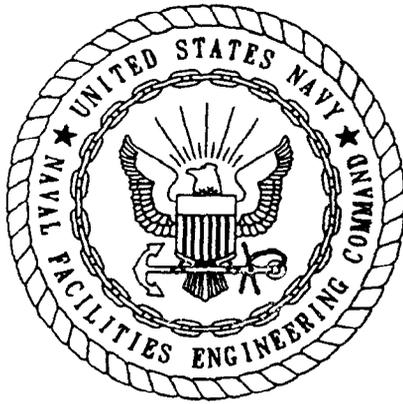


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NSB KINGS BAY
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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT
FOR SITES 5 AND 16 AND SITE HISTORY AND FILE INFORMATION FOR SITE 12 KINGS
BAY GA
6/1/1994
ABB ENVIRONMENTAL



**RESOURCE CONSERVATION AND RECOVERY ACT
FACILITY INVESTIGATION REPORT FOR SITES 5 AND 16
AND SITE HISTORY AND FILE INFORMATION FOR SITE
12**

**NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA**

VOLUME 1, SECTIONS 1 THROUGH 9

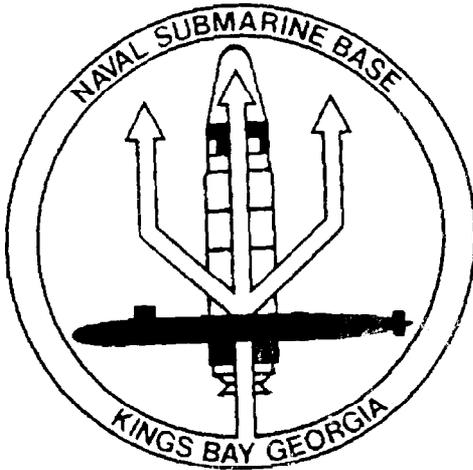
**CONTRACT TASK ORDER NO. 041
CONTRACT NO. N62467-89-D-0317**

JUNE 1994



**SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA
29419-9010**

31547-000
19.47.00.0003



The geologic work and professional opinions rendered in this Resource Conservation and Recovery Act Facility Investigation Report for Sites 5 and 16 and Site History and File Information for Site 12, Naval Submarine Base, Kings Bay, Georgia, were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.



Laura B. Harris

Professional Geologist No. 1063
Expires December 31, 1995

**Response to Comments from GA EPD on
the RFI Report for Sites 5 and 16, and Site History
and File Information for Site 12
NSB Kings Bay, Georgia**

| Comment No. | Section | Comment | Response |
|-------------|---------------|--|--|
| 1 | Section 1.2 | This section states that a Corrective Measure Study (CMS) is a part of the process for achieving remedial action goals. The Naval Submarine Base (NSB) should be aware that EPD does not require such documents. Upon determination by the facility that contamination has occurred, the facility is required to submit a Corrective Action Plan (CAP). While completion of the CMS may be required internally for NSB's decision-making purposes, the CAP is the only document required by EPD at this stage of the remedial process. | Section 1.2 will be revised to indicate that the RCRA Corrective Action Plan (CAP) (USEPA, 1988) provides a model for corrective action and uses a four-phased approach. This section will also be revised to indicate that the GA EPD requires a site-specific CAP to address remedial actions at a site, but does not require a Corrective Measures Study (CMS) for the process. |
| 2 | Section 1.3 | This section states that "The extent to which these [RFI] requirements will be met will be established by... the applicability or appropriateness of certain suggested requirements presented in the guidance documents." This statement requires explanation. | Section 1.3 will be revised and wording changed to add clarification. The RCRA CAP (USEPA, 1988) and the RCRA Facility Investigation Guidance (USEPA, 1989) provide a menu of possible activities that may be needed to characterize a site. The work that was conducted at Sites 5 and 16 did not necessarily include all of the possible activities included on the menu for a facility investigation. |
| 3 | Section 1.4 | This section indicates that the goal of the RFI process is the CMS. As stated above, the State of Georgia does not require a CMS. The goal of the RFI process is the development and implementation of a Corrective Action Plan. A CMS may be required for NSB's decision-making process, but it is not a requirement imposed by EPD. | Section 1.4 will be revised to indicate that the objectives of the RFI include determining the need for a site-specific CAP and, if needed, gather information in support of preparing the site-specific CAP. |
| 4 | Section 2.2.2 | This section states (for both sites 5 and 16) that water level measurements over a 24-hour period indicate that "no significant tidal influence on the aquifer" was observed. These statements should be quantified, and the method for making these determinations briefly described. | Section 2.2.2 will be expanded to include discussion of the tidal influence study. The discussion will include method of data collection, dates and times data were collected, times high and low tide occurred, height of tide, and magnitude of water level fluctuations observed during the study. |

**Response to Comments from GA EPD on
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| Comment No. | Section | Comment | Response |
|-------------|---------------|---|--|
| 5 | Section 3.1.1 | This section should define the limits of the waste disposal area, describe how the waste was characterized and how the waste disposal area was delineated. This has not been done adequately. Figure 3-1 shows conflicting information. It shows the "approximate landfill boundary" by means of a heavy black line on the map; however, the magnetometry data indicate that buried wastes are located outside this area. This conflict must be resolved. | <p>Section 3.1.1 will be revised to better describe and illustrate the lateral extent of buried ferrous wastes at Site 5. Geophysical methods employed at the site will be summarized. Locations of magnetic grid points and shaded magnetic contours map will be overlain on the site map in Figure 3-1. Terrain conductivity profiles and results will be included.</p> <p>The approximate landfill boundaries shown in Figure 3-1 will be removed. These boundaries were taken from information presented in the RFI Work Plan and reflect boundaries formed by the tree line, Towhee Trail, and a pond. The magnetometer survey extended beyond site boundaries as indicated by readings returning to background. Background magnetic signature was established at a location on Towhee Trail.</p> |
| 6 | Section 3.1.1 | It appears that the magnetometer survey did not extend beyond the "approximate landfill boundary" on the western edge of the site. It is not clear why the survey was not extended beyond this point, particularly in view of the fact that buried ferrous waste was indicated to be present beyond the "boundary" in other areas. | As indicated in the response to comment no. 5, Figure 3-1 will be revised to better illustrate magnetic survey results. The site boundaries presently shown are from the RFI Work Plan and represent the boundaries formed by the tree line, Towhee Trail, and a pond. This boundary, indicated by a heavy black line, will be removed. |
| 7 | Section 3.1.1 | The report should give the date(s) when the magnetometer survey was conducted. | Subsection 3.1.1 will be revised to include the dates that the magnetometer and terrain conductivity surveys were performed, which are January 31, 1992, and February 1, 1992, respectively. |
| 8 | Section 3.1.1 | The terrain conductivity data for Site 5 should be presented. | The terrain conductivity survey was performed as part of groundwater characterization, which is addressed in subsection 6.1.1. Within 6.1.1, the conductivity survey at Site 5 will be addressed. Graphics will be used to present the terrain conductivity data for the site. The stations where measurements were taken will be added to an existing site diagram in the text. A reference will be added to the text to direct the reader to the diagram where stations are shown. Discussion will be included to explain the results of the survey. |

**Response to Comments from GA EPD on
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| Comment No. | Section | Comment | Response |
|-------------|---------------|---|---|
| 9 | Section 3.1.1 | It is critical that the waste disposal area be accurately defined, so that the integrity of the background samples can be established. This has not been done for site 5. One of the upgradient wells (KBA-5-2) which has erroneously been referred to as a "background" well, is located immediately adjacent to (if not actually within) a waste disposal area. New background locations must be established which are both clearly upgradient and clearly outside the waste disposal area. | As indicated in the responses to comment nos. 5 and 6, Figure 3-1 will be revised to better illustrate magnetic survey results. The site boundaries presently shown are from the Initial Assessment Study and do not reflect current understanding of site conditions. Monitoring well KBA-5-2 was located based on the results of the magnetic survey and the inferred direction of groundwater flow prior to the installation of monitoring wells. The location of monitoring well KBA-5-2 is 20 to 30 feet from the middle of the magnetic anomaly which has been designated Area A. The hatched magnetic gradient contours adjacent to a magnetic high indicate decreasing gradient. This is a phenomena characteristic of magnetic data collected in an area where buried ferrous material are located. In Area A of Figure 3-1, the buried material would be located in the area of increasing gradient and is not inferred to extend to the north where decreasing vertical gradients were measured. Clarification will be added to the text to describe the location of the buried ferrous material as indicated by the magnetic data. |
| 10 | Section 3.2 | This section should define the limits of the waste disposal area and describe how the area was delineated. This has not been done adequately. It is not clear how the "approximate landfill boundary" shown on Figure 2-6 was determined. It is also not clear how the nature of the waste and the waste disposal practices at the site were determined. This section must be revised to provide this information. | The limits of the disposal area shown in Figure 2-6 were taken from the RFI Work Plan. Site 16 was first identified by an Initial Assessment Study. This study was conducted in 1985 by C.C. Johnson & Associates, Inc. The study included records searches, interviews, ground and aerial tours (C.C. Johnson, 1985). ABB-ES conducted a site visit as part of development of the work plan. Aerial photos were used to assist field team members in locating Site 16. A sewage lagoon and creek were used as landmarks during the site visit. The nature of wastes disposed at Site 16 and disposal practices described in the RFI Report are from the Initial Assessment Study. A reference to this study will be added to Section 3.2. Sections 3.2 and 6.2 of the RFI Report will be revised to describe how the location of the site was identified. |

**Response to Comments from GA EPD on
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and File Information for Site 12
NSB Kings Bay, Georgia**

| Comment No. | Section | Comment | Response |
|-------------|-------------------------------------|--|---|
| 11 | Section 3.2 | The terrain conductivity data for Site 16 should be presented. | The terrain conductivity survey was performed as part of groundwater characterization, which is addressed in subsection 6.2.1. The conductivity survey at Site 16 will be addressed within subsection 6.2.1. Graphics will be used to present the terrain conductivity data for the site. The stations where measurements were taken will be added to an existing site diagram in the text. A reference will be added to the text to direct the reader to the diagram where stations are shown. Discussion will be included to explain the results of the survey. |
| 12 | Section 4.0, Tables 4-1 & 4-2 | Required cleanup levels for groundwater are Maximum Contaminant Levels (MCLs), for contaminants for which these have been established and site specific background levels for all other contaminants. EPD has determined that these standards are protective of human health and the environment. No Alternate Concentration Limits (ACLs) have ever been approved by EPD. This section must be revised. In addition, EPD does not regulate on the basis of proposed regulations. Until and unless such regulations are promulgated, all references to them should be removed from the document. Further, the last paragraph makes reference to groundwater "that is not potentially suitable for human use." NSB should be aware that the State of Georgia considers all groundwater in the State to be of potential potable use and subject to the same cleanup standards as groundwater currently in use for drinking water supply. | The reference to proposed rules will be removed from Section 4.0. The discussion of ACLs will be deleted. Also, the last paragraph of section 4.0 will be deleted, thereby removing the reference to groundwater not potentially suitable for human use. |

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| Comment No. | Section | Comment | Response |
|-------------|-----------------|---|--|
| 13 | Section 5.1.1.1 | The quantitation limits described in this section do not correspond to those reported with the analytical results in Appendices F and G. This discrepancy must be fully explained. It is briefly mentioned, for volatile organic contaminants, in Section 5.2.3; however, no mention is made of inorganic analyses. | <p>Practical Quantitation Limits (PQLs) are determined by the laboratory based on method detection limit (MDL) studies. PQLs do not necessarily remain constant over time because laboratory QA/QC requirements include periodic MDL studies to recalculate PQLs. The text of subsection 5.1.1 and the PQLs listed in Table 5-1 will be revised. Ranges of PQLs will be presented in Table 5-1 where necessary. The validated data tables in Appendix F will be revised to replace reference to Contract Required Quantitation Limits (CRQLs) with PQL, because PQL is more appropriate for analytical reports associated with SW-846 analytical methods.</p> <p>Quantitation limits reported for environmental samples are affected by moisture content (solid samples), and dilution (solid and liquid samples). For organic analysis of soil samples, the sample quantitation limit is calculated by dividing the PQL by the percent solids (as a fraction) and multiplying by the dilution factor. The result is reported using one or two significant digits. For aqueous samples, the dilution factor and the PQL are used to calculate the sample quantitation limit.</p> <p>The inorganic data report differs from the organic data report. Data for non-detect inorganic analytes are reported relative to the MDL, whereas the data for non-detect organic analytes are reported relative to the PQL. This discussion will be incorporated into section 5.0.</p> |
| 14 | Section 6.0 | EPD does not regulate on the basis of proposed regulations. Until and unless such action levels are promulgated, cleanup levels for groundwater are MCLs, for contaminants for which these have been established and site specific background levels for all other contaminants. All references to proposed health-based action levels should be removed from the document. | Section 6.0 will be revised to remove reference to the proposed action levels. |
| 15 | Section 6.0 | The State of Georgia considers all ground water in the State to be potential sources of potable water. Required cleanup standards for groundwater are MCLs for contaminants for which these have been established, and site specific background levels for all other contaminants. | Section 4.0 addresses classification of all groundwater as potential drinking water and potential cleanup criteria. Section 4.0 will be revised to emphasize that GA EPD requires cleanup to background levels in the absence of MCLs. |

**Response to Comments from GA EPD on
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| Comment No. | Section | Comment | Response |
|-------------|--|---|--|
| 16 | Section 6.1.1 | This section discusses hydrocone sampling of groundwater for volatile organic contaminants. The actual laboratory results should be submitted, not just data summary tables. | All data are reported in subsection 6.1.1 for on-site and off-site laboratory analysis of volatile organic compounds (VOCs) in groundwater samples collected using hydrocone samplers. Data for all analytes and all samples is reported in the tables within the text. The laboratory report of the data is not included in the report because the data packages are comprised of several hundred pages and the validation reports would also need to be included. These materials are available in the ABB-ES Knoxville, TN, office should you want to review them or have them sent to you. |
| 17 | Section 6.1.1.1 | Determinations of the extent of contamination are made in relation to site specific background concentration, not to MCLs or action levels. This section does not discuss site background conditions. Background is the quality of groundwater which would have been characteristic of the site if site activities had not affected groundwater quality. (Please note that because most organic contaminants are man-made, site specific background concentrations for these contaminants will effectively be zero.) | Section 6.1.1.1 discusses characterization of groundwater quality with regard to VOCs. Samples from five consecutive sample events indicate concentrations of VOCs are not detectable in samples from all seven monitoring wells. Assuming that zero is defined as not detected, the data indicate that this requirement is met at the site. |
| 18 | Section 6.1.1.1 | Background is not synonymous with upgradient, although locations upgradient from waste disposal activities are likely areas from which to obtain samples for background determinations. Background concentrations must be established for this site and the document must be revised to assess contamination in relation to background. | A work plan will be developed to address additional investigation to obtain background data. The data collected during the six bimonthly sampling events do not indicate additional investigation of VOCs is warranted at Site 5. See response to comment no. 17. |
| 19 | Section 6.1.1.4, Tables 6-6 & Appendices F & G | The statistical information presented in Table 6-6 makes use of comparisons of mean upgradient and downgradient concentration values. This is not acceptable. The effective result of comparing mean values will be to minimize the concentrations of contamination. In addition, "upgradient" and "background" are not synonymous; background has not been established for this site. The goal of the RFI is to accurately delineate contamination, in comparison to background, so that informed decisions concerning remediation can be made. Once background values have been established, comparisons of water quality must be made on a well to well basis. | A recommendation will be made in the RFI Report for additional investigation at Site 5. A work plan for the additional work will be submitted to GA EPD for approval. The statistical methods to be used in evaluating data will be included in the work plan. |

**Response to Comments from GA EPD on
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| Comment No. | Section | Comment | Response |
|-------------|--|---|--|
| 20 | 6.1.1.4, Tables 6-6 & Appendices F & G | <p>There are several problems with the analytical results for Site 5. This section discusses analytical results for both filtered and unfiltered groundwater samples. EPD does not consider filtered results. These results and the conclusions regarding them should be removed from the document. Also, some of the analytical methods used (Antimony, Beryllium, and Thallium) have quantitation limits which are above the MCLs. This is not acceptable for a Resource Conservation and Recovery Act (RCRA) facility investigation. The standards set forth under the Contract Laboratory Program (CLP) are designed for Superfund sites, and do not necessarily meet the requirements of RCRA.</p> | <p>Section 6.1.1.4 will be revised to indicate that GA EPD does not regulate based on inorganic data from filtered samples. Conclusions based on data from filtered samples will be removed. The data for filtered samples should be included in the report because it could benefit potential future evaluations of remedial alternatives, if necessary.</p> <p>The analytical methods used for analysis of inorganic constituents in groundwater were SW-846 methods, which are appropriate for an RFI. CLP protocol was not used. The analytical tables in Appendices F and G will be revised to replace reference to Contract Required Quantitation Limits (CRQLs), which is CLP jargon, with PQL, which is more appropriate for SW-846 data reports.</p> <p>The MCLs for antimony, beryllium, and thallium were promulgated on July 17, 1992, (57 FR 31838) with an effective date of January 17, 1994. The RFI bimonthly sampling events were completed 1 year prior to the effective date. The data for antimony, beryllium, and thallium analyses presented in Appendices F and G were reviewed. The results of this review are presented here and will be added to the RFI Report. As discussed in response number 13, above, the inorganic data are reported relative to the MDL for non-detect analytes. The MDL for antimony was greater than the present MCL of 6 µg/l for all six sampling events. The MDL for beryllium</p> <p>(Continued on next page)</p> |

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| Comment No. | Section | Comment | Response |
|-------------|--|--|--|
| 20 | | | <p>(Continued from previous page)</p> <p>ranged from 0.19 to 0.80 $\mu\text{g}/\text{l}$ and was below the present MCL of 4 $\mu\text{g}/\text{l}$ for all six sampling events. The MDL for thallium exceeded the present MCL of 2 $\mu\text{g}/\text{l}$ during sampling events No. 3 and 6. The analytical data for beryllium can be used for comparison to the MCL, however, additional data are needed to evaluate antimony and thallium concentrations relative to newly promulgated MCLs.</p> <p>Based on Comment No. 18, the document will need to be revised to assess contamination in relation to background concentrations. Additional data will be needed to evaluate background conditions.</p> |
| 21 | 6.1.1.4, Tables 6-6 & Appendices F & G | The actual laboratory results, including all analyses of QA/QC samples, must be submitted. The data summary tables provided in the report, while useful, are interpretations and can not be fully evaluated. | <p>The tables of validated data in Appendix F include all analytes for environmental samples and associated QA/QC samples. The tables in Appendix F are inappropriately labelled as summary tables. The tables in Appendix F will be revised to reflect the completeness of the data presented. The summary ("hits") tables in Appendix G are comprised of data for each analyte that was detected. Because every compound is not necessarily detected in every sample, some non-detect values appear on the hits tables. The tables of validated data in Appendix F and the hits tables in Appendix G do not reflect data interpretation. These tables reflect concentrations detected by the laboratory and meeting data quality guidelines based on USEPA Level III data quality objectives.</p> <p>The Level III data packages that comprise the laboratory report of data for Site 5 and the associated data validation reports would occupy several boxes. The validation reports are included in 50 ring-bound volumes. These volumes include the laboratory report of data for the samples and would probably be the most convenient method for EPD personnel to review data. All of the raw data and validation reports will be sent to the NSB for permanent storage upon completion of the project. After reviewing this response, please notify the Navy if copies of validation reports (and/or raw data packages) should be shipped to GA EPD.</p> |

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| Comment No. | Section | Comment | Response |
|-------------|--|---|--|
| 22 | 6.1.1.4, Tables 6-6 & Appendices F & G | The "no further action" recommendation for groundwater at Site 5 can not be accepted on the basis of the information presented in the RFI report. The State of Georgia requires cleanup to MCLs or site specific background concentrations. The analytical results for unfiltered groundwater samples indicate that inorganic contaminants (Arsenic, Beryllium, Chromium, Cadmium, Lead, Nickel and possibly Antimony and Thallium) are present above MCLs at Site 5. Background concentrations have not been established for these constituents; therefore, the assertion that these constituents are naturally occurring has not been proven. (As stated above, "background" and "upgradient" are not necessarily synonymous.) Further investigation is required to establish background for the site and to define the extent of groundwater contamination to background in both the horizontal and vertical dimensions. | The RFI Report will be revised to indicate that additional data are needed to evaluate background concentrations of inorganics in groundwater and potential inorganic contaminants released from the site. |
| 23 | Sections 6.1.2 through 6.1.2.4 | None of the soil samples analyzed were taken from within the "approximate landfill boundaries" of Site 5. Therefore the potential for soil contamination has not been addressed. Additional soil samples must be collected and analyzed. | Surface soil samples were collected from within the disposal area of Site 5 and subsurface soil samples were collected from the perimeter of Site 5. The surface soil samples were collected from a soil horizon beneath fill material that had recently been graded over the site. Two surface soil sampling events were conducted. The analytical results of the surface soil and subsurface soil samples did not indicate that soil contamination was present at the site. Also, groundwater data from the site has not confirmed a release of hazardous constituents. A decision to perform additional soil sampling should be delayed until such time as sufficient evidence is obtained to confirm a release has occurred. |
| 24 | Sections 6.1.2 through 6.1.2.4 | These sections make frequent references to analyzing soil samples for "Appendix IX" constituents. Appendix IX is the list of constituents for analysis of groundwater samples. This should be corrected. | The parameters analyzed in soil samples included the same constituents listed in the Appendix IX groundwater monitoring list. The phrase "Appendix IX constituents" is used broadly to reference a readily identifiable list of parameters. |

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| Comment No. | Section | Comment | Response |
|-------------|--------------------------------|--|--|
| 25 | Sections 6.1.2 through 6.1.2.4 | The narrative describing the analytical results for the soil samples contains numerous inaccuracies and unsupported conclusions which can not be evaluated without the laboratory data. The actual laboratory results must be submitted. Data summary tables, while useful, can not be substituted. | The narrative in the text of the soil characterization discussion will be checked for accuracy. Clarification will be added by presenting pertinent information used in evaluating the analytical results within the subsections of 6.1.2. Such information may include, but not be limited to, method blank data and solubilities. The laboratory data presented in Appendix F is a complete presentation of validated data for all samples, including QA/QC samples. If, after reviewing these response to comments, GA EPD feels that all data have not been presented, please notify the Navy. The validation reports, contained in 50 ring-bound volumes, contain the laboratory data sheets and would be the most convenient means for reviewing the data. |
| 26 | Sections 6.1.2 through 6.1.2.4 | Table 6-9 presents data on naturally occurring inorganic concentrations in soil. While interesting, these data are not applicable to NSB. EPD requires that contamination be assessed in relation to site-specific background data, not data derived from literature searches. | Section 6.1.2.4 will be revised to indicate that naturally reported ranges of inorganics in soil were used for a preliminary screening of site soil data. The purpose of comparing site-specific concentrations to naturally reported ranges is to assess the site for extraordinary and unique characteristics related to concentrations of inorganics in soil. This comparison is not a basis for assessing potential contaminants in soil at the site. |
| 27 | Sections 6.1.2 through 6.1.2.4 | The "no further action" recommendation for soil at Site 5 can not be accepted on the basis of the information presented. The State of Georgia requires soil cleanup to TCLP values or site specific background concentrations. Background concentrations have not been established and site soils have not been sampled. Further investigation is required to establish background for the site and to define the extent of soil contamination to background in both the horizontal and vertical dimensions. | A work plan will be prepared to address additional investigation to establish background concentrations and other activities to confirm whether soil or groundwater contamination is indicated based on comparison to the background data. |

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| Comment No. | Section | Comment | Response |
|-------------|------------------------------------|---|---|
| 28 | Section 6.2 General Comments | The monitoring wells and soil borings at Site 16 are not located in such a fashion that they can reasonably be expected to produce results which are representative of site conditions. Monitoring well/soil boring KBA-16-2 is the only well which appears to lie directly downgradient of the site. None of the soil samples analyzed were obtained within Site 16. Additional monitoring wells must be installed and soil samples must be obtained to establish background values and to assess groundwater quality and the potential for soil contamination within and in the vicinity of Site 16. Because the analytical results were determined not to be representative of site conditions, the remainder of the report on Site 16 was not exhaustively reviewed. The "no further action" recommendation for this site is not supported by the data represented. The following comments should also be addressed in the revised Section 6.2. | As indicated in the response to comment no. 10, Section 6.2 will be revised to describe how the location of the site was identified. Discussion will be added to include an evaluation of the suitability of the existing configuration of monitoring wells. A work plan will be developed to address additional investigation of soil and groundwater. |
| 29 | Section 6.2.1 | The hydrocone sampling results for volatile organic contaminants do not appear to be included in this report. Data tables can not be substituted for the actual analytical results. | All data are reported in subsection 6.2.1 for on-site and off-site laboratory analysis of VOCs in groundwater samples collected using hydrocone samplers. Data for all analytes and all samples is reported in the tables within the text. The laboratory report of the data is not included in the report because the data packages are comprised of several hundred pages and the validation reports would also need to be included. These materials are available in the ABB-ES Knoxville, TN, office should you want to review them or have them sent to you. |
| 30 | Section 6.2.2 | This section refers to analysis of "Appendix IX" constituents in soil. Appendix IX is a list of groundwater constituents. This must be corrected. | The parameters analyzed in soil samples included the same constituents listed in the Appendix IX groundwater monitoring list. The phrase "Appendix IX constituents" is used broadly to reference a readily identifiable list of parameters. |

**Response to Comments from GA EPD on
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| Comment No. | Section | Comment | Response |
|-------------|---------------------------------|---|---|
| 31 | Section 6.2.2.1 through 6.2.2.4 | The actual laboratory results must be submitted. Data summary tables are interpretations and can not be fully evaluated. | The Level III data packages that comprise the laboratory report of data for Site 16 and the associated data validation reports would occupy several boxes. If the laboratory data packages and validation reports were appended to the RFI report, the report would require an extraordinary number of bound volumes. These materials are available in the ABB-ES Knoxville, TN, office should you want to review them or have them sent to you. Appendix F of Volume II of the RFI Report includes a complete presentation of validated data for samples from Site 16 and the associated QA/QC samples. The header on the data tables in Appendix F will be revised to reflect the completeness of the data presented. |
| 32 | Section 6.2.2.1 through 6.2.2.4 | Analytical results from filtered groundwater samples are not acceptable. Only results from unfiltered samples will be considered. | The discussion of characterization of groundwater at Site 16 will be revised to emphasize that unfiltered sample data are used as a basis for determining whether a release has occurred. |
| 33 | Section 6.2.2.1 through 6.2.2.4 | Statistical comparisons of background and downgradient water quality must be made on a well to well basis. Comparisons based on mean values for all downgradient wells are not acceptable. | Statistical analyses will be done in addition to those already performed to identify which data points (i.e., which well and which sample event) are significantly different from the upgradient mean concentration. This is the equivalent of a well to well comparison. |
| 34 | Section 8.4.1 | The RFI report presents EP Toxicity Test results from 1981 for soil/sludge removed from Site 2, the fire training pit. Although EP Toxicity testing was appropriate at the time for characterizing the waste soil/sludge to be excavated from the Fire Training Pit, such characterization was intended only for waste disposal purposes. The EP Toxicity Test is not and has never been adequate for making a determination on the potential for groundwater contamination. Groundwater contamination may have occurred even though the soil/sludge excavated from the pit did not reach the threshold limits for definition of a hazardous waste. | A work plan proposing a technical approach for evaluating potential groundwater contamination associated with Site 2 will be developed. This work plan will be submitted to GA EPD for approval. |

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| Comment No. | Section | Comment | Response |
|-------------|---------------|---|--|
| 35 | Section 8.4.1 | The relationship between Site 12 and Site 2 is not clear. The RFI report submitted does not present any analytical data on potential soil or groundwater contamination at Site 2. Despite the fact that Site 2 is contained within the geographic extent of Site 12, Site 2 was not included in the plan for the RFI. These two sites differ in function, waste characteristics, waste quantity and remedial history, as well as other parameters. Thus, the "no further action" recommendation approved by EPD for Site 12 can not be applied to Site 2. | See response to comment No. 34. |
| 36 | Section 9.0 | The recommendations made in this section for Sites 5 and 16 are not supported by the data presented. These recommendations must be reevaluated following the further investigation recommended in Comment 1 - 35 above. | Section 9.0 will be revised to reflect the revisions and recommendations indicated in this response to comments. |
| 37 | Appendix A | Complete well construction information should be provided for all monitoring wells at Sites 5 and 16. | A table(s) will be developed and incorporated into the report that provides well construction data for the monitoring wells at Sites 5 and 16. The boring logs in Appendix A contain well construction diagrams. |

| REPORT DOCUMENTATION PAGE | | | | Form Approved OMB No. 0704-0188 | |
|---|-------|--|---|--|--|
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Block No. 18, Subject Terms

Block No. 19, Abstract

This report presents information obtained from soil and groundwater investigations at two former disposal areas. The two areas are designated Site 5, Army Reserve Disposal Area, Towhee Trail, and Site 16, Army Reserve Disposal Area, Motor Missile Magazines. Site history and file information is presented for a third site, Site 12, Army Reserve Disposal Area, Current Dry Dock, that was approved for No Further Action following removal of wastes from the site. A former fire-fighting training pit included in the area of Site 12 has been identified and will require investigation to evaluate for residual groundwater contamination.

Follow-on investigations are needed to obtain chemical data for background soil and groundwater. Contamination of soil and groundwater at the sites must be evaluated relative to background conditions. The existing chemical data from the sites are inconclusive in regard to determining whether releases have occurred.

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**RESOURCE CONSERVATION AND RECOVERY ACT FACILITY
INVESTIGATION REPORT FOR SITES 5 AND 16 AND
SITE HISTORY AND FILE INFORMATION FOR SITE 12**

**NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA**

VOLUME I, SECTIONS 1 THROUGH 9

Unit Identification Code No. N42237

Contract Task Order No. 041

Contract No. N62467-89-D-0317

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June 1994



FOREWORD

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), the 1976 Resource Conservation and Recovery Act (RCRA) as augmented by the 1984 Hazardous and Solid Waste Amendments (HSWA), and as directed in Executive Order 12580 of January 1987, the Department of Defense (DOD) conducts an Installation Restoration (IR) program for evaluating and remediating problems related to releases and disposal of toxic and hazardous materials at DOD facilities.

The Naval Assessment and Control of Installation Pollutants (NACIP) program was developed by the Navy to implement the IR program for all Naval and Marine Corps facilities. The NACIP program was originally conducted in three phases: (1) Phase I, Initial Assessment Study, (2) Phase II, Confirmation Study (including a Verification Step and a Characterization Step), and (3) Phase III, Planning and Implementation of Remedial Measures. The three-phase IR program was modified and updated to be congruent with the CERCLA, SARA, RCRA, and HSWA driven DOD IR program.

The updated nomenclature for the RCRA and SARA process is as follows:

- Preliminary Assessment and Site Inspection
- Remedial Investigation
- Feasibility Study
- planning and implementation of remedial design

This report discusses the findings and results of an RCRA Facility Investigation (RFI) at Sites 5 and 16. This investigation included soil and groundwater sampling at Site 5, Army Reserve Disposal Area, Towhee Trail, and Site 16, Army Reserve Disposal Area, Motor Missile Magazines at Naval Submarine Base, Kings Bay, Georgia. Additionally, site history and file information for Site 12, Army Reserve Disposal Area, current Dry Dock, is included.

Southern Division Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) has the responsibility for implementation of the Navy and Marine Corps IR program in the southeastern and midwestern United States. Questions regarding this report should be addressed to the Public Affairs Office, Naval Submarine Base, Kings Bay, Georgia, at (912) 673-4714.

EXECUTIVE SUMMARY

Under contract to the U.S. Department of the Navy (Navy), Southern Division, Naval Facilities Engineering Command, this Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report was prepared for Site 5, Army Reserve Disposal Area, Towhee Trail; Site 12, Army Reserve Disposal Area, Current Dry Dock; and Site 16, Army Reserve Disposal Area, Motor Missile Magazines, located on the Naval Submarine Base in Kings Bay, Georgia. This report was prepared under the Navy's Comprehensive Long-Term Environmental Action, Navy Contract No. N62467-89-D-0317, Contract Task Order No. 041.

This report is a comprehensive presentation of information obtained from Sites 5 and 16 during the RFI. Six bimonthly groundwater sampling events were included in the RFI program. Investigation of environmental media at Sites 5 and 16 began in January 1992 when soil samples were collected and monitoring wells were installed. The sixth and last bimonthly groundwater sampling event was completed in January 1993. The soil and groundwater samples collected from Sites 5 and 16 were analyzed for volatile organic compounds, semivolatile organic compounds, pesticides, herbicides, polychlorinated biphenyl compounds, dioxins, furans, and inorganic analytes included in the U.S. Environmental Protection Agency Appendix IX list.

The soil and groundwater data collected from Sites 5 and 16 were evaluated without the benefit of a background data set. Also, magnetic data were not collected at Site 16 because of construction activities. Therefore, the location of the Site 16 disposal area has not been confirmed, but is currently based on historical information, aerial photographs, and ground tours. Additional investigative work will be planned for both sites and a supplemental RFI workplan prepared and submitted to the Georgia Department of Natural Resources for approval.

In compliance with the October 1991 RFI Workplan, site history and file information for Site 12, gathered by the Navy, are presented in this report. RFI investigative activities were not planned for Site 12 because the site was approved for No Further Action in 1990, subsequent to removal of wastes and contaminated soil from the site. Site 2, a former fire fighting training area, is included in the area of Site 12. The potential for contamination of groundwater at Site 2 will be assessed subsequent to development and approval of a workplan.

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GLOSSARY

| | |
|----------|---|
| ABB-ES | ABB Environmental Services, Inc. |
| ACL | alternative concentration limit |
| AIC | Acceptable Intake - Chronic |
| AIS | Acceptable Intake - Subchronic |
| ANOVA | Analysis of Variance |
| AWQC | Ambient Water Quality Criteria |
| B&K | Bruel & Kjaer |
| bls | below land surface |
| BTOC | below top of casing |
| CA | chlorinated aliphatic |
| CAP | Corrective Action Plan |
| CB | carboxylic acid |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CMS | Corrective Measure Study |
| CLEAN | Comprehensive Long-Term Environmental Action, Navy |
| CLP | USEPA Contract Laboratory Program |
| CRDL | contract required detection limit |
| CRQL | contract required quantitation limit |
| CSF | Cancer Assessment Group Slope Factor |
| CWA | Clean Water Act |
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| 4,4'-DDD | 4,4'-dichlorodipenyldichloroethane |
| DDE | dichlorodiphenyldichloroethylene |
| DDT | dichlorodiphenyltrichloroethane |
| DOD | Department of Defense |
| DOT | Department of Transportation |
| DQO | data quality objective |
| EP | Extraction Procedure |
| ft | feet |
| ft/min | feet per minute |
| ft/yr | feet per year |
| g/L | grams per liter |
| GA DNR | Georgia Department of Natural Resources |
| GC | gas chromatograph(y) |
| HEA | Health Effects Assessment |
| Hg | mercury |
| HSWA | Hazardous and Solid Waste Amendments |
| I.D. | identification |
| ICMS | Interim Corrective Measure Screening |
| in/yr | inches per year |
| IR | Installation Restoration |

GLOSSARY (continued)

| | |
|------------------|--|
| J | estimated value |
| K _{ow} | octanol-water partition coefficient |
| MCL | maximum contaminant level |
| MCLG | maximum contaminant level goal |
| MCA | monocyclic aromatic |
| MDL | method detection limit |
| mg/kg | micrograms per kilogram |
| mg/L | milligrams per liter |
| MLW | mean low water |
| mm | millimeter |
| mmhos/m | millimhos per meter |
| MOTKI | Military Ocean Terminal, Kings Bay |
| mph | miles per hour |
| MS/MSD | matrix spike and matrix spike duplicate |
| µg/L | micrograms per liter |
| µg/kg | micrograms per kilogram |
| NA | not applicable |
| NACIP | Naval Assessment and Control of Installation Pollutants |
| NCA | non-chlorinated aliphatic |
| ND | no data found |
| NEESA | Naval Energy and Environmental Support Activity |
| NF | not flammable |
| NR | not reported |
| NSB | Naval Submarine Base |
| % | percent |
| PA | polycyclic aromatic |
| PARCC | precision, accuracy, representativeness, comparability, and completeness |
| PCB | polychlorinated biphenyl |
| PID | photoionization detector |
| PQL | practical quantitation limit |
| QA/QC | quality assurance and quality control |
| QC | quality control |
| RCRA | Resource Conservation and Recovery Act |
| RfDs | reference doses |
| RFI | RCRA Facility Investigation |
| RPD | relative percentage difference |
| SARA | Superfund Amendments and Reauthorization Act |
| SDWA | Safe Drinking Water Act |
| SOUTHNAVFACENCOM | Southern Division, Naval Facilities Engineering Command |
| SVOC | semivolatile organic compound |
| SWMU | solid waste management unit |

GLOSSARY (continued)

| | |
|-------|--------------------------------------|
| TBC | to be considered |
| TCL | target compound list |
| TDS | total dissolved solids |
| TOC | top of casing |
| TSCA | Toxic Substances Control Act |
| TSS | total suspended solids |
| U | not detected |
| USEPA | U.S. Environmental Protection Agency |
| USGS | U.S. Geological Survey |
| VOC | volatile organic compound |

1.0 INTRODUCTION

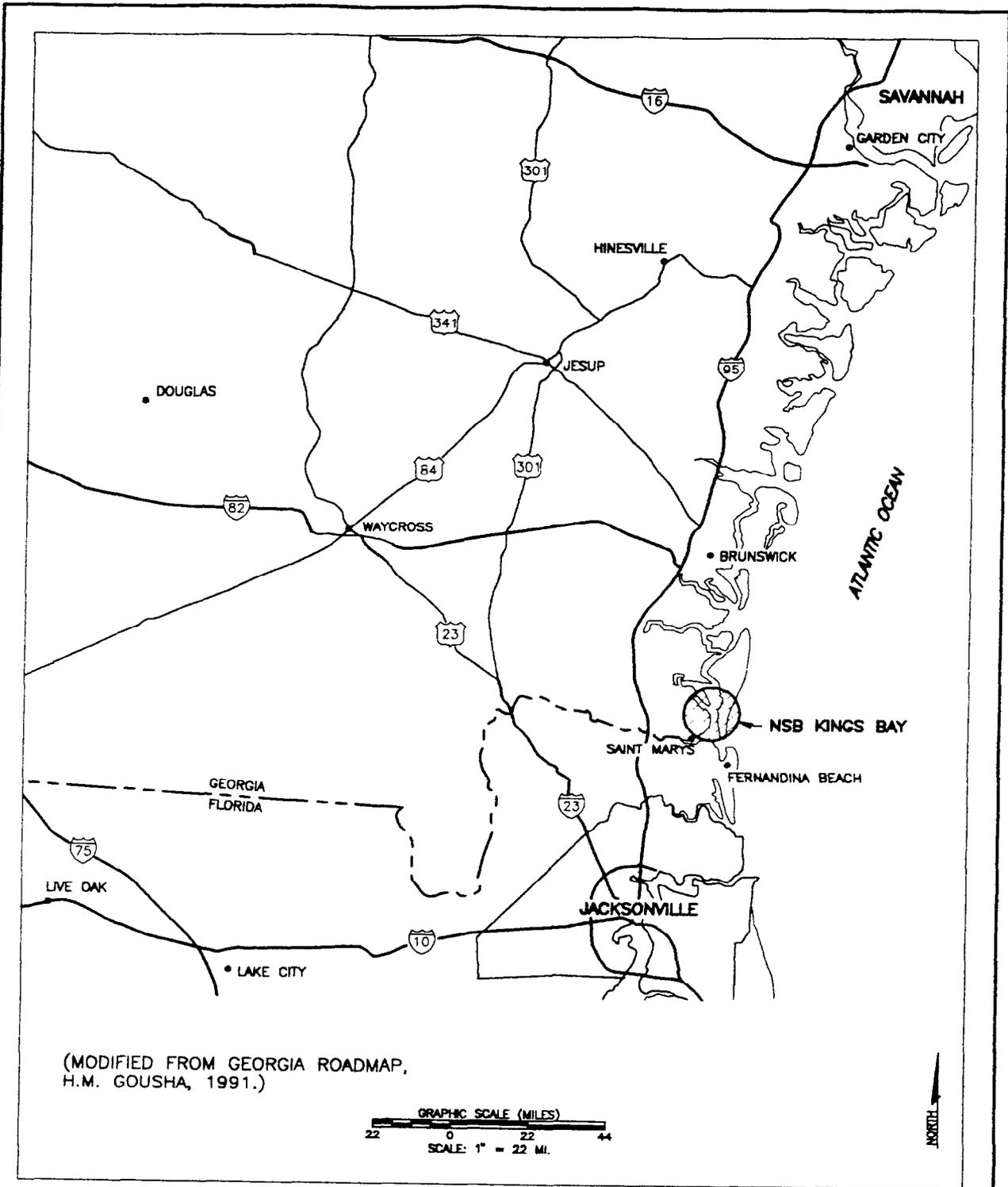
Under contract to the U.S. Department of the Navy (Navy), Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), this Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report was prepared for Site 5, Army Reserve Disposal Area, Towhee Trail, and Site 16, Army Reserve Disposal Area, Motor Missile Magazines, located on the Naval Submarine Base (NSB) in Kings Bay, Georgia. Additionally, site history and file information are presented for Site 12, Army Reserve Disposal Area, Current Dry Dock. A fourth site, Site 11, Old Camden County Landfill, was investigated and is reported separately in the RFI Interim Report for Site 11. This report was prepared under the Comprehensive Long-Term Environmental Action, Navy (CLEAN) Contract No. N62467-89-D-0317, Contract Task Order No. 041. The following subsections describe the regulatory setting, purpose of the report, the objectives of the RFI, and previous investigations.

1.1 FACILITY BACKGROUND. NSB Kings Bay is located in the southeastern corner of Georgia, approximately 8 miles north of the Georgia-Florida border (Figure 1-1). The NSB covers 16,168 acres and is located in Camden County. The Harriett's Bluff topographic quadrangle map includes the NSB area (Figure 1-2). The facility's history is summarized in the following paragraphs of this subsection.

The U.S. Army began operations at NSB Kings Bay in the early 1950's. The property originally was developed as a military ocean terminal. From its inception until June 30, 1965, the terminal was known as the Kings Bay Army Terminal. The Kings Bay Army Terminal was constructed to meet the Department of the Army's requirements for East Coast port facilities capable of transporting ammunition and other explosives in the event of a national emergency. During this time, the Kings Bay Army Terminal was used for training purposes by the U.S. Army Reserve.

On April 1, 1965, as a result of a major reorganization, the terminal was placed under the jurisdiction of the newly organized Military Traffic Management and Terminal Service. On July 1, 1965, the terminal became known as the U.S. Army Military Ocean Terminal, Kings Bay (MOTKI). MOTKI was designed to store ammunition or explosives for about 3 months and was directly subordinate to the Military Ocean Terminal, Southport, North Carolina. Facilities constructed at MOTKI included a 2,000-foot wharf, administrative buildings, work shops, utility buildings, and 47 miles of railroad track for transporting explosives. MOTKI had no assigned military personnel and was maintained and operated by 19 U.S. Civil Service employees for reserve training operations and contingency purposes from 1965 to 1978. The mission of MOTKI was to plan programs, make military repairs, and provide fire prevention and protection functions for the terminal. Because there was no immediate operational need for this installation, it was placed on inactive status from 1965 until July 1, 1978.

In 1978, the Navy selected MOTKI as the East Coast location for its Fleet Ballistic Missile submarine support facility. On July 1, 1978, the site was established under a developmental status and was named the Naval Submarine Support Base. Construction of a refit facility for one submarine Squadron (T-1) began in 1978 in anticipation of 10 Poseidon submarines. In 1979, the Navy moved Squadron 16 from Spain to Kings Bay, and the site's official name became the Naval Submarine Base, Kings Bay.

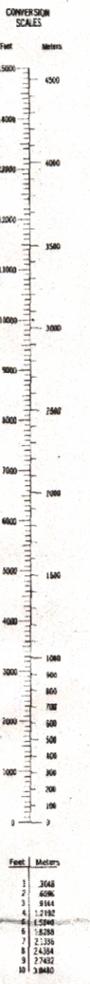


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| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: REGIONAL LOCATION MAP |  RFI REPORT FOR SITES 5 & 16 NAVAL SUBMARINE BASE KINGS BAY, GEORGIA |
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Produced by the United States Geological Survey and the National Ocean Service
Control by USGS, NOS/NOAA, and USACE
Orthophotomaps prepared by the Geological Survey from aerial photographs taken April 15, 1974. Topography by planimetric surveys 1958; revised from aerial photographs taken 1974. Field checked 1975. Map edited 1980.
Bathymetry compiled by the National Ocean Service from tide-coordinated hydrographic surveys.
Soundings compiled from NOS 11503 and 11504.
This information is not intended for navigational purposes.
Mean lower low water (dotted) line and mean high water (solid) line compiled by NOS from tide-coordinated aerial photographs.
Apparent shoreline (outer edge of vegetation) shown by photomaps.
Projection and 10,000-foot grid ticks. Georgia coordinate system, east zone (transverse Mercator).
1000-meter Universal Transverse Mercator grid, zone 17 1927 North American Datum.
To place on the predicted North American Datum 1983, move the projection lines 21 meters south and 17 meters west as shown by dashed corner ticks.
There may be private inholdings within the boundaries of the National or State reservations shown on this map.

UTM GRID AND 1983 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOURS AND ELEVATIONS IN METERS

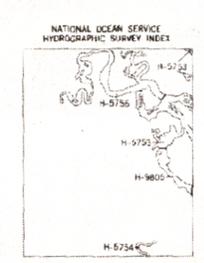
HYDROBATHYMETRIC SURVEY INFORMATION

| Survey Number | Survey Date | Survey Scale | Survey Unit | Survey Date |
|---------------|-------------|--------------|-------------|-------------|
| H-5753 | 1935 | 1:10,000 | 502-12 | |
| H-5754 | 1935 | 1:10,000 | 62-58 | |
| H-5755 | 1935 | 1:10,000 | 62-10 | |
| H-9825 | 1979 | 1:2,500 | 01-02 | |

SCALE 1:24 000

CONTOUR INTERVAL 1.5 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS - SOUNDINGS IN METERS
DATUM IS MEAN LOWER LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE

BASE MAP COMPLES WITH NATIONAL MAP ACCURACY STANDARDS
BATHYMETRIC SURVEY DATA COMPLES WITH INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) SPECIAL PUBLICATION 44 ACCURACY STANDARDS
AND/OR STANDARDS USED AT THE DATE OF THE SURVEY
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22062
AND NATIONAL OCEAN SERVICE, ROCKVILLE, MARYLAND 20852
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



ROAD CLASSIFICATION

Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road

Trails
Interstate Route U. S. Route State Route

HARRIETTS BLUFF, GA.
30081-G5-OM-024
1980
PHOTOREVISED 1988
DMA 4645 18E-SERIES V8450

Revisions shown in purple compiled in cooperation with State of Georgia agencies from aerial photographs taken 1983 and other sources. This information not checked. Map edited 1988.

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Currently, NSB Kings Bay supports TRIDENT submarines. New facilities completed in the early 1990's are for crew training, weapons handling and storage, submarine maintenance and repair, personnel support, and housing.

1.2 REGULATORY SETTING. Because NSB Kings Bay is operating under a current RCRA Part B permit, the facility is required to implement a RCRA corrective action program. The RCRA Corrective Action Plan (CAP) (Interim Final) (U.S. Protection Agency [USEPA], 1988a) was developed by the USEPA to provide a model for corrective action and uses a four-phase approach to evaluate the condition of solid waste management units (SWMUs) and direct corrective action, if necessary. The first step, a RCRA Facility Assessment, was not formally conducted at NSB Kings Bay by representatives of State and Federal regulatory agencies. However, the Georgia Department of Natural Resources (GA DNR) issued a Hazardous and Solid Waste Amendments (HSWA) Permit to the NSB on September 29, 1989. The permit identified four SWMUs (Figure 1-3) suspected to be sources of current or past releases of hazardous substances to the environment:

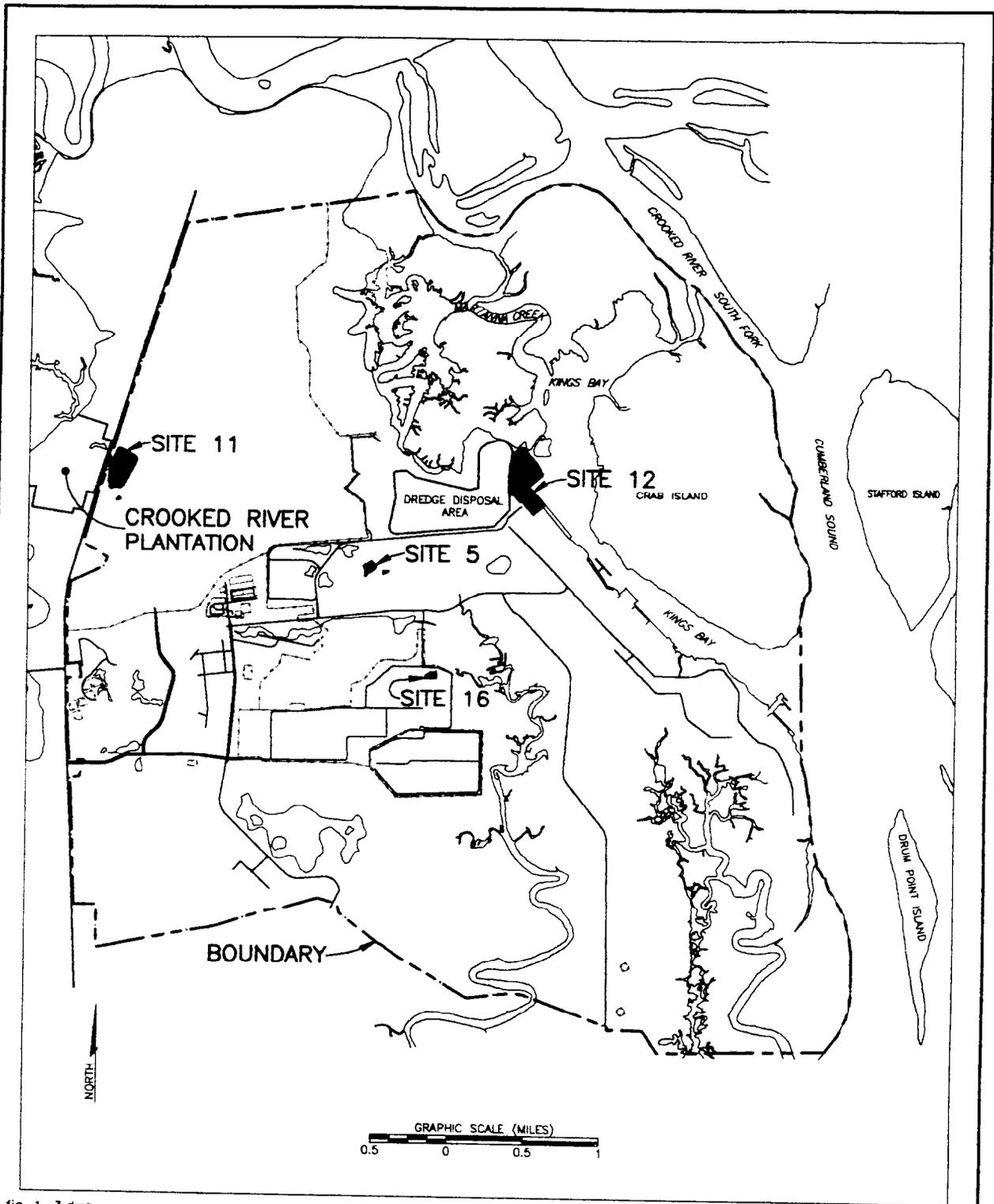
- Site 5, Army Reserve Disposal Area, Towhee Trail;
- Site 11, Old Camden County Landfill;
- Site 12, Army Reserve Disposal Area, Future Dry Dock (now referred to as the Current Dry Dock); and
- Site 16, Army Reserve Disposal Area, Motor Missile Magazines.

Site 12 is included in this RFI but no sampling or analysis has been conducted because it was remediated during construction of a dry dock. NSB Kings Bay conducted a records search and information review and the resulting site history and file information for Site 12 are included in Section 8.0 of this document.

The second step of corrective action includes development of an RFI workplan and conducting an RFI to establish the presence or absence of toxic or hazardous substances and obtain information on the nature and extent of the contamination. Information collected during the RFI stage will be used to establish whether there is a need to implement additional phases of the RCRA CAP. A possible third step, Interim Corrective Measures, would involve controlling the further migration of contaminants and/or controlling potential sources of release and would be implemented if needed. The fourth step, Corrective Measure Study (CMS), would evaluate and recommend specific technical methodologies for achieving long-term remedial action goals. GA DNR requires a site-specific CAP to address remedial actions at the site but does not require a CMS for the process.

The corrective action program at Site 11 has moved into the Interim Corrective Measures phase because groundwater contamination was found and has moved off NSB property towards a residential area. Site 11 is being addressed separately from the other sites to accommodate the rapid schedule for the corrective action program at the site.

1.3 PURPOSE OF REPORT. An RFI investigative phase has been conducted at Sites 5 and 16 over the past year. Table 1-1 summarizes this investigation. The objective of this report is to present a comprehensive overview of the information obtained from the field investigations conducted during the RFI at Sites 5 and 16. The RCRA CAP (Interim Final) (USEPA, 1988a) and the RFI guidance



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| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: SITE LOCATION MAP | |
| CHKD: KMH | FIGURE NO.: 1-3 | RFI REPORT FOR SITES 5 & 16 | |
| DATE: 6-9-94 | | NAVAL SUBMARINE BASE KINGS BAY, GEORGIA | |

KB NSB(RFI-5&16)*027
mlv.06.94

**Table 1-1
Investigative Chronology and Source Documents**

Resource Conservation and Recovery Act Facility Investigation Report
for Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Investigation | Dates Conducted | Activities ¹ | Source Document |
|-------------------|---------------------------|---|---|
| RFI Field Program | January and February 1992 | Soil borings Geophysical surveys Subsurface soil sampling Monitoring well installation Slug tests Groundwater sampling event No. 1 Surface soil sampling (Site 5) | Technical Memorandum No. 1 ² Potential Source of Contamination Investigation and Site Investigation Solid Waste Management Unit RCRA Facility Investigation Workplan ³ |
| RFI Field Program | May 1992 | Groundwater sampling event No. 2 | Technical Memorandum No. 2 ⁴ |
| RFI Field Program | July 1992 | Groundwater sampling No. 3 Surface soil sampling (Site 5) | Technical Memorandum No. 3 ⁵ |
| RFI Field Program | September 1992 | Groundwater sampling event No. 4 | Technical Memorandum No. 4 ⁶ |
| RFI Field Program | November 1992 | Hydrocone groundwater sampling | RFI Report for Sites 5 and 16 and File Information for Site 12 |
| RFI Field Program | November 1992 | Groundwater sampling event No. 5 | Technical Memorandum No. 5 ⁷ |
| RFI Field Program | January 1993 | Groundwater sampling event No. 6 | RFI Report for Sites 5 and 16 and File Information for Site 12 |

¹Activities listed were conducted at both Site 5 and Site 16 unless otherwise specified.

²ABB Environmental Services, Inc. (ABB-ES), 1992a.

³ABB-ES, 1991.

⁴ABB-ES, 1992b.

⁵ABB-ES, 1992c.

⁶ABB-ES, 1992e.

⁷ABB-ES, 1993a.

Note: RFI = Resource Conservation and Recovery Act (RCRA) Facility Investigation.

(USEPA, 1989a) provide a list of possible activities that may be needed to characterize a site. The work that was conducted at Sites 5 and 16 did not necessarily include all of the possible activities included on the list for a facility investigation. The RCRA CAP (Interim Final) (USEPA, 1988a) and the RFI guidance (USEPA, 1989a) were used in developing the format for presenting the information obtained during the investigations conducted at Sites 5 and 16.

Additionally, Section 8.0 of this report provides a summary of available information, gathered by the Navy, pertaining to past waste disposal practices and subsequent removal actions for Site 12. In April 1990, the NSB submitted an RFI workplan to the GA DNR recommending No Further Action at Site 12 because wastes and contaminated media were removed from the site in 1983. This plan was approved by GA DNR in September 1990. Subsequently, a second RFI workplan was developed, and approved by GA DNR, for the four sites at NSB through the Installation Restoration (IR) program (ABB Environmental Services, Inc. [ABB-ES], 1991). No RFI activities were scheduled for Site 12 because it was remediated in 1983. The October 1991 workplan specified that information pertaining to Site 12 would be gathered for inclusion in this RFI report.

1.4 OBJECTIVES OF RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) FACILITY INVESTIGATION (RFI). The objectives of an RFI are to provide the necessary information to:

- verify whether a release has occurred;
- characterize the release, if any, with respect to the type, concentration, and distribution of contaminants and the rate, direction, and distance of contaminant migration;
- establish the need, if any, for interim corrective measures if a release is characterized as either immediately or potentially threatening to human health or the environment;
- establish the need for a site-specific CAP based on information collected during the RFI; and,
- support preparation of the site-specific CAP.

The overall objectives of an RFI are fulfilled through phased investigations, with each successive phase being built upon the findings and conclusions of previous phases. An RFI is complete when either a site moves into the CMS phase and development of a site-specific CAP, or data are sufficient to support No Further Action.

1.5 PREVIOUS INVESTIGATIONS. Site 5, Army Reserve Disposal Area, Towhee Trail; Site 12, Current Dry Dock Area; and Site 16, Army Reserve Disposal Area, Motor Missile Magazines, were first investigated in 1985 when an Initial Assessment Study was performed at NSB Kings Bay under the IR program (C.C. Johnson, 1985). The Initial Assessment Study consisted of records searches, ground and aerial tours, and interviews. Sixteen sites were evaluated and none were recommended for further investigation. However, four sites, including Sites 5, 12, and 16, required further action under the facility HSWA permit issued to NSB Kings Bay by the GA DNR. An RFI workplan was prepared in response to the HSWA permit requirements (ABB-ES, 1991).

The RFI workplan did not include sampling or other field activities at Site 12. RFI investigative activities were implemented at Sites 5 and 16 in January 1992. The RFI included geophysical surveys and subsurface soil sampling at both sites, and the installation of seven groundwater monitoring wells at Site 5 and four groundwater monitoring wells at Site 16. The RFI at both sites included six bimonthly groundwater monitoring events.

The interpretations and conclusions presented in Sections 2.0 through 5.0 of this report are based on the results of the RFI field program conducted at Sites 5 and 16, including the groundwater sampling events.

1.6 REPORT ORGANIZATION. This report presents conclusions based on the analyses and evaluation of data collected during the RFI at Sites 5 and 16 and includes documentation for Site 12. The report is organized as follows.

- Introduction includes the facility background, regulatory setting, purpose of the report, objectives of the RFI, previous investigations, and report organization.
- Environmental Setting discusses regional and site-specific hydrogeology, soils, topography, surface water and drainage, and climate.
- Source Characterization discusses the disposal area and waste characteristics.
- Protection Standards presents groundwater and other relevant protection standards.
- Investigation Analyses summarizes data quality for the various analytical programs associated with the RFI.
- Contamination Characteristics discusses groundwater and soil analytical data in relation to evaluating the presence or absence of contamination.
- Potential Receptors discusses human populations and ecological systems potentially susceptible to contaminant exposure.
- Site History and File Information for Site 12 provides a summary of available information pertaining to past disposal practices and removal actions for Site 12.
- Conclusions and Recommendations summarizes results of the RFI and recommendations for additional investigation.

2.0 ENVIRONMENTAL SETTING

This section describes site hydrogeology, soils, topography, surface water and drainage, and climate.

2.1 TOPOGRAPHY, SURFACE WATER, AND DRAINAGE. Elevations at NSB Kings Bay are measured relative to mean low water (MLW), rather than mean sea level. The elevations at NSB Kings Bay range from 0 feet MLW at the shoreline to 35 feet above MLW in the western part of the base. The area around the base is generally flat and marshy and is traversed by meandering streams.

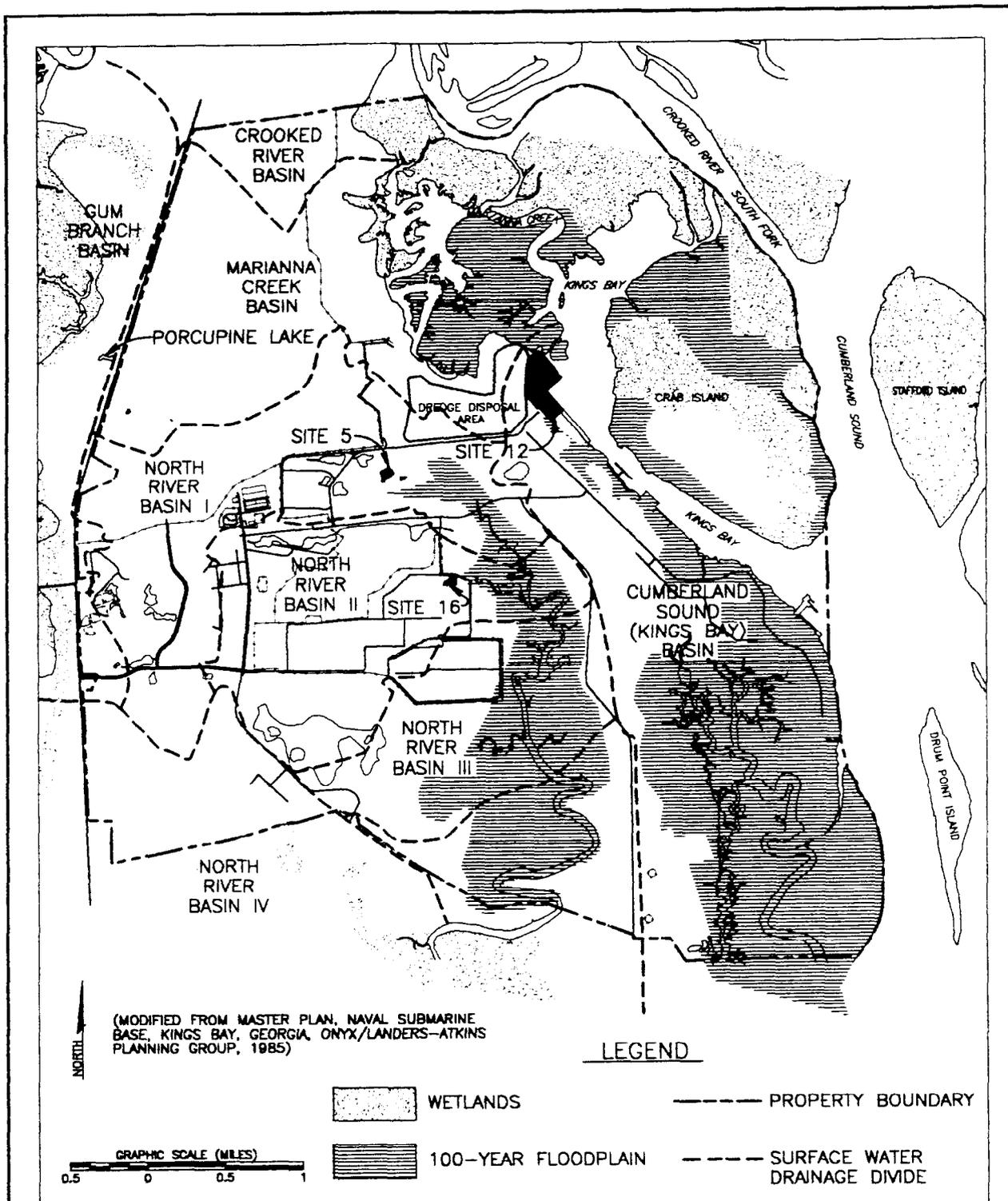
Site 12, located at the shoreline, is situated just above 0 feet MLW. Elevations at Sites 5 and 16 are approximately 20 feet above MLW. The land surface at Sites 5 and 16 is characterized by relatively flat to gently sloping surface topography. Drainage features provide topographic relief at Sites 5 and 16 and variations in elevations at both sites are approximately 5 feet, except for the slope to the northwest of Site 16 that drops off approximately 15 feet.

NSB Kings Bay is drained by three major drainage networks, Marianna Creek, North River, and Cumberland Sound Basins, as shown in Figure 2-1. Because the NSB is relatively flat, roads and disturbed areas form artificial drainage patterns and dividing lines between drainage basins. Surface runoff at NSB Kings Bay is to rivers and intermittent creeks via storm drainage ditches. Infiltration of precipitation to groundwater is promoted by the flat topography and permeable sands. Most surface water runoff is stored in the upland swamps and marshes and is diverted off base through long shallow ditches and intermittent creeks and rivers. Water may eventually migrate through the surficial aquifer and discharge into streams, rivers, and springs, including the North River, Crooked River, and Marianna Creek. These streams and rivers eventually flow into Kings Bay and the Cumberland Sound.

The NSB Kings Bay drainage network covers approximately 11,000 acres. Approximately 30 percent of this area is salt marsh, and the remainder consists of upland swamps and marshes. The major drainage outlet is the North River, draining approximately 49 percent of the area to the south. To the north, the Crooked River drains approximately 5 percent of the NSB, Marianna Creek drains 17 percent, and the remaining 29 percent drains eastward into the Cumberland Sound.

Water quality in freshwater bodies in and near the NSB is affected by concentrations of mercury, possibly from mercury-based fungicides, and low levels of dissolved oxygen (C.C. Johnson, 1985). Water quality within Kings Bay and Cumberland Sound are affected by dredging activities, spoils disposal effluent discharge, sewage effluent discharge, construction, runoff from pine plantations and small agricultural areas, and waterfront industrial operations. The freshwater bodies described above are used principally for non-contact recreation including boating, fishing, and navigation.

The elevations of the 10-, 100-, and 500-year floodplains in the region are 6.8, 12.4, and 16.5 feet above mean sea level, respectively (Onyx/Landers-Akins Planning Group, 1985). Approximately one-half of the facility lies within the 100-year floodplain. In general, land surrounding the low marshy areas near Marianna Creek and the North River lies within the 100-year floodplain.



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| CHKD: KMH | FIGURE NO.: 2-1 | RFI REPORT FOR SITES 5 & 16 | |
| DATE: 6-9-94 | | NAVAL SUBMARINE BASE KINGS BAY, GEORGIA | |

2.2 HYDROGEOLOGY. The hydrogeology for Sites 5 and 16 is described on a regional scale and a site-specific scale in the following subsections.

2.2.1 Regional Hydrogeology The Kings Bay region is located within the Coastal Plain physiographic province along the Georgia coastline. Seven different depositional shorelines have been discovered around Kings Bay as a result of sea level fluctuations during the Cenozoic era. The shoreline complexes have not been accurately dated, but are of approximate Pleistocene and Holocene ages (C.C. Johnson, 1985).

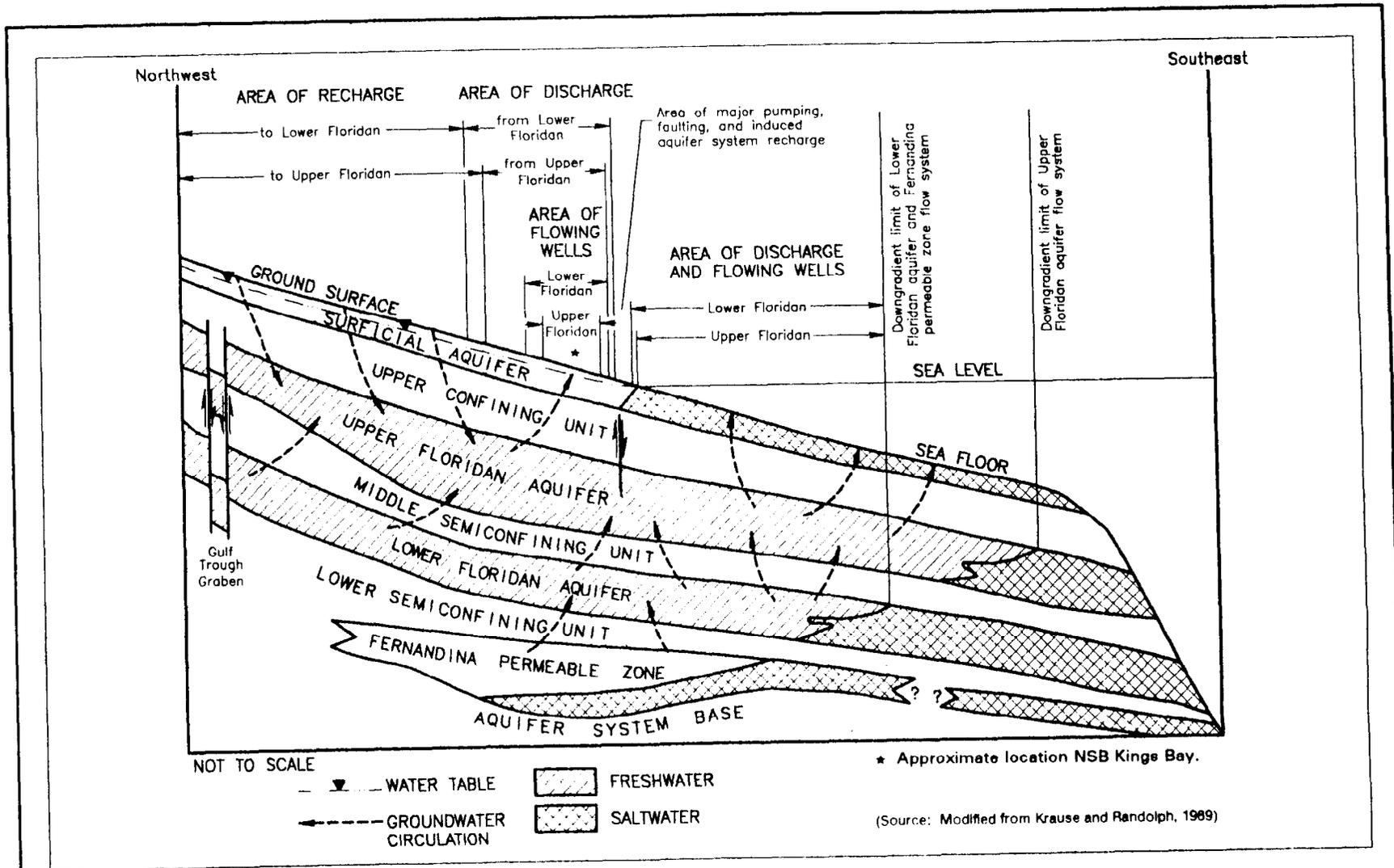
A principal source for the hydrogeologic information discussed below is the *Hydrogeology of the Floridan Aquifer System in Southeast Georgia and Adjacent Parts of Florida and South Carolina*, (Krause and Randolph, 1989). The uppermost aquifer in the Kings Bay area is the unconfined water table (surficial) aquifer. Below the surficial aquifer lies the upper confining unit. The primary artesian aquifer, or the Floridan aquifer system, lies below the upper confining unit (Figure 2-2). Figure 2-2 shows the conceptual model of the Floridan aquifer system from the Gulf Trough in the northwest to the offshore area in the southeast. Figure 2-3 provides a generalized correlation of these units with respect to stratigraphy, lithology, and hydrologic properties. Analyses of geophysical logs obtained from the U.S. Geological Survey (USGS) of area wells confirms a regional dip to the southeast of approximately 2 feet per mile in the above units.

The surficial aquifer extends from approximately 6 to 90 feet below land surface (bls) and consists of post-Miocene age unconsolidated fine- to very coarse-grained, well sorted sand. Layers of poorly sorted sand, clayey silty sand, and, at depth, argillaceous limestone are interbedded with these well-sorted sand beds.

The primary source of recharge to the surficial aquifer is infiltration from precipitation. Water movement is laterally downgradient with discharge to streams, ponds, and other surface water bodies. Evaporation and transpiration, as well as downward migration to lower aquifers, account for some water loss. Water levels in the surficial aquifer respond rapidly to rainfall. Seasonal variations correspond to variations in rainfall and evapotranspiration. The surficial aquifer functions as a source of recharge for the Floridan aquifer system by downward leakage through the secondary aquifer in areas where the water table in the surficial aquifer is above the potentiometric surface in the Floridan. Where the head gradient between the surficial aquifer and the Floridan is in the opposite direction, the surficial aquifer receives recharge from the Floridan aquifer system.

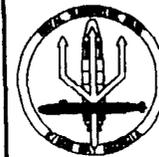
Water levels may fluctuate seasonally by 15 to 20 feet in areas of high topographic relief and high permeability aquifer material. In flat-lying areas where low permeability material is present, seasonal fluctuations are commonly less than 10 feet. The Kings Bay area is characterized by low topographic relief, but does have fairly permeable aquifer material. Water level fluctuations over the monitoring period 1992 to 1993 were less than 3 feet.

The upper confining unit, beginning at approximately 90 feet bls, ranges from 380 to 530 feet thick. This confining unit separates the water table aquifer from the Floridan aquifer system and includes not only extremely low permeability clay, but also moderately permeable sand beds. The confining unit is a regional formation, the Hawthorn Formation of late and middle Miocene age, present from



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| DMF | 7553-09 | CONCEPTUAL MODEL OF THE FLORIDAN AQUIFER SYSTEM |
| CHKD: | FIGURE NO.: | |
| KMH | 2-2 | |
| DATE: | | |
| 5-6-94 | | |



RFI REPORT FOR
SITES 5 & 16

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

| System | Series | Gulf Coast Stage | NORTHEAST FLORIDA AND EXTREME SOUTHEAST GEORGIA | | |
|------------|--------------------------|------------------|---|---|---|
| | | | Stratigraphic Unit | Lithology | Hydrostratigraphic Unit Hydrologic Properties |
| Quaternary | Holocene and Pleistocene | | Alluvium and terrace deposits | Chiefly sand, gravel, clay, shells, limestone, and marl. | Surficial aquifer: low to moderate yields |
| Tertiary | Pliocene | | Charton Formation | Shells, sand, and marl. | Surficial aquifer: low to moderate yields |
| | Miocene | | Hawthorn Formation | Chiefly interbedded sand, clay, and dolomite, and sandy phosphatic dolomite and marl. | Upper Confining Unit: low to moderate amounts of artesian and nonartesian water. Most of the Hawthorn forms the upper confining unit for the underlying artesian water, but in places, the lower part may be hydraulically connected to the Upper Floridan aquifer. |
| | Oligocene | Chickasawhayan | Suwannee Limestone | Limestone ranging from soft, chalky, and fossiliferous to dense, calcified, saccharoidal, and unfossiliferous, containing many solution cavities in recharge area. | Upper Floridan: yields moderate to large amount of water, but generally less than underlying Eocene formations. Uppermost unit of the Floridan aquifer system. |
| | Upper Eocene | Jacksonian | Ocala Limestone | White to gray, fossiliferous, recrystallized, porous limestone containing large solution cavities and caves in recharge area as well as at depth downgradient. | Upper Floridan: prolific aquifer; yields as much as 7,500 gallons per minute from two distinct water-bearing zones near the top and base of the formation. |
| | Middle Eocene | Claibornian | Avon Park Formation | Cream-colored to brown, chalky to well indurated, pelletal to micritic limestone interbedded with grained cream-colored to dark-brown, fine to medium crystalline, slightly vuggy dolomite. | Middle Confining Unit/Lower Floridan: not a significant contributor to the Floridan aquifer system in southeast Georgia. Yields moderate to large amounts of water in northeast Florida where the dolomite contains secondary permeability solution cavities. |
| | Lower Eocene | Sabinian | Oldsmar Formation | Off-white to light gray micritic limestone, interbedded with gray to light brown, fine- to medium-grained crystalline, commonly vuggy dolomite. In places, contains pore-filling gypsum and thin beds of anhydrite. | Lower Floridan: upper part acts as a semiconfining bed to basal part, which yields large amounts of water. |
| | Paleocene | Midwayan | Cedar Keys Formation | Gray and cream-colored, dolomitized limestone containing gypsum and anhydrite stringers, to finely crystalline dolomite and anhydrite. | Fernandina Zone: extremely low permeability. Acts as the lower confining unit of the Floridan aquifer system except where permeable in the Brunswick, Georgia, area, where it is part of the Lower Floridan aquifer. Contains mineralized water there. |
| Cretaceous | Upper | Navarroan | Lawson Limestone | Light tan to orange, recrystallized, sandy, porous dolostone and calcarenite. | Fernandina Zone: low permeability. Extremely high permeability locally in the Brunswick, Georgia, area where it is part of the Lower Floridan aquifer. Contains highly mineralized water there. |
| | | Tayloran | Undifferentiated | White to cream-colored, argillaceous, soft, chalky limestone to hard, gray, shaly marl. | Locally acts as the lower confining unit of the Floridan aquifer system in the Brunswick, Georgia, area because of low permeability. |

(Source: Modified from Krause and Randolph, 1989)

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| CHKD: LBH | FIGURE NO.: | |
| DATE: 5-6-94 | 2-3 | |

GENERALIZED CORRELATION OF COSTAL PLAINS STRATIGRAPHIC UNITS, LITHOLOGY, AND HYDROGEOLOGIC PROPERTIES



RFI REPORT FOR SITES 5 & 16

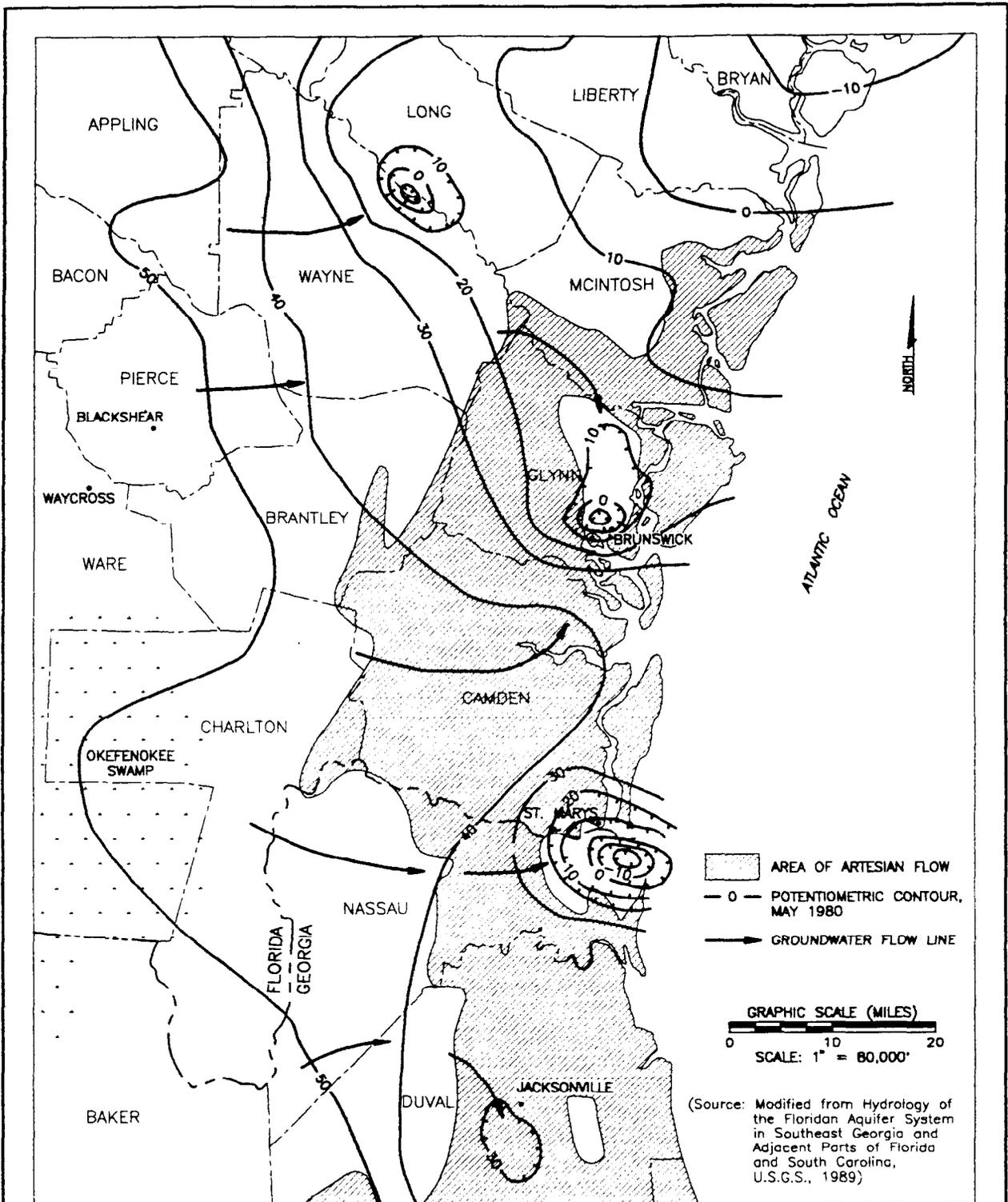
NAVAL SUBMARINE BASE KINGS BAY, GEORGIA

north Florida to South Carolina. Over most of the region, the unit consists of middle Miocene age, interbedded sand, silt, clay, and low permeability sandy clay beds. Groundwater yields in the confining unit are highly variable, and it is not considered a principal source of water (Krause and Randolph, 1989).

The Floridan aquifer system is composed of upper and lower permeable zones, termed the Upper Floridan and the Lower Floridan aquifers, respectively. This unit is used for drinking water, as it is of good quality and provides sufficient yield. In southeast Georgia and northeast Florida, the aquifer system contains cavities, cavernous zones, and solution channels. Primarily, these zones are found in the Upper Floridan, but the Lower Floridan contains some of the largest in its Fernandina zone. Most of these zones are oriented horizontally, enhancing lateral permeabilities. However, some solution channels have formed along probable zones of weakness caused by high-angle, nearly vertical fractures and faults. In extreme southeast Georgia and northeast Florida, permeable zones within the entire Floridan aquifer system are locally connected by these nearly vertical conduits. Faults are believed to be present in the Floridan aquifer system along the coast in extreme southeast Georgia and northeast Florida; however, none were indicated on regional structure maps (Krause and Randolph, 1989).

The Upper Floridan aquifer consists primarily of late Eocene Ocala limestone and equivalents. The Ocala is a very fossiliferous limestone having high effective porosity and permeability, especially the upper part. Migration of groundwater along bedding planes, joints, fractures, and other zones of weakness has developed secondary permeability that makes the Ocala extremely permeable. The Upper Floridan is composed of two permeable zones in the area of southeast Georgia. These units are designated the upper and lower water-bearing zones. The upper water-bearing zone ranges in thickness from 75 to 150 feet and consists of late Eocene age limestone that is very fossiliferous and permeable. The lower water-bearing zone ranges in thickness from 15 to 110 feet and consists of middle to late Eocene age dolomitic limestone that is recrystallized and less permeable than the upper water-bearing zone. Hydraulic characteristics of the Floridan aquifer system are primarily known for the Upper Floridan aquifer. Regional groundwater flow in the Upper Floridan is primarily easterly with southeasterly and northeasterly components (Figure 2-4). Because of the aquifer's heterogeneity, transmissivity ranges from nearly 0 near the aquifer's updip extent (east-central Georgia and southern South Carolina) to approximately 1 million feet squared per day in the thick carbonate sequence in southern Georgia. Because the Upper Floridan is so prolific, water supply wells in southeast Georgia generally do not tap other water-bearing units beneath the Upper Floridan (Krause and Randolph, 1989).

The Lower Floridan aquifer consists primarily of middle to lower Eocene carbonate rocks that are less fossiliferous and more dolomitic than the Upper Floridan aquifer. The permeability of the unit is primarily secondary, developed along bedding planes and other zones of weakness. In southeastern Georgia, the Lower Floridan aquifer includes a water-bearing zone designated the Fernandina permeable zone. The zone consists of Paleocene and late Cretaceous recrystallized limestone and dolomite that is extremely permeable. The middle semi-confining unit, which lies between the Upper and Lower Floridan aquifers, consists of middle Eocene, dense limestone and dolomite that is recrystallized and of low permeability.



fig_2-4.dwg

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| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: REGIONAL POTENTIOMETRIC SURFACE MAP FOR THE UPPER FLORIDAN AQUIFER | |
| CHKD: KMH | FIGURE NO.: 2-4 | RFI REPORT FOR SITES 5 & 16 | |
| DATE: 6-9-94 | | NAVAL SUBMARINE BASE KINGS BAY, GEORGIA | |

Information regarding locations of water supply wells in the vicinity of the NSB was obtained from the USGS. The locations of supply wells and use of groundwater are discussed in Subsection 7.2 of this report. Table 2-1 includes water level data for nine water supply wells tapping the Upper Floridan aquifer. Comparison of water level elevation to the elevation of land surface at the well indicates that the potentiometric head in the Upper Floridan is as much as 28 feet above land surface. Except for two water level elevations measured in 1985 and 1990 in the well identified as Grid No. 33E007 in Table 2-1, all water level elevations are above land surface at the well. These data indicate that the potentiometric surface of the Floridan aquifer is above the water table of the surficial aquifer. Therefore, in the vicinity of the NSB the surficial aquifer receives recharge from the Floridan aquifer. The presence of an upward potential decreases the likelihood that contaminants would migrate downward by advective transport through the confining layer.

2.2.2 Site-Specific Hydrogeology Geologic and hydrogeologic information was obtained from soil borings, slug tests, and groundwater sampling using a hydrocone groundwater sampler.

Site 5, Army Reserve Disposal Area, Towhee Trail. Site 5 is located in the west-central part of the NSB (see Figure 1-2). The site is composed of two areas covering approximately 8.5 acres. The site was used from 1969 to 1974 for disposal of tree stumps, wooden pallets, metal ammunition boxes, aluminum sheeting, concrete blocks, and kitchen wastes (C.C. Johnson, 1985). The wastes were disposed in excavations approximately 5 feet deep. The site is an open area surrounded by pines. More information regarding waste disposal at Site 5 is presented in Subsection 3.1.

Soil borings at Site 5 extended through the uppermost 15 feet of the surficial aquifer. Boring logs are presented in Appendix A. These borings were conducted for installation of seven monitoring wells. Table 2-2 presents monitoring well construction data for the monitoring wells at Site 5. Most of the site is covered by fill material to approximately 5 feet bls.

Fill material is composed of a mixture of black, red, and buff colored fine- and medium-grained sand. Well sorted medium sand was present over the remainder of the boring intervals. Soil color was red to black and several borings terminated in green to grey medium sand.

A groundwater potentiometric surface map was prepared from groundwater elevations measured at Site 5 on January 13, 1993, during the sixth monitoring event (Figure 2-5). Potentiometric surface maps for groundwater sampling rounds one through five are provided in Appendix B. The overall hydraulic gradient is toward the southeast at Site 5. Groundwater flows laterally and is interpreted to ultimately discharge to surface water. Some variations in groundwater flow exist at Site 5, such as divergent flow observed during the July 1992 sample event.

On February 21 and 22, 1992, water level measurements were recorded at Site 5 over a 24-hour period using a data logger and transducer to evaluate for tidal influence on groundwater levels. The transducer was placed approximately 1 foot above the bottom of the well in monitoring well KBA-5-2. The data logger was programmed to record water level measurements at 30 minute intervals. Figure 2-6 is a graph of water level displacement versus elapsed time. On the graph, displacement in water level is relative to the initial water level at the start of the monitoring.

**Table 2-1
Water Elevations of Area Wells¹**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Grid Number ² | Latitude | Longitude | Land Surface Elevation | Date Measured | Depth of Water (feet) | Water Elevation | Elevation Effective Length |
|--------------------------|-----------|-----------|---------------------------|---------------|--------------------------|-----------------|-------------------------------|
| 33E002 | 30°46'27" | 81°37'12" | 25.39 | 5-14-85 | -7.00 | 32.39 | -54.61 to -448.61 |
| | | | | 5-14-85 | -6.00 | 31.39 | |
| | | | | 10-20-86 | -7.60 | 32.99 | |
| | | | | 5-17-89 | -6.50 | 32.89 | |
| | | | | 5-15-90 | -5.83 | 31.22 | |
| 33E004 | 30°49'10" | 81°32'38" | 19.39 | 5-15-85 | -18.00 | 37.39 | -766.61 to 496.61 |
| 33E007 | 30°45'10" | 81°34'38" | 21.39 | 5-15-85 | -2.70 | 24.09 | -503.61 to 748.61 |
| | | | | 5-17-85 | 0.85 | 20.54 | |
| | | | | 5-16-90 | 1.22 | 20.17 | |
| 33E009 | 30°50'45" | 81°33'46" | 15.39 | 5-15-85 | -25.00 | 40.39 | -234.61 to 549.61 |
| | | | | 10-20-86 | -22.40 | 37.79 | |
| | | | | 5-20-88 | -26.81 | 42.20 | |
| | | | | 5-17-89 | -25.43 | 40.82 | |
| | | | | 5-16-90 | -25.68 | 41.07 | |
| 33E023 | 30°50'31" | 81°34'47" | 19.39 | 5-15-85 | -23.00 | 42.39 | -40.61 to 630.61 |
| | | | | 10-20-86 | -20.00 | 39.39 | |
| | | | | 5-17-89 | -21.01 | 40.40 | |
| 33E027 | 30°47'56" | 81°13'11" | 13.39 | 5-25-88 | -18.00 | 31.39 | -71.61 to 976.61 |
| | | | | 5-17-89 | -17.73 | 31.12 | |
| | | | | 5-16-90 | -17.86 | 31.25 | |
| 33E046 | 30°49'16" | 81°36'07" | 13.39 | 5-17-89 | -17.70 | 41.09 | -231.61 to 636.61 |
| | | | | 5-16-90 | -28.17 | 41.56 | |
| 33E047 | 30°45'15" | 81°36'57" | 16.51 | 6-10-89 | -3.46 | 19.97 | -70.49 to 94.49 |
| 33E048 | 30°45'15" | 81°36'57" | 16.51 | 9-28-90 | 1.60 | 18.11 | -317.49 to 476.49 |

¹ All elevations in feet relative to mean low water (feet mean low water).

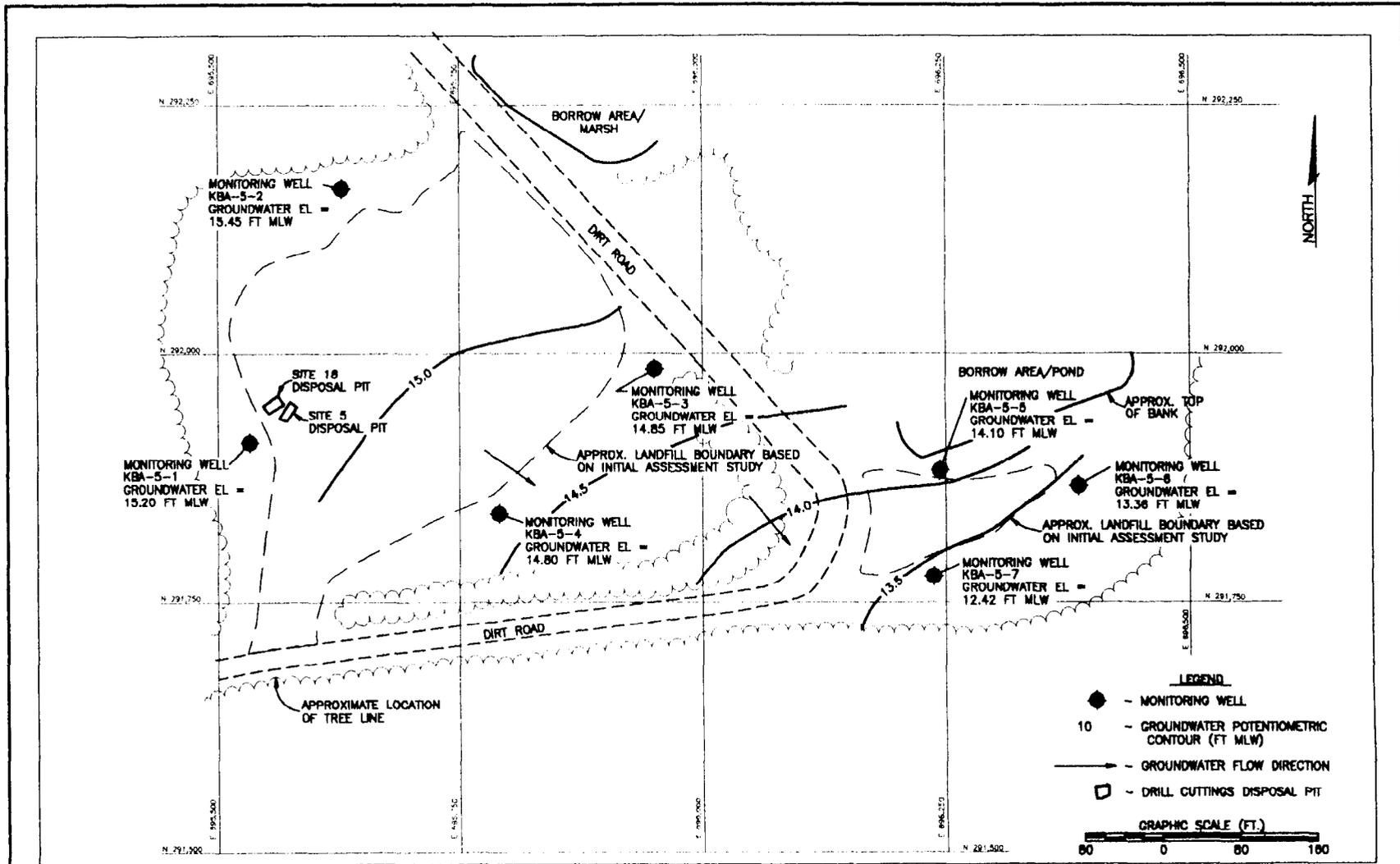
² Grid number is based on U.S. Geological Survey designations for a well location.

Table 2-2
Monitoring Well Construction Data for Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Monitoring Well Number | Borehole Depth (ft bls) | Total Well Depth (ft bls) | Screened Interval (ft bls) | Top of Sand Pack (ft bls) | Top of Bentonite (ft bls) | Total Well Depth (ft BTOC) | Screened Interval (ft BTOC) | Ground Surface (ft MLW) | Monitoring Well TOC Elevation (ft MLW) | Borehole Depth (ft MLW) | Screened Interval Elevation (ft MLW) |
|------------------------|-------------------------|---------------------------|----------------------------|---------------------------|---------------------------|----------------------------|-----------------------------|-------------------------|--|-------------------------|--------------------------------------|
| KBA-5-1 | 14.5 | 12.5 | 2.5 to 12.5 | 2.0 | 1.0 | 15.49 | 5.49 to 15.49 | 19.08 | 22.07 | 4.58 | 16.58 to 6.58 |
| KBA-5-2 | 14.0 | 12.5 | 2.5 to 12.5 | 2.0 | 1.0 | 15.94 | 5.94 to 15.94 | 16.19 | 19.63 | 2.19 | 13.69 to 3.69 |
| KBA-5-3 | 16.0 | 13.0 | 3.0 to 13.0 | 2.0 | 1.0 | 15.86 | 5.86 to 15.86 | 18.13 | 20.99 | 2.13 | 15.13 to 5.13 |
| KBA-5-4 | 15.0 | 12.5 | 2.5 to 12.5 | 2.0 | 1.0 | 15.39 | 5.39 to 15.39 | 18.83 | 21.72 | 3.83 | 16.33 to 6.33 |
| KBA-5-5 | 16.0 | 13.2 | 3.5 to 13.5 | 2.5 | 1.5 | 16.03 | 6.03 to 16.03 | 18.22 | 21.02 | 2.22 | 14.72 to 4.72 |
| KBA-5-6 | 17.0 | 13.3 | 3.3 to 13.3 | 2.5 | 1.5 | 16.59 | 6.59 to 16.59 | 19.56 | 22.85 | 2.56 | 16.26 to 6.26 |
| KBA-5-7 | 14.0 | 12.5 | 2.5 to 12.5 | 2.0 | 1.3 | 15.37 | 5.37 to 15.37 | 17.63 | 20.50 | 3.63 | 15.13 to 5.13 |

Notes: ft = feet.
bls = below land surface.
BTOC = below top of casing.
MLW = mean low water.
TOC = top of casing.



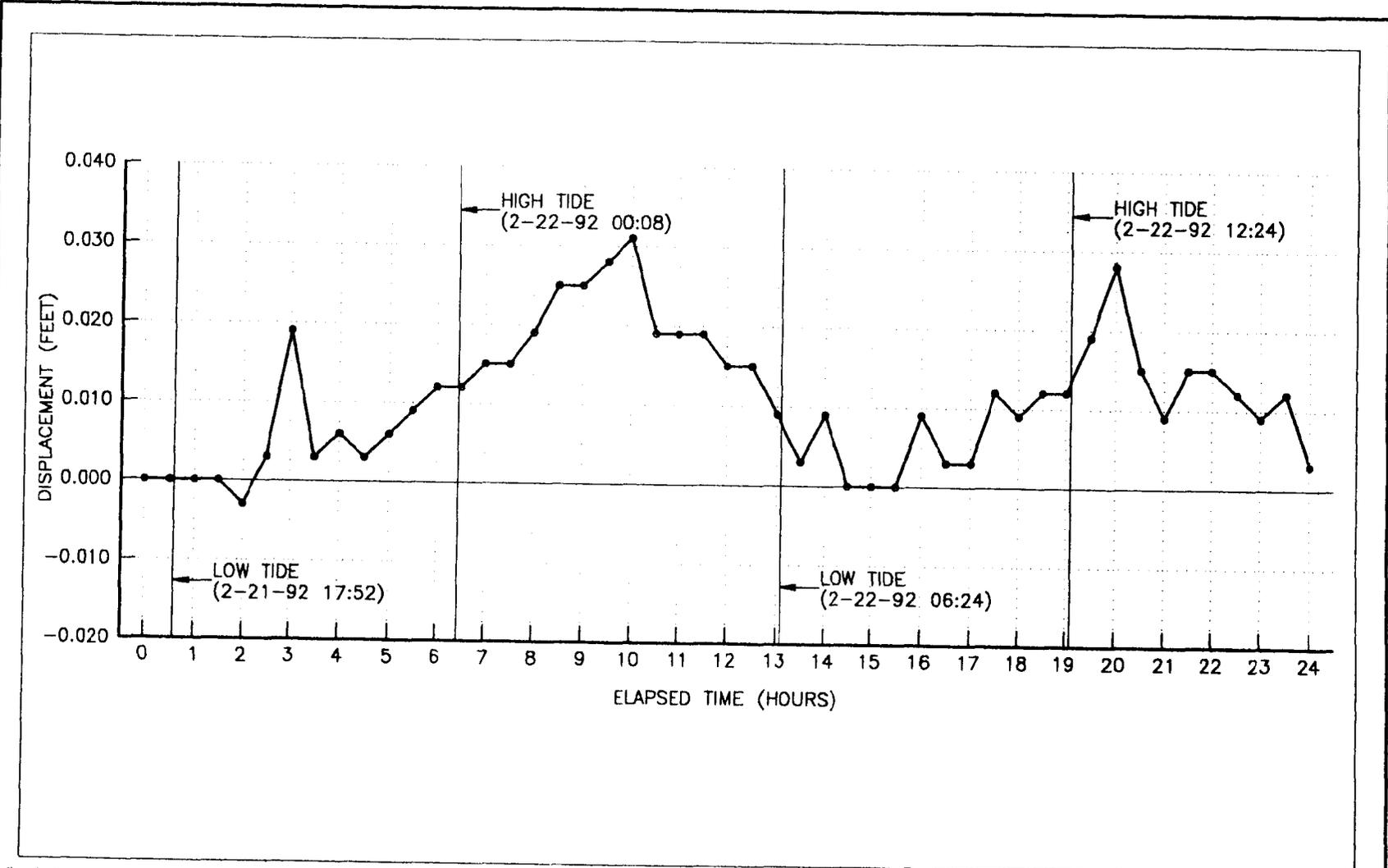
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| DWN: | PROJECT NO.: | TITLE: |
| DMF | 7553-09 | SITE 5 GROUNDWATER POTENTIOMETRIC SURFACE MAP, JANUARY 1993 |
| CHKD: | FIGURE NO.: | |
| LBH | 2-5 | |
| DATE: | | |
| 6-9-94 | | |



RFI REPORT FOR
SITES 5 & 16

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA



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|-----------------|-------------------------|--------|---|--|
| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: | SITE 5 GRAPH OF WATER LEVEL DISPLACEMENT OVER 24-HOUR PERIOD, FEBRUARY 21 AND 22, 1992 | |
| CHKD: LBH | FIGURE NO.: | | | |
| DATE: 6-9-94 | 2-6 | | | |

RFI REPORT FOR
SITES 5 & 16

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

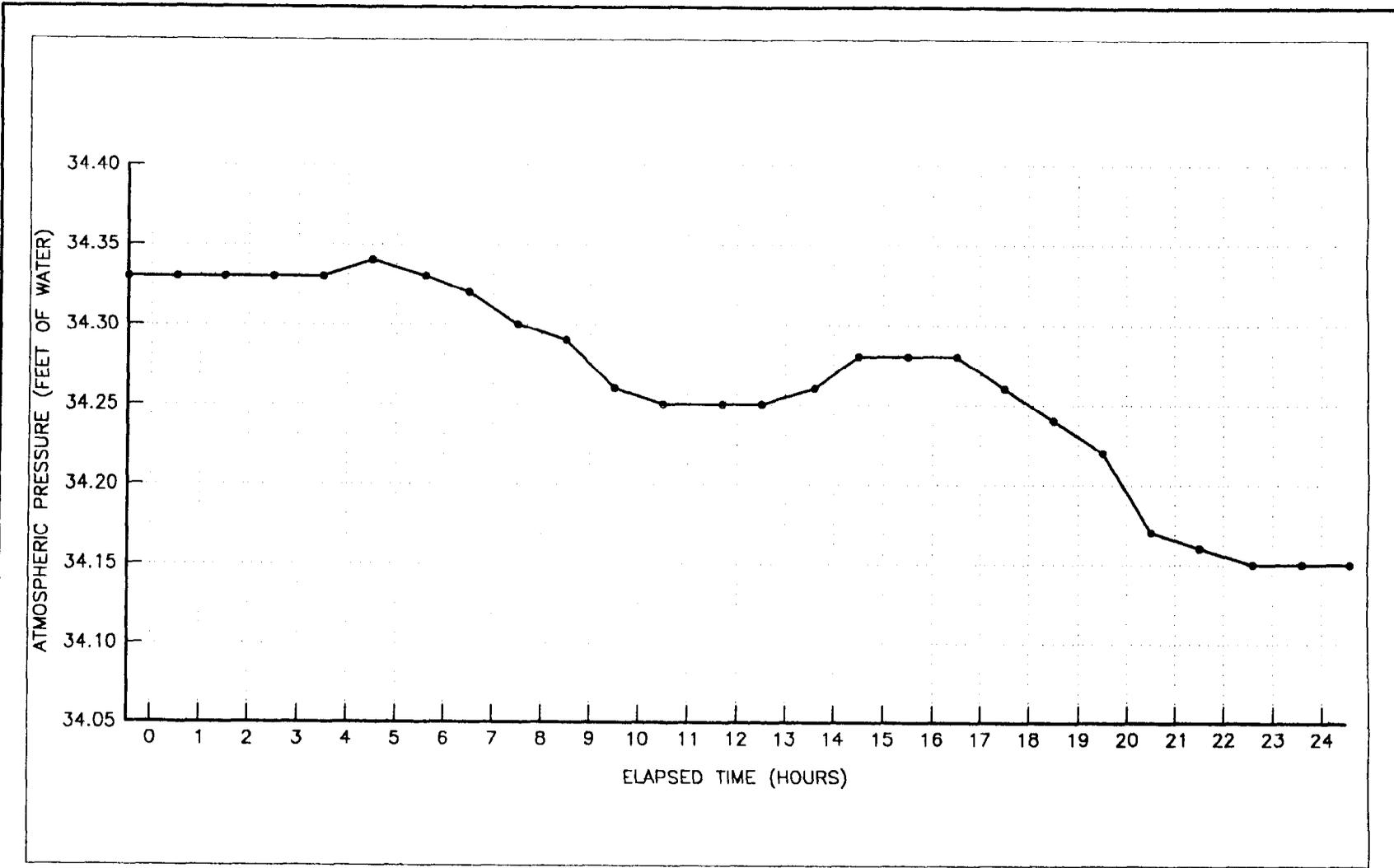
The water level displacement data were evaluated in comparison to tidal cycles and in comparison to barometric data for the time period included in the study. High and low tides are indicated on Figure 2-6. Figure 2-7 is a graph of atmospheric pressure for the same time period (i.e., 0 hours elapsed time on Figure 2-6 equals 0 hours elapsed time on Figure 2-7). The water level displacement data correlate well with the barometric data. The rise and fall in water levels correlate somewhat with tidal cycles, but overall variation in groundwater levels is very small (≤ 0.03 feet).

Estimates of hydraulic conductivities were measured at Site 5 by conducting rising head slug tests at four monitoring well locations. The slug test data were evaluated using a method of analysis developed by Bouwer and Rice (1976). The four monitoring wells tested include KBA-5-1, KBA-5-2, KBA-5-4, and KBA-5-5. The data collected at two monitoring wells, KBA-5-1 and KBA-5-4 are suspected of indicating drainage from the filter pack rather than from the aquifer. The hydraulic conductivity values associated with data from these two locations, 8.1×10^{-3} and 9.3×10^{-3} feet per minute (ft/min), are relatively higher than the values associated with the other two monitoring wells tested. Hydraulic conductivity values calculated from data associated with KBA-5-2 and KBA-5-5 are 3.2×10^{-3} and 3.1×10^{-3} ft/min, respectively. These values are considered to be indicative of the hydraulic conductivity of the aquifer.

The direct push subcontractor provided hydraulic conductivity values calculated based on rate of filling of the hydrocone sample chamber. Proprietary software based on method of analysis developed by Hvorslev (1951) as presented by Cedergren (1989) was used to calculate estimates of hydraulic conductivity. The hydraulic conductivities calculated from hydrocone data range from 2.6×10^{-4} to 1.8×10^{-3} ft/min.

Hydraulic conductivity values are preliminary estimates of the conductive properties of the surficial aquifer. The results are of the correct order of magnitude and provide values that can be used for planning any future, more comprehensive engineering studies. The methods used to calculate the hydraulic conductivity estimates for the slug tests data and hydrocone data are both based on time lag. The difference between the methods of Bouwer and Rice (1976) and Hvorslev (Cedergren, 1989) is in the graphical representation of the data, with mathematical differences resulting therefrom. Both methods use the same data and both log transform the head displacement data. Hvorslev's method plots head ratios, whereas Bouwer and Rice's method plots straight head data. The hydraulic conductivities resulting from either method of analysis should show little variation, being of similar magnitude. The observed variation between the range of hydraulic conductivities calculated from slug tests and those calculated using hydrocone data are attributable to differences in effective length (10 feet versus 1 foot) and differences in interval tested (i.e., depth in the aquifer).

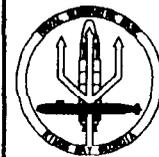
Hydraulic gradients were calculated using the groundwater potentiometric maps presented in Figure 2-5 and in Appendix B. Hydraulic gradients in the western part of Site 5 ranged from 0.001 to 0.004 foot per foot, the larger gradient being associated with the September and November 1992 water level data. The hydraulic gradient in the eastern part of Site 5 ranged from 0.004 to 0.006 foot per foot, the larger gradients being associated with February and May 1992 water level data. Seepage velocities were estimated using the hydraulic gradients discussed in this paragraph and hydraulic conductivity estimates from the slug tests conducted at monitoring wells KBA-5-2 and KBA-5-5. The calculations are



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|-----------------|-------------------------|--------|
| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: |
| CHKD: LBH | FIGURE NO.: | |
| DATE: 6-9-94 | 2-7 | |

GRAPH OF ATMOSPHERIC PRESSURE OVER
 24-HOUR PERIOD, JACKSONVILLE, FLORIDA
 FEBRUARY 21 AND 22, 1992



RFI REPORT FOR
 SITES 5 & 16

NAVAL SUBMARINE BASE
 KINGS BAY, GEORGIA

based on Darcian flow and effective porosity was assumed to be 30 percent. Monitoring well KBA-5-2 is located in the western part of Site 5. Hydraulic conductivity estimated from the slug test conducted at this location is 3.2×10^{-3} ft/min. Seepage velocities are estimated to range from 6 to 22 feet per year (ft/yr) in the western part of Site 5. Monitoring well KBA-5-5 is located in the eastern part of Site 5. The hydraulic conductivity estimate is 3.1×10^{-3} ft/min. Based on hydraulic gradients that range from 0.004 to 0.006 foot per foot, seepage velocities are estimated to range from 22 to 32 ft/yr.

Site 16, Army Reserve Disposal Area, Motor Missile Magazines. Site 16 is located in the south-central part of the NSB (see Figure 1-2). The site covers approximately 1 acre. Waste disposed included food, wood, trash, scrap metal, tree limbs, and empty paint and solvent cans (C.C. Johnson, 1985). The site was used for waste disposal from 1958 to 1964. The site was excavated to a depth of 3 to 5 feet before wastes were disposed. Subsection 3.2 provides more information about disposal of wastes at the site.

Four soil borings were conducted at Site 16 for installation of monitoring wells. Table 2-3 presents monitoring well construction data for the four monitoring wells. Soil borings at Site 16 extended to depths ranging from 17 to 19.5 feet bls. Site 16 is in an area where topography is man-made and was an active construction site during the field program conducted January and February of 1992. All borings terminated in fill material composed of layers of fine-grained sand varying in color from dark brown to white.

Figure 2-8 is a groundwater potentiometric surface map developed from water level measurements collected from Site 16 on January 15, 1993, during the sixth monitoring event. Potentiometric surface maps for sampling events one through five are provided in Appendix B. The overall hydraulic gradient is toward the northeast at Site 16, following the topography, which decreases in elevation to the northeast. The groundwater ultimately discharges to a marshy area to the northeast of the site.

On February 25 and 26, 1992, water level measurements were recorded at Site 16 over a 23-hour period using a data logger and pressure transducer to evaluate for tidal effects on groundwater levels. The transducer was placed approximately 1 foot above the bottom of the well in monitoring well KBA-16-1. Data were recorded at 30-minute intervals. Figure 2-9 is a graph of water level displacement versus elapsed time. On the graph, displacement in water level is relative to the initial water level at the start of the monitoring.

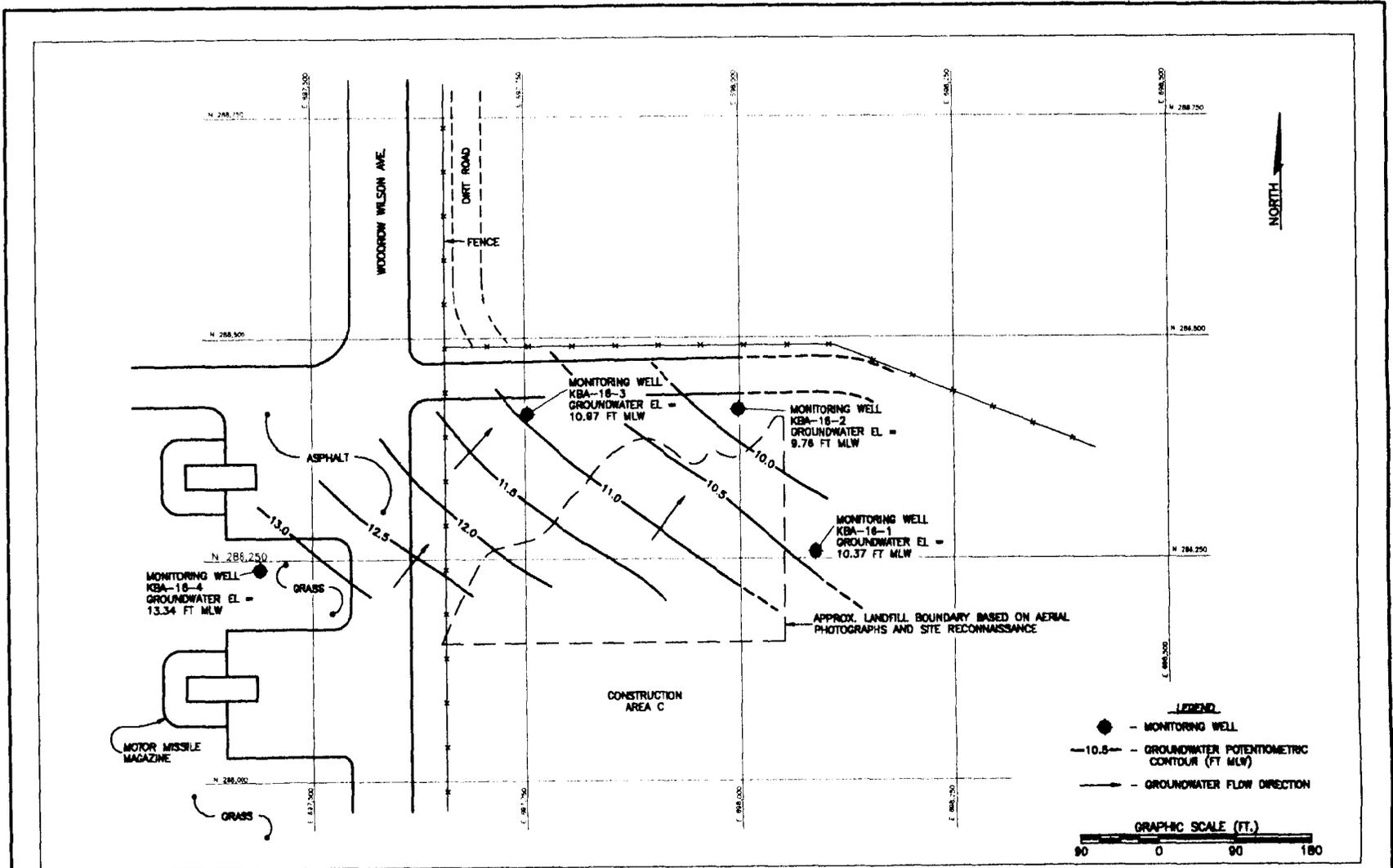
The water level displacement data were evaluated in comparison to tidal cycles and in comparison to barometric data for the time period included in the study. High and low tides are indicated on Figure 2-9. Figure 2-10 is a graph of atmospheric pressure for the same time period (i.e., 0 hours elapsed time on Figure 2-9 equals 0 hours elapsed time on Figure 2-10). The water level displacement data correlate well with the barometric data. The rise and fall in water levels do not correlate as well with tidal cycles.

Estimates of hydraulic conductivities were measured at Site 16 by conducting rising head slug tests at four monitoring well locations. The slug test data were evaluated using a method of analysis developed by Bouwer and Rice (1976). The four monitoring wells tested include KBA-16-1, KBA-16-2, KBA-16-3, and KBA-16-4. The data collected at one monitoring well, KBA-16-1, is suspected of indicating drainage from the filter pack. The hydraulic conductivity value of

**Table 2-3
Monitoring Well Construction Data for Site 16**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Monitoring Well Number | Borehole Depth (ft bls) | Total Well Depth (ft bls) | Screened Interval (ft bls) | Top of Sand Pack (ft bls) | Top of Bentonite (ft bls) | Total Well Depth (ft BTOC) | Screened Interval (ft BTOC) | Ground Surface (ft MLW) | Monitoring Well TOC Elevation (ft MLW) | Borehole Depth (ft MLW) | Screened Interval Elevation (ft MLW) |
|------------------------|-------------------------|---------------------------|----------------------------|---------------------------|---------------------------|----------------------------|-----------------------------|-------------------------|--|-------------------------|--------------------------------------|
| KBA-16-1 | 17.0 | 16.9 | 6.9 to 16.9 | 5.0 | 3.0 | 19.96 | 9.96 to 19.96 | 20.37 | 23.43 | 3.37 | 13.47 to 3.47 |
| KBA-16-2 | 20.0 | 17.5 | 7.5 to 17.5 | 5.5 | 3.5 | 19.89 | 9.89 to 19.89 | 18.37 | 20.76 | -1.63 | 10.87 to 0.87 |
| KBA-16-3 | 16.0 | 16.0 | 6.0 to 16.0 | 4.0 | 2.0 | 18.44 | 8.44 to 18.44 | 19.43 | 21.87 | 3.43 | 13.43 to 3.43 |
| KBA-16-4 | 17.0 | 15.0 | 5.0 to 15.0 | 3.0 | 2.0 | 17.82 | 7.82 to 17.82 | 18.74 | 21.56 | 1.74 | 13.74 to 3.74 |
| Notes: | ft | = feet. | | | | | | | | | |
| | bls | = below land surface. | | | | | | | | | |
| | BTOC | = below top of casing. | | | | | | | | | |
| | MLW | = mean low water. | | | | | | | | | |
| | TOC | = top of casing. | | | | | | | | | |

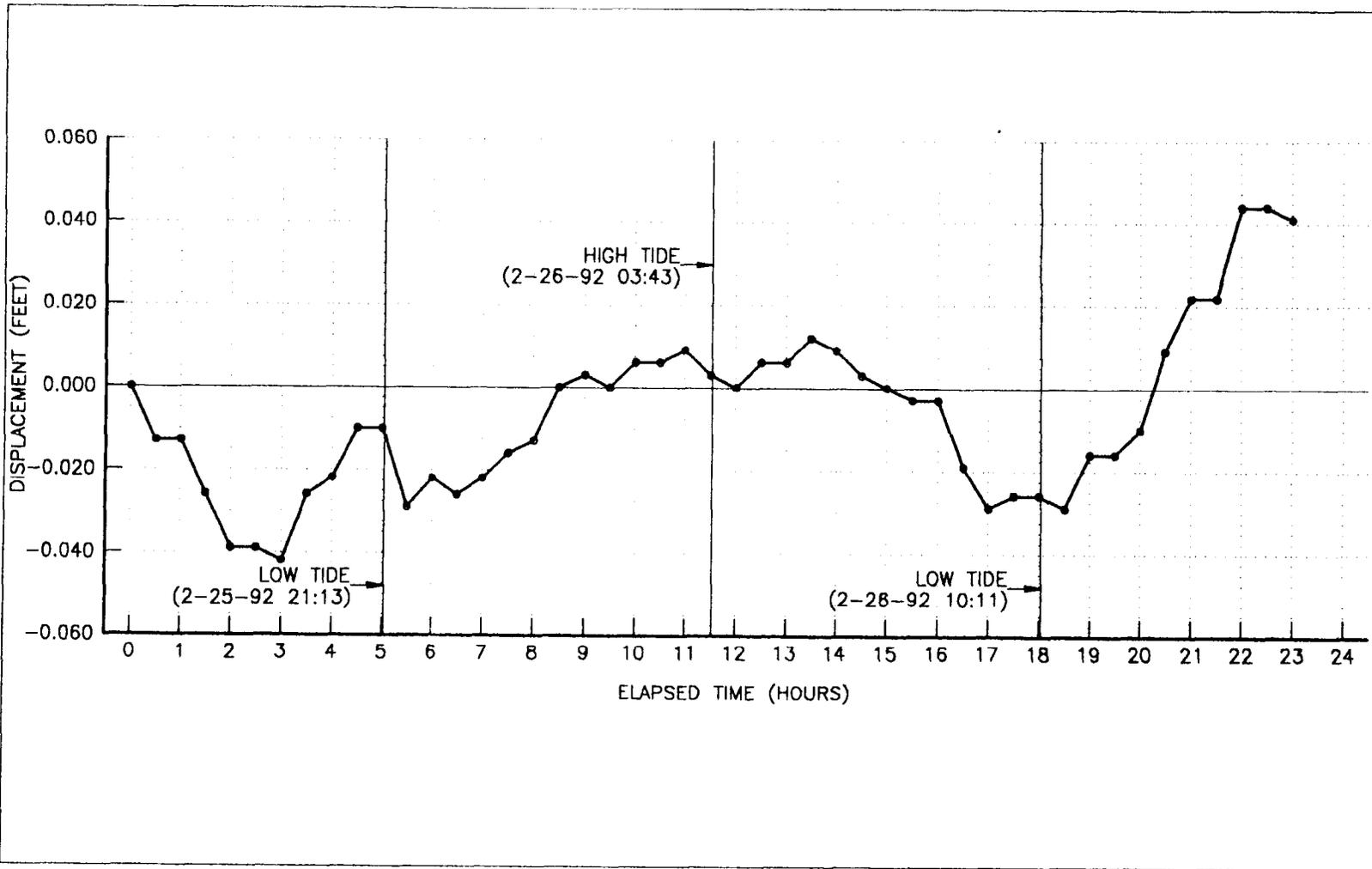


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| DMF | 7553-09 | SITE 16 GROUNDWATER POTENTIOMETRIC SURFACE MAP, JANUARY 1993 |
| CHKD: | FIGURE NO.: | |
| LBH | 2-8 | |
| DATE: | | |
| 6-9-94 | | |

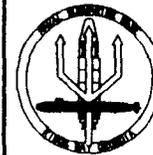
RFI REPORT FOR
SITES 5 & 16

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA



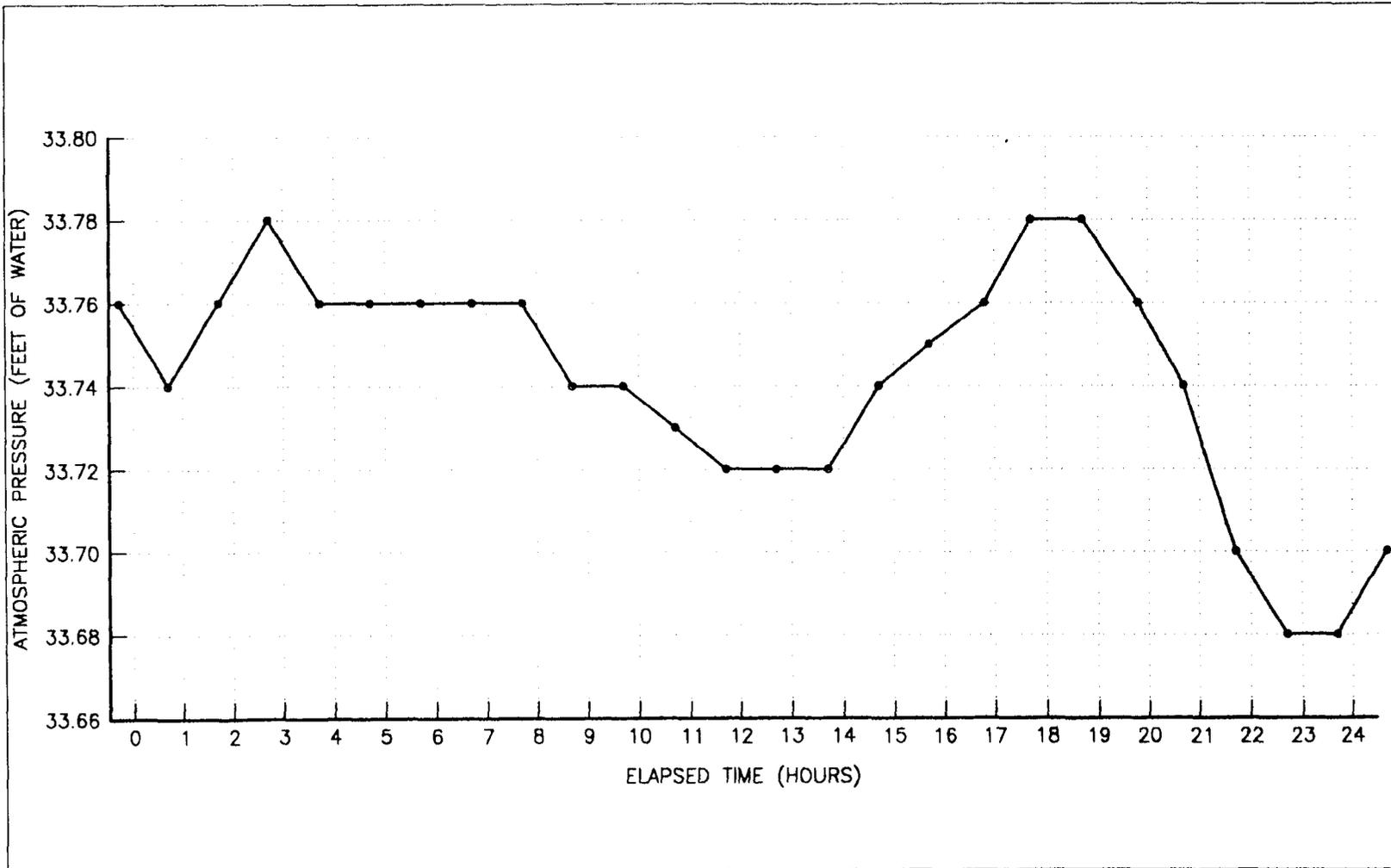
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| DWN: | PROJECT NO.: | TITLE: |
| DMF | 7553-09 | SITE 16 GRAPH OF WATER LEVEL DISPLACEMENT OVER 24-HOUR PERIOD, FEBRUARY 25 AND 26, 1992 |
| CHKD: | FIGURE NO.: | |
| LBH | 2-9 | |
| DATE: | | |
| 6-9-94 | | |



RFI REPORT FOR
SITES 5 & 16

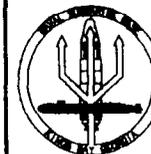
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA



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| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: |
| CHKD: LBH | FIGURE NO.: 2-10 | |
| DATE: 6-9-94 | | |

GRAPH OF ATMOSPHERIC PRESSURE OVER
24-HOUR PERIOD, JACKSONVILLE, FLORIDA
FEBRUARY 25 AND 26, 1992



RFI REPORT FOR
SITES 5 & 16

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

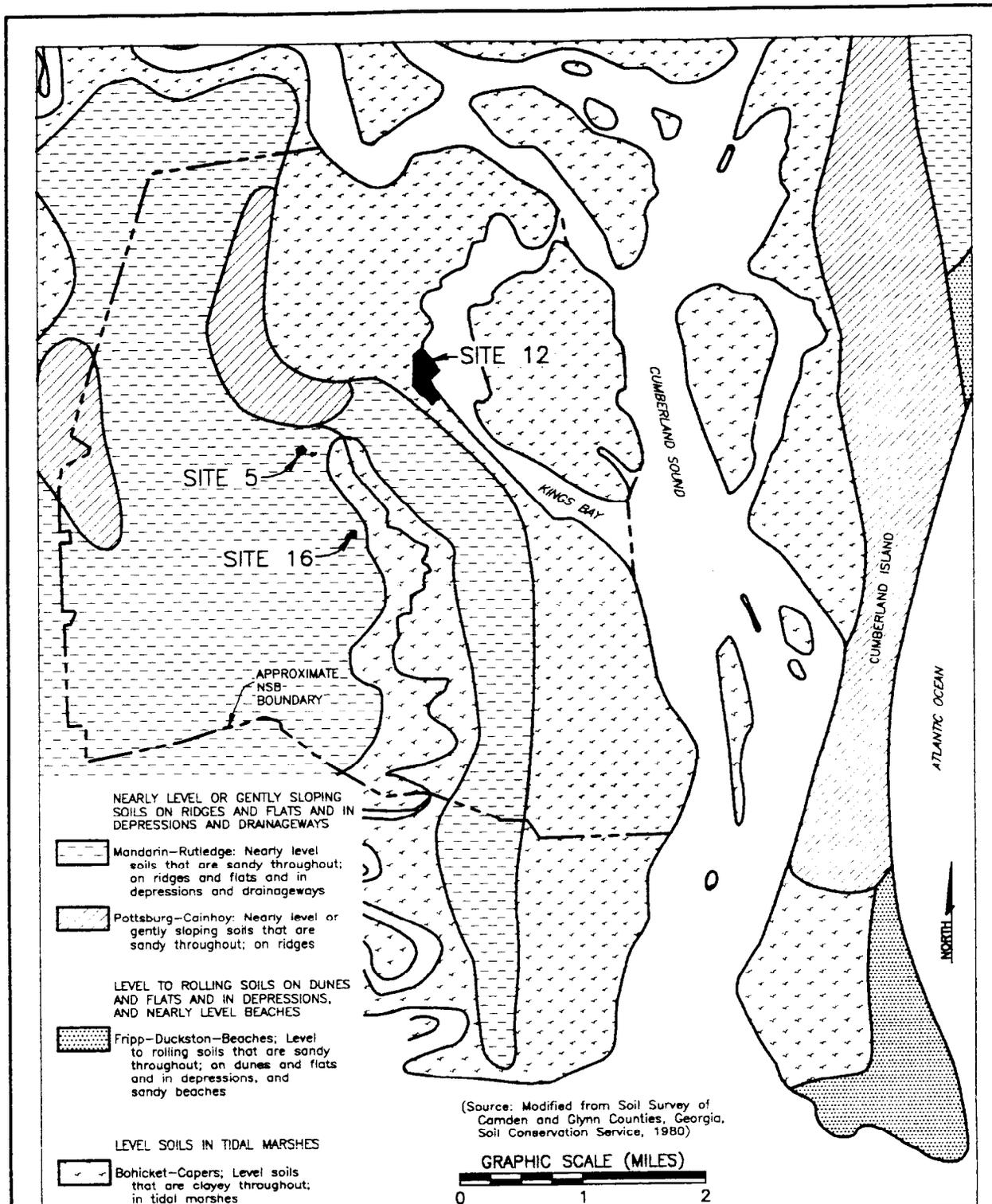
9.0×10^{-3} ft/min associated with data from monitoring well KBA-16-1 is relatively higher than the values associated with the other three monitoring wells. Hydraulic conductivity values calculated from data associated with monitoring wells KBA-16-2 through KBA-16-4 ranged from 2.1×10^{-3} to 4.2×10^{-3} ft/min. These values are considered to be indicative of the hydraulic conductivity of the aquifer.

The direct push subcontractor provided hydraulic conductivity estimates calculated based on rate of filling of the hydrocone sample chamber. Proprietary software based on the method of analysis developed by Hvorslev (1951) as presented in Cedergren (1989) was used to calculate estimates of hydraulic conductivity. The hydraulic conductivity values calculated from the hydrocone data range from 2.4×10^{-4} to 1.5×10^{-3} ft/min.

The hydraulic conductivity values serve as a preliminary estimate of the conductive properties of the surficial aquifer. The results are of the correct order of magnitude and can be used to plan any future, more comprehensive engineering studies. The methods used to calculate the hydraulic conductivity estimates for the slug tests data and hydrocone data are both based on time lag. The difference between the methods of Bouwer and Rice (1976) and Hvorslev (Cedergren, 1989) is in the graphical representation of the data, with mathematical differences resulting therefrom. Both methods use the same data and both log transform the head displacement data. Hvorslev's method plots head ratios, whereas Bouwer and Rice's method plots straight head data. The hydraulic conductivities resulting from either method of analysis should show little variation, being of similar magnitude. The observed variation between the range of hydraulic conductivities calculated from slug tests and those calculated using hydrocone data are attributable to differences in effective length (10 feet versus 1 foot) and differences in interval tested (i.e., depth in the aquifer).

Hydraulic gradients at Site 16 were calculated using the potentiometric maps presented in Figure 2-8 and in Appendix B. Hydraulic gradients in the western part of the site were generally lower than in the eastern part of the site, ranging from 0.004 to 0.007 foot per foot in the western part and 0.006 to 0.01 foot per foot in the eastern part. Seepage velocities were calculated using the hydraulic gradients discussed in this paragraph and the hydraulic conductivity estimates from slug tests conducted at the site. The calculations are based on Darcian flow and effective porosity was assumed to be 30 percent. In the western part of the site, hydraulic conductivity values associated with data from monitoring wells KBA-16-3 and KBA-16-4 are 4.2×10^{-3} and 2.1×10^{-3} ft/min. Seepage velocities in the western part of the site are estimated to range from 15 to 52 ft/yr. In the eastern part of the site, hydraulic conductivity estimated from data associated with monitoring well KBA-16-2 is 2.9×10^{-3} ft/min. Seepage velocities in the eastern part of the site are estimated to range from 30 to 51 ft/yr.

2.3 SOILS. Four soil map units are associated with the NSB Kings Bay area, the Mandarin-Rutledge, Pottsburg-Cainhoy, Fripp-Duckston-Beaches, and the Bohicket-Capers soils (Soil Conservation Service, 1980). The Mandarin-Rutledge and Pottsburg-Cainhoy soils are associated with nearly level or gently sloping soils on ridges and flats and in depressions and drainageways. The Fripp-Duckston-Beaches soils are associated with level to rolling soils on dunes and flats and in depressions, and nearly level beaches. The Bohicket-Capers soils are associated with level soils in tidal marshes (Figure 2-11).



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| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: GENERAL SOIL MAP | |
| CHKD: KMH | FIGURE NO.: 2-11 | RFI REPORT FOR SITES 5 & 16 | |
| DATE: 5-6-94 | | NAVAL SUBMARINE BASE KINGS BAY, GEORGIA | |

Mandarin-Rutledge Mandarin soils are typically fine-grained sand, somewhat poorly drained, and found on ridges and flats. A very dark gray surface layer approximately 3 inches thick is underlain by a predominantly light gray layer extending to a depth of 19 inches. A weakly cemented organic hardpan extends below this to approximately 34 inches. The hardpan is dark brown in the lower section, very dark brown in the middle section, and black in the upper section. Light gray, white, and grayish brown layers lie beneath the hardpan to a depth of 62 inches. A second weakly cemented black organic hardpan underlies these layers to a depth of 80 inches or more.

Rutledge soils are typically fine-grained sand, very poorly drained, and found in depressions and drainageways. A black surface layer approximately 15 inches thick is underlain by a layer that is light gray mottled with brownish gray in the upper section, light brownish gray in the middle section, and grayish brown mottled with very dark grayish brown in the lower section. This layer extends to a depth of 70 inches or more.

This unit has a slope of mainly less than 1 percent and lies in the east-central and extreme western part of Camden County and on the coastal islands. Because of the wetness of the soils, it has poor potential for most uses except woodlands.

Pottsburg-Cainhoy Pottsburg soils are typically sand, somewhat poorly drained, and nearly level. A gray surface layer approximately 4 inches thick is underlain by a layer that is light gray with brownish yellow and brown mottles in the upper section, and white with brownish yellow and dark grayish brown mottles in the lower section. This layer extends to a depth of 63 inches and is underlain by a weakly cemented, dark brown, organic hardpan that extends to a depth of 80 inches or more.

Cainhoy soils are typically fine-grained sand, somewhat excessively drained, and nearly level and gently sloping. A dark gray surface layer approximately 5 inches thick is underlain by a layer that is brownish yellow and extends to a depth of 23 inches. A very pale brown layer extends to a depth of 50 inches. Below this layer are light gray and white layers to a depth of 101 inches. Next, a black and dark, reddish brown layer extends to a depth of 120 inches.

This unit has a slope of 5 percent or less and lies on Cumberland Island and in the extreme western part of Camden County. Community development and recreation are the main uses for this unit. Due to the wetness of the soils on the lower landscapes, they have poor potential for urban uses. However, soils on the higher landscapes have good potential for most urban uses. The wetness of the lower landscape soils and the low available water capacity of the higher landscape soils are the main concerns for use and management of this map unit.

Fripp-Duckston-Beaches Fripp soils are typically fine-grained sand, excessively drained, and found on undulating and rolling dunes. A grayish brown surface layer approximately 6 inches thick is underlain by a layer that is pale brown in the upper section and white in the lower section. This layer extends to a depth of 80 inches.

Duckston soils are typically sand, poorly drained, and found in shallow depressions and on flats. A surface layer approximately 17 inches thick is grayish brown in the upper section and light brownish gray in the lower section.

Below this surface layer is a predominantly light gray layer, greenish gray in the lower section, extending to a depth of 80 inches.

Beaches soils are found adjacent to the ocean and are typically fine-grained sand, sand, coarse-grained sand, and varying amounts of small shell fragments. These soils are covered twice daily by the tide.

This unit has a slope ranging from 0 to 20 percent and lies on Cumberland Island. Soils in some areas have been developed for dwellings and recreation. Soils are too sandy for many wildlife and recreational uses. Because of flooding and wetness, the potential for most other uses is poor.

Bohicket-Capers Bohicket soils are typically very poorly drained soils that border the ocean and are flooded twice daily by the tides. A dark, silty clay loam approximately 8 inches thick is underlain by a dark greenish gray, silty clay and clay to a depth of 65 inches or more. Grass fibrous roots are found throughout the soil.

Capers soils are typically very poorly drained, extend inland along creeks and rivers, and are flooded frequently by the tide. A surface layer of very dark gray silty clay approximately 8 inches thick is underlain by a very dark gray and dark gray clay to a depth of approximately 42 inches. Next is a greenish gray clay to a depth of 60 inches or more. Fine grass roots are found throughout the soils.

This unit has a slope of less than 1 percent and is found mainly along the Cumberland Sound and the Satilla River. Soils in some areas have been developed for farming. However, because of flooding, wetness, and natural sulfur content, they are used primarily by wetland wildlife.

2.4 CLIMATE. NSB Kings Bay is located in an area characterized by a humid subtropical climate, with hot, wet summers and cool, dry winters. Table 2-4 summarizes climatological data for the Kings Bay area. The normal annual temperature is approximately 70 degrees Fahrenheit (°F). Because of the moderating effect of the ocean, temperatures rarely rise above 100 °F. Normal annual precipitation is estimated to be 53 inches (Thibodeaux, 1979). Precipitation occurs mainly as rain during summer months. Evapotranspiration rates range from 35 to 36 inches per year (in/yr). The average annual runoff for the southeastern Georgia area is estimated at less than 10 in/yr (Krause and Randolph, 1989). Based on the above estimates for annual precipitation, evapotranspiration, and surface water runoff, the annual infiltration to the surficial aquifer is estimated to be 7 inches. Relative humidity varies widely throughout the year, with an annual average of 87 percent in the morning and 55 percent in the afternoon. The highest relative humidity is generally encountered during June through October. The relative humidity is generally lowest during March through May (Thibodeaux, 1979).

Prevailing winds are westerly, with strong northerly components in winter and southerly components in summer. Figure 2-12 is a wind rose diagram for data obtained from the National Climatic Data Center for the period of record 1973 through 1982 from Jacksonville, Florida. Wind rose diagrams for each month of the year, over the period of record, are provided in Appendix C. Prevailing wind speeds are highest (9 to 10 miles per hour) in late winter and early spring and lowest during the summer. The seasonal and annual wind patterns are influenced

**Table 2-4
Summary of Climatological Data¹**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

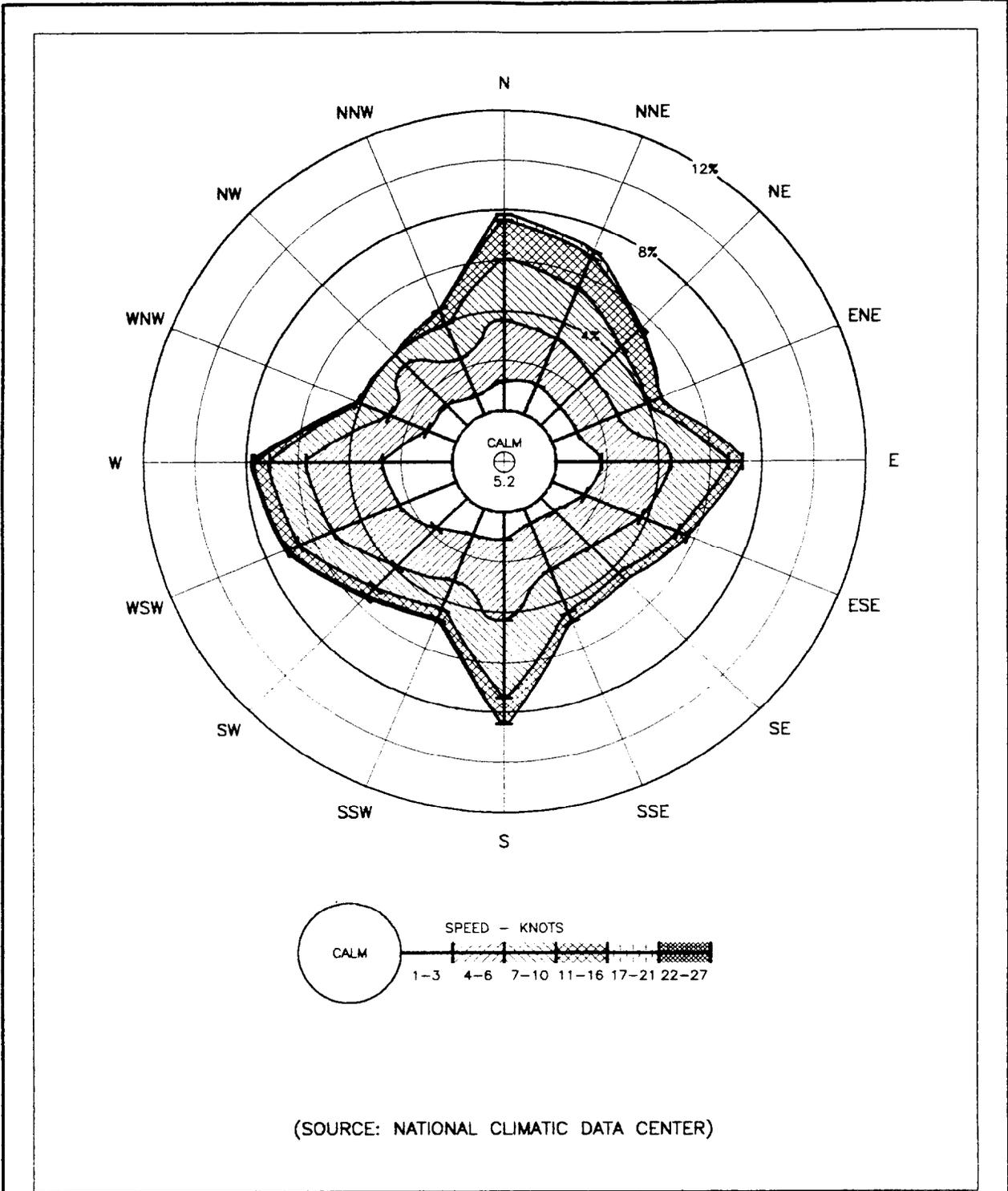
| Length of Record (years) | January | February | March | April | May | June | July | August | September | October | November | December | Annual | |
|--|---------|--------------------|-------|-------|-------|-------|-------|--------|-----------|---------|----------|----------|--------|-------|
| Average Relative Humidity (%) | 35 | 87/57 ² | 85/52 | 85/49 | 85/47 | 83/48 | 86/55 | 87/58 | 90/59 | 91/62 | 90/58 | 88/55 | 87/57 | 87/55 |
| Normal Monthly and Annual Precipitation (inches) | NR | 2.45 | 2.91 | 3.49 | 3.55 | 3.47 | 6.33 | 7.68 | 6.85 | 7.56 | 5.16 | 1.69 | 2.22 | 53.36 |
| Normal Monthly and Annual Average Temp (°F) | NR | 55.9 | 57.5 | 62.2 | 68.7 | 75.8 | 80.8 | 82.6 | 82.3 | 79.4 | 71.0 | 61.7 | 56.1 | 69.5 |
| Average Wind speed (mph) | 22 | 8.7 | 9.8 | 9.8 | 9.5 | 9.1 | 8.7 | 7.9 | 7.7 | 8.8 | 9.0 | 8.6 | 8.4 | 8.8 |

Source: Thibodeaux, 1979.

¹ Information reported for Jacksonville, Florida Station.

² 87/57 = Average relative humidity for 7:00 a.m./1:00 p.m.

Notes: % = percent.
NR = not reported.
°F = degrees Fahrenheit.
mph = miles per hour.



fig_2-12.dwg

| | | | |
|-----------------|-------------------------|---|---|
| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: WIND ROSE FOR JACKSONVILLE, FLORIDA, 1973-1982, ALL MONTHS |  |
| CHKD: KMH | FIGURE NO.: 2-12 | RFI REPORT FOR SITES 5 & 16 | |
| DATE: 6-9-94 | | NAVAL SUBMARINE BASE KINGS BAY, GEORGIA | |

by the land and water temperatures along the coast. Thunderstorms occur most frequently in summer months, and tornadoes commonly occur during March through May. Generally, hurricanes have occurred during the months of August and September.

3.0 SOURCE CHARACTERIZATION

Characteristics of the disposal areas and wastes at Sites 5 and 16 are described in the following subsections. Site 12 characteristics are addressed in Section 8.0 of this report.

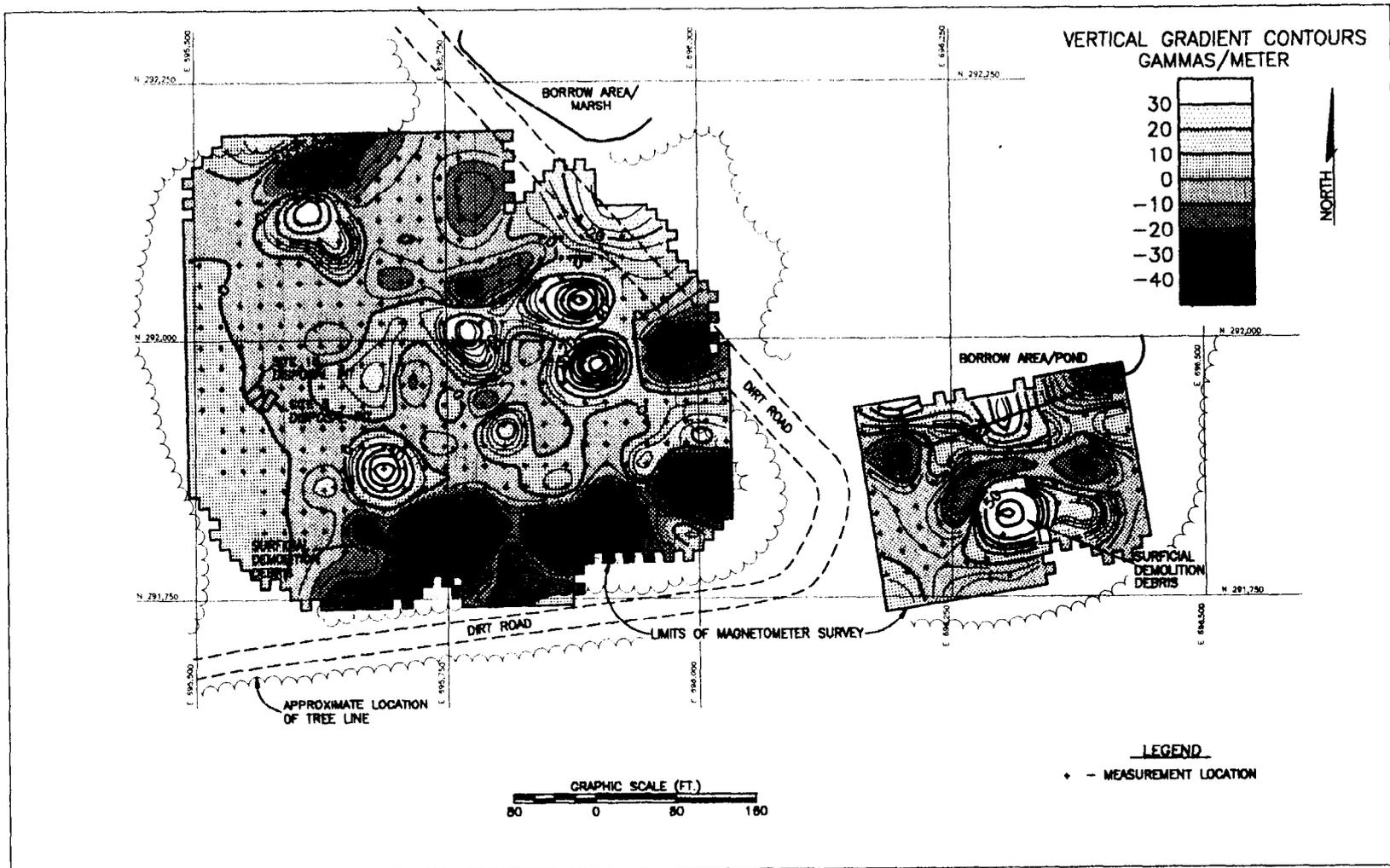
3.1 SITE 5, ARMY RESERVE DISPOSAL AREA, TOWHEE TRAIL.

3.1.1 Disposal Area Characteristics Site 5, Army Reserve Disposal Area, Towhee Trail, is located in the west-central part of the NSB (see Figure 1-2). The site is composed of two areas covering approximately 8.5 acres (see Figure 2-5). The larger part of Site 5 is on the western side of Towhee Trail (a dirt road shown on Figure 3-1), and is approximately 7 acres in area. The smaller part of Site 5 is on the eastern side of Towhee Trail and is approximately 1.5 acres. The larger area of the site measures approximately 550 feet in length by 400 feet wide at its maximum width. The smaller part of the site measures approximately 100 feet in length by 200 feet in width.

Magnetometer and terrain conductivity geophysical surveys were conducted at Site 5 during the RFI to delineate the lateral extent of buried wastes alleged to have been disposed at the site. The terrain conductivity survey was performed as part of groundwater characterization and is discussed in Subsection 6.1.1. Results of the magnetic survey indicated moderate amounts of buried ferrous refuse were disposed at the site. Figure 3-1 is a contour map of magnetic gradients developed from measurements collected during the magnetometer survey. The survey data indicate sporadic, spatially intermittent burial of material containing some ferrous metal. Metal debris on the surface at the site and influencing the magnetometer survey results is also shown on the contour map (Figure 3-1). The terrain conductivity survey was conducted along a transect extending along the southern and eastern periphery of the site in an attempt to establish whether any highly conductive areas could be delineated that would suggest the presence of potentially contaminated groundwater emanating from the site. No significant elevated conductivity values were found, suggesting no highly conductive groundwater is present in the vicinity of Site 5.

The landfill ceased operations in 1974. The larger part of Site 5 is an open area surrounded by pines currently used for staging fill material (dirt). Periodically, fill material is graded over this part of the site. Occasionally, small amounts of construction rubble are dumped on the surface. The smaller part of Site 5 is a grassy area adjacent to a pond. The pond is a former borrow pit. Several piles of material are present at the site, but heavy vegetation prevents visual observation of the material comprising the piles. Magnetic data indicate some ferrous material in the piles.

Site 5 was used by the Army Reserve from approximately 1969 to 1974. Both sections of the site were excavated to a depth of 5 feet before wastes were placed in them. Wastes were burned twice a year on the western side of Towhee Trail. No burning occurred on the eastern side of the road. Approximately 30 to 40 gallons of diesel fuel and waste engine oil were used to ignite the wastes. It is estimated that during the 5 years the site was in use, a total of 300 to 400 gallons of waste oil and fuel were burned.



fig_3-1.dwg

| | | |
|-----------------|-------------------------|--|
| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: |
| CHKD: LBH | FIGURE NO.: | SITE 5 MAGNETOMETER SURVEY, VERTICAL GRADIENT CONTOURS AND APPROXIMATE EXTENT OF BURIED FERROUS WASTE |
| DATE: 6-9-94 | 3-1 | |



RFI REPORT FOR
SITES 5 & 16

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

3.1.2 Waste Characteristics Information regarding wastes disposed at Site 5 was obtained during the Initial Assessment Study (C.C. Johnson, 1985). The Initial Assessment Study included records searches, interviews, and ground and aerial tours. Approximately 69,000 cubic yards of waste were placed in the landfill between 1969 and 1974, including tree stumps, wooden pallets, metal ammunition boxes (some empty and some filled with concrete), aluminum sheeting, concrete blocks, and kitchen waste. Also, a large pile of dredge spoils and gravel (from abandoned railroad tracks) were spread over most of the western part of the site. The spoils and gravel were spread to a depth of about 2 feet.

Knowledge of the chemical characteristics of the waste are based on the analytical results of soil and groundwater samples collected from Site 5. Organic compounds detected include those suspected of being laboratory or sampling artifacts, naturally occurring or background compounds, and fuel-related organic compounds. Other organic compounds detected include a polychlorinated biphenyl (PCB) and two solvents. Section 6.0 discusses results of soil and groundwater sampling in detail.

Table 3-1 summarizes physical data for 17 organic chemicals detected in groundwater and/or soil samples from the site. Contaminants detected in environmental media can be classified as chlorinated and non-chlorinated aliphatics, monocyclic aromatics, chlorinated and non-chlorinated polycyclic aromatics, and esters (Table 3-1). Physical properties having a significant effect on transformation and migration are discussed in the following paragraphs.

Chlorinated and non-chlorinated aliphatics detected in site media include acetone, 4-methyl-2-pentanone, methylene chloride, and trichlorofluoromethane. These compounds are relatively soluble, having octanol-water partition coefficient (K_{ow}) values generally less than 1,000 (Tetra Tech, 1989). The aliphatics detected do not appear to be related to one another, with the possible exception that 4-methyl-2-pentanone photooxidized to form acetone under laboratory conditions (Montgomery, 1991). Acetone and methylene chloride are commonly artifacts of sampling and/or analytical procedures. Trichlorofluoromethane is used as a propellant in aerosols and as a refrigerant and fire extinguishing agent. 4-Methyl-2-pentanone is a solvent used in paint, lacquers, and varnishes. The most prominent transformation processes for the aliphatics would be biotransformation and volatilization, and they are susceptible to photolysis and hydrolysis under suitable conditions.

Monocyclic aromatics detected in media from the site include toluene, ethylbenzene, xylenes, 3-methylphenol, and 4-methylphenol. These compounds are relatively soluble, having K_{ow} values ranging from 89 (4-methylphenol) to 1,600 (m-xylene) (Mackay, 1991; Tetra Tech, 1989). Three of these compounds are typically associated with gasoline, including toluene, ethylbenzene, and xylenes. Xylenes are also common solvents, particularly in paints. The phenols probably represent related transformation products. All these compounds are susceptible to biotransformation. Transformations of any type generally affect functional groups and not the ring structure of the molecules, and typically result in formation of alcohols, acids, or aldehydes. Abiotic hydrolysis is not likely because of the structure of this group of compounds. Under suitable conditions, photolysis would occur.

**Table 3-1
Physical and Chemical Characteristics of Volatile Organic Compounds and Semivolatile
Organic Compounds Detected in Media at Site 5**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Chemical | Physical Form | Chemical Class | Molecular Weight | Specific Density ¹ | Boiling Point (°C) | Solubility ² | Vapor Pressure ³ (mm Hg) | Flash Point (°C) |
|----------------------------|---------------|----------------|------------------|-------------------------------|--------------------|-------------------------|-------------------------------------|------------------|
| Acetone | Liquid | NCA | 58.1 | 0.7899 at 20/4 °C | 56.1 | Miscible | 180 | -17.8 |
| Bis(2-ethylhexyl)phthalate | Liquid | Ester | 390.6 | 0.9850 at 20/4 °C | 385 | 0.4 mg/L | 2x10 ⁻⁷ | 196 |
| Carbon disulfide | Liquid | Sulfide | 76.1 | 1.2632 at 20/4 °C | 46.2 | 1,185 mg/L | 297 | -30.0 |
| Ethylbenzene | Liquid | MCA | 106.2 | 0.8670 at 20/4 °C | 136 | 206 mg/L | 10 | 15.0 |
| Toluene | Liquid | MCA | 92.1 | 0.8669 at 20/4 °C | 111 | 524 mg/L | 22 | 4.4 |
| Trichlorofluoromethane | Liquid | CA | 137.4 | 1.4870 at 20/4 °C | 23.6 | 1.1 g/L | 687 | NF |
| o-Xylene | Liquid | MCA | 106.2 | 0.8802 at 20/4 °C | 144 | 152 mg/L | 9 | 17.0 |
| m-Xylene | Liquid | MCA | 106.2 | 0.8642 at 20/4 °C | 139 | 173 mg/L | 10 at 28 °C | 25 |
| p-Xylene | Liquid | MCA | 106.2 | 0.8811 at 20/4 °C | 138 | 200 mg/L | 10 at 27 °C | 27.2 |
| Naphthalene | Solid | PA | 128.2 | 1.1620 at 20/4 °C | 218 | 30 mg/L | 0.071 at 23 °C | 79.0 |
| 3 & 4 Methylphenol | Solid | MCA | 108.1 | 1.0178 at 20/4 °C | 202 | 23 g/L | 0.04 | 86.0 |
| Diethylphthalate | Liquid | Ester | 222.2 | 1.1175 at 20/4 °C | 298 | 1 g/L | 1.88x10 ⁻³ | 140 |
| 4-Methyl-2-pentanone | Liquid | NCA | 100.2 | 0.7978 at 20/4 °C | 117 | 17 g/L | 15 | 22.8 |
| Methylene chloride | Liquid | CA | 85 | 1.3266 at 20/4 °C | 40.2 | 20 g/L | 348.9 | ≥30 |
| 4,4'-DDE | Solid | CPA | 319.03 | ND | ND | 0.12 mg/L | 6.49x10 ⁻⁶ at 30 °C | ND |
| Aroclor 1260 (PCB) | Solid | CPA | 370.0 | 1.57 at 15.5/4 °C | 400 | 0.080 mg/L | 4.05x10 ⁻⁵ | ND |
| Benzoic acid | Solid | CB | 122 | 1.2659 at 15/4 °C | 249 | 3.4 g/L | 1 at 96 °C | 121 |

Sources: Montgomery, 1991.
Montgomery and Welkom, 1991.

¹ A value of 0.7899 at 20/4 degrees Celsius (°C) indicates a specific density of 0.7899 for the substance at 20 °C with respect to water at 4 °C.

² Solubility in freshwater at 25 °C.

³ Vapor pressure at 20 °C to 25 °C.

| | | | |
|--------|----------------------------------|-----------------------------|---|
| Notes: | °C = degrees Celsius. | MCA = monocyclic aromatic. | DDE = dichlorodiphenyldichloroethylene. |
| | mm = millimeter. | CA = chlorinated aliphatic. | CPA = chlorinated polycyclic aromatic. |
| | Hg = mercury. | g/L = grams per liter. | ND = no data found. |
| | NCA = non-chlorinated aliphatic. | NF = not flammable. | PCB = polychlorinated biphenyl. |
| | mg/L = milligrams per liter. | PA = polycyclic aromatic. | CB = carboxylic acid. |

Polycyclic aromatic compounds detected include naphthalene, Aroclor 1260 (a PCB), and 4,4'-dichlorodiphenyldichloroethylene (DDE). Naphthalene is typically associated with incomplete combustion of fuel, but could also be the natural by-product of incomplete combustion of plant material. The presence of 4,4'-DDE is attributed to the transformation of dichlorodiphenyltrichloroethane (DDT), a common pesticide in the past. Montgomery (1993) describes numerous chemical, physical, and biological processes that transform DDT to 4,4'-DDE. Polycyclic aromatic compounds are characterized by low solubilities, having K_{ow} values ranging from 2,000 (naphthalene) to more than 1 million for the larger, more complex molecules (Tetra Tech, 1989; Mackay, 1991). These compounds tend to adsorb to organic particulates that coat soil particles. Biotransformation is possible, but slower than for other organic compounds discussed in the preceding paragraphs. Abiotic hydrolysis is unlikely for naphthalene because it has no functional groups in its structure. Under suitable conditions, polycyclic aromatics readily undergo photolysis transformations.

Bis(2-ethylhexyl)phthalate and diethylphthalate contain a single benzene ring in common with the monocyclic aromatics, but are classified based on the presence of ester functional group(s). Phthalates are commonly artifacts of sampling and/or analysis procedures. Bis(2-ethylhexyl)phthalate is relatively insoluble in water, having a K_{ow} on the order of 100,000 (Montgomery, 1991). Diethylphthalate is more soluble, having a K_{ow} on the order of 1,000 (Montgomery, 1991). Both phthalates are subject to transformation by hydrolysis to form acids and alcohols (Montgomery, 1991).

3.2 SITE 16, ARMY RESERVE DISPOSAL AREA, MOTOR MISSILE MAGAZINES.

3.2.1 Disposal Area Characteristics The Army Reserve Disposal Area, Motor Missile Magazines, is located in the south-central part of the NSB (see Figure 1-2). The site is located east of Woodrow Wilson Avenue. The site covers approximately 1 acre, measuring approximately 250 feet long by 450 feet wide at its maximum dimensions (see Figure 2-8).

Site 16 was first identified as a potential source of contamination during the Initial Assessment Study conducted in 1985 by C.C. Johnson and Associates, Inc. The Initial Assessment Study included records searches, interviews, and ground and aerial tours (C.C. Johnson, 1985). During development of the RFI workplan (ABB-ES, 1991), field team members used historical aerial photographs and physical landmarks to locate Site 16. A former sewage lagoon and a creek to the north of Site 16, landmarks visible in aerial photographs, were used by field team members to locate the site. The approximate site boundary shown in Figure 2-8 is based on the location identified during the reconnaissance. The RFI workplan proposed a magnetometer survey to further delineate the disposal area (ABB-ES, 1991). During the RFI field program in January and February 1992, motor missile magazines were being constructed at Site 16. The construction activities, and metal used in the magazines, prevented using magnetometry at Site 16. Alternate means for delineating the site will be proposed in a Supplemental RFI Workplan.

The nature of waste and disposal practices described in this paragraph are based on information presented in the Initial Assessment Study (C.C. Johnson, 1985). Site 16 was used by the Army Reserve from 1958 to 1964. The site was excavated to a depth of 3 to 5 feet before wastes were placed there. Reportedly, burning of waste took place here, but it is unknown how often burning occurred or if any fuel was used to ignite the wastes. The site was covered with soil upon closure

and is currently the location of motor missile magazines. This site was an active construction area during most of the RFI. These construction activities and equipment present at the site prevented the use of magnetics as an investigative tool at Site 16.

3.2.2 Waste Characteristics Approximately 4,000 cubic yards of waste were disposed at the site between 1958 and 1964 including food, wood, trash, scrap metal, tree limbs, and empty paint and solvent cans (about one or two 1-gallon cans per month) (C.C. Johnson, 1985). Knowledge of the chemical characteristics of the wastes disposed at Site 16 are based on analytical results of soil and groundwater samples.

Table 3-2 summarizes physical data for 21 organic chemicals detected in groundwater and/or soil samples from Site 16. Contaminants detected in environmental media can be classified as non-chlorinated aliphatics, monocyclic aromatics, chlorinated and non-chlorinated aromatics, and esters (Table 3-2). The same types of chemicals were detected in samples from Site 5. Physical properties having a significant effect on transformation and migration are discussed in Subsection 3.1.2 of this report.

Table 3-2
Physical and Chemical Characteristics of Volatile Organic Compounds and
Semivolatile Organic Compounds Detected in Media from Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Chemical | Physical Form | Chemical Class | Molecular Weight | Specific Density ¹ | Boiling Point (°C) | Solubility ² | Vapor Pressure ³ (mm Hg) | Flash Point (°C) |
|----------------------------|---------------|----------------|------------------|-------------------------------|--------------------|-------------------------|-------------------------------------|------------------|
| Acetone | Liquid | NCA | 58.1 | 0.7899 at 20/4 °C | 56.1 | Miscible | 180 | -17.8 |
| Bis(2-ethylhexyl)phthalate | Liquid | Ester | 390.6 | 0.9850 at 20/4 °C | 385 | 0.4 mg/L | 2E-07 | 196 |
| Carbon disulfide | Liquid | Sulfide | 76.1 | 1.2632 at 20/4 °C | 46.2 | 1.7 g/L | 297 | -30.0 |
| Ethylbenzene | Liquid | MCA | 106.2 | 0.8670 at 20/4 °C | 136 | 206 mg/L | 10 at 26 °C | 15.0 |
| Toluene | Liquid | MCA | 92.1 | 0.8669 at 20/4 °C | 111 | 524 mg/L | 22 | 4.4 |
| o-Xylene | Liquid | MCA | 106.2 | 0.8802 at 20/4 °C | 144 | 152 mg/L | 9 | 17.0 |
| m-Xylene | Liquid | MCA | 106.2 | 0.8642 at 20/4 °C | 139 | 173 mg/L | 10 at 28 °C | 25 |
| p-Xylene | Liquid | MCA | 106.2 | 0.8811 at 20/4 °C | 138 | 200 mg/L | 10 at 27 °C | 27.2 |
| Naphthalene | Solid | PA | 128.2 | 1.1620 at 20/4 °C | 218 | 30 mg/L | 0.071 at 23 °C | 79.0 |
| 4-Methyl-2-pentanone | Liquid | NCA | 100.2 | 0.7978 at 20/4 °C | 117 | 17 g/L | 15 | 22.8 |
| Di-n-butylphthalate | Liquid | Ester | 278.4 | 1.0460 at 20/4 °C | 340 | 400 mg/L | <0.01 | 157 |
| 2-Butanone | Liquid | NCA | 72.1 | 0.8054 at 20/4 °C | 79.6 | 256 g/L | 71 | -9.0 |
| Acenaphthene | Solid | PA | 154 | 1.0241 at 90/4 °C | 279 | 3.47 mg/L | 0.00155 | ND |
| Fluorene | Solid | PA | 166 | 1.2030 at 0/4 °C | 298 | 1.69 mg/L | 0.01 | ND |
| Phenanthrene | Solid | PA | 178 | 1.179 at 25/4 °C | 340 | 1.18 mg/L | 6.8E-04 | 171 |
| Fluoranthene | Solid | PA | 202 | 1.2520 at 0/4 °C | 375 | 0.265 mg/L | 0.01 | ND |
| Pyrene | Solid | PA | 202 | 1.2710 at 23/4 °C | 393 | 0.013 mg/L | 6.85E-07 | ND |
| Benzo(a)anthracene | Solid | PA | 228 | 1.2740 at 20/4 °C | 438 | 0.014 mg/L | 5E-09 at 20 °C | ND |
| Chrysene | Solid | PA | 228 | 1.2740 at 20/4 °C | 448 | 0.006 mg/L | 6.3E-07 | ND |

See notes at the end of the table.

Table 3-2 (Continued)
Physical and Chemical Characteristics of Volatile Organic Compounds and
Semivolatile Organic Compounds Detected in Media from Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Chemical | Physical Form | Chemical Class | Molecular Weight | Specific Density ¹ | Boiling Point (°C) | Solubility ² | Vapor Pressure ³ (mm Hg) | Flash Point (°C) |
|----------------------|---------------|----------------|------------------|-------------------------------|--------------------|-------------------------|-------------------------------------|------------------|
| Benzo(b)fluoranthene | Solid | PA | 252 | ND | ND | 0.0012 mg/L | 5E-07 | ND |
| Benzo(k)fluoranthene | Solid | PA | 252 | ND | 480 | 0.00055 mg/L | 9.59E-11 | ND |
| Benzo(a)pyrene | Solid | PA | 252 | 1.351 | 495 | 0.0038 mg/L | 5.0E-07 at 20 °C | ND |
| 4,4'-DDD | Solid | PA | 320 | 1.4760 at 20/4 °C | 193 | 0.160 mg/L | 1.02E-06 at 30 °C | ND |

¹ A value of 0.7899 at 20/4 degrees Celsius (°C) indicates a specific density of 0.7899 for a substance at 20 °C with respect to water at 4 °C.

² Solubility in freshwater at 25 °C.

³ Vapor pressure at 20 °C to 25 °C.

Source: Montgomery, 1991.
 Montgomery and Welkom, 1991.

Notes: °C = degrees Celsius.
 mm = millimeter.
 Hg = mercury.
 NCA = non-chlorinated aliphatic.
 mg/L = milligrams per liter.
 g/L = grams per liter.
 MCA = monocyclic aromatic.
 PA = polycyclic aromatic.
 ND = no data found.
 4,4'-DDD = 4,4'-dichlorodipenyldichloroethane.

4.0 PROTECTION STANDARDS

The regulatory setting under which NSB Kings Bay operates is discussed in Subsection 1.2. The facility currently has an HSWA permit and is required to comply with RCRA and HSWA regulatory requirements. Under RCRA, cleanup levels (media protection standards) are established by regulatory agencies with program authority based on their assessment of actions necessary to protect human health and the environment.

Cleanup standards defined by the regulatory agency with program authority must be attained for hazardous substances remaining onsite at the completion of the corrective action. Corrective action implementation must also comply with regulatory requirements to protect public health and the environment. Generally, regulatory requirements pertain to either contaminant levels or to performance or design standards to ensure protection at all points of potential exposure.

Health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, and contaminants govern the extent of site remediation by providing either actual cleanup levels or a basis for calculating such levels. If a chemical has more than one regulatory requirement, the most stringent generally should be attained. If no regulatory requirement exists, the GA DNR requires cleanup to background levels.

Chemical-specific regulatory requirements for NSB Kings Bay, identified in Table 4-1, are described below. The State of Georgia does not classify groundwater aquifers. Therefore, assuming all groundwater may be a potential drinking water supply, the Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs), and maximum contaminant level goals (MCLGs), which are applicable to public water systems, are appropriate cleanup levels for potential drinking water supplies. MCLs are legally enforceable Federal drinking water standards, based on advisories and health effects of a contaminant, and reflect the technical and economic feasibility of removing the contaminants from water supplies. SDWA MCLGs are non-enforceable health goals established by the USEPA and set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety.

RCRA concentration limits (40 Code of Federal Regulations [CFR] part 264.94) are applicable to active RCRA facilities and establish three categories of groundwater protection standards: background concentrations, MCLs, and alternative concentration limits (ACLs). ACLs are not discussed in this section because GA DNR requires that RCRA MCLs or background levels be used as groundwater protection standards. RCRA MCLs are numerically the same as SDWA MCLs; therefore, by complying with SDWA MCLs, cleanup will be consistent with RCRA MCLs. If no MCL exists, GA DNR requires site-specific background levels as a groundwater protection standard.

The Georgia Hazardous Waste Management Rules are applicable when developing appropriate cleanup standards at a RCRA site. Georgia Hazardous Waste Management Rules are consistent with the regulatory requirements of 40 CFR Parts 260 through 270; therefore, RCRA groundwater protection standards are also applicable to Sites 5 and 16 under Georgia regulations. In addition, Georgia Rules for Safe Drinking Water or MCLs (GA DNR, July 1993) are applicable when developing appropriate cleanup levels. Georgia groundwater quality standards, MCLs, MCLGs,

| Table 4-1 Chemical-Specific Regulatory Requirements for Groundwater | |
|--|--|
| Resource Conservation and Recovery Act Facility Investigation Report for Sites 5 and 16 and Site History and File Information for Site 12 Naval Submarine Base Kings Bay, Georgia | |
| Requirement | Requirement synopsis |
| Federal | |
| RCRA Subpart F, Groundwater Protection Standards (40 CFR 254.94) | Subpart F outlines three possible standards for setting cleanup levels for remediation of groundwater contamination attributable to an RCRA facility. These standards include: (1) maximum contaminant levels (MCLs), (2) background concentrations, and (3) alternative concentration limits. |
| Safe Drinking Water Act (SDWA), MCLs (40 CFR 141.11 - 141.16) | MCLs have been promulgated for a number of common organic and inorganic contaminants. These are legally enforceable levels that regulate the concentration of contaminants in public drinking water supplies and are considered for groundwater aquifers used for drinking water or potential sources of drinking water. Groundwater contaminant concentrations are compared to MCLs during the evaluation of risks to human health due to consumption of groundwater. |
| SDWA, Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50 - 141.51) | MCLGs are health-based criteria for a number of organic and inorganic contaminants in drinking water sources. MCLGs are used in cases in which multiple contaminants or pathways of exposure present extraordinary risks to human health. As promulgated under SARA, MCLGs should be considered relevant and appropriate for groundwater remediation of actual and potential drinking water supplies. |
| Federal Ambient Water Quality Criteria (AWQC) | Federal AWQC include (1) health-based criteria for 95 carcinogenic and noncarcinogenic compounds and (2) water quality parameters. AWQC, established for the protection of human health, are set at levels considered safe for consumption of drinking water as well as consuming fish. Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release. These factors will determine whether AWQC are relevant and appropriate. |
| Federal (To Be Considered) | |
| USEPA Reference Doses (RfDs) | RfDs are dose levels developed by the USEPA for noncarcinogenic effects for lifetime exposure. |
| USEPA Cancer Assessment Group Slope Factors (CSFs) | CSFs are developed by the USEPA from Health Effects Assessments (HEA) or evaluation by the Carcinogenic Assessment Group. |
| Acceptable Intake, Chronic (AIC) and Subchronic (AIS), USEPA Health Assessment Documents | AIC and AIS values are developed from RfDs and HEAs for noncarcinogenic compounds. |
| See notes at end of table. | |

Table 4-1 (Continued)
Chemical-Specific Regulatory Requirements for Groundwater

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Requirement | Requirement synopsis |
|---|---|
| <u>State of Georgia</u> | |
| Georgia Rules for Safe Drinking Water (Georgia Department of Natural Resources, July 1993) | Georgia MCLs for drinking water have been promulgated for a number of common organic and inorganic contaminants. These are legally enforceable levels that regulate the concentration of contaminants in public drinking water supplies and are considered for groundwater aquifers used for drinking water or potential sources of drinking water. Groundwater contaminant concentrations are compared to MCLs during the evaluation of risks to human health due to consumption of groundwater. |
| Georgia Water Quality Control Regulations and Standards | Standards are established for in stream concentrations of the chemical constituents listed by the USEPA as toxic priority pollutants (Section 307(a)(1)) of the Federal CWA. |
| Notes: RCRA = Resource Conservation and Recovery Act. RfD = reference dose. CFR = Code of Federal Regulation. USEPA = U.S. Environmental Protection Agency. MCL = Maximum Contaminant Limit. CSF = Cancer Assessment Group Slope Factor. SDWA = Safe Drinking Water Act. HEA = Health Effects Assessment. MCLG = Maximum Contaminant Level Goal. AIC = Acceptable Intake - Chronic. SARA = Superfund Amendments and Reauthorization Act. AIS = Acceptable Intake - Subchronic. CWA = Clean Water Act. AWQC = Ambient Water Quality Criteria. | |

Ambient Water Quality Criteria (AWQC), and background levels will all be assessed and used during the evaluation of any needed corrective measures at Sites 5 and 16 to develop appropriate cleanup levels. A preliminary list of chemicals of potential concern and the associated chemical-specific regulation is presented in Table 4-2.

**Table 4-2
Chemical-Specific Values**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Chemical | Federal MCL ($\mu\text{g/L}$) | MCLG ($\mu\text{g/L}$) | Federal AWQC ¹ ($\mu\text{g/L}$) | Georgia Drinking ² Water Standards ($\mu\text{g/L}$) | Georgia Surface ³ Water Criteria ($\mu\text{g/L}$) |
|------------------------|---------------------------------------|-----------------------------|---|---|---|
| Acetone | — | — | — | — | — |
| Ethylbenzene | 700 | 700 | 1,400 | 700 | 28,718 |
| 2-Butanone | — | — | — | — | — |
| Carbon Disulfide | — | — | — | — | — |
| Toluene | 1,000 | 1,000 | 14,300 | 1,000 | 301,941 |
| Xylenes (Total) | 10,000 | 10,000 | — | 10,000 | — |
| 4-Methyl-2-pentanone | — | — | — | — | — |
| Trichlorofluoromethane | — | — | — | — | — |
| Naphthalene | — | — | — | — | — |

¹ Water Quality Criteria Summary Concentrations, Published Criteria (Water and Organisms), USEPA Office of Science and Technology, Health and Ecological Criteria Division, May 1991a.

² Georgia Drinking Water Standards, Rules for Safe Drinking Water, Chapter 391-3-5, Revised July 1993, Rules of Georgia Department of Natural Resources, Environmental Protection Division.

³ Georgia Surface Water Criteria, Georgia Water Quality Control Specifications and Standards, The Bureau of National Affairs, Inc., August 1991.

Notes: MCL = maximum contaminant level (USEPA, 1993; GA DNR, 1993).
 $\mu\text{g/L}$ = micrograms per liter.
MCLG = maximum contaminant level goal (USEPA, 1993; GA DNR, 1993).
AWQC = Ambient Water Quality Criteria.
— = none reported.
USEPA = U.S. Environmental Protection Agency.
GA DNR = Georgia Department of Natural Resources

5.0 INVESTIGATIVE ANALYSES

Section 5.0 summarizes the analytical programs for onsite and offsite analyses of various media sampled during field activities associated with the RFI conducted at Sites 5 and 16. The RFI included the initial field program, bimonthly groundwater sampling events, and the hydrocone groundwater sampling event. Section 5.0 summarizes the data quality and usability assessments that were performed for the investigation analyses.

5.1 RFI FIELD PROGRAM AND BIMONTHLY GROUNDWATER SAMPLING EVENTS. RFI field activities at Sites 5 and 16 included the collection of subsurface soil samples, the installation of groundwater monitoring wells, and the collection of six sets of groundwater samples. Surface soil samples were also collected at Site 5. All samples were collected in accordance with procedures outlined in the Quality Assurance Project Plan, Appendix A, of the NSB Kings Bay RFI Workplan (ABB-ES, 1991). Surface soil samples were collected at Site 5 in February and July 1992, and subsurface soil samples were collected at Sites 5 and 16 in February 1992. Groundwater samples were collected at both sites during six bimonthly sampling events as shown below.

| <u>Sampling Event No.</u> | <u>Month Sampled</u> |
|---------------------------|----------------------|
| 1 | February 1992 |
| 2 | May 1992 |
| 3 | July 1992 |
| 4 | September 1992 |
| 5 | November 1992 |
| 6 | January 1993 |

5.1.1 Chemical Analyses Surface and subsurface soil samples and groundwater samples were submitted to the contract laboratory for chemical analyses. Soil samples and groundwater samples collected during sampling events Nos. 1 and 2 were analyzed in accordance with USEPA SW-846 methods (USEPA, 1986) and Naval Energy and Environmental Support Activity (NEESA) Level C (USEPA Level III) documentation for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated dibenzo-dioxins and furans, organochlorine and organophosphorus pesticides, PCBs, herbicides, and inorganic analytes (including total cyanide and sulfide) listed in Appendix IX of 40 CFR Part 264. Table 5-1 lists compounds included in Appendix IX of 40 CFR Part 264, corresponding USEPA analytical method numbers, and practical quantitation limits (PQLs).

Data for dioxin, furan, and inorganic analytes are reported relative to method detection limits (MDLs) as standard laboratory practice. Because MDL studies are regularly conducted as part of laboratory quality assurance and quality control (QA/QC) procedures, MDLs may change periodically. MDL studies are performed on each analytical instrument used for sample analysis. Because MDLs vary over time and with each instrument, the quantitation limits for dioxins, furans, and inorganic constituents do not lend themselves to tabulation.

When inorganic analyses are conducted at a laboratory participating in the USEPA Contract Laboratory Program (CLP), the data report is automatically generated using software compatible with CLP reporting requirements. Inorganic analytes measured using SW-846 analytical methods are initially qualified according to CLP contract required detection limits (CRDLs) during the automated report generation

**Table 5-1
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| | PQL | |
|---|----------------------------------|----------------------------------|
| | Soil ($\mu\text{g}/\text{kg}$) | Water ($\mu\text{g}/\text{L}$) |
| Appendix IX Volatile Organic Compounds | | |
| Method: USEPA SW-846 Method 8240 | | |
| Chloromethane | 10 | 10 |
| Bromomethane | 10 | 10 |
| Vinyl chloride | 10 | 10 |
| Chloroethane | 10 | 10 |
| Methylene chloride | 5 | 5 |
| Acetone | 10 | 10 |
| Carbon disulfide | 5 | 5 |
| Trichlorofluoromethane | 5 | 5 |
| 1,1-Dichloroethene | 5 | 5 |
| 1,1-Dichloroethane | 5 | 5 |
| 1,2-Dichloroethene (total) | 5 | 5 |
| Chloroform | 5 | 5 |
| 1,2-Dichloroethane | 5 | 5 |
| 2-Butanone (methyl ethyl ketone) | 10 | 10 |
| 1,1,1-Trichloroethane | 5 | 5 |
| Carbon tetrachloride | 5 | 5 |
| Vinyl acetate | 10 | 10 |
| Bromodichloromethane | 5 | 5 |
| 1,2-Dichloropropane | 5 | 5 |
| cis-1,3-Dichloropropene | 5 | 5 |
| Trichloroethene | 5 | 5 |
| Dibromochloromethane | 5 | 5 |
| 1,1,2-Trichloroethane | 5 | 5 |
| Benzene | 5 | 5 |
| trans-1,3-Dichloropropene | 5 | 5 |
| 2-Chloroethylvinylether | 10 | 10 |
| Bromoform | 5 | 5 |
| 2-Hexanone | 10 | 10 |
| 4-Methyl-2-pentanone | 10 | 10 |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | PQL | |
|---|----------------------------------|----------------------------------|
| | Soil ($\mu\text{g}/\text{kg}$) | Water ($\mu\text{g}/\text{L}$) |
| Appendix IX Volatile Organic Compounds (Continued) | | |
| Method: USEPA SW-846 Method 8240 | | |
| Tetrachloroethene | 5 | 5 |
| 1,1,2,2-Tetrachloroethane | 5 | 5 |
| Toluene | 5 | 5 |
| Chlorobenzene | 5 | 5 |
| Ethylbenzene | 5 | 5 |
| Styrene | 5 | 5 |
| Xylene (total) | 5 | 5 |
| 1,3-Dichlorobenzene | 5 | 5 |
| 1,4-Dichlorobenzene | 5 | 5 |
| 1,2-Dichlorobenzene | 5 | 5 |
| Acrolein | 100 | 100 |
| Iodomethane | 10 | 10 |
| Acrylonitrile | 100 | 100 |
| Dibromomethane | 5 | 5 |
| Ethyl methacrylate | 5 | 5 |
| 1,2,3-Trichloropropane | 5 | 5 |
| trans-1,4-Dichloro-2-butene | 5 | 5 |
| Acetonitrile | 100 | 100 |
| 3-Chloropropene | 5 | 5 |
| Propionitrile | 100 | 100 |
| Methacrylonitrile | 5 | 5 |
| 1,4-Dioxane | 200 | 200 |
| Methyl methacrylate | 10 | 10 |
| 1,2-Dibromoethane | 5 | 5 |
| 1,1,1,2-Tetrachloroethane | 5 | 5 |
| 1,2-Dibromo-3-chloropropane | 10 | 10 |
| Pentachloroethane | 10 | 10 |
| Isobutyl alcohol | 200 | 200 |
| Chloroprene | 200 | 200 |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | PQL | |
|---|----------------------------------|----------------------------------|
| | Soil ($\mu\text{g}/\text{kg}$) | Water ($\mu\text{g}/\text{L}$) |
| Appendix IX Semivolatile Organic Compounds | | |
| Method: USEPA SW-846 Method 8270 | | |
| n-Nitrosodimethylamine | 330 | 10 |
| Phenol | 330 | 10 |
| Aniline | 330 | 10 |
| bis(2-Chloroethyl)ether | 330 | 10 |
| 2-Chlorophenol | 330 | 10 |
| 1,3-Dichlorobenzene | 330 | 10 |
| 1,4-Dichlorobenzene | 330 | 10 |
| Benzyl alcohol | 330 | 10 |
| 1,2-Dichlorobenzene | 330 | 10 |
| 2-Methylphenol | 330 | 10 |
| bis(2-Chloroisopropyl)ether | 330 | 10 |
| n-Nitrosodi-n-propylamine | 330 | 10 |
| Hexachloroethane | 330 | 10 |
| Nitrobenzene | 330 | 10 |
| Isophorone | 330 | 10 |
| 2-Nitrophenol | 330 | 10 |
| 2,4-Dimethylphenol | 330 | 10 |
| Benzoic acid | 1,600 | 50 |
| bis(2-Chloroethoxy)methane | 330 | 10 |
| 2,4-Dichlorophenol | 330 | 10 |
| 1,2,4-Trichlorobenzene | 330 | 10 |
| Naphthalene | 330 | 10 |
| 4-Chloroaniline | 330 | 10 |
| Hexachlorobutadiene | 330 | 10 |
| 4-Chloro-3-methylphenol | 330 | 10 |
| 2-Methylnaphthalene | 330 | 10 |
| Hexachlorocyclopentadiene | 330 | 10 |
| 2,4,6-Trichlorophenol | 330 | 10 |
| 2,4,5-Trichlorophenol | 1,600 | 50 |
| 2-Chloronaphthalene | 330 | 10 |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | PQL | |
|---|----------------------------------|----------------------------------|
| | Soil ($\mu\text{g}/\text{kg}$) | Water ($\mu\text{g}/\text{L}$) |
| Appendix IX Semivolatile Organic Compounds (Continued) | | |
| Method: USEPA SW-846 Method 8270 | | |
| 2-Nitroaniline | 1,600 | 50 |
| Dimethylphthalate | 330 | 10 |
| Acenaphthylene | 330 | 10 |
| 2,6-Dinitrotoluene | 330 | 10 |
| 3-Nitroaniline | 1,600 | 50 |
| Acenaphthene | 330 | 10 |
| 2,4-Dinitrophenol | 1,600 | 50 |
| 4-Nitrophenol | 1,600 | 50 |
| Dibenzofuran | 330 | 10 |
| 2,4-Dinitrotoluene | 330 | 10 |
| Diethylphthalate | 330 | 10 |
| 4-Chlorophenyl-phenylether | 330 | 10 |
| Fluorene | 330 | 10 |
| 4-Nitroaniline | 1,600 | 50 |
| 4,6-Dinitro-2-methylphenol | 1,600 | 50 |
| n-Nitrosodiphenylamine | 330 | 10 |
| Diphenylamine | 330 | 10 |
| 1,2-Diphenylhydrazine | 330 | 10 |
| 4-Bromophenyl-phenylether | 330 | 10 |
| Hexachlorobenzene | 330 | 10 |
| Pentachlorophenol | 1,600 | 50 |
| Phenanthrene | 330 | 10 |
| Anthracene | 330 | 10 |
| Di-n-butylphthalate | 330 | 10 |
| Fluoranthene | 330 | 10 |
| Pyrene | 330 | 10 |
| Butylbenzylphthalate | 330 | 10 |
| 3,3'-Dichlorobenzidine | 660 | 20 |
| Benzo(a)anthracene | 330 | 10 |
| Chrysene | 330 | 10 |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | PQL | |
|---|----------------------------------|----------------------------------|
| | Soil ($\mu\text{g}/\text{kg}$) | Water ($\mu\text{g}/\text{L}$) |
| Appendix IX Semivolatile Organic Compounds (Continued) | | |
| Method: USEPA SW-846 Method 8270 | | |
| bis(2-Ethylhexyl)phthalate | 330 | 10 |
| Di-n-octyl phthalate | 330 | 10 |
| Benzo(b)fluoranthene | 330 | 10 |
| Benzo(k)fluoranthene | 330 | 10 |
| Benzo(a)pyrene | 330 | 10 |
| Indeno(1,2,3-cd)pyrene | 330 | 10 |
| Dibenz(a,h)anthracene | 330 | 10 |
| Benzo(g,h,i)perylene | 330 | 10 |
| 2-Picoline | 1,600 | 50 |
| Methyl methanesulfonate | 330 | 10 |
| Ethyl methanesulfonate | 330 | 10 |
| Acetophenone | 330 | 10 |
| n-Nitrosopiperidine | 330 | 10 |
| Phenyl-tert-butylamine | 1,600 | 50 |
| 2,6-Dichlorophenol | 330 | 10 |
| n-Nitrosodi-n-butylamine | 330 | 10 |
| n-Nitrosodiethylamine | 330 | 10 |
| n-Nitrosopyrrolidine | 330 | 10 |
| Benzidine | 1,600 | 50 |
| 1,2,4,5-Tetrachlorobenzene | 1,600 | 50 |
| Pentachlorobenzene | 1,600 | 50 |
| 1-Naphthylamine | 1,600 | 50 |
| 2-Naphthylamine | 1,600 | 50 |
| 2,3,4,6-Tetrachlorophenol | 330 | 10 |
| Phenacetin | 330 | 10 |
| 4-Aminobiphenyl | 1,600 | 50 |
| Pentachloronitrobenzene | 1,600 | 50 |
| Pronamide | 330 | 10 |
| p-Dimethylaminoazobenzene | 330 | 10 |
| 7,12-Dimethylbenz(a)anthracene | 330 | 10 |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
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 Kings Bay, Georgia

| | PQL | |
|---|--------------|--------------|
| | Soil (µg/kg) | Water (µg/L) |
| Appendix IX Semivolatile Organic Compounds (Continued) | | |
| Method: USEPA SW-846 Method 8270 | | |
| 3-Methylcholanthrene | 330 | 10 |
| Pyridine | 1,600 | 50 |
| n-Nitrosomethylethylamine | 330 | 10 |
| n-Nitrosomorpholine | 330 | 10 |
| o-Toluidne | 330 | 10 |
| 3-Methylphenol | 330 | 20 |
| 4-Methylphenol | 330 | 20 |
| Hexachloropropene | 1,600 | 50 |
| p-Phenylenediamine | 1,600 | 50 |
| Safrole | 1,600 | 50 |
| Isosafrole | 1,600 | 50 |
| 1,4-Naphthoquinone | 1,600 | 50 |
| 1,3-Dinitrobenzene | 330 | 10 |
| 5-Nitro-o-toluidine | 330 | 10 |
| 1,3,5-Trinitrobenzene | 330 | 10 |
| 4-Nitroquinoline-1-oxide | 330 | 10 |
| Methapyrilene | 1,600 | 50 |
| Aramite | 1,600 | 50 |
| 3,3'-Dimethylbenzidine | 330 | 10 |
| 2-Acetamidofluorene | 330 | 10 |
| Hexachlorophene | 1,600 | 50 |
| Parameter: Polychlorinated Dibenzo- Furans/Dioxins⁴ | | |
| Method: USEPA SW-846 Method 8280 | | |
| Tetrachlorodibenzo-p-dioxins (total) | -- | -- |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | -- | -- |
| Pentachlorodibenzo-p-dioxins (total) | -- | -- |
| Hexachlorodibenzo-p-dioxins (total) | -- | -- |
| Tetrachlorodibenzofurans (total) | -- | -- |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
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 Kings Bay, Georgia

| | PQL | |
|---|--------------|----------------------|
| | Soil (µg/kg) | Water (µg/L) |
| Parameter: Polychlorinated Dibenzo- Furans/Dioxins⁴ (Continued) | | |
| Method: USEPA SW-846 Method 8280 | | |
| Pentachlorodibenzofurans (total) | — | — |
| Hexachlorodibenzofurans (total) | — | — |
| Parameter: Organochlorine Pesticides and PCBs | | |
| Method: USEPA SW-846 Method 8080 | | |
| alpha-Benzenehexachloride | 0.4 | 0.01, 0.05 |
| beta-Benzenehexachloride | 0.8 | 0.02, 0.05 |
| delta-Benzenehexachloride | 0.4 | 0.01, 0.05 |
| gamma-Benzenehexachloride (Lindane) | 0.4 | 0.01, 0.05 |
| Heptachlor | 0.4 | 0.01, 0.05 |
| Aldrin | 0.4 | 0.01, 0.05 |
| Heptachlor epoxide | 0.4 | 0.01, 0.05 |
| Endosulfan I | 0.8 | 0.02, 0.05 |
| Dieldrin | 0.8 | 0.02, 0.10 |
| 4,4'-Dichlorodiphenyldichloroethylene | 0.8 | 0.02, 0.10 |
| Endrin | 0.8 | 0.02, 0.10 |
| Endosulfan II | 0.8 | 0.02, 0.10 |
| 4,4'-Dichlorodipenyldichloroethane | 0.8 | 0.02, 0.10 |
| Endrin Aldehyde | 0.8 | 0.02, 0.10 |
| Endosulfan sulfate | 0.8 | 0.02, 0.10 |
| 4,4'-Dichlorodiphenyltrichloroethane | 0.8 | 0.02, 0.10 |
| Methoxychlor | 1.6 | 0.04, 0.50 |
| Endrin ketone | 0.8 | 0.02, 0.10 |
| Chlordane | 4.0 | 0.10, 0.50 |
| Toxaphene | 20 | 0.50, 1.0 |
| Aroclor 1016 | 32, 33 | 0.50, 0.80, 1.0, 2.0 |
| Aroclor 1221 | 80, 67 | 0.50, 2.0 |
| Aroclor 1232 | 80, 33 | 0.50, 2.0 |
| Aroclor 1242 | 32, 33 | 0.50, 0.80, 1.0 |
| Aroclor 1248 | 16, 33 | 0.40, 1.0 |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
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| | PQL | |
|--|----------------------------------|----------------------------------|
| | Soil ($\mu\text{g}/\text{kg}$) | Water ($\mu\text{g}/\text{L}$) |
| Parameter: Organochlorine Pesticides and PCBs | | |
| Method: USEPA SW-846 Method 8080 | | |
| Aroclor 1254 | 8, 33 | 0.20, 1.0 |
| Aroclor 1260 | 8, 33 | 0.20, 1.0 |
| Chlorobenzilate | 20 | 0.50 |
| Diallate | 40 | 1.0 |
| Isodrin | 0.8 | 0.02 |
| Kepon ⁵ | NA | 1.0 |
| Parameter: Herbicides | | |
| Method: USEPA SW-846 Method 8150 | | |
| (2,4-Dichlorophenoxy)acetic acid | 100 | 2.5 |
| (2,4,5-Trichlorophenoxy)acetic acid | 20 | 0.5 |
| Dinoseb ⁵ | NA | 2.5 |
| Silvex | 20 | 0.5 |
| Parameter: Organophosphorus Pesticides | | |
| Method: USEPA SW-846 Method 8140 | | |
| Triethylphosphorothioate | 50 | 1.0 |
| Thionazin | 50 | 1.0 |
| Sulfotepp | 50 | 1.0 |
| Phorate | 50 | 1.0 |
| Dimethoate ⁵ | — | 5.0 |
| Disulfoton | 50 | 1.0 |
| Methyl parathion | 50 | 1.0 |
| Ethyl parathion | 50 | 1.0 |
| Famphur | 50 | 1.0 |
| CRDL | | |
| Parameter: Inorganic Analytes⁶ | | |
| mg/kg | | |
| Method : Various SW-846 Methods | | |
| Antimony (Method 6010) | 12 | 60 |
| Arsenic (Method 7060) | 2 | 10 |
| See notes at end of table. | | |

Table 5-1 (Continued)
Appendix IX Compound List¹, Practical Quantitation Limits, and Corresponding SW-846
Methods² Used for Soil and Groundwater Samples³

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | | CRDL | |
|--|---------------|--------------|--------------|
| | | Soil (mg/kg) | Water (µg/L) |
| Parameter: Inorganic Analytes⁴ (Continued) | | | |
| Method : Various SW-846 Methods | | | |
| Barium | (Method 6010) | 40 | 200 |
| Beryllium | (Method 6010) | 1 | 5 |
| Cadmium | (Method 6010) | 1 | 5 |
| Chromium | (Method 6010) | 2 | 10 |
| Cobalt | (Method 6010) | 10 | 50 |
| Copper | (Method 6010) | 5 | 25 |
| Lead | (Method 7421) | 0.6 | 5 |
| Mercury | (Method 7470) | 0.1 | 0.2 |
| Nickel | (Method 6010) | 8 | 40 |
| Selenium | (Method 7740) | 1 | 5 |
| Silver | (Method 6010) | 2 | 10 |
| Thallium | (Method 7841) | 2 | 10 |
| Vanadium | (Method 6010) | 10 | 50 |
| Zinc | (Method 6010) | 4 | 20 |
| Cyanide | (Method 9010) | 1 | 10 |
| Tin | (Method 6010) | 41.6 | 208 |
| Sulfide | (Method 9030) | 4,000 | 100 |

¹ Title 40 Code of Federal Regulations, Part 264, Appendix IX, Groundwater Monitoring List.

² U.S. Environmental Protection Agency (USEPA), 1986, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846). 3rd Edition. Office of Solid Waste and Emergency Response.

³ Multiple practical quantitation limits (PQLs) are listed for analytes having PQLs that varied during the course of the investigation. PQLs are established by the laboratory and are based on method detection limit (MDL) studies. Sample quantitation limits reported for environmental samples in Appendices F and G may vary relative to the PQL because of moisture content and/or dilution.

⁴ PQLs are not listed for dioxins and furans because the data are reported relative to MDLs based on MDL studies. There are no published PQLs for these analytes in the SW-846 method manual and these analytes are not included in the Contract Laboratory Program (CLP).

⁵ Compound was not analyzed for in soil samples due to poor spiking studies performed at the laboratory.

⁶ The contract required detection limits (CRDLs) listed for inorganic analytes are from the CLP because SW-846 analytical data are reported using CLP protocol when analyses are conducted at a CLP laboratory. This protocol results in qualification of values as estimated when the values are greater than the MDL but less than the CLP contract required detection limits. The SW-846 methods do not specify quantitation limits for inorganic data.

Source: USEPA, 1986.

Notes: PQL = practical quantitation limit. USEPA = U.S. Environmental Protection Agency.
 µg/kg = micrograms per kilogram. CRDL = contract required detection limit.
 µg/L = micrograms per liter. mg/kg = milligrams per kilogram.

process. Further qualification during validation may also be done that involves using the CLP CRDLs. The CRDLs are also used because the SW-846 methods do not publish required quantitation limits for inorganic analytes. Table 5-1 references CLP CRDLs for inorganic analytes, but does not reference PQLs or CRDLs for dioxin and furan analytes. The reason required quantitation limits are not listed for dioxins and furans is that there are none published in the SW-846 method and these analytes are not included as CLP target compounds.

For soil samples, the analytical result obtained by analysis of the sample extract is based on mass of analyte per unit volume of extract and is relative to the MDL for non-detected analytes. This result is converted to reflect the mass of analyte per unit mass of sample (soil). The conversion is based on the ratio of mass of sample to the volume of extract. The analytical result is then adjusted to account for percentage of moisture in the soil sample. The calculations associated with quantifying concentrations of analytes in soil samples and associated with detection limits for non-detect analytes relative to MDLs, but also relative to unit mass of sample, are automated.

Appendix F contains tables of validated analytical data for samples collected during the RFI, including QA/QC samples. Data for all analytes included in the laboratory program for the RFI are presented in Appendix F. Appendix G contains summary data tables that list validated data for analytes detected in one or more samples referenced on the table. Some non-detect values (data qualified with a "U") appear in the summary tables because every sample in the group of samples tabulated may not contain a particular chemical.

The sample quantitation limits for environmental samples are affected by moisture content (solid samples) and dilution factor (solids and liquids). For organic analysis of soil samples, the sample quantitation limit is calculated by dividing the PQL by the percent solids (as a fraction) and multiplying by the dilution factor. For aqueous samples, the dilution factor and the PQL are used to calculate the sample quantitation limit. As noted in the previous paragraph, the sample quantitation limits for inorganic, dioxin, and furan data are based on the MDL and not the PQL.

Sample quantitation limits associated with the RFI data in Appendices F and G may also reflect action taken during a data validation in response to analytes associated with blank contamination. Qualification of sample results for compounds associated with blank contamination were made according to NEESA Level C (USEPA Level III) quality control guidelines. For organic compounds, these guidelines are as listed below.

- If a chemical is present in a method blank but not in associated samples, the sample results are reported unqualified at the PQL. For the five common VOC and SVOC laboratory contaminants, the PQL is as follows:

| | <u>Aqueous</u> | <u>Soil</u> |
|--------------------|----------------------|------------------------|
| Methylene chloride | 5 U $\mu\text{g/L}$ | 5 U $\mu\text{g/kg}$ |
| Acetone | 10 U $\mu\text{g/L}$ | 10 U $\mu\text{g/kg}$ |
| 2-Butanone | 10 U $\mu\text{g/L}$ | 10 U $\mu\text{g/kg}$ |
| Toluene | 5 U $\mu\text{g/L}$ | 5 U $\mu\text{g/kg}$ |
| Phthalates | 10 U $\mu\text{g/L}$ | 330 U $\mu\text{g/kg}$ |

- If a chemical is present in the sample above PQL but less than 5 times the concentration detected in the associated blanks (10 times for the chemicals listed above), the result is qualified as undetected, "U". The "U" designation signifies that the chemical was analyzed for but not detected.
- If the sample result is below the PQL and less than 5 times the blank value (10 times for the chemicals listed above), results are qualified by reporting as undetected at the PQL.
- If the chemical is present at greater than 5 times the PQL (10 times for the above chemicals), results are reported as unqualified.

Inorganic results for environmental samples, in which concentrations of metals were also found in associated blanks, are designated as undetected if the concentration in the sample is below CRDL and less than 5 times the blank value. For sample concentrations between 5 and 10 times that found in a blank that exhibited negative bias (concentration in blank is less than 0) for an inorganic analyte, the sample results are qualified as estimated. No qualification is required if the sample value is more than 5 times the blank value, and there is no negative bias or more than 10 times the blank value if there is a negative bias. All sample results qualified as estimated are considered useable data.

Based on analytical results for the soil samples collected during the initial field program and first two groundwater sampling events, Appendix IX parameters, such as pesticides, dioxins, and furans, that were not detected in soil or groundwater samples were deleted from the groundwater monitoring program at Sites 5 and 16. As a result, groundwater samples collected during the last four sampling events at Site 5 were analyzed for Appendix IX inorganics, Appendix IX PCBs, and a select list of Appendix IX VOCs. Groundwater samples collected during the last four sampling events at Site 16 were analyzed for Appendix IX inorganics and a select list of Appendix IX VOCs and SVOCs. In addition, both filtered and unfiltered groundwater samples were collected during the last four sampling events to evaluate the contribution of aquifer solids in groundwater to the total concentration of inorganic constituents in groundwater. Two analytical parameters, total dissolved solids (TDS) and total suspended solids (TSS), were added to the monitoring program after sampling event No. 2 to establish what percentage of the total solids in groundwater represents suspended particulates.

Table 5-2 lists the compounds and analytical methods included in the analytical program for sampling events 3 through 6 at Sites 5 and 16. Groundwater samples were analyzed for VOCs, SVOCs, PCBs, and inorganic analytes in accordance with the same USEPA SW-846 methods used during the first two sampling events (see Table 5-1) and NEESA Level C (USEPA Level III) documentation. The analytical methods on Table 5-2 correspond to methods on Table 5-1 and have the same PQLs for corresponding compounds.

5.1.2 Data Quality Assessment Summary Analytical results for environmental samples collected during the RFI field program and bimonthly sampling events were evaluated and validated according to NEESA Level C (USEPA Level III) quality control (QC) criteria to establish data quality and useability. NEESA Level C (USEPA Level III) documentation and validation requirements are described in the June 1988 NEESA *Sampling and Chemical Analysis Quality Assurance Requirements for*

**Table 5-2
Compound List for Groundwater Sampling Event Numbers 3 through 6**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

Parameter: Volatile Organic Compounds
Method: SW-846 Method 8240

| | |
|----------------------------|---------------------------|
| Chloromethane | cis-1,3-Dichloropropene |
| Bromomethane | Trichloroethane |
| Vinyl Chloride | Dibromochloromethane |
| Chloroethane | 1,1,2-Trichloroethane |
| Methylene chloride | Benzene |
| Acetone | trans-1,3-Dichloropropene |
| Carbon disulfide | Bromoform |
| Trichlorofluoromethane | 2-Hexanone |
| 1,1-Dichloroethene | 4-Methyl-2-pentanone |
| 1,1-Dichloroethane | Tetrachloroethane |
| 1,2-Dichloroethene (total) | 1,1,2,2-Tetrachloroethane |
| Chloroform | Toluene |
| 1,2-Dichloroethane | Chlorobenzene |
| 2-Butanone | Ethylbenzene |
| 1,1,1-Trichloroethane | Styrene |
| Carbon Tetrachloride | Xylene (total) |
| Vinyl Acetate | 1,3-Dichlorobenzene |
| Bromodichloromethane | 1,4-Dichlorobenzene |
| 1,2-Dichloropropane | 1,2-Dichlorobenzene |

Parameter: Polychlorinated Biphenyls
Method: SW-846 Method 8080

| | | |
|--------------|--------------|--------------|
| Aroclor-1016 | Aroclor-1221 | Aroclor-1232 |
| Aroclor-1242 | Aroclor-1248 | Aroclor-1254 |
| Aroclor-1260 | | |

Parameter: Appendix IX Inorganic Analytes
Method: SW-846 Methods (listed in parentheses)

| | | |
|------------------|-----------------|-----------------|
| Antimony (6010) | Copper (6010) | Thallium (7841) |
| Arsenic (7060) | Lead (7421) | Vanadium (6010) |
| Barium (6010) | Mercury (7470) | Zinc (6010) |
| Beryllium (6010) | Nickel (6010) | Tin (6010) |
| Cadmium (6010) | Selenium (7740) | Cyanide (9010) |
| Chromium (6010) | Silver (6010) | Sulfide (9030) |
| Cobalt (6010) | | |

Parameter: Semivolatile Organic Compounds (base and neutral fraction)
Method: SW-846 Method 8270

| | |
|-----------------------------|----------------------------|
| bis(2-Chloroethyl)Ether | 2,4-Dinitrotoluene |
| 1,3-Dichlorobenzene | Diethylphthalate |
| 1,4-Dichlorobenzene | 4-Chlorophenyl-phenylether |
| Benzyl Alcohol | Fluorene |
| 1,2-Dichlorobenzene | 4-Nitroaniline |
| bis(2-Chloroisopropyl)Ether | n-Nitrosodiphenylamine |
| n-Nitroso-di-n-propylamine | 4-Bromophenyl-phenylether |
| Hexachloroethane | Hexachlorobenzene |

See notes at end of table.

Table 5-2 (Continued)
Compound List for Groundwater Sampling Event Numbers 3 through 6

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

(Continued)

Parameter: Semivolatile Organic Compounds (base and neutral fraction)
Method: SW-846 Method 8270

| | |
|----------------------------|----------------------------|
| Nitrobenzene | Phenanthrene |
| Isophorone | Anthracene |
| bis(2-Chloroethoxy)methane | di-n-Butylphthalate |
| 1,2,4-Trichlorobenzene | Fluoranthene |
| Naphthalene | Pyrene |
| 4-Chloroaniline | Butylbenzylphthalate |
| Hexachlorobutadiene | 3,3'-Dichlorobenzidine |
| 2-Methylnaphthalene | Benzo(a)anthracene |
| Hexachlorocyclopentadiene | Chrysene |
| 2-Chloronaphthalene | bis(2-Ethylhexyl)phthalate |
| 2-Nitroaniline | di-n-Octyl phthalate |
| Dimethylphthalate | Benzo(b)fluoranthene |
| Acenaphthylene | Benzo(k)fluoranthene |
| 2,6-Dinitrotoluene | Benzo(a)pyrene |
| 3-Nitroaniline | Indeno(1,2,3-cd)pyrene |
| Acenaphthene | Dibenz(a,h)anthracene |
| Dibenzofuran | Benzo(g,h,i)perylene |

Parameter: Total Dissolved Solids and Total Suspended Solids
Method: Standard Methods-- Methods 2540C and 2540D

Sources: USEPA, 1986.
 American Public Health Association-American Water Works Association-Water Pollution Control Federation (APHA-AWWA-WPCF), 1989.

SW-846 = Test methods for evaluating solid wastes.

the Navy Installation Restoration Program (NEESA, 1988) (Document 20.2-047B). The USEPA functional guidelines for evaluating organic and inorganic laboratory data (USEPA, 1991b; 1988b) were used, where applicable, to validate the laboratory data. Data review and NEESA Level C (USEPA Level III) validation were performed under subcontract. Appendix D of this document provides a detailed assessment of the analytical performance and quality of data generated during the six sampling events.

Data quality indicators of precision, accuracy, representativeness, comparability, and completeness (PARCC) were evaluated for all data generated during this investigation. Appendix E of this report contains data tables summarizing analytical results for matrix spike and matrix spike duplicate (MS/MSD) samples, initial and continuing calibration standards, and compounds detected in field duplicate samples (Heartland Environmental Services, Inc., 1993). These data were used during each field event to evaluate the precision and accuracy of analytical methods and sampling techniques.

Field duplicate samples were collected during RFI field activities to assess sampling precision. Duplicate groundwater samples and soil samples were collected in accordance with NEESA Level C (USEPA Level III) guidelines at a minimum frequency of 10 percent (NEESA, 1988). All samples were collected in accordance with procedures outlined in the Quality Assurance Project Plan, Appendix A of the NSB Kings Bay RFI Workplan (ABB-ES, 1991). Tables 1.1 through 1.1.8 in Appendix E summarize compounds detected in duplicate soil and groundwater samples collected from Sites 5 and 16 as well as duplicate samples collected from Site 11, Old Camden County Landfill, at NSB Kings Bay. As shown in these tables, compounds detected in water and soil matrices that did not meet the relative percentage difference (RPD) criteria were largely due to low sample values at or below the quantitation limit. Low precision values for inorganic analytes in groundwater may also be attributable to the variation in the amount of suspended solids in each sample and the nature of the inorganic constituents sorbed to those suspended solids.

Tables 1.2 through 1.2.6 in Appendix E summarize percentage recoveries and RPDs for MS/MSD samples that did not fall within QC advisory limits. The precision of each analytical method is evaluated based on RPD results for MS/MSD analyses and the accuracy of each analytical method is evaluated based on percentage recoveries for MS/MSD samples. An evaluation of organic and inorganic MS/MSD analyses indicates that at least 92 percent of all RPD results and at least 89 percent of all recoveries were within QC limits.

Representativeness is the degree to which the data obtained from a sample collection activity accurately reflect the contamination at a site. Factors such as the proper selection of analytical methodology and sampling strategies establish the degree of representativeness achieved. Measures used during the chemical analyses of environmental samples to confirm analytical representativeness include the analyses of analytical method blanks. Measures used during field sampling to confirm sampling representativeness included collection of source water blanks, equipment rinsate blanks, and trip blanks. In accordance with NEESA guidance, one equipment rinsate blank was collected each day for each type of sampling equipment used that day, one source water blank was collected during each sampling event for each water source, and one trip blank was included in each cooler containing samples for VOC analysis. Rinsate blanks and source water blanks were analyzed for the same chemical parameters as associated environmental samples. Trip blanks were analyzed for VOCs only.

Included in Appendix D of this document is a detailed assessment of compounds detected in analytical method blanks and field blanks collected during the RFI and the subsequent impact on data quality and useability.

Comparability is the confidence with which one data set can be compared with another and the degree to which the data are found to be equivalent. Comparability cannot be accurately measured for data collected during RFI and bimonthly groundwater sampling events because two separate analytical laboratories were not used to analyze duplicate samples. However, the comparison of data collected during each groundwater sampling event suggests that the analytical methods employed during each event successfully confirmed the presence or absence of certain organic and inorganic constituents.

Analytical completeness is the percentage of useable data reported and validated compared with the total number of samples submitted for analysis. The goal for analytical completeness for the RFI is 95 percent useable data. Unusable analytical data are those results reported by the laboratory but rejected during the validation process. The following lists illustrate by matrix and analytical parameter those results judged useable expressed as a percentage of total fractions.

| <u>Parameter</u> | <u>Soil</u> | <u>Groundwater</u> | <u>Quality Control Samples</u> |
|---------------------|-------------|--------------------|------------------------------------|
| VOCs | 100.0 | 100.0 | 100.0 |
| SVOCs | 98.4 | 99.3 | 98.8 |
| Pesticides and PCBs | 100.0 | 100.0 | 100.0 |
| Herbicides | 100.0 | 100.0 | 100.0 |
| Dioxins and Furans | 100.0 | 100.0 | 100.0 |
| Inorganics | 100.0 | 100.0 | 100.0 |

As shown, the completeness goal of 95 percent was met for all matrices and all parameters. Overall, the data generated meet NEESA Level C (USEPA Level III) data quality objectives (DQOs) established for the RFI and are acceptable for use in site characterization and evaluation.

5.2 HYDROCONE GROUNDWATER SAMPLING EVENT. During November 1992, groundwater samples were collected using a hydrocone sampler at Sites 5 and 16. Samples were collected to confirm the absence of VOCs in groundwater below the screened interval of site monitoring wells. All samples were collected in accordance with procedures outlined in the Quality Assurance Project Plan, Appendix A of the NSB Kings Bay RFI Workplan (ABB-ES, 1991). A total of 48 groundwater samples, including 5 duplicate samples, were collected for onsite VOC analysis. Five groundwater samples, including one duplicate sample, were collected for offsite analysis.

5.2.1 Onsite Chemical Analyses Samples collected for onsite analysis were analyzed for target halogenated VOCs using a gas chromatographic field laboratory. The analytical method used was a modification of the USEPA SW-846 8010/8020 purge-and-trap gas chromatography (GC) method as described in the Interim Corrective Measures Study (ICMS) Investigation Workplan (ABB-ES, 1992d). A detailed summary of the modifications to the USEPA SW-846 8010/8020 method is presented in Subsection 3.1.1.1 of the ICMS Investigation Report (ABB-ES, 1993b). Table 5-3 provides a list of the 10 target compounds and corresponding reporting limits.

**Table 5-3
Target Compounds and Reporting Limits for Onsite Analyses**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compound Name | Reporting Limit (µg/L) |
|--------------------------|------------------------|
| Vinyl chloride | 2.0 |
| trans-1,2-Dichloroethene | 5.0 |
| cis-1,2-Dichloroethene | 5.0 |
| Trichloroethene | 5.0 |
| Tetrachloroethene | 5.0 |
| Benzene | 5.0 |
| Toluene | 5.0 |
| Ethylbenzene | 5.0 |
| m/p-Xylene | 10 |
| o-Xylene | 5.0 |

Note: µg/L = micrograms per liter.

5.2.2 Onsite Data Quality Assessment Summary Data generated by the onsite laboratory were reviewed against applicable performance criteria, and PARCC parameters were evaluated for the onsite data. A detailed discussion of the PARCC parameters is presented in Subsection 3.2.1.1 of the ICMS Investigation Report (ABB-ES, 1993b).

Overall, data generated by the onsite analytical laboratory met USEPA Level II criteria for field screening. All data collected from Sites 5 and 16 were suitable for use in site characterization and evaluation.

5.2.3 Offsite Chemical Analyses During the cone penetrometer investigation, five groundwater samples, including one duplicate, were collected for offsite analyses. Samples were submitted to the contract laboratory for analyses of halogenated and aromatic VOCs. Samples for VOC analyses were analyzed according to the CLP Statement of Work for multimedia samples (USEPA, 1991c). NEESA Level D (USEPA Level IV) documentation (NEESA, 1988) was used for VOC analyses.

Because many VOCs currently have Federal MCLs below their respective CLP contract required quantitation limits (CRQLs), it was necessary to achieve lower reporting limits for VOCs. Based on VOC MDL studies performed and submitted by the contract laboratory, lower reporting limits for VOCs were achieved. Table 5-4 lists the TCL VOCs, their corresponding MDLs, and the reporting limits used during this investigation. All reporting limits listed in Table 5-4 are lower than corresponding Federal Primary Drinking Water MCLs. Appendix D of the ICMS Investigation Report (ABB-ES, 1993a) contains data supporting the MDL study.

5.2.4 Offsite Data Quality Assessment Summary Analytical results for environmental samples collected during the investigation were evaluated and validated according to NEESA Level D (USEPA Level IV) QC criteria to establish

**Table 5-4
Method Detection Limits and Reporting
Limits for Volatile Organic Compounds**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Volatile Organic Compound | MDL (µg/L) | Reporting Limit (µg/L) |
|--|------------|------------------------|
| Method: Contract Laboratory Program Statement of Work for Organic Analysis, Multi-media, Multi-concentration, USEPA Document No. OLM01.0, 1991. | | |
| Chloromethane | 0.203 | 1 |
| cis-1,3-Dichloropropene | 0.274 | 1 |
| Bromomethane | 0.396 | 1 |
| Trichloroethene | 0.185 | 1 |
| Vinyl chloride | 0.165 | 1 |
| Dibromochloromethane | 0.190 | 1 |
| Chloroethane | 0.147 | 1 |
| 1,1,2-Trichloroethane | 0.268 | 1 |
| Methylene chloride | 9.712 | 10 |
| Benzene | 0.235 | 1 |
| Acetone | 3.491 | 5 |
| trans-1,3-Dichloropropene | 0.097 | 1 |
| Carbon disulfide | 0.114 | 1 |
| Bromoform | 0.230 | 1 |
| 1,1-Dichloroethene | 0.175 | 1 |
| 2-Hexanone | 0.465 | 5 |
| 1,1-Dichloroethane | 0.205 | 1 |
| 4-Methyl-2-pentanone | 0.746 | 5 |
| cis-1,2-Dichloroethene | 0.215 | 1 |
| Tetrachloroethene | 0.340 | 1 |
| trans-1,2-Dichloroethene | 0.254 | 1 |
| 1,1,2,2-Tetrachloroethane | 0.391 | 1 |
| Chloroform | 0.285 | 1 |
| Toluene | 0.167 | 1 |
| 1,2-Dichloroethane | 0.160 | 1 |
| Chlorobenzene | 0.238 | 1 |
| 2-Butanone | 0.709 | 5 |
| Ethylbenzene | 0.195 | 1 |
| 1,1,1-Trichloroethane | 0.221 | 1 |
| Styrene | 0.240 | 1 |
| Carbon tetrachloride | 0.354 | 1 |
| Xylenes (total) | 0.141 | 1 |
| See notes at end of table. | | |

**Table 5-4 (Continued)
Method Detection Limits and Reporting
Limits for Volatile Organic Compounds**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Volatile Organic Compound | MDL ($\mu\text{g/L}$) | Reporting Limit ($\mu\text{g/L}$) |
|--|-------------------------|-------------------------------------|
| Bromodichloromethane | 0.144 | 1 |
| 1,3-Dichlorobenzene | 0.126 | 1 |
| 1,2-Dichloropropane | 0.236 | 1 |
| 1,4-Dichlorobenzene | 0.164 | 1 |
| 1,2-Dichlorobenzene | 0.222 | 1 |
| Notes: MDL = method detection limit. $\mu\text{g/L}$ = micrograms per liter. USEPA = U.S. Environmental Protection Agency. | | |

data quality and useability. NEESA Level D documentation and validation requirements are equivalent to USEPA Level IV requirements and are described in the June 1988 NEESA *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program* (NEESA, 1988) (Document 20.2-047B). The USEPA functional guidelines for evaluating organic laboratory data (USEPA, 1991b; 1988b) were used to validate the laboratory data. Data review and NEESA Level D (USEPA Level IV) validation were performed under subcontract. The following paragraphs discuss analytical performance and the evaluation of PARCC parameters.

All CLP holding times, tuning and initial calibration standard criteria, internal standard and surrogate recovery criteria, and MS/MSD precision and accuracy criteria were met. Table 5-5 lists the CLP precision and accuracy requirements met for MS/MSD analysis. Overall, no qualification of data was required based on precision and accuracy.

Table 5-5
Summary of Precision and Accuracy Criteria for
Offsite Matrix Spike and Matrix Spike Duplicate Analyses

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Compound | MS/MSD Recovery Limits (Accuracy) | | MS/MSD RPD Limits (Precision) | |
|--------------------|--------------------------------------|-----------|----------------------------------|------|
| | Water (%) | Soil (%) | Water | Soil |
| 1,1-Dichloroethene | 61 to 145 | 59 to 172 | 14 | 22 |
| Trichloroethene | 71 to 120 | 62 to 137 | 14 | 24 |
| Benzene | 76 to 127 | 66 to 142 | 11 | 21 |
| Toluene | 76 to 125 | 59 to 139 | 13 | 21 |
| Chlorobenzene | 75 to 130 | 60 to 133 | 13 | 21 |

Notes: MS/MSD = matrix spike and matrix spike duplicate.
 RPD = relative percent difference (between matrix spike and matrix spike duplicate result).
 % = percent.

Representativeness is a qualitative parameter that expresses how well the sampling represents the environmental conditions of the sampled media. Field QC samples were collected in conformance with the requirements of the June 1988 NEESA *Sampling and Chemical Analysis Quality Assurance Requirements for the Navy Installation Restoration Program* (NEESA, 1988) (Document 20.2-047B) to give an indication of representativeness. These field QC samples included a field duplicate sample, two equipment rinsate blanks, three source water blanks, and two VOC trip blanks. Carbon disulfide was the only VOC detected in duplicate samples 05H1137 and 05H1137D. Concentrations of carbon disulfide were similar for the two samples (1 and 2 µg/L, respectively).

As shown in Table 5-6, no VOCs were detected in the trip blanks. One VOC, acetone, was detected in one equipment rinsate sample, BS116ER, at 7 µg/L. Acetone was also detected in environmental samples associated with BS116ER. Following guidelines for the validation of laboratory data (USEPA, 1991b), sample

Table 5-6
Summary of Laboratory Results for Field Blanks Associated with
Hydrocone Groundwater Samples Collected from Sites 5 and 16

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| VOC ANALYTE | PQL (µg/L) | Trip Blanks (µg/L) | | Rinsate Blanks (µg/L) | | Source Water Blanks (µg/L) | | |
|--------------------------|------------|--------------------|----------|-----------------------|----------|----------------------------|----------|----------|
| | | BT115FB | BT116FB | BS116ER | BS120ER | BS110FB | BS111FB | BS112FB |
| | | 11/14/92 | 11/16/92 | 11/14/92 | 11/16/92 | 11/16/92 | 11/16/92 | 11/16/92 |
| | | 11/19/92 | 11/27/92 | 11/19/92 | 11/27/92 | 11/27/92 | 11/27/92 | 11/27/92 |
| Chloromethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Bromomethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Vinyl chloride | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Chloroethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Methylene chloride | 10 | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Acetone | 5 | 5 U | 5 U | 7 | 5 U | 5 U | 5 U | 5 U |
| Carbon disulfide | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,1-Dichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,1-Dichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| cis-1,2-Dichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| trans-1,2-Dichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Chloroform | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 6 | 1 U |
| 1,2-Dichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 2-Butanone | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,1-Trichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Carbon tetrachloride | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Bromodichloromethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 7 | 1 U |
| 1,2-Dichloropropane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| cis-1,3-Dichloropropene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |

See notes at end of table.

Table 5-6 (Continued)
Summary of Laboratory Results for Field Blanks Associated with
Hydrocone Groundwater Samples Collected from Sites 5 and 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| VOC ANALYTE | PQL (µg/L) | Trip Blanks (µg/L) | | Rinsate Blanks (µg/L) | | Source Water Blanks (µg/L) | | |
|---------------------------|------------|--------------------|----------|-----------------------|----------|----------------------------|----------|----------|
| | | BT115FB | BT116FB | BS116ER | BS120ER | BS110FB | BS111FB | BS112FB |
| | | 11/14/92 | 11/16/92 | 11/14/92 | 11/16/92 | 11/16/92 | 11/16/92 | 11/16/92 |
| Trichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Dibromochloromethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 6 | 1 U |
| 1,1,2-Trichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Benzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| trans-1,3-Dichloropropene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Bromoform | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 2-Hexanone | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 4-Methyl-2-pentanone | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Tetrachloroethene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,1,2,2-Tetrachloroethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Toluene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Chlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Ethylbenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Styrene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| Xylene (total) | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,3-Dichlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,4-Dichlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,2-Dichlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U | 1 U |

Notes: µg/L = micrograms per liter.
 VOC = volatile organic compound.
 PQL = Practical Quantitation Limit.
 U = compound not detected at the stated quantitation limit.

results for acetone in associated samples have been qualified as undetected because concentrations were less than 10 times the rinsate concentration. Three VOCs, chloroform, bromodichloromethane, and dibromochloromethane, were detected in the source water blank representing potable water (BS111FB). These VOCs are trihalomethanes that commonly form in potable water chlorinated for drinking water disinfection. No qualification of data was required or performed based on source water blank contamination because none of the groundwater samples associated with BS111FB contained detectable concentrations of these VOCs. The completeness of the offsite data set was measured by establishing what percentage of the data set was considered valid after data review. The completeness for the offsite data was determined to be 100 percent.

Overall, the quality of the offsite sampling data generated during the field program met the established field QC criteria and was traceable to sample location. The data generated meet NEESA Level D (USEPA Level IV) DQOs established for the investigation and are acceptable for use in site characterization and evaluation.

5.2.5 Comparison of Onsite Laboratory Results with Offsite Laboratory Results

The only VOC detected in the hydrocone groundwater samples was carbon disulfide, which was detected in three samples at concentrations of 1 $\mu\text{g}/\text{L}$ and 2 $\mu\text{g}/\text{L}$. No VOCs were detected during onsite analyses. Therefore, comparison of onsite and offsite analytical data is limited because no target VOCs were detected in replicate samples. However, the absence of target VOCs in onsite and offsite replicate groundwater samples confirms the absence of target VOCs in groundwater at the sites. The presence of carbon disulfide in three groundwater samples is indicative of natural conditions.

Based on the measured precision and accuracy of the onsite and offsite results and the comparison of onsite and offsite laboratory results, the onsite data can be used to augment the offsite data for site characterization.

6.0 CONTAMINANT CHARACTERISTICS

An evaluation of contamination characteristics of groundwater and soil was conducted at Sites 5 and 16 based on data collected during the RFI. The methodology and results of these investigations are described in the following subsections.

Potential site-related contaminants were assessed by comparing analytical data for samples collected from sample locations for release detection to corresponding data for samples from upgradient locations. The data associated with samples from upgradient locations may not be representative of background conditions. GA DNR requires site contaminants be identified based on comparison to background concentrations. Additional sampling is needed to develop a background data set for soil and groundwater.

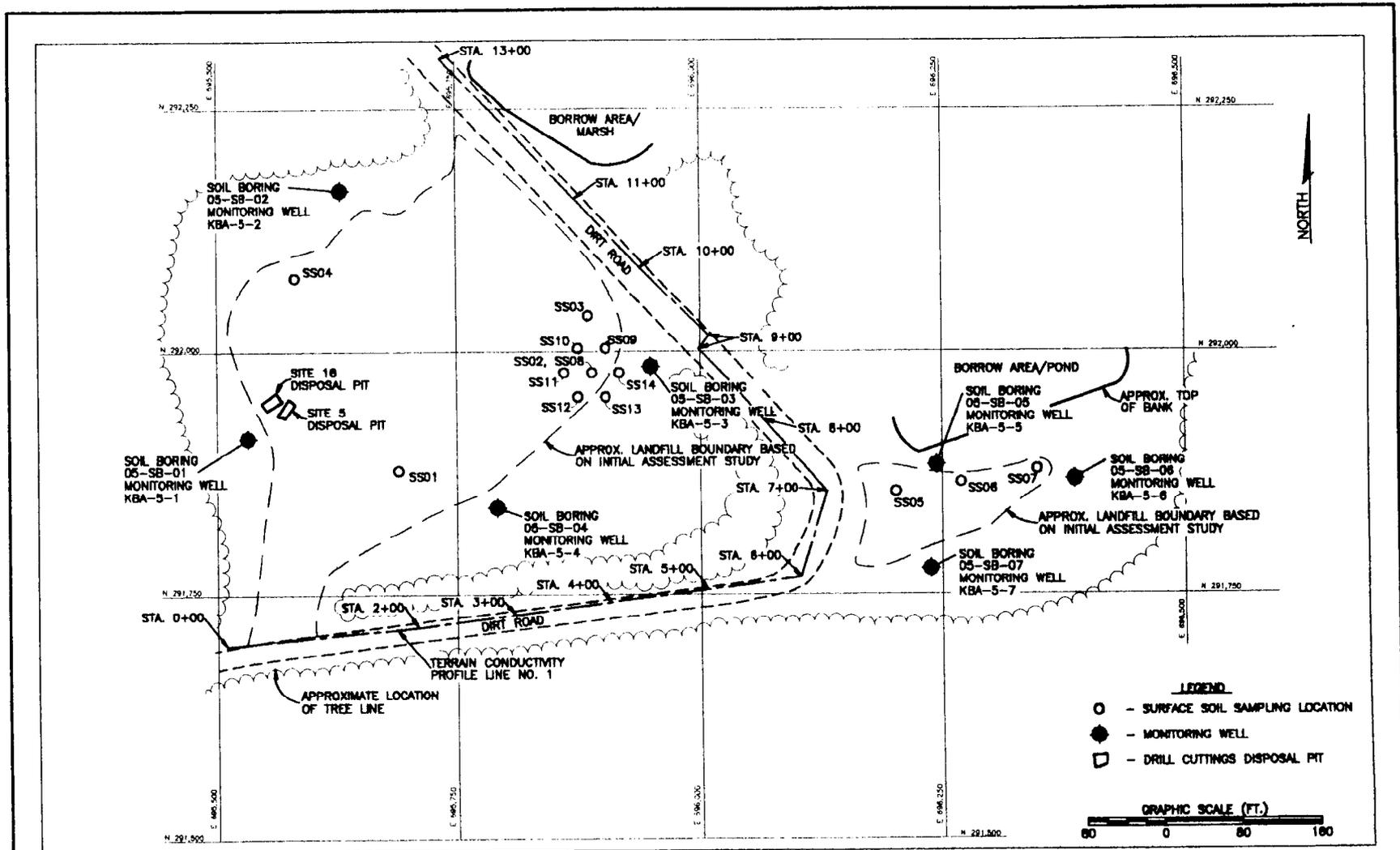
Several organic compounds, including acetone, methylene chloride, and phthalates, are commonly incidental to contamination during sampling and analysis. Concentrations of common artifact compounds in environmental samples were evaluated based on method blanks and other QC samples associated with RFI analyses. The absence in groundwater of highly soluble compounds detected in soil was also used as an indicator for evaluating whether detection of common artifact compounds was indicative of site conditions.

6.1 SITE 5, ARMY RESERVE DISPOSAL AREA, TOWHEE TRAIL. Investigation activities at Site 5 included collection and analyses of surface soil, subsurface soil, and groundwater samples. Results of laboratory analyses of samples of environmental media were used to evaluate the status of contamination at the site.

6.1.1 Groundwater Contamination On February 1, 1992, a terrain conductivity profile was conducted around the southern and eastern periphery of the reported landfill area (Figure 6-1) in an attempt to determine if any highly conductive areas could be delineated, which may suggest the presence of potentially contaminated groundwater emanating from the alleged landfill area. Figure 6-2 shows the results of the terrain conductivity survey conducted at Site 5. The terrain conductivity traverse was conducted along the profile line shown in Figure 6-1. Conductivity values ranged between 6 and 13 millimhos per meter (mmhos/m). The conductivity profile shows no significant elevated conductivity values along the length of the traverse, suggesting that no highly conductive groundwater was present in the vicinity of Site 5.

A groundwater monitoring program consisting of six bimonthly sampling events began in February 1992 to assess groundwater quality at the site. Seven groundwater monitoring wells, KBA-5-1 through KBA-5-7, were included in the monitoring program (Figure 6-1). These monitoring wells range from 12.5 to 13.3 feet deep and have 10-foot well screens that intercept the water table surface. Table 2-2 provides construction data for monitoring wells at Site 5. Monitoring wells KBA-5-1 and KBA-5-2 were located to provide information regarding groundwater quality upgradient of the disposal area. Monitoring wells KBA-5-3 through KBA-5-7 were installed to monitor for releases from the site.

Groundwater samples and QC samples were collected and submitted to a USEPA contract laboratory for analyses. Appendix F contains tables listing validated analytical data for all of the environmental samples and associated QA/QC samples



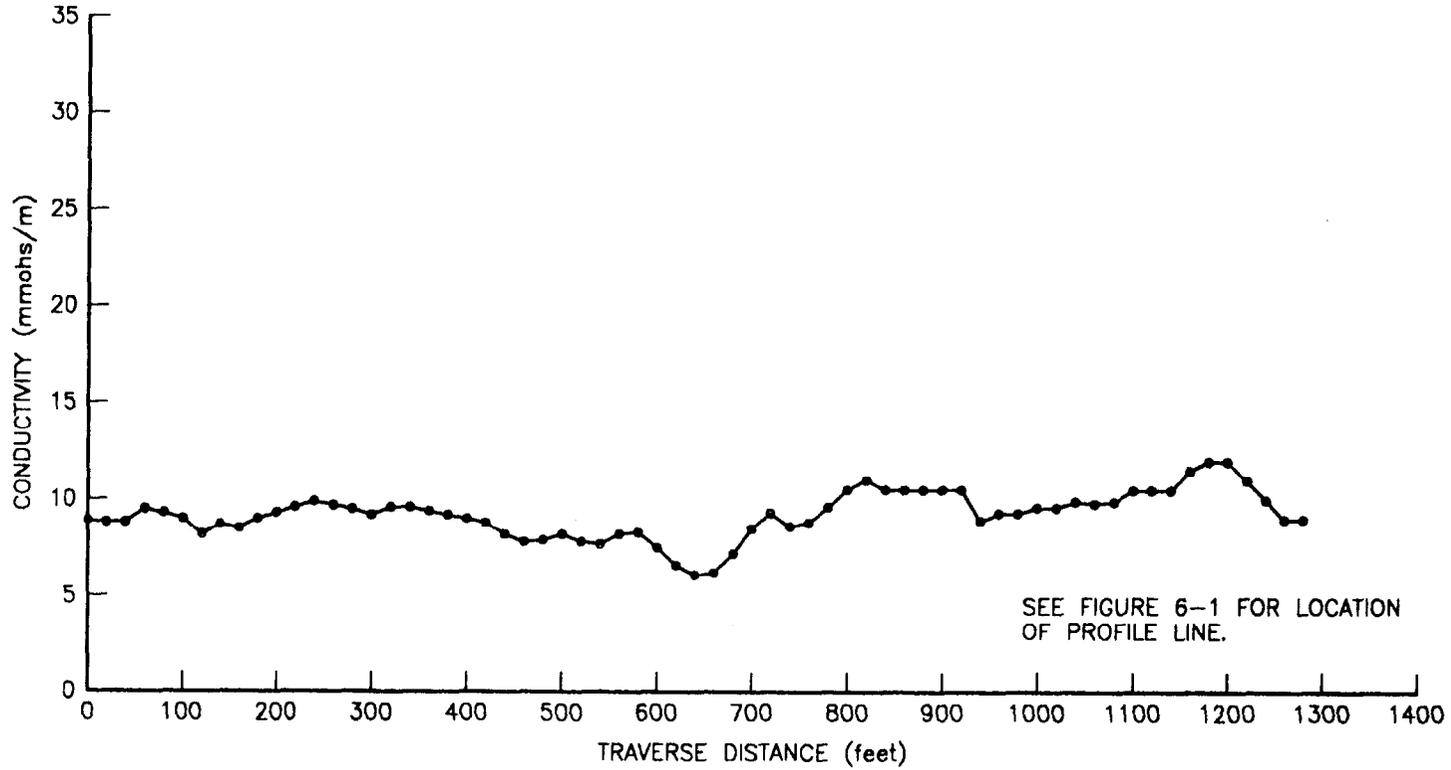
fig_6-1.dwg

| | | |
|-----------------|-------------------------|---|
| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: |
| CHKD: LBH | FIGURE NO.: | SITE 5 TERRAIN CONDUCTIVITY, MONITORING WELL, SOIL BORING, AND SURFACE SOIL SAMPLING LOCATIONS |
| DATE: 6-9-94 | 6-1 | |



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mmohs/m = millimohs per meter

fig_6-2.dwg

| | | |
|-----------------|-------------------------|--------|
| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: |
| CHKD: LBH | FIGURE NO.: 6-2 | |
| DATE: 6-9-94 | | |

GRAPH OF TERRAIN CONDUCTIVITY
 DATA COLLECTED FROM SITE 5
 FEBRUARY 1, 1992



RFI REPORT FOR
 SITES 5 & 16

NAVAL SUBMARINE BASE
 KINGS BAY, GEORGIA

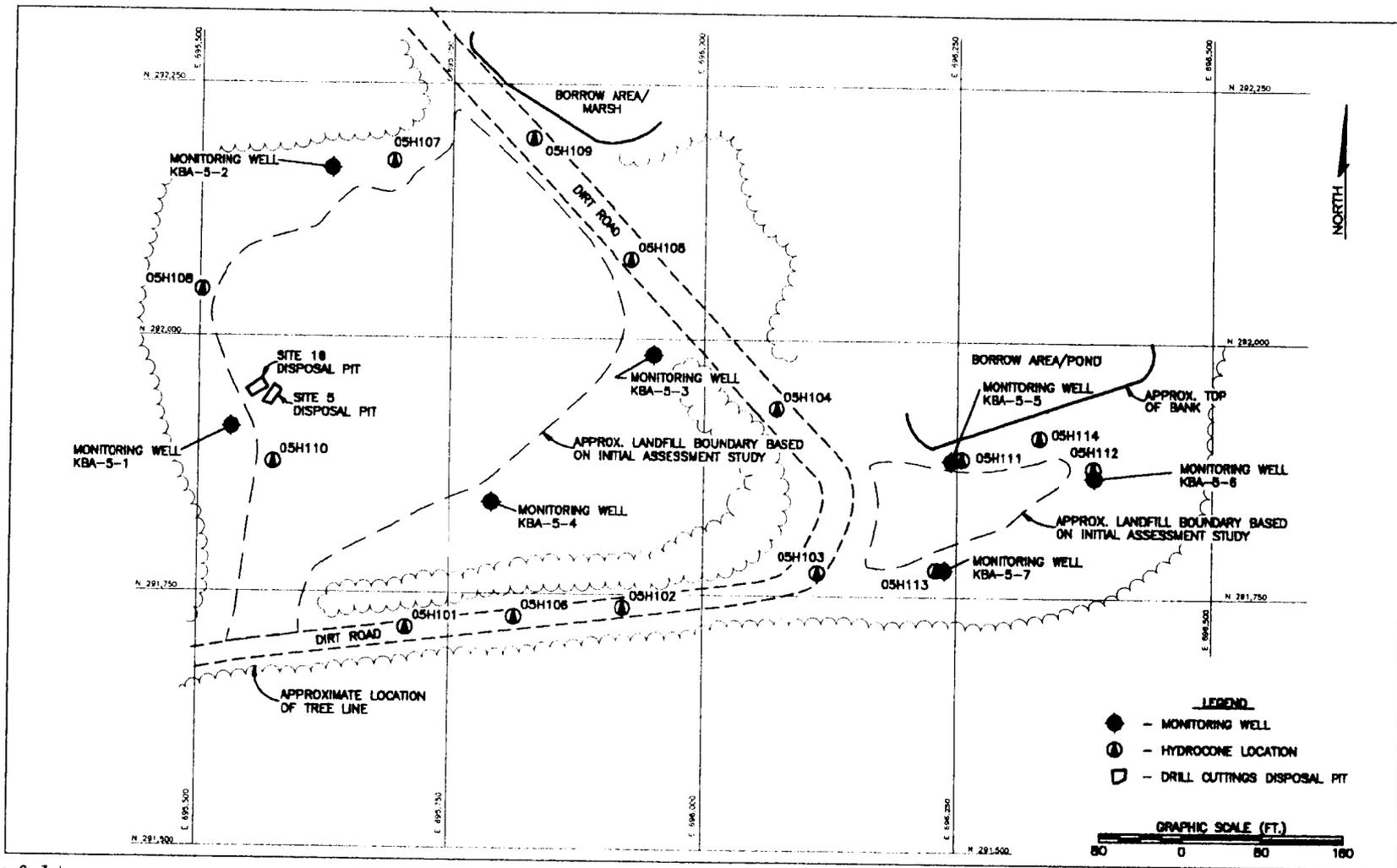
collected during the RFI investigation. The data in Appendix F are for all chemicals associated with each analytical method using during the RFI program. Appendix G contains analytical data tables that are derived from the tables in Appendix F. The data tables in Appendix G are summary tables listing validated analytical results for those analytes that were detected in one or more of the samples listed on a table. The summary tables in Appendix G were developed to provide a more manageable format, reducing the number of data points by eliminating analytes that were not detected in any of the samples listed on the table.

Upon opening each monitoring well, the headspace was screened for VOCs using a flame ionization detector or photoionization detector (PID). Before sample collection, each well was purged a minimum of three well volumes or until field parameters stabilized. Samples were collected within 24 hours following purging. Decontaminated Teflon™ bailers or a peristaltic pump with polyethylene tubing was used to purge the monitoring wells. Decontaminated Teflon™ bailers with nylon twine were used to collect the groundwater samples. For non-filtered samples, groundwater was transferred from the bailer directly into labeled sample containers. VOC samples were collected such that no headspace was present in the sample container. For inorganic samples requiring filtration, groundwater was pumped from the bailer through a 0.45-micron filter using a peristaltic pump with polyethylene tubing and then collected in a labeled sample container. Appropriate preservatives were added to the empty sample containers by the laboratory before delivery of the containers to the project site.

Following sample collection, field personnel checked pH values of an aliquot of all preserved samples except VOC samples. Samples for cyanide analysis were also checked for sulfide and chloride interference by testing an aliquot of the sample with lead acetate and potassium iodide test paper. Filled sample containers were placed in ice chests and packed with ice immediately after collection. Chain of custody was initiated in the field at the time of sample collection. Samples were shipped via overnight courier service to the laboratory on the date of collection. Field parameters recorded for groundwater samples included pH, conductivity, and temperature. These parameters were summarized for each of the six sampling rounds and are provided in Appendix H.

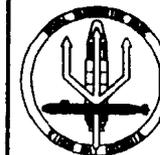
During November 13 through 16, 1992, groundwater samples were collected using a hydrocone sampler from 14 locations along the perimeter of the two suspected disposal areas comprising the site (Figure 6-3). The groundwater samples were collected at depths ranging from 15 to 38 feet bls. The hydrocone groundwater sampler consists of a telescoping assembly containing a 1-foot length of stainless steel well screen fitted with a cone tip. This assemblage was hydraulically advanced with a series of rods. When the screen was exposed by retracting the outer casing of the sample device, natural hydrostatic pressure forced groundwater to flow into the sample collection chamber. The sampler collects groundwater samples from a 1-foot interval. Samples were identified based on the upper limit of the sample interval.

The amount of groundwater entering the collection chamber was monitored by transducers and a computer on board the direct push vehicle. Argon back-pressure prevented volatilization of the sample during retrieval. The sample was held in the chamber for retrieval using argon gas back-pressure to impinge a small ball into its seat at the bottom of the sample collection chamber. The sample collection chamber and screen assemblage were lifted to the surface to recover the sample. To collect water from multiple intervals, the hole was re-entered



fig_6-3.dwg

| | | |
|--------|--------------|--|
| DWN: | PROJECT NO.: | TITLE: |
| DMF | 7553-09 | SITE 5 HYDROCONE SAMPLING LOCATIONS |
| CHKD: | FIGURE NO.: | |
| LBH | 6-3 | |
| DATE: | | |
| 5-6-94 | | |



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SITES 5 & 16

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with a clean sample collection chamber and screen assemblage and the hydrocone was advanced to the desired depth. Cross contamination was prevented by using O-rings to form water-tight seals above and below the sample chamber. A pressure transducer hooked up to a computer monitored the sample chamber for infiltration of water.

During sample collection, the rate of filling the 6.5-foot-long cylinder was recorded. These data were plotted with the computer to estimate permeability at specific intervals within the aquifer. The analysis was performed using Hvorslev's basic time lag method (Hvorslev, 1951). These permeability measurements are estimates and indicate the general magnitude of permeability for the interval tested. The results are presented in Appendix I.

All groundwater samples collected with the hydrocone were analyzed in the onsite laboratory for target VOCs including vinyl chloride, trans-1,2-dichloroethene, cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, benzene, toluene, ethylbenzene, m/p-xylene, and o-xylene. Four hydrocone groundwater samples, including one duplicate sample, were submitted to an offsite laboratory for confirmatory analysis. Offsite analysis included target compound list (TCL) VOCs using CLP methods. Hydrocone groundwater sampling was conducted at Sites 5 and 16 in conjunction with the investigation of VOC contamination at Site 11.

6.1.1.1 Volatile Organic Compounds in Groundwater VOC analytical results of the six bimonthly sampling events are summarized in Table 6-1. Tables 6-2 and 6-3 present all onsite and offsite laboratory data for hydrocone groundwater samples. Appendix G contains analytical summary tables for the six sample events. Appendix F contains validated data tables for all parameters analyzed during the RFI monitoring program. Because the data sets for the onsite and offsite analyses of groundwater samples collected using the hydrocone are small, all the data are presented in Tables 6-2 and 6-3.

Samples from five of seven groundwater monitoring wells contained detectable levels of VOCs, but only in samples collected during the first sampling event (February 1992). Four of six VOCs detected in groundwater samples from the site were detected in samples from upgradient monitoring wells and from release detection monitoring wells. Concentrations of acetone, carbon disulfide, 4-methyl-2-pentanone, and xylenes in upgradient groundwater samples ranged from 1 J $\mu\text{g/L}$ to 72 $\mu\text{g/L}$ (acetone). The "J" qualifier indicates the concentration is estimated because the concentration is below the PQL. Two VOCs, ethylbenzene and trichlorofluoromethane, were detected in downgradient groundwater samples only. Concentrations of VOCs detected in downgradient groundwater samples ranged from 1 J $\mu\text{g/L}$ to 7 $\mu\text{g/L}$.

VOCs were detected in groundwater samples collected during the first groundwater sampling event. No VOCs were detected in groundwater samples collected during the last five bimonthly sampling events. Carbon disulfide and acetone were detected in two groundwater samples collected using the hydrocone, 05H11137 and its replicate sample 05H11137D, at concentrations of 1 and 2 $\mu\text{g/L}$, and 15 J and 16 J, respectively. Carbon disulfide is a simple molecule that may be the result of biological activity involving naturally occurring organo-sulfur acids (Verschueren, 1983).

Xylenes and ethylbenzene are the only VOCs detected that are regulated under the SDWA. The MCL for xylenes is 10,000 $\mu\text{g/L}$ and the MCL for ethylbenzene is 700 $\mu\text{g/L}$. With the exception of acetone concentrations in an upgradient groundwater

Table 6-1
Summary of Volatile Organic Compound and Semivolatile Organic Compound
Analytical Data for Resource Conservation and Recovery Act Facility Investigation
Groundwater Monitoring Program at Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Monitoring Well I.D. | SVOCs Detected | VOCs Detected | Concentration (µg/L) | Associated Sample Events |
|----------------------|----------------------------|------------------------|----------------------|--------------------------|
| KBA-5-1 | | acetone | 72 | 1 |
| | | carbon disulfide | 2 J | 1 |
| KBA-5-2 | | carbon disulfide | 1 J | 1 |
| | | 4-methyl-2-pentanone | 3 J | 1 |
| | | xylene (total) | 4 J | 1 |
| | bis(2-ethylhexyl)phthalate | | 2 J | 2 |
| KBA-5-3 | | carbon disulfide | 2 J | 1 |
| KBA-5-4 | diethylphthalate | | 2 J | 1 |
| KBA-5-5 | | carbon disulfide | 1 J | 1 |
| | | 4-methyl-2-pentanone | 3 J | 1 |
| | | ethylbenzene | 1 J | 1 |
| | | xylene (total) | 6 | 1 |
| | bis(2-ethylhexyl)phthalate | | 18 | 2 |
| KBA-5-6 | | trichloroflouromethane | 7 | 1 |
| KBA-5-7 | | None | — | — |

Notes: I.D. = identification.
 SVOC = semivolatile organic compound.
 VOC = volatile organic compound.
 µg/L = micrograms per liter.
 J = estimated concentration.

Sources: ABB-ES, 1992a.
 ABB-ES, 1993a.
 ABB-ES, 1992b.
 ABB-ES, 1992c.
 ABB-ES, 1992e.

Table 6-2
Onsite Analytical Data for Hydrocone Groundwater Samples, Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compound ($\mu\text{g/L}$) | Sample Identification (05-) | | | | | | | | | | |
|------------------------------|-----------------------------|--------|--------|--------|--------|---------|--------|--------|---------|--------|--------|
| | H10118 | H10125 | H10215 | H10223 | H10230 | H10230D | H10315 | H10320 | H10325 | H10415 | H10423 |
| Vinyl chloride | 2 U | 2 U | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ |
| trans-1,2-Dichloroethene | 5 U | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ |
| cis-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Benzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Toluene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Ethylbenzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| m\p-Xylene | 10 UJ | 10 UJ | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| o-Xylene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Compound ($\mu\text{g/L}$) | Sample Identification (05-) | | | | | | | | | | |
| | H10431 | H10515 | H10520 | H10615 | H10622 | H10629 | H10715 | H10724 | H10724D | H10816 | H10823 |
| Vinyl chloride | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 UJ |
| trans-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| cis-1,2-Dichloroethene | 5 U | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 U |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Benzene | 5 U | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ |
| Toluene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 UJ |
| Ethylbenzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 UJ |
| m\p-Xylene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 UJ |
| o-Xylene | 5 U | 5 U | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 UJ |
| See notes at end of table. | | | | | | | | | | | |

Table 6-2 (Continued)
Onsite Analytical Data for Hydrocone Groundwater Samples, Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compound (µg/L) | Sample Identification (05-) | | | | | | | | | | |
|--------------------------|-----------------------------|--------|--------|--------|---------|--------|--------|--------|--------|--------|--------|
| | H10831 | H10931 | H11016 | H11022 | H11022D | H11028 | H11115 | H11122 | H11128 | H11137 | H11215 |
| Vinyl chloride | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 U | 2 UJ |
| trans-1,2-Dichloroethene | 5 U | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 U |
| cis-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 U |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Benzene | 5 UJ | 5 UJ | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 U | 5 U | 5 UJ | 5 UJ |
| Toluene | 5 UJ | 5 UJ | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 U | 5 U | 5 UJ | 5 UJ |
| Ethylbenzene | 5 UJ | 5 UJ | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 U | 5 U | 5 UJ | 5 UJ |
| m\p-Xylene | 10 UJ | 10 UJ | 10 U | 10 U | 10 U | 10 U | 10 UJ | 10 U | 10 U | 10 UJ | 10 UJ |
| o-Xylene | 5 UJ | 5 UJ | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 U | 5 U | 5 UJ | 5 UJ |

| Compound (µg/L) | Sample Identification (05-) | | | | | | | |
|--------------------------|-----------------------------|--------|--------|--------|--------|---------|--------|--------|
| | H11223 | H11231 | H11315 | H11321 | H11328 | H11328D | H11425 | H11430 |
| Vinyl chloride | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 UJ | 2 U | 2 U | 2 U |
| trans-1,2-Dichloroethene | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 UJ | 5 U | 5 U | 5 U |
| cis-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 UJ | 5 UJ |
| Benzene | 5 UJ | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Toluene | 5 UJ | 5 U | 5 U | 5 U | 5 UJ | 5 U | 5 U | 5 U |
| Ethylbenzene | 5 UJ | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| m\p-Xylene | 10 UJ | 10 U | 10 U | 10 U |
| o-Xylene | 5 UJ | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

Notes: µg/L = micrograms per liter.
 U = compound not detected at the stated quantitation limit.
 J = sample quantitation limit is considered estimated because an associated continuing calibration standard exceeded quality control limits.

Table 6-3
Offsite Laboratory Analytical Data for Hydrocone Groundwater Samples, Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | | Sample Location: | 05H10615 | 05H10622 | 05H11137 | 05H11137D |
|---------------------------|-----|------------------|----------|----------|----------|-----------|
| | | Lab Number: | 34424001 | 34424003 | 34437005 | 34437006 |
| | | Date Sampled: | 11/14/92 | 11/14/92 | 11/16/92 | 11/16/92 |
| | | Date Analyzed: | 11/19/92 | 11/19/92 | 11/27/92 | 11/27/92 |
| | | Dilution Factor: | 1.0 | 1.0 | 1.0 | 1.0 |
| ANALYTE | PQL | | | | | |
| Chloromethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Bromomethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Vinyl chloride | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Chloroethane | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Methylene chloride | 10 | 10 U | 10 U | 10 U | 10 U | 10 U |
| Acetone | 5 | 7 U | 7 U | 15 J | 16 J | |
| Carbon disulfide | 1 | 1 U | 1 U | 1 | 2 | |
| 1,1-Dichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | |
| 1,1-Dichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | |
| cis-1,2-Dichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | |
| trans-1,2-Dichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | |
| Chloroform | 1 | 1 U | 1 U | 1 U | 1 U | |
| 1,2-Dichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | |
| 2-Butanone | 5 | 5 U | 5 U | 5 U | 5 U | |
| 1,1,1-Trichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | |
| Carbon tetrachloride | 1 | 1 U | 1 U | 1 U | 1 U | |
| Bromodichloromethane | 1 | 1 U | 1 U | 1 U | 1 U | |
| 1,2-Dichloropropane | 1 | 1 U | 1 U | 1 U | 1 U | |
| cis-1,3-Dichloropropene | 1 | 1 U | 1 U | 1 U | 1 U | |
| Trichloroethene | 1 | 1 U | 1 U | 1 U | 1 U | |
| Dibromochloromethane | 1 | 1 U | 1 U | 1 U | 1 U | |
| 1,1,2-Trichloroethane | 1 | 1 U | 1 U | 1 U | 1 U | |
| Benzene | 1 | 1 U | 1 U | 1 U | 1 U | |
| trans-1,3-Dichloropropene | 1 | 1 U | 1 U | 1 U | 1 U | |
| Bromoform | 1 | 1 U | 1 U | 1 U | 1 U | |
| 2-Hexanone | 5 | 5 U | 5 U | 5 U | 5 U | |
| 4-Methyl-2-pentanone | 5 | 5 U | 5 U | 5 U | 5 U | |
| Tetrachloroethene | 1 | 1 U | 1 U | 1 U | 1 U | |
| 1,1,2,2-Tetrachloroethane | 1 | 1 U | 1 U | 1 U | 1 U | |

See notes at end of table.

Table 6-3 (Continued)
Offsite Laboratory Analytical Data for Hydrocone Groundwater Samples, Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | | Sample Location: | 05H10615 | 05H10622 | 05H11137 | 05H11137D |
|---------------------|-----|--|----------|----------|----------|-----------|
| | | Lab Number: | 34424001 | 34424003 | 34437005 | 34437006 |
| | | Date Sampled: | 11/14/92 | 11/14/92 | 11/16/92 | 11/16/92 |
| | | Date Analyzed: | 11/19/92 | 11/19/92 | 11/27/92 | 11/27/92 |
| | | Dilution Factor: | 1.0 | 1.0 | 1.0 | 1.0 |
| ANALYTE | PQL | | | | | |
| Toluene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Chlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Ethylbenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Styrene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Xylene (total) | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,3-Dichlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,4-Dichlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| 1,2-Dichlorobenzene | 1 | 1 U | 1 U | 1 U | 1 U | 1 U |
| Notes: | PQL | = practical quantitation limit. | | | | |
| | U | = compound not detected at the stated quantitation limit. | | | | |
| | J | = concentration qualified as estimated because the continuing calibration contained compounds with percent differences greater than 25 percent but less than 50 percent. | | | | |

sample and two groundwater samples collected with the hydrocone, all VOCs detected were measured at concentrations of 7 µg/L or less. For the most part, concentrations were below the reporting limits and near the instrument detection limit for the compounds.

Acetone is a common laboratory solvent that was detected in all groundwater samples collected during the first sampling event, but was qualified as undetected in seven of eight samples because of concentrations in associated method blanks. The concentration reported for the groundwater sample from KBA-5-1 was more than 10 times the concentration in the associated method blank, but was less than 10 times the concentration of acetone found in method blanks associated with other samples collected during the sample event. Detection of acetone as a result of sampling and analytical procedures was evaluated using the VOC data in Appendix F for trip blanks, equipment rinsates, and field blanks. These data can be found in Appendix F grouped with each sampling event. Table 6-4 summarizes acetone concentrations detected in the quality control samples associated with the RFI program at Sites 5 and 16. Eleven quality control samples contained acetone at concentrations ranging from 5 J to 280 µg/L. Four other quality control samples contained acetone concentrations that were qualified as not detected during data validation. The concentrations of acetone ranged from 12 to 100 µg/L, but were less than 10 times the concentration of acetone in associated method blanks.

Table 6-4
Summary of Acetone Concentrations in Quality Control Samples

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Sample Type | Number of Detections | Concentration Range (µg/L) | Sample Identifications |
|-------------------|-------------------------|-------------------------------|--|
| Trip Blank | 5 | 5 J to 70 | BT-10-FB, BT-11-FB, BT-25-FB, BT-26-FB, and BT-32-FB |
| Equipment Rinsate | 2 | 280 and 6 J | BS-14-ER and BS-26-ER |
| Field Blanks | 4 | 6 J to 35 J | BS-4-FB, BS-10-FB, BS-12-FB, and BS-21-FB |

Notes: µg/L = micrograms per liter.
J = estimated values.

6.1.1.2 Semivolatile Organic Compounds in Groundwater Groundwater samples were collected for SVOC analysis during the first and second sampling events. Except for phthalates, detected in groundwater samples from three sample locations, no SVOCs were detected in groundwater samples from Site 5.

The SVOCs bis(2-ethylhexyl)phthalate and diethylphthalate were detected in groundwater samples from monitoring wells KBA-5-2, KBA-5-4, and KBA-5-5. These SVOCs were detected in one groundwater sample from each of these wells. Concentrations were 2 J µg/L and 18 µg/L. However, the duplicate sample from monitoring well KBA-5-5 did not contain detectable concentrations of bis(2-ethylhexyl)phthalate. The presence of this compound in groundwater samples from the site may be a sampling or laboratory artifact. Phthalates are easily introduced into sample media by items such as gloves, plastic tubing, sample containers, or other materials having plastic components.

6.1.1.3 Pesticides, Herbicides, Polychlorinated Biphenyls, Dioxins, and Furans in Groundwater Groundwater samples from the first two sampling events at Site 5 were analyzed for Appendix IX pesticides, herbicides, dioxins, and furans. These types of compounds were not detected in groundwater samples from the site. PCBs were analyzed in groundwater samples from six sampling events because a surface soil sample collected during the initial field program in January and February of 1992 contained the PCB Aroclor-1260 at a concentration of 53 $\mu\text{g}/\text{kg}$. Additional soil samples collected from the site in July 1992 indicated that PCB concentrations in surface soils were significantly lower at less than 14 $\mu\text{g}/\text{kg}$. No PCBs were detected in groundwater samples collected from the site. PCBs are basically insoluble in water and the low concentrations detected in site soils do not warrant concern regarding groundwater contamination.

6.1.1.4 Inorganic Constituents in Groundwater Table 6-5 lists inorganic constituents detected in groundwater samples from Site 5. Also listed in Table 6-5 are the frequencies of detection, associated monitoring wells, and range of concentrations detected for each constituent. Appendix F contains validated analytical results for all inorganic analyses associated with groundwater and QA/QC samples collected during the RFI program. Appendix G contains data tables derived from the comprehensive tables in Appendix F. The summary tables list data for analytes that were detected in one or more groundwater samples referenced on the table, but does not list data for analytes that were not detected in any of the groundwater samples. Appendix J presents inorganic data for groundwater samples collected at Site 5 during the six sampling events. Data is presented in bar chart form for 11 inorganic constituents regulated under the SDWA.

Water level data collected from the seven monitoring wells at Site 5 during the July 1992 monitoring event indicated divergent groundwater flow (flow to the northwest in the western part of the site and to the southeast in the eastern part of the site). None of the monitoring wells are upgradient of the site based on the water table contour map for July 1992 (Appendix B). The water level data and water table contour maps for the other five sample events indicated that monitoring wells KBA-5-1 and KBA-5-2 could provide groundwater data representative of conditions upgradient of the site. Additional investigation will be needed to establish a background data set for the site. The existing data set for monitoring wells KBA-5-1 and KBA-5-2, excluding data associated with the July 1992 sampling event, was used for statistical comparisons to data from the other five detection monitoring wells. Because background data are not available, the observations presented in this subsection will need to be reassessed after additional information is obtained.

Probability plots were generated for the sample data to ascertain whether the normal or the log normal distribution better describes the data. In a probability plot, data plotted along a straight line indicate that the data can be explained by the normal distribution (for a normal probability plot). Log-transformed data were also plotted on a normal probability plot. Probability plots indicated that the data were better described by a log normal distribution.

Because the data are better described by the log normal distribution, the unfiltered data were log-transformed before statistical analyses were performed. The method used to determine if there are significant differences between monitoring well inorganic data and that of the upgradient wells is the Analysis of Variance (ANOVA) procedure. This procedure was used to determine if there is

**Table 6-5
Summary of Inorganic Analytical Data for Resource Conservation and
Recovery Act Facility Investigation Groundwater Monitoring Program for Site 5**

*Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia*

| Constituent | MCL ($\mu\text{g/L}$) | Frequency of Detection ¹ | Associated Monitoring Wells | Concentration Range ($\mu\text{g/L}$) | Frequency Above MCL ² |
|-------------|----------------------------|--|--|--|-------------------------------------|
| Antimony | 6 | 5/42 | KBA-5-4 KBA-5-5 KBA-5-6 KBA-5-7 | 11.3 J to 17.0 J | 5/5 |
| Arsenic | 50 | 42/42 | All | 2.8 J to 135 | 2/42 |
| Barium | 2,000 | 42/42 | All | 35.0 J to 1,080 | 0/42 |
| Beryllium | 4 | 35/42 | All | 0.24 J to 8.2 | 4/35 |
| Cadmium | 5 | 15/42 | All | 1.3 J to 27.4 | 5/15 |
| Chromium | 100 | 42/42 | All | 4.2 J to 271 | 7/42 |
| Cobalt | NA | 31/42 | All | 3.2 J to 62.6 J | NA |
| Copper | 1,300 | 41/42 | All | 4.3 J to 249 | 0/41 |
| Lead | 15 | 40/42 | All | 1.7 J to 68.9 | 10/40 |
| Mercury | 2 | 11/42 | All | 0.12 J to 0.51 | 0/11 |
| Nickel | 100 | 26/42 | All | 5.9 J to 128 | 2/26 |
| Selenium | 50 | 13/42 | All | 1.4 J to 6.3 | 0/13 |
| Silver | NA | 4/42 | KBA-5-1 KBA-5-4 KBA-5-6 KBA-5-7 | 1.6 J to 4.5 J | NA |
| Thallium | 2 | 8/42 | KBA-5-1 KBA-5-3 KBA-5-4 KBA-5-5 KBA-5-6 KBA-5-7 | 1.0 J to 3.4 J | 3/8 |
| Tin | NA | 2/42 | KBA-5-3 KBA-5-4 | 232 to 702 J | NA |
| Vanadium | NA | 40/42 | All | 3.9 J to 251 | NA |
| Zinc | NA | 42/42 | All | 23.2 to 519 | NA |
| Cyanide | 200 | 9/42 | KBA-5-4 KBA-5-5 KBA-5-6 KBA-5-7 | 1.1 J to 10.3 | 0/9 |
| Sulfide | NA | 32/42 | All | 100 to 2,100 | NA |

See notes at end of table.

Table 6-5 (Continued)
**Summary of Inorganic Analytical Data for Resource Conservation and
Recovery Act Facility Investigation Groundwater Monitoring Program for Site 5**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

¹ Number of sample locations where constituent was detected per total number of locations sampled.

² Number of sample locations where constituent concentration exceeded the MCL per number of sample locations where constituent was detected.

Notes: MCL = maximum contaminant level for drinking water (GA DNR, 1993; USEPA, 1993).
μg/L = micrograms per liter.
J = estimated value.
NA = not applicable.

an overall difference between inorganic concentrations between wells. Additionally, post-hoc analyses were employed to test for significant differences between inorganic concentrations observed at each individual well and with those observed at the upgradient wells. The procedure recommended for this analysis, derived from the USEPA (1989b) guidance document *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance*, is Bonferroni's pairwise comparison procedure (or Scheffe's for greater than five wells). The significance level for the test procedures was set at 5 percent (alpha equals 0.05).

For the purposes of this analysis, the data from the upgradient wells were combined and considered as a single well for the comparisons. Upgradient data from the July 1992 sampling event were not used in the analyses because of divergent groundwater flow during the sample event.

Table 6-6 presents the results from the comparison of the unfiltered inorganic data for monitoring wells KBA-5-3 through KBA-5-7 versus unfiltered inorganic data for monitoring wells KBA-5-1 and KBA-5-2. Scheffe's pairwise comparison procedure was used because there are more than five wells in the comparison. At the 0.05 significance level, the ANOVA procedure testing for overall differences between all wells yielded significant differences for cadmium and cyanide. Additionally, statistical results indicate marginal significance for arsenic, but no significant individual well differences were found. Scheffe's post-hoc procedure indicated that the cause of the ANOVA difference for cadmium was due to significant differences between both KBA-5-6 and KBA-5-7 and the upgradient cadmium concentrations. Cyanide difference was due to KBA-5-4.

Groundwater inorganic data from the site were compared to MCLs (see Table 6-5). Antimony was reported at estimated concentrations below the CRQL of 60 $\mu\text{g/L}$ on five occasions. On all occasions, reported concentrations were above the MCL of 6 $\mu\text{g/L}$. Seven other inorganic constituents were detected in unfiltered samples at concentrations above MCLs, including arsenic, beryllium, cadmium, chromium, lead, nickel, and thallium. Excluding antimony, in all cases where MCLs were exceeded, it occurred during the first three sampling events.

Comparison of filtered and unfiltered inorganic data suggests that suspended solids in groundwater samples can contribute to the concentrations of inorganic analytes. TDS and TSS were analyzed in groundwater samples collected during the last four monitoring events. These data were used to calculate percentages of suspended solids in unfiltered groundwater samples. Overall, percentage of solids in groundwater samples collected from the site ranged from 3 to 93 percent.

6.1.2 Soil Contamination Eight subsurface soil samples and eight surface soil samples were collected from Site 5 for analysis of Appendix IX constituents. An additional eight surface soil samples were collected for analysis of PCBs.

Figure 6-1 shows locations where subsurface soil and surface soil samples were collected. Table 6-7 summarizes analytical data for the soil samples collected from the site.

Borings were drilled using a Central Mining Equipment 45 drill rig equipped with 8-inch, outside diameter, hollow-stem augers. Each boring was initiated with post-hole diggers as a precautionary measure in case of unidentified utilities

Table 6-6
Statistical Results from Comparison of Log-Transformed Unfiltered Groundwater Data, Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Analyte | ANOVA Significance Level | Scheffe's Pairwise Comparison Significance Level | Significant Difference? |
|-----------|-----------------------------|---|--|
| Antimony | 0.548 | | No significant differences |
| Arsenic | 0.053 | | ANOVA marginal, No significant differences |
| Barium | 0.946 | | No significant differences |
| Beryllium | 0.806 | | No significant differences |
| Cadmium | 0.0007 | KBA-5-7: 0.019 KBA-5-6: 0.039 | ANOVA significant; both KBA-5-7 and KBA-5-6 significant. |
| Chromium | 0.822 | | No significant differences |
| Cobalt | 0.958 | | No significant differences |
| Copper | 0.901 | | No significant differences |
| Cyanide | 0.006 | KBA-5-4: 0.027 | ANOVA significant; KBA-5-4 significant |
| Lead | 0.725 | | No significant differences |
| Mercury | 0.781 | | No significant differences |
| Nickel | 0.843 | | No significant differences |
| Selenium | 0.946 | | No significant differences |
| Silver | 0.703 | | No significant differences |
| Sulfide | 0.643 | | No significant differences |
| Thallium | 0.441 | | No significant differences |
| Tin | 0.789 | | No significant differences |
| Vanadium | 0.581 | | No significant differences |
| Zinc | 0.313 | | No significant differences |

Note: ANOVA = analysis of variance.

Table 6-7
Summary of Laboratory Analyses of Surface and Subsurface Soil Samples Collected from Site 5^{1,2}

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compounds Detected | 05- PQL | SB-01 4 to 6 (feet) | SB-02 4 to 6 (feet) | SB-02D 4 to 6 (feet) | SB-03 4 to 6 (feet) | SB-04 4 to 6 (feet) | SB-05 4 to 6 (feet) | SB-06 4 to 6 (feet) | SB-07 4 to 6 (feet) |
|---|-------------------|---------------------------|---------------------------|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| APPENDIX IX VOCs (µg/kg) | | | | | | | | | |
| Methylene chloride | 5 | 20 U | 43 U | 16 U | 27 U | 37 U | 36 U | 90 | 74 |
| Acetone | 10 | 100 | 95 U | 35 U | 22 U | 180 | 170 | 460 | 7,900 |
| Carbon disulfide | 5 | 6 U | 6 U | 6 U | 6 U | 7 U | 7 U | 7 | 32 U |
| Toluene ³ | 5 | 6 U | 6 U | 6 U | 6 U | 7 U | 7 U | 4 J | 32 U |
| Xylene (total) ³ | 5 | 3 J | 3 J | 6 U | 3 J | 3 J | 9 | 15 | 20 |
| APPENDIX IX SVOCs (µg/kg) | | | | | | | | | |
| bis(2-Ethylhexyl)phthalate ³ | 330 | 410 | 590 | 360 | 450 | 270 J | 300 J | 360 | 720 |
| Benzoic Acid ³ | 1,600 | 2,000 U | 2,000 U | 2,000 U | 2,000 U | 2,100 U | 2,100 U | 210 J | 2,200 U |
| APPENDIX IX Inorganics (mg/kg) | | | | | | | | | |
| | CRDL ⁴ | | | | | | | | |
| Arsenic ³ | 2 | 1.1 J | 0.24 J | 0.17 U | 0.70 J | 1.0 J | 0.17 U | 0.17 U | 0.19 U |
| Barium ³ | 40 | 2.8 J | 5.0 J | 5.3 J | 3.6 J | 2.8 J | 3.6 J | 3.5 J | 4.9 J |
| Beryllium ³ | 1 | 0.16 J | 0.05 J | 0.07 J | 0.15 J | 0.15 J | 0.15 J | 0.05 U | 0.15 J |
| Chromium | 2 | 8.7 | 6.5 | 6.0 | 6.5 | 5.9 | 5.9 | 2.4 U | 6.8 |
| Copper | 5 | 2.0 U | 2.3 U | 1.6 U | 1.8 U | 3.4 U | 2.5 U | 1.4 U | 7.8 |
| Lead | 0.6 | 4.4 | 2.7 | 3.2 | 2.7 | 6.0 | 8.5 | 4.5 | 7.6 |
| Nickel ³ | 8 | 1.7 J | 0.98 J | 0.98 J | 1.5 J | 2.8 J | 1.7 J | 0.91 U | 9.2 |
| Selenium ³ | 1 | 0.93 J | 0.71 J | 0.33 J | 1.3 | 0.86 J | 0.40 J | 0.31 U | 1.8 |
| Vanadium ³ | 10 | 8.5 J | 2.2 U | 2.2 U | 3.4 J | 1.6 U | 2.1 U | 2.0 U | 2.8 J |
| Zinc | 4 | 6.7 | 3.3 U | 3.7 U | 2.8 U | 7.4 | 3.1 U | 4.7 U | 10.1 |
| Cyanide | 1 | 0.45 U | 0.44 U | 0.45 U | 0.44 U | 0.46 U | 4.6 | 0.43 U | 5.0 |
| See notes at end of table. | | | | | | | | | |

Table 6-7 (Continued)
Summary of Laboratory Analyses of Surface and Subsurface Soil Samples Collected from Site 5^{1,2}

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compounds Detected | 05- PQL | SS-01 1.6 to 2.0 (feet) | SS-02 1.5 to 1.9 (feet) | SS-03 2.1 to 2.5 (feet) | SS-03D 2.1 to 2.7 (feet) | SS-04 1.8 to 2.5 (feet) | SS-05 0.8 to 1.2 (feet) | SS-06 1.2 to 1.9 (feet) | SS-07 1.4 to 1.7 (feet) |
|--|------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| APPENDIX IX VOCs (µg/kg) | | | | | | | | | |
| Methylene chloride ⁵ | 5 | 31 U | 110 J | 1,100 U | 1,300 U | 35 U | 100 J | 41 U | 72 U |
| Acetone ⁵ | 10 | 28 U | 41 U | 12,000 | 17,000 | 71 U | 10 UJ | 10 U | 160 J |
| Carbon disulfide ⁵ | 5 | 6 U | 21 J | 790 U | 800 U | 6 U | 24 J | 6 | 14 J |
| Trichlorofluoromethane ⁵ | 5 | 6 U | 3 J | 790 U | 800 U | 6 U | 6 UJ | 5 U | 6 U |
| Toluene ^{3,5} | 5 | 6 U | 5 J | 790 U | 800 U | 6 U | 4 J | 1 J | 6 J |
| Xylene (total) ⁵ | 5 | 6 | 11 J | 790 U | 800 U | 10 | 21 J | 10 | 11 J |
| APPENDIX IX SVOCs (µg/kg) | | | | | | | | | |
| 3- and 4- Methylphenol ³ | 330 | 380 U | 380 U | 430 U | 430 U | 380 U | 380 U | 370 U | 82 J |
| Benzoic Acid ³ | 1,600 | 1,900 U | 1,800 U | 2,100 U | 2,100 U | 1,900 U | 660 J | 1,800 U | 460 J |
| Naphthalene ³ | 330 | 380 U | 380 U | 430 U | 430 U | 380 U | 380 U | 370 U | 44 J |
| Diethylphthalate ³ | 330 | 69 J | 380 U | 430 U | 430 U | 380 U | 380 U | 370 U | 370 U |
| bis(2-Ethylhexyl)Phthalate ³ | 330 | 53 J | 260 J | 790 | 710 J | 280 J | 210 J | 100 J | 160 J |
| APPENDIX IX Pesticides and PCBs (µg/kg) | | | | | | | | | |
| 4,4'-Dichlorodiphenyldichloroethylene ³ | 3.3 | 0.9 U | 0.7 J | 1.0 U | 1.0 U | 0.9 U | 0.9 U | 0.9 U | 0.9 U |
| Aroclor 1260 | 33 | 9 U | 53 | 10 U | 10 U | 9 U | 9 U | 9 U | 9 U |
| Compound Detected | 05- PQL | SS-08 1.2 to 2.0 (feet) | SS-08D 1.2 to 2.0 (feet) | SS-09 1.0 to 2.0 (feet) | SS-10 1.5 to 2.0 (feet) | SS-11 1.5 to 2.0 (feet) | SS-12 1.0 to 1.5 (feet) | SS-13 1.0 to 1.5 (feet) | SS-14 0.5 to 1.0 (feet) |
| Aroclor 1260 ³ | 33 | 8.7 J | 14 J | 39 U | 40 U | 39 U | 37 U | 4.4 J | 7.9 J |
| See notes at end of table. | | | | | | | | | |

Table 6-7 (Continued)
Summary of Laboratory Analyses of Surface and Subsurface Soil Samples Collected from Site 5^{1,2}

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compounds Detected | 05- CRDL ⁴ | SS-01 1.6 - 2.0 (feet) | SS-02 1.5 - 1.9 (feet) | SS-03 2.1 - 2.5 (feet) | SS-03D 2.1 - 2.7 (feet) | SS-04 1.8 - 2.5 (feet) | SS-05 0.8 - 1.2 (feet) | SS-06 1.2 - 1.9 (feet) | SS-07 1.4 - 1.7 (feet) |
|---------------------------------------|--------------------------|------------------------------|------------------------------|------------------------------|-------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| APPENDIX IX Inorganics (mg/kg) | | | | | | | | | |
| Barium ³ | 40 | 2.7 J | 8.0 J | 3.0 J | 3.0 J | 2.5 J | 4.3 J | 3.6 J | 2.8 J |
| Beryllium ³ | 1 | 0.07 J | 0.05 J | 0.15 J | 0.11 J | 0.04 U | 0.05 J | 0.04 J | 0.04 U |
| Chromium | 2 | 4.6 | 3.0 | 6.2 | 6.1 | 2.9 | 2.9 | 3.1 | 2.3 |
| Lead ³ | 0.6 | 5.4 | 6.4 | 5.3 | 5.5 | 4.1 | 4.7 | 4.0 | 3.3 |
| Vanadium ³ | 10 | 2.9 J | 2.6 J | 3.4 J | 3.2 J | 1.2 J | 2.7 J | 3.5 J | 2.1 J |
| Zinc | 4 | 15.8 | 31.0 | 15.9 | 11.9 | 5.0 | 4.8 | 8.8 | 4.1 J |
| Sulfide | 4,000 | 4,600 U | 4,700 U | 5,200 U | 5,100 | 4,600 | 4,600 U | 4,400 U | 4,600 U |

¹ No Appendix IX pesticides, polychlorinated biphenyl (PCBs), herbicides, dioxins, or furans were detected in subsurface soil samples at this site.

² No Appendix IX herbicides, dioxins, or furans were detected in surface soil samples at this site.

Data Qualifiers

³ Sample results flagged J as estimated because concentrations are less than the quantitation limit.

⁴ The contract required detection limits (CRDLs) listed for inorganic analytes are from the Contract Laboratory Program (CLP) because SW-846 analytical data are reported using CLP protocol when analyses are conducted at a CLP laboratory. This protocol results in qualification of values as estimated when the values are greater than the method detection limit but less than the CLP CRDL. The SW-846 methods do not specify quantitation limits for inorganic data.

⁵ Sample results for 05-SS-02 and 05-SS-07 flagged J as estimated and sample results for 05-SS-05 flagged J and UJ as estimated because surrogate recoveries were below QC limits.

Notes: PQL = practical quantitation limit.
 VOC = volatile organic compound.
 µg/kg = micrograms per kilogram.
 U = not detected.
 J = estimated value.
 SVOC = semivolatile organic compound.
 mg/kg = milligrams per kilogram.
 CRDL = contract required detection limit.
 PCB = polychlorinated biphenyl.

at the drilling location. Split-spoon samples were collected continuously at 2-foot intervals in each borehole. Each split-spoon sample was screened for VOCs with a PID. VOC screening data were recorded on field boring logs. Split-spoon samples were logged at each drilling location by a geologist. Information recorded on field logs was used to create the Geotechnical Graphics System™ logs in Appendix A.

The split-spoon sample from the interval above the groundwater table was collected, placed in sample jars, and submitted to the laboratory for analysis of Appendix IX parameters. One sample per boring, plus a duplicate sample, were analyzed by the laboratory. Field QC samples included a field duplicate, an MS/MSD, seven trip blanks, seven equipment rinsate samples, and three field blanks.

During February 1992, seven surface soil samples and a duplicate sample were collected at Site 5 using a hand auger (see Figure 6-1). Sample depths ranged from 0.8 to 2.7 feet bls. Samples were selected below intervals where changes in soil characteristics indicated the original surface of the landfill. Four samples were collected from locations where magnetic anomalies had been identified. These four samples (05-SS-01 through 05-SS-04) were collected from the 7-acre part of Site 5. Three other surface soil samples (05-SS-05 through 05-SS-07) were collected from the 1.5-acre part of Site 5. Locations for these three samples were arbitrarily selected because no magnetic anomalies were identified in that area of the site. Analyses of the seven surface soil samples and associated QC samples included Appendix IX parameters. QC samples included one duplicate sample, an MS/MSD, one equipment rinsate, and one trip blank.

Appendix F contains validated data for all analyses associated with surface and subsurface soil samples. Table 6-7 summarizes analytical data presented in Appendix F for analytes detected in soil samples from Site 5.

6.1.2.1 Volatile Organic Compounds in Soil The VOCs methylene chloride, acetone, carbon disulfide, toluene, and xylene were detected in both subsurface and surface soil samples at the site. Trichlorofluoromethane was also detected in one surface soil sample.

Methylene chloride and acetone are common laboratory contaminants detected in all eight surface soil samples and all eight subsurface soil samples. Concentrations of methylene chloride were qualified as undetected in six surface soil samples and six subsurface soil samples because of concentrations present in associated method blanks. Acetone was qualified as undetected in five surface soil samples and three subsurface soil samples because of concentrations in associated method blanks.

Methylene chloride concentrations for surface soil samples 05-SS-02 and 05-SS-05 and subsurface soil samples 05-SB-06 and 05-SB-07, ranged from 74 $\mu\text{g}/\text{kg}$ to 110 J $\mu\text{g}/\text{kg}$. Although these concentrations are more than 10 times the concentration in associated method blanks, other method blanks associated with soil samples from Site 5 contained concentrations of methylene chloride ranging from 7 to 330 $\mu\text{g}/\text{kg}$. This suggests that the concentrations reported for samples 05-SS-02, 05-SS-05, 05-SB-06, and 05-SB-07 are most likely laboratory artifacts. Additionally, the subsurface soil samples were collected from a 2-foot interval immediately above the water table, and a water-soluble compound such as methylene chloride found in soil at this interval should also be present in groundwater.

Groundwater VOC data for this site do not confirm the presence of methylene chloride in subsurface soil.

Acetone concentrations for surface soil samples 05-SS-03 and 05-SS-03D were reported to be 12,000 $\mu\text{g}/\text{kg}$ and 17,000 $\mu\text{g}/\text{kg}$, respectively, and 7,900 $\mu\text{g}/\text{kg}$ for subsurface soil sample 05-SB-07. The acetone concentrations in method blanks associated with the surface soil and subsurface soil samples were reported to be 770 $\mu\text{g}/\text{kg}$ and 6 J $\mu\text{g}/\text{kg}$, respectively. The apparent high levels of acetone reported for surface and subsurface soil samples referenced in this paragraph are considered artificially elevated because the analysis of these samples used procedures for medium level VOC concentrations. The Appendix IX VOC data for these samples do not indicate that medium level analyses were required to measure the concentrations detected. It is suspected that tentatively identified compounds could have interfered with low level analyses of these two samples. The reported detection limits for VOC analytes associated with the two surface soil samples are elevated because of analysis using medium concentration procedures.

Acetone was detected in surface soil sample 05-SS-07 and subsurface soil samples 05-SB-01, 05-SB-04, 05-SB-05, and 05-SB-06 at concentrations ranging from 100 to 460 $\mu\text{g}/\text{kg}$. These concentrations were more than 10 times the concentration of acetone in associated method blanks. However, acetone was found in other method blanks at concentrations ranging from 6 J $\mu\text{g}/\text{kg}$ to 770 $\mu\text{g}/\text{kg}$, which suggests the concentrations reported for these soil samples could be attributed to laboratory artifacts. Similar to methylene chloride, acetone is highly soluble in water and groundwater data from the site does not confirm its presence in subsurface soil from the 2-foot interval above the water table.

Toluene and xylene are fuel-related VOCs detected in surface and subsurface soil samples at concentrations ranging from 1 J to 6 J $\mu\text{g}/\text{kg}$, and 3 J $\mu\text{g}/\text{kg}$ to 21 J $\mu\text{g}/\text{kg}$, respectively. Toluene is also a common laboratory solvent. Toluene was detected in four surface soil samples, 05-SS-02, 05-SS-05, 05-SS-06, and 05-SS-07, and one subsurface soil sample, 05-SB-06. Xylene was detected in six surface soil samples, 05-SS-01, 05-SS-02, 05-SS-04, 05-SS-05, 05-SS-06, and 05-SS-07, and in all but one subsurface soil sample. The presence of low concentrations of fuel-related VOCs could be attributed to deposition of exhaust from vehicles used at the site and/or the use of fuel to ignite wastes disposed at the site.

Carbon disulfide was detected in four surface soil samples, 05-SS-02, 05-SS-05, 05-SS-06, and 05-SS-07, and one subsurface soil sample, 05-SB-06, at concentrations ranging from 6 $\mu\text{g}/\text{kg}$ to 24 J $\mu\text{g}/\text{kg}$. This compound was also detected in four groundwater samples from Site 5. Carbon disulfide is a simple molecule that can result from biological activity involving naturally occurring organo-sulfur acids (Verschueren, 1983). Its presence at the site is not considered related to waste disposal.

Trichlorofluoromethane was detected in one surface soil sample, 05-SS-02, at an estimated concentration of 3 J $\mu\text{g}/\text{kg}$. This measurement is below the reporting limit of 5 $\mu\text{g}/\text{kg}$ and is near the instrument detection limit for this compound. Trichlorofluoromethane was detected in one groundwater sample, but was not found in subsurface soil samples from the site. Trichlorofluoromethane is a compound used as a refrigerant and a fire extinguishing agent. The USEPA data validation guidelines for organic data review (USEPA, 1991b) indicate that trichlorofluoromethane can be associated with incidental contamination during

laboratory procedures. Trichlorofluoromethane is a type of freon and could be a component of the freon used in extractions associated with certain analyses.

6.1.2.2 Semivolatile Organic Compounds in Soil SVOCs detected in surface soil samples from Site 5 include benzoic acid, methylphenol, naphthalene, diethylphthalate, and bis(2-ethylhexyl)phthalate (see Table 6-7). Benzoic acid and bis(2-ethylhexyl)phthalate were also detected in subsurface soil samples (see Table 6-7).

Benzoic acid was detected in one subsurface soil sample, 05-SB-06, at a concentration of 210 J $\mu\text{g}/\text{kg}$, which is below the PQL of 1,600 $\mu\text{g}/\text{kg}$ for this compound. Benzoic acid was also detected in two surface soil samples, 05-SS-05 and 05-SS-07, at estimated concentrations of 660 J $\mu\text{g}/\text{kg}$ and 460 J $\mu\text{g}/\text{kg}$. Benzoic acid may be a naturally occurring organic acid unrelated to site activities. Industrial uses of benzoic acid include preparation of commercial chemicals, cosmetics, and pharmaceuticals, and it is used as a plasticizer and food preservative.

Methylphenol was detected in one surface soil sample, 05-SS-07, at a concentration of 82 J $\mu\text{g}/\text{kg}$, which is below the reporting limit for this compound. No other soil or groundwater samples from Site 5 were found to contain methylphenol. Methylphenol is a compound used in the manufacture of herbicides, resins, and textile products. Cresols are common constituents of phenolic cleaners and pine oils, and may also be present in weathering fuels or decomposing wood. The presence of 4-methylphenol in one soil sample at a low concentration may not represent an actual site-related release.

Naphthalene, a fuel-related compound, was detected in one surface soil sample, 05-SS-07, at a concentration of 44 J $\mu\text{g}/\text{kg}$, which is estimated because this concentration is below the reporting limit of 330 $\mu\text{g}/\text{kg}$ for this compound. Naphthalene would be associated with petroleum fuels, such as diesel, which was reportedly used to ignite debris disposed at the site. Naphthalene may also occur naturally as a breakdown product of wood and/or as a result of incomplete combustion of fuel or vegetation. No other soil or groundwater samples from the site contained naphthalene. These data do not suggest significant impact from the past use of diesel fuel at the site.

Two phthalate compounds, diethylphthalate and bis(2-ethylhexyl)phthalate, were detected in surface soil samples from the site. Diethylphthalate was detected in one sample, 05-SS-01, at a low concentration of 69 J $\mu\text{g}/\text{kg}$. Bis(2-ethylhexyl)phthalate was detected in all eight surface soil samples at concentrations ranging from 53 J $\mu\text{g}/\text{kg}$ to 790 $\mu\text{g}/\text{kg}$. Bis(2-ethylhexyl)phthalate was also detected in all eight subsurface soil samples from the site at concentrations ranging from 270 J $\mu\text{g}/\text{kg}$ to 720 $\mu\text{g}/\text{kg}$. Phthalates are common sampling and laboratory contaminants easily introduced into sample material from plastic items such as gloves, tubing, and sample containers. The presence of phthalate compounds in soil samples is not necessarily attributed to disposal activities at the site. Bis(2-ethylhexyl)phthalate was not detected in method blanks or rinsate blanks associated with the soil samples collected from Site 5, but was detected in method blanks associated with soil samples collected from another site included in the initial RFI field program at concentrations of 38 and 200 $\mu\text{g}/\text{kg}$. The concentrations reported in soil samples from Site 5 are less than 10 times the method blank concentrations associated with other soil samples collected during the investigation. This indicates its presence in surface soil

may be a laboratory artifact. Plastic debris observed at the site could also have caused phthalates to be present in surface soil.

6.1.2.3 Pesticides, Herbicides, Polychlorinated Biphenyls, Dioxins, and Furans in Soil Eight surface soil samples and eight subsurface soil samples were collected from Site 5 for analysis of Appendix IX pesticides, herbicides, PCBs, dioxins, and furans. No herbicides, dioxins, or furans were detected in the soil samples. One surface soil sample, 05-SS-02, was found to contain the pesticide, 4,4'-DDE at a concentration of 0.7 J $\mu\text{g}/\text{kg}$ and the PCB Aroclor-1260 at a concentration of 53 $\mu\text{g}/\text{kg}$ (see Table 6-7). No other soil samples or groundwater samples were found to contain pesticide or PCB compounds. The presence of a low concentration of 4,4'-DDE in one sample does not indicate significant impact of environmental media by past activities at the site. The low level of 4,4'-DDE is likely related to the past use of DDT in controlling pests prior to its being banned because 4,4'-DDE is a transformation product of DDT.

Eight additional surface soil samples, 05-SS-08 through 05-SS-14, including a duplicate sample, were collected from the site to establish whether Aroclor-1260 was present elsewhere at higher concentrations. These samples were submitted for analysis of Appendix IX PCBs. Aroclor-1260 was detected in four of these samples at concentrations ranging from 4.4 J to 14 J $\mu\text{g}/\text{kg}$ (see Table 6-7). These concentrations are estimated because they are below the reporting limit of 33 $\mu\text{g}/\text{kg}$ for Aroclor-1260. The concentrations detected in the additional soil samples are below the 53 $\mu\text{g}/\text{kg}$ initially detected in one soil sample. This indicates that significant concentrations of PCBs are not present at the site.

The concentrations of Aroclor-1260 in soil do not exceed allowable concentrations established under the Toxic Substances Control Act (TSCA), which is an applicable regulation for PCB-contaminated waste. Cleanup levels under TSCA are dependent on site-specific factors such as potential for exposure, but are on the order of 10,000 $\mu\text{g}/\text{kg}$ or more for soil.

6.1.2.4 Inorganics in Soil Eight surface soil samples and eight subsurface soil samples were collected and analyzed for Appendix IX inorganic constituents. Twelve inorganic compounds were detected in the soil samples (see Table 6-7).

The concentrations of inorganic trace elements detected in surface and subsurface soil samples were compared to reported naturally occurring concentrations for soils over limestones and calcareous rocks presented in Table 6-8 (derived from Kabata-Pendias and Pendias, 1984). Comparison of concentrations of inorganic constituents in soil samples from the site to concentrations reported as naturally occurring was done to assess the site for extraordinary or unique characteristics regarding concentrations of inorganics. This comparison is not a basis for assessing potential contaminants in the soil at the site. Except for selenium in one subsurface soil sample, none of the concentrations of inorganics detected in soil samples from the site exceeded reported natural ranges, and all were below mean concentrations for corresponding compounds. One sample, 05-SB-07, contained selenium at a concentration of 1.8 milligrams per kilogram (mg/kg), which is slightly above the reported natural range of 0.1 to 1.4 mg/kg , but is not considered a significant difference.

Table 6-9 summarizes the inorganic analytical data for subsurface and surface soil samples from Site 5. This table presents the ranges of concentrations and frequencies of detection for subsurface soil samples from borings located upgradient of the disposal area (05-SB-01 and 05-SB-02), subsurface soil samples

Table 6-8
Reported Naturally Occurring Inorganic Concentrations in Soil

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Compound | Naturally Occurring ¹ | |
|-----------|----------------------------------|-------------------------|
| | Range ² (mg/kg) | Arithmetic Mean (mg/kg) |
| Arsenic | 1.5 to 21 | 7.8 |
| Barium | 150 to 1,500 | 520 |
| Beryllium | 1 to 2 | 1.6 |
| Cadmium | 0.41 to 0.57 ³ | NR |
| Chromium | 5 to 150 | 50 |
| Lead | 10 to 50 | 22 |
| Nickel | <5 to 70 | 18 |
| Selenium | 0.1 to 1.4 | 0.19 |
| Silver | 0.3 to 8 ³ | NR |
| Vanadium | 10 to 150 | 72 |
| Zinc | 10 to 106 | 50 |

¹ Source: Kabata-Pendias and Pendias, 1984.
² For soils over limestone and calcareous rocks.
³ As reported for various soil types.

Notes: mg/kg = milligrams per kilogram.
 NR = not reported.

**Table 6-9
Summary of Inorganic Data for Soil Samples, Site 5**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Constituent | Subsurface Soil, Upgradient | | Subsurface Soil, Detection Well Borings | | Surface Soil, Within Site | |
|-------------|-----------------------------|------------------------|---|------------------------|-----------------------------|------------------------|
| | Concentration Range (mg/kg) | Frequency ¹ | Concentration Range (mg/kg) | Frequency ¹ | Concentration Range (mg/kg) | Frequency ¹ |
| Arsenic | ND to 1.1 J | 2/2 | ND to 1.0 J | 2/5 | ND | 0/7 |
| Barium | 2.8 J to 5.3 J | 2/2 | 2.8 J to 4.9 J | 5/5 | 2.5 J to 8.0 J | 7/7 |
| Beryllium | 0.05 J to 0.16 J | 2/2 | ND to 0.15 J | 4/5 | ND to 0.15 J | 5/7 |
| Chromium | 6.0 to 8.7 | 2/2 | ND to 6.8 | 4/5 | 2.3 to 6.2 | 7/7 |
| Copper | ND | 0/2 | ND to 7.8 | 1/5 | ND | 0/7 |
| Lead | 2.7 to 4.4 | 2/2 | 2.7 to 8.5 | 5/5 | 3.3 to 6.4 | 7/7 |
| Nickel | 0.98 J to 1.7 J | 2/2 | ND to 9.2 | 4/5 | ND | 0/7 |
| Selenium | 0.33 J to 0.93 J | 2/2 | ND to 1.8 | 4/5 | ND | 0/7 |
| Vanadium | ND to 8.5 J | 1/2 | ND to 3.4 J | 2/5 | 1.2 J to 3.4 J | 7/7 |
| Zinc | ND to 6.7 | 1/2 | ND to 10.1 | 2/5 | 4.1 J to 31.0 | 7/7 |
| Cyanide | ND | 0/2 | ND to 5.0 | 2/5 | ND | 0/7 |
| Sulfide | ND | 0/2 | ND | 0/5 | ND to 5,100 | 2/7 |

¹ Number of sample locations where analyte was detected per total number of sample locations.

Notes: mg/kg = milligrams per kilogram.
ND = not detected.
J = estimated value.

from borings 05-SB-03 through 05-SB-07 installed for release detection monitoring wells, and for surface soil samples 05-SS-01 through 05-SS-07 collected from locations within the disposal area. As discussed in Subsection 6.1.1.4, divergent groundwater flow was indicated by water level measurements collected during July 1992. The flow pattern indicated by the water table contour map for July 1992 (Appendix B) suggests that a groundwater divide bisected the site and none of the seven monitoring wells were upgradient of the disposal area. Additional background data are needed to evaluate site soil and groundwater for potential inorganic contaminants. The data for subsurface soil samples from borings 05-SB-01 and 05-SB-02, designated as representing upgradient conditions, will be assessed for potential inorganic contaminants after a background data set for inorganic constituents has been developed.

The inorganic data for the subsurface soil samples from borings 05-SB-03 through 05-SB-07 and for the seven surface soil samples were compared to the corresponding data for the subsurface soil samples from the upgradient soil borings. The determination of whether inorganic contaminants are present in soil will ultimately depend on comparison to background concentrations. Because background data are not available, a preliminary evaluation was done using data for the upgradient soil borings.

The presentation of data in Table 6-9 can be used to determine which analytes were detected at concentrations that exceed the corresponding concentrations for soil samples from the borings installed at upgradient locations. Table 6-10 presents the results of this comparison. Included in Table 6-10 are a list of analytes and corresponding maximum concentrations in soil samples from upgradient locations. The number of samples having an analyte concentration above the maximum upgradient and the concentration ranges for those samples are listed in Table 6-10 for subsurface soil samples from detection well borings 05-SB-03 through 05-SB-07 and for surface soil samples 05-SS-01 through 05-SS-07. Six inorganic constituents, including copper, lead, nickel, selenium, zinc, and cyanide, were detected in as many as three subsurface soil samples at concentrations above corresponding maximum concentrations in samples from upgradient locations. In surface soil samples, barium, lead, zinc, and sulfide were detected above concentrations in soil samples from upgradient locations.

Of the analytes listed in Table 6-10, copper, cyanide, and sulfide were not detected in soil samples from upgradient locations. Excluding these three analytes, concentrations of analytes in soil samples from detection well borings and from within the site exceeded corresponding maximum concentration in samples from upgradient locations by as much as 5 times. The significance of these findings cannot be evaluated fully until background data are obtained and comparisons are made relative to background.

6.2 SITE 16, ARMY RESERVE DISPOSAL AREA, MOTOR MISSILE MAGAZINES. Investigative activities conducted at Site 16 included a terrain conductivity survey and collection and analyses of subsurface soil samples and groundwater samples. Results of laboratory analyses of samples of environmental media were used to evaluate the status of contamination at the site. However, additional data are needed to develop a background data set.

Site 16 was first identified as a potential disposal area during the Initial Assessment Study through records searches, interviews, ground tours, and aerial tours (C.C. Johnson, 1985). When the RFI Workplan was developed in 1991, a site

Table 6-10
Comparison of Subsurface and Surface Soil Inorganic
Concentrations with Data from Upgradient Locations, Site 5

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Constituent | Maximum at Upgradient Locations (mg/kg) | Subsurface Soil - Detection Well Borings | | Surface Soil - Within Site | |
|-------------|---|--|-----------------------------|----------------------------|-----------------------------|
| | | Number of Locations | Concentration Range (mg/kg) | Number of Locations | Concentration Range (mg/kg) |
| Barium | 5.3 J | None | NA | 1 | 8.0 J |
| Copper | ND | 1 | 7.8 | None | NA |
| Lead | 4.4 | 4 | 4.5 to 8.5 | 4 | 4.7 to 6.4 |
| Nickel | 1.7 J | 2 | 2.8 J to 9.2 | None | NA |
| Selenium | 0.93 J | 2 | 1.3 to 1.8 | None | NA |
| Zinc | 6.7 | 2 | 7.4 to 10.1 | 4 | 8.8 to 31.0 |
| Cyanide | ND | 2 | 4.6 to 5.0 | None | NA |
| Sulfide | ND | None | NA | 2 | 4,600 to 5,100 |

Notes: mg/kg = milligrams per kilogram.
 J = estimated value.
 NA = not applicable.
 ND = not detected.

visit was conducted. The location and configuration of Site 16 were determined in the field using aerial photographs. A clearing in a wooded area evident on aerial photographs from 1957 and 1962 was in the area identified by the Initial Assessment Study. A former sewage lagoon and creek were references used to locate the area suspected of containing site 16.

A magnetometer survey was planned for Site 16, but construction activities at the location preempted using magnetics to confirm the location of a disposal area. Other geophysical methods will be evaluated for use in follow-on work at the site. The existing configuration of monitoring wells may not be located to adequately monitor potential releases from the disposal area. An evaluation of the suitability of the existing configuration of monitoring wells will be done after further investigation to confirm the location of the disposal area. Follow-on well installation activities will be planned to provide background data for soil and groundwater and to provide additional locations for release detection monitoring, if necessary.

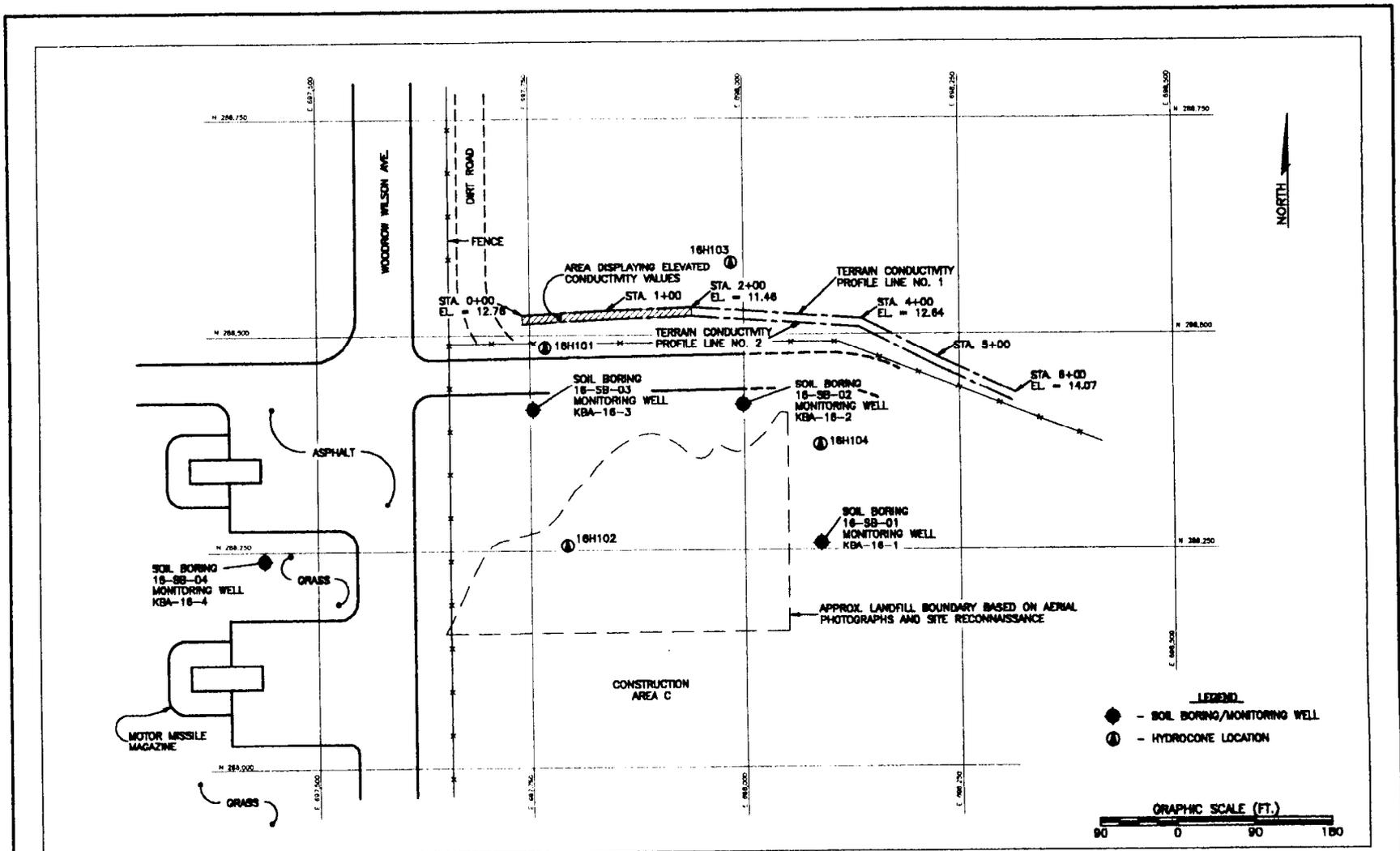
The soil and groundwater analytical data collected during the 1992 and 1993 RFI program is discussed in this subsection. The evaluations presented are based on the assumption that the disposal area is within the approximate site boundaries shown in Figure 6-4. These evaluations are presented without the benefit of a background data set and are subject to revision after the background data set has been developed.

6.2.1 Groundwater Contamination Two terrain conductivity profiles were conducted to the north of the site in an attempt to determine if any highly conductive areas could be delineated, which may suggest the presence of potentially contaminated groundwater. Figure 6-4 shows the locations of the two traverses. Figures 6-5 and 6-6 show the results of the terrain conductivity profiles. Elevated conductivity values were measured in the first 200 feet of each traverse. Riprap, assorted construction debris, and a culvert were observed protruding from the side of the embankment adjacent to the profile lines along the first 200 feet. Elevated conductivity values are attributed to the presence of these materials.

Six bimonthly groundwater sampling events were conducted at Site 16 during February 1992 to January 1993. Four groundwater monitoring wells, KBA-16-1 through KBA-16-4, were included in the monitoring program (Figure 6-4). These monitoring wells are 15 to 17.5 feet deep and have 10-foot well screens that intercept the water table.

Beginning with the third sampling event, both filtered and non-filtered samples were collected for inorganic analyses. Groundwater samples and QC samples were collected and submitted for analyses by a USEPA contract laboratory. The sampling methods used during the groundwater monitoring program were the same as those described for Site 5 in Subsection 6.1.1. Table 2-3 provides construction data for the monitoring wells at Site 16.

Appendix F contains tables listing validated analytical data for all of the environmental samples and associated QA/QC samples collected during the RFI investigation. The data in Appendix F are for all chemicals associated with each analytical method using during the RFI program. Appendix G contains analytical data tables that are derived from the tables in Appendix F. The data tables in Appendix G include validated analytical results for these analytes that were detected in one or more of the samples listed on a table. The summary tables in



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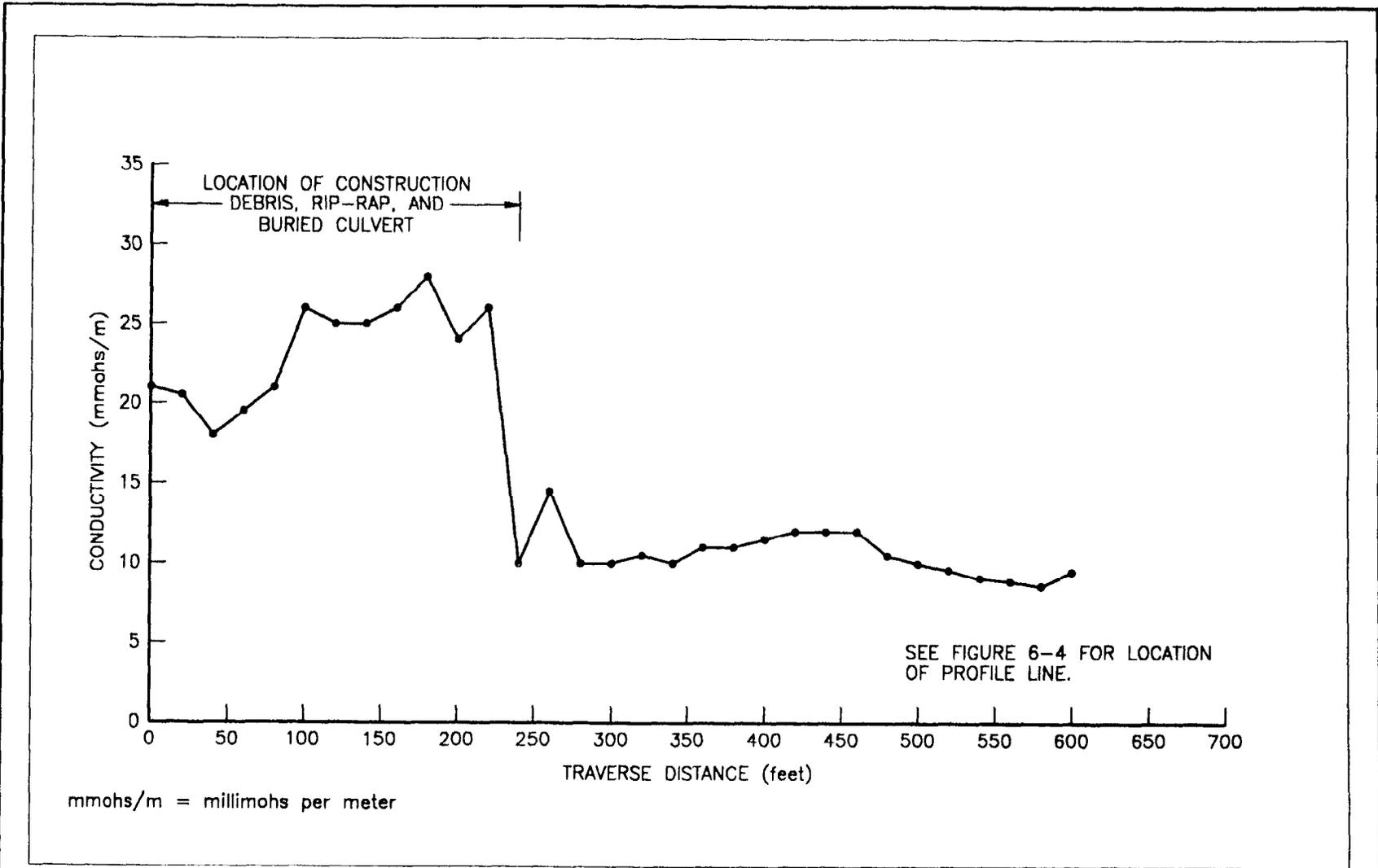
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| CHKD: LBH | FIGURE NO.: 6-4 | |
| DATE: 6-9-94 | | |

**SITE 16
TERRAIN CONDUCTIVITY,
MONITORING WELL, HYDROCONE, AND
SOIL BORING LOCATIONS**



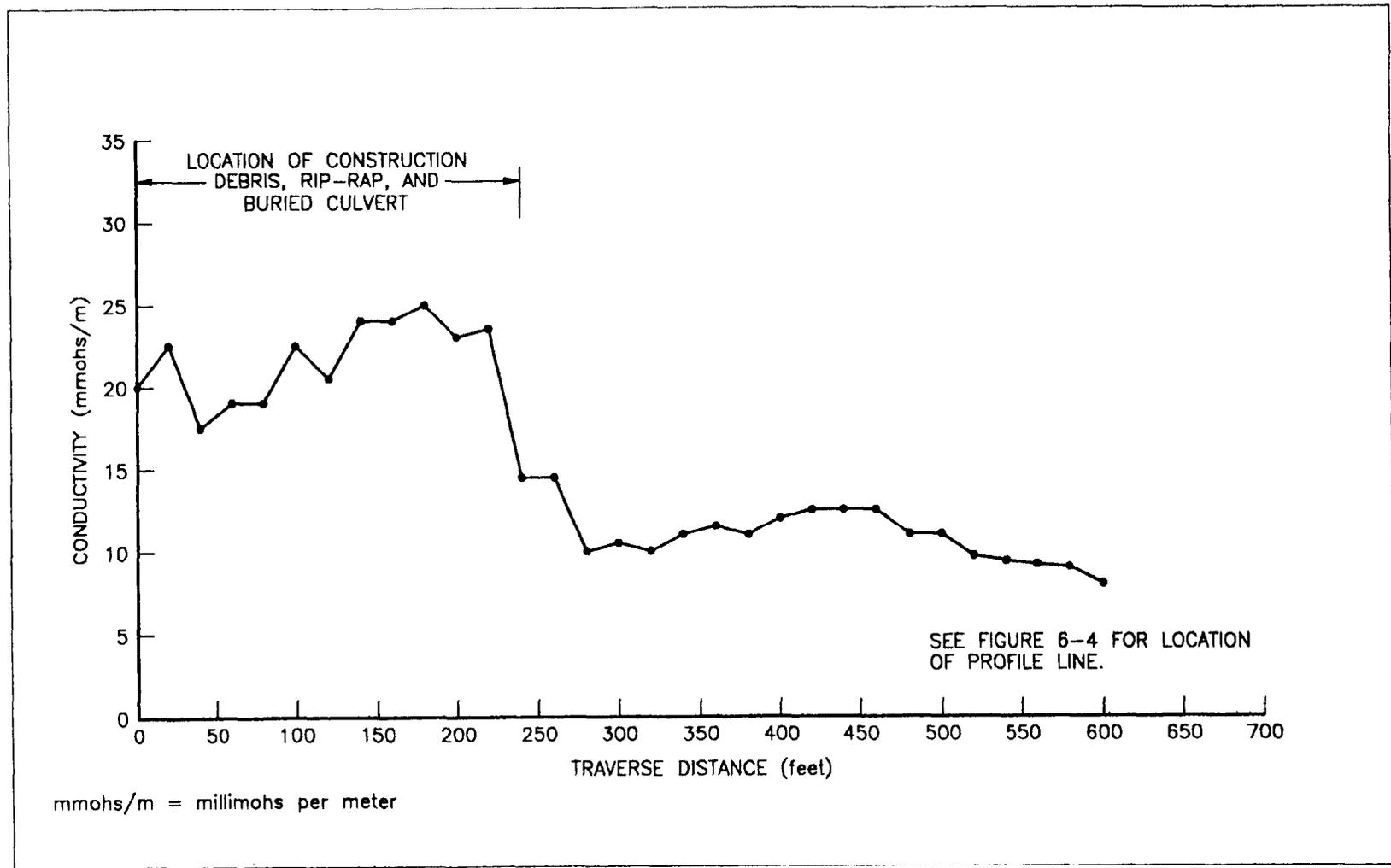
RFI REPORT FOR
SITES 5 & 16

NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA



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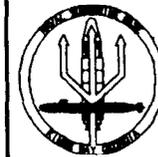
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| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: GRAPH OF TERRAIN CONDUCTIVITY DATA COLLECTED ALONG LINE NO. 1 AT SITE 16 FEBRUARY 1, 1992 | | |
| CHKD: LBH | FIGURE NO.: 6-5 | | | RFI REPORT FOR SITES 5 & 16 |
| DATE: 6-9-94 | | | | NAVAL SUBMARINE BASE KINGS BAY, GEORGIA |



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| DWN: DMF | PROJECT NO.: 7553-09 | TITLE: |
| CHKD: LBH | FIGURE NO.: | |
| DATE: 6-9-94 | 6-6 | |

GRAPH OF TERRAIN CONDUCTIVITY
 DATA COLLECTED ALONG LINE NO. 2 AT SITE 16,
 FEBRUARY 1, 1992



RFI REPORT FOR
 SITES 5 & 16

NAVAL SUBMARINE BASE
 KINGS BAY, GEORGIA

Appendix G were developed to provide a more manageable format, reducing the number of data points by eliminating analytes that were not detected in any of the samples listed on the table.

During November 16 and 17, 1992, groundwater samples were collected for VOC analyses using a hydrocone groundwater sampler and direct push technology. Groundwater sampling using the hydrocone equipment is described previously in Subsection 6.1.1. Groundwater samples were collected from four locations along the perimeter of the suspected disposal area comprising the site (Figure 6-4). Groundwater samples were collected from depths ranging from 18 to 37 feet bls. All groundwater samples collected with the hydrocone were analyzed in the onsite laboratory for target VOCs including vinyl chloride, trans-1,2-dichloroethene, cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, benzene, toluene, ethylbenzene, m/p-xylene, and o-xylene. Two hydrocone groundwater samples were submitted to an offsite laboratory for confirmatory analysis. Offsite analysis included TCL VOCs using CLP methods.

6.2.1.1 Volatile Organic Compounds in Groundwater The VOC results for the six bimonthly sampling events at Site 16 are summarized in Table 6-11. Tables 6-12 and 6-13 present all onsite and all offsite laboratory data for the hydrocone groundwater samples. Because the data sets for the onsite and offsite analyses of groundwater samples collected using the hydrocone are small, all the data are presented in Tables 6-12 and 6-13).

Samples from two of four monitoring wells contained detectable concentrations of VOCs. Three VOCs were detected in groundwater samples from monitoring well KBA-16-2, including 4-methyl-2-pentanone, ethylbenzene, and xylenes. Concentrations of these compounds were 3 J, 2 J, and 3 J $\mu\text{g/L}$, respectively, which are estimated because they are below the reporting limit. Acetone and toluene were detected in groundwater samples from monitoring well KBA-16-3 at concentrations of 10 and 5 $\mu\text{g/L}$, respectively. Acetone was detected in two groundwater samples collected using the hydrocone at concentrations of 38 J and 14 J $\mu\text{g/L}$ (Table 6-13).

The VOCs detected in samples from monitoring well KBA-16-2 were associated with the first sampling event. 4-Methyl-2-pentanone is a non-chlorinated solvent used in paints and varnishes. This VOC was detected in one groundwater sample collected from monitoring well KBA-16-2 at a concentration of 3 J $\mu\text{g/L}$. This concentration is below the reporting limit of 10 $\mu\text{g/L}$ for 4-methyl-2-pentanone. This VOC was not detected in other groundwater or soil samples collected from the site.

Ethylbenzene and xylenes are fuel-related VOCs detected in groundwater and soil samples from the site. Xylene is also a component in paint. Ethylbenzene and xylenes were detected in one groundwater sample collected from monitoring well KBA-16-2 at concentrations of 2 J and 3 J $\mu\text{g/L}$, respectively. These concentrations are below the Primary Drinking Water Standard MCLs of 700 $\mu\text{g/L}$ for ethylbenzene and 10,000 $\mu\text{g/L}$ for xylenes. No other soil or groundwater samples from the site contained ethylbenzene. Xylenes were detected in all four subsurface soil samples collected from the site.

Toluene was detected in a groundwater sample from monitoring well KBA-16-3 during the third sampling event. The concentration of 5 $\mu\text{g/L}$ of toluene is below the Primary Drinking Water Standard MCL of 1,000 $\mu\text{g/L}$ for toluene. No other groundwater samples collected from the site contained detectable concentrations of toluene.

Table 6-11
Volatile Organic Compound and Semivolatile Organic Compound Analytical
Data for Resource Conservation and Recovery Act Facility
Investigation Groundwater Monitoring Program at Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Monitoring Well I.D. | SVOCs Detected | VOCs Detected | Concentration Range (µg/L) | Associated Sample Events |
|--|----------------------------|----------------------|----------------------------|--------------------------|
| KBA-16-1 | | None | | |
| KBA-16-2 | | 4-Methyl-2-pentanone | 3 J | 1 |
| | bis(2-Ethylhexyl)phthalate | | 1 J to 28 | 2,3,4,5 |
| | | Ethylbenzene | 2 J | 1 |
| | | Xylene (total) | 3 J | 1 |
| | Naphthalene | | 1 J to 2 J | 4,5 |
| KBA-16-3 | | Acetone | 10 | 6 |
| | | Toluene | 5 | 3 |
| | di-n-Butylphthalate | | 2 J | 2 |
| | bis(2-Ethylhexyl)phthalate | | 7 J to 75 | 2,3 |
| KBA-16-4 | bis(2-Ethylhexyl)phthalate | | 3 J | 3 |
| Notes: I.D. = identification. SVOC = semivolatile organic compound. VOC = volatile organic compound. µg/L = micrograms per liter. J = estimated concentration. | | | | |
| Sources: ABB-ES, 1993a. ABB-ES, 1992a. ABB-ES, 1992b. ABB-ES, 1992c. ABB-ES, 1992e. | | | | |

Table 6-12
Onsite Analytical Data for Hydrocone Groundwater Samples, Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compound ($\mu\text{g/L}$) | Sample Identification (16-) | | | | | | | |
|------------------------------|-----------------------------|---|--------|--------|--------|--------|---------|--------|
| | H10118 | H10123 | H10128 | H10218 | H10227 | H10236 | H10236D | H10418 |
| Vinyl chloride | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| trans-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| cis-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Benzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Toluene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Ethylbenzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| m\p-Xylene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| o-Xylene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Compound ($\mu\text{g/L}$) | Sample Identification (16-) | | | | | | | |
| | H10424 | H10430 | H10318 | H10627 | H10366 | | | |
| Vinyl chloride | 2 U | 2 U | 2 U | 2 U | 2 U | | | |
| trans-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| cis-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| Benzene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| Toluene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| Ethylbenzene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| m\p-Xylene | 10 U | 10 U | 10 U | 10 U | 10 U | | | |
| o-Xylene | 5 U | 5 U | 5 U | 5 U | 5 U | | | |
| Notes: | $\mu\text{g/L}$ | = micrograms per liter. | | | | | | |
| | U | = compound not detected at the stated quantitation limit. | | | | | | |

Table 6-13
Offsite Laboratory Analytical Data for Hydrocone Groundwater Samples, Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | Sample Location: | 16H10123 | 16H10227 |
|----------------------------|------------------|----------|----------|
| | Lab Number: | 34437008 | 34437009 |
| | Date Sampled: | 11/16/92 | 11/16/92 |
| | Date Analyzed: | 11/27/92 | 11/27/92 |
| | Dilution Factor: | 1.0 | 1.0 |
| PQL | | | |
| Chloromethane | 1 | 1 U | 1 U |
| Bromomethane | 1 | 1 U | 1 U |
| Vinyl Chloride | 1 | 1 U | 1 U |
| Chloroethane | 1 | 1 U | 1 U |
| Methylene chloride | 10 | 10 U | 10 U |
| Acetone ¹ | 5 | 38 J | 14 J |
| Carbon disulfide | 1 | 2 | 1 U |
| 1,1-Dichloroethene | 1 | 1 U | 1 U |
| 1,1-Dichloroethane | 1 | 1 U | 1 U |
| cis-1,2-Dichloroethene | 1 | 1 U | 1 U |
| trans-1,2-Dichloroethene | 1 | 1 U | 1 U |
| Chloroform | 1 | 1 U | 1 U |
| 1,2-Dichloroethane | 1 | 1 U | 1 U |
| 2-Butanone | 5 | 5 U | 5 U |
| 1,1,1-Trichloroethane | 1 | 1 U | 1 U |
| Carbon tetrachloride | 1 | 1 U | 1 U |
| Bromodichloromethane | 1 | 1 U | 1 U |
| 1,2-Dichloropropane | 1 | 1 U | 1 U |
| cis-1,3-Dichloropropene | 1 | 1 U | 1 U |
| Trichloroethene | 1 | 1 U | 1 U |
| Dibromochloromethane | 1 | 1 U | 1 U |
| 1,1,2-Trichloroethane | 1 | 1 U | 1 U |
| Benzene | 1 | 1 U | 1 U |
| trans-1,3-Dichloropropene | 1 | 1 U | 1 U |
| Bromoform | 1 | 1 U | 1 U |
| 2-Hexanone | 5 | 5 U | 5 U |
| 4-Methyl-2-pentanone | 5 | 5 U | 5 U |
| Tetrachloroethene | 1 | 1 U | 1 U |
| 1,1,2,2-Tetrachloroethane | 1 | 1 U | 1 U |
| Toluene | 1 | 1 U | 1 U |
| Chlorobenzene | 1 | 1 U | 1 U |
| See notes at end of table. | | | |

Table 6-13 (Continued)
Offsite Laboratory Analytical Data for Hydrocone Groundwater Samples, Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| | | |
|------------------|----------|----------|
| Sample Location: | 16H10123 | 16H10227 |
| Lab Number: | 34437008 | 34437009 |
| Date Sampled: | 11/16/92 | 11/16/92 |
| Date Analyzed: | 11/27/92 | 11/27/92 |
| Dilution Factor: | 1.0 | 1.0 |

| PQL | | | |
|---------------------|---|-----|-----|
| Ethylbenzene | 1 | 1 U | 1 U |
| Styrene | 1 | 1 U | 1 U |
| 1,3-Dichlorobenzene | 1 | 1 U | 1 U |
| 1,4-Dichlorobenzene | 1 | 1 U | 1 U |
| 1,2-Dichlorobenzene | 1 | 1 U | 1 U |

¹ Values for acetone are qualified as estimated with a J qualifier because the continuing calibration contained compounds with percent differences between 25 and 50 percent.

Notes: PQL = practical quantitation limit.
 U = compound not detected at the stated quantitation limit.
 J = estimated value.

The concentration of 10 $\mu\text{g/L}$ of acetone detected in a groundwater sample from monitoring well KBA-16-3 was associated with the sixth sampling event conducted in January 1993. Acetone was also detected in two samples collected using the hydrocone. Concentrations of acetone in these two samples were 14 J and 38 J $\mu\text{g/L}$. Acetone is a common laboratory and sampling artifact in environmental samples. Acetone was not detected in the method blanks or trip blanks associated with these groundwater samples but was detected in 11 QC samples associated with the RFI program. A discussion of incidental contamination of samples with acetone is presented in Subsection 6.1.1.1. Concentrations of acetone in QC samples ranged from 5 J to 280 $\mu\text{g/L}$ (see Table 6-4). The concentrations of acetone in 11 QC samples and in a groundwater from only 1 of 6 sampling events suggests that it is an artifact of laboratory or sampling procedures.

In summary, five VOCs were detected in groundwater samples from Site 16 during the six bimonthly sampling events. One of the five, acetone, is suspected of being an artifact of sampling or laboratory procedures. The remaining four VOCs were each detected in only one groundwater sample and concentrations were 5 $\mu\text{g/L}$ or less. Of the VOCs detected, ethylbenzene, toluene, and xylenes have MCLs that are 700, 1,000, and 10,000 $\mu\text{g/L}$, respectively. These MCLs are at least 2 orders of magnitude greater than the concentrations detected in the groundwater samples.

6.2.1.2 Semivolatile Organic Compounds in Groundwater SVOCs detected in groundwater samples from Site 16 include phthalates and naphthalene. Bis(2-ethylhexyl)phthalate was detected in groundwater samples from monitoring well KBA-16-2 during four of six sample events at concentrations ranging from 1 J $\mu\text{g/L}$ to 28 $\mu\text{g/L}$ (see Table 6-11). Di-n-butylphthalate was detected in a groundwater sample from monitoring well KBA-16-3 associated with the second sampling event in May 1992, and bis(2-ethylhexyl) phthalate was detected in samples from this monitoring well during the second and third sampling events. This compound was also detected in a groundwater sample from monitoring well KBA-16-4 during the third sampling event in July 1992.

The presence of phthalates in groundwater samples from Site 16 is considered to be a sampling or laboratory artifact. Phthalates are easily introduced into sample media by sample gloves, sample containers, coolers, and other plastic material used in support of laboratory and sampling activities. Phthalates have low water solubility and tend to adsorb to particulates. It is unlikely that phthalates would migrate from the disposal area in groundwater. Bis(2-ethylhexyl)phthalate and di-n-butylphthalate have K_{ow} values of 100,000 and 37,200 (Montgomery and Welkom, 1991). In comparison, acetone, a water miscible compound, has a K_{ow} of 0.6. The K_{ow} is a measure of the hydrophobicity (tendency to partition out of water). Variation in K_{ow} values between compounds is primarily due to water solubility (Mackay, 1991). Hydrophobic compounds, such as phthalates, tend to sorb to organic carbon in soil.

Naphthalene was detected in groundwater samples from monitoring well KBA-16-2 during the fourth and fifth sampling events at concentrations of 1 J and 2 J $\mu\text{g/L}$, respectively. These concentrations are estimated because they are below the reporting limit of 10 $\mu\text{g/L}$ for naphthalene. These low concentrations are also near the instrument detection limit for naphthalene. This compound is associated with incomplete combustion of fossil fuel and plant material. Recent construction activities at the site could have contributed to the detection of naphthalene, because it is a component of exhaust from vehicles. Fuel-related SVOCs were detected in soil samples from monitoring well KBA-16-2, but naphthalene was not included. None of the fuel-related SVOCs detected in soil

have been detected in groundwater samples. K_{ow} values for the fuel-related SVOCs detected in soil and naphthalene range from 2,000 for naphthalene, the least complex compound to more than 1 million for the larger, more complex compounds (Tetra Tech 1989; Mackay, 1991).

6.2.1.3 Pesticides, Polychlorinated Biphenyls, Herbicides, Dioxins, and Furans in Groundwater Groundwater samples from the first two sampling events, February and May 1992, at Site 16 were analyzed for Appendix IX pesticides, herbicides, PCBs, dioxins, and furans. These constituents were not detected in groundwater at Site 16.

6.2.1.4 Inorganics in Groundwater Validated analytical data for inorganic analyses of groundwater and associated QC samples are included in Appendix F. Appendix G contains summary tables for the data presented in Appendix F. Appendix J includes graphs inorganic data for groundwater samples collected at Site 16 during the six sampling events. Data are presented in bar chart form for 11 inorganic constituents regulated under the SDWA.

Table 6-14 list the inorganic constituents that were detected in one or more groundwater samples from Site 16. Also shown on Table 6-14 are the frequencies of detection, associated monitoring wells, and concentration ranges for each inorganic constituent listed. With the exception of cadmium, mercury, silver, and thallium, the inorganic constituents listed were detected in samples from each of the four monitoring wells at the site.

A statistical comparison was performed on inorganic data for unfiltered groundwater samples collected during the groundwater monitoring program at Site 16. The methods used for Site 16 statistical analysis are described in Subsection 6.1.1.4. The statistical comparison for Site 16 inorganic data assumes that groundwater data from monitoring well KBA-16-4 is representative of groundwater quality upgradient and unaffected by potential releases from the disposal area. Additional investigation is needed to confirm the suitability of monitoring wells KBA-16-1 through KBA-16-3 for release detection. Collection of background data for groundwater is also needed. The observations presented in this subsection are preliminary and will need to be revisited after more information has been obtained.

Table 6-15 presents the results of a statistical comparison of inorganic data from the release detection monitoring wells, KBA-16-1 through KBA-16-3, to data from monitoring well KBA-16-4. Bonferroni's pairwise comparison was used because there were less than five wells in the comparison. The ANOVA procedure testing for overall differences between all wells yielded significant differences for beryllium, chromium, cobalt, nickel, selenium, vanadium, and zinc. The ANOVA results for arsenic and barium were marginal, but Bonferroni's pairwise comparison did not indicate significant differences attributable to any one monitoring well. Bonferroni's pairwise comparison also did not indicate that the ANOVA results for nickel were attributable to any one well.

Bonferroni's post-hoc procedure indicated that the cause of the ANOVA differences for beryllium, chromium, cobalt, vanadium, and zinc were attributable to data associated with monitoring well KBA-16-3. Monitoring well KBA-16-2 also tested as significantly different from cobalt and zinc, and was marginal for chromium. The pairwise comparison indicated that selenium concentrations in samples from monitoring well KBA-16-1 were marginally different.

Table 6-14
Summary of Inorganic Analytical Data for Resource Conservation and Recovery Act Facility
Investigation Groundwater Monitoring Program at Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Constituent | MCL ($\mu\text{g/L}$) | Frequency of Detection ¹ | Associated Monitoring Wells | Concentration Range ($\mu\text{g/L}$) | Frequency Above MCL ² |
|-------------|----------------------------|--|----------------------------------|---|-------------------------------------|
| Antimony | 6 | 5/24 | All | 11.3 J to 23.1 J | 5/5 |
| Arsenic | 50 | 23/24 | All | 1.5 J to 63.2 | 1/23 |
| Barium | 2,000 | 24/24 | All | 33.9 J to 538 | 0/24 |
| Beryllium | 4 | 19/24 | All | 0.44 J to 15.9 | 5/19 |
| Cadmium | 5 | 3/24 | KBA-16-1 KBA-16-2 | 1.5 J to 3.4 J | 0/3 |
| Chromium | 100 | 22/24 | All | 10.3 to 256 | 2/22 |
| Cobalt | — | 14/24 | All | 5.0 J to 74.4 | NA |
| Copper | 1,300 | 19/24 | All | 3.8 J to 82.8 | 0/19 |
| Lead | 15 | 22/24 | All | 3.6 to 41.2 J | 6/22 |
| Mercury | 2 | 5/24 | KBA-16-2 KBA-16-3 | 0.09 J to 0.82 | 0/5 |
| Nickel | 100 | 14/24 | All | 10.9 J to 274 | 2/14 |
| Selenium | 50 | 14/24 | All | 0.88 J to 10.6 | 0/14 |
| Silver | NA | 4/24 | KBA-16-1 KBA-16-2 KBA-16-4 | 1.4 J to 3.6 J | NA |
| Thallium | 2 | 3/24 | KBA-16-1 KBA-16-2 | 0.90 J to 17.3 J | 1/3 |
| Vanadium | NA | 24/24 | All | 10.6 J to 257 | NA |
| Zinc | NA | 18/24 | All | 25.6 to 297 | NA |
| Cyanide | 200 | 8/24 | All | 1.2 J to 18.5 | 0/8 |
| Sulfide | NA | 22/24 | All | 200 to 2,400 | NA |

¹ Number of sample locations where constituent was detected per total number of locations sampled.

² Number of sample locations where constituent concentration exceeded the MCL per number of sample locations where constituent was detected.

Notes: MCL = maximum contaminant level for drinking water (GA DNR, 1993; USEPA, 1993).
 $\mu\text{g/L}$ = micrograms per liter.
 J = estimated value.
 NA = not applicable.

Table 6-15
Statistical Results from Comparison of Log-Transformed Unfiltered Groundwater Data, Site 16

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Analyte | ANOVA Significance Level | Bonferroni Pairwise Comparison Significance Level | Significant Difference? |
|-----------|-----------------------------|--|---|
| Antimony | 0.877 | | No significant differences |
| Arsenic | 0.081 | KBA-16-2: 0.084 | ANOVA marginal; KBA-16-2 marginal |
| Barium | 0.078 | | ANOVA marginal; no significant differences |
| Beryllium | 0.008 | KBA-16-3: 0.014 | ANOVA significant; KBA-16-3 significant |
| Cadmium | 0.287 | | No significant differences |
| Chromium | 0.023 | KBA-16-3: 0.022 KBA-16-2: 0.100 | ANOVA significant; KBA-16-3 significant, KBA-16-2 marginal |
| Cobalt | 0.007 | KBA-16-2: 0.019 KBA-16-3: 0.033 | ANOVA significant; both KBA-16-2 and KBA-16-3 significant. |
| Copper | 0.928 | | No significant differences |
| Cyanide | 0.235 | | No significant differences |
| Lead | 0.105 | | No significant differences |
| Mercury | 0.162 | | No significant differences |
| Nickel | 0.048 | | ANOVA significant; no significant differences |
| Selenium | 0.027 | KBA-16-1: 0.100 | ANOVA significant; KBA-16-1 marginal |
| Silver | 0.419 | | No significant differences |
| Sulfide | 0.167 | | No significant differences |
| Thallium | 0.353 | | No significant differences |
| Tin | 0.992 | | No significant differences |
| Vanadium | 0.027 | KBA-16-3: 0.026 | ANOVA significant; KBA-16-3 significant |
| Zinc | 0.001 | KBA-16-3: 0.005 KBA-16-2: 0.041 | ANOVA significant; both KBA-16-3 and KBA-16-2 significant |

Note: ANOVA = analysis of variance.

Groundwater inorganic data from the site were compared to MCLs (Table 6-14). Antimony was reported in unfiltered groundwater samples at estimated concentrations below the CRDL of 60 $\mu\text{g}/\text{L}$ on five occasions. On all five occasions, reported concentrations were above the MCL of 6 $\mu\text{g}/\text{L}$. Six other inorganic constituents were detected in unfiltered groundwater samples at concentrations above MCLs, including arsenic, beryllium, chromium, lead, nickel, and thallium. Table 6-14 lists the frequency that a constituent concentration exceeded an MCL when detected in groundwater samples from the monitoring wells at the site.

Comparison of filtered and unfiltered inorganic data suggests that a significant amount of the inorganic concentrations are associated with suspended solids in groundwater samples. TDS and TSS were analyzed for in groundwater samples collected during the last four monitoring events. These data were used to calculate the percentage of suspended solids in the unfiltered groundwater samples. Overall, percentages of suspended solids ranged from 21 to 88 percent. Percentages of suspended solids in upgradient groundwater samples ranged from 21 to 66 percent, and in downgradient groundwater samples the range was 35 to 88 percent. Comparison of corresponding filtered and unfiltered data for inorganic constituents (Appendix J) indicates that a significant portion of the inorganic content of unfiltered groundwater samples is related to the presence of suspended solids. The GA DNR regulates based on data for unfiltered samples and comparison to background concentrations. Background data will need to be collected during followon investigations. It is recommended that the monitoring wells be developed periodically to reduce the amount of solids entering the well.

6.2.2 Soil Contamination Four subsurface soil samples were collected from Site 16 for analysis of Appendix IX constituents. The four samples were collected from soil borings made for installation of monitoring wells. Figure 6-3 shows the locations of the soil borings. The samples were collected from the 2-foot interval above the water table. Sample depths ranged from 8 to 12 feet bls. Table 6-16 summarizes analytical data for the soil samples collected from the site. Table 6-16 was prepared using the comprehensive data tables included in Appendix F. The compounds listed on Table 6-16 include all compounds that were detected in one or more soil samples from the site. Because every compound was not detected in every sample, some analytical results are qualified with a U qualifier indicating the compound was not detected in the sample.

6.2.2.1 Volatile Organic Compounds in Soil VOCs detected in subsurface soil samples include acetone, carbon disulfide, 2-butanone, toluene, and xylene.

Acetone, a common laboratory solvent, was detected in all four subsurface soil samples collected from the site. Acetone was qualified as undetected in two samples because a concentration of 10 $\mu\text{g}/\text{kg}$ acetone was detected in an associated method blank. The concentration of acetone reported for samples 16-SB-02 (51 $\mu\text{g}/\text{kg}$) and 16-SB-04 (110 $\mu\text{g}/\text{kg}$) were more than 10 times the concentration of acetone detected in associated method blanks and were not qualified.

The concentration of 110 $\mu\text{g}/\text{kg}$ of acetone reported for sample 16-SB-04 is only slightly more than 10 times the concentration of 10 $\mu\text{g}/\text{L}$ in the associated method blank. Although the reported concentrations of acetone in samples 16-SB-02 and 16-SB-04 cannot be directly attributable to laboratory contamination based on USEPA functional guidelines for assessing organic data, the absence of acetone in groundwater samples collected during the first five sampling events suggests that detection of acetone in the soil samples is a laboratory artifact. The soil

Table 6-16
Summary of Laboratory Analyses of Subsurface Soil Samples Collected from Site 16¹

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Compounds Detected | 16- PQL | SB-01 8 to 10 (feet) | SB-02 10 to 12 (feet) | SB-03 8 to 10 (feet) | SB-04 8 to 10 (feet) |
|---|-------------------|----------------------------|-----------------------------|----------------------------|----------------------------|
| APPENDIX IX VOCs (µg/kg) | | | | | |
| Acetone | 10 | 63 U | 51 | 87 U | 110 |
| Carbon disulfide ² | 5 | 6 U | 2 J | 6 U | 6 U |
| 2-Butanone | 10 | 11 U | 11 U | 12 U | 10 |
| Toluene ² | 5 | 6 U | 6 U | 6 U | 1 J |
| Xylene (total) ² | 5 | 3 J | 2 J | 4 J | 9 |
| APPENDIX IX SVOCs (µg/kg) | | | | | |
| Acenaphthene ² | 330 | 360 U | 99 J | 370 U | 350 U |
| Fluorene ² | 330 | 360 U | 61 J | 370 U | 350 U |
| Phenanthrene ² | 330 | 360 U | 130 J | 370 U | 350 U |
| Fluoranthene | 330 | 360 U | 1,000 | 370 U | 350 U |
| Pyrene | 330 | 360 U | 1,700 | 370 U | 350 U |
| Benzo(a)anthracene | 330 | 360 U | 390 | 370 U | 350 U |
| Chrysene | 330 | 360 U | 600 | 370 U | 350 U |
| bis(2-Ethylhexyl)phthalate | 330 | 390 | 520 | 630 | 1,100 |
| Benzo(b)fluoranthene ² | 330 | 360 U | 310 J | 370 U | 350 U |
| Benzo(k)fluoranthene ² | 330 | 360 U | 280 J | 370 U | 350 U |
| Benzo(a)pyrene ² | 330 | 360 U | 170 J | 370 U | 350 U |
| APPENDIX IX Pesticides and PCBs (µg/kg) | | | | | |
| 4,4'-Dichlorodipenyldichloroethane ² | 3.3 | 0.9 U | 0.9 U | 1 | 0.9 U |
| APPENDIX IX Inorganics (mg/kg) | | | | | |
| | CRDL ⁴ | | | | |
| Arsenic ² | 2 | 0.34 J | 0.28 J | 0.26 J | 0.16 J |
| Barium ² | 40 | 3.9 J | 6.4 J | 5.1 J | 2.1 J |
| Chromium ³ | 2 | 4.6 J | 12.2 | 1,540 | 4.9 |
| Copper ² | 5 | 2.4 J | 2.3 J | 2.4 J | 1.8 J |
| Lead | 0.6 | 3.9 | 3.4 | 2.5 | 1.5 |
| Nickel ² | 8 | 1.5 U | 3.0 J | 1.5 U | 1.5 U |
| Vanadium ² | 10 | 2.3 J | 1.8 J | 2.4 J | 1.5 J |
| Zinc ² | 4 | 1.8 J | 3.9 U | 3.4 J | 0.68 J |

See notes at end of table.

Table 6-16 (Continued)
Summary of Laboratory Analyses of Subsurface Soil Samples Collected from Site 16¹

Resource Conservation and Recovery Act Facility Investigation Report for
 Sites 5 and 16 and Site History and File Information for Site 12
 Naval Submarine Base
 Kings Bay, Georgia

| Compounds Detected | 16- CRDL ⁴ | SB-01 8 to 10 (feet) | SB-02 10 to 12 (feet) | SB-03 8 to 10 (feet) | SB-04 8 to 10 (feet) |
|--------------------|--------------------------|----------------------------|-----------------------------|----------------------------|----------------------------|
| Sulfide | 4,000 | 4,600 U | 18,300 | 4,700 U | 9,200 |

¹ No Appendix IX polychlorinated biphenyls (PCBs), herbicides, or dioxins and furans were detected in soil samples.

⁴ The Contract Laboratory Program (CLP) contract required detection limits (CRDLs) are listed for inorganic analytes because SW-846 analytical data are reported using CLP protocol when analyses are conducted at a CLP laboratory. This protocol results in qualification of values as estimated when the values are greater than the method detection limit but less than the CLP CRDL. The SW-846 methods do not specify quantitation limits for inorganic data.

Data Qualifiers

² Value(s) flagged J as estimated because concentrations are less than the quantitation limit.

³ Value flagged J as estimated because corresponding preparation blank exhibited negative bias for chromium.

Notes:

- PQL = practical quantitation limit.
- VOC = volatile organic compound.
- U = not detected.
- J = estimated value.
- SVOC = semivolatile organic compound
- µg/kg = micrograms per kilogram.
- PCB = polychlorinated biphenyl.
- mg/kg = milligrams per kilogram.
- CRDL = contract required detection limit.
- CLP = Contract Laboratory Program.

samples were collected from the boring at a depth immediately above the water table. Acetone has a K_{ow} value of 0.6 (Montgomery and Welkom, 1991) indicating it is a hydrophilic compound. When acetone is present in soil at the water table, it should be present in groundwater.

Carbon disulfide was detected in one subsurface soil sample, 16-SB-02, at a concentration of 2 J $\mu\text{g}/\text{kg}$, which is below the PQL of 5 $\mu\text{g}/\text{kg}$ for this VOC. No other soil or groundwater samples from the site were found to contain carbon disulfide. Its presence in one subsurface soil sample from the site may be related to past fill operations that involved the use of rubber-tire vehicles, or may be naturally occurring.

2-Butanone is a common laboratory solvent detected in one subsurface soil sample, 16-SB-04, at a concentration of 10 $\mu\text{g}/\text{kg}$. This VOC was not detected in other soil samples or groundwater samples collected from the site. 2-Butanone was not detected in method blanks or other QA/QC samples associated with the RFI. This VOC is hydrophilic, having a K_{ow} of 1.8 (Montgomery and Welkom, 1991), and should be in groundwater from the monitoring well associated with the boring from which the soil sample was collected.

Toluene and xylene are fuel-related VOCs detected in subsurface soil samples from Site 16. Toluene is also a common laboratory solvent. Toluene was detected in one subsurface soil sample, 16-SB-04, at a concentration of 1 J $\mu\text{g}/\text{kg}$. This concentration is below the reporting limit of 5 $\mu\text{g}/\text{kg}$ and approximately equal to the instrument detection limit for toluene. Xylene was detected in all four subsurface soil samples at concentrations ranging from 2 J $\mu\text{g}/\text{kg}$ to 9 $\mu\text{g}/\text{kg}$. The highest concentration is associated with sample 16-SB-04. Xylene was also detected in one groundwater sample from monitoring well KBA-16-2. Detection of xylene in soil and groundwater samples is considered representative of the sampled media.

Concentrations of VOCs in soil that are potentially related to waste disposal range from 1 J to 9 $\mu\text{g}/\text{kg}$. The VOCs are toluene and xylenes. It is recommended that the potential for higher concentrations of these VOCs be evaluated as part of future investigations at the site. However, if the existing configuration of detection monitoring wells, KBA-16-1 through KBA-16-3, is appropriately located relative to the disposal area, concentrations of toluene and xylenes in groundwater samples do not suggest the site is a source of VOC contaminants. Each of these VOCs was detected in one of 24 groundwater samples collected during the six sampling events and concentrations were 2 J and 5 $\mu\text{g}/\text{L}$ for xylenes and toluene, respectively. The groundwater data should reflect higher concentrations and consistent detection if site soils were contaminated with these VOCs.

6.2.2.2 Semivolatile Organic Compounds in Soil SVOCs were detected in subsurface soil samples from the site and include fuel-related SVOCs and a phthalate compound.

Polycyclic aromatic hydrocarbons are produced from incomplete combustion of fossil fuels and other organic materials, including plant debris. Compounds of this nature were detected in one subsurface soil sample, 16-SB-02, and include acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene. Concentrations ranged from 61 J $\mu\text{g}/\text{kg}$ to 1,700 $\mu\text{g}/\text{kg}$. Most concentrations are below their reporting limit of 330 $\mu\text{g}/\text{kg}$. Naphthalene, a related compound, was detected in groundwater from the monitoring well installed in this boring at

concentrations of 1 and 2 J $\mu\text{g/L}$. Wood debris was reportedly burned at the site and the presence of polycyclic aromatic hydrocarbons in subsurface soil from boring 16-SB-02 could be attributed to this activity. Polycyclic aromatic hydrocarbons are hydrophobic compounds having high K_{ow} values, indicating a very strong affinity for sorption to soil surfaces. Montgomery and Welkom (1991) report K_{ow} values for the 10 polycyclic aromatic compounds detected in sample 16-SB-02 that range from 8,318 for acenaphthene to over 7 million for benzo(k)fluoranthene.

Bis(2-ethylhexyl)phthalate was detected in all four subsurface soil samples at concentrations ranging from 390 to 1,100 $\mu\text{g/kg}$. This SVOC was not detected in the method blank associated with the soil samples, but was detected in other method blanks associated with the RFI analyses at concentrations as much as 200 $\mu\text{g/L}$. This suggests it is possible that the presence of this phthalate in environmental media could be a laboratory artifact. Most likely, its presence in soil samples is caused by both laboratory and sampling contamination. Phthalates are easily introduced into sampled media by plastic items such as gloves, tubing, or sample containers.

6.2.2.3 Pesticides, Herbicides, Polychlorinated Biphenyls, Dioxins, and Furans in Soil One pesticide compound was detected in a subsurface soil sample from Site 16. 4,4'-DDD (4,4'-dichlorodipenyldichloroethane) was detected at a concentration of 1 $\mu\text{g/kg}$ in subsurface soil sample 16-SB-03. No other soil or groundwater samples from the site were found to contain pesticides, herbicides, PCBs, dioxins, or furans. The detection of 1 $\mu\text{g/kg}$ of 4,4'-DDD in one sample does not indicate significant impact on environmental media by past activities at the site. The low level of 4,4'-DDD is likely related to the past use of DDT in controlling pests prior to its being banned. 4,4'-DDD is a transformation product of DDT. Wastes containing pesticides were not reported as being disposed at any of the disposal sites investigated during the RFI.

6.2.2.4 Inorganics in Soil Nine inorganic compounds were detected in four subsurface soil samples from Site 16 (see Table 6-16). Because the location of the Site 16 disposal area has not been confirmed, the relationship of the soil boring locations to the location of the wastes is somewhat uncertain. The location and configuration of the site shown in Figure 6-4 is based on information from the Initial Assessment Study (C.C. Johnson, 1985) and from a site visit where aerial photographs were used to locate the area suspected of containing the Site 16 disposal area. Additional investigative tasks will be planned to evaluate the general area for evidence of buried wastes.

The uncertainty of the location of the disposed wastes and lack of background data for soil cause evaluation of the inorganic data for soil samples collected during the 1992 to 1993 RFI program to be preliminary. The discussion of inorganic constituents in soil presented in this subsection is based on the assumption that the disposal area is contained within the approximate site boundaries shown in Figure 6-4. The data will be evaluated again after information is obtained from additional investigation of the site.

The concentrations of inorganics detected in subsurface soil samples were compared to reported naturally occurring concentrations for soils over limestone and calcareous rocks presented in Table 6-8 (derived from Kabata-Pendias and Pendias, 1984). Comparison of concentrations of inorganic constituents in soil samples from the site to concentrations reported as naturally occurring was done to assess the site for extraordinary or unique characteristics regarding

concentrations of inorganics. This comparison is not a basis for assessing potential contaminants in soil at the site. Except for chromium, none of the concentrations of metals detected in the subsurface soil samples exceeded reported natural ranges, and all were below mean concentrations for corresponding compounds.

The concentrations of inorganics detected in the subsurface soil sample from boring 16-SB-04, upgradient of the disposal area, are assumed to be unaffected by waste disposal. The data set for the four subsurface soil samples is small, so tables summarizing the inorganic data and comparisons performed were not developed as they were for Site 5 inorganic soil data. The presentation of inorganic data in Table 6-16 was considered adequate for the discussion presented in this subsection. Concentrations of inorganics detected in soil from borings 16-SB-01 through 16-SB-03, installed for release detection monitoring wells, were compared to corresponding concentrations from soil sample 16-SB-04. Results of this comparison indicate that all inorganic constituents detected in soil samples from detection well borings are present at concentrations above that detected in soil from the upgradient location.

Except for chromium concentration in one subsurface soil sample (16-SB-03), none of the concentrations of inorganic constituents were more than 3 times greater than the upgradient values. The concentrations of inorganics may vary between the upgradient and detection well locations because of differences in fill material. Although no marked differences in soil are indicated by comparing boring logs, construction activities in the two locations were not concurrent. It is not known if fill operations were concurrent over the entire area where sampling was conducted.

Chromium was detected in all four subsurface soil samples, but one soil sample was found to contain a high level of chromium relative to other onsite soil samples and relative to the reported natural range of chromium in soil. Subsurface soil sample 16-SB-03 contained chromium at a concentration of 1,540 mg/kg (total chromium). Other soil samples collected from the site contained chromium at concentrations ranging from 4.6 J mg/kg to 12.2 mg/kg. Chromium was also detected in two groundwater samples at relatively high concentrations. The concentrations of chromium in soil and groundwater samples from the site suggest that chromium is site-related.

Sulfide concentrations in the four subsurface soil samples range from non-detect to 18,300 mg/kg. This level of sulfide could be representative of uncontaminated marsh deposits used as fill at the site.

7.0 POTENTIAL RECEPTORS

7.1 SITE ACCESS. Site 5 is located in a wooded area and is almost completely surrounded by marshes. The larger part of Site 5 is currently used to stockpile fill material (soil). Occasionally, small amounts of construction rubble are dumped on the ground surface around the edges of the site. The site is in an area where access is controlled more so than the upper part of the base. Access to the area of Site 5 requires clearance from base security that is one level higher than that required for the upper base.

Site 16 is in an area where motor missiles are stored. Access to the area of the site is controlled by base security and requires clearance from the Strategic Weapons Facility Atlantic Command. There is generally little activity in the area of the site. There are periods of activity during missile movements and during drills.

7.2 GROUNDWATER USE. The USGS, GA DNR, and the Camden County Health Department were contacted for information regarding public and/or private water supply wells. Table 7-1 summarizes information obtained. Approximate locations of the wells are shown on Figure 7-1.

In the vicinity of the NSB Kings Bay, groundwater in the surficial aquifer is used primarily for irrigation. Irrigation wells draw water from the surficial aquifer using shallow wells. The RFI Interim Report (ABB-ES, 1993b) for Site 11 contains information regarding private irrigation wells in a residential subdivision near the NSB and downgradient of Site 11. There are no residential areas in the vicinity of Sites 5, 16, or 12.

The public water supply for NSB Kings Bay and surrounding towns and urban areas comes from the Floridan aquifer system. In Camden County, water treatment facilities for St. Marys and Kingsland are adequate for present demands. Currently, the City of St. Marys is served by two water supply wells. One well is located on Jefferson Road near the NSB Kings Bay boundary (No. 48 on Figure 7-1), approximately 3 miles southwest of Sites 5 and 16. The other well is located adjacent to the southern boundary of the St. Marys Airport (No. 49 on Figure 7-1), approximately 4 miles south-southwest of Sites 5 and 16. Two other wells are available on a standby basis. One is located near Mission Trace Drive in Mission Trace (No. 50 on Figure 7-1), approximately 3 miles southwest of Sites 5 and 16. The other is located on Ready Street near City Hall (No. 51 on Figure 7-1), approximately 5 miles south of Sites 5 and 16. The City of Kingsland is served by two water supply wells located off South Grove Boulevard near Colony Pines. These wells are more than 6 miles west-southwest of Sites 5 and 16 and are not in the Harriett's Bluff quadrangle.

Private wells supply water for most of the individual homes within the unincorporated areas of Camden County. NSB Kings Bay obtains its potable water from three groundwater wells within its property boundaries. One of the three wells is approximately 3.5 miles to the west-southwest of Site 5 (No. 12 on Figure 7-1) and two are approximately 3 miles to the east-northeast of Site 16 (Nos. 14 and 15 on Figure 7-1). These wells are approximately 800 to 900 feet deep and 18 inches in diameter.

The potential for future groundwater development of the Floridan aquifer system in the southeastern Georgia area ranges from 0 to 10 million gallons per day

**Table 7-1
Summary of Water Supply Well Data**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| USGS Grid No. ¹ | Map No. ² | Latitude | Longitude | Bottom of Casing (ft bls) | Well Depth (ft bls) | Station Name ³ | Well Use |
|----------------------------|----------------------|-------------|-------------|---------------------------|---------------------|-----------------------------|---------------|
| 33E002 | 1 | 30° 46' 27" | 81° 37' 12" | 80 | 474 | Rayonier, Inc. | Unused |
| 33E003 | 2 | 30° 47' 51" | 81° 32' 01" | 302 | - | NSB Refill Station | Unused |
| 33E004 | 3 | 30° 49' 10" | 81° 32' 38" | 186 | 516 | NSB Etowah | Recreational |
| 33E005 | 4 | 30° 52' 08" | 81° 35' 03" | - | 650 | W. Bailey | - |
| 33E006 | 5 | 30° 46' 08" | 81° 34' 52" | - | 750 | Finn & Neighbor | - |
| 33E007 | 6 | 30° 45' 10" | 81° 34' 38" | 525 | 770 | G. H. Davis | Domestic |
| 33E008 | 7 | 30° 50' 37" | 81° 33' 23" | 261 | 470 | Crooked River State Park | Unused |
| 33E009 | 8 | 30° 50' 45" | 81° 33' 46" | 250 | 565 | American Legion | - |
| 33E018 | 9 | 30° 48' 00" | 81° 31' 05" | 145 | 486 | NSB Club | Unused |
| 33E023 | 10 | 30° 50' 31" | 81° 34' 27" | 450 | 650 | R. Norieka | Domestic |
| 33E027 | 11 | 30° 47' 56" | 81° 31' 11" | 555 | 990 | NSB TW1 | Observational |
| 33E032 | 12 | 30° 47' 39" | 81° 34' 31" | 585 | 894 | NSB 1 | Commercial |
| 33E033 | 13 | 30° 47' 43" | 81° 33' 42" | 585 | 813 | NSB 2 | Fire Fighting |
| 33E034 | 14 | 30° 47' 52" | 81° 31' 12" | 500 | 810 | NSB 4 | Commercial |
| 33E035 | 15 | 30° 47' 59" | 81° 31' 19" | 500 | 800 | NSB 3 | Commercial |
| 33E037 | 16 | 30° 49' 13" | 81° 35' 31" | - | 575 | C. Drury, Laurel Island | Unused |
| 33E038 | 17 | 30° 51' 57" | 81° 31' 56" | 66 | 340 | Brunswick Pulp and Paper | Unused |
| 33E039 | 18 | 30° 47' 49" | 81° 33' 53" | 100/560/950 | 1,150 | NSB Observ. No. 1 | Observational |
| 33E040 | 19 | 30° 47' 49" | 81° 33' 53" | 100 | 750 | NSB Observ. No. 2 | Observational |
| 33E046 | 20 | 30° 49' 16" | 81° 36' 07" | 245 | 650 | Joiner/Greene/Crocker/Onell | Domestic |

See notes at end of table.

**Table 7-1 (Continued)
Summary of Water Supply Well Data**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| USGS Grid No. ¹ | Map No. ² | Latitude | Longitude | Bottom of Casing (ft bls) | Well Depth (ft bls) | Station Name ³ | Well Use |
|----------------------------|----------------------|-------------|-------------|---------------------------|---------------------|---------------------------|---------------|
| 33E047 | 21 | 30° 45' 15" | 81° 36' 57" | 87 | 111 | Osprey Cove Golf Course | Institutional |
| 33E048 | 22 | 30° 45' 15" | 81° 36' 57" | 334 | 502 | Osprey Cove Golf Course | Institutional |
| NA | 23 | 30° 49' 42" | 81° 34' 12" | -- | 45 | Private Residence | Domestic |
| NA | 24 | 30° 49' 45" | 81° 34' 06" | -- | 45 | Private Residence | Domestic |
| NA | 25 | 30° 52' 13" | 81° 36' 57" | -- | 200 (Avg) | Sadler Cove (39) | -- |
| NA | 26 | 30° 52' 06" | 81° 37' 04" | -- | 200 (Avg) | Mallard Pointe (112) | -- |
| NA | 27 | 30° 52' 27" | 81° 36' 49" | -- | 200 (Avg) | Sadler Creek (112) | -- |
| NA | 28 | 30° 50' 29" | 81° 36' 29" | -- | 200 (Avg) | London Hill (16) | -- |
| NA | 29 | 30° 52' 16" | 81° 35' 04" | -- | 200 (Avg) | Harriett's Bluff (6) | -- |
| NA | 30 | 30° 50' 35" | 81° 34' 17" | -- | 125 (Avg) | Timber Ridge (5) | -- |
| NA | 31 | 30° 50' 22" | 81° 34' 31" | -- | 125 (Avg) | Elliott's Plantation | -- |
| NA | 32 | 30° 50' 30" | 81° 34' 22" | -- | 125 (Avg) | Riverbend (3) | -- |
| NA | 33 | 30° 50' 39" | 81° 34' 19" | -- | 125 (Avg) | Marsh Point | -- |
| NA | 34 | 30° 50' 23" | 81° 34' 09" | -- | 125 (Avg) | Foxwood (40) | -- |
| NA | 35 | 30° 45' 36" | 81° 34' 43" | -- | 60 (Avg) | Gaines Davis (7) | -- |
| NA | 36 | 30° 45' 57" | 81° 34' 48" | -- | 60 (Avg) | New Hope Baptist Church | -- |
| NA | 37 | 30° 45' 39" | 81° 36' 06" | -- | 60 (Avg) | Woodsville | -- |
| NA | 38 | 30° 45' 02" | 81° 34' 25" | -- | 60 (Avg) | Bank South | -- |
| NA | 39 | 30° 45' 10" | 81° 35' 10" | -- | 60 (Avg) | Shadowlawn (4) | -- |
| NA | 40 | 30° 45' 29" | 81° 31' 26" | -- | 85 (Avg) | North River Oaks (9) | -- |

See notes at end of table.

**Table 7-1 (Continued)
Summary of Water Supply Well Data**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| USGS Grid No. ¹ | Map No. ² | Latitude | Longitude | Bottom of Casing (ft bls) | Well Depth (ft bls) | Station Name ³ | Well Use |
|----------------------------|----------------------|-------------|-------------|---------------------------|---------------------|---------------------------|-------------------------|
| NA | 41 | 30° 45' 25" | 81° 31' 21" | -- | 85 (Avg) | Highland Oaks (23) | -- |
| NA | 42 | 30° 45' 22" | 81° 31' 31" | -- | -- | River Oaks (24) | -- |
| NA | 43 | 30° 45' 13" | 81° 31' 35" | -- | 85 (Avg) | Chaney's MHP (2) | -- |
| NA | 44 | 30° 45' 10" | 81° 31' 22" | -- | 85 (Avg) | Pagan Street | -- |
| NA | 45 | 30° 44' 50" | 81° 31' 25" | -- | 85 (Avg) | Marchi Drive | -- |
| NA | 46 | 30° 44' 39" | 81° 31' 28" | -- | 85 (Avg) | Lonsome Pine Rd. | -- |
| NA | 47 | 30° 45' 21" | 81° 31' 20" | -- | 85 (Avg) | Palmetto Street | -- |
| NA | 48 | 30° 47' 14" | 81° 35' 17" | -- | -- | City of St. Marys | Public Supply |
| NA | 49 | 30° 45' 01" | 81° 33' 45" | -- | -- | City of St. Marys | Public Supply |
| NA | 50 | 30° 45' 52" | 81° 34' 25" | -- | -- | City of St. Marys | Public Supply (Standby) |
| NA | 51 | 30° 44' 24" | 81° 33' 02" | -- | -- | City of St. Marys | Public Supply (Standby) |
| NA | 52 | 30° 45' 00" | 81° 31' 24" | -- | -- | Point Peter | -- |
| NA | 53 | 30° 50' 07" | 81° 34' 18" | -- | -- | Unnamed | -- |
| NA | 54 | 30° 47' 58" | 81° 32' 45" | -- | -- | NSB 6 | Raw Water Supply |

¹ Grid No. is based on USGS designation for a well location.

² Map No. corresponds to location identification on Figure 7-1 of this report.

³ Number in parentheses indicates total number of supply wells in the area of the station.

Notes: USGS U.S. Geological Survey.
ft = feet.
bls = below land surface.
-- = no data.
NA = not applicable.
Avg = average.

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Produced by the United States Geological Survey and the National Ocean Service
Control by USGS, NOS/NOAA, and USCE
Orthophotomaf prepared by the Geological Survey from aerial photographs taken April 19, 1974. Topography by planimetric surveys 1958, revised from aerial photographs taken 1974. Bathymetry compiled by the National Ocean Service from tide-coordinated hydrographic surveys. Soundings compiled from NOS 11503 and 11504. This information is not intended for navigational purposes. Mean lower low water (dotted line) and mean high water (solid line) compiled by NOS from tide-coordinated aerial photographs. Apparent shoreline (outer edge of vegetation) shown by photomastix.
Projection and 10,000-foot grid ticks: Georgia coordinate system, east zone (Transverse Mercator), zone 17, 1927 North American Datum.
To place on the predicted North American Datum 1983, move the projection lines 21 meters south and 17 meters west as shown by dashed corner ticks. There may be private landholdings within the boundaries of the National or State Reservations shown on this map.

UTM GRID AND 1983 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOURS AND ELEVATIONS IN METERS

HYDROGRAPHIC SURVEY INFORMATION

| Survey Number | Survey Date | Survey Scale | Line (bearing (true), Mean) |
|---------------|-------------|--------------|-----------------------------|
| H-5253 | 1935 | 1:10,000 | 02-12 |
| H-5254 | 1935 | 1:10,000 | 02-08 |
| H-5756 | 1935 | 1:10,000 | 02-10 |
| H-9809 | 1974 | 1:2,500 | 01-02 |

SCALE 1:24,000

CONTOUR INTERVAL 1.5 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY 0.5 METER CONTOURS - SOUNDINGS IN METERS
DATUM IS MEAN LOWER LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE

BASE MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
BATHYMETRIC SURVEY DATA COMPLIES WITH INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO) SPECIAL PUBLICATION ON ACCURACY STANDARDS AND/OR STANDARDS USED AT THE DATE OF THE SURVEY

FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80226, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

NATIONAL OCEAN SERVICE
HYDROGRAPHIC SURVEY INDEX

ROAD CLASSIFICATION

| | |
|---------------------------------|---|
| Primary highway, hard surface | Light-duty road, hard or improved surface |
| Secondary highway, hard surface | Unimproved road |
| Trails | |

Interstate Route U.S. Route State Route

HARRIETTS BLUFF, GA.
30081-65-00-024
1980
PHOTOREVISED 1988
DMA 4645 15E-SERIES V8450

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(Krause and Randolph, 1989). Local variables include problems with water quality and excessive declines in groundwater levels.

7.3 SURFACE WATER USE. There are no surface water bodies within the limits of Site 5. Surface drainage from Site 5 is somewhat limited by surrounding vegetation and the presence of man-made obstacles (dirt piles grown over with vegetation and active stockpiles). Field crews observed that excess fill dirt was recently graded over the larger of the two areas where disposal occurred.

Surface drainage to the south along the entrance roadway may enter a marsh located along the southern side of Towhee Trail. The smaller part of Site 5 is heavily vegetated. A pond, formerly a borrow pit, is adjacent to the northern part of the smaller disposal area. The pond surface is approximately 5 feet below the adjacent land surface.

Site 12 is bordered by Kings Bay on the east and by a marsh to the north. The site is covered by asphalt pavement. Runoff drains to storm drains and is conveyed approximately 0.5 mile to a retention pond.

There are no surface water bodies within the limits of Site 16. The USGS Harriett's Bluff Quadrangle topographic map shows two tributaries, that join at the headwaters of the North River, located within approximately 0.2 mile of the site. One is located to the northeast and one to the south of Site 16. Runoff at the site is drained to two catch basins located on the northern boundary of the site. One is located immediately south of monitoring well KBA-16-2 and the other is adjacent to monitoring well KBA-16-3. Overflow drains located within each catch basin route stormwater to the north of the site. During the terrain conductivity survey, a culvert was observed on the northern face of the slope that is located to the north of Site 16. It is assumed that this culvert discharges stormwater to a low, marshy area. Drainage ultimately discharges to the North River.

The environmental and economic utilization of surface waters provides the basis for classification in the State of Georgia. The specific classifications are included in Chapter 3, Rule 6, Water Quality Control, of the Rules and Regulations of the State of Georgia, Title 391 (Bureau of National Affairs, 1991). Surface waters not specified in the rule are classified as best used for fishing. Rule 6 specifically classifies littoral waters of the North River on the oceanside of Cumberland Island as best suited for recreational use. No other classifications were specifically listed for surface water bodies in the area of NSB Kings Bay.

7.4 ENDANGERED, THREATENED, OR RARE SPECIES. Several endangered species have been listed as possibly occurring in the general area of NSB Kings Bay by the U.S. Fish and Wildlife Service and the GA DNR. Table 7-2 shows endangered, threatened, and unusual flora and fauna occurring or possibly occurring in the vicinity of NSB Kings Bay. Unusual species in the State of Georgia have been designated to include any resident species that exhibit special or unique features and, therefore, deserve special consideration for continued survival in the State (ABB-ES, 1991).

**Table 7-2
Endangered, Threatened, and Unusual Flora and Fauna
Occurring or Possibly Occurring in the Vicinity of Kings Bay**

Resource Conservation and Recovery Act Facility Investigation Report for
Sites 5 and 16 and Site History and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Common Name | Scientific Name | GA DNR | U.S. Fish and Wildlife Resources |
|--|-----------------------------------|--------|----------------------------------|
| Flora | | | |
| Buckthorn | <i>Bumelia thornei</i> | E | |
| Indian-plantain | <i>Cacalia diversifolia</i> | T | |
| Spider-lily | <i>Hymenocallis coronaria</i> | E | |
| Loosestrife | <i>Lythrum curtissii</i> | E | |
| Cow-bane | <i>Oxypolis canbyi</i> | T | |
| Panic grass | <i>Panicum hirstii</i> | E | |
| Trumpet leaf | <i>Sarracenia flava</i> | T | |
| White trumpet | <i>Sarracenia leucophylla</i> | T | |
| Hooded pitcher plant | <i>Sarracenia minor</i> | T | |
| Parrot pitcher plant | <i>Sarracenia psittacina</i> | T | |
| Amphibians | | | |
| Georgia blind cave salamander | <i>Haeidotrion wallacei</i> | U | |
| Reptiles | | | |
| American alligator | <i>Alligator mississippiensis</i> | | E |
| Eastern indigo snake | <i>Drymarchon corais</i> | T | T |
| Birds | | | |
| Ivory-billed woodpecker | <i>Campephilus principalis</i> | E | E |
| American peregrine falcon | <i>Falco peregrinus anatum</i> | E | T |
| Arctic peregrine falcon | <i>Falco peregrinus tundrius</i> | E | T |
| Bald eagle | <i>Haliaeetus leucocephalus</i> | E | E |
| Wood Stork | <i>Mycteria americana</i> | | E |
| Red-cockaded woodpecker | <i>Picoides borealis</i> | E | E |
| Bachman's warbler | <i>Vermivora bachmanni</i> | E | E |
| Source: ABB-ES, 1991. | | | |
| Notes: GA DNR = Georgia Department of Natural Resources. E = endangered. T = threatened. U = unusual. | | | |

8.0 SITE HISTORY AND FILE INFORMATION FOR SITE 12

This section provides a summary of available information, gathered by the Navy, pertaining to past waste disposal practices for Site 12, Army Reserve Disposal Area, Current Dry Dock Area. This information is submitted as specified by the RFI Workplan (ABB-ES, 1991).

Site 12 was identified as an IR site during the Initial Assessment Study. In 1985, the site was known as the Army Reserve Disposal Area, Future Dry Dock Area. Since issuance of the Initial Assessment Study, the construction of the Dry Dock was completed in 1990 (Figure 8-1).

8.1 SITE LOCATION. The Army Reserve Disposal Area, Current Dry Dock Area, is located along Kings Bay in the northeastern section of the NSB (see Figure 1-2). Site 12 is accessed via USS Mariano Villego Avenue.

8.2 SITE DESCRIPTION. As described in the Initial Assessment Study, the Army Reserve Disposal Area, Future Dry Dock, site was approximately 41 acres in size. It is surrounded on the east by Kings Bay, on the south by USS James Monroe Avenue, on the west by the dredge disposal area, and on the north by a marsh.

The site is currently covered by asphalt pavement. Presently the area of Site 12 is used for parking and roadways associated with the dry dock. Figure 8-1 shows the present configuration of the site.

8.3 PREVIOUS STUDIES. Prior to the development of the October 1991 RFI Workplan, the NSB Public Works Office developed an RFI workplan, which is included in Appendix K (Reference 1) of this document. Subsection I.B.3. of the NSB workplan indicated that all wastes were removed from Site 12 and recommended No Further Action at the site. In a letter dated September 28, 1990, from the Environmental Protection Division of the GA DNR (Appendix K, Reference 1), the NSB workplan was approved, indicating acceptance of the No Further Action proposal. Subsequently, the RFI Workplan developed under the IR program did not include investigation of Site 12 but specified that file information be gathered for inclusion in this RFI report.

According to the Initial Assessment Study, Site 12 was used by the Army Reserve for amphibious ship-to-shore materials loading and off-loading training operations from 1974 to 1978. Wastes handled at the site included empty wooden and metal ammunition boxes, concrete slabs, and dummy cargo. The total quantity of waste handled at Site 12 was estimated during the Initial Assessment Study to be approximately 467,000 cubic yards (C.C. Johnson & Associates, 1985).

In 1983, a contractor operating a backhoe at the site uncovered approximately six to eight 55-gallon drums. One of the drums was punctured by the backhoe, causing a spill. The stained soils and drums were removed from the NSB by a waste disposal contractor in 1983.

Site 12 was recommended for No Further Action in the Initial Assessment Study because the site did not pose a potential threat to human health or to the environment (C.C. Johnson & Associates, 1985).

8.4 SITE HISTORY AND SUPPORTING INFORMATION FOR SITE 12. Information pertaining to past waste disposal activities at Site 12 was obtained during a review of Navy files. Information sources for Site 12 include documentation of the site history and documentation of interviews performed during the Initial Assessment Study. This information indicates that waste disposed at the site included old army dummy cargo, wooden and metal ammunition boxes, concrete slabs, and a few 55-gallon drums (Appendix K, References 1, 2, and 3).

In addition, interview memoranda indicate that Site 12 was used by the Army for amphibious ship-to-shore training operations. The Army units were trained in transporting supplies and materials and camped in this area throughout the training exercises (Appendix K, References 4 and 5). Since 1978, contractors have used the Site 12 area as a temporary storage area for construction materials.

From August 1983 through spring of 1984, the American Dredging Company used the area for drum storage of 0.25 to 2 million pounds (in 55-gallon drums) of Tovex, a gel-like, ammonia-based underwater dredging explosive. Tovex was brought in on tank trucks and pumped into the 55-gallon drums. The Tovex was then pumped into holes in the bottom of the channel and detonated (Appendix K, Reference 5). Since spring of 1984, the Laport Dredging Company has used the Site 12 area for material storage.

During the construction of the dry dock in the early 1980's, construction crews reported excavating scrap metal, dunnage, nail kegs, and oxygen breathing apparatus canisters (Appendix K, Reference 5). Information obtained during the review of Navy files includes documentation of the removal of six to eight 55-gallon drums from Site 12. In addition, information pertaining to the removal of soils from a fire-fighting training pit located within the boundaries of Site 12 was located. This information is discussed in Subsections 8.4.1 and 8.4.2, respectively.

8.4.1 Removal of Soils from the Fire-Fighting Training Pit The Initial Assessment Study indicates that Site 2, Fire-fighting Training Pit, is contained within the Site 12 boundary. Site 2 was an unlined fire-fighting training pit used from 1979 to 1981. The site was approximately 30 feet by 30 feet by 2 feet deep. It was located in the waterfront area off Pelican Road near the intersection of Stimson Drive and USS James Monroe Avenue (C.C. Johnson & Associates, 1984; Appendix K, Reference 6). The pit was surrounded by soil with a thin layer of dredge spoils overlying organic silty clay. The area is flat with the water table at or near grade. Kings Bay is located approximately 300 feet from the pit (Appendix K, Reference 7). The general area suspected of containing the pit is shown on Figure 8-1.

Fire-training exercises were set-up at the site by placing contaminated diesel fuel, paints, and paint thinners into the bermed pit. The liquids in the pit were ignited approximately once every 2 months by the fire department. Approximately 1,500 gallons of waste engine oil and small amounts of diesel fuel, paints, and paint thinners were reportedly burned between 1980 and 1981. In 1980, a 1-time disposal of an unknown quantity of hydrazine was also burned at Site 2 (C.C. Johnson & Associates, 1985).

A soil core sample was taken from the pit in August 1981 and was tested for Extraction Procedure (EP) toxicity. The sample did not exceed the maximum concentration of contaminants for characteristics of EP toxicity (Appendix K,

Reference 8). EP toxicity analysis was appropriate for characterizing waste in 1981.

A letter dated September 17, 1981 (addressed to Mr. Craig Root, Camden County Administrator, from R.A. Currier, Captain, U.S. Navy Commanding Officer) requested permission to dispose of approximately 100 cubic yards of pit sludges from a fire-fighting training area in the Camden County Landfill located in Kingsland (Appendix K, Reference 9 and 10). Results of the previous EP toxicity testing results were attached to this letter. A second letter dated December 18, 1981, from the Camden County Health Department gave approval for the disposal of the waste (i.e., burnt oils, gasoline, etc.) at the county landfill (Appendix K, Reference 9). The Initial Assessment Study reported that approximately 100 cubic yards of soil were excavated from the pit and disposed by a waste disposal contractor in 1982 (C.C. Johnson & Associates, 1985).

Because of the EP toxicity results and the volume of soil excavated, Site 2 was recommended for No Further Action in the Initial Assessment Study because the site did not pose a potential threat to human health and the environment (C.C. Johnson & Associates, 1985). However, the potential for groundwater contamination resulting from activities conducted at Site 2 has not been evaluated. Additional investigation is needed at Site 2 to evaluate potential groundwater contamination.

8.4.2 Removal of Drums from Site 12 As previously discussed, a contractor operating a backhoe at Site 12 uncovered six to eight 55-gallon drums in 1982. According to an interview memorandum completed for the Initial Assessment Study, drums of waste oil were uncovered from an area approximately 100 feet from the old fire-fighting training facility in 1982. The drums may have been from the USS Simon Lake, which supplied waste oil in 55-gallon drums to the fire-fighting training area. During construction of the Dry Dock, one drum was punctured with the backhoe, which caused a spill. The spilled oil, stained soil, and remaining six to eight 55-gallon drums were recovered and removed from the area and disposed off base through the NSB Kings Bay Public Works Department (Appendix K, Reference 11).

On January 25, 1983, a work request was issued by the Public Works Officer of NSB Kings Bay to perform the following activities (Appendix K, Reference 12):

- excavate buried oil drums and debris from the new dry dock site located next to Kings Bay,
- dispose of waste oil by placing into the 78 Water Treatment Plant oil and water separator (if non-PCB contaminated) or by placing into 55-gallon Department of Transportation- (DOT) approved drums (if PCB contaminated),
- dispose of sand and soil containing minor amounts of oil by air drying and hauling to county disposal area (if non-PCB contaminated) or by placing into 55-gallon DOT-approved drums (if PCB contaminated), and
- coordinate with base environmental engineer to excavate, segregate, and label drums. Samples will be collected by the base environmental engineer for laboratory analysis.

A Hazardous Waste Manifest was also obtained during the file review. This manifest was prepared on March 30, 1984, for the Defense Property and Disposal Office at NSB Kings Bay. The manifest was prepared for the disposal of 8 55-gallon drums of hazardous waste solid classified as dirt contaminated with lead (400 pounds), 48 55-gallon drums of waste flammable liquid classified as paint and solvent (2,540 gallons), and 17 55-gallon drums of hazardous waste liquid classified as insulating varnish (935 gallons) (Appendix K, Reference 13).

9.0 SUMMARY AND RECOMMENDATIONS

The following subsections summarize results of groundwater and soil investigations conducted at Sites 5 and 16, NSB Kings Bay, Georgia. Recommendations are made based on these results. File information is summarized for Site 12 and recommendations are made based on the file information. Each site is addressed separately.

9.1 SITE 5, ARMY RESERVE DISPOSAL AREA, TOWHEE TRAIL.

9.1.1 Summary of Results The RFI at Site 5 included geophysical surveys, surface soil sampling, subsurface soil sampling, monitoring well installation, and groundwater sampling. Geophysical investigations were conducted using magnetics and terrain conductivity. Results of the magnetometer survey at Site 5 indicated limited disposal of ferrous material. No anomalous conductivity values were recorded during the terrain conductivity survey, which indicates there are no areas of highly conductive groundwater emanating from the site.

Groundwater. Seven monitoring wells were installed around the perimeter of two areas comprising Site 5. Groundwater level measurements collected during July 1992 indicated divergent groundwater flow such that none of the seven wells were located upgradient of the site. All other water level measurement data indicated that two monitoring wells, KBA-5-1 and KBA-5-2, were upgradient of the site. Additional data are needed to develop a background data set, especially for inorganic constituents. Some conclusions, however, can be drawn from the existing data from the site.

The RFI included a groundwater monitoring program composed of six bimonthly sampling events. Analyses for the first two sampling events included Appendix IX VOCs, SVOCs, pesticides, herbicides, PCBs, inorganics, dioxins, and furans. After the second sampling event, the monitoring program was reduced to include VOCs, SVOCs, PCBs, and inorganics. Additionally, during November 1992, groundwater samples were collected from depths below screened intervals of monitoring wells using direct push methods. These samples were analyzed in an onsite laboratory for select VOCs with at least 10 percent of the samples replicated for offsite confirmatory analysis of TCL VOCs using CLP procedures. Table 9-1 lists the compounds detected in soil and groundwater samples and the corresponding maximum concentrations detected.

No pesticides, herbicides, PCBs, dioxins, or furans were detected in groundwater samples collected from the site during the first and second monitoring events. When the analytical program was reduced, PCBs remained on the list of parameters for monitoring because of low concentrations detected in soil at the site. However, PCBs have not been detected in groundwater samples. VOCs were detected during the first sampling event, and included VOCs that are suspected of being laboratory or sampling artifacts, naturally occurring, and fuel-related VOCs. SVOCs detected in groundwater samples from the site were limited to phthalates. Phthalates are commonly introduced into sample media during sampling or analysis. The data do not suggest the site is a source of SVOC or VOC contamination of environmental media.

Table 9-1
Summary of Compounds and Concentrations Detected at Site 5

RFI Report for Sites 5 and 16 and Site History
and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compounds | MCL ($\mu\text{g/L}$) | Maximum Concentrations Detected at Site 5 | |
|---------------------------------------|----------------------------|---|---------------------------|
| | | Water ($\mu\text{g/L}$) | Soil ($\mu\text{g/kg}$) |
| Organic Compounds | | | |
| Acetone | - | 72 | 17,000 |
| bis(2-Ethylhexyl)phthalate | - | 18 | 790 |
| Carbon disulfide | - | 2 J | 24 J |
| 4,4'-Dichlorodiphenyldichloroethylene | - | ND | 0.7 J |
| Diethylphthalate | - | 2 J | 69 J |
| Ethylbenzene | 700 | 1 J | ND |
| Methylene chloride | 5 | ND | 110 J |
| Aroclor 1260 (PCB) | 0.5 | ND | 53 |
| Toluene | 1,000 | ND | 6 J |
| Trichlorofluoromethane | - | 7 | 3 J |
| Xylene (total) | 10,000 | 6 | 21 J |
| Naphthalene | - | ND | 44 J |
| 3- and 4- Methylphenol | - | ND | 82 J |
| 4-Methyl-2-pentanone | - | 3 J | ND |
| Benzoic acid | - | ND | 660 J |
| Inorganic Compounds | | | |
| | | | (mg/kg) |
| Antimony | 6 | 17.0 J | ND |
| Arsenic | 50 | 135 | 1.1 J |
| Barium | 2,000 | 1,080 | 8.0 J |
| Beryllium | 4 | 8.2 | 0.16 J |
| Cobalt | - | 62.6 J | ND |
| Copper | - | 249 | 7.8 |
| Cyanide | 200 | 10.3 | 5.0 |
| Lead | 15 | 68.9 | 8.5 |
| Mercury | 2 | 0.51 | ND |
| Selenium | 50 | 6.3 | 1.8 |
| Silver | - | 4.5 J | ND |
| Sulfide | - | 2,100 | 5,100 |
| Chromium | 100 | 271 | 8.7 |
| Nickel | 100 | 128 | 9.2 |

See notes at end of table.

Table 9-1 (Continued)
Summary of Compounds and Concentrations Detected at Site 5

RFI Report for Sites 5 and 16 and Site History
and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compounds | MCL ($\mu\text{g/L}$) | Maximum Concentrations Detected at Site 5 | |
|-----------|----------------------------|---|--------------|
| | | Water ($\mu\text{g/L}$) | Soil (mg/kg) |
| Thallium | 2 | 3.4 J | ND |
| Tin | - | 702 J | ND |
| Vanadium | - | 251 | 8.5 J |
| Zinc | - | 519 | 10.1 |
| Cadmium | 5 | 27.4 | ND |

Notes: MCL = maximum contaminant level for drinking water (GA DNR, 1993; USEPA, 1993).
 $\mu\text{g/L}$ = micrograms per liter.
 $\mu\text{g/kg}$ = micrograms per kilogram.
J = sample quantitation limit is considered estimated because an associated continuing calibration standard exceeded quality control limits.
PCB = polychlorinated biphenyl.
ND = none detected.
mg/kg = milligrams per kilogram.

During the first sampling event, samples collected from five of seven monitoring wells contained detectable concentrations of VOCs. Acetone, carbon disulfide, 4-methyl-2-pentanone, xylenes, ethylbenzene, and trichlorofluoromethane were detected at concentrations ranging from 1 J $\mu\text{g}/\text{L}$ to 72 $\mu\text{g}/\text{L}$ (acetone). The presence of acetone is attributed to laboratory and sampling artifacts. Concentrations of VOCs did not exceed applicable MCLs. For the most part, VOC concentrations were below reporting limits and near the instrument detection limit for the compounds. No VOCs have been detected in groundwater from Site 5 since the first monitoring event (February 1992).

Inorganic data for groundwater from Site 5 were evaluated by statistical comparison and concentrations detected were compared to MCLs. Because background data have not been collected to use in the evaluation, the presence or absence of inorganic contaminants cannot be fully assessed. The statistical comparison involved comparing data from monitoring wells KBA-5-1 and KBA-5-2 to data from monitoring wells KBA-5-3 through KBA-5-7. Water level data from the site indicate that monitoring wells KBA-5-1 and KBA-5-2 are upgradient of the site, except that water level data for the July 1992 sampling event indicated divergent flow. The July 1992 inorganic data for monitoring wells KBA-5-1 and KBA-5-2 were not used in the statistical comparison. After background data have been collected, the data from monitoring wells KBA-5-1 and KBA-5-2 can be compared to the background data to assess whether these two monitoring wells can provide groundwater quality information unaffected by potential releases from the site. The data from the other five monitoring wells will also be reevaluated based on the background groundwater quality.

Evaluation of the existing data from Site 5 indicate that cadmium concentrations in groundwater samples from monitoring wells KBA-5-6 and KBA-5-7 are significantly greater than concentrations in samples from the upgradient monitoring wells, KBA-5-1 and KBA-5-2. Also, cyanide concentrations in groundwater samples from monitoring well KBA-5-4 were significantly greater than concentrations upgradient of the site. In comparison to MCLs, eight inorganic constituents were detected in groundwater samples at concentrations above corresponding MCLs. The eight constituents are antimony, arsenic, beryllium, cadmium, chromium, lead, nickel, and thallium. Antimony is the only constituent detected at a concentration above its MCL during the last three sample events that were conducted in September and November 1992 and January 1993.

Soil. Eight subsurface soil samples and eight surface soil samples were collected from the site and submitted to the contract laboratory for analysis of Appendix IX VOCs, SVOCs, pesticides, herbicides, PCBs, inorganics, dioxins, and furans. Eight additional surface soil samples were collected from the site and analyzed for PCBs only. These additional surface soil samples were collected to evaluate the site for potential PCB contamination in response to a detection of a PCB compound in one of the initial surface soil samples. Analytes detected in the soil samples included VOCs, SVOCs, inorganics, a pesticide, and a PCB. Table 9-1 lists the compounds detected in soil and groundwater samples from the site and the corresponding maximum concentrations detected.

Similar to groundwater data, VOCs detected in soil samples from the site include laboratory and sampling artifacts, fuel-related VOCs, and a naturally occurring compound. VOCs detected include acetone, methylene chloride, carbon disulfide, toluene, xylenes, and trichlorofluoromethane. Methylene chloride and acetone concentrations were validated as not detected based on associated method blank contamination in 12 and 8 soil samples, respectively. Sixteen soil samples were

collected for VOC analysis. Concentrations of methylene chloride and acetone that were not qualified based on associated QC samples were considered suspect based on an evaluation of concentrations in method blanks and in QC samples collected during the RFI. Therefore, the presence of these VOCs is not considered representative of site conditions. The presence of carbon disulfide in soil samples is considered indicative of a background condition. Carbon disulfide is a simple molecule that could be the result of biological activity involving naturally occurring organo-sulfur acids (Verschueren, 1983). Trichlorofluoromethane, toluene, and xylene concentrations in soil samples were generally below their PQL of 5 µg/kg, with a maximum detected concentration of 21 J µg/kg.

SVOCs detected in soil include benzoic acid, methylphenol, naphthalene, and phthalates. Phthalates detected in soil samples include diethylphthalate and bis(2-ethylhexyl)phthalate, the later being detected in all soil samples. Phthalates are pervasive sampling and laboratory contaminants and are generally ubiquitous in the environment. Benzoic acid, detected in 3 of 16 soil samples, is suspected of being a naturally occurring organic acid. Methylphenol and naphthalene are potential site-related SVOCs, each detected in one soil sample at concentrations of 82 J and 44 J µg/kg, respectively.

One pesticide, 4,4'-DDE, and one PCB compound, Aroclor-1260, were detected in soil samples from the site at low concentrations. 4,4'-DDE was detected in one surface soil sample at an estimated concentration of 0.7 J µg/kg. Aroclor-1260 was detected in five surface soil samples at concentrations ranging from 4.4 J to 53 µg/kg.

Inorganic concentrations for soil samples from within and around the downgradient periphery of the site were compared to those associated with the two upgradient soil borings. Zinc, nickel, and cyanide concentrations in soil samples from within and downgradient of Site 5 exceeded concentrations in soil samples from upgradient locations by more than 3 times. One surface soil sample contained zinc at a concentration of 31 mg/kg, which is approximately 5 times the maximum concentration in upgradient soil samples. Nickel was detected in one subsurface soil sample at a concentration approximately 5 times the maximum concentration of 1.7 mg/kg detected in a soil sample from an upgradient location. Cyanide was not detected in soil samples collected from locations upgradient of the site, but was detected in two subsurface soil samples at concentrations of 4.6 and 5 mg/kg. A background data set is needed to fully evaluate potential contaminants in soil at Site 5.

9.1.2 Recommendations Confirmatory sampling is recommended for Site 5 in the form of a Supplemental RFI. Confirmatory activities should include collection of background chemical data for soil and groundwater. A workplan will be developed and submitted to GA DNR for approval, addressing the details of tasks to be conducted under the Supplemental RFI.

9.2 SITE 16, ARMY RESERVE DISPOSAL AREA, MOTOR MISSILE MAGAZINES.

9.2.1 Summary of Results The RFI at Site 16 included a geophysical survey, subsurface soil sampling, monitoring well installation, and groundwater sampling. Geophysical investigation was limited to a terrain conductivity survey along the downgradient perimeter of the site. Magnetometry could not be used because of interferences from construction activity at the site. Results of the terrain

conductivity survey indicated one area of anomalous readings in the vicinity of a buried culvert suspected of influencing the survey.

Groundwater. Four monitoring wells were installed at Site 16. The monitoring well locations were selected based on knowledge of the site location reported in the Initial Assessment Study (C.C. Johnson, 1985) and from aerial photographs and area reconnaissance. The suitability of the existing monitoring wells needs to be evaluated after additional efforts to confirm the location of the disposal area have been conducted. Also, a background data set needs to be developed so that potential contaminants can be identified relative to background conditions.

The RFI included a groundwater monitoring program made up of six bimonthly sampling events. Analyses for the first two sampling events included Appendix IX VOCs, SVOCs, pesticides, herbicides, PCBs, inorganics, dioxins, and furans. After the second sampling event, the monitoring program was reduced to include VOCs, the base and neutral fractions of SVOCs, and inorganics. Additionally, during November 1992, groundwater samples were collected from depths below screened intervals of monitoring wells using direct push methods. These samples were analyzed in an onsite laboratory for select VOCs with at least 10 percent of the samples replicated for offsite confirmatory analysis of TCL VOCs using CLP procedures. Table 9-2 lists the compounds detected in soil and groundwater samples and the corresponding maximum concentrations detected.

No pesticides, herbicides, PCBs, dioxins, or furans were detected in groundwater from the site during the first two sampling events. When the analytical program was reduced, the base and neutral fractions of the SVOCs remained on the monitoring list because of concentrations of fuel-related SVOCs in one subsurface soil sample from a detection well soil boring. VOCs detected in groundwater samples included fuel-related VOCs and those suspected of being caused by sampling or laboratory contamination. SVOCs detected in groundwater included one fuel-related compound and phthalates. Inorganic concentrations in groundwater samples from release detection monitoring wells (KBA-16-1 through KBA-16-3) were evaluated by statistical comparison to upgradient mean concentrations based on analytical data from samples collected from monitoring well KBA-16-4.

Five VOCs, including acetone, toluene, xylenes, ethylbenzene, and 4-methyl-2-pentanone, were detected in groundwater samples from two release detection monitoring wells. Each of these VOCs was detected in only one groundwater sample during the RFI monitoring program. The presence of acetone in one groundwater sample is suspected of being a sampling or laboratory artifact. Xylenes, ethylbenzene, and toluene are fuel-related VOCs detected at concentrations ranging from 1 J $\mu\text{g/L}$ to 5 $\mu\text{g/L}$. 4-Methyl-2-pentanone is a solvent used in paints and varnishes that was detected in one groundwater sample during the first sampling event at a concentration of 3 J $\mu\text{g/L}$.

SVOCs detected in groundwater include naphthalene and phthalates. Naphthalene is a fuel-related SVOC that could be associated with other SVOCs detected in a soil sample from the site. Naphthalene was detected in two groundwater samples from one of the release detection monitoring wells at concentrations of 1 J and 2 J $\mu\text{g/L}$. Phthalates detected in groundwater samples include bis(2-ethylhexyl)phthalate and di-n-butylphthalate. Concentrations ranged from 1 J to 28 $\mu\text{g/L}$. The presence of phthalates in groundwater samples is suspected of being incidental to sampling and analysis.

Table 9-2
Summary of Compounds and Concentrations Detected at Site 16

RFI Report for Sites 5 and 16 and Site History
and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compounds | MCL ($\mu\text{g/L}$) | Maximum Concentrations Detected at Site 16 | |
|------------------------------------|----------------------------|--|---------------------------|
| | | Water ($\mu\text{g/L}$) | Soil ($\mu\text{g/kg}$) |
| Organic Compounds | | | |
| Acetone | - | 10 | 110 |
| bis(2-Ethylhexyl)phthalate | - | 75 | 1,100 |
| Carbon disulfide | - | ND | 2 J |
| 4,4'-Dichlorodipenyldichloroethane | - | ND | 1 |
| Di-n-butylphthalate | - | 2 J | ND |
| Ethylbenzene | 700 | 2 J | ND |
| Toluene | 1,000 | 5 | 1 J |
| Xylene (total) | 10,000 | 3 J | 9 |
| Naphthalene | - | 2 J | ND |
| 4-Methyl-2-pentanone | - | 3 J | ND |
| 2-butanone | - | ND | 10 |
| Acenaphthene | - | ND | 99 J |
| Fluorene | - | ND | 61 J |
| Phenanthrene | - | ND | 130 J |
| Fluoranthene | - | ND | 1,000 |
| Pyrene | - | ND | 1,700 |
| Benzo(a)anthracene | - | ND | 390 |
| Chrysene | - | ND | 600 |
| Benzo(b)fluoranthene | - | ND | 310 J |
| Benzo(k)fluoranthene | - | ND | 280 J |
| Benzo(a)pyrene | 0.2 | ND | 170 J |
| Inorganic Compounds | | | (mg/kg) |
| Antimony | 6 | 23.1 J | ND |
| Arsenic | 50 | 63.2 | 0.34 J |
| Barium | 2,000 | 538 | 6.4 |
| Beryllium | 4 | 15.9 | ND |
| Cobalt | - | 74.4 | ND |
| Copper | - | 82.8 | 2.4 J |
| See notes at end of table. | | | |

Table 9-2 (Continued)
Summary of Compounds and Concentrations Detected at Site 16

RFI Report for Sites 5 and 16 and Site History
and File Information for Site 12
Naval Submarine Base
Kings Bay, Georgia

| Compounds | MCL ($\mu\text{g/L}$) | Maximum Concentrations Detected at Site 16 | |
|-----------|----------------------------|--|--------------|
| | | Water ($\mu\text{g/L}$) | Soil (mg/kg) |
| Cyanide | 200 | 18.5 | ND |
| Lead | 15 | 41.2 J | 3.9 |
| Mercury | 2 | 0.82 | ND |
| Selenium | 50 | 10.6 | ND |
| Silver | - | 3.6 J | ND |
| Sulfide | - | 2,400 | 18,300 |
| Chromium | 100 | 256 | 1,540 |
| Nickel | 100 | 274 | 3.0 J |
| Thallium | 2 | 17.3 J | ND |
| Vanadium | - | 257 | 2.4 J |
| Zinc | - | 297 | 3.4 J |
| Cadmium | 5 | 3.4 J | ND |

Notes: MCL = maximum contaminant level for drinking water (Environmental Protection Division, 1993; USEPA, 1993).
 $\mu\text{g/L}$ = micrograms per liter.
 $\mu\text{g/kg}$ = micrograms per kilogram.
ND = none detected.
J = estimated value.
mg/kg = milligrams per kilogram.

Similar to Site 5, evaluation of inorganic data from Site 16 was done without the benefit of background groundwater quality data. Statistical comparison of the data was done based on the assumption that groundwater quality upgradient of the site and at the location of monitoring well KBA-16-4 is unaffected by any releases from the disposal area. The data for groundwater samples from monitoring well KBA-16-4 were compared to data for groundwater samples from monitoring wells KBA-16-1 through KBA-16-3. This comparison indicates that concentrations of beryllium, chromium, cobalt, vanadium, and zinc in groundwater samples from monitoring well KBA-16-3 are significantly greater than concentrations upgradient of the site. Cobalt and zinc concentrations in samples from monitoring well KBA-16-2, and selenium concentrations in samples from KBA-16-1, were also significantly greater than concentrations upgradient of the site. In comparison to MCLs, seven inorganic constituents were detected in groundwater samples at concentrations above corresponding MCLs. The seven constituents are antimony, arsenic, beryllium, chromium, lead, nickel, and thallium.

Soil. Four subsurface soil samples were collected from the site and submitted to the contract laboratory for analysis of Appendix IX VOCs, SVOCs, pesticides, herbicides, PCBs, inorganics, dioxins, and furans. Analytes detected in the soil samples included VOCs, SVOCs, inorganics, and a pesticide.

VOCs detected in soil samples include acetone, carbon disulfide, 2-butanone, toluene, and xylenes. Acetone concentrations are suspected of being laboratory or sampling artifacts. This VOC is a hydrophilic compound and was not detected in groundwater samples from monitoring wells screened in the interval where soil samples were collected. Similarly, 2-butanone is a common laboratory solvent that was detected in a soil sample from the boring for the upgradient monitoring well. This VOC is also hydrophilic but was not detected in groundwater samples from the site. The presence of carbon disulfide in one soil sample is suspected of being a naturally occurring background condition. Xylene is a fuel-related VOC that was detected in all four soil samples from the site at concentrations ranging from 2 J to 9 $\mu\text{g}/\text{kg}$.

SVOCs were detected in one soil sample from the site and include fuel-related compounds and a phthalate. The fuel-related SVOCs detected could also be the result of incomplete combustion of organic material (i.e., wood and plants). Compounds detected include acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene. Concentrations ranged from 61 J $\mu\text{g}/\text{kg}$ to 1,700 $\mu\text{g}/\text{kg}$. None of these compounds were detected in groundwater from the site, but naphthalene, a related SVOC, was detected in two groundwater samples. The phthalate compound detected, bis(2-ethylhexyl)phthalate, was detected in two soil samples at concentrations of 520 and 390 $\mu\text{g}/\text{kg}$. Its presence is attributed to laboratory or sampling artifacts.

The pesticide 4,4'-DDD was detected in one soil sample at a concentration of 1 J $\mu\text{g}/\text{kg}$. The presence of this compound is attributed to the transformation of DDT, a common pesticide in the past.

Concentrations of inorganic constituents in soil samples from borings for release detection monitoring wells were compared to corresponding concentrations detected in the soil sample from the boring for the upgradient monitoring well. Nine inorganic constituents were detected in downgradient soil samples. All nine constituents were detected in one or more soil samples from borings for the detection monitoring wells at concentrations greater than corresponding

upgradient concentrations. However, except for chromium concentration in one soil sample, none of the inorganic constituents were present at concentrations more than 3 times greater than upgradient concentrations.

9.2.2 Recommendations Confirmatory sampling is recommended for Site 16 in the form of a Supplemental RFI. Confirmatory activities should include collection of background chemical data for soil and groundwater. A workplan will be developed and submitted to GA DNR for approval, addressing the details of tasks to be conducted under the Supplemental RFI.

9.3 SITE 12, ARMY RESERVE DISPOSAL AREA, CURRENT DRY DOCK.

9.3.1 Summary In the early 1980's, during construction of the dry dock, crews excavated scrap metal, dunnage, nail kegs, and oxygen breathing apparatus canisters from Site 12. Six to eight 55-gallon drums containing waste oil were excavated and removed from the area and disposed off base through the NSB Public Works Department. During this excavation one drum was ruptured causing a spill. The soils affected by the spill were excavated, placed in drums, and disposed in an offsite, permitted, hazardous waste disposal facility.

Site 12 also contained a former fire-fighting training area. A soil core sample was collected from the fire-fighting pit in 1981 and was submitted for EP toxicity analysis. The sample did not contain concentrations of contaminants above the maximum for EP toxicity characteristic. The EP toxicity analysis was appropriate for characterizing this waste in 1981.

Based on the results of the EP toxicity analysis, the NSB Kings Bay obtained permission to dispose of approximately 100 cubic yards of pit sludges from the fire-fighting training area in the Camden County Landfill in Kingsland, Georgia. In 1982, approximately 100 cubic yards of soil were excavated from the fire-fighting pit and disposed by a waste disposal contractor.

During construction of the dry dock, excavation and dredging activities removed much of the area of Site 12, including disposed material. The remainder of the site is covered with asphalt.

9.3.2 Recommendations In September 1990, GA DNR approved Site 12 for No Further Action based on recommendations submitted by the NSB in April 1990. However, the No Further Action approval does not include the fire-fighting training area that has been designated as Site 2. Further action should be taken at Site 2 to evaluate for groundwater contamination related to past fire-fighting activities.