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DRAFT REMEDIAL INVESTIGATION WORK PLAN ADDENDUM - PHASE III
VIRGIN ISLAND CHEMICAL SITE
ST. CROIX, U.S. VIRGIN ISLANDS

Prepared for
Island Chemical Company

HLA Project No. 35241.5

John S. Virgie, P.G.
Senior Geologist

Edward A. Nemecek, R.G., CPG
Principal Hydrogeologist
Regional Geosciences Manager

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Harding Lawson Associates
14 Washington Road, Building 7
Princeton Junction, New Jersey 08550
(609) 936-0700

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1.0 BACKGROUND

1.1 Introduction

Harding Lawson Associates (HLA) has prepared this *Remedial Investigation Work Plan Addendum* on behalf of Island Chemical Corporation (ICC) as part of the Remedial Investigation (RI) of the Virgin Island Chemical site (site) located in St. Croix, U.S. Virgin Islands. This RI Work Plan Addendum is intended to address issues discussed and agreed to during the meeting on October 17, 1996, with the U.S. Environmental Protection Agency, Region II (EPA) and comments presented in EPA's letter dated December 23, 1996. The work described in this document will be performed in accordance with the project *Sampling and Analysis Plan* (SAP), *Health and Safety Plan* (HASP), and *Quality Assurance Project Plan* (QAPP) provided with the *Remedial Investigation Work Plan* (Work Plan), dated March 17, 1994 and revised August 5, 1994 (HLA, 1994). Addenda to these documents are included as Appendixes

1.2 Site Description

1.2.1 Site Location

The site occupies approximately 3 acres in south central St. Croix, U.S. Virgin Islands (Figure 1-1). The site is located on Melvin Evans Highway (Route 66), approximately 1,500 feet north of the Alexander Hamilton Airport. The property is located on Plot 13Q of Estate Bethlehem Middle Works at 17°42'35" north latitude, 64°47'26" west longitude.

The site is bordered to the northeast and southeast by an intermittent stream identified as the River Gut. It is bordered to the west by an undeveloped lot and to the southwest by Route 66. A concrete batch plant and two automobile repair shops are located to the east of the site, across the River Gut. An asphalt paving company is located north-northwest of the site across the River Gut.

1.2.2 Site Structures

The facility is currently abandoned. The current layout of the facility is shown in Figure 1-2. Major onsite structures include the following:

- Laboratory and Warehouse Building
- Maintenance Building
- Above-Ground Storage Tank (AST) Farm
- Concrete Pads adjacent to AST Farm (former AST locations)
- Loading Dock
- Concrete Storage Pad
- Centrifuge and Dryer Building
- Reactor Process Area
- Former Process Pit (filled during previous work at this site)
- Generator Building
- Pump Building
- 250,000-Gallon Fire Water AST

1.2.3 Site Setting

The site is located in a valley. Surface elevations at the site range from approximately 30 to 40 feet above mean sea level (MSL). Land to the southwest (approximately 200 feet) and to the east (approximately 1,000 feet) of the site slopes steeply upward to roughly 150 to 200 feet above MSL.

The ground surface slopes gently across the site from southwest to northeast. Ground surface just beyond the northern and eastern fence lines slopes steeply downward approximately 12 to 15 feet into the River Gut. An earthen berm, approximately 4 feet high, partially separates the AST farm in the western part of the facility from the remainder of the site. On the western side of the berm, runoff drains from southwest to northeast. Surface drainage on the eastern portion of the site is controlled by the buildings, concrete paved areas, and two storm drains that channel runoff along the southeastern site boundary (Figure 1-2). Flow in the River Gut is intermittent and generally occurs only during the rainy season, between September and December. The Caribbean Sea is located approximately 4,500 feet south of the site.

Based on previous investigations, shallow soils beneath the site consist of alluvium. The geology and hydrogeology of St. Croix were discussed in more detail in the Work Plan and in the *Draft Data Summary Report* (DSR) , dated August 15, 1995 (HLA, 1995). Figure 1-3 presents a generalized geologic map of the island.

1.3 Previous Activities and Data Needs

Between September 1984 and March 1986, Enviro-Science, Inc. (ESI) performed a series of investigations of selected portions of the site. In September 1985 and March 1986, EPA collected several samples from the site. Between March 1989 and April 1991, EPA performed a preliminary assessment and drum removal. In February 1991, NUS Corporation (NUS) collected groundwater, soil and sediment samples as part of a Preliminary Assessment/Site Investigation, performed on behalf of EPA. Data generated during these activities were summarized in the Remedial Investigation Work Plan (HLA, 1994).

From October 1994 to August 1995, HLA implemented the EPA-approved Remedial Investigation Work Plan. Results of work performed to date were summarized in the DSR (HLA, 1995). The key findings of that investigation were:

- Volatile organic compounds (VOCs) were detected in soils and shallow groundwater samples collected at MW-1 in the vicinity of Tanks 8 and 9 in the above-ground storage tank (AST) area.
- The two primary constituents of concern identified in previous investigations, pyridine and chloroform, were not detected in any soil or groundwater samples collected during HLA's 1995 investigation.
- The visual reconnaissance performed after site clearing revealed no additional potential source areas.

Following EPA's review of the DSR, HLA prepared a proposal letter (April 12, 1996) and Phase II RI Work Plan (May 15, 1996) to address the following data needs requested by EPA:

- Obtain additional information in shallow groundwater flow direction over time.
- Extent of impacted soil and groundwater identified in the vicinity of Tanks 8 and 9 in the AST area.
- Groundwater quality near the center of the site (Former Process Pit Area).

From May through August 1996, HLA implemented the EPA-approved Phase II RI Work Plan. Results of the work performed during the completion of Phase II activities were summarized in the *Draft Supplemental Data Summary Report*, dated September 13, 1996 (HLA, 1996). The key findings of that investigation were:

- The lateral and vertical extent of VOCs in soils at the AST area were defined to the north, east, and south[1] of the identified source area, but not to the west (offsite). The extent of VOCs in groundwater was not defined in a downgradient or western direction .

- Chloroform was detected above the Federal Maximum Contaminant Level (MCL) in shallow groundwater at the former process pit area (Monitoring Well MW-2).

- Based on several months of continuous groundwater level monitoring, a shallow groundwater divide trending north-south is interpreted to exist at the site. The groundwater flow direction across the majority of the site west of the divide is to the west and northwest, and the flow direction in the easternmost portion of the site east of the divide to the east and northeast.

On October 17, 1996, EPA met with HLA to discuss the findings of the *Supplemental Data Summary Report*. EPA suggested that several data needs still remained and that they be addressed through supplemental investigative activities. Objectives are discussed below. Activities are identified in Section 2.0.

1.4 Objectives

The objectives of this phase (Phase III) of the RI are to address the following data needs identified during the October 17, 1996, meeting with EPA.

- Further evaluate the lateral and vertical extent (onsite and offsite) of toluene, ethylbenzene, and xylene (TEX) previously detected in soils and groundwater related to the small area near Tanks 8 and 9 in the AST area.

- Estimate hydrogeologic properties (specifically hydraulic conductivity) of the shallow and deep water-bearing zones onsite.

- Evaluate the flow direction in the deeper portion of the water-bearing zone.

- Perform groundwater sampling (including production wells P1 and P2) to evaluate the extent of VOCs, including chloroform, in groundwater.

- Evaluate Target Analyte List (TAL) metals concentrations onsite and in River Gut.

- Preliminarily evaluate the applicability of soil vapor extraction as a possible remedial alternative for soil in the AST area.

- Obtain available water quality data from Fairplains supply wells from the Virgin Island Water and Power Authority

The tasks described in Sections 2.0 and 3.0 of this RI Work Plan Addendum are designed to achieve these objectives. Following completion of these tasks, HLA will evaluate the findings of the RI and present results.

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[1] At the meeting on October 17, 1996, EPA's contractor, CDM Federal Programs, disputed that the extent of VOCs had been defined to the south of the presumed source area, since VOCs had been detected in southernmost boring SBB2. HLA noted that continuous field screening of soils from 0 to 18 feet at SBB2 did not detect VOCs. The presence of VOCs in soil samples from 20 to 22 feet and 22 to 24 feet at SBB2 is attributed to capillary effects by underlying, VOC-containing groundwater.

2.0 WORK PLAN APPROACH

Figure 2-1 presents a flow chart which summarizes the proposed tasks to be implemented to satisfy the data needs identified in Section 1.4. The tasks to be completed are as follows:

1. **AST Area Investigation:**

   <u>Soils</u>

   - Install soil borings offsite (west) of previous boring SBB17/MW-6 and, at the request of EPA, install four additional soil borings within the general AST area to evaluate the possible presence of additional source areas. Data from previous soil boring SBE1, which was installed near the former concrete pad, will also be used in this evaluation.
   - Preliminarily evaluate the applicability of soil vapor extraction (SVE) as a remedial alternative by collecting soil samples for analysis of grain size, moisture, total organic carbon, porosity, biological numeration, and nutrients.

   <u>Groundwater</u>

   - Evaluate the lateral extent of TEX in shallow groundwater offsite to the west of the AST area by collecting groundwater samples from temporary wells to be installed at multiple locations, and by installing an offsite shallow monitoring well near the downgradient extent of the plume; access restrictions may limit the well location.
   - Evaluate the vertical extent of TEX in groundwater beneath the AST area by installing a double-cased monitoring well whose depth will be based on TEX concentrations detected in depth-discrete groundwater Hydropunch® samples collected from a borehole next to MW-6.
   - Preliminary estimate of the hydrogeologic properties of the shallow and deep water-bearing zones by performing slug tests and by monitoring water level responses during development of the newly installed monitoring wells.

2. **Evaluation of Groundwater Quality:**

   - Evaluate site-wide distribution of VOCs in groundwater by collecting groundwater samples from onsite and offsite wells including the newly installed shallow well, newly installed deep well in AST area, shallow monitoring wells, and deep former production wells using low-flow purging techniques.

3. **Evaluation of Deep Zone Groundwater Flow Direction:**

   - Utilize a downhole television survey to evaluate the screen intervals and the integrity of onsite former production wells P1 and P2.
   - Measure the water level in the new deep well in the AST area and incorporate this information with water levels collected from existing onsite production wells to evaluate onsite flow direction in the deep portion of the water-bearing zone.
   - Obtain access, survey physical location and elevation, and measure water levels in all wells to which access is granted within a 0.25- mile radius of the site. Incorporate water level elevation data from offsite and onsite deep wells to further evaluate regional flow direction in the deep water-bearing zone; access restrictions may limit the number of wells to be monitored.

4. **Onsite Storm Drain and River Gut Sediment Sampling:**

   - Secure access to collect sediment samples from offsite locations in River Gut. Collect twenty sediment samples within the onsite drainage system and in the section of the River Gut along the site boundary to evaluate TAL metals concentrations. Sampling in River Gut will be conducted upstream, across from, and downstream of the site. These data will be evaluated with data from previous sampling activities; access restrictions may limit the number of samples to be collected.

5. **Data Validation**

   - Confirmation level laboratory data generated for investigative samples will be validated as discussed in the Work Plan.

6. **Data Evaluation and Reporting:**

   - Interpret, evaluate and summarize the results of the proposed supplemental investigation, incorporate the results with previous investigations, and prepare a report for submittal to the EPA.

7. **Meetings, Progress Reports, and Presentations to EPA**

8. **Management and Disposal of Investigation-Derived Wastes**

3.0 SUPPLEMENTAL REMEDIAL INVESTIGATION TASKS

The tasks to be completed during this phase of the RI are explained in more detail below. Specifics of well locations, wells to be sampled, soil sample locations, analytical parameters, and other activities may need to be modified based on possible legal access restrictions, physical restrictions and on the findings of various phases of each tasks. EPA will be notified of any substantive changes. These changes, if necessary, will be discussed with and approved by EPA prior to implementation. Work will be conducted following the procedures outlined in the previously approved Work Plan.

3.1 Field Sampling Program

3.1.1 Soil and Groundwater Investigation at AST Area

3.1.1.1 Property Access and Well Permits

ICC representatives have begun to secure offsite property access agreements. Prior to mobilization, ICC will make its best efforts to secure property access to offsite soil and groundwater sampling locations west of the AST area. Additionally, at this time ICC will attempt to gain access to all offsite well locations described in Section 3.1.4.2. Prior to mobilization, HLA will obtain the appropriate permits from the Virgin Island Department of Planning and Natural Resources to install the proposed monitoring wells.

3.1.1.2 Soil Sampling

Soil sampling will be performed to (1) investigate the lateral and vertical extent of TEX in soil offsite and adjacent to Tanks 8 and 9 (west of boring SBB17), (2) to assess the potential for other potential source areas in the general AST area, and (3) to collect preliminary data regarding the applicability of soil vapor extraction in the AST area as a possible remedial alternative. Proposed boring locations are shown on Figure 3-1. Three soil borings will be installed along a 20-foot radius offsite (west) of previous boring SBB17. Three additional offsite borings may be installed based on photoionization detector (PID) field screening results and field observations.

Four borings will be installed onsite within the AST area north and south of the previously defined impacted area to investigate the potential presence of other source areas. The results from soil boring SBE-1 (installed during Phase I activities adjacent to former Tank 20; no PID readings were measured and no VOCs were detected above the detection limit in samples collected from the boring installed at this location) will be used in conjunction with data from the four new borings to evaluate the general AST area.

Soil sampling will follow the detailed procedures that are described in the EPA-approved Work Plan and supporting documents and which have been implemented by HLA in previous phases of this RI. At each boring, soil samples will be collected continuously from ground surface to the water table using a split-spoon. Upon opening the split-spoon, the sample will be physically scored and screened for the presence of organic vapors using a PID. A sample from each 2-foot interval will then be immediately placed into a laboratory-prepared container. Additional sample volume from each interval will be placed into resealable plastic bags and screened in the field for headspace organic vapors using the procedures described in the Work Plan. Procedures for sample handling, management, and shipping will be implemented as described in the Work Plan.

Two soil samples from each boring will be analyzed: one from directly above the water table and one from the sample interval with the highest PID reading. Soil samples will be analyzed for target compound list (TCL) VOCs.

Shelby tube samples will be collected from two of the onsite borings for analysis of grain size, moisture, total organic carbon (TOC), and porosity. The samples will be collected from borings that exhibit the lowest PID readings. These samples will be collected using 3-inch outside diameter Shelby tubes. The Shelby tubes will be constructed of stainless steel tubing or equivalent materials.

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The lower end is beveled to form a tapered cutting edge. The upper end of the Shelby tube is fastened to a check valve that helps hold the sample in place as it is being withdrawn. The Shelby tube is positioned at the upper portion of the interval to be sampled, and advanced the length of the tube (typically 2 feet). The advancement of the Shelby Tube is performed smoothly and steadily by the application of hydraulic pressure from the drill rig to the drilling rod connected to the Shelby tube. The Shelby tube is extracted using the same mechanisms operated in reverse. Storage, shipping and handling of these samples is described in the revised draft SAP. The analysis of the Shelby tube soil samples will be performed by Raytheon Environmental Services Laboratory located in Boothwyn, Pennsylvania.

Two soil samples will be collected from two separate onsite soil borings for analysis of total heterotrophic plate count and a hydrocarbon utilizer (HCU) bacteria count. These two soil samples will also be submitted for analysis to evaluate the available nutrient levels. The nutrient profile will include analysis of TOC, alkalinity, iron, ammonia, sulfate, sulfide, nitrate, nitrite, pH, and ortho phosphorus. One of the soil sampling locations for the bacteria counts will be collected from a soil sampling interval which exhibits relatively high PID readings. The remaining sample will be collected from a sampling interval which exhibits moderate PID readings. Analysis of total heterotrophic plate count and a HCU bacteria count samples will be performed by HLA, if approved by EPA.

3.1.1.3 Offsite Shallow Groundwater Investigation

The purpose of this task is to determine the areal extent of the dissolved TEX in groundwater, where the TEX concentrations exceed their respective MCL. Groundwater samples will be collected at the water table at three locations along a 50-foot radius west (offsite) of MW-6 using temporary monitoring wells.

The temporary well points will be constructed of 2-inch diameter PVC screen and riser. A 5-foot long screen will be positioned across the static water level. A 6.5-inch diameter boring for the temporary wells will be advanced using hollow-stem auger drilling methods to a depth approximately 4 feet below the water table. The water table will be located by evaluating split-spoon samples collected from the borehole. The temporary well will be installed through the auger and the augers will be removed. The water level measuring points will be marked and later surveyed to allow for groundwater elevation calculations. An oil-water interface probe will be used to measure static water levels and monitor for the presence or absence of liquid phase hydrocarbons in each temporary well. After allowing sufficient time for groundwater to equilibrate, a teflon bailer will be lowered into the well to retrieve a groundwater sample which will be transferred to laboratory-cleaned 40-mL glass vials. The groundwater sample will be immediately analyzed onsite using a portable gas chromatograph (GC) calibrated for TEX. The groundwater samples that are collected will be placed in the purge and trap vessel, extracted and analyzed. The data collected through field GC screening is classified as screening level data,

Further investigation will be guided by the results of the onsite GC analysis of the three temporary well samples. If TEX concentrations exceed their respective MCLs, then additional groundwater samples will be collected by installing additional temporary wells using the above procedures at incremental 50-foot radius sample locations (i.e., approximately 100 feet from MW-6). If the results of all three of the first groundwater samples collected from the initial temporary well are below MCLs, then a 4-inch diameter monitoring well will be installed at the furthest downgradient or western location. The well will be installed and developed as described in the RIWP. The well screen will be 10 feet long, have a slot size of 0.020 inches, and extend approximately 5 feet below the encountered water table depth. Development water will be placed in 55-gallon drums and staged onsite pending disposal. The temporary wells will be removed within 48-hours after their installation. The PVC screen and riser will be extracted and the borings will be abandoned as described in the RIWP.

3.1.1.4 Onsite Deep Groundwater Investigation

The vertical extent of VOCs in groundwater at the AST area will be evaluated by installation of a double-cased monitoring well to be located near MW-6. A pilot soil boring will be advanced to a depth of approximately 5 feet below the encountered water table. No soil sampling will be performed in this boring (soil sampling was already performed in this area at SBB11 and SBB17). A steel casing will then be grouted in place at that depth to prevent cross-contamination during deeper drilling. The steel casing will be installed as follows. The pilot boring will be reamed to a diameter of 12-inches to the designated depth using mud rotary drilling techniques. An 8-inch diameter steel casing with welded joints will then be lowered to the bottom of the boring and centered. Cement grout will then be emplaced in the annular space around the casing via a tremie pipe from the bottom up. The drilling fluid in the annular space will be displaced by the grout, the drilling equipment will be decontaminated and the drilling fluid inside the casing will be circulated thoroughly with potable water until visible drilling fluids have been removed and relatively clear water remains inside the casing.

After the grout has set for at least 24 hours, a pilot boring will be advanced through the grout. Depth-discrete Hydropunch® samples will then be collected at 10-foot intervals (starting at the interval 5 feet below the steel casing). The Hydropunch® sampler is a specialized tool designed to obtain groundwater samples within the saturated zone without the installation of a monitoring well. It is constructed of stainless steel and Teflon with viton O-rings. The Hydropunch® sampler is designed to be driven by the slide hammer commonly used for obtaining split-spoon samples. The Hydropunch sampler will be removed from the boring between each sampling interval and decontaminated using procedures described in the SAP.

When the targeted sample depth is reached, the Hydropunch® sampler is opened by pulling back the outside sleeve of the tool. Soil friction holds the drive cone in place as the sleeve moves up. Once opened, groundwater flows through the dedicated disposable screen into the tool from the surrounding formation. After allowing sufficient time for groundwater to fill the sample chamber, a Teflon bailer will be lowered into the borehole to retrieve a groundwater sample which will be transferred to laboratory-cleaned 40-mL glass vials. These samples will be analyzed for TEX using the onsite field GC. The boring will be advanced to a depth where concentrations of any individual chemical do not exceed MCLs. The boring will then be advanced 10 feet below this depth, reamed to 8 inches in diameter and a 4-inch diameter monitoring well will be installed, using the procedures outlined in the SAP. A diagram of the proposed double-cased well is provided as Figure 3-2.

3.1.1.5 Aquifer Testing

Preliminary information on the hydrogeologic properties of the shallow and deep portions of the water-bearing zones will be obtained by conducting the following activities. During development of the newly installed wells, water levels will be continuously monitored in the well being developed and in the nearest (or nearby) adjacent wells either manually or by using an automated data logger-pressure transducer system. This will provide information regarding possible hydraulic connection between the shallow and deep portion of the water-bearing zone. Monitoring of recovery of water levels in selected onsite wells after development will also provide limited information on relative hydraulic conductivity between the upper and lower portions of the aquifer. Slug tests will also be performed at shallow and deep wells to supplement the data collected during well development.

3.1.1.6 Survey

The coordinate location and elevation of the temporary wells, soil borings and new wells will be surveyed as specified in the Work Plan. The horizontal position will be surveyed with respect to the Puerto Rican/Virgin Islands plane coordinate system (North American Datum of 1983, or NAD 83) and existing monitoring wells to the nearest tenth of a foot. The well locations will be converted from plane coordinates to latitude and longitude.

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The vertical position of the temporary wells, soil borings, and new wells will be surveyed with respect to Mean Sea Level (MSL) to the nearest hundredth of a foot. Well elevations to be surveyed include the top of inner casing, top of outer casing, and adjacent ground surface. The location of the inner casing elevation measurement will be permanently marked for future water level measurements. Temporary well elevations to be surveyed include the top of casing and adjacent ground surface. The ground surface at each of the soil borings will also be surveyed.

3.1.2 Site-Wide Groundwater Quality Sampling

After installation and development of the new wells in the AST area, groundwater samples will be collected from the onsite and offsite monitoring wells and the deep production wells P-1 and P-2. The site-wide groundwater sampling will be conducted to further evaluate groundwater quality at the site. Specifically, objectives of the site-wide groundwater sampling are (1) to evaluate the extent of TEX compounds related to the AST area, and (2) to assess the presence of chloroform previously reported at MW-2. Groundwater sampling will be conducted approximately 2 weeks after installation and development of the new wells.

At the request of EPA, low-flow (minimal drawdown) groundwater sampling procedures (as described in Puls and Barcelona, 1995) will be utilized in place of the procedures described in the Work Plan. A 2-inch diameter Grundfos® Redi Flo 2 submersible sampling pump or a bladder pump will be utilized for purging and sampling. As recommended by Puls and Barcelona (1993), HLA will purge and sample using a flow rate not to exceed 0.5 liters per minute. A water quality probe will be used to measure key indicator parameters (temperature, pH, specific conductance, redox, dissolved oxygen, and turbidity) during purging. After stabilization of the water quality indicator parameters, groundwater samples will be collected directly from the pump discharge line. Sample containers, preservation, shipping, and chain-of-custody procedures will be implemented as described in the Work Plan. Groundwater samples will be analyzed for TCL VOCs using CLP protocols. As requested by EPA, local precipitation records for the two-week period prior to each groundwater sampling event will be submitted when presenting groundwater analytical data.

3.1.3 Onsite Groundwater Elevation Monitoring

Groundwater elevations have been monitored at the site using automatic water level recorders (TUBERs) installed at MW-1 and MW-3 in August 1995 and at MW-4 and MW-5 in April 1996. Four recorders are currently installed. The most recent data (since June 1996) will be downloaded from these recorders during the upcoming field program. These data will be combined with water levels which will be measured manually from all wells prior to the site-wide groundwater sampling event. Groundwater contour maps will be prepared for multiple dates using the water table elevations calculated from the manual and automated measurements.

3.1.4 Evaluate Groundwater Flow Direction in Deep Water-Bearing Zone

HLA has recently received documents from the U.S. Geological Survey (USGS) entitled *Water Resources Data Puerto Rico and the U.S. Virgin Islands Water Year 1992, USGS Water-Data Report PR-92-1,1993* and *Water Wells on St. Croix, U.S. Virgin Islands, Open File Report 91-503, 1994*. HLA has also requested the most recent Water Resources Data report and any other relevant information concerning water level data on St. Croix from the USGS. HLA will utilize these data in conjunction with information obtained from the onsite and offsite deep wells, as described below, to estimate the regional flow direction of the deeper portion of the water-bearing zone.

3.1.4.1 Onsite Deep Wells

The onsite deep production wells (P-1 and P-2) will be evaluated using a downhole television camera to determine the actual well integrity and screen interval. After the survey, water levels will be measured at P-1 and P-2. These data will be combined with water level data from the new deep well to be installed in the AST area to preliminarily evaluate onsite flow direction in the deep water-bearing zone.

3.1.4.2 Offsite Deep Wells

The purpose of this task is to survey the locations and elevations of all offsite wells to which access is granted within a 0.25-mile radius of the site, and to measure groundwater levels in these wells to aid in evaluation of regional flow direction in the deep water-bearing zone in the vicinity of the site. The existence of these wells, or their accessibility, has not been field verified. The locations have been plotted based on existing records and aerial photograph review. The offsite groundwater production wells proposed to be surveyed include (see Figure 3-3):

- Former WAPA well directly south of site
- Well at Charlie's Concrete Company (east of site)
- Well at Meridian Engineering (northwest of site)
- Virgin Islands Port Authority (VIPA) Wells 1 and 2 (west of site)
- U.S. Geological Survey wells downstream of the site near confluence with Bethlehem Gut
- Well at Virgin Islands Paving Inc. (northwest of site).

Prior to mobilization for the field sampling program, ICC will make its best efforts to secure property access permission from the owners of the above wells, and will attempt to obtain relevant available information regarding the construction, usage, and status of these wells. The horizontal and vertical positions of these wells will then be surveyed following the procedures described in the Work Plan. Groundwater levels will then be measured at the wells using the procedures outlined in the Work Plan.

The groundwater elevations calculated from the offsite and onsite deep wells will be used to evaluate flow direction in the deep portion of the water-bearing zone. Water level contour map(s) will be prepared.

3.1.5 Storm Drain and River Gut Sediment Sampling

Three samples of River Gut sediments will be collected at the onsite, upstream and downstream locations shown in Figure 3-4. Samples SD1, SD2, and SD3 will be collected from the central storm drain system. Samples SD4 and SD7 will be collected from sediments, if present, in the southern storm drain system. These samples can only be collected if sufficient material exists for analytical purposes. Locations may have to be modified in the field to depositional areas where adequate sediment volumes are available. Sample SD1 will be collected from the storm drain at a point approximately 25 feet below the process area. Sample SD2 will be collected from the junction of the lines forming the central storm drain system. Sample SD3 will be collected from the settling basin which collects drainage from the central storm drain system before discharging to the River Gut. Sample SD4 will be collected from within the southern storm drain system at a point approximately 10 feet upgradient of the point where this system discharges to River Gut. Sample SD7 will be collected from sediments, if present, within the southern storm drain system at a point approximately 50 feet upgradient of SD4.

Samples RG1A through RG11 will be collected from the River Gut stream channel. Samples RG1A, RG1B, and RG1C will be located in the field at locations upstream of the abandoned railroad bridge, and upstream of drainage from the bulldozed area adjacent to the site within relatively close proximity (less than 25 feet) of each other within the River Gut. These samples will be evaluated as background sediment samples. Sample RG2 will be collected approximately 100 feet upstream of the site boundary just downstream of the abandoned railroad bridge. Sample RG2 will be collected from the northeastern stream bank in an area of non-site-related waste material observed in the fill. Sample location RG2 is located at a seep of petroleum-like material visually identified in the fill material on the northern bank of the River Gut. Sample RG3 will be collected from the center of the stream bed upstream of the former lab drain discharge. Sample RG4 will be collected from the center of the stream bed below the former lab drain. Sample RG5 will be collected from the center of the stream bed approximately 100 feet downstream from RG4.

Sample RG6 will be collected in an area of non-site-related waste material observed in the fill on the northeastern side of the River Gut bank. Sample RG7 will be collected from the River Gut stream bed at a point approximately 50 feet upstream from where the central storm drain system from the site discharges to River Gut. Sample RG8 will be collected from the River Gut stream bed at a point where the central storm drain system from the site discharges to River Gut. Sample RG9 will be will be collected from the River Gut stream bed at the point where southern storm drain system from the site discharges to River Gut.

Sample RG10 will be collected from sediment deposits on the upgradient side of the berm located in the River Gut channel near the site. Sample RG11 will be collected from sediment deposits on the upstream side of the sheet piling installed in the River Gut stream channel, downstream of the site. Samples RG12 and RG13 will be held in reserve and may be selected as additional sampling locations in the field. Several areas of non-site-related waste material have been observed during previous studies in the northeastern stream bank opposite the site. Samples RG12 and RG13 will be reserved for collecting sediments from the northeastern stream bank in an area of observed non-site-related waste material not already targeted by this investigation.

The samples will be analyzed for TAL metals, total organic carbon, particle grain size, pH, redox, and conductivity.

3.2 Data Validation

Confirmation level laboratory data generated for investigative samples will be validated as discussed in the Work Plan.

3.3 Data Evaluation

The data generated during this phase of the RI will be evaluated in conjunction with the data previously generated and reported by HLA (1995, 1996). The data will be evaluated to gain further information on the following:

- Onsite and offsite extent of TEX in soil and groundwater in AST Area
- Potential extent of chloroform, if any, in groundwater
- Flow direction(s) in the shallow and deep portion of the water-bearing zone
- Onsite sediment and River Gut sediment TAL metals concentrations

3.4 Update/Track ARARs

The list of Applicable or Relevant and Appropriate Requirements (ARARs) will continue to be refined, developed, and revised, as needed, throughout completion of the RI activities to take into consideration additional chemical data, site conditions, and potential remedial actions. Further, state and federal registers will continue to be reviewed periodically to identify changes to the ARARs that have already been identified.

3.5 Project Meetings and Reporting

3.5.1 Meetings with EPA

One meeting with EPA will be requested following receipt, interpretation, and validation of data generated during the implementation of this RI Work Plan Addendum and prior to preparation of a final Draft Data Summary Report Addendum (DSRA) or preparation of the RI, whichever is appropriate. At that time, the findings will be discussed along with the format for the final Draft DSRA. Additional meetings with EPA will be conducted as needed or upon request.

3.5.2 Monthly Progress Reports

Monthly progress reports will continue to be submitted to EPA on the 15th day of each month. The monthly progress reports will be prepared in accordance with the Administrative Order on Consent and the Work Plan.

3.6 Management of Investigation-Derived Waste

Investigation-derived waste (IDW) will be managed in accordance with procedures outlined in the Work Plan.

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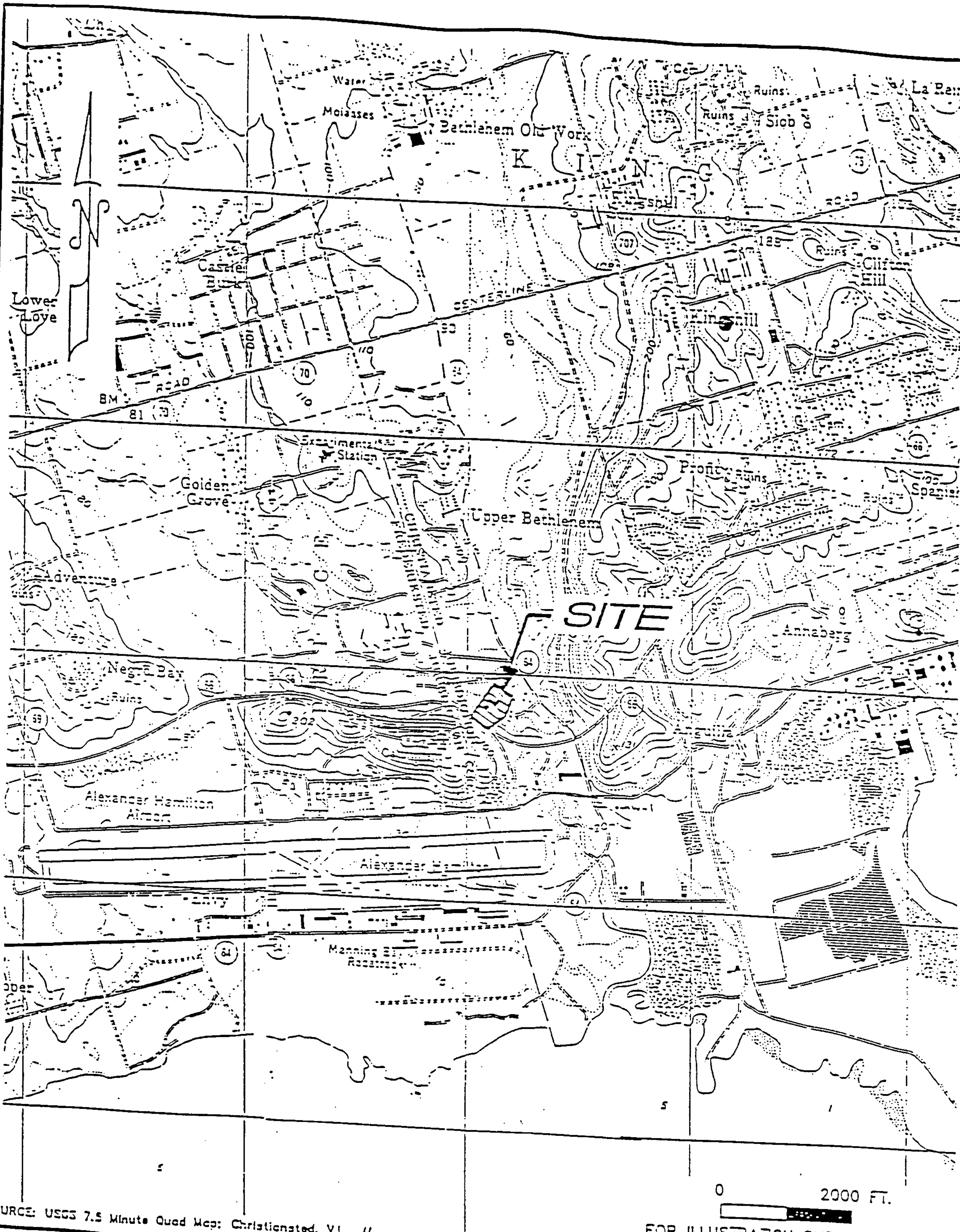
4.0 ANTICIPATED SCHEDULE

To be developed

FIGURES



SOURCE: USGS 7.5 Minute Quad Map: Christiansted, V.I.

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Engineering and Environmental Services
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Philadelphia, Pennsylvania 19106
215-627-4505

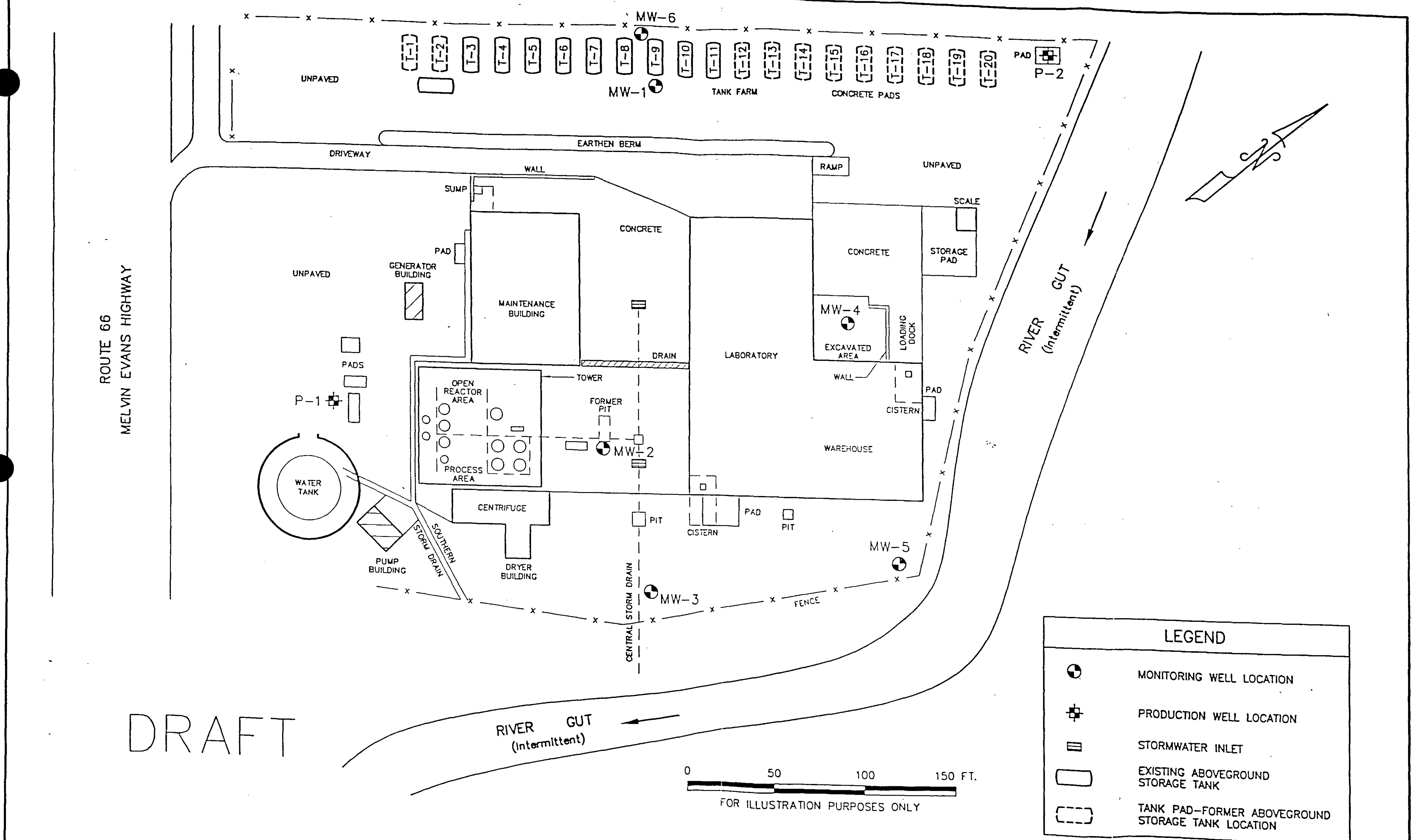
SITE LOCATION MAP

VIRGIN ISLAND CHEMICAL SITE
St. Croix, U.S. Virgin Islands

FIGURE 1-1

DRAWN	JOB NUMBER	APPROVED	DRAWING NUMBER	DATE	REVISED DATE
WGA	35241.5		35241A0A		

302205



SOURCE:

ADAPTED FROM SITE MAP, VI CHEMICAL, ST. CROIX, U.S.V.I. BY NUS CORPORATION DOCUMENT 02-9101-04-SI, UNDATED

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Engineering and Environmental Services
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Princeton Juction, New Jersey 08550
609-936-0700

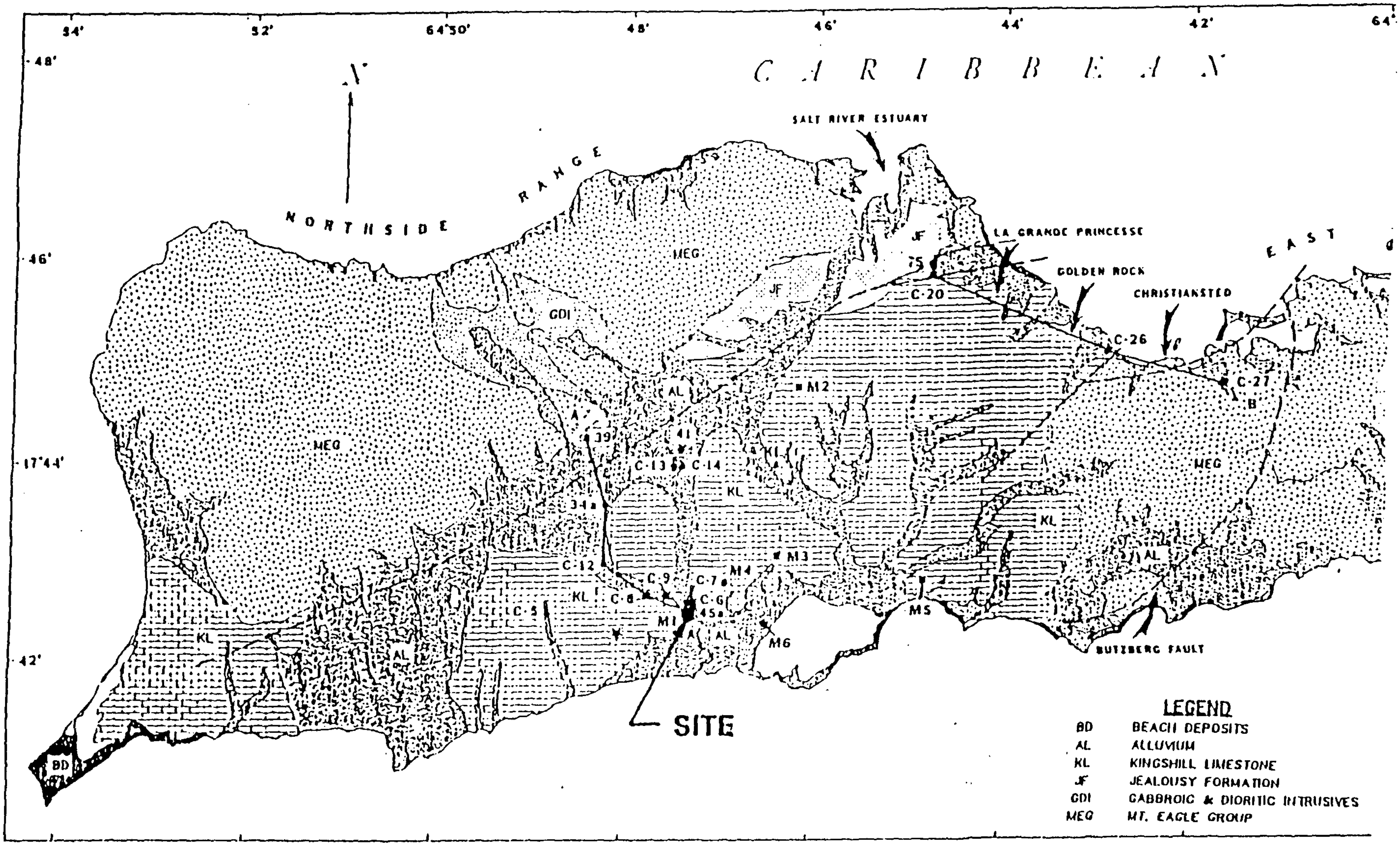
LOCATION OF MONITORING AND PRODUCTION WELLS

VIRGIN ISLAND CHEMICAL SITE
St. Croix, U.S. Virgin Islands

FIGURE 1-2

DRAWN	JOB NUMBER	APPROVED	DWG. No.	DATE	REVISED DATE
JSW/WGA	35241.2.12		35241B03	11/7/96	9/13/96

302206



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Philadelphia, Pennsylvania 19106
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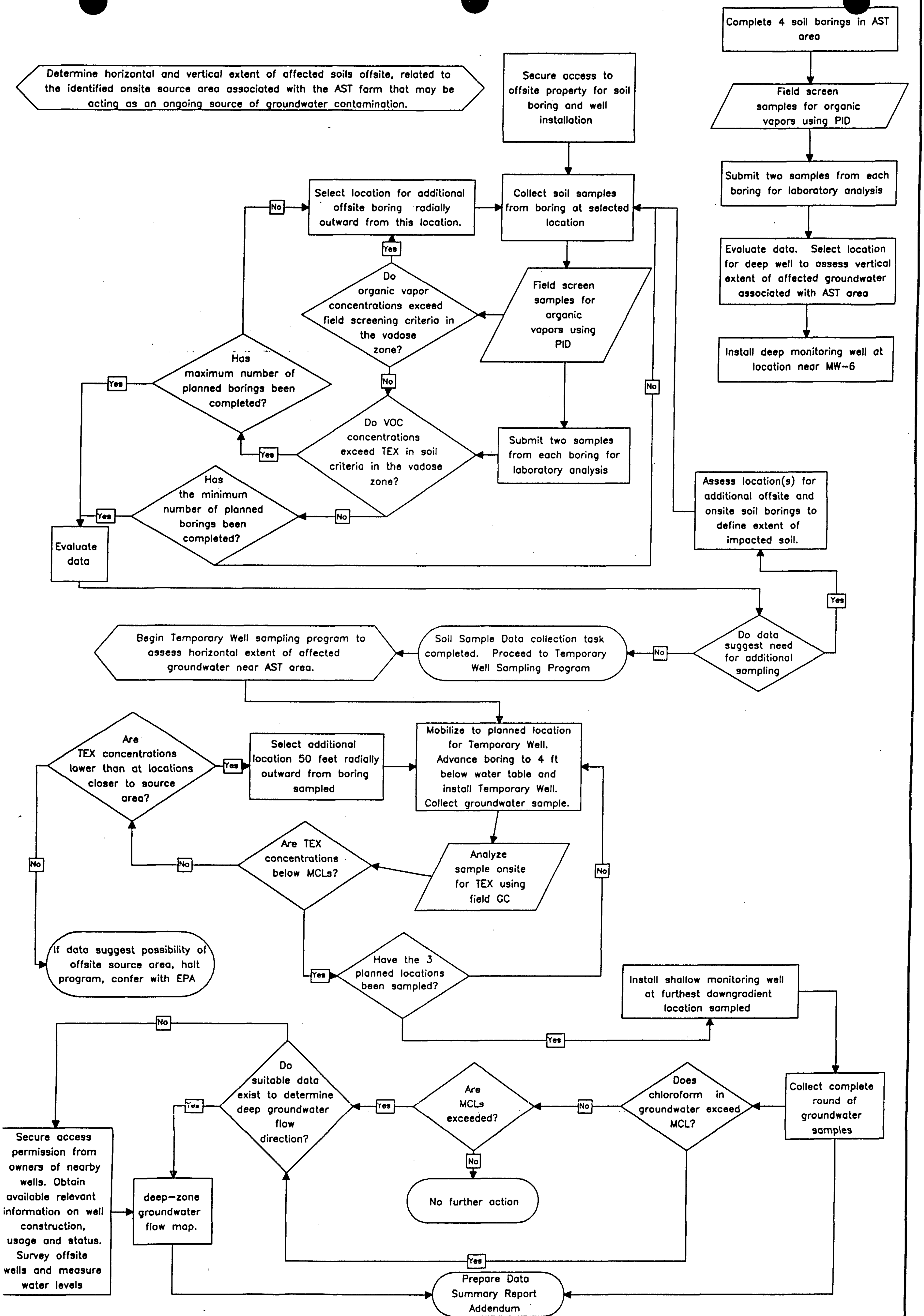
REGIONAL GEOLOGICAL MAP

VIRGIN ISLAND CHEMICAL SITE
St. Croix, U.S. Virgin Islands

FIGURE 1-3

DRAWN	JOB NUMBER	APPROVED	DRAWING NUMBER	DATE	REVISED DATE
WGA	35241.5			11/5/96	

302206A



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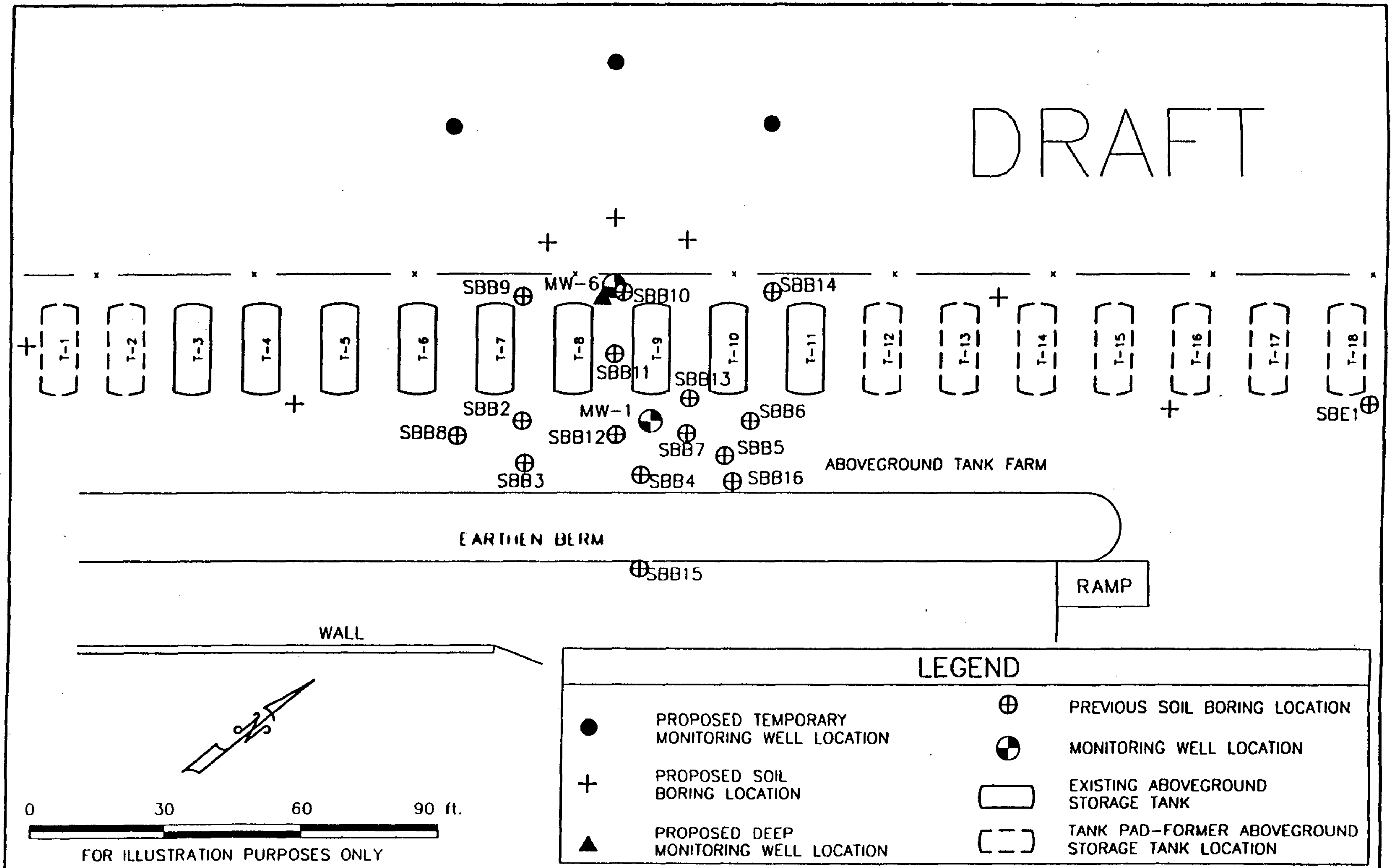
FLOW CHART

VIRGIN ISLAND CHEMICAL SITE
St. Croix, U.S. Virgin Islands

FIGURE 2-1

DRAWN	JOB NUMBER	APPROVED	DWG. No.	DATE	REVISED DATE
WGA	35241.5		35241B06	1/20/97	

302207



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14 Washington Road
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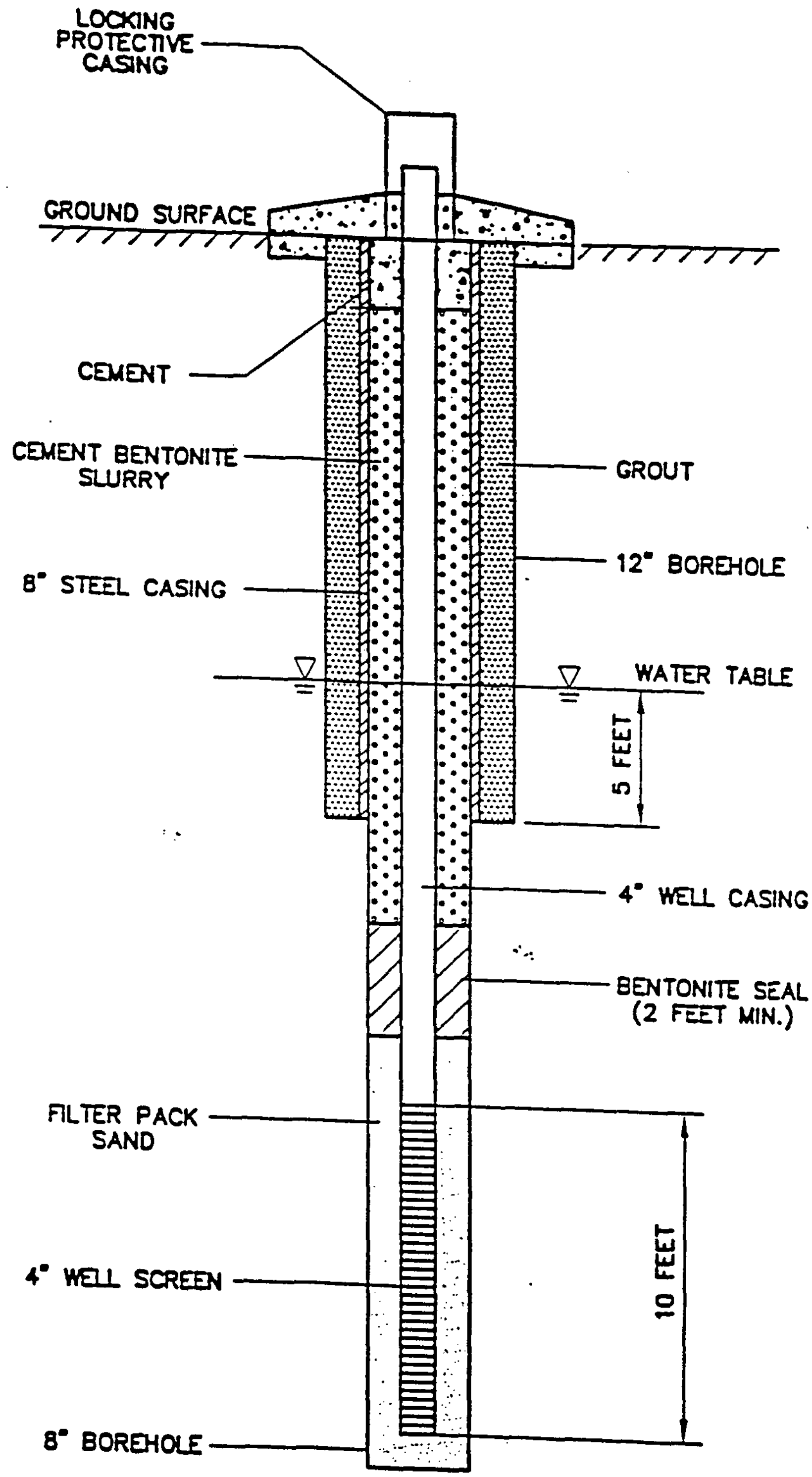
PROPOSED SAMPLING LOCATIONS

VIRGIN ISLAND CHEMICAL SITE
St. Croix, U.S. Virgin Islands

FIGURE
3-1

DRAWN	JOB NUMBER	APPROVED	DRAWING NUMBER	DATE	REVISED DATE
WGA	35241.5		35241A11	11/7/96	

302208



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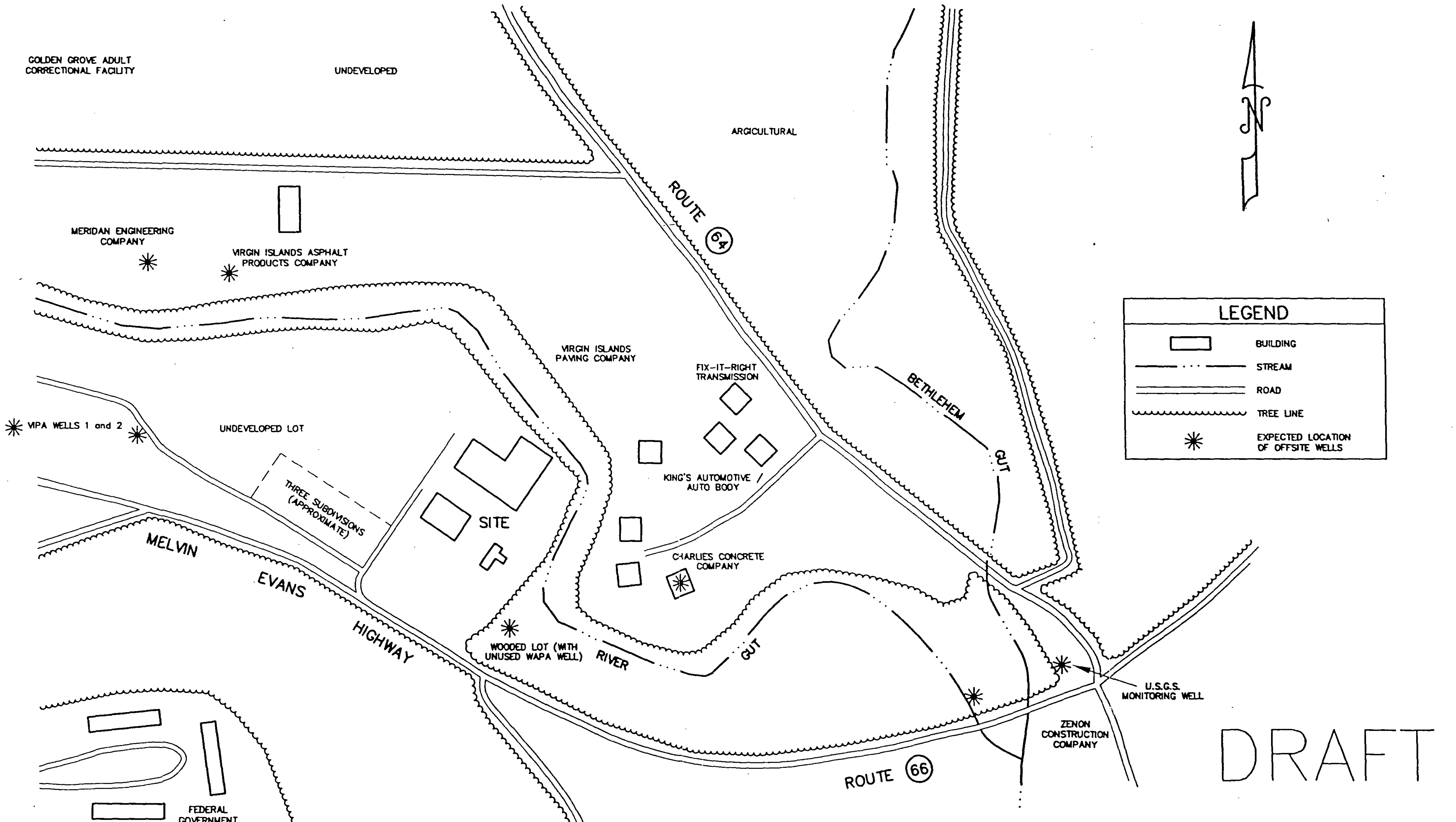
Engineering and
Environmental Services
14 Washington Road
Princeton Juction, New Jersey
609-936-0700

DOUBLE-CASED MONITORING WELL
CONSTRUCTION DIAGRAM

VIRGIN ISLAND CHEMICAL SITE
St. Croix, U.S. Virgin Islands

FIGURE
3-2

DRAWN	JOB NUMBER	APPROVED	DRAWING NUMBER	DATE	REVISED DATE
JSW/WGA	35241.5		35241A07	11/7/96	



0 200 400 600 FT.

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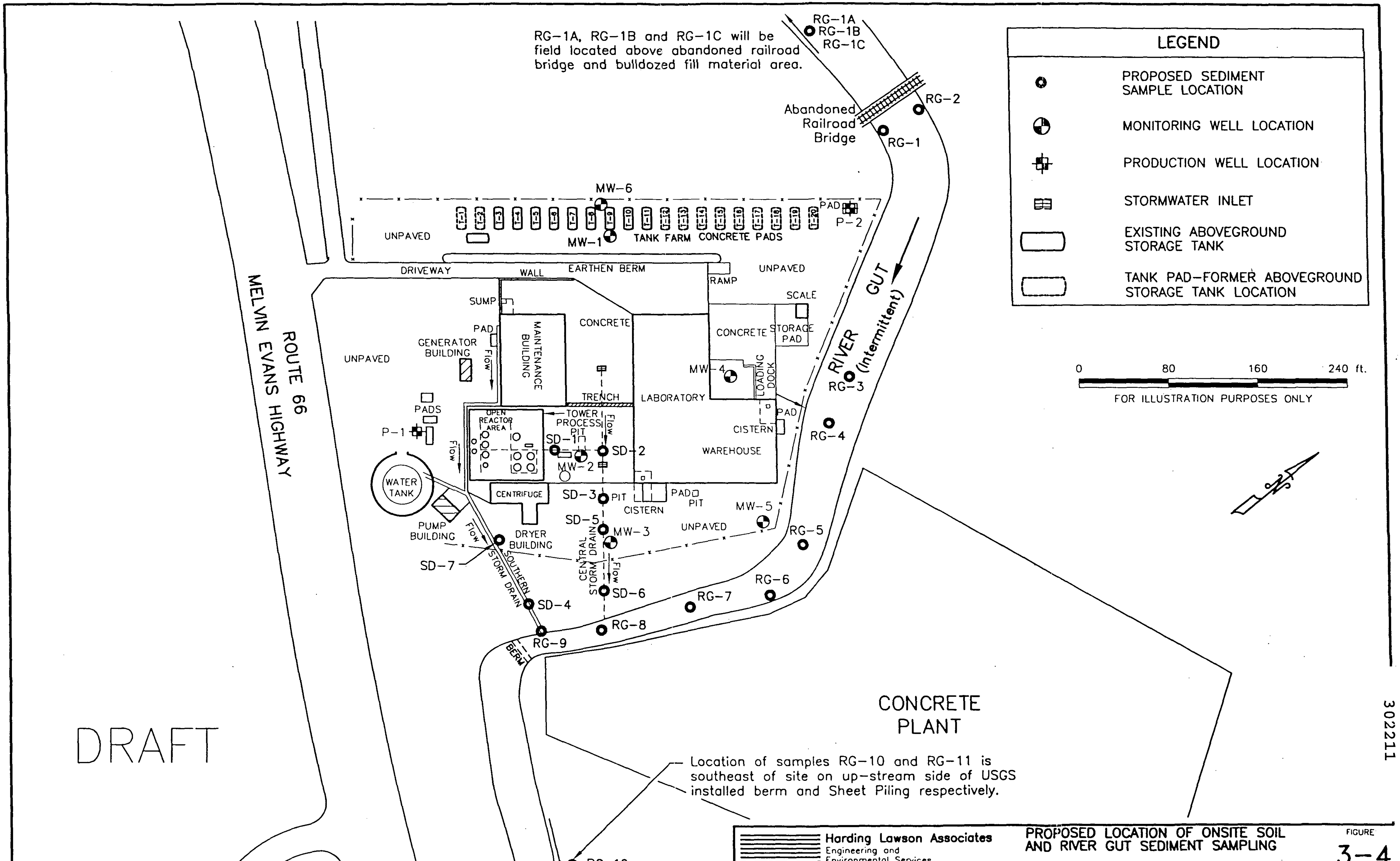
APPROXIMATE LOCATION OF OFFSITE PRODUCTION WELLS

VIRGIN ISLAND CHEMICAL SITE
St. Croix, U.S. Virgin Islands

FIGURE 3-3

DRAWN | JOB NUMBER | APPROVED | DWG. No. | DATE | REVISED DATE

302210



SOURCE:
SITE MAP, VI CHEMICAL, ST. CROIX, U.S.V.I. BY NUS CORPORATION DOCUMENT 02-9101-04-51, UNDATED AND AERIAL PHOTOGRAPHS

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APPENDIX AB

Containers, Preservation, Packaging, and Shipping Requirements

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Appendix AB. Containers, Preservation, Packaging, and Shipping Requirements

Island Chemical Company
St. Croix, U.S. Virgin Islands

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Analysis	Containers	Preservation	Technical Holding Time[1]	Volume of Container	Shipping	Normal Packaging
Groundwater Organic Analyses						
TCL VOCs	Three 40-ml glass vials with Teflon septum-lined caps	1:1 HCl to pH <2, cool to 4°C in dark storage	14 days	Fill completely, no air bubbles	Ship within 24-hours of collection by overnight carrier	Bubble pack
TCL SVOs	Two 1-liter amber glass bottles with Teflon™-lined caps	Cool to 4°C in dark storage	Extract within 7 days, analyze within 40 days after extraction	Fill 90% full	Ship within 24-hours of collection by overnight carrier	Bubble pack
Pyridine	Two 1-liter amber glass bottles with Teflon™-lined caps	Cool to 4°C in dark storage	Extract within 7 days, analyze within 40 days after extraction	Fill 90% full	Ship within 24-hours of collection by overnight carrier	Bubble pack
TCL Pesticides and PCBs	Two 1-liter amber glass bottles with Teflon™-lined caps	Cool to 4°C, $Na_2S_2O_3$	Extract within 7 days, analyze within 40 days after extraction	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Groundwater Inorganic Analyses						
TAL metals (unfiltered)	One 1-liter polyethylene bottle	HNO_3 to pH <2.0	6 months, except Hg - 28 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
TAL metals (filtered)	One 1-liter polyethylene bottle	HNO_3 to pH <2.0	6 months, except Hg - 28 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Cyanide	One 1-liter polyethylene bottle	NaOH to pH >12, cool to 4°C	14 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Soil Organic Analyses						
TCL VOCs	One 120-ml vial with Teflon™-septa lined lid	Cool to 4°C in dark storage	10 days	Fill completely	Ship within 24-hours of collection by overnight carrier	Bubble pack
TCL SVOs and Pyridine	Two 16-oz. amber glass jars with Teflon™-lined lid	Cool to 4°C in dark storage	Extract within 7 days and analyze within 40 days after extraction	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
TCL Pesticides and PCBs	One 4-oz wide-mouth glass jar with Teflon™-lined lid	Cool to 4°C	Extract within 7 days and analyze within 40 days after extraction	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack

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Analysis	Containers	Preservation	Technical Holding Time[1]	Volume of Container	Shipping	Normal Packaging
Soil Inorganic Analyses						
TAL Metals	One 8-oz wide-mouth glass jar with Teflon™-lined lid	Cool to 4°C	6 months, except Hg - 28 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Cyanide	One 8-oz wide-mouth glass jar with Teflon™-lined lid	Cool to 4°C	14 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Nitrate/Nitrite	One 32-oz glass bottle	Cool to 4°C	28 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Sulfate	One 32-oz glass bottle	Cool to 4°C	28 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Sulfide	One 32-oz glass bottle	Cool to 4°C	7 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Iron (total)	One 8-oz wide-mouth glass jar with Teflon™-lined lid	Cool to 4°C	6 months	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Alkalinity	One 32-oz glass bottle	Cool to 4°C	14 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Ammonia	One 32-oz glass bottle	Cool to 4°C	28 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Ortho phosphorus	One 32-oz glass bottle	Cool to 4°C	48-hours	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
pH	One 32-oz glass bottle	Cool to 4°C	As soon as possible	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Total Organic Carbon	Shelby Tube	None	28 days	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack

Appendix AB. Containers, Preservation, Packaging, and Shipping Requirements

Island Chemical Company
St. Croix, U.S. Virgin Islands

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Analysis	Containers	Preservation	Technical Holding Time[1]	Volume of Container	Shipping	Normal Packaging
Moisture	Shelby Tube	None	As soon as possible	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Grain size	Shelby Tube	None	None Set	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Porosity	Shelby Tube	None	None Set	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
HCU bacteria Count	500-ml Glass	Cool to 4°C	24-hours or as soon as possible	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack
Total plate bacteria count	500-ml Glass	Cool to 4°C	24-hours or as soon as possible	Fill 90%	Ship within 24-hours of collection by overnight carrier	Bubble pack

Parameters and detection limits will be consistent with methods listed in Tables C1-2 through C1-7 of the Quality Assurance Project Plan
Sample containers will be prepared according to OSWER Directive No 9240-05-05A, "Specification and Guidance for Obtaining Contaminant-Free Sample Containers, (December 1992)" or certified clean containers (e.g., I-Chem 300 series) will be used. Certificates of analysis verifying sample container cleanliness will be retained and available for review by USEPA.

1	The time of sample collection to extraction analysis	<	less than	>	greater than	°C	degree Celsius
g	gram	HCl	hydrochloric acid	H_2SO_4	sulfuric acid	Hg	mercury
HNO_3	nitric acid	ml	milliliter	NaOH	sodium hydroxide	$Na_2S_2O_3$	Sodium thiosulfate
oz.	ounce	SVOs	semivolatile organic compounds	TAL	Target Analyte List	TCL	Target Compound List
VOCs	volatile organic compounds						

APPENDIX AD

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AD1 INTRODUCTION

Harding Lawson Associates (HLA) has prepared this addendum to the EPA-approved Remedial Investigation Work Plan (RIWP) - Sampling and Analysis Plan (SAP) (HLA, 1994) on behalf of Island Chemical Company, Inc. (ICC). This SAP Addendum will be included in the RIWP as Appendix AD in support of the RIWP Addendum (RIWPA) and responds to requirements set forth in the National Contingency Plan. The RIWPA includes the following activities which were not specified in the original RIWP:

- Collection of stream sediment samples
- Collection of undisturbed soil samples using a Shelby tube sampling device
- Collection of groundwater samples using a Hydropunch® sampling device
- Onsite analysis of groundwater samples using a portable gas chromatograph (GC)
- Installation of soil borings and monitoring wells using mud-rotary drilling methods
- Installation of temporary monitoring wells
- Installation of double-cased monitoring wells
- Collection of groundwater samples using low-flow groundwater sampling procedures
- Estimation of hydraulic properties of the shallow aquifer using slug testing methods

Procedures for additional activities planned during the implementation of the RIWPA are described in the SAP, Appendix A of the original RIWP.

AD2 FIELD INVESTIGATION PROGRAM

Specific field procedures to perform the activities identified in Section AD1 above are presented in this addendum.

AD2.1 Stream Sediment Sampling

Efforts will be made to collect stream sediment samples when River Gut is not flowing. Section AD2.1.1, presents the sampling procedures to be followed if the stream is dry. However, if it is necessary to collect sediment samples when River Gut is flowing, HLA will follow the sampling procedures described in Section AD2.1.2.

AD2.1.1 Sediment Sampling When Stream is Dry

1. The proposed sample locations shown in Figure 3-4 of the RIWPA will be located by measuring from fixed visible reference points using a tape measure.
2. The area within roughly 10 to 20 feet of the proposed sample locations will be inspected visually to determine qualitatively the area of greatest sediment deposition. This area will be selected as the final sampling location.
3. A field-decontaminated, stainless steel trowel will be used to collect the sediment sample from the dry stream bed at the final sampling location. The trowel will be decontaminated before use following the procedures specified in Section A2.4.2.2 of the RIWP.

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4. The sediment sample will be transferred directly to laboratory-prepared sample containers which will then be sealed, labeled as described in Section A2.10.1 of the RIWP, and placed directly into a cooler with ice (approximately 4°C).

5. The final sample location will be marked and photographed to show its location with respect to fixed references.

6. The distance from each sampling point will be measured with respect to at least three fixed references and recorded to allow future relocation of the sample.

AD2.1.2 Sediment Sampling When Stream is Flowing

If possible, sediment sampling will be postponed until the stream is dry. If this is not practical, the stream sediments will be sampled using the following procedures:

1. Stream flow will be evaluated to determine if the stream can be entered safely.

2. Beginning at the furthest downstream location, HLA personnel will enter the stream at a location downstream of the proposed sampling location. All sample locations will be approached from the downstream direction to avoid disturbing upstream sediments that might be carried to downstream locations not yet sampled.

3. The proposed and final sample locations will be determined as described in Steps 1 and 2 of Section AD2.1.1.

4. A field-decontaminated Eckman Dredge sampler will be used to collect the sediment samples at each location.

5. The sediment sample will be transferred from the dredge to laboratory-prepared sample containers using a field-decontaminated stainless steel trowel. The sample container will then be sealed, labeled as described in Section A2.10.1 of the RIWP, and placed directly into a cooler with ice (approximately 4°C).

6. The sample location will be photographed and recorded as described in Steps 5 and 6 of Section AD2.1.1.

AD2.2 Shelby Tube Soil Sample Collection

Soil samples will be collected from fine-grained material using a Shelby tube sampling device. The Shelby tubes will be approximately 2 feet long, 3 inches in diameter and constructed of stainless steel tubing or equivalent materials. The upper end of the Shelby tube will be fastened to a check value that helps hold the sample in place as it is being withdrawn. Field documentation and equipment decontamination will be conducted as specified in the RIWP. The following procedures will be used to obtain undisturbed soil samples using the Shelby tube:

1. The boring will be advanced to the top of the interval to be sampled.

2. The drill bit and drilling rods will be removed from the boring and a field decontaminated Shelby tube sampler will attached to the drill rod assembly and lowered to the bottom of the boring.

3. The Shelby tube will then be pushed to the required depth, if possible. The Shelby tube will be advanced by the application of hydraulic pressure from the drill rig to the drill rod assembly.

4. Once the Shelby tube has been advanced to the final depth, activities will be halted for several minutes to allow the soil sample to equilibrate within the Shelby tube. The drill rod assembly will then be rotated 1/4 to 1/2 turn to separate the sample from the underlying soils.

5. The rod assembly with the Shelby tube sampler will then be withdrawn from the boring.
6. The Shelby tube will be disconnected from the drilling rod assembly and approximately 1 to 2 inches of soil will be removed from the bottom of the tube after it is recovered.
7. Both ends of the sample will then be sealed with several inches of paraffin, liquefied by heating. Care will be taken to completely seal the ends of the soil sample to prevent moisture loss
8. Once the paraffin has dried, any void space in the top of the tube will be filled tightly with a packing material, such as crumpled paper. Each end of the tube will be secured with a plastic end cap taped in place.
9. The outside of the Shelby tube will be labeled to indicate the sample identification, date of sampling, and top of the sample. Care will be taken to keep the sample in an upright position during handling. Instructions will be provided to the carrier to ship the samples in an upright position.

AD2.3 Hydropunch® Groundwater Sampling

Groundwater samples will be collected from the pilot boring for deep monitoring well MW-6 in the Above-ground Storage Tank (AST) area using a Hydropunch® sampling device. The Hydropunch® is a 5-foot long sampling device that consists of a drive point; 1-inch diameter, 4-foot long disposable screen; and a retractable stainless steel sleeve. The screen is made of poly vinyl chloride (PVC) or polypropylene. The Hydropunch® will be used to collect groundwater samples from selected depth intervals using the following procedures:

1. Once the boring has been advanced to the selected depth by the driller, the drill bit and rods will be removed.
2. The Hydropunch® sampler, equipped with an unused, disposable screen, will be attached to the drill rods and set at the bottom of the boring.
3. The Hydropunch® sampler will be driven into the formation using a 140- or 300-pound hammer. The Hydropunch® sampler will be driven 4-feet into the formation or until refusal is encountered. A total of 100 blows over a six-inch interval will be considered refusal. The number of blows and distance driven will be recorded.
4. If the Hydropunch® sampler is driven less than 1-foot before refusal is encountered, no sample will be collected, the boring will be advanced 5 feet, and a second attempt will be made to drive the Hydropunch® sampler into the formation.
5. If the Hydropunch® sampler is driven 1-foot or more, the sleeve will be retracted approximately one-half the distance that the sampling device was driven (i.e., retract the sleeve 2 feet if the sampler is driven 4 feet), exposing the disposable screen to the formation. Sufficient time will be given to allow groundwater to flow into the Hydropunch®. An electronic depth-to-water probe will be lowered inside the drill rods and Hydropunch® to monitor groundwater recharge.
6. Groundwater will be allowed to equilibrate in the Hydropunch® for a minimum of 30 minutes or until the water level inside the drill rods has reached 90 percent of the distance from the water table to the bottom of the sampler.
7. A field-decontaminated 1/2-inch diameter Teflon™ bailer will be lowered on Teflon™-coated stainless steel cable through the Hydropunch® rods to collect a groundwater sample from the screened interval. Prior to use at each sampling interval, the Teflon™ bailer and cable will be decontaminated following the procedures described in Section A2.4.2.2.

8. The color, qualitative turbidity and other pertinent observations of the groundwater sample will be noted and recorded in the field book.
9. Approximately 20 milliliters (mL) of groundwater sample will be poured directly into an unpreserved 40-mL glass vial, and submitted for onsite analysis of toluene, ethylbenzene, and xylenes by the field GC as described in Section AD2.7.
10. Co-located groundwater samples will be obtained for laboratory analysis at a rate of one sample for every ten screening samples. HLA will submit a minimum of one groundwater sample for laboratory analysis collected from zones displaying no detected volatile organic compounds (VOCs) by field screening. The co-located samples will be collected in 40-mL vials prepared by the laboratory, preserved in the field and submitted to the laboratory for analysis of Target Compound List (TCL) VOCs by Contract Laboratory Program (CLP) methodologies as specified in the RIWP. The co-located samples will be collected, preserved and handled as described in steps 23 through 27 of Section A2.8 of the RIWP.

AD2.4 Mud Rotary Drilling Methods

Mud-rotary drilling methods will be utilized to advance the deep boring for the double-cased well in the AST area. Mud-rotary drilling techniques are described below. Double cased well construction is described in Section AD2.5.1.1

1. Prior to set up, the drill rig and equipment will be decontaminated by steam cleaning and/or a potable water wash as described in Section A2.4.2 of the SAP.
2. The drill rig and mud tub will be placed at the selected drilling location. The mud tub will contain baffles to enhance settlement of solids entrained in the drilling fluid.
3. A tri-cone roller or wing bit will be attached to the drill rods.
4. The mud tub will be partially filled with potable water. The potable water will be obtained from the driller's office, consistent with previous work on this project. The driller will then circulate the water through the drilling tools and mud tub adding bentonite-based drilling mud as necessary to create a viscous drilling fluid. The amount of bentonite added and the viscosity of the fluid will be established in the field at the discretion of the driller.
5. Once the driller is satisfied that the drilling fluid is of adequate consistency, the driller will advance the borehole to the desired depth. During drilling, the drilling fluid will be pumped down through the drilling rods. The fluid will circulate to the ground surface by rising in the annular space of the boring. Cuttings from the boring will be entrained with the rising fluid and will be separated to the extent possible in the mud tub at the surface. The viscosity of the fluid may be altered during drilling activities at the driller's discretion by adding water or mud.
6. During drilling, solids will be removed from the mud tub as needed and containerized onsite in 55-gallon drums. Drummed investigation-derived waste will be staged onsite until proper disposal arrangements are completed.
7. Soil samples will be collected and logged as described in Section A2.4.3 of the SAP.
8. The volume of drilling fluid lost to the formation will be monitored during drilling and recorded on the field boring log.

AD2.5 Monitoring Well Installation

Drilling methods for the installation of monitoring wells will be selected based on field conditions and the anticipated depth of the borehole. It is anticipated that the borings for the shallow soil zone will be drilled using hollow-stem augers and that mud-rotary drilling methods will be necessary for the installation of deeper wells. Mud-rotary drilling methods may also be necessary for installation of shallow monitoring wells if problems with auguring are encountered

The procedures described below will be used to construct the proposed double-cased and temporary groundwater monitoring well. Procedures for well development and for construction of single-cased monitoring wells are described in Section A2.5 of the RIWP. Well construction details will be recorded by an HLA geologist. Equipment decontamination will be conducted as described in Section A2.4.2 of the RIWP.

AD2.5.1 Double-Cased Well Construction

The following procedures will be implemented during installation of the double-cased monitoring well at the site:

1. Prior to set up, the drill rig and equipment will be decontaminated by steam cleaning and/or a potable water wash as described in Section A2.4.2 of the SAP.
2. The driller will advance a 12-inch diameter boring to approximately 5 feet above the predicted water table depth using mud-rotary drilling techniques as described in Section AD2.4. The approximate depth to the water table will be estimated before drilling activities begin based on groundwater elevations measured at nearby monitoring wells.
3. Beginning at this depth, the driller will collect soil samples using a split-spoon sampling device as described in Section A2.4.3. Split-spoon samples will be collected continuously until the water table is encountered. An HLA geologist will examine the soil samples to determine the level of the water table.
4. The driller will then advance the boring to 5 feet below the water table.
5. An 8-inch diameter steel casing with welded or threaded joints will be lowered to the bottom of the boring and centered. The casing will be long enough to extend to the ground surface and will be seated using a hammer assembly.
6. A Portland cement/bentonite grout will be emplaced from the bottom up in the annulus around the casing using a tremmy pipe. The grout will be pumped into the boring until it displaces the drilling fluid and reaches the ground surface.
7. After the grout has set for at least 24 hours, the drilling fluid inside the casing will be circulated thoroughly with potable water until visible drilling fluids have been removed and clear water remains inside the casing.
8. Drilling equipment will be decontaminated and the drilling fluid will be replaced. If possible, water will be used instead of mud to drill the remainder of the boring. If mud is necessary, efforts will be made to minimize the amount of mud added to the drilling fluid.
9. An 8-inch diameter boring will be advanced through the casing to the final well depth. Sampling will be performed as appropriate following procedures described in other sections of the RIWP.
10. The remainder of the well construction methods will be the same as those used to construct single-cased monitoring wells as described in Section A2.5.1 of the RIWP.

Figure 3-2 depicts typical double-cased monitoring well construction. Equipment decontamination will be conducted as described in Section A2.4.2 of the RIWP.

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AD2.5.2 Temporary Monitoring Well Construction

Temporary groundwater monitoring wells will be installed following the methods described in Section A2.5.1 for single-cased monitoring wells. In general, the following procedures will be used unless field conditions require modifications:

1. Prior to set up, the drill rig and equipment will be decontaminated by steam cleaning and/or a potable water wash as described in Section A2.4.2 of the SAP.
2. The driller will advance a 6.5-inch diameter boring to approximately 5 feet above the predicted water table depth using hollow-stem auger drilling techniques as described in Section A2.4.1. The approximate depth to the water table will be estimated before drilling activities begin based on groundwater elevations measured at nearby monitoring wells.
3. Beginning at this depth, the driller will collect soil samples using a split-spoon sampling device as described in Section A2.4.3. Split-spoon samples will be collected continuously until the water table is encountered. An HLA geologist will examine the soil samples to determine the level of the water table.
4. The driller will then advance the boring to between 5 and 6 feet below the water table.
5. The temporary monitoring well will be constructed of 2-inch diameter, schedule 40, flush-joint, threaded PVC with a 10-foot section of 0.020-inch factory-slotted screen. The PVC well will be lowered into the boring and suspended such that approximately 5 feet of screen is above and below the water table. If the boring is drilled with hollow-stem augers, the well will be constructed inside the augurs before they are removed. If the boring is drilled using rotary drilling techniques, the drilling tools will be removed before the well is constructed.
6. The boring will be allowed to collapse naturally around the well screen. If necessary, a small amount of filter sand will be poured into the boring to bring the bottom of the boring to the appropriate depth. If addition of sand is necessary, it will be poured slowly to avoid bridging.
7. Plastic sheeting will be taped securely around the riser pipe approximately one foot above grade and spread out to form a skirt that extends radially at least 18 inches from the center of the well. The edges of the skirt will be covered and weighted prevent runoff from entering the well annulus.
8. The temporary well will be capped with a locking, expandable plug.
9. If the well boring was advanced using mud rotary drilling techniques, the well will be developed by pumping and surging with potable water to remove the visible drilling fluid. If the well was installed using hollow-stem augers, no well development will be performed.

Equipment decontamination will be conducted as described in Section A2.4.2 of the RIWP.

If the decision is made to complete a temporary well as a permanent monitoring well, the 2-inch casing and screen will be removed, the boring will be reamed and the well constructed as described in Section A2.5 of the RIWP. If the well is not converted to a permanent monitoring well, the temporary well will be abandoned by removing the 2-inch casing and screen and backfilling the boring with powdered bentonite.

AD2.6 Low Flow Purging and Groundwater Sampling

groundwater monitoring wells will be purged and sampled using low-flow groundwater sampling procedures as described in EPA's Groundwater Issue (EPA, April 1996). Groundwater sampling procedures will generally follow the steps described in Section A2.8. Field documentation, sampling preparation, and sampling apparatus decontamination procedures will be consistent with the RIWP. The low-flow groundwater sampling procedures are described below:

BEFORE ENTERING THE FIELD

- Project objectives and quality assurance procedures, sampling locations, sampling procedures, preservation, packaging and shipping requirements, and analytical parameters will be reviewed with field personnel.

- Previous water level measurements for each well, if available, will be reviewed before leaving for the site, and a summary of previous water level data will be taken to the field.

- Health and safety procedures will be reviewed with all personnel.

- A list of wells to be sampled and analyses to be performed will be prepared and transmitted to the laboratory.

- All field equipment will be tested to ensure that it is operating properly. Because of the remote location of the site, duplicate instruments will be mobilized to limit down time due to possible equipment malfunction.

- The laboratory will provide clean glassware required to collect the samples. The glassware will be cleaned in accordance with OSWER Directive 92540.0-05A. The glassware will include required preservatives and a list of which preservatives correspond to each analyte will be included with the glassware. The laboratory will provide sufficient glassware and/or samples for trip blanks, field blanks, and duplicate samples to be collected at the frequency described in the Quality Assurance Project Plan (QAPP) presented in Appendix C of the RIWP.

IN THE FIELD

1. Sampling crews will receive labeled sample kits from the field manager and will confirm that the kits contain appropriate sample bottles, preservatives, filter pumps, ice, sample labels, chain-of-custody records, and well construction information.

2. Before purging or sampling each well, equipment will be decontaminated. Decontamination of pumps will include rinsing the pump and tubing with soapy water and deionized water before use.

3. The well number, date, pertinent observations (e.g., weather, well condition), casing diameter, screened interval, and field instrument identifications will be recorded on groundwater sampling forms (Appendix AA).

4. Monitoring instruments will be calibrated against known standards before making well measurements (generally calibrated once per day). Calibration will be recorded on field calibration data sheets as included in Appendix AA.

5. The well will be uncapped from the upwind direction and a photo-ionization detector (PID) or flame-ionization detector (FID) will be used to record relative organic vapor concentrations upwind from the well, at the top of the casing and within the well casing. Procedures for use of the FID or PID will be consistent with the manufacturer's manual, which may vary slightly from model to model. The manual will be kept onsite at all times during equipment use.

6. Depth to water will be measured using an electronic interface probe. The probe will be lowered into the well until a contact with the water surface is indicated by an electronic signal.

7. The tape will be marked or held at the measuring point.

8. The electric tape will be checked to ensure that it has not been cut by a sharp casing edge after it is placed in and removed from the well.

9. The depth to water will be measured to an accuracy of 0.01 foot.

10. The probe will then be lowered below the groundwater and raised until the signal indicates that the probe is above the water table. The depth to water will be measured again as described in steps 7 through 9 above.

11. The groundwater elevation relative to mean sea level (MSL) will be determined by subtracting the depth to water from the surveyed top of casing elevation (measuring point). Measurements at each well will be taken at the marked survey point on the inner casing and will be repeated until two consecutive measurements are obtained that agree within ±0.02 foot. Water level measurements will be recorded on water level measurement forms (Appendix AA). Well identification, date, time, depth in feet to groundwater and remarks relevant to groundwater level measurements will be noted. Previous water level measurements for the well will be checked. If the difference between the current water level and the previous water level is greater than one foot, the water level will be remeasured.

12. The sample (pump intake) depth will be determined before sampling equipment is introduced into the well. In the wells in which the water level is above the top of the screen, the pump intake will be set at the middle of the screened interval. If the well is screened across the water table, the pump intake will be set at the mid-point between the groundwater level and the bottom of the well.

13. A field-decontaminated 2-inch diameter stainless steel submersible electrical sampling pump (Grunfos™ Redi-Flo II™ or equivalent) and dedicated 1/2-inch diameter Teflon™-lined tubing will be used to purge and sample the well. To minimize excessive mixing of the standing water column in the riser with the water in the screened interval and to minimize the disturbance of solids which may have settled on the bottom, the pump and tubing will be carefully and slowly lowered to the pre-determined installation depth.

14. Depth to water will be measured after the pump has been installed to evaluate the effect of water displacement. Prior to purging, a final depth-to-water measurement will be recorded. At the start of purging, the flow rate will be monitored until a rate between 0.1 and 0.5 liters per minute (Lpm) is obtained. The flow rate will be measured using a volume-calibrated container and a watch. The water level will be monitored periodically as a guide to flow rate adjustment. Efforts will be made to keep drawdown to less than 0.1 meters (0.328 feet) during purging. If this minimal drawdown cannot be sustained, the water level will be monitored until a constant drawdown is achieved.

15. If drawdown does not stabilize at the minimum purge rate of 0.1 Lpm, the pump will be shut down periodically during purging to allow the well to recharge so that the water level does not fall below the pump during purging.

16. After the drawdown has stabilized, HLA will measure specific conductivity, temperature, pH, reduction/oxidation (Redox) potential, dissolved oxygen (DO), and turbidity approximately every five minutes. Field measurements will be performed as described in Section A4.0 of the SAP.

17. Purging will continue until the following five parameters measured in the field have stabilized for three successive readings. Readings will be considered stabilized based on the following criteria set forth by EPA (*Groundwater Issue*, April 1996):

- Conductivity ± 3 percent
- pH ± 0.1 Standard Units

- Redox potential ± 10 millivolts,
- DO ± 10 percent
- Turbidity ± 10 percent

Temperature will be monitored but will not be used to establish stabilization.

18. Data on method and amount of water purged will be recorded on a groundwater sampling form (Appendix AA).

19. Water purged from the monitoring wells will be collected and stored at the site in properly labeled 55-gallon drums. The information specified on the drum label(s) will include, at a minimum, the date and well number(s) corresponding to the wells from which the water was removed. The water will be stored until final disposal arrangements are completed.

20. Sample collection will begin immediately after the five parameters noted above have stabilized.

21. During sample collection, the flow rate will remain the same as the established purge rate.

22. Except as noted in Step 24 and in Section A2.9, groundwater samples will be transferred directly from the pump discharge to the sample containers. VOC vials will be filled in a manner that minimizes head space or air bubbles. Samples for VOC analyses will be collected first. VOC sample vials will be filled to capacity and tightly capped to avoid retention of air bubbles. Remaining sample containers will be filled to approximately 90 percent of capacity. VOC sample containers will be preserved and filled according to EPA Region II CERCLA Quality Assurance Manual protocol (p. 31) as follows:

    - Collect three 40-milliliter vials of sample for VOC analysis.
    - Adjust the pH of one of the vials to less than 2 Standard Units by carefully adding 1:1 Hydrochloric acid (HCl) drop by drop to one of the filled 40-milliliter VOA vials. The number of drops of 1:1 HCl required will be recorded. The first vial may then be discarded.
    - Carefully add the same number of drops to the remaining two vials to be submitted for laboratory analysis. (The pH in the two vials for laboratory analysis should not be tested directly.)
    - Seal the vials.
    - The pH test is to be performed at each sampling location.
    - A fresh sample will be collected if an air bubble is detected in a VOC sample vial after sampling is complete.

23. Non-VOC samples will be placed into prepreserved laboratory-prepared sample bottles. A small portion of the sample will be poured from the filled sample bottle into a second clean container. The pH of the sample material in the second container will be tested in the field to confirm that it falls within the requirements of the QAPP. Additional preservative and sample material will be used to adjust the pH of the sample, if necessary.

24. Field-filtered samples will be obtained for analysis of metals where required. A 0.45-micron filter of compatible inert material will be used in filtering the samples. The filtering device will be either an in-line filter or pressure filter apparatus. The filtering apparatus currently planned for use on this project is the Gelman Sciences AquaPrep™ Flex Filter. The device uses a 10 mil PVC medical grade bag film with a Supor (inherently hydrophilic polysulfone)

membrane. The groundwater samples for field filtration will be transferred directly from the pump discharge line to the filter.

25. Preservation of samples to be analyzed for metals will be conducted after filtering. The filtered samples will be transferred directly from the filter apparatus to pre-preserved sample bottles. A small portion of the sample will then be poured out of the bottle for pH testing. If necessary, the pH of the sample will be adjusted by adding additional preservative.
26. Immediately after filling, samples will be placed in storage coolers on ice. Samples will be checked periodically with a thermometer to ensure preservation requirements are met. The temperature of the samples will also be recorded by the laboratory upon receipt.
27. Sample depth will be recorded, the groundwater sampling field data sheet will be completed and signed, and the chain-of-custody form will be signed.
28. The well cap will be closed and the well will be locked.

Quality assurance/quality control (QA/QC) samples are discussed in the QAPP (Appendix C).

AD2.7 Onsite VOC Analysis by Gas Chromatograph

Groundwater samples will be handled and analyzed onsite using a portable GC as described below.

1. Groundwater samples will be collected as described in steps 2 through 21 of Section AD2.6.
2. 20 mLs of groundwater will be collected in a 40-mL vial.
3. The sample will then be agitated (shaken) for 2 minutes.
4. A dedicated syringe will then be inserted into the vial and a measured volume of gas from the sample vial headspace will be collected for analysis using the GC. The GC utilized will be a PID equipped with an 10.6 electron volt lamp. The chromatographic column will be a 10-meter capillary column of fused silica coated with the adsorptive material. The inner diameter of the capillary column will be 0.021 inches (0.53 mm). Precolumn backflush will use a 9-meter analytical column and a 1-meter precolumn. Computing integrators will be used to plot the chromatogram for the detector analysis and to compute and record the area of the chromatographic peaks. The peak areas will be used to calculate concentrations for each of the compounds analyzed.

The field QC procedures will be performed as set forth in the QAPP addendum (Appendix CD).

AD2.8 Aquifer Slug Testing

Aquifer slug tests will be performed at select wells during the implementation of the RIWPA. One rising head test will be performed at the wells in which the water table intersects the screened interval. In wells in which the water level is above the top of the screened interval, a falling head and a rising head test will be performed. The tests will be conducted using a data logger and pressure transducers with chemically resistant cables. The data logger will be pre-programmed to collect incremental water level measurements using an approximately logarithmic time scale. Field decontamination procedures will be conducted as described in Section A2.4.2.2. The following procedures will be used during the slug tests:

1. Before beginning each test, the following information will be recorded:
   - Well internal diameter

- Location and elevation reference point from which water depth measurements are made
- Pre-test static water level (and elevation) of groundwater with respect to the reference point
- Date, time, and name(s) of personnel conducting test
- Well depth, screen depth and length, well radius, and depth, length, and radius of the gravel pack
- Volume or dimensions of slug
- Type of test (falling or rising head)
- Test number as recorded by the data logger
- Type of measuring device used

2. An initial depth-to-water measurement will be collected and recorded.
3. A decontaminated pressure transducer will be lowered into the well to a depth below the anticipated greatest depth of the slug. The water level will then be allowed to equilibrate.
4. The data logger will be initialized and set to the referenced water level
5. To initiate the falling head test, a decontaminated PVC or stainless steel slug will be completely introduced into the well as rapidly as possible while the data logger is started simultaneously. The slug will be of sufficient volume to displace a quantity of water that will require the well at least five minutes to equilibrate.
6. The falling head test will continue until the water level has returned to 90 percent of static.
7. Once the water level has returned to static, the rising head test can begin. The rising head test will be conducted by completely removing the slug from the well as rapidly as possible while simultaneously starting the data logger simultaneously started. The rising head test will continue until the water level returns to at least 90 percent of static.
8. The data will be downloaded directly from the datalogger to a portable computer in the field. The data will be used for analysis (using AQTESOLV®) of hydraulic conductivities using the Bower and Rice method.
9. If the data cannot be downloaded directly to a computer, the data will be printed in the field.

A field geologist or engineer will keep detailed notes for each test.

APPENDIX CD

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CD1 INTRODUCTION

This Addendum to the Quality Assurance Project Plan (QAPP, HLA 1994) has been prepared by Harding Lawson Associates (HLA) on behalf of Island Chemical Company, Inc. (ICC). This QAPP Addendum has been prepared as an Appendix to the EPA-approved Remedial Investigation Work Plan (RIWP). This Addendum to the QAPP will be included in the RIWP as Appendix CD. The RIWP Addendum (RIWPA) includes the following analytical activities which were not specified in the original EPA-approved RIWP, and therefore not included in the original QAPP:

- Onsite analysis of toluene, ethylbenzene and xylenes (TEX) in groundwater samples using a portable gas chromatograph (GC)
- Laboratory analysis of undisturbed soil samples for grain size, moisture, total organic carbon (TOC), and porosity
- Laboratory analysis for soil sample nutrient profiles including analysis of alkalinity, ammonia, iron, sulfate, sulfide, nitrate, nitrite, pH, and ortho-phosphorus.

Other procedures and quality assurance and quality control (QA/QC) protocols for activities planned during the implementation of the RIWP Addendum are discussed in the RIWP- Quality Assurance and Procedures Plan (QAPP, Appendix C).

CD2 Onsite Analysis Using the GC

Sample documentation will be consistent with that described the QAPP (Section 3.0), with the exception of a chain-of-custody form. The samples collected for onsite analysis will be logged in the field books, and analyzed immediately after collection. The following information will be recorded in the field book for each sample:

- Sample identification number
- Date and time of sample collection
- Sample location and depth
- Sampling techniques
- Sample type (media sampled)
- Container type

Onsite calibration and maintenance records of the onsite GC will be maintained by the field GC operator. These records will be filed onsite and may be subject to a QA audit. The onsite GC operator will maintain spare parts for equipment and will be capable of making minor repairs as needed.

Calibration records will be maintained as follows:

1. The GC operator will maintain a calibration record that will be kept with the GC at all times.
2. A label will be affixed to the GC showing description, manufacturer, model numbers, date of last calibration, calibrator's signature and due date of next calibration (where

applicable). Reports and compensation or correction figures will be maintained with the instrument.

3. Written step-wise calibration procedures will be available for each measurement instrument.

The calibration procedures for the field GC are described below (Source: Vironex Field Analytical Services):

1. GC operator will perform a two-point calibration using a 50-microgram per liter (μg/L) and a 500-μg/L standard of target compounds (TEX). The 50 μg/L standard is prepared by filling a 40 milliliter (mL) vial with 20 mLs of deionized water and adding 5 microliters (μL) of a 200 μg/mL standard solution of target compounds in methanol. The 500 μg/L standard is prepared by filling a 40 mL vial with 20 mLs of deionized water and adding 50 μL of a 200 μg/mL standard solution of the target compounds in methanol.
2. Agitate (shake) standards for 2 minutes prior to analysis.
3. Calculate the response factor (RF) for each target compound for each calibration concentration prior to analyzing site samples.
4. Determine the average RF for each target compound. The RF for each compound must be within 80-120 percent of the average RF from the initial calibration.
5. Determine percent relative standard deviation (%RSD) for each target compound (the %RSD may not exceed 20 percent).

The GC analysis QA/QC techniques and frequencies are summarized below:

- Analyze an instrument blank (as described in Section C6.3.2) at the start and end of each day.
- Analyze a method blank (as described in Section C6.3.2) at the beginning of each day and after any sample yielding high concentrations of one or more target compounds.
- Analyze one standard after every 10 samples.
- Analyze one duplicate sample for every 20 samples.
- Analyze target compound standards 1) at the start of each day, or 2) when the GC operating conditions have changed, or 3) when the GC column type is changed, or 4) when the RF of the daily mid-point calibration check is not within 85 percent to 115 percent of the average RF from the initial calibration.

The onsite analysis using the GC will be conducted in accordance with EPA Method 602 Modified. The method detection limits (MDLs) for the target compounds are as follows:

- Toluene 5 μg/L
- Ethylbenzene 5 μg/L
- Xylenes 5 μg/L

The GC that will be used to perform the onsite analyses can estimate concentrations lower than those listed above. If detected concentrations are below the given MDL, the result will be qualified to indicate that the concentration is estimated.

CD3 Laboratory Analytical Parameters and Methods

Approved laboratories will analyze co-located groundwater samples and perform several analyses on soil samples. Analytical parameters and methods for groundwater samples analyses are described in Section CD3.1. Analytical parameters and methods for soil sample analyses are identified in Section CD3.2.

CD3.1 Co-located Groundwater Samples

The co-located groundwater samples (split from groundwater samples analyzed onsite using the portable GC) will be submitted to a certified laboratory and analyzed for TCL VOCs as detailed in Section C5.0. Sample documentation, including a chain-of-custody form, will be performed in accordance with Section C3.0.

CD3.2 Soil Samples

Laboratory analytical parameters, methods, and method reporting limits to be used during the implementation of the RIWPA, which were not specified in Section C5.4, are as follows:

Soil

Analysis	Method	Reporting Limit
Nitrate	EPA Method 353.2	0.5 mg/kg
Nitrite	EPA Method 353.2	0.5 mg/kg
Sulfate	SW-846 Method 9036	100 mg/kg
Sulfide	SW-846 Method 9030	0.2 mg/kg
Iron (total)	EPA Method 6010	10 mg/kg
Alkalinity	EPA Method 310.1	10 mg/kg
Ammonia	EPA Method 350.2	2.5 mg/kg
Ortho Phosphorus	EPA Method 365.1	0.5 mg/kg
Total Organic Carbon	SW-846 Method 9060	100 mg/kg
Moisture	Standard Methods 209 F	Not Applicable
pH	SW-846 Method 9045 C Modified (M)	Not Applicable
Grain Size Analysis	ASTM D-422	Not Applicable
Porosity	By ASTM D-2216 and D-854	Not Applicable
HCU bacteria count	Standard Methods 9215C M	Not Applicable
Total plate bacteria count	Standard Methods 9215C M	Not Applicable

NOTES: mg/kg = milligrams per kilogram.

The listed reporting limits are subject to a slight change based on moisture content..

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Virgin Island Chemical Site
St. Croix, U.S. Virgin Islands

January 20, 1997

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Quality Assurance/Quality Control Reviewer

Jason M. Schindler, P.G.
Associate Hydrogeologist

This document was prepared for the sole use of the ICC and the regulatory agencies involved with the project, the only intended beneficiaries of our work. No other parties should rely on the information contained herein without the prior written consent of HLA.

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