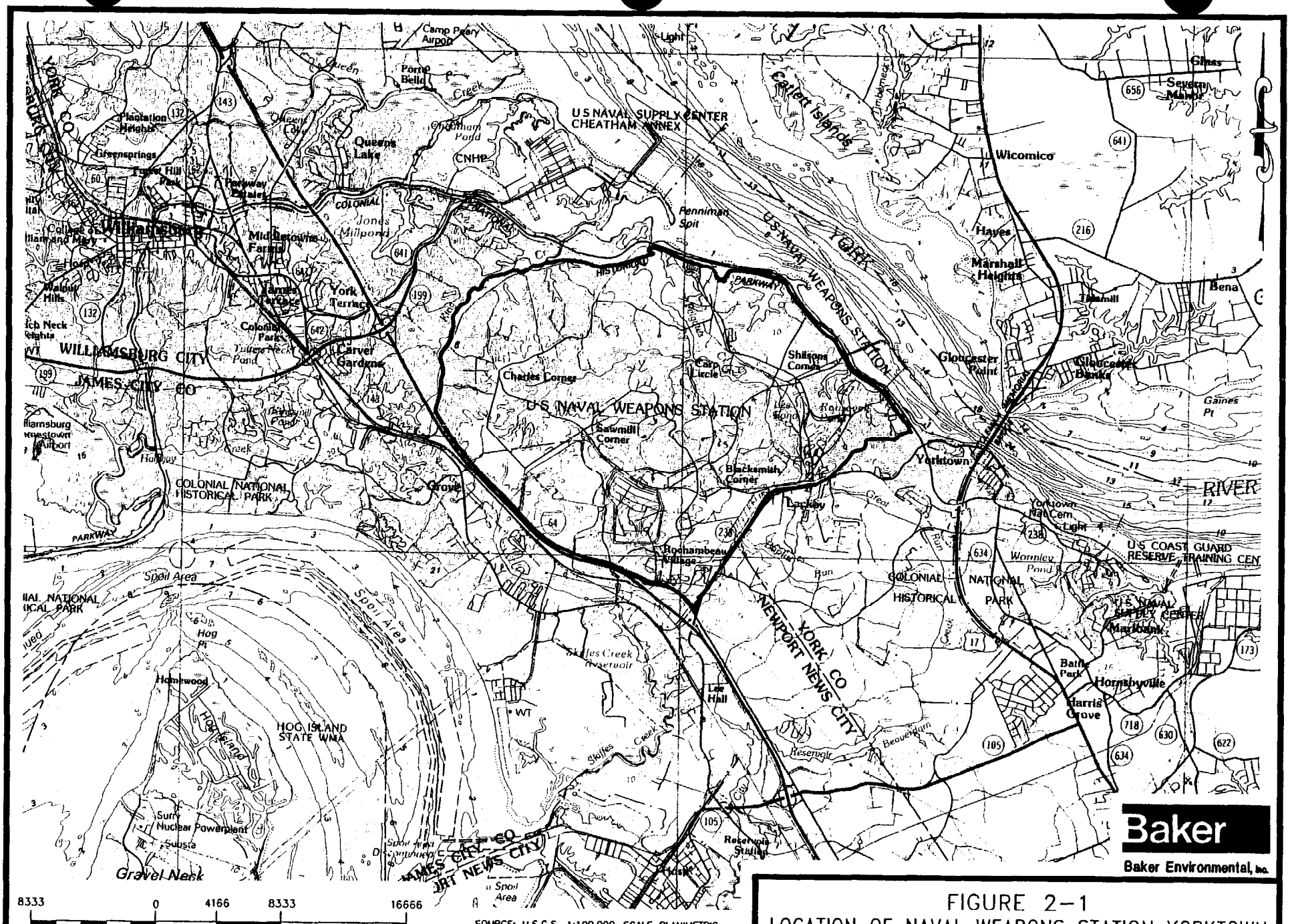


FIGURE 2-1
LOCATION OF NAVAL WEAPONS STATION YORKTOWN
YORKTOWN, VIRGINIA

with the lithologic description from the boring log for background monitoring well BGGW02A.

The Columbia aquifer is recharged by precipitation. The Cornwallis Cave aquifer is recharged by infiltration from leakage through the clay-silt unit (the Cornwallis Cave confining unit [Brockman and Richardson, 1992]). Some exchange also takes place between surface water in the creeks and ponds and the Cornwallis Cave aquifer. The direction of groundwater flow across the station is generally to the east-northeast toward the York River, but locally trends toward groundwater discharge zones and appears to coincide with surface streams. The top of the water table generally reflects the topography.

Data from monitoring wells installed throughout WPNSTA Yorktown as part of the Confirmation and RI Studies were used to assess the depth to groundwater within the York County shallow aquifer system. The groundwater levels for summer and fall 1992 indicated depths generally less than 30 ft below ground surface (bgs) throughout upland areas of WPNSTA Yorktown. At areas of WPNSTA Yorktown that are located close to surface water bodies, the depth to the water table is frequently less than 5 ft. The data from the monitoring wells confirmed that the groundwater flow direction within the shallow system is generally toward groundwater discharge zones coincident with surface drainages and streams. The monitoring well data also confirmed that the water level elevations roughly reflect the surface topography. Seasonal variations in groundwater flow direction within the shallow aquifer were not evident based upon the winter 1986 and fall 1987 data.

Surface water from reservoirs supplies the dominant source of domestic (individual home) water in many parts of James City and York Counties, as well as at WPNSTA Yorktown.

Four wells at WPNSTA Yorktown, located at Buildings 120, 352, 304, and 28, were completed in the principal artesian aquifer at depths of 445, 470, 480, and 538 ft bgs, respectively. The rated capacity of two of the wells is reportedly 300 gallons per minute (gpm) each. The wells were originally intended as emergency sources of potable water supplies in the event that off-station supplies were inadequate (C.C. Johnson, 1984);

however, based on water quality analysis, water from the wells was not certified as potable by the Virginia State Health Department due to high hardness and elevated concentrations of both total dissolved solids (TDS) and fluorides. The wells at Buildings 120, 304, and 352 have been decommissioned; however, they still remain accessible for use in groundwater monitoring, if necessary. The well at Building 28 has been permanently closed and capped, and therefore is not accessible for groundwater monitoring.

The dominant surface water features at WPNSTA Yorktown are the tributaries to the York River, Felgates Creek, Indian Field Creek, and their associated streams. These creeks are tidal and are in communication with the uppermost groundwater system.

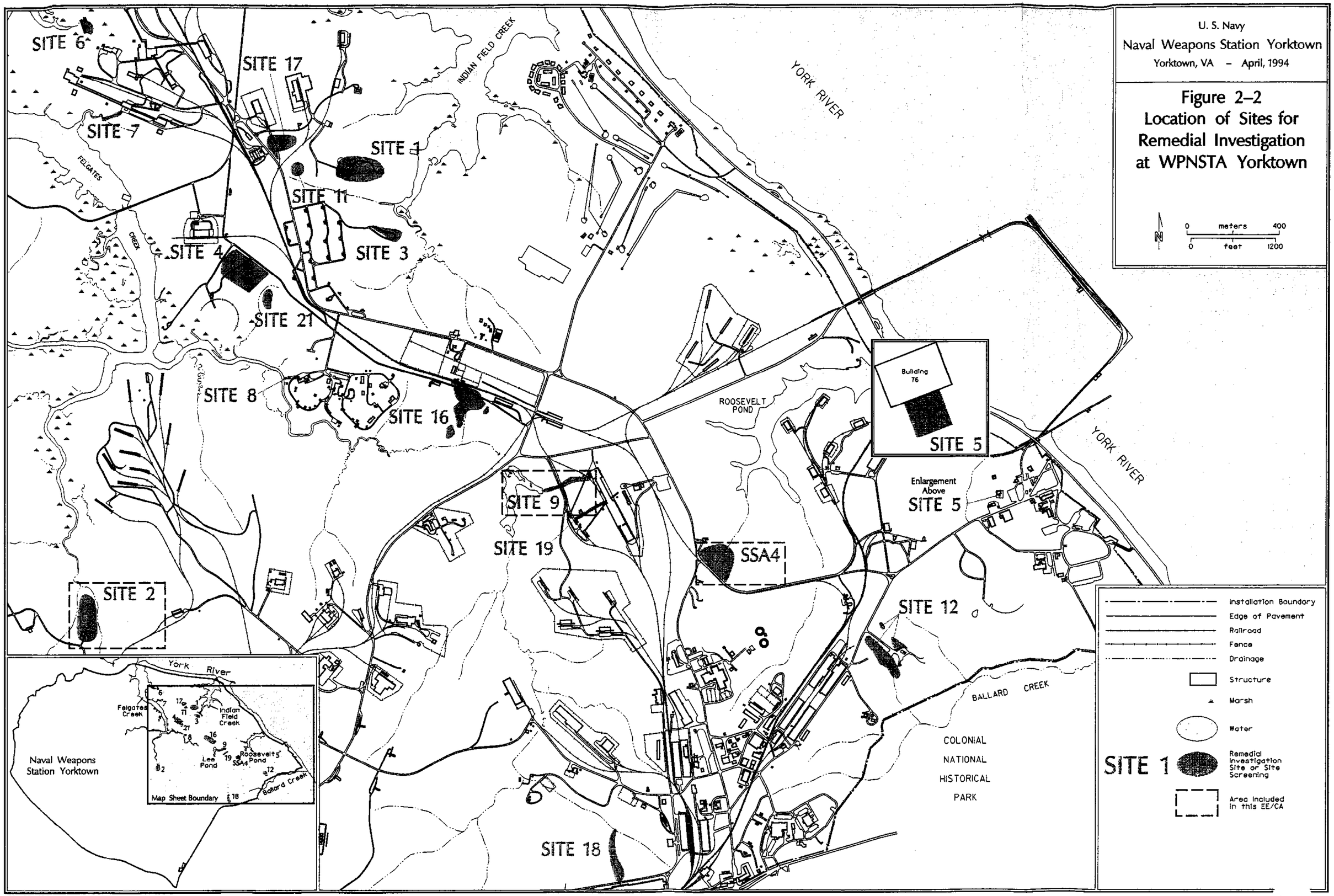
2.3 SUMMARY OF PREVIOUS INVESTIGATIONS AND AVAILABLE ANALYTICAL DATA

2.3.1 Previous Investigations

Prior to the most recent (1992) Round One RI activities, an Initial Assessment Study (IAS), a Confirmation Study, and a RI Interim Report were completed at WPNSTA Yorktown. The results of the IAS are summarized in the report entitled "Initial Assessment Study of Naval Weapons Station, Yorktown, Virginia," which was prepared by C. C. Johnson & Associates, Inc. and CH2M Hill in July 1984. The purpose of the IAS was to identify and assess sites posing a potential threat to human health or the environment due to contamination from past operations. A total of 19 potentially contaminated sites was identified based on information from historical records, aerial photographs, field inspections, and personnel interviews. Each site was evaluated for the types of contamination, migration pathways, and potential pollutant receptors. The IAS concluded that 15 of the 19 sites had the potential to pose a sufficient threat to human health or the environment, and thus warranted Confirmation Studies. Two additional areas, Site 21 and SSA 4, had not yet been discovered during the time of the IAS, but have since been added to the list of areas requiring further investigation. The locations of Sites 2 and 9 and SSA 4 in reference to these 16 sites are provided in Figure 2-2.

U. S. Navy
Naval Weapons Station Yorktown
Yorktown, VA – April, 1994

Figure 2–2
Location of Sites for Remedial Investigation at WPNSTA Yorktown



The Confirmation Studies were conducted by Dames & Moore in two rounds (Round 1 and Round 2). A Draft RI Interim Report prepared by Dames & Moore was submitted to LANTDIV on 24 February 1989. Versar subsequently revised the Draft RI Interim Report to incorporate comments submitted to LANTDIV by the Technical Review Committee (TRC). The TRC is a group comprised of regulatory personnel, academic representatives, and civic leaders. The TRC members may offer suggestions, challenge study methods, and provide additional information to the community. The revised RI Interim Report was submitted on 1 July 1991. The purpose of this report was to summarize available data for each site and, based on these data, provide recommendations for additional efforts to be conducted to complete the RI. Additional RI efforts were recommended for 14 of the 15 sites identified under the Confirmation Study.

During December 1991, WPNSTA Yorktown personnel identified an additional area, SSA 4, that had not been included in the previous investigations. A SSA, as defined in the Federal Facilities Agreement (FFA) for WPNSTA Yorktown, "may be a Resource Conservation and Recovery Act (RCRA) solid waste management unit (SWMU), a RCRA area of concern (AOC), or a CERCLA AOC." Visual inspections and an analysis of a sample collected of a drummed substance found on the site were performed. The results of the visual inspections and substance analysis are discussed in Subsection 2.3.5 and in Appendix A of this EE/CA.

2.3.2 Current Investigations

Soil, sediment, surface water, and groundwater samples were collected and analyzed during the Round One RI. The findings for Sites 2 and 9 from the Round One RI are summarized in the ensuing subsections of this EE/CA. A discussion of the applicable or relevant and appropriate requirements (ARARs) used in the Round One RI data evaluations is presented in Subsection 3.2. SSA 4 was not part of the Round One RI activities. Findings from the visual inspections and other sampling performed at SSA 4 are summarized in the ensuing subsections of this EE/CA, in the Site Visit Report contained in Appendix A, and in Appendix E.

2.3.3 Characterization of Site 2

2.3.3.1 Site-Specific Background for Site 2

Site 2, Turkey Road Landfill, is located in the central area of WPNSTA Yorktown. This two- to three-acre landfill is east of Turkey Road in a wetland adjacent to the southern branch of Felgates Creek. Operations at the landfill are believed to have begun some time in the 1940s and ceased in 1981. Wastes disposed of at Site 2 were reported to have included mercury and zinc-carbon batteries, tree stumps and limbs, construction rubble, weapons hardware (e.g., wings, fins, and power packs), electrical devices, and unidentified types of drums and/or tanks. Waste quantities were estimated at 8 tons per year (tpy) for more than 30 years, totaling 240 tons of waste disposed (C.C. Johnson, 1984). However, this estimate appears low based upon the size of the landfill.

2.3.3.2 Surface Water and Sediment Sampling at Site 2

Figure 2-3 provides sampling locations and selected analytical results for the surface water and sediment samples collected at Site 2. Seven surface water stations were sampled during the Round One RI sampling activities. The analyses from these samples indicated the following:

- Di-n-butylphthalate was detected at low concentrations (10J micrograms per liter (μg/L) and less) in surface water samples 2SW01-001, 2SW02-001, 2SW04-001, and 2SW05-001. Bis(2-ethylhexyl)phthalate was detected, also in low concentrations (7J μg/L and less) in surface water samples 2SW04-001, 2SW05-001, and 2SW06-001. These sample locations are both upstream and downstream from the site. Phthalates are common laboratory contaminants and are not considered to be site-related.

- Acetone, the only VOC detected in any of the surface water samples, was present in sample 2SW04-001. This low concentration of a common laboratory contaminant is not considered to be site-related.

- Surface water samples 2SW07-001 and 2SW03-001, and duplicate sample 2SW03-101, located farthest from the landfill, contained no detectable concentrations of volatile organic compounds (VOCs) or base/neutral/acid extractable organic compounds (BNAs).

SITE 2

Sediment Samples

2SD01–001
- 14 J Chloromethane
- 24 J 2-Butanone
- 1200 Toluene
- 210 J Di-n-butylphthalate
- 220 J Bis (2-ethylhexyl) phthalate

2SD01–002
- 21 J Toluene

2SD02–002
- 19 J 2-Butanone

2SD03–001
- 32 Carbon Disulfide

2SD03–101
- 20 Carbon Disulfide

2SD03–002
- 70 Carbon Disulfide

2SD04–001
- 5 J Toluene
- 350 J Pentachlorophenol
- 990 Bis (2-ethylhexyl) phthalate

2SD04–002
- 4 J Toluene
- 170 J Bis (2-ethylhexyl) phthalate

2SD05–001
- 350 Acetone
- 69 2-Butanone

2SD06–001
- 36 J 2-Butanone

2SD06–002
- 110 J Aroclor 1248 *

2SD07–001
- 24 Carbon Disulfide

2SD08–001
- 210 J Bis (2-ethylhexyl) phthalate
- 2.9 J 4,4'-DDE *

2SD08–002
- 160 J Bis (2-ethylhexyl) phthalate

2SD09–001
- 3 J Methylene Chloride

Surface Water Samples

2SW01–001
- 3 J Di-n-butylphthalate

2SW02–001
- 8 J Di-n-butylphthalate

2SW04–001
- 2 J Acetone
- 5 J Di-n-butylphthalate
- 5 J Bis (2-ethylhexyl) phthalate

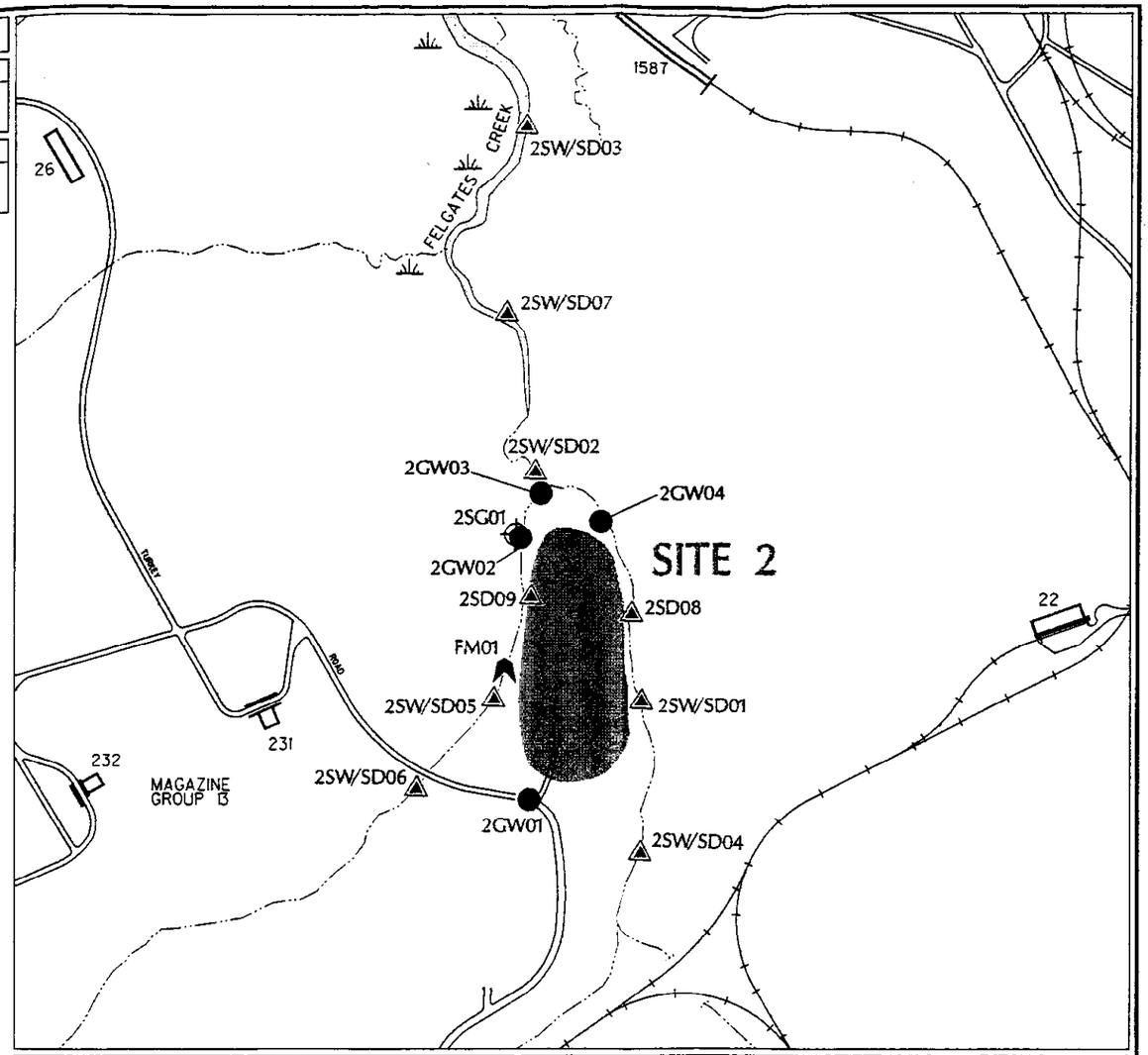
2SW05–001
- 10 J Di-n-butylphthalate
- 6 J Bis (2-ethylhexyl) phthalate

2SW06–001
- 7 J Bis (2-ethylhexyl) phthalate

Groundwater Samples

2GW02–001
- 2 J Phenol
- 1 J Diethyl phthalate

2GW04–001
- 2 J Phenol
- 2 J Diethyl phthalate



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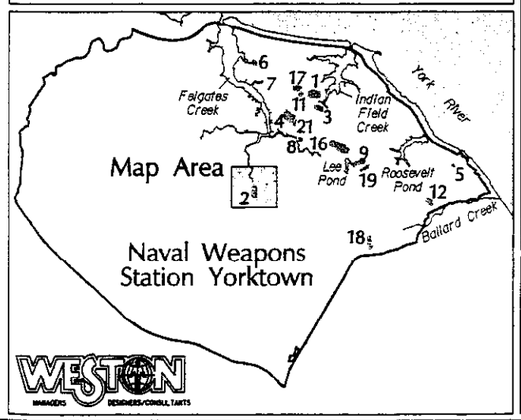
Naval Weapons Station Yorktown
Yorktown, VA – April, 1994



ANALYTICAL PARAMETER COLOR CODING

55 J	VOC (black)
91 J	BNA (cyan)
61 J	Pesticide (green)
43 J	PCB (orange)

1. Detected analytical parameter concentrations noted at left.
2. Analytical results reported in micrograms/Kilogram for sediment and surface soil samples and in micrograms/Liter for surface water and groundwater samples.

J - Estimated value
* - Meets or exceeds NOAA low effects range criteria

SITE 2 — Remedial Investigation Site

Sample Location Symbology:
- Existing Monitoring Well
- Round One Surface Water/Sediment
- Stream Flow Measurement Station
- Staff Gauge

0 meters 100
0 feet 400
N

Figure 2–3
SITE 2
Turkey Road Landfill

- No explosives, pesticides, or polychlorinated biphenyls (PCBs) were detected in any of the surface water samples.

- The total copper concentrations in samples 2SW01-001 and 2SW04-001 were above the Virginia Water Quality Standards (VWQS) and Clean Water Act (CWA) salt water chronic levels. The dissolved metals concentration of copper in sample 2SW04-001 was also above these levels. Since station 2SW04 is located upstream of the site, this concentration is believed attributable to another source.

- The total nickel concentration in sample 2SW02-001 was above the VWQS and CWA salt water chronic levels. The dissolved nickel concentrations in samples 2SW03-001, 2SW06-001, and 2SW07-001 were above the VWQS and CWA salt water chronic levels.

Previous studies, which were not confirmed by these analyses, had shown the presence of low concentrations of VOCs and pesticides.

A total of nine sediment stations was sampled at Site 2. The analyses from these samples indicated the following:

- Toluene, 2-butanone, acetone, and carbon disulfide were the only VOCs detected in any of the sediment samples.

- Two BNA compounds, bis(2-ethylhexyl)phthalate and pentachlorophenol, were detected in a few of the sediment samples at less than 1,000 μg/kg.

- Aroclor 1248 was detected in the sample collected from the 6- to 12-inch interval of sediment station 2SD06, but not in the 0- to 6-inch interval. This concentration exceeded the National Oceanic and Atmospheric Administration (NOAA) low effects range criteria.

- The pesticide 4,4-DDE was detected in the sample collected from the 0- to 6-inch interval of sediment station 2SD08; this concentration exceeded the NOAA low effects range criteria.

- Several of the metals concentrations exceeded the metals levels found in the background sediment samples, especially in the 6- to 12-inch interval. Silver concentrations exceeded the NOAA median effects range and the Apparent Effects Threshold (AET) criteria in five sediment samples collected from Site 2. Higher levels of metals were detected in the sediment samples analyzed during previous investigations than in those analyzed during the Round One RI.

2.3.3.3 Groundwater Sampling at Site 2

The groundwater analytical results obtained during the Round One RI activities were consistent with those obtained during previous investigations. Sampling locations and selected results are available in the Round One RI Report and are summarized in Figure 2-3. Tables containing metals concentrations for groundwater samples collected for the Round One RI are contained in Appendix B of this EE/CA.

Four groundwater samples were collected from the monitoring wells at Site 2. Only very low concentrations of BNA compounds were detected in the groundwater samples. Nitrate concentrations ranged from nondetect to 470 μg/L. No VOCs, explosives, pesticides, or PCBs were detected in any groundwater sample.

The metals analyses performed on the groundwater samples provided the following results:

- The total metals analysis of sample 2GW02-001 contained chromium (55 μg/L) and zinc (93.8 μg/L) above the Virginia Groundwater Standards (VGS). The lead concentration (15.5 μg/L) also exceeded the federal action level. None of these compounds was above any applicable regulatory concentrations in the dissolved metals sample.

- In the total metals sample from monitoring well 2GW03, zinc, at a concentration of 67.1 μg/L, exceeded the VGS. Zinc was below the applicable regulatory concentration in the dissolved metals sample.

- The total metals sample 2GW04-001 contained concentrations of arsenic, chromium, and zinc above the VGS. Arsenic, at a concentration of 110J μg/L, was also above the maximum contaminant level (MCL). Lead concentrations exceeded the federal action level. Arsenic, at 74.8 μg/L, was the only metal that was detected above applicable regulatory concentrations in the dissolved metals sample; this concentration exceeded both the MCL (50 μg/L) and the VGS (50 μg/L).

2.3.4 Characterization of Site 9

2.3.4.1 Site-Specific Background for Site 9

Site 9, the Plant 1 Explosives-Contaminated Wastewater Discharge Area, is located in the east-central area of WPNSTA Yorktown. Site 9 is east of Lee Pond, approximately 1,000 ft away from Site 16 and 400 ft away from Site 19. Lee Pond is a manmade impoundment located upgradient of the eastern branch of Felgates Creek. Site 9 has been used as the drainage way for Plant 1 (Building 10) explosives-contaminated wastewater and possibly for substantial quantities of organic solvents. Located along the drainage way prior to flowing under Bollman Road is a disposal area where railroad ties and weapons casings were discarded along the bank. On the other side of Bollman Road and Lee Pond, several drums are located in the drainage way. No information is available regarding the date(s) this material was disposed. Site 9 is located topographically downslope from Site 19, and was reportedly in use from the late 1930s to 1975. Based on estimated average discharges of 100 parts per million (ppm) for TNT and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and 30 ppm for octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) at five gpm for two hours per workday for forty years, an estimated 5,200 pounds of TNT and RDX and 1,600 pounds of HMX may have been discharged to the site (C.C. Johnson, 1984). Solvents such as trichloroethylene (TCE) may have been discharged from Plant 1 with the explosives wastewater. Contaminants from Plant 1 (Building 10) may have migrated via surface flow into Lee Pond or across the upper soils via overland flow into the pond. Lee Pond empties into the eastern branch of Felgates Creek, which in turn flows northward to the York River, located approximately 1.5 miles from Site 9.

In 1975, a carbon adsorption tower was installed to treat the contaminated wastewater prior to discharge into the drainage way. A National Pollutant Discharge Elimination System (NPDES) permit was granted by EPA Region III to allow the discharge. In 1986, the effluent from the tower was diverted to the sanitary sewer and ultimately to the Hampton Roads Sanitation District.

2.3.4.2 Surface Soil Sampling at Site 9

Detailed results of soil sampling activities at Site 9 can be found in the Final Round One RI Report (Baker/WESTON, July 1993) and in Figure 2-4. This report on Site 9 soils indicated the following:

- Several BNAs were detected across the site. The highest BNA concentrations were detected in the sample collected from location 9S16, ranging from 39J micrograms per kilogram (μg/kg) fluorene to 1,100 μg/kg fluoranthene.
- VOCs were not detected in any of the surface soil samples.
- The explosive 2,4,6-TNT was detected in soil samples 9S15, 9S16, 9S17, and 9S19 at concentrations ranging from 2,900 μg/kg to 2,100,000 μg/kg. The explosive compounds 2,4-dinitrotoluene (DNT) and 1,3,5-trinitrobenzene (TNB) were also detected in the sample collected from location 9S19, at concentrations of 3,200 and 3,000 μg/kg, respectively.
- Metals concentrations and pH levels were within the ranges found in the background surface soil samples.
- One subsurface soil sample was collected from the soil boring advanced at the location of 9HP03 and analyzed for VOCs due to a field observation of odor, indicating the possible presence of volatile compounds. Ethylbenzene, at an estimated concentration of 8J μg/kg, was the only VOC detected. This compound was not detected in the groundwater sample collected from the same location (discussed in Subsection 2.3.4.4).

2.3.4.3 Surface Water and Sediment Sampling at Site 9

The surface water and sediment sampling locations, along with the detected concentrations of analytes, are shown in Figure 2-4. The surface water samples collected from Site 9 indicated the following:

- Station 9SW06 showed the presence of 6J μg/L of 1,1 dichloroethane and 18 μg/L of 1,1,1 trichloroethane (TCA); 1,1,1-TCA was also detected in surface water sample 9SW01 at 1J μg/L. Trace amounts (<20J μg/L) of acetone were detected in surface samples 9SW04, 9SW05, and 9SW07.

SITE 9

Sediment Samples

9SD01–001

47 J	Acenaphthylene
540 J	Phenanthrene * +
130 J	Anthracene *
110 J	Carbazole
1100	Fluoranthene * +
850 J	Pyrene *
450 J	Benzo (a) anthracene *
550 J	Chrysene *
190 J	Bis (2-ethylhexyl) phthalate
440 J	Benzo (b) fluoranthene
420 J	Benzo (k) fluoranthene
410 J	Benzo (a) pyrene *
450 J	Indeno (1,2,3-cd) pyrene
200 J	Dibenzo (a,h) anthracene *
440 J	Benzo (g,h,i) perylene

9SD01–002

27 J	Fluorene
310 J	Phenanthrene * +
52 J	Anthracene
82 J	Carbazole
450 J	Fluoranthene
260 J	Pyrene
190 J	Benzo (a) anthracene
230 J	Chrysene
110 J	Bis (2-ethylhexyl) phthalate
210 J	Benzo (b) fluoranthene
220 J	Benzo (k) fluoranthene
180 J	Benzo (a) pyrene
100 J	Benzo (g,h,i) perylene

9SD02–001

51 J	**Acetone**
74 J	4-Methylphenol
60 J	Fluoranthene
49 J	Pyrene
160 J	Bis (2-ethylhexyl) phthalate

9SD02–002

59 J	Fluoranthene
880 J	Bis (2-ethylhexyl) phthalate

9SD03–001

140 J	Fluoranthene
120 J	Pyrene

9SD03–002

140 J	**Acetone**
57 J	2-Butanone
42 J	Fluoranthene
38 J	Pyrene
190 J	Bis (2-ethylhexyl) phthalate

9SD04–001

470 J	Phenanthrene * +
180 J	Di-n-butylphthalate
890	Fluoranthene *
690	Pyrene *
400 J	Benzo (a) anthracene *
550	Chrysene *
750	Benzo (k) fluoranthene
350 J	Benzo (a) pyrene
230 J	Indeno (1,2,3-c,d) pyrene
240 J	Benzo (g,h,i) perylene

9SD04–002

140 J	Phenanthrene
190 J	Di-n-butylphthalate
440 J	Fluoranthene
420 J	Pyrene *
230 J	Benzo (a) anthracene *
390 J	Chrysene
250 J	Benzo (b) fluoranthene
260 J	Benzo (k) fluoranthene
200 J	Benzo (a) pyrene
140 J	Indeno (1,2,3-cd) pyrene
130 J	Benzo (g,h,i) perylene

9SD05–001

470 J	Acenaphthene *
990 J	Fluorene **
8700	Phenanthrene **
2300	Anthracene **
1300 J	Carbazole
10000	Fluoranthene **
12000	Pyrene **
7500	Benzo (a) anthracene **
8600	Chrysene **
11000	Benzo (b) fluoranthene
6000	Benzo (a) pyrene **
2400	Indeno (1,2,3-cd) pyrene
1500 J	Dibenzo (a,h) anthracene **
650 J	Benzo (g,h,i) perylene

9SD05–002

1100 J	Naphthalene * +
1600 J	Acenaphthene ** +
1100 J	Dibenzofuran
1900	Fluorene ** +
9100	Phenanthrene ** +
3100	Anthracene ** +
2200	Carbazole
8100	Fluoranthene ** +
7400	Pyrene ** +
5800	Benzo (a) anthracene ** +
6800	Chrysene ** +
3500	Benzo (b) fluoranthene
4900	Benzo (k) fluoranthene
4300	Benzo (a) pyrene ** +
2400	Indeno (1,2,3-cd) pyrene
1400 J	Dibenzo (a,h) anthracene ** +

9SD06–001

210 J	Fluorene *
1600	Phenanthrene ** +
370 J	Anthracene * +
330 J	Di-n-butylphthalate
1800	Fluoranthene * +
1700	Pyrene * +
1100	Benzo (a) anthracene * +
1500	Chrysene * +
300 J	Bis (2-ethylhexyl) phthalate
950	Benzo (b) fluoranthene
1200	Benzo (k) fluoranthene
830	Benzo (a) pyrene * +
530 J	Indeno (1,2,3-cd) pyrene
320 J	Dibenzo (a,h) anthracene ** +

9SD06–002

5 J	Chloroethane
360 J	Phenanthrene * +
210 J	Di-n-butylphthalate
960	Fluoranthene *
750	Pyrene *
210 J	Benzo (a) anthracene
600	Chrysene *
390 J	Benzo (b) fluoranthene
400 J	Benzo (k) fluoranthene
180 J	Benzo (a) pyrene

9SD07–001

440 J	**Acetone**
67 J	2-Butanone
100 J	Fluoranthene
91 J	Pyrene
44 J	Benzo (a) anthracene
70 J	Chrysene
200 J	Bis (2-ethylhexyl) phthalate
76 J	Benzo (b) fluoranthene
68 J	Benzo (k) fluoranthene
53 J	Benzo (a) pyrene

9SD07–002

91 J	**Acetone**
43 J	2-Butanone
61 J	Fluoranthene
55 J	Pyrene
43 J	Chrysene

Groundwater Samples

9HP01–001

1 J	Diethyl phthalate

9HP02–001

6.3	1,3,5-Trinitrobenzene
2.2	2,4,6-TNT
12 J	2,4-Dinitrotoluene

9HP03–001

2300	2,4,6-TNT
0.89	2,4-Dinitrotoluene

Surface Water Samples

9SW01–001

1 J	1,1,1-Trichloroethane
4 J	2,6-Dinitrotoluene
4 J	Bis (2-ethylhexyl) phthalate
1.8 J	RDX
2.7	1,3,5-Trinitrobenzene
0.34	2,4-Dinitrotoluene
190	2,4,6-Trinitrotoluene

9SW02–001

1 J	4-Methylphenol
3 J	Bis (2-ethylhexyl) phthalate

9SW03–001

3 J	Bis (2-ethylhexyl) phthalate

9SW04–001

18 J	Acetone
4 J	2,6-Dinitrotoluene
3 J	Di-n-butylphthalate
0.29 J	2,4-Dinitrotoluene
190	2,4,6-Trinitrotoluene

9SW05–001

2 J	Acetone
7.8	RDX
2.8	2,4,6-Trinitrotoluene

9SW06–001

6 J	1,1-Dichloroethane
18	1,1,1-Trichloroethane
4	HMX
43	RDX
1.4 J	1,3,5-Trinitrobenzene
0.38	2,4-Dinitrotoluene
370	2,4,6-Trinitrotoluene

9SW07–001

19 J	Acetone
7 J	Toluene
1 J	Bis (2-ethylhexyl) phthalate
0.29 J	2,6-Dinitrotoluene

Surface Soil Samples

9S15–001

160 J	Phenanthrene
30 J	Anthracene
24 J	Carbazole
100 J	Di-n-butylphthalate
330 J	Fluoranthene
260 J	Pyrene
150 J	Benzo (a) anthracene
190 J	Chrysene
400 J	Bis (2-ethylhexyl) phthalate
200 J	Benzo (b) fluoranthene
160 J	Benzo (k) fluoranthene
130 J	Benzo (a) pyrene
94 J	Indeno (1,2,3-cd) pyrene
9400	2,4,6-TNT

9S16–001

39 J	Fluorene
640	Phenanthrene
75 J	Anthracene
72 J	Carbazole
110 J	Di-n-butylphthalate
1100	Fluoranthene
1100 J	Pyrene
550	Benzo (a) anthracene
590	Chrysene
520 J	Bis (2-ethylhexyl) phthalate
620	Benzo (b) fluoranthene
510 J	Benzo (k) fluoranthene
430 J	Benzo (a) pyrene
150 J	Indeno (1,2,3-cd) pyrene
150 J	Benzo (g,h,i) perylene
2900	2,4,6-TNT

9S17–001

580 J	Fluoranthene
540 J	Pyrene
110000	2,4,6-TNT

9S18–001

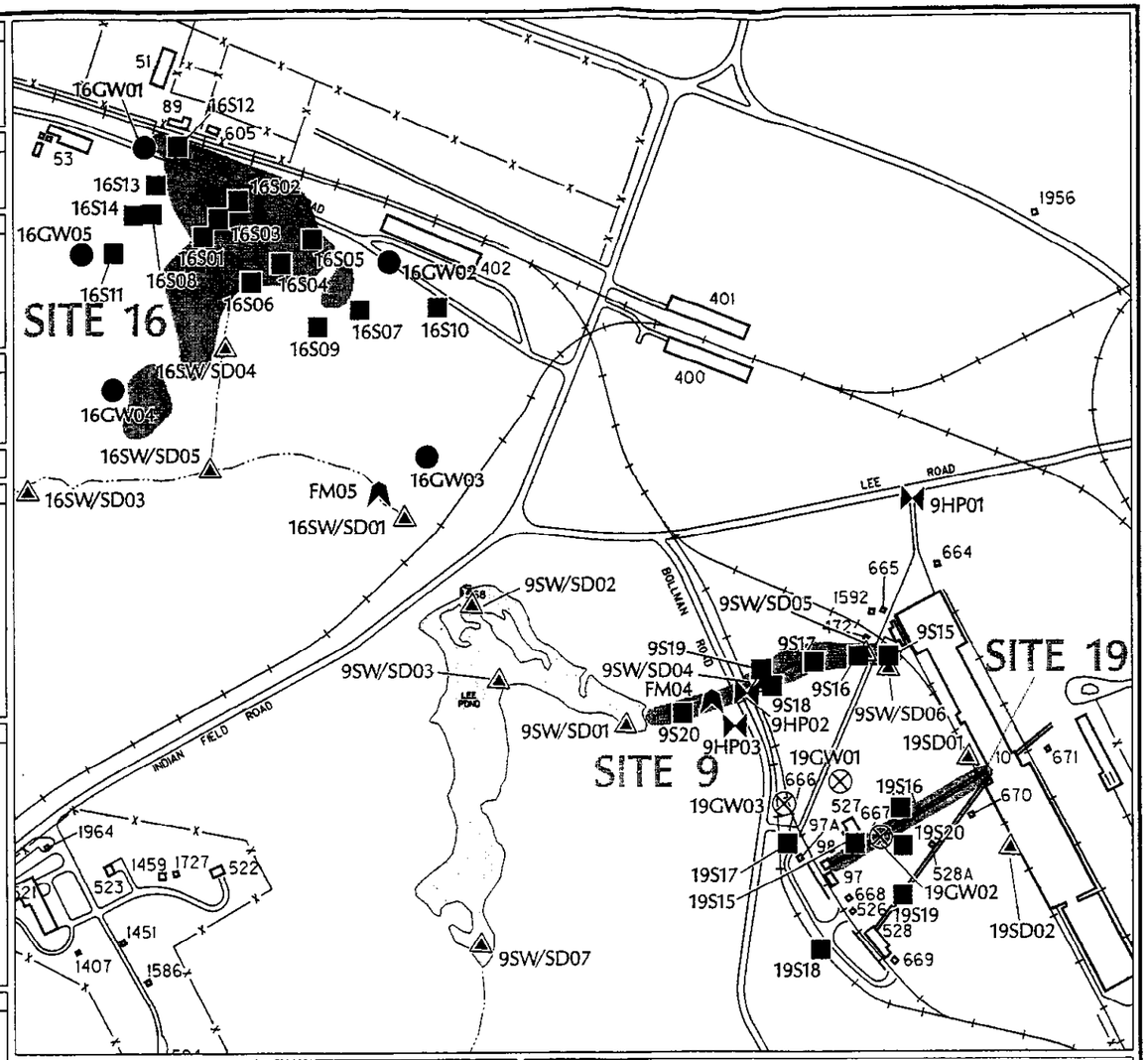
270 J	Phenanthrene
40 J	Anthracene
49 J	Carbazole
76 J	Di-n-butylphthalate
560	Fluoranthene
520 J	Pyrene
260 J	Benzo (a) anthracene
310 J	Chrysene
540 J	Bis (2-ethylhexyl) phthalate
300 J	Benzo (b) fluoranthene
300 J	Benzo (k) fluoranthene
200 J	Benzo (a) pyrene
130 J	Indeno (1,2,3-cd) pyrene
120 J	Benzo (g,h,i) perylene

9S19–001

3000	1,3,5-Trinitrobenzene
3200	2,4-Dinitrotoluene
2100000	2,4,6-TNT

9S20–001

63 J	Di-n-butylphthalate
37 J	Fluoranthene
34 J	Pyrene
21 J	Benzo (a) anthracene
26 J	Chrysene
270 J	Bis (2-ethylhexyl) phthalate
29 J	Benzo (b) fluoranthene
22 J	Benzo (k) fluoranthene
19 J	Benzo (a) pyrene



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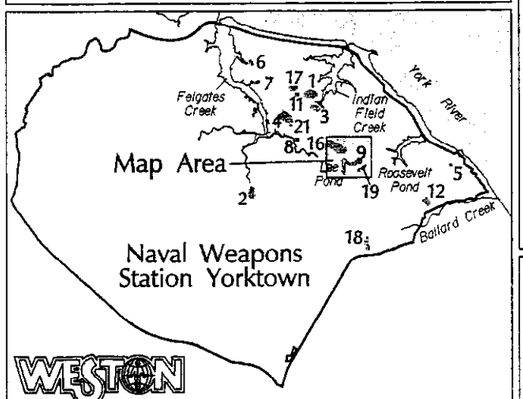
Naval Weapons Station Yorktown
Yorktown, VA – April, 1994



ANALYTICAL PARAMETER COLOR CODING	
55 J	VOC (black)
91 J	BNA (cyan)
43 J	Explosive (red)

1. Detected analytical parameter concentrations noted at left.
2. Analytical results reported in micrograms/Kilogram for sediment and surface soil samples and in micrograms/Liter for surface water and groundwater samples.

J - Estimated value
* - Meets or exceeds NOAA low effects range criteria
** - Meets or exceeds NOAA median effects range criteria
\+ - Exceeds NOAA apparent effects threshold

SITE 9 — Remedial Investigation Site

Sample Location Symbology:

- Existing Monitoring Well
- Round One Monitoring Well
- Round One Surface Water/Sediment
- Round One Surface Soil
- Stream Flow Measurement Station
- HydroPunch™

0 meters 100
0 feet 400

N

Figure 2–4
Site 9
Plant 1 Explosives – Contaminated Wastewater Discharge Area

- Explosives were detected in all surface water samples collected at Site 9, except for 9SW02 and 9SW03, which were furthest from the source. Samples 9SW01 and 9SW06 showed the highest levels of explosives contamination, along with the widest range of contaminants. 2,4,6-TNT was present in high concentrations (190 to 370 μg/L) in samples 9SW01, 9SW04, and 9SW06, located along the main drainage channel. Explosives concentrations were higher than those detected in previous investigations.

- Total and dissolved metals concentrations in the following samples were below the VWQS and CWA freshwater chronic criteria: 9SW01-001, 9SW03-001, 9SW03-101 (duplicate), 9SW04-001, 9SW05-001, and 9SW07-001.

- The lead concentration in the total metals sample 9SW02-001 (19.8 μg/L) exceeded the CWA freshwater chronic level of 3.2 μg/L. The zinc concentration in sample 9SW02-001 was above both the CWA and VWQS freshwater chronic criteria in the total metals sample. The dissolved metals sample did not contain detectable concentrations of lead or zinc above applicable regulatory criteria.

- Total and dissolved metals concentrations in samples 9SW03-001, 9SW03-101 (duplicate), 9SW04-001, and 9SW05-001 were below the VWQS and CWA freshwater chronic criteria.

- Copper exceeded the CWA freshwater chronic criteria in total metals sample 9SW06-001.

- The total and dissolved metals concentrations in surface water sample 9SW07-001 were below the VWQS and CWA freshwater chronic criteria.

The sediment samples collected at Site 9 indicated the following:

- Several BNA compounds were present, consistent with previous investigation results.

- Samples collected from locations 9SD01 and 9SD04 contained concentrations of polynuclear aromatic hydrocarbons (PAHs) that exceeded the NOAA low effects range and AET criteria. Samples from stations 9SD05 and 9SD06 contained levels of PAHs above the NOAA median effects range and AET criteria.

- Acetone and 2-butanone were the only VOCs detected in any of the sediment samples. Samples 9SD07-001 and 9SD07-002 showed concentrations of these compounds, which are common laboratory contaminants and are not considered to be site-related.

- No explosives were detected in any of the sediment samples collected from Site 9, consistent with previous investigation results.

- At least one of the following metals was detected in a sediment sample collected from Site 9 at a concentration above the NOAA low effects range criteria: arsenic, lead, mercury, copper, and zinc.

2.3.4.4 Groundwater Sampling at Site 9

Sampling locations and selected results are available in the Round One RI Report and are summarized in Figure 2-4. Tables containing metals concentrations for groundwater samples collected for the Round One RI are contained in Appendix B of this EE/CA.

The results from the three groundwater samples collected from HydroPunch™ samples at Site 9 indicated the following:

- No VOCs were detected in the groundwater samples.

- The only BNA compound detected in the groundwater samples was 1J μg/kg of diethyl phthalate from sample location 9HP01. This is a common laboratory contaminant and is not considered to be site-related.

- Explosives were found in groundwater samples 9HP03 and 9HP02. Sample 9HP03 contained 0.89 μg/L of 2,4-DNT and 2,300 μg/L of 2,4,6-TNT. Sample 9HP02 contained 6.3 μg/L of 1,3,5-TNB, 2.2 μg/L of 2,4,6-TNT, and 12J μg/L of 2,4-DNT.

- The total metals analysis of sample 9HP01-001 showed concentrations of barium, chromium, mercury, and zinc above the VGS. Barium and chromium concentrations were also detected above the MCLs. The lead concentration exceeded the federal action level. Beryllium and nickel concentrations were present above MCLs. All dissolved metals concentrations were below these regulatory concentrations.

- Barium, chromium, lead, mercury, and zinc were present at concentrations above the VGS in total metals sample 9HP02-001. The chromium concentration also exceeded the MCL. Lead was detected above the federal action level concentration. Beryllium and nickel concentrations were above MCLs. The dissolved metals analysis showed metals concentrations below applicable regulatory levels.

- The total metals analysis of sample 9HP03 contained cadmium, lead, and zinc concentrations above the VGS. Cadmium also exceeded the federal MCL. Lead exceeded the federal action level. Beryllium was present above the MCL. In the dissolved metals samples, zinc remained above the VGS.

- The total metals concentrations in groundwater samples collected from Site 9 were typically higher than those in background groundwater samples. The turbid sample caused by the HydroPunch™ sampler may be the cause for the higher total metals concentrations. The dissolved metals samples were similar to background ranges.

2.3.5 Characterization of SSA 4

2.3.5.1 Background for SSA 4

SSA 4 is located in the eastern portion of WPNSTA Yorktown near the intersection of Bypass Road and Main Road. This area lies on the north side of Bypass Road on a steep embankment that drains to Roosevelt Pond (see Figure 2-5). The area adjacent to Bypass Road consists of fill material and debris presumably placed to accommodate the construction of Bypass Road. SSA 4 was discovered and inspected by WPNSTA Yorktown personnel in December 1991. The approximate one-acre site was used as a disposal area for batteries, depth charges and underwater mine casings, World War II weapon casings, construction debris, cans, and other waste materials. All ordnance casings at SSA 4 are believed to be empty or inert. The Explosives Ordnance Disposal (EOD) at WPNSTA Yorktown conducted a preliminary review and established that these casings are inert and/ or empty. Five- and 55-gallon drums, some containing solid materials, were also disposed at this location. Surface water from Bypass Road (in addition to surface water from other areas) flows through the disposal area via drain pipes. The drain pipes emerge on the north side of the SSA 4 fill area at a drainage outfall. The outfall empties into a drainage way that conveys the surface water to Roosevelt Pond. Scattered waste materials line the drainage way. A Site Visit Report for SSA 4 is contained in Appendix A.

A sample of hardened yellow substance was removed from one of the 55-gallon drums and analyzed by WPNSTA Yorktown personnel using X-ray fluorescence (XRF). The yellow

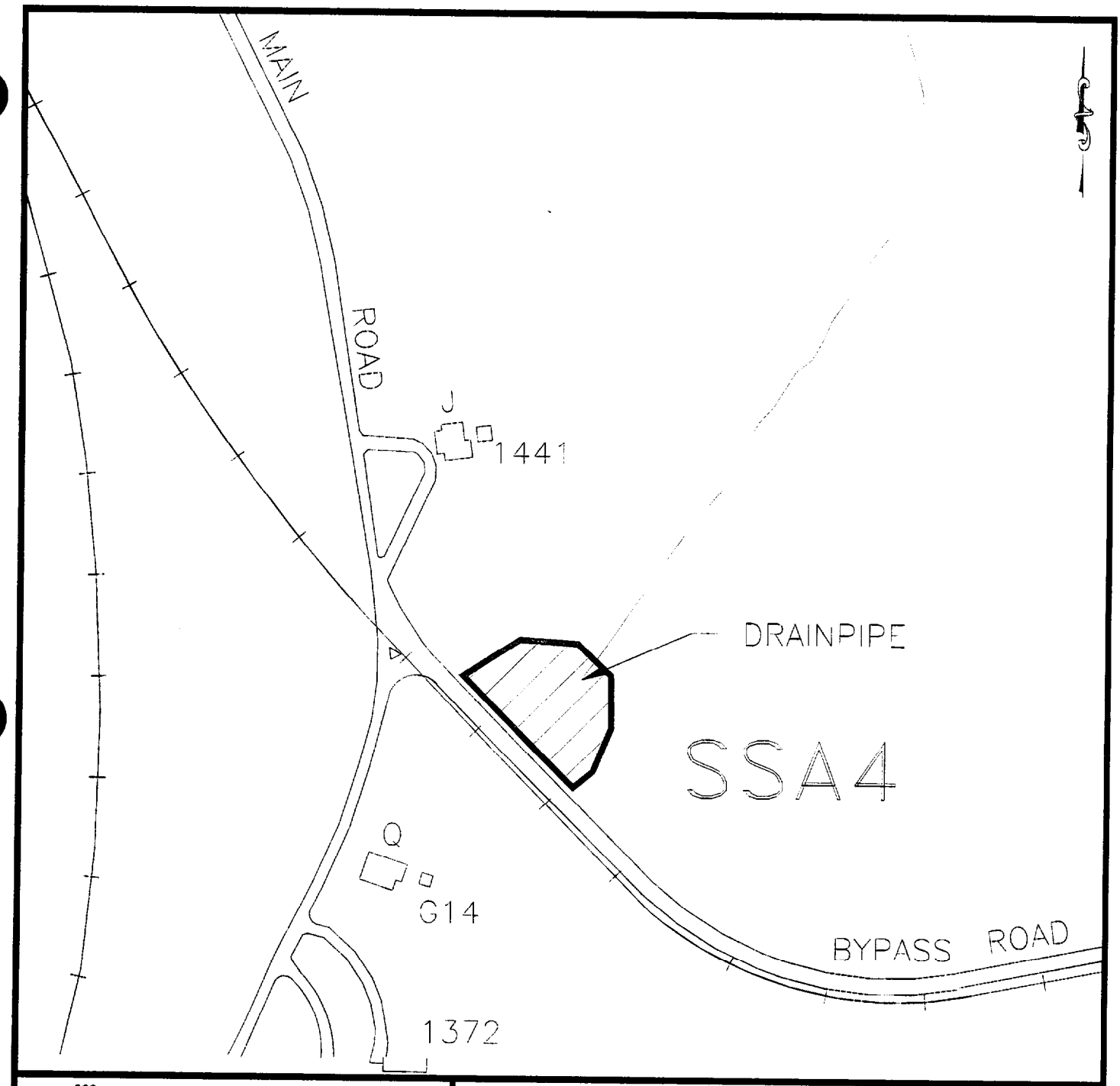
substance is believed to be yellow "stripe" paint which in the past was used to mark bombs. The analysis showed a composition containing zinc, chromium, and iron.

2.3.5.2 Surface Water and Sediment Sampling

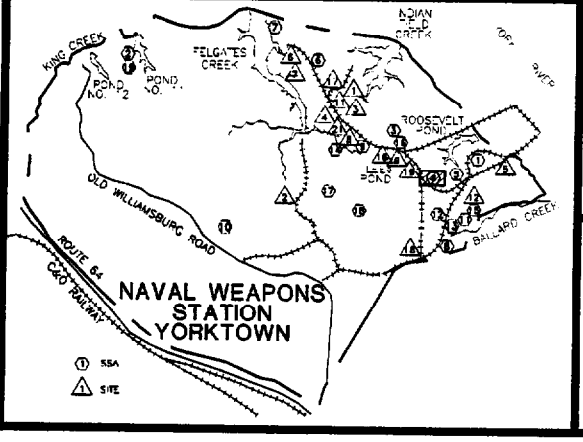
Surface water and sediment samples were collected by the Commonwealth of Virginia at SSA 4 on 19 March 1993. These results, presented in Appendix E, did not indicate the presence of any compounds above the detection limit.

2.4 STREAMLINED RISK EVALUATION

The results of previous investigations indicate that various contaminants, including metals, VOCs, explosives, and/or BNAs, have migrated to soils, sediments, surface water drainage ways, and groundwater located in the vicinity of Sites 2 and 9. These results indicate that waste materials such as mercury and zinc-carbon batteries, electrical equipment, and drums have potentially released contaminants into the environment. Although no sampling investigations were performed as part of the RI activities or previous studies in the vicinity of SSA 4, with the exception of limited surface water and sediment sampling performed by the Commonwealth of Virginia, waste materials disposed there may have caused or could in the near future cause similar contaminant releases to the environment. The removal actions at Sites 2 and 9 and SSA 4 are intended to address the surficial debris disposed at these sites. The various types of debris (e.g., drums, scrap metal, wood, mine casings, etc.) present at Sites 2 and 9 and SSA 4 pose potential physical hazards to station personnel and ecological receptors through incidental contact. In addition, the potential for environmental contamination exists upon the continued presence of these waste materials at these locations. Therefore, the removal of the surficial wastes at Sites 2 and 9 and SSA 4 would permanently eliminate physical hazards to human health and the environment, and would remove potential sources of environmental contamination from the surfaces of these areas.



200 0 100 200
1 inch = 200 ft.



BOUNDARY
DRAINAGE
EDGE OF PAVEMENT
MARSH
RAILROAD
FENCE
STRUCTURE

SITE SCREENING AREA

709-500

FIGURE 2-5
SSA 4
WEAPONS CASING/DRUM DISPOSAL AREA

NAVAL WEAPONS STATION YORKTOWN YORKTOWN, VIRGINIA

SECTION 3

IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

This section identifies the objectives for the proposed removal actions at Sites 2 and 9 and SSA 4. The potential ARARs developed as part of the RI activities at these locations are presented, along with other criteria specifically applicable to the removals discussed in this EE/CA. The purpose, scope, and scheduling requirements for implementation of the selected removal action alternatives are also described in this section in order to delineate any limits of performance of removal actions described in this EE/CA based upon time, budget, technical feasibility, and relevant criteria and standards.

For the RI/FS activities currently underway at WPNSTA Yorktown, the EPA has been identified as the lead regulatory agency, with the Virginia Department of Environmental Quality (VDEQ) and the TRC members playing a major role in directing the RI/FS process. However, the Navy is the lead agency for the removal actions as described in this EE/CA. Therefore, statutory limits regarding the cost and duration of removal actions that are federally driven are not applicable to the removal actions discussed in this EE/CA.

3.1 REMOVAL ACTION OBJECTIVES

The removal action objectives for Sites 2 and 9 and SSA 4 consist of:

- The elimination of physical hazards present at the three locations due to the surficial waste materials (e.g., telephone poles, drums, railroad ties, and mine casings).
- The removal of potential sources of environmental contamination at the surface of these disposal areas (e.g., drums and batteries).

These removal action objectives will be achieved by working within the specified project schedule and by attaining ARARs to the extent practicable.

3.2 ARARs

SARA mandates in Section 121(d) that site remediation under CERCLA comply with the requirements of all applicable or relevant and appropriate federal and commonwealth environmental and public health laws. For the removal actions to be performed, ARARs will be considered to the extent practicable, as described in NCP 300.415(i). These are known as the ARARs for the site or the site screening area. Applicable requirements are specific to the conditions present on the site for which all jurisdictional prerequisites of the law or requirements are satisfied. Relevant and appropriate requirements are those that do not have jurisdictional authority over the particular circumstances at the site but are meant to address similar situations and, therefore, are suitable for use at the site. The determination of applicability or relevance and appropriateness is made by EPA and the responsible commonwealth authority on a case-by-case basis.

ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs are particular to individual contaminants. Location-specific ARARs depend upon the location of the contamination and potential restrictions on activities conducted in these areas (i.e., wetlands, floodplains, etc.). Action-specific ARARs, as the name implies, govern the remedial actions. Action-specific ARARs are usually technology- or activity-based directions or limitations that control actions taken at CERCLA sites. A list of chemical-specific ARARs is presented in Table 3-1. Location- and action-specific ARARs are discussed in Subsections 3.1.2 and 3.1.3, respectively.

A partial list of potential ARARs is presented in the preamble to the NCP as amended in March 1990. Additional ARARs and To-Be-Considered criteria (TBCs) have been added during a thorough search of federal and commonwealth environmental requirements and advisories. Examples of the potentially applicable federal ARARs and TBCs for this EE/CA are presented in the following subsections. The Commonwealth of Virginia has adopted many of the federal standards as state-specific standards. Therefore, many of the examples presented here reflect both federal and commonwealth ARARs and TBCs.

Table 3-1

Summary of Chemical-Specific ARARs (μg/L)

Contaminants	Federal						Commonwealth of Virginia			
	Safe Drinking Water Act			Clean Water Act			Water Quality Standards			
	MCL[a]	PMCL[b]	SMCL[c]	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Ingesting Organisms	VGS	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Fish Consumption
Purgeable Organics										
Benzene	5	--	--	--	--	71[1,3]	--	--	--	710
Toluene	1,000	--	--	--	--	200,000[1]	--	--	--	200,000
Ethylbenzene	700	--	30	--	--	29,000[1]	--	--	--	29,000
Carbon Tetrachloride	5	--	--	--	--	4.4[1,3]	--	--	--	45
Chlorobenzene	100	--	--	--	--	21,000[1,7]	--	--	--	990
1,2-Dichloroethane	5	--	--	--	--	99[1,3]	--	--	--	--
1,1,1-Trichloroethane	200	--	--	--	--	**	--	--	--	--
1,1-Dichloroethylene	7	--	--	--	--	3.2[1,3]	--	--	--	--
1,2-Dichloropropane	5	--	--	--	--	--	--	--	--	--
Methylene Chloride	5	--	--	--	--	1,600[1,3]	--	--	--	--
Tetrachloroethylene	5	--	--	--	--	8.85[3]	--	--	--	3,519
Trichloroethylene	5	--	--	--	--	81[3]	--	--	--	807
Vinyl Chloride	2	--	--	--	--	525[3]	--	--	--	5,250
Styrene	100	--	--	--	--	--	--	--	--	--
Xylenes (Total)	10,000	--	20	--	--	--	--	--	--	--
Base/Neutral Extractable Organic Compounds										
Bis(2-ethylhexyl)phthalate	6	--	--	--	--	5.9[1,3]	--	--	--	59
Butyl Benzyl Phthalate	--	100	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	600	--	10	--	--	17,000[1]	--	--	--	17,000
Hexachlorocyclopentadiene	50	--	8	--	--	17,000[1,7]	--	--	--	--
Acid Extractable Organics										
Phenols	--	--	--	--	--	4,600,000[1,7]	1	--	--	--
Explosives										
2,4-Dinitrotoluene	--	--	--	--	--	9.1[3]	--	--	--	91

Table 3-1

Summary of Chemical-Specific ARARs (μg/L)
(Continued)

Contaminants	Federal						Commonwealth of Virginia			
	Safe Drinking Water Act			Clean Water Act			Water Quality Standards			
	MCL[a]	PMCL[b]	SMCL[c]	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Ingesting Organisms	VGS	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Fish Consumption
Pesticides/PCBs										
Aldrin	--	--	--	--	--	0.00014[1,3]	0.003	0.3	0.13	0.0014
Gamma-BHC	0.2	--	--	0.08[5]	--	0.063[3]	0.01	0.08	0.01	25
4,4'-DDT	--	--	--	0.001[5]	0.001[5]	0.00059[1,3]	0.001	0.001	0.001	0.0059
Endrin	2	--	--	0.0023[5]	0.0023[5]	0.81[1,7]	0.004	0.0023	0.0023	0.81
Heptachlor	0.4	--	--	0.0038[5]	0.0036[5]	0.00021[1,3]	0.001	0.0038	0.0036	0.0021
Heptachlor Epoxide	0.2	--	--	0.0038[5]	0.0036[5]	0.00011[1,3]	0.001	--	--	--
Chlordane	2	--	--	0.0043[5]	0.004[5]	0.00059[1,3]	0.01	0.0043	0.0040	0.0059
Toxaphene	3	--	--	0.0002	0.0002	0.00075[1,3]	--	0.0002	0.0002	0.0075
PCBs	0.5			.014[5]	.03[5]	.000045[1,3]		0.014	0.030	0.0045
Metals										
Aluminum	--	--	200	--	--	--	--	--	--	--
Antimony	6	--	--	--	--	4,300[1]	--	--	--	--
Arsenic	50	--	--	190[10]	36[10]	0.14[1,3,9]	50	--	--	--
Barium	2,000	--	--	--	--	--	1,000	--	--	--
Beryllium	4	--	--	**	**	*	--	--	--	--
Cadmium	5	--	--	1.1[4,10]	9.3[10]	--	0.4	--	9.3	170
Chromium (Total)	100	--	--	--	--	--	50	--	--	--
Chromium (Hexavalent)	--	--	--	11[10]	50[10]	--	--	11	50	3,400
Copper	1,300*	--	1,000	12[4,10]	2.9[10]	--	1,000	--	2.9	---
Iron	--	--	300	--	--	--	300	--	--	--
Lead	15*	--	--	3.2[4,10]	8.5[10]	--	50	--	--	--
Manganese	--	--	50	--	--	--	50	--	--	--
Mercury	2	--	--	0.012	0.025	--	0.05	0.012	0.025	0.146
Nickel	100	--	--	160[4,10]	8.3[10]	--	--	--	8.3	4,583
Nitrates	10,000	--	--	--	--	--	5,000	--	--	--

Table 3-1

Summary of Chemical-Specific ARARs (μg/L) (Continued)

Contaminants	Federal						Commonwealth of Virginia			
	Safe Drinking Water Act			Clean Water Act			Water Quality Standards			
	MCL[a]	PMCL[b]	SMCL[c]	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Ingesting Organisms	VGS	Freshwater Chronic Level	Salt Water Chronic Level	Human Health - Fish Consumption
Metals (Continued)										
Selenium	50	--	--	5	71[10]	**	10	5.0	71	11,200
Silver	--	--	100	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	100,000	--	--	--
Thallium	2	--	--	--	--	--	--	--	--	--
TPH	--	--	--	--	--	--	1,000	--	--	--
Zinc	--	--	5,000	110[4,10]	86[10]	--	50	--	86	--
Miscellaneous										
Total Cyanides	200	--	--	5.2	1	220,000[1,7]	5.0	5.2	1.0	215,000
pH	--	--	6.5-8.5	--	--	--	6.5-9.0	--	--	--

Notes:

All concentrations presented are in μg/L, except for pH, which is presented in pH units.
[a]MCL - Maximum Contaminant Level.
[b]PMCL - Proposed Maximum Contaminant Level.
[c]SMCL - Secondary Maximum Contaminant Level.
[d]VGS - Virginia Groundwater Standards.
[e]Clean Water Act Ambient Water Quality Criteria - Applicable to Commonwealth of Virginia (56 FR 58442, 19 November 1991).
[f]Water Quality Standards promulgated by the Water Division of the Department of Environmental Quality (VR 680-14-1), effective 27 September 1989.
[1]Criteria revised to reflect current agency reference dose (RfD). The fish tissue bioconcentration factor from the 1980 criteria documents was retained in all cases.
[2]EPA's Office of Research and Development's Environmental Criteria and Assessment Office prepared draft updates of criteria documents for arsenic, copper, and selenium, which are used instead of IRIS for this rulemaking. These documents are included in the record for the Ambient Water Quality Criteria (56 FR58442, 19 November 1991).
[3]Criteria in the matrix based on carcinogenicity (10^{-6} risk).
[4]Freshwater aquatic life criteria for these metals are expressed as a function of total hardness (mg $CaCO_3$/L). Values presented based on a total hardness of 100 mg/L.
[5]Aquatic life criteria for these compounds were issued using the 1980 guidelines for criteria development. The values shown are final acute values.
[6]Applies to methyl mercury.
[7]No criteria for protection of human health from consumption of aquatic organisms (excluding water) were presented in the 1980 criteria or in the 1986 Quality Criteria for Water. Nevertheless, sufficient information was presented in the 1980 document to allow calculation of a criterion, even though the results of such a calculation were not shown in the document.
[8]The criteria for 1,2-dichloropropane have been developed using the MCL (56 FR 3526, 30 January 1991).
[9]The criteria refers to the inorganic form only.
[10]Criteria for these metals are expressed as a function of the water effect ratio, as defined in 40 CFR 131.36(c).
*These values are action levels.
**EPA is not promulgating human health criteria for this contaminant.

3.2.1 Chemical-Specific ARARs

Chemical-specific requirements set health- or risk-based concentration limits or discharge limitations on various environmental media for specific hazardous substances, pollutants, or contaminants. These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or indicate a safe level of discharge that may occur during a remedial activity. The chemical-specific ARARs and TBCs are presented in Tables 3-1 through 3-3. There are no known chemical-specific ARARs for debris that would be relevant to this EE/CA.

For the proposed removal actions at Sites 2 and 9 and SSA 4, surface water standards are applicable. Specifically, the federal CWA and Commonwealth of Virginia water quality standards salt water chronic levels pertain to the surface water at Site 2. The federal CWA and Commonwealth of Virginia water quality standards freshwater chronic levels pertain to the surface water at Site 9 and SSA 4. Erosion and sedimentation (E&S) controls, as specified in Section 4 of this EE/CA, will be implemented at the disposal areas to prevent potentially contaminated runoff from entering surface water during and following removal actions. Groundwater ARARs have been included to evaluate the possible impact to groundwater from the contaminant sources at these locations.

Clean Water Act (CWA)

A Virginia Pollutant Discharge Elimination System (VPDES) Permit (VR 680-14-01) may be required if the selected remedy includes off-site discharging to surface water. The best available technology (BAT) that is economically achievable must be used.

The provisions of 40 Code of Federal Regulation (CFR) 131 (CWA) state that remedial actions shall attain federal surface water quality criteria where they are relevant and appropriate. Federal surface water quality criteria documents have been published for 65 pollutants listed as toxic under the CWA. These criteria became enforceable on 5 February

Table 3-2

NOAA Sediment Screening Values*

Analyte	ER-L[a] Concentration	ER-M[b] Concentration	AET Concentrations[c]
BNA (µg/kg)			
Acenaphthene	150	650	150
Anthracene	85	960	300
Benzo(a)anthracene	230	1,600	550
Benzo(a)pyrene	400	2,500	700
Chrysene	400	2,800	900
Dibenzo(a,h)anthracene	60	260	100
Fluoranthene	600	3,600	1,000
Fluorene	35	640	350
2-Methylnaphthalene	65	670	300
Naphthalene	340	2,100	500
Phenanthrene	225	1,390	260
Pyrene	350	2,200	1,000
Total PAHs	4,000	35,000	22,000
Pesticides/PCBs (µg/kg)			
Total PCBs	50	368	370
4,4′-DDT	1	7	6
4,4′-DDD	2	20	NSD[d]
4,4′-DDE	2	15	NSD[d]
Chlordane	0.5	6	2
Dieldrin	0.02	8	None
Endrin	0.02	45	NSD[d]
Metals (mg/kg)			
Antimony	2	25	25
Arsenic	33	85	50
Cadmium	5	9	5
Chromium	80	145	None

Table 3-2

NOAA Sediment Screening Values*
(Continued)

Analyte	ER-L[a] Concentration	ER-M[b] Concentration	AET Concentrations[c]
Copper	70	390	300
Lead	35	110	300
Mercury	0.15	1.3	1
Nickel	30	50	NSD[d]
Silver	1	2.2	1.7
Zinc	120	270	260

Notes:

*These values are provided as guidance and do not represent official NOAA standards.
[a]Effects Range - Low.
[b]Effects Range - Median.
[c]Apparent Effects Threshold.
[d]Not sufficient data.

Table 3-3

Drinking Water Health Advisories for Explosive Compounds

Explosive Compound	Health Advisory Concentration* (μg/L)
2,4-Dinitrotoluene	100
2,6-Dinitrotoluene	40
HMX	2,000
RDX	100
2,4,6-TNT	20

Note:

*Concentration based on a drinking water equivalent level. This is a lifetime exposure concentration protective of adverse, noncancer health effects, that assumes all of the exposure to a contaminant is from a drinking water source.

1993 and may be used by states to set surface water quality standards. Although these concentrations are intended to represent reasonable levels of pollutant concentrations consistent with the maintenance of designated water uses, states may appropriately modify these values to reflect local conditions.

Surface water quality levels are generally provided for different surface water use designations. Concentrations are specified that, if not exceeded, should protect most aquatic life against acute toxicity or chronic toxicity (24-hour average). For many chemical compounds, specific criteria have not been established because of insufficient data.

The Ambient Water Quality Criteria (40 CFR 129) require that the concentration of a toxic pollutant in navigable waters will not result in adverse impact on important aquatic life, nor on consumers of aquatic life, after exposure of that aquatic life to the pollutant for a period of time exceeding 96 hours and continuing through at least one reproductive cycle. These federal criteria were adopted, with revisions, by the Commonwealth of Virginia. Both criteria are included in Table 3-1.

Virginia Surface Water Standards

The Commonwealth of Virginia has established its own standards for surface water, which are presented in Table 3-1 along with the EPA CWA levels.

Safe Drinking Water Act (SDWA)

National Primary Drinking Water Standards (see Table 3-1) (40 CFR 141), MCLs, are applicable where the water will be provided to 25 or more people or to 15 or more service connections. When this occurs, the MCLs are the maximum levels allowed at the tap. In other cases, MCLs are relevant or appropriate for comparison to concentrations found in groundwater and, in some cases, surface water if the surface water is used as a source of drinking water.

MCL Goals (40 CFR 141) are the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. MCL Goals are not federally enforceable.

Secondary Drinking Water Standards (40 CFR 143), Secondary MCLs (SMCLs), apply to contaminants that primarily affect the aesthetic quality of drinking water and are not federally enforceable.

Virginia Groundwater Standards (VGS)

The Commonwealth of Virginia has established its own standards for groundwater, which are presented in Table 3-1 along with the EPA MCL, the Proposed MCL (PMCL), and the SMCL for most contaminants.

3.2.2 Location-Specific ARARs

Location-specific ARARs set restrictions on remedial action activities depending on the characteristics of the area and/or its surrounding environments. Location-specific ARARs may include restrictions on remedial actions occurring within wetlands and floodplains, near locations of known endangered species, or on protected waterways. These restrictions are discussed under "Other Potential ARARs or Guidelines TBC" in Subsection 3.4.

3.2.3 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based requirements or limitations taken with respect to hazardous wastes. WPNSTA Yorktown is required to follow the Navy's Installation Restoration (IR) Program. The Navy's IR Program details some factors that need to be considered in determining the appropriateness of a removal action. Discussion of these factors and how they relate to each removal alternative is contained in Subsections 5.2.2.1 and 5.3.2.1 of this EE/CA. Action-specific ARARs pertinent to the alternatives evaluated are discussed in Section 5 of this EE/CA.

Toxic Substances Control Act (TSCA)

Disposal of PCBs (40 CFR 761) is applicable if the remedy involves excavation of soils that contain PCBs.

Resource Conservation and Recovery Act (RCRA)

In general, the applicable solid waste requirements will be action-specific, applying to the remedial activities undertaken. The following are some examples of RCRA requirements (40 CFR 265) that may be applicable or relevant and appropriate:

General Waste Treatment (40 CFR 264 and 265): Although standards do not yet exist for general waste treatment in new facilities, standards do exist for interim status facilities (40 CFR 265, Subpart O) and include specific requirements for ignitable and reactive wastes. The interim status requirements may be relevant and appropriate if the treatment is performed on-site.

Incineration (40 CFR 265, Subpart O): This subpart includes performance standards for incinerators and monitoring, inspection, and operating requirements.

Land Disposal Restrictions (40 CFR 268): This part describes general requirements that must be met to dispose of a waste at a RCRA landfill.

Storage (40 CFR 265, Subparts I and J): These two subparts include standards for the storage of hazardous waste in containers (Subpart I) and tanks (Subpart J).

Site Closure With Waste In Place (40 CFR 264 and 265, Subpart G): Certain sections of both 40 CFR 264 and 265 may be relevant and appropriate if the waste is to be left in place. This could include capping, installation of slurry walls, grading and covering with vegetation, or consolidation of substances in one location. Subpart G of both 264 and 265 provides technical requirements for closure and post-closure activities.

Groundwater Monitoring (40 CFR 265, Subpart F): This subpart provides RCRA groundwater corrective action requirements that may be relevant or appropriate at the facility. These requirements include groundwater monitoring and groundwater protection standards.

Virginia Hazardous Waste Management Regulations (VHWMR)

Because Virginia administers an authorized state RCRA program, the Virginia Hazardous Waste Management Regulations (VHWMR) are applicable in lieu of the RCRA Regulations covered in 40 CFR 264-265. The Land Disposal Restrictions, 40 CFR 268, are still applicable.

Clean Air Act (CAA)

The substantive requirements of an emissions permit (40 CFR 50) would be required to be met if remedial activities have the potential for airborne discharges from the site. The BAT that is economically feasible must be used.

3.3 TBC CRITERIA

In addition to legally binding laws and regulations, federal and state environmental and public health programs issue unenforceable advisories or guidance that are not legally binding. These TBCs are evaluated along with ARARs. TBCs can include health advisories, reference doses and potency factors, proposed rules, guidance materials, or policy documents. When evaluating TBCs, professional judgement is required based upon the latest available information.

National Oceanic and Atmospheric Administration (NOAA)

Sediment screening values have been used as part of the data evaluation at WPNSTA Yorktown based on NOAA guidance. These criteria are useful as a preliminary screening

of sediments containing concentrations of chemicals whose presence may indicate a potential ecological risk. Three levels of criteria are provided, as shown in Table 3-2. The Effects Range-Low (ER-L) criteria are those concentrations at which 10% of the population would be expected or predicted to show adverse effects. The Effects Range-Median (ER-M) concentrations indicate levels at which approximately half of the population would be expected to show effects. These levels do not necessarily indicate that an ecological risk is present. The ER-L and ER-M guidance concentrations represent the concentrations at which 10% and 50%, respectively, of a study group showed evidence of adverse impact from these compounds. The Apparent Effects Threshold (AET) is the value at and above which adverse biological impacts are always predicted to occur.

The EPA Office of Water has published drinking water health advisories for explosive compounds that may serve as potential guidance values for explosive compound concentrations in the groundwater at WPNSTA Yorktown. Table 3-3 contains a list of these compounds and their associated values.

Risk-Based Concentrations

EPA Region III has developed risk-based screening levels for various compounds in several media. These values are concentrations of contaminants that have been calculated based upon assumptions as stated in the "Risk Assessment Guidance for Superfund (RAGS), Part A" (EPA, 1989), and equated to either a 10^{-6} excess lifetime cancer risk or a hazard quotient equal to 0.1 for carcinogenic and noncarcinogenic compounds, respectively. Appendix D provides a copy of the risk-based concentrations that will be considered as part of the removal actions described in this EE/CA.

3.4 OTHER POTENTIAL ARARS OR GUIDELINES TBC

Other potential ARARs or guidelines TBC include:

- Virginia Solid Waste Management Regulations (VR 672-20-10) — These regulations govern the classification and disposal requirements for solid waste.

- Groundwater Classification for Aquifers Underlying the Sites (EPA, 1986) — This ARAR is not considered applicable for the current removal actions since none of the removal actions include excavations or other activities that would impact groundwater.

- Occupational Safety and Health Administration (OSHA) Requirements for Hazardous Waste Workers (29 CFR 1910.20) — These regulations provide safety requirements for hazardous waste workers. This regulation is applicable to the removal actions proposed under this EE/CA.

- Department of Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR 107 and 171) — These regulations govern the rules for the transportation of hazardous materials. For the removal actions, the hazardous materials may include solvents, other chemicals, and environmental samples (although they may not be classified as hazardous).

- Regulations Pertaining to Activities That Affect the Navigation of Waters of the United States (33 CFR 320-329) — None of the activities to be conducted under the removal actions are anticipated to affect navigable waters.

- Endangered Species Act (50 CFR 81, 225, and 402) — The Endangered Species Act was enacted to protect endangered and threatened species and their habitats. The appropriate state agencies will be contacted by VDEQ in its role as ARAR coordinator to confirm that no federal- or state-listed species have been identified in these areas.

- Fish and Wildlife Conservation Act (50 CFR 83) — The Fish and Wildlife Conservation Act requires the protection of fish and wildlife by limiting actions that will alter or modify streams. The removal actions proposed in this EE/CA do not include modification of streams.

- Wild and Scenic Rivers Act (36 CFR 297) — This act protects the aesthetic quality of rivers. As stated above, no stream-impacting activities are planned as part of the removal actions.

- Drinking Water Health Advisory: Munitions - A Health Advisory on Munitions Chemicals (EPA, 1992) — This document provides laboratory studies of the effects of munitions in drinking water on animals.

- Virginia Wetlands Act (Code of Virginia, Sections 62.1-13.1 et seq.) — This act protects wetlands from being adversely altered or destroyed. Some of the activities at Site 2 will require working in wetland areas. The appropriate state agencies will be notified by VDEQ to evaluate the proper measures for the protection of wetlands.

- Virginia Wetlands Regulations (VR 450-01-0051) — As stated above, some of the removals at Site 2 may require activity in wetland areas. The Virginia Wetlands Regulations will be referred to for proper compliance.

- Wilderness Act (16 USC 1131 et seq.; 50 CFR 35.1 et seq.) — The Wildlife Act establishes nondegradation, maximum restoration, and protection of wilderness areas as primary management principles. These guidelines will be taken into consideration for the restoration of the sites.

- Coastal Zone Management Act (16 United States Code (USC) Section 1451 et seq.) — The Coastal Zone Management Act requires activities affecting land or water uses in a coastal zone to certify noninterference with coastal zone management, through compliance with approved state management programs. The Virginia Coastal Zone Management Office will be contacted by VDEQ to ensure compliance with their established guidelines.

- National Historic Preservation Act (36 CFR 800) — This act requires that the removal actions take into account effects on properties included in or eligible for the National Register of Historic Places and to minimize harm to National Historic Landmarks. The proposed removal actions at Sites 2 and 9 and SSA 4 are not located on currently listed properties. The State Historic Preservation Office will be contacted by the Navy to obtain a list of historic places to identify any historic landmarks/properties in the vicinity of these three sites.

- Chesapeake Bay Preservation Act (Code of Virginia, Sections 10.1-2100 et seq.) — This regulation covers activities that may impact the Chesapeake Bay or its tributaries. The removal action for the three sites will not impact such waters.

- Floodplain Management and Protection of Wetlands (40 CFR Part 6, Appendix A) — These requirements mandate action to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands to the extent possible. All removal actions will include measures to minimize impacts on wetlands.

These ARARs will be considered as applicable in this EE/CA and will be discussed further in the FS. Complete development of groundwater ARARs is not applicable for this removal action, but will be addressed in the FS.

3.5 REMOVAL ACTION SCOPE AND SCHEDULE

The removal scope for this EE/CA covers Sites 2 and 9 and SSA 4. The soils, groundwater, surface water, and/or sediment at Sites 2 and 9 contain contaminants and waste materials, as previously described in Section 2 of this EE/CA, that, for the most part, are a direct result of past waste disposal practices at WPNSTA Yorktown. Although sampling investigations were not performed for SSA 4, waste materials disposed there may have caused or could in the near future cause similar contaminant releases to the environment. Investigation and characterization activities indicate that the waste materials at the three disposal areas pose a potential threat to human health and the environment.

These waste materials constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to some contaminant migration due to surface runoff; their removal will reduce this problem. The removal alternative that will be developed should lessen the [redacted] from the waste materials by requiring completion of the waste removal activities within 1 year.

The remedial objectives of this EE/CA include the following:

- Removal, treatment (if necessary), recycling, and/or final disposal of the surficial/exposed and possibly subsurface waste materials, which consist of zinc-carbon batteries, drum containers and contents, scrap metal (including missile hardware and weapons casings), electrical equipment, railroad ties, and construction debris/tree stumps.
- Temporary containment/control such as berms and diversion ditches to control surface runon into the excavations and hay bales and silt fences to control runoff from the excavations will be installed by the Remediation Contractor with the approval of an E&S Plan by WPNSTA Yorktown.
- Site restoration, including regrading (as deemed necessary) and revegetation.

- Confirmation sampling of selected areas where removals are conducted; sampling should be of sufficient quantity/quality as to support a baseline/ ecological risk assessment.

This removal is considered to be a partial remediation. Soils, groundwater, sediments, and surface water contamination identified in previous reports and remaining subsurface waste materials/debris will not be addressed at this stage; remediation of these media will be considered further in the WPNSTA Yorktown RI/FS program. Activities for this partial removal action will be completed within 1 year of startup. It is the responsibility of the Remediation Contractor to provide to WPNSTA Yorktown personnel a detailed schedule and timeline for the completion of each task as part of the Work Plan submitted for approval. Approximate durations for the major tasks are included in the discussion of alternative implementability (see Subsections 5.2.2.6 and 5.3.2.6 of this EE/CA).

Decommissioning of the weapons casings at Sites 2 and 9 and SSA 4 will be conducted by the WPNSTA EOD; therefore, this step in the removal and disposal of the weapons casings will not be included with the cost estimates of the removal alternatives in this EE/CA.

SECTION 4
IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

Based upon the objectives developed in the previous section of this EE/CA, removal actions and technologies that may be appropriate for addressing the cleanup objectives are identified in this section. These removal actions and technologies, termed response actions in the following subsections, are evaluated based on their ability to meet the removal objectives, and if found appropriate, are combined to form alternatives in Section 5. In identifying response actions, previous experience with the technologies, as well as knowledge of potential uses of the technologies, are considered. Information from previous investigations and site visits conducted at Sites 2 and 9 and SSA 4 is used to determine whether a particular removal action is suitable to the type, quantity, and location of the waste materials.

Alternatives were eliminated if they did not meet four fundamental characteristics. The following four screening factors were considered when evaluating an alternative removal action:

- The feasibility of the technology.
- The acceptability of the technology in light of institutional considerations.
- The human health and environmental protection provided by the technology.
- The ability of the technology to produce the desired results within the short-term.

As noted in Sections 2 and 3 of this EE/CA, there are numerous chemical-, location-, and action-specific concerns relating to human health and environmental issues. It is assumed, for purposes of this EE/CA, that removal (full or partial) of the waste materials will lessen the concern of a contaminant release. Waste materials on the three disposal areas include scrap metal, weapons casings, batteries, construction debris, 5- and 55-gallon drums, railroad ties, electrical equipment, etc. Therefore, the primary goals of the removal alternative are the removal, treatment (if necessary), recycling, and final off-site disposal of surficial waste

materials. For the purpose of this section's response action identification and evaluation, the alternatives were considered to be protective of human health and the environment if the action resulted in the removal, treatment, and final disposal of, at a minimum, the surficial waste materials at Sites 2 and 9 and SSA 4.

General response actions have been identified for Sites 2 and 9 and SSA 4 based on the information and data presented and discussed in the previous sections of this EE/CA. Nine general response actions and their applicability to the removal of the waste materials at these locations are presented in Table 4-1. When removal of "associated soils" from the area is proposed in a response action, it is assumed that removal concerns only the soils disturbed during or associated with the removal of the waste materials. According to EE/CA guidance, alternative technologies that have not been proven or developed to the commercial scale are not considered as viable response actions for removals and therefore are not included here.

Response Action 1 (No Action) and Response Action 2 (Interim Controls and Monitoring) will not be considered for screening because they do not meet the main objective, which is to remove the accessible waste materials from Sites 2 and 9 and SSA 4. The remaining seven general response actions are evaluated in the following subsections and are summarized in Table 4-2.

4.1 REMOVAL OF SURFICIAL WASTE MATERIALS

The removal of surficial waste materials and their associated soils is conducted under this response action. The surficial waste materials and their associated soils will be removed by hand or heavy equipment. Surficial removal assumes removal of the waste material to a maximum depth of 1 ft below ground surface (bgs). If a large piece of debris is partially buried at a depth greater than 1 ft bgs, the entire piece of debris is removed but no further vertical excavation will be conducted even if waste materials are visible below the 1 ft bgs elevation. Precautions will be taken to minimize contaminant releases from punctured

Table 4-1

Identified General Response Actions
Sites 2 and 9 and SSA 4
WPNSTA
Yorktown, Virginia

Response Action	Applicability
1. No Action	---
2. Interim Controls and Monitoring	---
3. Removal of Surficial Waste Materials	X
4. Complete Removal of Waste Materials	X
5. Selective Removal of Waste Materials	X
6. Off-Site Disposal	X
7. Off-Site Treatment	X
8. On-Site Treatment	X
9. Containment	X

Notes:

X = Applicable.
--- = Not applicable.

Table 4-2

Response Actions Summary
Sites 2 and 9 and SSA 4
WPNSTA
Yorktown, Virginia

Response Action	Associated Technology
Removal Alternatives	
1. Removal of Surficial Waste Materials	• Excavation of Surficial Waste Materials and Their Associated Soils at Sites 2 and 9 and SSA 4; Interim E&S Controls
2. Complete Removal of Waste Materials	• Excavation of Both Surface and Subsurface Waste Materials and Their Associated Soils at Sites 2 and 9 and SSA 4; Interim E&S Controls
3. Selective Removal of Waste Materials	• Excavation and Separation of Surficial Waste Materials at Sites 2 and 9 and SSA 4; Complete Removal of Batteries and Their Associated Soils at Site 2 and SSA 4; Interim E&S Controls
Treatment Alternatives	
4. Off-Site Disposal	• Secure Landfill
5. Off-Site Treatment	• Incineration, Composting, Stabilization, Biological Treatment, Recycling
6. On-Site Treatment	• Incineration, Composting, Stabilization, Biological Treatment
7. Containment	• Soil Covers/Capping

drums, batteries, or electrical equipment during removal activities. This alternative includes the removal of all identified surficial waste materials with little or no separation of the waste materials from their associated soils. Removals under this alternative are in accordance with the following guidelines and restrictions:

- Drums located on the surface of each of the sites will be emptied, if necessary, opened on both ends, and crushed prior to disposal. Any liquids that are encountered in drums will be removed from the drums and placed in clean, new drums. These liquids will be tested to determine their composition, and then will be disposed accordingly. Drums found containing nonsolidified materials will be rinsed; all rinsate will be collected in a new (e.g., clean drum set aside for these types of liquids) liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the surficial identified waste materials have been removed from the site. The drummed rinsate will be disposed appropriately, based on analytical results. The drum removal is a surficial removal only. Surficial removal limits are based on field observations.

- The remaining surficial waste materials (i.e., batteries, scrap metal, wood, construction debris, railroad ties, electrical equipment, weapons casings, etc.) and associated soils will be removed from the surface of Sites 2 and 9 and SSA 4 to a depth not to exceed 1 ft bgs. Confirmatory sampling is conducted under this response action (to provide information on the residual soils) for the waste materials and drum disposal areas. These samples will be analyzed for VOCs, BNAs, metals, cyanide, explosives, pesticides/PCBs, and TPH. Surficial removal limits are based on field observations.

- Separation of the waste materials from the associated soils at Sites 2 and 9 and SSA 4 will not be conducted under this alternative. All soils displaced during removal activities at the sites will be disposed of with the appropriate waste materials. Separation of selected waste materials from the general waste may be necessary based on the disposal option chosen.

During removal activities at the three disposal areas, E&S controls, such as diversion ditches, berms, hay bales, and/or silt fencing, will be installed and maintained. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials and drums to inhibit the infiltration of surface water into the subsurface. Regrading will be performed, where applicable, to limit the amount of fill that may need to be removed during subsequent final remedial actions.

Surficial removal of the drums and the remaining waste materials reduces the potential for [redacted] personnel or civilians coming in contact with any harmful debris scattered on the surface of Sites 2 and 9 and SSA 4. Surficial removal provides an immediate benefit to human health as well as an achievable removal goal within the short-term. Full removal or treatment of the contaminated groundwater, soils, sediment, and surface water may be addressed at the disposal areas during the WPNSTA Yorktown RI/FS program.

Based on the above discussion, the removal of surficial waste materials will be retained for further consideration.

4.2 COMPLETE REMOVAL OF WASTE MATERIALS

The complete (surface and subsurface) removal of waste materials (batteries, construction debris, weapons casings, scrap metal, drums, etc.) and their associated soils at Sites 2 and 9 and SSA 4 would be conducted under this response. The identified waste materials and associated soils are removed by hand or heavy equipment. Precautions will be taken to minimize releases from punctured drums, batteries, or electrical equipment during removal activities. Since the exact condition and quantity of waste materials present at the sites have not been fully determined at this stage of WPNSTA Yorktown's RI/FS program, extensive scheduling and planning for long-term removal activities is required for this response. Removal will be conducted in accordance with the following guidelines:

- All surficial and subsurface waste materials (i.e., scrap metal, construction debris, batteries, electrical equipment, weapons casings, etc.) at Sites 2 and 9 and SSA 4 are completely removed under this removal action. Excavation boundaries for complete removal will continue to a depth and width to be determined in the field based on field observations and/or analytical results. Any water that enters the excavations will be pumped, temporarily stored, and sampled for HW characteristics and other analyses as required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or the disposal state's) regulations.

- Drums located at or below the surface of each of the locations will be emptied, if necessary, opened on both ends, and crushed prior to disposal.

Any liquids that are encountered in drums will be removed from the drums and placed in clean, new drums. These liquids will be tested to determine their composition, and then will be disposed accordingly. Drums found containing nonsolidified materials will be rinsed; all rinsate will be collected in a new liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the waste materials have been removed from the disposal area. The drummed rinsate will be disposed appropriately, based on analytical results.

- Separation of the waste materials from their associated soils will not be conducted. The soils displaced during debris removal will be disposed appropriately with the waste materials. Separation of selected waste materials from the general waste may be necessary based on the disposal option chosen.

Removal activities will continue until complete removal has been verified by field personnel. The complete removal response action includes testing and sampling of the soils, groundwater, surface water, and sediment prior to backfilling the excavations. Tests to detect subsurface batteries may include the use of geophysical methods such as an electromagnetic (EM) survey or magnetometry, trenching, and test pits. Sampling analyses at Sites 2 and 9 will be based on contaminant levels detected during the previous characterization and investigation activities conducted at the sites. At SSA 4, the selection of sampling parameters will be based on visual inspections and field observations. If results from this sampling show a need for further action, treatment alternatives such as groundwater treatment, soil stabilization, or additional excavation may be reviewed and implemented, in conjunction with the activities to be performed as part of the site screening process for SSA 4.

During removal activities at the three disposal areas, E&S controls such as diversion ditches, berms, hay bales, and silt fencing will be installed and maintained. All excavations will be backfilled using a fill material compatible with the surrounding soils. Regrading will be performed to limit the amount of fill material that may need to be removed during subsequent final remedial actions.

The complete removal of waste materials and associated soils does provide a benefit to human health and the environment. However, due to the length of time required to

perform complete removal, it is not beneficial in the short-term. This response action is not practical at this time because these three areas have not yet been fully characterized and the volume and extent of contaminated soils, groundwater, surface water, and sediment, as well as waste materials below the surface, are unknown. Furthermore, it is not certain that an action of this magnitude is warranted for these disposal areas. In addition, time and cost for complete removal with verification sampling cannot be accurately estimated at this stage of the RI/FS program. Full remediation of the contaminated groundwater, soils, sediment, and surface water may be considered at these locations during RI/FS activities.

Based on the considerations of time, cost, and need for human health benefits in the short-term, the complete removal response action will not be retained for further consideration.

4.3 SELECTIVE REMOVAL OF WASTE MATERIALS

For this response action, the extent of the removal (partial versus complete) of the waste materials is based on the specific material(s) in question. For purposes of this response action, surficial removal assumes removal of the waste material to a maximum depth of 1 ft bgs. If a large piece of debris is partially buried at a depth greater than 1 ft bgs, the entire piece of debris will be removed, but no further vertical excavation will be conducted even if waste materials are visible below the 1 ft bgs elevation. Removal of the selected wastes will continue in accordance with the following guidelines and limitations:

- The batteries, both surface and subsurface, and their associated soils at Site 2 and SSA 4 will be completely removed under this removal action. Excavation boundaries, for complete battery removal, will continue to a depth and width to be determined in the field based on field observation and/or testing. Prior to backfilling these excavated disposal areas, tests will be conducted to ensure complete removal. Testing will include the use of geophysical methods such as an EM survey or magnetometry, trenching, and test pits for the battery area excavations. Any water that enters the excavations will be pumped, temporarily stored, and sampled for HW characteristics and other analyses as required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or the disposal state's) regulations.

- Drums located on the surface of each of the disposal areas will be emptied, if necessary, opened on both ends, and crushed prior to disposal. Any liquids

that are encountered in drums will be removed from the drums and placed in clean, new drums. These liquids will be tested to determine their composition, and then will be disposed accordingly. Drums found containing nonsolidified materials will be rinsed; all rinsate will be collected in a new liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the surficial identified waste materials have been removed from the disposal area. The drummed rinsate will be disposed appropriately, based on analytical results. The drum removal is a surficial removal only. Surficial removal limits are based on field observations.

- The remaining surficial waste materials (i.e., scrap metal, wood, railroad ties, construction debris, electrical equipment, weapons casings, etc.) will be removed from the surface of the disposal areas to a depth not to exceed 1 ft bgs.

- Separation of the waste materials from their associated soils will be conducted. The soils displaced during debris removal will be staged in a lined, bermed staging area and tested for HW characteristics. The disposal of these soils will be determined based on these results. Separation of selected waste materials from the general waste may be necessary based on the disposal option chosen. Geophysical testing for subsurface batteries and confirmatory sampling are conducted under this response action. Surficial removal limits are based on field observations.

During removal activities at the three disposal areas, E&S controls such as diversion ditches, berms, hay bales, and silt fencing will be installed and maintained. Waste materials will be removed by hand or heavy equipment. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials and drums to inhibit the infiltration of surface water into the subsurface waste materials. The battery disposal excavations will be backfilled using a fill material compatible with the surrounding soils. Regrading will be performed, where applicable, to limit the amount of fill that may need to be removed during subsequent final remedial actions.

Complete waste removal of the batteries effectively eliminates the potential for additional contamination of the soils, groundwater, sediment, and surface water from these waste materials. Partial (surficial) removal of the drums and remaining waste materials also reduces the potential for further contamination of the surrounding environment, as well as

the likelihood of station personnel or civilians coming in contact with any harmful debris scattered on the surface of the sites. Partial removal provides an immediate benefit to human health, as well as an achievable removal goal within the short-term. Full removal or treatment of the contaminated groundwater, soils, sediment, surface water, and remaining wastes may be addressed at these locations during the WPNSTA Yorktown RI/FS program.

Based on the above considerations, the selective removal response action will be retained for further consideration.

4.4 OFF-SITE DISPOSAL

Off-site disposal includes the transportation and disposal of the contaminated materials to a secure landfill. Waste materials may need to be separated, depending on the contaminant(s) present.

4.4.1 Secure Landfill

Sanitary landfills are permitted to accept various waste materials, including commercial waste, construction waste, debris, demolition waste, discarded material, scrap metal, and nonregulated hazardous waste, by specific approval only. If the landfill is not permitted to accept specific materials, a special waste request must be submitted to the landfill and to VDEQ for approval prior to disposal of such materials. Sanitary landfills are not allowed to accept free liquids, regulated hazardous waste, and drums that have not been emptied and properly cleaned. There are five permitted sanitary landfills located near WPNSTA Yorktown.

Industrial landfills are generally permitted for the disposal of specific industrial wastes or wastes that are the by-product of a production process. Hazardous wastes, as defined by the Virginia Hazardous Waste Management Regulations, are not accepted.

Any wastes encountered (e.g., drum liquids) that may be considered a hazardous waste will be sampled to determine whether disposal under RCRA is required.

Off-site disposal in a secure landfill provides for protection of human health and the environment from the threat of additional releases from the waste materials and will be retained for further consideration.

4.4.2 Disposal Requirements

Analytical results must be submitted to the landfills receiving the wastes and a waste characterization form prepared. The waste characterization form generally includes a description of the waste, the waste quantity, the Toxicity Characteristic Leachate Procedure (TCLP) results, and the ignitability, corrosivity, and reactivity (ICR) results. As discussed below, VDEQ and the selected landfill must approve the disposal of special wastes into sanitary landfills. The approval process normally takes approximately 6 weeks.

The Virginia solid waste management facility (SWMF) designations are as follows:

- Sanitary Landfill: Sanitary landfills are permitted to accept various waste materials, including ash, commercial waste, construction waste, debris, demolition waste, discarded material, scrap metal, and nonregulated hazardous waste by specific approval only. If the landfill is not permitted to accept specific materials, a special waste request must be submitted to both the landfill and to VDEQ for approval prior to disposal of such materials. Sanitary landfills are not allowed to accept free liquids, regulated hazardous wastes, and drums that have not been emptied and properly cleaned.

  The disposal of special wastes requires approval by VDEQ and the selected landfill. Special wastes include asbestos waste, liquids, and drums. Other special wastes include discarded chemicals that are not regulated as hazardous wastes and hazardous materials associated with site cleanups. A listing of permitted private sanitary landfills near WPNSTA Yorktown that are permitted to accept special wastes is presented below:

  - Bethel Landfill (Permit No. 299) in Hampton, Virginia.
  - BFI Landfill (Permit No. 129) in Richmond, Virginia.
  - Chambers Landfill (Permit No. 531) in Richmond, Virginia.

- Construction/Demolition/Debris Landfill: These landfills can only accept construction wastes that are produced during the construction of structures, including lumber, wire, sheetrock, broken brick, shingles, glass, pipes, and concrete. Paints, coatings, solvents, asbestos, liquids, and garbage cannot be disposed at a construction debris landfill. Using the analytical results as an indication of the waste characteristics, and based on visual observation, materials at Sites 2 and 9 and SSA 4 cannot be disposed at a construction debris landfill.

- Industrial Waste Disposal Facility: Industrial landfills are generally permitted for the disposal of specific industrial wastes or wastes that are the by-product of a production process. Hazardous wastes, as defined by the Virginia Hazardous Waste Management Regulations, are not accepted. First Piedmont Landfill (Permit No. 65) in Chatham, Virginia, is an industrial landfill permitted to accept special wastes.

4.5 OFF-SITE TREATMENT

Off-site treatment methods that can be used as an alternative to off-site disposal include incineration, composting, stabilization, biological treatment, and recycling. Descriptions of these treatment technologies are presented in the subsections that follow.

4.5.1 Incineration

Incineration is a controlled process that uses combustion to convert a waste to a less bulky and/or less toxic material. Contaminated soils are excavated and combined with additives (if necessary), which in turn are heated in a rotary kiln or a multiple-hearth furnace. The incineration system includes the waste feed system, the kiln or furnace where combustion occurs, the auxiliary fuel feed system, an afterburner that destroys gaseous products produced within the incinerator, and air pollution control systems. The anticipated operating temperature for these units is approximately two-thirds as high as the contaminant's melting temperature. The noncombustible by-product is expected to exhibit extremely low leachability and remain stable in the environment. Incineration is a high-temperature process that has been proven to be effective in destroying even the most difficult to burn organic compounds.

This response action requires a separation of materials in the field during excavation. Applicable materials are then sent to an off-site permitted incinerator where test burns are conducted. Off-site incineration is a commercially available, practical method for removing some contaminants from soils and waste materials. As such, this response action will be retained for further consideration, particularly for contaminants that are banned from land disposal by EPA regulations (applicable if drums containing unknown liquids or land-banned contaminants are encountered).

4.5.2 Composting

Composting is a treatment technology in which contaminated soils are excavated and then degraded using a naturally occurring microbial process. Composting is a proven technology for achieving accelerated biodegradation of select industrial and municipal wastes under controlled conditions. Generally, there are three categories of compost systems: windrow, static pile, and in-vessel. In the windrow method, which is the most commonly used method, the mixture to be composted is piled in long rows (windrows) that are periodically turned by mechanical means to increase exposure of organic matter to oxygen. The static pile (forced aeration) approach utilizes a blower to aerate the mixture to be composted. The mixture is placed on a base of wood chips or other suitable material in which a network of aeration pipes has been constructed. Oxygen is then introduced by blowing or drawing air through the pile. In-vessel composting, which is currently being developed, occurs in closed containers where environmental conditions can be controlled.

The process flow is similar for all three composting systems. The material to be composted is mixed with a bulking agent or agents such as wood chips, straw, horse manure, sawdust, leaves, or paper. The bulking agent can serve as a source of carbon, nutrients, or microbes. In addition, it increases porosity and aeration. Once the mixture to be composted is in place, it undergoes a self-heating process caused by microbial activity. After composting, the treated material is usually cured for approximately 30 days. During this period, additional decomposition as well as stabilization, pathogen destruction, and degassing takes place.

Studies have shown that the majority of nitroaromatic and organic compounds can be biologically degraded by composting. Composting requires that separation of soils from their associated wastes be completed in the field during excavation. The composting technology is not appropriate for the waste materials (i.e., construction debris, batteries, scrap metal, drums, etc.). Composting could only be used on the soils separated from the waste materials at the disposal areas. The effectiveness of composting would first need to be verified by bench-scale and/or pilot-scale treatability studies. These studies can be costly and time consuming. Composting may also significantly increase the volume of material requiring final disposal. For these reasons, composting will not be retained for further consideration.

4.5.3 Stabilization

Stabilization is a treatment process used to immobilize waste constituents in a solid matrix through mixing with additives and binders (e.g., cement, lime, or thermosetting polymer). Application at Sites 2 and 9 and SSA 4 would involve the excavation and separation of contaminated soils from their associated waste materials and conversion of these soils into a solid mass that would immobilize leachable contaminants. Stabilization is a partial remedial measure. Stabilized materials must be properly disposed in an off-site permitted landfill that complies with applicable regulations.

Stabilization has been used successfully to immobilize waste materials; however, certain binding materials are sensitive to wastes containing organic compounds. Typically, wastes exhibiting organic compound concentrations in the 10% to 20% range are unsuitable for stabilization. Laboratory bench-scale and/or pilot-scale tests would be required to confirm the feasibility of stabilization and to determine the optimum binding materials for soils. Stabilization may also increase the final volume of material requiring disposal due to the addition of binding materials.

Because of the adverse effect that organic materials in the soils may have on the effectiveness of stabilization and the significant increase in volume of waste materials for disposal, stabilization will not be retained for further consideration.

4.5.4 Biological Treatment

Biological treatment is an innovative technology that, in recent years, has attracted much attention as a potentially inexpensive and efficient remediation alternative for many hazardous waste sites. The technology can be applied to both aqueous and soil matrices that have been contaminated with organic compounds. Biological treatment centers around biological degradation of the target compounds by microorganisms such as bacteria and fungi. Typically, the target compounds are used as a carbon and/or energy source by these microorganisms, and in the process, are effectively degraded and removed from the contaminated matrix. This technology, also known as bioslurry treatment, could be performed off-site in a treatment vessel.

The application of bioremediation to hazardous wastes is complex. Not all organic compounds are susceptible to biological degradation and metals cannot be treated this method. Careful characterization of the contaminated material, including bench-scale and pilot-scale treatability studies, must be conducted to identify the target compounds. Treatability studies can be costly and time consuming. Biological treatment has been documented as effective in some remedial activities; however, it only addresses the contaminants in the soil/sediment/groundwater and not the identified waste materials (i.e., drums, scrap metal, batteries, etc.). Based on the objective of this EE/CA, namely removal of surficial waste materials at Sites 2 and 9 and SSA 4, biological treatment will be eliminated from further consideration.

4.5.5 Recycling

Many of the waste materials identified at Site 2 and SSA 4, as discussed previously in Subsections 2.3.4 and 2.3.5 of this EE/CA, are recyclable. Various types of scrap metal are

candidates for some type of recycling process. The recycling response option requires that the recyclable materials be separated from other debris and soil prior to shipment to the recycling facility.

Even with the batteries separated from the loose soil, fouling due to dirt and exposure prevents effective recycling.

Recycling of the batteries from Site 2 and SSA 4 is not a viable option. The condition of the batteries along with their chemical composition makes recycling financially and operationally infeasible. Therefore, the recycling option will only be considered for scrap metal and other potential recyclable materials.

Sampling (wipe or chip) of the recyclable materials may be necessary. The Remediation Contractor, under guidance from the recycling facility, will determine if sampling is required. The recyclable materials will also be cleaned of any material (i.e., soil) adhering to their surfaces.

This response action will be retained for further consideration.

4.6 ON-SITE TREATMENT

On-site treatment would not be conducted until after the waste materials are removed from the soils. The wastes would be separated and, if necessary, contained until the on-site treatment is scheduled. The on-site treatment technologies considered under this response action include incineration, composting, stabilization, and biological treatment. These technologies are described in the subsections that follow.

4.6.1 Incineration

Incineration for off-site treatment was described in Subsection 4.5.1. On-site incineration would be a similar process, but incineration would be performed at the site using a mobile

or transportable incinerator. Mobile incinerators are transported intact to the site. Transportable systems are delivered to the site and assembled. Mobile and transportable incinerators rely on the same technologies as a commercial, stationary incinerator. However, the treatment capacities of mobile and transportable incinerators may be somewhat smaller than those of stationary incinerators.

For on-site incineration, a suitable location and pad would be required for the incinerator unit. Trial burns would also be required. Incineration would only be applicable to the soils associated with the waste materials or to solidified materials or liquids from drums. Waste materials (i.e., batteries, scrap metal, weapons casings, drums, etc.) could not be incinerated. The small size of the mobile and transportable systems would also demand that the feed soil be screened with a relatively small maximum permissible soil size. A shredder could be used to reduce oversize material. Due to the on-site time required for test burns, the additional area and pad required for the treatment unit, and the decreased capacity of on-site systems, on-site incineration will not be retained for further consideration.

4.6.2 Composting

Off-site composting was described in Subsection 4.5.2. On-site composting would use the same processes as off-site composting. An on-site composting facility would require a treatment area, preferably near the excavation areas. The most commonly used composting method, windrow composting, requires a large tract of land. Treatability studies and treatment time for composting would also require a significant amount of on-site time. For these reasons and for those reasons specified in Subsection 4.5.2, on-site composting will not be retained for further consideration.

4.6.3 Stabilization

On-site stabilization, similar to off-site stabilization (described in Subsection 4.5.3), would be performed at WPNSTA Yorktown. The disadvantages associated with off-site stabilization also apply to on-site stabilization. These disadvantages include the unsuitability

of stabilization when organic materials are present in the soil, the need for treatability studies, and an increase in the volume of material requiring final disposal. Therefore, on-site stabilization will not be retained for further consideration.

4.6.4 Biological Treatment

On-site biological treatment relies on the same processes as off-site biological treatment, which are described in Subsection 4.5.4. On-site biological treatment can be performed prior to removing the contaminated soil, or aboveground using the bioslurry process following the removal of contaminated soil. When performed on soil still in place, nutrients and oxygen (if necessary) are delivered to the soils through injection wells or an infiltration system. Soil and groundwater characteristics can greatly affect the results of this method. A treatability study on the contaminated soil and its ability to be remediated using on-site bioremediation would be required prior to full-scale treatment. Because of the uncertainties associated with on-site biological treatment and its applicability to the waste and soil at Sites 2 and 9 and SSA 4 at WPNSTA Yorktown, this technology will not be retained for further consideration.

4.7 CONTAINMENT

No removal actions are implemented under the containment response. However, mechanisms such as soil capping would be implemented to prevent direct access to the contaminants and reduce the infiltration of contaminants into the groundwater. Periodic monitoring and analysis of groundwater are also included in this response action. In the event that groundwater monitoring data indicate an adverse impact on the groundwater, an alternative response action may be implemented.

Containment measures such as soil capping or other types of covers are practical alternatives; however, much of the debris is scattered on the surface, protruding from the surface, or located on steep slopes and along streambeds, making it difficult to construct an effective cap or cover of uniform thickness and maintain the integrity of such a cap given

these site conditions. Therefore, based on the above statement and the fact that containment does not address the objective of removing the surficial waste, this technology will be eliminated from further consideration.

4.8 SUMMARY

Table 4-3 summarizes the removal limitations under each of the removal response actions. Based upon the evaluation conducted in this section, the following response actions have been retained for further consideration:

- Removal of Surficial Waste Materials.
- Selective Removal of Waste Materials.
- Off-Site Disposal.
- Off-Site Treatment.

Table 4-3

Removal Response Actions Summary

Waste Material	Removal Response Actions		
	Removal of Surficial Waste Materials*	**Complete Removal of Waste Materials**	**Selective Removal of Waste Materials***
Batteries	Surficial removal[a], sampling included	Complete removal[b], sampling included[c]	Complete removal, sampling included
Construction debris (including railroad ties at Site 9)	Surficial removal	Complete removal	Surficial removal
Scrap metal	Surficial removal	Complete removal	Surficial removal
Electrical equipment, wire, miscellaneous debris	Surficial removal	Complete removal	Surficial removal
5- and 55-gallon drums	Surficial removal	Complete removal	Surficial removal
Weapons casings	Surficial removal	Complete removal	Surficial removal
Associated soils	Separated from the waste materials[d]	Separated from the waste materials	Soils are separated from the waste materials

Notes:

*Retained for further consideration.

[a]Surficial removal assumes removal of the waste material to a maximum depth of 1 ft bgs. If a large piece of debris is partially buried (i.e., >1 ft bgs), the entire piece of debris is removed but no further vertical excavation is conducted even if waste materials are visible below the 1 ft bgs elevation.

[b]Complete removal assumes removal to whatever depth is necessary to remove all of the waste material present.

[c]Sampling consists of geophysical methods (EM survey, magnetometry, trenching, and/or test pits) to locate subsurface batteries and HW characteristics sampling of water that enters the excavations.

[d]Scrap metal and other recyclable materials are expected to require minimal soils separation.

SECTION 5
ANALYSIS OF REMOVAL ACTION ALTERNATIVES

5.1 INTRODUCTION

In this section, a detailed analysis of the response actions developed in Section 4 that satisfy the objectives stated in Section 3 is presented. This analysis facilitates a comparison of the alternatives based on the action-specific ARARs followed by a four-step analysis of each alternative. Relevant and applicable environmental standards and generally accepted engineering practices were considered in determining suitable actions or technologies. The response actions presented in Section 4 that met the necessary criteria are:

- Removal of Surficial Waste Materials.
- Selective Removal of Waste Materials.
- Off-Site Disposal.
- Off-Site Treatment.

The above response actions are combined in this section to form two different removal alternatives for final analysis in this EE/CA: 1) Removal of Surficial Waste Materials With Off-Site Treatment and Disposal; and 2) Selective Removal of Waste Materials With Off-Site Treatment and Disposal. These removal alternatives will be subjected to a more detailed analysis in order to select the appropriate alternative for implementation. The following criteria were used to evaluate these alternatives:

- Technical feasibility.
- Institutional considerations.
- Environmental and human health considerations.
- Cost analysis.

Expanded descriptions of these criteria are provided in the following subsections. Specific evaluation of the two alternatives based upon these criteria is provided in Subsections 5.2 and 5.3.

5.1.1 Technical Feasibility

The technical feasibility criterion addresses critical objectives in the evaluation of potential removal actions. These objectives include performance (effectiveness and useful life), reliability, implementation, compliance with ARARs, and safety. The evaluation of each removal action alternative is based on its ability to achieve the following technical goals:

- Performance — Two aspects of removal actions determine their desirability on the basis of performance: effectiveness and useful life. Effectiveness refers to the degree to which an action will prevent or minimize substantial danger to human health, welfare, or the environment. Useful life is the length of time that this level of effectiveness can be maintained.

- Reliability — To be reliable, a potential removal action alternative should incorporate proven technologies that have a demonstrated and dependable record of use, and should be capable of accomplishing the desired corrective results over the planned life of the remedial action. In addition, the frequency and complexity of necessary operations and maintenance (O&M) should be considered in evaluating the reliability of alternatives.

- Implementation — Additional important aspects of a removal alternative include its ability to be implemented, its relative ease of installation, and the time required to achieve a given level of response. The time requirements can generally be classified as the time required to implement a technology and the time required before results are actually realized.

- Compliance With ARARs — Chemical-specific ARARs, as discussed in Section 3 of this EE/CA, are not directly applicable to this EE/CA's waste material removal objective. However, discussion of the Navy's IR Program and action-specific ARARs is relevant to this type of removal and is discussed further in this section in relation to each alternative's removal limits.

- Safety — Each removal alternative can be evaluated with regard to safety. This evaluation can include short-term threats to the safety of nearby communities, to the environment, or to workers during implementation.

5.1.2 Institutional Requirements

Institutional factors can be critical to the overall ability to select and implement an effective removal action program. These criteria are used to evaluate the acceptability of each

technology to local, state, and federal agencies, as well as the potential for compliance with existing or future regulatory policies. As a result of such factors, ancillary equipment or approvals (i.e., E&S plan approvals, pre-acceptance of a disposal facility, etc.) may be required prior to implementation of the removal action. The Navy is required to meet the substantive requirements of many permits. Therefore, for later reference, "permit" does not necessarily reflect an issued document. All applicable state and federal requirements must be met and all plans must be approved by the regulatory agencies. The Remediation Contractor is responsible for compliance with the applicable regulatory approvals.

This evaluation criterion includes:

- Short-term impacts during construction, including odors, dust, truck traffic, and noise.
- Federal, state, and local government acceptance and regulatory permits.
- Local resident and community perceptions.
- WPNSTA Yorktown IR Program requirements.
- Long-term management and operational requirements.
- State and federal DOT regulations for the handling, shipping, and manifesting of wastes.

5.1.3 Human Health and Environmental Issues

The removal alternative selected must adequately protect human health and the environment. The alternatives are evaluated for their effectiveness in mitigating the existing or potential contaminant exposure to site personnel.

Documentation that the alternative protects humans and adequately controls both the long-term effects of the residual contamination and the short-term effects caused by implementation of the removal action is required. Applicable health and environmental standards (i.e., ARARs) are used to evaluate each alternative.

The overall goal of the selected removal alternative is to mitigate the existing environmental threats without creating additional adverse effects. The environmental effectiveness evaluation criterion focuses on the key environmental contaminants. The factors to be incorporated into the environmental effectiveness evaluation include:

- The likelihood of on-site source control or off-site removal actions being effective in mitigating and/or minimizing the threat to human health, welfare, and the local environment.
- The prevention of additional environmental (soil, surface water, and groundwater) contamination.
- The potential for adverse environmental effects resulting from the alternative or its implementation.

During the evaluation and implementation of waste material removal actions at the disposal areas, worker health and safety must also be considered. Any measures that have the potential for worker contact or release of hazardous substances must conform to OSHA requirements.

5.1.4 Cost Analysis

A removal alternative should be implemented and operated in a cost-effective manner and must mitigate the environmental concerns at the site. This requires ensuring that the results of a particular alternative cannot be achieved by less costly methods. In considering the cost-effectiveness of the various alternatives, costs are considered as follows:

- Capital costs.
- O&M costs.
- Post-removal (E&S controls) costs.

The present worth value method is typically used to evaluate the total cost of a removal alternative's strategy, including the post-closure period. Thus, the cost-effectiveness of the various alternatives is compared based on total present worth. However, for Sites 2 and 9 and SSA 4, the removal actions are required to be completed within 1 year. Therefore, the

cash flow discounting method to determine present worth is not necessary with the exception of maintenance of E&S controls, and the total costs are appropriate for use in comparing the alternatives.

The cost analysis presented in this EE/CA represents cost estimates for the developed removal alternatives based on the existing data presented herein.

5.2 ALTERNATIVE 1: REMOVAL OF SURFICIAL WASTE MATERIALS WITH OFF-SITE TREATMENT AND DISPOSAL

Alternative 1: Removal of Surficial Waste Materials With Off-Site Treatment and Disposal, entails the removal of surficial waste materials and their associated soils. Following removal from the disposal areas, the waste materials and their associated soils will be treated off-site (at an incinerator or by recycling) and/or disposed at an appropriate permitted landfill. Confirmational sampling is conducted under this alternative in the surficial excavation areas.

The surficial waste materials and their associated soils will be removed by hand or heavy equipment to a depth of 1 ft bgs. Precautions will be taken to minimize contaminant releases from punctured drums, batteries, or electrical equipment during removal activities. This alternative includes the removal of all identified surficial waste materials with little or no separation of the waste materials from their associated soils. Surficial waste materials, including tree stumps, weapons casings, electrical equipment (including power lines, poles, and hardware), scrap metal, batteries (mercury and zinc-carbon type and those from weapons), railroad ties, construction debris, and 5- to 55-gallon drums, will be removed from the soils at the three disposal areas. For the purposes of this EE/CA, it is assumed that no transformers or light ballasts (possibly containing PCBs) exist at the surface or will be encountered within the 1 ft bgs excavation depth.

Site 2 covers approximately 2 to 3 acres, part of which lies within a wetland area. Some scattered waste materials lie within the wetland portion. In an effort to minimize disturbance to the wetlands of Site 2, any waste removal operations in the wetland portion will be performed by hand, if feasible; operation of heavy equipment (e.g., for the removal

of mine casings) will be conducted at a minimum to reduce impact to wetland areas. Any disturbed wetlands will be restored to their original condition upon completion of the removal.

The portion of Site 9 containing the surficial waste materials is approximately 2,500 ft^2 in size. The disposal area lies on a steep embankment along a drainage way. Because of the steep slope, no heavy equipment will be used on the embankment to remove the waste materials from Site 9. Waste materials will be removed by hand or by heavy equipment positioned on top of the embankment.

SSA 4 covers an area of approximately 1 acre. This disposal area lies on a steep embankment that drains to Roosevelt Pond. The northern portion of the area contains a drainage outfall and a drainage way that discharge surface water to the pond. Most of the surficial waste material lies on the embankment that is not within the drainage way. However, some waste is scattered along the drainage way. Waste materials along the drainage way will be removed by hand to reduce any impact on the drainage way.

During removal activities at these disposal areas, E&S controls such as diversion ditches, berms, hay bales, and/or silt fencing will be installed and maintained. Staging of the removed material and associated soils may be necessary depending on the treatment and disposal facilities selected. A staging area will be set up to temporarily hold the waste materials prior to final off-site treatment and disposal. Following removal of the waste materials, any surface excavations will be backfilled with a clean, low-permeability fill material. Where applicable, regrading will be performed to limit the amount of fill that may need to be removed during subsequent final remedial actions.

5.2.1 Process Description

The removal/excavation and final off-site treatment and disposal of the surficial waste materials and their associated soils consist of the following process steps:

- Excavation/removal.
- Separation of batteries for hazardous waste disposal and scrap metal for recycling; staging of remaining waste materials.
- Sampling/analysis (of unknown materials in drums, if encountered).
- Off-site treatment (i.e., incineration and recycling)/disposal.
- Site restoration.

These steps are briefly described in the following subsections.

5.2.1.1 Excavation/Removal of Surficial Waste Materials

The surficial removal limits of the waste materials and their associated soils will be based on the areas previously identified in field observations. Vertical removal limits of surficial waste materials and their associated soils will be determined in the field, but will not exceed 1 ft bgs. If subsurface materials are visible below the 1 ft bgs limit, it will be noted for action in future RI/FS activities. The waste material (including batteries and drums) removal is a surficial removal only. Drums located on the surface of each of the disposal areas will be emptied, if necessary, opened on both ends, and crushed prior to disposal.

Special care will be taken to cause as little disturbance as possible to the natural environment or habitats present at the three locations. It is anticipated that nearby streams and wetlands will be minimally disturbed by removal activities. Wetland delineation studies may be required at Site 2, since some activities (removal of mine hardware) will occur near wetlands. The wetland characterization studies may identify additional regulatory requirements that must be followed prior to or during removal actions at the sites. Heavy mechanical equipment may not be able to access some of the more remote waste material areas. In an effort to reduce the impact to wetland areas, batteries and other smaller manageable wastes may be removed by hand. Conventional, readily available excavation equipment and hauling vehicles will be used, as required, especially for the excavation and removal of the mine casings and heavy wastes. Efforts relating to the removal of trees,

grubbing, reseeding, etc., will be coordinated with the Special Assistant, National Resources Management, Code 09C-2 at WPNSTA Yorktown.

E&S control measures, which typically include the installation of silt fences and the construction of surface water diversions, will be implemented prior to commencement of materials handling at the sites and maintained during the removal activities.

5.2.1.2 Separation/Staging

During removal of the waste materials and their associated soils, separation of the batteries (and their associated soils) and scrap metals from the other miscellaneous wastes is required due to treatment and disposal requirements. This separation will be conducted using available mechanical equipment and by hand, if necessary. All appropriate health and safety measures will be implemented. In addition, separation of certain drums may be required for testing purposes. Staging areas will be set up in open, vehicle-accessible areas at the sites to facilitate the hauling of the wastes to the appropriate off-site treatment and disposal facilities. The separation process will be controlled on a site-by-site basis by Navy personnel present during the removal activities.

5.2.1.3 Sampling

Under this alternative, confirmation sampling will be performed to characterize the surface soils in the removal areas. The samples will be analyzed for VOCs, BNAs, explosives, metals, cyanide, pesticides/PCBs, and TPH. While it is not expected that these compounds are present at every location, the extensive analyses will be used to support future RI/FS activities at these sites (i.e., ecological/baseline risk assessments).

Additional soil removal based on these analyses will be made by Navy personnel. Following or during removal of the waste materials, samples may also be requested by the Navy or the EPA Oversight Coordinator. Samples will be taken of any unidentifiable drum liquids and analyzed for HW characteristics to determine the appropriate disposal option. Sample

results are known for the media underlying or surrounding most of these waste materials at Sites 2 and 9. These sampling results were used in determining appropriate disposal alternatives for the waste materials at Sites 2 and 9 and in estimating the appropriate disposal alternatives for waste materials at SSA 4. Drums found containing nonsolidified materials will be rinsed and crushed prior to disposal. All rinsate will be collected in a new liquids drum. Compatibility testing of drum liquids will be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics and other required parameters after all surficial waste materials have been removed from the site. The drummed rinsate will be appropriately disposed based on the analytical results.

In addition, representative samples of batteries will be analyzed for leaching potential by testing for TCLP and ICR to determine the method of disposal.

5.2.1.4 Off-Site Treatment/Disposal

Two treatment options may be applicable to the waste materials removed from the surface of these sites, as previously discussed in Subsection 4.5 of this EE/CA. These options include incineration and recycling. Implementation of Alternative 1 includes the use of both off-site treatments methods. If a waste material (i.e., batteries, construction debris, electrical equipment, etc.) is encountered that is not applicable to either treatment option, it will be disposed of at an approved off-site landfill facility. The following is a discussion of both off-site treatment methods and landfill disposal as they pertain to the specific waste materials.

All waste material will be manifested in accordance with Virginia Department of Transportation (VDOT) regulations. Copies of the manifest will be kept on-site by WPNSTA Yorktown. All attempts will be made to limit dust emissions resulting from the waste material handling and transporting operations.

5.2.1.4.1 Incineration

This treatment method will be used for materials (as specified below) that cannot be disposed of in a sanitary or RCRA-approved landfill (i.e., contaminants that fall under the Land Ban restrictions). Applicable waste materials removed from the disposal areas will be transported from the staging areas directly to an incineration facility. The particular wastes are required to be received at the incinerator in specific quantities and conditions (i.e., in a fiber pack). Samples of the waste material will be sent to the incinerator in advance so that the off-site incinerator operators can perform any necessary analyses at their facility.

Drums

All drums will be emptied, as discussed in Subsection 5.2.1.3 of this EE/CA, of any liquids or other contents into a new liquids drum. Under this alternative, drum contents that cannot be disposed in a permitted landfill will be disposed at a permitted incineration facility. Any other liquids encountered during removal activities may be sampled and also disposed by incineration.

5.2.1.4.2 Recycling

Applicable waste materials (i.e., scrap steel and aluminum metal) will be removed from the sites and transported to a permitted recycling facility. Recyclable waste materials must be separated from soils and other debris during or immediately following removal from the sites. These materials will be staged in separate holding containers (i.e., roll-off boxes) prior to transportation to the recycling facility.

Scrap Metal

Under this alternative, all identified surficial scrap metals will be excavated, removed from the surface, and separated from the soils and/or any other debris encountered during the

removal. Weapons casings may also be recycled following inspection by the EOD team. The Remediation Contractor's personnel, under guidance from the recycling facility, will be responsible for evaluating the condition of the scrap metal for the recycling option. The grade and condition of the scrap metal will determine its value as recyclable material. Some scrap metal may not be of recyclable quality and will have to be disposed in a sanitary landfill.

5.2.1.4.3 Off-Site Disposal

Waste materials (including drums, batteries, construction debris, etc.) and their associated soils removed from the disposal areas will be transported from the staging areas directly to a disposal facility. Sanitary, industrial, or RCRA-approved landfills may be used depending on the nature and quantity of waste material and associated soils. Disposal information on the specific surficial waste materials most likely to be encountered for Alternative 1 is presented in the following paragraphs.

Drums

All drums containing liquids will be emptied (into an intact liquids drum), opened on both ends, and crushed prior to disposal. Drums containing solid materials will be opened on both ends, emptied, rinsed out, and crushed prior to disposal. Drums that are already empty will be opened and crushed. Separation of the drums from the surrounding attached soil is required under this alternative. All emptied and crushed drums, removed solidified material, and associated soils will be disposed of at a permitted sanitary landfill. Material from drums that cannot be disposed of in a sanitary or RCRA landfill will be sent for off-site treatment (i.e., incineration) as discussed in Subsection 5.2.1.4.1 of this EE/CA.

Batteries

Under this alternative, all batteries will be excavated/removed to the limited depth stated previously (1 ft bgs) and disposed of at a landfill permitted for disposal of the batteries

based on the available analytical results. Separation of the soils attached to the batteries or unearthed during the battery excavation will be conducted. Permits are required for disposal at a hazardous waste landfill.

Electrical Equipment/Construction Debris

All electrical equipment and construction debris (i.e., power lines, poles, broken brick, shingles, glass, lumber, railroad ties, etc.) on the surface of the three disposal areas will be removed and disposed of at a sanitary landfill. Separation of the soils unearthed during removal of the electrical equipment/construction debris will be conducted. As stated previously, it is assumed for purposes of this EE/CA that no transformers or light ballasts, possibly containing PCBs, will be encountered at the surface or within the 1 ft bgs excavation depth.

5.2.1.5 Site Restoration

All surface excavations resulting from the removal of the surficial waste materials and their associated soils will be backfilled prior to demobilization. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials and drums to inhibit the infiltration of surface water into the subsurface waste materials. Where applicable, regrading will be performed to limit the amount of fill that may need to be removed in subsequent final remedial actions. Seeding and mulching will also be conducted following placement of the fill material, as necessary.

5.2.2 Technical Considerations

The factors used to evaluate the technical feasibility of Alternative 1 include:

- Compliance with the ARARs.
- Effectiveness.
- Useful life.
- O&M.
- Demonstrated performance.

- Implementability.
- Safety.

These factors, as applied to Alternative 1, are discussed in the following subsections.

5.2.2.1 Compliance With the ARARs

The objective of this EE/CA is the removal of the surficial waste materials at Sites 2 and 9 and SSA 4. These disposal areas contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to contaminant migration due to surface runoff and potential leaching; their removal will mitigate this problem.

Chemical-specific ARARs, as discussed in Section 3 of this EE/CA, are not directly applicable to this EE/CA's waste material removal objective. However, discussion of the Navy's IR Program and action-specific ARARs is relevant to this type of removal and is discussed further in this subsection in relation to this alternative's removal limits. ARARs relevant to this EE/CA removal action are discussed in detail in Subsection 3.2 of this EE/CA.

WPNSTA Yorktown's IR Program considers the following factors in determining the appropriateness of a removal action: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants in soil largely at or near the surface that may migrate due to exposure or weather conditions; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

This alternative successfully addresses these IR Program factors. All surficial waste materials, including batteries, metal debris, 5- to 55-gallon drums, weapons casings, construction debris, electrical equipment, etc., will be removed, significantly reducing: 1) the potential threat of exposure to station personnel, civilians, and animal populations; 2) the

potential for the waste material to migrate; and 3) the threat of hazardous substances, pollutants, or contaminants in drums or other containers (i.e., batteries) to be released onto the surface. This surficial removal, in turn, also reduces the concern for surface water contamination from these sources.

Waste materials remaining below the surface will be addressed during the FS. All disposal and transportation requirements under VDEQ, VDOT, and RCRA (if necessary) will be implemented and enforced under this alternative.

5.2.2.2 Effectiveness

The effectiveness of a removal action alternative is dependent on the alternative's ability to perform the intended functions and comply with the ARARs to the extent practicable, as discussed in Subsection 5.2.2.1.

Excavation techniques are: 1) proven technologies for conventional applications; 2) often used for removal actions; and 3) involve few technical concerns. For separation/staging of the batteries and drums from the other waste materials and their associated soils, health and safety measures will be implemented to limit field personnel from personal exposure with the waste materials and soils. Mechanical separation will be conducted whenever possible.

Both off-site treatment technologies, incineration and recycling, are proven and widely used options for the final elimination of waste materials. Incineration systems have been documented as effective for the destruction and disposal of organic portions of hazardous wastes.

Off-site disposal in a secure, permitted landfill is technically viable because the design of the landfill is based on standard engineering practices. Whether the material is sent to a sanitary, industrial, or RCRA-approved hazardous waste landfill, measures are installed at the landfills to ensure the reliability of the technology and the security of the material in the landfill.

5.2.2.3 Useful Life

The excavation and off-site treatment and disposal of the surficial waste materials and their associated soils alternative is a permanent, irreversible solution for Sites 2 and 9 and SSA 4 because the surficial waste materials and their associated soils will be removed from the three disposal areas. The operating time for this alternative, after design and permitting, is currently estimated at 5 to 6 months.

5.2.2.4 O&M

The O&M anticipated for this alternative is in conformance with the desired time limits. The necessary hauling and excavation equipment will be in operation for approximately 6 months. Conventional, readily available excavation equipment and hauling vehicles will be utilized. E&S controls will be maintained in all areas during removal activities.

5.2.2.5 Demonstrated Performance

As noted previously, excavation and off-site treatment and disposal techniques are proven technologies for conventional removal action applications.

5.2.2.6 Implementability

The approximate time required for excavation and off-site treatment and disposal is as follows:

- Permit issues/approvals (for construction and/or off-site disposal of drums): 1 to 2 months.
- Filing of waste disposal profile sheets with permitted landfill: 1 to 2 months.
- Preparation of specifications and subcontractor selection: 2 to 3 months.

- Field preparation: 1 month.
- Excavation, treatment, and disposal: 5 to 6 months.

5.2.2.7 Safety

All applicable safety precautions (i.e., dust control measures) and devices (i.e., air monitoring equipment), in conformance with an approved HASP, are required during removal activities. It is the responsibility of the Remediation Contractor to develop and implement a HASP.

5.2.3 Institutional Considerations

The institutional considerations associated with the excavation and off-site treatment and disposal of the surficial waste materials and their associated soils are listed below:

- Removal issues associated with the IR Program are addressed (see Subsection 5.2.2.1 of this EE/CA).
- Prior to all on-site activities, permission for construction may be required to comply with WPNSTA Yorktown regulations.
- During excavation activities, E&S controls and dust controls will be implemented.
- Prior to the disposal of drums, any solidified materials will be removed and disposed of in a sanitary or hazardous waste landfill or by incineration, as specified in Subsection 5.2.1.4.3; a permit may be required from VDEQ for sanitary landfill disposal.
- Prior to off-site disposal, VDEQ may be required to approve the off-site disposal location (i.e., appropriate landfill) for batteries and associated soils.
- During operations, all applicable OSHA regulations must be enforced.
- DOT requirements must be met for the transportation of all materials/soils removed from Sites 2 and 9 and SSA 4. State Hazardous Waste Manifests, permits, or licenses may also be required.

- Long-term liability remains in the event of failure of the treatment/disposal facility.

5.2.4 Human Health and Environmental Considerations

The following human health and environmental issues are associated with this alternative:

- All of the surficial waste materials and their associated soils will be excavated and treated or disposed off-site. This action can be expected to effectively reduce/eliminate: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants associated with debris and in soil largely at or near the surface that may migrate via ground/surface water due to exposure, leaching, and/or weather conditions; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

- With the proper installation and implementation of dust control measures and temporary staging areas, the local environment would not be impacted by the excavation activities.

- There are few local human health or environmental impacts associated with off-site treatment and disposal because the waste materials would be removed from the sites to a more secure final location. In the case of landfill or treatment facility failure, the possibility exists for impact to the area surrounding the facilities.

5.2.5 Cost Analysis

The total cost of implementation for Alternative 1 is estimated at $1,113,400 and consists of capital and O&M costs (present worth), as outlined in Table 5-1. The volumes of waste materials used in this cost estimate were estimated from various sources, including site descriptions from Round One RI activities, the Site Visit Report for SSA 4 (contained in Appendix A), conversations with RI personnel, and comparison with the landfills and landfill disposal areas in the Final EE/CA for Sites 4, 16, and 21 at WPNSTA Yorktown (Baker/ WESTON, December 1993). Costs for some other items (e.g., E&S control materials costs) were based on engineering judgment. This alternative considers the potential for cost recovery due to recycling; however, recycling requires additional labor costs for the

Table 5-1

Estimated Costs for Alternative 1
Sites 2 and 9 and SSA 4
Removal of Surficial Waste Materials
With Off-Site Treatment and Disposal

Cost Item	Quantity	Unit Cost ($)	Amount ($)
Capital Costs			
• Mobilization/Demobilization and Construction Facilities		Lump Sum	77,500
• Clearing and Grubbing		Lump Sum	37,700
• E&S Controls		Lump Sum	20,622
• Site Access Road and Staging Area		Lump Sum	82,757
• Removal/Grading/Restoration of Disturbed Areas (Staging Area/Site Access Road)		Lump Sum	31,000
• Removal/Loading/Preparation/Backfill			84,121
- Removal of Surficial Batteries and Associated Soils	30 yd^3	196.07 per yd^3	
- Backfill Battery Excavations (with low-permeability soils)	22.6 yd^3	16.71 per yd^3	
- Removal of Surficial Drums (no on-site soil separation)	150 yd^3	26.88 per yd^3	
- Remove Materials From Drums and Crush Drums	150 yd^3	105.18 per yd^3	
- Removal of Surficial Waste Materials (no on-site soil separation)	140 yd^3	16.57 per yd^3	
- Backfill Drum Excavations (with low-permeability soils)	112.5 yd^3	16.71 per yd^3	
- Backfill Surficial Waste Excavations (with low-permeability soils)	105 yd^3	16.71 per yd^3	
- Removal of 140 Weapons Casings	Lump Sum	52,100	
• Transportation and Disposal			427,826.20
- Scrap Metal and Miscellaneous Debris (to Sanitary Waste Landfill)	100 yd^3	62.50 per yd^3	
- Recycle of Scrap Metal	40 yd^3	0.00	
- Batteries and Associated Soils (to Hazardous Waste Landfill)	30 yd^3	340 per yd^3	
- Drums (to Hazardous Waste Landfill)	105 yd^3	340 per yd^3	
- Drums (to Sanitary Waste Landfill)	45 yd^3	62.50 per yd^3	
- Transport of Weapons Casings to EOD	140	135/casing	
- Sampling and Decon of Weapons Casings (following EOD decommissioning)	140	1,285/casing	

Table 5-1

Estimated Costs for Alternative 1
Sites 2 and 9 and SSA 4
Removal of Surficial Waste Materials
With Off-Site Treatment and Disposal
(Continued)

Cost Item	Quantity	Unit Cost ($)	Amount ($)
- Recycle of Weapons Casings	140	0.00	
- Soils Sampling[b]	80	$1,711/sample	
- Excavation of Stained Soils Associated With Staging Areas	Lump Sum	840.70	
- Sampling of Decon Water and Collected Runoff Water	Lump Sum	11,250	
- Sampling of Disposal Materials (TCLP/ICR)[a]	7	1,624/sample	
- 10,000-Gallon Water Holding Tank	Lump Sum	13,725	
• Permitting Fees/Equipment for Construction/Separation Activities		Lump Sum	4,000
• Permit for Drums With Solidified Material		Lump Sum	10,000
• Disposal Contingency for Unknown Liquids in Drums (and Land Ban Materials)		Lump Sum	4,000
O&M Costs (Present Worth)			
• Drum Sampling (Unknown Liquids)			
- Labor	40 hours	60/hr	2,400
- Analytics (TCLP, ICR)[a]	10 each	1,150/sample	11,500
• E&S Controls Maintenance (Based on 3 Years, at 6% Interest)	3 years		13,400
Subtotal (Rounded)			806,800
Administrative and Construction Services (20%)			161,400
Contingency (15% of subtotal plus administrative)			145,200
Total (Rounded)			$1,113,400

Notes:

Costs incurred by WPNSTA EOD for decommissioning weapons casings not included.
[a]Toxicity Characteristic Leachate Procedure (TCLP), and Ignitability, Corrosivity, and Reactivity (ICR).
[b]Assumes each sample will be analyzed for VOCs, BNAs, metals, cyanide, explosives, pesticides/PCBs, and TPH.

separation/segregation of wastes. Backup spreadsheets detailing this cost estimate are contained in Appendix C of this EE/CA.

5.3 ALTERNATIVE 2: SELECTIVE REMOVAL OF WASTE MATERIALS WITH OFF-SITE TREATMENT AND DISPOSAL

For Alternative 2, Selective Removal of Waste Materials With Off-Site Treatment and Disposal, the extent of the removal (partial or complete) of the waste materials is based on the specific material(s) in question. Waste materials at the three disposal areas, as previously described in Section 4, include batteries, 5- and 55-gallon drums, construction debris, railroad ties, scrap metal, electrical equipment, weapons casings, etc. Removal limits for the selected wastes will be in accordance with the guidelines and limitations previously stated and summarized in Table 4-3.

Removal activities will include complete (surface and subsurface) removal of all concentrated battery disposal areas (and their associated soils) from Site 2 and SSA 4 and surficial drum and miscellaneous waste materials removal from all three disposal areas. For the purposes of this EE/CA, it is assumed that no transformers or light ballasts (possibly containing PCBs) exist at the surface or will be encountered within the 1 ft bgs excavation depth. Following removal of the waste materials and separation and/or segregation, the waste materials will be treated (i.e., incineration or recycling) or disposed of off-site at an appropriate permitted landfill.

All soils disturbed or associated with the removal of the batteries at Site 2 and SSA 4 will be removed and sampled. The disposal method selected will be based on the analytical results. All soils disturbed or associated with the surficial removal of the remaining waste materials will be separated from the waste materials and sampled. The analytical methods will determine the appropriate disposal method.

The surficial waste materials will be located based on field observations. Removal of these identified materials will be executed using hand and mechanical equipment. Precautions

will be taken to minimize contaminant release from punctured drums, batteries, or electrical equipment during removal activities.

As previously stated in the discussion of Alternative 1, Site 2 covers approximately 2 to 3 acres, part of which lies within a wetland area. Most of the waste within Site 2 covers the portion that does not lie within the wetland. However, some scattered waste materials do lie within the wetland portion. In an effort to minimize disturbance to the wetlands of Site 2, any waste removal operations in the wetland portion will be performed by hand, where feasible. Heavy equipment will be operated in wetland areas, where necessary (i.e., for the removal of mine casings and other heavy wastes).

The portion of Site 9 containing the surficial waste materials is approximately 2,500 ft^2 in size. The disposal area lies on a steep embankment along a drainage way. Because of the steep slope, no heavy equipment will be used on the embankment to remove the waste materials from Site 9. Waste materials will be removed by hand or by heavy equipment positioned on top of the embankment.

SSA 4 covers an area of approximately 1 acre. This disposal area lies on a steep embankment that drains to Roosevelt Pond. The northern portion of the area contains a drainage outfall and a drainage way that discharge surface water to the pond. Most of the surficial waste material lies on the embankment that is not within the drainage way. However, some waste is scattered along the drainage way. Waste materials along the drainage way will be removed by hand, where feasible, to reduce any impact on the drainage way.

Staging and separation of the removed materials and/or associated soils will be necessary for this alternative. Staging areas will be set up to temporarily hold the waste materials prior to final off-site treatment/disposal. These staging areas will be properly lined and bermed, and will be constructed to prevent the possible contamination of the staging area due to leaching or rainwater infiltration.

5.3.1 Process Description

The removal, excavation, and final off-site treatment or disposal of the waste materials on the three sites consist of the following process steps:

- Excavation/removal.
- Separation of batteries for appropriate disposal, scrap metal for recycling, and associated soils from surficial waste materials; staging of remaining waste materials.
- Backfilling of low-permeability soils.
- Sampling of excavation areas.
- Sampling of batteries (and unknown materials in drums, if encountered).
- Off-site treatment (i.e., incineration and recycling)/disposal.
- Site restoration.

These steps are briefly described in the following subsections.

5.3.1.1 Excavation/Removal of Selected Waste Materials

The batteries, both surface and subsurface, and their associated soils at Site 2 and SSA 4 will be completely removed under this selective removal alternative. Excavation boundaries for complete battery removal will be based on areas identified in the field and will continue to a depth and width to be determined based on visual observation and/or testing. Drums located on the surface at each of the disposal areas will be emptied, if necessary, opened on both ends, and crushed prior to disposal. The remaining surficial waste materials (i.e., scrap metal, wood, railroad ties, construction debris, electrical equipment, weapons casings, etc.) will be removed from the surface of the three locations to a depth not to exceed 1 ft bgs. Surficial removal limits are based on field observations.

If surficial waste materials are visible below the 1 ft bgs limit, it will be noted for action in the FS. Separation of the unearthed/disturbed soils from the surficial waste materials will be conducted as part of this alternative. All soils separated from the surficial waste materials will be staged in the immediate vicinity of the excavation. Following removal of the surficial waste materials, the staged soils will be sampled to determine the appropriate disposal method.

Special care will be taken to cause as little disturbance as possible to the natural environment or habitats present at the disposal areas. It is anticipated that nearby streams and wetlands will be minimally disturbed during removal activities. Wetland characterization studies may be required at Site 2, since some activities (removal of mine hardware) will occur near wetlands. The wetland characterization studies may identify additional regulatory requirements that must be followed prior to or during removal actions at these areas. Heavy mechanical equipment may not be able to access some of the more remote waste material areas. In an effort to reduce the impact to wetland areas, batteries and other smaller manageable wastes may be removed by hand. Conventional, readily available excavation equipment and hauling vehicles will be utilized as required, especially for the excavation and removal of the mine casings and heavy wastes. Efforts relating to the removal of trees, grubbing, reseeding, etc., will be coordinated with the Special Assistant, Natural Resources Management, Code 09C-2 at WPNSTA Yorktown.

E&S control measures, which typically include the installation of silt fences and the construction of surface water diversions, will be implemented prior to commencement of materials handling at the sites and maintained during the removal activities.

5.3.1.2 Separation/Staging

Following removal of the batteries and remaining surficial waste materials from the surfaces, separation of the batteries for hazardous waste disposal, scrap metals for recycling, and associated soils from the surficial waste materials will be required. Soils associated with the battery removal will be sampled to determine the appropriate disposal method. This

separation will be conducted using available mechanical equipment and by hand, if necessary. All appropriate health and safety measures will be implemented to minimize field personnel exposure to the materials. Mechanical equipment will be used whenever possible. Staging areas will be set up in an open vehicle-accessible area at the sites to facilitate hauling to the appropriate off-site treatment or disposal facility. The separation process will be controlled on a site-by-site basis by Navy personnel present during the removal activities.

5.3.1.3 Sampling

Prior to backfilling the excavated battery disposal areas, geophysical methods such as an EM survey or magnetometry will be conducted to identify anomalies associated with buried batteries. These anomalies may be verified using trenching or test pits.

Under this alternative, confirmation sampling will be performed to characterize the surface soils in the removal areas. The samples will be analyzed for VOCs, BNAs, explosives, metals, cyanide, pesticides/PCBs, and TPH. While it is not expected that these compounds are present at every location, the extensive analyses will be used to support future RI/FS activities at these areas (i.e., ecological/baseline risk assessments).

Additional soil removal based on these analyses will be made by Navy personnel. Following or during removal of the waste materials, samples may be requested by the EPA Oversight Contractor or Navy personnel. Samples will be taken of any unidentifiable drum liquids and analyzed for HW characteristics to determine the appropriate disposal option. Sample results are known for the soils underlying or surrounding most of these waste materials at Sites 2 and 9. These sampling results were used in determining appropriate disposal alternatives for the waste materials at Sites 2 and 9 along with the data collected as part of the removal action activities and in estimating the appropriate disposal alternatives for waste materials at SSA 4. For this option, all drums found will be rinsed and crushed prior to disposal. All rinsate will be collected in a new liquids drum. Compatibility testing of drum liquids will be implemented if any liquids consolidation activities are required. Rinsate

liquids will be sampled for HW characteristics and other required parameters after all of the surficial waste materials have been removed from the site. The drummed rinsate will be appropriately disposed based on analytical results.

In addition, representative samples of batteries will be analyzed for leaching potential by testing for TCLP and ICR to determine the appropriate method of disposal.

5.3.1.4 Off-Site Treatment/Disposal

Two treatment options are applicable to the waste materials removed from the surface of these sites, as previously discussed in Subsection 4.7. These options include incineration and recycling. Implementation of Alternative 2 includes the use of both off-site treatment methods. If a waste material (i.e., batteries, construction debris, electrical equipment, etc.) is encountered that is not applicable to either treatment option, it will be disposed of at an approved off-site landfill facility. The following is a discussion of both off-site treatment methods and landfill disposal as they pertain to the specific waste materials.

All waste material will be manifested in accordance with VDOT regulations. Copies of the manifest will be kept on-site by WPNSTA Yorktown. All attempts will be made to limit dust emissions resulting from the waste material handling and transporting operations.

5.3.1.4.1 Incineration

This treatment method will be utilized for materials (as specified below) that cannot be disposed of in a sanitary or RCRA-approved landfill (i.e., contaminants that fall under the Land Ban restrictions). Applicable waste materials removed from the sites will be transported from the staging areas directly to an incineration facility. The particular wastes are required to be received at the incinerator in specific quantities and conditions (i.e., in a fiber pack). Samples of the waste material will be sent to the incinerator in advance so that the off-site incinerator can perform any necessary analyses at their facility.

Drums

All drums will be emptied, as discussed in Subsection 5.3.1.3 of this EE/CA, of any liquids or other contents into a new intact liquids drum. Under this alternative, drum contents that cannot be disposed in a permitted landfill will be disposed at a permitted incineration facility. Any other liquids encountered during removal activities may be sampled and also disposed of by incineration.

5.3.1.4.2 Recycling

Applicable waste materials (i.e., scrap steel and aluminum metal) will be removed from the sites and transported to a permitted recycling facility. Recyclable waste materials must be separated from soils and other debris during or immediately following removal from the sites. These materials will be staged in separate holding containers (i.e., roll-off boxes) prior to transportation to the treatment facility.

Scrap Metal

Under this alternative, all identified surficial scrap metals will be excavated, removed from the surface, and separated from the soils and/or any other debris encountered during the removal. Weapons casings may also be recycled following inspection by EOD. The Remediation Contractor's personnel, under guidance from the recycling facility, will be responsible for evaluating the condition of the scrap metal for the recycling option. The grade and condition of the scrap metal will determine its value as recyclable material. Some scrap metal may not be of recyclable quality and will have to be disposed of in a sanitary landfill.

5.3.1.4.3 Off-Site Disposal

Waste materials (including drums, batteries, surface debris, etc.) removed from the disposal areas will be transported from the staging areas directly to a disposal facility. Sanitary,

industrial, or RCRA-approved landfills may be used depending on the nature and quantity of waste material. Disposal information on the specific surficial waste materials most likely to be encountered in Alternative 2 is presented in the following paragraphs.

Drums

All drums containing liquids, as previously stated, will be emptied (into an intact liquids drum), opened on both ends, and crushed prior to disposal. Drums containing solid materials will be opened on both ends, emptied, rinsed, and crushed prior to disposal. Drums that are already empty will be opened and crushed. All drums will be separated from any soils disturbed during the drum removal. All emptied and crushed drums and solidified material will be disposed at a permitted sanitary landfill. Material from drums that cannot be disposed of in a sanitary or RCRA landfill will be sent for off-site treatment (i.e., incineration) as discussed in Subsection 5.3.1.4.1.

Batteries

Under this alternative, all batteries and their associated soils will be fully excavated/ removed as stated previously and tested to determine the disposal method (hazardous waste landfill or sanitary landfill). Separation of the batteries from their associated soils and other waste materials unearthed during the battery excavation will be conducted. Permits are required for disposal at a hazardous waste landfill.

Electrical Equipment/Construction Debris

All electrical equipment and construction debris (i.e., power lines, poles, broken brick, shingles, glass, lumber, fire extinguishers, railroad ties, etc.) on the surface of the three areas will be removed and disposed of at a sanitary landfill. Separation of the soils unearthed during removal of the electrical equipment and other debris will be conducted. As stated previously, it is assumed for purposes of this EE/CA that no transformers or light ballasts,

possibly containing PCBs, will be encountered at the surface or within the 1 ft bgs excavation depth.

5.3.1.5 Site Restoration

All surface excavations resulting from the removal of the surficial waste materials and their associated soils will be backfilled prior to demobilization. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials and drums to inhibit the infiltration of surface water into the subsurface waste materials. The battery excavations will be backfilled using a fill material compatible with the surrounding soils. Where applicable, regrading will be performed to limit the amount of fill that may need to be removed in subsequent final remedial actions. Seeding and mulching will also be conducted following placement of the fill material.

5.3.2 Technical Considerations

The factors used to evaluate the technical feasibility of Alternative 2 include:

- Compliance with the ARARs.
- Effectiveness.
- Useful life.
- O&M.
- Demonstrated performance.
- Implementability.
- Safety.

These factors, as applied to Alternative 2, are discussed in the following subsections.

5.3.2.1 Compliance With the ARARs

The objective of this EE/CA is the removal of the surficial waste materials at Sites 2 and 9 and SSA 4. These areas contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These

materials are also expected to contribute to contaminant migration due to potential leaching and surface runoff; their removal will mitigate this problem.

Chemical-specific ARARs, as discussed in Section 3 of this EE/CA, are not directly applicable to this EE/CA's waste material removal objective since no surface or groundwater treatment or sampling is conducted as part of a response action. However, discussion of the Navy's IR Program and action-specific ARARs is relevant to this type of removal and is discussed further in this subsection in relation to this alternative's removal limits. ARARs relevant to this EE/CA removal action are discussed in detail in Subsection 3.2 of this EE/CA.

As stated previously in Subsection 5.2.2.1 of this EE/CA, WPNSTA Yorktown's IR Program considers the following factors in determining the appropriateness of a removal action: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants in soil largely at or near the surface that may migrate due to exposure or weather conditions; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

Under Alternative 2, all surficial waste, including batteries, metal debris, 5- to 55-gallon drums, weapons casings, etc., are removed, significantly reducing: 1) the potential threat of exposure to base personnel, civilians, and animal populations; 2) the potential for the waste material to migrate; and 3) the threat of hazardous substances, pollutants, or contaminants in drums or other containers (i.e., batteries) to be released onto the surface. This surficial removal, in turn, also reduces the concern for surface water contamination from these sources. Subsurface battery removal also reduces the potential threat of exposure to nearby human and animal populations and eliminates the threat of contaminant release from the batteries. Other waste materials remaining below the surface and soils associated with the surface debris will be addressed during the FS. All disposal and transportation requirements under VDEQ, VDOT, and RCRA (if necessary), as discussed in Subsection 3.2 of this EE/CA, are implemented and enforced under this alternative.

5.3.2.2 Effectiveness

The effectiveness of a removal action alternative is dependent on the alternative's ability to perform the intended functions and comply with the ARARs as discussed in Subsection 5.3.2.1.

Excavation techniques are: 1) proven technologies for conventional applications; 2) often used for removal actions; and 3) involve few technical concerns. For separation/staging of the waste materials, measures will be taken to limit/eliminate field personnel from personal contact with the waste materials and soils.

Both treatment technologies, incineration and recycling, are proven, widely used options for final elimination of waste materials. Various types of incineration systems have been documented as effective for the destruction and disposal of the organic portion of hazardous wastes.

Off-site disposal in a secure, permitted landfill is technically viable because the design of the landfill is based on standard engineering practices. Whether the material is sent to a sanitary, industrial, or RCRA-approved landfill, measures are installed at the landfills to ensure the reliability of the technology and the security of the material in the landfill.

5.3.2.3 Useful Life

The excavation and off-site treatment/disposal of the waste materials alternative is a permanent, irreversible solution for Sites 2 and 9 and SSA 4 in the aspect that surface and subsurface batteries and surficial waste materials, along with their associated soils, will be removed from all three sites. In addition, the soils associated with the removal of the batteries are also removed and permanently disposed of off-site. Future RI/FS activity conducted at WPNSTA Yorktown will address residual soils and other contaminated media at the disposal areas. The operating time for this alternative, after design and permit compliance, is currently estimated at 7 to 8 months.

5.3.2.4 O&M

The O&M anticipated for this alternative is in conformance with the desired time limits. The necessary hauling and excavation equipment will be in operation for approximately 8 months. Conventional, readily available excavation equipment and hauling vehicles will be used. E&S controls will be maintained in all areas during removal activities.

5.3.2.5 Demonstrated Performance

As noted previously, excavation and off-site disposal or treatment techniques are proven technologies for conventional removal action applications.

5.3.2.6 Implementability

The approximate time required for excavation and off-site disposal or treatment of the selected waste materials is as follows:

- Permit issues/approvals for construction activities: 1 to 2 months.
- Filing of waste disposal profile sheets with permitted landfill: 1 to 2 months.
- Preparation of specifications and subcontractor selection: 2 to 3 months.
- Field preparation: 1 month.
- Excavation and disposal: 7 to 8 months (this option will be more labor-intensive than Alternative 1 due to the additional separation/segregation of wastes/soils and the removal of subsurface batteries).

5.3.2.7 Safety

All applicable safety precautions (i.e., dust control measures) and devices (i.e., air monitoring equipment), in conformance with an approved HASP, are required during removal activities. It is the responsibility of the Remediation Contractor to develop and implement a HASP.

5.3.3 Institutional Considerations

The institutional considerations associated with the excavation and off-site disposal or treatment of the selected waste materials are listed below:

- Removal issues associated with the IRP are addressed (see Subsection 5.3.2.1 of this EE/CA).
- Prior to all on-site activities, permission for construction may be required to comply with WPNSTA Yorktown regulations.
- During excavation activities, E&S controls and dust controls will be implemented.
- During operations, all applicable OSHA regulations must be enforced.
- Prior to the disposal of batteries, approval may be required from VDEQ regarding the disposal location (i.e., appropriate landfill) based on analytical results.
- DOT requirements must be met for the transportation of all materials/soils removed from Sites 2 and 9 and SSA 4. State Hazardous Waste Manifests, permits, or licenses may also be required.
- Long-term liability remains in the event of failure of the treatment/disposal facility.

5.3.4 Human Health and Environmental Considerations

The following human health and environmental issues are associated with this alternative:

- All of the batteries, surface drums, and remaining surficial waste materials will be excavated and disposed/treated off-site. This action can be expected to effectively reduce/eliminate: 1) actual or potential exposure of nearby human populations or animals from hazardous substances, pollutants, or contaminants; 2) high levels of hazardous substances, pollutants, or contaminants associated with wastes/debris largely at or near the surface that may migrate via ground/surface water due to exposure , potential leaching, and/or weather conditions; and 3) hazardous substances, pollutants, or contaminants in drums or other bulk storage containers that pose a threat of release.

- With the proper installation and implementation of dust control measures and temporary staging areas, the local environment would not be impacted by the excavation activities.

- There are few local human health or environmental impacts associated with off-site disposal/treatment because the waste materials would be removed from the sites to a more secure location. However, the associated soils will remain in place. In the case of landfill or treatment facility failure, the possibility exists for impact to the area surrounding the facilities.

5.3.5 Cost Analysis

The total cost of implementation for Alternative 2 is estimated at $1,188,300 and consists of capital and O&M costs (present worth), as outlined in Table 5-2. The volumes of waste materials used in this cost estimate were estimated from various sources, including area descriptions from Round One RI activities, the Site Visit Report for SSA 4 (contained in Appendix A), conversations with RI personnel, and comparison with the landfills and land disposal areas in the Draft Final EE/CA for Sites 4, 16, and 21 at WPNSTA Yorktown (WESTON, May 1993). Costs for some items (e.g., E&S control materials costs) were based on engineering judgment. This alternative considers the potential for cost recovery due to recycling; however, recycling requires additional labor costs for the separation/segregation of wastes. In addition, a much greater volume of waste material (i.e., batteries and their associated soils) is removed under this alternative. Backup spreadsheets detailing the costs in Table 5-2 are contained in Appendix C of this EE/CA. The costs associated with the disposal of the batteries into a hazardous waste landfill may be significantly reduced if disposal of the batteries and their associated soils into a nonhazardous landfill is approved.

Table 5-2

Estimated Costs for Alternative 2
Sites 2 and 9 and SSA 4
Selective Removal of Waste Materials
With Off-Site Treatment and Disposal

Cost Item	Quantity	Unit Cost ($)	Amount ($)
Capital Costs			
• Mobilization/Demobilization and Construction Facilities		Lump Sum	96,500
• Clearing and Grubbing		Lump Sum	37,700
• E&S Controls		Lump Sum	20,622
• Site Access Road and Staging Area		Lump Sum	82,757
• Removal/Grading/Restoration of Disturbed Areas (Staging Area/Site Access Road)		Lump Sum	31,000
• Removal/Loading/Preparation/Backfill			95,083.21
- Removal of All Batteries and Associated Soils	75 yd^3	196.07 per yd^3	
- Backfill Battery Excavations (with low-permeability soils)	56.3 yd^3	16.71 per yd^3	
- Removal of Surficial Drums (on-site soil separation required)	150 yd^3	31.26 per yd^3	
- Remove Materials From Drums and Crush Drums	150 yd^3	105.18 per yd^3	
- Removal of Surficial Waste Materials (on-site soil separation required)	140 yd^3	23.13 per yd^3	
- Backfill Drum Excavations (with low-permeability soils)	112.5 yd^3	16.71 per yd^3	
- Backfill Surficial Waste Excavations (with low-permeability soils)	105 yd^3	16.71 per yd^3	
- Removal of 140 Weapons Casings	Lump Sum	52,100	
• Transportation and Disposal			452,126.20
- Scrap Metal, Construction Debris, etc. (to Sanitary Waste Landfill)	100 yd^3	62.50 per yd^3	
- Recycle of Scrap Metal	40 yd^3	0.00	
- Batteries and Associated Soils (to Hazardous Waste Landfill)	75 yd^3	340 per yd^3	
- Drums (to Hazardous Waste Landfill)	105 yd^3	340 per yd^3	
- Drums (to Sanitary Waste Landfill)	45 yd^3	62.50 per yd^3	
- Transport of Weapons Casings to EOD	140	135/casing	
- Sampling and Decon of Weapons Casings (following EOD decommissioning)	140	1,285/casing	
- Recycle of Weapons Casings	140	0.00	

Table 5-2

Estimated Costs for Alternative 2
Sites 2 and 9 and SSA 4
Selective Removal of Waste Materials
With Off-Site Treatment and Disposal
(Continued)

Cost Item	Quantity	Unit Cost ($)	Amount ($)
- Sampling/Excavation of Stained Soils Associated With Staging Areas	Lump Sum	840.70	
- Soils Sampling[b]	80	1,711/sample	
- Sampling of Decon Water and Collected Runoff Water	Lump Sum	11,250	
- Sampling of Disposal Materials (TCLP and ICR)	7	1,624/sample	
- 10,000-Gallon Water Holding Tank	Lump Sum	13,725	
- Testing for Subsurface Batteries	5 days	1,800 per day	
• Permitting Fees/Equipment for Construction/ Separation Activities		Lump Sum	4,000
• Permit for Drums With Solidified Material		Lump Sum	10,000
• Disposal Contingency for Unknown Liquids in Drums (and Land Ban Materials)		Lump Sum	4,000
O&M Costs (Present Worth)			
• Drum Sampling (Unknown Liquids)			
- Labor	40 hr	60/hr	2,400
- Analytics (TCLP, ICR)[a]	10 each	1,150/sample	11,500
• E&S Controls Maintenance (Based on 3 Years, at 6% Interest)	3 years		13,400
Subtotal (Rounded)			861,100
Administrative and Construction Services (20%)			172,200
Contingency (15% of subtotal plus administrative)			155,000
Total (Rounded)			$1,188,300

Notes:

Costs incurred by WPNSTA EOD for decommissioning weapons casings not included.
[a]Toxicity Characteristic Leachate Procedure (TCLP), and Ignitability, Corrosivity, and Reactivity (ICR).
[b]Assumes each sample will be analyzed for VOCs, BNAs, metals, cyanide, explosives, pesticides/PCBs, and TPH.

SECTION 6
COMPARATIVE ANALYSIS OF REMOVAL ALTERNATIVES

In this section, information from the previous section is used to discuss and compare the alternatives on the basis of technical feasibility, environmental effectiveness, institutional requirements, human health considerations, and cost. The purpose of this comparative analysis is to identify the strengths and weaknesses of each alternative relative to each other so that the most appropriate alternative can be selected. The two alternatives that have been developed are: Alternative 1: Removal of Surficial Waste Materials With Off-Site Treatment and Disposal; and Alternative 2: Selective Removal of Waste Materials With Off-Site Treatment and Disposal.

6.1 ENVIRONMENTAL EFFECTIVENESS

Alternatives that result in the destruction of hazardous substances, or in the reduction of the toxicity, mobility, or volume of the waste, and have been proven reliable in the field under similar conditions on the same waste materials, are preferred. Also preferred are alternatives that are widely demonstrated to be effective, have permanent and irreversible useful lives, and will perform under all possible environmental conditions at the removal location. Alternatives that are unproven, relatively ineffective, unreliable, short-term, or susceptible to adverse area conditions are rejected.

6.1.1 Alternative 1: Removal of Surficial Waste Materials With Off-Site Treatment and Disposal

The off-site disposal of surficial waste materials and their associated soils at a landfill facility does not result in the total reduction of the toxicity of the waste materials or soil; however, the mobility of the affected waste materials and soil is dramatically reduced through off-site disposal. The treatment of selected wastes by incineration and recycling reduces the mobility and volume of waste materials and their associated soils. This alternative successfully achieves the objective of this EE/CA by removing the identified surficial waste materials and treating or disposing of them off-site, and by removing and disposing of the

surrounding soils unearthed during the excavation activities. These disposal areas contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to contaminant migration due to surface runoff; their removal will mitigate this problem. This alternative provides a permanent disposal of the recycled and incinerated materials, and a reliable disposal of the materials to landfills.

6.1.2 Alternative 2: Selective Removal of Waste Materials With Off-Site Treatment and Disposal

Alternative 2 recommends the removal and disposal of all concentrated battery disposal areas (surface and subsurface) and remaining surficial waste materials at a permitted landfill or treatment (i.e., incineration or recycling) facility. Alternative 2 is a permanent, irreversible solution for Sites 2 and 9 and SSA 4 in the aspect that the batteries and surficial waste materials will be completely removed from the sites. In addition, the soils associated with the removals are also removed and permanently disposed off-site.

Disposal at a permitted landfill does not reduce the toxicity of the waste materials, but does achieve the main objective of this removal action, i.e., the removal and off-site disposal of the selected identified waste materials. A treatment facility also accomplishes this objective while reducing the toxicity and providing an effective alternative to off-site disposal at a landfill. Both of these options have been proven effective in past removal actions.

These disposal areas contain waste materials that constitute both a physical hazard and a potential health and environmental hazard due to the potential for direct contact. These materials are also expected to contribute to contaminant migration due to potential leaching and surface runoff. The removal (surface and subsurface) of the battery disposal areas effectively mitigates the potential for further migration of the various identified contaminants through sediment and surface water runoff.

Alternative 2 provides for recycling of the scrap metal and mine casings, incineration of the drum contents (if necessary), and reliable disposal of the remaining waste materials to

landfills. This off-site disposal or treatment option is efficient in meeting the objectives of this EE/CA; these options have also been documented to be reliable in past removal projects.

6.2 TECHNICAL FEASIBILITY

A comparison of the technical feasibility of the alternatives is presented in Table 6-1.

6.3 INSTITUTIONAL REQUIREMENTS

The institutional considerations associated with the excavation and off-site disposal and/or treatment of the waste materials (surface and/or subsurface), as stated in Subsections 5.2.3 and 5.3.3 of this EE/CA, are listed below:

- The removal objective is completed within 1 year.
- Removal issues associated with the Navy's IR Program are addressed (see Subsections 5.2.2.1 and 5.3.2.1 of this EE/CA).
- Prior to all on-site activities, permission for implementation and construction may be required to comply with WPNSTA Yorktown regulations. Both alternatives may require permit(s) for separation/recycling. Both alternatives may require a permit to dispose of solidified materials from drums.
- During excavation activities, E&S controls and dust controls will be implemented.
- During operations, all applicable OSHA regulations must be enforced.
- DOT requirements must be met for the transportation of all materials/soils removed from Sites 2 and 9 and SSA 4. State Hazardous Waste Manifests, permits, or licenses may also be required.
- Long-term liability remains in the event of failure of the treatment/disposal facility.

Table 6-1

Technical Feasibility Comparison

Criteria	Alternative No.1: Removal of Surficial Waste Materials With Off-Site Treatment and Disposal	Alternative No.2: Selective Removal of Waste Materials With Off-Site Treatment and Disposal
Effectiveness	Proven effective in various field removal actions, involves separation (batteries and scrap metal) technical concerns. Satisfies EE/CA objective of surficial removal and off-site disposal of waste materials.	Proven effective in various field removal actions, involves separation (soils, batteries, and scrap metal) technical concerns. Exceeds EE/CA objective by removing surficial waste materials and subsurface batteries and disposing of them off-site.
Useful Life	Permanent, irreversible	Permanent, irreversible
Maintenance Requirements	Little/no long-term maintenance requirements. E&S controls during and following removal operations.	Little/no long-term maintenance requirements. E&S controls during and following removal operations.
Construction Capability	Conventional and readily available equipment and hauling vehicles. Separation equipment will be required.	Conventional and readily available equipment and hauling vehicles. Separation equipment will be required.
Implementation Time	Approximately 8 to 10 months; separation/segregation of wastes may be encountered and may cause extensions/delays.	Approximately 1 year (additional time required for removal of subsurface batteries); separation/ segregation of wastes may be encountered and may cause extensions/delays.
Beneficial Results Time Frame	Long-term	Long-term
Community Health and Safety	Not threatened - beneficial	Not threatened - beneficial
Worker Health and Safety	Minimal concern with proper OSHA enforcement	Minimal concern with proper OSHA enforcement

Both alternatives comply with the required institutional considerations. Alternative 1 reduces the threat of contaminant migration in the surface soils (to 1 ft bgs only) associated with the waste materials since the associated soil is being disposed of off-site. Alternative 2 requires a slightly longer on-site operation time; however, the selective removal of contaminated waste materials (i.e., batteries and associated soils at Site 2 and SSA 4) effectively eliminates a greater volume of waste material.

6.4 HUMAN HEALTH CONSIDERATIONS

It is not anticipated that implementation of either alternative will adversely impact the health of the surrounding community when properly implemented. Removal of the surficial waste materials and/or soils lessens the threat to the human population at WPNSTA Yorktown and to the sensitive ecosystem in the area. Alternative 2 provides an additional benefit in that a greater volume of the waste material (i.e., subsurface batteries) is removed and disposed at a permitted landfill facility.

6.5 COST CONSIDERATIONS

The costs for Alternatives 1 and 2 have been detailed in Tables 5-1 and 5-2. Although the costs for several items are similar, the overall cost for Alternative 2 is greater due to the larger removal volume of batteries and the required separation of soils from waste materials. There is no profit shown for recycling the scrap metal and weapons casings in either alternative due to the level of difficulty in assessing the value (if any) derived from the recycling of the metals present at these locations. However, if the grade of metals is high and the quantity of the recyclable scrap metal is greater than estimated, a profit may be realized from the recyclable material.

SECTION 7
RECOMMENDED REMOVAL ACTION ALTERNATIVE

Two removal alternatives have been developed and evaluated for Sites 2 and 9 and SSA 4: Alternative 1 — Removal of Surficial Waste Materials With Off-Site Treatment and Disposal; and Alternative 2 — Selective Removal of Waste Materials With Off-Site Treatment and Disposal. The two alternatives have both advantages and disadvantages that were noted in Section 6 of this EE/CA.

Based on an examination of the information presented in this report, Alternative 2 is recommended for implementation at Sites 2 and 9 and SSA 4. This removal alternative meets and surpasses the EE/CA's removal objective by removing both surface waste materials and subsurface batteries and disposing of them off-site. Alternative 2 allows for complete removal of the batteries and their associated soils at Site 2 and SSA 4. This extensive removal effectively eliminates a primary potential source of some of the identified contamination at these areas. This alternative also entails removal of the surficial waste materials, including 5- to 55-gallon drums, weapons casings, scrap metal, construction debris, railroad ties, electrical hardware, etc., which contributes to mitigating potential contaminant migration due to surface runoff.

The combination of complete removal of the batteries along with surficial removal of the remaining waste materials provides for a significant decrease in potential sources of contamination at the three sites. This removal alternative also surpasses the removal objective with the removal of a greater volume of waste materials, thus providing a decrease in both the physical hazards and the health and environmental hazards associated with direct contact with the waste materials.

Alternative 2 was analyzed with respect to the four criteria (technical feasibility, institutional considerations, human health and environmental consideration, and cost) used to evaluate the alternatives throughout Sections 4, 5, and 6 of this EE/CA. This analysis confirmed that the selective removal of the waste materials with off-site treatment and disposal was the

most appropriate combination of response actions. Removal under this alternative, as summarized in the following paragraphs, provides a cost-effective benefit to human health and the environment while being a documented and proven removal action.

In accordance with Alternative 2 - Selective Removal of Waste Materials With Off-Site Treatment and Disposal, removal will be conducted under the following guidelines:

- The batteries, both surface and subsurface, and their associated soils at Site 2 and SSA 4 are completely removed under this selected removal action. Excavation boundaries, for complete battery removal, will continue to a depth and width to be determined in the field based on visual observation and/or testing. Prior to backfilling these excavated disposal areas, tests will be conducted to ensure complete removal. Testing will include the use of geophysical methods such as an EM survey or magnetometry, trenching, and test pits for the battery area excavations. Confirmation sampling will also be performed to provide information on the residual soils. Any water that enters the excavations will be pumped, temporarily stored, and sampled for HW characteristics and other analyses as required by the disposal facility prior to disposal in accordance with Commonwealth of Virginia (or the disposal state's) regulations.

- Drums, located on the surface of each of the sites, will be emptied, if necessary, opened on both ends, and crushed prior to disposal. Samples will be taken of any unidentifiable drum liquids and analyzed for HW characteristics to determine what disposal option is appropriate. Drums found containing nonsolidified materials will be rinsed; all rinsate will be collected in a new liquids drum. Compatibility testing of drum liquids will need to be implemented if any liquids consolidation activities are required. Rinsate liquids will be sampled for HW characteristics after all of the surficial waste materials have been removed from the site. The drummed rinsate will be disposed appropriately, based on analytical results. The drum removal is a surficial removal only. Surficial removal limits are based on field observations.

- The remaining surficial waste materials (i.e., scrap metal, wood, railroad ties, construction debris, electrical equipment, weapons casings, etc.) will be removed from the surface of the sites to a depth not to exceed 1 ft bgs.

- Separation of the waste materials from their associated soils will be conducted. The soils displaced during the removals will be sampled to determine the appropriate disposal method. Separation of selected waste materials from the general may be necessary based on the disposal option chosen. Surficial removal limits are based on field observations.

- Identified waste materials are removed by hand or heavy equipment. A low-permeability fill material will be placed in all surficial excavations after removal of the waste materials and drums to inhibit the infiltration of surface water into the subsurface waste materials. The battery disposal excavations will be backfilled using a fill material compatible with the surrounding soils. Regrading will be performed, where applicable, to limit the amount of fill that may need to be removed during subsequent final remedial action.

The cost for the chosen removal alternative is greater than that of Alternative 1; however, Alternative 2 provides a more complete waste material removal action (i.e., subsurface battery removal) that can be implemented in a relatively short time period. The costs associated with the disposal of the batteries in a hazardous landfill may be significantly reduced if these waste materials are approved for disposal in a nonhazardous landfill.

Navy personnel will oversee the Remediation Contractor's removal activities to ensure that the removal is conducted according to a prescribed Work Plan. It will be the responsibility of the Remediation Contractor to: 1) ensure compliance with the applicable regulatory requirements (e.g., E&S Plan) and waste disposal approvals; 2) provide personnel to inspect the material at the sites to determine its recyclable quality and disposal requirements; 3) track and document all removals, sampling and analysis reports, disposal manifests, and restoration activities; 4) develop and enforce a HASP; and 5) maintain the necessary E&S controls following the removal activities for a specified time period.

APPENDIX A

SITE VISIT REPORT FOR SSA 4

WPNSTA YORKTOWN
SITE VISIT REPORT FOR SSA 4
WASTE CHARACTERIZATION/INSPECTION
2 March 1993

A.1 OBJECTIVES AND GOALS

The purpose of this site investigation was to compile an inventory of the waste materials present at SSA 4. This area was not surveyed or sampled, nor were the boundaries of the site defined during any of the previous WPNSTA Yorktown site investigations. The intent of this site visit was to gather a sufficient amount of information regarding the type and quantity of waste materials at the site in order to adequately estimate the volume of surficial materials present. This information will be used to evaluate the need for an immediate removal action at the site.

A.2 SITE DESCRIPTION

The southwest boundary of SSA 4 is located approximately 70 ft northeast of the intersection of Main and Bypass Roads, east of the Quarters-J Building. This site, approximately 1 acre in size, is bounded on the south side by a tree line located approximately 100 ft from and paralleling Bypass Road. The tree line is located at the top of a steep slope that contains waste materials. There is a drainage outfall that carries drainage from the surrounding areas approximately 1,200 ft into Roosevelt Pond. The distance from the intersection of Main and Bypass Roads to the drainage outfall is approximately 300 ft. The drainage outfall pipe, which collects surface water from south of Bypass Road and flows north, is in the center of a ravine more than 30 ft below the top of the south slope marked by the tree line. There is an access road to the northwest side of the site from Main Road. It appears that the area was used for the placement of fill material during the construction of Bypass Road, and during that time the drainage outfall was installed. It also appears that the water table in this area is discharging to the surface streams and ultimately into Roosevelt Pond. Waste materials are scattered or piled across the entire slope and along the drainage way to Roosevelt Pond.

A.2.1 Waste Characterization

SSA 4 is a bomb disposal site. A steep slope on the south side of the site is entirely covered with 55-gallon drums, 3-ft-long bomb casings, and miscellaneous debris. The slope relief is approximately 40 ft. The debris on the south slope and in the drainage way includes: deteriorated depth charge casings; drums containing paint (mostly dried or empty); construction debris; batteries (three different types); scrap metal; missile hardware; concrete; c-blocks; copper wire; red canisters (may have been used for fire fighting); more than 50 bomb casings; and buckets. Additional debris, including canisters, intact 55-gallon drums, and 5-gallon buckets containing a black tar substance (apparently used to line the bomb casings), continue more than 500 ft downstream from the outfall in the drainage way to Roosevelt Pond.

At approximately 500 ft from the drainage outfall, the drainage stream splits into two meandering streams draining a bog that extends approximately 280 ft to the west edge/end of Roosevelt Pond. At approximately 200 ft from the outfall, ship brand-type toilets are visible.

No labels were visible on the drums, canisters, or buckets. One bomb casing label could be partially read as follows (Note: the # signs represent illegible writing on the bomb):

Aircraft
Depth Bom###
##Mark -####
#Ex Mfg. Co.##
Contr. No. Nord##
Loading Date ####
#Ord. Dr. No.###

The depth of fill material extending under Bypass Road may be close to 40 ft. There is no visible debris along the south side of Bypass Road, nor are there any signs of dumping along the road other than occasional glass, pipes, and wire.

A.2.2 Waste Estimates

The following estimates are based on this visual site investigation only. No trenching or moving of material took place during this investigation.

Waste Material	Quantity of Each Item
Weapons Casings (both large and small)	200 total
Batteries	200 total
55-Gallon Drums	50 total
5-Gallon Drums	100 total
Canisters (fire extinguishers)	20 total
Construction Debris	Scattered over 1 acre

The condition of most of the material is deteriorated, although some of the drums and buckets are still intact. If a volume of fill material is necessary, a 3-ft depth of waste materials can be assumed.

APPENDIX B

GROUNDWATER SAMPLING TABLES

NOTES FOR APPENDIX B TABLES

J = Estimated concentration. Compound is present below the established detection limit, but above the instrument detection limit.

UJ = Analyte nondetect; estimated detection limit assigned by data validators due to QC difficulties.

U = Compound is not detected above the reported detection limit.

R = Data rejected by data validators due to laboratory QC difficulties.

Surface water and groundwater data are presented in units of micrograms per liter.

* = Compound is present at a concentration greater than twice the maximum background concentration detected in the samples collected as part of the Round One RI field activities.

Shaded cell indicates metal concentration exceeds NOAA sediment screening criteria.

(a) Exceeds NOAA Effects Range - Low (ER-L) level.
(b) Exceeds NOAA Effect Range - Median (ER-M) level.

Shaded cell indicates metal concentration exceeds one or more ARARs.

(a) Exceeds VGS only.
(b) Exceeds federal MCL only.
(c) Exceeds federal SMCL only.
(d) Exceeds federal MCL and VGS.
(e) Exceeds SMCL and VGS.

** = Federal criteria for copper and lead are action levels.

Metals and Nitrates Concentrations for Groundwater Samples Collected at Sites 2 and 9 During Round One RI Activities at WPNSTA Yorktown

SITE ID	Federal	Federal	VGS	2GW01-001	2GW02-001	2GW03-001	2GW04-001
ANALYTE	MCL	SMCL					
Aluminum		200		5,810 (c) *	19,900 (c) *	15,700 (c) *	35,800 (c) *
Aluminum (dissolved)				35.00 U	37.70 U	78.80 U	78.80 U
Antimony	6			44.00 UJ	44.00 UJ	44.00 UJ	44.00 UJ
Antimony (dissolved)				44.00 U	44.00 U	44.00 U	44.00 U
Arsenic	50		50	5.90 J	39.60 J	11.40 J	110 J (d)
Arsenic (dissolved)				2.00 UJ	19.70	2.00 U	74.80 (d)
Barium	2,000		1,000	31.10 J	108	161 *	197 *
Barium (dissolved)				15.00	40.70	68.00	58.00
Beryllium	4			1.00 U	1.50	1.10	3.50 *
Beryllium (dissolved)				1.00 U	1.00 U	1.00 U	1.00 U
Cadmium	5		0.04	4.00 U	4.00 U	4.00 U	4.00 U
Cadmium (dissolved)				4.00 U	4.50 (a)	4.00 U	4.00 U
Calcium				258,000 *	109,000	132,000	71,600
Calcium (dissolved)				278,000 *	110,000	132,000	66,700
Chromium	100		50	33.20	55.00 (a) *	38.60	97.40 (a) *
Chromium (dissolved)				8.00 U	8.00 U	8.00 U	8.00 U
Cobalt				12.40 J	10.00 J	6.00 UJ	24.60 J *
Cobalt (dissolved)				6.00 U	6.00 U	6.00 U	9.80
Copper	1,300**	1,000	1000	8.40	16.90	6.60	15.90
Copper (dissolved)				5.00 U	5.00 U	5.00 U	5.00 U
Iron		300	300	21,300 (e)	47,900 (e)	96,200 (e) *	88,900 (e) *
Iron (dissolved)				19.00 U	124	3,280 (e)	19.00 U
Lead	15**		50	3.60 J	15.50 (b)	20.00 UJ	20.90 (b)
Lead (dissolved)				2.00 UJ	2.00 UJ	2.00 UJ	2.00 U
Magnesium				20,500 *	12,400 *	30,000 *	29,500 *
Magnesium (dissolved)				19,800 *	10,000 *	24,800 *	21,600 *
Manganese		50	50	1,360 J (e) *	234 J (e)	348 J (e) *	584 J (e) *
Manganese (dissolved)				2.00 U	38.80	109 (e) *	116 (e) *
Mercury	2		0.05	0.10 U	0.10 U	0.10 UJ	0.10 U
Mercury (dissolved)				0.10 U	0.10 U	0.10 U	0.10 U
Nickel	100			34.80	18.00 U	18.00 U	29.80
Nickel (dissolved)				18.00 U	18.00 U	18.00 U	18.00 U
Potassium				5,300 J *	8,400 J *	20,700 *	21,200 *
Potassium (dissolved)				4,830 *	7,840 *	20,100 *	19,100 *
Selenium	50		10	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
Selenium (dissolved)				20.00 UJ	2.00 U	2.00 UJ	2.00 U
Silver		100		6.00 U	6.00 U	6.00 U	6.00 U
Silver (dissolved)				6.00 U	6.00 U	7.00 U	9.60 U
Sodium			100,000	10,600	108,000 (a) *	367,000 (a) *	244,000 (a) *
Sodium (dissolved)				11,300 *	127,000 (a) *	383,000 (a) *	274,000 (a) *
Thallium	2			2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
Thallium (dissolved)				2.00 U	2.00 U	2.00 UJ	2.00 U
Vanadium				6.00 UJ	38.50 J *	14.90 J	64.20 J *
Vanadium (dissolved)				6.00 U	7.80	6.00 U	7.80
Zinc		5,000	50	58.10 U	93.80 (a)	67.10 (a)	136 (a)
Zinc (dissolved)				14.00 UJ	11.10 UJ	13.50 UJ	6.10 UJ
Nitrates	10,000		5,000	470	270	170	100 U

Metals and Nitrates Concentrations for Groundwater Samples Collected at Sites 2 and 9 During Round One RI Activities at WPNSTA Yorktown

SITE ID	Federal	Federal	VGS	9HP01-001	9HP02-001	9HP03-001
ANALYTE	MCL	SMCL				
Aluminum		200		85,300 J (c) *	62,800 J (c) *	31,100 J (c) *
Aluminum (dissolved)				35.00 UJ	35.00 UJ	35.00 UJ
Antimony	6			44.00 R	44.00 R	44.00 R
Antimony (dissolved)				44.00 R	44.00 R	44.00 R
Arsenic	50		50	2.00 R	2.60 J	6.90 J
Arsenic (dissolved)				2.00 R	2.00 R	23.20 J
Barium	2,000		1,000	2,070 (d) *	1,010 J (a) *	728 J *
Barium (dissolved)				22.90	39.60 J	515 J *
Beryllium	4			25.30 (b) *	10.40 J (b) *	5.10 J (b) *
Beryllium (dissolved)				1.00 U	1.10 J	1.10 J
Cadmium	5		0.04	4.00 U	4.00 U	5.80 (d)
Cadmium (dissolved)				4.00 U	4.00 U	4.00 U
Calcium				125,000	2,030,000 J *	85,300 J
Calcium (dissolved)				41,500	126,000 J	83,700 J
Chromium	100		50	205 J (d) *	299 J (d) *	32.40 J
Chromium (dissolved)				8.00 UJ	8.00 UJ	8.00 U
Cobalt				339 *	147 J *	34.30 J *
Cobalt (dissolved)				6.00 U	6.00 UJ	11.60 J
Copper	1,300**	1,000	1000	26.00 *	56.30 J *	16.00 J
Copper (dissolved)				5.00 U	5.00 UJ	5.00 UJ
Iron		300	300	256,000 J (e) *	254,000 J (e) *	107,000 J (e) *
Iron (dissolved)				23.30 UJ	19.00 U	42,300 J (e)
Lead	15**		50	39.20 J (b) *	119 (d) *	248 (d) *
Lead (dissolved)				2.00 UJ	2.00 UJ	20.00 UJ
Magnesium				12,400 *	23,500 J *	27,500 J *
Magnesium (dissolved)				2,100	3;360 J	26,500 J *
Manganese		50	50	9,130 (e) *	8,890 J (e) *	1,070 J (e) *
Manganese (dissolved)				21.90	587 J (e) *	251 J (e) *
Mercury	2		0.05	1.24 (a) *	1.82 J (a) *	0.10 UJ
Mercury (dissolved)				0.10 U	0.10 UJ	0.10 UJ
Nickel	100			118 (b)	164 J (b)	38.00 J
Nickel (dissolved)				18.00 U	18.00 UJ	18.00 UJ
Potassium				8,420 *	11,600 *	27,200 *
Potassium (dissolved)				970 U	1,400	26,900 *
Selenium	50		10	2.00 R	20.00 R	2.00 R
Selenium (dissolved)				2.00 R	2.00 R	2.00 R
Silver		100		20.90	13.60	9.40
Silver (dissolved)				6.00 U	6.00 U	6.00 U
Sodium			100,000	5,540 J	28,600 J *	22,900 J *
Sodium (dissolved)				5,110 J	12,200 J *	23,800 J *
Thallium	2			2.00 UJ	2.00 UJ	2.00 UJ
Thallium (dissolved)				2.00 UJ	2.00 UJ	2.00 UJ
Vanadium				203 J *	363 J *	40.60 J *
Vanadium (dissolved)				9.10 U	13.90 UJ	6.00 UJ
Zinc		5,000	50	347 J (a) *	438 J (a) *	3,940 J (a) *
Zinc (dissolved)				12.20 J	6.10 J	774 J (a)
Nitrates	10,000		5,000	NA	NA	NA

APPENDIX C

COST ANALYSIS BACKUP SPREADSHEETS

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W.O. NO. :06629-001-012-4000-00
LOCATION :YORKTOWN WEAPONS STATION, YORKTOWN, VA.
ESTIMATE :CONCEPTUAL/PRELIMINARY
ESTIMATOR :NGA
DATE : 14-Dec-93 09:31 AM

ESTIMATE ACCURACY: +30% TO -15%

FILENAME: LANTDIV4.WK1

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4 PROJECT SUMMARY										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES				65,500.00		7,000.00		0.00	5,000.00	77,500.00
2	CLEARING AND GRUBBING				0.00		0.00		0.00	37,700.00	37,700.00
3	EROSION AND SEDIMENTATION CONTROLS				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS				22,000.00		4,800.00		1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS				38,615.15		41,006.00		0.00	4,500.00	84,121.15
7	TRANSPORTATION AND DISPOSAL				30,640.70		46,200.00		6,325.00	344660.50	427,826.20
8	PERMITTING FEES	1.0	LS								4,000.00
9	PERMIT FOR DRUMS WITH SOLIDIFIED MATERIAL	1.0	LS								10,000.00
10	DISPOSAL CONTINGENCY FOR UNKNOWN LIQUIDS IN DRUMS (AND LAND BAN MATERIALS)	1.0	LS								4,000.00
	SUBTOTAL										779,500.00
11	OPERATIONS AND MAINTENANCE COSTS: (PRESENT WORTH)										
	DRUM SAMPLING LABOR	40.0	HRS			60.00					2,400.00
	ANALYTICS	10.0	EA							1150.00	11,500.00
	EROSION AND SEDIMENTATION CONTROLS MAINTENANCE (3 YEARS DURATION; INTEREST @ 6%)	3.0	YRS								13,400.00
	PROJECT SUBTOTAL										806,800.00
12	ADMIN. AND CONSTRUCTION SERVICES @ 20%										161,400.00
13	CONTINGENCY @ 15%										145,200.00
	T O T A L (ROUNDED)										1,113,400.00

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

FILENAME: LANTDIV4.WK1

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES										
1A	MOBILIZATION AND DEMOBILIZATION - ALLOWANCE	1.0	LS	5000.00	5,000.00	4200.00	4,200.00	0.00	0.00	3,500.00	12,700.00
1B	CONSTRUCTION FACILITIES										
	TEMPORARY FACILITIES REQUIRED FOR SUPPORT OF FIELD ACTIVITIES										
	APPROXIMATE DURATION	6.0	MO								
	MONTHLY ALLOWANCE FOR TEMPORARY FACILITIES										
	ALLOW $9,500.00 PER MONTH	1.0	MO	9500.00	57,000.00	0.00	0.00	0.00	0.00	0.00	57,000.00
	ALLOWANCE FOR INSTALLATION/SETUP	1.0	LS	3500.00	3,500.00	2800.00	2,800.00	0.00	0.00	1,500.00	7,800.00
	SUBTOTAL				65,500.00		7,000.00		0.00	5,000.00	77,500.00
2	CLEARING AND GRUBBING										
	SITE 2	4.0	ACRE								
	SITE 9	1.25	ACRE								
	SITE SSA4	2.0	ACRE								
	TOTAL AREA	7.25	ACRE	0.00	0.00	0.00	0.00	0.00	0.00	37,700.00	37,700.00
3	EROSION AND SEDIMENTATION CONTROLS										
	SILT FENCING	4960.0	LF	1.35	6,696.00	0.56	2,777.60	0.00	0.00	0.00	9,473.60
	ROCK CHECK DAMS	35.0	EA	28.75	1,006.25	63.00	2,205.00	0.00	0.00	0.00	3,211.25
	STAKED HAYBALES	180.0	EA	3.75	675.00	5.84	1,050.30	0.00	0.00	0.00	1,725.30
	TIRE CLEANERS	6.0	EA	57.50	345.00	94.50	567.00	0.00	0.00	0.00	912.00
	MAINTENANCE	1.0	LS	2500.00	2,500.00	2800.00	2,800.00	0.00	0.00	0.00	5,300.00
	NOTE: FOR COMBINED SITES 2, 9 AND SSA4										
	SUBTOTAL				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA										
4A	SITE ACCESS ROAD										
	GRADING, GEOTEXTILE AND CRUSHED STONE	4388.9	SY	4.87	21,373.94	1.08	4,740.01	0.00	0.00	0.00	26,113.96
	NOTE: FOR COMBINED SITES 2, 9 AND SSA4										
4B	STAGING AREA(S)										
	NOTE: FOR COMBINED SITES 2, 9 AND SSA4										
	GRADING	2222.2	SY	0.80	1,777.76	0.50	1,111.10	0.00	0.00	0.00	2,888.86
	GEOTEXTILES	4444.4	SY	1.89	8,399.92	0.15	666.66	0.00	0.00	0.00	9,066.58
	HDPE MEMBRANE LINER, 40 MIL	2222.2	SY	6.66	14,799.85	0.98	2,177.76	0.00	0.00	0.00	16,977.61
	RECOVERY SUMP AND PUMP	2.0	EA	5175.00	10,350.00	1120.00	2,240.00	1500.00	3,000.00	0.00	15,590.00
	ELECTRICAL POWER	2.0	EA	500.00	1,000.00	560.00	1,120.00	1500.00	3,000.00	7,000.00	12,120.00
	SUBTOTAL				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
	TOTAL SHEET NO. 2										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

FILENAME: LANTDIV4.WK1

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS, STAGING AREA AND SITE ACCESS	2.0	EA	11000.00	22,000.00	2400.00	4,800.00	600.00	1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS										
A	REMOVAL OF SURFICIAL BATTERIES AND ASSOCIATED SOILS										
	AREA 2	15.0	CY	14.07	211.05	182.00	2,730.00	0.00	0.00	0.00	2,941.05
	AREA SSA4	15.0	CY	14.07	211.05	182.00	2,730.00	0.00	0.00	0.00	2,941.05
B	BACKFILL BATTERY EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 2	11.3	CY	10.06	113.20	6.65	74.81	0.00	0.00	0.00	188.02
	AREA SSA4	11.3	CY	10.06	113.20	6.65	74.81	0.00	0.00	0.00	188.02
C	REMOVAL OF ALL SURFACE DRUMS, NO SOILS SEPARATION REQUIRED										
	AREA 2	25.0	CY	9.38	234.50	17.50	437.50	0.00	0.00	0.00	672.00
	AREA 9	40.0	CY	9.38	375.20	17.50	700.00	0.00	0.00	0.00	1,075.20
	AREA SSA4	85.0	CY	9.38	797.30	17.50	1,487.50	0.00	0.00	0.00	2,284.80
D	REMOVE MATERIALS FROM DRUMS AND CRUSH DRUMS										
	AREA 2	25.0	CY	35.18	879.38	70.00	1,750.00	0.00	0.00	0.00	2,629.38
	AREA 9	40.0	CY	35.18	1,407.00	70.00	2,800.00	0.00	0.00	0.00	4,207.00
	AREA SSA4	85.0	CY	35.18	2,989.88	70.00	5,950.00	0.00	0.00	0.00	8,939.88
E	REMOVAL OF SURFICIAL WASTE MATERIALS, NO SOILS SEPARATION REQUIRED										
	AREA 2	40.0	CY	7.82	312.80	8.75	350.00	0.00	0.00	0.00	662.80
	AREA 9	60.0	CY	7.82	469.20	8.75	525.00	0.00	0.00	0.00	994.20
	AREA SSA4	40.0	CY	7.82	312.80	8.75	350.00	0.00	0.00	0.00	662.80
	WEAPONS	140.0	EA	200.00	28,000.00	140.00	19,600.00	0.00	0.00	4,500.00	52,100.00
	WORK ITEM SUBTOTAL				36,426.56		39,559.63		0.00	4,500.00	80,486.18
	TOTAL SHEET NO. 3										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV4.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS (CONTINUED)										
	WORK ITEM SUBTOTAL, BROUGHT FORWARD				36,426.56		39,559.63		0.00	4,500.00	80,486.18
I	BACKFILL DRUM EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 2	18.8	CY	10.06	188.67	6.65	124.69	0.00	0.00	0.00	313.36
	AREA 9	30.0	CY	10.06	301.88	6.65	199.50	0.00	0.00	0.00	501.38
	AREA SSA4	63.8	CY	10.06	641.48	6.65	423.94	0.00	0.00	0.00	1,065.42
J	BACKFILL SURFICIAL WASTE EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 2	30.0	CY	10.06	301.88	6.65	199.50	0.00	0.00	0.00	501.38
	AREA 9	45.0	CY	10.06	452.81	6.65	299.25	0.00	0.00	0.00	752.06
	AREA SSA4	30.0	CY	10.06	301.88	6.65	199.50	0.00	0.00	0.00	501.38
	SUBTOTAL				38,615.15		41,006.00		0.00	4,500.00	84,121.15
	TOTAL SHEET NO. 4										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV4.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

ITEM	DESCRIPTION ALTERNATIVE 1	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
7	TRANSPORTATION AND DISPOSAL										
A	DISPOSAL OF SOILS, BATTERIES, AND OTHER AT HAZARDOUS WASTE DISPOSAL SITE										
	BATTERIES AND ASSOCIATED SOILS	30.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	10,200.00	10,200.00
	TRANSPORT OF WEAPONS CASINGS, ROUND TRIP, EOD	140.0	EA	0.00	0.00	35.00	4,900.00	0.00	0.00	14,000.00	18,900.00
B	DISPOSAL OF DRUMS AND CONTENTS										
	DRUMS, TOTAL	150.0	CY								
	HAZARDOUS	105.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	35,700.00	35,700.00
	SANITARY	45.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	2,812.50	2,812.50
C	DISPOSAL OF WASTE MATERIALS AT SANITARY LANDFILL										
	SURFICIAL WASTE MATERIALS	100.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	6,250.00	6,250.00
D	RECYCLE WASTE MATERIALS										
	SURFICIAL WASTE MATERIALS	40.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	WEAPONS	140.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	SAMPLING AND DECON OF WEAPONS CASINGS 24 HOUR LAB TURNAROUND	140.0	EA	200.00	28,000.00	280.00	39,200.00	0.00	0.00	112,700.00	179,900.00
F	SOILS SAMPLING										
	SITE 2	35.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	59,885.00	59,885.00
	SITE 9	20.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	34,220.00	34,220.00
	SITE SSA4	25.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	42,775.00	42,775.00
G	EXCAVATION OF STAINED SOILS	10.0	CY	14.07	140.70	70.00	700.00	0.00	0.00	0.00	840.70
H	WATER SAMPLING (24 HOUR LAB TURNAROUND)	5.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	11,250.00	11,250.00
I	SAMPLING OF DISPOSAL MATERIALS, TCLP & IRC	7.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	11,368.00	11,368.00
J	WATER HOLDING TANK, 10,000 GALLON CAPACITY	1.0	LS	2500.00	2,500.00	1400.00	1,400.00	6325.00	6,325.00	3,500.00	13,725.00
	SUBTOTAL				30,640.70		46,200.00		6,325.00	344,660.50	427,826.20
	SOILS SAMPLING COST PER LABORATORY ANALYSIS:										
	TCL VOC									248.00	
	TCL BNA									453.00	
	TAL METAL									277.00	
	PESTICIDES/PCB									269.00	
	EXPLOSIVES									334.00	
	TOC									62.00	
	TPH									68.00	
	TOTAL PER ANALYSIS									1,711.00	
	TOTAL SHEET NO. 5										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W.O. NO. :06629-001-012-4000-00
LOCATION :YORKTOWN WEAPONS STATION, YORKTOWN, VA.
ESTIMATE :CONCEPTUAL/PRELIMINARY
ESTIMATOR :NGA
DATE : 14-Dec-93 09:31 AM

ESTIMATE ACCURACY: +30% TO -15%

FILENAME: LANTDIV4.WK1

ITEM	DESCRIPTION ALTERNATIVE 2	MATERIAL UNIT QUANTITY	MATERIAL UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4 PROJECT SUMMARY										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES				84,500.00		7,000.00		0.00	5,000.00	96,500.00
2	CLEARING AND GRUBBING				0.00		0.00		0.00	37,700.00	37,700.00
3	EROSION AND SEDIMENTATION CONTROLS				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS				22,000.00		4,800.00		1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS				39,587.77		50,995.44		0.00	4,500.00	95,083.21
7	TRANSPORTATION AND DISPOSAL				30,640.70		50,200.00		6,325.00	364960.50	452,126.20
8	PERMITTING FEES	1.0	LS								4,000.00
9	PERMIT FOR DRUMS WITH SOLIDIFIED MATERIAL	1.0	LS								10,000.00
10	DISPOSAL CONTINGENCY FOR UNKNOWN LIQUIDS IN DRUMS (AND LAND BAN MATERIALS)	1.0	LS								4,000.00
	SUBTOTAL										833,800.00
11	OPERATIONS AND MAINTENANCE COSTS: (PRESENT WORTH)										
	DRUM SAMPLING LABOR	40.0	HRS			60.00					2,400.00
	ANALYTICS	10.0	EA							1150.00	11,500.00
	EROSION AND SEDIMENTATION CONTROLS MAINTENANCE (3 YEARS DURATION; INTEREST @ 6%)	3.0	YRS								13,400.00
	PROJECT SUBTOTAL										861,100.00
12	ADMIN. AND CONSTRUCTION SERVICES @ 20%										172,200.00
13	CONTINGENCY @ 15%										155,000.00
	T O T A L (ROUNDED)										1,188,300.00

SHEET NO. 1

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV4.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
1	MOBILIZATION AND DEMOBILIZATION, AND CONSTRUCTION FACILITIES										
1A	MOBILIZATION AND DEMOBILIZATION - ALLOWANCE	1.0	LS	5000.00	5,000.00	4200.00	4,200.00	0.00	0.00	3,500.00	12,700.00
1B	CONSTRUCTION FACILITIES										
	TEMPORARY FACILITIES REQUIRED FOR SUPPORT OF FIELD ACTIVITIES										
	APPROXIMATE DURATION	8.0	MO								
	MONTHLY ALLOWANCE FOR TEMPORARY FACILITIES										
	ALLOW $9,500.00 PER MONTH	1.0	MO	9500.00	76,000.00	0.00	0.00	0.00	0.00	0.00	76,000.00
	ALLOWANCE FOR INSTALLATION/SETUP	1.0	LS	3500.00	3,500.00	2800.00	2,800.00	0.00	0.00	1,500.00	7,800.00
	SUBTOTAL				84,500.00		7,000.00		0.00	5,000.00	96,500.00
2	CLEARING AND GRUBBING										
	SITE 2	4.00	ACRE								
	SITE 9	1.25	ACRE								
	SITE SSA4	2.00	ACRE								
	TOTAL AREA	7.25	ACRE	0.00	0.00	0.00	0.00	0.00	0.00	37,700.00	37,700.00
3	EROSION AND SEDIMENTATION CONTROLS										
	SILT FENCING	4960.0	LF	1.35	6,696.00	0.56	2,777.60	0.00	0.00	0.00	9,473.60
	ROCK CHECK DAMS	35.0	EA	28.75	1,006.25	63.00	2,205.00	0.00	0.00	0.00	3,211.25
	STAKED HAYBALES	180.0	EA	3.75	675.00	5.84	1,050.30	0.00	0.00	0.00	1,725.30
	TIRE CLEANERS	6.0	EA	57.50	345.00	94.50	567.00	0.00	0.00	0.00	912.00
	MAINTENANCE	1.0	LS	2500.00	2,500.00	2800.00	2,800.00	0.00	0.00	0.00	5,300.00
	NOTE: FOR COMBINED SITES 2, 9 AND SSA4										
	SUBTOTAL				11,222.25		9,399.90		0.00	0.00	20,622.15
4	SITE ACCESS ROAD AND STAGING AREA										
4A	SITE ACCESS ROAD										
	GRADING, GEOTEXTILE AND CRUSHED STONE	4388.9	SY	4.87	21,373.94	1.08	4,740.01	0.00	0.00	0.00	26,113.96
	NOTE: FOR COMBINED SITES 2, 9 AND SSA4										
4B	STAGING AREA(S)										
	NOTE: FOR COMBINED SITES 2, 9 AND SSA4										
	GRADING	2222.2	SY	0.80	1,777.76	0.50	1,111.10	0.00	0.00	0.00	2,888.86
	GEOTEXTILES	4444.4	SY	1.89	8,399.92	0.15	666.66	0.00	0.00	0.00	9,066.58
	HDPE MEMBRANE LINER, 40 MIL	2222.2	SY	6.66	14,799.85	0.98	2,177.76	0.00	0.00	0.00	16,977.61
	RECOVERY SUMP AND PUMP	2.0	EA	5175.00	10,350.00	1120.00	2,240.00	1500.00	3,000.00	0.00	15,590.00
	ELECTRICAL POWER	2.0	EA	500.00	1,000.00	560.00	1,120.00	1500.00	3,000.00	7,000.00	12,120.00
	SUBTOTAL				57,701.47		12,055.53		6,000.00	7,000.00	82,757.00
	TOTAL SHEET NO. 2										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

FILENAME: LANTDIV4.WK1

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
5	REMOVAL/GRADING AND RESTORATION OF DISTURBED AREAS, STAGING AREA AND SITE ACCESS	2.0	EA	11000.00	22,000.00	2400.00	4,800.00	600.00	1,200.00	3,000.00	31,000.00
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS										
A	REMOVAL OF ALL BATTERIES AND ASSOCIATED SOILS										
	AREA 2	30.0	CY	14.07	422.10	182.00	5,460.00	0.00	0.00	0.00	5,882.10
	AREA SSA4	45.0	CY	14.07	633.15	182.00	8,190.00	0.00	0.00	0.00	8,823.15
B	BACKFILL BATTERY EXCAVATIONS WITH LOW PERMEABILITY BACKFILL										
	AREA 2	22.5	CY	10.06	226.35	6.65	149.63	0.00	0.00	0.00	375.98
	AREA SSA4	33.8	CY	10.06	339.53	6.65	224.44	0.00	0.00	0.00	563.96
C	REMOVAL OF ALL SURFACE DRUMS, WITH ONSITE SOILS SEPARATION										
	AREA 2	25.0	CY	9.38	234.50	21.88	546.88	0.00	0.00	0.00	781.38
	AREA 9	40.0	CY	9.38	375.20	21.88	875.00	0.00	0.00	0.00	1,250.20
	AREA SSA4	85.0	CY	9.38	797.30	21.88	1,859.38	0.00	0.00	0.00	2,656.68
D	REMOVE MATERIALS FROM DRUMS AND CRUSH DRUMS										
	AREA 2	25.0	CY	35.18	879.38	70.00	1,750.00	0.00	0.00	0.00	2,629.38
	AREA 9	40.0	CY	35.18	1,407.00	70.00	2,800.00	0.00	0.00	0.00	4,207.00
	AREA SSA4	85.0	CY	35.18	2,989.88	70.00	5,950.00	0.00	0.00	0.00	8,939.88
E	REMOVAL OF SURFICIAL WASTE MATERIALS, WITH ONSITE SOILS SEPARATION										
	AREA 2	40.0	CY	7.82	312.80	15.31	612.50	0.00	0.00	0.00	925.30
	AREA 9	60.0	CY	7.82	469.20	15.31	918.75	0.00	0.00	0.00	1,387.95
	AREA SSA4	40.0	CY	7.82	312.80	15.31	612.50	0.00	0.00	0.00	925.30
	WEAPONS	140.0	EA	200.00	28,000.00	140.00	19,600.00	0.00	0.00	4,500.00	52,100.00
	WORK ITEM SUBTOTAL				37,399.18		49,549.06		0.00	4,500.00	91,448.24
	TOTAL SHEET NO. 3										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

FILENAME: LANTDIV4.WK1

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
6	REMOVAL, LOADING, AND PREPARATION OF MISCELLANEOUS DEBRIS (CONTINUED)										
	WORK ITEM SUBTOTAL, BROUGHT FORWARD				37,399.18		49,549.06		0.00	4,500.00	91,448.24
I	BACKFILL DRUM EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 2	18.8	CY	10.06	188.67	6.65	124.69	0.00	0.00	0.00	313.36
	AREA 9	30.0	CY	10.06	301.88	6.65	199.50	0.00	0.00	0.00	501.38
	AREA SSA4	63.8	CY	10.06	641.48	6.65	423.94	0.00	0.00	0.00	1,065.42
J	BACKFILL SURFICIAL WASTE EXCAVATIONS WITH LOW PERMEABILITY SOILS										
	AREA 2	30.0	CY	10.06	301.88	6.65	199.50	0.00	0.00	0.00	501.38
	AREA 9	45.0	CY	10.06	452.81	6.65	299.25	0.00	0.00	0.00	752.06
	AREA SSA4	30.0	CY	10.06	301.88	6.65	199.50	0.00	0.00	0.00	501.38
	SUBTOTAL				39,587.77		50,995.44		0.00	4,500.00	95,083.21
	TOTAL SHEET NO. 4										

ROY F. WESTON, INC.
WEST CHESTER, PENNSYLVANIA

PROJECT :LANTDIV "NAVY CLEAN" CTO - 0125
W. O. NO. :06629-001-012-4000-00

FILENAME: LANTDIV4.WK1

ITEM	DESCRIPTION ALTERNATIVE 2	UNIT QUANTITY	UNIT	MATERIAL UNIT COST	MATERIAL TOTAL MATERIAL	LABOR UNIT COST	LABOR TOTAL LABOR	EQUIPMENT UNIT COST	EQUIPMENT TOTAL EQUIPMENT	SUBCONTRACTS TOTAL SUBCONTRACTS	TOTAL
	INTERIM REMEDIATION OF SITES 2, 9 AND SSA4										
7	TRANSPORTATION AND DISPOSAL										
A	DISPOSAL OF SOILS, BATTERIES, AND OTHER AT HAZARDOUS WASTE DISPOSAL SITE										
	BATTERIES AND ASSOCIATED SOILS	75.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	25500.00	25,500.00
	TRANSPORT OF WEAPONS CASINGS, ROUND TRIP, EOD	140.0	EA	0.00	0.00	35.00	4,900.00	0.00	0.00	14,000.00	18,900.00
B	DISPOSAL OF DRUMS AND CONTENTS										
	DRUMS, TOTAL	150.0	CY								
	HAZARDOUS	105.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	35,700.00	35,700.00
	SANITARY	45.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	2,812.50	2,812.50
C	DISPOSAL OF WASTE MATERIALS AT SANITARY LANDFILL										
	SURFICIAL WASTE MATERIALS	100.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	6,250.00	6,250.00
D	RECYCLE WASTE MATERIALS										
	SURFICIAL WASTE MATERIALS	40.0	CY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	WEAPONS	140.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	SAMPLING AND DECON OF WEAPONS CASINGS 24 HOUR LAB TURNAROUND	140.0	EA	200.00	28,000.00	280.00	39,200.00	0.00	0.00	112,700.00	179,900.00
F	SOILS SAMPLING *										
	AREA 2	35.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	59,885.00	59,885.00
	AREA 9	20.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	34,220.00	34,220.00
	AREA SSA4	25.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	42,775.00	42,775.00
G	EXCAVATION OF STAINED SOILS	10.0	CY	14.07	140.70	70.00	700.00	0.00	0.00	0.00	840.70
H	WATER SAMPLING (24 HOUR LAB TURNAROUND)	5.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	11,250.00	11,250.00
I	SAMPLING OF DISPOSAL MATERIALS, TCLP & IRC	7.0	EA	0.00	0.00	0.00	0.00	0.00	0.00	11,368.00	11,368.00
I	WATER HOLDING TANK, 10,000 GALLON CAPACITY	1.0	LS	2500.00	2,500.00	1400.00	1,400.00	6325.00	6,325.00	3,500.00	13,725.00
J	TESTING FOR SUBSURFACE BATTERIES	5.0	DAYS	0.00	0.00	800.00	4,000.00	0.00	0.00	5,000.00	9,000.00
	SUBTOTAL				30,640.70		50,200.00		6,325.00	364,960.50	452,126.20
	* SEE ALTERNATIVE NO. 1 FOR ANALYSIS DETAIL COSTS										
	TOTAL SHEET NO. 5										

APPENDIX D

RISK-BASED CONCENTRATIONS

United States
Environmental Protection Agency

Region III
Philadelphia, PA 19107

EPA/903/R-93-001
January 1993

Region III
Technical Guidance Manual
Risk Assessment

Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening

EPA Contact: Dr. Roy L. Smith

EPA
Region III

Hazardous Waste Management Division
Office of Superfund Programs
January 1993

Human health risk assessment includes effort-intensive steps which require many detailed calculations by experts. Most baseline risk assessments are dominated by a few chemicals and a few routes of exposure. Effort expended on minor contaminants and exposure routes, i.e., those which do not influence overall risk, is essentially wasted. This guidance is intended to identify and focus on dominant contaminants of concern and exposure routes at the earliest feasible point in the baseline risk assessment. Use of these methods will decrease effort and time spent assessing risk, without loss of protectiveness. This guidance is not intended for other risk assessment activities, such as determining preliminary remediation goals.

SELECTING CONTAMINANTS AND EXPOSURE ROUTES OF CONCERN

Most samples from hazardous waste sites are analyzed for 103 target compounds and analytes recommended by the EPA Superfund program. Semi-volatile analysis can detect additional tentatively identified compounds not on the target lists. Special analytical services procedures, if used, may find still more contaminants. The combined number of contaminants detected at a site sometimes exceeds one hundred.

While EPA considers it necessary to gather information on many contaminants, very little of this data actually influences the overall quantitative assessment of health risk. For most sites, baseline risk assessments are dominated by a few contaminants and a few routes of exposure. The remaining tens, or hundreds, of detected contaminants have a minimal influence on total risk. This small impact is lost by rounding. Entire environmental media may contain not a single contaminant at a concentration which could adversely affect public health. Quantitative risk calculations using data from such "risk-free" media have no effect on the overall risk estimate for the site.

The EPA baseline risk assessment process at several points requires careful data evaluation by scientific experts. These evaluations, which are contaminant-specific, include: (1) statistical comparisons between site-related and background samples, (2) special handling of undetected contaminants, (3) calculation of toxicity equivalence, (4) evaluation of frequency of detection, and (5) comparison with ARARs. Because overall risk is usually driven by a few contaminants and exposure routes, effort spent in detailed evaluation of minor contaminants and routes of exposure is essentially wasted. For some sites, this wasted effort exceeds 90% of the total.

The baseline risk assessment process can be made more efficient by focusing on dominant contaminants and routes of exposure at the earliest feasible stage. The mechanisms recommended for this are (1) a re-ordering of the process of eliminating contaminants and routes of exposure, and (2) use of a risk-based concentration screen. Appropriately used, this process can dramatically reduce the effort of risk assessment, while not changing the result significantly.

EXISTING GUIDANCE

Chapter 5 of "RAGS IA" (Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A); EPA, 1989) provides a detailed procedure for evaluating data for a baseline risk assessment. This

procedure includes steps by which the risk assessor selects contaminants of concern in each exposure medium. These steps are summarized in Table 1.

There are two major limitations to the RAGS procedure. First, the eliminating step (a concentration toxicity screen) comes late in the process. Many of the preceding steps (e.g., evaluation of quantitation limits, comparison with background, calculation of toxicity equivalence, and evaluation of frequency of detection) are contaminant- and medium-specific. They require the sustained attention of an expert, and cannot be automated. If the contaminant is eliminated, this work is wasted.

The second limitation is that the concentration toxicity screen compares only relative risk among contaminants in the same medium. While very efficient at selecting dominant contaminants in each medium, this method does not evaluate significance of total risk for the medium. Thus, the concentration toxicity screen can eliminate contaminants, but not routes of exposure.

RECOMMENDED METHODOLOGY

This guidance makes two changes intended to remove the limitations in existing guidance. These recommendations are intended for baseline risk assessments.

1. Re-ordering of steps. The eliminating screen is moved forward in the data evaluation process to a point immediately following data quality evaluation. The new process is shown in Table 2. Effort-intensive steps such as evaluation of quantitation limits and comparison with background now follow the eliminating screen. The steps are divided into four categories: data quality evaluation, initial data set reduction, re-inclusion of special cases, and optional final data set reduction.

The data quality evaluation steps (evaluating appropriateness of methods and qualifiers, significance of blank contamination, and need for special analyses) should be done as described in RAGS IA, Chapter 5. Next, the risk assessor should consult with the RPM to discuss the use of the risk-based concentration table (described in item [2] below) as a screening mechanism. With the RPM's approval, the risk assessor should reduce the data set and document the rationale for eliminating contaminants or routes of exposure from further analysis.

After the initial data set reduction, the risk assessor and RPM should consider [illegible] specific contaminants on the basis of historical data, toxicity, mobility, persistence, bioaccumulation, special exposure routes, special treatability problems, or exceedance of ARARs. These activities should proceed as described in Section 5.9 of RAGS IA.

Finally, optional further reductions in the data set may be justified, based on the status of a contaminant as an essential nutrient, low frequency of detection, or no statistical difference between site and background levels. These evaluations, the most complicated and contaminant-specific, are saved for last.

2. Screening by risk-based concentrations. The screening method is changed from the relative concentration toxicity screen of RAGS IA to an absolute comparison of risk. This is done by means of a table of risk-based concentrations (Appendix I). This table contains levels of nearly 600 contaminants in air, drinking water, fish tissue, and soil, which correspond to a systemic hazard quotient of 0.1 or a lifetime cancer risk of 10^{-6}. The risk-based concentrations were developed using protective default exposure scenarios suggested by EPA (1991) and the best available reference doses and carcinogenic potency slopes (see the table for sources), and represent relatively protective environmental concentrations at which EPA would typically not take action.

The risk-based concentration screen is used as follows:

(a) The risk assessor extracts the maximum concentration of each substance detected in each medium.

(b) If the maximum concentration exceeds the risk-based concentration for that medium, the contaminant is retained for risk assessment, for all routes of exposure involving that medium. Otherwise the contaminant is dropped for that medium.

(c) If a specific contaminant does not exceed its risk-based concentration for any medium, the contaminant is dropped from the risk assessment.

(d) If no contaminant in a specific medium exceeds its risk-based concentration, the medium is dropped from the risk assessment.

(e) All contaminants and exposure routes which are dropped are kept on a sub-list and considered for re-inclusion, based on special properties.

(f) If the risk assessor wants to include a route of exposure not covered in the risk-based concentration table, the equations provided in Appendix I can serve as the basis for new risk-

based concentrations. Similarly, the risk assessor can use the same equations to calculate alternate risk levels (i.e., other than a systemic hazard quotient of 0.1 and lifetime cancer risk of 10^{-6}) to be the basis for screening.

SUMMARY

The process by which contaminants and exposure routes are selected in quantitative risk assessment can be made less effort-intensive by two simple changes. First, high-effort steps should be postponed until later in the selection process, because performing these operations on trivial contaminants and exposure routes is pointless. Second, changing from a relative concentration toxicity screen to an absolute risk-based concentration screen improves the risk assessor's ability to focus on dominant contaminants and exposure routes at an earlier stage.

REFERENCES

EPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". OSWER Directive 9285.6-03, Office of Emergency and Remedial Response, March 25, 1991.

EPA, 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, December, 1989. EPA/540/1-89/002.

For additional information, call (215) 597-6682.

Approved by: _____

Thomas C. Voltaggio, Director
Hazardous Waste Management Division

Table 1. Summary of existing EPA guidance on selecting contaminants of concern (EPA, 1989, chapter 5)
Section 5.1: Combining data from site investigations
1. Determine if methods are appropriate
2. Evaluate quantitation limits
3. Determine if qualifiers are appropriate
4. Determine if significant blank contamination exists
5. Determine if special analyses for tentatively identified compounds are needed
6. Compare site samples to background
Section 5.9: Further reduction in the number of chemicals (optional)
7. Consult with RPM
8. Document rationale for eliminating chemicals
9. Examine historical information
10. Consider exceptional toxicity, mobility, persistence, or bioaccumulation
11. Consider special exposure routes
12. Consider special treatability problems
13. Determine if contaminants exceed ARARs
14. Group chemicals by class, evaluate toxicity equivalence
15. Evaluate frequency of detection
16. Evaluate essentiality
17. Use a concentration toxicity screen

Table 2. EPA Region III guidance on selecting contaminants and exposure routes of concern
A. Data quality evaluation
1. Determine if methods are appropriate
2. Determine if qualifiers are appropriate
3. Determine if significant blank contamination exists
4. Determine if special analyses for tentatively identified compounds are needed
B. Reduce data set using risk-based concentration screen
5. Consult with RPM
6. Use risk-based concentration table to screen contaminants and exposure routes of concern
7. Document rationale for eliminating chemicals and exposure routes
C. Consider re-including eliminated chemicals and routes, based on:
8. Historical information
9. Exceptional toxicity, mobility, persistence, or bioaccumulation
10. Special exposure routes
11. Special treatability problems
12. ARARs exceedance
13. Toxicity equivalence of chemical class (*e.g.*, CDD/CDFs, PAHs)
D. Make further specific reductions in data set (optional)
14. Evaluate essentiality
15. Evaluate frequency of detection
16. Compare site samples to background

Appendix I:
EPA Region III Risk-Based Concentration Table
Background Information

The risk-based concentrations were calculated as follows:

GENERAL: Separate risk-based concentrations were calculated for carcinogenic and non-carcinogenic effects of each compound for each pathway. The concentration in the table is the lower of the two, rounded to two significant figures. For non-carcinogenic effects, the averaging time equals the exposure duration, so the exposure duration term has been used for both. The following terms were used in the calculations:

General:

Oral carcinogenic slope factor $(mg/kg/d)^{-1}$:	SF_o
Inhaled carcinogenic slope factor $(mg/kg/d)^{-1}$:	SF_i
Oral reference dose (mg/kg/d):	RfD_o
Inhaled reference dose (mg/kg/d):	RfD_i
Target cancer risk:	TR
Target hazard quotient:	THQ
Body weight, adult (kg):	BW_a
Body weight, child age 1-6 (kg):	BW_c
Averaging time (years of life):	AT
Air breathed (m^3/d):	IR_a
Drinking water ingestion (L/d):	IR_w
Fish ingestion (g/d):	IR_f
Soil ingestion - age adjusted (mg/d)	IRS_{ad}
Soil ingestion - age 1-6 (mg/d):	IRS_c
Soil ingestion - adult (mg/d):	IRS_a

Residential:

Exposure frequency (d/y):	EF_r
Exposure duration (y):	ED_r
Volatilization factor (L/m^3):	VF

Commercial/industrial:

Exposure frequency (d/y):	EF_c
Exposure duration (y):	ED_c

The priority among sources of toxicological constants was as follows: (1) IRIS, (2) HEAST, (3) HEAST alternative method, (4) ECAO-Cincinnati, (5) other EPA documents, (6) withdrawn from IRIS, and (7) withdrawn from HEAST. Each source was used only if numbers from higher-priority sources were unavailable.

ALGORITHMS:

1. Residential water use ($\mu g/L$). Volatilization terms were calculated only for compounds with "y" in the "Volatile" column. Compounds having a Henry's Law constant greater than 10^{-5} were considered volatile. The list may be incomplete, but is unlikely to include false positives. The equations and the volatilization factor (VF, above) were obtained from the draft RAGS IB. Oral potency slopes and reference doses were used for both oral and inhaled exposures for volatile compounds lacking inhalation values. Inhaled potency slopes were substituted for unavailable oral potency slopes only for volatile compounds; inhaled RfDs were substituted for unavailable oral RfDs for both volatile and non-volatile compounds.

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot ([VF \cdot IR_a \cdot CPS_i] + [IR_w \cdot SF_o])}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot BW_a \cdot ED_r \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot \left(\frac{VF \cdot IR_a}{RfD_i} + \frac{IR_w}{RfD_o}\right)}$$

2. Air ($\mu g/m^3$). Oral potency slopes and references were used where inhalation values were not available.

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot IR_a \cdot SF_i}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_i \cdot BW_a \cdot ED_r \cdot 365\frac{d}{y} \cdot 1000\frac{mg}{mg}}{EF_r \cdot ED_r \cdot IR_a}$$

3. Fish (mg/kg):

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y}}{EF_r \cdot ED_r \cdot \frac{IR_f}{1000\frac{g}{kg}} \cdot SF_o}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_o \cdot BW_a \cdot ED_c \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IR_s}{1000\frac{mg}{kg}}}$$

4. Soil commercial/industrial (mg/kg): The default exposure assumption that only 50% of incidential soil ingestion occurs at work has been omitted.

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IRS_c}{10^6\frac{mg}{kg}} \cdot SF_o}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_o \cdot BW_a \cdot ED_c \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IRS_c}{10^6\frac{mg}{kg}}}$$

5. Soil residential (mg/kg):

a. Carcinogenic effects:

$$\frac{TR \cdot BW_a \cdot AT \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IRS_{ac}}{10^6\frac{mg}{kg}} \cdot CPS_o}$$

b. Non-carcinogenic effects:

$$\frac{THQ \cdot RfD_o \cdot BW_c \cdot ED_c \cdot 365\frac{d}{y}}{EF_c \cdot ED_c \cdot \frac{IRS_c}{10^6\frac{mg}{kg}}}$$

EXPOSURE ASSUMPTIONS:	
1-General:	
Target cancer risk:	1e-06
Target hazard quotient:	0.1
Body weight, adult (kg):	70
Body weight, age 1-6 (kg):	15
Averaging time (years of life):	70
Air breathed (m3/d):	20
Drinking water ingestion (l/d):	2
Fish ingestion (g/d):	54
Soil ingestion - age adjusted (mg/d):	100
Soil ingestion - age 1-6 (mg/d):	200
Soil ingestion - adult (mg/d):	100
2-Residential:	
Exposure frequency (d/y):	350
Exposure duration (y):	30
Volatilization factor (L/m3):	0.5
3-Occupational:	
Exposure frequency (d/y):	250
Exposure duration (y):	25

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Acephate	4.00e-03 i		8.70e-03 i			9.8	0.98	0.36	330	31
Acetaldehyde		2.57e-03 i		7.70e-03 i		9.4	0.94			
Acetone	1.00e-01 i					370	37	14	10000	780
Acetone cyanohydrin	7.00e-02 h	2.86e-03 a				260	1	9.5	7200	550
Acetonitrile	6.00e-03 i	1.43e-02 a				22	5.2	0.81	610	47
Acetophenone	1.00e-01 i	5.71e-06 a			y	0.0042	0.0021	14	10000	780
Acifluorfen	1.30e-02 i					47	4.7	1.8	1300	100
Acrolein	2.00e-02 h	5.71e-06 i				73	0.0021	2.7	2000	160
Acrylamide	2.00e-04 i		4.50e+00 i	4.55e+00 i		0.019	0.0019	0.0007	0.64	0.38
Acrylic acid	8.00e-02 i	8.57e-05 i				290	0.031	11	8200	630
Acrylonitrile		5.71e-04 i	5.40e-01 i	2.38e-01 i		0.16	0.036	0.0058	5.3	3.2
Alachlor	1.00e-02 i		8.05e-02 h			1.1	0.11	0.039	36	21
Alar	1.50e-01 i					550	55	20	15000	1200
Aldicarb	2.00e-04 i					0.73	0.073	0.027	20	1.6
Aldicarb sulfone	3.00e-04 x					1.1	0.11	0.041	31	2.3
Aldrin	3.00e-05 i		1.70e+01 i	1.72e+01 i		0.005	0.0005	0.00019	0.17	0.1
Ally	2.50e-01 i					910	91	34	26000	2000
Allyl alcohol	5.00e-03 i					18	1.8	0.68	510	39
Allyl chloride	5.00e-02 h	2.86e-04 i				180	0.1	6.8	5100	390
Aluminum	2.90e+00 o					11000	1100	390	300000	23000
Aluminum phosphide	4.00e-04 i					1.5	0.15	0.054	41	3.1
Amdro	3.00e-04 i					1.1	0.11	0.041	31	2.3
Ametryn	9.00e-03 i					33	3.3	1.2	920	70
m-Aminophenol	7.00e-02 h					260	26	9.5	7200	550
4-Aminopyridine	2.00e-05 h					0.073	0.0073	0.0027	2	0.16
Amitraz	2.50e-03 i					9.1	0.91	0.34	260	20
Ammonia		2.86e-02 i				100	10			
Ammonium sulfamate	2.00e-01 i					730	73	27	20000	1600
Aniline		2.86e-04 i	5.70e-03 i			1	0.1	0.55	500	300
Antimony and compounds	4.00e-04 i					1.5	0.15	0.054	41	3.1
Antimony pentoxide	5.00e-04 h					1.8	0.18	0.068	51	3.9
Antimony potassium tartrate	9.00e-04 h					3.3	0.33	0.12	92	7
Antimony tetroxide	4.00e-04 h					1.5	0.15	0.054	41	3.1
Antimony trioxide	4.00e-04 h					1.5	0.15	0.054	41	3.1
Apollo	1.30e-02 i					47	4.7	1.8	1300	100
Aramite	3.00e-02 h		2.50e-02 i	2.49e-02 i		3.4	0.34	0.13	110	68
Arsenic	3.00e-04 i					1.1	0.11	0.041	31	2.3
Arsenic (as carcinogen)			1.75e+00 i	1.51e+01 i		0.049	0.00057	0.0018	1.6	0.97

Key to Data Sources: i=IRIS x=Withdrawn from IRIS h=HEAST a=HEAST alternate method y=Withdrawn from HEAST c=EPA-ECAO o=Other EPA documents

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Assure	9.00e-03 i					33	3.3	1.2	920	70
Asulam	5.00e-02 i					180	18	6.8	5100	390
Atrazine	5.00e-03 i		2.22e-01 h			0.38	0.038	0.014	13	7.7
Avermectin B1	4.00e-04 i					1.5	0.15	0.054	41	3.1
Azobenzene			1.10e-01 i	1.09e-01 i		0.77	0.078	0.029	26	15
Barium and compounds	7.00e-02 i	1.43e-04 a				260	0.052	9.5	7200	550
Baygon	4.00e-03 i					15	1.5	0.54	410	31
Bayleton	3.00e-02 i					110	11	4.1	3100	230
Baythroid	2.50e-02 i					91	9.1	3.4	2600	200
Benefin	3.00e-01 i					1100	110	41	31000	2300
Benomyl	5.00e-02 i					180	18	6.8	5100	390
Bentazon	2.50e-03 i					9.1	0.91	0.34	260	20
Benzaldehyde	1.00e-01 i				y	61	37	14	10000	780
Benzene			2.90e-02 i	2.91e-02 i	y	0.49	0.29	0.11	99	59
Benzidine	3.00e-03 i		2.30e+02 i	2.35e+02 i		0.00037	0.000036	0.000014	0.012	0.0074
Benzoic acid	4.00e+00 i					15000	1500	540	410000	31000
Benzotrichloride			1.30e+01 i			0.0066	0.00066	0.00024	0.22	0.13
Benzyl alcohol	3.00e-01 h					1100	110	41	31000	2300
Benzyl chloride			1.70e-01 i		y	0.083	0.05	0.019	17	10
Beryllium and compounds	5.00e-03 i		4.30e+00 i	8.40e+00 i		0.02	0.001	0.00073	0.67	0.4
Bidrin	1.00e-04 i					0.37	0.037	0.014	10	0.78
Biphenthrin (Talstar)	1.50e-02 i					55	5.5	2	1500	120
1,1-Biphenyl	5.00e-02 i					180	18	6.8	5100	390
Bis(2-chloroethyl)ether			1.10e+00 i	1.16e+00 i	y	0.012	0.0074	0.0029	2.6	1.5
Bis(2-chloroisopropyl)ether	4.00e-02 i		7.00e-02 h	3.50e-02 h	y	0.35	0.24	0.045	41	24
Bis(chloromethyl)ether			2.20e+02 i	2.17e+02 i	y	0.000065	0.000039	0.000014	0.013	0.0077
Bis(2-chloro-1-methylethyl)ether			7.00e-02 y	7.00e-02 y		1.2	0.12	0.045	41	24
Bis(2-ethylhexyl)phthalate (DEHP)	2.00e-02 i		1.40e-02 i			6.1	0.61	0.23	200	120
Bisphenol A	5.00e-02 i					180	18	6.8	5100	390
Boron	9.00e-02 i	5.71e-03 h				330	2.1	12	9200	700
Boron trifluoride		2.00e-04 h				0.73	0.073			
Bromodichloromethane	2.00e-02 i		1.30e-01 i		y	0.11	0.066	0.024	22	13
Bromoethene				1.10e-01 h	y	0.13	0.077			
Bromoform (tribromomethane)	2.00e-02 i		7.90e-03 i	3.85e-03 i	y	3.1	2.2	0.4	360	160
Bromomethane	1.40e-03 i	1.43e-03 i			y	0.87	0.52	0.19	140	11
4-Bromophenyl phenyl ether	5.80e-02 o					210	21	7.8	5900	450
Bromophos	5.00e-03 h					18	1.8	0.68	510	39
Bromoxynil	2.00e-02 i					73	7.3	2.7	2000	160

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Bromoxynil octanoate	2.00e-02 i					73	7.3	2.7	2000	160
1,3-Butadiene				9.80e-01 i	y	0.014	0.0087			
1-Butanol	1.00e-01 i					370	37	14	10000	780
Butylate	5.00e-02 i					180	18	6.8	5100	390
Butyl benzyl phthalate	2.00e-01 i					730	73	27	20000	1600
Butylphthalyl butylglycolate	1.00e+00 i					3700	370	140	100000	7800
Cacodylic acid	3.00e-03 h					11	1.1	0.41	310	23
Cadmium and compounds	5.00e-04 i			6.30e+00 i		1.8	0.0014	0.068	51	3.9
Caprolactam	5.00e-01 i					1800	180	68	51000	3900
Captafol	2.00e-03 i		8.60e-03 h			7.3	0.73	0.27	200	16
Captan	1.30e-01 i		3.50e-03 h			24	2.4	0.9	820	490
Carbaryl	1.00e-01 i					370	37	14	10000	780
Carbazole			2.00e-02 h			4.3	0.43	0.16	140	85
Carbofuran	5.00e-03 i					18	1.8	0.68	510	39
Carbon disulfide	1.00e-01 i	2.86e-03 h			y	2.1	1	14	10000	780
Carbon tetrachloride	7.00e-04 i		1.30e-01 i	5.25e-02 i	y	0.22	0.16	0.024	22	5.5
Carbosulfan	1.00e-02 i					37	3.7	1.4	1000	78
Carboxin	1.00e-01 i					370	37	14	10000	780
Chloral	2.00e-03 i					7.3	0.73	0.27	200	16
Chloramben	1.50e-02 i					55	5.5	2	1500	120
Chloranil			4.03e-01 h			0.21	0.021	0.0078	7.1	4.2
Chlordane	6.00e-05 i		1.30e+00 i	1.30e+00 i		0.066	0.0066	0.0024	2.2	0.47
Chlorimuron-ethyl	2.00e-02 i					73	7.3	2.7	2000	160
Chlorine dioxide		5.71e-05 i				0.21	0.021			
Chloroacetaldehyde	6.90e-03 o					25	2.5	0.93	710	54
Chloroacetic acid	2.00e-03 h					7.3	0.73	0.27	200	16
2-Chloroacetophenone		8.57e-06 i				0.031	0.0031			
4-Chloroaniline	4.00e-03 i					15	1.5	0.54	410	31
Chlorobenzene	2.00e-02 i	5.71e-03 a			y	3.9	2.1	2.7	2000	160
Chlorobenzilate	2.00e-02 i					73	7.3	2.7	2000	160
p-Chlorobenzoic acid	2.00e-01 h					730	73	27	20000	1600
4-Chlorobenzotrifluoride	2.00e-02 h					73	7.3	2.7	2000	160
2-Chloro-1,3-butadiene	7.00e-03 h	2.86e-02 a			y	11	10	0.95	720	55
1-Chlorobutane	4.00e-01 h				y	240	150	54	41000	3100
2-Chloroethyl vinyl ether	2.50e-02 o				y	15	9.1	3.4	2600	200
Chloroform	1.00e-02 i		6.10e-03 i	8.05e-02 i	y	0.21	0.11	0.52	470	78
Chloromethane			1.30e-02 h	6.30e-03 h	y	1.9	1.4	0.24	220	130
4-Chloro-2-methylaniline			5.80e-01 h			0.15	0.015	0.0054	4.9	2.9

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
4-Chloro-2,2-methylaniline hydrochloride			4.60e-01 h			0.19	0.019	0.0069	6.2	3.7
beta-Chloronaphthalene	8.00e-02 i					290	29	11	8200	630
o-Chloronitrobenzene			2.50e-02 h		y	0.57	0.34	0.13	110	68
p-Chloronitrobenzene			1.80e-02 h		y	0.79	0.47	0.18	160	95
2-Chlorophenol	5.00e-03 i					18	1.8	0.68	510	39
2-Chloropropane		2.86e-02 h			y	17	10			
Chlorothalonil	1.50e-02 i		1.10e-02 h			7.7	0.77	0.29	260	120
o-Chlorotoluene	2.00e-02 i				y	12	7.3	2.7	2000	160
Chlorpropham	2.00e-01 i					730	73	27	20000	1600
Chlorpyrifos	3.00e-03 i					11	1.1	0.41	310	23
Chlorpyrifos-methyl	1.00e-02 h					37	3.7	1.4	1000	78
Chlorsulfuron	5.00e-02 i					180	18	6.8	5100	390
Chlorthiophos	8.00e-04 h					2.9	0.29	0.11	82	6.3
Chromium III and compounds	1.00e+00 i	5.71e-07 y				3700	0.00021	140	100000	7800
Chromium VI and compounds	5.00e-03 i			4.20e+01 i		18	0.0002	0.68	510	39
Coal tars				2.20e+00 h			0.0039			
Cobalt		2.86e-04 e				1	0.1			
Coke Oven Emissions				2.17e+00 i			0.0039			
Copper and compounds	3.71e-02 h					140	14	5	3800	290
Crotonaldehyde	1.00e-02 x		1.90e+00 h	1.90e+00 y		0.045	0.0045	0.0017	1.5	0.9
Cumene	4.00e-02 i	2.57e-03 h				150	0.94	5.4	4100	310
Cyanazine	2.00e-03 x					7.3	0.73	0.27	200	16
Cyanides										
Barium cyanide	1.00e-01 h					370	37	14	10000	780
Copper cyanide	5.00e-03 i					18	1.8	0.68	510	39
Calcium cyanide	4.00e-02 i					150	15	5.4	4100	310
Cyanogen	4.00e-02 i					150	15	5.4	4100	310
Cyanogen bromide	9.00e-02 i					330	33	12	9200	700
Cyanogen chloride	5.00e-02 i					180	18	6.8	5100	390
Free cyanide	2.00e-02 i					73	7.3	2.7	2000	160
Hydrogen cyanide	2.00e-02 i					73	7.3	2.7	2000	160
Potassium cyanide	5.00e-02 i					180	18	6.8	5100	390
Potassium silver cyanide	2.00e-01 i					730	73	27	20000	1600
Silver cyanide	1.00e-01 i					370	37	14	10000	780
Sodium cyanide	4.00e-02 i					150	15	5.4	4100	310
Zinc cyanide	5.00e-02 i					180	18	6.8	5100	390
Cyclohexanone	5.00e+00 i				y	3000	1800	680	510000	39000

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Cyclohexlamine	2.00e-01 i					730	73	27	20000	1600
Cyhalothrin/Karate	5.00e-03 i					18	1.8	0.68	510	39
Cypermethrin	1.00e-02 i					37	3.7	1.4	1000	78
Cyromazine	7.50e-03 i					27	2.7	1	770	59
Dacthal	5.00e-01 i					1800	180	68	51000	3900
Dalapon	3.00e-02 i					110	11	4.1	3100	230
Danitol	5.00e-04 i					1.8	0.18	0.068	51	3.9
DDD			2.40e-01 i			0.35	0.035	0.013	12	7.1
DDE			3.40e-01 i			0.25	0.025	0.0093	8.4	5
DDT	5.00e-04 i		3.40e-01 i	3.40e-01 i		0.25	0.025	0.0093	8.4	3.9
Decabromodiphenyl ether	1.00e-02 i				y	6.1	3.7	1.4	1000	78
Demeton	4.00e-05 i					0.15	0.015	0.0054	4.1	0.31
Diallate			6.10e-02 h		y	0.23	0.14	0.052	47	28
Diazinon	9.00e-04 h					3.3	0.33	0.12	92	7
1,4-Dibromobenzene	1.00e-02 i				y	6.1	3.7	1.4	1000	78
Dibromochloromethane	2.00e-02 i		8.40e-02 i		y	0.17	0.1	0.038	34	20
1,2-Dibromo-3-chloropropane		5.71e-05 i	1.40e+00 h	2.40e-03 h	y	0.035	0.021	0.0023	2	1.2
1,2-Dibromoethane			8.50e+01 i	7.70e-01 i	y	0.00096	0.011	0.000037	0.034	0.02
Di-n-butyl phthalate	1.00e-01 i					370	37	14	10000	780
Dicamba	3.00e-02 i					110	11	4.1	3100	230
1,2-Dichlorobenzene	9.00e-02 i	5.71e-02 a			y	37	21	12	9200	700
1,3-Dichlorobenzene	8.90e-02 o				y	54	32	12	9100	700
1,4-Dichlorobenzene		2.00e-01 h	2.40e-02 h		y	0.59	0.35	0.13	120	71
3,3'-Dichlorobenzidine			4.50e-01 i			0.19	0.019	0.007	6.4	3.8
1,4-Dichloro-2-butene				9.30e+00 h	y	0.0015	0.00092			
Dichlorodifluoromethane	2.00e-01 i	5.71e-02 a			y	39	21	27	20000	1600
1,1-Dichloroethane	1.00e-01 h	1.43e-01 a			y	81	52	14	10000	780
1,2-Dichloroethane (EDC)			9.10e-02 i	9.10e-02 i	y	0.16	0.094	0.035	31	19
1,1-Dichloroethylene	9.00e-03 i		6.00e-01 i	1.75e-01 i	y	0.058	0.049	0.0053	4.8	2.8
1,2-Dichloroethylene (cis)	1.00e-02 h				y	6.1	3.7	1.4	1000	78
1,2-Dichloroethylene (trans)	2.00e-02 i				y	12	7.3	2.7	2000	160
1,2-Dichloroethylene (mixture)	9.00e-03 h				y	5.5	3.3	1.2	920	70
2,4-Dichlorophenol	3.00e-03 i					11	1.1	0.41	310	23
4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	8.00e-03 i					29	2.9	1.1	820	63
2,4-Dichlorophenoxyacetic Acid (2,4-D)	1.00e-02 i				y	6.1	3.7	1.4	1000	78
1,2-Dichloropropane		1.14e-03 i	6.80e-02 h		y	0.21	0.13	0.046	42	25

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1,3-Dichloropropene	3.00e-04 i	5.71e-03 i	1.80e-01 h	1.30e-01 h	y	0.1	0.066	0.018	16	2.3
2,3-Dichloropropanol	3.00e-03 i					11	1.1	0.41	310	23
Dichlorvos	8.00e-04 x		2.90e-01 i			0.29	0.029	0.011	9.9	5.9
Dicofol			4.40e-01 x			0.19	0.019	0.0072	6.5	3.9
Dicyclopentadiene	3.00e-02 h	5.71e-05 a			y	0.042	0.021	4.1	3100	230
Dieldrin	5.00e-05 i		1.60e+01 i	1.61e+01 i		0.0053	0.00053	0.0002	0.18	0.11
Diethylene glycol, monobutyl ether		5.71e-03 h				21	2.1			
Diethylene glycol, monoethyl ether	2.00e+00 h					7300	730	270	200000	16000
Diethylformamide	1.10e-02 h					40	4	1.5	1100	86
Di(2-ethylhexyl)adipate	6.00e-01 i		1.20e-03 i			71	7.1	2.6	2400	1400
Diethyl phthalate	8.00e-01 i					2900	290	110	82000	6300
Diethylstilbestrol			4.70e+03 h			0.000018	0.0000018	0.00000067	0.00061	0.00036
Difenzoquat (Avenge)	8.00e-02 i					290	29	11	8200	630
Diflubenzuron	2.00e-02 i					73	7.3	2.7	2000	160
Diisopropyl methylphosphonate (DIMP)	8.00e-02 i					290	29	11	8200	630
Dimethipin	2.00e-02 i					73	7.3	2.7	2000	160
Dimethoate	2.00e-04 i					0.73	0.073	0.027	20	1.6
3,3'-Dimethoxybenzidine			1.40e-02 h			6.1	0.61	0.23	200	120
Dimethylamine		5.71e-06 x				0.021	0.0021			
N-N-Dimethylaniline	2.00e-03 i					7.3	0.73	0.27	200	16
2,4-Dimethylaniline			7.50e-01 h			0.11	0.011	0.0042	3.8	2.3
2,4-Dimethylaniline hydrochloride			5.80e-01 h			0.15	0.015	0.0054	4.9	2.9
3,3'-Dimethylbenzidine			9.20e+00 h			0.0093	0.00093	0.00034	0.31	0.19
1,1-Dimethylhydrazine			2.60e+00 h	3.50e+00 h		0.033	0.0024	0.0012	1.1	0.66
1,2-Dimethylhydrazine			3.70e+01 h	3.70e+01 h		0.0023	0.00023	0.000085	0.077	0.046
N,N-Dimethylformamide	1.00e-01 h	8.57e-03 i				370	3.1	14	10000	780
2,4-Dimethylphenol	2.00e-02 i					73	7.3	2.7	2000	160
2,6-Dimethylphenol	6.00e-04 i					2.2	0.22	0.081	61	4.7
3,4-Dimethylphenol	1.00e-03 i					3.7	0.37	0.14	100	7.8
Dimethyl phthalate	1.00e+01 h					37000	3700	1400	1000000	78000
Dimethyl terephthalate	1.00e-01 i					370	37	14	10000	780
4,6-Dinitro-o-cyclohexyl phenol	2.00e-03 i					7.3	0.73	0.27	200	16
1,2-Dinitrobenzene	4.00e-04 h					1.5	0.15	0.054	41	3.1
1,3-Dinitrobenzene	1.00e-04 i					0.37	0.037	0.014	10	0.78
1,4-Dinitrobenzene	4.00e-04 h					1.5	0.15	0.054	41	3.1
2,4-Dinitrophenol	2.00e-03 i					7.3	0.73	0.27	200	16
Dinitrotoluene mixture			6.80e-01 i			0.13	0.013	0.0046	4.2	2.5

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2,4-Dinitrotoluene	2.00e-03 i		i			7.3	0.73	0.27	200	16
2,6-Dinitrotoluene			6.80e-01 i			0.13	0.013	0.0046	4.2	2.5
Dinoseb	1.00e-03 i					3.7	0.37	0.14	100	7.8
di-n-Octyl phthalate	2.00e-02 h					73	7.3	2.7	2000	160
1,4-Dioxane			1.10e-02 i			7.7	0.77	0.29	260	150
Diphenamid	3.00e-02 i					110	11	4.1	3100	230
Diphenylamine	2.50e-02 i					91	9.1	3.4	2600	200
1,2-Diphenylhydrazine			8.00e-01 i	7.70e-01 i		0.11	0.011	0.0039	3.6	2.1
Diquat	2.20e-03 i					8	0.8	0.3	220	17
Direct black 38			8.60e+00 h			0.0099	0.00099	0.00037	0.33	0.2
Direct blue 6			8.10e+00 h			0.011	0.0011	0.00039	0.35	0.21
Direct brown 35			9.30e+00 h			0.0092	0.00092	0.00034	0.31	0.18
Disulfoton	4.00e-05 i					0.15	0.015	0.0054	4.1	0.31
Diuron	2.00e-03 i					7.3	0.73	0.27	200	16
Dodine	4.00e-03 i					15	1.5	0.54	410	31
Endosulfan	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Endothall	2.00e-02 i					73	7.3	2.7	2000	160
Endrin	3.00e-04 i					1.1	0.11	0.041	31	2.3
Epichlorohydrin	2.00e-03 h	2.86e-04 i	9.90e-03 i	4.20e-03 i		7.3	0.1	0.27	200	16
1,2-Epoxybutane		5.71e-03 i				21	2.1			
EPTC (S-Ethyl dipropylthiocarbamate)	2.50e-02 i					91	9.1	3.4	2600	200
Ethephon (2-chloroethyl phosphonic acid)	5.00e-03 i					18	1.8	0.68	510	39
Ethion	5.00e-04 i					1.8	0.18	0.068	51	3.9
2-Ethoxyethanol	4.00e-01 h	5.71e-02 i				1500	21	54	41000	3100
2-Ethoxyethanol acetate	3.00e-01 a					1100	110	41	31000	2300
Ethyl acetate	9.00e-01 i					3300	330	120	92000	7000
Ethyl acrylate			4.80e-02 h			1.8	0.18	0.066	60	35
Ethylbenzene	1.00e-01 i	2.86e-01 i			y	130	100	14	10000	780
Ethylene cyanohydrin	3.00e-01 h					1100	110	41	31000	2300
Ethylene diamine	2.00e-02 h					73	7.3	2.7	2000	160
Ethylene glycol	2.00e+00 i					7300	730	270	200000	16000
Ethylene glycol, monobutyl ether		5.71e-03 h				21	2.1			
Ethylene oxide			1.02e+00 h	3.50e-01 h		0.083	0.024	0.0031	2.8	1.7
Ethylene thiourea (ETU)	8.00e-05 i		6.00e-01 h			0.14	0.014	0.0053	4.8	0.63
Ethyl chloride	2.00e-02 e	2.86e+00 i			y	71	1000	2.7	2000	160
Ethyl ether	2.00e-01 i				y	120	73	27	20000	1600

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Ethyl methacrylate	9.00e-02 h					330	33	12	9200	700
Ethyl p-nitrophenyl phenylphosphorothioate	1.00e-05 i					0.037	0.0037	0.0014	1	0.078
Ethylnitrosourea			1.40e+02 h			0.00061	0.000061	0.000023	0.02	0.012
Ethylphthalyl ethyl glycolate	3.00e+00 i					11000	1100	410	310000	23000
Express	8.00e-03 i					29	2.9	1.1	820	63
Fenamiphos	2.50e-04 i					0.91	0.091	0.034	26	2
Fluometuron	1.30e-02 i					47	4.7	1.8	1300	100
Fluoride	6.00e-02 i					220	22	8.1	6100	470
Fluoridone	8.00e-02 i					290	29	11	8200	630
Flurprimidol	2.00e-02 i					73	7.3	2.7	2000	160
Flutolanil	6.00e-02 i					220	22	8.1	6100	470
Fluvalinate	1.00e-02 i					37	3.7	1.4	1000	78
Folpet	1.00e-01 i		3.50e-03 i			24	2.4	0.9	820	490
Fomesafen			1.90e-01 i			0.45	0.045	0.017	15	9
Fonofos	2.00e-03 i					7.3	0.73	0.27	200	16
Formaldehyde	2.00e-01 i			4.55e-02 i		730	0.19	27	20000	1600
Formic Acid	2.00e+00 h					7300	730	270	200000	16000
Fosetyl-al	3.00e+00 i					11000	1100	410	310000	23000
Furan	1.00e-03 i					3.7	0.37	0.14	100	7.8
Furazolidone			3.80e+00 h			0.022	0.0022	0.00083	0.75	0.45
Furfural	3.00e-03 i	1.43e-02 a				11	5.2	0.41	310	23
Furium			5.00e+01 h			0.0017	0.00017	0.000063	0.057	0.034
Furmecyclox			3.00e-02 i			2.8	0.28	0.11	95	57
Glufosinate-ammonium	4.00e-04 i					1.5	0.15	0.054	41	3.1
Glycidaldehyde	4.00e-04 i	2.86e-04 h				1.5	0.1	0.054	41	3.1
Glyphosate	1.00e-01 i					370	37	14	10000	780
Haloxyfop-methyl	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Harmony	1.30e-02 i					47	4.7	1.8	1300	100
Heptachlor	5.00e-04 i		4.50e+00 i	4.55e+00 i	y	0.0031	0.0019	0.0007	0.64	0.38
Heptachlor epoxide	1.30e-05 i		9.10e+00 i	9.10e+00 i	y	0.0016	0.00094	0.00035	0.31	0.1
Hexabromobenzene	2.00e-03 i				y	1.2	0.73	0.27	200	16
Hexachlorobenzene	8.00e-04 i		1.60e+00 i	1.61e+00 i	y	0.0088	0.0053	0.002	1.8	1.1
Hexachlorobutadiene	2.00e-03 i		7.80e-02 i	7.70e-02 i	y	0.18	0.11	0.04	37	16
HCH (alpha)			6.30e+00 i	6.30e+00 i		0.014	0.0014	0.0005	0.45	0.27
HCH (beta)			1.80e+00 i	1.80e+00 i		0.047	0.0047	0.0018	1.6	0.95
HCH (gamma) Lindane	3.00e-04 i		1.30e+00 h			0.066	0.0066	0.0024	2.2	1.3
HCH-technical			1.80e+00 i	1.79e+00 i		0.047	0.0048	0.0018	1.6	0.95

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Hexachlorocyclopentadiene	7.00e-03 i	2.00e-05 h			y	0.015	0.0073	0.95	720	55
Hexachlorodibenzo-p-dioxin mixture (HxCDD)			6.20e+03 i	4.55e+03 i		0.000014	0.0000019	0.00000051	0.00046	0.00027
Hexachloroethane	1.00e-03 i		1.40e-02 i	1.40e-02 i	y	0.61	0.37	0.14	100	7.8
Hexachlorophene	3.00e-04 i					1.1	0.11	0.041	31	2.3
n-Hexane	6.00e-02 h	5.71e-02 i			y	35	21	8.1	6100	470
Hexazinone	3.30e-02 i					120	12	4.5	3400	260
Hydrazine, hydrazine sulfate			3.00e+00 i	1.72e+01 i		0.028	0.0005	0.0011	0.95	0.57
Hydrogen chloride		2.00e-03 i				7.3	0.73			
Hydrogen sulfide	3.00e-03 i	2.57e-04 i				11	0.094	0.41	310	23
p-Hydroquinone	4.00e-02 h					150	15	5.4	4100	310
Imazalil	1.30e-02 i					47	4.7	1.8	1300	100
Imazaquin	2.50e-01 i					910	91	34	26000	2000
Iprodione	4.00e-02 i					150	15	5.4	4100	310
Isobutanol	3.00e-01 i				y	180	110	41	31000	2300
Isophorone	2.00e-01 i		9.50e-04 i			90	9	3.3	3000	1600
Isopropalin	1.50e-02 i					55	5.5	2	1500	120
Isopropyl methyl phosphonic acid (IMPA)	1.00e-01 i					370	37	14	10000	780
Isoxaben	5.00e-02 i					180	18	6.8	5100	390
Kepone			1.80e+01 e			0.0047	0.00047	0.00018	0.16	0.095
Lactofen	2.00e-03 i					7.3	0.73	0.27	200	16
Lead (tetraethyl)	1.00e-07 i					0.00037	0.000037	0.000014	0.01	0.00078
Linuron	2.00e-03 i					7.3	0.73	0.27	200	16
Lithium	2.00e-02 e					73	7.3	2.7	2000	160
Londax	2.00e-01 i					730	73	27	20000	1600
Malathion	2.00e-02 i					73	7.3	2.7	2000	160
Maleic anhydride	1.00e-01 i					370	37	14	10000	780
Maleic hydrazide	5.00e-01 i					1800	180	68	51000	3900
Malononitrile	2.00e-05 h					0.073	0.0073	0.0027	2	0.16
Manconeb	3.00e-02 h					110	11	4.1	3100	230
Maneb	5.00e-03 i					18	1.8	0.68	510	39
Manganese and compounds	1.00e-01 x	1.14e-04 i				370	0.042	14	10000	780
Mephosfolan	9.00e-05 h					0.33	0.033	0.012	9.2	0.7
Mepiquat	3.00e-02 i					110	11	4.1	3100	230
Mercury and compounds (methyl)	3.00e-04 i					1.1	0.11	0.041	31	2.3
Mercury and compounds (inorganic)	3.00e-04 h	8.57e-05 h				1.1	0.031	0.041	31	2.3
Merphos	3.00e-05 i					0.11	0.011	0.0041	3.1	0.23

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Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Merphos oxide	3.00e-05 i					0.11	0.011	0.0041	3.1	0.23
Metalaxyl	6.00e-02 i					220	22	8.1	6100	470
Methacrylonitri'	1.00e-04 i	2.00e-04 a				0.37	0.073	0.014	10	0.78
Methamidopho	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Methanol	5.00e-01 i					1800	180	68	51000	3900
Methidathion	1.00e-03 i					3.7	0.37	0.14	100	7.8
Methomyl	2.50e-02 i					91	9.1	3.4	2600	200
Methoxychlor	5.00e-03 i					18	1.8	0.68	510	39
2-Methoxyethanol	4.00e-03 h	5.71e-03 i				15	2.1	0.54	410	31
2-Methoxyethanol acetate	2.00e-03 a					7.3	0.73	0.27	200	16
2-Methoxy-5-nitroaniline			4.60e-02 h			1.9	0.19	0.069	62	37
Methyl acetate	1.00e+00 h					3700	370	140	100000	7800
Methyl acrylate	3.00e-02 a					110	11	4.1	3100	230
2-Methylaniline (o-toluidine)			2.40e-01 h			0.35	0.035	0.013	12	7.1
2-Methylaniline hydrochloride			1.80e-01 h			0.47	0.047	0.018	16	9.5
Methyl chlorocarbonate	1.00e+00 x					3700	370	140	100000	7800
2-Methyl-4-chlorophenoxyacetic acid	5.00e-04 i					1.8	0.18	0.068	51	3.9
4-(2-Methyl-4-chlorophenoxy) butyric acid (MCPB)	1.00e-02 i					37	3.7	1.4	1000	78
2-(2-Methyl-4-chlorophenoxy) propionic acid	1.00e-03 i					3.7	0.37	0.14	100	7.8
2-(2-Methyl-1,4-chlorophenoxy) propionic acid (MCPP)	1.00e-03 i					3.7	0.37	0.14	100	7.8
Methylcyclohexane		8.57e-01 h				3100	310			
4,4'-Methylenediphenyl isocyanate		5.71e-06 h			y	0.0035	0.0021			
4,4'-Methylenebisbenzenearnine			2.50e-01 h			0.34	0.034	0.013	11	6.8
4,4'-Methylene bis(2-chloroaniline)	7.00e-04 h		1.30e-01 h	1.30e-01 h		0.66	0.066	0.024	22	5.5
4,4'-Methylene bis(N,N'-dimethyl)aniline			4.60e-02 i			1.9	0.19	0.069	62	37
Methylene bromide	1.00e-02 a				y	6.1	3.7	1.4	1000	78
Methylene chloride	6.00e-02 i	8.57e-01 h	7.50e-03 i	1.65e-03 i	y	5.4	5.2	0.42	380	230
Methyl ethyl ketone	5.00e-02 h	2.86e-01 i				180	100	6.8	5100	390
Methyl hydrazine			1.10e+00 h			0.077	0.0077	0.0029	2.6	1.5
Methyl isobutyl ketone	5.00e-02 h	2.29e-02 a				180	8.3	6.8	5100	390
Methyl methacrylate	8.00e-02 h					290	29	11	8200	630
2-Methyl-5-nitroaniline			3.30e-02 h			2.6	0.26	0.096	87	52
Methyl parathion	2.50e-04 i					0.91	0.091	0.034	26	2
2-Methylphenol (o-cresol)	5.00e-02 i					180	18	6.8	5100	390

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3-Methylphenol (m-cresol)	5.00e-02 i					180	18	6.8	5100	390
4-Methylphenol (p-cresol)	5.00e-03 h					18	1.8	0.68	510	39
Methyl styrene (mixture)	6.00e-03 a	1.14e-02 a			y	6	4.2	0.81	610	47
Methyl styrene (alpha)	7.00e-02 a				y	43	26	9.5	7200	550
Methyl tertbutyl ether (MTBE)	5.00e-03 e	1.43e-01 i				18	52	0.68	510	39
Metolaclor (Dual)	1.50e-01 i					550	55	20	15000	1200
Metribuzin	2.50e-02 i					91	9.1	3.4	2600	200
Mirex	2.00e-04 i		1.80e+00 h			0.047	0.0047	0.0018	1.6	0.95
Molinate	2.00e-03 i					7.3	0.73	0.27	200	16
Molybdenum	5.00e-03 h					18	1.8	0.68	510	39
Monochloramine	1.00e-01 h					370	37	14	10000	780
Naled	2.00e-03 i					7.3	0.73	0.27	200	16
Napropamide	1.00e-01 i					370	37	14	10000	780
Nickel and compounds	2.00e-02 i					73	7.3	2.7	2000	160
Nickel refinery dust				8.40e-01 i			0.01			
Nickel subsulfide				1.70e+00 i			0.005			
Nitrapyrin	1.50e-03 x					5.5	0.55	0.2	150	12
Nitrate	1.60e+00 i					5800	580	220	160000	13000
Nitric Oxide	1.00e-01 i					370	37	14	10000	780
Nitrite	1.00e-01 i					370	37	14	10000	780
2-Nitroaniline	6.00e-05 h	5.71e-05 h				0.22	0.021	0.0081	6.1	0.47
3-Nitroaniline	3.00e-03 o					11	1.1	0.41	310	23
4-Nitroaniline	3.00e-03 o					11	1.1	0.41	310	23
Nitrobenzene	5.00e-04 i	5.71e-04 a			y	0.34	0.21	0.068	51	3.9
Nitrofurantoin	7.00e-02 h					260	26	9.5	7200	550
Nitrofurazone			1.50e+00 h	9.40e+00 h		0.057	0.00091	0.0021	1.9	1.1
Nitrogen dioxide	1.00e+00 i					3700	370	140	100000	7800
Nitroguanidine	1.00e-01 i					370	37	14	10000	780
4-Nitrophenol	6.20e-02 o					230	23	8.4	6300	480
2-Nitropropane		5.71e-03 i		9.40e+00 h		21	0.00091			
N-Nitrosodi-n-butylamine			5.40e+00 i	5.60e+00 i		0.016	0.0015	0.00058	0.53	0.32
N-Nitrosodiethanolamine			2.80e+00 i			0.03	0.003	0.0011	1	0.61
N-Nitrosodiethylamine			1.50e+02 i	1.51e+02 i		0.00057	0.000057	0.000021	0.019	0.011
N-Nitrosodimethylamine			5.10e+01 i	4.90e+01 i		0.0017	0.00017	0.000062	0.056	0.033
N-Nitrosodiphenylamine			4.90e-03 i			17	1.7	0.64	580	350
N-Nitroso di-n-propylamine			7.00e+00 i			0.012	0.0012	0.00045	0.41	0.24
N-Nitroso-N-methylethylamine			2.20e+01 i			0.0039	0.00039	0.00014	0.13	0.077
N-Nitrosopyrrolidine			2.10e+00 i	2.14e+00 i		0.041	0.004	0.0015	1.4	0.81

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m-Nitrotoluene	1.00e-02 h				y	6.1	3.7	1.4	1000	78
p-Nitrotoluene	1.00e-02 h				y	6.1	3.7	1.4	1000	78
Norflurazon	4.00e-02 i					150	15	5.4	4100	310
NuStar	7.00e-04 i					2.6	0.26	0.095	72	5.5
Octabromodiphenyl ether	3.00e-03 i					11	1.1	0.41	310	23
Octahydro-1357-tetranitro-1357-tetrazocine (HMX)	5.00e-02 i					180	18	6.8	5100	390
Octamethylpyrophosphoramide	2.00e-03 h					7.3	0.73	0.27	200	16
Oryzalin	5.00e-02 i					180	18	6.8	5100	390
Oxadiazon	5.00e-03 i					18	1.8	0.68	510	39
Oxamyl	2.50e-02 i					91	9.1	3.4	2600	200
Oxyfluorfen	3.00e-03 i					11	1.1	0.41	310	23
Paclobutrazol	1.30e-02 i					47	4.7	1.8	1300	100
Paraquat	4.50e-03 i					16	1.6	0.61	460	35
Parathion	6.00e-03 h					22	2.2	0.81	610	47
Pebulate	5.00e-02 h					180	18	6.8	5100	390
Pendimethalin	4.00e-02 i					150	15	5.4	4100	310
Pentabromo-6-chloro cyclohexane			2.30e-02 h			3.7	0.37	0.14	120	74
Pentabromodiphenyl ether	2.00e-03 i					7.3	0.73	0.27	200	16
Pentachlorobenzene	8.00e-04 i				y	0.49	0.29	0.11	82	6.3
Pentachloronitrobenzene	3.00e-03 i		2.60e-01 h		y	0.055	0.033	0.012	11	6.6
Pentachlorophenol	3.00e-02 i		1.20e-01 i			0.71	0.071	0.026	24	14
Permethrin	5.00e-02 i					180	18	6.8	5100	390
Phenmedipham	2.50e-01 i					910	91	34	26000	2000
Phenol	6.00e-01 i					2200	220	81	61000	4700
m-Phenylenediamine	6.00e-03 i					22	2.2	0.81	610	47
p-Phenylenediamine	1.90e-01 h					690	69	26	19000	1500
Phenylmercuric acetate	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Phenylphenol			1.94e-03 h			44	4.4	1.6	1500	880
Phorate	2.00e-04 h					0.73	0.073	0.027	20	1.6
Phosmet	2.00e-02 i					73	7.3	2.7	2000	160
Phosphine	3.00e-04 i	8.57e-06 h				1.1	0.0031	0.041	31	2.3
Phosphorus (white)	2.00e-05 i					0.073	0.0073	0.0027	2	0.16
p-Phthalic acid	1.00e+00 h					3700	370	140	100000	7800
Phthalic anhydride	2.00e+00 i					7300	730	270	200000	16000
Picloram	7.00e-02 i					260	26	9.5	7200	550
Pirimiphos-methyl	1.00e-02 i					37	3.7	1.4	1000	78
Polybrominated biphenyls	7.00e-06 h		8.90e+00 h			0.0096	0.00096	0.00035	0.32	0.055

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Polychlorinate iphenyls (PCBs)			7.70e+00 i			0.011	0.0011	0.00041	0.37	0.22
Polychlorinate rphenyls (PCTs)			4.50e+00 e			0.019	0.0019	0.0007	0.64	0.38
Polynuclear aromatic hydrocarbons										
Acenaphthene	6.00e-02 i					220	22	8.1	6100	470
Anthanthrene			2.31e+00 o	1.93e+00 o		0.037	0.0044	0.0014	1.2	0.74
Anthracene	3.00e-01 i					1100	110	41	31000	2300
Benz[a]anthracene			1.06e+00 o	8.85e-01 o		0.08	0.0096	0.003	2.7	1.6
Benzo[b]fluoranthene			8.96e-01 o	7.49e-01 o		0.095	0.011	0.0035	3.2	1.9
Benzo[j]fluoranthene			3.82e-01 o	3.19e-01 o		0.22	0.027	0.0083	7.5	4.5
Benzo[k]fluoranthene			3.88e-01 o	3.25e-01 o		0.22	0.026	0.0081	7.4	4.4
Benzo[ghi]perylene			1.55e-01 o	1.29e-01 o		0.55	0.066	0.02	18	11
Benzo[a]pyrene			7.30e+00 i	6.10e+00 h		0.012	0.0014	0.00043	0.39	0.23
Benzo[e]pyrene			5.11e-02 o	4.27e-02 o		1.7	0.2	0.062	56	33
Dibenz[ah]anthracene			8.10e+00 o	6.77e+00 o		0.011	0.0013	0.00039	0.35	0.21
Fluoranthene	4.00e-02 i					150	15	5.4	4100	310
Fluorene	4.00e-02 i					150	15	5.4	4100	310
Indeno[1,2,3-cd]pyrene			2.03e+00 o	1.70e+00 o		0.042	0.005	0.0016	1.4	0.84
Naphthalene	4.00e-02 h					150	15	5.4	4100	310
Phenanthrene	2.90e-02 o					110	11	3.9	3000	230
Pyrene	3.00e-02 i					110	11	4.1	3100	230
Prochloraz	9.00e-03 i		1.50e-01 i			0.57	0.057	0.021	19	11
Profluralin	6.00e-03 h					22	2.2	0.81	610	47
Prometon	1.50e-02 i					55	5.5	2	1500	120
Prometryn	4.00e-03 i					15	1.5	0.54	410	31
Pronamide	7.50e-02 i					270	27	10	7700	590
Propachlor	1.30e-02 i					47	4.7	1.8	1300	100
Propanil	5.00e-03 i					18	1.8	0.68	510	39
Propargite	2.00e-02 i					73	7.3	2.7	2000	160
Propargyl alcohol	2.00e-03 i					7.3	0.73	0.27	200	16
Propazine	2.00e-02 i					73	7.3	2.7	2000	160
Propham	2.00e-02 i					73	7.3	2.7	2000	160
Propiconazole	1.30e-02 i					47	4.7	1.8	1300	100
Propylene glycol	2.00e+01 h					73000	7300	2700	2000000	160000
Propylene glycol, monoethyl ether	7.00e-01 h					2600	260	95	72000	5500
Propylene glycol, monomethyl ether	7.00e-01 h	5.71e-01 i				2600	210	95	72000	5500
Propylene oxide		8.57e-03 i	2.40e-01 i	1.30e-02 i		0.35	0.66	0.013	12	7.1
Pursuit	2.50e-01 i					910	91	34	26000	2000
Pydrin	2.50e-02 i					91	9.1	3.4	2600	200

Key to Data Sources: i=IRIS x=Withdrawn from IRIS h=HEAST a=HEAST alternate method y=Withdrawn from HEAST e=EPA-ECAO o=Other EPA documents

Contaminant	Oral RfD (mg/kg/d)		Inhaled RfD (mg/kg/d)		Oral Potency Slope 1/(mg/kg/d)		Inhaled Potency Slope 1/(mg/kg/d)		VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
Pyridine	1.00e-03	i								3.7	0.37	0.14	100	7.8
Quinalphos	5.00e-04	i								1.8	0.18	0.068	51	3.9
Quinoline					1.20e+01	h				0.0071	0.00071	0.00026	0.24	0.14
RDX (Cyclonite)	3.00e-03	i			1.10e-01	i				0.77	0.077	0.029	26	15
Resmethrin	3.00e-02	i								110	11	4.1	3100	230
Ronnel	5.00e-02	h								180	18	6.8	5100	390
Rotenone	4.00e-03	i								15	1.5	0.54	410	31
Savey	2.50e-02	i								91	9.1	3.4	2600	200
Selenious Acid	5.00e-03	i								18	1.8	0.68	510	39
Selenium	5.00e-03	i								18	1.8	0.68	510	39
Selenourea	5.00e-03	h								18	1.8	0.68	510	39
Sethoxydim	9.00e-02	i								330	33	12	9200	700
Silver and compounds	5.00e-03	i								18	1.8	0.68	510	39
Simazine	2.00e-03	h			1.20e-01	h				0.71	0.071	0.026	24	14
Sodium azide	4.00e-03	i								15	1.5	0.54	410	31
Sodium diethyldithiocarbamate	3.00e-02	i			2.70e-01	h				0.32	0.032	0.012	11	6.3
Sodium fluoroacetate	2.00e-05	i								0.073	0.0073	0.0027	2	0.16
Sodium metavanadate	1.00e-03	h								3.7	0.37	0.14	100	7.8
Strontium, stable	6.00e-01	i								2200	220	81	61000	4700
Strychnine	3.00e-04	i								1.1	0.11	0.041	31	2.3
Styrene	2.00e-01	i			3.00e-02	o			y	0.47	0.28	0.11	95	57
Sythane	2.50e-02	i								91	9.1	3.4	2600	200
2,3,7,8-TCDD (dioxin)					1.50e+05	h	1.50e+05	h		0.00000057	0.000000057	0.000000021	0.000019	0.000011
Tebuthiuron	7.00e-02	i								260	26	9.5	7200	550
Temephos	2.00e-02	h								73	7.3	2.7	2000	160
Terbacil	1.30e-02	i								47	4.7	1.8	1300	100
Terbufos	2.50e-05	h								0.091	0.0091	0.0034	2.6	0.2
Terbutryn	1.00e-03	i								3.7	0.37	0.14	100	7.8
1,2,4,5-Tetrachlorobenzene	3.00e-04	i							y	0.18	0.11	0.041	31	2.3
1,1,1,2-Tetrachloroethane	3.00e-02	i			2.60e-02	i	2.59e-02	i	y	0.55	0.33	0.12	110	66
1,1,2,2-Tetrachloroethane					2.00e-01	i	2.03e-01	i	y	0.07	0.042	0.016	14	8.5
Tetrachloroethylene (PCE)	1.00e-02	i			5.20e-02	e	2.03e-03	e	y	1.4	3.7	0.061	55	33
2,3,4,6-Tetrachlorophenol	3.00e-02	i								110	11	4.1	3100	230
p,a,a,a-Tetrachlorotoluene					2.00e+01	h			y	0.00071	0.00043	0.00016	0.14	0.085
Tetrachlorovinphos	3.00e-02	i			2.40e-02	h				3.5	0.35	0.13	120	71
Tetraethyldithiopyrophosphate	5.00e-04	i								1.8	0.18	0.068	51	3.9
Tetrahydrofuran	2.00e-03	o								7.3	0.73	0.27	200	16
Thallic oxide	7.00e-05	h								0.26	0.026	0.0095	7.2	0.55

Key to Data Sources: i=IRIS x=Withdrawn from IRIS h=HEAST a=HEAST alternate method y=Withdrawn from HEAST e=EPA-ECAO o=Other EPA documents.

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ Industrial soil (mg/kg)	Residential soil (mg/kg)
Thallium acetate	9.00e-05 i					0.33	0.033	0.012	9.2	0.7
Thallium carbonate	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Thallium chloride	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Thallium nitrate	9.00e-05 i					0.33	0.033	0.012	9.2	0.7
Thallium selenite	9.00e-05 i					0.33	0.033	0.012	9.2	0.7
Thallium sulfate	8.00e-05 i					0.29	0.029	0.011	8.2	0.63
Thiobencarb	1.00e-02 i					37	3.7	1.4	1000	78
2-(Thiocyanomethylthio)-benzothiazole (TCMTB)	3.00e-02 y					110	11	4.1	3100	230
Thiofanox	3.00e-04 h					1.1	0.11	0.041	31	2.3
Thiophanate-methyl	8.00e-02 i					290	29	11	8200	630
Thiram	5.00e-03 i					18	1.8	0.68	510	39
Tin and compounds	6.00e-01 h					2200	220	81	61000	4700
Toluene	2.00e-01 i	1.14e-01 h			y	75	42	27	20000	1600
Toluene-2,4-diamine			3.20e+00 h			0.027	0.0027	0.00099	0.89	0.53
Toluene-2,5-diamine	6.00e-01 h					2200	220	81	61000	4700
Toluene-2,6-diamine	2.00e-01 h					730	73	27	20000	1600
Toxaphene			1.10e+00 i	1.12e+00 i		0.077	0.0076	0.0029	2.6	1.5
Tralomethrin	7.50e-03 i					27	2.7	1	770	59
Triallate	1.30e-02 i					47	4.7	1.8	1300	100
Triasulfuron	1.00e-02 i					37	3.7	1.4	1000	78
1,2,4-Tribromobenzene	5.00e-03 i				y	3	1.8	0.68	510	39
Tributyltin oxide (TBTO)	3.00e-05 i					0.11	0.011	0.0041	3.1	0.23
2,4,6-Trichloroaniline			3.40e-02 h			2.5	0.25	0.093	84	50
2,4,6-Trichloroaniline hydrochloride			2.90e-02 h			2.9	0.29	0.11	99	59
1,2,4-Trichlorobenzene	1.00e-02 i	2.57e-03 a			y	1.8	0.94	1.4	1000	78
1,1,1-Trichloroethane	9.00e-02 h	2.86e-01 a			y	130	100	12	9200	700
1,1,2-Trichloroethane	4.00e-03 i		5.70e-02 i	5.60e-02 i	y	0.25	0.15	0.055	50	30
Trichloroethylene (TCE)	6.00e-03 e		1.10e-02 y	6.00e-03 e	y	2.1	1.4	0.29	260	47
Trichlorofluoromethane	3.00e-01 i	2.00e-01 a			y	130	73	41	31000	2300
2,4,5-Trichlorophenol	1.00e-01 i					370	37	14	10000	780
2,4,6-Trichlorophenol			1.10e-02 i	1.09e-02 i		7.7	0.78	0.29	260	150
2,4,5-Trichlorophenoxyacetic Acid	1.00e-02 i					37	3.7	1.4	1000	78
2-(2,4,5-Trichlorophenoxy) propionic acid	8.00e-03 i					29	2.9	1.1	820	63
1,1,2-Trichloropropane	5.00e-03 i				y	3	1.8	0.68	510	39
1,2,3-Trichloropropane	6.00e-03 i				y	3.7	2.2	0.81	610	47
1,2,3-TCP as carcinogen			2.70e+00 e		y	0.0053	0.0032	0.0012	1.1	0.63

Key to Data Sources: i=IRIS x=Withdrawn from IRIS h=HEAST a=HEAST alternate method y=Withdrawn from HEAST e=EPA-ECAO o=Other EPA documents.

Contaminant	Oral RfD (mg/kg/d)	Inhaled RfD (mg/kg/d)	Oral Potency Slope 1/(mg/kg/d)	Inhaled Potency Slope 1/(mg/kg/d)	VOC	Tap water (µg/l)	Ambient air (µg/m3)	Fish (mg/kg)	Commercial/ industrial soil (mg/kg)	Residential soil (mg/kg)
1,2,3-Trichloropropene	5.00e-03 h				y	3	1.8	0.68	510	39
1,1,2-Trichloro-1,2,2-trifluoroethane	3.00e+01 i	8.57e+00 h			y	5900	3100	4100	3100000	230000
Tridiphane	3.00e-03 i					11	1.1	0.41	310	23
Triethylamine		2.00e-03 i				7.3	0.73			
Trifluralin	7.50e-03 i		7.70e-03 i			11	1.1	0.41	370	59
Trimethyl phosphate			3.70e-02 h			2.3	0.23	0.085	77	46
1,3,5-Trinitrobenzene	5.00e-05 i					0.18	0.018	0.0068	5.1	0.39
Trinitrophenylmethylnitramine	1.00e-02 h					37	3.7	1.4	1000	78
2,4,6-Trinitrotoluene	5.00e-04 i		3.00e-02 i			1.8	0.18	0.068	51	3.9
Uranium (soluble salts)	3.00e-03 i					11	1.1	0.41	310	23
Vanadium	7.00e-03 h					26	2.6	0.95	720	55
Vanadium pentoxide	9.00e-03 i					33	3.3	1.2	920	70
Vanadyl sulfate	2.00e-02 h					73	7.3	2.7	2000	160
Vanadium sulfate	2.00e-02 h					73	7.3	2.7	2000	160
Vernam	1.00e-03 i					3.7	0.37	0.14	100	7.8
Vinclozolin	2.50e-02 i					91	9.1	3.4	2600	200
Vinyl acetate	1.00e+00 h	5.71e-02 i				3700	21	140	100000	7800
Vinyl chloride			1.90e+00 h	3.00e-01 h	y	0.025	0.028	0.0017	1.5	0.9
Warfarin	3.00e-04 i					1.1	0.11	0.041	31	2.3
m-Xylene	2.00e+00 i	2.00e-01 y			y	140	73	270	200000	16000
o-Xylene	2.00e+00 i	2.00e-01 y			y	140	73	270	200000	16000
p-Xylene		8.57e-02 y			y	52	31			
Xylene (mixed)	2.00e+00 i				y	1200	730	270	200000	16000
Zinc	3.00e-01 i					1100	110	41	31000	2300
Zinc phosphide	3.00e-04 i					1.1	0.11	0.041	31	2.3
Zineb	5.00e-02 i					180	18	6.8	5100	390

Key to Data Sources: i=IRIS x=Withdrawn from IRIS h=HEAST a=HEAST alternate method y=Withdrawn from HEAST e=EPA-ECAO o=Other EPA documents

APPENDIX E

COMMONWEALTH OF VIRGINIA SAMPLING RESULTS

SPECTRALYTIX

April 26, 1993

David Grimes
Virginia Water Control Board
4900 Cox Road
P.O. Box 11143
Richmond, VA 23230

Dear Mr. Grimes:

Enclosed are the preliminary results subject to your final approval for ten water samples submitted for various analytical parameters. The electronic (diskette) copy of the data requested will be available at a later date.

We are pleased to have been afforded the opportunity to provide your firm with analytical services. Please feel free to call me if you have any questions about these results.

Sincerely,

Jocelyn A. Johnson
Project Manager

Spectralytix Project # VWC93-008
Client Project Name: Bioaccumulation

[illegible] Street
[illegible]
[illegible]
[illegible]
[illegible]
Fax 301 921 1068

CASE NARRATIVE FOR
SPECTRALYTIX PROJECT # VWC93-008

Ten water samples were extracted and analyzed according to the VIMS protocol. No problems were encountered during extraction or analysis.

Client: VA WATER CONTROL BOARD/BIOACCUMULATION
Client Sample ID: NWS07
SPECTRALYTIX Sample ID: VWC93-008-93030715 Sample Type: Water
Date Sampled : 03/19/93 Date Received: 03/20/93
Date Analyzed : 04/02/93

Analyte	Result	Detection Limit	Units
alpha-BHC	ND	0.05	µg/L
beta-BHC	ND	0.05	µg/L
delta-BHC	ND	0.05	µg/L
gamma-BHC (Lindane)	ND	0.05	µg/L
Heptachlor	ND	0.05	µg/L
Aldrin	ND	0.05	µg/L
Heptachlor epoxide	ND	0.05	µg/L
gamma-Chlordane	ND	0.05	µg/L
Endosulfan I	ND	0.05	µg/L
alpha-Chlordane	ND	0.05	µg/L
Dieldrin	ND	0.1	µg/L
4,4'-DDE	ND	0.1	µg/L
Endrin	ND	0.1	µg/L
Endosulfan II	ND	0.1	µg/L
4,4'-DDD	ND	0.1	µg/L
Endrin aldehyde	ND	0.1	µg/L
Endosulfan sulfate	ND	0.1	µg/L
4,4'-DDT	ND	0.1	µg/L
Endrin ketone	ND	0.1	µg/L
Pentachlorobenzene	ND	0.1	µg/L
Hexachlorobenzene	ND	0.1	µg/L
Dioxin	ND	1.0	µg/L
PCB-1016	ND	1.0	µg/L
PCB-1221	ND	1.0	µg/L
PCB-1232	ND	1.0	µg/L
PCB-1242	ND	1.0	µg/L
PCB-1248	ND	1.0	µg/L
PCB-1254	ND	1.0	µg/L
PCB-1260	ND	1.0	µg/L

Units of µg/L are equivalent to ppb.
ND = Compound not detected at or above the listed detection limit.

Polynuclear Aromatic Hydrocarbons - EPA Method 8100 via 8270

Client: VA WATER CONTROL BOARD/BIOACCUMULATION
Client Sample ID: NWS07
SPECTRALYTIX Sample ID: VWC93-008-93030715 Sample Type: Water
Date Sampled : 03/19/93 Date Received: 03/20/93
Date Analyzed: 04/09/93

Analyte	Acid Result	Base Neutral Result	Detection Limit	Units
Naphthalene	ND	ND	1	µg/L
2-Methylnaphthalene	ND	ND	1	µg/L
2-Chloronaphthalene	ND	ND	1	µg/L
Acenaphthylene	ND	ND	1	µg/L
Acenaphthene	ND	ND	1	µg/L
Dibenzofuran	ND	ND	1	µg/L
Phenanthrene	ND	ND	1	µg/L
Anthracene	ND	ND	1	µg/L
Fluoranthene	ND	ND	1	µg/L
Pyrene	ND	ND	1	µg/L
Benzo(a)anthracene	ND	ND	1	µg/L
Chrysene	ND	ND	1	µg/L
Benzo(b)fluoranthene	ND	ND	1	µg/L
Benzo(k)fluoranthene	ND	ND	1	µg/L
Benzo(a)pyrene	ND	ND	1	µg/L
Indeno(1,2,3-cd)pyrene	ND	ND	1	µg/L
Dibenz(a,h)anthracene	ND	ND	1	µg/L
Benzo(g,h,i)perylene	ND	ND	1	µg/L
Fluorene	ND	ND	1	µg/L

Units of µg/L are equivalent to ppb.
ND = Compound not detected at or above the listed detection limit.

Tentatively Identified Compounds
Semivolatile Organics Via GC/MS - EPA Method 625

Client: VA WATER CONTROL BOARD/BIOACCUMULATION
Client Sample ID: NWS07
SPECTRALYTIX Sample ID: VWC93-008-93030715 Sample Type: Water
Date Sampled : 03/19/93 Date Received: 03/20/93
Date Extracted: 03/26/93 Date Analyzed: 04/09/93

Acid Compound	CAS #	Result	Detection Limit	Units
None Detected		ND	1	µg/L

Base Neutral Compound	CAS #	Result	Detection Limit	Units
None Detected		ND	1	µg/L

Units of µg/L are equivalent to ppb

EPA Chemicals of Highest Concern
EPA Method 8080

Client: VA WATER CONTROL BOARD/BIOACCUMULATION
Client Sample ID: NWS09
SPECTRALYTIX Sample ID: VWC93-008-93030717 Sample Type: Water
Date Sampled : 03/19/93 Date Received: 03/20/93
Date Analyzed : 04/02/93

Analyte	Result	Detection Limit	Units
alpha-BHC	ND	0.05	µg/L
beta-BHC	ND	0.05	µg/L
delta-BHC	ND	0.05	µg/L
gamma-BHC (Lindane)	ND	0.05	µg/L
Heptachlor	ND	0.05	µg/L
Aldrin	ND	0.05	µg/L
Heptachlor epoxide	ND	0.05	µg/L
gamma-Chlordane	ND	0.05	µg/L
Endosulfan I	ND	0.05	µg/L
alpha-Chlordane	ND	0.05	µg/L
Dieldrin	ND	0.1	µg/L
4,4'-DDE	ND	0.1	µg/L
Endrin	ND	0.1	µg/L
Endosulfan II	ND	0.1	µg/L
4,4'-DDD	ND	0.1	µg/L
Endrin aldehyde	ND	0.1	µg/L
Endosulfan sulfate	ND	0.1	µg/L
4,4'-DDT	ND	0.1	µg/L
Endrin ketone	ND	0.1	µg/L
Pentachlorobenzene	ND	0.1	µg/L
Hexachlorobenzene	ND	0.1	µg/L
Dioxin	ND	1.0	µg/L
PCB-1016	ND	1.0	µg/L
PCB-1221	ND	1.0	µg/L
PCB-1232	ND	1.0	µg/L
PCB-1242	ND	1.0	µg/L
PCB-1248	ND	1.0	µg/L
PCB-1254	ND	1.0	µg/L
PCB-1260	ND	1.0	µg/L

Units of µg/L are equivalent to ppb.
ND = Compound not detected at or above the listed detection limit.

Polynuclear Aromatic Hydrocarbons - EPA Method 8100 via 8270

Client: VA WATER CONTROL BOARD/BIOACCUMULATION
Client Sample ID: NWS09
SPECTRALYTIX Sample ID: VWC93-008-93030717 Sample Type: Water
Date Sampled : 03/19/93 Date Received: 03/20/93
Date Analyzed: 04/09/93

Analyte	Acid Result	Base Neutral Result	Detection Limit	Units
Naphthalene	ND	ND	1	µg/L
2-Methylnaphthalene	ND	ND	1	µg/L
2-Chloronaphthalene	ND	ND	1	µg/L
Acenaphthylene	ND	ND	1	µg/L
Acenaphthene	ND	ND	1	µg/L
Dibenzofuran	ND	ND	1	µg/L
Phenanthrene	ND	ND	1	µg/L
Anthracene	ND	ND	1	µg/L
Fluoranthene	ND	ND	1	µg/L
Pyrene	ND	ND	1	µg/L
Benzo(a)anthracene	ND	ND	1	µg/L
Chrysene	ND	ND	1	µg/L
Benzo(b)fluoranthene	ND	ND	1	µg/L
Benzo(k)fluoranthene	ND	ND	1	µg/L
Benzo(a)pyrene	ND	ND	1	µg/L
Indeno(1,2,3-cd)pyrene	ND	ND	1	µg/L
Dibenz(a,h)anthracene	ND	ND	1	µg/L
Benzo(g,h,i)perylene	ND	ND	1	µg/L
Fluorene	ND	ND	1	µg/L

Units of µg/L are equivalent to ppb.
ND = Compound not detected at or above the listed detection limit.

Tentatively Identified Compounds
Semivolatile Organics Via GC/MS - EPA Method 625

Client: VA WATER CONTROL BOARD/BIOACCUMULATION
Client Sample ID: NWS09
SPECTRALYTIX Sample ID: VWC93-008-93030717 Sample Type: Water
Date Sampled : 03/19/93 Date Received: 03/20/93
Date Extracted: 03/26/93 Date Analyzed: 04/09/93

Acid Compound	CAS #	Result	Detection Limit	Units
None Detected		ND	1	µg/L

Base Neutral Compound	CAS #	Result	Detection Limit	Units
None Detected		ND	1	µg/L

Units of µg/L are equivalent to ppb